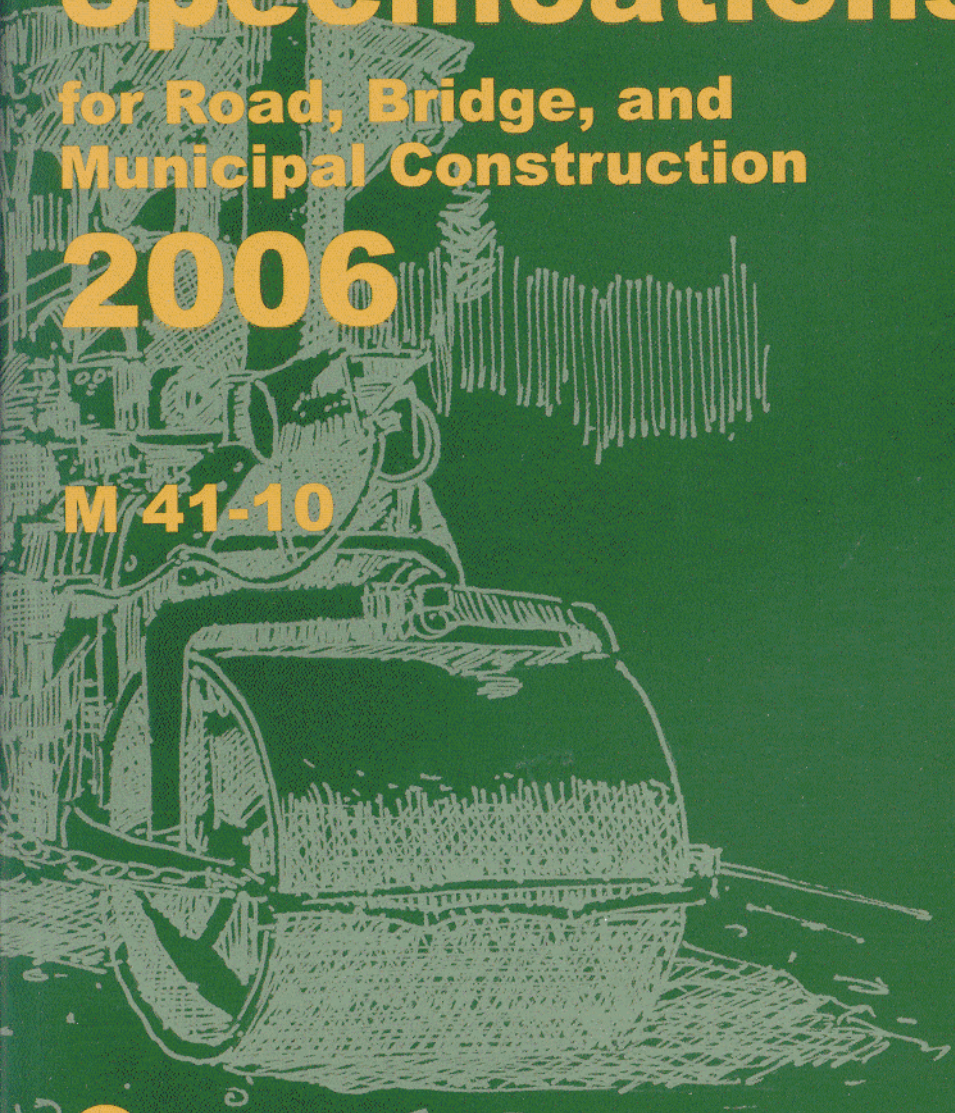
Standard Specifications

for Road, Bridge, and Municipal Construction

2006

M 41-10



Washington State
Department of Transportation

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FOREWORD

These Standard Specifications for Road, Bridge and Municipal Construction have been developed to serve as a baseline for the work that is delivered to the public by the Washington State Department of Transportation (WSDOT). The Standard Specifications are incorporated into the written agreement (Contract) between WSDOT as Contracting Agency and the Contractor except where the Contract indicates that a particular specification has been amended or replaced with a special provision to resolve a project specific issues. The decision to amend or replace any standard specification with a special provision is made during the design process and is based upon the sound engineering judgment of the project designer.

These Standard Specifications reflect years of refinement through the literally hundreds of projects that the Department delivers each year. In addition, the standards are the results of countless hours of development and review by both our internal WSDOT staff as well as our Industry partners through the Joint WSDOT/Associated General Contractors Standing Committees.

Finally, these standards reflect the contracting philosophy and balance of risk-sharing that the Department has adopted through the years. We believe that this balance of risks gives us the lowest final cost solution to our transportation needs. Shifting risk to the contractor can provide more certainty on final cost, while resulting in higher initial cost. On the other hand, accepting more risk by the owner can result in lower initial costs, but less certainty on final cost. We at the Department of Transportation believe that we have reached the optimum point of balance for risk, and will continue to consider this balance on all future specification revisions.

The language above indicates that these specifications are to be used only as a guideline during the design process and that is true. Once they have been incorporated into a contract, however, they become the legal and enforceable language of that contract. The Standard Specifications, along with the Amendments to the Standards and the Project Special Provisions in the contract documents, define a contract and are no longer seen as guidelines, but rather as the written agreement, subject to revision only through the change order process.

This preface is for informational purposes only and is not to be used to interpret or affect the terms of the Contract between WSDOT as Contracting Agency and the Contractor.

Kevin J. Dayton, P.E.
State Construction Engineer

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DIVISION 1
GENERAL REQUIREMENTS

1-01 DEFINITIONS AND TERMS

1-01.1 General

The following abbreviations and terms are defined here as they are used in any contract documents and specifications. When used in the proposal form to denote items of work and units of measurements, abbreviations are defined to mean the full expression.

1-01.2 Abbreviations

1-01.2(1) Associations and Miscellaneous

These abbreviations are used in plans and specifications as defined here:

AAA	American Arbitration Association
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AGA	American Gas Association
AGC	Associated General Contractors of America
AI	Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMS	Aerospace Material Specification
ANLA	American Nursery and Landscape Association
ANSI	American National Standards Institute
APA	American Plywood Association
API	American Petroleum Institute
APWA	American Public Works Association
ARA	American Railway Association
AREA	American Railway Engineering Association
ARTBA	American Road & Transportation Builders Association
ASA	American Standards Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
AWPA	American Wood Preservers' Association
AWS	American Welding Society
AWWA	American Water Works Association
CFR	Code of Federal Regulations
CLI	Chain Link Institute
CRAB	County Road Administration Board

CRSI	Concrete Reinforcing Steel Institute
DIPRA	Ductile Iron Pipe Research Association
EEI	Edison Electric Institute
EPA	Environmental Protection Agency
ESAL	Equivalent Single Axle Loads
FHWA	Federal Highway Administration
FOP	Field Operating Procedure
FSS	Federal Specifications and Standards, General Services Administration
HUD	United States Department of Housing and Urban Development
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
IES	Illumination Engineering Society
IMSA	International Municipal Signal Association
LID	Local Improvement District
LPI	Lighting Protection Institute
MSHA	Mine Safety and Health Act
MUTCD	Manual on Uniform Traffic Control Devices
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
NRMCA	National Ready Mix Concrete Association
OMWBE	Office of Minority and Women's Business Enterprises
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PPI	Plastic Pipe Institute
P/PCI	Precast/Prestressed Concrete Institute
QPL	Qualified Products List
RAM	Request for Approval of Material
RCW	Revised Code of Washington (Laws of the State)
RID	Road Improvement District
SAE	Society of Automotive Engineers
SEPA	State Environmental Policy Act
SOP	Standard Operating Procedure
SSPC	Steel Structures Painting Council
TIB	Transportation Improvement Board
UL	Underwriter Laboratory
ULID	Utility Local Improvement District

UMTA	Urban Mass Transit Administration
WAC	Washington Administrative Code
WAQTC	Western Alliance for Quality Transportation Construction
WCLIB	West Coast Lumber Inspection Bureau
WISHA	Washington Industrial Safety and Health Administration
WRI	Wire Reinforcement Institute
WSDOE	Washington State Department of Ecology
WSDOT	Washington State Department of Transportation
WWPA	Western Wood Products Association

1-01.2(2) Items of Work and Units of Measurement

Plans and specifications may include common engineering and construction abbreviations. Many such abbreviations need no definition. But when the following abbreviations are used, they will only mean:

Agg.	Aggregate
Al.	Aluminum
ATB	Asphalt Treated Base
BST	Bituminous Surface Treatment
Cl.	Class
Cfm	Cubic Feet per Minute
Cfs	Cubic Feet per Second
Comb.	Combination
Conc.	Concrete
CPF	Composite Pay Factor
Crib.	Cribbing
Culv.	Culvert
cy or cu yd.	Cubic Yard
Diam.	Diameter
ESAL	Equivalent Single Axle Loads
Est.	Estimate or Estimated
Excl.	Excluding
F	Fahrenheit
Gph	Gallon per Hour
Gpm	Gallon per Minute
Hund.	Hundred
HMA	Hot Mix Asphalt
In.	Inch
Incl.	Including
JMCIF	Job Mix Compliance Incentive Factor
JMF	Job Mix Formula
Lb	Pound(s)
LF or Lin. Ft.	Linear Foot (Feet)
LS	Lump Sum

M	Thousand
MBM	Thousand Feet Board Measure
MUTS	Minimum Ultimate Tensile Strength
PCPS	Precast Prestressed
Pres.	Pressure
PSI	Pounds per Square Inch
PVC	Polyvinyl Chloride
RAP	Recycled Asphalt Pavement
Reg.	Regulator
Reinf.	Reinforced, Reinforcing
Sec.	Section
St.	Steel
Str.	Structural
sy or sq. yd.	Square Yard(s)
Th.	Thick or Thickness
Tr.	Treatment
Va	Air Voids
VC	Vitrified Clay
VFA	Voids Filled with Asphalt
VMA	Voids in Mineral Aggregate

1-01.3 Definitions

Addendum

A written or graphic document, issued to all bidders and identified as an addendum prior to bid opening, which modifies or supplements the bid documents and becomes a part of the contract.

Auxiliary Lane

The part of the roadway next to traveled ways for parking, speed changes, turning, weaving, truck climbing or for anything that adds to through traffic movement.

Award

The formal decision of the Contracting Agency to accept the lowest responsible and responsive bidder for the work.

Bid, Proposal

The offer of a bidder on a properly completed proposal form to perform the contract.

Bidder

An individual, partnership, firm, corporation, or joint venture, submitting a proposal or bid. When required by law or otherwise the individual, partnership, firm, corporation, or joint venture shall be prequalified.

Bid Documents

The component parts of the proposed contract which may include, but are not limited to, the proposal form, the proposed contract provisions, the proposed contract plans, addenda, and subsurface boring logs (if any).

Bridge Approach Embankments

An embankment beneath a structure and extending 100 feet beyond a structure's end (at subgrade elevation for the full embankment width) plus an access ramp on a 10:1 slope to the original ground elevation. Also, any embankment that replaces unsuitable foundation soil beneath the bridge approach embankment.

Call for Bids (Advertisement for Bids)

The published public notice soliciting proposals or bids for work stating, among other things, the time, place, and date for receiving and opening the bids.

Commission, Washington State Transportation Commission

The appointive body having authority over state transportation matters as provided by law.

Completion Dates

Substantial Completion Date is the day the Engineer determines the Contracting Agency has full and unrestricted use and benefit of the facilities, both from the operational and safety standpoint, and only minor incidental work, replacement of temporary substitute facilities, or correction or repair remains for the physical completion of the total contract.

Physical Completion Date is the day all of the work is physically completed on the project. All documentation required by the contract and required by law does not necessarily need to be furnished by the Contractor by this date.

Completion Date is the day all the work specified in the contract is completed and all the obligations of the Contractor under the contract are fulfilled by the Contractor. All documentation required by the contract and required by law must be furnished by the Contractor before establishment of this date.

Contract

The written agreement between the Contracting Agency and the Contractor. It describes, among other things:

1. What work will be done, and by when;
2. Who provides labor and materials; and
3. How Contractors will be paid.

The contract includes the contract (agreement) form, bidder's completed proposal form, contract provisions, contract plans, standard specifications, standard plans, addenda, various certifications and affidavits, supplemental agreements, change orders, and subsurface boring logs (if any).

Contract Bond

The approved form of security furnished by the Contractor and the Contractor's surety as required by the contract, that guarantees performance of all the work required by the contract and payment to anyone who provides supplies or labor for the performance of the work.

Contract Form (Agreement Form)

The form provided by the Contracting Agency that requires the authorized signatures of the Contractor and the Contracting Agency to result in formal execution of the contract.

Contracting Agency

Agency of Government that is responsible for the execution and administration of the contract.

Contractor

The individual, partnership, firm, corporation, or joint venture, contracting with the Contracting Agency to do prescribed work.

Contract Plans

A publication addressing the work required for an individual project. At the time of the call for bids, the contract plans may include, but are not limited to, the following: a vicinity map, a summary of quantities, structure notes, signing information, traffic control plans, and detailed drawings; all for a specific individual project. At the time of the contract execution date, the contract plans include any addenda.

Contract Provisions

A publication addressing the work required for an individual project. At the time of the call for bids, the contract provisions may include, for a specific individual project, the amendments to the standard specifications, the special provisions, a listing of the applicable standard plans, the prevailing minimum hourly wage rates, and an informational proposal form with the listing of bid items. The proposed contract provisions may also include, for a specific individual project, the Required Contract Provisions Federal-aid Construction Contracts, and various required certifications or declarations. At the time of the contract execution date, the contract provisions include the proposed contract provisions and include any addenda, a copy of the contract form, and a copy of the proposal form with the contract prices and extensions.

Department, Department of Transportation

The State Agency authorized by law to administer transportation-related work.

Engineer

The Contracting Agency's representative who administers the construction program for the Contracting Agency.

Federal Highway Administration

The Federal Agency authorized to approve plans and contracts for Federal-Aid Highway projects. They also inspect such projects to ensure contract compliance.

Frontage Road

A local street or road usually next to an arterial highway that serves abutting property and adjacent areas and controls access.

Highway

A public way for vehicles, including the entire right of way.

Inspector

The Project Engineer's representative who inspects contract performance in detail.

Laboratory

The laboratories of the Contracting Agency, or other laboratories the Contracting Agency authorizes to test work, soils, and materials.

Plans

The contract plans or standard plans which show location, character, and dimensions of prescribed work including layouts, profiles, cross-sections, and other details.

Project Engineer

The Engineer's representative who directly supervises the engineering and administration of a construction project.

Proposal Form

The form provided to bidders by the Contracting Agency for submittal of a proposal or bid to the Contracting Agency for a specific project. The form includes the item number, estimated plan quantity, and item description of the bid items along with blank spaces to be completed by the bidder for the unit prices, extensions, the total bid amount, signatures, date, acknowledgment of addenda, and the bidder's address. The required certifications and declarations are part of the form.

Right of Way

Land, property, or property interest, usually in a strip, acquired for or devoted to transportation purposes.

Roadbed

The graded part of the roadway within top and side slopes, prepared as a foundation for the pavement structure and shoulders.

Roadway

The portion of the right of way within the outside limits of the side slopes.

Secretary, Secretary of Transportation

The chief executive officer of the Department and other authorized representatives.

Shoulder

The part of the roadway next to the traveled way or auxiliary lanes. It provides lateral support of base and surface courses and is an emergency stopping area for vehicles.

Special Provisions

Supplemental specifications and modifications to the standard specifications and the amendments to the standard specifications that apply to an individual project.

Specifications

Provisions and requirements for the prescribed work.

Standard Plans

A manual of specific plans or drawings adopted by the Contracting Agency which show frequently recurring components of work that have been standardized for use.

State

The state of Washington acting through its representatives.

Structures

Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, endwalls, buildings, service pipes, sewers, underdrains, foundation drains, and other features found during work that the contract may or may not classify as a structure.

Subcontractor

An individual, partnership, firm, corporation, or joint venture who is sublet part of the contract by the Contractor.

Subgrade

The top surface of the roadbed on which subbase, base, surfacing, pavement, or layers of similar materials are placed.

Substructure

The part of the structure *below*:

1. The bottom of the grout pad for the simple and continuous span bearing, or
2. The bottom of the girder or bottom slab soffit, or
3. Arch skewbacks and construction joints at the top of vertical abutment members or rigid frame piers.

Substructures include endwalls, wingwalls, barrier and railing attached to the wingwalls, and cantilever barriers and railings.

Superstructure

The part of the structure *above*:

1. The bottom of the grout pad for the simple and continuous span bearing, or
2. The bottom of the girder or bottom slab soffit, or
3. Arch skewbacks and construction joints at the top of vertical abutment members or rigid frame piers.

and extending:

1. from the back of pavement seat to the back of pavement seat when the endwalls are attached to the superstructure, or
2. from the expansion joint at the end pier to the expansion joint at the other end pier when the endwalls are not attached to the superstructure.

Superstructures include, but are not limited to, girders, slab, barrier, and railing attached to the superstructure.

Superstructures do not include endwalls, wingwalls, barrier and railing attached to the wingwalls, and cantilever barriers and railings unless supported by the superstructure.

Surety

A company that is bound with the Contractor to ensure performance of the contract, payment of all obligations pertaining to the work, and fulfillment of such other conditions as are specified in the contract, contract bond, or otherwise required by law.

Titles (or Headings)

The titles or headings of the sections and subsections herein are intended for convenience of reference and shall not be considered as having any bearing on their interpretation.

Traveled Way

That part of the roadway made for vehicle travel excluding shoulders and auxiliary lanes.

Work

The provision of all labor, materials, tools, equipment, and everything needed to successfully complete a project according to the contract.

Working Drawings

Shop drawings, shop plans, erection plans, falsework plans, framework plans, cofferdam, cribbing and shoring plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data, including a schedule of submittal dates for working drawings where specified, which the Contractor must submit to the Engineer for approval.

1-02 BID PROCEDURES AND CONDITIONS

1-02.1 Prequalification of Bidders

The Contracting Agency will provide a bid proposal form only after a prospective bidder submits a "Standard Questionnaire and Financial Statement." This questionnaire enables the Contracting Agency to decide whether or not the bidder is qualified to perform highway, road, or other public work. The questionnaire shall be sworn to before a person authorized to take oaths.

On the basis of this questionnaire, the Contracting Agency will either specify the type and amount of work it considers the prospective bidder prequalified to perform or advise the prospective bidder of the reasons they failed to be prequalified. To remain prequalified, the bidder must submit an updated questionnaire once a year and supplements whenever required by the Contracting Agency.

A submittal deadline applies to any prospective bidder not prequalified or from whom a supplemental questionnaire is due. To receive consideration for issuance of a bid proposal form on a specific project, the questionnaire (or supplement) must be received by the Prequalification Engineer no less than 15 days prior to the scheduled bid opening.

The Contracting Agency may withdraw a bidder's prequalification or reduce its amount if:

1. The extent of other work the bidder has under contract (Contracting Agency or otherwise) justifies such action, or
2. Past or present work on a Contracting Agency contract has been less than satisfactory.

If a bidder's questionnaire does not contain sufficient information, the Contracting Agency may refuse to provide a bid proposal form and disregard any bid submitted. After opening bids, the Contracting Agency may decide that a prequalified bidder is not responsible and may refuse to accept the bid on that basis. Such a refusal will be conclusive unless the bidder appeals within five days to the Superior Court of Thurston County. Any appeal shall be heard within ten days after it is filed and shall provide at least five days' notice to the Contracting Agency.

The bidder shall ensure that the combination of the bid amount and other contract work with the Contracting Agency does not exceed the prequalification amount. If this combination does exceed the prequalification amount, the Contracting Agency may determine the bidder to be not responsible and refuse to award a contract.

Two or more prospective bidders may, in a joint venture, prequalify and bid jointly on a single contract. Each shall have filed a "Standard Questionnaire and Financial Statement." Together they shall also file a standard form of "Individual Project Statement of Joint Venture" and a joint venture agreement in a form acceptable to the Contracting Agency.

To bid jointly on a continuous joint venture on more than one contract, two or more prospective bidders shall submit:

1. A "Standard Questionnaire and Financial Statement" compiled for the joint venture;
2. A "Standard Questionnaire and Financial Statement" for each member (if the Contracting Agency has no copy on file); and
3. A copy of the "Joint Venture Agreement" signed by each member of the joint venture and naming each person authorized to sign documents on its behalf.

(If any member is a corporation, a corporate resolution shall accompany the agreement. This resolution shall authorize the joint venture agreement and name the officer(s) authorized to sign the joint venture agreement or contract on behalf of the corporation.)

The Contracting Agency will treat the continuing joint venture as a new firm and decide its prequalification on that basis.

Any joint venture and each of its members is subject to Section 1-02.14.

1-02.2 Plans and Specifications

The Contracting Agency will place review copies of the plans and specifications on file in the offices of:

1. All Regional Administrators of the Department,
2. The County Engineer of the county in which the work is located, and
3. These plans service offices of the Associated General Contractors of America: Seattle, Spokane, and Tacoma, Washington.

Prospective bidders may purchase plans and specifications from the Department of Transportation in Olympia, Washington, for the fee given in the call for bids. The fee shall accompany each request for plans. Checks shall be payable to the State of Washington, Department of Transportation.

After award of the contract, the plans and specifications will be issued without charge on the following basis:

To Prime Contractor	No. of Sets	Basis of Distribution
Reduced plans (11”x 17”) and special provisions	10	Furnished automatically upon award.
Additional reduced plans (11” x 17”) and special provisions	10	Furnished only upon request for projects with more than 100 plan sheets.
Large plans (22” x 34”) and special provisions	1	Furnished only upon request.
Additional large plans (22” x 34”) and special provisions	1	Furnished only upon request for projects with more than 100 plan sheets.

To Subcontractors and Suppliers	No. of Sets	Basis of Distribution
Reduced plans (11”x 17”) and accompanying special provisions	1	Furnished only upon request by the Prime Contractor for an approved subcontractor or material supplier.

Additional plans may be purchased by payment of the current rates.

1-02.3 Estimated Quantities

The quantities shown in the proposal form and the contract forms are estimates and are stated only for bid comparison purposes. The Contracting Agency does not warrant expressly or by implication, that the actual quantities of work will correspond with those estimates. Payment will be made on the basis of the actual quantities of each item of work completed in accordance with the contract requirements.

1-02.4 Examination of Plans, Specifications, and Site of Work

1-02.4(1) General

The bidder shall carefully examine the bid documents as defined in Section 1-01.3. Submittal of a bid shall be conclusive evidence that the bidder has made these examinations and understands all requirements for the performance of the completed work. The bidder further warrants, agrees, and acknowledges by submitting a bid that it:

1. Has taken steps reasonably necessary to ascertain the nature and location of the work;
2. Has investigated and satisfied itself as to the general and local conditions which can affect the work or its cost, including but not limited to:
   a. conditions bearing upon acquisition, transportation, disposal, handling, and storage of materials;
   b. the availability of labor, materials, water, electric power, and roads;
   c. uncertainties of weather, river stages, tides, or similar physical conditions at the site;
   d. the conformation and condition of the ground;
   e. the character of equipment and facilities needed preliminary to and during work performance; and
   f. the site biological hazards and associated physical hazards.
3. Has satisfied itself as to the character, quality, and quantity of surface and subsurface materials or obstacles to be encountered insofar as this information is reasonably ascertainable from an inspection of the work site (including material sites) as well as from the bid documents and other information made a part of this contract; and
4. Has satisfied itself as to the adequacy of time allowed for the completion of the physical work on the contract.

Any failure of the bidder to take the actions described and acknowledged in this clause shall not relieve the bidder from responsibility for estimating properly the difficulty and cost of successfully performing the work, or from proceeding to successfully perform the work without additional expense to the Contracting Agency.

The bidder agrees that the Contracting Agency shall not be liable to it on any claim for additional payment or additional time or any claim whatsoever if the claim directly or indirectly results from the bidder's failure to investigate and familiarize itself sufficiently with the conditions under which the contract is to be performed.

The bidder shall be familiar and comply with all Federal, State, tribal, and local laws, ordinances, and regulations which might affect those engaged in the work. The Contracting Agency will not consider any plea of misunderstanding or ignorance of such requirements.

Bid prices shall reflect what the bidder anticipates to be the cost of completing the work, including methods, materials, labor, and equipment. Except as the contract may provide, the bidder shall receive no payment for any costs that exceed those in the bid prices.

Prospective bidders are advised that projects with work on or adjacent to water may require insurance coverage in compliance with:

1. The Longshoremen's and Harbor Worker's Compensation Act (administered by U.S. Department of Labor), or
2. The State Industrial Insurance (administrated by the Washington State Department of Labor and Industries), or
3. Both.

The Contractor shall bear all cost for such insurance as provided in Section 1-07.10.

No Claim shall be allowed because of any ambiguity in the contract if:

1. The bidder discovers an ambiguity but fails to notify the Contracting Agency; or
2. The bidder failed to discover a patent ambiguity that would be discovered by a reasonably prudent contractor in preparing its bid.

Any prospective bidder desiring an explanation or interpretation of the bid documents, must request the explanation or interpretation in writing soon enough to allow a written reply to reach all prospective bidders before the submission of their bids. Oral explanations, interpretations, or instructions given by anyone before the award of a contract will not be binding on the Contracting Agency. Any information given a prospective bidder concerning any of the bid documents will be furnished to all prospective bidders as an addendum if that information is deemed by the Contracting Agency to be necessary in submitting bids or if the Contracting Agency concludes that the lack of the information would be prejudicial to other prospective bidders.

1-02.4(2) Subsurface Information

If the Contracting Agency has made subsurface investigation of the site of the proposed work, the boring log data and soil sample test data accumulated by the Contracting Agency will be made available for inspection by the bidders. The boring logs shall be considered as part of the contract. However, the Contracting Agency makes no representation or warranty expressed or implied that:

1. The bidders' interpretations from the boring logs are correct;
2. Moisture conditions and indicated water tables will not vary from those found at the time the borings were made; and
3. The ground at the location of the borings has not been physically disturbed or altered after the boring was made.

The Contracting Agency specifically makes no representations, guarantees, or warranties as to the condition, materials, or proportions of the materials between the specific borings regardless of any subsurface information the Contracting Agency may make available to the prospective bidders.

The availability of subsurface information from the Contracting Agency shall not relieve the bidder or the Contractor from any risks or of any duty to make examinations and investigations as required by Section 1-02.4(1) or any other responsibility under the contract or as may be required by law.

1-02.5 Proposal Forms

At the request of a prequalified bidder, the Contracting Agency will provide a proposal form for any project on which the bidder is eligible to bid.

The proposal form will identify the project and its location and describe the work. It will also list estimated quantities, units of measurement, the items of work, and the materials to be furnished at the unit bid prices. The bidder shall complete spaces on the proposal form that call for unit prices, extensions, the total bid amount, signatures, date, acknowledgment of addenda, and the bidder's address. The required certifications are included as part of the proposal form.

1-02.6 Preparation of Proposal

The Contracting Agency will accept only those proposals properly executed on forms it provides. Unless it approves in writing, the Contracting Agency will not accept proposals on forms attached to the Plans and stamped "Informational".

All prices shall be in legible figures (not words) written in ink or typed. The proposal shall include:

1. A unit price for each item (omitting digits more than four places to the right of the decimal point),
2. An extension for each unit price (omitting digits more than two places to the right of the decimal point), and
3. The total contract price (the sum of all extensions).

In the space provided on the signature sheet, the bidder shall confirm that all addenda has been received.

The bidder shall submit a completed "Disadvantaged, Minority or Women's Business Enterprise Certification" if it applies.

The bidder shall submit with the bid a list of:

1. Subcontractors who will perform the work of heating, ventilation and air conditioning, plumbing as described in Chapter 18.106 RCW and electrical as described in Chapter 19.28 RCW, and
2. The work those subcontractors will perform on the contract.
3. Shall not list more than one subcontractor for each category of work identified, except, when subcontractors vary with bid alternates, in which case the bidder shall identify which subcontractor will be used for which alternate.

If no subcontractor is listed, the bidder acknowledges that it does not intend to use any subcontractor to perform those items of work.

Proposals of corporations shall be signed by the officer or officers having authority to sign them. If a bidder is a copartnership, the proposal shall be signed by an authorized member of the copartnership. When the bidder is a joint venture, the proposal shall be signed by one or more individuals as authorized by the Joint Venture.

1-02.7 Bid Deposit

A deposit of at least 5 percent of the total bid shall accompany each bid. This deposit may be by cash, certified check, cashier's check, or a proposal bond (surety bond). Any proposal bond shall be on a form acceptable to the Contracting Agency and shall be signed by the bidder and the surety. A proposal bond shall not be conditioned in any way to modify the minimum 5 percent required. The surety shall: (1) be registered with the Washington State Insurance Commissioner, and (2) appear on the current Authorized Insurance List in the State of Washington published by the Office of the Insurance Commissioner.

The failure to furnish a bid deposit of a minimum of 5 percent shall make the bid nonresponsive and shall cause the bid to be rejected by the Contracting Agency.

1-02.8 Noncollusion Declaration and Lobbying Certification

1-02.8(1) Noncollusion Declaration

When required by Section 112(c) Title 23, United States Code, a declaration shall be provided certifying that the bidder has not taken part in collusion or other action that would restrain competitive bidding.

The Code of Federal Regulations 23 CFR 635.112(f)(1) requires that: "Each bidder shall file a sworn or unsworn statement executed by, or on behalf of the person, firm, association, or corporation submitting the bid, certifying that such persons, firm, association, or corporation has not either directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with the submitted bid. Failure to submit the sworn or unsworn statement as part of the bid proposal package will make the bid nonresponsive and not eligible for award consideration." In addition, 23 CFR 635.112(f)(1) requires that the Contracting Agency provide the form for the declaration to prospective bidders and that the declaration shall be executed by such persons, firm, association, or corporation under penalty of perjury under the laws of the United States.

Therefore, by signing the proposal, the bidder will be deemed to have signed and agreed to the requirements of the Noncollusion Declaration.

1-02.8(2) Lobbying Certification

Section 319 of Public Law 101-121 prohibits payment of Federal Funds for contract lobbying by the Contractor and any subcontractor or lower tier subcontractor whose contract exceeds $100,000. A Certification for Federal-Aid Contracts (Form DOT 272-040) is provided in the proposal form for contracts exceeding $100,000 to address this requirement.

By signing the proposal, the bidder will be deemed to have signed and agreed to the conditions and requirements of the Certification for Federal-Aid Contracts.

The Contractor shall ensure that a Certification for Federal-Aid Contracts (Form DOT 272-040) is included in every contract with any subcontractor or lower tier subcontractor whose contract exceeds $100,000. By signing the contract any subcontractor or lower tier subcontractor will be deemed to have signed and agreed to the conditions and requirements of the Certification for Federal-Aid Contracts. The Contractor shall keep evidence in their files that such subcontractor or lower tier subcontractor has committed to this requirement.

Section 319 of Public Law 101-121 also provides that, if any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the Contractor shall complete and submit to the Contracting Agency the Standard Form LLL, DISCLOSURE OF LOBBYING ACTIVITIES, in accordance with the instructions on the form. Any subcontractor or lower tier subcontractor whose contract exceeds $100,000 shall disclose in the same manner as the Contractor, except that, Standard Form LLL shall be submitted to the Contractor for processing to the Contracting Agency.

Audits will be conducted to ensure compliance with this section.

The Certification for Federal-Aid Contracts (Form DOT 272-040) may be reproduced from the proposal form. The disclosure form is available from the Washington State Department of Transportation's Pre-Contract Office, Transportation Building, Olympia, Washington 98504.

1-02.9 Delivery of Proposal

Each proposal shall be sealed and submitted in the envelope provided with it. The bidder shall fill in all blanks on this envelope to ensure proper handling and delivery.

The Contracting Agency will not consider proposals it receives after the time fixed for opening bids in the call for bids.

1-02.10 Withdrawal or Revision of Proposal

After submitting a bid proposal to the Contracting Agency, the bidder may withdraw or revise it if:

1. The bidder submits a written request signed by an authorized person, and
2. The Contracting Agency receives the request before the time for opening bids.

The original bid proposal may be revised and resubmitted as the official bid proposal if the Contracting Agency receives it before the time for opening bids.

1-02.11 Combination and Multiple Proposals

A project may be organized for bidding and construction by various methods to enable proposals to be submitted for combined projects or for the construction method specified. The Contracting Agency reserves the right to award combined or separate bids or by such other method deemed most advantageous to the Contracting Agency. Only those combined bids specifically prescribed in the project special provisions will be accepted. If contracts are awarded for combinations of projects, separate contracts will be written for each project included in the combination.

A bidder submitting more than one proposal at a letting may attach one of the following statements to each proposal:

"We prefer to be awarded not more than (Number) contracts for projects for which we have submitted bids at this letting;" or

"We prefer to be awarded contracts of a total value of not more than $____ for projects for which we have submitted bids at this letting."

Such attachments will not make the proposals irregular. The Contracting Agency will award each contract to the lowest responsible bidder but will consider such attachment in determining the responsibility of the bidder to perform each contract for which a statement has been attached.

1-02.12 Public Opening of Proposals

Proposals will be opened and publicly read at the time indicated in the call for bids unless the bid opening has been delayed or canceled. Bidders, their authorized agents, and other interested parties are invited to be present.

1-02.13 Irregular Proposals

1. A proposal will be considered irregular and will be rejected if:
   a. The bidder is not prequalified;
   b. The authorized proposal form furnished by the Contracting Agency is not used or is altered;
   c. The completed proposal form contains any unauthorized additions, deletions, alternate bids, or conditions;
   d. The bidder adds provisions reserving the right to reject or accept the award, or enter into the contract;
   e. A price per unit cannot be determined from the bid proposal;
   f. The proposal form is not properly executed;
   g. The bidder fails to submit or properly complete a subcontractor list, if applicable, as required in Section 1-02.6.
   h. The bidder fails to submit or properly complete a Disadvantaged, Minority or Women's Business Enterprise Certification, if applicable, as required in Section 1-02.6; or
   i. The bid proposal does not constitute a definite and unqualified offer to meet the material terms of the bid invitation.
2. A proposal may be considered irregular and may be rejected if:
   a. The proposal does not include a unit price for every bid item;
   b. Any of the unit prices are excessively unbalanced (either above or below the amount of a reasonable bid) to the potential detriment of the Contracting Agency;
   c. Receipt of addenda is not acknowledged;
   d. A member of a joint venture or partnership and the joint venture or partnership submit proposals for the same project (in such an instance, both bids may be rejected); or
   e. If proposal form entries are not made in ink.

1-02.14 Disqualification of Bidders

A bidder may be deemed not responsible and the proposal rejected if:

1. More than one proposal is submitted for the same project from a bidder under the same or different names;
2. Evidence of collusion exists with any other bidder. Participants in collusion will be restricted from submitting further bids;
3. A bidder is not prequalified for the work or to the full extent of the bid;
4. An unsatisfactory performance record exists based on past or current Contracting Agency work;
5. There is uncompleted work (Contracting Agency or otherwise) which might hinder or prevent the prompt completion of the work bid upon;

6. The bidder failed to settle bills for labor or materials on past or current contracts;
7. The bidder has failed to complete a written public contract or has been convicted of a crime arising from a previous public contract;
8. The bidder is unable, financially or otherwise, to perform the work;
9. A bidder is not authorized to do business in the state of Washington; or
10. There are any other reasons deemed proper by the Contracting Agency.

1-02.15 Pre-Award Information

Before awarding any contract, the Contracting Agency may require one or more of these items or actions of the apparent lowest responsible bidder:

1. A complete statement of the origin, composition, and manufacture of any or all materials to be used,
2. Samples of these materials for quality and fitness tests,
3. A progress schedule (in a form the Contracting Agency requires) showing the order of and time required for the various phases of the work,
4. A breakdown of costs assigned to any bid item,
5. Attendance at a conference with the Engineer or representatives of the Engineer, or
6. Any other information or action taken that is deemed necessary to ensure that the bidder is the lowest responsible bidder.

1-03 AWARD AND EXECUTION OF CONTRACT

1-03.1 Consideration of Bids

After opening and reading proposals, the Contracting Agency will check them for correctness of extensions of the prices per unit and the total price. If a discrepancy exists between the price per unit and the extended amount of any bid item, the price per unit will control. The total of extensions, corrected where necessary, will be used by the Contracting Agency for award purposes and to fix the amount of the contract bond.

The right is reserved by the Contracting Agency to waive informalities in the bidding, accept a proposal of the lowest responsible bidder, reject any or all bids, republish the call for bids, revise or cancel the work, or require the work to be done in another way if the best interest of the Contracting Agency is served.

A bidder who wishes to claim error after the bids have been publicly opened and read as required by RCW 47.28.090 shall promptly notify the Contracting Agency that an error occurred. The bidder shall submit a notarized affidavit or declaration under penalty of perjury signed by the bidder and accompanied by the work sheets used in the preparation of the bid, requesting relief from the responsibilities of award. The affidavit or declaration shall describe the specific error(s) and certify that the work sheets are the ones used in preparing the bid.

The affidavit or declaration shall be submitted no later than 5:00 p.m. on the first business day after bid opening or the claim will not be considered. The Contracting Agency will review the affidavit or declaration and the certified work sheets to determine the validity of the claimed error and if the error is of the kind for which the law allows relief from forfeiture of the bid deposit. If the Contracting Agency concurs in the claim of error and determines that the error is of the kind which allows relief from forfeiture, the bidder will be relieved of responsibility and the bid deposit of the bidder will be returned. If the Contracting Agency does not concur in the error or determines that the error is not the kind for which the law allows relief, the Contracting Agency may award the contract and if the bidder refuses to execute the contract, the bidder's bid deposit shall be forfeited as required by RCW 47.28.100.

1-03.2 Award of Contract

Normally, contract award or bid rejection will occur within 45 calendar days after bid opening. If the lowest responsible bidder and the Contracting Agency agree, this deadline may be extended. If they cannot agree on an extension by the 45 calendar day deadline, the Contracting Agency reserves the right to award the contract to the next lowest responsible bidder or reject all bids. The Contracting Agency will notify the successful bidder of the contract award in writing.

1-03.3 Execution of Contract

Within 20 calendar days after the award date, the successful bidder shall return the signed Contracting Agency-prepared contract, an insurance certification as required by Section 1-07.18, and a satisfactory bond as required by law and Section 1-03.4. Before execution of the contract by the Contracting Agency, the successful bidder shall provide any pre-award information the Contracting Agency may require under Section 1-02.15.

Until the Contracting Agency executes a contract, no proposal shall bind the Contracting Agency nor shall any work begin within the project limits or within Contracting Agency-furnished sites. The Contractor shall bear all risks for any work begun outside such areas and for any materials ordered before the contract is executed by the Contracting Agency.

If the bidder experiences circumstances beyond their control that prevents return of the contract documents within 20 calendar days after the award date, the Contracting Agency may grant up to a maximum of 20 additional calendar days for return of the documents, provided the Contracting Agency deems the circumstances warrant it.

1-03.4 Contract Bond

The successful bidder shall provide an executed contract bond for the full contract amount. This contract bond shall:

1. Be on a Contracting Agency-furnished form;
2. Be signed by an approved surety (or sureties) that:
   a. Is registered with the Washington State Insurance Commissioner, and
   b. Appears on the current Authorized Insurance List in the State of Washington published by the Office of the Insurance Commissioner,
3. Be conditioned upon the faithful performance of the contract by the Contractor within the prescribed time; and
4. Guarantee that the surety shall indemnify, defend, and protect the Contracting Agency against any claim of direct or indirect loss resulting from the failure:
   a. Of the Contractor (or any of the employees, subcontractors, or lower tier subcontractors of the Contractor) to faithfully perform the contract, or
   b. Of the Contractor (or the subcontractors or lower tier subcontractors of the Contractor) to pay all laborers, mechanics, subcontractors, lower tier subcontractors, materialperson, or any other person who provides supplies or provisions for carrying out the work.

The Contracting Agency may require sureties or surety companies on the contract bond to appear and qualify themselves. Whenever the Contracting Agency deems the surety or sureties to be inadequate, it may, upon written demand, require the Contractor to furnish additional surety to cover any remaining work. Until the added surety is furnished, payments on the contract will stop.

1-03.5 Failure to Execute Contract

Failure to return the insurance certification and bond with the signed contract as required in Section 1-03.3, or failure to provide Disadvantaged, Minority or Women's Business Enterprise information if required in the contract, or failure or refusal to sign the contract shall result in forfeiture of the proposal bond or deposit of this bidder. If this should occur, the Contracting Agency may then award the contract to the second lowest responsible bidder or reject all remaining bids. If the second lowest responsible bidder fails to return the required documents as stated above within the time provided after award, the contract may then be awarded successively in a like manner to the remaining lowest responsible bidders until the above requirements are met or the remaining proposals are rejected.

1-03.6 Return of Bid Deposit

When proposals have been examined and corrected as necessary, proposal bonds and deposits accompanying proposals ineligible for further consideration will be returned. All other proposal bonds and deposits will be held until the contract has been properly executed. When the contract has been properly executed, all remaining deposits or bonds, except those subject to forfeiture, will be returned.

1-03.7 Judicial Review

Any decision made by the Contracting Agency regarding the award and execution of the contract or bid rejection shall be conclusive subject to the scope of judicial review permitted under Washington Law. Such review, if any, shall be timely filed in the Superior Court of Thurston County, Washington.

1-04 SCOPE OF THE WORK

1-04.1 Intent of the Contract

The intent of the contract is to prescribe a complete work. Omissions from the contract of details of work that are necessary to carry out the intent of the contract shall not relieve the Contractor from performing the omitted work.

1-04.1(1) Bid Items Included in the Proposal

The Contractor shall provide all labor, materials, tools, equipment, transportation, supplies, and incidentals required to complete all work for the items included in the proposal.

1-04.1(2) Bid Items Not Included in the Proposal

When the contract specifies work that has no bid item, and the work is not specified as being included with or incidental to other bid items, an equitable adjustment will be made in accordance with Section 1-04.4 unless that work is customarily considered as incidental to other items.

1-04.2 Coordination of Contract Documents, Plans, Special Provisions Specifications, and Addenda

The complete contract includes these parts: the contract form, bidder's completed proposal form, contract plans, contract provisions, standard specifications, standard plans, addenda, various certifications and affidavits, supplemental agreements, change orders, and subsurface boring logs (if any). These parts complement each other in describing a complete work. Any requirement in one part binds as if stated in all parts. The Contractor shall provide any work or materials clearly implied in the contract even if the contract does not mention it specifically.

Any inconsistency in the parts of the contract shall be resolved by following this order of precedence (e.g., 1 presiding over 2, 3, 4, 5, 6, and 7; 2 presiding over 3, 4, 5, 6, and 7; and so forth):

1. Addenda,
2. Proposal Form,
3. Special Provisions,
4. Contract Plans,
5. Amendments to the Standard Specifications,
6. Standard Specifications, and
7. Standard Plans.

On the contract plans, working drawings, and standard plans, figured dimensions shall take precedence over scaled dimensions.

This order of precedence shall not apply when work is required by one part of the contract but omitted from another part or parts of the contract. The work required in one part must be furnished even if not mentioned in other parts of the contract.

If any part of the contract requires work that does not include a description for how the work is to be performed, the work shall be performed in accordance with standard trade practice(s). For purposes of the contract, a standard trade practice is one having such regularity of observance in the trade as to justify an expectation that it will be observed by the Contractor in doing the work.

In case of any ambiguity or dispute over interpreting the contract, the Engineer's decision will be final as provided in Section 1-05.1.

1-04.3 Vacant

1-04.4 Changes

The Engineer reserves the right to make, at any time during the work, such changes in quantities and such alterations in the work as are necessary to satisfactorily complete the project. Such changes in quantities and alterations shall not invalidate the contract nor release the surety, and the Contractor agrees to perform the work as altered. Among others, these changes and alterations may include:

1. Deleting any part of the work,
2. Increasing or decreasing quantities,
3. Altering specifications, designs, or both,
4. Altering the way the work is to be done,
5. Adding new work,
6. Altering facilities, equipment, materials, services, or sites, provided by the Contracting Agency.
7. Ordering the Contractor to speed up or delay the work.

The Engineer will issue a written change order for any change unless the remainder of this section provides otherwise.

If the alterations or changes in quantities significantly change the character of the work under the contract, whether or not changed by any such different quantities or alterations, an adjustment, excluding loss of anticipated profits, will be made to the contract. The basis for the adjustment shall be agreed upon prior to the performance of the work. If a basis cannot be agreed upon, then an adjustment will be made either for or against the Contractor in such amount as the Engineer may determine to be fair and equitable. If the alterations or changes in quantities do not significantly change the character of the work to be performed under the contract, the altered work will be paid for as provided elsewhere in the contract. The term *significant change* shall be construed to apply only to the following circumstances:

A. When the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction or

B. When an item of work, as defined elsewhere in the contract, is increased in excess of 125 percent or decreased below 75 percent of the original contract quantity. For the purpose of this section, an item of work will be defined as any item that qualifies for adjustment under the provisions of Section 1-04.6.

For Item 1, an equitable adjustment for deleted work will be made as provided in Section 1-09.5.

For Item 2, if the actual quantity of any item, exclusive of added or deleted amounts included in agreed change orders, increases or decreases by more than 25 percent from the original plan quantity, the unit contract prices for that item may be adjusted in accordance with Section 1-04.6.

For any changes except Item 1 (deleted work) or Item 2 (increasing or decreasing quantities), the Engineer will determine if the change should be paid for at unit contract price(s). If the Engineer determines that the change increased or decreased the Contractor's costs or time to do any of the work including unchanged work, the Engineer

will make an equitable adjustment to the contract. The equitable adjustment will be by agreement with the Contractor. However, if the parties are unable to agree, the Engineer will determine the amount of the equitable adjustment in accordance with Section 1-09.4 and adjust the time as the Engineer deems appropriate. Extensions of time will be evaluated in accordance with Section 1-08.8. The Engineer's decision concerning equitable adjustment and extension of time shall be final as provided in Section 1-05.1.

The Contractor shall proceed with the work upon receiving:

1. A written change order approved by the Engineer, or
2. An oral order from the Project Engineer before actually receiving the written change order.

Changes normally noted on field stakes or variations from estimated quantities, except as provided in subparagraph A or B above, will not require a written change order. These changes shall be made at the unit prices that apply. The Contractor shall respond immediately to changes shown on field stakes without waiting for further notice.

The Contractor shall obtain written consent of the surety or sureties if the Engineer requests such consent.

The Contracting Agency has a policy for the administration of cost reduction alternatives proposed by the Contractor. The Contractor may submit proposals for changing the Plans, Specifications, or other requirements of the Contract. These proposals must reduce the cost or time required for construction of the project. When determined appropriate by the Contracting Agency, the Contractor will be allowed to share the savings.

Guidelines for submitting Cost Reduction Incentive Proposals are available at the Project Engineer's office. The actions and requirements described in the guidelines are not part of the Contract. The guidelines requirements and the Contracting Agency's decision to accept or reject the Contractor's proposal are not subject to arbitration under the arbitration clause or otherwise subject to litigation.

1-04.4(1) Minor Changes

Payments or credits for changes amounting to $5,000 or less may be made under the bid item "Minor Change". At the discretion of the Contracting Agency, this procedure for Minor Changes may be used in lieu of the more formal procedure as outlined in Section 1-04.4, Changes.

The Contractor will be provided a copy of the completed order for Minor Change. The agreement for the Minor Change will be documented by signature of the Contractor, or notation of verbal agreement. If the Contractor is in disagreement with anything required by the order for Minor Change, the Contractor may protest the order as provided in Section 1-04.5.

Payments or credits will be determined in accordance with Section 1-09.4. For the purpose of providing a common proposal for all bidders, the Contracting Agency has entered an amount for "Minor Change" in the Proposal to become a part of the total bid by the Contractor.

1-04.5 Procedure and Protest by the Contractor

If in disagreement with anything required in a change order, another written order, or an oral order from the Engineer, including any direction, instruction, interpretation, or determination by the Engineer, the Contractor shall:

1. Immediately give a signed written notice of protest to the Project Engineer or the Project Engineer's field inspectors before doing the work;
2. Supplement the written protest within 15 calendar days with a written statement providing the following:
   a. The date of the protested order;
   b. The nature and circumstances that caused the protest;
   c. The contract provisions that support the protest;
   d. The estimated dollar cost, if any, of the protested work and how that estimate was determined; and
   e. An analysis of the progress schedule showing the schedule change or disruption if the Contractor is asserting a schedule change or disruption; and
3. If the protest is continuing, the information required above, shall be supplemented as requested by the Project Engineer. In addition, the Contractor shall provide the Project Engineer, before final payment, a written statement of the actual adjustment requested.

Throughout any protested work, the Contractor shall keep complete records of extra costs and time incurred. The Contractor shall permit the Engineer access to these and any other records needed for evaluating the protest as determined by the Engineer.

The Engineer will evaluate all protests provided the procedures in this section are followed. If the Engineer determines that a protest is valid, the Engineer will adjust payment for work or time by an equitable adjustment in accordance with Section 1-09.4. Extensions of time will be evaluated in accordance with Section 1-08.8. No adjustment will be made for an invalid protest.

In spite of any protest, the Contractor shall proceed promptly with the work as the Engineer orders.

The Contractor accepts all requirements of a change order by: (1) endorsing it, (2) writing a separate acceptance, or (3) not protesting in the way this section provides. A change order that is not protested as provided in this section shall be full payment and final settlement of all claims for contract time and for all costs of any kind, including costs of delays, related to any work either covered or affected by the change.

By not protesting as this section provides, the Contractor also waives any additional entitlement and accepts from the Engineer any written or oral order (including directions, instructions, interpretations, and determinations).

By failing to follow the procedures of this section and Section 1-09.11, the Contractor completely waives any claims for protested work.

1-04.6 Variation in Estimated Quantities

Payment to the Contractor will be made only for the actual quantities of work performed and accepted in conformance with the contract. When the accepted quantity of work performed under a unit item varies from the original proposal quantity, payment will be at the unit contract price for all work unless the total accepted quantity of any contract item, adjusted to exclude added or deleted amounts included in change orders accepted by both parties, increases or decreases by more than 25 percent from the original proposal quantity. In that case, payment for contract work may be adjusted as described herein:

The adjusted final quantity shall be determined by starting with the final accepted quantity measured after all work under an item has been completed. From this amount, subtract any quantities included in additive change orders accepted by both parties. Then, to the resulting amount, add any quantities included in deductive change orders accepted by both parties. The final result of this calculation shall become the adjusted final quantity and the basis for comparison to the original proposal quantity.

1. Increased Quantities.

   Either party to the contract will be entitled to renegotiate the price for that portion of the adjusted final quantity in excess of 1.25 times the original proposal quantity. The price for excessive increased quantities will be determined by agreement of the parties, or, where the parties cannot agree, the price will be determined by the Engineer based upon the actual costs to perform the work, including reasonable markup for overhead and profit.

2. Decreased Quantities.

   Either party to the contract will be entitled to an equitable adjustment if the adjusted final quantity of work performed is less than 75 percent of the original bid quantity. The equitable adjustment shall be based upon and limited to three factors:

   a. Any increase or decrease in unit costs of labor, materials or equipment, utilized for work actually performed, resulting solely from the reduction in quantity;
   b. Changes in production rates or methods of performing work actually done to the extent that the nature of the work actually performed differs from the nature of the work included in the original plan; and
   c. An adjustment for the anticipated contribution to unavoidable fixed cost and overhead from the units representing the difference between the adjusted final quantity and 75% of the original plan quantity.

The following limitations shall apply to renegotiated prices for increases and/or equitable adjustments for decreases:

1. The equipment rates shall be actual cost but shall not exceed the rates set forth in the AGC/WSDOT Equipment Rental Agreement (referred to in Section 1-09.6) that is in effect at the time the work is performed.
2. No payment will be made for extended or unabsorbed home office overhead and field overhead expenses to the extent that there is an unbalanced allocation of such expenses among the contract bid items.
3. No payment for consequential damages or loss of anticipated profits will be allowed because of any variance in quantities from those originally shown in the proposal form, contract provisions, and contract plans.
4. The total payment (including the adjustment amount and unit prices for work performed) for any item that experiences an equitable adjustment for decreased quantity shall not exceed 75% of the amount originally bid for the item.

If the adjusted final quantity of any item does not vary from the quantity shown in the proposal by more than 25%, then the Contractor and the Contracting Agency agree that all work under that item will be performed at the original contract unit price and within the original time for completion.

When ordered by the Engineer, the Contractor shall proceed with the work pending determination of the cost or time adjustment for the variation in quantities.

The Contractor and the Contracting Agency agree that there will be no cost adjustment for decreases if the Contracting Agency has entered the amount for the item in the proposal form only to provide a common proposal for bidders.

1-04.7 Differing Site Conditions (Changed Conditions)

During the progress of the work, if preexisting subsurface or latent physical conditions are encountered at the site, differing materially from those indicated in the contract, or if preexisting unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the contract, are encountered at the site, the party discovering such conditions shall promptly notify the other party in writing of the specific differing site conditions before they are disturbed and before the affected work is performed.

Upon written notification, the Engineer will investigate the conditions and if he/she determines that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the contract, an adjustment, excluding loss of anticipated profits, will be made and the contract modified in writing accordingly. The Engineer will notify the Contractor of his/her determination whether or not an adjustment of the contract is warranted.

No contract adjustment which results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice.

The equitable adjustment will be by agreement with the Contractor. However, if the parties are unable to agree, the Engineer will determine the amount of the equitable adjustment in accordance with Section 1-09.4. Extensions of time will be evaluated in accordance with Section 1-08.8.

If the Engineer determines that different site conditions do not exist and no adjustment in costs or time is warranted, such determination shall be final as provided in Section 1-05.1.

If there is a decrease in the costs or time required to perform the work, failure of the Contractor to notify the Engineer of the differing site conditions shall not affect the Contracting Agency's right to make an adjustment in the costs or time.

No claim by the Contractor shall be allowed unless the Contractor has followed the procedures provided in Section 1-04.5 and 1-09.11.

1-04.8 Progress Estimates and Payments

Engineer-issued progress estimates or payments for any part of the work shall not be used as evidence of performance or quantities. Progress estimates serve only as basis for partial payments. The Engineer may revise progress estimates any time before final acceptance. If the Engineer deems it proper to do so, changes may be made in progress estimates and in the final estimate.

1-04.9 Use of Buildings or Structures

The Engineer will decide whether any building or structure on the right of way may remain during the work and whether the Contractor may use such a building or structure.

1-04.10 Use of Materials Found on the Project

With the Engineer's written approval, the Contractor may use on the project: stone, gravel, sand, other materials from on-site excavation, or timbers removed in the course of the work. Approval will not be granted if:

1. The excavated materials or timber fail to meet contract requirements;
2. The excavated materials or timber are required for other use under the contract;
3. The excavated materials are required for use as Selected Materials under Section 2-03.3(10); or
4. Such use is not in the best interests of the Contracting Agency as determined by the Engineer, whose decision shall be final as provided in Section 1-05.1.

Any material disturbed by, but not used in, the work shall be disposed of as provided elsewhere in the contract or as ordered by the Engineer in accordance with Section 1-04.4.

1-04.11 Final Cleanup

The Contractor shall perform final cleanup as provided in this section to the Engineer's satisfaction. The Engineer will not establish the physical completion date until this is done. The highway right of way, material sites, and all ground the Contractor occupied to do the work shall be left neat and presentable. The Contractor shall:

1. Remove all rubbish, surplus materials, discarded materials, falsework, camp buildings, temporary structures, equipment, and debris; and
2. Deposit in embankments, or remove from the project, all unneeded, oversized rock left from grading, surfacing, or paving.

The Contractor shall not remove warning, regulatory, or guide signs unless the Engineer approves.

1-05 CONTROL OF WORK

1-05.1 Authority of the Engineer

The Engineer shall be satisfied that all the work is being done in accordance with the requirements of the contract. The contract and specifications give the Engineer authority over the work. Whenever it is so provided in this contract, the decision of the Engineer shall be final: provided, however, that if an action is brought within the time allowed in this contract challenging the Engineer's decision, that decision shall be subject to the scope of judicial review provided in such cases under Washington case law.

The Engineer's decisions will be final on all questions including, but not limited to, the following:

1. Quality and acceptability of materials and work,
2. Measurement of unit price work,
3. Acceptability of rates of progress on the work,
4. Interpretation of plans and specifications,
5. Determination as to the existence of changed or differing site conditions,
6. Fulfillment of the contract by the Contractor,
7. Payments under the contract including equitable adjustment,
8. Suspension(s) of work,
9. Termination of the contract for default or public convenience,
10. Determination as to unworkable days, and
11. Approval of working drawings.

The Project Engineer represents the Engineer on the project, with full authority to enforce contract requirements and carry out the Engineer's orders. If the Contractor fails to respond promptly to the requirements of the contract or orders from the Engineer:

1. The Project Engineer may use Contracting Agency resources, other contractors, or other means to accomplish the work, and
2. The Contracting Agency will not be obligated to pay the Contractor, and will deduct from the Contractor's payments any costs that result when any other means are used to carry out the contract requirements or Engineer's orders.

At the Contractor's risk, the Project Engineer may suspend all or part of the work if:

1. The Contractor fails to fulfill contract terms, to carry out the Engineer's orders, or to correct unsafe conditions of any nature;
2. The weather or other conditions are unsuitable; or
3. It is in the public interest.

Nothing in these Specifications or in the contract requires the Engineer to provide the Contractor with direction or advice on how to do the work. If the Engineer approves or recommends any method or manner for doing the work or producing materials, the approval or recommendation shall not:

1. Guarantee that following the method or manner will result in compliance with the contract,
2. Relieve the Contractor of any risks or obligations under the contract, or
3. Create any Contracting Agency liability.

1-05.2 Authority of Assistants and Inspectors

The Project Engineer may appoint assistants and inspectors to assist in determining that the work and materials meet the contract requirements. Assistants and inspectors have the authority to reject defective material and suspend work that is being done improperly, subject to the final decisions of the Project Engineer or, when appropriate, the Engineer.

Assistants and inspectors are not authorized to accept work, to accept materials, to issue instructions, or to give advice that is contrary to the contract. Work done or material furnished which does not meet the contract requirements shall be at the Contractor's risk and shall not be a basis for a claim even if the inspectors or assistants purport to change the contract.

Assistants and inspectors may advise the Contractor of any faulty work or materials or infringements of the terms of the contract; however, failure of the Project Engineer or the assistants or inspectors to advise the Contractor does not constitute acceptance or approval.

1-05.3 Plans and Working Drawings

The contract plans are defined in Section 1-01.3. Any proposed alterations by the Contractor affecting the requirements and information in the contract plans shall be in writing and will require approval of the Engineer.

To detail and illustrate the work, the Engineer may furnish to the Contractor additional plans and explanations consistent with the original plans. The Contractor shall perform the work according to these additional plans and explanations.

The Contractor shall submit supplemental working drawings as required for the performance of the work. Except as noted, all drawings and other submittals shall be delivered directly to the Project Engineer. The drawings shall be on sheets measuring 22 by 34-inches, 11 by 17-inches, or on sheets with dimensions in multiples of $8^1/_2$ by 11 inches. The drawings shall be provided far enough in advance of actual need to allow for the review process by the Contracting Agency or other agencies. This may involve resubmittals because of revisions or rejections. Unless otherwise stated in the contract, the Engineer will require up to 30 calendar days from the date the submittals or resubmittals are received until they are sent to the Contractor. After a plan or drawing has been approved and returned to the Contractor, all changes that the Contractor proposes shall be submitted to the Project Engineer for review and approval. This time will increase if the drawings submitted do not meet the contract requirements or contain insufficient details.

If more than 30 calendar days are required for the Engineer's review of any individual submittal or resubmittal, an extension of time will be considered in accordance with Section 1-08.8.

The Contractor shall obtain the Engineer's written approval of the drawings before proceeding with the work they represent. This approval shall neither confer upon the Contracting Agency nor relieve the Contractor of any responsibility for the accuracy of the drawings or their conformity with the contract. The Contractor shall bear all risk and all costs of any work delays caused by nonapproval of these drawings or plans.

Unit bid prices shall cover all costs of working drawings.

1-05.4 Conformity With and Deviations From Plans and Stakes

The Special Provisions may require that the Contractor be contractually responsible for part or all of the project surveying. For survey requirements not the responsibility of the Contractor, the Engineer will lay out and set construction stakes and marks needed to establish the lines, grades, slopes, cross-sections, and curve superelevations. These stakes and marks will govern the Contractor's work. The Contractor shall take full responsibility for detailed dimensions, elevations, and slopes measured from them.

All work performed shall be in conformity with the lines, grades, slopes, cross sections, superelevation data, and dimensions as shown in the Plans, or as staked. If the Plans, Special Provisions, or these Specifications, state specific tolerances, then the work shall be performed within those limits. The Engineer's decision on whether the work is in conformity shall be final, as provided in Section 1-05.1.

The Contractor shall not deviate from the approved plans and working drawings unless the Engineer approves in writing.

When the Contracting Agency is responsible for roadway surveying, and the Contractor trims the subgrade with an automatic machine guided by reference lines, the Engineer will set control stakes for line and grade only once after grading is complete. To gain better control with unusual pavement widths or for other reasons, the Engineer may set more control stakes without added cost to the Contractor. The Contractor shall set reference lines from these control stakes for trimming subgrade, for surfacing, and for controlling the paving machines.

The Contractor shall work to preserve stakes, marks, and monuments set by the Engineer. The Contracting Agency will deduct from payments due the Contractor all costs to replace such stakes, marks, and monuments carelessly or willfully damaged or destroyed by the Contractor's operation.

The Contractor shall provide enough safe areas to permit the Engineer to set those points and elevations that are the responsibility of the Contracting Agency and to perform random checks of the surveying performed by the Contractor.

The Contractor shall keep the Engineer informed of staking requirements to provide the Engineer with adequate time to set the stakes for which the Contracting Agency is responsible. Contractor requests for stakes shall be made at least three working days before the Engineer needs to begin the staking operation.

1-05.5 Vacant

1-05.6 Inspection of Work and Materials

The Engineer may inspect all work and materials for conformity with contract terms. To ensure the Engineer's safety and access during these inspections, the Contractor shall provide any equipment needed, such as walkways, railings, ladders, and platforms.

When the Engineer requests, the Contractor shall (without charge) provide samples of materials used or to be used in the work. If the Contractor uses materials tested and approved for one project in an unrelated project, the Contracting Agency may deduct its testing and inspection costs from payments due the Contractor. The Engineer may order the Contractor to remove and replace, and bear the cost of doing so, any materials used without inspection.

Any inspections, tests, measurements, or other actions by Contracting Agency employees serve only one purpose: to assure the Engineer that work, materials, progress rate, and quantities comply with contract terms. Such work by Contracting Agency employees shall not relieve the Contractor from doing any contract-assigned work or from determining whether contract requirements are being met. The Contractor shall correct any substandard work or materials. The Engineer will reject unsuitable work or materials even though inspected or paid for in a progress estimate.

If the Engineer requests, then the Contractor shall remove or uncover any area of the completed work. After the Engineer inspects it, the Contractor shall restore the area to the standard the contract requires. The Contractor shall bear the cost of uncovering, removing, and restoring the exposed work: (a) if it proves unacceptable, or (b) if it was placed without authority or without due notice to the Engineer. The Contracting Agency will pay these costs by agreed price or by force account if the work proves to be acceptable and the Contractor had performed the original work with the authority of and due notice to the Engineer.

The Contractor, if advised to do so by the Engineer, shall permit representatives from other agencies to inspect the work when it is to be done:

1. On any railroad, utility, or facility of a public agency; or
2. To the satisfaction of any federal, state, or municipal agency.

In any crushing or screening operation, the Contractor shall provide and install a mechanical sampler that:

1. Is automatic or semi-automatic;
2. Can safely and easily obtain representative samples of the materials being produced;
3. Can convey the samples to ground level in Contracting Agency-provided sacks;
4. Moves at an even rate through the full width of the materials stream falling from the discharge end of the belt, gate, or chute;
5. Is power driven during the material intercept cycle; and
6. Can be adjusted to take samples of about 100 pounds as often as the Engineer requires.

No material from the crushing or screen operation will be accepted until after the Engineer has approved the design and operation of the sampling equipment. The Contractor shall bear all costs of providing the sampling equipment, the power to operate it, and the space for its use.

1-05.7 Removal of Defective and Unauthorized Work

The Contracting Agency will not pay for unauthorized or defective work. Unauthorized or defective work includes: work and materials that do not conform to contract requirements; work done beyond the lines and grades set by the plans or the Engineer; and extra work and materials furnished without the Engineer's written approval. At the Engineer's order, the Contractor shall immediately remedy, remove, replace, or dispose of unauthorized or defective work or materials and bear all costs of doing so.

1-05.8 Vacant

1-05.9 Equipment

At the Engineer's request, the Contractor shall provide an operating and maintenance manual for each model or type of mixing, placing, or processing equipment before using it in the work. The Contractor shall also provide test instruments to confirm whether the equipment meets operating requirements, such as vibration rate, revolutions-per-minute, or any other requirements.

The contract may require automatically controlled equipment for some operations. If the automatic controls on such equipment fail, then the Contractor may operate the equipment manually for the remainder of that normal working day, provided the method of operation produces results otherwise meeting the specifications. Continued operation of the equipment manually beyond this working day will be permitted only by specific authorization of the Engineer.

The Engineer will reject equipment that repeatedly breaks down or fails to produce results within the required tolerances. The Contractor shall have no claim for additional payment or for extension of time due to rejection and replacement of any equipment.

1-05.10 Guarantees

The Contractor shall furnish to the Contracting Agency any guarantee or warranty furnished as a customary trade practice in connection with the purchase of any equipment, materials, or items incorporated into the project.

1-05.11 Final Inspection

The Engineer will not make the final inspection until the physical work required by the contract, including final cleanup and all extra work ordered by the Engineer, has been completed. The physical completion date for the contract will be determined as provided in Section 1-08.5.

1-05.12 Final Acceptance

The Contractor must perform all the obligations under the contract before a completion date and final acceptance can occur. Failure of the Contractor to perform all the obligations under the contract shall not bar the Contracting Agency from unilaterally accepting the contract as provided in Section 1-09.9. The Secretary accepts the completed contract and the items of work shown in the final estimate by signature of the Final Contract Voucher Certification. The date of that signature constitutes the acceptance date. Progress estimates or payments shall not be construed as acceptance of any work under the contract.

The Contractor agrees that neither completion nor final acceptance shall relieve the Contractor of the responsibility to indemnify, defend, and protect the Contracting Agency against any claim or loss resulting from the failure of the Contractor (or the subcontractors or lower tier subcontractors) to pay all laborers, mechanics, subcontractors, materialpersons, or any other person who provides labor, supplies, or provisions for carrying out the work or for any payments required for unemployment compensation under Title 50 RCW or for industrial insurance and medical aid required under Title 51 RCW.

Final acceptance shall not constitute acceptance of any unauthorized or defective work or material. The Contracting Agency shall not be barred from requiring the Contractor to remove, replace, repair, or dispose of any unauthorized or defective work or material or from recovering damages for any such work or material.

1-05.13 Superintendents, Labor, and Equipment of Contractor

At all times, the Contractor shall keep at the work site a set of the plans, specifications, special provisions, and addenda. The Contractor shall devote the attention required to make reasonable progress on the work and shall cooperate fully with the Engineer and inspectors.

Either the Contractor in person or an authorized representative shall remain on site whenever the work is underway. Before the work begins, the Contractor shall name in writing an experienced superintendent who understands the contract and is able to supervise the work. This superintendent shall have full authority to represent and act for the Contractor. Any superintendent who repeatedly fails to follow the Engineer's written or oral orders, directions, instructions, or determinations, shall be subject to removal from the project. Upon the written request of the Engineer, the Contractor shall immediately remove such superintendent and name a replacement in writing.

Competent supervisors experienced in the task being performed shall continuously oversee the contract work. At the Engineer's written request, the Contractor shall immediately remove and replace any incompetent, careless, or negligent employee.

Noncompliance with the Engineer's request to remove and replace personnel at any level shall be grounds for terminating the contract under the terms of Section 1-08.10.

The Contractor shall keep all machinery and equipment in good, workable condition. It shall be adequate for its purpose and used by competent operators.

The Engineer will rate the Contractor's performance and contract compliance in these categories:

1. Progress of Work,
2. Quality of Work,
3. Equipment,
4. Administration/Management/Supervision, and
5. Coordination and Control of subcontractors.

Whenever the Contracting Agency evaluates the Contractor's prequalification under RCW 47.28.070, it will take these reports into account.

1-05.13(1) Emergency Contact List

The Contractor shall submit an Emergency Contact List to the Engineer no later than five calendar days after the date the contract is executed. The list shall include, at a minimum, the Prime Contractor's Project Manager, or equivalent, the Prime Contractor's Project Superintendent and the Traffic Control Supervisor. The list shall identify a representative with delegated authority to act as the emergency contact on behalf of the Prime Contractor and include one or more alternates. The emergency contact shall be available upon the Engineer's request at other than normal working hours. The Emergency Contact List shall include 24-hour telephone numbers for all individuals identified as emergency contacts or alternates.

1-05.14 Cooperation With Other Contractors

The Contracting Agency may perform other work at or near the site, including any material site, with other forces than those of the Contractor. This work may be done with or without a contract. If such work takes place within or next to this project, the Contractor shall cooperate with all other contractors or forces. The Contractor shall carry out work under this project in a way that will minimize interference and delay for all forces involved. The Engineer will resolve any disagreements that may arise among the contractors or the Contractor and the Contracting Agency over the method or order of doing the work. The Engineer's decision in these matters shall be final, as provided in Section 1-05.1.

The coordination of the work shall be taken into account by the Contractor as part of the site investigation in accordance with Section 1-02.4 and any resulting costs shall be incidental and included within the unit bid prices in the contract.

1-05.15 Method of Serving Notices

Any written notice to the Contractor required under these Specifications may be served on the Contractor either personally or by mailing or by delivery to the last post office address known to the Engineer.

All correspondence from the Contractor shall be directed to the Project Engineer.

1-06 CONTROL OF MATERIAL

1-06.1 Approval of Materials Prior To Use

Prior to use, the Contractor shall notify the Engineer of all proposed materials. The Contractor shall use the Qualified Product List or the Request for Approval of Material form.

All equipment, materials, and articles incorporated into the permanent work:

1. Shall be new, unless the special provisions permit otherwise;
2. Shall meet the requirements of the contract and be approved by the Engineer;
3. May be inspected or tested at any time during their preparation and use; and
4. Shall not be used in the work if they become unfit after being previously approved.

1-06.1(1) Qualified Products List (QPL)

The QPL is a listing of manufactured products that have been evaluated and determined suitable for use in highway construction.

If the Contractor elects to use the QPL, the most current list available at the time the product is proposed for use, shall be used. The QPL submittal shall be prepared by the Contractor in accordance with the instructions in the QPL and submitted to the Engineer prior to use.

The QPL identifies the approved products, the applicable specification section, and the basis for acceptance at the project level. The listing is divided into two categories, "Approved" and "Conditionally Approved". "Approved" products are denoted with an "A". Those products may be accepted without additional sampling. "Conditionally Approved" products are denoted with a "CA". The acceptance and use of these products is based upon additional job sampling and/or documentation. All additional acceptance actions need to be completed prior to the material being incorporated into the work.

The Contractor shall advise the Engineer of the intended items for use from the QPL by reference to the contract bid item.

The use of listed products shall be restricted to the Standard Specification for which they are listed and fulfillment of the acceptance requirement defined in the QPL. Qualified products not conforming to the specifications, not fulfilling the acceptance requirements, or improperly handled or installed, shall be replaced at the Contractor's expense.

To qualify for continued listing on the QPL, products may be sampled and tested for conformance to the Standard Specifications. The Contracting Agency reserves the right to make revisions to the QPL at any time.

If there is a conflict between the QPL and the contract, the provisions of the contract shall take precedence over the QPL.

1-06.1(2) Request for Approval of Material (RAM)

The RAM shall be used when the Contractor elects not to use the QPL or the material is not listed in the QPL. The RAM shall be prepared by the Contractor in accordance with the instructions on the form (DOT 350-071) and submitted to the Engineer for approval before the material is incorporated into the work.

Approval of the material does not constitute acceptance of the material for incorporation into the work.

Additional acceptance actions as noted on the RAM need to be completed prior to the materials being incorporated into the work.

When requesting approval of an item that requires fabrication, both the fabricator and the manufacturer of the base material shall be identified on the RAM.

1-06.2 Acceptance of Materials

1-06.2(1) Samples and Tests for Acceptance

The Contractor shall deliver representative samples (from the Contractor, Producer, or Fabricator) to the Engineer without charge before incorporating material into the work. In providing samples, the Contractor shall provide the Engineer with sufficient time and quantities for testing before use. The Engineer may require samples at any time. Samples not taken by or in the presence of the Engineer will not be accepted for test, unless the Engineer permits otherwise.

The Contractor shall designate specific Contractor employees as points of contact for concrete testing and acceptance. Alternates shall be designated to ensure that direct contact is maintained during concrete placement. If designated by the Contractor to the Engineer, the concrete supplier will receive all 28 day concrete strength test results.

The Project Engineer will designate specific Contracting Agency employees as points of contact for concrete testing and acceptance.

The Contractor may observe any of the sampling and testing performed by the Engineer. If the contractor observes a deviation from the specified sampling and testing procedures, the Contractor shall verbally described the deviations observed to the Engineer or designated representative immediately, and shall confirm these observed deviations in writing to the Engineer within 24 hours, referencing the specific procedures and steps. The Engineer will respond in writing within three working days of the receipt of the contractor's written communications.

All field and laboratory materials testing by the Engineer will follow methods described in contract documents, or in the Washington State Department of Transportation *Materials Manual*, using qualified testing personnel and calibrated or verified equipment. The following provisions will apply when the Contracting Agency uses the specifications or methods from the sources named below:

ASTM — American Society for Testing and Materials. The ASTM designation number refers to this society's latest adopted or tentative standard. The standard or tentative standard in effect on the bid advertising date will apply in each case.

The Contracting Agency will consider any revisions to become effective on December 1 of the year they are adopted.

Copies of any separate ASTM specifications or testing method may be obtained from: the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA.

AASHTO — American Association of State Highway and Transportation Officials. An AASHTO number refers to that organization's currently published (1) "Standard Specifications for Highway Materials and Methods of Sampling and Testing" or any adopted revisions, or (2) "Interim Specifications and Methods of Sampling and Testing Adopted by the AASHTO Subcommittee on Materials."

Any standards, revisions, and interim standards in effect on the bid advertising date will apply. Standards, revisions, and interim standards will be considered as becoming effective on December 1 of the year that they are adopted.

Copies of "Standard Specifications for Highway Materials and Methods of Sampling and Testing" may be obtained from the American Association of State Highway and Transportation Officials, 917 National Press Building, Washington, D.C.

Federal Specification — U.S. Government Federal Stock Catalogue. The specification number refers to the most recent revision adopted by the General Services Administration. Revisions in effect on the bid advertising date will apply.

The Contracting Agency will consider any revision as in effect 60 calendar days after its adoption.

Copies of separate specifications listed in the Federal Stock Catalogue may be obtained at the prices indicated from the Business Service Center, General Services Administration, Regional Office Building, Seventh and D Streets, Washington, D.C.

Other Publications — Any other publication referred to in these Specifications or the special provisions will mean its latest edition. Requirements, and any revisions, in effect on the bid advertising date will apply. The Contracting Agency will consider them as in effect 60 calendar days after publication.

Copies may be obtained from the publishing organizations. For example, copies of standard grading and dressing rules may be obtained from: West Coast Lumber Inspection Bureau in Seattle, Washington or Portland, Oregon, and from the Western Wood Products Association, Portland, Oregon.

WAQTC — Western Alliance for Quality Transportation Construction. The WAQTC designation number refers to this alliance's latest adopted or tentative standard. The standard or tentative standard in effect on the bid advertising date will apply in each case. The Contracting Agency will consider them as in effect 60 calendar days after publication.

Copies of any separate WAQTC testing method may be obtained from: The WSDOT Quality Systems Manager, State Materials Laboratory, PO Box 47365, Olympia, Washington, 98504-7365.

1-06.2(2) Statistical Evaluation of Materials for Acceptance

1-06.2(2)A General

Where specified, acceptance sampling and testing will be done by the Contracting Agency and statistically evaluated for acceptance by the provisions of this subsection. All test results for a lot will be analyzed collectively and statistically by the quality level analysis procedures shown at the end of this subsection to determine the total percent of the lot that is within specification limits and to determine an appropriate pay factor. Lots and sublots are defined in the appropriate subsection of these Specifications for the material being statistically evaluated.

Quality level analysis is a statistical procedure for determining the percent compliance of the material with these Specifications. Quality level is the computed percent of material meeting these Specifications and is determined from the arithmetic mean, (X_m), and the sample standard deviation (S), for each constituent of the lot.

Any necessary rounding off of test results or calculations will be accomplished according to the following rule:

1. The final significant digit will not be changed when the succeeding digit is less than 5.
2. The final significant digit will be increased by one when the succeeding digit is 5 or greater.

Table 1
Quality Levels
Quality Level Analysis by Standard Deviation Method

PU or PL Percent Within Limits for Positive Values of QU or QL	Upper Quality Index QU or Lower Quality Index QL														
	n-3	n-4	n-5	n-6	n-7	n-8	n-9	n-10 to n-11	n-12 to n-14	n-15 to n-18	n-19 to n-25	n-26 to n-37	n-38 To n-69	n-70 to n-200	n-201 to n-
100	1.16	1.50	1.79	2.03	2.23	2.39	2.53	2.65	2.83	3.03	3.20	3.38	3.54	3.70	3.83
99	-	1.47	1.67	1.80	1.89	1.95	2.00	2.04	2.09	2.14	2.18	2.22	2.26	2.29	2.31
98	1.15	1.44	1.60	1.70	1.76	1.81	1.84	1.86	1.91	1.93	1.96	1.99	2.01	2.03	2.05
97	-	1.41	1.54	1.62	1.67	1.70	1.72	1.74	1.77	1.79	1.81	1.83	1.85	1.86	1.87
96	1.14	1.38	1.49	1.55	1.59	1.61	1.63	1.65	1.67	1.68	1.70	1.71	1.73	1.74	1.75
95	-	1.35	1.44	1.49	1.52	1.54	1.55	1.56	1.58	1.59	1.61	1.62	1.63	1.63	1.64
94	1.13	1.32	1.39	1.43	1.46	1.47	1.48	1.49	1.50	1.51	1.52	1.53	1.54	1.55	1.55
93	-	1.29	1.35	1.38	1.40	1.41	1.42	1.43	1.44	1.44	1.45	1.46	1.46	1.47	1.47
92	1.12	1.26	1.31	1.33	1.35	1.36	1.36	1.37	1.37	1.38	1.39	1.39	1.40	1.40	1.40
91	1.11	1.23	1.27	1.29	1.30	1.30	1.31	1.31	1.32	1.32	1.33	1.33	1.33	1.34	1.34
90	1.10	1.20	1.23	1.24	1.25	1.25	1.26	1.26	1.26	1.27	1.27	1.27	1.28	1.28	1.28
89	1.09	1.17	1.19	1.20	1.20	1.21	1.21	1.21	1.21	1.22	1.22	1.22	1.22	1.22	1.23
88	1.07	1.14	1.15	1.16	1.16	1.16	1.16	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
87	1.06	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.13	1.13
86	1.04	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
85	1.03	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
84	1.01	1.02	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99
83	1.00	0.99	0.98	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.95	0.95	0.95
82	0.97	0.96	0.95	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
81	0.96	0.93	0.91	0.90	0.90	0.89	0.89	0.89	0.89	0.88	0.88	0.88	0.88	0.88	0.88
80	0.93	0.90	0.88	0.87	0.86	0.86	0.86	0.85	0.85	0.85	0.85	0.84	0.84	0.84	0.84
79	0.91	0.87	0.85	0.84	0.83	0.82	0.82	0.82	0.82	0.81	0.81	0.81	0.81	0.81	0.81
78	0.89	0.84	0.82	0.80	0.80	0.79	0.79	0.79	0.78	0.78	0.78	0.78	0.77	0.77	0.77

77	0.87	0.81	0.78	0.77	0.76	0.76	0.76	0.75	0.75	0.75	0.75	0.74	0.74	0.74	0.74
76	0.84	0.78	0.75	0.74	0.73	0.73	0.72	0.72	0.72	0.71	0.71	0.71	0.71	0.71	0.71
75	0.82	0.75	0.72	0.71	0.70	0.70	0.69	0.69	0.69	0.68	0.68	0.68	0.68	0.68	0.67
74	0.79	0.72	0.69	0.68	0.67	0.66	0.66	0.66	0.66	0.65	0.65	0.65	0.65	0.64	0.64
73	0.76	0.69	0.66	0.65	0.64	0.63	0.63	0.63	0.62	0.62	0.62	0.62	0.62	0.61	0.61
72	0.74	0.66	0.63	0.62	0.61	0.60	0.60	0.60	0.59	0.59	0.59	0.59	0.59	0.58	0.58
71	0.71	0.63	0.60	0.59	0.58	0.57	0.57	0.57	0.57	0.56	0.56	0.56	0.56	0.55	0.55
70	0.68	0.60	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.53	0.53	0.53	0.53	0.53	0.52
69	0.65	0.57	0.54	0.53	0.52	0.52	0.51	0.51	0.51	0.50	0.50	0.50	0.50	0.50	0.50
68	0.62	0.54	0.51	0.50	0.49	0.49	0.48	0.48	0.48	0.48	0.47	0.47	0.47	0.47	0.47
67	0.59	0.51	0.47	0.47	0.46	0.46	0.46	0.45	0.45	0.45	0.45	0.44	0.44	0.44	0.44
66	0.56	0.48	0.45	0.44	0.44	0.43	0.43	0.43	0.42	0.42	0.42	0.42	0.41	0.41	0.41
65	0.52	0.45	0.43	0.41	0.41	0.40	0.40	0.40	0.40	0.39	0.39	0.39	0.39	0.39	0.39
64	0.49	0.42	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.36
63	0.46	0.39	0.37	0.36	0.35	0.35	0.35	0.34	0.34	0.34	0.34	0.34	0.33	0.33	0.33
62	0.43	0.36	0.34	0.33	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31	0.31	0.31	0.31
61	0.39	0.33	0.31	0.30	0.30	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.28	0.28	0.28
60	0.36	0.30	0.28	0.27	0.27	0.27	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.25
59	0.32	0.27	0.25	0.25	0.24	0.24	0.24	0.24	0.23	0.23	0.23	0.23	0.23	0.23	0.23
58	0.29	0.24	0.23	0.22	0.21	0.21	0.21	0.21	0.21	0.21	0.20	0.20	0.20	0.20	0.20
57	0.25	0.21	0.20	0.19	0.19	0.19	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
56	0.22	0.18	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.15	0.15	0.15
55	0.18	0.15	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
54	0.14	0.12	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
53	0.11	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
52	0.07	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
51	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 2
Pay Factors
Required Quality Level for a Given Sample Size (n) and a Given Pay Factor

Pay Factor	n-3	n-4	n-5	n-6	n-7	n-8	n-9	n-10 to n-11	n-12 to n-14	n-15 to n-18	n-19 to n-25	n-26 to n-37	n-38 to n-69	n-70 to n-200	n-201 to n-
1.05	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1.04	90	91	92	93	93	93	94	94	95	95	96	96	97	97	99
1.03	80	85	87	88	89	90	91	91	92	93	93	94	95	96	97
1.02	75	80	83	85	86	87	88	88	89	90	91	92	93	94	95
1.01	71	77	80	82	84	85	85	86	87	88	89	90	91	93	94
1.00	68	74	78	80	81	82	83	84	85	86	87	89	90	91	93
0.99	66	72	75	77	79	80	81	82	83	85	86	87	88	90	92
0.98	64	70	73	75	77	78	79	80	81	83	84	85	87	88	90
0.97	62	68	71	74	75	77	78	78	80	81	83	84	85	87	89
0.96	60	66	69	72	73	75	76	77	78	80	81	83	84	86	88
0.95	59	64	68	70	72	73	74	75	77	78	80	81	83	85	87
0.94	57	63	66	68	70	72	73	74	75	77	78	80	81	83	86
0.93	56	61	65	67	69	70	71	72	74	75	77	78	80	82	84
0.92	55	60	63	65	67	69	70	71	72	74	75	77	79	81	83
0.91	53	58	62	64	66	67	68	69	71	73	74	76	78	80	82
0.90	52	57	60	63	64	66	67	68	70	71	73	75	76	79	81
0.89	51	55	59	61	63	64	66	67	68	70	72	73	75	77	80
0.88	50	54	57	60	62	63	64	65	67	69	70	72	74	76	79
0.87	48	53	56	58	60	62	63	64	66	67	69	71	73	75	78
0.86	47	51	55	57	59	60	62	63	64	66	68	70	72	74	77
0.85	46	50	53	56	58	59	60	61	63	65	67	69	71	73	76
0.84	45	49	52	55	56	58	59	60	62	64	65	67	69	72	75
0.83	44	48	51	53	55	57	58	59	61	63	64	66	68	71	74
0.82	42	46	50	52	54	55	57	58	60	61	63	65	67	70	72
0.81	41	45	48	51	53	54	56	57	58	60	62	64	66	69	71
0.80	40	44	47	50	52	53	54	55	57	59	61	63	65	67	70
0.79	38	43	46	48	50	52	53	54	56	58	60	62	64	66	69
0.78	37	41	45	47	49	51	52	53	55	57	59	61	63	65	68
0.77	36	40	43	46	48	50	51	52	54	56	57	60	62	64	67
0.76	34	39	42	45	47	48	50	51	53	55	56	58	61	63	66
0.75	33	38	41	44	46	47	49	50	51	53	55	57	59	62	65

Reject Quality Levels Less Than Those Specified for a 0.75 Pay Factor

Note: If the computed Quality Level does not correspond exactly to a figure in the table, use the next lower value.

1-06.2(2)B Financial Incentive

As an incentive to produce superior quality material, a pay factor greater than 1.00 may be obtained with the maximum pay factor being 1.05. A lot containing nonspecification material will be accepted provided the Composite Pay Factor reaches the minimum value specified elsewhere. A lot containing nonspecification material which fails to obtain at least the specified minimum Composite Pay Factor will be rejected by the Engineer. The Engineer will take one or more of the following actions when rejected material has been incorporated into the work:

1. Require complete removal and replacement with specification material at no additional cost to the Contracting Agency.
2. At the Contractor's written request, allow corrective work at no additional cost to the Contracting Agency and then an appropriate price reduction that may range from no reduction to no payment.
3. At the Contractor's written request, allow material to remain in place with an appropriate price reduction that may range from a designated percentage reduction to no payment.

Any lot for which at least three samples have been obtained, and all of the test results meet one of the appropriate criteria listed below, will receive at least a 1.00 Composite Pay Factor:

1. All test results are within the allowable limits specified for the item, or
2. All test results are greater than or equal to a minimum specification limit, or
3. All test results are less than or equal to a maximum specification limit.

Computation of the quality level in these instances will be for determining the amount of any bonus that might be warranted.

Lots represented by less than 3 samples or unsampled lots will be exempt from statistical based acceptance.

1-06.2(2)C Removed and Rejected Materials

The Contractor may, prior to sampling, elect to remove any defective material and replace it with new material at no expense to the Contracting Agency. Any such new material will be sampled, tested, and evaluated for acceptance as a part of the sublot in accordance with this statistical sampling and testing procedure.

The Engineer may reject a sublot that tests show to be defective. Such rejected material shall not be used in the work, and the results of tests run on the rejected material will not be included in the original lot acceptance tests.

1-06.2(2)D Quality Level Analysis

Procedures for determining the quality level and pay factors for a material are as follows:

1. Determine the arithmetic mean, (X_m), of the test results for each specified material constituent:

$$X_m = \frac{\Sigma x}{n}$$

where:
$\sum$ = summation of
x = individual test value
n = total number test values

2. Compute the sample standard deviation, "S", for each constituent:

$$S = \left[\frac{n\sum x^2 - (\sum x)^2}{n(n-1)} \right]^{\frac{1}{2}}$$

where: $\sum x^2$ = summation of the squares of individual test values

$(\sum x)^2$ = summation of the individual test values squared

3. Compute the upper quality index, (Q_U), for each constituent:

$$Q_u = \frac{USL - X_m}{S}$$

where: USL (upper specification limit) = target value plus allowable tolerance

4. Compute the lower quality index, (Q_L), for each constituent:

$$Q_L = \frac{X_m - LSL}{S}$$

where: LSL (lower specification limit) = target value minus allowable tolerance

5. For each constituent determine P_U (the percent within the upper specification limit which corresponds to a given Q_U) from Table 1. Note: If a USL is 100.00 percent or is not specified, P_U will be 100.

   Note: For negative values of Q_U, P_U is equal to 100 minus the table P_U. If the value of Q_U does not correspond exactly to a figure in the table, use the next higher value.

6. For each constituent determine P_L (the percent within the lower specification limit which corresponds to a given Q_L) from Table 1. Note: If a LSL is not specified, P_L will be 100.

   Note: For negative values of Q_L, P_L is equal to 100 minus the table P_L. If the value of Q_L does not correspond exactly to a figure in the table, use the next higher value.

7. For each constituent determine the quality level (the total percent within specification limits):

   Quality Level = $(P_U + P_L) - 100$

8. Using the quality level from step 7, determine the pay factor (PF_i) from Table 2 for each constituent tested.

9. Determine the Composite Pay Factor (CPF) for each lot.

$$CPF = \frac{f_1(\overline{PF_1}) = f_2(\overline{PF_2}) + \cdots + f_i(\overline{PF_i})}{\sum f_i}$$

where: $\frac{i = 1 \text{ to } j}{f_i}$ = price adjustment factor listed in these Specifications for the applicable material

j = number of constituents being evaluated

10. Determine an item adjustment factor:

(item) adjustment factor = CPF - 1

The (item) adjustment factor will be applied to the unit contract price for specific materials. For specific materials, the (item) adjustment factor will be identified as "Quality Incentive Factor," "Compliance Incentive Factor," etc.

1-06.3 Manufacturer's Certificate of Compliance

The Engineer may accept certain materials on the basis of a Manufacturer's Certificate of Compliance as an alternative to material inspection and testing. When a Manufacturer's Certificate of Compliance is authorized by these Specifications or the special provisions, the certification shall be furnished prior to use of the material.

The Contractor may request, in writing, authority from the Engineer to install such materials prior to submitting the required certification; however, no payment will be made for the work in the absence of an acceptable Manufacturer's Certificate of Compliance. The Contracting Agency reserves the right to deny the request for good cause. If for any reason the Contractor has not provided an acceptable Manufacturer's Certificate of Compliance by the physical completion date established by Section 1-08.5, the Contracting Agency will assess the usefulness of the installed material. At the Engineer's discretion, the Contracting Agency will either require replacement of the material by the Contractor at no expense to the Contracting Agency or process the final payment as provided by Section 1-09.9 without paying for the materials or any portion of the work performed to install the materials provided on such a basis. The unit contract prices for the work shall be used to determine the amount to be withheld. Where unit contract prices do not exist, as in a lump sum item, the amount to be withheld shall be an equitable adjustment, covering labor, equipment and materials, determined in accordance with Section 1-09.4.

The Manufacturer's Certificate of Compliance must identify the manufacturer, the type and quantity of material being certified, the applicable specifications being affirmed, and the signature of a responsible corporate official of the manufacturer and include supporting mill tests or documents. A Manufacturer's Certificate of Compliance shall be furnished with each lot of material delivered to the work and the lot so certified shall be clearly identified in the certificate.

All materials used on the basis of a Manufacturer's Certificate of Compliance may be sampled and tested at any time. Any material not conforming to the requirements will be subject to rejection whether in place or not. The Contracting Agency reserves the right to refuse to accept materials on the basis of a Manufacturer's Certificate of Compliance.

1-06.4 Handling and Storing Materials

In storage and handling, the Contractor shall protect materials against damage from careless handling, from exposure to weather, from mixture with foreign matter, and from all other causes. The Engineer will reject and refuse to test materials improperly handled or stored.

The Contractor shall repair, replace, or make good all Contracting Agency-provided materials that are damaged or lost due to the Contractor's operation or while in the Contractor's possession, at no expense to the Contracting Agency.

1-06.5 Vacant

1-06.6 Sieves for Testing

Test sieves shall be made either: (1) of woven wire cloth conforming to AASHTO Designation M 92 or ASTM Designation E 11, or (2) of square-hole, perforated plates conforming to ASTM Designation E 323.

1-07 LEGAL RELATIONS AND RESPONSIBILITIES TO THE PUBLIC

1-07.1 Laws to be Observed

The Contractor shall always comply with all Federal, State, tribal or local laws, ordinances, and regulations that affect work under the contract. The Contractor shall indemnify, defend, and save harmless the State (including the Governor, Commission, Secretary, and any agents, officers, and employees) against any claims that may arise because the Contractor (or any employee of the Contractor or subcontractor or materialperson) violated a legal requirement.

The Contractor shall be responsible for the safety of all workers and shall comply with all appropriate state safety and health standards, codes, rules, and regulations, including, but not limited to, those promulgated under the Washington Industry Safety and Health Act RCW Chapter 49.17 (WISHA) and as set forth in Title 296 WAC (Department of Labor and Industries). The Contractor shall likewise be obligated to comply with all federal safety and health standards, codes, rules, and regulations that may be applicable to the contract work.

U.S. Mine Safety and Health Administration rules apply when the project includes pit or quarry operations. Among other actions, these regulations require the Contractor to notify the nearest Mine Safety and Health sub district office (1) of the project before it begins, (2) of the starting date, and (3) of the physical completion date.

Without usurping the authority of other agencies, the Contracting Agency will cooperate with them in their efforts to enforce legal requirements. Upon awareness of a violation of a legal requirement, the Engineer will notify the Contractor in an effort to achieve compliance. The Engineer may also notify the agency responsible for enforcement if the Engineer deems that action is necessary to achieve compliance with legal requirements. The Engineer will also assist the enforcement agency to obtain Contractor compliance to the extent such assistance is consistent with the provisions of the contract.

The Contracting Agency will not adjust payment to compensate the Contractor for changes in legal requirements unless those changes are specifically within the scope of RCW 39.04.120. For changes under RCW 39.04.120, the Contracting Agency will compensate the Contractor by negotiated change order as provided in Section 1-04.4.

Under certain conditions, the Contracting Agency will adjust payment to compensate for tax changes. First, the changes shall involve federal or state taxes on materials or fuel used in or consumed for the project. Second, the changes shall increase or decrease Contractor-paid taxes by more than $500. For items in the original contract, the tax change must occur after the bid opening date. For negotiated contracts or items in a supplemental agreement, the tax change must take place after the execution date of the contract or agreement. Within these conditions, the Contracting Agency will adjust compensation by the actual dollar amounts of increase or decrease caused by the tax changes. If the Engineer requests it, the Contractor shall certify in writing that the contract price does not include any extra amount to cover a possible change in taxes.

The Contracting Agency may audit the records of the Contractor as provided in Section 1-09.12, to verify any claim for compensation because of changes in laws or taxes.

1-07.2 State Taxes

The Washington State Department of Revenue has issued special rules on the state sales tax. Sections 1-07.2(1) through 1-07.2(3) are meant to clarify those rules. The Contractor should contact the Financial System Manager, Department of Transportation, Olympia, for answers to questions in this area. The Contracting Agency will not adjust its payment if the Contractor bases a bid on a misunderstood tax liability.

The Contractor shall include all Contractor-paid taxes in the unit bid prices or other contract amounts. In some cases, however, state retail sales tax will not be included. Section 1-07.2(2) describes this exception.

The Contracting Agency will pay the retained percentage only if the Contractor has obtained from the State Department of Revenue a certificate showing that all contract-related taxes have been paid (RCW 60.28.050). The Contracting Agency may deduct from its payments to the Contractor any amount the Contractor may owe the State Department of Revenue, whether the amount owed relates to this contract or not. Any amount so deducted will be paid into the proper State fund.

1-07.2(1) State Sales Tax: Work Performed on City, County, or Federally-Owned Land

State Department of Revenue Rule 171 and its related rules apply for this section.

The special provisions of the contract will identify those parts of the project that require work on land owned by:

1. A municipal corporation,
2. A political subdivision of the State, or
3. The United States of America.

For work performed on such land, the Contractor shall include Washington State retail sales taxes in the various unit bid prices or other contract amounts. These retail sales taxes shall include those the Contractor pays on purchases of materials, equipment, and supplies used or consumed in doing the work.

1-07.2(2) State Sales Tax: Work on State-Owned or Private Land

State Department of Revenue Rule 170 and its related rules apply for this section.

The special provisions of the contract will identify those parts of the project that require work on State-owned or private land.

For work performed on State-owned or private land, the Contractor shall collect from the Contracting Agency, retail sales tax on the full contract price. The Contracting Agency will automatically add this sales tax to each payment to the Contractor. For this reason, the Contractor shall not include the retail sales tax in the unit bid prices or in any other contract amount.

However, the Contracting Agency will not add in sales tax the Contractor (prime or subcontractor) pays on the purchase or rental of tools, machinery, equipment, or consumable supplies not integrated into the project. Such sales taxes shall be included in the unit bid prices or in any other contract amount whether the State owns the construction site or not.

1-07.2(3) Services

The Contractor shall not collect retail sales tax from the Contracting Agency on any contract wholly for professional or other services (as defined in State Department of Revenue Rules 138 and 224).

1-07.3 Forest Protection and Merchantable Timber Requirements

1-07.3(1) Forest Fire Prevention

When the work is in or next to State or Federal forests, the Contractor shall know and observe all laws and rules (State or Federal) on fire prevention and sanitation. The Contractor shall ask the local forest supervisor or regional manager to outline requirements for permits, sanitation, fire-fighting equipment, and burning.

The Contractor shall take all reasonable precautions to prevent and suppress forest fires. In case of forest fire, the Contractor shall immediately notify the nearest forest headquarters of its exact site and shall make every effort to suppress it. If needed, the Contractor shall require his/her employees and those of any subcontractor to work under forest officials in fire-control efforts.

1-07.3(2) Merchantable Timber Requirements

When merchantable timber is to be cut, the Contractor shall obtain a permit from the appropriate regional office of the State Department of Natural Resources and comply fully with the State Forest Practices Act.

No person may export from the United States, or sell, trade, exchange, or otherwise convey to any other person for the purpose of export from the United States, timber originating from the project.

The Contractor shall comply with the Forest Resources Conservation and Shortage Relief Amendments Act of 1993, (Public Law 103-45), and the Washington State Log Export Regulations, (WAC 240-15).

1-07.4 Sanitation

1-07.4(1) General

The Contractor shall provide employees with all accommodations required by the State Department of Social and Health Services and other agencies. These accommodations shall be kept clean, neat, and sanitized, and shall not create any public nuisance. The Contractor shall keep all campsites clean, burn or properly dispose of all refuse, and leave each site in a neat and sanitary condition.

1-07.4(2) Health Hazards

Biological hazards and associated physical hazards may be present in the worksite. The Contractor shall take precautions and perform any necessary work to provide and maintain a safe and healthful worksite in accordance with applicable laws. Payment for work necessary to provide and maintain a safe worksite will be incidental to associated items of contract work unless the contract includes provisions to the contrary.

1-07.5 Environmental Regulations

1-07.5(1) General

Throughout the work, the Contractor shall comply with all current rules of the resource agencies having jurisdiction over the affected areas. Some, though not all, of these rules are summarized below. Any of these agencies may, without prejudice to the Contracting Agency, add rules as needed to protect game, fish, or the environment.

The following restrictions apply to all work:

1. No work shall occur within the jurisdictional areas unless authorized in the contract provisions and associated environmental permits.

2. No materials shall be placed below the ordinary high water line except as may be specified in the contract.
3. No equipment shall enter waters of the State, except as may be specified in the contract.

1-07.5(2) State Department of Fish and Wildlife

In doing the work, the Contractor shall:

1. Not degrade water in a way that would harm fish. (Criteria: Washington State Water Quality Regulations.)
2. Release any fish stranded by the project into a flowing stream or open water.
3. Replant any stream bank or shoreline area if the project disturbs vegetative cover. Replanted trees, brush, or grasses shall resemble the type and density of surrounding growth, unless the special provisions permit otherwise.
4. Leave, when the work is complete, an open-water channel at the lowest level of any isolated pothole to connect it with the main body of water.
5. Prevent any fish-threatening silt buildup on the bed or bottom of any body of water.
6. Never block stream flow or fish passage.
7. Never remove gravel or other bottom material from the high-water flow channel bed of any stream or from the bottom of any other body of water, except as may be permitted by the special provisions.
8. Dispose of any project debris by removal, burning, or placement above high-water flows.

If the work in (1) through (3) above differs little from what the contract requires, the Contracting Agency will measure and pay for it at unit contract prices. But if contract items do not cover those areas, the Contracting Agency will pay pursuant to Section 1-09.4. Work in (4) through (8) above will be incidental to contract pay items.

1-07.5(3) State Department of Ecology

In doing the work, the Contractor shall:

1. Get a waste discharge permit from the Ecology Department before:
   a. Washing aggregate; or
   b. Discharging water from pit sites or excavations into a ground or surface waterway when the water contains turbidity, silt, or foreign materials.
2. Give the Project Engineer a copy of each waste discharge permit before the work begins.
3. Control drainage and erosion in a manner that reduces waterway pollution.
4. Perform work in such a manner that all materials and substances not specifically identified in the contract documents to be placed in the water do not enter waters of the State, including wetlands.
5. Use equipment that is free of external petroleum-based products.
6. Remove accumulations of soil and debris from drive mechanisms (wheels, tracks, tires) and undercarriage of equipment prior to using equipment below the ordinary high water line.
7. Clean loose dirt and debris from all materials placed below the ordinary high water line. No materials shall be placed below the ordinary high water line without the Engineer's approval.

8. Notify the Engineer and Ecology Department immediately should oil, chemicals, or sewage spill into waters of the State

1-07.5(4) Air Quality

The Contractor shall comply with all rules of local air pollution authorities. If there are none, air-quality rules of the State Department of Ecology shall govern the work.

The Washington Clean Air Act requires that rock crushing, rock drilling, asphalt batch plants, and concrete plants receive an air quality permit in advance of the operation. The air quality permit process may include additional State Environment Policy Act (SEPA) requirements. Contractors or operators should contact the appropriate air pollution control authority well in advance of intended start-up. The permit process may require up to 30 days.

When the work includes demolition of any existing facility, the Contractor shall comply with the requirements of the National Emission Standards for Asbestos. Any requirement included in state or Federal regulations on this subject that applies to the "owner or operator" shall be the responsibility of the Contractor.

1-07.6 Permits and Licenses

Contractors shall obtain all required permits and licenses and give any notices these call for.

The Contracting Agency will support the Contractor in efforts to obtain a temporary operating permit in its name if:

1. A local rule or an agency policy prevent issuing the permit to a private firm;
2. The Contractor takes all action to obtain the permit;
3. The permit will serve the public interest;
4. The permit applies only to work under the contract;
5. The Contractor agrees in writing: (a) to comply with all the issuing agency requires, and (b) to hold the Contracting Agency harmless for any work-related liability incurred under the permit; and
6. The permit costs the Contracting Agency nothing.

1-07.7 Load Limits

1-07.7(1) General

While moving equipment or materials on any public highway, the Contractor shall comply with all laws that control traffic or limit loads. The contract neither exempts the Contractor from such laws nor licenses overloads. At the Engineer's request, the Contractor shall provide any facts needed to compute the equipment's weight on the roadway.

When the Contractor moves equipment or materials within the project limits as shown in the Plans, legal load limits shall apply on:

1. Any road open to and in use by public traffic; or
2. Any existing road not scheduled for major reconstruction under the current contract; or
3. Any newly paved road (with final lift in place) built under this contract. The Contractor may haul overloads (not more than 25 percent above load limits) on such roads not open to public traffic if this does not damage completed work. The Contractor shall pay all repair costs of any overload damage.

Elsewhere on the project, the Contractor may operate equipment with only the load-limit restrictions in 1, 2, and 3 in Section 1-07.7(2). The Contractor shall remain responsible, however, for all load-caused damage. All vehicles subject to license on a tonnage basis shall be licensed to maximum legal capacity before operating under these limits.

If necessary and safe to do so, and if the Contractor requests it in writing, the Engineer may approve higher load limits than those in the load-limit restrictions in 1, 2, and 3 in Section 1-07.7(2). The written request shall:

1. Describe loading details;
2. Describe the arrangement, movement, and position of equipment on the structure or over culverts and pipes; and
3. State that the Contractor assumes all risk for damage.

Unit prices shall cover all costs for operating over bridges and culverts. Nothing in this section affects the Contractor's other responsibilities under these Specifications or under public highway laws.

1-07.7(2) Load-Limit Restrictions

1. **Structures Designed for Direct Bearing of Live Loads.** The gross or maximum load on each vehicle axle shall not exceed the legal load limit by more than 35 percent. No more than one vehicle shall operate over any structure at one time. The Contractor shall immediately remove any dirt, rock, or debris that may gather on the structure's roadway surface.

   If the Contractor desires to utilize work methods resulting in load that exceed any of the restrictions described above, the Contractor shall submit calculations and other supporting information (as specified in Section 6-01.6 for bridges under construction) to the Engineer for approval in accordance with Sections 6-01.6 and 6-01.9. The Engineer will review the calculations and supporting information to determine if the loading meets the criteria specified in Section 6-01.6. The Contractor shall not place or operate construction vehicles or equipment on or over the structure until receiving the Engineer's approval of the submittal.

2. **Underpasses and Reinforced Concrete Box Culverts Under Embankments.** Loads shall not exceed 24,000 pounds on a single axle and 16,000 pounds each on tandem axles spaced less than 10 feet apart. These limits are permitted only if the embankment has: (a) been built to specifications, and (b) reached at least 3 feet above the top of the underpass or culvert.

   When the embankment has reached 5 feet above the top of the underpass or culvert, the Contractor may increase per-axle loads up to 100,000 pounds if outside wheel spacing is at least 7 feet on axle centers.

3. **Pipe Culverts and Sewer Pipes.** Loads over pipe culverts and sewer pipes shall not exceed 24,000 pounds on a single axle and 16,000 pounds each on tandem axles spaced less than 10 feet apart. These limits are permitted only if: (a) the culvert or pipe has been installed and backfilled to specifications, and (b) the embankment has reached at least 2 feet above the top limit of pipe compaction.

When the embankment has reached 5 feet above the top limit of pipe compaction, the Contractor may increase per-axle loads up to 100,000 pounds if outside wheel spacing is at least 7 feet on axle centers, except that:

a. For Class III reinforced concrete pipes, the embankment shall have risen above the top limit of compaction at least 6 feet.

b. For Class II reinforced concrete pipes, the maximum load for each axle shall be 80,000 pounds if outside wheel spacing is at least 7 feet on axle centers. In this case, the embankment shall have risen above the top limit of compaction at least 6 feet.

1-07.8 High Visibility Apparel

The Contractor shall require all personnel at the work site under their control (including subcontractors and lower tier subcontractors) to comply with the following:

1. To wear reflective vests, except that during daylight hours, clothing of orange, yellow, strong yellow green or fluorescent versions of these colors may be worn in lieu of vests. Flaggers must wear reflective vests and hard hats at all times;
2. During hours of darkness, to wear vests, white coveralls or either high visibility reflective fluorescent lime yellow pants with fluorescent orange strip or reflective fluorescent orange pants with fluorescent lime yellow strip.
3. When rain gear is worn during hours of darkness, it shall be white or yellow;
4. The reflective vests shall always be the outermost garments.

Exceptions to these requirements are: (1) when personnel are out of view of, or not exposed to traffic, (2) when personnel are inside a vehicle, or (3) where it is obvious that such apparel is not needed for the employees safety from traffic.

Reflective vests shall be high visibility lime-yellow in base color with orange-red trim and 3M silver Scotchlite reflective material (or equivalent) or orange-red base color with lime-yellow reflective stripe. Vests shall have 230 or more square inches of reflective trim as measured on a medium vest. The 3M type 6187 (or equivalent) 2” wide lime-yellow reflective stripe can be used as the lime-yellow trim on a red-orange vest. All components to these garments must be visible in 360 degrees, from all angles and the reflective material visible at a minimum of 1,000-feet.

Reflective vests, hard hats, white coveralls, rain gear, and other apparel shall be furnished and maintained in a neat, clean, and presentable condition at no expense to the Contracting Agency.

1-07.9 Wages

1-07.9(1) General

This contract is subject to the minimum wage requirements of RCW 39.12 and to RCW 49.28 (as amended or supplemented). On Federal-aid projects, Federal wage laws and rules also apply. The hourly minimum rates for wages and fringe benefits are listed in the contract provisions. When Federal wage and fringe benefit rates are listed, the rates match those identified by the U.S. Department of Labor’s “Decision Number” shown in the contract provisions.

The Contractor, any subcontractor, and all individuals or firms required by RCW 39.12, WAC 296-127, or the Federal Davis-Bacon and Related Acts (DBRA) to pay minimum prevailing wages, shall not pay any worker less than the minimum hourly wage rates and fringe benefits required by RCW 39.12 or the DBRA. Higher wages and benefits may be paid.

By including the hourly minimum rates for wages and fringe benefits in the contract provisions, the Contracting Agency does not imply that the Contractor will find labor available at those rates. The Contractor shall be responsible for any amounts above the minimums that will actually have to be paid. The Contractor shall bear the cost of paying wages above those shown in the contract provisions.

When the project is subject to both State and Federal hourly minimum rates for wages and fringe benefits and when the two rates differ for similar kinds of labor, the Contractor shall not pay less than the higher rate unless the State rates are specifically preempted by Federal law. When the project involves both highway work and building work, the contract provisions may list a Federal wage and fringe benefit rate for the highway work and a separate Federal wage and fringe benefit rate for the building work. The area in which the worker is physically employed shall determine which Federal wage and fringe benefit rate shall be used to compare against the State wage and fringe benefit rate.

If employing labor in a class not listed in the contract provisions, the Contractor shall request a determination of the correct wage rate for that class and locality from the Industrial Statistician, Washington State Department of Labor and Industries (State L&I), and from the U.S. Secretary of Labor on Federal-aid projects. The Contractor shall provide a copy of these determinations to the Engineer.

The Contractor shall ensure that any firm (Supplier, Manufacturer, or Fabricator) that falls under the provisions of RCW 39.12 because of the definition "Contractor" in WAC 296-127-010, complies with all the requirements of RCW 39.12.

The Contractor shall be responsible for compliance with the requirements of the DBRA and RCW 39.12 by all firms (Subcontractors, Lower Tier Subcontractors, Suppliers, Manufacturers, or Fabricators) engaged in any part of the work necessary to complete this contract. Therefore, should a violation of this subsection occur by any firm that is providing work or materials for completion of this contract whether directly or indirectly responsible to the Contractor, the Contracting Agency will take action against the Contractor, as provided by the provisions of the contract, to achieve compliance, including but not limited to, withholding payment on the contract until compliance is achieved.

In the event the Contracting Agency has an error (omissions are not errors) in the listing of the hourly minimum rates for wages and fringe benefits in the contract provisions, the Contractor, any subcontractor, any lower tier subcontractor, or any other firm that is required to pay prevailing wages, shall be required to pay the rates as determined to be correct by State L&I (or by the U.S. Department of Labor when that agency sets the rates). A change order will be prepared to ensure that this occurs. The Contracting Agency will reimburse the Contractor for the actual cost to pay the difference between the correct rates and the rates included in the contract provisions, subject to the following conditions:

1. The affected firm relied upon the rates included in the contract provisions to prepare its bid and certifies that it did so;
2. The allowable amount of reimbursement will be the difference between the rates listed and rates later determined to be correct plus only appropriate payroll markup the employer must pay, such as, social security and other payments the employer must make to the Federal or State Government;

3. The allowable amount of reimbursement may also include some overhead cost, such as, the cost for bond, insurance, and making supplemental payrolls and new checks to the employees because of underpayment for previously performed work; and
4. Profit will not be an allowable markup.

Firms that anticipated, when they prepared their bids, paying a rate equal to, or higher than, the correct rate as finally determined will not be eligible for reimbursement.

1-07.9(2) Posting Notices

In a location acceptable to State L&I, the Contractor shall ensure the following is posted:

1. One copy of the approved "Statement of Intent to Pay Prevailing Wages" for the Contractor, each subcontractor, each lower tier subcontractor, and any other firm (Supplier, Manufacturer, or Fabricator) that falls under the provisions of RCW 39.12 because of the definition of "Contractor" in WAC 296-127-010;
2. One copy of the prevailing wage rates for the project;
3. The address and telephone number of the Industrial Statistician for State L&I (along with notice that complaints or questions about wage rates may be directed there); and
4. FHWA 1495/1495A "Wage Rate Information" poster if the project is funded with Federal-aid.

1-07.9(3) Apprentices

If employing apprentices, the Contractor shall submit to the Engineer written evidence showing:

1. Each apprentice is enrolled in a program approved by the Washington State Apprenticeship and Training Council;
2. The progression schedule for each apprentice; and
3. The established apprentice-journey level ratios and wage rates in the project locality upon which the Contractor will base such ratios and rates under the contract. Any worker for whom an apprenticeship agreement has not been registered and approved by the Washington State Apprenticeship and Training Council shall be paid at the prevailing hourly journey level rate as provided in RCW 39.12.021.

1-07.9(4) Disputes

If labor and management cannot agree in a dispute over the proper prevailing wage rates, the Contractor shall refer the matter to the Director of State L&I (or to the U.S. Secretary of Labor when that agency sets the rates). The Director's (or Secretary's) decision shall be final, conclusive, and binding on all parties.

1-07.9(5) Required Documents

On forms provided by the Industrial Statistician of State L&I, the Contractor shall submit to the Engineer the following for itself and for each firm covered under RCW 39.12 that provided work and materials for the contract:

1. A copy of an approved "Statement of Intent to Pay Prevailing Wages" State L&I's form number F700-029-000. The Contracting Agency will make no payment under this contract for the work performed until this statement has been approved by State L&I and a copy of the approved form has been submitted to the Engineer.
2. A copy of an approved "Affidavit of Prevailing Wages Paid," State L&I's form number F700-007-000. The Contracting Agency will not release to the Contractor any funds retained under RCW 60.28.011 until all of the "Affidavit of Prevailing Wages Paid" forms have been approved by State L&I and a copy of all the approved forms have been submitted to the Engineer.

The Contractor shall be responsible for requesting these forms from State L&I and for paying any approval fees required by State L&I.

Certified payrolls are required to be submitted by the Contractor to the Engineer, for the Contractor and all subcontractors or lower tier subcontractors, on all Federal-aid projects and, when requested in writing by the Engineer, on projects funded with only Contracting Agency funds. If these payrolls are not supplied within ten calendar days of the end of the preceding weekly payroll period for Federal-aid projects or within ten calendar days from the date of the written request on projects with only Contracting Agency funds, any or all payments may be withheld until compliance is achieved. Also, failure to provide these payrolls could result in other sanctions as provided by State laws (RCW 39.12.050) and/or Federal regulations (29 CFR 5.12). All certified payrolls shall be complete and explicit. Employee labor descriptions used on certified payrolls shall coincide exactly with the labor descriptions listed on the minimum wage schedule in the contract unless the Engineer approves an alternate method to identify the labor used by the Contractor to compare with the labor listed in the contract provisions. When an apprentice is shown on the certified payroll at a rate less than the minimum prevailing journey wage rate, the apprenticeship registration number for that employee from the State Apprenticeship and Training Council shall be shown along with the correct employee classification code.

1-07.9(6) Audits

The Contracting Agency may inspect or audit the Contractor's wage and payroll records as provided in Section 1-09.12.

1-07.10 Worker's Benefits

The Contractor shall make all payments required for unemployment compensation under Title 50 RCW and for industrial insurance and medical aid required under Title 51 RCW. If any payment required by Title 50 or Title 51 is not made when due, the Contracting Agency may retain such payments from any money due the Contractor and pay the same into the appropriate fund. Such payment will be made only after giving the Contractor 15 days prior written notice of the Contracting Agency's intent to disburse the funds to the Washington State Department of Labor and Industries or Washington State Employment Security Department as applicable. The payment will be made upon expiration of the 15 calendar day period if no legal action has been commenced to resolve the validity of the claim. If legal action is instituted to determine the validity of the claim prior to the expiration of the 15-day period, the Contracting Agency will hold the funds until determination of the action or written settlement agreement of the appropriate parties.

For work on or adjacent to water, the Contractor shall make the determination as to whether workers are to be covered under the Longshoremen's and Harbor Worker's Compensation Act administered by the U.S. Department of Labor, or the State Industrial Insurance coverage administered by the Washington State Department of Labor and Industries.

The Contractor shall include in the various items in the bid proposal all costs for payment of unemployment compensation and for providing either or both of the insurance coverages. The Contractor will not be entitled to any additional payment for: (1) failure to include such costs, or (2) determinations made by the U.S. Department of Labor or the Washington State Department of Labor and Industries regarding the insurance coverage.

The Public Works Contract Division of the Washington State Department of Labor and Industries will provide the Contractor with applicable industrial insurance and medical aid classification and premium rates. After physical completion of the project, the Contractor shall submit a "Request for Release" to the Washington State Department of Labor and Industries on the form they provide. The "Request for Release" form is for the purpose of obtaining a release with respect to the payments of industrial insurance and medical aid premiums.

1-07.11 Requirements For Nondiscrimination

1-07.11(1) General Application

Discrimination in all phases of contracted employment, contracting activities and training is prohibited by Title VI of the Civil Rights Act of 1964, Section 162(a) of the Federal-Aid Highway Act of 1973, Section 504 of the Rehabilitation Act of 1973, the Age Discrimination Act of 1975, the Justice System Improvement Act of 1979, the American with Disabilities Act of 1990, the Civil Rights Restoration Act of 1987, 49 CFR Part 21, RCW 49.60 and other related laws and statutes. The referenced legal citations establish the minimum requirements for affirmative action efforts and define the basic nondiscrimination provisions as required by this section of these Standard Specifications.

1-07.11(2) Contractual Requirements

1. The Contractor shall not discriminate against any employee or applicant for contracted employment because of race, creed, color, national origin, sex, age, marital status, or the presence of any physical, sensory or mental disability.
2. The Contractor shall, in all solicitations or advertisements for employees, state that all qualified applicants will be considered for employment, without regard to race, creed, color, national origin, sex, age, marital status, or the presence of any physical, sensory, or mental disability.
3. The Contractor shall insert the following notification in all solicitations for bids for work or material subject to federal laws and regulations and made in connection with all program and activities and, in adapted form in all proposals for negotiated agreements:

   The Contractor in accordance to Title VI of the Civil Rights Act of 1964, 78 Stat.252, 42 U.S. Code 2000d to 2000d-4, and Title 49 Code of Federal Regulations, Part 21, hereby notifies all bidders that it will affirmatively ensure that in any contract entered into pursuant to this advertisement, minority business enterprises will be afforded full opportunity to submit

bids in response to this invitation and will not be discriminated against on the grounds of race, color national origin and sex in consideration for an award.

4. The Contractor shall make decisions with regard to selection and retention of sub Contractors, procurement of materials and equipment and similar actions related to the contract without regard to race, creed, color, national origin, sex, age, marital status, or the presence of any physical, sensory, or mental disability.
5. The Contractor shall send to each labor union, employment agency, or representative of workers with which the Contractor has a collective bargaining agreement or other contract or understanding, a notice advising the labor union, employment agency or worker's representative, of the Contractor's commitments under this contract with regard to nondis crimination.
6. The Contractor shall permit access to its books, records and accounts by the Contracting Agency for the purpose of investigating to ascertain compliance with these specifications. In the event that information required of a Contractor is in the possession of another who fails or refuses to furnish this information, the Contractor shall describe, in writing, what efforts were made to obtain the information.
7. The Contractor shall maintain records with the name and address of each minority/female worker referred to the Contractor and what action was taken with respect to the referred worker.
8. The Contractor shall notify the Contracting Agency whenever the union with which the Contractor has a collective bargaining agreement has impeded the Contractor's efforts to effect minority/female workforce utilization. This being the case, the Contractor shall show what relief they have sought under such collective bargaining agreements.
9. The Contractor is encouraged to participate in Contracting Agency and Washington State Human Rights Commission approved program(s) designed to train craft-workers for the construction trades.

1-07.11(2)A Equal Employment Opportunity (EEO) Responsibilities

Title VI Responsibilities

During the performance of this contract, the Contractor, for itself, its assignees and successors in interest (hereinafter referred to as the "Contractor") agrees as follows:

1. **Compliance With Regulations.** The Contractor shall comply with the Regulations relative to nondiscrimination in federally assisted programs of the Department of Transportation (hereinafter DOT), Title 49, Code of Federal Regulations, part 21, as they may be amended from time to time, (hereinafter referred to as the Regulations), which are herein incorporated by reference and made a part of this contract.
2. **Nondiscrimination.** The Contractor, with regard to the work performed by it during the contract, shall not discriminate on the grounds of race, color, sex, or national origin in the selection and retention of subcontractors, including procurement of materials and leases of equipment. The Contractor shall not participate either directly or indirectly in the discrimination prohibited by Section 21.5 of the Regulations, including employment practices when the contract covers a program set forth in Appendix B of the Regulations.

3. **Solicitations for Subcontracts, Including Procurement of Materials and Equipment.** In all solicitations either by competitive bidding or negotiations made by the Contractor for work to be performed under a subcontract, including procurement of materials or leases of equipment, each potential subcontractor or supplier shall be notified by the Contractor of the Contractor's obligations under this contract and the Regulations relative to nondiscrimination on the ground of race, color, sex, or national origin.
4. **Information and Reports.** The Contractor shall provide all information and reports required by the Regulations or directives issued pursuant thereto, and shall permit access to its books, records, accounts, other sources of information, and its facilities as may be determined by the Washington State Department of Transportation or the Federal Highway Administration to be pertinent to ascertain compliance with such Regulations, orders and instructions. Where any information required of a Contractor is in the exclusive possession of another who fails or refuses to furnish this information, the Contractor shall so certify to the Washington State Department of Transportation, or the Federal Highway Administration as appropriate, and shall set forth what efforts it has made to obtain the information.
5. **Sanctions for Noncompliance.** In the event of the Contractor's noncompliance with the nondiscrimination provisions of this contract, the Washington State Department of Transportation shall impose such contract sanctions as it or the Federal Highway Administration may determine to be appropriate, including, but not limited to:
   a. Withholding of payments to the Contractor under the contract until the Contractor complies, and/or;
   b. Cancellation, termination, or suspension of the contract, in whole or in part.
6. **Incorporation of Provisions.** The Contractor shall include the provisions of paragraphs (1) through (5) in every subcontract, including procurement of materials and leases of equipment, unless exempt by the Regulations, or directives issued pursuant thereto. The Contractor shall take such action with respect to any subcontractor or procurement as the Washington State Department of Transportation or the Federal Highway Administration may direct as a means of enforcing such provisions including sanctions for noncompliance.

   Provided, however, that in the event a Contractor becomes involved in, or is threatened with, litigation with a subcontractor or supplier as a result of such direction, the Contractor may request the Washington State Department of Transportation enter into such litigation to protect the interests of the state and, in addition, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

1-07.11(3) Equal Employment Opportunity Officer

The Contractor shall officially designate and make known to the Engineer during the preconstruction meetings and discussions the firm's Equal Employment Opportunity Officer (hereinafter referred to as the EEO Officer). The EEO Officer will also be responsible for making him/herself known to each of the Contractor's employees. The EEO Officer must possess the responsibility, authority, and capability for administering and promoting an active and effective Contractor program of equal employment opportunity.

1-07.11(4) Dissemination of Policy

1-07.11(4)A Supervisory Personnel

All members of the Contractor's staff who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, shall be made fully cognizant of, and shall implement the Contractor's equal employment opportunity policy and contractual responsibilities to provide equal employment opportunity in each grade and classification of employment. To ensure that the above agreement will be met, the following actions shall be taken as a minimum:

1. **EEO Meetings.** Periodic meetings of supervisory and personnel office employees shall be conducted before the start of work and then not less often than once every 6 months, at which time the Contractor's equal employment opportunity policy and its implementation shall be reviewed and explained. The meetings shall be conducted by the EEO Officer or other knowledgeable company official.
2. **EEO Indoctrination.** All new supervisory or personnel office employees shall be given a thorough indoctrination by the EEO Officer or other knowledgeable company official covering all major aspects of the Contractor's equal employment opportunity obligations within 30 days following their reporting for duty with the Contractor.
3. **Internal EEO Procedures.** All personnel who are engaged in direct recruitment for the project shall be instructed by the EEO Officer or appropriate company official in the Contractor's procedures for locating and hiring minority group and female employees.

1-07.11(4)B Employees, Applicants, and Potential Employees

In order to make the Contractor's equal employment opportunity policy known to all employees, prospective employees, and potential sources of employees, e.g., schools, employment agencies, labor unions (where appropriate), college placement officers, community organizations, etc., the Contractor shall take the following actions:

1. **Notices and Posters.** Notices and posters setting forth the Contractor's equal employment opportunity policy shall be placed in areas readily accessible to employees, applicants for employment, and potential employees.
2. **EEO Indoctrination.** The Contractor's equal employment opportunity policy and the procedures to implement such policy shall be brought to the attention of employees by means of meetings, employee handbooks, or other appropriate means.

1-07.11(5) Sanctions

In the event of the Contractor is found in noncompliance with the provisions of Section 1-07.11, the Contracting Agency may impose such contract sanctions as it or the Federal Highway Administration may determine necessary to gain compliance including, but not limited to:

1. Progress payment requests may not be honored until the noncompliance is remedied to the satisfaction of the Contracting Agency.
2. The contract may be suspended, in whole or in part, until such time as the Contractor is determined to be in compliance by the Contracting Agency.
3. The Contractor's pre-qualification may be suspended or revoked pursuant to WAC 468-16. The Contracting Agency may refer the matter to the Federal Highway Administration (FHWA) for possible federal sanctions.
4. The contract may be terminated.

1-07.11(6) Incorporation of Provisions

The Contractor shall include the provisions of Section 1-07.11(2) Contractual Requirements (1) through (4) and the Section 1-07.11(5) Sanctions in every subcontract including procurement of materials and leases of equipment. The Contractor shall take such action or enforce sanctions with respect to a subcontractor or supplier as the Contracting Agency or the FHWA may direct as a means of enforcing such provisions. In the event a Contractor becomes involved in litigation with a subcontractor or supplier as a result of such direction, the Contractor may request the Contracting Agency enter into such litigation to protect their interests and the Contracting Agency may request the federal government to enter into such litigation to protect the interests of the United States.

1-07.11(7) Vacant

1-07.11(8) Vacant

1-07.11(9) Subcontracting, Procurement of Materials, and Leasing of Equipment

Nondiscrimination. The Contractor shall not discriminate on the grounds of race, color, religion, sex, national origin, age, or disability in the selection and retention of subcontractors, including procurement of materials and leases of equipment.

Solicitation and Utilization. The Contractor shall use their best effort to solicit bids from, and to utilize, disadvantaged, minority, and women subcontractors, or subcontractors with meaningful minority and women representation among their employees.

Subcontractor EEO Obligations. The Contractor shall notify all potential subcontractors and suppliers of the EEO obligations required by the contract. The Contractor shall use their efforts to ensure subcontractors compliance with their equal employment opportunity obligations.

1-07.11(10) Records and Reports

1-07.11(10)A General

The Contractor shall keep such records as are necessary to determine compliance with the Contractor's equal employment opportunity obligations. The records kept by the Contractor shall be designated to indicate:

1. **Work Force Data.** The number of minority and nonminority group members and women employed in each work classification on the project.
2. **Good Faith Efforts — Unions.** The progress and efforts being made in cooperation with unions to increase employment opportunities for minorities and women (applicable only to contractors who rely in whole or in part on unions as a source of their work force).
3. **Good Faith Efforts — Recruitment.** The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minority and female employees.
4. **Subcontracting.** The progress and efforts being made in securing the services of disadvantaged, minority, and women subcontractors or subcontractors with meaningful minority and female representation among their employees.

1-07.11(10)B Required Records and Retention

All records must be retained by the Contractor for a period of three years following acceptance of the contract work. All records shall be available at reasonable times and places for inspection by authorized representatives of either the Washington State Department of Transportation or the Federal Highway Administration.

Federal-Aid Highway Construction Contractors Annual EEO Report

FHWA #1391. This form is required for all federally assisted projects provided the contract is equal to or greater than $10,000 and for every associated subcontract equal to or greater than $10,000. Each contract requires separate reports filed for the Contractor and each subcontractor (subject to the above noted criteria). These forms are due by August 25th in every year during which work was performed in July. The payroll period to be reflected in the report is the last payroll period in July in which work was performed. This report is required of each Contractor and subcontractor for each federally assisted contract on which the Contractor or subcontractor performs work during the month of July.

Monthly Employment Utilization Reports

WSDOT Form #820-010. This form (or substitute form as approved by the Contracting Agency) is required for all federally assisted projects if the contract is equal to or greater then $10,000 and for every associated subcontract equal to or greater than $10,000. These monthly reports are to be maintained in the respective Contractor or subcontractor's records.

In addition, for contracts with a value of $100,000 or more, the Contractor shall submit copies of the completed WSDOT form 820-010 or approved substitute to the Contracting Agency by the fifth of each month throughout the term of the contract. The Contractor shall also collect and submit these forms monthly from every subcontractor who holds a subcontract with a value of $100,000 or more.

Failure to submit the required reports by their due dates may result in the withholding of progress estimate payments.

1-07.12 Federal Agency Inspection

Federal laws, rules, and regulations shall be observed by the Contractor on Federal-aid projects. This work is subject to inspection by the appropriate Federal agency. The Contractor shall cooperate with the Federal agencies in these inspections. These inspections shall not make the Federal Government a party to the contract and shall not constitute an interference with the rights of the Contracting Agency or the Contractor.

1-07.13 Contractor's Responsibility for Work

1-07.13(1) General

All work and material for the contract, including any change order work, shall be at the sole risk of the Contractor until the entire improvement has been completed as determined by the Engineer, except as provided in this section.

The Contractor shall rebuild, repair, restore, and make good all damages to any portion of the permanent or temporary work occurring before the physical completion date and shall bear all the expense to do so, except damage to the permanent work caused by: (a) acts of God, such as earthquake, floods, or other cataclysmic phenomenon of nature, or (b) acts of the public enemy or of governmental authorities; or (c) slides in cases where Section 2-03.3(11) is applicable; Provided, however, that these exceptions shall not apply should damages result from the Contractor's failure to take reasonable precautions or to exercise sound engineering and construction practices in conducting the work.

If the performance of the work is delayed as a result of damage by others, an extension of time will be evaluated in accordance with Section 1-08.8.

Nothing contained in this section shall be construed as relieving the Contractor of responsibility for, or damage resulting from, the Contractor's operations or negligence, nor shall the Contractor be relieved from full responsibility for making good any defective work or materials as provided for under Section 1-05.

1-07.13(2) Relief of Responsibility for Completed Work

Upon written request, the Contractor may be relieved of the duty of maintaining and protecting certain portions of the work, as described below, which have been completed in all respects in accordance with the requirements of the contract. If the Engineer provides written approval, the Contractor will be relieved of the responsibility for damage to said completed portions of the work resulting from use by public traffic or from the action of the elements or from any other cause, but not from damage resulting from the Contractor's operations or negligence.

Portions of the work for which the Contractor may be relieved of the duty of maintenance and protection as provided in the above paragraph include but are not limited to the following:

1. The completion of 1/4 mile of roadway or 1/4 mile of one roadway of a divided highway or a frontage road including the traveled way, shoulders, drainage control facilities, planned roadway protection work, lighting, and any required traffic control and access facilities.
2. A bridge or other structure of major importance.
3. A complete unit of a traffic control signal system or of a highway lighting system.
4. A complete unit of permanent highway protection work.
5. A building that is functionally complete and open to the public.
6. Any contract proposal item.

1-07.13(3) Relief of Responsibility for Damage by Public Traffic

When it is necessary for public traffic to utilize a highway facility during construction, the Contractor will be relieved of responsibility for damages to permanent work by public traffic under the following circumstances:

1. The work is in accordance with the contract plans or approved stage construction plans,
2. The work is on a section of roadway required by the contract to be opened to public traffic, and
3. The traffic control is in accordance with the approved traffic control plans.

If traffic is relocated to another section of roadway, the Contractor shall resume responsibility for the work until such time as the section of roadway is again open to public traffic or the Contractor submits a written request for work that is completed to a point where relief can be granted in accordance with Section 1-07.13(2).

1-07.13(4) Repair of Damage

The Contractor shall promptly repair all damage to either temporary or permanent work as ordered by the Engineer. For damage qualifying for relief under Sections 1-07.13(1), 1-07.13(2) or 1-07.13(3), payment will be made in accordance with Section 1-09.4 using the estimated bid item "Reimbursement for Third Party Damage".

In the event the Contracting Agency pays for damage to the Contractor's work or for damage to the Contractor's equipment caused by third parties, any claim the Contractor had or may have had against the third party shall be deemed assigned to the Contracting Agency, to the extent of the Contracting Agency's payment for such damage.

Payment will be limited to repair of damaged work only. No payment will be made for delay or disruption of work.

For the purpose of providing a common proposal for all bidders, the Contracting Agency has entered an amount for "Reimbursement For Third Party Damage" in the proposal to become a part of the total bid by the Contractor.

1-07.14 Responsibility for Damage

The State, Governor, Commission, Secretary, and all officers and employees of the State, including but not limited to those of the Department, will not be responsible in any manner: for any loss or damage that may happen to the work or any part; for any loss of material or damage to any of the materials or other things used or employed in the performance of work; for injury to or death of any persons, either workers or the public; or for damage to the public for any cause which might have been prevented by the Contractor, or the workers, or anyone employed by the Contractor.

The Contractor shall be responsible for any liability imposed by law for injuries to, or the death of, any persons or damages to property resulting from any cause whatsoever during the performance of the work, or before final acceptance.

Subject to the limitations in this section, the Contractor shall indemnify, defend, and save harmless the State, Governor, Commission, Secretary, and all officers and employees of the State from all claims, suits, or actions brought for injuries to, or death of, any persons or damages resulting from construction of the work or in consequence of any negligence regarding the work, the use of any improper materials in the work, caused in whole or in part by any act or omission by the Contractor or the agents or employees of the Contractor during performance or at any time before final acceptance. In addition to any remedy authorized by law, the State may retain so much of the money due the Contractor as deemed necessary by the Engineer to ensure indemnification until disposition has been made of such suits or claims.

Subject to the limitations in this section, the Contractor shall indemnify, defend, and save harmless any county, city, or region, its officers, and employees connected with the work, within the limits of which county, city, or region the work is being performed, all in the same manner and to the same extent as provided above for the protection of the State, its officers and employees, provided that no retention of money due the Contractor be made by the State except as provided in RCW 60.28, pending disposition of suits or claims for damages brought against the county, city, or district.

The Contractor will not be required to indemnify, defend, or save harmless the indemnitee as provided in the preceding paragraphs of this section if the claim, suit, or action for injuries, death, or damages is caused by the sole negligence of the indemnitee. Where such claims, suits, or actions result from the concurrent negligence of (a) the indemnitee or the indemnitee's agents or employees and (b) the Contractor or the Contractor's agent or employees, the indemnity provisions provided in the preceding paragraphs of this section shall be valid and enforceable only to the extent of the Contractor's negligence or the negligence of its agents and employees.

The Contractor shall bear sole responsibility for damage to completed portions of the project and to property located off the project caused by erosion, siltation, runoff, or other related items during the construction of the project. The Contractor shall also bear sole responsibility for any pollution of rivers, streams, ground water, or other waters that may occur as a result of construction operations.

The Contractor shall exercise all necessary precautions throughout the life of the project to prevent pollution, erosion, siltation, and damage to property.

The Contracting Agency will forward to the Contractor all claims filed against the State according to RCW 4.92.100 that are deemed to have arisen in relation to the Contractor's work or activities under this contract, and, in the opinion of the Contracting Agency, are subject to the defense, indemnity, and insurance provisions of these Standard Specifications. Claims will be deemed tendered to the Contractor and insurer, who has named the State as a named insured or an additional insured under the contract's insurance provisions, once the claim has been forwarded via certified mail to the Contractor. The Contractor shall be responsible to provide a copy of the claim to the Contractor's designated insurance agent who has obtained/met the contract's insurance provision requirements.

Within 60 calendar days following the date a claim is sent by the Contracting Agency to the Contractor, the Contractor shall notify the Claimant and WSDOT (Risk Management Office, PO Box 47418, Olympia, WA 98504-7418) of the following:

a. whether the claim is allowed or is denied in whole or in part, and, if so, the specific reasons for the denial of the individual claim, and if not denied in full, when payment has been or will be made to the claimant(s) for the portion of the claim that is allowed, or

b. if resolution negotiations are continuing. In this event, status updates will be reported no longer than every 60 calendar days until the claim is resolved or a lawsuit is filed.

If the Contractor fails to provide the above notification within 60 calendar days, then the Contractor shall yield to the Contracting Agency sole and exclusive discretion to allow all or part of the claim on behalf of the Contractor, and the **Contractor shall be deemed to have WAIVED any and all defenses, objections, or other avoidances to the Contracting Agency's allowance of the claim, or the amount allowed by the**

Contracting Agency, under common law, constitution, statute, or the contract and these Standard Specifications. If all or part of a claim is allowed, the Contracting Agency will notify the Contractor via certified mail that it has allowed all or part of the claim and make appropriate payments to the claimant(s) with State funds.

Payments of State funds by the Contracting Agency to claimant(s) under this section will be made on behalf of the Contractor and at the expense of the Contractor, and the Contractor shall be unconditionally obligated to reimburse the Contracting Agency for the "total reimbursement amount", which is the sum of the amount paid to the claimant(s), plus all costs incurred by the Contracting Agency in evaluating the circumstances surrounding the claim, the allowance of the claim, the amount due to the claimant, and all other direct costs for the Contracting Agency's administration and payment of the claim on the Contractor's behalf. The Contracting Agency will be authorized to withhold the total reimbursement amount from amounts due the Contractor, or, if no further payments are to be made to the Contractor under the contract, the Contractor shall directly reimburse the Contracting Agency for the amounts paid within 30 days of the date notice that the claim was allowed was sent to the Contractor. In the event reimbursement from the Contractor is not received by the Contracting Agency within 30 days, interest shall accrue on the total reimbursement amount owing at the rate of 12 per cent per annum calculated at a daily rate from the date the contractor was notified that the claim was allowed. The Contracting Agency's costs to enforce recovery of these amounts are additive to the amounts owing.

1-07.15 Temporary Water Pollution/Erosion Control

In an effort to prevent, conted for the project.

The Contractor shall perform all temporary water pollution/erosion control measures shown in the Plans, specified in the Special Provisions, proposed by the Contractor and approved by the Engineer, or ordered by the Engineer as work proceeds.

1-07.15(1) Spill Prevention, Control and Countermeasures Plan

The Contractor shall prepare a project specific spill prevention, control and countermeasures (SPCC) plan to be used for the duration of the project. The plan shall be submitted to the Engineer prior to the commencement of any on site construction activities. The Contractor shall maintain a copy of the plan at the work site, including any necessary updates as the work progresses. If hazardous materials are encountered during construction, the Contractor shall do everything possible to control and contain the material until appropriate measures can be taken. Hazardous material, as referred to within this specification, is defined in RCW 70.105.010 under "Hazardous Substances". Occupational safety and health requirements that may pertain to SPCC planning are contained in but not limited to WAC 296-824 and WAC 296-843.

The SPCC plan shall address the following project-specific information:

1. SPCC Plan Elements
   A. Site Information

      Identify general site information useful in construction planning, recognizing potential sources of spills, and identifying personnel responsible for managing and implementing the plan.

B. Project Site Description

Identify staging, storage, maintenance, and refueling areas and their relationship to drainage pathways, waterways, and other sensitive areas. Specifically address:

- the Contractor's equipment maintenance, refueling, and cleaning activities.
- the Contractor's on site storage areas for hazardous materials.

C. Spill Prevention and Containment

For each of the locations identified in B, above, specifically address:

1. Spill prevention and containment measures to be used at each location.
2. The method of collecting and treating, or disposing of runoff from each location.
3. The method of diverting project runoff from each location.

D. Spill Response

Outline spill response procedures including assessment of the hazard, securing spill response and personal protective equipment, containing and eliminating the spill source, and mitigation, removal and disposal of the material.

E. Standby, On-Site, Material and Equipment

The plan shall identify the equipment and materials the Contractor will maintain on site to carry out the preventive and responsive measures for the items listed.

F. Reporting

The plan shall list all federal, state and local agency telephone numbers the Contractor must notify in the event of a spill.

G. Program Management

Identify site security measures, inspection procedures and personnel training procedures as they relate to spill prevention, containment, response, management and cleanup.

H. Preexisting Contamination

If preexisting contamination in the project area is described elsewhere in the plans or specifications, the SPCC plan shall indicate measures the Contractor will take to conduct work without allowing release or further spreading of the materials.

I. Work Below the Ordinary High Water Line

Identify equipment that will be used below the ordinary high water line. Outline daily inspection and cleanup procedures that ensure equipment is free of all external petroleum-based products. Identify refueling procedures for equipment that cannot be moved from below the ordinary high water line.

2. Attachments
   A. Site plan showing the locations identified in (1. B. and 1. C.) noted previously.
   B. Spill and Incident Report Forms, if any, that the Contractor will be using.

Implementation Requirements

The Contractor shall implement prevention and containment measures identified in the SPCC plan prior to performing any of the following:

1. Placing materials or equipment in staging or storage areas
2. Equipment refueling
3. Equipment washing
4. Stockpiling contaminated materials

Payment

The lump sum contract price for the "SPCC Plan" shall be full pay for:

1. All costs associated with creating the SPCC plan.
2. All costs associated with providing and maintaining on site standby materials and equipment described in the SPCC plan.
3. All costs associated with implementing the prevention and containment measures identified in the approved SPCC plan.

As to other costs associated with spills, the contractor may request payment as provided for in the Contract. No payment shall be made if the spill was caused by or resulted from the Contractor's operations, negligence or omissions.

1-07.16 Protection and Restoration of Property

1-07.16(1) Private/Public Property

The Contractor shall not use Contracting Agency owned or controlled property other than that directly affected by the contract work without the approval of the Engineer. If the Engineer grants such approval, the Contractor shall then vacate the area when ordered to do so by the Engineer. Approval to temporarily use the property shall not create any entitlement to further use or to compensation for any conditions or requirements imposed.

The Contractor shall protect private or public property on or in the vicinity of the work site. The Contractor shall ensure that it is not removed, damaged, destroyed, or prevented from being used unless the contract so specifies.

Property includes land, utilities, trees, landscaping, improvements legally on the right-of-way, markers, monuments, buildings, structures, pipe, conduit, sewer or water lines, signs, and other property of all description whether shown on the plans or not.

If the Engineer orders, or if otherwise necessary, the Contractor shall install protection, acceptable to the Engineer, for property such as that listed in the previous paragraph. The Contractor is responsible for locating and protecting all property that is subject to damage by the construction operation.

If the Contractor (or agents/employees of the Contractor) damage, destroy, or interfere with the use of such property, the Contractor shall restore it to original condition. The Contractor shall also halt any interference with the property's use. If the Contractor refuses or does not respond immediately, the Engineer may have such property restored by other means and subtract the cost from money that will be or is due the Contractor.

The Contractor may access the worksite from adjacent properties. The Contractor shall not use or allow others to use this access to merge with public traffic. During non-working hours, the Contractor shall provide a physical barrier that is either locked or physically unable to be moved without equipment. The access shall not go through any existing structures. The access may go through fencing. The Contractor shall control or prevent animals from entering the worksite to the same degree that they were controlled before the fence was removed. The Contractor shall prevent persons not involved in the contract work from entering the worksite through the access or through trails and pathways intersected by the access. If the contract documents require that existing trails or pathways be maintained during construction, the Contractor will insure the safe passage of trail or pathway users. The Contractor shall effectively control airborne particulates that are generated by use of the access. The location and use of the access shall not adversely affect wetlands or sensitive areas in any manner. The Contractor shall be responsible for obtaining all haul road agreements, permits and/or easements associated with the access. The Contractor shall replace any fence, repair any damage and restore the site to its original state when the access is no longer needed. The Contractor shall bear all costs associated with this worksite access.

1-07.16(2) Vegetation Protection and Restoration

Existing vegetation, where shown in the Plans or designated by the Engineer, shall be saved and protected through the life of the contract. The Engineer will designate the vegetation to be saved and protected by a site preservation line and/or individual flagging.

Damage which may require replacement of vegetation includes bark stripping, broken branches, exposed root systems, cut root systems, poisoned root systems, compaction of surface soil and roots, puncture wounds, drastic reduction of surface roots or leaf canopy, changes in grade greater than 6 inches, or any other changes to the location that may jeopardize the survival or health of the vegetation to be preserved.

When large roots of trees designated to be saved are exposed by the Contractor's operation, they shall be wrapped with heavy burlap for protection and to prevent excessive drying. The burlap shall be kept moist and securely fastened until the roots are covered to finish grade. All burlap and fastening material shall be removed from the roots before covering. All roots 1 inch or smaller in diameter, which are damaged, shall be pruned with a sharp saw or pruning shear. Damaged, torn, or ripped bark shall be removed as ordered by the Engineer at no additional cost to the Contracting Agency.

Any pruning activity required to complete the work as specified shall be performed by persons qualified as a Certified Arborist at the direction of the Engineer.

If due to, or for any reason related to the Contractor's operation, any tree, shrub, ground cover or herbaceous vegetation designated to be saved is destroyed, disfigured, or damaged to the extent that continued life is questionable as determined by the Engineer, it shall be removed by the Contractor at the direction of the Engineer.

The Contractor will be assessed damages equal to triple the value of the vegetation as determined in the *Guide for Plant Appraisal*, Current Edition, published by the International Society of Arboriculture or the estimated cost of restoration with a similar species. Shrub, ground cover, and herbaceous plant values will be determined using the Cost of Cure Method. Any damage so assessed will be deducted from the monies due or that may become due the Contractor.

1-07.16(3) Fences, Mailboxes, Incidentals

The Contractor shall maintain any temporary fencing to prevent pedestrians from entering the worksite and to preserve livestock, crops, or property when working through or adjacent to private property. The Contractor is liable for all damages resulting from not complying with this requirement.

The usefulness of existing mail or paper boxes shall not be impaired. If the contract anticipates removing and reinstalling the mail or paper boxes, the provisions of Section 8-18 will apply. If the mail or paper boxes are rendered useless solely by acts (or inaction) of the Contractor or for the convenience of the Contractor, the work shall be performed as provided in Section 8-18 at the Contractor's expense.

1-07.16(4) Archaeological and Historical Objects

Archaeological or historical objects, such as ruins, sites, buildings, artifacts, fossils, or other objects of antiquity that may have significance from a historical or scientific standpoint, which may be encountered by the Contractor, shall not be further disturbed. The Contractor shall immediately notify the Engineer of any such finds.

The Engineer will determine if the material is to be salvaged. The Contractor may be required to stop work in the vicinity of the discovery until such determination is made. The Engineer may require the Contractor to suspend work in the vicinity of the discovery until salvage is accomplished.

If the Engineer finds that the suspension of work in the vicinity of the discovery increases or decreases the cost or time required for performance of any part of the work under this contract, the Engineer will make an adjustment in payment or the time required for the performance of the work in accordance with Sections 1-04.4 and 1-08.8.

1-07.16(5) Payment

All costs to comply with this section and for the protection and repair specified in this section, unless otherwise stated, are incidental to the contract and are the responsibility of the Contractor. The Contractor shall include all related costs in the unit bid prices of the contract.

1-07.17 Utilities and Similar Facilities

The Contractor shall protect all private and public utilities from damage resulting from the work. Among others, these utilities include: telephone, telegraph, and power lines; sewer and water lines; railroad tracks and equipment; and highway lighting and signing systems.

Chapter 19.122 of the Revised Code of Washington (RCW) relates to underground utilities. In accordance with this RCW, the Contractor shall call the One-Number Locator Service for field location of utilities. If no locator service is available for the area, notice shall be provided individually to those owners of utilities known to, or suspected of, having underground facilities within the area of the proposed excavation.

If the work requires removing or relocating a utility, the contract will assign the task to the Contractor or the utility owner. When this task is assigned to the utility owner and work is not complete before the Contractor begins work, the Contractor shall immediately notify the Engineer in writing.

Any authorized agent of the Contracting Agency or utility owners may enter the highway right-of-way to repair, rearrange, alter, or connect their equipment. The Contractor shall cooperate with such efforts and shall avoid creating delays or hindrances to those doing the work. As needed, the Contractor shall arrange to coordinate work schedules.

To ease or streamline the work, the Contractor may desire to ask utility owners to move, remove, or alter their equipment in ways other than those listed in the plans or special provisions. The Contractor shall make the arrangements and pay all costs that arise from them.

In some cases, the Plans or special provisions may not show all underground facilities. If the work requires these to be moved, the Engineer will provide for other forces to move them or issue a written change order requiring the Contractor to do so as provided in Section 1-04.4.

All costs required to protect public and private utilities as provided in this section shall be at the Contractor's expense. When others delay the work through late removal or relocation of any utility or similar facility, the Contractor's loss of time will be adjusted by extending contract time in keeping with Section 1-08.8.

If the contract provides notice that utilities will be adjusted, relocated, replaced, or constructed during the prosecution of the work, the Contractor shall carry out the work in a way that will minimize interference and delay for all forces involved. Any costs resulting from the coordination and prosecution of the work regarding utility adjustment, relocation, replacement, or construction shall be at the Contractor's expense as provided in Section 1-05.14.

1-07.18 Public Liability and Property Damage Insurance

The Contractor shall obtain and keep in force the following policies of insurance. The policies shall be with companies or through sources approved by the State Insurance Commissioner pursuant to Chapter 48.05, RCW. Unless otherwise indicated below, the policies shall be kept in force from the execution date of the contract until the date of acceptance by the Secretary (Section 1-05.12).

1. Owners and Contractors Protective Insurance providing bodily injury and property damage liability coverage with limits of $3,000,000 per occurrence and in the aggregate for each policy period, written on Insurance Services Office (ISO) form CG0009 together with Washington State Department of Transportation Amendatory Endorsement No. CG 29 08, specifying the State of Washington as a named insured.

   The Contractor may choose to terminate this insurance after the date of Substantial Completion as determined by the Engineer or, should Substantial Completion not be achieved, after the date of Physical Completion as determined by the Engineer. In the event the Contractor elects to terminate this coverage, prior to acceptance of the contract, the Contractor shall first obtain an endorsement to the Commercial General Liability Insurance described below that establishes the Contracting Agency on that policy as an additional insured.
2. Commercial General Liability Insurance written under ISO Form CG0001 or its equivalent with minimum limits of $3,000,000 per occurrence and in the aggregate for each policy period. This protection may be a CGL policy or any combination of primary, umbrella or excess liability coverage affording total liability limits of not less than $3,000,000. Products and completed operations coverage shall be provided for a period of one year following final acceptance of the work.
3. Commercial Automobile Liability Insurance providing bodily injury and property damage liability coverage for all owned and nonowned vehicles assigned to or used in the performance of the work with a combined single

limit of not less than $1,000,000 each occurrence with the State named as an additional insured in connection with the Contractor's Performance of the contract.

The Owners and Contractors Protective Insurance policy shall not be subject to a deductible or contain provisions for a deductible. The Commercial General Liability policy and the Commercial Automobile Liability Insurance policy may, at the discretion of the Contractor, contain such provisions. If a deductible applies to any claim under these policies, then payment of that deductible will be the responsibility of the Contractor, notwithstanding any claim of liability against the Contracting Agency. However in no event shall any provision for a deductible provide for a deductible in excess of $50,000.00.

Prior to contract execution, the Contractor shall file with the Department of Transportation, Contract Payment Section, P.O. Box 47420, Olympia, WA 98504-7420, ACORD Form Certificates of Insurance evidencing the minimum insurance coverages required under these specifications.

All insurance policies and Certificates of Insurance shall include a requirement providing for a minimum of 45 days prior written notice to the Contracting Agency of any cancellation or reduction of coverage. All insurance coverage required by this section shall be written and provided by "occurrence-based" policy forms rather than by "claims made" forms.

Failure on the part of the Contractor to maintain the insurance as required shall constitute a material breach of contract upon which the Contracting Agency may, after giving five working days notice to the Contractor to correct the breach, immediately terminate the contract or, at its discretion, procure or renew such insurance and pay any and all premiums in connection therewith, with any sums so expended to be repaid to the Contracting Agency on demand, or at the sole discretion of the Contracting Agency, offset against funds due the Contractor from the Contracting Agency.

All costs for insurance, including any payments of deductible amounts, shall be considered incidental to and included in the unit contract prices and no additional payment will be made.

1-07.19 Gratuities

The Contractor shall not extend any loan, gratuity, or gift of money in any form whatsoever to any employee or officer of the Contracting Agency; nor will the Contractor rent or purchase any equipment or materials from any employee or officer of the Contracting Agency. Before payment of the final estimate will be made, the Contractor shall execute and furnish the Contracting Agency an affidavit certifying compliance with these provisions of the contract.

The Contractor shall comply with all applicable sections of the State Ethics law, RCW 42.52, which regulates gifts to State officers and employees. Under that statute, any Contracting Agency officer or employee who has or will participate with the Contractor regarding any aspect of this Contract is prohibited from seeking or accepting any gift, gratuity, favor or anything of economic value from the Contractor. Accordingly, neither the Contractor nor any agent or representative shall offer anything of economic value as a gift, gratuity, or favor directly or indirectly to any such officer or employee.

1-07.20 Patented Devices, Materials, and Processes

The Contractor shall assume all costs arising from the use of patented devices, materials, or processes used on or incorporated in the work, and agrees to indemnify, defend, and save harmless the State, Governor, Commission, Secretary, and their duly authorized agents and employees from all actions of any nature for, or on account of the use of any patented devices, materials, or processes.

1-07.21 Rock Drilling Safety Requirements

It shall be the Contractor's responsibility to maintain safe working conditions during rock drilling, by keeping dust concentration below the threshold limit value or by providing those protective devices that may be required by the State Department of Labor and Industries.

1-07.22 Use of Explosives

When using explosives, the Contractor shall use the utmost care to protect life and property, to prevent slides, and to leave undisturbed all materials, outside the neat lines of the cross-section.

Explosives shall be handled, marked, stored, and used in compliance with WAC 296-52 and such local laws, rules, and regulations that may apply. The stricter provisions shall apply.

All explosives shall be stored securely as required by all laws and ordinances that apply. Each storage place shall be clearly marked: "Dangerous-Explosives." No explosives shall be left unprotected.

If public utilities or railroads own equipment near the blast site, the Contractor shall notify the owners of the location, date, time, and approximate duration of the blasting. This notice shall be given sufficiently in advance to enable all owners to take any steps as they deem necessary to protect their property from injury.

Blasting near proposed structures shall be completed before work on them begins. When the use of explosives is necessary for the prosecution of the work, the Contractor's insurance shall contain a special clause permitting the blasting.

1-07.23 Public Convenience and Safety

1-07.23(1) Construction Under Traffic

The Contractor shall conduct all operations with the least possible obstruction and inconvenience to the public. The Contractor shall have under construction no greater length or amount of work than can be prosecuted properly with due regards to the rights of the public. To the extent possible, the Contractor shall finish each section before beginning work on the next. The Contractor shall enter interstate highways only through legal movements from existing roads, streets, and through other access points specifically allowed by the contract documents.

To disrupt public traffic as little as possible, the Contractor shall permit traffic to pass through the work with the least possible inconvenience or delay. The Contractor shall maintain existing roads and streets within the project limits, keeping them open, and in good, clean, safe condition at all times. Deficiencies caused by the Contractor's operations shall be repaired at the Contractor's expense. Deficiencies not caused by the Contractor's operations shall be repaired by the Contractor, when ordered by the Engineer, at the Contracting Agency's expense. The Contractor shall also maintain roads and streets adjacent to the project limits when affected by the Contractor's operations.

Snow and ice control will be performed by the Contracting Agency on all projects. Cleanup of snow and ice control debris will be at the Contracting Agency's expense. The Contractor shall perform the following:

1. Remove or repair any condition resulting from the work that might impede traffic or create a hazard.
2. Keep existing traffic signal and highway lighting systems in operation as the work proceeds. (The Contracting Agency will continue the routine maintenance on such system.)
3. Maintain the striping on the roadway at the Contracting Agency's expense. The Contractor shall be responsible for scheduling when to renew striping, subject to the approval of the Engineer. When the scope of the project does not require work on the roadway, the Contracting Agency will be responsible for maintaining the striping.
4. Maintain existing permanent signing. Repair of signs will be at the Contracting Agency's expense, except those damaged due to the Contractor's operations.
5. Keep drainage structures clean to allow for free flow of water. Cleaning of existing drainage structures will be at the Contracting Agency's expense when approved by the Engineer, except when flow is impaired due to the Contractor's operations.

To protect the rights of abutting property owners, the Contractor shall:

1. Conduct the construction so that the least inconvenience as possible is caused to abutting property owners;
2. Maintain ready access to driveways, houses, and buildings along the line of work;
3. Provide temporary approaches to crossing or intersecting roads and keep these approaches in good condition; and
4. Provide another access before closing an existing one whenever the contract calls for removing and replacing an abutting owner's access.

When traffic must pass through grading areas, the Contractor shall:

1. Make cuts and fills that provide a reasonably smooth, even roadbed;
2. Place, in advance of other grading work, enough fill at all culverts and bridges to permit traffic to cross;
3. Make roadway cuts and fills, if ordered by the Engineer, in partial-width lifts, alternating lifts from side to side to permit traffic to pass on the side opposite the work;
4. Install culverts on half the width of the traveled way, keeping the other half open to traffic and unobstructed until the first half is ready for use;
5. After rough grading or placing any subsequent layers, prepare the final roadbed to a smooth, even surface (free of humps and dips) suitable for use by public traffic; and
6. Settle dust with water, or other dust palliative, as the Engineer may order.

If grading work is on or next to a roadway in use, the Contractor shall finish the grade immediately after rough grading and place surfacing materials as the work proceeds.

The Contractor shall conduct all operations to minimize any drop-offs (abrupt changes in roadway elevation) left exposed to traffic during nonworking hours. Unless otherwise specified in the Traffic Control Plan, drop-offs left exposed to traffic during nonworking hours shall be protected as follows:

1. Drop-offs up to 0.20 foot, unless otherwise ordered by the Engineer, may remain exposed with appropriate warning signs alerting motorists of the condition.
2. Drop-offs more than 0.20 foot that are in the traveled way or auxiliary lane will not be allowed unless protected with appropriate warning signs and further protected as indicated in 3b or 3c below.
3. Drop-offs more than 0.20 foot, but no more than 0.50 foot, that are not within the traveled way shall be protected with appropriate warning signs and further protected by having one of the following:
   a. A wedge of compacted stable material placed at a slope of 4:1 or flatter.
   b. Channelizing devices (Type I barricades, plastic safety drums, or other devices 36 inches or more in height) placed along the traffic side of the drop-off and a new edge of pavement stripes placed a minimum of 3 feet from the drop-off. The maximum spacing between the devices in feet shall be the posted speed in miles per hour. Pavement drop-off warning signs shall be placed in advance and throughout the drop-off treatment.
   c. Temporary concrete barrier or other approved barrier installed on the traffic side of the drop-off with 2-feet between the drop-off and the back of the barrier and a new edge of pavement stripe a minimum of 2-feet from the face of the barrier. An approved terminal, flare, or impact attenuator will be required at the beginning of the section. For night use, the barrier shall have standard delineation such as paint, reflective tape, lane markers, or warning lights.
4. Drop-offs more than 0.50 foot not within the traveled way or auxiliary lane shall be protected with appropriate warning signs and further protected as indicated in 3a, 3b, or 3c if all of the following conditions are met:
   a. The drop-off is less than 2-feet;
   b. The total length throughout the project is less than 1 mile;
   c. The drop-off does not remain for more than three working days;
   d. The drop-off is not present on any of the holidays listed in Section 1-08.5; and
   e. The drop-off is only on one side of the roadway.
5. Drop-offs more than 0.50 foot that are not within the traveled way or auxiliary lane and are not otherwise covered by No. 4 above shall be protected with appropriate warning signs and further protected as indicated in 3a or 3c.
6. Open trenches within the traveled way or auxiliary lane shall have a steel-plate cover placed and anchored over them. A wedge of suitable material, if required, shall be placed for a smooth transition between the pavement and the steel plate. Warning signs shall be used to alert motorists of the presence of the steel plates.

The Contractor shall be responsible for providing adequate safeguards, safety devices, protective equipment, and any other needed actions to protect the life, health, and safety of the public, and to protect property in connection with the performance of the work covered by the contract. The Contractor shall perform any measures or actions the Engineer may deem necessary to protect the public and property. The responsibility and expense to provide this protection shall be the Contractor's except that which is to be furnished by the Contracting Agency as specified in other sections of these Specifications. Nothing contained in this contract is intended to create any third-party beneficiary rights in favor of the public or any individual utilizing the highway facilities being constructed or improved under this contract.

1-07.23(2) Construction and Maintenance of Detours

Unless otherwise approved, the Contractor shall maintain two-way traffic during construction. The Contractor shall build, maintain in a safe condition, keep open to traffic, and remove when no longer needed:

1. Detours and detour bridges that will accommodate traffic diverted from the roadway or bridge during construction,
2. Detour crossings of intersecting highways, and
3. Temporary approaches.

Unit contract prices will cover construction, maintenance, and removal of all detours shown in the plans or proposed by the Contracting Agency.

The Contractor shall pay all costs to build, maintain, and remove any other detours, whether built for the Contractor's convenience or to facilitate construction operations. Any detour proposed by the Contractor shall not be built until the Engineer approves. Surfacing and paving shall be consistent with traffic requirements.

Upon failure of the Contractor to immediately provide, maintain, or remove detours or detour bridges when ordered to do so by the Engineer, the Contracting Agency may, without further notice to the Contractor or the Surety, provide, maintain, or remove the detours or detour bridges and deduct the costs from any payments due or coming due the Contractor.

1-07.24 Rights of Way

All rights of way for the completed facility will be provided by the Contracting Agency in advance of construction. Any exceptions will be noted in the special provisions. Should the necessary right of way not be available as provided in the contract, an extension of time will be considered in accordance with Section 1-08.8.

1-07.25 Opening of Sections to Traffic

The Contracting Agency reserves the right to use and open to traffic any portion of the work before the physical completion date of the entire contract without constituting acceptance of any of the work. This action will not cause the Contracting Agency to incur any liability to the Contractor except as may otherwise be provided in the contract.

If the Contracting Agency opens any portion of the work prior to the physical completion date of the entire contract because early opening is specified in the contract or when the Contractor has failed to prosecute the work continuously and efficiently, any work remaining shall be performed by the Contractor at the unit contract prices for the items of work involved. No additional payment will be made for costs incurred by the Contractor because of: (1) inconvenience, additional length of travel to conform to

established traffic patterns and planned access features; (2) compliance with statutes governing traffic regulations and limitations of loads; or (3) additional flagging costs necessary to protect the operations and the traveling public. The Contractor shall take all costs due to traffic using portions of the work into account when submitting the bid proposal, and the unit contract prices for the various items of work involved shall include these costs.

1-07.26 Personal Liability of Public Officers

Neither the Governor, the Commission, the Secretary, the Engineer, nor any other officer or employee of the State shall be personally liable for any acts or failure to act in connection with the contract, it being understood that in such matters, they are acting solely as agents of the State.

1-07.27 No Waiver of State's Legal Rights

The State shall not be precluded or estopped by any measurement, estimate, or certificate made either before or after the completion and acceptance of the work and payment therefore from showing the true amount and character of the work performed and materials furnished by the Contractor, or from showing that any such measurement, estimate, or certificate is untrue or incorrectly made, or that the work or materials do not conform in fact to the contract. The State shall not be precluded or estopped, not with standing any such measurement, estimate, or certificate, and payment in accordance therewith, from recovering from the Contractor and the Sureties such damages as it may sustain by reason of the Contractor's failure to comply with the terms of the contract. Neither the acceptance by the Secretary, nor any payment for the whole or any part of the work, nor any extension of time, nor any possession taken by the State shall operate as a waiver of any portion of the contract or of any power herein reserved or any right to damages herein provided, or bar recovery of any money wrongfully or erroneously paid to the Contractor. A waiver of any breach of the contract shall not be held to be a waiver of any other or subsequent breach.

The Contractor and the State recognize that the impact of overcharges to the State by the Contractor resulting from antitrust law violations by the Contractor's suppliers or subcontractors adversely affects the State rather than the Contractor. Therefore, the Contractor agrees to assign to the State any and all claims for such overcharges.

1-08 PROSECUTION AND PROGRESS

1-08.1 Subcontracting

Work done by the Contractor's own organization shall account for at least 30 percent of the awarded contract price. Before computing this percentage, however, the Contractor may subtract (from the awarded contract price) the costs of any subcontracted work on items the contract designates as specialty items.

The Contractor shall not subcontract work unless the Engineer approves in writing. Each request to subcontract shall be on the form the Engineer provides. If the Engineer requests, the Contractor shall provide proof that the subcontractor has the experience, ability, and equipment the work requires. The Contractor shall require each subcontractor to comply with Section 1-07.9 and to furnish all certificates and statements required by the contract.

Along with the request to sublet, the Contractor shall submit the names of any contracting firms the subcontractor proposes to use as lower tier subcontractors. Collectively, these lower tier subcontractors shall not do work that exceeds 25 percent of the total amount subcontracted to a subcontractor. When a subcontractor is responsible for construction of a specific structure or structures, the following work may be performed by lower tier subcontractors without being subject to the 25 percent limitation:

1. Furnishing and driving of piling, or
2. Furnishing and installing concrete reinforcing and post-tensioning steel.

Except for the 25 percent limit, lower tier subcontractors shall meet the same requirements as subcontractors.

The Engineer will approve the request only if satisfied with the proposed subcontractor's record, equipment, experience, and ability. Approval to subcontract shall not:

1. Relieve the Contractor of any responsibility to carry out the contract,
2. Relieve the Contractor of any obligations or liability under the contract and the Contractor's bond,
3. Create any contract between the Contracting Agency and the subcontractor, or
4. Convey to the subcontractor any rights against the Contracting Agency.

The Contracting Agency will not consider as subcontracting: (1) purchase of sand, gravel, crushed stone, crushed slag, batched concrete aggregates, ready mix concrete, off-site fabricated structural steel, other off-site fabricated items, and any other materials supplied by established and recognized commercial plants; or (2) delivery of these materials to the work site in vehicles owned or operated by such plants or by recognized independent or commercial hauling companies. However, the Washington State Department of Labor and Industries may determine that RCW 39.12 applies to the employees of such firms identified in 1 and 2 above in accordance with WAC 296-127. If this should occur, the provisions of Section 1-07.9, as modified or supplemented, shall apply.

On all projects funded with Contracting Agency funds only, the Contractor shall certify to the actual amounts paid Disadvantaged, Minority, or Women's Business Enterprise firms that were used as subcontractors, lower tier subcontractors, manufacturers, regular dealers, or service providers on the contract. This Certification shall be submitted to the Project Engineer on WSDOT form 421-023, "Annual Report of Amounts Paid as MBE/WBE Participants", annually for the State fiscal year July 1 through June 30, or through physical completion of the contract, whichever occurs

earliest. The report is due July 20th following the fiscal year end or 20 calendar days after physical completion of the contract.

On all projects funded with both Contracting Agency funds and Federal assistance the Contractor shall submit a "Quarterly Report of Amounts Credited as DBE Participation" on a quarterly basis for every quarter in which the contract is active (work is accomplished) or upon completion of the project, as appropriate. The quarterly reports are due on the 20th of April, July, October, and January for the four respective quarters. When required, this "Quarterly Report of Amounts Credited as DBE Participation" is in lieu of WSDOT form 421-023, "Annual Report of Amounts Paid as MBE/WBE Participants".

If dissatisfied with any part of the subcontracted work, the Engineer may request in writing that the subcontractor be removed. The Contractor shall comply with this request at once and shall not employ the subcontractor for any further work under the contract.

1-08.1(1) Subcontract Completion and Return of Retainage Withheld

The following procedure shall apply to all subcontracts entered into as a part of this Contract:

Requirements

1. The subcontractor shall make a written request to the Contractor for the release of the subcontractor's retainage or retainage bond.
2. Within ten (10) working days of the request, the Contractor shall determine if the subcontract has been satisfactorily completed and shall inform the subcontractor, in writing, of the Contractor's determination.
3. If the Contractor determines that the subcontract has been satisfactorily completed, the subcontractor's retainage or retainage bond shall be released by the Contractor within ten (10) working days from the date of the written notice.
4. If the Contractor determines that the subcontractor has not achieved satisfactory completion of the subcontract, the Contractor must provide the subcontractor with written notice, stating specifically why the subcontract work is not satisfactorily completed and what has to be done to achieve completion. The Contractor shall release the subcontractor's retainage or retainage bond within eight (8) working days after the subcontractor has satisfactorily completed the work identified in the notice.
5. In determining whether satisfactory completion has been achieved , the Contractor may require the subcontractor to provide documentation such as certifications and releases, showing that all laborers, lower-tiered subcontractors, suppliers of material and equipment, and others involved in the subcontractor's work have been paid in full. The Contractor may also require any documentation from the subcontractor that is required by the subcontract or by the Contract between the Contractor and Contracting Agency or by law such as affidavits of wages paid, material acceptance certifications and releases from applicable governmental agencies to the extent that they relate to the subcontractor's work.
6. If the Contractor fails to comply with the requirements of the specification and the subcontractor's retainage or retainage bond is wrongfully withheld, the subcontractor may seek recovery against the Contractor under applicable prompt pay statutes in addition to any other remedies provided for by the subcontract or by law.

Conditions

1. This clause does not create a contractual relationship between the Contracting Agency and any subcontractor as stated in Section 1-08.1. Also, it is not intended to bestow upon any subcontractor, the status of a third-party beneficiary to the Contract between the Contracting Agency and the Contractor.
2. This section of the Contract does not apply to retainage withheld by the Contracting Agency from monies earned by the Contractor. The Contracting Agency shall continue to process the release of that retainage based upon the completion date of the project as defined in Section 1-08.5 Time for Completion and in accordance with the requirements and procedures set forth in chapter 60.28 RCW.

Payment

The Contractor will be solely responsible for any additional costs involved in paying retainage to the subcontractors prior to total project completion. Those costs shall be incidental to the respective bid items.

1-08.2 Assignment

The Contractor shall not assign all or any part of the work unless the Engineer approves in writing. The Engineer will not approve any proposed assignment that would relieve the original Contractor or Surety of responsibility under the contract.

Money due (or that will become due) to the Contractor may be assigned. If given written notice, the Contracting Agency will honor such an assignment to the extent the law permits. But the assignment shall be subject to all setoffs, withholdings, and deductions required by law and the contract.

1-08.3 Progress Schedule

The Contractor shall submit a preliminary progress schedule (first 60 working days) to the Engineer no later than five calendar days after the date the contract is executed. This preliminary schedule shall show work to be performed during the first 60 working days of the contract.

The Contractor shall submit five copies of the progress schedule (total working days) to the Engineer no later than 30 calendar days after the date the contract is executed. This schedule and any supplemental schedule shall show: (1) physical completion of all work within the specified contract time, (2) the proposed order of work, and (3) projected starting and completion times for major phases of the work and for the total project. The schedule shall be developed by a critical path method. The Contractor shall provide sufficient material, equipment, and labor to meet the completion times in this schedule.

The Contracting Agency allocates its resources to a contract based on the total time allowed in the contract. The Contracting Agency will accept a progress schedule indicating an early physical completion date but cannot guarantee the Contracting Agency's resources will be available to meet the accelerated schedule. No additional compensation will be allowed if the Contractor is not able to meet their accelerated schedule due to the unavailability of Contracting Agency's resources or for other reasons beyond the Contracting Agency's control.

The Contractor shall submit supplemental progress schedules when requested by the Project Engineer or as required by any provision of the contract. These supplemental schedules shall reflect any changes in the proposed order of the work, any construction delays, or other conditions that may affect the progress of the work. The Contractor shall provide the Project Engineer with the supplemental progress schedules within ten calendar days of receiving written notice of the request.

The original and all supplemental progress schedules shall not conflict with any time and order-of-work requirement in the contract.

If the Engineer deems that the original or any necessary supplemental progress schedule does not provide the information required in this section, the Contracting Agency may withhold progress payments until a schedule containing the required information has been submitted by the Contractor and approved by the Engineer.

The Engineer's approval of any schedule shall not transfer any of the Contractor's responsibilities to the Contracting Agency. The Contractor alone shall remain responsible for adjusting forces, equipment, and work schedules to ensure completion of the work within the time(s) specified in the contract.

1-08.4 Prosecution of Work

The Contractor shall begin work within 10 calendar days from the date of execution of the contract by the Contracting Agency, unless otherwise approved in writing. The Contractor shall diligently pursue the work to the physical completion date within the time specified in the contract. Voluntary shutdown or slowing of operations by the Contractor shall not relieve the Contractor of the responsibility to complete the work within the time(s) specified in the contract.

1-08.5 Time for Completion

The Contractor shall complete all physical contract work within the number of "working days" stated in the Contract Provisions or as extended by the Engineer in accordance with Section 1-08.8. Every day will be counted as a "working day" unless it is a nonworking day or an Engineer determined unworkable day. A nonworking day is defined as a Saturday, a Sunday, a day on which the contract specifically suspends work, or one of these holidays: January 1, the third Monday of January, the third Monday of February, Memorial Day, July 4, Labor Day, November 11, Thanksgiving Day, the day after Thanksgiving, and Christmas Day. When any of these holidays fall on a Sunday, the following Monday shall be counted a nonworking day. When the holiday falls on a Saturday, the preceding Friday shall be counted a nonworking day.

The days between December 25 and January 1 will be classified as nonworking days, provided that, the Contractor actually suspends work on the project.

An unworkable day is defined as a partial or whole day the Engineer declares to be unworkable because of weather, conditions caused by the weather, or such other conditions beyond the control of the Contractor that prevents satisfactory and timely performance of the work, and such performance, if not hindered, would have otherwise progressed toward physical completion of the work.

Contract time shall begin on the first working day following the 10th calendar day after the date the Contracting Agency executes the contract. The contract provisions may specify another starting date for contract time, in which case, time will begin on the starting date specified.

Each working day shall be charged to the contract as it occurs, until the contract work is physically complete. If substantial completion has been granted and all the authorized working days have been used, charging of working days will cease. Each week the Engineer will provide the Contractor a statement that shows the number of working days: (1) charged to the contract the week before; (2) specified for the physical completion of the contract; and (3) remaining for the physical completion of the contract. The statement will also show the nonworking days and any partial or whole day the Engineer declares as unworkable. Within 10 calendar days after the date of each statement, the Contractor shall file a written protest of any alleged discrepancies in it. To be considered by the Engineer, the protest shall be in sufficient detail to enable the Engineer to ascertain the basis and amount of time disputed. By not filing such detailed protest in that period, the Contractor shall be deemed as having accepted the statement as correct.

The Engineer will give the Contractor written notice of the physical completion date for all work the contract requires. That date shall constitute the physical completion date of the contract, but shall not imply the Secretary's acceptance of the work or the contract.

The Engineer will give the Contractor written notice of the completion date of the contract after all the Contractor's obligations under the contract have been performed by the Contractor. The following events must occur before the Completion Date can be established:

1. The physical work on the project must be complete; and
2. The Contractor must furnish all documentation required by the contract and required by law, to allow the Contracting Agency to process final acceptance of the contract. The following documents must be received by the Project Engineer prior to establishing a completion date:
    a. Certified Payrolls (Federal-aid Projects)
    b. Material Acceptance Certification Documents
    c. Annual Report of Amounts Paid as MBE/WBE Participants or Quarterly Report of Amounts Credited as DBE Participation, as required by the Contract Provisions.
    d. FHWA 47 (Federal-aid Projects)
    e. Final Contract Voucher Certification

1-08.6 Suspension of Work

The Engineer may order suspension of all or any part of the work if:

1. Unsuitable weather and such other conditions beyond the control of the Contractor that prevent satisfactory and timely performance of the work; or
2. The Contractor does not comply with the contract or the Engineer's orders.

When ordered by the Engineer to suspend or resume work, the Contractor shall do so immediately.

If the work is suspended for reason (1) above, the period of work stoppage will be counted as unworkable days. But if the Engineer believes the Contractor should have completed the suspended work before the suspension, all or part of the suspension period may be counted as working days. The Engineer will set the number of unworkable days (or parts of days) by deciding how long the suspension delayed the entire project.

If the work is suspended for reason (2) above, the period of work stoppage will be counted as working days. The lost work time, however, shall not relieve the Contractor from any contract responsibility.

If the performance of all or any part of the work is suspended, delayed, or interrupted for an unreasonable period of time by an act of the Contracting Agency in the administration of the contract, or by failure to act within the time specified in the contract (or if no time is specified, within a reasonable time), the Engineer will make an adjustment for any increase in the cost or time for the performance of the contract (excluding profit) necessarily caused by the suspension, delay, or interruption. However, no adjustment will be made for any suspension, delay, or interruption if (1) the performance would have been suspended, delayed, or interrupted by any other cause, including the fault or negligence of the Contractor, or (2) an equitable adjustment is provided for or excluded under any other provision of the contract.

If the Contractor believes that the performance of the work is suspended, delayed, or interrupted for an unreasonable period of time and such suspension, delay, or interruption is the responsibility of the Contracting Agency, the Contractor shall immediately submit a written notice of protest to the Engineer as provided in Section 1-04.5. No adjustment shall be allowed for any costs incurred more than 10 calendar days before the date the Engineer receives the Contractor's written notice of protest. If the Contractor contends damages have been suffered as a result of such suspension, delay, or interruption, the protest shall not be allowed unless the protest (stating the amount of damages) is asserted in writing as soon as practicable, but no later than the date of the Contractor's signature on the Final Contract Voucher Certification. The Contractor shall keep full and complete records of the costs and additional time of such suspension, delay, or interruption and shall permit the Engineer to have access to those records and any other records as may be deemed necessary by the Engineer to assist in evaluating the protest.

The Engineer will determine if an equitable adjustment in cost or time is due as provided in this section. The equitable adjustment for increase in costs, if due, shall be subject to the limitations provided in Section 1-09.4, provided that no profit of any kind will be allowed on any increase in cost necessarily caused by the suspension, delay, or interruption.

Request for extensions of time will be evaluated in accordance with Section 1-08.8.

The Engineer's determination as to whether an adjustment should be made will be final as provided in Section 1-05.1.

No claim by the Contractor under this clause shall be allowed unless the Contractor has followed the procedures provided in this Section and in Sections 1-04.5 and 1-09.11.

1-08.7 Maintenance During Suspension

Before and during any suspension (as described in Section 1-08.6) the Contractor shall protect the work from damage or deterioration. Suspension shall not relieve the Contractor from anything the contract requires unless this section states otherwise.

At no expense to the Contracting Agency, the Contractor shall provide through the construction area a safe, smooth, and unobstructed roadway for public use during suspension (as required in Section 1-07.23 or the special provisions). This may include a temporary road or detour.

If the Engineer determines that the Contractor failed to pursue the work diligently before the suspension, or failed to comply with the contract or orders, then the Contractor shall maintain the temporary roadway in use during suspension. In this case, the Contractor shall bear the maintenance costs. If the Contractor fails to maintain the temporary roadway, the Contracting Agency will do the work and deduct all resulting costs from payments due to the Contractor.

If the Engineer determines that the Contractor has pursued the work diligently before the suspension, then the Contracting Agency will do the routine maintenance work (and bear its cost). This Contracting Agency-provided maintenance work will include only routine maintenance of:

1. The traveled way, auxiliary lanes, shoulders, and detour surface,
2. Roadway drainage along and under the traveled roadway or detour, and
3. All barricades, signs, and lights needed for directing traffic through the temporary roadway or detour in the construction area.

The Contractor shall protect and maintain (and bear the costs of doing so) all other work in areas not used by traffic.

After any suspension during which the Contracting Agency has done the routine maintenance, the Contractor shall accept the traveled roadway or detour as is when work resumes. The Contractor shall make no claim against the Contracting Agency for the condition of the roadway or detour.

After any suspension, the Contractor shall retain all responsibilities the contract assigns for repairing or restoring the roadway, its slopes, and its drainage system to the requirements of the plans.

1-08.8 Extensions of Time

The Contractor shall submit any requests for time extensions to the Engineer in writing no later than 10 working days after the delay occurs. The request shall be limited to the change in the critical path of the Contractor's schedule attributable to the change or event giving rise to the request. To be considered by the Engineer, the request shall be in sufficient detail (as determined by the Engineer) to enable the Engineer to ascertain the basis and amount of the time requested. The Contractor shall be responsible for showing on the progress schedule that the change or event: (1) had a specific impact on the critical path, and except in cases of concurrent delay, was the sole cause of such impact, and (2) could not have been avoided by resequencing of the work or other reasonable alternatives. If a request, combined with previous extension requests, equals 20 percent or more of the original contract time, the Contractor's letter of request must bear consent of Surety. In evaluating any request, the Engineer will consider how well the Contractor used the time from contract execution up to the point of the delay and the effect the delay has on any completion times included in the special provisions.

The contract's time for physical completion will be extended for a period equal to the time the Engineer determines the work was delayed because of:

1. Unsuitable weather, provided that:
   a. The Engineer had not already allowed it as an unworkable day under Section 1-08.5, and
   b. The Contractor had timely filed a written protest asserting that time the Engineer charged as a working day should have been allowed as an unworkable day.

2. Any action, neglect, or default of the Contracting Agency, its officers, or employees, or of any other contractor employed by the Contracting Agency;
3. Fire or other casualty for which the Contractor is not responsible;
4. Strikes;
5. Any other conditions for which these Specifications permit time extensions such as:
   a. In Section 1-04.4 if a change increases the time to do any of the work including unchanged work;
   b. In Section 1-04.5 if increased time is part of a protest that is found to be a valid protest;
   c. In Section 1-04.6 if increases exceed 25 percent and these increases caused a delay in completing the contract;
   d. In Section 1-04.7 if a changed condition is determined to exist which caused a delay in completing the contract;
   e. In Section 1-05.3 if the Contracting Agency does not approve properly prepared and acceptable drawings within 30 calendar days;
   f. In Section 1-07.13 if the performance of the work is delayed as a result of damage by others;
   g. In Section 1-07.17 if the removal or the relocation of any utility by forces other than the Contractor caused a delay;
   h. In Section 1-07.24 if a delay results from all the right of way necessary for the construction not being purchased and the special provisions does not make specific provisions regarding unpurchased right of way;
   i. In Section 1-08.6 if the performance of the work is suspended, delayed, or interrupted for an unreasonable period of time that proves to be the responsibility of the Contracting Agency; or
   j. In Section 1-09.11 if a dispute or claim also involves a delay in completing the contract and the dispute or claim proves to be valid.
6. Exceptional causes not specifically identified in items 1 through 5, provided the request letter proves the Contractor had no control over the cause of the delay and could have done nothing to avoid or shorten it.

   Working days added to the contract by time extensions, when time has overran, shall only apply to days on which liquidated damages or direct engineering have been charged, such as the following:

   If substantial completion has been granted prior to all of the authorized working days being used, then the number of days in the time extension will eliminate an equal number of days on which direct engineering charges have accrued. If the substantial completion date is established after all of the authorized working days have been used, then the number of days in the time extension will eliminate an equal number of days on which liquidated damages or direct engineering charges have accrued.

The Engineer will not allow a time extension for any cause listed above if it resulted from the Contractor's default, collusion, action or inaction, or failure to comply with the contract.

The Contracting Agency considers the time specified in the special provisions as sufficient to do all the work. For this reason, the Contracting Agency will not grant a time extension for:

- Failure to obtain all materials and workers;
- Changes, protest, increased quantities, or changed conditions (Section 1-04) that do not delay the completion of the contract or prove to be an invalid or inappropriate time extension request;
- Delays caused by nonapproval of drawings or plans as provided in Section 1-05.3;
- Rejection of faulty or inappropriate equipment as provided in Section 1-05.9;
- Correction of thickness deficiency as provided in Section 5-05.5(1)B.

The reasons for and times of extensions shall be determined by the Engineer, and such determination will be final as provided in Section 1-05.1.

1-08.9 Liquidated Damages

Time is of the essence of the contract. Delays inconvenience the traveling public, obstruct traffic, interfere with and delay commerce, and increase risk to highway users. Delays also cost tax payers undue sums of money, adding time needed for administration, engineering, inspection, and supervision.

Because the Contracting Agency finds it impractical to calculate the actual cost of delays, it has adopted the following formula to calculate liquidated damages for failure to complete the physical work of a contract on time.

Accordingly, the Contractor agrees:

1. To pay (according to the following formula) liquidated damages for each working day beyond the number of working days established for physical completion, and
2. To authorize the Engineer to deduct these liquidated damages from any money due or coming due to the Contractor.

LIQUIDATED DAMAGES FORMULA

$$LD = \frac{0.15C}{T}$$

where:
LD = liquidated damages per working day (rounded to the nearest dollar)
C = original contract amount
T = original time for physical completion

When the contract work has progressed to the extent that the Contracting Agency has full use and benefit of the facilities, both from the operational and safety standpoint, and only minor incidental work, replacement of temporary substitute facilities, or correction or repair remains to physically complete the total contract, the Engineer may determine the contract work is substantially complete. The Engineer will notify the Contractor in writing of the substantial completion date. For overruns in contract time occurring after the date so established, the formula for liquidated damages shown above will not apply. For overruns in contract time occurring after the substantial completion date, liquidated damages shall be assessed on the basis of direct engineering and related costs assignable to the project until the actual physical completion date of all the contract

work. The Contractor shall complete the remaining work as promptly as possible. Upon request by the Project Engineer, the Contractor shall furnish a written schedule for completing the physical work on the contract.

Liquidated damages will not be assessed for any days for which an extension of time is granted. No deduction or payment of liquidated damages will, in any degree, release the Contractor from further obligations and liabilities to complete the entire contract.

1-08.10 Termination of Contract

1-08.10(1) Termination for Default

The Contracting Agency may terminate the contract upon the occurrence of any one or more or the following events:

1. If the Contractor fails to supply sufficient skilled workers or suitable materials or equipment;
2. If the Contractor refuses or fails to prosecute the work with such diligence as will ensure its physical completion within the original physical completion time and any extensions of time which may have been granted to the Contractor by change order or otherwise;
3. If the Contractor is adjudged bankrupt or insolvent, or makes a general assignment for the benefit of creditors, or if the Contractor or a third party files a petition to take advantage of any debtor's act or to reorganize under the bankruptcy or similar laws concerning the Contractor, or if a trustee or receiver is appointed for the Contractor or for any of the Contractor's property on account of the Contractor's insolvency, and the Contractor or its successor in interest does not provide adequate assurance of future performance in accordance with the contract within 15 calendar days of receipt of a request for assurance from the Contracting Agency;
4. If the Contractor disregards laws, ordinances, rules, codes, regulations, orders or similar requirements of any public entity having jurisdiction;
5. If the Contractor disregards the authority of the Contracting Agency;
6. If the Contractor performs work which deviates from the contract, and neglects or refuses to correct rejected work; or
7. If the Contractor otherwise violates in any material way any provisions or requirements of the contract.

Once the Contracting Agency determines that sufficient cause exists to terminate the contract, written notice shall be given to the Contractor and its Surety indicating that the Contractor is in breach of the contract and that the Contractor is to remedy the breach within 15 calendar days after the notice is sent. In case of an emergency such as potential damage to life or property, the response time to remedy the breach after the notice may be shortened. If the remedy does not take place to the satisfaction of the Contracting Agency, the Engineer may, by serving written notice to the Contractor and Surety either:

1. Transfer the performance of the work from the Contractor to the Surety; or
2. Terminate the contract and at the Contracting Agency's option prosecute it to completion by contract or otherwise. Any extra costs or damages to the Contracting Agency shall be deducted from any money due or coming due to the Contractor under the contract.

If the Engineer elects to pursue one remedy, it will not bar the Engineer from pursuing other remedies on the same or subsequent breaches.

Upon receipt of a notice that the work is being transferred to the Surety, the Surety shall enter upon the premises and take possession of all materials, tools, and appliances for the purpose of completing the work included under the contract and employ by contract or otherwise any person or persons satisfactory to the Engineer to finish the work and provide the materials without termination of the contract. Such employment shall not relieve the Surety of its obligations under the contract and the bond. If there is a transfer to the Surety, payments on estimates covering work subsequent to the transfer shall be made to the extent permitted under law to the Surety or its agent without any right of the Contractor to make any claim.

If the Engineer terminates the contract or provides such sufficiency of labor or materials as required to complete the work, the Contractor shall not be entitled to receive any further payments on the contract until all the work contemplated by the contract has been fully performed. The Contractor shall bear any extra expenses incurred by the Contracting Agency in completing the work, including all increased costs for completing the work, and all damages sustained, or which may be sustained, by the Contracting Agency by reason of such refusal, neglect, failure, or discontinuance of work by the Contractor. If liquidated damages are provided in the contract, the Contractor shall be liable for such liquidated damages until such reasonable time as may be required for physical completion of the work. After all the work contemplated by the contract has been completed, the Engineer will calculate the total expenses and damages for the completed work. If the total expenses and damages are less than any unpaid balance due the Contractor, the excess will be paid by the Contracting Agency to the Contractor. If the total expenses and damages exceed the unpaid balance, the Contractor and the Surety shall be jointly and severally liable to the Contracting Agency and shall pay the difference to the State of Washington, Department of Transportation on demand.

In exercising the Contracting Agency's right to prosecute the physical completion of the work, the Contracting Agency shall have the right to exercise its sole discretion as to the manner, method, and reasonableness of the costs of completing the work. In the event that the Contracting Agency takes bids for remedial work or physical completion of the project, the Contractor shall not be eligible for the award of such contracts.

In the event the contract is terminated, the termination shall not affect any rights of the Contracting Agency against the Contractor. The rights and remedies of the Contracting Agency under the Termination Clause are in addition to any other rights and remedies provided by law or under this contract. Any retention or payment of monies to the Contractor by the Contracting Agency will not release the Contractor from liability.

If a notice of termination for default has been issued and it is later determined for any reason that the Contractor was not in default, the rights and obligations of the parties shall be the same as if the notice of termination had been issued pursuant to Termination for Public Convenience in Section 1-08.10(2). This shall include termination for default because of failure to prosecute the work, and the delay was found to be excusable under the provisions of Section 1-08.8.

1-08.10(2) Termination for Public Convenience

The Engineer may terminate the contract in whole, or from time to time in part, whenever:

1. The Contractor is prevented from proceeding with the work as a direct result of an Executive Order of the President with respect to the prosecution of war or in the interest of national defense; or an Executive Order of the President or Governor of the State with respect to the preservation of energy resources;
2. The Contractor is prevented from proceeding with the work by reason of a preliminary, special, or permanent restraining order of a court of competent jurisdiction where the issuance of such restraining order is primarily caused by acts or omissions of persons or agencies other than the Contractor; or
3. The Engineer determines that such termination is in the best interests of the Contracting Agency.

1-08.10(3) Termination for Public Convenience Payment Request

After receipt of Termination for Public Convenience as provided in Section 1-08.10(2), the Contractor shall submit to the Contracting Agency a request for costs associated with the termination. The request shall be prepared in accordance with the claim procedures outlined in Sections 1-09.11 and 1-09.12. The request shall be submitted promptly but in no event later than 90 calendar days from the effective date of termination.

The Contractor agrees to make all records available to the extent deemed necessary by the Engineer to verify the costs in the Contractor's payment request.

1-08.10(4) Payment for Termination for Public Convenience

Whenever the contract is terminated in accordance with Section 1-08.10(2), payment will be made in accordance with Section 1-09.5 for the actual work performed.

If the Contracting Agency and the Contractor cannot agree as to the proper amount of payment, then the matter will be resolved as outlined in Section 1-09.13 except that, if the termination occurs because of the issuance of a restraining order as provided in Section 1-08.10(2), the matter will be resolved through mandatory and binding arbitration as described in Sections 1-09.13(3) A and B, regardless of the amount of the claim.

1-08.10(5) Responsibility of the Contractor and Surety

Termination of a contract shall not relieve the Contractor of any responsibilities under the contract for work performed. Nor shall termination of the contract relieve the Surety or Sureties of obligations under the contract bond or retainage bond for work performed.

1-09 MEASUREMENT AND PAYMENT

1-09.1 Measurement of Quantities

In measuring all acceptably completed bid items of work, the Engineer will:

1. Use United States standard measure,
2. Make all measurements as described in this section, unless individual specifications require otherwise,
3. Follow methods generally recognized as conforming to good engineering practice,
4. Conform to the usual practice of the Contracting Agency by carrying measurements and computations to the proper significant figure or fraction of units for each item, and
5. Measure horizontally or vertically (unless otherwise specified).

The terms listed below shall be defined as follows in all measurements under this section:

"Lump Sum" (when used as an item of payment): complete payment for the work described for that item in the contract.

"Gage" (in measurement of plates): the U.S. Standard Gage.

"Gage" (in measurement of galvanized sheets used to manufacture corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing): that specified in AASHTO M 36, M 167, M 196, M 197, or M 219.

"Gage" (in measurement of wire): that specified in AASHTO M 32.

"Ton": 2,000 pounds of avoirdupois weight.

For each basis of measurement listed below, the Engineer will use the method of measurement described. For bid items or materials measured on the basis of:

Hour - measured for each hour that work is actually performed. Portions of an hour will be rounded up to a half hour.

Square Yard or Square Foot — the measurement shall be a calculation from the neat dimensions shown in the Plans or as altered by the Engineer. If there is an exception within the measured area where the item of work is not performed (such as a drainage vault within a measured sidewalk) and if the exception area is greater than 9 square feet, then the area of the exception will be subtracted from the payment area calculated from the neat dimensions.

Linear Foot (pipe culverts, guard rail, underdrains, etc.) — measured parallel to the structure's base or foundation, unless the plans require otherwise.

Weight — weighed as required in Section 1-09.2.

Volume (of excavation and embankment) — measured by the average-end-area method or by the finite element analysis method utilizing digital terrain modeling techniques. All or some computations may be based on ground elevations and other data derived photogrammetrically. The Engineer may correct for curvature.

Volume (in the hauling vehicle) — measured at the point of delivery. Hauling vehicles may be of any size or type the Engineer approves provided that the body is of such shape that the actual contents may be readily and accurately determined. If the Engineer requires, the Contractor shall level loads at the delivery point to facilitate measurement.

For each item listed below, the Engineer will use the method of measurement described.

Structures — measured on the neat lines shown in the plans or as altered by the Engineer. When a complete structure or structural unit is specified as the unit of measurement, the unit shall include all fittings and accessories.

Timber — measured by the thousand board feet (MBM) actually used in the structure. Measurements will be based on nominal widths and thicknesses and the extreme length of each piece.

Standard Manufactured Items (fence, wire, plates, rolled shapes, pipe conduit, etc., when specified) — measured by the manufacturer's identification of gage, unit weight, section dimension, etc. The Engineer will accept manufacturing tolerances set by each industry unless cited specifications require more stringent tolerances.

Cement — measured by the pound, ton, or sack. A sack shall be 94 pounds.

Asphalt — measured by the gallon or ton. If measured by gallon, measurement will be made at 60 F (or will be corrected to the volume at 60 F in keeping with ASTM D 1250). If shipped by rail, truck, or transport, measurement will be by net certified scale masses or certified volumes (corrected for material lost en route or not actually incorporated into the work).

No measurement will be made for:

1. Work performed or materials placed outside lines shown in the plans or set by the Engineer;
2. Materials wasted, used, or disposed of in a manner contrary to the contract;
3. Rejected materials (including those rejected after placement if the rejection resulted from the Contractor's failure to comply with the contract);
4. Hauling and disposing of rejected materials;
5. Material remaining on hand after the work is completed, except as provided in Sections 1-09.5 and 1-09.10; or
6. Any other work or material contrary to any contract provision.

1-09.2 Weighing Equipment

1-09.2(1) General Requirements for Weighing Equipment

Any highway or bridge construction materials to be proportioned or measured and paid for by weight shall be weighed on a scale. These materials include natural, manufactured or processed materials obtained from natural deposits, stockpiles, or bunkers.

Scales

Scales shall:

1. Be accurate to within one-half of 1 percent throughout the range of use;
2. Not include spring balances;
3. Include beams, dials, or other reliable readout equipment;
4. Be arranged so that operators and inspectors can safely and easily see the dials, beams, rods, and operating scale mechanisms;
5. Be built to prevent scale parts from binding, vibrating, or being displaced and to protect all working parts from falling material, wind, and weather; and
6. Be carefully maintained, with bunkers and platforms kept clear of accumulated materials that could cause errors and with knife edges given extra care and protection.

Weighers

The Contractor shall provide, set up, and maintain the scales necessary to perform this work. "Contractor provided scale operations" are defined as operations where a scale is set up specifically for the project and most, if not all, material weighed on the scale is utilized for contract work. In this situation, the contracting agency will provide a person to operate the scale, write tickets, perform scale checks and prepare reports.

The Contractor may also utilize permanently installed, certified, commercial scales. "Commercial scale operations" include the use of established scales used to sell materials to the public on a regular basis. In addition, for the purposes of this specification, all batch, hopper, and belt scales are considered to be commercial scales. Commercial scales shall meet the same requirements as Contractor-provided scales. When a commercial scale is used, the Contractor may utilize a commercial scale operator provided it is at no additional cost to the contracting agency. In addition, the Contractor shall ensure that:

1. the Engineer is allowed to observe the weighing operation and check the daily scale weight record;
2. scale verification checks are performed at the direction of the contracting agency (see "1-09.2(5) Measurement");
3. several times each day, the commercial scale operator records and makes certain the platform scale balances and returns to zero when the load is removed; and
4. test results and scale weight records for each day's hauling operations are provided to the Engineer daily. Unless otherwise approved, reporting shall utilize form 422-027, Scaleman's Daily Report.

Trucks and Tickets

Each truck to be weighed shall bear a unique identification number. This number shall be legible and in plain view of the scale operator. Each vehicle operator shall obtain a weigh or load ticket from the scale operator. The Contractor shall provide tickets for self-printing scales. All tickets shall, at a minimum, contain the following information:

1. date of haul;
2. contract number;
3. contract unit bid item;
4. unit of measure;
5. identification of hauling vehicle; and
6. weight delivered
    a. net weight in the case of batch and hopper scales
    b. gross weight, tare and net weight in the case of platform scales (tare may be omitted if a tare beam is used)
    c. approximate load out weight in the case of belt conveyor scales

The vehicle operator shall deliver the ticket in legible condition to the material receiver at the material delivery point.

1-09.2(2) Specific Requirements for Batching Scales

Each batching scale shall be designed to support a weighing container. The arrangement shall make it convenient for the operator to remove material from the weighing container while watching readout devices. Any weighing container mounted on a platform scale shall have its center of gravity directly over the platform centerline. Batching scales used for Portland or asphalt cement shall not be used for batching other materials.

Readout devices used for batching or hopper scales shall be marked at intervals evenly spaced throughout and shall be based on the scale's nominal rated capacity. These intervals shall not exceed one-tenth of 1 percent of the nominal rated capacity. Before use at a new site and then at 6-month intervals, all batching and hopper scales shall be: approved under rules of the Weights and Measures Section of the Washington State Department of Agriculture, or serviced and tested with at least 10,000 pounds by an agent of its manufacturer. In either case, the Contractor shall provide the Engineer with a copy of the final test results.

1-09.2(3) Specific Requirements for Platform Scales

Each platform scale shall be able to weigh the entire hauling vehicle or combination of connected vehicles at one time. No part of the vehicle or vehicle combination will be permitted off the platform as it is weighed. A tare weight shall be taken of each hauling vehicle at least twice daily.

Any platform scale shall be installed and maintained with the platform level and with rigid bulkheads at either end to prevent binding or shifting. The readout device shall be marked at intervals of no more than 40 pounds. Test records shall show results to the nearest 20 pounds. During weighing operations, weights shall be read and recorded to the nearest 100 pounds. Before use at a new site and then at 6-month intervals, any platform scale shall be: approved under rules of the Washington State Department of Agriculture's Weights and Measures Section, or serviced and tested with at least 10,000 pounds by an agent of its manufacturer. In either case, the Contractor shall provide the Engineer with a copy of the final test results.

Any Contractor-supplied scale shall include a scale house with a floor space of at least 6 by 10-feet. The scale house shall be wind and weather tight, shall have windows for light and ventilation, shall include a door, and shall be lockable. It shall include a table, a chair, electrical power, and a space heater. The Contractor shall provide a rest room near the scale house.

1-09.2(4) Specific Requirements for Belt Conveyor Scales

The Engineer may approve conveyor-belt weighing of untreated materials if the method and device meet all general requirements for weighing equipment. The recording tape, odometer, totalizer, calibration adjustment, and clock-time imprinter shall be kept locked and the Engineer shall retain all keys. All belt-conveyor scales shall comply with the requirements for Belt-Conveyor Scales in the National Institute of Standards and Technology (NIST) Handbook No. 44, except where these specifications modify those requirements.

A static load test shall be made: each day after the belt-conveyor has run continuously for about 30 minutes, and again, immediately after the air temperature changes significantly. If the static load test reveals a need for adjustment, the Contractor shall perform a chain test. The Contractor shall make the computation of the test chain calibration, the calibration procedures and results, and related records available for the engineer's review. The test chain shall be clearly marked with its calibration, carried in a suitable container, and kept immediately available for testing.

1-09.2(5) Measurement

Scale Verification Checks

Regardless of the type of scale used, a scale verification test shall be performed daily. The Contractor shall designate a separate, certified, platform scale or a separate commercial platform scale, independent of the scale used for weighing construction materials, to be used for scale verification checks. Each batch, hopper or platform scale will be tested by routing a loaded truck onto a separate certified platform scale or a separate commercial platform scale and comparing the weights. If such a separate scale is not reasonably available, the Engineer may approve a Contractor request to use an alternate method of scale verification checks as described on Form 422-027, "Scaleman's Daily Report" and as appropriate for the type of scale.

To test the accuracy of a belt-conveyor scale, the Contractor shall weigh five or more payloads from sequential hauling units and compare these weights with weights of the same payloads taken on a separate certified platform scale. If the test results fluctuate, the engineer may require more than five check loads. Conveyor weights will be based on tonnage values taken from the sealed odometer at the beginning and end of each check period.

If scale verification checks shows the scale has been under weighing, it shall be adjusted immediately. The Contractor shall not be compensated for any loss from under weighing.

If scale verification checks show the scale has been overweighing, its operation will cease immediately until adjusted. The contracting agency will calculate the combined weight of all materials weighed after the last verification check showing accurate results. This combined weight will then be reduced for payment by the percentage of scale error that exceeds one-half of 1 percent.

Minor Construction Items

If the specifications and plans require weight measurement for minor construction items, the Contractor may request permission to convert volume to weight. If the Engineer approves, an agreed factor may be used to make this conversion and volume may be used to calculate the corresponding weight for payment.

1-09.2(6) Payment

The Contracting Agency will pay for no materials received by weight unless they have been weighed as required in this section or as required by another method the Engineer has approved in writing.

Unit contract prices for the various pay items of the project cover all costs related to weighing and proportioning materials for payment. These costs include but are not limited to:

- furnishing, installing, certifying, and maintaining scales
- furnishing a scale house
- providing a weigher with a commercial scale, if necessary
- providing self-printing tickets, if necessary
- rerouting a truck for verification weighing
- assisting the engineer with scale verification checks
- any other related costs associated with meeting the requirements of this section.

1-09.3 Scope of Payment

The payment provided for in the contract shall be full payment to the Contractor for:

1. Furnishing all materials and performing all work under the contract (including changes in the work, materials, or plans) in a complete and acceptable manner;
2. All risk, loss, damage, or expense of whatever character arising out of the nature or prosecution of the work; and
3. All expense incurred resulting from a suspension or discontinuance of the work as specified under the contract.

The payment of any estimate or retained percentage shall not relieve the Contractor of the obligation to make good any defective work or materials.

Unless the plans and special provisions provide otherwise, the unit contract prices for the various bids items shall be full payment for all labor, materials, supplies, equipment, tools, and all other things required to completely incorporate the item into the work as though the item were to read "In Place."

If the "Payment" clause in the specifications, for an item included in the proposal, covers and considers all work and material essential to that item, then the work or materials will not be measured or paid for under any other item that may appear elsewhere in the proposal or specifications.

Certain payment items appearing in these Specifications may be modified in the plans and proposal to include:

1. The words "For Structure," "For Concrete Barrier," "For Bridge," etc. with the intent of clarifying specific use of the item; or
2. The words "Site (Site Designation)," with the intent of clarifying where a specific item of work is to be performed.

Modification of payment items in this manner shall in no way change the intent of the specifications relating to these items.

1-09.4 Equitable Adjustment

The equitable adjustment provided for elsewhere in the contract shall be determined in one or more of the following ways:

1. If the parties are able to agree, the price will be determined by using:
   a. Unit prices, or
   b. Other agreed upon prices;
2. If the parties cannot agree, the price will be determined by the Engineer using:
   a. Unit prices, or
   b. Other means to establish costs.

The following limitations shall apply in determining the amount of the equitable adjustment:

1. The equipment rates shall be actual cost but shall not exceed the rates set forth in the AGC/WSDOT Equipment Rental Agreement in effect at the time the work is performed as referred to in Section 1-09.6, and
2. To the extent any delay or failure of performance was concurrently caused by the Contracting Agency and the Contractor, the Contractor shall be entitled to a time extension for the portion of the delay or failure of performance concurrently caused, provided it make such a request pursuant to Section 1-08.8; however, the Contractor shall not be entitled to any adjustment in contract price.
3. No claim for anticipated profits on deleted, terminated, or uncompleted work will be allowed.
4. No claim for consequential damages of any kind will be allowed.

1-09.5 Deleted or Terminated Work

The Engineer may delete work by change order as provided in Section 1-04.4 or may terminate the contract in whole or part as provided in Section 1-08.10(2). When the contract is terminated in part, the partial termination shall be treated as a deletion change order for payment purposes under this section.

Payment for completed items will be at unit contract prices.

When any item is deleted in whole or in part by change order or when the contract is terminated in whole or in part, payment for deleted or terminated work will be made as follows:

1. Payment will be made for the actual number of units of work completed at the unit contract prices unless the Engineer determines the unit prices are inappropriate for the work actually performed. When that determination is made by the Engineer, payment for work performed will be as mutually agreed. If the parties cannot agree the Engineer will determine the amount of the equitable adjustment in accordance with Section 1-09.4;
2. Payment for partially completed lump sum items will be as mutually agreed. If the parties cannot agree, the Engineer will determine the amount of the equitable adjustment in accordance with Section 1-09.4;
3. To the extent not paid for by the contract prices for the completed units of work, the Contracting Agency will pay as part of the equitable adjustment those direct costs necessarily and actually incurred by the Contractor in anticipation of performing the work that has been deleted or terminated;
4. The total payment for any one item in the case of a deletion or partial termination shall not exceed the bid price as modified by approved change orders less the estimated cost (including overhead and profit) to complete the work and less any amount paid to the Contractor for the item;
5. The total payment where the contract is terminated in its entirety shall not exceed the total contract price as modified by approved change orders less those amounts paid to the Contractor before the effective date of the termination; and
6. No claim for damages of any kind or for loss of anticipated profits on deleted or terminated work will be allowed because of the termination or change order.

Contract time shall be adjusted as the parties agree. If the parties cannot agree, the Engineer will determine the equitable adjustment for contract time.

Acceptable materials ordered by the Contractor prior to the date the work was terminated as provided in Section 1-08.10(2) or deleted as provided in Section 1-04.4 by the Engineer, will either be purchased from the Contractor by the Contracting Agency at the actual cost and shall become the property of the Contracting Agency, or the Contracting Agency will reimburse the Contractor for the actual costs connected with returning these materials to the suppliers.

1-09.6 Force Account

The terms of the contract or of a change order may call for work or material to be paid for by force account. If so, then the objective of this specification is to reimburse the Contractor for all costs associated with the work, including costs of labor, small tools, supplies, equipment, specialized services, materials, applicable taxes and overhead and to include a profit commensurate with those costs. The amount to be paid shall be determined as shown below:

1. **For Labor:** Labor reimbursement calculations shall be based on a "Project Labor List" (List,) prepared and submitted by the Contractor and by any subcontractor before that firm commences force account work. Once a List is approved by the Engineer, it shall be used to calculate force account labor payment until a new List is submitted and approved. The Engineer may compare the List to payrolls and other documents and may, at any time, require the Contractor to submit a new List. The Contractor may submit a new List at any time without such a requirement. Prior payment calculations shall not be adjusted as a result of a new List.

   To be approved, the List must be accurate and meet the requirements of this section. It shall include regular time and overtime rates for all employees (or work classifications) expected to participate in force account work. The rates shall include the basic wage and fringe benefits, the current rates for Federal Insurance Compensation Act (FICA), Federal Unemployment Tax Act (FUTA) and State Unemployment Tax Act (SUTA), the company's present rates for Medical Aid and Industrial Insurance premiums and the planned payments for travel and per diem compensation.

   In the event that an acceptable initial List or requested revised List is not received by the time that force account calculations are begun, the Engineer will develop a List unilaterally, utilizing the best data available, that will be used until a Contractor's List is received and approved. Again, prior calculations, prepared using the Engineer's List, will not be revised as a result of differences with the Contractor's List.

   In addition to compensation for direct labor costs defined above, the Contracting Agency will pay Contractor 29 percent of the sum of the costs calculated for labor reimbursement to cover project overhead, general company overhead, profit, bonding, insurance, Business & Occupation tax, and any other costs incurred. This amount will include any costs of safety training and health tests, but will not include such costs for unique force account work that is different from typical work and which could not have been anticipated at time of bid.

2. **For Materials:** The Contracting Agency will reimburse invoice cost for Contractor-supplied materials. For the purpose of this provision, "Materials" shall include those items incorporated into the work, supplies used during the work and items consumed. This cost shall include freight and handling charges and applicable taxes. Before work is started, the Engineer may require the Contractor to obtain multiple quotations for the materials to be utilized and select the vendor with prices and terms most advantageous to the Contracting Agency.

   The Contracting Agency will provide a list of the types and quantities of Contractor-supplied materials witnessed by the Contracting Agency as being utilized in force account work. The list will be furnished promptly after the material is incorporated, on a daily basis unless agreed otherwise. The Contractor may propose corrections to the list and will supply prices for the materials and other costs and return the list to the Contracting Agency. To support the prices, the Contractor shall attach valid copies of vendor invoices. If invoices are not available for materials from the Contractor's stocks, the Contractor shall certify actual costs (at a reasonable level) by affidavit. The Engineer will review the prices and any Contractor-proposed corrections and, if reasonable, approve the completed list. Once approved, the prices will be utilized in the calculation of force account reimbursement for materials.

   If, in the case of non-invoiced materials supported by Contractor affidavit, the price appears to be unreasonable, the Engineer will determine the cost for all or part of those materials, utilizing the best data available.

   The Contracting Agency reserves the right to provide materials. In this case, the Contractor will receive no payment for any costs, overhead, or profit arising from the value of the materials themselves. Additional costs to handle and place the Agency-furnished material shall be compensated as described in this specification.

   In addition to compensation for direct materials cost, the Contracting Agency will pay the Contractor 21 percent of the sum of the costs calculated for materials reimbursement to cover project overhead, general company overhead, profit, bonding, insurance, Business & Occupation tax, and any other costs incurred.

3. **For Equipment:** The Contracting Agency will reimburse the Contractor for the cost of equipment utilized in the work. The equipment provided by the Contractor shall be of modern design and in good working condition. For the purpose of this provision, "provided" shall mean that the equipment is owned (either through outright ownership or through a long-term lease) and operated by the Contractor or Subcontractor or that the equipment is rented and operated by the Contractor or Subcontractor. Equipment that is rented with operator shall not be included here, but shall be considered a service and addressed according to section 4 of this provision.

   The amount of payment for any Contractor-owned equipment that is utilized shall be determined according to the version of the AGC/WSDOT Equipment Rental Agreement which is in effect at the time the force account

is authorized. The rates listed in the Rental Rate Blue Book (as modified by the current AGC/WSDOT Equipment Rental Agreement) shall be full compensation for all fuel, oil, lubrication, ordinary repairs, maintenance, and all other costs incidental to furnishing and operating the equipment except labor for operation.

Payment for rented equipment will be made on the basis of a valid invoice, covering the time period of the work. Before work is started, the Engineer may require the Contractor to obtain multiple quotations for the rental of equipment to be utilized and select the vendor with prices and terms most advantageous to the Contracting Agency. In the event that prior quotations are not obtained and the vendor is not a firm independent from the Contractor or subcontractor, then after-the-fact quotations may be obtained by the Engineer from the open market in the vicinity and the lowest such quotation may be used in place of submitted invoice.

In addition to the payments for Contractor-owned and rented equipment, one or more lump-sum payments may be made for small tools. The amount to be paid shall be determined as outlined in the AGC/WSDOT Equipment Rental Agreement.

The Contracting Agency will add 21 percent to equipment costs to cover project overhead, general company overhead, profit, bonding, insurance, Business & Occupation tax, and any other costs incurred. This markup will be over and above those equipment costs and will not be adjusted for any equipment overhead amounts included in the Blue Book rates.

Current copies of the Rental Rate Blue Book and the AGC/WSDOT Equipment Rental Agreement will be maintained at each Region office of the Department of Transportation (Compact Disk Version) and at each of the offices of the Associated General Contractors of America (in Seattle, Spokane, Tacoma, and Wilsonville, Oregon) where they are available for inspection.

4. **For Services:** Compensation under force account for specialized services shall be made on the basis of an invoice from the providing entity. A "specialized service" shall be one that is typically billed through invoice in standard industry practice. Before work is started, the Engineer may require the Contractor to obtain multiple quotations for the service to be utilized and select the provider with prices and terms most advantageous to the Contracting Agency. In the event that prior quotations are not obtained and the service invoice is submitted by a subcontractor, then after-the-fact quotations may be obtained by the Engineer from the open market in the vicinity and the lowest such quotation may be used in place of the submitted invoice.

   Except as noted below, the Contracting Agency will pay the Contractor an additional 21 percent of the sum of the costs included on invoices for specialized services to cover project overhead, general company overhead, profit, bonding, insurance, Business & Occupation tax, and any other costs incurred.

   When a supplier of services is compensated through invoice, but acts in the manner of a subcontractor, as described in Section 6 of this provision, then markup for that invoice shall be according to Section 6. "Contractor Markup on Subcontractors' Work".

5. **For Mobilization:** Force account mobilization is defined as the preparatory work performed by the Contractor including procurement, loading and transportation of tools and equipment, and personal travel time (when such travel time is a contractual obligation of the Contractor or a customary payment for the Contractor to all employees). Mobilization also includes the costs incurred during demobilization. Pro-rata adjustments may be made when the mobilization applies to both force account and other contract work. The Contracting Agency will pay for mobilization for off-site preparatory work for force account items provided that notice has been provided sufficiently in advance to allow the Engineer to witness the activity, if desired.

   Any costs experienced during mobilization activities for labor, equipment, materials or services shall be listed in those sections of the force account summary and paid accordingly.

6. **For Contractor Markup on Subcontractor's Work:** When work is performed on a force account basis by one or more approved subcontractors, by lower-tier subcontractors or suppliers, or through invoice by firm(s) acting in the manner of a subcontractor, the Contractor will be allowed an additional markup, from the table below, applied to the costs computed for work done by each subcontractor through Sections 1, 2, 3, and 4, to compensate for all administrative costs, including project overhead, general company overhead, profit, bonding, insurance, Business & Occupation tax, and any other costs incurred.

   A firm may be considered to be acting as a subcontractor when the Engineer observes one or more of the following characteristics:

   a. The person in charge of the firm's activities takes an active role in managing the overall project, including extensive coordination, interpretation of plans, interaction with the Contracting Agency or management of a complex and interrelated operation.
   b. Rented equipment is provided fueled, operated and maintained by the firm. Operators of rented equipment are supervised directly by the firm's representative. There is little interaction between the Contractor and the employees of the firm.
   c. The firm appears to be holding the risk of performance and quality of the work.
   d. The firm appears to be responsible for liability arising from the work.

   Markups on Work Performed by Subcontractor(s):

(1)	On amounts paid for work performed by each Subcontractor on each force account and calculated through Sections 1-4,	up to $25,000	12%
(2)	On amounts greater than	$25,000 up to $100,000	10%
(3)	On amounts greater than	$100,000	7%

   The amounts and markup rates shall be calculated separately for each subcontractor on each force account item established.

The payments provided above shall be full payment for all work done on a force account basis. The calculated payment shall cover all expenses of every nature, kind, and description, including those listed above and any others incurred on the work being paid through force account. Nothing in this provision shall preclude the Contractor from

seeking an extension of time or time-related damages to unchanged work arising as a result of the force account work. The amount and costs of any work to be paid by force account shall be computed by the Engineer, and the result shall be final as provided in Section 1-05.1.

An item that has been bid at a unit price or lump sum in the Proposal will not be paid as force account unless a change as defined in Section 1-04.4 has occurred and the provisions require a payment adjustment. Items which are included in the Proposal as Force Account or which are added by change order as Force Account may, by agreement of the parties at any time, be converted to agreed unit prices or lump sums applicable to the remaining work.

1-09.7 Mobilization

Mobilization consists of preconstruction expenses and the costs of preparatory work and operations performed by the Contractor which occur before 10 percent of the total original contract amount is earned from other contract items. Items which are not to be included in the item of Mobilization include but are not limited to:

1. Any portion of the work covered by the specific contract item or incidental work which is to be included in a contract item or items.
2. Profit, interest on borrowed money, overhead, or management costs.
3. Any costs of mobilizing equipment for force account work.

Based on the lump sum contract price for "Mobilization," partial payments will be made as follows:

1. When 5 percent of the total original contract amount is earned from other contract items, excluding amounts paid for materials on hand, 50 percent of the amount bid for mobilization, or 5 percent of the total original contract amount, whichever is the least, will be paid.
2. When 10 percent of the total original contract amount is earned from other contract items, excluding amounts paid for materials on hand, 100 percent of the amount bid for mobilization, or 10 percent of the total original contract amount, whichever is the least, will be paid.
3. When the substantial completion date has been established for the project, payment of any amount bid for mobilization in excess of 10 percent of the total original contract amount will be paid.

Nothing herein shall be construed to limit or preclude partial payments otherwise provided by the contract.

1-09.8 Payment for Material on Hand

The Contracting Agency may reimburse the Contractor for materials purchased before their use in the work if they:

1. Meet the requirements of the plans and specifications;
2. Are delivered to or stockpiled near the project or other Engineer-approved storage sites; and
3. Consist of: sand, gravel, surfacing materials, aggregates, reinforcing steel, bronze plates, structural steel, machinery, piling, timber and lumber (not including forms or falsework), large signs unique to the project, prestressed concrete beams or girders, or other materials the Engineer may approve.

The Contracting Agency may reimburse the Contractor for traffic signal controllers as follows:

1. Fifty percent when the traffic signal controller and all components are received and assembled into a complete unit at the State Materials Laboratory.
2. One hundred percent when the traffic signal controller is approved for shipment to the project by the State Materials Laboratory.

The Contractor shall provide sufficient written evidence of production costs to enable the Engineer to compute the cost of Contractor-produced materials (such as sand, gravel, surfacing material, or aggregates). For other materials, the Contractor shall provide invoices from material suppliers. Each invoice shall be detailed sufficiently to enable the Engineer to determine the actual costs. Payment for materials on hand shall not exceed the total contract cost for the contract item.

If payment is based upon an unpaid invoice, the Contractor shall provide the Engineer with a paid invoice within 60 calendar days after the Contracting Agency's initial payment for materials on hand. If the paid invoice is not furnished in this time, any payment the Contracting Agency had made will be deducted from the next progress estimate and withheld until the paid invoice is supplied.

The Contracting Agency will not pay for material on hand when the invoice cost is less than $2,000. As materials are used in the work, credits equaling the partial payments for them will be taken on future estimates. Partial payment for materials on hand shall not constitute acceptance. Any material will be rejected if found to be faulty even if partial payment for it has been made.

1-09.9 Payments

The basis of payment will be the actual quantities of work performed according to the contract and as specified for payment.

Payments will be made for work and labor performed and materials furnished under the contract according to the price in the proposal unless otherwise provided.

Partial payments will be made once each month, based upon partial estimates prepared by the Engineer. Unless otherwise provided, payments will be made from the Motor Vehicle Fund.

Failure to perform any of the obligations under the contract by the Contractor may be decreed by the Contracting Agency to be adequate reason for withholding any payments until compliance is achieved.

Upon completion of all work and after final inspection (Section 1-05.11), the amount due the Contractor under the contract will be paid based upon the final estimate made by the Engineer and presentation of a Final Contract Voucher Certification signed by the Contractor. Such voucher shall be deemed a release of all claims of the Contractor unless a claim is filed in accordance with the requirements of Section 1-09.11 and is expressly excepted from the Contractor's certification on the Final Contract Voucher Certification. The date the Secretary signs the Final Contract Voucher Certification constitutes the final acceptance date (Section 1-05.12).

If the Contractor fails, refuses, or is unable to sign and return the Final Contract Voucher Certification or any other documentation required for completion and final acceptance of the contract, the Contracting Agency reserves the right to establish a completion date (for the purpose of meeting the requirements of RCW 60.28) and unilaterally accept the contract. Unilateral final acceptance will occur only after the

Contractor has been provided the opportunity, by written request from the Engineer, to voluntarily submit such documents. If voluntary compliance is not achieved, formal notification of the impending establishment of a completion date and unilateral final acceptance will be provided by certified letter from the Secretary to the Contractor, which will provide 30 calendar days for the Contractor to submit the necessary documents. The 30 calendar day period will begin on the date the certified letter is received by the Contractor. The date the Secretary unilaterally signs the Final Contract Voucher Certification shall constitute the completion date and the final acceptance date (Section 1-05.12). The reservation by the Contracting Agency to unilaterally accept the contract will apply to contracts that are physically completed in accordance with Section 1-08.5, or for contracts that are terminated in accordance with Section 1-08.10. Unilateral final acceptance of the contract by the Contracting Agency does not in any way relieve the Contractor of their responsibility to comply with all Federal, State, tribal, or local laws, ordinances, and regulations that affect the work under the contract.

Payment to the Contractor of partial estimates, final estimates, and retained percentages shall be subject to controlling laws.

1-09.9(1) Retainage

Pursuant to RCW 60.28, a sum of 5 percent of the monies earned by the Contractor will be retained from progress estimates. Such retainage shall be used as a trust fund for the protection and payment (1) to the State with respect to taxes imposed pursuant to Title 82, RCW, and (2) the claims of any person arising under the Contract.

Monies retained under the provisions of RCW 60.28 shall, at the option of the Contractor, be:

1. Retained in a fund by the Contracting Agency, or
2. Deposited by the Contracting Agency in an escrow (interest-bearing) account in a bank, mutual saving bank, or savings and loan association (interest on monies so retained shall be paid to the Contractor). Deposits are to be in the name of the Contracting Agency and are not to be allowed to be withdrawn without the Contracting Agency's written authorization. The Contracting Agency will issue a check representing the sum of the monies reserved, payable to the bank or trust company. Such check shall be converted into bonds and securities chosen by the Contractor as the interest accrues.

At the time the Contract is executed the Contractor shall designate the option desired. The Contractor in choosing option (2) agrees to assume full responsibility to pay all costs that may accrue from escrow services, brokerage charges or both, and further agrees to assume all risks in connection with the investment of the retained percentages in securities. The Contracting Agency may also, at its option, accept a bond in lieu of retainage.

Release of the retainage will be made 60 days following the Completion Date (pursuant to RCW 39.12, and RCW 60.28) provided the following conditions are met:

1. On contracts totaling more than $20,000, a release has been obtained from the Washington State Department of Revenue.
2. Affidavits of Wages Paid for the Contractor and all Subcontractors are on file with the Contracting Agency (RCW 39.12.040).

3. A release has been obtained from the Washington State Department of Labor & Industries (per Section 1-07.10) and the Washington State Employment Security Department.
4. All claims, as provided by law, filed against the retainage have been resolved.

In the event claims are filed and provided the conditions or 1, 2, and 3 are met, the Contractor will be paid such retained percentage less an amount sufficient to pay any such claims together with a sum determined by the Contracting Agency sufficient to pay the cost of foreclosing on claims and to cover attorney's fees.

1-09.10 Payment for Surplus Processed Materials

After the Contract is completed, the Contractor will be reimbursed actual production costs for surplus processed material produced by the Contractor from Contracting Agency-provided sources if its value is $3,000 or more (determined by actual production costs).

The quantity of surplus material eligible for reimbursement of production costs shall be the quantity produced (but an amount not greater than 110 percent of plan quantity or as specified by the Engineer), less the actual quantity used. The Contracting Agency will determine the actual amount of surplus material for reimbursement.

The Contractor shall not dispose of any surplus material without permission of the Engineer. Surplus material shall remain the property of the Contracting Agency without reimbursement to the Contractor if it is not eligible for reimbursement.

1-09.11 Disputes and Claims

1-09.11(1) Disputes

When disputes occur during a contract, the Contractor shall pursue resolution through the Project Engineer. The Contractor shall follow the procedures outlined in Section 1-04.5. If the negotiation using the procedures outlined in Section 1-04.5 fails to provide satisfactory resolution, the Contractor shall pursue the more formalized method outlined in Section 1-09.11(2) for submitting a claim.

1-09.11(2) Claims

If the Contractor claims that additional payment is due and the Contractor has pursued and exhausted all the means provided in Section 1-09.11(1) to resolve a dispute, the Contractor may file a claim as provided in this section. The Contractor agrees to waive any claim for additional payment if the written notifications provided in Section 1-04.5 are not given, or if the Engineer is not afforded reasonable access by the Contractor to complete records of actual cost and additional time incurred as required by Section 1-04.5, or if a claim is not filed as provided in this section. The fact that the Contractor has provided a proper notification, provided a properly filed claim, or provided the Engineer access to records of actual cost, shall not in any way be construed as proving or substantiating the validity of the claim. If the claim, after consideration by the Engineer, is found to have merit, the Engineer will make an equitable adjustment either in the amount of costs to be paid or in the time required for the work, or both. If the Engineer finds the claim to be without merit, no adjustment will be made.

All claims filed by the Contractor shall be in writing and in sufficient detail to enable the Engineer to ascertain the basis and amount of the claim. All claims shall be submitted to the Project Engineer as provided in Section 1-05.15. As a minimum, the following information must accompany each claim submitted:

1. A detailed factual statement of the claim for additional compensation and time, if any, providing all necessary dates, locations, and items of work affected by the claim.
2. The date on which facts arose which gave rise to the claim.
3. The name of each Contracting Agency individual, official, or employee involved in or knowledgeable about the claim.
4. The specific provisions of the contract which support the claim and a statement of the reasons why such provisions support the claim.
5. If the claim relates to a decision of the Engineer which the contract leaves to the Engineer's discretion or as to which the contract provides that the Engineer's decision is final, the Contractor shall set out in detail all facts supporting its position relating to the decision of the Engineer.
6. The identification of any documents and the substance of any oral communications that support the claim.
7. Copies of any identified documents, other than Contracting Agency documents and documents previously furnished to the Contracting Agency by the Contractor, that support the claim (manuals which are standard to the industry, used by the Contractor, may be included by reference).
8. If an extension of time is sought:
   a. The specific days and dates for which it is sought,
   b. The specific reasons the Contractor believes a time extension should be granted,
   c. The specific provisions of Section 1-08.8 under which it is sought, and
   d. The Contractor's analysis of its progress schedule to demonstrate the reason for a time extension.
9. If additional compensation is sought, the exact amount sought and a breakdown of that amount into the following categories:
   a. Labor;
   b. Materials;
   c. Direct equipment. The actual cost for each piece of equipment for which a claim is made or in the absence of actual cost, the rates established by the AGC/WSDOT Equipment Rental Agreement which was in effect when the work was performed. In no case shall the amounts claimed for each piece of equipment exceed the rates established by that Equipment Rental Agreement even if the actual cost for such equipment is higher. The Contracting Agency may audit the Contractor's cost records as provided in Section 1-09.12 to determine actual equipment cost. The following information shall be provided for each piece of equipment:
      (1) Detailed description (e.g., Motor Grader Diesel Powered Caterpillar 12 "G," Tractor Crawler ROPS & Dozer Included Diesel, etc.);
      (2) The hours of use or standby; and
      (3) The specific day and dates of use or standby;
   d. Job overhead;
   e. Overhead (general and administrative);
   f. Subcontractor's claims (in the same level of detail as specified herein is required for any subcontractor's claims); and

g. Other categories as specified by the Contractor or the Contracting Agency.

10. A notarized statement shall be submitted to the Project Engineer containing the following language:

Under the penalty of law for perjury or falsification, the undersigned,

_____, _____
(name) (title)

of _____
(company)

hereby certifies that the claim for extra compensation and time, if any, made herein for work on this contract is a true statement of the actual costs incurred and time sought, and is fully documented and supported under the contract between the parties.

Dated _____/s/_____

Subscribed and sworn before me this _____ day of _____.

_____
Notary Public

My Commission Expires:_____

It will be the responsibility of the Contractor to keep full and complete records of the costs and additional time incurred for any alleged claim. The Contractor shall permit the Engineer to have access to those records and any other records as may be required by the Engineer to determine the facts or contentions involved in the claim. The Contractor shall retain those records for a period of not less than three years after final acceptance.

The Contractor shall pursue administrative resolution of any claim with the Engineer or the designee of the Engineer.

Failure to submit with the Final Contract Voucher Certification such information and details as described in this section for any claim shall operate as a waiver of the claims by the Contractor as provided in Section 1-09.9.

Provided that the Contractor is in full compliance with all the provisions of this section and after the formal claim document has been submitted, the Contracting Agency will respond, in writing, to the Contractor as follows:

1. Within 45 calendar days from the date the claim is received by the Contracting Agency if the claim amount is less than $100,000;
2. Within 90 calendar days from the date the claim is received by the Contracting Agency if the claim amount is equal to or greater than $100,000; or
3. If the above restraints are unreasonable due to the complexity of the claim under consideration, the Contractor will be notified within 15 calendar days from the date the claim is received by the Contracting Agency as to the amount of time which will be necessary for the Contracting Agency to prepare its response.

Full compliance by the Contractor with the provisions of this section is a contractual condition precedent to the Contractor's right to seek judicial relief.

1-09.11(3) Time Limitation and Jurisdiction

For the convenience of the parties to the contract it is mutually agreed by the parties that any claims or causes of action which the Contractor has against the State of Washington arising from the contract shall be brought within 180 calendar days from the date of final acceptance (Section 1-05.12) of the contract by the State of Washington; and it is further agreed that any such claims or causes of action shall be brought only in the Superior Court of Thurston County. The parties understand and agree that the Contractor's failure to bring suit within the time period provided, shall be a complete bar to any such claims or causes of action. It is further mutually agreed by the parties that when any claims or causes of action which the Contractor asserts against the State of Washington arising from the contract are filed with the State or initiated in court, the Contractor shall permit the State to have timely access to any records deemed necessary by the State to assist in evaluating the claims or action.

1-09.12 Audits

1-09.12(1) General

The Contractor's wage, payroll, and cost records on this contract shall be open to inspection or audit by representatives of the Contracting Agency during the life of the contract and for a period of not less than three years after the date of final acceptance of the contract. The Contractor shall retain these records for that period. The Contractor shall also guarantee that the wage, payroll, and cost records of all subcontractors and all lower tier subcontractors shall be retained and open to similar inspection or audit for the same period of time. The audit may be performed by employees of the Contracting Agency or by an auditor under contract with the Contracting Agency. The Contractor, subcontractors, or lower tier subcontractors shall provide adequate facilities, acceptable to the Engineer, for the audit during normal business hours. The Contractor, subcontractors, or lower tier subcontractors shall make a good faith effort to cooperate with the auditors. If an audit is to be commenced more than 60 calendar days after the final acceptance date of the contract, the Contractor will be given 20 calendar days notice of the time when the audit is to begin. If any litigation, claim, or audit arising out of, in connection with, or related to this contract is initiated, the wage, payroll, and cost records shall be retained until such litigation, claim, or audit involving the records is completed.

1-09.12(2) Claims

All claims filed against the Contracting Agency shall be subject to audit at any time following the filing of the claim. Failure of the Contractor, subcontractors, or lower tier subcontractors to maintain and retain sufficient records to allow the auditors to verify all or a portion of the claim or to permit the auditor access to the books and records of the Contractor, subcontractors, or lower tier subcontractors shall constitute a waiver of a claim and shall bar any recovery thereunder.

1-09.12(3) Required Documents for Audits

As a minimum, the auditors shall have available to them the following documents:

1. Daily time sheets and supervisor's daily reports.
2. Collective Bargaining Agreements.
3. Insurance, welfare, and benefits records.

4. Payroll registers.
5. Earnings records.
6. Payroll tax forms.
7. Material invoices and requisitions.
8. Material cost distribution worksheet.
9. Equipment records (list of company equipment, rates, etc.).
10. Vendors', rental agencies', subcontractors', and lower tier subcontractors' invoices.
11. Contracts between the Contractor and each of its subcontractors, and all lower-tier subcontractor contracts and supplier contracts.
12. Subcontractors' and lower tier subcontractors' payment certificates.
13. Canceled checks (payroll and vendors).
14. Job cost reports, including monthly totals.
15. Job payroll ledger.
16. General ledger.
17. Cash disbursements journal.
18. Financial statements for all years reflecting the operations on this contract. In addition, the contracting Agency may require, if it deems appropriate, additional financial statements for 3 years preceding execution of the contract and 3 years following final acceptance of the contract.
19. Depreciation records on all company equipment whether these records are maintained by the company involved, its accountant, or others.
20. If a source other than depreciation records is used to develop costs for the Contractor's internal purposes in establishing the actual cost of owning and operating equipment, all such other source documents.
21. All documents which relate to each and every claim together with all documents which support the amount of damages as to each claim.
22. Worksheets or software used to prepare the claim establishing the cost components for items of the claim including but not limited to labor, benefits and insurance, materials, equipment, subcontractors, all documents which establish the time periods, individuals involved, the hours for the individuals, and the rates for the individuals.
23. Worksheets, software, and all other documents used by the Contractor to prepare its bid.

An audit may be performed by employees of the Contracting Agency or a representative of the Contracting Agency. The Contractor and its subcontractors shall provide adequate facilities acceptable to the Contracting Agency for the audit during normal business hours. The Contractor and all subcontractors shall cooperate with the Contracting Agency's auditors.

1-09.13 Claims Resolution

1-09.13(1) General

Prior to seeking claim resolution through nonbinding alternative dispute resolution processes, binding arbitration, or litigation, the Contractor shall proceed under the administrative procedures in Sections 1-04.5, 1-09.11 and any special provision provided in the contract for resolution of disputes. The provisions of these sections must be complied with in full, as a condition precedent to the Contractor's right to seek claim resolution through any nonbinding alternative dispute resolution process, binding arbitration or litigation.

1-09.13(2) Nonbinding Alternative Disputes Resolution (ADR)

Nonbinding ADR processes are encouraged and available upon mutual agreement of the Contractor and the Contracting Agency for all claims submitted in accordance with Section 1-09.11, provided that:

1. All the administrative remedies provided for in the contract have been exhausted;
2. The Contracting Agency has been given the time and opportunity to respond to the Contractor as provided in Section 1-09.11(2); and
3. The Contracting Agency has determined that it has sufficient information concerning the Contractor's claims to participate in a nonbinding ADR process.

The Contracting Agency and the Contractor mutually agree that the cost of the nonbinding ADR process shall be shared equally by both parties with each party bearing its own preparation costs.

The type of nonbinding ADR process shall be agreed upon by the parties and shall be conducted within the State of Washington at a location mutually acceptable to the parties.

The Contractor agrees that the participation in a nonbinding ADR process does not in any way waive the requirement that binding arbitration or litigation proceedings must commence within 180 calendar days of final acceptance of the contract, the same as any other claim or causes of action as provided in Section 1-09.11(3).

1-09.13(3) Claims $250,000 or Less

The Contractor and the Contracting Agency mutually agree that those claims which total $250,000 or less, submitted in accordance with Section 1-09.11 and not resolved by nonbinding ADR processes, shall be resolved through mandatory and binding arbitration as described herein.

1-09.13(3)A Administration of Arbitration

Arbitration shall be as agreed by the parties or, if the parties cannot agree, arbitration shall be administered through the American Arbitration Association (AAA) using the following arbitration methods:

1. The current version of the Northwest Region Expedited Commercial Arbitration Rules shall be used for claims with an amount less than $25,000.
2. The current version of the Expedited Procedures of the Construction Industry Arbitration Rules shall be used for claims with an amount equal to or greater than $25,000 and less than $50,000.

3. The current version of the standard procedures of the Construction Industry Arbitration Rules shall be used for claims with an amount equal to or greater than $50,000 and not greater than $250,000.

The Contracting Agency and the Contractor mutually agree the venue of any arbitration hearing shall be within the State of Washington and any such hearing shall be conducted within the State of Washington.

The Contracting Agency and the Contractor mutually agree to be bound by the decision of the arbitrator, and judgment upon the award rendered by the arbitrator may be entered in the Superior Court of Thurston County. The decision of the arbitrator and the specific basis for the decision shall be in writing. The arbitrator shall use the contract as a basis for decisions.

1-09.13(3)B Procedures to Pursue Arbitration

If the dispute cannot be resolved through administrative procedures provided in Sections 1-04.5, 1-09.11, and any special provision provided in the contract for resolution of disputes or through a mutually agreed upon nonbinding ADR process, the Contractor shall advise the Engineer, in writing, that mandatory and binding arbitration is desired. The parties may agree on an arbitration process, or, if the parties cannot agree a demand for arbitration shall be filed by the Contractor, in accordance with the AAA rules, with the Contracting Agency, and with the AAA. Selection of the arbitrator and the administration of the arbitration shall proceed in accordance with AAA rules using arbitrators from the list developed by the AAA, except that: for claims under $25,000 using the Northwest Region Expedited Commercial Arbitration Rules, arbitration selection shall proceed pursuant to Section 55 of the Expedited Procedure of the Construction Industry Arbitration Rules. Arbitration shall proceed utilizing the appropriate rule of the AAA as determined by the dollar amount of the claim as provided in Section 1-09.13(3)A.

Unresolved disputes which do not involve delays or impacts to unchanged work may be brought to binding arbitration prior to physical completion of the project, provided that:

1. All the administrative remedies provided for in the contract have been exhausted;
2. The dispute has been pursued to the claim status as provided in Section 1-09.11(2); and
3. The Contractor certifies in writing that claims for delays or impacts to the work will not result from the dispute.

Unless the Contracting Agency and the Contractor agree otherwise, all other unresolved claims (disputes which have been pursued to the claim status) which arise from a contract must be brought in a single arbitration hearing and only after physical completion of the contract. The total of those unresolved claims cannot be greater than $250,000 to be eligible for arbitration.

In addition, the Contractor agrees arbitration proceedings must commence, by filing of the aforementioned demand for arbitration, within 180 calendar days of final acceptance of the contract, the same as any other claim or causes of action as provided in Section 1-09.11(3).

The scope and extent of discovery shall be determined by the arbitrator in accordance with AAA rules. In addition, each party for claims greater than $25,000 shall serve upon the other party a "statement of proof." The statement of proof shall be served, with a copy to the AAA, no less than 20 calendar days prior to the arbitration hearing and shall include:

1. The identity, current business address, and residential address of each witness who will testify at the hearing,
2. The identity of a witness as an expert if an expert witness is to be called, a statement as to the subject matter and the substance of the facts and opinions on which the expert is expected to testify, a summary of the grounds for each opinion, and a resume of the expert's qualifications, and
3. A list of each document that the party intends to offer in evidence at the arbitration hearing. Either party may request from the other party a copy of any document listed. If such a request is made, a copy of the document shall be provided within five calendar days from the date the request is received.

The arbitrator may permit a party to call a witness or offer a document not shown or included in the statement of proof only upon a showing of good cause.

1-09.13(4) Claims in Excess of $250,000

The Contractor and the Contracting Agency mutually agree that those claims in excess of $250,000, submitted in accordance with Section 1-09.11 and not resolved by nonbinding ADR processes, shall be resolved through litigation unless the parties mutually agree to resolve the claim through binding arbitration.

1-10 TEMPORARY TRAFFIC CONTROL

1-10.1 General

The Contractor, utilizing contractor labor and contractor-provided equipment and materials (except when such labor, equipment or materials are to be provided by the Contracting Agency as specifically identified herein), shall plan, manage, supervise and perform all temporary traffic control activities needed to support the work of the contract.

1-10.1(1) Materials

Materials shall meet the requirements of the following sections:

Stop/Slow Paddles	9-35.1
Construction Signs	9-35.2
Wood Sign Posts	9-35.3
Sequential Arrow Signs	9-35.4
Portable Changeable Message Signs	9-35.5
Barricades	9-35.6
Traffic Safety Drums	9-35.7
Barrier Drums	9-35.8
Traffic Cones	9-35.9
Tubular Markers	9-35.10
Warning Lights and Flashers	9-35.11
Truck-Mounted Attenuator	9-35.12

1-10.1(2) Description

The Contractor shall provide flaggers, spotters and all other personnel required for labor for traffic control activities and not otherwise specified as being furnished by the Contracting Agency.

The Contractor shall perform all procedures necessary to support the contract work.

The Contractor shall provide signs and other traffic control devices not otherwise specified as being furnished by the Contracting Agency. The Contractor shall erect and maintain all construction signs, warning signs, detour signs, and other traffic control devices necessary to warn and protect the public at all times from injury or damage as a result of the Contractor's operations which may occur on or adjacent to highways, roads, or streets. No work shall be done on or adjacent to the roadway until all necessary signs and traffic control devices are in place.

The traffic control resources and activities described shall be used for the safety of the public, of the Contractor's employees, and of the Contracting Agency's personnel and to facilitate the movement of the traveling public. Traffic control resources and activities may be used for the separation or merging of public and construction traffic when such use is in accordance with a specific approved traffic control plan.

Upon failure of the Contractor to immediately provide flaggers; erect, maintain, and remove signs; or provide, erect, maintain, and remove other traffic control devices when ordered to do so by the Engineer, the Contracting Agency may, without further notice to the Contractor or the Surety, perform any of the above and deduct all of the costs from the Contractor's payments.

The Contractor shall be responsible for providing adequate labor, sufficient signs, and other traffic control devices, and for performing traffic control procedures needed for the protection of the work and the public at all times regardless of whether or not the labor, devices or procedures have been ordered by the Engineer, furnished by the Contracting Agency, or paid for by the Contracting Agency.

Wherever possible when performing contract work, the Contractor's equipment shall follow normal and legal traffic movements. The Contractor's ingress and egress of the work area shall be accomplished with as little disruption to traffic as possible. Traffic control devices shall be removed by picking up the devices in a reverse sequence to that used for installation. This may require moving backwards through the workzone. When located behind barrier or at other locations shown on approved traffic control plans, equipment may operate in a direction opposite to adjacent traffic.

The Contractor is advised that the Contracting Agency may have entered into operating agreements with one or more law enforcement organizations for cooperative activities. Under such agreements, at the sole discretion of the Contracting Agency, law enforcement personnel may enter the workzone for enforcement purposes and may participate in the Contractor's traffic control activities. The responsibility under the contract for all traffic control resides with the Contractor and any such participation by law enforcement personnel in Contractor traffic control activities will be referenced in the Special Provisions or will be preceded by an agreement and, if appropriate, a cost adjustment. Nothing in this contract is intended to create an entitlement, on the part of the Contractor, to the services or participation of the law enforcement organization.

1-10.2 Traffic Control Management

1-10.2(1) General

It is the Contractor's responsibility to plan, conduct and safely perform the work. The Contractor shall manage temporary traffic control with his or her own staff. Traffic control management responsibilities shall be formally assigned to one or more company supervisors who are actively involved in the planning and management of field contract activities. The Contractor shall provide the Engineer with a copy of the formal assignment. The duties of traffic control management may not be subcontracted.

The Contractor shall designate an individual or individuals to perform the duties of the primary Traffic Control Supervisor (TCS). The designation shall also identify an alternate TCS who can assume the duties of the primary TCS in the event of that person's inability to perform. The TCS shall be responsible for safe implementation of approved Traffic Control Plans provided by the Contractor.

The designated individuals shall be certified as worksite traffic control supervisors by one of the organizations listed in the Special Provisions. Possession of a current flagging card by the TCS is mandatory. A traffic control management assignment and a TCS designation are required on all projects that will utilize traffic control.

The Contractor shall maintain 24-hour telephone numbers at which the Contractor's assigned traffic control management personnel and the TCS can be contacted and be available upon the Engineer's request at other than normal working hours. These persons shall have the resources, ability and authority to expeditiously correct any deficiency in the traffic control system.

1-10.2(1)A Traffic Control Management

The responsibilities of the Contractor's traffic control management personnel shall include:

1. Overseeing and approving the actions of the Traffic Control Supervisor (TCS) to ensure that proper safety and traffic control measures are implemented and consistent with the specific requirements created by the Contractor's workzones and the Contract. Some form of oversight shall be in place and effective even when the traffic control management personnel are not present at the jobsite.
2. Providing the Contractor's designated TCS with approved Traffic Control Plans (TCPs) which are compatible with the work operations and traffic control for which they will be implemented. Having the latest adopted edition of the *Manual On Uniform Traffic Control Devices for Streets and Highways* (*MUTCD*,) including the *Washington State Modifications to the MUTCD* and applicable standards and specifications available at all times on the project.
3. Discussing proposed traffic control measures and coordinating implementation of the Contractor-adopted traffic control plan(s) with the Engineer.
4. Coordinating all traffic control operations, including those of subcontractors and suppliers, with each other and with any adjacent construction or maintenance operations.
5. Coordinating the project's activities (such as ramp closures, road closures, and lane closures) with appropriate police, fire control agencies, city or county engineering, medical emergency agencies, school districts, and transit companies.
6. Overseeing all requirements of the contract that contribute to the convenience, safety, and orderly movement of vehicular and pedestrian traffic.
7. Reviewing the TCS's diaries daily and being aware of field traffic control operations.
8. Being present on-site a sufficient amount of time to adequately satisfy the above-listed responsibilities.

Failure to carry out any of the above-listed responsibilities shall be a failure to comply with the contract and may result in a suspension of work as described in Section 1-08.6.

1-10.2(1)B Traffic Control Supervisor

A Traffic Control Supervisor (TCS) shall be present on the project whenever flagging or spotting or other traffic control labor is being utilized or less frequently, as authorized by the Engineer.

The TCS shall personally perform all the duties of the TCS. During nonwork periods, the TCS shall be available to the job site within a 45-minute time period after notification by the Engineer.

The TCS's duties shall include:

1. Having a current set of approved traffic control plans (TCPs), applicable contract provisions as provided by the Contractor, the latest adopted edition of the *MUTCD,* including the *Washington State Modifications to the MUTCD*, the book *Quality Guidelines for Work Zone Traffic Control Devices,* and applicable standards and specifications.

2. Inspecting traffic control devices and nighttime lighting for proper location, installation, message, cleanliness, and effect on the traveling public. Traffic control devices shall be inspected at least once per hour during working hours except that Class A signs and nighttime lighting need to be checked only once a week. Traffic control devices left in place for 24 hours or more shall also be inspected once during the nonworking hours when they are initially set up (during daylight or darkness, whichever is opposite of the working hours). The TCS shall correct, or arrange to have corrected, any deficiencies noted during these inspections.
3. Preparing a daily traffic control diary on each day that traffic control is performed using DOT Forms 421-040A and 421-040B, and submitting them to the Engineer no later than the end of the next working day. The Contractor may use alternate forms if approved by the Engineer. Diary entries shall include, but not be limited to:
   a. Time of day when signs and traffic control devices are installed and removed,
   b. Location and condition of signs and traffic control devices,
   c. Revisions to the traffic control plan,
   d. Lighting utilized at night, and
   e. Observations of traffic conditions.
4. Making minor revisions to the traffic control plan to accommodate site conditions provided that the original intent of the traffic control plan is maintained and the revision has the concurrence of both the Contractor and the Engineer.
5. Attending traffic control coordinating meetings or coordination activities as necessary for full understanding and effective performance.
6. Ensuring that all needed traffic control devices and equipment are available and in good working condition prior to the need to install or utilize them.

The TCS may perform the work described in Section 1-10.3(1)A **Flaggers and Spotters** or in Section 1-10.3(1)B **Other Traffic Control Labor** and be compensated under those bid items, provided that the duties of the TCS are accomplished.

1-10.2(2) Traffic Control Plans

The traffic control plan or plans appearing in the contract documents show a method of handling traffic. All construction signs, flaggers, spotters and other traffic control devices are shown on the traffic control plan(s) except for emergency situations. Where mainline contract traffic control plans are developed with the intent of operating without the use of flaggers or spotters, the plans shall contain a note that states, “NO FLAGGERS OR SPOTTERS”. The use of flaggers or spotters to supplement these traffic control plans will not be allowed except in a case where no other means of traffic control can be used or in the event of an emergency. If the Contractor proposes the use of flaggers or spotters with one of these plans, this will constitute a modification requiring approval by the Engineer. The modified plans shall show locations for all the required advance warning signs and a safe, protected location for the flagging station. If flagging is to be performed during hours of darkness, the plan shall include appropriate illumination for the flagging station.

When the Contractor's chosen method of performing the work in the contract requires some form of temporary traffic control, the Contractor shall either: (1.) designate and adopt, in writing, the traffic control plan or plans from the contract documents that support that method; or (2.) submit a Contractor's plan that modifies, supplements or replaces a plan from the contract documents. Any Contractor-proposed modification, supplement or replacement shall show the necessary construction signs, flaggers, spotters and other traffic control devices required to support the work. Any Contractor-proposed traffic control plan shall conform to the established standards for plan development as shown in the *MUTCD*, Part VI. The Contractor's submittal, either designating and adopting a traffic control plan from the contract documents or proposing a Contractor-developed plan, shall be provided to the Engineer for approval at least ten calendar days in advance of the time the signs and other traffic control devices are scheduled to be installed and utilized. The Contractor shall be solely responsible for submitting any proposed traffic control plan or modification, obtaining the Engineer's approval and providing copies of the approved Traffic Control Plans to the Traffic Control Supervisor.

1-10.2(3) Conformance to Established Standards

Flagging, signs, and all other traffic control devices and procedures furnished or provided shall conform to the standards established in the latest WSDOT adopted edition of the *Manual On Uniform Traffic Control Devices for Streets and Highways* (*MUTCD*,) published by the U.S. Department of Transportation and the *Washington State Modifications to the MUTCD*. Judgment of the quality of devices furnished will be based upon *Quality Guidelines for Work Zone Traffic Control Devices*, published by the American Traffic Safety Services Association. Copies of the *MUTCD* and *Quality Guidelines for Work Zone Traffic Control Devices* may be purchased from the American Traffic Safety Services Association, 15 Riverside Parkway, Suite 100, Fredericksburg, Virginia 22406-1022. The *Washington State Modifications to the MUTCD* may be obtained from the Department of Transportation, Olympia, Washington 98504.

In addition to the standards of the MUTCD described above, the Contracting Agency has scheduled the implementation of crashworthiness requirements for most workzone devices. The National Cooperative Highway Research Project (NCHRP) Report 350 has established requirements for crash testing. Workzone devices are divided into four categories. Each of those categories and, where applicable, the schedule for implementation is described below:

Category 1 includes those items that are small and lightweight, channelizing, and delineating devices that have been in common use for many years and are known to be crashworthy by crash testing of similar devices or years of demonstrable safe performance. These include cones, tubular markers, flexible delineator posts, and plastic drums. All Category 1 devices used on the project shall meet the requirements of NCHRP 350 as certified by the manufacturer of the device.

Category 2 includes devices that are not expected to produce significant vehicular velocity change, but may otherwise be hazardous. Examples of this class are barricades, portable sign supports and signs, intrusion alarms and vertical panels. All new Category 2 devices purchased after October 1, 2000 shall meet the requirements of NCHRP 350. Existing equipment, purchased prior to October 1, 2000, may be used on the project until December 31, 2007. For the purpose of definition, a sign support and sign shall be considered a single unit. A new sign may be purchased for an existing sign support and the entire unit will be defined as "existing equipment."

Category 3 is for hardware expected to cause significant velocity changes or other potentially harmful reactions to impacting vehicles. Barriers, fixed sign supports, crash cushions, truck mounted attenuators (TMA's) and other work zone devices not meeting the definitions of Category 1 or 2 are examples from this category. Many Category 3 devices are defined in the design of the project. Where this is the case, NCHRP 350 requirements have been incorporated into the design and the Contractor complies with the requirements by constructing devices according to the plans and specifications. Where the device is a product chosen by the Contractor, the device chosen must be compliant with the requirements of NCHRP 350.

Category 4 includes portable or trailer-mounted devices such as arrow displays, temporary traffic signals, area lighting supports, and portable changeable message signs. There is presently no implementation schedule for mandatory crashworthiness compliance for these devices.

The condition of signs and traffic control devices shall be acceptable or marginal as defined in the book *Quality Guidelines for Work Zone Traffic Control Device*s, and will be accepted based on a visual inspection by the Engineer. The Engineer's decision on the condition of a sign or traffic control device shall be final. A sign or traffic control device determined to be unacceptable shall be removed from the project and replaced within 12 hours of notification.

1-10.3 Traffic Control Labor, Procedures and Devices

1-10.3(1) Traffic Control Labor

The Contractor shall furnish all personnel for flagging, spotting, for the execution of all procedures related to temporary traffic control and for the setup, maintenance and removal of all temporary traffic control devices and construction signs necessary to control traffic during construction operations.

Workers engaged as flaggers or spotters shall wear reflective vests and hard hats. During hours of darkness, white coveralls or white or yellow rain gear shall also be worn. The vests and other apparel shall be in conformance with Section 1-07.8.

1-10.3(1)A Flaggers and Spotters

Flaggers and Spotters shall be posted where shown on approved Traffic Control Plans or where directed by the Engineer. All flaggers and spotters shall possess a current flagging card issued by the State of Washington, Oregon, Montana, or Idaho. The flagging card shall be immediately available and shown to the Contracting Agency upon request.

Flagging stations shall be shown on Traffic Control Plans at locations where construction operations require stopping or diverting public traffic. Flagging stations shall be staffed only when flagging is required. This staffing may be continuous or intermittent, depending on the nature of the construction activity. Whenever a flagger is not required to stop or divert traffic, the flagger shall move away from the flagging station to a safer location. During hours of darkness, flagging stations shall be illuminated in a manner that insures that flaggers can easily be seen but that does not cause glare to the traveling public. Flaggers shall be equipped with portable two-way radios, with a range suitable for the project. The radios shall be capable of having direct contact with project management (foremen, superintendents, etc.).

The Contractor shall furnish the MUTCD standard Stop/Slow paddles for all flagging operations. The specification for Stop/Slow paddles in Section 9-35.1 requires 24" paddles and all new paddles purchased for the project shall conform to those provisions. Previously specified 18" paddles may be used at the request of the Contractor until December 31, 2005.

Spotting stations shall be shown on Traffic Control Plans at locations where a spotter can detect errant drivers or other hazards and provide an effective warning to other workers. Spotting stations will not be allowed at locations where the spotter will be in unnecessary danger. The Contractor shall furnish noise-makers or other effective warning devices for spotting operations. The duties of a spotter shall not include flagging.

1-10.3(1)B Other Traffic Control Labor

In addition to flagging or spotting duties, the Contractor shall provide personnel for all other traffic control procedures required by the construction operations and for the labor to install, maintain and remove any traffic control devices shown on Traffic Control Plans.

1-10.3(2) Traffic Control Procedures

1-10.3(2)A One-Way Traffic Control

The project work may require that traffic be maintained on a portion of the roadway during the progress of the work using one-way traffic control. If this is the case, the Contractor's operation shall be confined to one-half the roadway, permitting traffic on the other half. If shown on an approved traffic control plan or directed by the Engineer, one-way traffic control, in accordance with the MUTCD, shall be provided and shall also conform to the following requirements:

In any one-way traffic control configuration, side roads and approaches will be closed or controlled by a flagger or by appropriate approved signing. A side road flagger will coordinate with end flaggers where there is line of sight and with the pilot car where the end flaggers cannot be seen.

Queues of vehicles will be allowed to take turns passing through the workzone in the single open lane. When one-way traffic control is in effect, Contractor vehicles shall not use the open traffic lane except while following the same rules and routes required of the public traffic.

As conditions permit, the Contractor shall, at the end of each day, leave the work area in such condition that it can be traveled without damage to the work, without danger to traffic, and without one-way traffic control. If, in the opinion of the Engineer, one-way traffic control cannot be dispensed with after working hours, then the operation will be continued throughout the non-working hours.

1-10.3(2)B Rolling Slowdown

For work operations on multi-lane roadways that necessitate short-term roadway closures of 15 minutes or less, the Contractor may implement a rolling slowdown. Where included in an approved traffic control plan, a rolling slowdown shall be accomplished using one traffic control vehicle with flashing amber lights for each lane to be slowed down plus one control vehicle to serve as a chase vehicle for traffic ahead of the blockade. The traffic control vehicles shall enter the roadway and form a moving blockade to reduce traffic speeds and create a clear area in front of the moving blockade to accomplish the work without a total stoppage of traffic.

A portable changeable message sign shall be placed ahead of the starting point of the traffic control to warn traffic of the slowdown. The sign shall be placed far enough ahead of the work to avoid any expected backup of vehicles.

The location where the traffic control vehicles shall begin the slowdown and the speed at which the moving blockade will be allowed to travel will be calculated to accommodate the estimated time needed for closure. The chase control vehicle shall follow the slowest vehicle ahead of the blockade. When the chase vehicle passes, the Contractor may begin the work operation. In the event that the work operation is not completed when the moving blockade reaches the site, all work except that necessary to clear the roadway shall cease immediately and the roadway shall be cleared and reopened as soon as possible.

All ramps and entrances to the roadway between the moving blockade and work operation shall be temporarily closed using flaggers. Radio communications between the work operation and the moving blockade shall be established and utilized to adjust the speed of the blockade to accommodate the closure time needed.

1-10.3(2)C Lane Closure Setup/Takedown

Where allowed by the contract and where shown on approved traffic control plans or directed by the Engineer, the Contractor shall set up traffic control measures to close one or more lanes of a multi-lane facility. When this is to occur, the following sequence shall be followed:

1. Advance warning signs are set up on the shoulder of the roadway opposite the lane to be closed,
2. Advance warning signs are set up on the same shoulder as the lane to be closed,
3. A truck-mounted attenuator, with arrow board, is moved into place at the beginning of the closure taper,
4. Channelization devices are placed to mark the taper and the length of the closure as shown on the traffic control plan.

   Once the lane is closed, the TMA/arrow board combination may be replaced with an arrow board without attenuator.

If additional lanes are to be closed, this shall be done in sequence with previous lane closures using the same sequence of activities. A truck-mounted attenuator with arrow board is required during the process of closing each additional lane and may be replaced with an arrow board without attenuator after the lane is closed. Each closed lane shall be marked with a separate arrow board at all times.

Traffic control for lane closures shall be removed in the reverse order of its installation.

1-10.3(2)D Mobile Operations

Where construction operations are such that movement along the length of a roadway is continuous or near-continuous to the extent that a stationary traffic control layout will not be effective, the Contractor shall implement a moving, or mobile, traffic control scheme. Such moving control shall always be conducted in the same direction as the adjacent traffic.

Where shown on an approved traffic control plan or where directed by the Engineer, mobile traffic control shall consist of portable equipment, moving with the operation. A portable changeable message sign shall be established in advance of the operation, far enough back to provide warning of both the operation and of any queue of traffic that has

formed during the operation. The advance sign shall be continuously moved to stay near the back of the queue at all times. A truck-mounted attenuator, with arrow board, shall be positioned and maintained at a fixed distance upstream of the work. A shadow vehicle, with truck-mounted attenuator shall be positioned and maintained immediately upstream of the work.

1-10.3(2)E Patrol & Maintain Traffic Control Measures

At all times, when temporary traffic control measures are in place, the Contractor shall provide for patrolling and maintaining these measures. The work shall consist of resetting mislocated devices, assuring visibility of all devices, cleaning and repairing where necessary, providing maintenance for all equipment, including replacing batteries and light bulbs as well as keeping motorized and electronic items functioning, and adjusting the location of devices to respond to actual conditions, such as queue length, unanticipated traffic conflicts and other areas where planned traffic control has proven ineffective.

This work shall be performed by the Contractor, either by or under the direction of the Traffic Control Supervisor. Personnel, with vehicles if necessary, shall be dispatched so that all traffic control can be reviewed at least once per hour during working hours and at least once during each non-working day.

1-10.3(3) Traffic Control Devices

1-10.3(3)A Construction Signs

All construction signs required by approved traffic control plans, as well as any other appropriate signs directed by the Engineer shall be furnished by the Contractor. The Contractor shall provide the posts or supports and erect and maintain the signs in a clean, neat, and presentable condition until the need for them has ended. Post mounted signs shall be installed as shown in Standard Plans. When the need for construction signs has ended, the Contractor, upon approval of the Engineer, shall remove all signs, posts, and supports from the project and they shall remain the property of the Contractor.

No passing zones on the existing roadway that are marked with paint striping and which striping is to be obliterated by construction operations shall be replaced by “Do Not Pass” and “Pass With Care” signs. The Contractor shall provide and install the posts and signs. The signs shall be maintained by the Contractor until they are removed or until the contract is physically completed. When the project includes striping by the Contractor, the signs and posts shall be removed by the Contractor when the no passing zones are reestablished by striping. The signs and posts will become the property of the Contractor. When the Contractor is not responsible for striping and when the striping by others is not completed when the project is physically completed, the posts and signs shall be left in place and shall become the property of the Contracting Agency.

All existing signs, new permanent signs installed under this contract, and construction signs installed under this contract that are inappropriate for the traffic configuration at a given time shall be removed or completely covered with metal, plywood, or an Engineer approved product specifically manufactured for sign covering during periods when they are not needed.

Construction signs will be divided into two classes. Class A construction signs are those signs that remain in service throughout the construction or during a major phase of the work. They are mounted on posts, existing fixed structures, or substantial supports

of a semi-permanent nature. Class A signs will be designated as such on the approved Traffic Control Plan. "Do Not Pass" and "Pass With Care" signs are classified as Class A construction signs. Sign and support installation for Class A signs shall be in accordance with the Contract Plans or the Standard Plans. Class B construction signs are those signs that are placed and removed daily, or are used for short durations which may extend for one or more days. They are mounted on portable or temporary mountings.

Where it is necessary to add weight to signs for stability, the only allowed method will be a bag of sand that will rupture on impact. The bag of sand shall have a maximum weight of 40 pounds, and shall be suspended no more than 1 foot from the ground.

Signs, posts, or supports that are lost, stolen, damaged, destroyed, or which the Engineer deems to be unacceptable while their use is required on the project shall be replaced by the Contractor.

1-10.3(3)B Sequential Arrow Signs

Where shown on an approved traffic control plan or where ordered by the Engineer, the Contractor shall provide, operate and maintain sequential arrow signs. In some locations, the sign will be shown as a unit with an attenuator. In other locations, the plan will indicate a stand-alone unit.

1-10.3(3)C Portable Changeable Message Sign

Where shown on an approved traffic control plan or where ordered by the Engineer, the Contractor shall provide, operate and maintain portable changeable message signs. These signs shall be available, on-site, for the entire duration of their projected use.

1-10.3(3)D Barricades

Where shown on an approved traffic control plan or where ordered by the Engineer, the Contractor shall provide, install and maintain barricades. Barricades shall be kept in good repair and shall be removed immediately when, in the opinion of the Engineer, they are no longer functioning as designed.

Where it is necessary to add weight to barricades for stability, the only allowed method will be a bag of sand that will rupture on impact. The bag of sand shall have a maximum weight of 40 pounds, and shall be suspended no more than 1 foot from the ground.

1-10.3(3)E Traffic Safety Drums

Where shown on an approved Traffic Control Plan, or where ordered by the Engineer, the Contractor shall provide, install and maintain traffic safety drums.

Used drums may be utilized, provided all drums used on the project are of essentially the same configuration.

The drums shall be designed to resist overturning by means of a weighted lower unit that will separate from the drum when impacted by a vehicle.

Drums shall be regularly maintained to ensure that they are clean and that the drum and reflective material are in good condition. If the Engineer determines that a drum has been damaged beyond usefulness, or provides inadequate reflectivity, a replacement drum shall be furnished.

When the Engineer determines that the drums are no longer required, they shall be removed from the project and shall remain the property of the Contractor.

1-10.3(3)F Barrier Drums

Where shown on approved Traffic Control Plans and as ordered by the Engineer, barrier drums shall be placed on temporary concrete barrier at the following approximate spacing:

Concrete Barrier Placement	Barrier Drum Spacing in Feet
Tangents ½ mile or less[1]	2 times posted speed limit
Tangents greater than ½ mile[1]	4 times posted speed limit
Tapers and Curves[2]	posted speed limit

Note [1] A minimum of 3 barrier drums shall be used.

Note [2] A minimum of 5 barrier drums shall be used.

Temporary concrete barrier reflectors may be excluded when using barrier drums.

Both legs of the barrier drums shall be completely filled with sand. The top oval should not be filled.

Used barrier drums may be used, provided all barrier drums used on the project are of essentially the same configuration.

Barrier drums shall be regularly maintained to ensure that they are clean and that the barrier drum and reflective material are in good condition. If the Engineer determines that a barrier drum has been damaged beyond usefulness, or provides inadequate reflectivity, a replacement barrier drum shall be furnished.

When the Engineer determines that the drums are no longer required, they shall be removed from the project and shall remain the property of the Contractor.

1-10.3(3)G Traffic Cones

Where shown on an approved traffic control plan or where ordered by the Engineer, the Contractor shall provide, install and maintain traffic cones. Cones shall be kept in good repair and shall be removed immediately when directed by the Engineer. Where wind or moving traffic frequently displace cones, an effective method of stabilizing cones, such as stacking two together at each location, shall be employed.

1-10.3(3)H Tubular Markers

Where shown on an approved traffic control plan or where ordered by the Engineer, the Contractor shall provide, install and maintain tubular markers. Tubular markers shall be kept in good repair and shall be removed immediately when directed by the Engineer. Tubular markers are secondary devices and are not to be used as substitutes for cones or other delineation devices without an approved traffic control plan.

Where the Traffic Control Plan shows pavement-mounted tubular markers, the adhesive used to fasten the base to the pavement shall be suitable for the purpose, as approved by the Engineer. During the removal of pavement-mounted tubular markers, care shall be taken to avoid damage to the existing pavement. Any such damage shall be repaired by the Contractor at no cost to the Contracting Agency.

1-10.3(3)I Warning Lights and Flashers

Where shown attached to traffic control devices on an approved traffic control plan or where ordered by the Engineer, the Contractor shall provide and maintain flashing warning lights. Lights attached to advance warning signs shall be Type B, high-intensity. Lights attached to traffic safety drums, barricades or other signs shall be Type C, steady-burning low intensity or, where attention is to be directed to a specific device, Type A, flashing low-intensity units.

1-10.3(3)J Truck-Mounted Attenuator

Where shown on an approved traffic control plan or where ordered by the Engineer, the Contractor shall provide, operate and maintain truck-mounted impact attenuators (TMA). These attenuators shall be available, on-site, for the entire duration of their projected use.

The TMA shall be positioned to separate and protect construction workzone activities from normal traffic flow.

During use, the attenuator shall be in the full down-and-locked position. For stationary operations, the truck's parking brake shall be set.

1-10.4 Measurement

1-10.4(1) Lump Sum Bid for Project (No Unit Items)

When the bid proposal contains the item "Project Temporary Traffic Control", there will be no measurement of unit items for work defined by Section 1-10 except as described in Section 1-10.4(3). Also, except as described in Section 1-10.4(3), all of Sections 1-10.4(2) and 1-10.5(2) is deleted.

No specific unit of measurement will apply to the lump sum item of "Project Temporary Traffic Control."

1-10.4(2) Item Bids with Lump Sum for Incidentals

When the bid proposal does not contain the item "Project Temporary Traffic Control", Sections 1-10.4(1) and 1-10.5(1) are deleted and the bid proposal will contain some or all of the following items, measured as noted.

No specific unit of measurement will apply to the lump sum item of "Traffic Control Supervisor."

"Flaggers and Spotters" will be measured by the hour. Hours will be measured for each flagging or spotting station, shown on an approved Traffic Control Plan, when that station is staffed in accordance with Section 1-10.3(1)A. When a flagging station is staffed on an intermittent basis, no deduction will be made in measured hours provided that the person staffing the station is in a standby mode and is not performing other duties.

"Other Traffic Control Labor" will be measured by the hour. With the exception of patrolling and maintaining, hours will be measured for each person engaged in any one of the following activities:

- Operating a pilot vehicle during one-way piloted traffic control.
- Operating a traffic control vehicle or a chase vehicle during a rolling slowdown operation.

- Operating a vehicle or placing/removing traffic control devices during the setup or takedown of a lane closure. Performing preliminary work to prepare for placing and removing these devices.
- Operating any of the moving traffic control equipment, or adjusting signing during a mobile operation as described in Section 1-10.3(2)D.
- Patrolling and maintaining traffic control measures as described in Section 1-10.3(2)E. The hours of one person will be measured for each patrol route necessary to accomplish the review frequency required by the provision, regardless of the actual number of persons per route.
- Placing and removing Class B construction signs. Performing preliminary work to prepare for placing and removing these signs.
- Relocation of Portable Changeable Message Signs within the project limits.
- Installing and removing Barricades, Traffic Safety Drums, Barrier Drums, Cones, Tubular Markers and Warning Lights and Flashers to carry out approved Traffic Control Plan(s). Performing preliminary work to prepare for installing these devices.

Time spent on activities other than those listed will not be measured under this item.

"Construction Signs, Class A" will be measured by the square foot of panel area for each sign designated on an approved Traffic Control Plan as Class A or for each construction sign installed as ordered by the Engineer and designated as Class A at the time of the order. Class A signs may be used in more than one location and will be measured for each new installation. Class B construction signs will not be measured. Sign posts or supports will not be measured.

"Sequential Arrow Sign" will be measured by the hour for the time that each sign is operating as shown on an approved Traffic Control Plan.

"Portable Changeable Message Sign" will be measured per each one time only for each portable changeable message sign used on the project. The final pay quantity shall be the maximum number of such signs in place at any one time as approved by the Engineer.

"Operation of Portable Changeable Message Sign" will be measured by the hour for each hour of operation. The hours of operation will be determined by the Engineer. Hours of operation in excess of those determined by the Engineer will be at the Contractor's expense.

"Truck Mounted Impact Attenuator" will be measured per each one time only for each truck with mounted impact attenuator used on the project. The final pay quantity shall be the maximum number of truck-mounted impact attenuators in place at any one time.

"Operation of Truck-Mounted Impact Attenuator" will be measured by the hour for each truck-mounted attenuator manned and operated. Manned and operated shall be when the truck-mounted impact attenuator has an operator and is required to move, in operating position, with the construction operation or when moving the TMA from one position to another on the project.

No specific unit of measurement will apply to the force account item of "Repair Truck-Mounted Impact Attenuator".

No specific unit of measurement will apply to the lump sum item of "Other Temporary Traffic Control".

1-10.4(3) Reinstating Unit Items with Lump Sum Traffic Control

The contract provisions may establish the project as lump sum, in accordance with Section 1-10.4(1) and also include one or more of the items included above in Section 1-10.4(2). When that occurs, the corresponding measurement provision in Section 1-10.4(2) is not deleted and the work under that item will be measured as specified.

1-10.4(4) Owner-Provided Resources

The contract provisions may call for specific items of labor, materials or equipment, noted in Section 1-10 as the responsibility of the Contractor, to be supplied by the Contracting Agency. When this occurs, there will be no adjustment in measurement of unit quantities.

1-10.5 Payment

1-10.5(1) Lump Sum Bid for Project (No Unit Items)

"Project Temporary Traffic Control", lump sum.

The lump sum contract payment shall be full compensation for all costs incurred by the Contractor in performing the contract work defined in Section 1-10, except for costs compensated by bid proposal items inserted through contract provisions as described in Section 1-10.4(3).

1-10.5(2) Item Bids with Lump Sum for Incidentals

"Traffic Control Supervisor", lump sum.

The lump sum contract payment shall be full compensation for all costs incurred by the Contractor in performing the contract work defined in Section 1-10.2(1)B.

"Flaggers and Spotters", per hour.

The unit contract price, when applied to the number of units measured for this item in accordance with Section 1-10.4(2), shall be full compensation for all costs incurred by the Contractor in performing the contract work defined in Section 1-10.3(1)A.

"Other Traffic Control Labor", per hour.

The unit contract price, when applied to the number of units measured for this item in accordance with Section 1-10.4(2), shall be full compensation for all labor costs incurred by the Contractor in performing the contract work specifically mentioned for this item in Section 1-10.4(2).

"Construction Signs Class A", per square foot.

The unit contract price, when applied to the number of units measured for this item in accordance with Section 1-10.4(2), shall be full compensation for all costs of labor, materials and equipment incurred by the Contractor in performing the contract work described in Section 1-10.3(3)A. In the event that "Do Not Pass" and "Pass With Care" signs must be left in place, a change order, as described in Section 1-04.4, will be required. When the bid proposal contains the item "Sign Covering", then covering those signs indicated in the contract will be measured and paid according to Section 8-21.

"Sequential Arrow Sign", per hour.

The unit contract price, when applied to the number of units measured for this item in accordance with Section 1-10.4(2), shall be full compensation for all costs of labor, materials and equipment incurred by the Contractor in performing the contract work described in Section 1-10.3(3)B.

"Portable Changeable Message Sign", per each.

The unit contract price, when applied to the number of units measured for this item in accordance with Section 1-10.4(2), shall be full compensation for all costs of labor, materials and equipment incurred by the Contractor in procuring all portable changeable message signs required for the project and for transporting these signs to and from the project.

"Operation of Portable Changeable Message Sign", per hour.

The unit contract price, when applied to the number of units measured for this item in accordance with Section 1-10.4(2), shall be full compensation for all costs of labor, materials and equipment incurred by the Contractor in performing the contract work described in Section 1-10.3(3)C except for costs compensated separately under the items "Other Traffic Control Labor" and "Portable Changeable Message Sign".

"Truck-Mounted Impact Attenuator", per each.

The unit contract price, when applied to the number of units measured for this item in accordance with Section 1-10.4(2), shall be full compensation for all costs of labor, materials and equipment incurred by the Contractor in performing the contract work described in Section 1-10.3(3)J except for costs compensated separately under the items "Operation of Truck-Mounted Impact Attenuator" and "Repair Truck-Mounted Impact Attenuator".

"Operation of Truck-Mounted Impact Attenuator", per hour.

The unit contract price, when applied to the number of units measured for this item in accordance with Section 1-10.4(2), shall be full compensation for all costs of labor, materials and equipment incurred by the Contractor in operating truck-mounted impact attenuators on the project.

"Repair Truck-Mounted Impact Attenuator", by force account.

All costs of repairing or replacing truck-mounted impact attenuators that are damaged by the motoring public while in use as shown on an approved Traffic Control Plan will be paid for by force account as specified in Section 1-09.6. To provide a common proposal for all bidders, the Contracting Agency has estimated the amount of force account for "Repair Truck-Mounted Impact Attenuator" and has entered the amount in the Proposal to become a part of the total bid by the Contractor. Truck-mounted attenuators damaged due to the Contractor's operation or damaged in any manner when not in use shall be repaired or replaced by the Contractor at no expense to the Contracting Agency.

"Other Temporary Traffic Control", lump sum.

The lump sum contract payment shall be full compensation for all costs incurred by the Contractor in performing the contract work defined in Section 1-10, and which costs are not compensated by one of the above-listed items.

1-10.5(3) Reinstating Unit Items with Lump Sum Traffic Control

The contract provisions may establish the project as lump sum, in accordance with Section 1-10.4(1) and also reinstate the measurement of one or more of the items described in Section 1-10.4(2). When that occurs, the corresponding payment provision in Section 1-10.5(2) is not deleted and the work under that item will be paid as specified.

DIVISION 2
EARTHWORK

2-01 CLEARING, GRUBBING, AND ROADSIDE CLEANUP

2-01.1 Description

The Contractor shall clear, grub, and clean up those areas staked or described in the Special Provisions. This work includes protecting from harm all trees, bushes, shrubs, or other objects selected to remain.

"Clearing" means removing and disposing of all unwanted material from the surface, such as trees, brush, down timber, or other natural material.

"Grubbing" means removing and disposing of all unwanted vegetative matter from underground, such as sod, stumps, roots, buried logs, or other debris.

"Roadside cleanup", whether inside or outside the staked area, means work done to give the roadside an attractive, finished appearance.

"Debris" means all unusable natural material produced by clearing, grubbing, or roadside cleanup.

2-01.2 Disposal of Usable Material and Debris

When possible, the Contractor should sell all usable material such as timber, chips, or firewood produced by clearing, grubbing, or roadside cleanup. The Contractor shall not allow the public to fell trees.

The Contractor shall meet all requirements of state, county, and municipal regulations regarding health, safety, and public welfare in the disposal of all debris.

The Contractor shall dispose of all debris by one or more of the three disposal methods described below.

Disposal of debris in a Contractor-provided waste site shall meet the requirements of Section 2-03.3(7)C.

2-01.2(1) Disposal Method No. 1 — Open Burning

The open burning of residue resulting from land clearing is restricted by Chapter 173-425 of the Washington Administrative Code. No commercial open burning shall be conducted without authorization from the Washington State Department of Ecology or the appropriate local air pollution control authority.

Open burning, when permitted, shall be done in a high stack that meets these requirements:

1. Diameter — at least 20-feet.
2. Height — one foot or more for every foot of diameter.
3. Content — clean debris, with stumps free of excess dirt, stacked in well-ventilated piles.
4. Stacking equipment — debris must be stacked and the fire maintained by clamshell or similar equipment, not by bulldozer or front-end loader.
5. Number of stacks — no more than one fire every 200 yards may be burning at one time.
6. Additional debris shall not be added to a burning stack.

2-01.2(2) Disposal Method No. 2 — Waste Site

Debris shall be hauled to a waste site obtained and provided by the Contractor in accordance with Section 2-03.3(7)C.

2-01.2(3) Disposal Method No. 3 — Chipping

Chipping shall be done by machines that can grind debris into wood chips. Wood chips to be sold may be any size. Unsold chips shall be no larger than 6 square inches and no thicker than $^1/_2$-inch. The Contractor shall spread unsold chips evenly on the project site and tractor-walk them into the ground.

Stumps shall be hauled to a waste site obtained by the Contractor.

2-01.3 Construction Requirements

2-01.3(1) Clearing

The Contractor shall:

1. Fell trees only within the area to be cleared.
2. Close-cut parallel to the slope of the ground all stumps to be left in the cleared area outside the slope stakes.
3. Close cut all stumps that will be buried by fills 5-feet or less in depth.
4. Follow these requirements for all stumps that will be buried by fills deeper than 5-feet:
   a. Close-cut stumps under 18-inches in diameter.
   b. Trim stumps that exceed 18-inches in diameter to no more than 12-inches above original ground level.
5. Leave standing any trees or native growth indicated by the Engineer.
6. Trim all trees to be left standing to the height specified by the Engineer, neatly cutting all limbs close to the tree trunk.
7. Thin clumps of native growth as the Engineer may direct.
8. Protect, by fencing if necessary, all trees or native growth from any damage caused by construction operations.

2-01.3(2) Grubbing

The Contractor shall:

1. Grub deep enough to remove all stumps, large roots, buried logs, and other vegetative material.
2. Grub all areas:
   a. Indicated by the Engineer or by the Special Provisions.
   b. To be excavated, including area staked for slope treatment.
   c. Where subdrainage trenches will be dug, unsuitable material removed, or structures built.
   d. In which hillsides or existing embankments will be terraced as described in Section 2-03.3(14).
   e. Upon which embankments will be placed, except where the subgrade or slope elevation exceeds 5-feet above the natural ground surface, the Contractor may close cut all trees, stumps, and large roots less than 18-inches in diameter.

A contract may include grubbing without mentioning clearing or roadside cleanup. In that case, the Contractor shall remove and dispose of all upturned stumps and roots of windfalls that lie within the cleared area of the right of way, even though they are outside the area staked for grubbing. Such work shall be incidental to other work covered by the Contract.

2-01.3(3) Vacant

2-01.3(4) Roadside Cleanup

Roadside cleanup, as ordered by the Engineer, consists of work not otherwise provided for in the Contract. Such work may include:

1. Removing trees, snags, down timber, upturned stumps, large rocks and boulders, and other unsightly matter outside the areas staked for clearing or grubbing.
2. Thinning trees or brush.
3. Filling holes, and smoothing and contouring the ground.
4. Shaping the ends of cuts and fills to fit adjacent terrain and to enhance the area's appearance.
5. Obliterating abandoned roads and reshaping the areas to blend naturally with surroundings.

Methods and equipment used in roadside cleanup shall be approved by the Engineer.

2-01.4 Measurement

No unit of measurement shall apply to the lump sum price for clearing and grubbing.

When clearing and grubbing is paid per acre, the following areas will be excluded from measurement:

1. Any area along an existing highway that requires no work.
2. Any gap that requires no work, provided the gap is at least 50-feet long when measured parallel to the center line and contains at least 2,500 square feet.

Isolated areas of less than 2,500 square feet that require work lying between areas excluded from measurement will be counted as having 2,500 square feet. If these isolated areas occur intermittently, the final measurement shall not exceed the total area containing the several isolated areas when measured as continuous.

Clearing and grubbing may be combined in the proposal. If the proposal calls for such combined work to be measured "per acre," the measurement methods described above will apply. If the proposal designates such combined work as "lump sum," the Contracting Agency will not base payment on any unit of measurement.

2-01.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid items when they are included in the proposal:

"Clearing and Grubbing," per acre or lump sum.

The unit contract price per acre or lump sum for "Clearing and Grubbing" shall be full pay for all work described in this section except "Roadside Cleanup."

"Roadside Cleanup," by force account as provided in Section 1-09.6.

To provide a common proposal for all bidders, the Contracting Agency has entered an amount in the proposal to become a part of the Contractor's total bid.

2-02 REMOVAL OF STRUCTURES AND OBSTRUCTIONS

2-02.1 Description

The work described in this section includes removing and disposing of, or salvaging, materials named in the Special Provisions or identified by the Engineer. The work also includes the backfilling of trenches, holes, or pits that result from such removal.

2-02.2 Vacant

2-02.3 Construction Requirements

With certain exceptions, the Contractor shall raze, remove, and dispose of all buildings and foundations, structures, fences, and other obstructions that lie wholly or partially within the right of way. The exceptions are utility-owned equipment and any other items the Contracting Agency may direct the Contractor to leave intact.

When salvageable material is to remain Contracting Agency property, the Special Provisions will identify the material and describe how the Contractor shall remove it and where it will be stored.

Any material not named in the Special Provisions as Contracting Agency property will become the property of the Contractor and shall be removed from the project.

The Contractor may dispose of waste material in Contracting Agency owned sites if the Special Provisions or the Engineer permits it. Otherwise, the Contractor shall arrange to dispose of waste at no expense to the Contracting Agency and the disposal shall meet the requirements of Section 2-03.3(7)C.

2-02.3(1) Removal of Foundations

When removing foundations the Contractor shall:

1. Remove foundations to a depth of at least 5-feet below finished ground elevation or subgrade elevation, whichever is lower.
2. Break up basement floors to promote drainage.
3. Fill basements or other cavities left by the removal of structures. The fill shall match the level of surrounding ground. Fill within the slopes of the roadbed shall be compacted to meet the requirements of Section 2-03.3(14)C, Method B.

2-02.3(2) Removal of Bridges, Box Culverts, and other Drainage Structures

When salvaging any steel or wooden bridge that will remain Contracting Agency property, the Contractor shall prevent unnecessary damage to the material. Steel members shall be match-marked.

Unless otherwise directed, the Contractor shall remove foundations of existing structures to a point 2-feet below: the finished ground elevation, the adjacent ground elevation, or the natural stream bottom. If a foundation lies wholly or partially on the site of a new structure, it shall be removed to a level that accommodates building the new structure.

Any blasting shall be subject to the Engineer's approval. The Contractor must complete all blasting before the placement of new work.

2-02.3(3) Removal of Pavement, Sidewalks, Curbs, and Gutters

In removing pavement, sidewalks, curbs, and gutters, the Contractor shall:

1. Haul broken-up pieces into the roadway embankment or to some off-project site.
2. Material that is to be incorporated into the embankment shall be broken into pieces not exceeding 18-inches in any dimension, and no part of any piece shall be within three feet of the top, side, or end surface of the embankment or any structure.
3. Make a vertical saw cut between any existing pavement, sidewalk, curb, or gutter that is to remain and the portion to be removed.
4. Replace at no expense to the Contracting Agency any existing pavement designated to remain that is damaged during the removal of other pavement.

2-02.4 Measurement

No specific unit of measurement shall apply to the lump sum item of removal of structure and obstruction.

2-02.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when it is included in the proposal:

"Removal of Structure and Obstruction", lump sum.

If pavements, sidewalks, curbs, or gutters lie within an excavation area, their removal will be paid for as part of the quantity removed in excavation.

2-03 ROADWAY EXCAVATION AND EMBANKMENT

2-03.1 Description

The work described in this section, regardless of the nature or type of the materials encountered, includes excavating and grading the roadway, excavating in borrow pits, excavating below grade, excavating channels, removing slide material, and disposing of all excavated material. These activities may be performed in making cuts, embankments, slopes, roadway ditches, approaches, parking areas, highway-driveway intersections, and in completing related work.

The work excludes these items if they are designated as pay items in the Contract:

1. Haul.
2. Excavation for structures and ditches.
3. Removal of unsuitable materials.

The Plans may divide the project into separate areas (Roadway Excavation, Area A, Roadway Excavation, Area B, etc.). Such division does not imply any classification of materials in the areas. The boundaries of the areas shall not be changed regardless of how similar or dissimilar the materials are from one area to another.

All work described here must reasonably conform to the alignment, grade, and cross-sections shown in the Plans or established by the Engineer.

2-03.2 Vacant

2-03.3 Construction Requirements

2-03.3(1) Widening of Cuts

If routine cuts do not supply enough material to form the embankment, the Contractor shall obtain more fill from cuts inside or outside the right of way as the Engineer may direct or from widening one or both sides of existing cuts as designated by the Engineer. In either case, the Contractor shall dress the sides of the cuts to any slopes the Engineer may require. If the Contractor has dressed a cut before the Engineer orders it widened, the Contracting Agency will pay for the resloping as provided in Section 1-04.4.

2-03.3(2) Rock Cuts

Preserving Rock Below Subgrade. The Contractor shall take care not to break down, loosen, or damage the rock under the subgrade line, except as provided by Section 2-03.3(3). Normally cuts will be made from the top, lift by lift, to protect the rock bench that will remain. The Contractor shall be responsible for methods used and for any damage caused to the roadbed, regardless of any previous approvals by the Engineer.

Scaling and Dressing. To leave rock cuts in a safe, stable condition, the Contractor shall scale and dress them, removing all loose fragments and rocks not firmly fastened to the rock slope. The Contractor shall also remove any overhanging rock the Engineer sees as a hazard to roadway users.

If the Engineer requires it, the Contractor shall remove loose fragments and rocks lying outside the slope stakes. Payment for such extra work shall be by force account as provided in Section 1-09.6. The Contracting Agency will pay for loading and hauling these materials at the unit contract prices that apply or as provided in Section 1-04.4.

Controlled Blasting. When blasting to establish slopes $^1/_2$ to 1 or steeper, and more than 10 feet high, the Contractor shall use controlled blasting. The Engineer may require the Contractor to use controlled blasting to form the faces of other slopes, even if the slopes could be formed by nonblasting methods.

Controlled blasting refers to the controlled use of explosives and blasting accessories in carefully spaced and aligned drill holes to provide a free surface or shear plane in the rock along the specified backslope. Controlled blasting techniques covered by this specification include presplitting and cushion blasting.

Not less than two weeks prior to commencing drilling and blasting operations or at any time the Contractor proposes to change the drilling and blasting methods, the Contractor shall submit a blasting plan to the Engineer for review. The blasting plan shall contain the full details of the drilling and blasting patterns and controls the Contractor proposes to use for both the controlled and production blasting. The blasting plan shall contain the following minimum information:

1. Station limits of proposed shot.
2. Plan and section views of proposed drill pattern including free face, burden, blast hole spacing, blast hole diameter, blast hole angles, lift height, and subdrill depth.
3. Loading diagram showing type and amount of explosives, primers, initiators, and location and depth of stemming.
4. Initiation sequence of blast holes including delay times and delay system.
5. Manufacturer's data sheets for all explosives, primers, and initiators to be employed.

Review of the blast plan by the Engineer shall not relieve the Contractor of the responsibility for the accuracy and adequacy of the plan when implemented in the field.

When using control blasting the Contractor shall:

1. Prior to commencing full-scale blasting operations, the Contractor shall demonstrate the adequacy of the proposed blast plan by drilling, blasting, and excavating short test sections, up to 100 feet in length, to determine which combination of method, hole spacing, and charge works best. When field conditions warrant, the Contractor may be ordered to use test section lengths less than 100 feet.

   Unless otherwise approved by the Engineer, the Contractor shall begin the tests with the controlled blast holes spaced 30-inches apart, then adjust if needed, until the Engineer approves the spacing to be used for full-scale blasting operations.
2. The Contractor shall completely remove all overburden soil and loose or decomposed rock along the top of the excavation for a distance of at least 30 feet beyond the end of the production hole drilling limits, or to the end of the cut, before drilling the presplitting holes.
3. The controlled blast holes shall be not less than $2^1/_2$ inches nor more than 3 inches in diameter.
4. The Contractor shall control drilling operations by the use of the proper equipment and technique to ensure that no hole shall deviate from the plane of the planned slope by more than 9 inches either parallel or normal to the slope. Drill holes exceeding these limits shall not be paid for unless satisfactory slopes are being obtained.

5. Controlled blast holes shall extend a minimum of 30 feet beyond the limits of the production holes to be detonated, or to the end of the cut as applicable.
6. The length of controlled blast holes for any individual lift shall not exceed 20 feet unless the Contractor can demonstrate to the Engineer the ability to stay within the above tolerances and produce a uniform slope. If greater than 5 percent of the presplit holes are misaligned in any one lift, the Contractor shall reduce the height of the lifts until the 9-inch alignment tolerance is met. Upon satisfactory demonstration, the length of holes may be increased to a maximum of 60 feet with written approval of the Engineer.
7. When the cut height requires more than one lift, a maximum 2-foot offset between lifts will be permitted to allow for drill equipment clearances. The Contractor shall begin the control blast hole drilling at a point that will allow for necessary offsets and shall adjust, at the start of lower lifts, to compensate for any drift that may have occurred in the upper lifts.
8. Before placing charges, the Contractor shall determine that the hole is free of obstructions for its entire depth. All necessary precautions shall be exercised so that the placing of the charges will not cause caving of material from the walls of the holes.
9. The maximum diameter of explosives used in presplit holes shall not be greater than $^1/_2$ the diameter of the presplit hole.
10. Only standard explosives manufactured especially for controlled blasting shall be used in controlled blast holes, unless otherwise approved by the Engineer. Bulk ammonium nitrate and fuel oil (ANFO) shall not be allowed to be loaded in the presplit holes.

    If fractional portions of standard explosive cartridges are used, they shall be firmly affixed to the detonating cord in a manner that the cartridges will not slip down the detonating cord nor bridge across the hole. Spacing of fractional cartridges along the length of the detonating cord shall not exceed 30 inches center to center and shall be adjusted to give the desired results.

    Continuous column cartridge type of explosives used with detonating cord shall be assembled and affixed to the detonating cord in accordance with the explosive manufacturer's instructions, a copy of which shall be furnished to the Engineer.
11. The bottom charge of a presplit hole may be larger than the line charges but shall not be large enough to cause overbreak. The top charge of the presplitting hole shall be placed far enough below the collar, and reduced sufficiently, to avoid overbreaking and heaving.
12. The upper portion of all presplit holes, from the top most charge to the hole collar, shall be stemmed. Stemming materials shall be sand or other dry angular material, all of which passes a $^3/_8$-inch sieve.
13. If presplitting is specified, the detonation of these holes shall be fired first.
14. If cushion blasting is specified, the detonation of these holes shall be fired last on an instantaneous delay after all other blasting has taken place in the excavation.

15. Production blast holes shall not be drilled closer than 6 feet to the controlled blast line, unless approved by the Engineer. The bottom of the production holes shall not be lower than the bottom of the controlled blast holes. Production holes shall not exceed 6 inches in diameter, unless approved by the Engineer. Detonation of production holes shall be on a delay sequence toward a free face.
16. The use of horizontal blast holes for either production or controlled blasting is prohibited.

2-03.3(3) Excavation Below Grade

Rock Excavation. When the Contractor finds rock or other hard material at the subgrade elevation, it shall be excavated the full width of the roadbed to at least 6 inches below subgrade, then backfilled with rock fragments, gravel, or other free-draining material not more than 4 inches in diameter.

If the Contractor uses a subgrade trimmer, the backfill shall be rock, gravel, or other free-draining material not more than 2 inches in diameter. The Contractor shall save the finer free-draining material from excavations or borrow pits to use in backfilling the top 6 inches of the subgrade. All such material shall be approved by the Engineer.

Sub excavation. At any time, the Engineer may order excavation below subgrade to remove soft and uncompactible material. The replacement material shall be free-draining and granular, or other materials as determined by the Engineer.

Draining Rock Pockets. If blasting below subgrade leaves a rock pocket that will not drain, the Contractor shall dig a trench from the pocket bottom to the roadside ditch, then backfill both the pocket and the trench with rock fragments, gravel, or other material approved by the Engineer, at no expense to the Contracting Agency.

Compaction. If the density of the natural earth under any area of the roadway is less than that required in Section 2-03.3(14)C, Method B, the Engineer may direct the Contractor to:

1. Scarify the earth to a depth of 6 inches.
2. Aerate or water.
3. Compact the scarified area to the required density.
4. Excavate to a specific depth.
5. Backfill the excavated area in layers, using the previously excavated material or other material.
6. Compact each layer to meet the compaction requirements for embankments.

2-03.3(4) Sluicing

The Contractor shall not excavate by sluicing unless the Special Provisions specifically call for it.

2-03.3(5) Slope Treatment

The tops of all roadway cut slopes, except solid rock cuts, shall be rounded in accordance with the Standard Plan. Unless otherwise noted in the Plans or Special Provisions, Class A slope treatment shall be utilized.

If a layer of earth covers a rock cut, the slope shall be rounded above the rock as if it were an earth slope.

When the Contractor removes stumps or any embedded material from the rounded area, the void shall be backfilled and stabilized to prevent erosion.

All work required to complete slope treatment, including excavation, haul, and slope rounding, shall be included in the unit bid price for roadway excavation.

2-03.3(6) Deposit of Rock for the Contracting Agency's Use

At the Engineer's direction, the Contractor shall deposit excavated rock at the roadside or elsewhere. If this requires the Contractor to use material that would otherwise have gone into an embankment, the Contracting Agency will pay for the extra cubic yards of excavation needed to complete the embankment. Any such rock deposit shall be Contracting Agency property. The Contractor shall be responsible for safekeeping the deposit until the Contracting Agency has removed it or until the contract is completed.

2-03.3(7) Disposal of Surplus Material

2-03.3(7)A General

The Contractor shall haul all excavation to the nearest embankment unless the Engineer declares the hauling distance to be too great. If excavation yields more material than needed for nearby embankments, the Contractor shall dispose of the excess in keeping with the Special Provisions or as the Engineer directs.

2-03.3(7)B Haul

When the contract includes a payment item for haul, the Contracting Agency will pay as follows for hauling excess excavation to a disposal site:

1. If the Contracting Agency provides a site, but the Contractor chooses to haul elsewhere, the Contracting Agency will pay for the actual distance up to but not exceeding the distance that would have been necessary using the Contracting Agency site.
2. If the Contracting Agency does not provide a site, the Contracting Agency will pay for the actual distance up to but not exceeding the distance necessary to haul to a site 1 mile from the project limits.

2-03.3(7)C Contractor-Provided Disposal Site

If the Contracting Agency provides no waste site, but requires disposal of excess excavation or other materials, the Contractor shall arrange for disposal at no expense to the Contracting Agency, except as provided in Section 2-03.3(7)B, Item 2.

The Contractor shall acquire all permits and approvals required for the use of the disposal site. The cost of any such permits and approvals shall be included in the bid prices for other work.

The Contractor shall provide the Engineer the location of all disposal sites to be used and also provide copies of the permits and approvals for such disposal sites before any waste is hauled off the project.

Disposal of excess material within a wetland area will not be allowed without a Section 404 permit issued by the U.S. Corps of Engineers and approval by the local agency with jurisdiction over the wetlands. Wetlands are defined as those areas inundated or saturated by ground or surface water at a frequency and duration sufficient to support, and that under normal circumstance do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

The Contractor shall protect, indemnify, and save harmless the Contracting Agency from any damages that may arise from the Contractor's activities in making these arrangements. Such indemnity shall be in accordance with RCW 4.24.115 as amended by CH. 305, Laws of 1986. Any action required to satisfy any permit and/or any approval requirements in a Contractor provided disposal site shall be performed by the Contractor at no additional expense to the Contracting Agency.

Reclamation of a Contractor-supplied waste site must conform to the requirements of Section 3-03.

2-03.3(8) Wasting Material

If, against the Engineer's orders, the Contractor wastes material needed for the embankment, it shall be replaced at no expense to the Contracting Agency with material the Engineer approves.

2-03.3(9) Roadway Ditches

At each transition from cut to fill, the Contractor shall divert any roadway ditch away from the embankment in natural ground. Ditches shall never permit water to flow into or upon embankment material.

2-03.3(10) Selected Material

When the contract or the Engineer calls for it, selected material shall be used for finishing the top part of the subgrade, for structural or other backfill, or for other purposes. Unless the Special Provisions specify otherwise, the Engineer may identify as "selected" any material excavated within the right-of-way, including the excavation of local borrow.

Direct Hauling. If it is practical, the Contractor shall haul selected material immediately from excavation to its final place on the roadbed. The Contracting Agency will pay for such work at the unit contract prices for excavating, hauling, watering, and compacting.

Delayed Excavation. If it is impractical to haul selected material to its final place at once, the Contractor shall delay excavation until the placement will be workable. The Contracting Agency will not pay extra for delayed excavation.

Stockpiling. The Engineer may allow the Contractor to stockpile selected materials if delaying the excavation will hamper grading or force impractical movements of equipment. In this case, the Engineer will direct where and when the Contractor shall excavate, stockpile, haul, and place the selected materials.

Sections 2-03.4 and 2-03.5 describe how the Contracting Agency will measure and pay for excavating and hauling these stockpiled selected materials. The neat line volume of material removed will provide the basis for measuring material taken from the stockpile.

2-03.3(11) Slides

If a slide occurs on a finished slope before final acceptance of the work, the Contractor shall remove or replace the slide material. The Contractor shall also refinish the slope to the condition and with the materials required by the Engineer.

The Contracting Agency will pay for the excavation at the unit contract price and for resloping on a force account basis. The Engineer may authorize payment for the excavation by agreed price or force account if:

1. The slide material cannot be measured accurately; or
2. Excavation of slide material requires equipment not available on the project.

If the Contractor undercuts or destroys a slope, or has failed to implement erosion control devices as shown in the Contract or in the TESC plan, it shall be resloped to the original alignment or to a new one established by the Engineer at no expense to the Contracting Agency.

2-03.3(12) Overbreak

Overbreak includes that part of any material excavated, displaced, or loosened outside the staked or reestablished slope or grade. Such material is considered overbreak whether its movement resulted from blasting, from the character of the material itself, or from any other cause. Overbreak, however, does not include material from slides as described in Section 2-03.3(11).

If the Engineer does not approve use of the overbreak, the Contractor shall remove, haul, and dispose of it at no expense to the Contracting Agency. In this case, the Contractor shall follow the procedure for handling surplus described in Section 2-03.3(7).

If the Engineer approves, the Contractor may use overbreak:

1. To complete an embankment when the excavated material unexpectedly falls short of the amount required. The Contracting Agency will pay the roadway excavation contract price for the volume of material the overbreak replaces, and will pay the contract price for haul. However, no payment will be made if overbreak is used when other material is available within the neat lines of the roadway prism.
2. To replace borrow excavation originally planned for an embankment. The Contracting Agency will pay for overbreak used this way at the unit contract price for roadway or borrow excavation, whichever costs less. The Engineer will include haul to be paid as in the original proposal in comparing the costs under the two payment methods.

2-03.3(13) Borrow

Borrow is the excavation of material outside the roadway prism or outside the limits of any other excavation area required by the contract. Before any borrow site can be used, it must be measured and approved by the Engineer. Any material excavated from a borrow site before the site is measured will not be paid for. The widening of roadway cuts and ditches will be considered roadway excavation, not borrow.

If the contract documents designate borrow sources, the Contractor may utilize those sources or may obtain borrow from other sites. If borrow is obtained from a Contractor-provided site, there will be no additional cost to the Contracting Agency beyond the contract unit price for the excavated borrow material. There will be no payment for aeration of the borrowed material from a Contractor-provided site, even if the contract contains an item for aeration and even if the contract documents designate borrow sources.

If neither the Plans nor the Special Provisions name a source for borrow, the Contractor shall provide a source at no expense to the Contracting Agency.

The Contractor shall reclaim all borrow sites, Contracting Agency-owned, Contracting Agency-supplied, or obtained by the Contractor, in keeping with Section 3-03.

2-03.3(14) Embankment Construction

The Contracting Agency classifies embankment construction as:

1. Rock embankment — in which the material in all or any part of an embankment contains 25 percent or more, by volume, gravel or stone 4 inches or more in diameter. Section 2-03.3(14)A.
2. Earth embankment — made of any material other than that used in rock embankment. Section 2-03.3(14)B.

Unstable Base. If the Engineer believes the natural earth base will impair an embankment or make it unstable, the Contractor shall stabilize or remove and dispose of the base material in keeping with this section or Section 2-03.3(14)E.

Hillside Terraces. Unless the Engineer directs otherwise, the Contractor shall terrace the original ground or embankment on hillsides, on the sides of existing embankments, and in transitions from cuts to fills. Each terrace shall penetrate the slope at least 5 feet and shall not be more than 5 feet high. The horizontal face of the terrace shall slope outward at approximately 0.05 foot per foot. The Engineer may order the Contractor to place gravel backfill, pipe drains or both to drain any seepage.

All costs for building terraces shall be included in the prices for other work.

Soft Base. On wet or swampy ground, the Contractor shall haul and spread embankment material by methods that will disturb the base as little as possible. If the Engineer approves, the Contractor may place the lower part of the fill by dumping and spreading successive loads to form a uniform layer just thick enough to support equipment used to place and compact upper layers.

Normally the Contractor shall not increase the planned depth of the embankment over a soft base merely to permit the use of heavier equipment. But if the Contractor proves that the planned depth will not support light hauling vehicles, the Engineer may approve a deeper fill. The Contractor shall not claim extra pay if these restrictions require the use of lighter equipment or different construction methods than originally planned for use on the soft base.

2-03.3(14)A Rock Embankment Construction

The Contractor shall build rock embankments in horizontal layers. No layer shall be deeper than 18 inches unless the rocks in the fill material average more than 18 inches in diameter. The Contractor shall separate and distribute the larger pieces of rock and fill the spaces between them with smaller rocks and earth. With the Engineer's approval, the Contractor may dispose of rocks larger than the average size instead of placing them in the embankment.

Compacting. The Contractor shall use a 50-ton compression roller or a vibratory roller having a dynamic force of at least 40,000 pounds impact per vibration and at least 1,000 vibrations per minute. In either case, the roller shall make one full coverage for each 6 inches, or any fraction of 6 inches, of lift depth.

When lift depth is 18 inches or less, the Contractor may use a 10-ton compression roller or a vibratory roller having a dynamic force of at least 30,000 pounds impact per vibration and at least 1,000 vibrations per minute. In either case, the roller shall make four full coverages for each 6 inches, or any fraction of 6 inches, of lift depth.

Rollers must exert reasonably even pressure over the area covered. The Contractor shall limit the speed of compression rollers to no more than 4 miles per hour, and the speed of vibratory rollers to no more than 1.5 miles per hour.

If possible, the Contractor shall compact the material even further by routing empty and loaded hauling equipment evenly over the entire width of the embankment.

When the Engineer believes rolling to be physically impractical, rolling may be omitted on part or all of a layer.

Should excessive moisture threaten the stability of the embankment the Engineer may order the Contractor to alter the operation. This may include alternating layers of wet and dry materials, drying materials before placing, or halting work in the problem areas. In this case the Contracting Agency will not increase payment, but will pay the unit contract prices for the pay items that apply.

Top Layer. The Contractor shall build each rock embankment up to 6 inches below subgrade. The top 6-inch layer of embankment shall be of rock, gravel, or other free-draining material that does not exceed 4 inches in diameter. When the Plans require use of a subgrade trimmer, these materials in the top layer may not exceed 2 inches in diameter.

When practical, and as approved by the Engineer, the Contractor shall save the finer free-draining material from excavations or borrow pits for use in topping rock fills. If selected materials suitable for topping are available, the Contracting Agency will pay for them as described in Section 2-03.3(10). If such materials are not available on site, the Contracting Agency will pay for imported materials by including them in the unit contract price for gravel borrow or borrow excavation, each including haul. If the proposal does not include these items, the Contracting Agency will pay as provided in Section 1-04.4.

2-03.3(14)B Earth Embankment Construction

The Contractor shall place earth embankments in horizontal layers of uniform thickness. These layers shall run full width from the top to the bottom of the embankment. Slopes shall be compacted to the required density as part of embankment compaction.

During grading operations, the Contractor shall shape the surfaces of embankments and excavations to uniform cross-sections and eliminate all ruts and low places that could hold water. The Contractor shall raise the center of an embankment above the sides. When the surface of an embankment intersects a side hill, the surface shall be sloped away at a rate not to exceed 20:1.

2-03.3(14)C Compacting Earth Embankments

This section describes three methods (A, B, and C) for building earth embankments. The Contractor shall use Method B unless the Special Provisions require another method.

Method A. Each embankment shall be made of layers no more than 2 feet thick. The Contractor shall compact each layer by routing loaded haul equipment over its entire width. If the Engineer approves, the Contractor may use end dumping to begin placing a side hill fill too narrow for hauling equipment. When the fill is wide enough, the remaining layers shall be compacted by the loaded hauling equipment.

Method B. The top 2-feet of each embankment shall be compacted to 95 percent of the maximum density as determined by the compaction control tests described in Section 2-03.3(14)D. All material below the 2-foot level shall be compacted to 90 percent of the same maximum density.

In the top 2 feet, horizontal layers shall not exceed 4 inches in depth before compaction. No layer below the top 2 feet shall exceed 8 inches in depth before compaction.

The Contractor shall use compacting equipment approved by the Engineer.

Method C. Each layer of the entire embankment shall be compacted to 95 percent of the maximum density as determined by the compaction control tests described in Section 2-03.3(14)D.

In the top 2 feet, horizontal layers shall not exceed 4 inches in depth before compaction. No layer below the top 2 feet shall exceed 8 inches in depth before compaction.

The Contractor shall use compacting equipment approved by the Engineer.

Under Methods B or C, the Engineer may permit the Contractor to increase layer thickness up to 18 inches before compaction, provided:

1. The layer is more than 2 feet below the top of the embankment,
2. An approved vibratory roller is used, and
3. The required density is obtained throughout the full depth and width of each layer.

Whatever the method used, any embankment inaccessible to large compacting equipment shall be compacted with small mechanical or vibratory compactors.

Moisture Content. Within the limits described below, the Contractor shall adjust moisture content during compaction to produce a firm, stable embankment. The Contractor shall not begin compaction until the moisture content is so adjusted.

Under Method B, the moisture content of the material shall not exceed 3 percent above the optimum determined by the tests described in Section 2-03.3(14)D. If the material contains too little moisture to compact properly, the Engineer may order the Contractor to water the material in specific amounts. In this case, the Contracting Agency will pay the unit contract price for water (Section 2-07).

Under Method C, the moisture content shall not vary more than 3 percent above or below optimum determined by the tests described in Section 2-03.3(14)D.

The Engineer may permit the Contractor to place materials having a higher moisture content than specified in this section if:

1. The material consists of free-draining rock, gravel, or sand that produces a firm, stable embankment; and
2. The excess moisture will not impair the embankment.

However, the Engineer may at any time require the Contractor to return to normal moisture-content specifications.

The Contracting Agency will consider all costs of drying embankment material to be incidental to other work. If, however, the Contract includes an aeration item, the Contracting Agency will pay for such work as specified in Sections 2-03.4 and 2-03.5.

If weather prevents drying excavation or borrow materials to the required moisture content, the Engineer may order the Contractor to alter normal procedures or equipment to prevent damage to the partial or complete embankment. In this case, the Contracting Agency will not increase payment, but will pay the unit contract prices for the pay items that apply.

The Contractor shall repair at no expense to the Contracting Agency any partial or complete embankment that loses stability because of continued hauling across it. Evidence of lost stability shall include pumping or rutting. The Contractor shall also alter hauling equipment or procedures to prevent further damage.

If it appears that rain or snow will soak an area that has been aerated, the Contractor shall temporarily seal it against the weather. Should the Contractor fail to do so, any additional aeration required to restore the area to its previous condition shall be done at no expense to the Contracting Agency.

2-03.3(14)D Compaction and Moisture Control Tests

Maximum density and optimum moisture content shall be determined by one of the following methods:

1. Materials with less than 30 percent by weight retained on the U.S. No. 4 sieve shall be determined using FOP for AASHTO T 99 Method A.
2. Materials with 30 percent or more by weight retained on the U.S. No. 4 sieve and less than 30 percent retained on the $^3/_4$-inch sieve shall be determined by WSDOT Test Method No. 606 or FOP for AASHTO T 180 Method D. The determination of which test procedure to use will be made solely by the Contracting Agency.
3. Materials with 30 percent or more retained on the $^3/_4$-inch sieve shall be determined by WSDOT Test Method No. 606.

In place density will be determined using Test Methods WSDOT FOP for AASHTO T 310 and WSDOT SOP for T 615.

2-03.3(14)E Unsuitable Foundation Excavation

When the contract or the Engineer requires it, the Contractor shall excavate unstable natural ground before building any embankment over it. This unstable material may include peat, muck, swampland, buried logs and stumps, or other material not fit for an embankment base. The Contractor shall excavate such material to the boundaries set by the Engineer.

The work will not be considered unsuitable foundation excavation if the materials:

1. Came from the roadway cut, ditch, or channel-change prisms.
2. Resulted from structure excavation Class A or B.
3. Are covered in Section 2-03.3(3).

If the Contract provides no bid item for unsuitable foundation excavation, the Contracting Agency will pay as provided in Section 1-04.4.

2-03.3(14)F Displacement of Unsuitable Foundation Materials

If the Contract requires it, the Contractor shall displace or remove any overburden of peat, muck, or other unstable material to permit placing the embankment on underlying firm ground. The Engineer will determine the elevation at which the ground is firm enough to support the embankment.

To displace such material, the Contractor shall use explosives or any other method the Engineer requires. If this work upheaves overburden material outside the slopes of the new fill, the Contractor shall level the material to make it presentable.

The Contracting Agency will pay for the work described in this section by force account. Any other costs related to the work shall be incidental to building the embankment and shall be included in the unit contract prices for the work items that apply.

2-03.3(14)G Backfilling

When water fills an area after the removal of soft or unstable materials, the Contractor shall, if possible, drain the site so that any backfill may be compacted. If drainage is not possible, the Contractor shall use granular material for backfilling in water, including areas where blasting has displaced the soft material. The Special Provisions may require other backfilling methods.

The costs of pumping or digging temporary drainage ditches shall be incidental to and included in other items of work that apply.

2-03.3(14)H Prefabricated Vertical Drains

The Contractor shall furnish all necessary labor, equipment and materials, and perform all operations necessary for the installation of prefabricated vertical drains in accordance with the details shown in the Plans and with the requirements of these Specifications.

The prefabricated drain shall consist of a continuous plastic drainage core wrapped in a nonwoven geotextile material as specified in the Contract.

The drains shall be free of defects, rips, holes, or flaws. During shipment and storage, the drain shall be wrapped in a heavy-duty protective covering. The storage area shall protect the drain material from sunlight, mud, dirt, dust, debris, and detrimental substances. Manufacturer certification shall be provided for all drain materials delivered to the project.

Vertical drains shall be staked by the Contractor and constructed prior to embankment construction.

Prior to installation of vertical drains, a sand drainage blanket shall be placed on the ground surface for use as a working platform. This platform shall have a minimum depth of 2 feet and shall consist of uncompacted material meeting the requirements of Section 9-03.13(1).

Vertical drains shall be installed with equipment that will cause a minimum of subsoil disturbance. A mandrel or sleeve shall be advanced through the subsoil using vibratory, constant load, or constant rate of advance methods. The mandrel shall have a maximum cross-sectional area of 14 square inches, shall protect the prefabricated drain material from tears, cuts, and abrasions during installation, and shall be provided with an “anchor” plate or rod. The “anchor” plate or rod shall provide sufficient strength to prevent the soil from entering the bottom during installation and shall anchor the bottom of the drain at the required depth when the mandrel is removed. Use of falling weight impact hammers or jetting will not be allowed within the compressible subsoil to be drained.

The prefabricated drains shall be installed vertically from the working surface to the required elevations and in a sequence that will not require equipment to travel over previously installed drains. The Contractor shall provide the Engineer with a suitable means of verifying the plumbness of the equipment and determining the depth of the drain at any time. The equipment shall not deviate more than 0.25 inches per foot from vertical.

Splices or connections in the prefabricated drain material shall be done in a professional manner to ensure continuity of the wick material. The prefabricated drain shall be cut to leave at least 6 inches protruding above the working platform at each drain location.

Where obstructions are encountered which cannot be penetrated the Contractor shall abandon the hole. A maximum of two attempts shall be made to install a new drain within 18 inches of the obstructed hole. Drains that otherwise deviate from the plan location by more than 6 inches, or that are damaged or improperly installed, will be rejected.

Installation of the drains should consider and be coordinated with the geotechnical instrumentation shown in the Plans. Special care shall be taken when installing drains near instrumentation already in place. Replacement of instrumentation damaged by the Contractor will be the responsibility of the Contractor.

The Contractor shall demonstrate that the equipment, method, and materials produce a satisfactory installation in accordance with these Specifications. For this purpose, the Contractor shall be required to install trial drains at different locations within the work area.

At least two weeks prior to the installation of the drainage wicks, the Contractor shall submit to the Engineer, for review and approval, details of the sequence and method of installation. The submittal shall, at a minimum, contain the dimensions and length of mandrel, a detailed description of the proposed method(s) for overcoming obstructions, and the proposed method(s) for splicing drains.

Approval by the Engineer will not relieve the Contractor of the responsibility to install prefabricated vertical drains in accordance with the Plans, Special Provisions, and these Specifications. If, at any time, the Engineer considers the method of installation does not produce a satisfactory drain, the Contractor shall alter the method and equipment as necessary.

2-03.3(14)I Embankments at Bridge and Trestle Ends

This work consists of filling around the ends of trestles and bridges, the area defined in Section 1-01.3. The Contractor shall begin and complete this work as soon as possible after each bridge is completed or when the Engineer requires.

The Contractor shall select fill material from the excavation sources elsewhere on the project. Bridge approach embankments shall be compacted to at least 95 percent of the maximum density as determined by the tests described in Section 2-03.3(14)D. In any embankment area where piles will be installed, the Contractor shall remove all solid material, rocks, broken concrete, etc., larger than 3 inches across that would interfere with pile driving.

To prevent the bridge from being distorted or displaced, the Contractor shall place backfill evenly around all sides and parts of the structure. The Contractor shall not backfill any abutment prior to placing the superstructure. After the superstructure is in place, use of small compactors may be required to compact the backfill around the structure. Embankments and backfill behind the abutments must be brought up in layers and compacted concurrently. The difference in backfill height against each abutment shall not exceed 2 feet unless approved by the Engineer.

The Contractor may request, in writing, approval to place the abutment backfill (either full or partial height) prior to placement of the superstructure. To receive this approval, the Contractor shall submit calculations for the Engineer's review. The calculations shall prove that the abutment is stable, both for overturning and sliding, without the superstructure in place. The stability calculations shall assume a loading of 30 lbs/ft^3 equivalent fluid pressure and include at least a 2-foot surcharge for the backfill placement equipment. If the abutment backfill is allowed to be placed prior to completion of the superstructure, the Contractor shall bear any added cost that results from the change.

The Contractor shall build the embankment under the bridge to the dimensions shown in the Standard Plans or detailed in the Plans.

Cost related to all work described in this section shall be incidental to other work and included in the unit contract prices that apply.

2-03.3(14)J Gravel Borrow Including Haul

When required by the Plans or the Engineer, the Contractor shall use gravel borrow meeting the requirements of Section 9-03.14(1) to:

1. Build structural embankments.
2. Backfill excavation of unsuitable foundation material above the ground water table.
3. Backfill below-grade excavation above the ground water table.
4. Construct mechanically stabilized earth walls.
5. Construct reinforced soil slopes.

Gravel borrow shall be compacted according to Section 2-03.3(14)C and 2-03.3(14)D.

2-03.3(14)K Select or Common Borrow Including Haul

When required by the Plans or the Engineer, the Contractor shall use select borrow meeting the requirements of Section 9-03.14(2), or common borrow meeting the requirements of Section 9-03.14(3) to:

1. Build embankments.
2. Backfill excavation of unsuitable foundation material above the ground water table.
3. Backfill below-grade excavation above the ground water table.

Where specified, select borrow may be used for constructing reinforced slopes.

Select borrow and common borrow shall be compacted according to Section 2-03.3(14)C and 2-03.3(14)D.

2-03.3(14)L Embankment Widening for Guardrail

Embankments widened for the installation of beam guardrail shall be terraced. Each terrace shall penetrate the slope 2-feet and shall not be more than 5 feet high. Compaction shall be in accordance with Method A, as specified in Section 2-03.3(14)C. Guardrail posts shall not be installed until the embankment widening is completed and compacted.

2-03.3(14)M Excavation of Channels

Excavation of channels includes all ditches 8 or more feet wide at the bottom.

Before excavating, the Contractor shall clear and grub the area in accordance with Section 2-01.

2-03.3(15) Aeration

The Contracting Agency may include aeration as a contract item if material from test holes in excavation or borrow sites is too wet to compact properly. Even if the Contract includes such an item, the Contractor shall make every effort to reduce the need for aeration. The Contractor shall do so by using methods known to be effective in building embankments with wet materials. Such methods include open ditching to drain excavation areas or alternating layers of wet and dry materials. These and similar methods will be incidental to excavation and their costs shall be included in the unit contract price for roadway excavation, for borrow excavation (including haul), and for haul.

If aeration is not a contract item, its cost shall be incidental to and included in the excavation and embankment items.

Aeration Equipment. The Engineer may direct the Contractor to use aeration equipment in these areas: roadway excavation, borrow sites, or embankments. The Contracting Agency does not guarantee the moisture-reducing effectiveness of any single type of equipment. The Engineer may, however, require the use of any type that will best aerate a given area.

If the Contractor uses any of the following types of equipment, it shall meet these minimum requirements:

1. Heavy duty power grader. This machine shall have a moldboard measuring 12 feet long, 24-inches high, and $^{3}/_{4}$-inch thick. Each grader shall carry its maximum number of standard scarifier-rippers or discs.
2. Heavy duty gang plow. It shall have at least five 16-inch bottoms. Its tractor shall be able to move no less than $1^{1}/_{2}$ miles per hour while plowing at least 9 inches deep through fairly wet material.
3. Heavy duty tandem discs. This machine shall cut a swath at least 8 feet wide with discs no less than 28 inches in diameter. Its tractor shall be able to turn fairly wet material at least 6 inches deep while moving at 2 miles per hour or more.
4. Heavy duty self-propelled, rotary pulverizer. This machine shall have paddles attached to a transverse shaft. It shall travel $1^{1}/_{2}$ miles per hour or more while aerating a swath at least 6 feet wide to a depth of 6 inches.

The Contractor shall not use any aerating equipment listed above in tandem nor use any of this equipment to carry out other bid items of work while aerating.

The Engineer may halt aerating work when weather conditions prevent satisfactory results.

2-03.3(16) End Slopes

The Engineer will determine when and where to build end slopes, whether these occur at the beginning or end of a project, at the borders of excavation or embankments, at bridge ends, or elsewhere. The Contractor shall build end slopes not detailed in the

Plans to the line and grade designated by the Engineer regardless of centerline limits shown in the Plans. All work to complete and maintain these end slopes shall be considered as work to be performed under the Contract.

2-03.3(17) Snow Removal

If snow deep enough to interfere with the work covers a cut or an embankment, the Contractor shall remove and deposit it outside the slope stakes. Snow removal must be done at least 100-feet ahead of excavation and embankment work. The Contractor shall remove snow at no expense to the Contracting Agency.

2-03.3(18) Stepped Slope Construction

When the Plans or the Engineer requires it, the Contractor shall shape slopes cut in soft rock to a stepped pattern conforming closely to the typical cross-section in the Plans. Stepped slopes shall meet these requirements:

1. Each step shall be 1 to 2-feet high.
2. The horizontal depth of each step will depend on its relationship to the staked slope ratio. The approximate midpoint of each horizontal tread shall occur on the staked slope line.
3. The treads shall be approximately level in all directions.
4. The ends of the steps shall be blended into the natural ground, with loose material removed from transitional areas.
5. If the Contractor cannot rip a rock outcropping within a cut, the steps shall be blended into the rock.
6. Large rocks and material that may fall into the ditch line or onto the roadway shall be removed, but scaling is not required.

The compaction and seeding requirements of Section 8-01.3(2) shall not apply to stepped slope construction.

The Contracting Agency will measure stepped slope excavation by the area defined by the staked slope line. The unit contract price per cubic yard for roadway or borrow excavation shall be full pay for all labor and equipment required to build stepped slopes.

2-03.4 Measurement

"Roadway Excavation", "Roadway Excavation Incl. Haul", "Roadway Excavation – Area ___", "Roadway Excavation Incl. Haul – Area ___" "Unsuitable Foundation Excavation", and "Common Borrow Incl. Haul" will be measured by the cubic yard. All excavated material will be measured in the position it occupied before the excavation was performed. An original ground measurement will be taken using cross-section or digital terrain modeling survey techniques. For Roadway Excavation items, the original ground will be compared with the planned finished roadway section shown in the plans. Slope/ground intercept points defining the limits of the measurement will be as staked. For Unsuitable Foundation Excavation and Common Borrow items, the original ground will be compared with a survey of the excavation area taken after the work is completed. When the Contracting Agency requires excavated material to be stockpiled, re-excavated and moved again, a second measurement will be made, adding quantity for the same item used in the original excavation. The second measurement will be a comparison of the original cross-section of the stockpile with a cross-section of the stockpile area after the second excavation is completed. If the excavation item does not include Haul, then the measurement provisions of Section 2-04 shall apply.

"Gravel Borrow Incl. Haul" and "Select Borrow Incl. Haul" will be measured by the cubic yard or ton. Measurement by cubic yard will be made in the hauling vehicle.

"Sand Drainage Blanket" will be measured by the ton with deductions made for the weight of moisture above 8 percent.

"Embankment Compaction" (Methods B and C in Section 2-03.3(14)C) will be measured by the cubic yard. An original ground measurement will be taken using cross-section or digital terrain modeling survey techniques. Quantities will be determined based on a comparison of the original ground measurement with the finished embankment section as staked. No allowance will be made for material that settles. No deduction will be taken for other items constructed within the embankment (bridge abutments, piers, columns, backfill, pipes, etc.). The Contracting Agency will exclude from compaction measurement material that is wasted or placed under water and not compacted in layers as provided by Sections 2-03.3(14)A and 2-03.3(14)C. In cuts, where excavation has been made below the planned subgrade elevation, and in fills where excavation has been made below original ground, compaction will be measured by the cubic yard in the cross-section of compacted backfill material. When material below grade in cuts or in original ground beneath fills is scarified and recompacted, embankment compaction will be measured by its compacted depth, up to a maximum of 6-inches. There is no specific unit of measure and no measurement will be made for method A compaction as described in 2-03.3(14)C.

No specific unit of measure will apply to the force account item of "Aeration".

"Controlled Blasting of Rock Face" will be measured by the linear foot of hole drilled. Holes will be measured from the top of the rock surface to the elevation of the roadway ditch or to a bench elevation set by the Engineer. Quantities shown in the Plans are based on 30-inch hole spacing. Actual quantities will depend on field conditions and results from test sections.

"Prefabricated Vertical Drains" will be measured by the linear foot. Trial drains will be measured and included in the payment quantity for the "Prefabricated Vertical Drains". The drains will be measured from the top of the working platform to the bottom of each hole.

2-03.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Roadway Excavation", per cubic yard.

"Roadway Excavation Incl. Haul", per cubic yard.

"Roadway Excavation – Area ____", per cubic yard.

"Roadway Excavation Incl. Haul – Area ____", per cubic yard.

The unit contract price per cubic yard for "Roadway Excavation", "Roadway Excavation Incl. Haul", "Roadway Excavation – Area __" and "Roadway Excavation Incl. Haul – Area ___" shall be full compensation for all costs incurred for excavating, loading, placing, or otherwise disposing of the material. For haul, the unit contract price as provided in Section 2-04 shall apply, except when the pay item is shown as including haul. In that case the unit contract price per cubic yard shall include haul.

When the Engineer orders excavation below subgrade, unit contract prices shall apply, unless the work and/or the equipment to perform the work differs materially from the excavation above subgrade, then payment will be in accordance with Section 1-04.4.

"Unsuitable Foundation Excavation", per cubic yard.

"Unsuitable Foundation Excavation Incl. Haul", per cubic yard.

The unit contract price per cubic yard for "Unsuitable Foundation Excavation" and "Unsuitable Foundation Excavation Incl. Haul" shall be full payment for all costs incurred for excavating, loading, and disposing of the material. For haul, the unit contract price as provided in Section 2-04 shall apply, except when the bid item is shown as including haul. In that case, the unit contract price per cubic yard shall include haul.

"Common Borrow Incl. Haul", per cubic yard.

The unit contract price per cubic yard for "Common Borrow Incl. Haul" shall be full compensation for all costs incurred for excavating, loading, hauling, placing, or otherwise disposing of the material. The unit contract price includes removing, disposing of, wasting, or stockpiling any material in the borrow site that does not meet the specifications for "Common Borrow".

"Select Borrow Incl. Haul", per ton.

"Select Borrow Incl. Haul", per cubic yard.

"Gravel Borrow Incl. Haul", per ton.

"Gravel Borrow Incl. Haul", per cubic yard.

"Sand Drainage Blanket", per ton.

The unit contract price per ton or cubic yard for "Select Borrow Incl. Haul", "Gravel Borrow Incl. Haul" and "Sand Drainage Blanket" shall be full compensation for all costs incurred for excavating, loading, hauling, and placing the material unless otherwise specified in the proposal.

"Embankment Compaction", per cubic yard.

The unit contract price per cubic yard for "Embankment Compaction" shall be full compensation for all costs incurred for all material, labor, tools, equipment, and incidentals required.

When embankments are constructed using Method A compaction, payment for embankment compaction will not be made as a separate item. All costs for embankment compaction shall be included in other bid items involved.

If the bid item "Embankment Compaction" is not provided in the proposal, compensation for costs incurred to perform the work described in Section 2-03.3(14), Embankment Construction, shall be included in payment for other items of work in the contract.

"Aeration", by force account.

"Aeration" will be paid for by force account as specified in Section 1-09.6. The payment for aeration and other related unit contract prices shall be full compensation for all costs incurred to perform the work described in Section 2-03.3(15). Should the Contractor fail to seal an aerated area prior to inclement weather, additional aeration to restore the area to its previous condition shall be at the Contractor's expense.

For the purpose of providing a common proposal for all bidders, the Contracting Agency has entered an amount in the proposal to become a part of the total bid by the Contractor.

"Controlled Blasting of Rock Face", per linear foot.

The unit contract price per linear foot for "Controlled Blasting of Rock Face" shall be full compensation for all costs incurred to perform the work described in Section 2-03.3(2). Measurement and payment for roadway excavation and haul related to blasting shall be as provided under those items in this section and shall include the volume of material excavated from the benches or setbacks approved for drilling separate lifts.

"Prefabricated Vertical Drain", per linear foot.

The unit contract price per linear foot shall be full compensation for all costs incurred to perform the work, including trial drains, as described in Section 2-03.3(14)H.

2-04 HAUL

2-04.1 Description

This work consists of transporting excavated material from its original site to its final place in the work.

The balance points shown in the Plans are only approximate. The Engineer may change the balance points to help equalize quantities of materials or to dispose of surpluses.

When the Plans require hauling, the Contractor shall not substitute wasting or borrowing. The Contracting Agency will not pay extra for cross-hauling unless the Engineer so orders.

2-04.2 Vacant

2-04.3 Vacant

2-04.4 Measurement

The Contracting Agency will measure haul in units of haul where one unit equals 100 cubic yards of excavated material hauled 100 feet.

Excavated material will be measured in its original position. The Engineer will provide a copy of the location mass diagram upon request.

Haul On Right of Way. To compute units of haul, the Contracting Agency will measure haul distance parallel to the centerline (or base line) of the highway. Lateral distance (cross-hauling) will not be measured.

Quantities to be measured in this way include: (1) material from the roadway prism or prisms, (2) borrow from widened cuts, (3) waste deposited in the right of way or alongside it, and (4) material from auxiliary lanes — frontage roads, speed change lanes, paralleling and loop ramps, cross roads, and other lanes that supplement through-traffic movements.

If the Plans show more than one centerline or base line (as in a multi-lane highway), the Plans or Special Provisions will describe the line by which haul will be computed.

Waste Haul Off Right of Way. The Contracting Agency will measure the cross-section and length of any waste embankment to calculate waste quantities. If the Plans or Special Provisions do not specify a haul route, the Contracting Agency will compute haul along the long axis of the waste embankment, thence along a line running perpendicular to the highway center line, starting at the center line and ending at the nearest end of the waste embankment.

However, when a route is specified, haul distance will be measured along that route. If the Contractor chooses to use a route shorter than that computed or specified, the Contracting Agency will base payment on the length of the route actually used.

2-04.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when it is included in the proposal:

"Haul", per unit.

2-05 VACANT

2-06 SUBGRADE PREPARATION

2-06.1 Description

This work consists of preparing graded roadbed for surfacing or surfaced roadbed for paving.

2-06.2 Vacant

2-06.3 Construction Requirements

2-06.3(1) Subgrade for Surfacing

In preparing the roadbed for surfacing, the Contractor shall:

1. Remove from the roadbed, immediately before placing surfacing materials, all brush, weeds, vegetation, grass, and other debris.
2. Dispose of all debris as the Engineer directs.
3. Drain water from all low spots or ruts.
4. Shape the entire subgrade to a uniform surface running reasonably true to the line, grade, and cross-section as staked.
5. If necessary, the Contractor shall process the subgrade in cut areas to remove materials too coarse for mechanical trimming and recompaction.
6. Compact the subgrade to a depth of 6 inches. Compaction shall achieve 95 percent of the maximum density determined under the tests described in Section 2-03.3(14)D. If the underlying material is too soft to permit proper compaction of the subgrade, the Contractor shall loosen, aerate (or excavate and remove), and compact the subgrade until the top layer can be compacted as required.
7. Remove excess material that does not drift to low spots during grading and shaping. The Contractor shall dispose of this excess by placing it where the subgrade lacks material or by wasting it, as the Engineer directs.
8. Add materials as the Engineer directs where the subgrade needs more to bring it up to grade. The Contractor shall water and compact these added materials as needed to produce a true finished subgrade.

If the contract requires a trimming machine, it shall:

1. Maintain the grade and transverse slopes automatically through sensors that respond to reference lines on both edges of each roadway.
2. Create a smooth, uniform surface free from chatter and ripples.

2-06.3(2) Subgrade for Pavement

Before any paving is placed, the Contractor shall bring the subgrade to the required line, grade, and cross-section. The Contractor shall compact the subgrade to a depth of 6 inches to 95 percent standard density as determined by the compaction control tests for granular materials. The compacted area shall be wide enough to let paving machines operate without visible distortion of surfacing material.

The Contractor shall maintain the subgrade in the required condition until the pavement is placed. The Contractor may remove material just before paving if the Plans require thicker areas of pavement.

2-06.4 Vacant

2-06.5 Measurement and Payment

2-06.5(1) Subgrade Constructed Under Same Contract

Surfacing or Treated Base. If the Contractor builds a subgrade for surfacing or treated base, the Contracting Agency will consider subgrade preparation as part of the construction work. In this case, measurement and payment will conform to Section 2-03. Such payment shall be the full price for all subgrade preparation work.

Pavement. If the Contractor builds a subgrade for pavement, the Contracting Agency will follow the criteria in Section 5-04 (for HMA pavement) or Section 5-05 (for cement concrete pavement) to measure and pay for materials used to prepare the subgrade. The Contracting Agency will measure and pay for water as specified in Section 2-07.

2-06.5(2) Subgrade Not Constructed Under Same Contract

When the Contractor prepares an existing subgrade for surfacing (one not built under the present contract), the Contracting Agency will measure and pay for the work by these criteria:

1. **Final Conditioning.** All the following work on the subgrade shall be included in other contract bid items: clearing vegetation and other debris, draining water, smoothing to prepare for staking, grading, shaping, and compacting to a 6-inch depth to final line, grade, and cross-section.
2. **Excess Materials.** If the Contractor must dispose of excess materials during grading and shaping, the Contracting Agency will measure and pay for the work as roadway excavation. If the contract includes no pay item for roadway excavation, the Contracting Agency will measure and pay as provided in Section 1-04.4.
3. **Added Materials.** If the subgrade requires more materials, the Contracting Agency will pay the unit contract price for each kind of material the Contractor provides. The unit contract price shall be full pay for furnishing, placing, and compacting the materials. When unit contract prices do not apply, the Contracting Agency will measure and pay for the work as provided in Section 1-04.4.
4. **Excavation and Backfill.** If the Engineer orders the Contractor to excavate unstable spots in the subgrade, the Contracting Agency will measure and pay for the work as roadway excavation. If the contract does not include roadway excavation as a pay item, payment will be by agreed price or force account. The Contracting Agency will pay unit contract prices for suitable backfill material when included in the contract and will pay as provided in Section 1-04.4 when not included.
5. **Subgrade Protection.** No payment shall be made for protecting the subgrade.

2-07 WATERING

2-07.1 Description

This work consists of furnishing, hauling, and applying water for compacting embankments, constructing subgrade, placing of crushed surfacing, dust control, and as the Engineer requires.

2-07.2 Vacant

2-07.3 Construction Requirements

The Contractor shall apply water by means of tank trucks equipped with spray bars. Spray controls shall ensure that the water flows evenly and in the amounts required by the Engineer. The Engineer may direct that the Contractor apply water at night or early in the morning to reduce evaporation losses.

2-07.4 Measurement

Water shall be measured by tanks or tank trucks of known capacity or by meters approved by the Engineer. The Contractor shall supply and install any meters at no expense to the Contracting Agency.

2-07.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when it is included in the proposal:

"Water", per M gal.

The unit contract price per M gallon for "water" shall be full pay for all labor, materials, tools, and equipment necessary to furnish, haul, and apply the water.

When the contract does not include water as a pay item, providing and applying the water shall be incidental to construction. All costs shall be included in the other contract pay items.

2-08 VACANT

2-09 STRUCTURE EXCAVATION

2-09.1 Description

Structure excavation consists of excavating and disposing of all natural material or man-made objects that must be removed to make way for bridge foundations, retaining walls, culverts, trenches for pipelines, conduits, and other structures as shown in the Plans.

This work also includes, unless the contract provides otherwise, removing whole or partial structures, grubbing structure sites that would not otherwise be grubbed, building and later removing shoring, cofferdams, or caissons, pumping or draining excavated areas, protecting excavated materials from the weather, and placing and compacting backfill.

2-09.2 Materials

Materials shall meet the requirements of the following sections:

Portland Cement	9-01
Fine Aggregate for Portland Cement Concrete	9-03.1(2)
Admixture for Concrete	9-23.6
Fly Ash	9-23.9
Ground granulated Blast Furnace Slag	9-23.10
Water	9-25

2-09.3 Construction Requirements

2-09.3(1) General Requirements

All structure excavation, trenching, and shoring shall be performed in strict compliance with Chapter 296-155 WAC as well as all other applicable local, Contracting Agency, and Federal laws and regulations.

2-09.3(1)A Staking, Cross-Sectioning, and Inspecting

The Contractor shall not begin excavating until after the stakes have been set to locate and/or outline the structure and taken cross-sections to determine how much material to remove. The Engineer will occasionally inspect material taken from and material remaining in the excavation.

2-09.3(1)B Depth of Excavation

The Contractor shall excavate foundation pits to the depth the Plans require, or to any revised depth ordered by the Engineer.

2-09.3(1)C Removal of Unstable Base Material

When the material at the bottom of an excavation is not stable enough to support the structure, the Contractor shall excavate below grade and replace the unstable material with gravel backfill.

Gravel backfill shall meet the requirements of Section 9-03.12. It shall be placed in layers not more than 6 inches thick with each layer compacted to 95 percent of the maximum density determined by the Compaction Control Test, Section 2-03.3(14)D.

2-09.3(1)D Disposal of Excavated Material

The Engineer may direct the Contractor to dispose of excavated material in embankments, backfills, or remove it from the site.

All costs for disposing of excavated material within the project limits shall be included in the unit contract price for structure excavation, Class A or B. If, however, the Contractor must load and haul the material to a disposal site, the Contracting Agency will pay as provided in Section 1-04.4 for loading and hauling. The Contracting Agency will not pay for handling at the disposal site. Any such disposal shall meet the requirements of Section 2-03.3(7)C.

If the contract includes structure excavation, Class A or B, including haul, the unit contract price shall include all costs for loading and hauling the material the full required distance.

2-09.3(1)E Backfilling

The backfilling of openings dug for structures shall be a necessary part of and incidental to the excavation. Unless the Engineer directs otherwise, backfill material shall be nonclay material containing no pieces more than 3 inches across, no frozen lumps, and no wood or other foreign material.

When specified in the contract or when approved by the Engineer, the Contractor shall supply controlled density fill as backfill material.

Alternative Sources. When material from structure excavation is unsuitable for use as backfill, the Engineer may: require the Contractor to use other material covered by the contract if such substitution involves work that does not differ materially from what would otherwise have been required; require the Contractor to substitute selected material in accordance with Section 2-03.3(10); require the Contractor to use controlled density fill; or require the Contractor to obtain material elsewhere. Material obtained elsewhere will be paid for in accordance with Section 1-04.4.

Controlled Density Fill (CDF) or Controlled Low Strength Material (CLSM) is a ready mixed flowable fill and shall be a blend of cement, sand, water, any necessary admixtures and fly ash or ground granulated blast furnace slag. CDF shall be designed as a low strength, flowable material requiring no subsequent vibration or tamping to achieve 100% consolidation.

CDF shall be designed to have a minimum 28-day strength of 100 psi and a maximum 28-day strength not to exceed 275 psi.

Test for 28-day compressive strength shall be done in accordance with ASTM D-4832. Test for unit weight, yield, cement content, and air content shall be done in accordance with ASTM D 6023. Test for slump shall be in accordance with WSDOT FOP for AASHTO T 119. The water/cement ratio shall be calculated on the total weight of cementitious material. The following are considered cementitious materials: Portland cement, fly ash, ground granulated blast furnace slag and microsilica. The use of air entrainment, air generators, or foaming agents may be needed to meet the performance specifications.

As an alternate to the above contractor proposed CDF mix designs the following CDF mix design may be used.

Controlled Density Fill (CDF)		
Ingredients	**Amount per cubic yard**	**Specific Gravity**
Portland Cement	50 lb.	3.15
Fine Aggregate Class 1 or 2	3,300 lb. (3,500 lb. if Fly Ash Class C is used)	2.67
Air Entrainment Admixture	Per manufacturer's recommendations	
Fly Ash Class F or	300 lb.	2.2
Fly Ash Class C	150 lb.	2.2
Water	300 lb. (maximum)	1.0

The contractor shall provide a mix design in writing to the Engineer. No CDF shall be placed until the Engineer has reviewed the mix design. The CDF consistency shall be flowable (approximate slump 3 to 10-inches). CDF shall meet the requirements of Section 6-02.3(5)C and shall be accepted based on a Certificate of Compliance. The producer shall provide a Certificate of Compliance for each truckload of controlled density fill. The Certificate of Compliance shall verify that the delivered material is in compliance with the mix design and shall include:

Agency Contract No.
Date
Truck No.
Batched Weights of Each Ingredient

The certification shall be signed by a responsible representative of the producer, other than the driver, affirming the accuracy of the information provided.

Stockpiling. The Engineer may require the Contractor to selectively remove and stockpile any usable material excavated for a structure. If this material meets the requirements for gravel backfill for walls it may replace gravel as wall or abutment backfill.

If the Contractor stockpiles excavated material for use as backfill, it shall be protected with plastic sheeting or by some other method from contamination and weather damage. If the material becomes too wet or contaminated in the stockpile, the Contractor shall dispose of and replace it with an equal amount of suitable material, all at no expense to the Contracting Agency. All costs for storing, protecting, rehandling, and placing stockpiled material shall be included in the unit contract price for structure excavation, Class A or B.

Compaction. Backfill from structure excavation shall be placed and compacted in keeping with the following requirements:

1. Backfill supporting roadbed, roadway embankments, or structures — placed in horizontal layers no more than 6 inches thick with each layer compacted to 95 percent of the maximum density determined by the Compaction Control Test, Section 2-03.3(14)D.
2. Gravel backfill for drains — placed in horizontal layers no more than 12 inches thick, with each layer compacted by at least three passes of a vibratory compactor approved by the Engineer.
3. All other structure excavation backfill — placed in layers no more than 2 feet thick (loose), with each layer tamped and graded so that final settling will leave the backfill flush with surrounding ground.

4. Compaction of controlled density fill will not be required.

Timing. Backfill shall not be placed against any concrete structure until the concrete has attained 90 percent of its design strength and a minimum age of 14 days, except that reinforced concrete retaining walls 15-feet in height or less may be backfilled after the wall has attained 90 percent of its design compressive strength and curing requirements of Section 6-02.3(11) are met. Footings and columns may be backfilled as soon as forms have been removed, so long as the backfill is brought up evenly on all sides.

The Engineer may order the Contractor to use lean concrete in backfilling around piers and in front of abutments and walls. The Contracting Agency will pay for such backfilling as provided in Section 1-04.4.

If water prevents the Contractor from properly placing and compacting backfill, it shall be removed by pumping or other means.

All costs not defined in this section that relate to providing, placing, and compacting backfill shall be at the Contractor's expense.

2-09.3(1)F Items to Remain

If the Contractor damages or removes pavement or anything else meant to remain outside the excavation area, it shall be repaired or replaced at no expense to the Contracting Agency.

2-09.3(2) Classification of Structure Excavation

1. **Class A.** Structure excavation required for bridge and retaining wall footings, pile caps, seals, and wingwalls shall be classified as structure excavation Class A. If the excavation requires a cofferdam, structural shoring, or extra excavation, the work outside the neat lines of the structure excavation Class A shall be classified as shoring or extra excavation Class A.
2. **Class B.** All other structure excavation shall be Class B. If this excavation requires cofferdams, shoring, or extra excavation, the work outside the neat lines of the structure excavation Class B shall be classified as shoring or extra excavation Class B.

2-09.3(3) Construction Requirements, Structure Excavation, Class A

2-09.3(3)A Preservation of Channel

When foundations or substructures are to be built in or next to running streams, the Contractor shall:

1. Excavate inside cofferdams, caissons, or sheet piling unless dredging or open pit excavation is permitted.
2. Backfill foundations placed inside cofferdams and behind sheet piling prior to removing cofferdams or sheet piling. This backfill shall be level with the original streambed and shall prevent scouring.
3. Remove any excavation material that may have been deposited in or near the stream so that the watercourse is free from obstruction.
4. Maintain water depth and horizontal clearances required for traffic to pass on navigable streams, furnishing any channel signals or lights required during construction.
5. Place riprap around the outside of cofferdams, as specified, to repair local scour.

2-09.3(3)B Excavation Using Open Pits — Extra Excavation

The Contractor may dig open pits or perform extra excavation without shoring or cofferdams, if:

1. Footings can be placed in dry material away from running water.
2. The integrity of the completed structure and its surroundings is not reduced.
3. Worker safety is ensured as required by law.
4. The excavation does not disturb the existing pavement or any other adjacent facilities.

If a slide occurs in an open pit, the Contractor shall remove the slide material. If the slide disturbs an area over which a highway will be built, the Contractor shall backfill and compact the site to the original ground line as the Engineer directs. The Contractor shall pay all costs related to removing slide material and restoring a slide area.

The Contractor shall drain or pump any water from the pit, taking care not to stir up or soften the bottom. If equipment in the pit or inadequate water removal makes the foundation material unstable, the Contractor shall, at no expense to the Contracting Agency, remove and replace it with material the Engineer approves.

When the Engineer believes ground water flow may impair a concrete footing, the Contractor shall place under it a layer of gravel at least 6 inches thick. Before placing the gravel, the Contractor shall excavate to whatever grade the Engineer requires. This provision shall not apply to the building of concrete seals.

The Contractor may omit forms when the earthen sides of a footing excavation will stand vertically. In this case, the Contractor may excavate to the neat line dimensions of the footing and pour concrete against the undisturbed earth. If the hole is larger than neat line dimensions, the Contractor shall bear the cost of the extra concrete.

2-09.3(3)C Preparation for Placing Foundations

When a foundation will rest on rock, excavation shall penetrate it at least 1 foot, or more if the plans require, to form a key for the footing. The Contractor shall cut the bottom of the excavation to a firm surface, level, stepped, or serrated as the Engineer directs, and remove all loose material.

For an arch abutment, the back face shall be trimmed to true lines so that concrete can be poured against undisturbed material.

If concrete will rest on any excavated surface other than solid rock, the Contractor shall not disturb the bottom of the excavation. The Contractor shall also remove all loose or soft material just before pouring the concrete.

Upon completing any foundation excavation, the Contractor shall notify the Engineer. No concrete or other permanent part of the structure may be placed until the Engineer has given permission to proceed.

2-09.3(3)D Shoring and Cofferdams

Definitions. Structural shoring is defined as a shoring system that is installed prior to excavation. Structural shoring shall provide lateral support of soils and limit lateral movement of soils supporting structures, utilities, railroads, etc., such that these items are not damaged as a result of the lateral movement of the supporting soils.

Structural shoring systems includes driven cantilever sheet piles, sheet piles with tiebacks, sheet pile cofferdams with wale rings or struts, prestressed spud piles, cantilever soldier piles with lagging, soldier piles with lagging and tiebacks, and multiple tier tieback systems.

Trench boxes, sliding trench shields, jacked shores, and shoring systems that are installed after excavation are not allowed as structural shoring.

A cofferdam is any watertight enclosure, sealed at the bottom and designed for the dewatering operation, that surrounds the excavated area of a structure. The Contractor shall use steel sheet pile or interlocking steel pile cofferdams in all excavation that is under water or affected by ground water.

Submittals and Design Requirements. The Contractor shall submit working drawings and calculations showing the proposed methods and construction details of structural shoring or cofferdams in accordance with Sections 6-01.9 and 6-02.3(16). The Contractor shall not begin construction of structural shoring or cofferdams, nor begin excavation operations, until approval of the structural shoring submittal has been given by the Project Engineer.

Structural shoring and cofferdams shall be designed for conditions stated in this Section using methods shown in the USS *Steel Sheet Piling Design Manuals*, published by United States Steel, and Division I Section 5 of the *AASHTO Standard Specifications for Highway Bridges Sixteenth Edition - 1996* and current interims, and as described in the *Foundations and Earth Structures - Design Manual 7.2 May 1982* published by the Department of the Navy. Allowable stresses for materials shall not exceed stresses and conditions allowed by Section 6-02.3(17)B.

The structural shoring system shall be designed for site specified conditions which shall be shown and described in the working drawings. Examples of such items that shall be shown on the structural shoring submittal and supported by calculations include, but are not limited to, the following:

1. Soil properties; heights; soil slopes; soil benches; water tables; and controlling cross sections showing adjacent existing foundations and utilities.
2. Location and weight of construction equipment adjacent to the excavation; location of adjacent traffic; and structural shoring system material properties, spacing, size, connection details, weld sizes, and embedment depths.
3. Structural shoring installation and construction sequence, procedure, length of time for procedure and time between operations; proof load testing procedure if any; deadman anchor design and geometry; no load zones; grouting material and strengths; and a list of all assumptions.
4. Methods and materials to be used to fill voids behind lagging, when soldier piles with lagging are used as structural shoring.

Construction Requirements. Structural shoring or cofferdams shall be provided for all excavations near completed structures (foundations of bridges, walls, or buildings), near utilities, and near railroads.

All other excavations 4-feet or more in depth shall either be shored with structural shoring or cofferdams, or shall meet the open-pit requirements of Section 2-09.3(3)B.

Existing foundations shall be supported with structural shoring if the excavation is within the limits defined by a plane which extends out from the nearest edge of the existing footing a level distance of $^1/_2$ the width of the existing footing and then down a slope of $1^1/_2$ horizontal to 1 vertical.

When structural shoring or cofferdams are utilized, all excavation and structural shoring shall be constructed in accordance with the approved structural shoring submittal, including any required construction sequence noted in the working drawings. The Contractor shall remain responsible for satisfactory results.

If soldier piles are placed in drilled holes, then the hole shall be filled to the top of the soldier pile either with controlled density fill, if water is not present in the hole, or lean concrete. Backfilling soldier pile drilled holes with pea gravel or sand is not allowed.

If lagging is used, void space behind the lagging shall be minimized. If the Engineer determines that the voids present could result in damage or serviceability problems for the structural shoring system or any structures or facilities adjacent to the structural shoring system, the Contractor shall cease excavation and lagging installation, and shall fill the voids specified by the Engineer in accordance with the approved structural shoring submittal. Further excavation and lagging placement shall not continue until the specified voids are filled to the satisfaction of the Engineer.

Excavation shall not proceed ahead of lagging installation by more than 4-feet or by the height that the soil will safely stand, whichever is least. For tieback shoring systems, excavation shall not proceed ahead by more than 4-feet of the tie installation and proof testing.

In using cofferdams or structural shoring, the Contractor shall:

1. Extend cofferdams well below the bottom of the excavation, and embed structural shoring as shown in the structural shoring submittal as approved by the Engineer.
2. Provide enough clearance for constructing forms, inspecting concrete exteriors, and pumping water that collects outside the forms. If cofferdams tilt or move laterally during placement, the Contractor, at no expense to the Contracting Agency, shall straighten or enlarge them to provide the required clearance.
3. Secure the cofferdam in place to prevent tipping or movement.
4. Place structural shoring or cofferdams so that they will not interfere with any pile driving required.
5. Not place any shoring, braces, or kickers inside the cofferdams and structural shoring that will induce stress, shock, or vibration to the permanent structure.
6. Vent cofferdams at the elevation commensurate with seal weight design, or as shown in the Plans.
7. Remove all bracing extending into the concrete being placed.

When the work is completed, the Contractor shall:

1. Remove all structural shoring to at least 2-feet below the finished ground line.
2. Remove all cofferdams to the natural bed of the waterway.

2-09.3(3)E Bearing Tests

The Engineer may stop the excavation to make bearing tests at any time. The Contractor shall assist with these tests in any way the Engineer requires.

During any test period, the Contractor shall, at no expense to the Contracting Agency, maintain ordinary working conditions at the bottom of the hole. The Contracting Agency will pay force account for all labor and materials the Contractor supplies for such tests. A single test shall not exceed 72 hours.

2-09.3(4) Construction Requirements, Structure Excavation, Class B

The above requirements for structure excavation Class A, shall apply also to structure excavation Class B, except as revised below. In addition, the Contractor shall follow Division 7 of these Specifications as it applies to the specific kinds of work.

The hole for any catch basin or manhole shall provide at least 1 foot of clearance between outside structural surfaces and the undisturbed earth bank.

If workers enter any trench or other excavation 4 feet or more in depth that does not meet the open pit requirements of Section 2-09.3(3)B, it shall be shored or other safety method constructed in conformance with WISHA requirements. The Contractor alone shall be responsible for worker safety and the Contracting Agency assumes no responsibility.

The Contractor must submit six sets of plans before shoring. These must meet the plan requirements set forth in Section 2-09.3(3)D.

Trench boxes may be used for structure excavation, Class B. Approval of trench boxes can be done by the Project Engineer provided it is not used to support adjacent traffic, existing footings, or other structures. The Contractor shall submit three sets of the manufacturer's certified trench box plans containing Professional Engineer's stamp and seal, depth restrictions, and serial number for field verification of trench box.

Upon completing the work, the Contractor shall remove all shoring unless the Plans or the Engineer direct otherwise.

2-09.4 Measurement

Excavated materials will be measured in their original position by the cubic yard. The Contracting Agency will measure and pay for only the material excavated from inside the limits this section defines. If the Contractor excavates outside these limits or performs extra excavation as described in Section 2-09.3(3)B, it shall be considered for the Contractor's benefit and shall be included in the cost of other bid items.

Horizontal Limits. The Contracting Agency will use the sides of the trench or pit as horizontal limits in measuring excavation. No payment for structure excavation will be made for material removed (1) more than 1 foot outside the perimeter of any pile cap, footing, or seal, (2) more than 3 feet beyond the roadway side of a wing wall, and (3) more than 1 foot beyond the other sides and end of a wing wall.

For all pipes, pipe arches, structural plate pipes, and underpasses, the structure excavation quantity will be calculated based on the following trench widths:

For drain and underdrain pipes, trench width = I.D. + 12 inches.

For pipes 15-inches and under, trench width = I.D. + 30 inches.

For pipes 18 inches and over, trench width = (1.5 x I.D.) + 18 inches.

For a manhole, catch basin, grate inlet, or drop inlet, the limits will be 1 foot outside the perimeter of the structure.

For drywells, the limits shall be in accordance with the Standard Plans.

Lower Limits. For a pile cap, footing, or seal, the bottom elevation shown in the Plans, or set by the Engineer, will serve as the lower limit in measuring structure excavation. For a wing wall, the lower limit will follow a line parallel to the bottom and 1 foot below it. Any swell from pile driving will be excluded from excavation quantities.

For pipelines the bottom outside of the pipe will serve as the lower limit for measuring excavation. The Engineer may set another limit when excavation must be made below grade.

Upper Limits. The top surface of the ground or streambed as the work begins will be the upper limit for measuring excavation. If the Contract, or a separate contract, includes a pay item for grading to remove materials, the upper limit will be the neat lines of the grading section shown in the Plans.

The Engineer may order the Contractor to partially build the embankment before placing pipe. In this case, the upper limit for measurement will be not more than 4-feet above the invert of the pipe. For a structural plate pipe, pipe arch, or underpass, the upper limit will be the top of the embankment at the time of installation as specified in Section 7-03.3(1)A.

Gravel Backfill. Gravel backfill, except when used as bedding for culvert, storm sewer, sanitary sewer, manholes, and catch basins, will be measured by the cubic yard in place determined by the neat lines required by the Plans.

Shoring or Extra Excavation. No specific unit of measurement shall apply to the lump sum item of shoring or extra excavation Class A. Shoring or extra excavation Class B will be measured by the square foot as follows:

> The area for payment will be one vertical plane measured along the centerline of the trench, including structures. Measurement will be made from the existing ground line to the bottom of the excavation and for the length of the work actually performed. If the contract includes a pay item for grading to remove materials, the upper limit for measurement will be the neat lines of the grading section shown in the Plans. The bottom elevation for measurement will be the bottom of the excavation as shown in the Plans or as otherwise established by the Engineer.

Controlled density fill will be measured by the cubic yard for the quantity of material placed per the producer's invoice.

2-09.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid items when they are included in the proposal:

"Structure Excavation Class A", per cubic yard.

"Structure Excavation Class B", per cubic yard.

"Structure Excavation Class A Incl. Haul", per cubic yard.

"Structure Excavation Class B Incl. Haul", per cubic yard.

Payment for reconstruction of surfacing and paving within the limits of structure excavation will be at the applicable unit prices for the items involved.

If the Engineer orders the Contractor to excavate below the elevations shown in the plans, the unit contract price per cubic yard for "Structure Excavation Class A or B" will apply. But if the Contractor excavates deeper than the plans or the Engineer requires, the Contracting Agency will not pay for material removed from below the required elevations. In this case, the Contractor, at no expense to the Contracting Agency, shall replace such material with concrete or other material the Engineer approves.

"Shoring or Extra Excavation Cl. A _____", lump sum.

When extra excavation is used in lieu of constructing the shoring, cofferdam or caisson, the lump sum contract price shall be full pay for all excavation, backfill, compaction, and other work required. If select backfill material is required for backfilling within the limits of structure excavation, it shall also be required as backfill material for the extra excavation at the Contractor's expense.

If it is necessary to place riprap outside of cofferdams to repair local scour, it shall be paid by agreed price or force account.

If the Engineer requires shoring, cofferdams, or caissons when the contract provides no bid item for such work, the Contracting Agency will pay as provided in Section 1-04.4.

If the Engineer requires the Contractor to build shoring or extra excavation Class A that extends below the elevation shown in the Plans, the Contracting Agency will pay the lump sum price and no more when the extra depth does not exceed 3-feet. For depths greater than 3 feet below the elevations shown, payment will be as provided in Section 1-04.4.

"Shoring or Extra Excavation Class B", per square foot.

The unit contract price per square foot shall be full pay for all excavation, backfill, compaction, and other work required when extra excavation is used in lieu of constructing shoring. If select backfill material is required for backfilling within the limits of the structure excavation, it shall also be required as backfill material for the extra excavation at the Contractor's expense.

If there is no bid item for shoring or extra excavation Class B on a square foot basis and the nature of the excavation is such that shoring or extra excavation is required as determined by the Engineer, payment to the Contractor for the work will be made in accordance with Section 1-04.4.

"Gravel Backfill (_____)", per cubic yard.

"Controlled Density Fill", per cubic yard.

2-10 DITCH EXCAVATION

2-10.1 Description

This work consists of excavating open ditches to the required lines, grades, and cross-sections. The work also includes disposing of all excavated material regardless of its nature or type.

Ditch Excavation: Includes all excavation in open ditches less than 8 feet wide at the bottom, but excludes ditches that are part of the roadway. Ditches 8 or more feet wide at the bottom shall be constructed in accordance with the requirements of Section 2-03.3(14)M.

2-10.2 Vacant

2-10.3 Construction Requirements

Before excavating any open ditch, the Contractor shall clear and grub the area as required by Section 2-01.

The Contractor may build dikes or berms with excavated material, or may dispose of it as the Plans or the Engineer requires.

2-10.4 Measurement

Ditch excavation will be measured by the cubic yard in its original site, and the quantities calculated by the neat lines of the staked cross-sections.

2-10.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when included in the proposal:

"Ditch Excavation", per cubic yard.

For hauling, the Contracting Agency will pay the unit contract price for hauling excavated material (Section 2-04). If the pay item for excavation includes haul, the unit contract price per cubic yard shall cover all costs for hauling the material any distance required.

2-11 TRIMMING AND CLEANUP

2-11.1 Description

This work consists of dressing and trimming the entire roadway(s) improved under the contract, including frontage roads, connecting ramps, auxiliary lanes, and approach roads. This work extends to roadbeds, shoulders, and ditches.

2-11.2 Vacant

2-11.3 Construction Requirements

The Contractor shall:

1. Trim shoulders and ditches to produce smooth surfaces and uniform cross-sections that conform to the grades set by the Engineer.
2. Open and clean all channels, ditches, and gutters to ensure proper drainage.
3. Dress the back slope of any ditch or borrow pit that will remain adjacent to the roadway. Round off the top of the back slope and distribute the material evenly along its base.
4. Remove and dispose of all weeds, brush, refuse, and debris that lie on the roadbed, shoulders, ditches, and slopes.
5. Remove from paved shoulders all loose rocks and gravel.
6. Distribute evenly along the embankment any material not needed to bring the shoulders to the required cross-section.

The Contractor shall not:

1. Use heavy equipment (tractors, graders, etc.) to trim the shoulders of an existing or new bituminous surface.
2. Drag, push, or scrape shoulder material across completed surfacing or pavement.

When the contract requires the Contractor to rebuild part of a roadway only the rebuilt areas shall be trimmed and cleaned up. If the Contractor's work obstructs ditches or side roads, they shall be cleared and the debris disposed of as the Engineer directs.

2-11.4 Measurement

No specific unit of measurement shall apply to the lump sum item of trimming and cleanup.

2-11.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when it is included in the proposal:

"Trimming and Cleanup", lump sum.

2-10 DITCH EXCAVATION

2-10.1 Description

This work consists of excavating open ditches to the required lines, grades, and cross-sections. The work also includes disposing of all excavated material regardless of its nature or type.

Ditch Excavation: Includes all excavation in open ditches less than 8 feet wide at the bottom, but excludes ditches that are part of the roadway. Ditches 8 or more feet wide at the bottom shall be constructed in accordance with the requirements of Section 2-03.3(14)M.

2-10.2 Vacant

2-10.3 Construction Requirements

Before excavating any open ditch, the Contractor shall clear and grub the area as required by Section 2-01.

The Contractor may build dikes or berms with excavated material, or may dispose of it as the Plans or the Engineer requires.

2-10.4 Measurement

Ditch excavation will be measured by the cubic yard in its original site, and the quantities calculated by the neat lines of the staked cross-sections.

2-10.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when included in the proposal:

"Ditch Excavation", per cubic yard.

For hauling, the Contracting Agency will pay the unit contract price for hauling excavated material (Section 2-04). If the pay item for excavation includes haul, the unit contract price per cubic yard shall cover all costs for hauling the material any distance required.

lock-type stitch. The minimum seam allowance, i.e., the minimum distance from the geotextile edge to the stitch line nearest to that edge, shall be $1^1/_2$-inches if a flat or prayer seam, Type SSa-2, is used. The minimum seam allowance for all other seam types shall be 1.0 inch. The seam, stitch type, and the equipment used to perform the stitching shall be as recommended by the manufacturer of the geotextile and as approved by the Engineer.

The seams shall be sewn in such a manner that the seam can be inspected readily by the Engineer or a representative. The seam strength will be tested and shall meet the requirements stated herein.

2-12.3(1) Underground Drainage

Trench walls shall be smooth and stable. The geotextile shall be placed in a manner which will ensure intimate contact between the soil and the geotextile (i.e., no voids, folds, or wrinkles).

The geotextile shall either be overlapped a minimum of 12 inches at all longitudinal and transverse joints, or the geotextile joints shall be sewn for medium survivability drainage applications. In those cases where the trench width is less than 12 inches, the minimum overlap shall be the trench width.

In moderate survivability geotextile underdrain applications, the minimum overlap shall be 12 inches, or the geotextile joints shall be sewn, except where the geotextile is used in area drains. An area drain is defined as a geotextile layer placed over or under a horizontal to moderately sloping layer of drainage aggregate. For area drains, the geotextile shall be overlapped a minimum of 2 feet at all longitudinal and transverse joints, or the geotextile joints shall be sewn together. The minimum initial lift thickness over the geotextile in the area drain shall be 12 inches.

In all cases, the upstream geotextile sheet shall overlap the next downstream sheet.

2-12.3(2) Separation

The geotextile shall either be overlapped a minimum of 2 feet at all longitudinal and transverse joints, or the geotextile joints shall be sewn together. The initial lift thickness shall be 6 inches or more.

2-12.3(3) Soil Stabilization

The geotextile shall either be overlapped a minimum, of 2 feet at all longitudinal and transverse joints, or the geotextile shall be sewn together. The initial lift thickness shall be 12 inches or more. Compaction of the first lift above the geotextile shall be by Method A (Section 2-03.3(14)C). No vibratory compaction will be allowed on the first lift.

2-12.3(4) Permanent Erosion Control and Ditch Lining

Unless otherwise specified in the Plans, the geotextile shall either be overlapped a minimum of 2 feet at all longitudinal and transverse joints, or the geotextile joints shall be sewn together. If overlapped, the geotextile shall be placed so that the upstream strip of geotextile will overlap the next downstream strip. When placed on slopes, each strip shall overlap the next downhill strip.

Placement of aggregate and riprap or other cover material on the geotextile shall start at the toe of the slope and proceed upwards. The geotextile shall be keyed at the top and the toe of the slope as shown in the Plans. The geotextile shall be secured to the slope, but shall be secured loosely enough so that the geotextile will not tear when the riprap or other cover material is placed on the geotextile. The geotextile shall not be keyed at the top of the slope until the riprap or other cover material is in place to the top of the slope.

All voids in the riprap or other cover material that allow the geotextile to be visible shall be backfilled with quarry spalls or other small stones, as designated by the Engineer, so that the geotextile is completely covered. When an aggregate cushion between the geotextile and the riprap or other cover material is required, it shall have a minimum thickness of 12 inches.

An aggregate cushion will be required to facilitate drainage when hand placed riprap, sack riprap, or concrete slab riprap, as specified in Sections 9-13.2, 9-13.3, or 9-13.4, respectively, is used with the geotextile.

Grading of slopes after placement of the riprap or other cover material will not be allowed if grading results in stone movement directly on the geotextile. Under no circumstances shall stones with a weight of more than 100 pounds be allowed to roll downslope. Stones shall not be dropped from a height greater than 3 feet above the geotextile surface if an aggregate cushion is present, or 1 foot if a cushion is not present. Lower drop heights may be required if geotextile damage from the stones is evident, as determined by the Engineer. If the geotextile is placed on slopes steeper than 2:1, the stones shall be placed on the slope without free-fall for moderate survivability, high survivability, and ditch lining geotextiles.

2-12.4 Measurement

Construction geotextile, with the exception of temporary silt fence geotextile and underground drainage geotextile used in trench drains, will be measured by the square yard for the ground surface area actually covered.

Underground drainage geotextile used in trench drains will be measured by the square yard for the perimeter of drain actually covered.

2-12.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Construction Geotextile for Underground Drainage," per square yard.

"Construction Geotextile for Separation," per square yard.

"Construction Geotextile for Soil Stabilization," per square yard.

"Construction Geotextile for Permanent Erosion Control," per square yard.

"Construction Geotextile for Ditch Lining," per square yard.

Sediment removal behind silt fences will be paid by force account under temporary water pollution/erosion control. If a new silt fence is installed in lieu of sediment removal, the silt fence will be paid for at the unit contract price per linear foot for "Construction Geotextile for Temporary Silt Fence."

DIVISION 3
PRODUCTION FROM QUARRY AND PIT SITES AND STOCKPILING

3-01 PRODUCTION FROM QUARRY AND PIT SITES

3-01.1 Description

This work shall consist of manufacturing and producing crushed and screened aggregates including pit run aggregates of the kind, quality, and grading specified for use in the construction of Portland cement concrete, hot mix asphalt, asphalt treated base, crushed surfacing, maintenance rock, ballast, gravel base, gravel backfill, gravel borrow, riprap, and bituminous surface treatments of all descriptions.

The requirements specified shall apply whether the source is ledge rock, talus, gravel, sand, or any combination thereof.

3-01.2 Material Sources, General Requirements

3-01.2(1) Approval of Source

Material sources must be approved in advance of use in the work in accordance with the requirements of Section 1-06. This approval of source may require sampling and testing. If sampling is required, the samples must be taken at locations designated and witnessed by the Engineer or a designated representative. The Contractor is responsible for providing representative preliminary samples of aggregate sources to the Engineer.

3-01.2(2) Preparation of Site

The portion of the quarry or pit site to be used shall be cleared and grubbed, and the area from which materials are to be taken shall be stripped of overburden as provided in Section 3-01.2(3). All combustible debris resulting from these operations shall be disposed of by the Contractor in a manner satisfactory to the Engineer.

3-01.2(3) Stripping Quarries and Pits

Stripping of quarries and pits shall consist of the removal, after clearing and grubbing, of the surface material and overburden which is unsuitable for the kind of material to be borrowed or produced for use. Materials from stripping, to be used later as provided on the site reclamation plan specified in Section 3-03, shall be deposited within the quarry or pit site at such a location as not to interfere with future development within the site.

3-01.2(4) Production Requirements

All oversize stones, rock fragments, or boulders occurring in the source, up to and including those measuring 18 inches in the greatest dimension, shall be utilized in the manufacture of crushed material.

If the grading or quality of raw material in sources used for the manufacture of products covered by this section is such that the fracture, grading, or quality of the product specified cannot be obtained by utilizing the natural material, fine portions of the raw material shall be rejected to the extent necessary to produce products meeting all requirements of these Specifications. Failure of the Contracting Agency to include a scalping requirement in the special provisions shall not relieve the Contractor of the responsibility for rejecting fine portions of the material if such becomes necessary to produce products meeting all requirements of these Specifications. Scalping shall be performed after the pit-run or quarry-run material has passed through the primary crusher.

When scalping over a screen of a specified size is required in the special provisions, the scalping screen shall be of such size and capacity that enough of the fine material will be removed to produce specification material.

Washing and reclaiming of the reject material and subsequent addition of this material to any finished products will not be allowed unless specifically authorized in writing by the Engineer.

Surplus screenings accumulated during the crushing and screening of specified roadway materials will be considered separate and distinct from reject material resulting from scalping operations.

Both fine and coarse concrete aggregates shall be thoroughly washed in order to remove clay, loam, alkali, bark, sticks, organic castings, or other deleterious matter. Washing will be required in the production of other materials if necessary to produce products meeting all the quality requirements of these Specifications.

When producing screened gravel or sand materials, the Contractor shall remove all oversize material by screening at the pit site. The Contractor's operations in the pit shall be conducted so that the grading of individual loads will be reasonably uniform. In general, the Contractor shall utilize the most suitable materials available and shall make as many moves of the loading equipment as may be necessary to fulfill these requirements.

Where pit-run materials meet specifications, screening or processing will not be required.

3-01.2(5) Final Cleanup

Upon completion of the Contractor's operation, the quarry or pit shall be cleared of all rubbish, temporary structures, and equipment, and shall be left in a neat and presentable condition. The pit or quarry shall be reclaimed in accordance with the approved site reclamation plan specified in Section 3-03.

3-01.3 State Furnished Material Sources

Unless specified in the Special Provisions, no Contracting Agency material sources are provided and the contractor shall bear full responsibility for furnishing all materials.

3-01.3(1) Quality and Extent of Material

Contracting Agency furnished material sources will be shown in the Plans and described in the Special Provisions. The quality of material in such sources will be acceptable in general, but the Contractor shall determine the amount of equipment and work required to produce the material meeting these Specifications. It shall be understood that it is not feasible to ascertain from samples, the limits for an entire source, and that variations shall be considered as usual and are to be expected. The Engineer may order procurement of material from any portion of a source and may reject portions of the source as unacceptable.

Since many material sources are acquired in fee by the Contracting Agency for use on future projects as well as for this contract, it is in the public interest to preserve the future usefulness and adequacy of a source insofar as may be practical. To achieve this end, the Contractor shall not perform any work within the source until receiving the Engineer's approval of the Contractor's work plan within the limits of the source.

3-01.3(2) When More Than One Site Is Provided

When more than one quarry or pit site is provided in the Special Provisions, the Contractor may obtain material from any of the sources. The Contracting Agency will specify the quantity of raw material available, as determined by tests, in each quarry or pit site. If the Contractor sets up in a site, and it is found that the quantity of raw material from that site, when the site is exhausted, is less than that specified by the Contracting Agency, then the provisions of Section 3-01.3(5) will apply.

3-01.3(3) Reject Materials

All scalpings that are unsatisfactory for use under these Specifications or Special Provisions shall be considered as reject material, subject to disposal as approved by the Engineer. Reject material shall be placed at such a location as not to interfere with future development within the site.

3-01.3(4) Surplus Screenings

The surplus screenings accumulated during the production of the specified materials shall be stockpiled at a location within the site provided and become the property of the Contracting Agency. The stockpile site shall be prepared and constructed by the Contractor in accordance with the provisions of Section 3-02. All costs incurred in producing, hauling, and stockpiling the surplus screenings shall be incidental to the production of the specified materials and shall be included by the Contractor in the unit bid prices in the contract.

3-01.3(5) Moving Plant

If, in the opinion of the Engineer, there should be insufficient suitable material in any quarry or pit site made available by the Contracting Agency, the Contracting Agency will acquire at its expense an additional source, in which event the Contractor will be required to move the crushing plant to the new quarry or site. Under such conditions, payment for the Contractor's costs for the move will be made on a force account basis. Payment will be limited to the labor, equipment, and materials required for the move, and no allowance will be made for payment of standby costs for the crushing plant nor other equipment which may be temporarily idle as a result of the move.

The clearing, grubbing, and preparing of the new quarries or pit sites as specified in Section 3-01.2(2) will be paid for in the manner provided in these specifications for "Clearing", "Grubbing", and "Stripping Including Haul". If there is no bid item applicable, the payment for the preparation of the new site will be as provided in Section 1-04.4.

If the moving of the plant due to shortage of the supply of material necessitates a longer haul on materials than required from the original source, the Contracting Agency will reimburse the Contractor for the additional haul at the rate of $0.25 per ton mile haul. The unit ton mile shall be the equivalent of one ton of material hauled a distance of 1 mile. The haul distance will be measured in one-half mile units, fractional half-miles being allowed as full half-miles. If the requirement for moving of the crushing plant results in a delay of performance of work which is critical to completion of the project, as shown by the Contractor's approved progress schedule, the Engineer will authorize a suspension of work for the time required for the move.

The above allowances, insofar as they may be applicable, shall be full pay for all claims of any kind or description by reason of the necessity of changing from one site to another due to shortage of the supply from sources made available by the Contracting Agency. Before moving a crushing plant as outlined above, the Contractor shall secure from the Engineer an order in writing to do so. Should the Contractor fail to secure such order, it shall be considered sufficient proof that the move was immaterial insofar as to cost, and no allowance or pay will be made by reason of such move.

3-01.4 Contractor Furnished Material Sources

3-01.4(1) Acquisition and Development

If, under the terms of the Contract, the Contractor is required to provide a source of materials, or if the Contractor elects to use materials from sources other than those provided by the Contracting Agency, the Contractor shall, at no expense to the Contracting Agency, make all necessary arrangements for obtaining the material and shall ensure the quantity of suitable material is available. The Contractor is responsible for providing representative preliminary samples to the Engineer. All preliminary sampling is to be witnessed by the Engineer or a designated representative. Approval of the source does not relieve the Contractor from meeting the Acceptance Requirements of the material, nor does it guarantee that the material will meet those requirements without additional or proper processing.

Approval of a Contractor's source offered in lieu of a Contracting Agency-provided source will be contingent upon the material therein being of equal quality, and no additional costs will accrue to the Contracting Agency as a result of such approval. Equivalency of quality will be based on those test values listed in the special provisions as being representative of material in the Contracting Agency-provided source. If no such values are listed, the minimum specification requirements will apply. When measurement by weight is specified and when the specific gravity of material produced from the Contractor's source is greater than that from the Contracting Agency-furnished source, any additional material required to construct the minimum specified surfacing depth shall be furnished by the Contractor at no expense to the Contracting Agency.

The Contractor shall notify the State Departments of Ecology, Fish and Wildlife, and Natural Resources, in writing, of the intent to furnish the source, and shall, at no expense to the Contracting Agency, make all necessary arrangements with these agencies for the determinations of regulations which might be imposed upon the Contractor during removal of materials from the source.

The source shall be selected so that, after the materials have been removed, the pit will drain to a natural drainage course and no ponding will result. Should the source selected by the Contractor be one which would not drain as outlined herein, permission shall be obtained by the Contractor from the governing body of the city or county for the removal of materials from the pit or quarry.

The Contractor will not be permitted to operate a pit or a quarry site visible from a state highway unless it can be demonstrated to the complete satisfaction of the Engineer that no unsightly condition will result from or remain as a result of the Contractor's operations. If, in the opinion of the Engineer, unsightly conditions exist after removal of materials from the site, the Contractor shall correct such unsightly conditions as hereinafter provided.

Following removal of materials from the pit, the entire site shall be cleared of all rubbish, temporary structures, and equipment which have resulted from the Contractor's occupancy and operations. The Contractor shall obliterate or screen to the satisfaction of the Engineer any unsightly conditions that remain. The Contractor shall secure a written release from the permitter upon fulfillment of these requirements. All costs for cleaning up the pit site and for the installation or erection of screening or for other work required to correct unsightly conditions shall be at the Contractor's expense. The requirements of this paragraph shall not apply to pits being operated commercially.

All costs in connection with acquiring the rights to take materials from the source, for exploring and developing the site, for complying with the regulations of the aforesaid State agencies, for preparing the site as provided in Sections 3-01.2(2) and 3-03, for cleaning up the site, and for correcting unsightly conditions, shall be included in the unit contract prices for the various pay items of work involved.

3-01.4(2) Surplus Screenings

Surplus screenings accumulated during the manufacture of specified material shall remain the property of the Contractor.

3-01.4(3) Substitution of Gravel Deposit in Lieu of Ledge Rock or Talus Source Provided by the Contracting Agency

If the Contractor elects to substitute a gravel deposit of an approved source for the manufacture of ballast, crushed surfacing, or mineral aggregate in lieu of a ledge rock or talus source provided by the Contracting Agency in the contract, all pit run materials passing a $^1/_2$ inch square sieve, or larger if ordered by the Engineer, shall be removed prior to crushing.

3-01.4(4) Gravel Base

If the contract requires the Contractor to provide the source of Gravel Base, or if the Contractor elects to furnish said material from sources other than those provided by the Contracting Agency, the material shall be produced from approved sources in accordance with the requirements of Section 3-01. The grading and quality shall be as specified in Section 9-03.10.

When Gravel Base is specified, Gravel Borrow may be used in lieu of Gravel Base provided the stabilometer value of the Gravel Borrow is a minimum of 67 and 0.1 foot of crushed surfacing top course is substituted for the top 0.1 foot of the depth specified for Gravel Base.

Measurement and payment will be in accordance with Section 4-02.

3-01.5 Measurement

For payment purposes, all crushed, screened, or naturally occurring materials that are to be paid for by the ton, dependent upon their grading, will be limited to the following water contents naturally occurring in the material source:

% By Weight Passing U.S. No. 4	Maximum Water Content % By Weight
Less than 20%	4%
20% or more	8%

Water in excess of the maximum permissible amounts naturally occurring in the material source, as determined by the Engineer, will be deducted from the tonnage of material to be paid for on a daily basis.

If the Contractor uses the Central Plant Mix Method of mixing water and surfacing materials in accordance with Section 4-04, the added water will be measured in accordance with Section 4-04.4. All other water added to the materials by the Contractor will be deducted from the weight of the aggregates including the added water, on a daily basis.

Clearing and grubbing of quarries and pit sites will be measured in accordance with Section 2-01 when the proposal includes such bid items and such work is required on a source provided by the Contracting Agency, except as modified in Section 3-01.3(5).

Stripping of quarries and pit sites will be measured in cubic yards in its original position by cross-sectioning when the proposal includes such bid item and such stripping is required on a source provided by the Contracting Agency, except as modified in Section 3-01.3(5).

Measurement of the particular materials or aggregates to be produced will be as specified in the appropriate section of these Specifications.

3-01.6 Payment

All costs, except as specified, in connection with the production of materials meeting all quality requirements of these Specifications shall be included in the unit contract prices of the various bid items involved.

Clearing and grubbing of quarries and pit sites will be paid in accordance with Section 2-01 when the proposal includes such bid items and such work is required on a source provided by the Contracting Agency, except as modified in Section 3-01.3(5).

"Stripping Incl. Haul" will be paid for at the unit contract price per cubic yard when the proposal includes such bid item and such stripping is required on a source provided by the Contracting Agency, except as modified in Section 3-01.3(5).

3-02 STOCKPILING AGGREGATES

3-02.1 Description

This work shall consist of preparing the stockpile sites and placing the specified aggregates in the stockpiles at the sites and in the amounts as shown in the Plans or as approved by the Engineer.

This section also includes the requirements pertaining to the removal of aggregates from stockpiles and the requirements for dressing up the stockpiles and stockpile site at the completion of the work.

3-02.2 General Requirements

3-02.2(1) Stockpile Sites Provided by the Contracting Agency

The Contracting Agency may acquire and make available to the Contractor suitable areas as shown in the Plans for the construction of stockpiles. The stockpiled aggregates may be for use in the immediate work or may be for future use as more fully described below. In either event, if the aggregates are required by these Specifications to be stockpiled, all costs in connection with the preparation of the stockpile sites as required in Section 3-02.2(5) shall be included in the various bid items involved in the contract; except that clearing and grubbing of the site will be measured and paid for in accordance with Section 2-01 only when such bid items are included in the proposal. In the event there is no bid item included in the proposal for construction and maintenance of haul roads to the stockpile site, the Contractor shall construct and maintain the haul roads as necessary and the cost thereof shall be included in the various bid items in the contract.

3-02.2(2) Stockpile Site Provided by the Contractor

If the Plans do not provide a stockpile site for the use of the Contractor in stockpiling certain types and sizes of aggregates which are required by these Specifications to be stockpiled prior to use in the immediate work, all costs in connection with the acquisition of a site, the preparation of the site, construction of the stockpiles, and the removal of the aggregates from the stockpiles shall be included in the contract prices of the various bid items of work involved.

3-02.2(3) Stockpiling Aggregates for Future Use

The Contracting Agency may require the production and stockpiling of aggregates on sites provided by the Contracting Agency for use on future construction or maintenance projects to be performed under a subsequent contract or by Contracting Agency forces.

When the contract includes the bid item or items for specific aggregates in stockpile and these aggregates are not to be used in work required under the contract, the Contractor shall produce or furnish these aggregates complying with the quality and grading requirements of these Specifications and shall prepare the site and place the aggregates in stockpile in accordance with the requirements of this Section or as ordered by the Engineer in accordance with Section 1-04.4.

3-02.2(4) Stockpiling Aggregates for Immediate Use

If the Contractor elects to stockpile aggregates from a source owned or controlled by the Contracting Agency prior to use in the immediate work, the stockpiling shall be done within the area of the site provided by the Contracting Agency and in accordance with the requirements of these Specifications. If the Contractor elects to lease land to stockpile

the aggregates, the stockpiling shall be done in accordance with these Specifications and upon proof that the lease will extend for a period of not less than one year beyond the completion date of the contract. All excess aggregates remaining in stockpiles after satisfying the needs of the contract — whether upon the site provided by the Contracting Agency or upon land leased by the Contractor — shall be disposed of in accordance with Section 1-09.10. All costs resulting from the production of the excess aggregates shall be included in the cost of production of the aggregates actually incorporated in the work.

If the Contractor elects to stockpile aggregates from a source not provided by the Contracting Agency prior to use in the immediate work, it will be subject to the approval of the Engineer and provided that the aggregates comply with the quality and grading requirements of these Specifications. All costs in connection with the acquisition of the stockpile site, the preparation of the site, construction of the stockpiles, and the removal of the aggregates from the stockpiles shall be included in the contract prices of the various bid items of work involved.

3-02.2(5) Preparation of Site

Before placing aggregates upon the stockpile site, the site shall be cleared of vegetation, trees, stumps, brush, rocks, or other debris and the ground leveled to a smooth, firm, uniform surface. The debris resulting from clearing and preparing the site shall be disposed of in a manner satisfactory to the Engineer.

3-02.2(6) Construction of Stockpiles

Stockpiles shall be constructed upon the prepared sites in accordance with stakes set by the Engineer. The piles when completed shall be neat and regular in shape. The stockpile height shall be limited to a maximum of 24 feet.

Stockpiles in excess of 200 cubic yards shall be built up in layers not more than 4 feet in depth. Stockpile layers shall be constructed by trucks, clamshells, or other methods approved by the Engineer. Pushing aggregates into piles with a bulldozer will not be permitted. Each layer shall be completed over the entire area of the pile before depositing aggregates in the succeeding layer. The aggregate shall not be dumped so that any part of it runs down and over the lower layers in the stockpile. The method of dropping from a bucket or spout in one location to form a cone shaped pile will not be permitted. Any method of placing aggregates in stockpiles, which in the opinion of the Engineer, breaks, degrades, or otherwise damages the aggregate, will not be permitted. Plank runways will be required, when deemed necessary by the Engineer, for operating trucks on stockpiles to avoid tracking dirt or other foreign matter onto the stockpiled materials. Stockpiles of less than 200 cubic yards shall be piled in a manner to prevent segregation of the various sizes of material.

No equipment other than pneumatic tired equipment shall be used in constructing the stockpiles of processed or manufactured aggregates.

Stockpiles of different types or sizes of aggregate shall be spaced far enough apart, or separated by suitable walls or partitions, to prevent the mixing of the aggregates. Aggregate shall not be deposited where traffic, vehicles, or Contractor's equipment will either run over or through the piles, or in any way cause foreign matter to become mixed with the aggregates.

3-02.2(7) Removing Aggregates from Stockpiles

Aggregates shall be removed from stockpile in a manner to avoid separation of sizes or admixture of dirt or foreign material. The method and equipment used for loading will be approved by the Engineer.

No equipment other than pneumatic tired equipment shall be used on stockpiles of processed or manufactured aggregates in removing the materials from the stockpiles. When removing materials from the face of the stockpile, the equipment shall be operated in a manner to face-load from the floor to the top of the stockpile to obtain maximum uniformity of material.

The Contractor shall remove only the amount of materials from the stockpile required to satisfy the needs of the contract. If a surplus remains in the stockpile, the Contractor shall leave the surplus material in neat, compact piles, free of foreign matter. The entire stockpile site shall be left in a neat and presentable condition.

3-02.3 Additional Requirements for Specific Aggregates

3-02.3(1) Washed Aggregates

Drainpipes under the stockpile shall be provided at the Contractor's expense when, in the opinion of the Engineer, such drains are necessary to properly drain the aggregates.

The roads and ground adjacent to the stockpile shall be kept free of dust. Washed aggregate that has become coated with foreign material prior to use shall be washed until free of all foreign material or it may be rejected.

Washed aggregate shall drain in hauling conveyances or stockpiles at least 12 hours before being weighed or measured for batching and for a longer time if so directed by the Engineer.

3-02.4 Measurement

Clearing and grubbing of the stockpile site will be measured in accordance with Section 2-01 when the proposal includes such bid items and such work is required on a stockpile site provided by the Contracting Agency.

Specific materials or aggregates designated in the proposal to be in stockpile will be measured by the ton unless the proposal shows by the cubic yard. The cubic yard volume for pay quantity will be determined by cross-sectioning the completed stockpile or by computation of the volume between the original ground surface and the stockpile surface using digital terrain modeling survey techniques.

Specific materials or aggregates designated in the proposal to be from stockpile will be measured by the ton or by the cubic yard, whichever is shown in the proposal. If payment is to be made on the basis of cubic yards, measurement will be made of the volume in the hauling vehicle at the point of delivery on the roadway.

3-02.5 Payment

All costs involved in preparing stockpile sites shall be included in the unit contract prices for the various bid items being stockpiled, excepting that clearing and grubbing will be paid in accordance with Section 2-01 when the proposal includes such bid items and such work is required on a stockpile site provided by the Contracting Agency.

3-03 SITE RECLAMATION

3-03.1 Description

This work shall consist of reclaiming land used for borrowing material, mining for aggregates, sorting or wasting materials as specified.

3-03.2 General Requirements

3-03.2(1) Contracting Agency-Provided Sites

All borrow, quarry, or pit sites of over 3 acres in size of disturbed land or resulting in pit walls more than 30 feet high and steeper than a one to one slope which are owned or furnished by the Contracting Agency shall be reclaimed as shown in the Plans and as designated by the Engineer.

Ultimate reclamation plans are not normally required for borrow, quarry, or pit sites not meeting the above criteria or for stockpile or waste sites. However, all such sites shall be reclaimed to the extent necessary to control erosion and provide a satisfactory appearance consistent with anticipated future use.

3-03.2(2) Contractor-Provided Sites

All borrow, quarry, and pit sites of over 3 acres in size of disturbed land or resulting in pit walls more than 30 feet high and steeper than a one to one slope which are owned or furnished by the Contractor shall be reclaimed in accordance with the conditions and requirements of an approved reclamation permit acquired from the Department of Natural Resources.

When the Contractor obtains a reclamation permit from the Department of Natural Resources, evidence of such approval shall be furnished to the Engineer prior to any work within the site.

Ultimate reclamation plans are not required for borrow, quarry, or pit sites not meeting the above criteria or for stockpile or waste sites. However, all such sites shall be reclaimed to the extent necessary to control erosion and provide a satisfactory appearance consistent with anticipated future use.

Compliance with the State Environmental Policy Act (SEPA) is required for sites involving more than 100 cubic yards of excavation or landfill throughout the lifetime of the site unless the local agency in which the project is located establishes a greater amount. Sites involving more than 500 cubic yards of excavation or landfill throughout the lifetime of the site always require compliance with SEPA.

Under no circumstance will the Contractor be allowed to waste material within a wetland as defined in Section 2-03.3(7).

3-03.2(3) Out of State Sites

All out of state borrow, quarry or pit, stockpile, and waste sites which are furnished by the Contractor exclusively for use on this contract shall be reclaimed in accordance with an approved reclamation plan that is in compliance with local area restrictions.

3-03.3 Reclamation Plans

3-03.3(1) Contracting Agency-Provided Sites

Reclamation plans for all borrow, quarry, or pit sites which are owned or furnished by the Contracting Agency will normally be furnished by the Contracting Agency and the requirements thereof included in the contract documents. Should conditions require operations within a Contracting Agency-owned or Contracting Agency-furnished site not provided for in the plans, the Contractor shall reclaim these sites in accordance with a reclamation plan furnished by the Engineer.

3-03.3(2) Contractor-Provided Sites

A plan will not be required except on specific request for those sources of material for which the Contractor has obtained a valid surface mining permit issued by the Department of Natural Resources and has paid all required fees.

3-03.4 Construction Requirements

3-03.4(1) Erosion Control

All sites owned or furnished by the Contracting Agency will specify the kind and amount of erosion control, if any, and include the requirements thereof in the contract documents.

All sites owned or furnished by the Contractor shall, if specified on a reclamation plan approved by the Engineer, require erosion control in accordance with Section 8-01 or plant materials in accordance with Section 8-02.

3-03.4(2) Deviations from Approved Reclamation Plans

Reclamation of any site which deviates from the approved reclamation plan will not be permitted without first revising the approved reclamation plan and obtaining the approval of the Engineer.

3-03.5 Payment

3-03.5(1) Contracting Agency-Provided Sites

All costs in connection with reclaiming sites to the full extent required by the contract shall be included in the costs of other items of work involved in the project.

Payment will be made for any work described in Sections 8-01 or 8-02 at applicable unit contract prices.

3-03.5(2) Contractor-Provided Sites

All costs involved in complying with the requirements of a reclamation permit acquired from the Department of Natural Resources, complying with the requirements of a reclamation plan approved by the Engineer, or with reclaiming sites to the full extent required by the contract shall be included in the costs of other items of work involved in the project.

DIVISION 4
BASES

4-01 VACANT

4-02 GRAVEL BASE

4-02.1 Description

This work shall consist of constructing one or more layers of gravel base upon a prepared subgrade in accordance with these Specifications and in conformity with the lines, grades, depth, and typical cross-section shown in the Plans or as established by the Engineer.

4-02.2 Materials

Materials shall meet the requirements of the following section:

Gravel Base	9-03.10

4-02.3 Construction Requirements

Gravel base shall be uniformly spread upon the prepared subgrade to the depth, width, and cross-section shown in the Plans. Construction methods used shall meet the applicable requirements of Sections 4-04.3.

4-02.4 Measurement

Gravel base will be measured in the same manner prescribed for the measurement of crushed surfacing materials as set forth in Section 4-04.4 except as follows:

Where gravel base is specified, the Contractor may elect to substitute materials as described in Section 3-01.4(4). Crushed surfacing and gravel borrow, used in lieu of gravel base, will be measured and paid for as gravel base. In no case shall crushed surfacing, used in lieu of gravel base, be included in any bid items for crushed surfacing.

4-02.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when shown in the proposal:

"Gravel Base", per ton, or per cubic yard.

4-03 VACANT

4-04 BALLAST AND CRUSHED SURFACING

4-04.1 Description

This work consists of constructing one or more courses of crushed stone upon a prepared subgrade in accordance with these Specifications in conformity with the lines, grades, depth, and typical cross-sections shown in the Plans or as established by the Engineer.

Surfacing materials and ballast may also be specified to be placed in stockpiles for future use.

4-04.2 Materials

Materials shall meet the requirements of the following sections:

Ballast	9-03.9(1)
Shoulder Ballast	9-03.9(2)
Crushed Surfacing	9-03.9(3)
Maintenance Rock	9-03.9(4)

4-04.3 Construction Requirements

4-04.3(1) Equipment

All equipment necessary for the satisfactory performance of this construction shall be on the project and approved by the Engineer prior to beginning work. If central mix plant methods are used, the central mixing plant shall comply with the following requirements:

The cold aggregate feeder shall be mechanically operated and adjustable to the extent necessary to provide a uniform and continuous flow of materials. These materials shall be deposited in an approved mixer with a sufficient amount of water being added to obtain the required density when spread and compacted. The water shall be weighed or metered, and dispensed through a device providing uniform dispersion across the mixer.

The mixing plant shall be provided with weighing or calibrating devices, feeders, provisions for sampling, and other devices and equipment so designed, coordinated, and operated to produce a uniform mixture, and to permit the sampling of the materials before and after mixing. The mixer shall be kept in good condition, and mixing blades or paddles shall be of proper size, adjustment, and clearance to provide positive and uniform mixing of the mixture at all times.

The capacity of the plant and equipment furnished for the work shall be adequate at all times to provide for efficient and continuous operations insofar as practical.

4-04.3(2) Subgrade

The subgrade shall be prepared as specified in Section 2-06 and shall be approved by the Engineer before placing ballast or surfacing materials.

4-04.3(3) Mixing

Unless otherwise specified, the Contractor may use either, or both, of the following described methods:

1. **Central Plant Mix Method.** The surfacing material and water shall be mixed in an approved mixing plant as described in Section 4-04.3(1). The completed mixture shall be a thoroughly mixed combination of proportioned materials and water, uniform in distribution of particle sizes and moisture content. A mixture containing water in excess of the proportion established by the Engineer will not be accepted.
2. **Road Mix Method.** After material for each layer of surfacing has been placed, the material shall be mixed until uniform throughout by motor graders or other equipment approved by the Engineer. Water to facilitate mixing and compacting shall be added in amounts approved by the Engineer.

4-04.3(4) Placing and Spreading

1. **Central Plant Mix Method.** After mixing, material for each layer of surfacing shall be transported to the roadway in approved vehicles. Vehicles for hauling the mixture shall be capable of depositing the mixture within the receiving hopper of the spreading equipment, or in windrows of uniform size in front of the spreading equipment, with a minimum of segregation of the mix.

   A motor grader may be used as the spreading machine or the spreading machine shall be capable of receiving the material by direct deposit in its hopper from the hauling vehicle or from a uniform windrow, and be capable of spreading and screeding the material to a depth and surface that when compacted will be true to line, grade, depth of course, and cross-section without further shaping.
2. **Road Mix Method.** Each layer of surfacing material shall be spread by equipment that is approved by the Engineer. Equipment that causes segregation of the surfacing material during the spreading operation will not be allowed. Similar types of spreading equipment shall be used throughout the limits of each separate spreading operation. Spreading on small areas of less than 2,000 square yards or on areas irregular in shape, may be accomplished by other means as approved by the Engineer.

The following nominal depth of compacted material shall not be exceeded in any one course without the approval of the Engineer:

Ballast	0.50 foot
Gravel Base	0.75 foot
Crushed Surfacing	0.35 foot

4-04.3(5) Shaping and Compaction

Immediately following spreading and final shaping, each layer of surfacing shall be compacted to at least 95 percent of the standard density determined by the requirements of Section 2-03.3(14)D before the next succeeding layer of surfacing or pavement is placed. The determination of field in-place density shall be made by the Nuclear gauge. When the thickness of surfacing is less than 0.15 foot, density testing will not be required and the Engineer will determine the number of coverages required for the particular compaction equipment available.Vibratory compactors and rollers shall obtain the specified density for each layer. A mist spray of water shall be applied as needed to replace moisture lost by evaporation. The completed layer shall have a smooth, tight, uniform surface true to the line, grade, and cross-section shown in the plans, or as staked.

4-04.3(6) Keystone

When necessary, as determined by the Engineer, crushed surfacing top course shall be used for keystone to key the top surface of ballast, gravel base, crushed surfacing base course, or any other surfacing course that requires keying. The keystone shall be spread evenly on top of the surfacing course by means of approved spreading equipment. The surface shall be watered and, if necessary, bladed lightly until the keystone is worked into the interstices of the surfacing course without excessive displacement and shall be compacted. The operations of adding keystone, wetting, blading, and compacting shall be continued until the course has become thoroughly keyed and compacted.

When keystone is required, that is subject to public traffic, it shall be placed before terminating each day's operation.

Keystone placed for the convenience of the Contractor, with approval of the Engineer, for the purpose of creating a more dense surface on which to pave will be allowed within the top 0.20 foot of crushed surfacing base course, gravel base, or ballast. Keystone placed for this purpose will be paid for at the lower unit contract price for either the base material being keyed or crushed surfacing top course.

4-04.3(7) Miscellaneous Requirements

The surface of each layer of surfacing material shall be maintained true to line, grade, and cross-section by grading, watering, and rolling until placing the next succeeding course. The first course of surfacing material shall be placed on all available subgrade before placing the succeeding course unless otherwise authorized by the Engineer. Unless otherwise approved, there shall be a distance of not less than one station between the construction of any two courses of surfacing or ballast.

Should irregularities develop in any surface during or after compaction, they shall be remedied by loosening the surface and correcting the defects after which the entire area including the surrounding surface shall be thoroughly recompacted. Any additional materials necessary to make the repairs shall be furnished by the Contractor at the unit contract price.

4-04.3(8) Weather Limitations

When, in the opinion of the Engineer, the weather is such that satisfactory results cannot be obtained, the Contractor shall suspend operations until the weather is favorable. No surfacing materials shall be placed in snow or on a soft, muddy, or frozen subgrade.

4-04.3(9) Hauling

Hauling equipment shall be routed over the roadway in a manner to be most effective in the compacting of the surfacing. Hauling over any of the surfacing in the process of construction will not be permitted when, in the opinion of the Engineer, the effect will be detrimental. All loads shall be of uniform capacity unless deviation is expressly authorized by the Engineer.

4-04.3(10) Hours of Work

The Contractor shall arrange surfacing operations so that the placing of materials will be accomplished during daylight hours. However, when necessary to complete the project within the time specified, or to avoid peak periods of public traffic, work may be undertaken during the hours of darkness, provided the Contractor furnishes and operates adequate lighting. Inability to demonstrate reliable and satisfactory results will be reason to order termination of night operations, and the Contractor shall procure additional

equipment and personnel necessary to satisfactorily complete the work as specified while operating during daylight hours only.

4-04.3(11) Shoulder Ballast

Shoulder ballast shall not be placed until the abutting pavement has been completed unless designated by the Engineer. Shoulder ballast shall be placed through a spreader box in one lift. Processing of the shoulder ballast course on the roadway will not be permitted. Compaction shall be accomplished by making a minimum of three passes over the aggregate with a vibratory compactor of a type acceptable to the Engineer. The density requirements of Section 4-04.3(5) shall not apply.

4-04.4 Measurement

Crushed surfacing top course, base course, ballast, and gravel base, when mixed at a central plant, will be measured by the ton. The weight of water added at the plant will be deducted on a daily basis from the total tonnage of aggregates, including water, placed that day which were processed through the central plant and placed on the roadway. The resultant tonnage of surfacing materials will be paid for at the unit contract price. The weight of deducted water will be converted to gallons and will be paid for at the unit contract price for water.

Crushed surfacing top course, base course, ballast, and gravel base, when mixed by the road mix method, will be measured by the ton or by the cubic yard. If measured by the cubic yard, measurement will be made in the hauling conveyance at the point of delivery on the roadway.

Shoulder ballast will be measured by the ton or by the cubic yard.

Crushed surfacing materials for placement in stockpile will be measured by the ton or cubic yard. If measured by the cubic yard, the volume will be determined by cross-sectioning the stockpile.

Maintenance rock will be measured in the same manner prescribed for crushed surfacing materials.

Water used in placing and compacting surfacing materials on the roadway will be measured in accordance with Section 2-07.

4-04.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Crushed Surfacing Top Course (or Base Course)", per ton, or per cubic yard.

"Crushed Surfacing Top Course (or Base Course) in Stockpile", per ton, or per cubic yard.

"Crushed Surfacing Top Course (or Base Course) from Stockpile", per ton, or per cubic yard.

"Ballast", per ton, or per cubic yard.

"Ballast in Stockpile", per ton, or per cubic yard.

"Ballast from Stockpile", per ton, or per cubic yard.

"Shoulder Ballast", per ton, or per cubic yard.

"Shoulder Ballast in Stockpile", per ton or per cubic yard.

"Shoulder Ballast from Stockpile", per ton or per cubic yard.

"Maintenance Rock 1/2 In. Minus in Stockpile", per ton, or per cubic yard.

4-05 VACANT

4-06 ASPHALT TREATED BASE

4-06.1 Description

Asphalt treated base consists of a compacted course of base material which has been weatherproofed and stabilized by treatment with an asphalt binder.

The work shall consist of one or more courses of asphalt treated base placed on the subgrade in accordance with these Specifications and in conformity with the lines, grades, thicknesses, and typical cross-sections shown in the Plans or as staked.

4-06.2 Materials

Materials shall meet the requirements of the following sections:

Asphalt	9-02.1
Anti-Stripping Additive	9-02.4
Aggregates	9-03.6

The grade of paving asphalt shall be as required in the contract.

4-06.3 Construction Requirements

4-06.3(1) Asphalt Mixing Plant

Asphalt mixing plants for asphalt treated base shall meet the following requirements:

Heating

The plant shall be capable of heating the aggregates to the required temperature.

Proportioning

The mixing plant shall be capable of proportioning: the aggregates to meet the specifications; and the asphalt at the rate specified by the Engineer. If the aggregates are supplied in two or more sizes, means shall be provided for proportioning or blending the different sizes of aggregates to produce material meeting the specification requirements.

Mixing

The mixer shall be capable of producing a uniform mixture of uniformly coated aggregates meeting the requirements of these Specifications.

4-06.3(2) Preparation of Aggregates

Aggregates for asphalt treated base shall be stockpiled before use in accordance with the requirements of Section 3-02.

The aggregates shall be heated as required by the Engineer.

4-06.3(2)A Mix Design

The mix design requirements for asphalt treated base shall be as described in Section 5-04.3(7)A.

4-06.3(3) Heating of Asphalt Material

Heating of the asphalt material shall conform to the requirements of Section 5-04.3(6).

4-06.3(4) Mixing

The asphalt treated base shall be mixed in accordance with the requirements of Section 5-04.3(8).

4-06.3(5) Hauling Equipment

Hauling equipment for asphalt treated base shall conform to the requirements of Section 5-04.3(2).

4-06.3(6) Spreading and Finishing

Asphalt treated base shall be spread with a spreading machine equipped with a stationary, vibratory, or oscillating screed or cut-off device, subject to the approval of the Engineer. Approval of the equipment shall be based on a job demonstration that the finished product will meet all requirements of the specifications. Automatic controls will not be required.

The temperature of the mixture at the time compaction is achieved shall be a minimum of 185°F.

4-06.3(6)A Subgrade Protection Course

Unless otherwise specified by the Engineer, the Contractor shall place the asphalt treated base as a protection for the prepared subgrade on all sections of individual roadways which are to receive asphalt treated base as soon as 10,000 square yards of subgrade is completed. This requirement shall not be limited to contiguous areas on the project.

The surface of the subgrade protection layer when constructed on a grading project shall conform to grade and smoothness requirements that apply to the subgrade upon which it is placed.

4-06.3(6)B Finish Course

The final surface course of the asphalt treated base, excluding shoulders, shall not deviate at any point more than $^{3}/_{8}$ inch from the bottom of a 10-foot straightedge laid in any direction on the surface on either side of the roadway crown. Failure to meet this requirement shall necessitate sufficient surface correction to achieve the required tolerance, as approved by the Engineer, at no expense to the Contracting Agency.

When Portland cement concrete pavement is placed on an asphalt base, the surface tolerance of the asphalt base shall be such that no elevation lies more than 0.05 feet below nor 0.00 feet above the plan grade minus the specified plan depth of Portland cement concrete pavement. Prior to placing the Portland cement concrete pavement, any such irregularities shall be brought to the required tolerance by grinding or other means approved by the Engineer, at no expense to the Contracting Agency.

4-06.3(7) Density

The asphalt treated base shall be compacted to a density of not less than 80 percent of the maximum theoretical density established for the mix by WSDOT FOP for AASHTO T 209. The density of the base shall be determined by means of tests on cores taken from the roadway or with the nuclear gauge in accordance with Section 5-04.3(10)B. The frequency of these tests shall be at the discretion of the Engineer, but in no case shall it be less than one control lot for each normal day's production. The use of equipment which results in damage to the materials or produces substandard workmanship will not be permitted.

4-06.3(8) Anti-Stripping Additive

An anti-stripping additive shall be added to the asphalt material in accordance with Section 9-02.4, when directed by the Engineer.

4-06.4 Measurement

Asphalt treated base including paving asphalt will be measured by the ton.

4-06.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Asphalt Treated Base", per ton.

"Anti-Stripping Additive", by force account.

"Anti-Stripping Additive" will be paid for in accordance with Section 1-09.6 except that no overhead, profit or other costs will be allowed. Payment will be made only for the invoice cost of the additive. The quantity of asphalt material shall not be reduced by the quantity of anti-stripping additive. For the purpose of providing a common proposal for all bidders, the Contracting Agency has entered an amount in the proposal to become a part of the total bid by the Contractor.

DIVISION 5
SURFACE TREATMENTS AND PAVEMENTS

5-01 CEMENT CONCRETE PAVEMENT REHABILITATION

5-01.1 Description

This work consists of rehabilitating or replacing section(s) of Portland cement concrete pavement in accordance with these Specifications and in conformity with the lines, grades, thicknesses, and typical cross-sections shown in the Plans or established by the Engineer.

5-01.2 Materials

Materials shall meet the following requirements as listed:

Portland Cement	9-01
Fine Aggregate	9-03
Coarse Aggregate	9-03
Combined Aggregate	9-03
Joint Filler	9-04.1
Joint Sealants	9-04.2
Reinforcing Steel	9-07
Dowel Bars	9-07.5
Tie Bars	9-07.6
Concrete Patching Material	9-20
Curing Materials and Admixtures	9-23
Water	9-25
Epoxy Resins (bonding agents)	9-26

Parting Compound shall be a curing compound, grease or other substance approved by the Engineer.

Subsealing

Pozzolan meeting the requirements of AASHTO M 295 may also be used.

Standard Mix Design (by volume) for subsealing is as follows:

1 part Portland cement Type I or II

3 parts pozzolan

2.25 parts water

The Contractor shall supply the Engineer with test reports of the slurry to be used on the project. The Contractor shall use the services of a laboratory that has an equipment calibration/verification system and a technician training and evaluation process per AASHTO R-18 to conduct all tests. The test reports shall show one, three, and seven-day strengths, flow cone times, and time of initial set. The seven-day compressive strength shall not be less than 600 psi as measured using AASHTO T-106. Time of efflux shall range from 9 to 15 seconds for the cement concrete pavement slabs and 16 to 25 seconds for the cement concrete bridge approach slabs as per ASTM C939.

The Engineer shall approve any deviation from the standard mix design.

Dowel Bar Retrofit

Dowel bar expansion caps shall be tight fitting and made of non-metallic material, which will allow for ¼-inch of movement at each end of the bar.

Chairs for supporting the dowel bar shall be epoxy coated according to Section 9-07.3 or made from non-metallic material.

The foam insert shall be closed cell foam faced with poster board material or plastic faced material on each side commonly referred to as foam core board by office suppliers. The foam insert shall be capable of remaining in a vertical position and tight to all edges during the placement of the concrete patching material. Caulking filler used for sealing the transverse joint at the bottom and sides of the slot shall be a silicone caulk.

Concrete Patching Material

Concrete Patching Material shall be used for partial depth spall repair, panel replacement and dowel bar retrofit.

5-01.3 Construction Requirements

5-01.3(1)A Concrete Mix Design for Concrete Patching Materials

1. **Materials.** The prepackaged concrete patching material shall conform to Section 9-20. The aggregate extender shall conform to Section 9-03.1(4), AASHTO Grading No. 8.
2. **Submittals and Acceptance.** The Contractor shall use the Manufacturer's recommended proportions for the mix design to be submitted to the Engineer for the concrete patching material. The Contractor's submittal shall include the mix proportions of the prepackaged mix, water, aggregated extender, and the proposed sources for all aggregates. Acceptance shall be based on field verification of the prepackaged patching material, and that the amount of added water and aggregate extender complies with the mix design.

5-01.3(1)B Equipment

In addition to Sections 5-05.3(3)A ,5-05.3(3)B, 5-05.3(3)D and 5-05.3(3)E the following shall apply.

Mobile volumetric mixers shall be calibrated in accordance with Section 6-09.3(1)H. The references to the latex admixture shall not apply.

Air compressors shall be of sufficient size and capacity to perform the work to the satisfaction of the Engineer.

The equipment for grinding cement concrete pavement shall use diamond embedded saw blades gang mounted on a self propelled machine that is specifically designed to smooth and texture concrete pavement. The equipment shall not damage the underlying surface, cause fracture, or spalling of any joints.

All equipment shall be maintained in good condition.

Subsealing

Grout mixers shall consist of a cement injection pump and a high-speed colloidal mixing machine. The colloidal mixing machine shall operate at a minimum speed of 1,200 rpm and shall consist of a rotor operating in close proximity to a stator, creating a high shearing action and subsequent pressure release to make a homogeneous mixture. Water shall be added to the batch through a meter or scale with a totalizer for the day's consumption.

Wooden cylindrical plugs or other devices approved by the Engineer shall be provided to temporarily plug the application holes until the material has set. The plugs shall be slightly tapered on one end for ease in driving.

5-01.3(2) Material Acceptance

5-01.3(2)A Concrete Patching Material

The concrete patch material shall be as specified in Section 9-20.

5-01.3(2)B Portland Cement Concrete

The point of acceptance will be at the discharge of the placement system.

The concrete producer shall provide a certificate of compliance for each truckload of concrete in accordance with Section 6-02.3(5)B.

Acceptance testing for compliance of air content and 28 day compressive strength shall be conducted from samples obtained according to FOP for WAQTC TM 2. Air content shall be determined by conducting WAQTC FOP for AASHTO T 152. If the Contractor fails to provide the Aggregate Correction Factor per WAQTC FOP for AASHTO T 152 with the mix design, one will not be applied. Compressive Strength shall be determined by WSDOT FOP for AASHTO T 22 and WSDOT FOP for AASHTO T 23.

Rejection of Concrete

Rejection by the Contractor: The Contractor may, prior to sampling, elect to remove any defective material and replace it with new material at no expense to the Contracting Agency. The replacement material will be sampled, tested and evaluated for acceptance.

Rejection without Testing: The Engineer may reject any load that appears defective prior to placement. Material rejected before placement shall not be incorporated into the pavement. No payment will be made for the rejected materials unless the Contractor requests that the rejected material be tested. If the Contractor elects to have the rejected materials tested, a sample will be taken and both the air content and strength shall be tested by WSDOT.

Payment for rejected material will be based on the results of the one sample, which was taken and tested. If the rejected material fails either test, no payment will be made for the rejected material and in addition, the cost of sampling and testing, at the rate of $250.00 per sample shall be borne by the Contractor. If the rejected material passes both tests the mix will be compensated for at actual invoice cost and the cost of the sampling and testing will borne by the Contracting Agency.

5-01.3(3) Subsealing

Subsealing shall not be done when the pavement is wet, or when water is present under the pavement. The maximum surface temperature for testing and subsealing is 70ºF.

The Contractor shall test all transverse joints through the areas as shown in the Plans.

The testing will determine the need for subsealing. Testing will be accomplished by applying a 9,000 lb load on each side of the joint to measure the vertical movement (along the right lane edge or the edge nearest the shoulder). The testing equipment shall be able to record the information to within 0.001-inch. The Contractor shall submit the method of testing, for approval by the Engineer, prior to commencing work. Testing will be required before and after the grouting operation. All testing will be conducted when the concrete pavement surface temperature is 70ºF or less, except the Engineer shall stop testing earlier if there is evidence of slab lockup due to thermal expansion or as required by other traffic control plans. To determine the location of subsealing, both the leave and approach outside corner of the slab will be tested. Any slab exhibiting a deflection greater than 0.025-inch will be subsealed.

If the slab deflection is greater than 0.025-inch after the initial grouting, a second grouting and third test shall be performed. If the third test fails, the Engineer will make a determination whether to re-grout a third time or to remove the slab.

During the subsealing operation, a positive means of monitoring lift that is accurate to within 0.001-inch, as approved by the Engineer, shall be used. The upward movement of the pavement shall not be greater than 0.025-inch. The maximum allowable pressure for the subseal operation shall not exceed 100 pounds per square-inch, except that a short surge of 300 pounds per square-inch will be allowed when starting to pump the hole in order for the grout to penetrate into the void structure. The pressure shall be monitored by an accurate pressure gauge in the grout line that is protected from the grout slurry. Water displaced from the void structure by grout shall be allowed to flow freely. Excessive loss of the grout through cracks, joints, or from backpressure in the hose or in the shoulder area will not be allowed.

5-01.3(4) Replace Portland Cement Concrete Panel

Curing, cold weather work, concrete pavement construction in adjacent lanes, and protection of pavement shall meet the requirements of Section 5-05.3.

Concrete slabs to be replaced as shown in the Plans or staked by the Engineer shall be at least 6.0-feet long and full width of an existing pavement panel. The portion of the panel to remain in place shall have a minimum dimension of 6-feet in length and full panel width; otherwise the entire panel shall be removed and replaced. There shall be no new joints closer than 3.0-feet to an existing transverse joint or crack. Vertical saw cutting full pavement depth is required along all longitudinal joints and at transverse locations. Removal of existing cement concrete pavement shall not cause damage to adjacent slabs that are to remain in place. The Contractor, at no cost to the Contracting Agency, shall repair any damage caused by the Contractor's operation. In areas that will be ground, slab replacements shall be performed prior to pavement grinding.

When new concrete pavement is to be placed against existing cement concrete pavement, epoxy coated tie bars and epoxy coated dowel bars shall be drilled and grouted into the existing pavement with epoxy resin, type I or IV as specified in Section 9-26. Tie bars are not required for panel replacements less than a full panel.

Dowel bars shall be placed at the mid depth of the concrete slab, centered over the transverse joint, and parallel to the centerline and to the roadway surface.

Placement tolerances for dowel bars

1. ± 1-inch of the middle of the concrete slab depth.
2. ± 1-inch of being centered over the transverse joint.
3. ± ½-inch from parallel to the centerline.
4. ± ½-inch from parallel to the roadway surface.

Dowel bars may be adjusted to avoid contact with existing dowel bars in the transverse joint at approach slabs or existing panels without exceeding specified tolerances.

Tie bars shall be placed at the mid depth of the concrete slab, centered over the joint, perpendicular to centerline, and parallel to the roadway surface.

Placement tolerances for tie bars

1. ±1-inch of the middle of the concrete slab depth.
2. ±1-inch of being centered over the joint.
3. ±1-inch from perpendicular to the centerline.
4. ±1-inch from parallel to the roadway surface.

The horizontal position of tie bars may be adjusted to avoid contact with existing tie bars in the longitudinal joint where panel replacement takes place.

Dowel bars and tie bars shall be placed according to the Standard Plan when multiple panels are placed.

Panels shall be poured separately from the bridge approach slab.

Dowel bars to be drilled into existing concrete or at a new transverse contraction joint shall have a parting compound, such as curing compound, grease, or other Engineer approved equal, applied to them prior to placement.

The tie bar and dowel bar holes shall be blown clean with compressed air before grouting. The bar shall be centered in the hole for the full length of embedment before grouting. The grout shall then be pumped into the hole around the bar in a manner that the back of the hole will be filled first. Blocking or shimming shall not impede the flow of the grout into the hole. Dams, if needed, shall be placed at the front of the holes to confine the grout. The dams shall permit the escape of air without leaking grout and shall not be removed until grout has cured in the hole.

The Contractor shall smooth the surfacing below the removed panel and compact it to the satisfaction of the Engineer. Crushed surfacing base course, or hot mix asphalt may be needed to bring the surfacing to grade prior to placing the new concrete.

If the material under the removed panel is uncompactable and the Engineer requires it, the Contractor shall excavate the subgrade two feet, place a soil stabilization construction geotextile meeting the requirements of Section 9-33, and backfill with crushed surfacing base course. This work may include:

1. Furnishing and hauling crushed surfacing base course to the project site.
2. Excavating uncompactable material.
3. Furnishing and placing a soil stabilization construction geotextile.
4. Backfilling and compacting crushed surfacing base course (excluding compacting the surface immediately below the removed panel, if compactable).
5. Removing, hauling and restocking any unused crushed surfacing base course.

Side forms shall meet the requirements of Section 5-05.3(7)B whenever a sawed full depth vertical face cannot be maintained.

The Contractor shall place polyethylene film in accordance with AASHTO M 171 along all existing concrete surfaces and between the bottom of the slab and treated bases prior to placing concrete.

Grade control shall be the responsibility of the Contractor.

All panels shall be struck off level with the adjacent panels and floated to a smooth surface.

Final finish texturing shall meet the requirements of Section 5-05.3(11).

In areas where the Plans do not require grinding, the surface smoothness will be measured with a 10-foot straightedge by the Engineer in accordance with Section 5-05.3(12). If the replacement panel is located in an area that will be ground as part of portland cement concrete pavement grinding in accordance with Section 5-01.3(9), the surface smoothness shall be measured, by the Contractor, in conjunction with the smoothness measurement done in accordance with Section 5-01.3(10).

All transverse and longitudinal joints shall be sawed and sealed in accordance with Section 5-05.3(8). The Contractor may use a hand pushed single blade saw for sawing joints.

Portland cement concrete shall meet the criteria of Sections 5-05.3(1), 5-05.3(2) and 5-05.3(5)A. Where accelerated pavement construction is required the Contractor may use concrete patching materials for panel replacement as specified in Section 9-20.

Opening to traffic shall meet the requirements of Section 5-05.3(17).

5-01.3(5) Partial Depth Spall Repair

Removal of the existing pavement shall not damage any pavement to be left in place. Any existing pavement that is to remain that has been damaged shall be repaired at the Contractor's expense. If jackhammers are used for removing pavement, they shall not weigh more than 30 pounds, and chipping hammers shall not weigh more than 15 pounds. All power driven hand tools used for the removal of pavement shall be operated at angles less than 45 degrees as measured from the surface of the pavement to the tool. The patch limits shall extend beyond the spalled area a minimum of 3.0-inches. Repair areas shall be kept square or rectangular. Repair areas that are within 12.0-inches of another repair area shall be combined.

A vertical saw cut shall be made to a minimum depth of 3.0-inches around the area to be patched as marked by the Engineer. The Contractor shall remove material within the perimeter of the saw cut to a depth of 3.0-inches, or to sound concrete as determined by the Engineer. Repair depths that exceed one third of the total slab shall require full depth repair.

The surface patch area shall be sand blasted and all loose material removed. All sandblasting residue shall be removed using dry oil-free air.

Spall repair shall not be done in areas where dowel bars or heavy reinforcing steel are encountered.

When a partial depth repair is placed directly against an adjacent longitudinal joint, polyethylene film shall be placed between the existing concrete and the area to be patched.

Patches that abut working transverse joints or cracks require placement of a compressible insert. The new joint or crack shall be formed to the same width as the existing joint or crack. The compressible joint material shall be placed into the existing joint 1.0-inch below the depth of repair. The compressible insert shall extend at least 3.0-inches beyond each end of the patch boundaries.

Patches that abut the lane/shoulder joint require placement of a formed edge, along the slab edge, even with the surface.

The patching material shall be mixed, placed, consolidated, finished and cured according to manufacturer's recommendations. Slab/patch interfaces that will not receive pavement grinding shall be sealed (painted) with a 1:1 cement-water grout along the patch perimeter.

The Contractor shall reseal all joints in accordance with Section 5-05.3(8)B.

Opening to traffic shall meet the requirements of Section 5-05.3(17).

5-01.3(6) Dowel Bar Retrofit

Dowel bars shall be installed in the existing concrete pavement joints and transverse cracks where shown in the Plans or as marked by the Engineer.

Saw cut slots will be required in the pavement to place the center of the dowel at mid-depth in the concrete slab. The completed slot shall provide a level, secure surface for the feet of the dowel bar chairs. Slots that intersect longitudinal or random cracks shall not be retrofitted. When gang saws are used, slots that are not used shall be cleaned and sealed with an epoxy resin, type I or IV. The epoxy resin shall conform to the requirements of Section 9-26. The transverse joint between Portland Cement Concrete Pavement and a Bridge approach slab shall not be retrofitted.

Saw cut slots shall be prepared such that dowel bars can be placed at the mid depth of the concrete slab, centered over the transverse joint, and parallel to the centerline and to the roadway surface.

Placement tolerances for dowel bars

1. ± 1-inch of the middle of the concrete slab depth.
2. ± 1-inch of being centered over the transverse joint.
3. ± ½-inch from parallel to the centerline.
4. ± ½-inch from parallel to the roadway surface.

If jackhammers are used to break loose the concrete they shall weigh less than 30 pounds.

All slot surfaces shall be cleaned to bare concrete by sand blasting or pressure washing. The cleaning shall remove all slurry, parting compound, and other foreign materials prior to installation of the dowel. If a pressure washer is used to clean the slots the pressure at the nozzle shall not exceed 4000 psi. Any damage to the concrete shall be repaired by the Contractor at no cost to the Contracting Agency. All wash water shall be cleaned from the slots prior to placement of any slot patching material. Traffic shall not be allowed on slots where concrete has been removed.

Prior to placement, the dowel bars shall be lightly coated with a parting compound and placed on a chair that will provide a minimum of ½-inch clearance between the bottom of the dowel and the bottom of the slot.

The chair design shall hold the dowel bar tightly in place during placement of the concrete patching material. Immediately prior to placement of the dowel bar and concrete patching material, the Contractor shall caulk the transverse joint or crack at the bottom and sides of the slot as shown in the Plans. The caulking filler shall not be placed any farther than $^{1}/_{2}$-inch outside either side of the joint or crack. The transverse joint or crack shall be caulked sufficiently to satisfy the above requirements and to prevent any of the patching material from entering the joint/crack at the bottom or sides of the slot.

A $^{3}/_{8}$-inch thick foam insert shall be placed at the middle of the dowel to maintain the transverse joint. The foam insert shall fit tightly around the dowel and to the bottom and edges of the slot and be a minimum of 1½-inch below the existing concrete surface. The foam insert shall be capable of remaining in a vertical position and held tightly to all edges during placement of the patch. If for any reason the foam insert shifts during placement of the patch the work shall be rejected and redone at the Contractor's expense.

Patching material shall be consolidated by using a 1.0-inch or less diameter vibrator as approved by the Engineer. The Contractor shall not overwork the patching material during the patch consolidation process.

The patching material on the surface of the dowel bar slots shall not be overworked, causing segregation and leaving the fine material on the surface. The patching material shall be left $^{1}/_{8}$-inch to $^{1}/_{4}$-inch high and not finished flush with the existing concrete surface.

The joint shall be maintained by saw cutting the surface with a hand pushed single blade saw. The cut width shall be $^{3}/_{16}$ to $^{5}/_{16}$-inch and the depth 1½-inches. The cut length shall be $2^{1}/_{4}$-feet long centered over the three retrofit epoxy-coated dowel bars and shall be sawed within 24 hours after placement of the concrete patching material.

Opening to traffic shall meet the requirements of Section 5-05.3(17).

5-01.3(7) Sealing Existing Concrete Random Cracks

The Contractor shall route, clean and seal existing concrete random cracks where indicated by the Engineer. Cracks smaller than $^{5}/_{16}$-inch in width shall be routed to $^{5}/_{16}$-inch wide by 1-inch deep prior to placing the sealant. Cracks over $^{5}/_{16}$-inch in width shall be cleaned and sealed.

All incompressible material shall be completely removed from the existing random crack to a depth of $^{3}/_{4}$-inch. Immediately prior to sealing, the cracks shall be blown clean with dry, oil free compressed air.

The top surface of the sealant shall be at least ¼-inch below the surface of the pavement.

5-01.3(8) Sealing Existing Transverse and Longitudinal Joints

The Contractor shall clean and seal existing transverse and longitudinal joints where shown in the Plans or as marked by the Engineer.

Old sealant and incompressible material shall be completely removed from the joint to the depth of the new reservoir with a diamond blade saw. The removed sealant shall become the property of the Contractor and be removed from the jobsite.

Removal of the old sealant for the entire depth of the joint is not required if the depth of the new reservoir is less than the depth of the existing joint.

Joints constructed with joint tape do not require cleaning and sealing.

Immediately prior to sealing, the cracks shall be blown clean with dry oil-free compressed air. The joints shall be completely dry before the sealing installation may begin. Immediately following the air blowing, the sealant material shall be installed in conformance to manufacturer's recommendations and in accordance with Section 5-05.3(8)B.

The top surface of the sealant shall be at least ¼-inch below the surface of the pavement.

5-01.3(9) Portland Cement Concrete Pavement Grinding

Pavement grinding shall begin within 10 working days of placing dowel bar retrofit patching materials. Once the grinding operation has started it shall be continuous until completed. The right travel lane in the direction of traffic shall be ground first.

The pavement shall be ground in a longitudinal direction beginning and ending at lines normal to the pavement centerline. The minimum overlap between longitudinal passes shall be 2.0-inches. 95% of the surface area of the pavement to be ground shall have a minimum of $^{1}/_{8}$-inch removed by grinding.

Bridge decks, bridge approach slabs and bridge overlay insets shall not be ground. The ground pavement shall be feathered to match the elevation of the above features.

5-01.3(9)A Surface Finish

The final surface texture shall be uniform in appearance with longitudinal corduroy type texture. The grooves shall be between $^{3}/_{32}$ and $^{5}/_{32}$-inches wide, and no deeper than $^{1}/_{16}$-inch. The land area between the grooves shall be between $^{1}/_{16}$ and $^{1}/_{8}$-inches wide.

5-01.3(10) Pavement Smoothness

Section 5-05.3(12) is supplemented with the following:

Where the pavement is ground, calculation of the profile index shall exclude dips and depressions in the existing roadway. The profilograph generated reports shall be provided to the Engineer prior to payment.

5-01.3(11) Concrete Slurry

All concrete slurry and grinding residue shall be removed from the roadway on a continual basis immediately behind the grinding or cutting operations. Slurry shall not be allowed to drain across open traffic lanes and shoulders. Slurry shall not be allowed to drain into any waterway, placed on the roadway slope within 200-feet of any waterway, or other areas as designated by the Engineer. Prior to commencing grinding or cutting operations, the Contractor shall submit to the Engineer for approval a plan to prevent contaminants, such as grinding slurry or concrete debris, from entering ditches, culverts, or other waterways, including wetlands or aquifers.

Concrete slurry shall be collected from the roadway and disposed of by the Contractor off the project site. The Contractor shall provide a copy of the permit for an approved waste site for the disposal of the slurry prior to the start of the grinding.

Opening to traffic shall meet the requirements of Section 5-05.3(17).

5-01.4 Measurement

Testing cement concrete pavement slabs for subsealing will be measured per each transverse joint, for each traffic lane tested. Measurement of this item will be made only once and will not be measured again after necessary retesting.

Pavement subseal will be measured by the cubic foot of dry materials.

Retrofit dowel bars will be measured per each for the actual number of bars used in the completed work.

Cement concrete pavement grinding will be measured by the square yard, based on the actual width and length of area ground. Extra passes to meet the specifications or overlaps will not be measured.

5-01.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Testing Cement Concrete Pavement Slabs For Subsealing", per each.

The unit contract price per each, when multiplied by the number of units measured, shall be full payment for all costs to complete the testing of all joints located in the areas shown in the Plans. The costs of any retesting required by the specifications shall also be included.

"Drill Hole for Subsealing", per each.

"Pavement Subseal", per cubic foot.

"Replace Cement Concrete Panel", per square yard.

The unit contract price per square yard shall be full payment for all costs to complete the work as specified, including saw cutting full depth, removal and disposal of the existing panels off of the State's right-of-way, preparing the surfacing below the new panel, provide, place and compact the crushed surfacing or hot mix asphalt, furnishing and placing polyethylene film, furnishing and placing the portland cement concrete, drilling the holes, providing and anchoring the dowel bars and tie bars, and for all incidentals required to complete the work as specified.

"Retrofit Dowel Bars", per each.

The unit contract price per each shall be full payment for all costs to complete the work as specified, including furnishing and installing parting compound, dowel bar expansion caps, caulking filler, foam core insert material, cement patch where pavement is removed for dowel bar retrofit and for all incidentals required to complete the work as specified.

"Partial Depth Spall Repair", by force account as provided in Section 1-09.6.

To provide a common proposal for all bidders, the Contracting Agency has entered an amount in the proposal to become a part of the total bid by the Contractor.

"Sealing Existing Concrete Random Crack", per linear foot.

The unit contract price per linear foot for "Sealing Existing Concrete Random Crack" shall be full payment for all costs to complete the work as specified, including removing incompressible material, preparing and sealing existing random cracks where existing random cracks are cleaned and for all incidentals required to complete the work as specified.

"Sealing Transverse and Longitudinal Joints", per linear foot.

The unit contract price per linear foot for "Sealing Transverse and Longitudinal Joints", shall be full payment for all costs to complete the work as specified, including removing incompressible material, preparing and sealing existing transverse and longitudinal joints where existing transverse and longitudinal joints are cleaned and for all incidentals required to complete the work as specified. "Cement Concrete Pavement Grinding", per square yard.

The unit contract price per square yard for "Cement Concrete Pavement Grinding", when multiplied by the number of units measured, shall be full payment for all costs to complete the work as specified. The costs of any additional pavement grinding, profiling, removal and disposing of slurry required to complete the work as specified is also included in this payment.

"Replace Uncompactable Material", by force account as provided in Section 1-09.6

Payment for "Replace Uncompactable Material" will be by force account as provided in Section 1-09.6. For the purpose of providing a common proposal for bidders, the Contracting Agency has entered an amount in the proposal to become a part of the total bid by the Contractor.

5-02 BITUMINOUS SURFACE TREATMENT

5-02.1 Description

This work shall consist of constructing a single or multiple course bituminous surface treatment in accordance with these Specifications and in conformity with the lines and cross-sections shown in the Plans or as designated by the Engineer. During bituminous surface treatment paving operations, temporary raised pavement markings shall be maintained throughout the project. Temporary raised pavement markings shall be installed on the roadway that was paved that day. Temporary raised pavement markings shall be in accordance with Section 8-23.

5-02.1(1) Bituminous Surface Treatment Class A

This method of treatment requires two applications of asphalt and three applications of aggregate as specified. The second application (tack coat) shall be applied not less than ten days after the first application (prime coat) for cutback asphalts and as approved by the Engineer for emulsified asphalts.

5-02.1(2) Bituminous Surface Treatment Classes B, C, and D

These methods require the placing of one application of asphalt and one or more sizes of aggregate as specified to an existing asphalt roadway to seal and rejuvenate the surface and to produce a uniform roadway surface with good nonskid characteristics.

5-02.2 Materials

Materials shall meet the requirements of the following sections:

Asphalt (grade specified)	9-02
Anti-Stripping Additive	9-02.4
Aggregates	9-03.4

Aggregate to be used for bituminous surface treatment shall be of the type and size called for in the Plans or in the proposal.

The particular asphalt to be used on any project shall be that which is called for in the Special Provisions, the proposal, or shown in the Plans, and may be conditionally accepted at the source.

When cutback asphalts are specified or ordered by the Engineer for BST Class A, or for BST Class C used in conjunction with BST Class A, construction shall not begin until the need for anti-stripping additive has been determined. The Contractor shall allow a minimum of seven working days after the necessary aggregate, asphalt, and additive samples have been received in the Headquarter's Materials Laboratory in Tumwater for the necessary tests. Additional time will be required if the Contractor has requested more than one source of asphalt or additive be approved.

5-02.3 Construction Requirements

5-02.3(1) Equipment

The equipment used by the Contractor shall include scarifying, mixing, spreading, finishing and compacting equipment, an asphalt distributor, and equipment for heating asphalt material and shall be subject to approval by the Engineer before its use on the work.

The distributor shall have a capacity of not less than 1,000 gallons, and shall be so designed, equipped, maintained, and operated that asphalt material of an even heat shall be uniformly applied at the required rate. It shall be equipped with a 10-foot spray bar with extensions, pressure pump and gauge, volume gauge so located as to be observed easily by the Inspector from the ground, a tachometer to control accurately the speed and spread of asphalt, and two thermometers, one installed permanently in the tank to indicate temperatures of the asphalt at all times. The power for operating the pressure pump shall be supplied by a power unit which will provide a uniform spray from each of the nozzles across the spray bar and extensions.

Rollers shall be self-propelled pneumatic-tired or smooth-wheeled rollers, each weighing not less than 10 tons.

Spreading equipment shall be self-propelled, supported on at least four pneumatic tires, with an approved device for accurately metering and distributing the aggregate uniformly over the roadway surface.

Brooms shall be motorized with a positive means of controlling vertical pressure.

Other equipment necessary to satisfactorily perform the work as specified herein or as designated by the Engineer, shall be subject to approval by the Engineer before its use on the work.

Additional units shall be placed on the work when, in the opinion of the Engineer, it is considered necessary in order to fulfill the requirements of these Specifications, or to complete the work within the time specified.

5-02.3(2) Preparation of Roadway Surface

5-02.3(2)A Untreated Surfaces

The existing roadway surface shall be shaped to a uniform grade and cross-section as shown in the Plans, or as designated by the Engineer.

The roadway shall be sprinkled, bladed, and rolled, after which the top 1-inch of dampened material shall be bladed back and forth across the roadway until the entire roadway surface shows a uniform grading from coarse to fine and conforms to the line, grade, and cross-section shown in the Plans, or as staked. The entire surface shall then be rolled with a smooth-wheeled or pneumatic-tired roller, or both, as designated by the Engineer, except that the final rolling shall be accomplished with a smooth-wheeled roller as specified in Section 5-02.3(1). Rolling shall continue until the entire roadway presents a firm and unyielding surface.

In the event the compacted aggregates are of such gradation as to resist penetration of the cutback asphalts, the Contractor shall loosen no more than the upper $^1/_2$-inch of surface and relay without compaction immediately before the prime coat application.

No traffic will be allowed on the repaired surface until the prime coat of asphalt and aggregate is applied.

During the operation of blading and rolling, water shall be applied, if necessary, in the amount and at the locations designated by the Engineer.

Immediately before the prime coat of asphalt is applied, the roadway surface shall be stable and unyielding, dry to medium damp condition, free from irregularities and material segregation, and true to line, grade, and cross-section.

5-02.3(2)B Treated Surfaces

The existing bituminous surface shall be swept with a power broom until it is free from dirt or other foreign matter. Hand push brooms shall be used to clean omissions of the power broom. In addition to power and hand brooms, the use of other equipment may be necessary to thoroughly clean the roadway prior to the application of asphalt. Berms created by the removal of dirt or other foreign matter shall be evenly distributed over the remaining shoulder or roadway slope.

As soon as the existing surface has been thoroughly cleaned, all holes in the surface, edges, and edge breaks shall be patched. The holes and breaks shall be thoroughly cleaned of all dirt and loose material. For shallow holes and breaks, a small amount of asphalt shall be placed in the bottom of the hole, covered with aggregate and thoroughly tamped or rolled. For holes 1-inch or more in depth, a premix material of aggregate mixed with asphalt as determined by the Engineer shall be used. Asphalt used for patching shall be heated to the temperature specified in Section 5-02.3(3).

Before placing the premix material in the hole, the bottom and edges of the hole shall be swabbed with asphalt. The premixed material shall then be placed and thoroughly tamped or rolled. A small amount of fine screenings shall then be spread on the top of the patch.

Larger depression areas shall be corrected by pre-leveling with premix material or with successive applications of bituminous surface treatment as shown in the Plans or as designated by the Engineer to re-establish a crown-section.

All costs for patching as described above shall be included in the unit contract price per ton for “Asphalt (grade)” and per cubic yard for “Agg. From Stockpile for BST.”

5-02.3(2)C Soil Residual Herbicide

Where shown in the Plans, soil residual herbicide shall be applied in accordance with Section 5-04.3(5)D. All other provisions of Section 5-04 pertaining to soil residual herbicide shall apply.

5-02.3(3) Application of Asphalt

Upon the properly prepared roadway surface, asphalt of the grade specified in the Special Provisions shall be uniformly applied with distributors and specified aggregates spread at the following rates:

	Application Rate		
	Asphalt (gal. per sq. yd.) Applied	Aggregate Size (In.)	Aggregates (lbs. per sq. yd.) Applied
Class A			
Prime Coat	0.35-0.55	$^1/_2$-U.S. No. 4 or $^3/_4$-$^1/_2$	25-40
Tack Coat	0.35-0.50	$^1/_2$-U.S. No. 4 U.S. No. 4-0	25-35 4-6
Class B	0.40-0.60	$^5/_8$-U.S. No. 4 U.S. No. 4-0	25-40 4-6
Class C	0.35-0.50	$^1/_2$-U.S. No. 4 U.S. No. 4-0	20-30 4-6
Class D	0.20-0.35	$^3/_8$-#10	18-25
Pre Seal	0.15-0.20	U.S. No. 4-0	8-15

The Engineer will determine the application rates.

Longitudinal joints will be allowed at only the centerline of the roadway, the center of the driving lanes, or the edge of the driving lanes.

To ensure uniform distribution of asphalt, prior to beginning work, the distributor bar shall be operated over a pit or vat. A minimum of 100 gallons of material shall remain in the distributor at the end of each shot. To avoid gaps and ridges at transverse junctions of separate applications of asphalt, the Contractor shall spread sufficient building paper over the treated surface to ensure that the spray jets will be functioning normally when the untreated surface is reached. If ordered by the Engineer, the joints shall be cut back to a neat edge prior to placing the building paper.

Should ridges, overlaps, or gaps occur at transverse joints, the Contractor shall repair the defects to the satisfaction of the Engineer. In lieu of repair the Engineer may elect to accept the completed joints and will deduct from monies due or that may become due the Contractor, the sum of $200 for each joint where the deviations described above are found.

All costs involved in making the corrections to defects described above shall be borne by the Contractor and no payment will be made for this work.

Omissions (skips) by the distributor shall be immediately covered by hand patching with the same grade of asphalt and aggregate used on the project.

The area covered by any one spread of asphalt shall be no more than can be covered with aggregate within one minute from the time of application upon any part of the spread. If field conditions warrant, this time may be increased as designated by the Engineer.

Unless otherwise designated by the Engineer, asphalt shall be spread toward the source of aggregate to avoid injury to the freshly treated surface.

Before they are applied to the roadway, asphalt materials shall be heated to the temperature determined by the Engineer, but within the following limits:

Type and Grade of Asphalt	Distributor Spraying Min. F	Temperature Max. F
LIQUID ASPHALTS		
MC, RC70 Viscosity	120	180
MC, RC250 Viscosity	165	220
MC, RC800 Viscosity	200	255
MC, RC3000 Viscosity	230	280
ASPHALT EMULSIONS		
CSS-1, CSS-1h, STE-1	70	140
CRS-1, CRS-2, CMS-2	125	185
CMS-2s, CMS-2h	125	185

5-02.3(4) Change in Grades of Asphalt

At any time during the progress of the work, the Engineer may order the use of other grades of asphalt materials in substitution of the grades specified in the Special Provisions if the intent of the specifications will be better attained.

If the market price of the grade substituted is higher than that of the grade specified, the difference will be added to the unit contract price for asphalt, or if lower, it will be deducted from the unit contract price.

5-02.3(5) Application Method of Aggregates

After the asphalt has been spread evenly over the roadway surface, aggregates of the type specified shall be evenly applied to the roadway surface by spreader equipment.

All aggregate stockpiles shall be watered down to provide aggregates that are uniformly damp at the time of placement on the roadway.

The aggregate shall be spread in one operation in such a manner that an 8-inch strip of asphalt is left exposed along the longitudinal joint to form a lap for the succeeding applications of asphalt. If necessary, thin or bare spots in the spread of aggregate shall be corrected by hand spreading or by the use of an approved motor patrol grader equipped with a wire broom moldboard or other methods subject to approval of the Engineer.

A minimum of three rollers shall be used. Two pneumatic-tired rollers shall provide two complete coverages immediately behind the spreading equipment for the coarse aggregate. The third roller which provides the final rolling shall be a smooth wheeled roller for Class A construction over untreated bases. A pneumatic-tired roller shall be used in all other situations.

The maximum rate of roller travel shall be limited to 5 mph.

The Contractor shall apply fine aggregates to the roadway with additional spreading equipment immediately following the initial rolling of the coarse aggregate unless otherwise specified in the contract documents or ordered by the Engineer. Excess aggregate shall be removed from the roadway.

The operation of trucks hauling aggregate from the stockpile shall be so regulated that no damage, as determined by the Engineer, will result to the highway or the freshly applied asphalt surface.

The completed surface shall be allowed to cure overnight and shall be broomed off the following morning before 10 a.m. If brooming causes rock to be turned or if the Engineer determines that additional cure is needed, the Contractor shall broom the roadway when directed by the Engineer.

If, after completion of the initial brooming, the Engineer determines the need to remobilize for additional brooming, the Contractor shall rebroom the areas designated by the Engineer.

5-02.3(6) Additional Asphalt and Aggregate

If the application of asphalt or aggregate, or both, is insufficient or excessive for the required results, the Engineer may require the Contractor to make an additional application of one or both materials in accordance with these Specifications, or at the direction of the Engineer. Additional asphalt or aggregate used will be paid for at the unit contract prices for the materials used.

5-02.3(7) Patching and Correction of Defects

Omissions by the distributor or damage to the treated surface of any coat shall be immediately covered by hand patching with asphalt in adequate quantities. Holes which develop in the surface shall be patched in the same manner as specified in Section 5-02.3(2)A. All costs incurred by the Contractor, in coating omissions and patching, shall be included in the unit contract prices for the materials used.

Defects such as raveling, lack of uniformity, or other imperfections caused by faulty workmanship shall be corrected and new work shall not be started until such defects have been remedied.

All improper workmanship and defective materials resulting from overheating, improper handling or application, shall be removed from the roadway by the Contractor and be replaced with approved materials and workmanship at no expense to the Contracting Agency.

If the Engineer determines a fog seal is necessary at any time during the life of the contract, the Contractor shall apply a fog seal of CSS-1 at the rate of 0.07 to 0.18 (0.02 to 0.05 residual) gallons per square yard. The emulsified asphalt shall be diluted with water at a rate of one part water to one part emulsified asphalt unless otherwise directed by the Engineer.

5-02.3(8) Progress of Work

The Contractor shall organize the work so that progress will be equivalent to at least 3 centerline miles work per day of completed prime or tack coat on Class A bituminous surface treatment, or 4 miles work per day of completed roadway on Classes B, C, or D bituminous surface treatment. No longitudinal joints shall remain open overnight.

5-02.3(9) Protection of Structures

All bridge handrails, guardrails, curbs, road signs, or other facilities shall be protected from splashing of the asphalt. All costs incurred by the Contractor in necessary protective measures shall be included in the unit contract prices for the various bid items of work involved.

5-02.3(10) Unfavorable Weather

Asphalt shall not be applied to wet material. Subject to the determination of the Engineer, asphalt shall not be applied during rainfall, sand or dust storms, or before any imminent storms that might damage the construction. The Engineer will have the discretion as to whether the surface and materials are dry enough to proceed with construction.

The application of any asphalt to the roadway shall be restricted to the following conditions:

The roadway surface temperature shall be at least 60ºF and the air temperature at least 60ºF and rising, or

The air temperature shall be not less than 70ºF when falling and the wind shall be less than 10 miles per hour as estimated by the Engineer.

No asphalt shall be applied which cannot be covered one hour before darkness. The Engineer may require the Contractor to delay application of asphalt until the atmospheric and roadway conditions are satisfactory.

Construction of bituminous surface treatments on any traveled way shall not be carried out before May 15 or after August 15 of any year except upon written order of the Regional Administrator.

5-02.3(11) Anti-Stripping Additive

When requested by the Engineer, an anti-stripping additive shall be added to the asphalt material in accordance with Section 9-02.4.

5-02.4 Measurement

Processing and finishing will be measured by the mile to the nearest 0.01 mile along the main line roadway. All related supplemental roadways and irregular shaped areas will be incidental.

Asphalt of the grade or grades specified will be measured by the ton in accordance with Section 1-09.1.

Asphalt for fog seal will be measured by the ton, before dilution, in accordance with Section 1-09.

Aggregate from stockpile, and furnishing and placing aggregate will be measured by the cubic yard in trucks at the point of delivery on the roadway.

Additional brooming will be measured by the hour.

Water will be measured in accordance with Section 2-07.

5-02.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Processing and Finishing", per mile.

"Asphalt (_____)", per ton.

"Asphalt for Fog Seal", per ton.

"Anti-Stripping Additive", by force account.

"Anti-Stripping Additive" will be paid for in accordance with Section 1-09.6 except that no overhead, profit, or other costs will be allowed. Payment will be made only for the invoice cost of the additive. The quantity of asphalt material shall not be reduced by the quantity of anti-stripping additive. For the purpose of providing a common proposal for all bidders, the Contracting Agency has entered an amount in the proposal to become a part of the total bid by the Contractor.

"Agg. from Stockpile for BST", per cubic yard.

"Furnishing and Placing Crushed (_____)", per cubic yard.

"Additional Brooming", per hour.

"Water", per M gal.

If the proposal does not include a bid item for water, the Contractor shall dampen stockpiled or furnished aggregate as required, and the cost thereof shall be included in other items of the work.

5-03 VACANT

5-04 HOT MIX ASPHALT

5-04.1 Description

This work shall consist of providing and placing one or more layers of plant-mixed hot mix asphalt (HMA) on a prepared foundation or base in accordance with these Specifications and the lines, grades, thicknesses, and typical cross-sections shown in the Plans.

HMA shall be composed of asphalt binder and mineral materials as may be required, mixed in the proportions specified to provide a homogeneous, stable, and workable mixture.

5-04.2 Materials

Materials shall meet the requirements of the following sections:

Asphalt Binder	9-02.1(4)
Cationic Emulsified Asphalt	9-02.1(6)
Anti-Stripping Additive	9-02.4
Aggregates	9-03.8
Blending Sand	9-03.8(4)
Mineral Filler	9-03.8(5)
Recycled Material	9-03.21

The contract documents may establish that the various mineral materials required for the manufacture of HMA will be furnished in whole or in part by the Contracting Agency. If the documents do not establish the furnishing of any of these mineral materials by the Contracting Agency, the Contractor shall be required to furnish such materials in the amounts required for the designated mix. Mineral materials include coarse and fine aggregates, blending sand, and mineral filler.

The Contractor may choose to utilize recycled asphalt pavement (RAP) in the production of HMA. If utilized, the amount of RAP shall not exceed 20% of the total weight of aggregate in the mix. The RAP may be from pavements removed under the contract, if any, or pavement material from an existing stockpile.

The grade of asphalt binder shall be as required by the contract. Prior to the submittal of the mix design, the Contractor shall provide a written designation of the grade of PG asphalt binder to be used. The Contractor may propose the substitution of alternate grades of performance grade (PG) asphalt binder at no cost to the Contracting Agency. The proposal will be approved if the proposed alternate asphalt binder has an average 7-day maximum pavement design temperature that is equal to or higher than the specified asphalt binder and has a minimum pavement design temperature that is equal to or lower than the specified asphalt binder. The substituted alternate grade of asphalt binder shall be used in all HMA contract items of the same class and originally specified grade of asphalt binder. Blending of asphalt binder from different sources is not permitted.

When the Contracting Agency provides aggregates or provides a source for the production of aggregates, the contract provisions will establish the approximate percentage of asphalt binder required in the mixture for each class of pavement.

Production of aggregates shall comply with the requirements of Section 3-01.

Preparation of stockpile site, the stockpiling of aggregates, and the removal of aggregates from stockpiles shall comply with the requirements of Section 3-02.

5-04.3 Construction Requirements

5-04.3(1) HMA Mixing Plant

Plants used for the preparation of HMA shall conform to the following requirements:

1. **Equipment for Preparation of Asphalt Binder.** Tanks for the storage of asphalt binder shall be equipped to heat and hold the material at the required temperatures. The heating shall be accomplished by steam coils, electricity, or other approved means so that no flame shall be in contact with the storage tank. The circulating system for the asphalt binder shall be designed to ensure proper and continuous circulation during the operating period. A valve for the purpose of sampling the asphalt binder shall be placed in either the storage tank or in the supply line to the mixer.
2. **Thermometric Equipment.** An armored thermometer, capable of detecting temperature ranges expected in the HMA mix, shall be fixed in the asphalt binder feed line at a location near the charging valve at the mixer unit. The thermometer location shall be convenient and safe for access by inspectors.

   The plant shall also be equipped with an approved dial-scale thermometer, a mercury actuated thermometer, an electric pyrometer, or another approved thermometric instrument placed at the discharge chute of the drier to automatically register or indicate the temperature of the heated aggregates. This device shall be in full view of the plant operator.
3. **Sampling and Testing of Mineral Materials.** The HMA plant shall be equipped with a mechanical sampler for the sampling of the mineral materials. The mechanical sampler shall meet the requirements of Section 1-05.6 for the crushing and screening operation.

   The contractor shall provide sufficient space as required for the setup and operation of the field testing facilities of the Contracting Agency.

5-04.3(2) Hauling Equipment

Trucks used for hauling HMA shall have tight, clean, smooth metal beds and shall have a cover of canvas or other suitable material of sufficient size to protect the mixture from adverse weather. Whenever the weather conditions during the workshift include, or are forecast to include, precipitation or an air temperature less than 45°F, the cover shall be securely attached to protect the HMA.

In order to prevent the HMA mixture from adhering to the hauling equipment, truck beds are to be sprayed with an environmentally benign release agent. Excess release agent shall be drained prior to filling hauling equipment with HMA. Petroleum derivatives or other coating material that contaminate or alter the characteristics of the HMA shall not be used. For hopper trucks, the conveyer shall be in operation during the process of applying the release agent.

5-04.3(3) Hot Mix Asphalt Pavers

HMA pavers shall be self-contained, power-propelled units, provided with an internally heated vibratory screed and shall be capable of spreading and finishing courses of HMA plant mix material in lane widths required by the paving section shown in the Plans.

The screed shall be operated in accordance with the manufacturer's recommendations and shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, segregating, or gouging the mixture. A copy of the manufacturer's recommendations shall be provided upon request by the Contracting Agency. Extensions will be allowed provided they produce the same results, including ride, density, and surface texture as obtained by the primary screed. Extensions without augers and an internally heated vibratory screed shall not be used in the traveled way.

When laying HMA, the paver shall be operated at a uniform forward speed consistent with the plant production rate and roller train capacity to result in a continuous operation. The auger speed and flight gate opening shall be adjusted to coordinate with the operation.

The paver shall be equipped with automatic screed controls with sensors for either or both sides of the paver. The controls shall be capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing automatic signals that operate the screed to maintain the desired grade and transverse slope. The sensor shall be constructed so it will operate from a reference line or a mat referencing device.

The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. The paver shall be equipped with automatic feeder controls, properly adjusted to maintain a uniform depth of material ahead of the screed.

Manual operation of the screed will be permitted in the construction of irregularly shaped and minor areas. These areas include, but are not limited to, gore areas, road approaches, tapers and left-turn channelizations.

When specified in the contract, reference lines for vertical control will be required. Lines shall be placed on both outer edges of the traveled way of each roadway. Horizontal control utilizing the reference line will be permitted. The grade and slope for intermediate lanes shall be controlled automatically from reference lines or by means of a mat referencing device and a slope control device. When the finish of the grade prepared for paving is superior to the established tolerances and when, in the opinion of the Engineer, further improvement to the line, grade, cross-section, and smoothness can best be achieved without the use of the reference line, a mat referencing device may be substituted for the reference line. Substitution of the device will be subject to the continued approval of the Engineer. A joint matcher may be used subject to the approval of the Engineer. The reference line may be removed after the completion of the first course of HMA when approved by the Engineer. Whenever the Engineer determines that any of these methods are failing to provide the necessary vertical control, the reference lines will be reinstalled by the Contractor.

The Contractor shall furnish and install all pins, brackets, tensioning devices, wire, and accessories necessary for satisfactory operation of the automatic control equipment.

If the paving machine in use is not providing the required finish, the Project Engineer may suspend work as allowed by Section 1-08.6. Any cleaning or solvent type liquids spilled on the pavement shall be thoroughly removed before paving proceeds.

5-04.3(4) Rollers

Rollers shall be of the steel wheel, vibratory, or pneumatic tire type, in good condition and capable of reversing without backlash. Operation of the roller shall be in accordance with the manufacturer's recommendations. When ordered by the Project Engineer for any roller planned for use on the project, the Contractor shall provide a copy of the manufacturer's recommendation for the use of that roller for compaction of HMA. The number and weight of rollers shall be sufficient to compact the mixture in compliance with the requirements of Section 5-04.3(10). The use of equipment that results in crushing of the aggregate will not be permitted. Rollers producing pickup, washboard, uneven compaction of the surface, displacement of the mixture or other undesirable results shall not be used.

5-04.3(5) Conditioning of Existing Surface

When the surface of the existing pavement or old base is irregular, the Contractor shall bring it to a uniform grade and cross-section as shown on the plans or approved by the Engineer.

Preleveling of uneven or broken surfaces over which HMA is to be placed may be accomplished by using an asphalt paver, a motor patrol grader, or by hand raking, as approved by the Engineer.

5-04.3(5)A Preparation of Existing Surfaces

Before construction of HMA on an existing paved surface, the entire surface of the pavement shall be clean. All fatty asphalt patches, grease drippings, and other objectionable matter shall be entirely removed from the existing pavement. All pavements or bituminous surfaces shall be thoroughly cleaned of dust, soil, pavement grindings, and other foreign matter. All holes and small depressions shall be filled with an appropriate class of HMA.The surface of the patched area shall be leveled and compacted thoroughly.

A tack coat of asphalt shall be applied to all paved surfaces on which any course of HMA is to be placed or abutted. Tack coat shall be uniformly applied to cover the existing pavement with a thin film of residual asphalt free of streaks and bare spots. A heavy application of tack coat will be applied to all joints. For roadways open to traffic, the application of tack coat shall be limited to surfaces that will be paved during the same working shift. The spreading equipment shall be equipped with a thermometer to indicate the temperature of the tack coat material.

Equipment shall not operate on tacked surfaces until the tack has broken and cured. If the Contractor's operation damages the tack coat it shall be repaired prior to placement of the HMA.

Unless otherwise approved by the Engineer, the tack coat shall be CSS-1, CSS-1h, or STE-1 emulsified asphalt. The CSS-1 and CSS-1h emulsified asphalt may be diluted with water at a rate not to exceed one part water to one part emulsified asphalt. The tack coat shall not exceed the maximum temperature recommended by the emulsified asphalt manufacturer.

5-04.3(5)B Preparation of Untreated Roadway

When designated in the plans the existing roadway shall be prepared and primed. The roadway preparation shall be performed in accordance with the Bituminous Surface Treatment provisions for this type of work (Section 5-02.3(2)A), except that only one application of asphalt and one application of aggregate shall be applied. The aggregate

shall conform either to the requirements of Section 9-03.4, 9-03.8 or shall consist of other material approved by the Engineer. All other provisions of Section 5-02 pertaining to bituminous surface treatment Class A shall apply to this preparation work, except as hereinafter modified.

The prime coat shall be applied over the full length of the project. HMA shall not be placed until the prime coat has cured for 5 days unless otherwise approved by the Engineer.

Should any holes, breaks, or irregularities develop in the roadway surface after the prime coat has been applied, they shall be patched, as described in Section 5-04.3(5)A, before placement of the HMA pavement. The Contractor shall maintain the completed prime coat by blading or brooming with equipment and procedures approved by the Engineer, until the HMA pavement is placed.

After the maintenance, patching or repair work has been completed and immediately prior to placing the HMA, the surface of the prime coat shall be swept clean of all dirt, dust, or other foreign matter.

When the prime coat application is not specified in the Special Provisions or shown in the Plans, the Contractor shall prepare the untreated roadway as described above and shall omit the prime coat treatment. The HMA shall be constructed on the prepared subgrade.

The Contractor shall prepare untreated shoulders and traffic islands by blading and compacting to provide a sound base for paving and shall omit the prime coat treatment. The HMA shall be constructed on the prepared subgrade.

5-04.3(5)C Crack Sealing

When the proposal includes a pay item for crack sealing, all cracks and joints ¼-inch and greater in width shall be cleaned with a stiff-bristled broom and compressed air and then shall be filled completely with sand slurry.

The sand slurry shall consist of approximately 20 percent CSS-1 emulsified asphalt, approximately 2 percent Portland cement, water (if required), and the remainder clean U.S. No. 4-0 paving sand. The components shall be thoroughly mixed and then poured into the cracks and joints until full. The following day, any cracks or joints that are not completely filled shall be topped off with additional sand slurry. After the sand slurry is placed, the filler shall be struck off flush with the existing pavement surface and allowed to cure. The HMA overlay shall not be placed until the slurry has fully cured. The requirements of Section 1-06 will not apply to the Portland cement and paving sand used in the sand slurry.

5-04.3(5)D Soil Residual Herbicide

Where shown in the Plans, the Contractor shall apply one application of an approved soil residual herbicide. The requirements of Section 8-02.3(2)A shall apply to this application. Paving shall begin within 24 hours after application of the herbicide.

The material to be used shall be registered with the Washington State Department of Agriculture for use under pavement. Before use, the Contractor shall obtain approval of the material to be used and the proposed rate of application from the Project Engineer. The following information shall be included in the request for approval of the material:

1. Brand Name of the Material;
2. Manufacturer;
3. Environmental Protection Agency (EPA) Registration Number;
4. Material Safety Data Sheet; and
5. Proposed Rate of Application.

5-04.3(5)E Pavement Repair

The Contractor shall excavate pavement repair areas and shall backfill these with HMA in accordance with the details shown in the Plans and as staked.

The Project Engineer will determine the excavation depth, which may vary up to one foot. The determination will depend on the location of material suitable for support of the pavement.

The minimum width of any pavement repair area shall be three feet unless shown otherwise in the Plans. Before any excavation, the existing pavement shall be sawcut or shall be removed by a pavement grinder.

Asphalt for tack coat shall be required as specified in Section 5-04.3(5)A. A heavy application of tack coat shall be applied to all surfaces of existing pavement in the pavement repair area.

The Contractor shall excavate only within one lane at a time unless approved otherwise by the Project Engineer. Any repair areas started during a workshift shall be completed during the same workshift. The Contractor shall not excavate more area than can be completely finished during the same shift.

Excavated materials will become the property of the Contractor and shall be disposed in a Contractor-provided site off the right-of-way or used in accordance with Sections 2-02.3(3) or 9-03.21.

The Contractor shall conduct the excavation operations in a manner that will protect the pavement that is to remain. Pavement not designated to be removed that is damaged as a result of the Contractor's operations shall be repaired by the Contractor to the satisfaction of the Project Engineer at no cost to the Contracting Agency.

Placement of the HMA backfill shall be accomplished in lifts not to exceed 0.35 foot compacted depth. Each lift shall be thoroughly compacted by a mechanical tamper or a roller.

5-04.3(6) Heating of Asphalt Binder

The temperature of the asphalt binder shall not exceed the maximum recommended by the asphalt binder manufacturer. The asphalt binder shall be heated in a manner that will avoid local variations in heating. The heating method shall provide a continuous supply of asphalt binder to the mixer at a uniform average temperature with no individual variations exceeding 25°F.

5-04.3(7) Preparation of Aggregates

The aggregates shall be stockpiled according to the requirements of Section 3-02. Sufficient storage space shall be provided for each size of aggregate. The aggregates shall be removed from stockpile(s) in a manner to ensure a minimum of segregation when being moved to the HMA plant for processing into the final mixture. Different aggregate sizes shall be kept separated until they have been delivered to the HMA plant.

5-04.3(7)A Mix Design

1. **General.** Prior to the production of HMA, the Contractor shall determine a design aggregate structure and asphalt binder content in accordance with WSDOT Standard Operating Procedure 732. Once the design aggregate structure and asphalt binder content have been determined, the Contractor shall submit the HMA mix design on DOT form 350-042 demonstrating that the design meets the requirements of Sections 9-03.8(2) and 9-03.8(6). For HMA accepted by commercial evaluation only the first page of DOT form 350-042 and the percent of asphalt binder is required. In no case shall the paving begin before the determination of anti-strip requirements has been made.

   Changes to the aggregate or asphalt binder require approval of the Engineer and may require a new mix design submittal from the contractor. For aggregate this will include changes in the source of material or a change in the percentage of material from a stockpile greater than 5%. Asphalt binder changes include the source of the crude petroleum supplied to the refinery, the refining process and additives or modifiers in the asphalt binder. For mix designs that will be used in more than one calendar year and have not changed the contractor shall submit a certification that the mix design has not changed.

2. **Statistical or Nonstatistical Evaluation.** When the contract calls for either of these evaluation methods, the Contractor shall submit representative samples of the mineral materials that are to be used in the HMA production. The Contracting Agency will use these samples to determine anti-strip requirements, if any, in accordance with WSDOT test method T 718 and will also conduct verification testing of the mix design. Verification testing of HMA mix designs proposed by the contractor that include RAP will be completed without the inclusion of the RAP. Submittal of RAP samples is not required. A mix design verification report will be provided within 25 calendar days after a mix design submittal has been received in the State Materials Laboratory in Tumwater.

   If the results of the verification testing of the mix design by the Contracting Agency are within the tolerances in Section 9-03.8(7) the mix design will be considered verified. HMA requiring nonstatistical evaluation must have a verified mix design before paving will be allowed. Where HMA requires statistical evaluation, and where the mix design did not meet the required tolerances to be verified, the contractor shall have the option to either resubmit a new mix design or proceed to paving the HMA mixture test section.

   The mix design will be the initial job mix formula (JMF) for the class of mix. Any additional adjustments to the JMF will require the approval of the Project Engineer and may be made per Section 9-03.8(7).

3. **Commercial Evaluation.** Verification of the mix design by the Contracting Agency is not required. The Project Engineer will determine anti-strip requirements for the HMA. For commercial HMA, the contractor shall select a class of HMA and design level of Equivalent Single Axle Loads (ESAL's) appropriate for the required use.

5-04.3(8) Mixing

After the required amounts of mineral materials and asphalt binder have been introduced into the mixer the HMA shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the asphalt binder throughout the mineral materials is ensured.

When discharged, the temperature of the HMA shall not exceed the maximum temperature recommended by the asphalt binder manufacturer. A maximum water content of 2 percent in the mix, at discharge, will be allowed providing the water causes no problems with handling, stripping, or flushing. If the water in the HMA causes any of these problems, the moisture content shall be reduced as directed by the Project Engineer.

Storing or holding of the HMA in approved storage facilities will be permitted during the daily operation but in no event shall the HMA be held for more than 24 hours. HMA held for more than 24 hours after mixing shall be rejected. Rejected HMA shall be disposed of by the Contractor at no expense to the Contracting Agency. The storage facility shall have an accessible device located at the top of the cone or about the third point. The device shall indicate the amount of material in storage. No HMA shall be accepted from the storage facility when the HMA in storage is below the top of the cone of the storage facility, except as the storage facility is being emptied at the end of the working shift.

5-04.3(8)A Acceptance Sampling and Testing—HMA Mixture

1. **General.** Acceptance of HMA shall be as provided under statistical, nonstatistical or commercial evaluation.

   Acceptance of HMA by statistical evaluation is administered under the provisions of Section 5-04.5(1) Quality Assurance Price Adjustments. Statistical evaluation will be used for a class of HMA when the proposal quantities for that class of HMA exceed 2,500 tons.

   Nonstatistical evaluation will be used for the acceptance of HMA when the proposal quantities for a class of HMA are 2,500 tons or less.

   Commercial evaluation will be used for Commercial HMA and for other classes of HMA in the following applications: sidewalks, road approaches, ditches, slopes, paths, trails, gores, prelevel, and pavement repair. Other nonstructural applications of HMA accepted by commercial evaluation shall be as approved by the Project Engineer. Sampling and testing of HMA accepted by commercial evaluation will be at the option of the Project Engineer. The proposal quantity of HMA that is accepted by commercial evaluation will be excluded from the quantities used in the determination of statistical and nonstatistical evaluation.
2. **Aggregates.** For HMA under statistical evaluation the gradation of aggregates will be included in the statistical calculations. The acceptance criteria for aggregate properties of sand equivalent, uncompacted void content and fracture will be their conformance to the requirements of Section 9-03.8(2). These properties will not be included in the statistical evaluation.
3. **Sampling.** Samples for acceptance testing will be obtained on a random basis from the hauling vehicle. The Contractor shall provide adequate platforms to enable samples to be obtained in accordance with WAQTC FOP for AASHTO T 168. The platforms shall allow the sample to be taken by either the WSDOT inspector or Contractor's representative without entering the hauling vehicle.

4. **Definition of Sampling Lot and Sublot.** For the purpose of acceptance sampling and testing, a lot is defined as the total quantity of material or work produced for each job mix formula (JMF) placed. A lot is represented by randomly selected samples that will be tested for acceptance. All of the test results obtained from the acceptance samples from a given lot shall be evaluated collectively. Only one lot per mix design will be expected to occur. The initial JMF is defined in Section 5-04.3(7)A Mix Design. The Contractor may request a change in the JMF in accordance with Section 9-03.8(7). If the request is approved, all of the material produced up to the time of the change will be evaluated on the basis of tests on samples taken from that material and a new lot will begin.

   Sampling and testing for statistical evaluation shall be performed on a random basis. The sublot size shall be determined to provide not less than three uniform-sized sublots with a maximum sublot size of 800 tons. Should a lot contain fewer than three sublots, the HMA will be accepted in accordance with nonstatistical evaluation.

   Sampling and testing for nonstatistical evaluation shall be performed on the frequency of one sample per sublot. The sublots shall be approximately uniform in size with a maximum sublot size of 800 tons.

   The quantity of material represented by the final sublot for either statistical or nonstatistical evaluation may be increased to a maximum of 2 times the sublot quantity calculated.

5. **Test Results.** The Engineer will furnish the Contractor with a copy of the results of all acceptance testing performed in the field at the beginning of the next paving shift. The Engineer will also provide the Composite Pay Factor (CPF) of the completed sublots after three sublots have been produced. The CPF will be provided by the midpoint of the next paving shift after sampling.

   Sublot sample test results (gradation and asphalt binder content) may be challenged by the Contractor. For HMA mixture accepted by statistical evaluation with a mix design that did not meet the verification tolerances, the test results in the test section including the percent air voids (Va) may be challenged. To challenge test results, the Contractor shall submit a written challenge within seven calendar days after receipt of the specific test results. A split of the original acceptance sample will be sent for testing to either the Region Materials Laboratory or the State Materials Laboratory as determined by the Project Engineer. The split of the sample with challenged results will not be tested with the same equipment or by the same tester that ran the original acceptance test. The challenge sample will be tested for a complete gradation analysis and for asphalt binder content.

   The results of the challenge sample will be compared to the original results of the acceptance sample test and evaluated according to the following criteria:

Deviation	
U.S. No. 4 sieve and larger	Percent passing ±4.0
U.S. No. 8 sieve	Percent passing ±2.0
U.S. No. 200 sieve	Percent passing ±0.4
Asphalt binder	Percent binder content ±0.3
Va Percent	Va ±0.7

If the results of the challenge sample testing are within the allowable deviation established above for each parameter, the acceptance sample test results will be used for acceptance of the HMA. The cost of testing will be deducted from any monies due or that may come due the Contractor under the contract at the rate of $250 per challenge sample. If the results of the challenge sample testing are outside of any one parameter established above, the challenge sample will be used for acceptance of the HMA and the cost of testing will be the Contracting Agency's responsibility.

6. **Test Methods.** Testing of HMA for compliance of volumetric properties (VMA, VFA and Va) will be by WSDOT Standard Operating Procedure SOP 731. Testing for compliance of asphalt binder content will be by WSDOT FOP for AASHTO T 308. Testing for compliance of gradation will be by WAQTC FOP for AASHTO T 27/T 11.

7. **Test Section - HMA Mixture.** A mixture test section shall be constructed for every mix design accepted by Statistical Evaluation. The test section shall be used to determine if the mix meets the requirements of Sections 9-03.8(2) and 9-03.8(6). The HMA mixture test section may be constructed simultaneously with the compaction test section (Section 5-04.3(10)B).

   The test section shall be constructed at the beginning of paving and will be at least 600 tons and a maximum of 800 tons or as approved by the Engineer. No further wearing or leveling HMA will be paved the day of or the day following the construction of the test section. The mixture in the test section will be evaluated as a lot with a minimum of three sublots required. If more than one test section is required, each test section shall be a separate lot.

   For a test section to be acceptable, with or without a verified mix design, the pay factor (PF) for each of gradation, asphalt binder, VMA and Va shall be 0.95 or greater, and the remaining test requirements in Section 9-03.8(2) (dust/asphalt ratio, sand equivalent, uncompacted void content and fracture) shall conform to the requirements of that Section. When the pay factor for any item is less than 0.95 the Contractor shall make adjustments to the mix in accordance with Section 9-03.8(7) and construct another test section. The Project Engineer may waive the requirement for the construction of another test section.

   For all HMA of the same class and PG asphalt binder grade payment for the HMA in the test section(s) will be in accordance with the provisions of 5-04.5(1) Quality Assurance Price Adjustments. The CPF for the HMA represented by the first test section shall be a minimum of 0.75 if the mix design was verified by the Contracting agency. The calculation of the CPF in a test section with a verified mix design will include gradation and asphalt binder content. The calculation of the CPF in a test section with a mix design that did not verify will include gradation, asphalt binder content and percent air voids (Va).

5-04.3(9) Spreading and Finishing

The mixture shall be laid upon an approved surface, spread, and struck off to the grade and elevation established. HMA pavers complying with Section 5-04.3(3) shall be used to distribute the mixture. Unless otherwise directed by the Engineer, the nominal compacted depth of any layer of any course shall not exceed the following:

HMA Class 1"	0.35-feet
HMA Class $^3/_4$" and HMA Class $^1/_2$"	0.30-feet
HMA Class $^3/_8$"	0.10-feet

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the paving may be done with other equipment or by hand.

When more than one JMF is being utilized to produce HMA, the material produced for each JMF shall be placed by separate spreading and compacting equipment. The intermingling of HMA produced from more than one JMF is prohibited. Each strip of HMA placed during a work shift shall conform to a single JMF established for the class of HMA specified unless there is a need to make an adjustment in the JMF.

5-04.3(10) Compaction

5-04.3(10)A General

Immediately after the HMA has been spread and struck off, and after surface irregularities have been adjusted, the mix shall be thoroughly and uniformly compacted. The completed course shall be free from ridges, ruts, humps, depressions, objectionable marks, and irregularities and shall conform to the line, grade, and cross-section shown in the Plans. If necessary, the JMF may be altered in accordance with Section 9-03.8(7) to achieve desired results.

Compaction shall take place when the mixture is in the proper condition so that no undue displacement, cracking, or shoving occurs. Areas inaccessible to large compaction equipment shall be compacted by mechanical or hand tampers. Any HMA that becomes loose, broken, contaminated, shows an excess or deficiency of asphalt, or is in any way defective, shall be removed and replaced with new hot mix that shall be immediately compacted to conform to the surrounding area.

The type of rollers to be used and their relative position in the compaction sequence shall generally be the Contractor's option, provided specification densities are attained. An exception shall be that pneumatic tired rollers shall be used between October 1st of any year and April 1st of the following year. Coverages with a vibratory or steel wheel roller may precede pneumatic tired rolling. Unless the Project Engineer has approved otherwise, vibratory rollers shall not be operated in the vibratory mode when the internal temperature of the mix is less than 175°F. Regardless of mix temperature, a vibratory roller shall not be operated in a vibratory mode when checking or cracking of the mat occurs. Vibratory rollers in the vibratory mode are prohibited on bridge decks.

5-04.3(10)B Control

1. **General.** HMA used in traffic lanes, including lanes for ramps, truck climbing, weaving, and speed change, and having a specified compacted course thickness greater than 0.10 foot, shall be compacted to a specified level of relative density. The specified level of relative density shall be a Composite Pay Factor (CPF) of not less than 0.75 when evaluated in accordance with

Section 1-06.2, using a minimum of 91.0 percent of the reference maximum density as determined by WSDOT FOP for AASHTO T 209. The specified level of density attained will be determined by the statistical evaluation of tests taken in accordance with FOP for WAQTC TM 8 and WSDOT SOP T 729 on the day the mix is placed (after completion of the finish rolling). Each lot will be divided into five sublots. The sublot locations within each density lot will be determined by the stratified random sampling procedure conforming to WSDOT Test Method No. 716. The quantity represented by each density lot will be no greater than a single day's production or 400 tons, whichever is less, except the final lot each day may be increased to a maximum of 600 tons.

The Engineer may also evaluate the HMA for low cyclic density of the pavement. Low cyclic density areas are defined as spots or streaks in the pavement that are less than 89.0 percent of the reference maximum density. If four or more low cyclic density areas are identified in a lot, a cyclic density price adjustment will be assessed for that lot. The price adjustment will be calculated as 15% of the unit bid price for the quantity of HMA represented by that lot. Only one area per delivered truck and one area per delivered trailer of HMA will be counted toward the number of low cyclic density areas. Any area tested for density under Section 5-04.3(10)B Control 1. General, will be included in this analysis.

2. **Test Section - Compaction.** For HMA requiring a specified level of relative density a compaction test section may be constructed for each mix design. Prior to the start of paving the Contractor shall notify the PE that a test section is requested and will be constructed.

   The test section, if requested, shall be constructed at the beginning of paving, and shall be done using the equipment and rolling patterns that the Contractor expects to use in the paving operation. The test section will be a maximum of 800 tons. Only one test section will be allowed per mix design. When a compaction test section and HMA mixture test section (Section 5-04.3(8)A) are both required they may be constructed simultaneously. All of the HMA in the test section shall be evaluated in accordance with 5-04.3(10)B. The CPF for compaction for the HMA in a density lot that includes a test section shall be a minimum of 0.75. If a test section is not completed, the HMA will be accepted by statistical evaluation. The Contractor may continue paving operations upon completion of the 800 tons in the test section. HMA placed in excess of 800 tons will be accepted by statistical evaluation. This will require consideration of the presence of the correlation factor for the nuclear density gauge and may require resolution after the correlation factor is known.

3. **Test Results.** The Project Engineer will furnish the Contractor with a copy of the results of all compaction acceptance testing within one working day. Acceptance of HMA compaction will be based on the statistical evaluation and CPF so determined.

   For compaction lots falling below a 1.00 pay factor and thus subject to price reduction or rejection, cores may be used as an alternate to the nuclear density gauge tests. When cores are taken by the Contracting Agency at the request of the Contractor, they shall be requested by noon of the next workday after receiving the test results. The cores will be taken at locations independent from the nuclear density gauge tests in accordance with WSDOT Test Method

No. 716. When the CPF for the lot based on the results of the HMA cores is less than 1.00, the cost for the coring will be deducted from any monies due or that may become due the Contractor under the contract at the rate of $125 per core.

HMA constructed under conditions other than those listed above in paragraph "1. General" shall be compacted on the basis of a test point evaluation of the compaction train. The test point evaluation shall be performed in accordance with instructions from the Project Engineer. The number of passes with an approved compaction train, required to attain the maximum test point density, shall be used on all subsequent paving.

HMA for preleveling shall be thoroughly compacted. HMA that is used for preleveling wheel rutting shall be compacted with a pneumatic tire roller unless otherwise approved by the Engineer.

5-04.3(11) Reject HMA

1. **Rejection by Contractor.** The Contractor may, prior to sampling, elect to remove any defective material and replace it with new material. Any such new material will be sampled, tested, and evaluated for acceptance.
2. **Rejection Without Testing.** The Project Engineer may, without sampling, reject any batch, load, or section of roadway that appears defective in gradation or asphalt binder content. Material rejected before placement shall not be incorporated into the pavement. Any rejected section of roadway shall be removed.

   No payment will be made for the rejected materials or the removal of the materials unless the Contractor requests that the rejected material be tested. If the contractor elects to have the rejected material tested, a minimum of three representative samples will be obtained and tested. Acceptance of rejected material will be based on conformance with the statistical acceptance specification. If the CPF for the rejected material is less than 0.75, no payment will be made for the rejected material, and in addition, the cost of sampling and testing shall be borne by the Contractor. However, if the CPF is greater than or equal to 0.75, the cost of sampling and testing will be borne by the Contracting Agency and the mix will be compensated at a CPF of 0.75. If rejection occurs after placement and the CPF is greater than 0.75, compensation for the rejected mix will be at the calculated CPF with an addition of 25 percent of the unit contract price added for the cost of removal and disposal.
3. **A Partial Sublot.** In addition to the random acceptance sampling and testing, the Project Engineer may also isolate from a normal sublot any material that is suspected of being defective in relative density, gradation or asphalt binder content. Such isolated material will not include an original sample location. A minimum of three random samples of the suspect material will be obtained and tested. The material will then be statistically evaluated as an independent lot in accordance with Section 1-06.2(2).
4. **An Entire Sublot.** An entire sublot that is suspected of being defective may be rejected. When a sublot is rejected a minimum of two additional random samples from this sublot will be obtained. These additional samples and the original sublot will be evaluated as an independent lot in accordance with Section 1-06.2(2).

5. **A Lot in Progress.** The Contractor shall shut down operations and shall not resume HMA placement until such time as the Project Engineer is satisfied that specification material can be produced:
   a. When the Composite Pay Factor (CPF) of a lot in progress drops below 1.00 and the Contractor is taking no corrective action, or
   b. When the Pay Factor (PF) for any constituent of a lot in progress drops below 0.95 and the Contractor is taking no corrective action, or
   c. When either the PFi for any constituent or the CPF of a lot in progress is less than 0.75.
6. **An Entire Lot.** An entire lot with a CPF of less than 0.75 will be rejected. The designated percentage reduction as defined in Section 1-06.2(2)B under Financial Incentive Paragraph 1, Item 3, shall be 25 percent.

5-04.3(12) Joints

5-04.3(12)A Transverse Joints

The Contractor shall conduct operations such that the placing of the top or wearing course is a continuous operation or as close to continuous as possible. Unscheduled transverse joints will be allowed and the roller may pass over the unprotected end of the freshly laid mixture only when the placement of the course must be discontinued for such a length of time that the mixture will cool below compaction temperature. When the work is resumed, the previously compacted mixture shall be cut back to produce a slightly beveled edge for the full thickness of the course.

A temporary wedge of HMA constructed on a 50H:1V shall be constructed where a transverse joint is open to traffic. The HMA in the temporary wedge shall be separated from the permanent HMA by strips of heavy wrapping paper. The wrapping paper shall be removed and the joint trimmed to a slightly beveled edge for the full thickness of the course prior to resumption of paving.

The material that is cut away shall be wasted and new mix shall be laid against the cut. Rollers or tamping irons shall be used to seal the joint.

5-04.3(12)B Longitudinal Joints

The longitudinal joint in any one course shall be offset from the course immediately below by not more than 6-inches nor less than 2-inches. All longitudinal joints constructed in the wearing course shall be located at a lane line or an edge line of the traveled way. Except, on one-lane ramps a longitudinal joint may be constructed at the center of the traffic lane, subject to approval by the Project Engineer, if:

1. The ramp must remain open to traffic, or
2. The ramp is closed to traffic and a hot-lap joint is constructed.

If a hot-lap joint is allowed, two paving machines shall be used; a minimum compacted density in accordance with Section 5-04.3(10)B shall be achieved throughout the traffic lane; and construction equipment other than rollers shall not operate on any uncompacted mix.

When HMA is placed adjacent to cement concrete pavement, the Contractor shall construct longitudinal joints between the HMA and the cement concrete pavement. The joint shall be sawed to the dimensions shown on Standard Plan A-1 and filled with joint sealant meeting the requirements of Section 9-04.2.

5-04.3(13) Surface Smoothness

The completed surface of all courses shall be of uniform texture, smooth, uniform as to crown and grade, and free from defects of all kinds. The completed surface of the wearing course shall not vary more than 1/8-inch from the lower edge of a 10-foot straightedge placed on the surface parallel to the centerline. The transverse slope of the completed surface of the wearing course shall vary not more than ¼-inch in 10-feet from the rate of transverse slope shown in the Plans.

When deviations in excess of the above tolerances are found that result from a high place in the HMA, the pavement surface shall be corrected by one of the following methods:

1. Removal of material from high places by grinding with an approved grinding machine, or
2. Removal and replacement of the wearing course of HMA, or
3. By other method approved by the Project Engineer.

Correction of defects shall be carried out until there are no deviations anywhere greater than the allowable tolerances.

Deviations in excess of the above tolerances that result from a low place in the HMA and deviations resulting from a high place where corrective action, in the opinion of the Project Engineer, will not produce satisfactory results will be accepted with a price adjustment. The Project Engineer shall deduct from monies due or that may become due to the Contractor the sum of $500.00 for each and every section of single traffic lane 100-feet in length in which any excessive deviations described above are found.

When Portland cement concrete pavement is to be placed on HMA, the surface tolerance of the HMA shall be such that no surface elevation lies above the plan grade minus the specified plan depth of Portland cement concrete pavement. Prior to placing the Portland cement concrete pavement, any such irregularities shall be brought to the required tolerance by grinding or other means approved by the Project Engineer.

When utility appurtenances such as manhole covers and valve boxes are located in the traveled way, the roadway shall be paved before the utility appurtenances are adjusted to the finished grade.

5-04.3(14) Planing Bituminous Pavement

Planing shall be performed in such a manner that the underlying pavement is not torn, broken, or otherwise damaged by the planing operation. Delamination or raveling of the underlying pavement will not be construed as damage due to the Contractor's operations. Pavement outside the limits shown in the plans or designated by the Engineer that is damaged by the Contractor's operations shall be repaired to the satisfaction of the Engineer, at the Contractor's expense.

For mainline planing operations, the equipment shall have automatic controls, with sensors for either or both sides of the equipment. The controls shall be capable of sensing the grade from an outside reference line, or a mat-referencing device. The automatic controls shall have a transverse slope controller capable of maintaining the mandrel at the desired transverse slope (expressed as a percentage) within plus or minus 0.1 percent.

The planings and other debris resulting from the planing operation shall become the property of the Contractor and be disposed of in accordance with Section 2-03.3(7)C. The planings may be utilized as RAP, within the requirements of Section 5-04.2 or 9-03.21.

5-04.3(15) HMA Road Approaches

HMA approaches shall be constructed at the locations shown in the Plans or where staked by the Project Engineer. The work shall be performed in accordance with Section 5-04.

5-04.3(16) Weather Limitations

HMA for wearing course shall not be placed on any traveled way between October 1 of any year and April 1 of the following year without written approval from the Project Engineer.

Asphalt for prime coat shall not be applied when the ground temperature is lower than 50°F without written approval of the Project Engineer.

HMA shall not be placed on any wet surface, or when the average surface temperatures are less than those specified in the following table, or when weather conditions otherwise prevent the proper handling or finishing of the bituminous mixtures:

	Surface Temperature Limitation	
Compacted Thickness (Feet)	**Wearing Course**	**Other Courses**
Less than 0.10	55°F	45°F
0.10 to 0.20	45°F	35°F
0.21 to 0.35	35°F	35°F
More than 0.35	(Not Applicable)	25ºF*

*Only on dry subgrade, not frozen and when air temperature is rising.

5-04.3(17) Paving Under Traffic

When the roadway being paved is open to traffic, the following requirements shall apply:

The Contractor shall keep on-ramps and off-ramps open to traffic at all times except when paving the ramp or paving across the ramp. During such time, and provided that there has been an advance warning to the public, the ramp may be closed for the minimum time required to place and compact the mixture. In hot weather, the Project Engineer may require the application of water to the pavement to accelerate the finish rolling of the pavement and to shorten the time required before reopening to traffic.

Before closing a ramp, advance warning signs shall be placed and signs shall also be placed marking the detour or alternate route. Ramps shall not be closed on consecutive interchanges at the same time.

During paving operations, temporary pavement markings shall be maintained throughout the project. Temporary pavement markings shall be installed on the roadway prior to opening to traffic. Temporary pavement markings shall be in accordance with Section 8-23.

All costs in connection with performing the work in accordance with these requirements, except the cost of temporary pavement markings, shall be included in the unit contract prices for the various bid items involved in the contract.

5-04.3(18) Vacant

5-04.3(19) Sealing of Pavement Surfaces

Where shown in the Plans, the Contractor shall apply a fog seal. Before application of the fog seal all surfaces shall be thoroughly cleaned of dust, soil, pavement grindings, and other foreign matter. The fog seal shall be CSS-1 or CSS-1h emulsified asphalt uniformly applied to the pavement. The finished application shall be free of streaks and bare spots. The emulsified asphalt shall be diluted at a rate of one part water to one part emulsified asphalt unless otherwise directed by the Project Engineer. The diluted emulsified asphalt shall be applied at the rate of 0.10 to 0.18 (0.03 to 0.05 residual) gallons per square yard. The emulsified asphalt shall be applied within the temperature range specified for these asphalt emulsions in Section 5-02.3(3). Unless otherwise approved by the Project Engineer, the fog seal shall be applied prior to opening to traffic.

5-04.3(20) Anti-Stripping Additive

When directed by the Project Engineer, an anti-stripping additive shall be added to the HMA in accordance with Section 9-02.4.

5-04.3(21) Asphalt Binder Revision

When the Contracting Agency provides a source of aggregate, the expected percentage content of new asphalt binder in the resulting mix will be identified in the contract documents.

Should the actual percentage of new asphalt binder required by the job mix formula for asphalt concrete produced with Agency-provided aggregate vary by more than plus or minus 0.3 percent from the amount shown in the documents, an adjustment in payment will be made. The adjustment in payment (plus or minus) will be based on the invoice cost to the Contractor. No adjustment will be made when the Contractor elects not to use a Contracting Agency-provided source, or when no source is made available by the Contracting Agency.

5-04.4 Measurement

HMA Cl. ___ PG ___, HMA for ___ Cl. ___ PG ___, and Commercial HMA will be measured by the ton in accordance with Section 1-09.2, with no deduction being made for the weight of asphalt binder, blending sand, mineral filler, or any other component of the mixture. If the Contractor elects to remove and replace mix as allowed by Section 5-04.3(11), the material removed will not be measured.

Preparation of Untreated Roadway will be measured by the mile once along the centerline of the main line roadway. No additional measurement will be made for ramps, auxiliary lanes, service roads, frontage roads, or shoulders. Measurement will be to the nearest 0.01 mile.

No specific unit of measure will apply to the force account item of Crack Sealing.

Soil Residual Herbicide will be measured by the mile for the stated width to the nearest 0.01 mile or by the square yard, whichever is designated in the proposal.

Pavement Repair Excavation will be measured by the square yard of surface marked prior to excavation.

Asphalt for Prime Coat will be measured by the ton in accordance with Section 1-09.2.

Prime Coat Aggregate will be measured by the cubic yard, truck measure, or by the ton, whichever is designated in the proposal.

Asphalt For Fog Seal will be measured by the ton, before dilution, in accordance with Section 1-09.2.

Longitudinal Joint Seals between the HMA and cement concrete pavement will be measured by the linear foot along the line and slope of the completed joint seal.

Planing Bituminous Pavement will be measured by the square yard.

Temporary Pavement Marking will be measured by the linear foot as provided in Section 8-23.4.

Removing Temporary Pavement Marking will be measured by the linear foot as provided in Section 8-23.4.

Water will be measured by the M gallon as provided in Section 2-07.4.

No specific unit of measure will apply to the calculated item of Anti-Stripping Additive.

No specific unit of measure will apply to the calculated item of Job Mix Compliance Price Adjustment.

No specific unit of measure will apply to the calculated item of Compaction Price Adjustment.

No specific unit of measure will apply to the calculated item of Cyclic Density Price Adjustment.

No specific unit of measure will apply to the calculated item of Asphalt Binder Revision.

5-04.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"HMA Cl. ___ PG ___", per ton.

"HMA for Approach Cl. ___ PG ___", per ton.

"HMA for Preleveling Cl. ___ PG ___", per ton.

"HMA for Pavement Repair Cl. ___ PG ___", per ton.

"Commercial HMA", per ton.

The unit contract price per ton for "HMA Cl. ___ PG ___", "HMA for Approach Cl. ___ PG ___", "HMA for Preleveling Cl. ___ PG ___", "HMA for Pavement Repair Cl. ___ PG ___", and "Commercial HMA" shall be full compensation for all costs incurred to carry out the requirements of Section 5-04 except for those costs included in other items which are included in this sub-section and which are included in the proposal.

"Preparation of Untreated Roadway", per mile.

The unit contract price per mile for "Preparation of Untreated Roadway" shall be full pay for all work described under Section 5-04.3(5)B, with the exception, however, that all costs involved in patching the roadway prior to placement of HMA shall be included in the unit contract price per ton for "HMA Cl. ___ PG ___" which was used for patching. If the proposal does not include a bid item for "Preparation of Untreated Roadway", the roadway shall be prepared as specified, but the work shall be included in the contract prices of the other items of work.

"Crack Sealing", by force account.

"Crack Sealing" will be paid for by force account as specified in Section 1-09.6. For the purpose of providing a common proposal for all bidders, the Contracting Agency has entered an amount in the proposal to become a part of the total bid by the Contractor.

"Soil Residual Herbicide ____ ft. Wide," per mile, or

"Soil Residual Herbicide", per square yard.

The unit contract price per mile or per square yard for "Soil Residual Herbicide" shall be full payment for all costs incurred to obtain, provide and install herbicide in accordance with Section 5-04.3(5)D.

"Pavement Repair Excavation Incl. Haul", per square yard.

The unit contract price per square yard for "Pavement Repair Excavation Incl. Haul" shall be full payment for all costs incurred to perform the work described in Section 5-04.3(5)E with the exception, however, that all costs involved in the placement of HMA shall be included in the unit contract price per ton for "HMA for Pavement Repair Cl. ___ PG ___", per ton.

"Asphalt for Prime Coat", per ton.

The unit contract price per ton for "Asphalt for Prime Coat" shall be full payment for all costs incurred to obtain, provide and install the material in accordance with Section 5-04.3(5)B.

"Prime Coat Agg.", per cubic yard, or per ton.

The unit contract price per cubic yard or per ton for "Prime Coat Agg." shall be full pay for furnishing, loading, and hauling aggregate to the place of deposit and spreading the aggregate in the quantities required by the Engineer.

"Asphalt for Fog Seal", per ton.

The unit contract price per ton for "Asphalt for Fog Seal" shall be full pay for all costs of material, labor, tools, and equipment necessary for the application of the fog seal as specified. If there is no bid item and a fog seal is required, it shall be applied and the work shall be included in the unit contract prices of the other work items.

"Longitudinal Joint Seal", per linear foot.

The unit contract price per linear foot for "Longitudinal Joint Seal" shall be full payment for all costs incurred to perform the work described in Section 5-04.3(12).

"Planing Bituminous Pavement", per square yard.

The unit contract price per square yard for "Planing Bituminous Pavement" shall be full payment for all costs incurred to perform the work described in Section 5-04.3(14).

"Temporary Pavement Marking", per linear foot.

Payment for "Temporary Pavement Marking" is described in Section 8-23.5.

"Removing Temporary Pavement Marking", per linear foot.

Payment for "Removing Temporary Pavement Marking" is described in Section 8-23.5.

"Water", per M gallon.

Payment for "Water" is described in Section 2-07.5.

"Anti-Stripping Additive", by calculation.

"Anti-Stripping Additive" will be paid for in accordance with Section 1-09.6 except that no overhead, profit or other costs shall be allowed. Payment shall be made only for the invoice cost of the additive. The quantity of asphalt binder shall not be reduced by the quantity of anti-stripping additive used. For the purpose of providing a common proposal for all bidders, the Contracting Agency has entered an amount in the proposal to become a part of the total bid by the Contractor.

"Job Mix Compliance Price Adjustment," by calculation.

"Job Mix Compliance Price Adjustment" will be calculated and paid for as described in Section 5-04.5(1).

"Compaction Price Adjustment," by calculation.

"Compaction Price Adjustment" will be calculated and paid for as described in Section 5-04.5(1).

"Cyclic Density Price Adjustment," by calculation.

"Cyclic Density Price Adjustment" will be calculated and paid for as described in Section 5-04.3(10)B.

"Asphalt Binder Revision" by calculation.

"Asphalt Binder Revision" will be calculated and paid for as described in Section 5-04.3(21).

5-04.5(1) Quality Assurance Price Adjustments

All HMA will be subject to price adjustments. Price adjustments for HMA mixture will be based on the requirements of 5-04.3(8). Price adjustments for HMA compaction will be based on the requirements in 5-04.3(10). For the purpose of providing a common proposal for all bidders, the Contracting Agency has estimated a calculated amount for all price adjustment items and has entered these amounts in the proposal to become a part of the total bid by the Contractor. Statistical analysis of the HMA will be performed in accordance with Section 1-06.2.

5-04.5(1)A Price Adjustments for Quality of HMA Mixture

Statistical analysis of quality of gradation and asphalt content will use the following price adjustment factors:

Table of Price Adjustment Factors

Constituent	Factor "f"
All aggregate passing: $1\frac{1}{2}$", 1", $\frac{3}{4}$", $\frac{1}{2}$", $\frac{3}{8}$" and U.S. No.4 sieves	2
All aggregate passing U.S. No. 8 sieve	15
All aggregate passing U.S. No. 200 sieve	20
Asphalt binder	52
Va	30

A pay factor will be calculated for each sieve listed that is equal to or smaller than the maximum allowable aggregate size (100% passing sieve) and for the asphalt binder. The "f" factor provided for Va will only be used for the calculation of the pay factor for test section(s) when the mix design was not verified in Section 5-04.3(7)A.

1. **Statistical Evaluation.** For each lot of HMA produced under Statistical Evaluation, a Job Mix Compliance Incentive Factor (JMCIF) will be determined. The JMCIF equals the algebraic difference of CPF minus 1.00 multiplied by 60 percent. The Job Mix Compliance Price Adjustment will be calculated as the product of the JMCIF, the quantity of HMA in the lot in tons, and the unit contract price per ton of mix.
2. **Nonstatistical Evaluation.** Each lot of HMA produced under Nonstatistical Evaluation and having all constituents falling within the tolerance limits of the job mix formula shall be accepted at the unit contract price with no further evaluation. When one or more constituents fall outside the nonstatistical tolerance limits in Section 9-03.8(7), the lot shall be evaluated in accordance with Section 1-06.2 to determine the appropriate CPF. The nonstatistical tolerance limits will be used in the calculation of the CPF and the maximum CPF shall be 1.00. When less than three sublots exist, backup samples of the existing sublots or samples from the roadway shall be tested to provide a minimum of three sets of results for evaluation.
3. **Commercial Evaluation.** If sampled and tested, HMA produced under Commercial Evaluation and having all constituents falling within the tolerance limits of the job mix formula shall be accepted at the unit contract price with no further evaluation. When one or more constituents fall outside the commercial tolerance limits in Section 9-03.8(7), the lot shall be evaluated in accordance with Section 1-06.2 to determine the appropriate CPF. The commercial tolerance limits will be used in the calculation of the CPF and the maximum CPF shall be 1.00. When less than three sublots exist, backup samples of the existing sublots or samples from the street shall be tested to provide a minimum of three sets of results for evaluation.

For each lot of HMA produced under Nonstatistical or Commercial Evaluation when the calculated CPF is less than 1.00, a Nonconforming Mix Factor (NCMF) will be determined. The NCMF equals the algebraic difference of CPF minus 1.00 multiplied by 60 percent. The Job Mix Compliance Price Adjustment will be calculated as the product of the NCMF, the quantity of HMA in the lot in tons, and the unit contract price per ton of mix.

If a constituent is not measured in accordance with these Specifications, its individual pay factor will be considered 1.00 in calculating the Composite Pay Factor (CPF).

5-04.5(1)B Price Adjustments for Quality of HMA Compaction

For each compaction control lot, a Compaction Incentive Price Adjustment Factor (CIPAF) will be determined. The CIPAF equals the algebraic difference of the CPF minus 1.00 multiplied by 40 percent. The Compaction Price Adjustment will be calculated as the product of CIPAF, the quantity of HMA in the compaction control lot in tons, and the unit contract price per ton of mix.

5-05 CEMENT CONCRETE PAVEMENT

5-05.1 Description

This work shall consist of constructing a pavement composed of Portland cement concrete on a prepared subgrade or base in accordance with these Specifications and in conformity with the lines, grades, thicknesses, and typical cross-sections shown in the Plans or established by the Engineer.

5-05.2 Materials

Materials shall meet the requirements of the following sections:

Portland Cement	9-01
Fine Aggregate	9-03
Coarse Aggregate	9-03
Combined Aggregate	9-03
Joint Filler	9-04.1
Joint Sealants	9-04.2
Reinforcing Steel	9-07
Dowel Bars	9-07.5
Tie Bars	9-07.6
Curing Materials and Admixtures	9-23
Water	9-25
Epoxy Resins	9-26

5-05.3 Construction Requirements

5-05.3(1) Concrete Mix Design for Paving

The Contractor shall provide a concrete mix design for each design of concrete specified in the contract. The Contractor shall use ACI 211.1 as a guide to determine proportions. Concrete strength, placement, and workability shall be the responsibility of the Contractor. Following approval of the Contractor's proposal, all other requirements of Section 5-05 shall apply.

1. **Materials.** Materials shall conform to Section 5-05.2. Fine aggregate shall conform to Section 9-03.1(2), Class 1. Coarse aggregate shall conform to Section 9-03.1(4) AASHTO grading No. 467. An alternate combined gradation may be proposed, which has a maximum aggregate size equal to or greater than a 2-inch square sieve. The combined aggregate gradation shall conform to Section 9-03.1(5).

   Fly ash, if used, shall not exceed 35 percent by weight of the total cementitious material, shall conform to Section 9-23.9 and shall be limited to Class F with a maximum CaO content of 15 percent by weight.

   Ground granulated blast furnace slag, if used, shall not exceed 25 percent by weight of the total cementitious material and shall conform to Section 9-23.10. When both ground granulated blast furnace slag and fly ash are included in the concrete mix, the total weight of both these materials is limited to 35 percent by weight of the total cementitious material. As an alternative to the use of fly ash, ground granulated blast furnace slag and cement as separate components, a blended hydraulic cement that meets the requirements of Section 9-01.2(4) Blended Hydraulic Cements may be used.

The water/cement ratio shall be calculated on the total weight of cementitious material. The following are considered cementitious materials: Portland cement, fly ash, ground granulated blast furnace slag and microsilica. The minimum cementitious material for any mix design shall be 564 pounds per cubic yard.

2. **Submittals.** The Contractor's submittal shall include the mix proportions per cubic yard and the proposed sources for all ingredients including the power plant that generated the fly ash. The mix shall be capable of providing a minimum flexural strength of 650 psi at 14 days. Evaluation of strength shall be based on statistically analyzed results of 5 beam specimens made according to WSDOT T 808 and tested according to WSDOT T 802 that demonstrate a quality level of not less than 80 percent analyzed in accordance with Section 1-06.2(2)D. In addition the Contractor shall fabricate, cure, and test 5 sets of cylinders, for evaluation of both 14 and 28 day strengths, according to WSDOT FOP's for AASHTO T 22 and AASHTO T 23 using the same mix design as used in fabrication of the beams. Compressive strength data (for 28 day strength) shall be submitted to the Engineer for use in determination of a conversion factor of flexural strength to compressive strength, which will be used by the Engineer for strength acceptance testing.

   Mix designs submitted by the Contractor shall provide a unique identification for each proposal and shall include test data confirming that concrete made in accordance with the proposed design will meet the requirements of these Specifications. Test data shall be from an independent testing lab or from a commercial concrete producer's lab. If the test data is developed at a producer's lab, the Engineer or a representative may witness all testing.

3. **Mix Design Modifications.** The Contractor may initiate minor adjustments to the approved mix proportions. A plus or minus 200 pound variation in both the coarse and fine aggregate target weight will be allowed from the approved Contractor provided mix design weight as a modification without resubmittal.

   Utilizing admixtures to accelerate the set or to increase workability will be permitted only when approved by the Engineer. Only non-chloride accelerating admixtures that meet the requirements of Section 9-23.6 Admixture for Concrete, shall be used.

   The Contractor shall notify the Engineer in writing of any proposed modification. A new mix design will designate a new lot.

5-05.3(2) Consistency

The materials shall be mixed with sufficient water to produce a stiff concrete which will hold its shape when deposited upon the subgrade. Concrete placed during wet weather must be mixed with sufficient water to produce a very stiff mixture. The consistency shall be such that separation of the mortar from the coarse aggregate will not occur in handling.

The water/cementitious material ratio, by weight, shall not exceed 0.44. When slip form paving equipment is used, the Contractor shall further control concrete consistency to ensure that edge slump conforms to the requirements of Section 5-05.3(11).

5-05.3(3) Equipment

Equipment necessary for handling materials and performing all parts of the work shall be approved by the Engineer as to design, capacity, and mechanical condition. The equipment shall be at the jobsite sufficiently ahead of the start of paving operations to be examined thoroughly and approved.

5-05.3(3)A Batching Plant and Equipment

1. **General.** The batching plant shall include bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk, a bin, hopper, and separate scale for cement shall be included. The weighing hoppers shall be properly sealed and vented to preclude dusting during operation. The batching plant shall be equipped with a suitable batch counter that cannot be reset, which will correctly indicate the number of batches proportioned.
2. **Bins and Hoppers.** Bins with adequate separate compartments for fine aggregate and for each size of the coarse aggregate shall be provided in the batching plant.

5-05.3(3)B Mixing Equipment

1. **General.** Concrete may be mixed at a batching plant or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.
2. **Batching Plant.** Mixing shall be in an approved mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform weight within the specified mixing period.

   Mixers shall be cleaned at suitable intervals. The pickup and throw-over blades in the drum shall be repaired or replaced when they are worn down $^3/_4$-inch or more. The Contractor shall have available at the jobsite a copy of the manufacturer's design, showing dimensions and arrangements of the blades in reference to original height and depth, or provide permanent marks on blades to show points of $^3/_4$-inch wear from new conditions. Drilled holes $^1/_4$-inch in diameter near each end and at midpoint of each blade are recommended.
3. **Truck Mixers and Truck Agitators.** Truck mixers used for mixing and hauling concrete, and truck agitators used for hauling plant-mixed concrete, shall conform to the requirements of Section 6-02.3(4)A.
4. **Nonagitator Trucks.** Bodies of nonagitating hauling equipment for concrete shall be smooth, mortar-tight, metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation. Covers shall be provided when needed for protection. Plant-mixed concrete may be transported in nonagitated vehicles provided that the concrete is delivered to the site of the work and discharge is completed within 45 minutes after the introduction of mixing water to the cement and aggregates, and provided the concrete is in a workable condition when placed.

5-05.3(3)C Finishing Equipment

The standard method of constructing concrete pavement on state highways shall be with approved slip-form paving equipment designed to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine so a dense and homogeneous pavement is achieved with a minimum of hand finishing. On other roads and on WSDOT projects requiring less than 500 square yards of cement concrete pavement or requiring individual placement areas of less than 500 square yards, irregular areas, intersections and at locations inaccessible to slip-form paving equipment, cement concrete pavement may be placed with approved placement and finishing equipment utilizing stationary side forms. Hand screeding and float finishing of cement concrete pavement may only be utilized on small irregular areas as allowed by the Engineer.

5-05.3(3)D Joint Sawing Equipment

The Contractor shall provide approved power driven concrete saws for sawing joints, adequate in number of units and power to complete the sawing at the required rate. The Contractor shall provide at least one standby saw in good working order. An ample supply of saw blades shall be maintained at the site of the work at all times during sawing operations. The Contractor shall provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job both before and continuously during concrete placement. Sawing equipment shall be available immediately and continuously upon call by the Engineer on a 24 hour basis, including Saturdays, Sundays and holidays.

5-05.3(3)E Smoothness Testing Equipment

The Contractor shall provide a California-type computerized profilograph, complete with recorder, for determining the profile index of the pavement according to WSDOT Test Method No. 807. The profilograph shall be on the project, calibrated, in good working condition, and ready for operation before construction of any concrete pavement begins. The operator shall be competent and experienced in operation of the equipment.

5-05.3(4) Measuring, and Batching Materials

The batch plant site, layout, equipment, and provisions for transporting material shall ensure a continuous supply of material to the work.

1. **Measuring Materials**

   a. Aggregates. The fine aggregate and each size of coarse aggregate shall be measured by weighing, the weight for the particular aggregates used being proportional to their respective bulk specific gravities. The weighing of each size of material shall be a separate and distinct operation.

      Corrections shall be made for variations in weight of materials due to the moisture content.

      The equipment for weighing aggregates shall conform to the requirements of Section 1-09.2.

   b. Cement. Cement shall be weighed on scales meeting the requirements of Section 1-09.2. Adequate provision shall be made to prevent loss of cement between the batch box and the mixer.

   c. Water. Water may be measured either by volume or by weight. The accuracy of measuring the water shall be within a range of error of not over 1 percent.

2. **Batching Materials.** On all projects requiring more than 2500 cubic yards of Portland cement concrete for paving, the batching plant shall be equipped to proportion aggregates and cement by weight by means of automatic and interlocked proportioning devices of approved type.

5-05.3(4)A Acceptance of Portland Cement Concrete Pavement

Acceptance of Portland cement concrete pavement shall be as provided under statistical or nonstatistical acceptance. Determination of statistical or nonstatistical shall be based on proposal quantities and shall consider the total of all bid items involving of a specific class.

Statistical acceptance will apply only to contracts advertised, awarded and administered by WSDOT, unless specifically provided otherwise in the Special Provisions. Contracting agencies other than WSDOT must specifically invoke statistical acceptance in their Special Provisions if it is desired.

Statistical Acceptance, (1) applies only to WSDOT projects, (2) is administered under the provisions of Section 5-05.5, and (3) will be used for a class of mix when the proposal quantities for that class of mix is 1500 cubic yards or greater.

Nonstatistical Acceptance will be used (1) for a class of mix when the proposal quantities for that class of mix is less than 1500 cubic yards and (2) all contracts advertised, awarded and administered by agencies other than WSDOT.

The point of acceptance will be per WAQTC FOP for TM 2 (Western Alliance for Quality Transportation Construction) or at the point of discharge when a pump is used.

Acceptance of Concrete. The concrete producer shall provide a certificate of compliance for each truckload of concrete in accordance with Section 6-02.3(5)B.

For the purpose of acceptance sampling and testing, a lot is defined as the total quantity of material to be used that was produced for the same class of mix. All of the test results obtained from the same material shall be evaluated collectively and shall constitute a lot. The quantity represented by each sample will constitute a sublot. Sampling and testing for statistical acceptance shall be performed on a random basis at the frequency of one sample per sublot. Sublot size shall be determined to the nearest 10 cubic yards to provide not less than three uniform sized sublots with a maximum sublot size of 500 cubic yards.

The Engineer will furnish the Contractor with a copy of the results of all acceptance testing performed within 2 working days after testing. The Engineer will also provide the Composite Pay Factor (CPF) of the completed sublots after three have been tested.

Acceptance testing for compliance of air content and 28 day compressive strength shall be conducted from samples prepared according to WAQTC FOP TM 2. Air content shall be determined by conducting WAQTC FOP for AASHTO T 152. If the Contractor fails to provide the Aggregate Correction Factor per WAQTC FOP for AASHTO T 152 with the mix design, one will not be applied. Compressive Strength shall be determined by AASHTO T 23 and AASHTO T 22.

The quality limits as defined in section 1-06.2(2)D shall be as follows. The lower quality limit for Air Content shall be 3.0% the upper quality limit for Air Content shall be 7.0%. The lower quality limit for compressive strength shall be 1200 psi less than that established in the mix design as the arithmetic mean of the five sets of 28 day compressive strength cylinders, or 3000 psi, whichever is higher. These compressive strength cylinders are to be cast at the same time as the flexural beams that were used to prequalify the mix design under Section 5-05.3(1). There is no upper quality limit for 28 day compressive strength.

The price adjustment factor defined in Section 1-06.2(2)D shall be six (6) for compressive strength and four (4) for air content.

If either the air content or compressive strength is not measured in accordance with this section its individual pay factor will be considered to be 1.00 in calculating the Composite Pay Factor.

Rejection of Concrete

1. **Rejection by the Contractor.** The Contractor may, prior to sampling, elect to remove any defective material and replace it with new material at no expense to the Contracting Agency. Any such new material will be sampled, tested and evaluated for acceptance.
2. **Rejection Without Testing.** The Engineer may reject any load that appears defective prior to placement. Material rejected before placement shall not be incorporated into the pavement. No payment will be made for the rejected materials unless the Contractor requests that the rejected material be tested. If the Contractor elects to have the rejected materials tested, a sample will be taken and both the air content and strength shall be tested by WSDOT.

Payment for rejected material will be based on the results of the one sample, which was taken and tested. If the rejected material fails either test, no payment will be made for the rejected material and in addition, the cost of sampling and testing, at the rate of $250.00 per sample shall be borne by the Contractor. If the rejected material passes both tests the mix will be compensated at a CPF of 1.00 and the cost of the sampling and testing will borne by the Contracting Agency.

5-05.3(5) Mixing Concrete

The concrete may be mixed in a batching plant or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials are in the drum. Ready-mixed concrete shall be mixed and delivered in accordance with the requirements of Section 6-02.3(4), 6-02.3(4)A and 6-02.3(4)B.

When mixed in a batching plant, the mixing time shall not be less than 50 seconds nor more than 90 seconds.

The mixer shall be operated at a drum speed as shown on the manufacturer's nameplate on the mixer. Any concrete mixed less than the specified time shall be discarded and disposed of by the Contractor at no expense to the Contracting Agency. The volume of concrete mixed per batch shall not exceed the mixer's rated capacity, as shown on the manufacturer's standard rating plate on the mixer.

Each concrete mixing machine shall be equipped with a device for counting automatically the number of batches mixed during the day's operation.

Retempering concrete by adding water or by other means will not be permitted.

5-05.3(5)A Limitations of Mixing

Concrete shall not be mixed, placed, or finished when the natural light is inadequate, as determined by the Engineer, unless an adequate and approved artificial lighting system is operated.

Mixing and placing concrete shall be discontinued when a descending air temperature in the shade away from artificial heat reaches 40ºF and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35ºF unless authorized in writing by the Engineer.

When mixing and placing is authorized during cold weather, the aggregates may be heated by either steam or dry heat prior to being placed in the mixer. The apparatus used shall heat the mass uniformly and shall be arranged to preclude the possible occurrence of overheated areas which might injure the materials. Unless otherwise authorized, the temperature of the mixed concrete shall be not less than 50ºF and not more than 90ºF at the time of discharge into the hauling conveyance. No concrete shall be mixed with frozen aggregates.

5-05.3(6) Subgrade

The subgrade shall be constructed in accordance with Section 2-06.

The subgrade shall be prepared and compacted a sufficient distance beyond each edge of the area which is to receive concrete pavement in order to accommodate the slip-form equipment. Concrete shall not be placed on a frozen subgrade nor during heavy rainfall.

The subgrade shall be moist before the concrete is placed.

When the subgrade is an asphalt treated base the surface shall be clean and free of any deleterious materials. When placing concrete on a treated base, the surface temperature shall not exceed 90°F. If water is used for cooling any excess water standing in pools or flowing on the surface shall be removed prior to placing concrete.

5-05.3(7) Placing, Spreading, and Compacting Concrete

The provisions relating to the frequency and amplitude of internal vibration shall be considered the minimum requirements and are intended to ensure adequate density in the hardened concrete. Referee testing of hardened concrete will be performed by cutting cores from the finished pavement after a minimum of 24 hours of curing. Density determination will be made based on the water content of the core as taken. WSDOT Test Method T 810 shall be used for the determination of core density. Reference cores will be taken at the minimum rate of one for each 500 cubic yards of pavement, or fraction thereof. These same cores will be used for thickness measurements as required by Section 5-05.5(1).

The average density of the cores shall be at least 97 percent of the approved mix design density with no cores having a density of less than 96 percent.

Failure to meet the above requirement will be considered as evidence that the minimum requirements for vibration are inadequate for the job conditions, and additional vibrating units or other means of increasing the effect of vibration shall be employed so that the density of the hardened concrete as indicated by further referee testing shall conform to the above listed requirements. Primary units of pavement, as defined in Section 5-05.5(1), not meeting the prescribed minimum density shall be removed and replaced with satisfactory material. At the option of the Engineer, noncomplying material may be accepted at a reduced price.

5-05.3(7)A Slip-Form Construction

The concrete shall be distributed uniformly into final position by a self-propelled slip-form paver without delay. The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose. The paver shall vibrate the concrete for the full width and depth of the strip of pavement being placed and the vibration shall be adequate to provide a consistency of concrete that will stand normal to the surface with sharp well-defined edges. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms.

The plastic concrete shall be effectively consolidated by internal vibration with transverse vibrating units for the full width of pavement and/or a series of equally spaced longitudinal vibrating units. The space from the outer edge of the pavement to the outer longitudinal unit shall not exceed 9-inches. The spacing of internal units shall be uniform and not exceed 18-inches.

The term internal vibration means vibration by vibrating units located within the specified thickness of pavement section.

The rate of vibration of each vibrating unit shall be not less than 7,500 cycles per minute, and the amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete along the entire length of the vibrating unit and for a distance of at least 1 foot. The frequency of vibration or amplitude shall be varied proportionately with the rate of travel to result in a uniform density and air content. The paving machine shall be equipped with a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

The concrete shall be held at a uniform consistency. The slip-form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete shall be coordinated to provide uniform progress with stopping and starting of the paver held to a minimum. If, for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads on crawler tracks or rubber-tired wheels on which the bearing surface is offset to run a sufficient distance from the edge of the pavement to avoid breaking the pavement edge.

5-05.3(7)B Stationary Side Form Construction

Side form sections shall be straight, free from warps, bends, indentations, or other defects. Defective forms shall be removed from the work. Metal side forms shall be used except at end closures and transverse construction joints where straight forms of other suitable materials may be used.

Side forms may be built up by rigidly attaching a section to either top or bottom of forms. If such buildup is attached to the top of metal forms, the buildup shall be of metal.

Width of the base of all forms shall be equal to at least 80 percent of specified pavement thickness.

Side forms shall be of sufficient rigidity, both in the form and in the interlocking connection with adjoining forms, that springing will not occur under the weight of subgrading and paving equipment or from the pressure of concrete. The Contractor shall provide sufficient forms so that there will be no delay in placing the concrete due to lack of forms.

Before placing side forms, the underlying material shall be at the proper grade. Side forms shall have full bearing upon the foundation throughout their length and width of base and shall be placed to the required grade and alignment of the edge of the finished pavement. They shall be firmly supported during the entire operation of placing, compacting, and finishing the pavement.

Forms shall be drilled in advance of being placed to line and grade to accommodate tie bars where these are specified.

Immediately in advance of placing concrete and after all subgrade operations are completed, side forms shall be trued and maintained to the required line and grade for a distance sufficient to prevent delay in placing concrete.

Side forms shall remain in place at least 12 hours after the concrete has been placed, and in all cases until the edge of the pavement no longer requires the protection of the forms. Curing compound shall be applied to the concrete immediately after the forms are removed.

Side forms shall be thoroughly cleaned and oiled each time they are used and before concrete is placed against them.

Concrete shall be spread, screeded, shaped, and consolidated by one or more self-propelled machines. These machines shall uniformly distribute and consolidate concrete without segregation so that completed pavement will conform to required cross section with a minimum of handwork.

The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to that of concrete delivery.

Concrete for the full paving width shall be effectively consolidated by means of surface vibrators, in combination with internal vibrators, or by some other method of consolidation that produces equivalent results without segregation.

When vibrators are used to consolidate concrete, the rate of vibration shall be not less than 3,500 cycles per minute for surface vibrators and shall be not less than 7,000 cycles per minute for internal vibrators. Amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete more than 1 foot from the vibrating element. The Contractor shall furnish a tachometer or other suitable device for measuring and indicating frequency of vibration.

Power to vibrators shall be connected so that vibration ceases when forward or backward motion of the machine is stopped.

5-05.3(8) Joints

Joints in cement concrete pavement will be designated as longitudinal and transverse contraction joints and longitudinal and transverse construction joints, and shall be constructed as shown in the Plans and in accordance with the following provisions:

All contraction joints shall be constructed at the locations, intervals, and depths shown in the Standard Plan. The faces of all joints shall be constructed perpendicular to the surface of the cement concrete pavement.

5-05.3(8)A Contraction Joints

All transverse and longitudinal contraction joints shall be formed with suitable power-driven concrete saws. The Contractor shall provide sufficient sawing equipment capable of completing the sawing to the required dimensions and at the required rate to control cracking. The Contractor shall provide adequate artificial lighting facilities for night sawing. Joints shall not vary from the specified or indicated line by more than $^{3}/_{4}$-inch.

Commencement of sawing transverse contraction joints will be dependent upon the setting time of the concrete and shall be done at the earliest possible time following placement of the concrete without tearing or raveling the adjacent concrete excessively.

Longitudinal contraction joints shall be sawed as required to control cracking and as soon as practical after the initial control transverse contraction joints are completed.

Any damage to the curing material during the sawing operations shall be repaired immediately after the sawing is completed.

When cement concrete pavement is placed adjacent to existing cement concrete pavement, the vertical face of all existing working joints shall be covered with building paper or other suitable material.

5-05.3(8)B Sealing Sawed Contraction Joints

Sawed contraction joints shall be filled with a joint sealant filler conforming to the requirements of Section 9-04.2. Joints shall be thoroughly clean at the time of sealing and if the hot-poured type is used the joints shall be dry. Care shall be taken to avoid air pockets. The hot-poured compound shall be applied in two or more layers, if necessary. The cold-poured compound shall be applied under sufficient pressure to fill the groove from bottom to top and to a point approximately 1/4-inch below the surface of the concrete. The joint filled with cold-poured compound shall then be covered with a strip of nonabsorbent paper at least twice as wide as the joint and the paper shall be left in place.

5-05.3(8)C Construction Joints

When placing of concrete is discontinued for more than 45 minutes, a transverse construction joint shall be installed. Construction joints shall be as shown in the Standard Plan.

Transverse construction joints shall be constructed between cement concrete pavement and reinforced concrete bridge approach slabs.

All transverse and longitudinal construction joints, including the joint between new and existing pavement when widened, shall be sawed and sealed with joint filler conforming to the requirements of Sections 5-05.3(8)A and 9-04.2.

5-05.3(9) Vacant

5-05.3(10) Tie Bars and Dowel Bars

Epoxy-coated tie bars shall be placed at all longitudinal contraction and construction joints, in accordance with the requirements shown in the Standard Plan. In addition, tie bars shall be installed when concrete shoulders are placed as a separate operation or when widening existing pavement.

Epoxy-coated tie bars shall be placed at longitudinal construction joints between lanes in a manner that the individual bars are located at the required elevation and spaced as shown in the Standard Plan and in a manner that the vertical edge of the concrete is not deformed or otherwise damaged during placement of the bars.

Placement tolerances for tie bars shall be within 1-inch of the middle of the concrete slab, within 1-inch of being centered over the joint and placed parallel or perpendicular to centerline within 1-inch of the vertical and horizontal plane.

Epoxy-coated dowel bars will be required for the construction joint at the end of paving operations each day and they shall be placed in accordance with the Standard Plan. Epoxy coated dowel bars shall be placed at all transverse contraction joints as shown in the contract or in accordance with the Standard Plans. All dowel bars shall have a parting compound, such as curing compound, grease or other Engineer approved equal applied to them prior to placement.

Placement tolerances for dowel bars shall be within 1-inch of the middle of the concrete slab, within 1-inch of being centered over the transverse joint and parallel to centerline within $^1/_2$-inch of the vertical and the horizontal plane.

Dowel bars that are mounted in a cage for placing shall allow for movement of the bars within the cage. Cutting of stiffeners within the cage is not recommended.

When new concrete pavement is to be placed against existing cement concrete pavement, epoxy-coated tie bars shall be drilled and set into the existing pavement with an epoxy bonding agent in accordance with the Standard Plan and specified tolerances for placement of tie bars. The epoxy-bonding agent shall meet the requirements of Section 9-26.1 for Type 1 epoxy. The Contractor may use any method for drilling the holes, provided the method selected does not damage the existing concrete. Any damage caused by the Contractor's operations shall be repaired by the Contractor at no cost to the Contracting Agency and the repair shall be to the satisfaction of the Engineer.

The tie bar holes shall be blown clean with compressed air before grouting. The bar shall be centered in the hole for the full length of embedment before grouting. The grout shall then be pumped into the hole around the bar in a manner that the back of the hole will be filled first. Blocking or shimming shall not impede the flow of the grout into the hole. Dams, if needed, shall be placed at the front of the holes to confine the grout. The dams shall permit the escape of air without leaking grout and shall not be removed until grout has cured in the hole.

5-05.3(11) Finishing

After the concrete has been given a preliminary finish by means of finishing devices incorporated in the slip-form paving equipment, the surface of the fresh concrete shall be checked by the Contractor with a straightedge device not less than 10-feet in length. High areas indicated by the straightedge device shall be removed by the hand-float method. Each successive check with the straightedge device shall lap the previous check path by at least $^1/_2$ of the length of the straightedge. The requirements of this paragraph may be waived if it is successfully demonstrated that other means will consistently produce a surface with a satisfactory profile index and meeting the 10-foot straightedge requirement specified in Section 5-05.3(12).

Any edge slump of the pavement, exclusive of specified edging, in excess of $^1/_4$-inch shall be erected before the concrete has hardened. If edge slump on any 1-foot or greater length of hardened concrete exceeds 1-inch, the concrete shall be repaired as provided in Section 5-05.3(22).

The pavement shall be given a final finish surface by texturing with a comb perpendicular to the centerline of the pavement. The comb shall produce striations approximately $^1/_8$-inch to $^3/_{16}$-inch in depth. Randomly space the striations from $^1/_2$-inch to $1^1/_4$-inch. The comb shall be operated mechanically either singly or in gangs with several placed end to end. Finishing shall take place with the elements of the comb as nearly perpendicular to the concrete surface as is practical, to eliminate dragging the mortar. If the striation equipment has not been previously approved, a test section shall be constructed prior to approval of the equipment. If the pavement has a raised curb without a formed concrete gutter, the texturing shall end 2-feet from the curb line.

At the beginning and end of paving each day, the Contractor shall, with an approved stamp, indent the concrete surface near the right hand edge of the panel to indicate the date, month, and year of placement.

At approximate 500-foot intervals where designated by the Engineer the Contractor shall, with an approved stamp, indent the concrete surface near the right hand edge of the pavement with the stationing of the roadway.

5-05.3(12) Surface Smoothness

The pavement smoothness will be checked under supervision of the Engineer no later than 5:00 p.m. of the day following placement of concrete, with equipment furnished and operated by the Contractor. Smoothness of all pavement placed except shoulders, ramp tapers, intersections and small or irregular areas as defined by Section 5-05.3(3) unless specified otherwise, will be measured with a recording profilograph, as specified in Section 5-05.3(3), parallel to centerline, from which the profile index will be determined in accordance with WSDOT Test Method 807.

For the purpose of qualifying the equipment and methods used by the Contractor, a daily profile index will be computed. For pavement placed in a 12-foot width or less, the daily profile index will be the average of two profiles made approximately 3-feet from and parallel to each edge of the pavement. If the pavement is placed in a width greater than 12-feet, the daily profile index will be computed as the average of profiles made approximately 3-feet from and parallel to each edge and at the approximate location of each planned longitudinal joint.

The daily profile index of the finished pavement thus determined will be 7-inches per mile, or less. Only equipment and methods that consistently produce a finished surface meeting this requirement shall be used. Should the daily profile index exceed the rate of 7-inches per mile, the paving operations shall be discontinued until other methods or equipment are provided by the Contractor. Such revised methods and equipment shall again be discontinued if they do not produce a finished surface having a daily profile index of 7-inches per mile, or less. Operations shall not be resumed until the Engineer approves further changes in methods and equipment as proposed by the Contractor.

All areas representing high points having deviations in excess of 0.3-inch as determined by procedures described in WSDOT Test Method 807, shall be reduced by abrasive methods until such deviations do not exceed 0.1-inch as determined by reruns of the profilograph. High areas of individual profiles shall be reduced by abrasive means so that the profile index will not exceed 0.7-inch in any 0.1 mile section. All high areas in excess of 0.1-inch shall be reduced to 0.0-inch prior to reducing any high points of 0.1-inch or less. Low spots exceeding .25-inch shall be corrected in a manner approved by the Engineer.

When any of the daily profile indexes exceed 7-inches per mile, final acceptance of the pavement for smoothness parallel to the centerline will be based on profile indexes as measured with the profilograph, operating by the Contractor under the supervision of the Engineer, along a line parallel to the edge of pavement and each longitudinal joint and will not be averaged for acceptance purposes. The final acceptance profile indexes will be measured after all corrective work is complete and will demonstrate that all 0.1-mile sections on the project are within the 0.7-inch Specification.

When cement concrete pavement abuts bridges, the finished pavement parallel to centerline within 15-feet of the abutting joint shall be uniform to a degree that no variations greater than $^{1}/_{8}$-inch are present when tested with a 10-foot straightedge.

When paving intersections, small or irregular areas, as defined in Section 5-05.3(3), surface smoothness will be measured with a 10 foot straightedge no later than 5:00 p.m. of the day following the placing of the concrete. A 10 foot straightedge will be placed

parallel to the centerline so as to bridge any depressions and touch all high spots. Should the surface vary more than 1/8-inch from the lower edge of the straightedge, the high portion shall be reduced by the Contractor to the 1/8-inch tolerance by abrasive means at no expense to the Contracting Agency. It is further provided that if reduction of high portions of the surface involves breaking, dislodging, or other disturbance of the aggregates, such cutting will not be permitted until the pavement has achieved its design age. If in the opinion of the Engineer irregularities cannot be satisfactorily removed by such methods, the Contractor shall remove and replace the pavement at no expense to the Contracting Agency.

Smoothness perpendicular to the centerline will be measured with a 10-foot straight edge. The transverse slope of the finished pavement shall be uniform to a degree such that no variations greater than 1/4-inch are present when tested with a 10-foot long straightedge laid in a direction perpendicular to the centerline. Any areas that are in excess of this specified tolerance shall be corrected by abrasive means.

5-05.3(13) Curing

Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be cured in accordance with one of the following methods the Contractor may elect.

5-05.3(13)A Curing Compound

Liquid membrane-forming concrete curing compound Type 2 meeting the requirements of Section 9-23.2 shall be applied to the entire area of the exposed surface of the concrete with an approved mechanical spray machine. The spray fog shall be protected from the wind with an adequate shield. It shall be applied uniformly at the rate of one gallon to not more than 150 square feet.

The compound shall be applied with equipment of the pressure tank or pump type equipped with a feed tank agitator which ensures continuous agitation of the compound during spraying operations. The nozzle shall be of the two-line type with sufficient air to properly atomize the compound.

The curing compound shall not be applied during or immediately after rainfall. If it becomes necessary to leave the pavement uncoated overnight, it shall be covered with polyethylene sheeting, which shall remain in place until weather conditions are favorable for the application of the curing compound.

In the event that rain falls on the newly coated pavement before the film has dried sufficiently to resist damage, or in the event of damage to the film from any cause, the Contractor shall apply a new coat of curing compound in one or two applications to the affected area at the rate which, in the opinion of the Engineer, will result in a film of curing value equal to that specified in the original coat.

Before placing the curing compound in the spray tank, it shall be thoroughly agitated as recommended by the Manufacturer. The compound shall not be diluted by the addition of solvents nor be altered in any manner. If the compound has become chilled to the extent that it is too viscous for proper stirring or application or if portions of the vehicle have been precipitated from solution, it shall be heated to restore proper fluidity but it shall not be heated above 100ºF. All curing compound shall have approval prior to placing in the spray tanks.

The curing compound shall be applied immediately after the concrete has been finished and after any bleed water that has collected on the surface has disappeared, or at a time designated by the Engineer. If hair checking develops in the pavement before finishing is completed, the Engineer may order the application of the curing compound at an earlier stage, in which event any concrete cut from the surface in finishing operations shall be removed entirely from the pavement. If additional mortar is then needed to fill torn areas, it shall be obtained ahead of the spraying operations. All areas cut by finishing tools subsequent to the application of the curing compound shall immediately be given new applications at the rate specified above.

The curing compound, after application, shall be protected by the Contractor from injury until the pavement has reached a minimum compressive strength of 2500 psi. All traffic, either by foot or otherwise, shall be considered as injurious to the film of the applied compound.

The Contractor shall provide on the job a sufficient quantity of white polyethylene sheeting to cover all the pavement laid in three hours of maximum operation. This sheeting shall be reserved exclusively for the protection of the pavement in case of rain or breakdown of the spray equipment used for applying the curing compound. The protective sheeting shall be placed over the pavement when ordered, and in the manner specified by the Engineer.

Areas from which it is impossible to exclude traffic shall be protected by a covering of sand or earth not less than 1 foot in thickness or by other suitable and effective means. The protective covering shall be placed no earlier than 24 hours after application of the compound.

All liquid membrane-forming curing compounds shall be removed from the Portland cement concrete pavement to which traffic delineators are to be bonded. Curing compound removal shall not be started until the pavement has attained sufficient flexural strength for traffic to be allowed on it. The Contractor shall submit a proposed removal method to the Engineer and shall not begin the removal process until the Engineer has approved the removal method.

The Contractor shall assume all liabilities for and protect the Contracting Agency from any damages or claims arising from the use of materials or processes described herein.

5-05.3(13)B White Polyethylene Sheeting

The sheeting shall be placed over the pavement immediately after finishing operations are completed, or at a time designated by the Engineer.

The sheeting shall be laid so that individual sheets overlap at least 2-feet, and the lapped areas shall be held in close contact with the pavement by weighting with earth or boards to prevent movement by the wind. The sheeting shall extend downward to cover the edges of the pavement and shall be secured to the subgrade with a continuous bank of earth or surfacing material. Any holes occurring in the sheeting shall be patched immediately to the satisfaction of the Engineer. The sheeting shall be maintained against injury and remain in place until the pavement has reached a minimum compressive strength of 2500 psi.

5-05.3(13)C Wet Curing

Wet curing shall be accomplished by applying a continuous fog or mist spray to the entire pavement surface until it has reached a minimum compressive strength of 2500 psi. If water runoff is not a concern, continuous sprinkling is acceptable. Sprinkling shall not begin until the concrete has achieved initial set as determined by AASHTO T 197 or other approved method.

5-05.3(14) Cold Weather Work

When the air temperature is expected to reach the freezing point during the day or night and the pavement has not reached 50 percent of its design strength or 2500 psi which ever is greater the concrete shall be protected from freezing. The Contractor shall, at no expense to the Contracting Agency, provide a sufficient supply of straw, hay, grass, earth, blankets, or other suitable blanketing material and spread it over the pavement to a sufficient depth to prevent freezing of the concrete. The Contractor shall be responsible for the quality and strength of the concrete thus cured. Any concrete injured by frost action or freezing shall be removed and replaced at the Contractor's expense in accordance with these Specifications.

5-05.3(15) Concrete Pavement Construction in Adjacent Lanes

Unless otherwise shown in the Plans or in the Special Provisions, the pavement shall be constructed in multiple lanes; that is, two or more adjacent lanes paved in a single operation. Longitudinal contraction joints shall be used between adjacent lanes that are paved concurrently, and construction joints shall be used when lanes are paved separately. Tie bars shall be installed during initial lane construction.

The Contractor shall replace, at no expense to the Contracting Agency, any panels on the new pavement that are cracked or broken as a result of the Contractor's operations.

5-05.3(16) Protection of Pavement

The Contractor shall protect the pavement and its appurtenances from any damage. Protection shall include personnel to direct traffic and the erection and maintenance of warning signs, lights, barricades, temporary take-down bridges across the pavement with adequate approaches, and whatever other means may be necessary to accommodate local traffic and to protect the pavement during the curing period or until opened to traffic as determined by the Engineer.

The operation of construction equipment on the new pavement will not be allowed until the pavement has developed a compressive strength of 2500 psi as determined from cylinders, made at the time of placement, cured under comparable conditions, and tested in accordance with AASHTO T 22. Exceptions would be one track from a slip form-paving machine when paving adjacent lanes or light vehicles required for sawing operations or taking cores.

Placement of shoulder material may commence when the pavement has developed a compressive strength of 1800 psi as determined from cylinders made at the time of placement, cured under comparable conditions, and tested in accordance with AASHTO T 22 as long as construction equipment is not operated on the new pavement.

A continuous barrier of the design shown in the Plans shall be constructed and maintained along the edge of the pavement being constructed and adjacent to the portion of the roadway used for traffic. The barriers shall be left in place until the new pavement is ready to be opened to traffic and shall then be removed by the Contractor.

Any damage to the pavement occurring prior to final acceptance shall be replaced or repaired in accordance with Section 5-05.3(22).

5-05.3(17) Opening to Traffic

The pavement may be opened to traffic when the concrete has developed a compressive strength of 2500 psi as determined from cylinders, made at the time of placement, cured under comparable conditions, and tested in accordance with AASHTO T 22.

Fabrication, curing, and testing of cylinders to measure early strength shall be the responsibility of the Contractor. The Contractor shall obtain the services of an independent laboratory to perform these activities and these laboratories shall be approved by the Engineer. At the Contractor's option, the time for opening pavement may be determined through the use of the maturity test in accordance with ASTM C 1074. The Contractor shall develop the maturity-strength relationship and provide maturity curves along with supporting data for approval by the Engineer. The Contractor shall furnish all equipment, including thermal or maturity meter, thermocouples, wire, and qualified personnel to monitor maturity and provide information to the Engineer. Field procedures to monitor maturity shall be submitted to the Engineer for approval prior to use. The pavement shall not be opened to traffic until the maturity-strength relationship shows the pavement has a compressive strength of 2500 psi and approved by the Engineer.

The pavement shall be cleaned prior to opening to traffic.

All costs associated with early-strength cylinders shall be at the Contractor's expense.

5-05.3(18) Vacant

5-05.3(19) Reinforced Concrete Bridge Approach Slabs

Approach slab concrete shall be Class 4000 conforming to the requirements of Section 6-02.

Reinforced concrete bridge approach slabs shall be constructed at the locations shown in the Plans designated by the Engineer and in accordance with the contract documents.

The approach slabs shall be constructed full bridge deck width from outside usable shoulder to outside usable shoulder at an elevation to match the structure. Pavement ends and the bridge ends of the approach slabs shall be constructed as shown in the Plans. The approach slabs shall be modified as shown in the Plans to accommodate the grate inlets at the bridge ends if the grate inlets are required.

Screed rail support, installation, and finish machine requirements shall be as specified for bridge deck slabs.

Reinforced concrete bridge approach slab anchors shall be installed as detailed in the Plans. The anchor rods, couplers, and nuts shall conform to Section 9-06.5(1). The steel plates shall conform to ASTM A 36. All metal parts shall receive one coat of formula A-11-99 paint. The pipe shall be any non-perforated PE or PVC pipe of the diameter specified in the Plans. Polystyrene shall conform to Section 9-04.6. The anchors shall be installed parallel both to profile grade and center line of roadway. The Contractor shall secure the anchors to ensure that they will not be misaligned during concrete placement. For Method B anchors installations, the epoxy resin used to install the anchors shall conform to Section 9-26.1.

The compression seal shall be as noted in the contract documents.

Finishing of the reinforced concrete bridge approach slabs shall be accomplished by either a combination of finishing machine and hand finishing or by hand finishing methods only. The finished and cured approach slabs shall be free from any deviation exceeding 1/8-inch under a 10-foot straightedge placed parallel and perpendicular to the centerline of the roadway. Bridge approach slabs may be opened to traffic in accordance with Section 5-05.3(17). Bridge approach slabs shall be cured in accordance with Section 5-05.3(13).

5-05.3(20) Vacant

5-05.3(21) Vacant

5-05.3(22) Repair of Defective Pavement Slabs

Broken slabs, slabs with random cracks, nonworking contraction joints near cracks, edge slumping and spalls along joints and cracks shall be replaced or repaired as specified at no expense to the Contracting Agency, and shall be accomplished prior to completion of joint sealing.

Pavement slabs containing more than one crack shall be entirely removed and replaced. Pavement slabs containing a single crack shall be removed and replaced such that the minimum dimension of the removed slab is 6-feet long and full panel width. The portion of the panel to remain in place shall have a minimum dimension of 6-feet in length and full panel width, otherwise entire removal and replacement of the slab is required. There shall be no new joints closer than 3-feet to an existing transverse joints. Saw cutting full pavement depth is required along all longitudinal joints and at transverse locations. Tie bars and dowel bars shall be used in accordance Section 5-05.3(10).

Spalls and edge slumping shall be repaired by making vertical saw cuts at least 3-inches outside the affected area and to a minimum depth of 3-inches. Repair depths that exceed one third of the total slab depth or encounter dowel bars or reinforcing steel will require full depth repair. When the affected area is directly against a longitudinal or transverse joint, a debonding medium, (compressible joint insert or polyethylene strip) must be placed between the existing concrete and the area to be patched. For transverse joints, the compressible joint material must be placed into the existing joint 1-inch below the depth of the repair and extended at least 3-inches beyond each end of the patch boundaries. If the affected area is directly against an asphalt pavement, a formed edge even with the surface is required. The concrete in the affected area shall be chipped out to sound concrete with a pneumatic hammer with a maximum weight of 30 pounds. The formed cavity shall be sand blasted with dry, oil-free air and thoroughly cleaned of all loose material. Where required, an epoxy bonding agent shall be applied to the dry, cleaned surface of the cavity in a thin even coat, using a stiff-bristle brush. Placement of Portland cement concrete or epoxy concrete or mortar shall immediately follow the application of the epoxy bonding agent. The epoxy bonding agent shall meet the requirements of Section 9-26.1(1) for Type II epoxy (Portland cement concrete placement) or Type III epoxy (epoxy concrete or mortar placement). Epoxy concrete or mortar shall meet the requirements of Section 9-26.3(1)A. Low areas which grinding cannot feasibly remedy, shall be sandblasted, filled with epoxy bonded mortar, and textured by grinding. The epoxy bonding agent shall meet the requirements of Section 9-26.1(1)B for Type II epoxy. The patch mixture should be placed and vibrated to eliminate any voids. Vibrators greater than 1-inch shall not be used. If cementitious repair material is used, the patch perimeter shall be sealed with a 1:1 cement-water grout. The patch mixture shall be cured according to the manufactures recommendation.

5-05.4 Measurement

Cement concrete pavement will be measured by the cubic yard for the completed pavement. The volume will be determined from measurements taken as listed below.

1. The width measurement will be the width of the pavement shown on the typical cross-section in the Plans, additional widening where called for, or as otherwise specified in writing by the Engineer.
2. The length will be measured horizontally along the center of each roadway or ramp.
3. The depth will be determined from the reference cores. The depth utilized to calculate the volume shall not exceed the plan depth plus 0.5-inches.

The volume of the pavement section represented by the reference core shall equal the measured length x width x reference core depth.

Epoxy-coated tie bar with drill hole will be measured by the unit for the actual number of bars used in the completed work.

Bridge approach slab will be measured by the square yard.

The ride smoothness compliance adjustment calculation is the volume of pavement, in cubic yards, represented by the profilograph.

The calculation for Portland cement concrete compliance adjustment is the volume of concrete represented by the CPF and the Thickness deficiency adjustment.

5-05.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Cement Conc. Pavement", per cubic yard.

The unit contract price per cubic yard for "Cement Conc. Pavement" shall include furnishing and installing tie bars, except those tie bars drilled into cement concrete pavement will be paid under the item "Epoxy-Coated Tie Bar with Drill Hole".

"Cement Conc. Pavement - Including Dowels ", per cubic yard.

The unit contract price per cubic yard for "Cement Conc. Pavement - Including Dowels" shall include furnishing and installing epoxy coated dowel bars and tie bars, except those tie bars drilled into cement concrete pavement will be paid under the item "Epoxy-Coated Tie Bar with Drill Hole".

"Epoxy-Coated Tie Bar with Drill Hole", per each.

"Bridge Approach Slab", per square yard.

The unit contract price per square yard for "Bridge Approach Slab" shall be full pay for providing, placing, and compacting the crushed surfacing base course, furnishing and placing Class 4000 concrete, and furnishing and installing compression seal, anchors, and reinforcing steel.

"Ride Smoothness Compliance Adjustment", by calculation.

Payment for "Ride Smoothness Compliance Adjustment" will be calculated by multiplying the unit contract price for cement concrete pavement, times the volume for adjustment, times the percent of adjustment determined from the schedule below.

1. Adjustment will be based on the initial profile index before corrective work.
2. "Ride Smoothness Compliance Adjustment" will be calculated for each 0.1 mile section represented by profilogram using the following schedule:

Ride Smoothness Profile Index (Inches per mile)	Compliance Adjustment (Percent adjustment)
1.0 or less	+4
over 1.0 to 2.0	+3
over 2.0 to 3.0	+2
over 3.0 to 4.0	+1
over 4.0 to 7.0	0
over 7.0	-2*

*Also requires correction to 7-inches per mile.

"Portland Cement Concrete Compliance Adjustment", by calculation.

Payment for "Portland Cement Concrete Compliance Adjustment" will be calculated by multiplying the unit contract price for the cement concrete pavement, times the volume for adjustment times the percent of adjustment determined from the calculated CPF and the Deficiency Adjustment listed in Section 5-05.5(1)A.

5-05.5(1) Pavement Thickness

Cement concrete pavement shall be constructed in accordance with the thickness requirements in the Plans and Specifications. Tolerances allowed for subgrade construction and other provisions, which may affect thickness, shall not be construed to modify such thickness requirements.

A primary unit of pavement is defined as the area of pavement placed in each day's paving operations or a complete intersection. Within such primary unit of pavement, there may be an area or areas, which are deficient in thickness by more than 0.05 foot. This deficient area or areas will be defined as a secondary unit or units. If secondary units are found to exist, the primary unit area will be reduced by the secondary unit area included therein. At a time determined by the Engineer, thickness measurements will be made in each primary unit of pavement at the minimum rate of one measurement for each 500 cubic yards of pavement, or fraction thereof. The exact location and number of thickness measurements within each primary unit, both longitudinally and transversely, will be determined by the Engineer. In general, thickness measurements will be made at uniform intervals throughout each primary unit of pavement.

If thickness deficiencies greater than 0.05 foot are found to exist, supplemental thickness measurements will be made in accordance with Section 5-05.5(1)B. Pavement thickness variations, if any, from the thickness requirements in the Plans and Specifications will be determined by comparing the actual thickness measurement with the thickness specified at the location where the measurement was made. Such variation will be determined to the nearest 0.01 foot as either excess or deficient thickness.

No challenges shall be allowed to be made for any thickness measurements that indicate a thickness that is within 0.05-feet of the design depth.

5-05.5(1)A Thickness Deficiency of 0.05 Foot or Less

If no thickness measurements in a primary unit are deficient by more than 0.05 foot, all thickness deficiencies in such unit will be averaged to the nearest 0.01 foot to determine the average thickness deficiency, if any, in that primary unit. For the purpose of determining the average thickness deficiency, an excess thickness variation of more than 0.02 foot will be considered to be 0.02 foot greater than the specified thickness.

For each primary unit of pavement which is deficient in average thickness by not more than 0.05 foot, the Contractor shall pay to the Contracting Agency, or the Contracting Agency may deduct from any moneys due or that may become due the Contractor under the contract, a sum computed by multiplying the deficiency adjustment from the following table by the unit contract price by the volume of such unit.

Average Thickness Deficiency (feet)	Deficiency Adjustment (per cubic yard)
0.01	2%
0.02	4%
0.03	9%
0.04	16%
0.05	25%

5-05.5(1)B Thickness Deficiency of More Than 0.05 Foot

Where a thickness deficiency greater than 0.05 foot is encountered, the Engineer will determine from supplemental thickness measurements the limits of the secondary unit area. Thickness measurements will be made in each panel of pavement adjacent transversely and longitudinally to the panel of the original measurement. This procedure will continue, regardless of unit boundaries, until such secondary unit area is bounded by panels with a thickness deficiency of 0.05 foot or less. Cores taken to isolate the secondary unit will not be used to compute average thickness of the primary unit.

Panels are the areas bounded by longitudinal and transverse joints and pavement edges. If longitudinal or transverse joints are eliminated by the Special Provisions, by the Plans, or for any other reasons, the limits of panels will be determined by the Engineer as if such joints had been constructed.

The secondary unit area will be made up of entire panels only. The entire panel will be considered to be of the thickness shown by measurement.

After the Engineer has determined the limits of the secondary unit area, a further determination will be made whether any panels within this area are usable and may be left in place. Following this determination, the Contractor shall remove and replace at no expense to the Contracting Agency such panels as the Engineer may designate in accordance with the following:

If the area to be removed is not bounded by longitudinal or transverse joints, the Contractor shall saw, at no expense to the Contracting Agency, weakened plane joints at the locations designated by the Engineer. The subgrade shall be lowered to meet the full thickness requirements. The replaced pavement will be tested for thickness by means of additional measurements and will be subject to all of the requirements of the Specifications.

Usable panels may be removed and replaced as outlined above at the option of the Contractor, or these panels will be permitted to remain in place, provided that no payment will be made for any panels which are left in place, and that a further penalty will be assessed in the amount of 25 percent of the Contractor's unit bid price for all such panels. The Contracting Agency may deduct such amount from any moneys due or that may become due the Contractor under the Contract.

The cost of all thickness measurements made to determine the secondary unit areas, including filling the core holes with concrete, will be deducted at the rate of $150.00 per core from any moneys due or that may become due the Contractor under the Contract.

All additional work required and any delay to the Contractor's operations as a result of this Specification shall not be cause for additional pay nor for an extension of time.

DIVISION 6
STRUCTURES

6-01 GENERAL REQUIREMENTS FOR STRUCTURES

6-01.1 Description

This section relates to structural and incidental items used in any or all types of existing or proposed structures. These provisions supplement the detailed specifications supplied for any given structure. These provisions apply only when relevant and when they do not conflict with the Plans or Special Provisions.

6-01.2 Foundation Data

Foundation data in the Plans (from test borings, test pits, or other sources) were obtained only to guide the Department in planning and designing the project. These data reasonably represent the best information available to the Department concerning conditions and materials at the test sites at the time the investigations were made.

6-01.3 Clearing the Site

The Contractor shall clear the entire site of the proposed structure to the limits staked by the Engineer.

6-01.4 Appearance of Structures

To achieve a more pleasing appearance, the Engineer may require the Contractor to adjust the height and alignment of bridge railings, traffic barrier, and structural curbs.

6-01.5 Vacant

6-01.6 Load Restrictions on Bridges Under Construction

Bridges under construction shall remain closed to all traffic, including construction equipment, until the substructure and the superstructure, through the roadway deck, are complete for the entire structure, except as provided herein. Completion includes release of all falsework, removal of all forms, and attainment of the minimum design concrete strength and specified age of the concrete in accordance with these Specifications. Once the structure is complete, Section-1-07.7 shall govern all traffic loading, including construction traffic (equipment).

If necessary and safe to do so, and if the Contractor requests it in writing, the Engineer may approve traffic on a bridge prior to completion. The maximum distributed load at each construction equipment support shall not exceed the design load by more than 33 percent. The written request shall:

1. Describe the extent of the structure completion at time of the proposed equipment loading;
2. Describe the loading magnitude, arrangement, movement, and position of traffic (equipment) on the bridge, including but not limited to the following:
    a. Location of construction equipment, including outriggers, spreader beams and supports for each, relative to the bridge framing plan (bridge girder layout);
    b. Mechanism of all load transfer (load path) to the bridge;

3. Provide stress calculations under the design criteria specified in the AASHTO Standard Specifications for Highway Bridges, current edition, prepared by (or under the direction of) a professional engineer, licensed under Title 18 RCW state of Washington, and carrying the professional engineer's signature and seal, including but not limited to the following:
   a. Supporting calculations showing that the flexural and shear stresses in the main load carrying members due to the construction load are within the allowable stresses;
   b Supporting calculations showing that the flexural and shear stresses in the bridge deck due to the construction load are within the allowable stresses;
4. Provide supporting material properties, catalogue cuts, and other information describing the construction equipment and all associated outriggers, spreader beams, and supports; and,
5. State that the Contractor assumes all risk for damage.

6-01.7 Navigable Streams

The Contractor shall keep navigable streams clear so that water traffic may pass safely, providing and maintaining all lights and signals required by the U.S. Coast Guard. The Contractor shall also comply with all channel depth and clearance line requirements of the U.S. Corps of Engineers. This may require removing material deposited in the channel during construction.

6-01.8 Approaches to Movable Spans

No roadway or sidewalk slab on the approach span at either end of a movable span may be placed until after the movable span has been completed, adjusted and closed.

6-01.9 Working Drawings

The Contractor shall submit supplemental working drawings with calculations as required for the performance of the work. The drawings shall be on sheets measuring 22 by 34-inches, 11 by 17-inches, or on sheets with dimensions in multiples of $8^1/_2$ by 11-inches. All drawings shall be to scale in keeping with standard drafting procedures. The design calculations shall be on sheets measuring $8^1/_2$ by 11-inches. They shall be legible, with all terms identified, and may include computer printouts. The drawings and calculations shall be provided far enough in advance of actual need to allow for the review process by the Contracting Agency, which may involve rejection, revision, or resubmittal. Unless otherwise stated in the contract, the Engineer will require up to 30 calendar days from the date the submittals are received until they are sent to the Contractor. This time will increase if the drawings submitted do not meet the contract requirements or contain insufficient details.

Unless designated otherwise by the Contractor, submittals of working drawing plans will be reviewed in the order they are received by the Engineer. In the event that several working drawing plans are submitted simultaneously, the Contractor shall specify the sequence in which these plans are to be reviewed. The Engineer's review time shall be as specified above for the first plan in the specified sequence and up to an additional two weeks for each plan lower in the specified sequence. A plan is defined as one or more working drawings that pertain to a unit of superstructure or a complete pier. If the Contractor does not submit a working drawing review sequence for simultaneous plan submittals, the review sequence shall be at the Engineer's discretion.

Working drawings and calculations shall be prepared by (or under the direction of) a Professional Engineer, licensed under Title 18 RCW, State of Washington, and shall carry the Professional Engineer's signature and seal.

If more than the specified number of days are required for the Engineer's review of any individual submittal or resubmittal, an extension of time will be considered in accordance with Section 1-08.8.

6-01.10 Utilities Supported by or Attached to Bridges

Installation of utility pipes and conduit systems shall conform to the details shown in the Plans and as specified in the utility agreement between the utility company and the Contracting Agency.

All utility pipes and conduit systems supported by or attached to bridge structures shall be labeled with Type I reflective sheeting conforming to Section 9-28.12, and the following:

Content	Label Background Color	Lettering Utility Color
Electrical Power	Red	Black
Gas, Oil, Steam, Petroleum, and other gaseous materials	Yellow	Black
CATV, Telecommunication, Alarm, and Signal	Orange	Black
Potable Water	Blue	White
Reclaimed Water,Irrigation, Slurry	Purple	White
Sewer and Storm Drain	Green	White

The purple color background for the label for reclaimed water, irrigation, and slurry, shall be generated by placing transparent film over white reflective material. The purple tint of the transparent film shall match Federal Standard Color 595B No. 37100. Color chips are available from the source specified in Section 9-08.4(7).

The label text shall identify the utility contents and include the emergency one-call phone number 1-800-424-5555.

The minimum length of the label color field shall be the longer of either one letter width beyond each end of the label text, or the length specified below:

Minimum Pipe O.D. (inches)	Maximum Pipe O.D. (inches)	Minimum Length of Label Color Field (inches)	Letter Height (inches)
$^3/_4$	$1^1/_4$	8	$^1/_2$
$1^1/_2$	2	8	$^3/_4$
$2^1/_2$	6	12	$1^1/_4$
8	10	24	$2^1/_2$
12	—	32	$3^1/_2$

Utility pipes and conduit systems shall be labeled on both sides of each bridge pier, and adjacent to each entrance hatch into a box girder cell. For utility pipes and conduit systems within bridge spans exceeding 300-feet, labels shall also be applied to the utility pipes and conduit systems between the piers at a maximum spacing of 300-feet. The label shall be visible at a normal eye height.

6-01.11 Name Plates

The Contractor shall install no permanent plates or markers on a structure unless the Plans show it.

6-01.12 Final Cleanup

When the structure is completed, the Contractor shall leave it and the entire site in a clean and orderly condition. Structure decks shall be swept and washed. Temporary buildings, falsework, piling, lumber, equipment, and debris shall be removed. The Contractor shall level and fine grade all excavated material not used for backfill, and shall fine grade all slopes and around all piers, bents, and abutments.

The Contractor is advised that after the structure is complete, a representative(s) of the WSDOT Bridge Preservation Office may perform an Inventory Inspection of the structure. The purpose of the Inventory Inspection is to field verify certain contract details, to provide a base-line condition assessment of the structure, and to identify any potential maintenance features.

6-01.13 Architectural Features

To ensure uniform texture and color, the Contractor shall obtain all cement for the structure from the same manufacturing plant unless the Engineer waives this requirement in writing.

6-01.14 Premolded Joint Filler

When the Plans call for premolded joint filler, the Contractor shall fasten it with galvanized wire nails to one side of the joint. The nails must be no more than 6-inches apart and shall be $1^1/_2$-inches from the edges over the entire joint area. The nails shall be at least $1^1/_2$-inches longer than the thickness of the filler.

The Contractor may substitute for the nails any adhesive approved by the Engineer. This adhesive, however, shall be compatible with Resilient Bituminous Preformed Expansion Joint Filler (ASTM D 1751) and capable of bonding the filler to Portland cement concrete.

6-01.15 Normal Temperature

Bridge plans state dimensions at a normal temperature of 64ºF. Unless otherwise noted, these dimensions are horizontal or vertical.

6-02 CONCRETE STRUCTURES

6-02.1 Description

This work consists of the construction of all structures (and their parts) made of Portland cement concrete with or without reinforcement. Any part of a structure to be made of other materials shall be built as these Specifications require elsewhere.

6-02.2 Materials

Materials shall meet the requirements of the following sections:

Portland Cement	9-01
Aggregates for Portland Cement Concrete	9-03.1
Gravel Backfill	9-03.12
Joint and Crack Sealing Materials	9-04
Reinforcing Steel	9-07
Epoxy-Coated Reinforcing Steel	9-07
Prestressed Concrete Girders	9-19
Curing Materials and Admixtures	9-23
Fly Ash	9-23
Microsilica Fume	9-23.11
Plastic Waterstop	9-24
Water	9-25
Elastomeric Bearing Pads	9-31

6-02.3 Construction Requirements

6-02.3(1) Classification of Structural Concrete

The class of concrete to be used shall be as noted in the Plans and these Specifications. The numerical class of concrete defines the specified minimum compressive strength at 28 days in accordance with AASHTO T 22. The letter designation following the class of concrete identifies the specific use; P for Piling applications, W for Underwater applications, and D for Deck applications.

The Contractor may request, in writing, permission to use a different class of concrete with either the same or a higher compressive strength than specified. The substitute concrete shall be evaluated for acceptance based on the specified class of concrete. The Engineer will respond in writing. The Contractor shall bear any added costs that result from the change.

6-02.3(2) Proportioning Materials

The total water soluble Chloride ion (Cl-) content of the mixed concrete shall not exceed 0.06 percent by weight of cementitious material for prestressed concrete nor 0.10 percent by weight of cementitious material for reinforced concrete. An initial evaluation may be obtained by testing individual concrete ingredients for total chloride ion content per AASHTO T 260 and totaling these to determine the total water soluble Chloride ion (Cl-) or the total water soluble Chloride ion (Cl-) in accordance with ASTM C 1218.

Unless otherwise specified, the Contractor shall use Type I or II Portland cement in all concrete as defined in Section 9-01.2(1).

The use of fly ash is required for Class 4000D and 4000P concrete. The use of fly ash and ground granulated blast furnace slag is optional for all other classes of concrete.

Fly ash, if used, shall not exceed 35 percent by weight of the total cementitious material and shall conform to Section 9-23.9. Ground granulated blast furnace slag, if used, shall not exceed 25 percent by weight of the total cementitious material and shall conform to Section 9-23.10. When both ground granulated blast furnace slag and fly ash are included in the concrete mix, the total weight of both these materials is limited to 35 percent by weight of the total cementitious material.

The water/cement ratio shall be calculated on the total weight of cementitious material. The following are considered cementitious materials: Portland cement, fly ash, ground granulated blast furnace slag and microsilica.

As an alternative to the use of fly ash, ground granulated blast furnace slag and cement as separate components, a blended hydraulic cement that meets the requirements of Section 9-01.2(4) Blended Hydraulic Cements may be used.

6-02.3(2)A Contractor Mix Design

The Contractor shall provide a mix design in writing to the Engineer for all classes of concrete specified in the Plans except for those accepted based on a Certificate of Compliance. No concrete shall be placed until the Engineer has reviewed the mix design. The required average 28 day compressive strength shall be selected per ACI 318, chapter 5, Section 5.3.2. ACI 211.1 and ACI 318 shall be used to determine proportions. The proposed mix for Class 4000P shall provide a minimum fly ash content per cubic yard of 100 pounds and a minimum cement content per cubic yard of 600 pounds. The proposed mix for Class 4000D shall provide a minimum fly ash content per cubic yard of 75 pounds and a minimum cement content per cubic yard of 660 pounds. All other concrete mix designs, except those for lean concrete and commercial concrete, shall have a minimum cementitious material content of 564 pounds per cubic yard of concrete.

The Contractor's submittal of a mix design shall be on WSDOT form 350-040 and shall provide a unique identification for each mix design and shall include the mix proportions per cubic yard, the proposed sources, the average 28 day compressive strength for which the mix is designed, the fineness modulus, water cement ratio, and the aggregate correction factor per WAQTC FOP for AASHTO T 152. Concrete placeability, workability, and strength shall be the responsibility of the Contractor. The Contractor shall notify the Engineer in writing of any mix design modifications.

Fine aggregate shall conform to Section 9-03.1(2) Class 1 or Class 2.

Coarse aggregate shall conform to Section 9-03. The nominal maximum size aggregate for Class 4000P shall be $^1/_2$-inch. The nominal maximum size aggregate for Class 4000D shall be $^3/_4$-inch.

Nominal maximum size for concrete aggregate is defined as the smallest standard sieve opening through which the entire amount of the aggregate is permitted to pass.

Class 4000D and 4000P concrete shall include a water reducing admixture in the amount recommended by the manufacturer. A retarding admixture is required in concrete Class 4000P. Water reducing and retarding admixtures are optional for all other concrete classes.

A high-range water reducer (superplasticizer) may be used in all mix designs. Microsilica fume may be used in all mix designs. The use of a high-range water reducer or microsilica fume shall be submitted as a part of the Contractor's concrete mix design.

Air content shall be a minimum of 4.5 percent and a maximum of 7.5 percent for all concrete placed above the finished ground line.

6-02.3(2)B Commercial Concrete

Commercial concrete shall have a minimum compressive strength at 28 days of 3000 psi in accordance with WSDOT FOP for AASHTO T 22. Commercial concrete placed above the finished ground line shall be air entrained and have an air content from 4.5 percent to 7.5 percent per WAQTC FOP for AASHTO T 152. Commercial concrete does not require plant approval, mix design, or source approvals for cement, aggregate, and other admixtures.

Where concrete Class 3000 is specified for nonstructural items such as, culvert headwalls, plugging culverts, concrete pipe collars, pipe anchors, monument cases, luminaire bases, pedestals, cabinet bases, guardrail anchors, sign post foundations, fence post footings, sidewalks, curbs, and gutters, the Contractor may use commercial concrete. If commercial concrete is used for sidewalks, curbs, and gutters, it shall have a minimum cementitious material content of 564 pounds per cubic yard of concrete, shall be air entrained, and the tolerances of Section 6-02.3(5)C shall apply. Commercial concrete shall not be used for structural items such as, bridges, retaining walls, box culverts, or foundations for high mast luminaires, mast arm traffic signals, cantilever signs, and sign bridges. The Engineer may approve other nonstructural items not listed for use as commercial concrete.

6-02.3(2)C Vacant

6-02.3(2)D Lean Concrete

Lean concrete shall contain between 145 and 200 pounds of cement per cubic yard and have a maximum water/cement ratio of 2.

6-02.3(3) Admixtures

Concrete admixtures shall be added to the concrete mix at the time of batching the concrete or in accordance with the manufacturer's written procedure and as approved by the Engineer. A copy of the manufacturer's written procedure shall be furnished to the Engineer prior to use of any admixture. Any deviations from the manufacturer's written procedures shall be submitted to the Engineer for approval. Admixtures shall not be added to the concrete with the modified procedures until the Engineer has approved them in writing.

When the Contractor is proposing to use admixtures from different admixture manufacturers they shall provide evidence to the Engineer that the admixture will be compatible and not adversely effect the air void system of the hardened concrete. Test results complying with ASTM C 457 shall be provided as the evidence to satisfy this requirement. Admixture combinations which have been previously tested and which are in compliance with ASTM C 457 shall be listed in the Qualified Products List (QPL). Proposed combinations not found in the QPL shall meet this requirement.

Accelerators shall not be used.

Air entrained cement shall not be used to air entrain concrete.

6-02.3(4) Ready-Mix Concrete

All concrete, except commercial concrete and lean concrete shall be batched in a prequalified manual, semi-automatic, or automatic plant as described in Section 6-02.3(4)A. The Engineer is not responsible for any delays to the Contractor due to problems in getting the plant certified.

6-02.3(4)A Qualification of Concrete Suppliers

Prequalification may be obtained through an inspection conducted by the Plant Manager, defined as the person directly responsible for the daily plant operation, using the NRMCA or WSDOT checklist, through certification by NRMCA, or by an independent evaluation certified by a professional engineer using NRMCA or Contracting Agency guidelines. Information concerning NRMCA certification may be obtained from the National Ready Mix Concrete Association at 900 Spring Street, Silver Springs, MD 20910. The Contracting Agency and the NRMCA certification have similar requirements for plant and delivery equipment. Whereas Plant Manager certification shall be done prior to the start of a project and every six months throughout the life of the project, the NRMCA certification shall be good for a two year period.

If prequalification is done by the Plant Manager the following shall be performed:

1. The checklist cover page shall be signed by the Plant Manager and notarized.
2. The signed and notarized cover page shall be submitted to the Project Engineer with the concrete mix design (WSDOT Form 350-040), water meter verification, truck list, and admixture dispensing certification.
3. The checklists shall be maintained by the Plant Manager and are subject to review at any time by the Contracting Agency.
4. The water meter shall be verified every six months.

For central-mixed concrete, the mixer shall be equipped with a timer that prevents the batch from discharging until the batch has been mixed for the prescribed mixing time. A mixing time of one minute will be required after all materials and water have been introduced into the drum. Shorter mixing time may be allowed if the mixer performance is tested in accordance with (AASHTO M 157 Annex A1 Concrete Uniformity Requirements). Tests shall be conducted by an independent testing lab or by a commercial concrete producer's lab. If the tests are performed by a producer's lab, the Engineer or a representative will witness all testing.

For shrink-mixed concrete, the mixing time in the stationary mixer shall not be less than 30 seconds or until the ingredients have been thoroughly blended.

For transit-mixed or shrink-mixed concrete, the mixing time in the transit mixer shall be a minimum of 70 revolutions at the mixing speed designated by the manufacturer of the mixer. Following mixing, the concrete in the transit mixer may be agitated at the manufacturer's designated agitation speed. A maximum of 320 revolutions (total of mixing and agitation) will be permitted prior to discharge.

All transit-mixers shall be equipped with an operational revolution counter and a functional device for measurement of water added. All mixing drums shall be free of concrete buildup and the mixing blades shall meet the minimum specifications of the drum manufacturer. A copy of the manufacturer's blade dimensions and configuration shall be on file at the concrete producer's office. A clearly visible metal data plate (or plates) attached to each mixer and agitator shall display: (1) the maximum concrete capacity of the drum or container for mixing and agitating, and (2) the rotation speed of the drum or blades for both the agitation and mixing speeds. Mixers and agitators shall always operate within the capacity and speed-of-rotation limits set by the manufacturer. Any mixer, when fully loaded, shall keep the concrete uniformly mixed. All mixers and agitators shall be capable of discharging the concrete at a steady rate. Only those transit-mixers which meet the above requirements will be allowed to deliver concrete to any Contracting Agency project covered by these Specifications.

In transit-mixing, mixing shall begin within 30 seconds after the cement is added to the aggregates.

Central-mixed concrete, transported by truck mixer/agitator, shall not undergo more than 250 revolutions of the drum or blades before beginning discharging. To remain below this limit, the suppler may agitate the concrete intermittently within the prescribed time limit. When water or admixtures are added after the load is initially mixed, an additional 30 revolutions will be required at the recommended mixing speed.

For each project, at least biannually, or as required, the Plant Manager will examine mixers and agitators to check for any buildup of hardened concrete or worn blades. If this examination reveals a problem, or if the Engineer wishes to test the quality of the concrete, slump tests may be performed with samples taken at approximately the $^1/_4$ and $^3/_4$ points as the batch is discharged. The maximum allowable slump difference shall be as follows:

If the average of the two slump tests is ≤ 4-inches, the difference shall be ≤ 1-inch or if the average of the two slump tests is >4-inches, the difference shall be ≤ $1^1/_2$-inches.

If the slump difference exceeds these limits, the equipment shall not be used until the faulty condition is corrected. However, the equipment may continue in use if longer mixing times or smaller loads produce batches that pass the slump uniformity tests.

All concrete production facilities will be subject to verification inspections at the discretion of the Engineer. Verification inspections are a check for: current scale certifications; accuracy of water metering devices; accuracy of the batching process; and verification of coarse aggregate quality.

If the concrete producer fails to pass the verification inspection, the following actions will be taken:

1. For the first violation, a written warning will be provided.
2. For the second violation, the Engineer will give written notification and the Contracting Agency will assess a price reduction equal to 15 percent of the invoice cost of the concrete that is supplied from the time of the infraction until the deficient condition is corrected.
3. For the third violation, the concrete supplier is suspended from providing concrete until all such deficiencies causing the violation have been permanently corrected and the plant and equipment have been reinspected and meets all the prequalification requirements.
4. For the fourth violation, the concrete supplier shall be disqualified from supplying concrete for one year from the date of disqualification. At the end of the suspension period the concrete supplier may request that the facilities be inspected for prequalification.

6-02.3(4)B Jobsite Mixing

For small quantities of concrete, the Contractor may mix concrete on the job site provided the Contractor has requested in writing and received written permission from the Engineer. The Contractor's written request shall include a mix design, batching and mixing procedures, and a list of the equipment performing the job-site mixing. All job site mixed concrete shall be mixed in a mechanical mixer.

If the Engineer permits, hand mixing of concrete will be permitted for pipe collars, pipe plugs, fence posts, or other items approved by the Engineer, provided the hand mixing is done on a watertight platform in a way that distributes materials evenly throughout the mass. Mixing shall continue long enough to produce a uniform mixture. No hand mixed batch shall exceed $^1/_2$ cubic yard.

Concrete mixed at the jobsite is never permitted for placement in water.

6-02.3(4)C Consistency

The maximum slump for concrete shall be:

1. 3.5-inches for vibrated concrete placed in all bridge roadway slabs, bridge approach slabs, and flat slab bridge superstructures.
2. 4.5-inches for all other vibrated concrete.
3. 7-inches for non-vibrated concrete. (Includes Class 4000P)
4. 9-inches for shafts when using Class 4000P, provided the water cement ratio does not exceed 0.44 and a water reducer is used meeting the requirements of 9-23.6.
5. 5.5-inches for all concrete placed in curbs, gutters, and sidewalks.

When a high range water reducer is used, the maximum slump listed in 1, 2, 3, and 5 above, may be increased an additional 2-inches.

6-02.3(4)D Temperature and Time For Placement

Concrete temperatures shall remain between 55ºF and 90ºF while it is being placed. Precast concrete that is heat cured per Section 6-02.3(25)D shall remain between 50ºF and 90ºF while being placed. The batch of concrete shall be discharged at the project site no more than $1^1/_2$ hours after the cement is added to the concrete mixture. The time to discharge may be extended to $1^3/_4$ hours if the temperature of the concrete being placed is less than 75ºF. With the approval of the Engineer and as long as the temperature of the concrete being placed is below 75ºF, the maximum time to discharge may be extended to two hours. When conditions are such that the concrete may experience an accelerated initial set, the Engineer may require a shorter time to discharge. The time to discharge may be extended upon written request from the Contractor. This time extension will be considered on a case by case basis and requires the use of specific retardation admixtures and the approval of the Engineer.

6-02.3(5) Acceptance of Concrete

6-02.3(5)A General

Lean concrete and commercial concrete will be accepted based on a Certificate of Compliance to be provided by the supplier as described in Section 6-02.3(5)B.

All other concrete will be accepted based on conformance to the requirement for temperature, slump, air content for concrete placed above finished ground line, and the specified compressive strength at 28 days for sublots as tested and determined by the Contracting Agency.

A sublot is defined as the material represented by an individual strength test. An individual strength test is the average compressive strength of cylinders from the same sample of material.

Each sublot will be deemed to have met the specified compressive strength requirement when both of the following conditions are met:

1. Individual strength tests do not fall below the specified strength by more than $12^1/_2$ percent or 500 psi, whichever is least.
2. An individual strength test averaged with the two preceding individual strength tests meets or exceeds specified strength (for the same class and exact mix I.D. of concrete on the same contract).

When compressive strengths fail to satisfy one or both of the above requirements, the Contractor may:

1. Request acceptance based on the Contractor/Suppliers strength test data for cylinders made from the same truckload of concrete as the Contracting Agency cylinders; provided:
   a. The Contractor's test results are obtained from testing cylinders fabricated, handled, and stored for 28 days in accordance with WSDOT FOP for AASHTO T 23 and tested in accordance with AASHTO T 22. The test cylinders shall be the same size cylinders as those cast by the Contracting Agency.
   b. The technician fabricating the cylinders is qualified by either ACI, Grade 1 or WAQTC to perform this work.
   c. The laboratory performing the tests per AASHTO T 22 has an equipment calibration/certification system, and a technician training and evaluation process per AASHTO R-18.
   d. Both the Contractor and Contracting Agency have at least 15 test results from the same mix to compare. The Contractor's results could be used if the Contractor's computed average of all their test results is within one standard deviation of the Contracting Agency's average test result. The computed standard deviation of the Contractor's results must also be within plus or minus 200 psi of the Contracting Agency's standard deviation.
2. Request acceptance of in-place concrete strength based on core results. This method will not be used if the Engineer determines coring would be harmful to the integrity of the structure. Cores, if allowed, will be obtained by the Contractor in accordance with AASHTO T 24 and delivered to the Contracting Agency for testing in accordance with AASHTO T 22. If the concrete in the structure will be dry under service conditions, the core will be air dried at a temperature of between 60ºF and 80ºF and at a relative humidity of less than 60 percent for seven days before testing, and will be tested air dry.

Acceptance for each sublot by the core method requires that the average compressive strength of three cores be at least 85 percent of the specified strength with no one core less than 75 percent of the specified strength. When the Contractor requests strength analysis by coring, the results obtained will be accepted by both parties as conclusive and supersede all other strength data for the concrete sublot.

If the Contractor elects to core, cores shall be obtained no later than 50 days after initial concrete placement. The Engineer will concur in the locations to be cored. Repair of cored areas shall be the responsibility of the Contractor. The cost incurred in coring and testing these cores, including repair of core locations, shall be borne by the Contractor.

6-02.3(5)B Certification of Compliance

The concrete producer shall provide a Certificate of Compliance for each truckload of concrete. The Certificate of Compliance shall verify that the delivered concrete is in compliance with the mix design and shall include:

Manufacturer plant (batching facility)
Contracting Agency contract number.
Date
Time batched
Truck No.
Initial revolution counter reading
Quantity (quantity batched this load)
Type of concrete by class and producer design mix number
Cement producer, type, and Mill Certification No. (The mill test number as required by Section 9-01.3 is the basis for acceptance of cement.)
Fly ash (if used) brand and Type
Approved aggregate gradation designation

Mix design weight per cubic yard and actual batched weights for:

Cement
Fly ash (if used)
Coarse concrete aggregate and moisture content (each size)
Fine concrete aggregate and moisture content
Water (including free moisture in aggregates)
Admixtures brand and total quantity batched
- Air-entraining admixture
- Water reducing admixture
- Other admixture

The Certificate of Compliance shall be signed by a responsible representative of the concrete producer, affirming the accuracy of the information provided. In lieu of providing a machine produced record containing all of the above information, the concrete producer may use the Contracting Agency-provided printed forms, which shall be completed for each load of concrete delivered to the project.

For commercial concrete, the Certificate of Compliance shall include, as a minimum, the batching facility, date, and quantity batched per load.

6-02.3(5)C Conformance to Mix Design

Cement, coarse and fine aggregate weights shall be within the following tolerances of the mix design:

Batch Volumes less than or equal to 4 cubic yards		
Cement	+5%	-1%
Aggregate	+10%	-2%
Batch Volumes more than 4 cubic yards		
Cement	+5%	-1%
Aggregate	+2%	-2%

If the total cementitious material weight is made up of different components, these component weights shall be within the following tolerances:

1. Portland cement weight plus 5% or minus 1 percent of that specified in the mix design.
2. Fly ash weight plus or minus 5 percent of that specified in the mix design.
3. Microsilica weight plus or minus 10 percent of that specified in the mix design.

Water shall not exceed the maximum water specified in the mix design.

6-02.3(5)D Test Methods

Acceptance testing will be performed by the Contracting Agency in accordance with the WSDOT Materials Manual. The test methods to be used with this specification are:

WSDOT FOP for AASHTO T 22	Compressive Strength of Cylindrical Concrete Specimens
WSDOT FOP for AASHTO T 23	Making and Curing Concrete Test Specimens in the Field
WSDOT FOP for AASHTO T 119	Slump of Hydraulic Cement Concrete
FOP for WAQTC TM 2	Sampling Freshly Mixed Concrete
WAQTC FOP for AASHTO T 152	Air Content of Freshly Mixed Concrete by the Pressure Method
WSDOT FOP for AASHTO T 231	Capping Cylindrical Concrete Specimens
WSDOT FOP for AASHTO T 309	Temperature of Freshly Mixed Portland Cement Concrete

6-02.3(5)E Point of Acceptance

Determination of concrete properties for acceptance will be made based on samples taken as follows:

Bridge decks, overlays, and barriers at the discharge of the placement system.

All other placements at the truck discharge.

It shall be the Contractor's responsibility to provide adequate and representative samples of the fresh concrete to a location designated by the Engineer for the testing of concrete properties and making of cylinder specimens. Samples shall be provided as directed in Sections 1-06.1 and 1-06.2. Once the Contractor has turned over the concrete for acceptance testing, no more mix adjustment will be allowed. The concrete will either be accepted or rejected.

6-02.3(5)F Water/Cement Ratio Conformance

The actual water cement ratio shall be determined from the certified proportions of the mix, adjusting for on the job additions. No water may be added after acceptance testing or after placement has begun, except for concrete used in slip forming. For slip-formed concrete, water may be added during placement but shall not exceed the maximum water cement ratio in the mix design, and shall meet the requirements for consistency as described in Section 6-02.3(4)C. If water is added, an air and temperature test shall be taken prior to resuming placement to ensure that specification conformance has been maintained.

6-02.3(5)G Sampling and Testing Frequency for Temperature, Consistency, and Air Content

Concrete properties shall be determined from concrete as delivered to the project and as accepted by the Contractor for placement. The Contracting Agency will test for acceptance of concrete for slump, temperature, and air content, if applicable, as follows:

Sampling and testing will be performed before concrete placement from the first truck load. Concrete shall not be placed until tests for slump, temperature, and entrained air (if applicable) have been completed by the Engineer, and the results indicate that the concrete is within acceptable limits. Except for the first load of concrete, up to $^1/_2$ cubic yard may be placed prior to testing for acceptance. Sampling and testing will continue for each load until two successive loads meet all applicable acceptance test requirements. After two successive tests indicate that the concrete is within specified limits, the sampling and testing frequency may decrease to one for every five truck loads. Loads to be sampled will be selected in accordance with the random selection process as outlined in WAQTC FOP for TM 2.

When the results for any subsequent acceptance test indicates that the concrete as delivered and approved by the Contractor for placement does not conform to the specified limits, the sampling and testing frequency will be resumed for each truck load. Whenever two successive subsequent tests indicate that the concrete is within the specified limits, the random sampling and testing frequency of one for every five truck loads may resume.

Sampling and testing for a placement of one class of concrete consisting of 50 cubic yards or less will be as listed above, except:

Sampling and testing will continue until one load meets all of the applicable acceptance requirements, and

After one set of tests indicate that the concrete is within specified limits, the remaining concrete to be placed may be accepted by visual inspection.

6-02.3(5)H Sampling and Testing for Compressive Strength

Acceptance testing for compressive strength shall be conducted at the same frequency as the acceptance tests for temperature, consistency, and air content.

6-02.3(5)I Vacant

6-02.3(5)J Vacant

6-02.3(5)K Rejecting Concrete

Rejection Without Testing — The Engineer, prior to sampling, may reject any batch or load of concrete that appears defective in composition; such as cement content or aggregate proportions. Rejected material shall not be incorporated in the structure.

6-02.3(5)L Concrete With Non-Conforming Strength

Concrete with cylinder compressive strengths (fc) that fail to meet acceptance level requirements shall be evaluated for structural adequacy. If the material is found to be adequate, payment shall be adjusted in accordance with the following formula:

$$\text{Pay adjustment} = \frac{2(f'c - fc)(UP)(Q)}{f'c}$$

where f′c = Specified minimum compressive strength at 28 days.
fc = Compressive strength at 28 days as determined by AASHTO Test Methods.
UP = Unit contract price per cubic yard for the class of concrete involved.
Q = Quantity of concrete represented by an acceptance test based on the required frequency of testing.

Concrete that fails to meet minimum acceptance levels using the coring method will be evaluated for structural adequacy. If the material is found to be adequate, payment shall be adjusted in accordance with the following formula:

$$\text{Pay adjustment} = \frac{3.56(.85f'c - f\ cores)(UP)(Q)}{f'c}$$

where f'c = Specified minimum compressive strength at 28 days.
f cores = Compressive strength of the cores as determined by AASHTO T-22.
UP = Unit contract price per cubic yard for the class of concrete involved.
Q = Quantity of concrete represented by an acceptance test based on the required frequency of testing.

Where these Specifications designate payment for the concrete on other than a per cubic yard basis, the unit contract price of concrete shall be taken as $300 per cubic yard for concrete Class 4000, 5000, and 6000. For concrete Class 3000, the unit contract price for concrete shall be $160 per cubic yard.

6-02.3(6) Placing Concrete

The Contractor shall not place concrete:

1. On frozen or ice-coated ground or subgrade;
2. Against or on ice-coated forms, reinforcing steel, structural steel, conduits, precast members, or construction joints;
3. Under rainy conditions; placing of concrete shall be stopped before the quantity of surface water is sufficient to affect or damage surface mortar quality or cause a flow or wash the concrete surface;
4. In any foundation until the Engineer has approved its depth and character;
5. In any form until the Engineer has approved it and the placement of any reinforcing in it; or
6. In any work area when vibrations from nearby work may harm the concrete's initial set or strength.

When a foundation excavation contains water, the Contractor shall pump it dry before placing concrete. If this is impossible, an underwater concrete seal shall be placed that complies with Section 6-02.3(6)B. This seal shall be thick enough to resist any uplift.

All foundations and forms shall be moistened with water just before the concrete is placed. Any standing water on the foundation or in the form shall be removed.

The Contractor shall place concrete in the forms as soon as possible after mixing. The concrete shall always be plastic and workable. For this reason, the Engineer may reduce the time to discharge even further. Concrete placement shall be continuous, with no interruption longer than 30 minutes between adjoining layers unless the Engineer approves a longer time. Each layer shall be placed and consolidated before the preceding layer takes initial set. After initial set, the forms shall not be jarred, and projecting ends of reinforcing bars shall not be disturbed.

In girders or walls, concrete shall be placed in continuous, horizontal layers 1.5 to 2.5-feet deep. Compaction shall leave no line of separation between layers. In each part of a form, the concrete shall be deposited as near its final position as possible.

Any method for placing and consolidating shall not segregate aggregates or displace reinforcing steel. Any method shall leave a compact, dense, and impervious concrete with smooth faces on exposed surfaces. Plastering is not permitted. Any section of defective concrete shall be removed at the Contractor's expense.

To prevent aggregates from separating, the length of any conveyor belt used to transport concrete shall not exceed 300-feet. If the mix needs protection from sun or rain, the Contractor shall cover the belt. When concrete pumps are used for placement, a Contractor's representative shall, prior to use on the first placement of each day, visually inspect the pumps water chamber for water leakage. No pump shall be used that allows free water to flow past the piston.

If a concrete pump is used as the placing system, the pump priming slurry shall be discarded before placement. Initial acceptance testing may be delayed until the pump priming slurry has been eliminated from the concrete being pumped. Eliminating the priming slurry from the concrete may require that several cubic yards of concrete are discharged through the pumping system and discarded. Use of a concrete pump requires a reserve pump (or other backup equipment) at the site.

If the concrete will drop more than 5-feet, it shall be deposited through a sheet metal (or other approved) conduit. If the form slopes, the concrete shall be lowered through approved conduit to keep it from sliding down one side of the form. No aluminum conduits or tremies shall be used to pump or place concrete.

Before placing concrete for roadway slabs on steel spans, the Contractor shall release the falsework under the bridge and let the span swing free on its supports. Concrete in flat slab bridges shall be placed in one continuous operation for each span or series of continuous spans.

Concrete for roadway slabs and the stems of T-beams or box-girders shall be placed in separate operations if the stem of the beam or girder is more than 3-feet deep. First the beam or girder stem shall be filled to the bottom of the slab fillets. Roadway slab concrete shall not be placed until enough time has passed to permit the earlier concrete to shrink (at least 12 hours). If stem depth is 3-feet or less, the Contractor may place concrete in one continuous operation if the Engineer approves.

Between expansion or construction joints, concrete in beams, girders, roadway slabs, piers, columns, walls, and traffic and pedestrian barriers, etc., shall be placed in a continuous operation.

No traffic or pedestrian barrier shall be placed until after the roadway slabs are complete for the entire structure. No concrete barriers shall be placed until the falsework has been released and the span supports itself. The Contractor may choose not to release the deck overhang falsework prior to the barrier placement. The Contractor shall submit calculations to the Engineer indicating the loads induced into the girder webs due to the barrier weight and any live load placed on the structure do not exceed the design capacity of the girder component. This analysis is not required for bridges with concrete superstructures. No barrier, curb, or sidewalk shall be placed on steel or prestressed concrete girder bridges until the roadway slab reaches a compressive strength of at least 3,000 psi.

The Contractor may construct traffic and pedestrian barriers by the slipform method. However, the barrier may not deviate more than $^{1}/_{4}$-inch when measured by a 10-foot straightedge held longitudinally on the front face, back face, and top surface. Electrical conduit within the barrier shall be constructed in accordance with the requirements of Section 8-20.3(5).

When placing concrete in arch rings, the Contractor shall ensure that the load on the falsework remains symmetrical and uniform.

Unless the Engineer approves otherwise, arch ribs in open spandrel arches shall be placed in sections. Small key sections between large sections shall be filled after the large sections have shrunk.

6-02.3(6)A Weather and Temperature Limits to Protect Concrete

Hot Weather Protection

The Contractor shall provide concrete within the specified temperature limits by:

1. Shading or cooling aggregate piles (sprinkling of fine aggregate piles with water is not allowed). If sprinkling of the coarse aggregates is to be used, the piles moisture content shall be monitored and the mixing water adjusted for the free water in the aggregate. In addition, when removing the coarse aggregate, it shall be removed from at least 1 foot above the bottom of the pile.
2. Refrigerating mixing water; or replacing all or part of the mixing water with crushed ice, provided the ice is completely melted by placing time.

If the concrete would probably exceed 90ºF using normal methods, the Engineer may require approved temperature-reduction measures be taken before the placement begins.

If air temperature exceeds 90ºF, the Contractor shall use water spray or other approved methods to cool all concrete-contact surfaces to less than 90ºF. These surfaces include forms, reinforcing steel, steel beam flanges, and any others that touch the mix. The Contractor shall reduce the time between mixing and placing to a minimum and shall not permit mixer trucks to remain in the sun while waiting to discharge concrete. Chutes, conveyors, and pump lines shall be shaded.

If bridge roadway slabs are placed while air temperature exceeds 90ºF, the Contractor shall:

1. Cover the top layer of reinforcing steel with clean, wet burlap immediately before concrete placement;
2. Sprinkle cool water on the forms and reinforcing steel just before the placement if the Engineer requires it;
3. Finish the concrete slab without delay; and
4. Provide at the site water-fogging equipment to be used if needed after finishing to prevent plastic cracks.

If the evaporation rate at the concreting site is 0.20 pounds per square foot of surface per hour or more (determined from Table 6-02.3(6)), the Contractor shall surround the fresh concrete with an enclosure. This enclosure will protect the concrete from wind blowing across its surface until the curing compound is applied. If casting deck concrete that is 80ºF or hotter, the Contractor shall install approved equipment at the site to show relative humidity and wind velocity.

Cold Weather Protection

The Contractor is solely responsible for protecting concrete from inclement weather during the entire curing period. The Contractor shall provide a written procedure for cold weather concreting to the Engineer for review and approval. The procedure shall detail how the Contractor will prevent the concrete temperature from falling below 50º F. Extra protection shall be provided for areas especially vulnerable to freezing (such as exposed top surfaces, corners and edges, thin sections, and concrete placed into steel forms). Permission given by the Engineer to place concrete during cold weather will in no way ensure acceptance of the work by the Contracting Agency. Should the concrete placed under such conditions prove unsatisfactory in any way, the Engineer shall still have the right to reject the work although the plan and the work were carried out with the Engineer's permission.

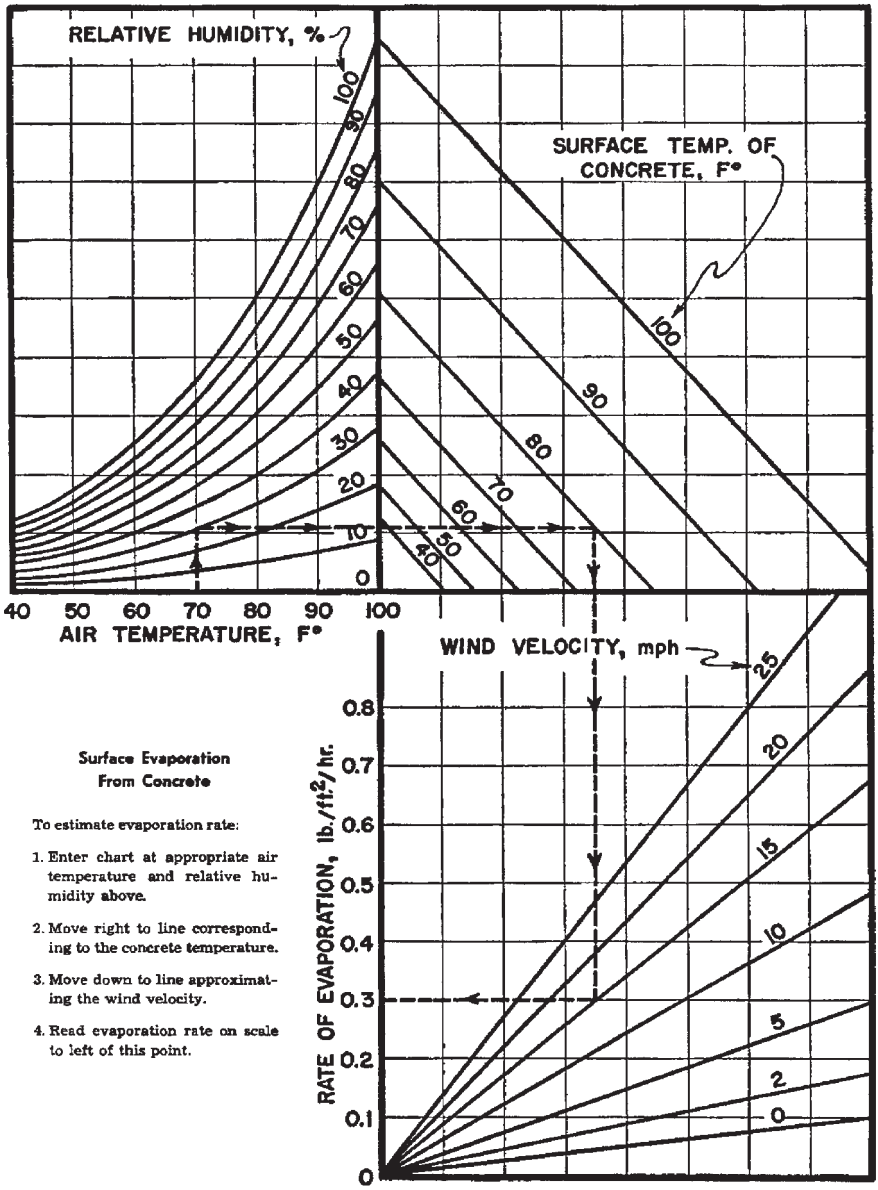
If weather forecasts predict air temperatures below 35º F during the seven days just after the concrete placement, the Contractor may place the concrete only if his approved cold weather concreting plan is implemented.

The Contractor shall provide and maintain a maturity meter in the concrete at a location specified by the Engineer for each concrete placement. During curing, data from the maturity meter shall be readily available to the Engineer. The Contractor shall record and provide time and temperature data on hourly intervals.

The Contractor shall not mix nor place concrete while the air temperature is below 35º F, unless the water or aggregates (or both) are heated to at least 70º F. The aggregate shall not exceed 150º F. If the water is heated to more than 150º F, it shall be mixed with the aggregates before the cement is added. Any equipment and methods shall heat the materials evenly. Concrete placed in shafts and piles is exempt from such preheating requirements.

The Contractor may warm stockpiled aggregates with dry heat or steam, but not by applying flame directly or under sheet metal. If the aggregates are in bins, steam or water coils or other heating methods may be used if aggregate quality is not affected. Live steam heating is not permitted on or through aggregates in bins. If using dry heat, the Contractor shall increase mixing time enough to permit the super-dry aggregates to absorb moisture.

Surface Evaporation from Concrete
Table 6-02.3(6)



Surface Evaporation From Concrete

To estimate evaporation rate:

1. Enter chart at appropriate air temperature and relative humidity above.
2. Move right to line corresponding to the concrete temperature.
3. Move down to line approximating the wind velocity.
4. Read evaporation rate on scale to left of this point.

Any concrete placed in air temperatures below 35º F shall be immediately protected. In addition to the monitoring of the concrete temperature with a maturity meter the Contractor shall provide recording thermometers or other approved devices to monitor the surface temperature of the concrete. The concrete surface temperature shall be maintained at or above 50º F and the relative humidity shall be maintained above 80 percent. These conditions shall be maintained for a minimum of seven days or for the cure period required by Section 6-02.3(11), whichever is longer. If artificial heat is used to maintain the temperature inside an enclosure, moisture shall be added to the enclosure to maintain the humidity as stated above. The Contractor shall stop adding moisture 24 hours before removing the heat.

If at any period during curing the concrete temperature falls below 50º F on the maturity meter or recording thermometer, no curing time is awarded for that day and the required curing time will be extended day for day where the temperature falls below 50º F. Should the Contractor fail to adequately protect the concrete and the temperature of the concrete falls below 35º F during curing, the Engineer may reject it.

6-02.3(6)B Placing Concrete in Foundation Seals

If the Plans require a concrete seal, the Contractor shall place the concrete underwater inside a watertight cofferdam, tube, or caisson. Seal concrete shall be placed in a compact mass in still water. It shall remain undisturbed and in still water until fully set. While seal concrete is being deposited, the water elevation inside and outside the cofferdam shall remain equal to prevent any flow through the seal in either direction. The cofferdam shall be vented at the vent elevation shown in the Plans. The thickness of the seal is based upon this vent elevation.

The seal shall be at least 18-inches thick unless the Plans show otherwise. The Engineer may change the seal thickness during construction which may require redesign of the footing and the pier shaft or column. Although seal thickness changes may result in the use of more or less concrete, reinforcing steel, and excavation, payment will remain as originally defined in unit contract prices.

To place seal concrete underwater, the Contractor shall use a concrete pump or tremie. The tremie shall have a hopper at the top that empties into a watertight tube at least 10-inches in diameter. The discharge end of the tube on the tremie or concrete pump shall include a device to seal out water while the tube is first filled with concrete. Tube supports shall permit the discharge end to move freely across the entire work area and to drop rapidly to slow or stop the flow. One tremie may be used to concrete an area up to 18-feet per side. Each additional area of this size requires one additional tremie.

Throughout the underwater concrete placement operation, the discharge end of the tube shall remain submerged in the concrete and the tube shall always contain enough concrete to prevent water from entering. The concrete placement shall be continuous until the work is completed, resulting in a seamless, uniform seal. If the concreting operation is interrupted, the Engineer may require the Contractor to prove by core drilling or other tests that the seal contains no voids or horizontal joints. If testing reveals voids or joints, the Contractor shall repair them or replace the seal at no expense to the Contracting Agency.

Concrete Class 4000W shall be used for seals, and it shall meet the consistency requirements of Section 6-02.3(4)C.

6-02.3(6)C Dewatering Concrete Seals and Foundations

After a concrete seal is constructed, the Contractor shall pump the water out of the cofferdam and place the rest of the concrete in the dry. This pumping shall not begin until the seal has set enough to withstand the hydrostatic pressure (three days for gravity seals and ten days for seals containing piling or shafts). The Engineer may extend these waiting periods to ensure structural safety or to meet a condition of the operating permit.

If weighted cribs are used to resist hydrostatic pressure at the bottom of the seal, the Contractor shall anchor them to the foundation seal. Any method used (such as dowels or keys) shall transfer the entire weight of the crib to the seal.

No pumping shall be done during or for 24 hours after concrete placement unless done from a suitable sump separated from the concrete work by a watertight wall. Pumping shall be done in a way that rules out any chance of concrete being carried away.

6-02.3(6)D Protection Against Vibration

Freshly placed concrete shall not be subjected to excessive vibration and shock waves during the curing period until it has reached a 2000 psi minimum compressive strength for concrete Class 4000 and lower strength classes of concrete. For higher strength classes of concrete, the minimum compressive strength for ending the vibration restriction shall be the concrete Class designation (specified in psi) divided by two.

After the first 5 hours from the time the concrete has been placed and consolidated, the Contractor shall keep all vibration producing operations at a safe horizontal distance from the freshly placed concrete by following either the prescriptive safe distance method or the monitoring safe distance method. These requirements for the protection of freshly placed concrete against vibration shall not apply for plant cast concrete, pile driving, shaft installation or soldier pile shaft installation operations, nor shall they apply to the vibrations caused by the traveling public. See Section 6-05.3(11)H, Shaft Special Provisions, and Section 6-16 respectively for pile driving, shaft installation, and soldier pile shaft installation operations.

Prescriptive Safe Distance Method

After the concrete has been placed and consolidated, the Contractor shall keep all vibration producing operations at a safe horizontal distance from the freshly placed concrete as follows:

MINIMUM COMPRESSIVE STRENGTH, f 'c	SAFE HORIZONTAL DISTANCE (1)	
	EQUIPMENT CLASS L (2)	EQUIPMENT CLASS H (3)
< 1000 psi	75-feet	125-feet
1000 psi to < 1400 psi	30-feet	50-feet
1400 psi to 2000 psi	15-feet	25-feet

(1) The safe horizontal distance shall be reduced to 10-feet for small rubber tire construction equipment like backhoes under 50,000 pounds, concrete placing equipment, and legal highway vehicles if such equipment travels at speeds of:
- ≤ 5 mph on relatively smooth roadway surfaces or
- ≤ 3 mph on rough roadway surfaces (i.e. with potholes)

(2) Equipment Class L (Low Vibration) shall include tracked dozers under 85,000 pounds, track vehicles, trucks (unless excluded above), hand operated jack hammers, cranes, auger drill rig, caisson drilling, vibratory roller compactors under 30,000 pounds.

(3) Equipment Class H (High Vibration) shall include machine operated impact tools, pavement breakers, and other large pieces of equipment.

After the concrete has reached a minimum compressive strength specified above, the safe horizontal distance restrictions would no longer apply.

Monitoring Safe Distance Method

The Contractor may monitor the vibration producing operations in order to decrease the safe horizontal distance requirements of the prescriptive safe distance method. If this method is chosen, all construction operations that produce vibration or shock waves in the vicinity of freshly placed concrete shall be monitored by the Contractor with monitoring equipment sensitive enough to detect a minimum peak particle velocity (PPV) of 0.10-inches per second. Monitoring devices shall be placed on or adjacent to the freshly placed concrete when the measurements are taken. During the time subsequent to the concrete placement, the Contractor shall cease all vibration or shock producing operations in the vicinity of the newly placed concrete when the monitoring equipment detects excessive vibration and shock waves defined as exceeding the following PPV's:

MINIMUM COMPRESSIVE STRENGTH, f 'c	MAXIMUM PPV
< 1000 psi	0.10 in/sec
1000 psi to < 1400 psi	1.0 in/sec
1400 psi to 2000 psi	2.0 in/sec

After the concrete has reached a minimum compressive strength specified above, the safe horizontal distance restrictions would no longer apply.

6-02.3(7) Concrete Exposed to Sea Water

If sea water will contact a completed concrete structure, the Contractor shall:

1. Mix the concrete for at least 2 minutes.
2. Control water content to produce concrete that will be as impermeable as possible.
3. Compact the concrete as the Engineer may require, avoiding the formation of any stone pockets.
4. Place only clean, rust-free reinforcement bars in the concrete.
5. Coat form surfaces heavily with shellac and any approved form release agent.
6. Leave forms intact for at least 30 days after concrete placement (longer if the Engineer requires) to prevent sea water from contacting the concrete.
7. Leave the surface of concrete just as it comes from the forms.
8. Provide special handling for any concrete piles used in sea water to avoid even slight deformation cracks.

The Engineer shall decide the range of disintegration possible by exposure to sea water. This range shall extend from a point below the level of extreme low tide up to a point above the level of extreme high tide. Wave action and other conditions will also affect the Engineer's decision on this range. Unless the Engineer approves otherwise, the Contractor shall not locate construction joints within this range. All concrete within this range shall be poured in the dry.

6-02.3(8) Concrete Exposed to Alkaline Soils or Water

The requirements for concrete in seawater shall also apply to concrete in alkaline soils or water. In addition, the Contractor shall:

1. Let the concrete set at least 30 days (longer if possible) before allowing soil or water to contact it directly;
2. Vibrate each batch of concrete immediately after it has been placed into the forms, using enough vibrating tampers to do this effectively; and
3. Hand tamp, if necessary, to produce smooth, dense outside surfaces.

6-02.3(9) Vibration of Concrete

The Contractor shall supply enough vibrators to consolidate the concrete (except that placed underwater) according to the requirements of this section. Each vibrator must:

1. Be designed to operate while submerged in the concrete,
2. Vibrate at a rate of at least 7,000 pulses per minute, and
3. Receive the Engineer's approval on its type and method of use.

Immediately after concrete is placed, vibration shall be applied in the fresh batch at the point of deposit. In doing so, the Contractor shall:

1. Space the vibrators evenly, no farther apart than twice the radius of the visible effects of the vibration;
2. Ensure that vibration intensity is great enough to visibly affect a weight of 1-inch slump concrete across a radius of at least 18-inches;
3. Insert the vibrators slowly to a depth that will effectively vibrate the full depth of each layer, penetrating into the previous layer on multilayer pours;
4. Protect partially hardened concrete (i.e., nonplastic, which prevents vibrator penetration when only its own weight is applied) by preventing the vibrator from penetrating it or making direct contact with steel that extends into it;
5. Not allow vibration to continue in one place long enough to form pools of grout;
6. Continue vibration long enough to consolidate the concrete thoroughly, but not so long as to segregate it;
7. Withdraw the vibrators slowly when the process is complete; and
8. Not use vibrators to move concrete from one point to another in the forms.

When vibrating and finishing top surfaces that will be exposed to weather or wear, the Contractor shall not draw water or laitance to the surface. In high lifts, the top layer shall be shallow and made up of a concrete mix as stiff as can be effectively vibrated and finished.

To produce a smooth, dense finish on outside surfaces, the Contractor shall hand tamp the concrete.

6-02.3(10) Roadway Slabs

A pre-concreting conference shall be held five to ten working days before placing concrete to discuss construction procedures, personnel, and equipment to be used. Those attending shall include:

1. (representing the Contractor) The superintendent and all foremen in charge of placing steel reinforcing bars, of placing the concrete, and of finishing it; and
2. (representing the State) The Project Engineer and key inspection assistants.

If the project includes more than one slab, and if the Contractor's key personnel change between concreting operations, an additional conference shall be held just before each slab is placed.

The Contractor shall not place roadway slabs until the Engineer agrees that:

1. Concrete producing and placement rates will be high enough to meet placing and finishing deadlines,
2. Finishers with enough experience have been employed, and
3. Adequate finishing tools and equipment are at the site.

The finishing machine shall be self-propelled and be capable of forward and reverse movement under positive control. The finishing machine shall be equipped with a rotating cylindrical single or double drum screed not exceeding 60-inches in length. The finishing machine shall have the necessary adjustments to produce the required cross-section, line, and grade. Provisions shall be made for the raising and lowering of all screeds under positive control. The upper vertical limit of screed travel shall permit the screed to clear the finished concrete surface. When placing concrete abutting a previously placed slab, the side of the finishing machine adjacent to the existing slab shall be equipped to travel on the existing slab.

For bridge deck widenings of 20' or less, or where jobsite conditions do not allow the use of conventional configuration finishing machines described above, the Contractor may propose the use of a hand operated motorized power screed such as a "texas" or "bunyon" screed. This screed shall be capable of finishing the deck to the same standards as the finishing machine. The Contractor shall not begin placing deck concrete until receiving the Engineer's approval of this screed and the placing procedures.

The Contractor may use hand-operated strike-boards only when the Engineer approves for special conditions and small areas (less than 10-feet in width and 200-feet in length). These boards must be sturdy and able to strike off the full placement width without intermediate supports. Strike-boards, screed rails, and any specially made auxiliary equipment shall receive the Engineer's approval before use. All finishing requirements in these specifications apply to hand-operated finishing equipment.

Screed rails shall rest on adjustable supports that can be removed with the least possible disturbance to the screeded concrete. The supports shall rest on structural members or on forms rigid enough to resist deflection. Supports shall be removable to at least 2-inches below the finished surface. If possible, the Contractor shall place screed rails outside the finishing area. But if they are placed inside the area, they shall be placed above the finished surface.

Screed rails (with their supports) shall be strong enough and stiff enough to permit the finishing machine to operate effectively on them. All screed rails shall be placed and secured for the full length of the slab before the concreting begins. If the Engineer approves in advance, the Contractor may move rails ahead onto previously set supports while concreting progresses. But such movable rails and their supports shall not change the set elevation of the screed.

On steel truss and girder spans, screed rails and bulkheads may be placed directly on transverse steel floorbeams, with the strike-board moving at right angles to the centerline of the roadway.

Before any concrete is placed, the finishing machine shall be operated over the entire length of the slab to check screed deflection. Concrete placement may begin only if the Engineer approves after this test.

Immediately before placing concrete, the Contractor shall check (and adjust if necessary) all falsework and wedges to minimize settlement and deflection from the added mass of the concrete slab. The Contractor shall also install devices, such as telltales, by which the Engineer can readily measure settlement and deflection.

The Contractor shall schedule the concrete placement so that it can be completely finished during daylight. After dark finishing is permitted if the Engineer approves and if the Contractor provides adequate lighting.

The placement operation shall cover the full width of the roadway or the full width between construction joints. The Contractor shall locate any construction joint over a beam or web that can support the slab on either side of the joint. The joint shall not occur over a pier unless the Plans permit. Each joint shall be formed vertically and in true alignment. The Contractor shall not release falsework or wedges supporting pours on either side of a joint until each side has aged as these Specifications require.

Placement of concrete for slabs shall comply with Section 6-02.3(6). The Engineer shall approve the placement method. In placing the concrete, the Contractor shall:

1. Place it (without segregation) against concrete placed earlier, as near as possible to its final position, approximately to grade, and in shallow, closely spaced piles;
2. Consolidate it around reinforcing steel by using vibrators before strike-off by the finishing machine;
3. Not use vibrators to move concrete;
4. Not revibrate any concrete surface areas where workers have stopped prior to screeding;
5. Remove any concrete splashed onto reinforcing steel in adjacent segments before concreting them;
6. Tamp and strike off the concrete with a template or strike board moving slowly forward at an even speed;
7. Maintain a slight excess of concrete in front of the cutting edge across the entire width of the placement operation;
8. Make enough passes with the strike-board (without bringing excessive amounts of mortar to the surface) to create a surface that is true and ready for final finish; and
9. Leave a thin, even film of mortar on the concrete surface after the last pass of the strike-board.

Workers shall complete all post screeding operations without walking on the concrete. This may require work bridges spanning the full width of the slab.

After removing the screed supports, the Contractor shall fill the voids with concrete (not mortar).

If necessary, as determined by the Engineer, the Contractor shall float the surface left by the finishing machine to remove roughness, minor irregularities, and seal the surface of the concrete. Floating shall leave a smooth and even surface. The floats shall be at least 4-feet long. Each transverse pass of the float shall overlap the previous pass by at least half the length of the float. The first floating shall be at right angles to the strike-off. The second floating shall be at right angles to the centerline of the span. A smooth riding surface shall be maintained across construction joints.

Expansion joints shall be finished with a $^1/_2$-inch radius edger.

After floating, but while the concrete remains plastic, the Contractor shall test the entire slab for flatness (allowing for crown, camber, and vertical curvature). The testing shall be done with a 10-foot straightedge held on the surface. The straightedge shall be advanced in successive positions parallel to the centerline, moving not more than one half the length of the straightedge each time it advances. This procedure shall be repeated with the straightedge held perpendicular to the centerline. An acceptable surface shall be one free from deviations of more than $^1/_8$-inch under the 10-foot straightedge.

If the test reveals depressions, the Contractor shall fill them with freshly mixed concrete, strike off, consolidate, and refinish them. High areas shall be cut down and refinished. Retesting and refinishing shall continue until an acceptable, deviation free surface is produced. The hardened concrete shall meet all smoothness requirements of these Specifications even though the tests require corrective work.

The Contractor will texture the bridge deck by combing the final surface perpendicular to the centerline. Made of a single row of metal tines, the comb shall leave striations in the fresh concrete approximately $^3/_{16}$-inch deep by $^1/_8$-inch wide and spaced approximately $^1/_2$-inch apart. The Engineer will decide actual depths at the site. (If the comb has not been approved, the Contractor shall obtain the Engineer's approval by demonstrating it on a test section.)

The Contractor may operate the combs manually or mechanically, either singly or with several placed end to end. The timing and method used shall produce the required texture without displacing larger particles of aggregate. Texturing shall end 2-feet from curb lines. This 2-foot untextured strip shall be hand finished with a steel trowel.

If the Plans call for an overlay (to be constructed under the same contract), such as hot mix asphalt, latex modified concrete, epoxy concrete, or similar, the Contractor shall produce the final finish by dragging a strip of damp, seamless burlap lengthwise over the full width of the slab or by brooming it lightly. A burlap drag shall equal the slab in width. Approximately 3-feet of the drag shall contact the surface, with the least possible bow in its leading edge. It must be kept wet and free of hardened lumps of concrete. When it fails to produce the required finish, the Contractor shall replace it. When not in use, it shall be lifted clear of the slab.

After the slab has cured, the surface shall not vary more than $^1/_8$-inch under a 10-foot straightedge placed parallel and perpendicular to the centerline.

The Contractor shall cut high spots down with a diamond faced, saw-type cutting machine. This machine shall cut through mortar and aggregate without breaking or dislodging the aggregate or causing spalls.

Low spots shall be built up utilizing a grout or concrete with a strength equal to or greater than the required 28-day strength of the roadway slab. The method of build-up shall be submitted to the Engineer for approval.

The surface texture on any area cut down or built up shall match closely that of the surrounding deck. The entire bridge roadway slab must provide a smooth riding surface.

Concrete for sidewalk slabs shall be well compacted, struck off with a strike-board, and floated with a wooden float to achieve a surface that does not vary more than $^1/_8$inch under a 10-foot straightedge. An edging tool shall be used to finish all sidewalk edges and expansion joints. The final surface shall have a granular texture that will not turn slick when wet.

6-02.3(11) Curing Concrete

After placement, concrete surfaces shall be cured as follows:

1. Bridge roadway slabs (except those made of concrete Class 4000D), flat slab bridge superstructures, bridge sidewalks, box culvert tops, roofs of cut and cover tunnels — curing compound covered by white, reflective type sheeting or continuous wet curing. Curing by either method shall be for at least 10 days.
2. Class 4000D concrete (regardless of structure type) — two coats of curing compound and continuous wet cure using heavy quilted blankets or burlap for 14 days.
3. All other concrete surfaces (except traffic barriers and rail bases) — continuous moisture for at least three days. When continuous moisture or wet curing is required, the Contractor shall keep the concrete surfaces wet with water during curing.

The Contractor may provide continuous moisture by watering a covering of heavy quilted blankets, by keeping concrete surfaces wet with water continuously and covering with a white reflective type sheeting, or by wetting the outside surfaces of wood forms.

When curing Class 4000D, two coats of curing compound that complies with Section 9-23.2 shall be applied immediately (not to exceed 15 min.) after tining any portion of the deck. The surface shall be covered with presoaked heavy quilted blankets or burlap as soon as the concrete has set enough to allow covering without damaging the finish. Soaker hoses are required and shall be placed on top of burlap or blankets and shall be charged with water frequently to keep the entire deck covering wet during the course of curing.

For all other concrete requiring curing compound, the Contractor shall apply two coats (that complies with Section 9-23.2) to the fresh concrete. The compound shall be applied immediately after finishing. Application of the second coat shall run at right angles to that of the first. The two coats shall total at least 1 gallon per 150 square feet and shall obscure the original color of the concrete. If any curing compound spills on construction joints or reinforcing steel, the Contractor shall clean it off before the next pour.

If the Plans call for an asphalt overlay, the Contractor shall use the clear curing compound (Type 1D), applying at least 1 gallon per 150 square feet to the concrete slab. Otherwise, the Contractor shall use white pigmented curing compound (Type 2), agitating it thoroughly just before and during application. If other materials are to be bonded to the surface, the Contractor shall remove the curing compound by sandblasting or acceptable high pressure water washing.

The Contractor shall have on the site, back-up spray equipment, enough workers, and a bridge from which they will apply the curing compound. The Engineer may require the Contractor to demonstrate (at least one day before the pour) that the crew and equipment can apply the compound acceptably.

The Contractor shall cover the top surfaces with white, reflective sheeting, leaving it in place for at least ten days. Throughout this period, the sheeting shall be kept in place by taping or weighting the edges where they overlap.

The unit contract prices shall cover all concrete curing costs.

6-02.3(11)A Curing and Finishing Concrete Traffic and Pedestrian Barrier

The Contractor shall supply enough water and workers to cure and finish concrete barrier as required in this section. Unit contract prices shall cover all curing and finishing costs.

Fixed-Form Barrier

The edge chamfers shall be formed by attaching chamfer strips to the barrier forms.

After troweling and edging a barrier (while the forms remain in place), the Contractor shall:

1. Brush the top surface with a fine bristle brush;
2. Cover the top surface with heavy, quilted blankets; and
3. Spray water on the blankets and forms at intervals short enough to keep them thoroughly wet for three days.

After removing the forms, the Contractor shall:

1. Remove all lips and edgings with sharp tools or chisels;
2. Fill all holes with mortar;
3. True up corners of openings;
4. Remove concrete projecting beyond the true surface by stoning or grinding;
5. Cover the barrier with heavy, quilted blankets (not burlap);
6. Keep the blankets continuously wet for at least seven days.

The Contractor may do the finishing work described in steps 1 through 4 above during the second (the seven day) curing period if the entire barrier is kept covered except the immediate work area. Otherwise, no finishing work may be done until at least ten days after pouring.

After the ten day curing period, the Contractor shall remove from the barrier all form-release agent, mud, dust, and other foreign substances in either of two ways: (1) by light sandblasting and washing with water, or (2) by spraying with a high-pressure water jet. The water jet equipment shall use clean fresh water and shall produce (at the nozzle) at least 1,500 psi with a discharge of at least 3 gpm. The water jet nozzle shall have a 25 degree tip and shall be held no more than 9-inches from the surface being washed.

After cleaning, the Contractor shall use brushes to rub 1:1 mortar into air holes and small crevices on all surfaces except the brushed top. This mortar shall consist of one part Portland cement (of the same brand used in the concrete) and one part clean, fine plaster sand. As soon as the mortar takes its initial set, the Contractor shall rub it off with a piece of sacking or carpet. The barrier shall then be covered with wet blankets for at least 48 hours.

No curing compound shall be used on fixed-form concrete barrier. The completed surface of the concrete shall be even in color and texture.

Slip-Form Barrier

The edge radius shall be formed by attaching radius strips to the barrier slip form.

The Contractor shall finish slip-form barrier by: (1) steel troweling to close all surface pockmarks and holes; and (2) for plain surface barrier, lightly brushing the front and back face with vertical strokes and the top surface with transverse strokes.

After finishing, the Contractor shall cure the slip-form barrier by using either method A (curing compound) or B (wet blankets) described below.

Method A. Under the curing compound method, the Contractor shall:

1. Spray two coats of clear curing compound (Type 1D) on the concrete surface after the free water has disappeared. (Coverage of combined coats shall equal at least 1 gallon per 150 square feet.)
2. No later than the morning after applying the curing compound, cover the barrier with white, reflective sheeting for at least ten days.
3. After the ten day curing period, remove the curing compound as necessary by light sandblasting or by spraying with a high-pressure water jet to produce an even surface appearance. The water jet equipment shall use clean fresh water and shall produce (at the nozzle) at least 2,500 psi with a discharge of at least 4 gpm. The water jet nozzle shall have a 25-degree tip and shall be held no more than 9-inches from the surface being cleaned. The Contractor may propose to use a curing compound/concrete sealer. The Engineer will evaluate the proposal and if found acceptable, shall approve the proposal in writing. As a minimum, the Contractor's proposal shall include:

   Product identity

   Manufacturer's recommended application rate

   Method of application and necessary equipment

   Material Safety Data Sheet (MSDS)

   Sample of the material for testing

   Allow 14 working days for evaluating the proposal and testing the material.

Method B. Under the wet cure method, the Contractor shall:

1. Provide an initial cure period by continuous fogging or mist spraying for at least the first 24 hours.
2. After the initial cure period, cover the barrier with a heavy quilted blanket.
3. Keep the blankets continuously wet for at least ten days. (No additional finishing is required at the end of the curing period.)

6-02.3(12) Construction Joints

If the Engineer approves, the Contractor may add, delete, or relocate construction joints shown in the Plans. Any request for such changes shall be in writing, accompanied by a drawing that depicts them. The Contractor will bear any added costs that result from such changes.

All construction joints shall be formed neatly with grade strips or other approved methods. The Contracting Agency will not accept irregular or wavy pour lines. Wire mesh forming material shall not be used. All joints shall be horizontal, vertical, or perpendicular to the main reinforcement. The Contractor shall not use an edger on any construction joint, and shall remove any lip or edging before making the adjacent pour.

If the Plans require a roughened surface on the joint, the Contractor shall strike it off to leave grooves at right angles to the length of the member. The grooves shall be $^1/_2$-inch to 1-inch wide, $^1/_4$-inch to $^1/_2$-inch deep, and spaced equally at twice the width of the groove. If the first strike-off does not produce the required roughness, the Contractor shall repeat the process before the concrete reaches initial set. The final surface shall be clean and without laitance or loose material.

If the Plans do not require a roughened surface, the Contractor shall include shear keys at all construction joints. These keys shall provide a positive, mechanical bond. Shear keys shall be formed depressions and the forms shall not be removed until the concrete has been in place at least 12 hours. Forms shall be slightly beveled to ensure ready removal. Raised shear keys are not allowed.

Shear keys for the tops of beams, at tops and bottoms of boxed girder webs, in diaphragms, and in crossbeams shall:

1. Be formed with 2- by 8-inch wood blocks;
2. Measure 8-inches lengthwise along the beam or girder stem;
3. Measure 4-inches less than the width of the stem, beam, crossbeam, etc. (measured transverse of the stem); and
4. Be spaced at 16-inches center to center.

Unless the Plans show otherwise, in other locations (not named above), shear keys shall equal approximately one third of the joint area and shall be approximately $1^1/_2$-inches deep.

Before placing new concrete against cured concrete, the Contractor shall thoroughly clean and roughen the cured face and wet it with water. Before placing the reinforcing mat for footings on seals, the Contractor shall: (1) remove all scum, laitance, and loose gravel and sediment; (2) clean the construction joint at the top of the seals; and (3) chip off any high spots on the seals that would prevent the footing steel from being placed in the position required by the Plans.

6-02.3(13) Expansion Joints

This section outlines the requirements of specific expansion joints shown in the Plans. The Plans may require other types of joints, seals, or materials than those described here.

Joints made of a vulcanized, elastomeric compound (with neoprene as the only polymer) shall be installed with an approved lubricant adhesive as recommended by the manufacturer. The length of a seal shall match that required in the Plans without splicing or stretching.

Open joints shall be formed with a template made of wood, metal, or other suitable material. Insertion and removal of the template shall be done without chipping or breaking the edges or otherwise injuring the concrete.

Any part of an expansion joint running parallel to the direction of expansion shall provide a clearance of at least $^1/_2$-inch (produced by inserting and removing a spacer strip) between the two surfaces. The Contractor shall ensure that the surfaces are precisely parallel to prevent any wedging from expansion and contraction.

All poured rubber joint sealer (and any required primer) shall conform with Section 9-04.2(2).

6-02.3(14) Finishing Concrete Surfaces

All concrete shall show a smooth, dense, uniform surface after the forms are removed. If it is porous, the Contractor shall bear the cost of repairing it. The Contractor shall clean and refinish any stained or discolored surfaces that may have resulted from their work or from construction delays.

Subsections A and B (below) describe two classes of surface finishing.

6-02.3(14)A Class 1 Surface Finish

The Contractor shall apply a Class 1 finish to all surfaces of concrete members to the limits designated in the contract plans.

The Contractor shall follow steps 1 through 8 below. When steel forms have been used and when the surface of filled holes matches the texture and color of the area around them, the Contractor may omit steps 3 through 8. To create a Class 1 surface, the Contractor shall:

1. Remove all bolts and all lips and edgings where form members have met;
2. Fill all holes greater than 1/4-inch with 1:2 mortar floated to an even, uniform finish;
3. Thoroughly wash the surface of the concrete with water;
4. Brush on a 1:1 mortar, working it well into the small air holes and other crevices in the face of the concrete;
5. Brush on no more mortar than can be finished in one day;
6. Rub the mortar off with burlap or a piece of carpet as soon as it takes initial set (before it reaches final set);
7. Fog-spray water over the finish as soon as the mortar paint has reached final set; and
8. Keep the surface damp for at least two days.

If the mortar becomes too hard to rub off as described in step 6, the Contractor shall remove it with a Carborundum stone and water. Random grinding is not permitted.

6-02.3(14)B Class 2 Surface Finish

The Contractor shall apply a Class 2 finish to all above-ground surfaces not receiving a Class 1 finish as specified above unless otherwise indicated in the contract. Surfaces covered with fill do not require a surface finish.

To produce a Class 2 finish, the Contractor shall remove all bolts and all lips and edgings where form members have met and fill all form tie holes.

6-02.3(15) Date Numerals

Standard date numerals shall be placed where shown in the Plans. The date shall be for the year in which the structure is completed. When traffic barrier is placed on an existing structure, the date shall be for the year in which the original structure was completed. Unit contract prices shall cover all costs relating to these numerals.

6-02.3(16) Plans for Falsework and Formwork

The Contractor shall submit all plans for falsework and formwork for approval or preapproval directly to the Bridge and Structures Office, Construction Support Engineer, Washington State Department of Transportation, PO Box 47340, Olympia, WA 98504-7340 as described in Section 6-02.3(16)A or 6-02.3(16)B. The Contractor shall also submit two sets of the falsework and formwork plans to the Project Engineer. Approval will not reduce the Contractor's responsibility for ensuring the adequacy of the formwork and falsework. All falsework and formwork shall be constructed in accordance with approved falsework and formwork plans.

Except for the placement of falsework foundation pads and piles, the construction of any unit of falsework shall not start until the Engineer has reviewed and approved the falsework plans for that unit. Falsework driven piling, temporary concrete footings, or timber mudsills may be placed as described in Section 6-02.3(17)D prior to approval at the Contractor's own risk, except for the following conditions:

1. The falsework is over or adjacent to roadways or railroads as described in Section 6-02.3(17)C, or
2. The falsework requires prior placement of shoring or cofferdams as described in Section 2-09.3(3)D.

Costs associated with modifying falsework to bring it into compliance with the approved falsework plans shall be at the Contractor's expense.

If the project involves a railroad or the U.S. Bureau of Reclamation, additional sets for the portion of the project that involves them shall be sent to:

US Postal Service:

Washington State Department of Transportation
Bridge and Structures Engineer
Construction Support
PO Box 47340
Olympia WA 98504-7340

FedEx:

Washington State Department of Transportation
Bridge and Structures Engineer
Construction Support
4500 3rd Avenue SE
Lacey WA 98503

1. Four sets for each railroad company affected, and
2. Six sets for the U.S. Bureau of Reclamation.

The Department will review the falsework and formwork plans and calculations, and if they are acceptable, will obtain the required approvals from the appropriate railroad company or the U.S. Bureau of Reclamation. After the Department has received approval and any comments from the railroad company or the U.S. Bureau of Reclamation, two copies of the falsework and formwork plans will then be marked with any comments and returned to the Contractor.

Plan approval is not required for footing or retaining walls unless they are more than 4-feet high (excluding pedestal height).

The design of falsework and formwork shall be based on:

1. Applied loads and conditions which are no less severe than those described in Section 6-02.3(17)A, "Design Loads;"
2. Allowable stresses and deflections which are no greater than those described in Section 6-02.3(17)B, "Allowable Stresses and Deflections;"
3. Special loads and requirements no less severe than those described in Section 6-02.3(17)C, "Falsework and Formwork at Special Locations;" and
4. Conditions required by other Sections of 6-02.3(17), Falsework and Formwork." Plan approval can be done by the Project Engineer for footings and walls 4-feet to 8-feet high (excluding pedestal height) provided:
5. Concrete placement rate is 4-feet per hour or less.
6. Facing is $^{3}/_{4}$-inch plywood with grade as specified per Section 6-02.3(17)J.
7. Studs, with plywood face grain perpendicular, are 2x4's spaced at 12-inches.
8. Walers with 3,000 pound safe working load ties spaced at 24-inches are 2-2x4's spaced at 24-inches.

Plan approval can be done by the Project Engineer for manufactured certified steel round column forming for column heights up to 20-feet. Concrete placement rate shall not exceed 10-feet per hour. Bracing requirements shall be per manufacturer's recommendations or submitted according to Section 6-02.3(16).

The falsework and formwork plans shall be scale drawings showing the details of proposed construction, including: sizes and properties of all members and components; spacing of bents, posts, studs, wales, stringers, wedges and bracing; rates of concrete placement, placement sequence, direction of placement, and location of construction joints; identify falsework devices and safe working load as well as identifying any bolts or threaded rods used with the devices including their diameter, length, type, grade, and required torque. Show in the falsework plans the proximity of falsework to utilities or any nearby structures including underground structures. Formwork accessories shall be identified according to Section 6-02.3(17)H, "Formwork Accessories." All assumptions, dimensions, material properties, and other data used in making the structural analysis shall be noted on the drawing.

The Contractor shall furnish two copies of the associated design calculations to the Bridge and Structures Office, Construction Support Engineer for examination as a condition for approval. The design calculations shall show the stresses and deflections in load supporting members. Construction details which may be shown in the form of sketches on the calculation sheets shall be shown in the falsework or formwork drawings as well. Falsework or formwork plans will not be approved in any case where it is necessary to refer to the calculation sheets for information needed for complete understanding of the falsework and formwork plans or how to construct the falsework and formwork.

All falsework and formwork plans and design calculations submitted to the Bridge and Structures Office shall be prepared by (or under the direct supervision of) a Professional Engineer, licensed under Title 18 RCW, State of Washington, in the branch of Civil or Structural Engineering.

Each sheet of falsework and formwork plans shall carry the following:

1. Professional Engineer's original signature, date of signature, original seal, registration number, and date of expiration.
2. The initials and dates of all participating design professionals.
3. Clear notation of all revisions including identification of who authorized the revision, who made the revision, and the date of the revision.
4. The contract number, contract title, and sequential sheet number. These shall also be on any related documents.
5. Identify where the falsework and formwork plan will be utilized by referencing Contract Plan sheet number and related item or detail.

Design calculations shall carry on the cover page, the Professional Engineer's original signature, date of signature, original seal, registration number, and date of expiration. The cover page shall include the contract number, contract title, and sequential index to calculation page numbers.

A State of Washington Professional Engineer, licensed under Title 18 RCW, State of Washington, in the branch of Civil or Structural Engineering may be retained to check, review and certify falsework and formwork plans and calculations of an individual who is licensed in another state provided that the following conditions are satisfied:

1. That the work being reviewed was legally prepared by an individual holding valid registration in another state as a civil or structural engineer.
2. The Washington State Professional Engineer conducts independent calculations and reviews all technical matters contained within the subject work, falsework and formwork plans, Contract Plans, Specifications, legal requirements, technical standards, other related documents; and has verified that the design meets all applicable specifications and is in agreement with the specific site conditions and geometry.
3. All falsework and formwork plan sheets shall carry the Washington State Professional Engineer's original signature, date of signature, original seal, registration number, and date of expiration.
4. Two copies of the Washington State Professional Engineer's independent calculations shall be submitted to the Bridge and Structures Office, Construction Support Engineer for review along with the falsework and formwork plans. The independent calculations shall carry on the cover page the Washington State Professional Engineer's original signature, date of signature, original seal, registration number, and date of expiration. The cover page shall include the following: the contract number, contract title, and sequential index to calculation page numbers
5. The Washington State Professional Engineer shall keep, a signed and sealed copy of the falsework, formwork plans, independent calculations, specifications and other related documentation that represents the extent of the review.

6-02.3(16)A Nonpreapproved Falsework and Formwork Plans

The Contractor shall submit six copies of all non-preapproved falsework and formwork plans, and two copies of the design calculations, directly to the following for review and approval and submit two copies of the falsework and formwork plans to the Project Engineer.

US Postal Service:

Washington State Department of Transportation
Bridge and Structures Engineer
Construction Support
PO Box 47340
Olympia WA 98504-7340

FedEx:

Washington State Department of Transportation
Bridge and Structures Engineer
Construction Support
4500 3rd Avenue SE
Lacey WA 98503

Reviewed falsework and formwork plans will be returned from the Bridge and Structures Office, Construction Support Engineer to the Project Engineer who will forward them to the Contractor within the time allowed according to Section 6-01.9. The time allowed begins when the Contractor's transmittal and submittal including all required copies of the falsework and/or formwork plans and calculations, catalog data, and other technical information are received by the Bridge and Structures Office, Construction Support Engineer. Fax copies are considered only informational. For multiple submittals or multiple parts to the same submittal and priority of review see Section 6-01.9.

Plans returned to the Contractor for correction shall be corrected and clean (without any previous WSDOT stamps and comments) revised falsework and formwork plans resubmitted to the Bridge and Structures Office, Construction Support Engineer for review and approval.

The Contractor may revise approved falsework and formwork plans, provided sufficient time is allowed for the Engineer's review and approval before construction is started on the revised portions. Such additional time will not be more than that which was originally allowed per Section 6-01.9. After a plan or drawing is approved and returned to the Contractor, all changes that the Contractor proposed shall be submitted to the Project Engineer for review and approval.

6-02.3(16)B Preapproved Formwork Plans

The Contractor may request preapproval on formwork plans for abutments, wingwalls, diaphragms, retaining walls, columns, girders and beams, box culverts, railings, and bulkheads. Plans for falsework supporting the roadway slab for interior spans between precast prestressed concrete girders may also be submitted for preapproval. Other falsework plans, however, will not be preapproved, but shall be submitted for review and approval as required in Section 6-02.3(16)A.

To apply for preapproval, the Contractor shall submit one reproducible drawing for each formwork plan sheet and two copies of the design calculations directly to:

US Postal Service:

Washington State Department of Transportation
Bridge and Structures Engineer
Construction Support
PO Box 47340
Olympia WA 98504-7340

Fedex:

Washington State Department of Transportation
Bridge and Structures Engineer
Construction Support
4500 3rd Avenue SE
Lacey WA 98503

The Bridge and Structures Office, Construction Support Engineer will return the formwork plan to the Contractor stamped "Preapproved" with an effective date of approval or will indicate any changes required for approval. The reviewed formwork plan will be returned from the Bridge and Structures Office, Construction Support Engineer to the Contractor within the time allowed according to Section 6-01.9. The time allowed begins when the Contractor's transmittal and submittal including all required information are received by the Bridge and Structures Office, Construction Support Engineer.

For each contract on which the preapproved formwork plans will be used, the Contractor shall submit three copies to the Project Engineer. Construction shall not begin until the Project Engineer has given approval.

If the forms being constructed have any deviations to the preapproved formwork plan, the Contractor shall submit formwork plan revisions for review and approval per Section 6-02.3(16)A.

6-02.3(17) Falsework and Formwork

Formwork and falsework are both structural systems. Formwork contains the lateral pressure exerted by concrete placed in the forms. Falsework supports the vertical and/or the horizontal loads of the formwork, reinforcing steel, concrete, and live loads during construction.

The Contractor shall set falsework, to produce in the finished structure, the lines and grades indicated in the Contract Plans. The setting of falsework shall allow for shrinkage, settlement, falsework girder camber, and any structural camber the Plans or the Engineer require.

Concrete forms shall be mortar tight, true to the dimensions, lines, and grades of the structure. Curved surfaces shown in the Contract Plans shall be constructed as curved surfaces and not chorded, except as allowed in Section 6-02.3(17)J. Concrete formwork shall be of sufficient strength and stiffness to prevent overstress and excess deflection as defined in Section 6-02.3(17)B. The rate of depositing concrete in the forms shall not exceed the placement rate in the approved formwork plan. The interior form shape and dimensions shall also ensure that the finished concrete will conform with the Contract Plans.

If the new structure is near or part of an existing one, the Contractor shall not use the existing structure to suspend or support falsework unless the Plans or Special Provisions state otherwise. For prestressed girder and T-beam bridge widenings or stage construction, the roadway deck and the diaphragm forms may be supported from the existing structure or previous stage, if approved by the Engineer. For steel plate girder bridge widenings or stage construction, only the roadway deck forms may be supported from the existing structure or previous stage, if approved by the Engineer. See Section 6-02.3(17)E for additional conditions.

On bridge roadway slabs, forms designed to stay in place made of steel or precast concrete panels shall not be used.

For post-tensioned structures, both falsework and forms shall be designed to carry the additional loads caused by the post-tensioning operations. The Contractor shall construct supporting falsework in a way that leaves the superstructure free to contract and lift off the falsework during post-tensioning. Forms that will remain inside box girders to support the placement of the roadway slab concrete shall, by design, resist girder contraction as little as possible. See Section 6-02.3(26) for additional conditions.

6-02.3(17)A Design Loads

The design load for falsework shall consist of the sum of dead and live vertical loads, and a design horizontal load. The minimum total design load for any falsework shall not be less than 100 lbs./sf. for combined live and dead load regardless of structure thickness.

The entire superstructure cross-section, except traffic barrier, shall be considered to be placed at one time for purposes of determining support requirements and designing falsework girders for their stresses and deflections, except as follows:

For concrete box girder bridges, the girder stems, diaphragms, crossbeams, and connected bottom slabs, if the stem wall is placed more than 5 days prior to the top slab, may be considered to be self supporting between falsework bents at the time the top slab is placed, provided that the distance between falsework bents does not exceed 4 times the depth of the portion of the girder placed in the preceding concrete placements.

Falsework bents shall be designed for the entire live load and dead load, including all load transfer that takes place during post-tensioning, and braced for the design horizontal load.

Dead loads shall include the weight of all successive placements of concrete, reinforcing steel, forms and falsework, and all load transfer that takes place during post-tensioning. The weight of concrete with reinforcing steel shall be assumed to be not less than 160 pounds per cubic foot.

Live loads shall consist of the actual mass of any equipment to be supported by falsework applied as concentrated loads at the points of contact, and a minimum uniform load of not less than 25 lbs./sf. applied over the entire falsework plan area supported, plus a minimum load of not less than 75 pounds per linear foot applied at the outside edge of deck overhangs.

The design horizontal load to be resisted by the falsework bracing system in any direction shall be:

> The sum of all identifiable horizontal loads due to equipment, construction sequence, side-sway caused by geometry or eccentric loading conditions, or other causes, and an allowance for wind plus an additional allowance of 1 percent of the total dead load to provide for unexpected forces. In no case shall the design horizontal load be less than three percent of the total dead load.

The minimum horizontal load to be allowed for wind on each heavy-duty steel shoring tower having a vertical load carrying capacity exceeding 30 kips per leg shall be the sum of the products of the wind impact area, shape factor, and the applicable wind pressure value for each height zone. The wind impact area is the total projected area of all the elements in the tower face normal to the applied wind. The shape factor for heavy-duty steel shoring towers shall be taken as 2.2. Wind pressure values shall be determined from the following table:

Wind Pressure on Heavy-Duty Steel Shoring Towers

Height Zone (Feet Above Ground)	Wind Pressure Value: Adjacent to Traffic	Wind Pressure Value: At Other Locations
0 to 30	20 psf	15 psf
30 to 50	25 psf	20 psf
50 to 100	30 psf	25 psf
Over 100	35 psf	30 psf

The minimum horizontal load to be allowed for wind on all other types of falsework, including falsework girders and forms supported on heavy-duty steel shoring towers, shall be the sum of the products of the wind impact area and the applicable wind pressure value for each height zone. The wind impact area is the gross projected area of the falsework support system, falsework girders, forms and any unrestrained portion of the permanent structure, excluding the areas between falsework posts or towers where diagonal bracing is not used. Wind pressure values shall be determined from the following table:

Wind Pressure on All Other Types of Falsework		
	Wind Pressure Value	
Height Zone (Feet Above Ground)	For Members Over and Bents Adjacent to Traffic Openings	At Other Locations
0 to 30	2.0 Q psf	1.5 Q psf
30 to 50	2.5 Q psf	2.0 Q psf
50 to 100	3.0 Q psf	2.5 Q psf
Over 100	3.5 Q psf	3.0 Q psf

The value of Q in the above tabulation shall be determined as follows:

$Q = 1 + 0.2W$; but Q shall not be more than 10.

Where:

W is the width of the falsework system, in feet, measured normal to the direction of the wind force being considered.

The falsework system shall also be designed so that it will be sufficiently stable to resist overturning prior to the placement of the concrete. The minimum factor of safety against falsework overturning in all directions from the assumed horizontal load for all stages of construction shall be 1.25. If the required resisting moment is less than 1.25 times the overturning moment, the difference shall be resisted by bracing, cable guys, or other means of external support.

Design of falsework shall include the vertical component (whether positive or negative) of bracing loads imposed by the design horizontal load. Design of falsework shall investigate the effects of any horizontal displacement due to stretch of the bracing. This is particularly important when using cable or rod bracing systems.

If the concrete is to be post-tensioned, the falsework shall be designed to support any increased or redistributed loads caused by the prestressing forces.

6-02.3(17)B Allowable Design Stresses and Deflections

The maximum allowable stresses listed in this Section are based on the use of identifiable, undamaged, high-quality materials. Stresses shall be appropriately reduced if lesser quality materials are to be used.

These maximum allowable stresses include all adjustment factors, such as the short term load duration factor. The maximum allowable stresses and deflections used in the design of the falsework and formwork shall be as follows:

Deflection

Deflection resulting from dead load and concrete pressure for exposed visible surfaces, $^1/_{360}$ of the span.

Deflection resulting from dead load and concrete pressure for unexposed non-visible surfaces, including the bottom of the deck slab between girders, $^1/_{270}$ of the span.

In the foregoing, the span length shall be the center line to center line distance between supports for simple and continuous spans, and from the center line of support to the end of the member for cantilever spans. For plywood supported on members wider than $1^1/_2$-inches, the span length shall be taken as the clear span plus $1^1/_2$-inches. Also, dead load shall include the weight of all successive placements of concrete, reinforcing

steel, forms and falsework self weight. Only the self weight of falsework girders may be excluded from the calculation of the above deflections provided that the falsework girder deflection is compensated for by the installation of camber strips.

Where successive placements of concrete are to act compositely in the completed structure, deflection control becomes extremely critical. Maximum deflection of supporting members — $^{1}/_{500}$ of the span for members constructed in several successive placements (such as concrete box girder and concrete T-beam girder structures) falsework components shall be sized, positioned, and/or supported to minimize progressive increases in deflection of the structure which would preload the concrete or reinforcing steel before it becomes fully composite.

Timber

Each species and grade of timber/lumber used in constructing falsework and formwork shall be identified in the drawings. The allowable stresses and loads shall not exceed the lesser of stresses and loads given in the table below or factored stresses for designated species and grade in Table 7.3 of the *Timber Construction Manual, Third Edition* by the American Institute of Timber Construction.

Compression perpendicular to the grain reduced to 300 psi for use when moisture content is 19 percent or more (areas exposed to rain, concrete curing water, green lumber).	450 psi
Compression parallel to the grain but not to exceed 1,500 psi.	$\frac{480{,}000 \text{ psi}}{(L/d)^2}$
Flexural stress for members with a nominal depth greater than 8-inches.	1,800 psi
Flexural stress psi for members with a nominal depth of 8-inches or less.	1,500 psi
The maximum horizontal shear.	140 psi
AXIAL tension.	1,200 psi
The maximum modulus of elasticity (E) for timber.	1,600,000 psi

Where:

L is the unsupported length; and

d is the least dimension of a square or rectangular column, or the width of a square of equivalent cross-sectional area for round columns.

The allowable stress for compression perpendicular to the grain, and for horizontal shear shall not be increased by any factors such as short duration loading. Additional requirements are found in other parts of Section 6-02.3(17). Criteria for the design of lumber and timber connections are found in Section 6-02.3(17)I.

Plywood for formwork shall be designed in accordance with the methods and stresses allowed in the *APA Design/Construction Guide for Concrete Forming* as published by the American Plywood Association, Tacoma, Washington. As concrete forming is a special application for plywood, wet stresses shall be used and then adjusted for forming conditions such as duration of load, and experience factors. Concrete pour pressures shall be per Section 6-02.3(17)J.

Steel

For identified grades of steel, design stresses shall not exceed those specified in the *Manual of Steel Construction - Allowable Stress Design, Ninth Edition* by the American Institute of Steel Construction, except as follows:

Compression, flexural but not to exceed $0.6F_y$	$\frac{12{,}000{,}000 \text{ psi}}{Ld/bt}$
The modulus of elasticity (E) shall be	29,000,000 psi

When the grade of steel cannot be positively identified as with salvaged steel and if rivets are present, design stresses shall not exceed the following:

Yield point f_y	30,000 psi
Tension, axial, and flexural	16,000 psi
Compression, axial except L/r shall not exceed 120	$14{,}150 - 0.37(KL/r)^2$ psi
Shear on gross section of the web of rolled shapes	9,500 psi
Web crippling for rolled shapes	22,500 psi
Compression, flexural but not to exceed 16,000 psi and L/b not greater than 39	$16{,}000 - 5.2(L/b)^2$ psi
The modulus of elasticity (E) shall be	29,000,000 psi

Where:

- L is the unsupported length;
- d is the least dimension of rectangular columns, or the width of a square of equivalent cross-sectional area for round columns, or the depth of beams;
- b is the flange width;
- t is the thickness of the compression flange;
- r is the radius of gyration of the compression flange about the weak axis of the member; and
- F_y is the specified minimum yield stress, psi, for the grade of steel used.

All dimensions are expressed in inches.

6-02.3(17)C Falsework and Formwork at Special Locations

In addition to the minimum requirements specified in Sections 6-02.3(17)A and 6-02.3(17)B, falsework towers or posts supporting beams directly over roadways or railroads which are open to traffic or the public shall be designed and constructed so that the falsework will be stable if subjected to impact by vehicles. The use of damaged materials, unidentifiable material, salvaged steel or steel with burned holes or questionable weldments shall not be used for falsework described in this section. For the purposes of this specification the following public or private facilities shall also be considered as "roadways": pedestrian pathways and other structures such as bridges, walls, and buildings.

The dimensions of the clear openings to be provided through the falsework for roadways, railroads, or pedestrian pathways shall be as specified in the Contract.

Falsework posts or shoring tower systems which support members that cross over a roadway or railroad shall be considered as adjacent to roadways or railroads. Other falsework posts or shoring towers shall be considered as adjacent to roadways or railroads only if the following conditions apply:

1. Located in the row of falsework posts or shoring towers nearest to the roadway or railroad; and
2. Horizontal distance from the traffic side of the falsework to the edge of pavement is less than the total height of the falsework and forms; or
3. The total height of the falsework and forms is greater than the horizontal clear distance between the base of the falsework and a point 10-feet from the centerline of track.

The Contractor shall provide any additional features for the work needed to ensure that the falsework will be stable for impact by vehicles; providing adequate safeguards, safety devices, protective equipment, and any other needed actions to protect property and the life, health, and safety of the public; and shall comply with the provisions in Section 1-07.23 and Section 6-02.3(17)M. The falsework design at special locations, shall incorporate the minimum requirements detailed in this Section, even if protected by concrete median barrier.

The vertical load used for the design of falsework posts and towers which support the portion of the falsework over openings, shall be the greater of the following:

1. 150 percent of the design load calculated in accordance with Section 6-02.3(17)B, but not including any increased or redistributed loads caused by the post-tensioning forces; or
2. 100 percent of the design load plus the increased or redistributed loads caused by the post-tensioning forces.

Each falsework post or each shoring tower leg adjacent to roadways or railroads shall consist of either steel with a minimum section modulus about each axis of 9.5-inches cubed or sound timbers with a minimum section modulus about each axis of 250-inches cubed.

Each falsework post or shoring tower leg adjacent to roadways or railroads shall be mechanically connected to its supporting footing at its base, or otherwise laterally restrained, to withstand a force of not less than 2,000 pounds applied at the base of the post or tower leg in any direction except toward the roadway or railroad track. Posts or tower legs shall be connected to the falsework cap and stringer by mechanical connections capable of resisting a load in any horizontal direction of not less than 1,000 pounds.

For falsework spans over roadways and railroads, all falsework stringers shall be mechanically connected to the falsework cap or framing. The mechanical connections shall be capable of resisting a load in any direction, including uplift on the stringer, of not less than 500 pounds. All associated connections shall be installed before traffic is allowed to pass beneath the span.

When timber members are used to brace falsework bents which are located adjacent to roadways or railroads, all connections shall be bolted through the members using $^{5}/_{8}$-inch diameter or larger bolts.

Concrete traffic barrier shall be used to protect all falsework adjacent to traveled roadways. The falsework shall be located so that falsework footings, mudsills, or piles are at least 2-feet clear of the traffic barrier and all other falsework members shall also be at least 2-feet clear of the traffic barrier. Traffic barrier used to protect falsework shall not be fastened, guyed, or blocked to any falsework but shall be fastened to the pavement according to details shown in the Plans. The installation of concrete traffic barrier shall be completed before falsework erection is begun. The traffic barrier at the falsework shall

not be removed until approved by the Engineer. Falsework openings which are provided for the Contractor's own use (not for public use) shall also use concrete traffic barrier to protect the falsework, except the minimum clear distance between the barrier and falsework footings, mudsills, piles, or other falsework members shall be at least 3-inches.

Falsework bents within 20-feet of the center line of a railroad track shall be braced to resist the required horizontal load or 2,000 pounds whichever is greater.

Pedestrian openings through falsework shall be paved or surfaced with full width continuous wood walks which shall be wheel chair accessible and shall be kept clear. Pedestrians shall be protected from falling objects and water falling from construction above. Overhead protection for pedestrians shall extend at least 4-feet beyond the edge of the bridge deck. Plans and details of the overhead protection and pathway shall be submitted with the falsework plans for review and approval. Pedestrian openings through falsework shall be illuminated by temporary lighting, constructed and maintained by the Contractor. The temporary lighting shall be constructed in accordance with local electrical code requirements. The temporary lighting shall be steady burning 60 watt, 120 volt lamps with molded waterproof lamp holders spaced at 25-foot centers maximum. All costs relating to pedestrian pathway paving, wood walks, overhead protection, maintenance, operating costs, and temporary pedestrian lighting shall be incidental to applicable adjacent items of work.

6-02.3(17)D Falsework Support Systems: Piling, Temporary Concrete Footings, Timber Mudsills, Manufactured Shoring Towers, Caps, and Posts

The Contractor shall support all falsework on either driven piling, temporary concrete footings, or timber mudsills. Temporary concrete footings shall be designed as reinforced concrete which may be either cast in place or precast. All components for a falsework support system shall be sized for the maximum design loads and allowable stresses described in the preceding sections.

The falsework drawings shall include a superstructure placing diagram showing the concrete placing sequence, direction of placements, and construction joint locations. When a sequence for placing concrete is shown in the Contract Plans or Specifications, no deviation will be permitted.

If the Plans call for piling or foundation shafts to support permanent structures, the Contractor may not use mudsills or temporary concrete footings for falsework support unless the underlying soil passes the settlement test described in this section.

Piling

When using piling to support the falsework, the Contractor's falsework plans shall specify the minimum required bearing and depth of penetration for the piling. Also, the falsework drawings shall show the maximum horizontal distance that the top of a falsework pile may be pulled in order to position it under its cap. The falsework plans shall show the maximum allowable deviation of the top of the pile, in its final position, from a vertical line through the point of fixity of the pile. The calculations shall account for pile stresses due to combined axial and flexural stress and secondary stresses.

Timber piling (untreated) shall be banded before driving. The following shall be identified in the falsework plans: lengths, minimum tip diameter, and expected diameter at ground line. The Contractor shall comply with the requirements of Sections 9-10.1 and 9-10.1(1). The maximum allowable load for timber piles shall be 45 tons. Steel piling shall be identified in the falsework plans. If steel pipe piling is used, the pipe diameter

and wall thickness shall be identified in the falsework plans. Steel piling shall meet the requirements of Section 9-10.5. The formulas in Section 6-05.3(12) shall be used to determine the bearing capacity of the falsework piling. If the Engineer approves, the pile bearing capacity may instead be determined by test loading the piling to twice the falsework design load. The Contractor shall provide the Engineer an opportunity to witness these tests and provide a plan of the test and cross-sections showing the locations and elevations of the proposed tests to the Engineer for approval.

Temporary Concrete Footings and Timber Mudsills

Timber mudsills or temporary concrete footings may be used in place of driven piling, provided tests show that the soil can support twice the falsework design load and that the mudsill or temporary concrete footing will not settle more than 1/4-inch when loaded with the design load. The tests shall be done at the falsework site, at the same elevation of the mudsill, and conducted under conditions representative of the actual site conditions. The acceptable tests for various soil types are:

1. **Granular Soil.** The Contractor shall conduct on-site tests according to AASHTO T 235. The Contractor shall provide the Engineer an opportunity to witness these tests and provide a plan of the test and cross-sections showing the locations and elevations of the proposed tests to the Engineer for approval.
2. **Fine Grained or Organic Soil.** The Contractor shall employ a Geotechnical Engineer to investigate the foundation soils and certify in writing that each mudsill or temporary footing will meet the load-settlement requirements described above. The allowable bearing capacities, elevations and locations of specific falsework mudsills shall be listed in the certification. Soils information used to determine the soil bearing capacity and settlement shall be submitted with the written certification to the Engineer for review and approval.

Timber mudsills or temporary concrete footings for falsework shall be designed to carry the loads imposed upon them without exceeding the estimated soil bearing capacity and specified maximum settlement. Where mudsills or temporary footings are used in the vicinity of permanent spread footings, the allowable mudsill bearing pressure shall be less than that of the permanent footings. This is because elevation difference, smaller bearing area, and the lack of surrounding overburden provides a lower bearing capacity than the permanent spread footings. The mudsills shall be designed for bearing capacities at the location that they are to be used. Timber mudsills or temporary concrete footings shall be designed as unyielding foundations under full design loads. The soil pressure bearing values assumed in the design of the falsework (normally not more than 3,000 pounds per sq. ft.) shall be shown in the falsework drawings. The minimum edge distances from the edge of the post or shoring tower leg to the edge or end of the mudsill member shall be shown in the falsework drawings. Timber mudsills and temporary concrete footings shall be designed such that member deflections do not exceed 1/4-inch and that member allowable stresses are not exceeded.

Full cross-sectional views of all falsework on timber mudsills or temporary concrete footings to be placed in side slopes or above excavations shall be shown in the falsework drawings. Footings or mudsills which are stepped or placed above an excavation shall have all related geometry and slope stability items identified in the falsework plan. Details and calculations for any shoring system to support the embankment or excavation shall be included.

Mudsills or temporary concrete footings placed in benches in slopes shall be set back from the face of the slope one-half the mudsill or temporary concrete footing width, but not less than 1-foot 0-inches. The bench including the setback shall be level in its narrow dimension. Slopes between benches measured from the top of slope at one bench to the toe of slope at the next bench below shall be no steeper than $1^1/_2$ horizontal to 1 vertical.

Falsework shall be founded on a solid footing, safe against undermining, protected from softening, and capable of supporting the loads imposed. The preparation of the soil to receive the temporary footing is important to ensure that the falsework does not experience localized settlement that could result in falsework failure. In preparing the soil for a timber mudsill or temporary concrete footing, the Contractor shall:

1. Place it on dry soil that is either undisturbed or compacted to 95 percent of maximum density, as determined by the compaction control tests in Section 2-03.3(14)D performed by the Contractor and submitted to the Engineer for review;
2. Place mudsills or footings level with full contact bearing on the soil with no voids. Place each distribution plate or corbel member between the post or tower leg and the mudsill members such that there is full contact bearing;
3. Place grout or a compacted layer of fine material under the mudsill if it is supported by rock or coarse sand and gravel;
4. Provide the Engineer with a sample of any off-site material to be used under the mudsill;
5. Allow up to five working days for the Engineer's approval before using the off-site material; and
6. Provide erosion control measures to protect the soil of the mudsill or footing from undermining and softening.

Anticipated total settlements and incremental settlements of falsework and forms due to successive concrete placements shall be shown in the falsework plans. These shall include falsework footing settlement and joint take-up. Total anticipated settlements shall not exceed 1-inch including joint take-up. When using mudsills, the Contractor shall prepare for the possibility of reshoring with the use of such devices as screw jacks or hydraulic jacks and adjustment of wedge packs. The placing of concrete shall be discontinued if unanticipated settlement occurs, including settlements that deviate more than plus or minus $^3/_8$-inch from those indicated on the approved falsework drawing. Concrete placement shall not resume until corrective measures satisfactory to the Engineer are provided. If satisfactory corrective measures are not provided prior to initial set of the concrete in the affected area, placing of concrete shall be discontinued at a location determined by the Engineer. All unacceptable concrete shall be removed as determined by the Engineer.

Where the maximum leg load exceeds 30 kips, foundations for individual steel towers shall be designed and constructed to provide uniform settlement at each tower leg for all loading conditions.

Bents, Shoring Towers, Piling, Posts, and Caps

Plans for falsework bents or shoring tower systems, including manufactured tower systems shall have plan, cross-section, and elevation view scale drawings showing all geometry. Show in the falsework plans the proximity of falsework to utilities or any nearby structures including underground structures. The ground elevation, cross-slopes,

relation of stringers to one another, and dimensions to posts or piling shall be shown in the falsework plans. Column, pile, or tower heights shall be indicated. Member sizes, wall thickness and diameter of steel pipe columns or piles shall be shown in the falsework plans. Location of wedges, minimum bearing area and type of wedge material shall be identified in the falsework plans. Bracing size, location, material and all connections shall be described in the falsework plans.

The relationship of the falsework bents or shoring tower systems to the permanent structure's pier and footing shall be shown. Load paths shall be as direct as possible. Loads shall be applied through the shear centers of all members to avoid torsion and buckling conditions. Where loads cause twisting, biaxial bending, or axial loading with bending, the affected members shall be designed for combined stresses and stability.

Posts or columns shall be constructed plumb with tops and bottoms carefully cut to provide full end bearing. Caps shall be installed at all bents supported by posts or piling unless approved falsework plans specifically permit otherwise. Caps shall be fastened to the piling or posts. The falsework shall be capable of supporting non uniform or localized loading without adverse effect. For example, the loading of cantilevered ends of stringers or caps shall not cause a condition of instability in the adjacent unloaded members.

Timber posts and piling shall be fastened to the caps and mudsills by through-bolted connections, drift pins, or other approved connections. The minimum diameter of round timber posts shall be shown in the falsework plans. Timber caps and timber mudsills shall be checked for crushing from columns or piling under maximum load.

Steel posts and piling shall be welded or bolted to the caps, and shall be bolted or welded to the foundation. Steel members shall be checked for buckling, web yielding, and web crippling.

Wedges shall be used to permit formwork to be taken up and released uniformly. Wedges shall be oak or close-grained Douglas fir. Cedar wedges or shims shall not be used anywhere in a falsework or forming system. Wedges shall be used at the top or bottom of shores, but not at both top and bottom. After the final adjustment of the shore elevation is complete, the wedges shall be fastened securely to the sill or cap beam. Only one set of wedges (with one optional block) shall be used at one location. Screw jacks (or other approved devices) shall be used under arches to allow incremental release of the falsework.

Sand jacks may be used to support falsework and are used for falsework lowering only. Sand jacks shall be constructed of steel with snug fitting steel or concrete pistons. Sand jacks shall be filled with dry sand and the jack protected from moisture throughout its use. They shall be designed and installed in such a way to prevent the unintentional migration or loss of sand. All sand jacks shall be tested per Section 6-02.3(17)G.

When falsework is over or adjacent to roadways or railroads, all details of the falsework system which contribute to the horizontal stability and resistance to impact shall be installed at the time each element of the falsework is erected and shall remain in place until the falsework is removed. For other requirements see Section 6-02.3(17)C.

Transverse construction joints in the superstructure shall be supported by falsework at the joint location. The falsework shall be constructed in such a manner that subsequent pours will not produce additional stresses in the concrete already in place.

Manufactured Shoring Tower Systems and Devices

Manufactured proprietary shoring tower systems shall be identified in the falsework plans by make and model and safe working load capacity per leg. The safe working load for shoring tower systems shall be based upon a minimum $2^1/_2$ to 1 factor of safety.

The safe working load capacity, anticipated deflection (or settlement), make and model shall be identified in the falsework plans for manufactured devices such as: single shores, overhang brackets, support bracket and jack assemblies, friction collars and clamps, hangers, saddles, and sand jacks. The safe working load for shop manufactured devices shall be based on a minimum ultimate strength safety factor of 2 to 1. The safe working load for field fabricated devices and all single shores shall be based on a minimum ultimate strength safety factor of 3 to 1.

The safe working load of all devices shall not be exceeded. The design loads shall be as defined by Section 6-02.3(17)A. The maximum allowable free end deflection of deck overhang brackets under working loads applied shall not exceed $^3/_{16}$-inch measured at the edge of the concrete slab regardless of the fact that the deflection may be compensated for by pre-cambering or of setting the elevations high. The Contractor shall comply with all manufacturer's specifications; including those relating to bolt torque, placing washers under nuts and bolt heads, cleaning and oiling of parts, and the reuse of material. Devices which are deteriorated, bent, warped, or have poorly fitted connections or welds, shall not be installed.

Shoring tower or device capacity as shown in catalogs or brochures published by the manufacturer shall be considered as the maximum load which the shoring is able to safely support under ideal conditions. These maximum values shall be reduced for adverse loading conditions; such as horizontal loads, eccentricity due to unbalanced spans or placing sequence, and uneven foundation settlement.

Depending on load-carrying capacity, steel shoring systems are classified as pipe-frame systems, intermediate strength systems, and heavy-duty systems. The two types of pipe-frame shoring base frames in general use are the ladder type and the cross-braced type. In the ladder type, frame rigidity is provided by horizontal struts between the vertical legs, whereas in the cross-braced type rigidity is provided by diagonal cross-bracing between the legs.

Copies of catalog data and/or other technical data shall be furnished with the falsework plans to verify the load-carrying capacity, deflection, and manufacturers installation requirements of any manufactured product or device proposed for use. Upon request by the Engineer, the Contractor shall furnish manufacturer certified test reports and results showing load capacity, deflection, test installation conditions, and identify associated components and hardware for shoring tower systems or other devices. In addition to manufacturer's requirements, the criteria shown in the following sections for manufactured proprietary shoring tower systems and devices shall be complied with when preparing falsework plans, calculations, and installing these shoring tower systems and devices as falsework.

Alternative criteria and/or systems may be approved if a written statement on the manufacturer's letter head, signed by the shoring or device manufacturer (not signed by a material supplier or the Contractor) is submitted to the Engineer for approval and addresses the following:

1. Identity of the specific Contract on which the alternative criteria and/or system will apply;
2. Description of the alternative criteria and/or system;
3. Technical data and test reports;
4. The conditions under which the particular alternative criteria may be followed;
5. That a design based on the alternative criteria will not overstress or over deflect any shoring component or device nor reduce the required safety factor.

In any case where the falsework drawings detail a manufactured product and the manufacturer's safe working load, load versus deflection curves, factor of safety, and installation requirements cannot be found in any catalog, the Engineer may require load testing per Section 6-02.3(17)G to verify the safe working load and deflection characteristics.

Tower leg loads shall not exceed the limiting values under any loading condition or sequence. Frame extensions and any reduced capacity shall be shown in the falsework plans. Screw jacks shall fit tight in the leg assemblies without wobble. Screw jacks shall be plumb and straight. Shoring towers shall be installed plumb, and load distribution beams shall be arranged such that vertical loads are distributed to all legs for all successive concrete placements. There shall be no eccentric loads on shoring tower heads unless the heads have been designed for such loading. Shoring towers shall remain square or rectangular in plan view and shall not be skewed. There shall be no interchanging of parts from one manufactured shoring system to another. Bent or faulty components shall not be used.

For manufactured shoring towers that allow ganging of frames, the number of ganged frames shall be limited to one frame per opposing side of a tower, and the total number of legs per ganged tower shall not exceed eight legs. Ganged frames shall be installed per the manufacturer's published standards using the manufacturer's components. Other gang arrangements shall not be used.

For manufactured steel shoring tower systems, the contractor shall have bracing designed and installed for horizontal loads and falsework overturning per Section 6-02.3(17)A. Minimum bracing criteria and allowable leg loads are described in the following paragraphs.

All shoring tower systems and bracing shall be thoroughly inspected by the Contractor for plumb vertical support members, secure connections, and straight bracing members immediately prior to, at intervals during, and immediately after every concrete placement. For manufactured shoring tower systems, the maximum allowable deviation from the vertical is $^1/_8$-inch in 3-feet. If this tolerance is exceeded, concrete shall not be placed until adjustments have brought the shoring towers within the acceptable tolerance.

Cross-Braced Type Base Frames

The maximum allowable load per leg for cross-braced type base frame shoring is limited by the height of the extension frame and the type of screw jack (swivel or fixed head) used at the top of the frame. The maximum load on one leg of a frame shall not exceed four times the load on the other leg under any given loading condition or sequence. The maximum load on one of the two frames making up a tower shall not exceed four times the load on the opposite frame under any given loading condition or sequence. If swivel-head screw jacks are used, the allowable leg loads shall not exceed that shown in the following table:

	Maximum Allowable Leg Load in Pounds			
Extension Frame Height	**2′-0"**	**3′-0"**	**4′-0"**	**5′-0"**
Screw height 12" or less	11,000	11,000	10,000	9,400
Screw height exceeds 12"	8,200	8,200	8,000	7,800

If fixed-head screw jacks are used at the top of the extension frame, the maximum allowable load per leg shall be 11,000 pounds for all extension frame heights up to 5-feet with screw jack height extensions of 12-inches or less. Fixed-head screw jacks exceeding 12-inches shall use the values in the table above. Screw jack extensions shall not exceed the manufacturer's published recommendations. Extension frames shall be braced. Side cross-braces are required for extension heights up to 2-feet 0-inches. Both side and end cross-braces are required from over 2-feet 0-inches to 5-feet 0-inches extension heights.

Supplemental bracing shall be installed on shoring towers 20-feet or more in height and shall connect rows of towers to each other so rows of frames are continuously cross-braced in one plane. Supplemental bracing shall be installed as follows:

1. In the transverse direction (the direction parallel to the frame) one horizontal brace and one diagonal brace shall be attached to each tower face, for every three frames of shoring height, including an extension frame if used. The lowest horizontal brace shall be located near the top of the third tower frame, and any additional horizontal braces spaced no farther than three frames apart. The diagonal braces shall be located on opposite tower faces, and shall run in opposite directions across the plane of the tower row.
2. In the longitudinal direction (the direction perpendicular to the frames), when shoring height is four frames or more, a horizontal brace shall be installed on one face of each tower, with the lowest brace located no higher than the top of the fourth frame and any additional horizontal braces spaced no farther than four frames apart. When shoring height is six frames or more, diagonal cross-bracing shall be installed in the longitudinal direction similar to the transverse direction.
3. When roadway grade, soffit profile, or superelevation exceeds 4 percent slope for any height of shoring tower, a continuous brace parallel to the slope shall be attached to each frame extension or screw jack of the tower within 6-inches of the top. These braces shall be in addition to bracing previously described.

The bracing shall be fastened securely to each frame leg and shall be located within 6-inches of the frame member intersections. The ends of diagonal braces shall not be attached to shoring frames at locations where towers have little or no load. Diagonal brace ends shall be attached to tower frames near the top and bottom at locations where significant gravity load is maintained throughout all construction sequences, such as directly below box girder outside webs, thus precluding lift-off due to the vertical component of the brace reaction. Supplemental bracing shall be shown in the falsework drawings. The connection details, including the method of connection and exact location of the connecting devices, shall be in accordance with the manufacturer's recommendations and shall be shown in the falsework drawings.

Ladder Type Base Frames

Ladder type base frame shoring shall be limited to the following maximum loads and conditions, regardless of any conflicting information which may be found in manufacturer's catalogs or brochures:

1. If the shoring system consists of a single tier of braced base frames, leg loads shall not exceed 10,000 pounds.
2. If the shoring system consists of two or three tiers of base frames, leg loads shall not exceed 7,500 pounds.
3. If an extension staff is used, the maximum allowable leg load shall be reduced to 6,000 pounds.
4. The maximum load on one leg of a frame shall not exceed four times the load on the other leg under any given loading condition or sequence. The maximum load on one of the two frames making up a tower shall not exceed four times the load on the opposite frame under any given loading condition or sequence.

Maximum allowable leg loads as shown above shall apply when fixed-head screw jacks are used, or when swivel-head jacks are used at either the top or bottom of the tower. A screw jack extension shall not exceed 12-inches. Swivel-head screw jacks shall not be used at both the top and bottom of ladder-type frames. For any combination of ladder-type base frames or base frames with staff extensions, the total height of the shoring shall not exceed 20-feet, including screw jack extensions.

When roadway grade, soffit profile, or superelevation exceeds 4 percent slope for heights of shoring towers 20-feet or less, a continuous brace parallel to the slope shall be attached to each staff extension or screw jack of the tower within 6-inches of the top. These braces shall be attached per conditions described previously for cross-braced frames.

Intermediate Strength Shoring

Steel shoring, consisting of cross-braced tubular members capable of carrying up to 25 kips per tower leg, is considered intermediate strength shoring. The use of a 25-kip type falsework shoring system shall meet the following conditions and limitations:

1. If swivel-head screw jacks are used at either the top or bottom of the tower, the maximum allowable load shall be reduced to 20 kips per tower leg.
2. The screw-jack extensions shall not exceed 14-inches.
3. Extension frames shall be braced. Side cross-braces are required for all extension-frame heights. In addition, end cross-braces (braces across the face of the extension frame) shall be provided for extension frame heights of 3-feet or more.
4. The maximum load on one leg of a frame, or on one frame of a tower, shall not exceed four times the load on the opposite leg or frame under any given loading condition or sequence.
5. Shoring towers 20-feet or more in height shall have supplemental bracing installed in accordance with the criteria for bracing "Cross-braced Type Base Frames," except that no supplemental bracing will be required in the longitudinal direction (the direction perpendicular to the frame).
6. When roadway grade, soffit profile, or superelevation exceeds 4 percent slope for any height of shoring tower, a continuous brace parallel to the slope shall be attached to each frame extension or screw jack of the tower within 6-inches of the top. These braces shall be in addition to bracing required in item 5.

The use of 25-kip shoring, when designed and erected in conformance with the above criteria, is acceptable for tower heights up to five frames plus a fully-extended extension frame plus the maximum allowable screw-jack adjustment. For any proposed use exceeding this limiting height, the Contractor shall furnish a statement signed by the shoring manufacturer covering the specific installation. The statement shall provide assurance that the shoring will carry the loads to be imposed without overstressing any shoring component or reducing the required safety factor.

Heavy-Duty Shoring Systems

Shoring capable of carrying up to 100 kips per tower leg is considered heavy duty shoring. The following criteria applies to these systems.

If tower legs, including any extension unit, are utilized as single-post shores braced in one direction only, the shores shall be analyzed as individual steel columns.

If the total height of the shoring does not exceed the height of a single tower unit, including any extension unit, and if both the base and extension units are fully braced in both directions in accordance with the manufacturer's recommendations, individual tower legs may be considered as capable of carrying the safe working load recommended by the manufacturer without regard to the load on adjacent legs.

If the shoring consists of two or more units stacked one above the other, either with or without an extension unit, the differential leg loading within a given tower unit shall not exceed the following limitations:

Differential Leg Loading	
Maximum load on any leg in the tower unit	**Maximum to Minimum load ratio**
10 kips or less	10 to 1
10 kips to 50 kips	6 to 1
50 kips to 75 kips	5 to 1
75 kips or more	4 to 1

A complete stress analysis of steel beams used as continuous caps over two or more tower units shall be performed to determine the effect of continuity on tower leg loads. Resulting moment shear shall be added to or subtracted from the simple beam reaction to obtain the actual leg load and may produce a significant load differential.

Heavy-duty shoring shall be diagonally braced or otherwise externally supported at the top unless the towers are stable against overturning as defined in Section 6-02.3(17)A. When designing external bracing, including cable bracing, attention shall be given to the bracing connection to the falsework. Connections shall be designed to transfer horizontal and vertical forces from the falsework to the bracing system without overstressing any tower component. All external bracing, attachment locations, and connection details shall be shown in the falsework plans.

6-02.3(17)E Stringers, Beams, Joists, Roadway Slab Support, and Deck Overhangs

All stringers, beams, joists, and roadway slab support shall be designed for the design loads, deflections, and allowable stresses described in the preceding Sections 6-02.3(17)A, B, and C and for the following conditions.

At points of support, stringers, beams, joists, and trusses shall be restrained against rotation about their longitudinal axis. The effect of biaxial bending shall be investigated in all cases where falsework beams are not set plumb and the structure cross-slope exceeds 3 percent.

For box girder and T-beam bridges, the centerline of falsework beams or stringers shall be located within 2-feet of the bridge girder stems and preferably directly under the stems or webs. Stringers supporting formwork for concrete box girder and T-beam slab overhangs shall be stiff enough so that the differential deflection due to the roadway slab pour is no more than $^{3}/_{16}$-inch between the outside edge of the roadway slab and the exterior web even if camber strips can compensate for the deflection.

Friction shall not be relied upon for lateral stability of beams or stringers. If the compression flange of a beam is not laterally restrained, the allowable bending stress shall be reduced to prevent flange buckling. If flange restraint is provided and since it is impossible to predict the direction in which a compression flange will buckle, positive restraint shall be provided in both directions. Flange restraint shall be designed for a minimum load of two percent of the calculated compression force in the beam flange at the point under consideration.

Camber strips shall be used to compensate for falsework take-up and deflection, vertical alignment, and the anticipated structure dead load deflection shown in the camber diagram in the Contract Plans. Camber is the adjustment to the profile of a load-supporting beam or stringer so that the completed structure will have the lines and grades shown in the Plans. The dead load camber diagram shown in the Contract Plans is the predicted structure dead load deflection due to self mass. This dead load camber shall be increased by:

1. Amount of anticipated falsework take up;
2. Anticipated deflection of the falsework beam or stringer under the actual load imposed; and
3. Any vertical curve compensation.

Camber strips shall be fastened by nailing to the top of wood members, or by clamping or banding in the case of steel members. Camber strips shall have sufficient contact bearing area to prevent crushing under total load. As a general rule, camber strips are not required unless the total camber adjustment exceeds $^{1}/_{4}$-inch for exterior falsework stringers and $^{1}/_{2}$-inch for interior stringers.

On concrete box girder structures, the forms supporting the roadway slab shall rest on ledgers or similar supports and shall not be supported from the bottom slab except as provided below. The form supports shall be fastened within 18-inches of the top of the web walls, producing a clear span between web walls. The roadway slab forms may be supported or posted from the bottom slab if the following conditions are met:

1. Permanent access, shown in the Contract Plans, is provided to the cells, and the centerline to centerline distance between web walls is greater than 10-feet;
2. Falsework stringers designed for total load, stresses and deflections per Section 6-02.3(17)A and B are located directly below each row of posts;
3. Posts have adequate lateral restraint; and
4. All forms (including the roadway deck forms), posts, and bracing are completely removed.

The falsework and forms on concrete box girder structures supporting a sloping web and deck overhang shall consist of a lateral support system which is designed to resist all rotational forces acting on the stem, including those caused by the placement of deck slab concrete, roadway deck formwork mass, finishing machine, and other live loads. Stem reinforcing steel shall not be stressed by the construction of the roadway deck slab placement. Overhang brackets shall not be used for the support of roadway slab forms from sloping web concrete box girder bridges.

Deck slab forms between girders or webs shall be constructed such that there is no differential settlement relative to the girders. The support systems for form panels supporting concrete deck slabs and overhangs on girder bridges (such as steel plate girders and prestressed girders) shall be designed as falsework. Falsework supporting deck slabs and overhangs on girder bridges shall be supported directly by the girders so that there will be no differential settlement between the girders and the deck forms during placement of deck concrete.

6-02.3(17)F Bracing

All falsework bracing systems shall be designed to resist the horizontal design load in all directions with the falsework in either the loaded or unloaded condition. All bracing, connection details, specific locations of connections, and hardware used shall be shown in the falsework plans. Falsework diagonal bracing shall be thoroughly analyzed with particular attention given to the connections. The allowable stresses in the diagonal braces may be controlled by the joint strength or the compression stability of the diagonal. Timber bracing for timber falsework bents shall have connections designed per Section 6-02.3(17)I. Any damaged cross-bracing, such as split timber members shall be replaced. Steel strapping shall avoid making sharp angles or right-angle bends. A means of preventing accidental loss of tension shall be provided for steel strapping. See Sections 6-02.3(17)A, B, and C for design loads and allowable stresses.

Bracing shall not be attached to concrete traffic barrier, guardrail posts, or guardrail.

To prevent falsework beam or stringer compression flange buckling, cross-bracing members and connections shall be designed to carry tension as well as compression. All components, connection details and specific locations shall be shown in the falsework plans. Bracing, blocking, struts, and ties required for positive lateral restraint of beam flanges shall be installed at right angles to the beam in plan view. If possible, bracing in adjacent bays shall be set in the same transverse plane. However, if because of skew or other considerations, it is necessary to offset the bracing in adjacent bays, the offset distance shall not exceed twice the depth of the beam.

All falsework and bracing shall be inspected by the Contractor for plumbness of vertical support members, secure connections, tight cables, and straight bracing members immediately prior to, during, and immediately after every concrete placement.

Bracing shall be provided to withstand all imposed loads during erection of the falsework and all phases of construction for falsework adjacent to any roadway, sidewalk, or railroad track which is open to the public. All details of the falsework system which contribute to horizontal stability and resistance to impact, including the bolts in bracing, shall be installed at the time each element of the falsework is erected and shall remain in place until the falsework is removed. The falsework plans shall show provisions for any supplemental bracing or methods to be used to conform to this requirement during each phase of erection and removal. Wind loads shall be included in the design of such bracing or methods. Loads, connections, and materials for falsework adjacent to roadways, shall also be in accordance with Section 6-02.3(17)C.

Cable or Tension Bracing Systems

When cables, wire rope, steel rod, or other types of tension bracing members are used as external bracing to resist horizontal forces, or as temporary bracing to support bents while falsework is being erected or removed adjacent to traffic, all elements of the bracing system shall be shown in the falsework plans. Bracing shall not be attached to concrete traffic barrier, guardrail posts, or guardrail. Any damaged bracing, such as frayed and kinked guying systems shall be replaced. Wire rope shall avoid making sharp angles or right-angle bends and a means of preventing accidental loss of tension shall be provided. The following information shall be submitted to the Engineer for approval:

1. Cable diameter, rod, or tension member size, and allowable working load.
2. Location and method of attaching the cable, rod, or tension member to the falsework. The connecting device shall be designed to transfer both horizontal and vertical forces to the cable without overstressing any falsework component.
3. The type of cable connectors or fastening devices (such as U-bolt clips, plate clamps, etc.) to be used and the efficiency factor for each type. If cables are to be spliced, the splicing method shall be shown.
4. Method of tightening cables, rods, or tension members after installation if tightening is necessary to ensure their effectiveness. Method of preventing accidental loosening.
5. Anchorage details, including the size and mass of concrete anchor blocks, the assumed coefficient of friction for surface anchorages, and the assumed lateral soil bearing capacity for buried anchorages.
6. Method of pre-stretching or preloading cable or tension members.
7. Determination of the potential stretch or elongation of the tension member under the design load and if the resulting lateral deflection will cause excessive secondary stresses in the falsework.

Copies of manufacturer's catalog or brochure showing technical data pertaining to the type of cable to be used shall be furnished with the falsework plans. Technical data shall include the cable diameter, the number of strands and the number of wires per strand, ultimate breaking strength or recommended safe working strength, and any other information as may be needed to identify the cable.

In the absence of sufficient technical data to identify the cable, or if it is old and obviously worn, the Contractor shall perform cable breaking tests to establish the safe working load for each reel of cable furnished. For static guy cable the minimum factor of safety shall be 3 to 1. The Contractor shall provide the Engineer an opportunity to witness these tests.

When cable bracing is used to prevent the overturning of heavy-duty shoring, attention shall be given to the connections by which forces are transferred from the shoring to the cables. Cable restraint shall be designed to act through the cap system to prevent the inadvertent application of forces which the shoring is not designed to withstand. Cables shall not be attached to any tower component.

Cable splices made by lapping and clipping with "Crosby" type clamps shall not be used. Other splicing methods may be used; however, at each location where the cable is spliced, cable strength shall be verified by a load test.

When cables are used as external bracing to resist overturning of a falsework system, the horizontal load to be carried by the cables shall be calculated as follows:

1. When used with heavy-duty shoring systems, cables shall be designed to resist the difference between 1.25 times the total overturning moment and the resistance to overturning provided by the individual falsework towers.
2. When used with pipe-frame shoring systems where supplemental bracing is required, cables shall be designed to resist the difference between 1.25 times the total overturning moment and the resistance to overturning provided by the shoring system as a whole.
3. When used as external bracing to prevent overturning of all other types of falsework, including temporary support during erection and removal of falsework at traffic openings, cables shall be designed to resist 1.25 times the total overturning moment.

The maximum allowable cable design load shall be determined using the following criteria:

1. If the cable is new, or is in uniformly good condition, and if it can be identified by reference to a manufacturer's catalog or other technical publication, the allowable load shall be the ultimate strength of the cable as specified by the manufacturer, multiplied by the efficiency of the cable connector, and divided by a safety factor of 3 (i.e., safe working load = breaking strength x connector efficiency/safety factor).
2. If the cable is used but still in serviceable condition, or is new or nearly new but cannot be found in a manufacturer's catalog, the Contractor shall perform load breaking tests. In this case, the cable design load shall not exceed the breaking strength, as determined by the load test, multiplied by the connector efficiency factor, and divided by a safety factor of 3.
3. If the cable is used and still in serviceable condition, or is a new or nearly new cable which cannot be identified, and if load breaking tests are not performed, the cable design load shall not exceed the safe working load shown in the wire rope capacities table multiplied by the cable connector efficiency.

   Cable connectors shall be designed in accordance with criteria shown in the following tables "Efficiency of Wire Rope Connections" and "Applying Wire Rope Clips." Cable safe working loads are provided in table "Wire Rope Capacities."

Efficiency of Wire Rope Connections
(As compared to Safe Loads on Wire Rope)

Type of Connection	Connector Efficiency
Wire Rope	100%
Sockets — Zink Type	100%
Wedge Sockets	70%
Clips — Crosby Type With Thimble	80%
Knot and Clip (Contractors Knot)	50%
Plate Clamp — Three Bolt Type With Thimble	80%
Spliced Eye and Thimble:	
$^1/_4$" and smaller	100%
$^3/_8$" to $^3/_4$"	95%
$^7/_8$" to 1"	88%
$1^1/_8$" to $1^1/_2$"	82%
$1^5/_8$" to 2"	75%
$2^1/_8$" and larger	70%

Wire Rope Capacities
Safe Load in Pounds for New Plow Steel Hoisting Rope
6 Strands of 19 Wires, Hemp Center
(Safety Factor of 6)

Diameter Inches	Weight Lbs./Ft.	Safe Load Lbs.
$^1/_4$	0.10	1,050
$^5/_{16}$	0.16	1,500
$^3/_8$	0.23	2,250
$^7/_{16}$	0.31	3,070
$^1/_2$	0.40	4,030
$^9/_{16}$	0.51	4,840
$^5/_8$	0.63	6,330
$^3/_4$	0.95	7,930
$^7/_8$	1.29	10,730
1	1.60	15,000
$1^1/_8$	2.03	18,600
$1^1/_4$	2.50	23,000
$1^3/_8$	3.03	25,900
$1^1/_2$	3.60	30,700
$1^5/_8$	4.23	35,700
$1^3/_4$	4.90	41,300

Applying Wire Rope Clips

The only correct method of attaching U-bolt wire rope clips to rope ends is to place the base (saddle) of the clip against the live end of the rope, while the "U" of the bolt presses against the dead end.

The clips are usually spaced about six rope diameters apart to give adequate holding power. A wire-rope thimble shall be used in the loop eye to prevent kinking when wire rope clips are used. The correct number of clips for safe application, and spacing distances, are shown below:

Number of Clips and Spacing for Safe Application

Improved Plow Steel Rope Diameter Inches	Number of Clips: Drop Forged	Number of Clips: Other Material	Minimum Spacing (Inches)
3/8	2	3	3
1/2	3	4	3 1/2
5/8	3	4	4
3/4	4	5	4 1/2
7/8	4	5	5 1/4
1	5	6	6
1 1/8	6	6	6 3/4
1 1/4	6	7	7 1/2
1 3/8	7	7	8 1/4
1 1/2	7	8	9

Anchor Blocks

Concrete anchor blocks and connections used to resist forces from external bracing shall be shown in the falsework plans. Concrete anchor blocks shall be proportioned to resist both sliding and overturning. When designing anchor block stability, the mass of the anchor block shall be reduced by the vertical component of the cable or brace tension to obtain the net or effective mass to be used in the anchorage computations.
The coefficient of friction assumed in the design shall not exceed the following:

	Friction Coefficient
Anchor block set on sand	0.40
Anchor block set on clay	0.50
Anchor block set on gravel	0.60
Anchor block set on pavement	0.60

Note: Multiply the friction coefficient by 0.67 if it is likely the supporting material is wet or will become wet during the construction period.

The method of connecting the cable or brace to the anchor block is part of the anchor block design. The connection shall be designed to resist both horizontal and vertical forces.

Temporary Bracing for Bridge Girders

Bridge girders (such as steel plate girders and prestressed girders) shall be braced and tied to resist forces that would cause rotation or torsion in the girders caused by the placing of concrete for diaphragms or the deck. These conditions also apply to bridge widenings and stage constructed bridges where construction sequences can cause rotation or torsion in the girders. Falsework support brackets or braces shall not be welded to structural steel members or reinforcing steel.

On prestressed girder spans, the Contractor shall install cross-bracing between girders at each end and midspan to prevent lateral movement or rotation. This bracing shall be placed prior to the release of the girders from the erection equipment. The bracing shall not be removed until the diaphragms or the deck have been placed and cured for a minimum of 24 hours.

When deck overhang or the distance from the centerline of the exterior girder (or outside girder of a staged construction) to the near edge of the roadway slab on a prestressed girder span exceeds the distances listed in the table below, the Contractor shall provide extra bracing for the exterior girder at the midpoint between diaphragms (or at more frequent intervals). This bracing shall include: (1) a cross-tie connecting the top flange of each exterior girder with its counterpart on the other side, and (2) braces between the bottom flanges and top flanges of all girders.

Girder Series	Distance in Inches
W42G	30
W50G	42
W58G	63
W74G	66
Prestressed concrete tub girders with webs with flanges	30
WF42G, WF50G, WF58G, WF74G, W83G, and W95G	70
W32BTG, W38BTG, and W62BTG	70
WF74PTG, W83PTG, and W95PTG	70

If a concrete finishing machine is supported at the outside edge of the slab, the Contractor shall account for its added mass in the design of bracing.

Roadway deck forming systems may require bracing or ties between girders for the girder to adequately support the form loading. When braces, struts, or ties are required, they shall be designed and detailed by the Contractor and shall be shown in the falsework/formwork plans submitted to the Engineer for approval. These braces, struts, and ties shall be furnished and installed by the Contractor at no additional cost to the Contracting Agency.

6-02.3(17)G Testing Falsework Devices

The Contractor shall establish the load capacity and deflection (or settlement) of all friction collars and clamps, brackets, hangers, saddles, sand jacks, and similar devices utilizing a recognized independent testing laboratory approved by the Engineer. Laboratory tests shall use the same materials and design that will be used on the project. Test loads shall be applied to the device in the same manner that the device will experience loading on the project. Any bolts or threaded rods used with the device shall be identified as to diameter, length, type, grade, and torque. Any wedges, blocks, or shims

used with the device on the project shall also be tested with the device. Any adjustable jack system used as a part of a device shall be tested with the device and shall have its maximum safe working extended height identified. Devices shall not be tested in contact with the permanent structure. Independent members with the same properties as the permanent structure shall be used to test device connections.

At least fourteen (14) days prior to the test, the Contractor shall submit a test procedure and scale drawing for the Engineer's approval showing how the device will be tested and how data will be collected. The Contractor shall provide the Engineer an opportunity to witness these tests.

The approved independent testing laboratory shall provide a certified test report which shall be signed and dated. The test report shall clearly identify the device tested including trademarks and model numbers; identify all parts and materials used, including grade of steel, or lumber, member section dimensions; location, size, and the maximum tested extended height of any adjustable jacks; indicate condition of materials used in the device; indicate the size, length and location of all welds; indicate how much torque was used with all bolts and threaded rods. The report shall describe how the device was tested, report the results of the test, provide a scale drawing of the device showing the location(s) of where deflections or settlements were measured, and show where load was applied. Deflections or settlements shall be measured at load increments and the results shall be clearly graphed and labeled. Prior to installation of falsework devices named in this section, the Contractor shall submit the certified test reports to the Engineer for review and approval.

The safe working load for shop manufactured devices named in this section shall be derived by dividing the ultimate strength by a safety factor of 2.0. The safe working load for field fabricated or field modified devices (including the use of timber blocks or wedges with the device) shall be determined by dividing the ultimate strength by a safety factor of 3.0. Working load shall include masses of all successive concrete placements, falsework, forms, all load transfer that takes place during post-tensioning, and any live loads; such as workers, roadway finishing machines, and concrete delivery systems. The maximum allowable free end deflection of deck overhang brackets with combined dead and live working loads applied shall be $^{3}/_{16}$-inch even though deflection may be compensated for by pre-cambering or setting the elevations high. The Contractor shall comply with all manufacturer's specifications; including those relating to bolt torque, cleaning and oiling of parts, and the reuse of material. Devices which are deteriorated, bent, warped or have poorly fitted connections or welds, shall not be installed.

6-02.3(17)H Formwork Accessories

Formwork accessories such as form ties, form anchors, form hangers, anchoring inserts, and similar hardware shall be specifically identified in the formwork plans including the name and size of the hardware, manufacturer, safe working load, and factor of safety. The grade of steel shall also be indicated for threaded rods, coil rods, and similar hardware. Wire form ties and taper ties shall not be used. Welding or clamping formwork accessories to Contract Plan reinforcing steel will not be allowed. Driven types of anchorages for fastening forms or form supports to concrete, and Contractor fabricated "J" hooks shall not be used. Field drilling of holes in prestressed girders is not allowed.

The following table from ACI 347R-88 provides minimum safety factors for formwork accessories. The hardware proposed shall meet these minimum ultimate strength requirements or the manufacturer's minimum requirements, whichever provides the greater factor of safety. The Contractor shall attach copies of the manufacturer's catalog cuts and/or test data of hardware proposed, to the formwork plans and submit the falsework and formwork plans and calculations for review and approval per Section 6-02.3(16). In situations where catalog cuts and/or test data are not available, testing shall be performed in accordance with Section 6-02.3(17)G.

Minimum Safety Factors of Formwork Accessories*

Accessory	Safety Factor	Type of Construction
Form Tie	2.0	All applications.
Form Anchor	2.0	Formwork supporting form mass and concrete pressures only.
Form Anchor	3.0	Formwork supporting masses of forms, concrete, construction live loads, and impact.
Form Hangers	2.0	All applications.
Anchoring Inserts	2.0	Placed in previous opposing concrete placement to act as an anchor for form tie.

*Safety factors are based on ultimate strength of the formwork accessory.

The bearing area of external holding devices shall be adequate to prevent excessive bearing stress on form lumber. Form ties and form hangers shall be arranged symmetrically on the supporting members to minimize twisting or rotation of the members. Form tie elongation shall not exceed the allowable deflection of the wale or member that it supports. Inserts, bolts, coil rods, and other fasteners shall be analyzed and designed for appropriately combined bending, shear, torsion, and tension stresses. The formwork shall not be attached to Contract Plan rebar or rebar cages. However, the Contractor may install additional reinforcing steel for formwork anchorage.

Frictional resistance shall not be considered as contributing to the stability of any connection or connecting device, except those designed as friction connectors such as U-bolt friction-type connectors.

Form anchors and anchoring inserts shall be designed considering concrete strength at time of loading, available embedment, location in the member, and any other factors affecting their working strength, and shall be installed in concrete per the manufacturer's published requirements. Form anchors and anchoring inserts embedded in previous concrete placements shall not be loaded until the concrete has reached the required design strength. The required design strength of concrete for loading of an anchor shall be shown in the formwork drawing if it is assumed that the anchor will be loaded before the concrete has reached its 28 day strength.

Installation of permanent concrete inserts, such as form ties hangers, or embedded anchor assemblies, shall permit removal of all metal to at least $^1/_2$-inch below the concrete surface. Holes shall be patched in accordance with Section 6-02.3(14). During removal of the outer unit, the bond between the concrete and the inner unit or rod shall not be broken.

6-02.3(17)I Timber Connections

Timber connections shall be designed in accordance with the methods, stresses, and loads allowed in the Timber Construction Manual, Third Edition by the American Institute of Timber Construction (AITC). Timber falsework and formwork connections shall be designed using wet condition stresses for all installations West of the Cascade Range crest line and by criteria provided in the following sections. Frictional resistance shall not be considered as contributing to the stability of any timber connection.

Bolted Connections

Tabulated values in the AITC Timber Construction Manual-Third Edition are based on square posts. For a round post or pile, the main member thickness shall be the side of a square post having the same cross-sectional area as the round post used.

The AITC Table 6.20 for Douglas Fir-Larch bolt Group 3 and for Hem-Fir bolt Group 8 show design values for bolts to be used when the load is applied either parallel or perpendicular to the direction of the wood grain. When the load is applied at an angle to the grain, as is the case with falsework bracing, the design value for the main member shall be obtained from the Hankinson formula shown in the AITC manual.

Design values in the AITC Table 6.20 apply only to three member joints (bolt in double-shear) in which the side members are each $^1/_2$ the thickness of the main member. This joint configuration is not typical of bridge falsework where side members are usually much smaller than main members. For two member joints (single shear bolt condition), the AITC Table 6.20 values shall be adjusted by a single shear load factor as follows:

1. 0.75 for installations East of the Cascade Range crest line, except as shown in item 3 below;
2. 0.50 for installations West of the Cascade Range crest line; and
3. 0.50 for load acting at an angle to the bolt axis, as is the case with longitudinal bracing when falsework bents are skewed.

Except for connections in falsework adjacent to or over railroads or roadways, threaded rods and coil rods may be used in place of bolts of the same diameter with no reduction in the tabulated values. At openings for roadways and railroads, all connections shall be bolted using $^5/_8$-inch diameter or larger through bolts.

Bolt holes shall be a minimum $^1/_{32}$-inch to a maximum $^1/_8$-inch larger than the bolt diameter. A washer not less than a standard cut washer shall be installed between the wood and the bolt head and between the wood and the nut to distribute the bearing stress under the bolt head and nut and to avoid crushing the fibers. In lieu of standard cut washers, metal plates or straps with dimensions at least equal to that of a standard cut washer may be substituted.

When steel bars or shapes are used as diagonal bracing, the tabulated design values shown in AITC Table 6.20 for the main members loaded parallel to grain (P value) are increased 75 percent for joints made with bolts $^1/_2$-inch or less in diameter, 25 percent for joints made with bolts $1^1/_2$-inch in diameter, and proportionally for intermediate diameters. No increase in the tabulated values is allowed for perpendicular-to-grain loading (Q value).

Clearance requirements for end, edge, and bolt spacing distance shall be as shown below. All distances are measured from the end or side of the wood member to the center of the bolt hole. For members which are subject to load reversals the larger controlling distances shall be used for design. For parallel-to-grain loading, the minimum distances for full design load:

1. In tension, minimum end distance shall be 7 times the bolt diameter;
2. In compression, minimum end distance shall be 4 times the bolt diameter; and
3. In tension or compression, the minimum edge distance shall be 1.5 times the bolt diameter.

For perpendicular-to-grain loading, the minimum distance for full design load:

1. Minimum end distance shall be 4 times the bolt diameter;
2. Edge distance toward which the load is acting shall be at least 4 times the bolt diameter; and
3. Distance on the opposite edge shall be at least 1.5 bolt diameters.

Minimum clearance (spacing) between adjacent bolts in a row shall be 4 times the bolt diameter, measured center-to-center of the bolt holes.

When more than two bolts are used in a line parallel to the axis of the side member, additional requirements shall be followed as shown in the AITC manual.

Lag Screw Connections

Design values for lag screws subject to withdrawal loading are found in AITC Table 6.27. Values for wood having a specific gravity of 0.51 for Douglas Fir-Larch or 0.42 for Hem-Fir shall be assumed when using the table. The withdrawal values are in pounds per inch of penetration of the threaded part of the lag screw into the side grain of the member holding the point, with the axis of the screw perpendicular to that member. The maximum load on a given screw shall not exceed the allowable tensile strength of the screw at the root section.

AITC recommends against subjecting lag screws to end-grain withdrawal loading. However, if this condition cannot be avoided, the design value shall be 75 percent of the corresponding value for withdrawal from the side grain.

Values in the Group II wood species column shall be used for Douglas Fir-Larch and the Group III wood species column shall be used for Hem-Fir. When the load is applied at an angle to the grain, as is the case with falsework bracing, the design value shall be obtained from the Hankinson formula shown in the AITC manual.

When lag screws are subjected to a combined lateral and withdrawal loading, as would be the case with longitudinal bracing when the falsework bents are skewed, the effect of the lateral and withdrawal forces shall be determined separately. The withdrawal component of the applied load shall not exceed the allowable value in withdrawal. The lateral component of the applied load shall not exceed the allowable lateral load value.

Lag screws shall be inserted in lead holes as follows:

1. The clearance hole for the shank shall have the same diameter as the shank, and the same depth of penetration as the length of unthreaded shank;
2. The lead hole for the threaded portion shall have a diameter equal to 60 to 75 percent of the shank diameter and a length equal to at least the length of the threaded portion. The larger percentile figure in each range shall apply to screws of the greater diameters used in Group II wood species;
3. The threaded portion of the screw shall be inserted in its lead hole by turning with a wrench, not by driving with a hammer; and
4. To facilitate insertion, soap or other lubricant shall be used on the screws or in the lead hole.

Drift Pin and Drift Bolt Connections

When drift pins or drift bolts are used, the required length and penetration shall be determined using the following criteria. The lateral load-carrying capacity of drift pins and drift bolts driven into the side grain of a wood member shall be limited to 75 percent of the design values for a common bolt of the same diameter and length in the main member. For drift pin connections, the pin penetration into the connected members shall be increased to compensate for the absence of a bolt head and nut. For drift bolts or pins driven into the end grain of a member, the lateral load-carrying capacity shall be limited to 60 percent of the allowable side grain load (perpendicular to grain value) for an equal diameter bolt with nut. To develop this allowable load the drift bolt or pin shall penetrate at least 12 diameters into the end grain. To fully develop the allowable load of the drift bolts or pins, they shall be driven into predrilled holes, $^{1}/_{16}$-inch less in diameter than the drift pin or bolt diameter.

The criteria shown in the AITC *Timber Construction Manual-Third Edition* shall apply to drift bolt or pin connection allowable loads for the following conditions:

1. Withdrawal resistance; and
2. When there are more than two drift bolts or pins in a joint, allowable loads shall be further reduced by applying applicable modification factors shown in the AITC Table 6.3.

Nailed and Spiked Joints

Joints using nails or spikes shall conform to the provisions of AITC. For side grain withdrawal, the values in AITC Table 6.35 for wood having a specific gravity of 0.51 for Douglas Fir-Larch and a specific gravity of 0.42 for Hem-Fir shall be used. End grain withdrawal shall not be used. For lateral loading, the values in AITC Table 6.36 for wood species Group II for Douglas Fir-Larch and wood species Group III for Hem-Fir shall be used. Diameters listed in the tables apply to fasteners before application of any protective coating.

When more than one nail or spike is used in a joint, the total design value for the joint in withdrawal or lateral resistance shall be the sum of the design values for the individual nails or spikes.

The tabulated design values for lateral loads are valid only when the nail penetrates into the main member at least 11 diameters for Douglas Fir-Larch and 13 diameters for Hem-Fir. Note that the values are maximum values for the type and size of fastener shown. The tabulated values shall not be increased even if the actual penetration is exceeded.

When main member penetration is less than 11 diameters for Douglas Fir-Larch and 13 diameters for Hem-Fir, the design value shall be determined by straight-line interpolation between zero and the tabulated load, except that penetration shall not be less than $^{1}/_{3}$ of that specified.

Double-headed or duplex nails used in falsework and formwork construction are shorter than common wire nails or box nails of the same size designation. They have less penetration into the main member and therefore their load-carrying capacity shall be adjusted accordingly.

Nail and spike minimum spacing in timber connections shall be as follows:

1. The average center-to-center distance between adjacent nails, measured in any direction, shall not be less than the required penetration into the main member for the size of nail being used; and

2. The minimum end distance in the side member, and the minimum edge distance in both the side member and the main member, shall not be less than $^1/_2$ of the required penetration.

Allowable values for withdrawal and lateral load resistance are reduced when toe nails are used in accordance with the following:

1. For withdrawal loading, the design load shall not exceed $^2/_3$ of the value shown in the applicable design table; and
2. For lateral loading, the design load shall not exceed $^5/_6$ of the value shown in the applicable design table.

Toe nails are recommended to be driven at an approximate angle of 30 degrees with the piece and started approximately $^1/_3$ of the length of the nail from the end or side of the piece.

Timber Connection Adjustment for Duration of Load

Tabulated values for timber fasteners are for normal duration of load and may be increased for short duration loading, except for connections used in falsework and formwork for post tensioned structures and staged construction sequences. Duration of load adjustment for timber connections shall not be allowed for all post tensioned structures and for staged construction sequences where delayed and/or staged loading occurs for any type of concrete structure. The adjustment for duration of load as described in this section applies only to design values for timber connectors, such as nails, bolts, and lag screws. Allowable stresses for timber and structural steel components used in the connection, as described in Section 6-02.3(17)B, are maximums and thus shall not be increased.

Tabulated values for nails, bolts, and lag screws may be adjusted by the following duration-of-load factors:

1. 1.25 for falsework design governed by the minimum design horizontal load or greater (three percent or greater of the dead load);
2. 1.33 for falsework design governed by wind load; and
3. 2.00 for falsework design governed by impact loading.

6-02.3(17)J Face Lumber, Studs, Wales, and Metal Forms

Elements of this section shall be designed for the loads, allowable stresses, deflections, and conditions which pertain from other subsections of Section 6-02.3(17).

Forms battered or inclined above the concrete will tend to lift up as concrete is placed and shall have positive anchorage or counterweights designed to resist uplift and shall be shown in the formwork plans. Where the concrete pouring sequence causes fresh concrete to be significantly higher along one side of tied forms than the opposite side, a positive form anchorage system shall be designed capable of resisting the imbalance of horizontal thrust, and prevent the dislocation and sliding of the entire form unit.

Wooden forms shall be faced with smooth sanded, exterior plywood. This plywood shall meet the requirements of the National Bureau of Standards, U.S. Product Standard PS 1, and the Design Specification of the American Plywood Association (APA). Each full sheet shall bear the APA stamp. The Contractor shall list in the form plans the grade and class of plywood. If the Engineer approves the manufacturer's certification of structural properties, the Contractor may use plywood that does not carry the APA stamp. Plywood panels stamped "shop" or "shop cutting," shall not be used.

Plyform is an APA plywood specifically designed and manufactured for concrete forming. Plyform differs from conventional exterior plywood grades in strength and the exterior face panels are sanded smooth and factory oiled. Likewise, there is a significant difference between grades designated Class 1, Class 2, and Structural I Plyform.

The grades of plywood for various form applications shall be as follows:

1. **Traffic and Pedestrian Barriers** (except those that will receive an architectural surface treatment) — Plywood used for these surfaces shall be APA grade High Density Overlaid (HDO) Plyform Class I. But if the Contractor coats the form to prevent it from leaving joint and grain marks on the surface, plywood that meets or exceeds APA grades B-B Plyform Class I or B-C (Group I species) may be used. Under this option, the Contractor shall provide for the Engineer's approval a 4-foot square, test panel of concrete formed with the same plywood and coating as proposed in the form plans. This panel shall include one form joint along its centerline. The Contractor shall apply coating material, according to the manufacturer's instructions, before applying chemical release agents.
2. **Other Exposed Surfaces** (all but those on traffic and pedestrian barriers) — Plywood used to form these surfaces shall meet or exceed the requirements of APA grades B-B Plyform Class I or B-C (Group I series). If one face is less than B quality, the B (or better) face shall contact the concrete.
3. **Unexposed Surfaces** (such as the undersides of roadway slabs between girders, the interiors of box girders, etc., and traffic and pedestrian barriers where surfaces will receive an architectural treatment) — Plywood used to form these surfaces may be APA grade CDX, provided the Contractor complies with stress and deflection requirements stated elsewhere in these Specifications.

Form joints on an exposed surface shall be in a horizontal or vertical plane. But in wingwalls and box girders, side form joints shall be placed at right angles and parallel to the roadway grade. Joints parallel to studs or joists shall be backed by a stud or joist. Joints at right angles to studs and joists shall be backed by a stud or other backing the Engineer approves. Perpendicular backing is not required if studs or joists are spaced:

1. Nine inches or less on center and covered with $^1/_2$-inch plywood, or
2. Twelve inches or less on center and covered with $^3/_4$-inch plywood.

The face grain of plywood shall run perpendicular to studs or joists unless shown otherwise on the Contractor's formwork plans and approved by the Engineer. Proposals to deviate from the perpendicular orientation shall be accompanied by supporting calculations of the stresses and deflections.

Forming for all exposed curved surfaces shall follow the shape of the curve shown in the Contract Plans and shall not be chorded except as follows. On any retaining wall that follows a horizontal circular curve, the wall stems may be a series of short chords if:

1. The chords within the panel are the same length, unless otherwise approved by the Engineer;
2. The chords do not vary from a true curve by more than $^1/_2$-inch at any point; and
3. All panel points are on the true curve.

Where architectural treatment is required, the angle point for chords in wall stems shall fall at vertical rustication joints.

For exposed surfaces of abutments, wingwalls, piers, retaining walls, and columns, the Contractor shall build forms of plywood at least $^{3}/_{4}$-inch thick with studs no more than 12-inches on center. The Engineer may approve exceptions, but deflection of the plywood, studs, or wales shall never exceed $^{1}/_{360}$ of the span (or $^{1}/_{270}$ of the span for unexposed surfaces, including the bottom of the deck slab between girders).

All form plywood shall be at least $^{1}/_{2}$-inch thick except on sharply curved surfaces. There, the Contractor may use $^{1}/_{4}$-inch plywood if it is backed firmly with heavier material.

Round columns or rounded pier shafts shall be formed with a self-supporting metal shell form or form tube that leaves a smooth, nonspiralling surface. Wood forms are not permitted.

Metal forms shall not be used elsewhere unless the Engineer is satisfied with the surface and approves in writing. The Engineer may withdraw approval for metal forms at any time. If permitted to use a combination of wood and metal in forms, the Contractor shall coat the forms so that the texture produced by the wood matches that of the metal. Aluminum shall not be used for metal forms.

For design purposes, the Contractor shall assume that on vertical surfaces concrete exerts 150 pounds per sq. ft. per foot of depth. However, when the depth is reached where the rate of placement controls the pressure, the following table applies:

Rate of Placing Feet per Hour	Pressure, Pounds per Square Foot for Temperature of Concrete as Shown	
	60ºF	70ºF and above
2	470	375
3	640	565
4	725	625
5	815	690
6	900	750
7	990	815
8	1,075	875
9	1,165	935
10	1,250	1,000
15	1,670	1,300

The pressures in the above table have been increased to provide an allowance for the vibration and impact.

All corners shall be beveled $^{3}/_{4}$-inch. However, footings, footing pedestals, and seals need not be beveled unless required in the Plans.

All forms shall be as mortar-tight as possible with no water standing in them as the concrete is placed.

The Contractor shall apply a parting compound on forms for exposed concrete surfaces. This compound shall be a chemical release agent that permits the forms to separate cleanly from the concrete. The compound shall not penetrate or stain the surface and shall not attract dirt or other foreign matter. After the forms are removed, the concrete surface shall be dust-free and have a uniform appearance. The Contractor shall apply the compound at the manufacturer's recommended rate to produce a surface free of dusting action and yet provide easy removal of the forms.

If an exposed concrete surface will be sealed, the release agent shall not contain silicone resin. Before applying the agent, the Contractor shall provide the Engineer a written statement from the manufacturer stating whether the resin in the base material is silicone or nonsilicone.

The Contractor shall select a parting compound from the current Qualified Products List, or submit to the Engineer a sample of the parting compound at least ten working days before its use. Approval or disapproval shall be based on laboratory test results or selection off the current Qualified Products List.

The Engineer may reject any forms that will not produce a satisfactory surface.

6-02.3(17)K Concrete Forms on Steel Spans

Concrete forms on all steel structures shall be removable and shall not remain in place. Where needed, the forms shall have openings for truss or girder members. Each opening shall be large enough to leave at least $1^1/_2$-inches between the concrete and steel on all sides of the steel member after the forms have been removed. Unit contract prices cover all costs related to these openings.

Any form support for a roadway slab that rests on a plate girder flange shall apply the load within 6-inches of the girder web centerline. The Contractor shall not weld any part of the form to any steel member.

The compression member or bottom connection of cantilever formwork support brackets shall bear either within six inches maximum vertically of the bottom flange or within six inches maximum horizontally of a vertical web stiffener. The Contractor shall also furnish and install temporary struts and ties to prevent rotation of the steel girder. Partial depth cantilever formwork support brackets that do not conform to the above requirements shall not be used, unless the Contractor submits details showing the additional formwork struts and ties used to brace the steel girder against web distortion caused by the partial depth bracket, and receives the Engineer's approval of the submittal.

If the Engineer permits bolt holes in the web to support form brackets, the holes shall be shop drilled unless otherwise approved by the Engineer. The Contractor shall fill the holes with fully torqued AASHTO M 164 bolts per Section 6-03.3(33). Each bolt head shall be placed on the exterior side of the web. There shall be no holes made in the flanges.

6-02.3(17)L Finishing Machine Support System

Before using any finishing machine, the Contractor shall obtain the Engineer's approval of detailed drawings that show the system proposed to support it. The Contractor shall not attach this (or any other) equipment support system to the sides or suspend it from any girder unless the Engineer permits. The Engineer will not permit such a method if it will unduly alter stress patterns or create too much stress in the girder.

6-02.3(17)M Restricted Overhead Clearance Sign

The Contractor shall notify the Engineer not less than 15 working days before the anticipated start of each falsework and girder erection operation whenever such falsework or girders will reduce clearances available to the public traffic. Falsework openings shall not be more restrictive to traffic than shown in the Contract Plans.

Where the height of vehicular openings through falsework is less than 15-feet, a W 12-2 "Low Clearance Symbol Sign" shall be erected on the shoulder in advance of the falsework and two or more W 12-301 and/or W 12-302 signs shall be attached to the falsework to provide accurate usable clearance information over the entire falsework

opening. The posted low clearance shall include an allowance for anticipated falsework girder deflection (rounded-up to the next whole inch) due to design dead load, including all successive concrete pours. W 12-302 signs shall be used to designate prominent clearance restrictions and limits of usable clearance. In addition, where the clearance is less than the legal height limit (14-feet 0-inches), a W 12-2 sign shall be erected in advance of the nearest intersecting road or wide point in the road at which a vehicle can detour or turn around. A W 13-501 sign indicating the distance to the low clearance shall be installed below the advance sign. The Engineer will furnish the above noted signs and the Contractor shall erect and maintain them, all in accordance with Section 1-10.3(3).

When erecting falsework that restricts overhead clearance above a railroad track, the Contractor shall immediately (as soon as the restriction occurs) place restricted overhead clearance signs. Sign details are shown in the Standard Plans. Unit contract prices cover all costs relating to these signs.

6-02.3(17)N Removal of Falsework and Forms

The Engineer will decide, on the basis of post-placement curing conditions, the exact number of days that shall elapse before form or falsework removal. If the Engineer does not specify otherwise, the Contractor may request to remove forms based on the criteria listed in the table below. Both compressive strength and number of days criteria must be met if both are listed. The number of days shall be from the time of the last pour the forms support. In no case shall the Contractor remove forms or falsework without the Engineer's approval.

Concrete Placed In	Percent of Specified Minimum Compressive Strength	Number of Days
Columns, wall faces, mass piers and abutments (except pier caps), traffic and pedestrian barriers, and any other side form not supporting the concrete weight.[1]	—	3
Pier caps continuously supported.[2]	60	3
Sidewalks not supported on bridge roadway slabs.[2]	70	—
Crossbeams, caps, pier caps not continuously supported, struts and top slabs on concrete box culverts, inclined columns and inclined walls.[2,3]	80	5
Roadway slabs supported on wood or steel stringers or on steel or prestressed concrete girders.[2]	80	10
Box girders, T-beam girders, and flat-slab superstructure.[2,3]	80	14
Arches.[2,3]	—	21

[1]Where forms do not support the load of concrete.

[2]Where forms support the load of concrete.

[3]Where continuous spans are involved, the time for all spans will be determined by the last concrete placed affecting any span.

Before releasing supports from beneath beams and girders, the Contractor shall remove forms from columns to enable the Engineer to inspect the column concrete.

The Contractor may remove the side forms of footings 24 hours after concrete placement if a curing compound is applied immediately. But this compound shall not be applied to that area of the construction joint between the footing and the column or wall.

The Contractor may remove side forms, traffic barrier forms, and pedestrian barrier forms after 24 hours if these forms are made of steel or dense plywood, an approved water reducing additive is used, and the concrete reaches a compressive strength of 1400 psi before form removal. This strength shall be proved by test cylinders made from the last concrete placed into the form. The cylinders shall be cured according to WSDOT FOP for AASHTO T 23.

Wet curing shall comply with the requirements of Section 6-02.3(11). The concrete surface shall not become dry during form removal or during the entire curing period.

Before placing forms for traffic and pedestrian barriers, the Contractor shall completely release all falsework under spans.

Before releasing forms under concrete subjected to temperatures colder than 50ºF, the Contractor shall first prove that the concrete meets desired strength — regardless of the time that has elapsed.

The Engineer may approve leaving in place forms for footings in cofferdams or cribs. This decision will be based on whether removing them would harm the cofferdam or crib and whether the forms will show in the finished structure.

All cells of a box girder structure which have permanent access shall have all forms completely removed, including the roadway deck forms. All debris and all projections into the cells shall be removed. Unless otherwise shown in the Plans, the roadway slab interior forms in all other cells where no permanent access is available, may be left in place.

Falsework and forms supporting sloping exterior webs shall not be released until the roadway deck and deck overhang concrete has obtained its removal strength and number of days criteria listed in the table above. Stem reshoring shall not be used.

Open joints shown in the Plans shall have all forms completely removed, including Styrofoam products and form anchors, allowing the completed structure to move freely.

If the Contractor intends to support or suspend falsework and formwork from the bridge structure while the falsework and formwork is being removed, the Contractor shall submit a falsework and formwork removal plan and calculations for review and approval. The falsework and formwork removal plan shall include the following:

1. The location and size of any cast-in-place falsework lowering holes and how the holes are to be filled;
2. The location, capacity, and size of any attachments, beams, cables, and other hardware used to attach to the structure or support the falsework and formwork;
3. The type, capacity and factor of safety, weight, and spacing of points of reaction of lowering equipment; and
4. The weight at each support point of the falsework and formwork being lowered.

All other forms shall be removed whether above or below the level of the ground or water. Sections 6-02.3(7) and 6-02.3(8) govern form removal for concrete exposed to sea water or to alkaline water or soil. The forms inside of hollow piers, girders, abutments, etc. shall be removed through openings shown in the Plans or approved by the Engineer.

6-02.3(17)O Early Concrete Test Cylinder Breaks

The fabrication, curing, and testing of the early cylinders shall be the responsibility of the Contractor. Early cylinders are defined as all cylinders tested in advance of the design age of 28 days whose purpose is to determine the in-place strength of concrete in a structure prior to applying loads or stresses. The Contractor shall retain a testing laboratory to perform this work. Testing laboratories' equipment shall be calibrated within one year prior to testing and testers shall be either ACI certified or qualified in accordance with AASHTO R 18.

The concrete cylinders shall be molded in accordance with WSDOT FOP for AASHTO T 23 from concrete last placed in the forms and representative of the quality of concrete placed in that pour.

The cylinders shall be cured in accordance with WSDOT FOP for AASHTO T 23. The Engineer may approve the use of cure boxes meeting the requirements of this test method. Special cure boxes to enhance cylinder strength will not be allowed.

The concrete cylinders shall be tested for compressive strength in accordance with AASHTO T 22. The number of early cylinder breaks shall be in accordance with the Contractor's need and as approved by the Engineer.

The Contractor shall furnish the Engineer with all test results, proof of equipment calibration, and tester's certification. The test results will be reviewed and approved before any forms are removed. The Contractor shall not remove forms without the approval of the Engineer.

All costs in connection with furnishing cylinder molds, fabrication, curing, and testing of early cylinders shall be included in the unit contract prices for the various bid items of work involved.

6-02.3(18) Placing Anchor Bolts

The Contractor shall comply with the following requirements in setting anchor bolts in piers, abutments, or pedestals:

1. If set in the wet concrete, the bolts shall be accurately placed before the concrete is placed.
2. If the bolts are set in drilled holes, hole diameter shall exceed bolt diameter by at least 1-inch. Grouting shall comply with Section 6-02.3(20).
3. If the bolts are set in pipe, grouting shall comply with Section 6-02.3(20).
4. If freezing weather occurs before bolts can be grouted into sleeves or holes, they shall be filled with an approved antifreeze solution (non-evaporating).

6-02.3(19) Bridge Bearings

6-02.3(19)A Vacant

6-02.3(19)B Bridge Bearing Assemblies

For all fixed, sliding, or rolling bearings, the Contractor shall:

1. Machine all sliding and rolling surfaces true, smooth, and parallel to the movement of the bearing;
2. Polish all sliding surfaces;
3. Anchor expansion bearings securely, setting them true to line and grade;

4. Avoid placing concrete in such a way that it might interfere with the free action of any sliding or rolling surface.

Grout placement under steel bearings shall comply with Section 6-02.3(20).

6-02.3(20) Grout for Anchor Bolts and Bridge Bearings

Grout shall be a prepackaged grout, mixed, placed, cured as recommended by the manufacturer, or the grout shall be produced using Type I or II Portland cement, fine aggregate Class 1 or Class 2, and water, in accordance with these Specifications.

Grout shall meet the following requirements:

Requirement	Compressive Strength
Test Method	AASHTO Test Method T 106
Values	4,000 psi @ 7 days

Grout shall be a workable mix with flowability suitable for the intended application.

If the Contractor elects to use a prepackaged grout, a material sample and laboratory test data from an independent testing laboratory shall be submitted to the Engineer for approval with the request for approval of material sources.

If the Contractor elects to use a grout consisting of Type I or II Portland cement, fine aggregate Class 1, admixture, and water, the mix proportions and laboratory test data from an independent test laboratory shall be submitted to the Engineer for approval with the request for approval of material sources.

The Contractor shall receive approval from the Engineer before using the grout.

Field grout cubes shall be made in accordance with WSDOT Test Method 813 for either prepackaged grout or a contractor provided mix when requested by the Engineer, but not less than one per bridge pier or one per day.

Before placing grout, the concrete on which it is to be placed shall be thoroughly cleaned, roughened, and wetted with water to ensure proper bonding. The grout pad shall be cured as recommended by the manufacturer or kept continuously wet with water for three days. The grout pad may be loaded when a minimum of 4000 psi compressive strength is attained.

Before placing grout into anchor bolt sleeves or holes, the cavity shall be thoroughly cleaned and wetted to ensure proper bonding.

To grout bridge bearing masonry plates, the Contractor shall:

1. Build a form approximately 4-inches high with sides 4-inches outside the base of each masonry plate;
2. Fill each form to the top with grout;
3. Work grout under all parts of each masonry plate;
4. Remove each form after the grout has hardened;
5. Remove the grout outside each masonry plate to the base of the masonry plate;
6. Bevel off the grout neatly to the top of the masonry; and
7. Place no additional load on the masonry plate until the grout has set at least 72 hours.

After all grout under the masonry plate and in the anchor bolt cavities has attained a minimum strength of 4,000 psi, the anchor bolt nuts shall be tightened to snug-tight. “Snug-tight” means either the tightness reached by (1) a few blows from an impact wrench, or (2) the full effort of a person using a spud wrench. Once the nut is snug-tight, the anchor bolt threads shall be burred just enough to prevent loosening of the nut.

6-02.3(21) Drainage of Box Girder Cells

To drain box girder cells, the Contractor shall provide and install, according to details in the Plans, short lengths of nonmetallic pipe in the bottom slab at the low point of each cell. The pipe shall have a minimum inside diameter of 4-inches. If the difference in plan elevation is 2-inches or less, the Contractor shall install pipe in each end of the box girder cell. All drainage holes shall be screened in accordance with the Plan details.

6-02.3(22) Drainage of Substructure

The Contractor shall use weep holes and gravel backfill that complies with Section 9-03.12(2) to drain fill material behind retaining walls, abutments, tunnels, and wingwalls. To maintain thorough drainage, weep holes shall be placed as low as possible. Weep holes shall be covered with geotextile meeting the requirements of Section 9-33.2, Table 2 Class C before backfilling. Geotextile screening shall be bonded to the concrete with an approved adhesive. Gravel backfill shall be placed and compacted as required in Section 2-09.3(1)E. In addition, if the Plans require, tiling, French or rock drains, or other drainage devices shall be installed.

If underdrains are not installed behind the wall or abutment, all backfill within 18-inches of weep holes shall comply with Section 9-03.12(4). Unless the Plans require otherwise, all other backfill behind the wall or abutment shall be gravel backfill for walls.

6-02.3(23) Opening to Traffic

Bridges with a roadway slab made of Portland cement concrete shall remain closed to all traffic, including construction equipment, until the concrete has reached the 28-day specified compressive strength. This strength shall be determined with cylinders made of the same concrete as the roadway and cured under the same conditions. A concrete deck bridge shall never be opened to traffic earlier than ten days after the deck concrete was placed and never before the Engineer has approved.

For load restrictions on bridges under construction, refer to Section 6-01.6.

6-02.3(24) Reinforcement

Although the Plans normally include a bar list and bending diagram, these shall be used at the Contractor's risk. The Engineer advises the Contractor to check the order from the Plans.

Before delivery of the reinforcing bars, the Contractor shall submit to the Engineer two informational copies of the supplemental bending diagrams.

Various steel reinforcing bars, including those in crossbeams, may be shown as straight in the bar list sheets of the Plans. The Contractor shall bend these bars as required to conform to the configuration of the structure and as detailed in the Plans.

6-02.3(24)A Field Bending

If the Plans call for field bending of steel reinforcing bars, the Contractor shall bend them in keeping with the structure configuration and the Plans and Specifications.

Bending steel reinforcing bars partly embedded in concrete shall be done as follows:

Field bending shall not be done:

1. On bars size No. 14 or No. 18,
2. When air temperature is lower than 45ºF,
3. By means of hammer blows or pipe sleeves, or
4. While bar temperature is in the range of 400º to 700ºF.

In field-bending steel reinforcing bars, the Contractor shall:

1. Make the bend gradually;
2. Apply heat as described in Tables 2 and 3 for bending bar sizes No. 6 thru No. 11 and for bending bar sizes No. 5 and smaller when the bars have been previously bent. Previously unbent bars of sizes No. 5 and smaller may be bent without heating;
3. Use a bending tool equipped with a bending diameter as listed in Table 1;
4. Limit any bend to these maximums — 135 degrees for bars smaller than size No. 9, and 90 degrees for bars size No. 9 and No. 11;
5. Straighten by moving a hickey bar (if used) progressively around the bend.

In applying heat for field-bending steel reinforcing bars, the Contractor shall:

1. Use a method that will avoid damages to the concrete;
2. Insulate any concrete within 6-inches of the heated bar area;
3. Ensure, by using temperature-indicating crayons or other suitable means, that steel temperature never exceeds the maximum temperatures shown in Table 2 below;
4. Maintain the steel temperature within the required range shown in Table 2 below during the entire bending process;
5. Apply two heat tips simultaneously at opposite sides of bars larger than size No. 6 to assure a uniform temperature throughout the thickness of the bar. For size No. 6 and smaller bars, apply two heat tips, if necessary;
6. Apply the heat for a long enough time that within the bend area the entire thickness of the bar — including its center — reaches the required temperature;
7. Bend immediately after the required temperature has been reached;
8. Heat at least as much of the bar as Table 3 below requires;
9. Locate the heated section of the bar to include the entire bending length; and
10. Never cool bars artificially with water, forced air, or other means.

Table 1
Bending Diameters for Field-Bending Reinforcing Bars

	Bend Diameter/Bar Diameter Ratio	
Bar Size	**Heat Not Applied**	**Heat Applied**
No. 4, No. 5	8	8
No. 6 through No. 9	Not Permitted	8
No. 10, No. 11	Not Permitted	10

The minimum bending diameters for stirrups and ties for No. 4 and No. 5 bars when heat is not applied shall be specified in Section 9-07.

Table 2
Preheating Temperatures for Field-Bending Reinforcing Bars

	Temperature (F)	
Bar Size	**Minimum**	**Maximum**
No. 4	1,200	1,250
No. 5, No. 6	1,350	1,400
No. 7 through No. 9	1,400	1,450
No. 10, No. 11	1,450	1,500

Table 3
Minimum Bar Length to be Heated (d = nominal diameter of bar)

	Bend Angle		
Bar Size	**45°**	**90°**	**135°**
No. 4 through No. 8	8d	12d	15d
No. 9	8d	12d	Not Permitted
No. 10, No. 11	9d	14d	Not Permitted

6-02.3(24)B Protection of Materials

The Contractor shall protect reinforcing steel from all damage. When placed into the structure, the steel shall be free from dirt, loose rust or mill scale, paint, oil, and other foreign matter.

When transporting, storing, or constructing in close proximity to bodies of salt water, plain and epoxy-coated steel reinforcing bar shall be kept in enclosures that provide protection from the elements.

If plain or epoxy-coated steel reinforcing bar is exposed to mist, spray, or fog that may contain salt, it shall be flushed with fresh water prior to concrete placement.

When the Engineer requires protection for reinforcing steel that will remain exposed for a length of time, the Contractor shall protect the reinforcing steel:

1. By cleaning and applying a coat of paint Formula No. A-9-73 over all exposed surfaces of steel, or
2. By cleaning and painting paint Formula No. A-9-73 on the first 6-inches of the steel bars protruding from the concrete and covering the bars with polyethylene sleeves.

The paint shall have a minimum dry film thickness of 1 mil.

6-02.3(24)C Placing and Fastening

The Contractor shall position reinforcing steel as the Plans require and shall ensure that the steel does not move as the concrete is placed.

When spacing between bars is 1 foot or more, they shall be tied at all intersections. When spacing is less than 1 foot, every other intersection shall be tied. If the Plans require bundled bars, they shall be tied together with wires at least every 6-feet. All epoxy-coated bars in the top mat of the roadway slab shall be tied at all intersections. Other epoxy-coated bars shall also be tied at all intersections, but shall be tied at alternate intersections when spacing is less than 1 foot in each direction. Wire used for tying epoxy-coated reinforcing steel shall be plastic coated. **Tack welding is not permitted on reinforcing steel**.

Abrupt bends in the steel are permitted only when one steel member bends around another. Vertical stirrups shall pass around main reinforcement or be firmly attached to it.

For slip-formed concrete, the reinforcing steel bars shall be tied at all intersections and cross braced to keep the cage from moving during concrete placement. Cross bracing shall be with additional reinforcing steel. Cross bracing shall be placed both longitudinally and transversely.

After reinforcing steel bars are placed in a traffic or pedestrian barrier and prior to slip-form concrete placement, the Contractor shall check clearances and reinforcing steel bar placement. This check shall be accomplished by using a template or by operating the slip-form machine over the entire length of the traffic or pedestrian barrier. All clearance and reinforcing steel bar placement deficiencies shall be corrected by the Contractor before slip-form concrete placement.

Mortar blocks (or other approved devices) shall be used to maintain the concrete coverage required by the Plans. The Mortar blocks shall:

1. Have a bearing surface measuring not greater than 2-inches in either dimension, and
2. Have a compressive strength equal to that of the concrete in which they are embedded.

In slabs, each mortar cube shall have either: (1) a grooved top that will hold the reinforcing bar in place, or (2) an embedded wire that protrudes and is tied to the reinforcing steel. If this wire is used around epoxy-coated bars, it shall be coated with plastic.

Mortar blocks may be accepted on a Manufacturers Certificate of Compliance, which shall include test results on sets of two 2-inch square specimens per AASHTO T 106. Each pair of specimens shall represent 2,500 or fewer mortar blocks and shall be made of the same mortar as the blocks and cured under the same conditions.

In lieu of mortar blocks, the Contractor may use metal or plastic chair supports to hold uncoated bars. Any surface of a metal chair support that will not be covered by at least $^{1}/_{2}$-inch of concrete shall be one of the following:

1. Hot-dip galvanized after fabrication in keeping with AASHTO M 232 Class D,
2. Coated with plastic firmly bonded to the metal. This plastic shall be at least $^{3}/_{32}$-inch thick where it touches the form and shall not react chemically with the concrete when tested in the State Materials Laboratory. The plastic shall not shatter or crack at or above -5ºF and shall not deform enough to expose the metal at or below 200ºF, or
3. Stainless steel that meet the requirements of ASTM A 493, Type 302. Stainless steel chair supports are not required to be galvanized or plastic coated.

In lieu of mortar blocks, epoxy-coated reinforcing bars may be supported by one of the following:

1. Metal chair supports coated entirely with a dielectric material such as epoxy or plastic,
2. Other epoxy-coated reinforcing bars, or
3. Plastic chair supports.

Plastic chair supports shall be lightweight, non-porous, and chemically inert in concrete. Plastic chair supports shall have rounded seatings, shall not deform under load during normal temperatures, and shall not shatter or crack under impact loading in cold weather. Plastic chair supports shall be placed at spacings greater than 1 foot along the bar and shall have at least 25 percent of their gross place area perforated to compensate for the difference in the coefficient of thermal expansion between plastic and concrete. The shape and configuration of plastic supports shall permit complete concrete consolidation in and around the support.

In roadway and sidewalk slabs, the Contractor shall place reinforcing steel mats carefully to provide the required concrete cover. A "mat" is two layers of steel. Top and bottom mats shall be supported enough to hold both in their proper positions. If No. 4 bars make up the lower layer of steel in a mat, it shall be blocked at not more than 3-foot intervals (or 4-foot intervals for bars No. 5 and larger). Wire ties to girder stirrups shall not be considered as blocking. To provide a rigid mat, the Contractor shall add other supports and tie wires to the top mat as needed.

If a bar will interfere with a bridge drain, it shall be bent in the field to bypass the drain.

Clearances shall be at least:

4-inches between:	Main bars and the top of any concrete masonry exposed to the action of salt or alkaline water.
$2^1/_2$-inches between:	Adjacent bars in a layer. Slab bars and the top of the roadway slab. Main bars and the surface of concrete deposited against earth (without intervening forms).
2-inches between:	Adjacent layers. Main bars and the surface of concrete (except in walls and slabs). Reinforcing bars and the faces of forms for exposed aggregate finish.
$1^1/_2$-inches between:	Main bars and the surface of concrete in retaining walls. Slab bars and the top of the slab (except roadway slabs). Stirrups and ties and the surface of the concrete.
1-inch between:	Slab bars and the bottom of the slab. Curb or sidewalk bars and the surface of the concrete.

Reinforcing steel bars shall not vary more than the following tolerances from their position shown in the Plans:

Members 10-inches or less in thickness	$\pm^1/_4$ in.
Members more than 10-inches in thickness	$\pm^3/_8$ in.
Drilled Shafts top of rebar cage elevation	+6 in./-3 in.
Except:	
The distance between the nearest reinforcingsteel bar surface and the top surface of the roadway deck slab	$+^1/_4$ in.
Longitudinal spacing of bends and ends of bars	±1 in.
Length of bar laps	$-1^1/_2$ in.
Embedded length	
No 3 through No. 11	-1 in.
No. 14 through No. 18	-2 in.
When reinforcing steel bars are to be placedat equal spacing within a plane:	
Stirrups and ties	±1 in.
All other reinforcement	±1 bar dia.

Before placing any concrete, the Contractor shall:

1. Clean all mortar from reinforcement, and
2. Obtain the Engineer's permission to place concrete after the Engineer has inspected the placement of the reinforcing steel. (Any concrete placed without the Engineer's permission shall be rejected and removed.)

6-02.3(24)D Splicing

The Contractor shall supply steel reinforcing bars in the full lengths the Plans require. Unless the Engineer approves in writing, the Contractor shall not change the number, type, or location of splices.

The Engineer may permit the Contractor to use thermal or mechanical splices in place of the method shown in the Plans if they are of an approved design. Use of a new design may be granted if:

1. The Contractor provides technical data and proof from the manufacturer that the design will perform satisfactorily, and
2. Sample splices and materials from the manufacturer pass the Engineer's tests.

After a design has been approved, any changes in detail or material shall require new approval.

The Contractor shall:

1. Not lap-splice reinforcing bars Nos. 14 or 18.
2. Not permit any welded or mechanical splice to deviate in alignment more than $^1/_4$-inch per $3^1/_2$-feet of bar.
3. Distribute splices evenly, grouping them together only at points of low tensile stress.
4. Ensure at least 2-inches clearance between any splice and the nearest bar or the surface of the concrete (or $1^1/_2$-inch for the length of the sleeve on mechanical splices).

5. Rigidly clamp or wire all splices in a way the Engineer approves.
6. Place lap-spliced bars in contact for the length of the splice and tie them together near each end.
7. Securely fasten the ends and edges of welded-wire-fabric reinforcement, overlapping them enough to maintain even strength.

6-02.3(24)E Welding Reinforcing Steel

Welding of steel reinforcing bars shall conform to the requirements of the Special Provisions, Plans, and these Specifications.

When welding is required, steel reinforcing bars shall be supplied that are suitable for welding. Steel which is to be welded shall have a maximum carbon equivalent of 0.65 percent. The carbon equivalent shall be determined by the following formula:

$$CE = \% C + \% Mn/6 + \% Cu/40 + \% Ni/20 + \% Cr/10 - \% Mo/50 - \% V/10$$

In addition, carbon shall not exceed 0.45 percent nor manganese 1.30 percent.

Before any welding begins, the Contractor shall obtain the Engineer's approval of a written welding procedure for each type of welded splice to be used, including the procedure specifications and joint details. The procedure specifications shall specify: material specification; manual or machine; position of weld; filler metal specification and classification; shielding gas; single or multiple pass; single or multiple arc; either shielded metal arc, flux cored arc, or gas metal arc welding process; preheat and interpass temperature; welding current; polarity; and root treatment. The welding procedure shall specify welding sequence, pass number, electrode size, welding current amperes and voltage for each joint detail. All the aforementioned information shall be contained on a form that specifies the procedure number, revision number, and the Contractor. The form shall be signed and dated.

Electrodes for manual shielded metal arc welding (SMAW) of Grade 60 steel reinforcing bars shall conform to the requirements of AWS A5.5 of the low hydrogen E90 series.

Solid and composite electrodes for gas metal arc welding (GMAW) and flux-cored arc welding (FCAW) of Grade 60 steel reinforcing bar shall conform to the requirements of AWS A5.28, ER90S and AWS A5.29, E90T respectively. The Contractor shall demonstrate that each combination of electrode and shielding proposed for use will produce the following mechanical properties:

FCAW Grade E90T	
Tensile Strength	90,000 psi
Yield Strength	78,000 psi
Elongation in 2-inches	17%

Compliance may be verified from manufacturer's certified test reports, or from actual testing of weld specimens.

All welding shall be protected from air currents, drafts, and precipitation to prevent loss of heat or loss of arc shielding. Short circuiting transfer with gas metal arc welding will not be allowed. Slugging of welds will not be allowed. No field welding of reinforcing bars will be permitted when the ambient temperature is below 32ºF.

The minimum preheat and interpass temperature for welding Grade 60 reinforcing bars shall be in accordance with AWS D1.4 Table 5.2 and mill certification of carbon equivalence, per lot of reinforcing. Preheating shall be applied to the reinforcing bars and other splice members within 6-inches of the weld, unless limited by the available lengths of the bars or splice member.

Generally, post heating of welded splices is only required for direct butt welded splices of Grade 60 bars size No. 9 or larger and shall be done immediately after welding before the splice has cooled to 700ºF. Post heating shall not be less than 800ºF nor more than 1,000ºF and held at this temperature for not less than 10 minutes before allowing the splice to cool naturally to ambient temperature.

Weld joint and welder qualifications shall be made by the following procedures. The joint qualification and welder qualification shall be according to the following tests.

Under supervision of the State Materials and Fabrication Inspector, the welder shall weld three test joints of the largest size reinforcing bar to be weld spliced, per type of joint shown in the Plans. Two of the test welds shall be test loaded to no less than 125 percent of the minimum specified yield strength of the bar. The remaining test weld shall be mechanically cut perpendicular to the direction of the welding and macroetched. The macroetch specimen for Flare V groove welds will be inspected for the weld size and effective throat as shown in the Plans. Indirect butt splices shall be cut mechanically at two locations to provide a transverse cross-section of each of the bars spliced in the test assembly. The sections shall show the full cross-section of the weldment, the root of the weld, and any reinforcement. The etched cross-section shall have complete penetration and complete fusion with the base metal and between successive passes in the weld. Groove welds of direct butt splices and flare-groove welds shall not have reinforcement exceeding $^{1}/_{8}$-inch in height measured from the main body of the bar and shall have a gradual transition to the base metal surface. No cracks will be allowed in either the weld metal or heat-affected zone. All craters shall be filled to the full cross-section of the weld. Weld metal shall be free from overlay. Undercutting deeper than $^{1}/_{32}$-inch will not be allowed except at points where welds intersect the raised pattern of deformations where undercutting less than $^{1}/_{16}$-inch deep will be acceptable. The sum of diameters of piping porosity in groove welds shall not exceed $^{1}/_{8}$-inch in any linear inch of weld or exceed $^{9}/_{16}$-inch in any 6-inch length of weld. Corrections to welds with shielded metal arc, gas metal arc, or flux-cored arc welding processes shall be made in accordance with Engineer's approval

A welder qualified in the vertical position shall then be qualified for the horizontal and flat positions. A welder qualified for the horizontal position shall then be qualified for the flat position but not the vertical position. A welder qualified in the flat position shall be qualified for the flat position only.

Welders qualified for direct butt splice groove welds are qualified for indirect butt splice groove welds and fillet welds. A welder qualified for indirect butt splice grooved welds is not qualified for direct butt splice welds. The welder qualifications shall remain in effect indefinitely unless, (1) the welder is not engaged in a given process of welding for which he/she is qualified for a period exceeding six months, or (2) there is some specific reason to question a welder's ability.

Weld joint geometry shall be as shown in the Plans and these Specifications. Welding machines shall be D.C. current, reverse polarity, and in good working condition.

The Contractor is responsible for using a welding sequence that will limit the alignment distortion of the bars due to the effects of welding. The maximum out-of-line permitted will be $^{1}/_{4}$-inch from a 3.5-foot straight-edge centered on the weld and in line with the bar.

The following procedure for welding steel reinforcing bars is recommended:

Sheared bar ends shall be burned or sawed off a minimum of $^1/_2$-inch to completely remove the ruptured portion of the steel shear area prior to welding butt splices. Surfaces to be welded shall be smooth, uniform, and free from fins, tears, cracks, and other defects. Surfaces to be welded and surfaces adjacent to a weld shall also be free from loose or thick scale, slag, rust, moisture, grease, paint, epoxy covering, or other foreign materials. All tack welds shall be within the area of the final weld. No other tack weld will be permitted. Double bevel groove welds require chipping, grinding, or gouging to sound metal at the root of the weld before welding the other side. Progression of vertical welding shall be upward. The ground wire from the welding machine shall be clamped to the bar being welded.

Should the Contractor elect to use a procedure which differs in any way from the procedure recommended, the Contractor shall submit the changes, in writing, to the Engineer for approval. Approved weld procedures shall be strictly followed.

6-02.3(24)F Mechanical Splices

The Contractor shall form mechanical splices with an Engineer-approved system using sleeve filler metal, threaded coupling, or another method that complies with this section.

If necessary to maintain required clearances after the splices are in place, the Contractor shall adjust, relocate, or add stirrups, ties, and bars.

Before splicing, the Contractor shall provide the Engineer with the following information for each shipment of splice material:

1. The type or series identification (and heat treatment lot number for threaded-sleeve splices),
2. The grade and size of bars to be spliced,
3. A manufacturer's catalog with complete data on material and procedures,
4. A written statement from the manufacturer that the material is identical to that used earlier by the Engineer in testing and approving the system design, and
5. A written statement from the Contractor that the system and materials will be used according to the manufacturer's instructions and all requirements of this section.

All splices shall meet these criteria:

1. Tension splices shall develop at least 130 percent of the yield tensile strength specified for the unspliced bar. The ultimate tensile strength of the sleeve shall exceed that of the other parts of the completed splice.
2. AASHTO M 31 bars within a splice sleeve shall not slip more than 0.03-inch for Grade 40 bars, nor more than 0.045-inch for Grade 60 bars. This slippage shall be measured between gage points clear of the splice sleeve. Measurements shall be taken at an initial load of 3,000 psi and again after loading to 90 percent of the minimum specified yield strength for the unspliced bar and then relaxed to 3,000 psi.
3. Maximum allowable bar size:
   a. Mechanical butt splice — No. 14
   b. Mechanical lap splice — No. 6

The Engineer will visually inspect the splices and accept all that appear to conform with the test samples. For sleeve-filler splices, the Engineer will allow voids within the limits on file in the design approval. If the Engineer considers any splice defective, it shall be removed and replaced at the Contractor's expense.

In preparing sleeve-filler metal splices, the Contractor shall:

1. Clean the bar surfaces by: (a) oxyacetylene torch followed by power wire brushing, or (b) abrasive blasting;
2. Remove all slag, mill scale, rust, and other foreign matter from all surfaces within and 2-inches beyond the sleeve;
3. Grind down any projection on the bar that would prevent placing the sleeve;
4. Prepare the ends of the bars as the splice manufacturer recommends and as the approved procedure requires; and
5. Preheat, just before adding the filler, the entire sleeve and bar ends to 300ºF, plus or minus 50ºF. (If a gas torch is used, the flame shall not be directed into the sleeve.)

When a metallic, sleeve-filler splice is used (or any other system requiring special equipment), both the system and the operator shall qualify in the following way under the supervision of the State Materials and Fabrication Inspector. The operator shall prepare six test splices (three vertical, three horizontal) using bars having the same AASHTO Designation and size (maximum) as those to be used in the work. Each test sample shall be 42-inches long, made up of two 21-inch bars joined end-to-end by the splice. The bar alignment shall not deviate more than $^{1}/_{8}$-inch from a straight line over the whole length of the sample. All six samples must meet the tensile strength and slip criteria specified in this section.

The Contractor shall provide labor, materials, and equipment for making these test samples at no expense to the Contracting Agency. The Contracting Agency will test the samples at no cost to the Contractor.

6-02.3(24)G Job Control Tests

As the work progresses, the Engineer may require the Contractor to provide a sample splice (thermal or mechanical) to be used in a job control test. The operator shall create this sample on the job site with the Engineer present using bars of the same size as those being spliced in the work. The sample shall comply with all requirements of these Specifications, and is in addition to all other sample splices required for qualification. The Engineer will require no more than two samples on any project with fewer than 200 splices and no more than one sample per 100 splices on any project with more than 200 splices.

6-02.3(24)H Epoxy-Coated Steel Reinforcing Bar

This work is furnishing, fabricating, coating, and placing epoxy-coated steel reinforcing bars as the Plans, these Specifications, and the Special Provisions require. Coating material shall be applied electrostatically, by spraying, or by the fluidized-bed method.

All epoxy-coated bars shall comply with the requirements of Section 9-07. Fabrication may occur before or after coating.

The Contractor shall protect epoxy-coated bars from damage using padded or nonmetallic slings and straps free from dirt or grit. To prevent abrasion from bending or sagging, the Contractor shall lift bundled bars with a strong-back, multiple supports, or a platform bridge. Bundled bars shall not be dropped or dragged. During shop or field storage, bars shall rest on wooden or padded cribbing. The Contractor may substitute other methods for protecting the bars if the Engineer approves. If the Engineer believes the coated bars have been badly damaged, they will be rejected.

Metal chairs and supports shall be coated with epoxy (or another inert coating if the Engineer approves). The Contractor may use other support devices with the Engineer's approval. Plastic coated tie wires (approved by the Engineer) shall be used to protect the coated bars from being damaged during placement.

The bars shall be placed as the Plans require and held firmly in place during placing and setting of the concrete. All bars shall be placed and fastened as specified in Section 6-02.3(24)C.

In the interval between installing coated bars and concreting the deck, the Contractor shall protect the coating from damage that might result from other construction work.

The Engineer will inspect the coated bars after they are placed and before the deck concrete is placed. The Contractor shall patch any areas that show significant damage (as defined below).

Significant damage means any opening in the coating that exposes the steel in an area that exceeds:

1. 0.05 square inch (approximately $^1/_4$-inch square or $^1/_4$-inch in diameter or the equivalent).
2. 0.012 square inches (approximately $^1/_8$-inch square or $^1/_8$-inch in diameter) when the opening is within $^1/_4$-inch of another opening of equal or larger size.
3. 6-inches long, any width.
4. 0.50 square inch aggregate area in any 1-foot length of bar.

The Contractor shall patch significantly damaged areas with Engineer-approved patching material obtained from the epoxy resin manufacturer. This material shall be compatible with the coating and inert in concrete. Areas to be patched shall be clean and free of surface contaminants. Patching shall be done before oxidation occurs and according to the resin manufacturer's instructions.

6-02.3(25) Prestressed Concrete Girders

The Contractor shall perform quality control inspection. The manufacturing plant of prestressed concrete girders shall be certified by the Precast/Prestressed Concrete Institute's Plant Certification Program for the type of prestress member to be produced and shall be approved by WSDOT as a Certified Prestress Concrete Fabricator prior to the start of production. WSDOT certification will be granted at, and renewed during, the annual prestressed plant review and approval process.

Prior to the start of production of girders, the Contractor shall advise the Engineer of the production schedule. The Contractor shall give the Inspector safe and free access to the work. If the Inspector observes any nonspecification work or unacceptable quality control practices, the Inspector will advise the plant manager. If the corrective action is not acceptable to the Engineer, the girder(s) will be subject to rejection by the Engineer.

The Contracting Agency intends to perform Quality Assurance Inspection. By its inspection, the Contracting Agency intends only to facilitate the work and verify the quality of that work. This inspection shall not relieve the Contractor of any responsibility for identifying and replacing defective material and workmanship.

The various types of girders are:

Prestressed Concrete Girder – Refers to prestressed concrete girders of all types, including prestressed concrete I girders, prestressed concrete wide flange I girders, bulb tee girders, deck bulb tee girders, thin flange deck bulb tee girders, precast prestressed concrete members, spliced prestressed concrete girders, and prestressed concrete tub girders.

Prestressed Concrete I Girder – Refers to a prestressed concrete girder with a flanged I shaped cross section, requiring a cast-in-place concrete deck to support traffic loads. WSDOT standard girders in this category include Series W42G, W50G, W58G, and W74G.

Prestressed Concrete Wide Flange I Girder – Refers to a prestressed concrete girder with an I shaped cross section with wide top and bottom flanges, requiring a cast-in-place concrete deck to support traffic loads. WSDOT standard girders in this category include Series WF42G, WF50G, WF58G, WF74G, W83G, and W95G.

Bulb Tee Girder – Refers to a prestressed concrete girder, with a wide top flange requiring a cast-in-place concrete deck to support traffic loads. WSDOT standard girders in this category include Series W32BTG, W38BTG, and W62BTG.

Deck Bulb Tee Girder – Refers to a bulb tee girder with a top flange designed to support traffic loads, and designed to be mechanically connected at the flange edges to adjacent girders at the job site. Except where specific requirements are otherwise specified for these girders, deck bulb tee girders shall conform to all requirements specified for bulb tee girders. WSDOT standard girders in this category include Series W35DG, W41DG, W53DG, and W65DG.

Thin Flange Deck Bulb Tee Girder – Refers to a bulb tee girder with a top flange width equal to the girder spacing and requiring a cast-in-place concrete deck to support traffic loads. Except where specific requirements are otherwise specified for these girders, thin flange deck bulb tee girders shall conform to all requirements specified for bulb tee girders. WSDOT standard girders in this category include Series W32TFG, W38TFG, W50TFG, and W62TFG.

Precast Prestressed Member (PCPS Member) – Refers to a precast prestressed slab, precast prestressed ribbed section, or a deck double tee girder. PCPS members are designed to be mechanically connected at the flange or member edges to adjacent PCPS members at the job site. Except where specific requirements are otherwise specified for these girders, PCPS members shall conform to all requirements specified for deck bulb tee girders.

Spliced Prestressed Concrete Girder – Refers to prestressed concrete girders initially fabricated in segments to be longitudinally spliced together with cast-in-place concrete closures at the job site. Except where specific requirements are otherwise specified for these girders, spliced prestressed concrete girders shall conform to all requirements specified for prestressed concrete girders. Anchorages shall conform to Sections 6-02.3(26)B, 6-02.3(26)C, and 6-02.3(26)D. Ducts shall conform to the Section 6-02.3(26)E requirements for internal embedded installation, and shall

be round, unless the Engineer approves use of elliptical shaped ducts. Duct-wedge plate transitions shall conform to Section 6-02.3(26)E. Prestressing reinforcement shall conform to Section 6-02.3(26)F. WSDOT standard girders in this category include Series WF74PTG, W83PTG, and W95PTG.

Prestressed Concrete Tub Girder – Refers to prestressed concrete trapezoidal box or bathtub girders including those fabricated in segments to be spliced together with cast-in-place concrete closures at the job site. Except where specific requirements are otherwise specified for these girders, prestressed concrete tub girders shall conform to all requirements specified for prestressed concrete girders and spliced prestressed concrete girders. WSDOT standard girders in this category include Series U**G* or Series UF**G*, where U specifies webs without flanges, UF specifies webs with flanges, ** specifies the girder height in inches, and * specifies the bottom flange width in feet.

6-02.3(25)A Shop Plans

The Plans show design conditions and details for prestressed girders. Deviations will not be permitted, except as specifically allowed by these Specifications and by manufacturing processes approved by the annual plant approval process.

Shop plans shall show the size and location of all cast-in holes for installation of deck formwork hangers and/or temporary bracing. Holes for formwork hangers shall match approved deck formwork plans designed in accordance with Section 6-02.3(16). There shall be no field-drilled holes in prestressed concrete girders. Post-tensioning ducts in spliced prestressed concrete girders shall be located so their center of gravity is in accordance with the Plans.

The Contractor shall have the option to furnish Series W74G prestressed concrete girders with minor dimensional differences from those shown in the Plans. The $2^{5}/_{8}$-inch top flange taper may be reduced to $1^{5}/_{8}$-inches and the bottom flange width may be increased to 2-feet 2-inches. Other dimensions of the girder shall be adjusted as necessary to accommodate the above mentioned changes. Reinforcing steel shall be adjusted as necessary. The overall height and top flange width shall remain unchanged.

If the Contractor elects to provide a prestressed concrete girder with an increased web thickness, shop plans along with supporting design calculations shall be submitted to the Engineer for approval prior to girder fabrication. The girder shall be designed for at least the same load carrying capacity as the girder shown in the Plans. The load carrying capacity of the mild steel reinforcement shall be the same as that shown in the Plans.

The Contractor may alter bulb tee girder dimensions as specified from that shown in the Plans if:

1. The girder has the same or higher load carrying capacity (using current AASHTO Design Specification);
2. The Engineer approves, before the girder is made, complete design calculations for the girder;
3. The Contractor adjusts substructures to yield the same top of roadway elevation shown in the Plans;
4. The depth of the girder is not increased by more than 2-inches and is not decreased;
5. The web thickness is not increased by more than 1-inch and is not decreased;

6. The top flange minimum thickness of the girder is not increased by more than 2-inches, providing the top flange taper section is decreased a corresponding amount;
7. The top flange taper depth is not increased by more than 1-inch; and
8. The bottom flange width is not increased by more than 2-inches.

The Contractor shall provide five copies of the shop plans to the Engineer for approval, except as otherwise noted. Shop drawings for spliced prestressed concrete girders shall conform to Section 6-02.3(26)A, and seven copies of the shop drawings shall be submitted to the Engineer for approval. The shop drawings for spliced prestressed concrete girders shall include all details related to the post-tensioning operations in the field, including details of hardware required, tendon geometry, blockout details, and details of additional or modified steel reinforcing bars required in cast-in-place closures. Approval of shop plans means only that the Engineer accepts the methods and materials. Approval does not imply correct dimensions.

6-02.3(25)B Casting

Before casting girders, the Contractor shall have possession of an approved set of shop drawings. Side forms shall be steel except that cast-in-place concrete closure forms for spliced prestressed concrete girders, interior forms of prestressed concrete tub girders, and end bulkhead forms of prestressed concrete girders may be plywood. Interior voids for precast prestressed slabs with voids shall be formed by either wax soaked cardboard or expanded polystyrene forms. The interior void forms shall be secured in the position as shown in the Plans and shall remain in place.

All concrete mixes to be used shall be pre-approved in the WSDOT plant certification process and must meet the requirements of Section 9-19.1. The temperature of the concrete when placed shall be between 50ºF and 90ºF.

Slump shall not exceed 4-inches for normal concrete nor 7-inches with the use of a high range water reducing admixture, nor 9-inches when both a high range water reducing admixture is used and the water/cement ratio is less than or equal to 0.35. The high range water reducer shall meet the requirements of Sections 9-23.6 and 9-23.7.

Air-entrainment is not required in the concrete placed into prestressed precast concrete girders, including cast-in-place concrete closures for spliced prestressed concrete girders.

No welds will be permitted on steel within prestressed girders. Once the prestressing steel has been installed, no welds or grounds for welders shall be made on the forms or the steel in the girder, except as specified.

The Contractor may form circular block-outs in the girder top flanges to receive falsework hanger rods. These block-outs shall:

1. Not exceed 1-inch in diameter;
2. Be spaced no more than 72-inches apart longitudinally on the girder;
3. Be located 3-inches or more from the outside edge of the top flange on Series W42G, W50G, W58G, girders, and all prestressed concrete tub girders with webs with flanges, 6-inches or more for Series W74G girders, and 7-inches or more for Series WF42G, WF50G, WF58G, WF74G, WF74PTG, W83G, W83PTG, W95G, W95PTG, W32BTG, W38BTG, W62BTG girders and other bulb tee girders.

The Contractor may form circular block-outs in the girder webs to support brackets for roadway slab falsework. These block-outs shall:

1. Not exceed 1-inch in diameter,
2. Be spaced no more than 72-inches apart longitudinally on the girder, and
3. Be positioned so as to clear the girder reinforcing and prestressing steel.

6-02.3(25)C Prestressing

Each stressing system shall have a pressure gauge or load cell that will measure jacking force. Any gauge shall display pressure accurately and readably with a dial at least 6-inches in diameter or with a digital display. Each jack and its gauge shall be calibrated as a unit and shall be accompanied by a certified calibration chart. The Contractor shall provide one copy of this chart to the Engineer. The cylinder extension during calibration shall be in approximately the position it will occupy at final jacking force.

Jacks and gauges shall be recalibrated and recertified:

1. Annually,
2. After any repair or adjustment, and
3. Anytime there are indications that the jack calibration is in error.

The Engineer may use pressure cells to check jacks, gauges, and calibration charts before and during tensioning.

All load cells shall be calibrated and shall have an indicator that shows prestressing force in the strand. The range of this cell shall be broad enough that the lowest 10 percent of the manufacturer's rated capacity will not be used to measure jacking force.

From manufacture to encasement in concrete, all reinforcement used in girders shall be protected against dirt, oil, grease, damage, rust, and all corrosives. If strands in the stressing bed are exposed before they are encased in concrete, the Contractor shall protect them from contamination or corrosion. The protection method requires the Engineer's approval. If steel has been damaged or if it shows rust or corrosion that cannot be fully removed with a soft cloth, it will be rejected.

Post-tensioning of spliced prestressed concrete girders shall conform to Section 6-02.3(26)G, and the following requirements:

1. Before tensioning, the Contractor shall remove all side forms from the cast-in-place concrete closures. From this point until 48 hours after grouting the tendons, the Contractor shall keep all construction and other live loads off the superstructure and shall keep the falsework supporting the superstructure in place.
2. Once the post-tensioning steel is installed, no welds or welding grounds shall be attached to metal forms, structural steel, or steel reinforcing bars of the structural member.
3. The Contractor shall not tension the post-tensioning reinforcement until the concrete in the cast-in-place closures reaches the minimum compressive strength specified in the Plans (or 5,000 psi if the concrete strength is not specified in the Plans). This strength shall be measured with concrete cylinders made of the same concrete and cured under the same conditions as the cast-in-place closures.
4. All post-tensioning shall be completed before placing the sidewalks and barriers on the superstructure.

6-02.3(25)D Curing

During curing, the Contractor shall keep the girder in a saturated curing atmosphere until the girder concrete has reached the required release strength. If the Engineer approves, the Contractor may shorten curing time by heating the outside of impervious forms. Heat may be radiant, convection, conducted steam, or hot air. With steam, the arrangement shall envelop the entire surface with saturated steam. The Engineer will not permit hot air curing until after approving the Contractor's proposed method to envelop and maintain the girder in a saturated atmosphere. Saturated atmosphere means a relative humidity of at least 90 percent. The Contractor shall never allow dry heat to touch the girder surface at any point.

Under heat curing methods, the Contractor shall:

1. Keep all unformed girder surfaces in a saturated atmosphere throughout the curing time;
2. Embed a thermocouple (linked with a thermometer accurate to plus or minus 5ºF) 6 to 8-inches from the top or bottom of the girder on its centerline and near its midpoint;
3. Monitor with a recording sensor (accurate to plus or minus 5ºF) arranged and calibrated to continuously record, date, and identify concrete temperature throughout the heating cycle;
4. Make this temperature record available for the Engineer to inspect;
5. Heat concrete to no more than 100ºF during the first two hours after placing the concrete, and then increase no more than 25ºF per hour to a maximum of 175ºF;
6. Cool concrete, after curing is complete, no more than 25ºF per hour, to 100ºF; and
7. Keep the temperature of the concrete above 60ºF until the girder reaches release strength.

The Contractor may strip side forms from prestressed concrete girders once the concrete has reached a minimum compressive strength of 3,000 psi. All damage from stripping is the Contractor's responsibility.

Curing of cast-in-place concrete closures for spliced prestressed concrete girders shall conform to Section 6-02.3(11).

6-02.3(25)E Contractors Control Strength

Concrete strength shall be measured on test cylinders cast from the same concrete as that in the girder. These cylinders shall be cured under time-temperature relationships and conditions that simulate those of the girder. If the forms are heated by steam or hot air, test cylinders will remain in the coolest zone throughout curing. If forms are heated another way, the Contractor shall provide a record of the curing time-temperature relationship for the cylinders for each girder to the Engineer. When two or more girders are cast in a continuous line and in a continuous pour, a single set of test cylinders may represent all girders provided the Contractor demonstrates uniformity of casting and curing to the satisfaction of the Engineer.

The Contractor shall mold, cure, and test enough of these cylinders to satisfy specification requirements for measuring concrete strength. The Contractor may use 4-inch by 8-inch or 6-inch by 12-inch cylinders. If heat is used to shorten curing time, the Contractor shall let cylinders cool for at least $^1/_2$-hour before testing.

Test cylinders may be cured in a moist room or water tank in accordance with WSDOT FOP for AASHTO T-23 after the girder concrete has obtained the required release strength. If, however, the Contractor intends to ship the girder prior to the standard 28-day strength test, the design strength for shipping shall be determined from cylinders placed with the girder and cured under the same conditions as the girder. These cylinders may be placed in a noninsulated, moisture-proof envelope.

To measure concrete strength in the girder, the Contractor shall randomly select two test cylinders and average their compressive strengths. The compressive strength in either cylinder shall not fall more than 5 percent below the specified strength. If these two cylinders do not pass the test, two other cylinders shall be selected and tested.

If too few cylinders were molded to carry out all required tests on the girder, the Contractor shall remove and test cores from the girder under the surveillance of the Engineer. If the Contractor casts cylinders to represent more than one girder, all girders in that line shall be cored and tested.

For precast prestressed members, a test shall consist of four cores measuring 3-inches in diameter by 6-inches in height (for slabs) and by the thickness of the web (for ribbed sections). Two cores shall be taken from each side of the member and on each side of the member's span midpoint, at locations approved by the Engineer. The core locations for precast prestressed slabs shall be near mid-depth of the slab, within the middle third of the span length, and shall avoid all prestressing strands and steel reinforcing bars. The core locations for precast prestressed ribbed sections shall be immediately beneath the top flange, within the middle third of the span length, and shall avoid all prestressing strands and steel reinforcing bars.

For prestressed concrete tub girders, a test shall consist of four cores measuring 3-inches in diameter by the thickness of the web, taken from each web approximately three feet to the left and to the right of the center of the girder span. The cores shall avoid all prestressing strands and steel reinforcing bars.

For all other prestressed concrete girders, a test shall consist of three cores measuring 3-inches in diameter by the thickness of the web and shall be removed from just below the top flange; one at the midpoint of the girder's length and the other two approximately 3-feet to the left and approximately 3-feet to the right.

The cores shall be taken in accordance with AASHTO T 24 and shall be tested in accordance with WSDOT FOP for AASHTO T 22. The Engineer may accept the girder if the average compressive strength of the four cores from the precast prestressed member, or prestressed concrete tub girder, or of the three cores from any other prestressed concrete girder, is at least 85 percent of the specified compressive strength with no one core less than 75 percent of specified compressive strength.

If the girder is cored to determine the release strength, the required patching and curing of the patch shall be done prior to shipment. If there are more than three holes or if they are not in a neutral location, the prestress steel shall not be released until the holes are patched and the patch material has attained a minimum compressive strength equal to the required release compressive strength or 4,000 psi, whichever is larger.

The Contractor shall coat cored holes with an epoxy bonding agent and patch the holes using the same type concrete as that in the girder, or a mix approved during the annual plant review and approval. The epoxy bonding agent shall meet the requirements of Section 9-26.1 for Type II, Grade 2 epoxy. The girder shall not be shipped until tests show the patch material has attained a minimum compressive strength of 4,000 psi

6-02.3(25)F Prestress Release

Side and flange forms that restrain deflection shall be removed before release of the prestressing reinforcement.

All harped and straight strands shall be released in a way that will produce the least possible tension in the concrete. This release shall not occur until tests show each girder has reached the minimum compressive strength required by the Plans.

The Contractor may request permission to release the prestressing reinforcement at a minimum concrete compressive strength less than specified in the Plans. This request shall be submitted to the Engineer for approval in accordance with Section 6-01.9 and shall be accompanied with calculations showing the adequacy of the proposed release concrete compressive strength. The release strength shall not be less than 3,500 psi, except that the release strength for spliced prestressed concrete girders shall not be less than 4,000 psi. The calculated release strength shall meet the requirements outlined in the Washington State Department of Transportation Bridge Design Manual for tension and compression at release. The proposed minimum concrete compressive strength at release will be evaluated by the Contracting Agency. Fabrication of girders using the revised release strength shall not begin until the Contracting Agency has provided written approval of the revised release compressive strength. If a reduction of the minimum concrete compressive strength at release is allowed, the Contractor shall bear any added cost that results from the change.

6-02.3(25)G Protection of Exposed Reinforcement

When a girder is removed from its casting bed, all bars and strands projecting from the girder shall be cleaned and painted with a minimum dry film thickness of 1 mil of paint Formula No. A-9-73. During handling and shipping, projecting reinforcement shall be protected from bending or breaking. Just before placing concrete around the painted projecting bars or strands, the Contractor shall remove from them all dirt, oil, and other foreign matter.

Grouting of post-tensioning ducts for spliced prestressed concrete girders shall conform to Section 6-02.3(26)H.

6-02.3(25)H Finishing

The Contractor shall apply a Class 1 finish, as defined in Section 6-02.3(14), to:

1. The exterior surfaces of the outside girders;
2. The bottoms, sides, and tops of the lower flanges on all girders; and

All other girder surfaces shall receive a Class 2 finish.

The interface on I-girders and other girders that contact the cast-in-place deck shall have a finish of dense, screeded concrete without a smooth sheen or laitance on the surface. After vibrating and screeding, and just before the concrete reaches initial set, the Contractor shall texture the interface. This texture shall be applied with a steel brooming tool that etches the surface transversely leaving grooves $^1/_8$-inch to $^1/_4$-inch wide, between $^1/_8$-inch and $^1/_4$-inch deep, and spaced $^1/_4$-inch to $^1/_2$-inch apart.

On the deck bulb tee girder section and all precast prestressed members, the Contractor shall test the roadway deck surface portion for flatness. This test shall occur after floating but while the concrete remains plastic. Testing shall be done with a 10-foot straightedge parallel to the girder centerline and with a flange width straightedge at right angles to the girder centerline. The Contractor shall fill depressions, cut down high spots, and refinish to correct any deviation of more than $^1/_4$-inch within the straightedge length.

This section of the roadway surface shall be finished to meet the requirements for finishing roadway slabs, as defined in Section 6-02.3(10) except that, if approved by the Engineer, a coarse stiff broom may be used to provide the finish in lieu of a metal tined comb.

The Contractor may repair rock pockets and other defects in the girder provided the repair is covered in the annual plant approval package. All other repairs and repair procedures shall be documented and approved by the Engineer prior to acceptance of the girder.

6-02.3(25)I Fabrication Tolerances

The girders shall be fabricated as shown in the Plans and shall meet the dimensional tolerances listed below. Construction tolerances of cast-in-place closures for spliced prestressed concrete girders shall conform to the tolerances specified for spliced prestressed concrete girders. Actual acceptance or rejection will depend on how the Engineer believes a defect outside these tolerances will affect the structure's strength or appearance:

1. Prestressed Concrete Girder Length (overall): ± $^1/_4$-inch per 25-feet of beam length, up to a maximum of ± 1-inch.
2. Precast Prestressed Member Length (overall): ± 1-inch.
3. Width (flanges): + $^3/_8$-inch, - $^1/_4$-inch.
4. Width (narrow web section): + $^3/_8$-inch, - $^1/_4$-inch.
5. Width (Precast Prestressed Member): ± $^1/_4$-inch.
6. Girder Depth (overall): ± $^1/_4$-inch.
7. Flange Depth:

For I and Wide Flange I girders:	± $^1/_4$-inch
For bulb tee and deck bulb tee girders:	+ $^1/_4$-inch, - $^1/_8$-inch
For PCPS members:	+ $^1/_4$-inch, - $^1/_8$-inch

8. Strand Position in Prestressed Concrete Girder: ± $^1/_4$-inch from the center of gravity of an individual strand; ± $^1/_2$-inch from the center of gravity of a bundled strand group.
9. Strand Position in Precast Prestressed Member: ±$^1/_4$-inch from the center of gravity of a bundled strand group and of an individual strand.
10. Longitudinal Position of the Harping Point:

Single harping point	± 18-inches
Multiple bundled strand groups	
First bundled strand group	± 6-inches
Second bundled strand group	± 18-inches
Third bundled strand group	± 30-inches

11. Position of an interior void, vertically and horizontally (Precast Prestressed Slab with voids): ± $^1/_2$-inch.
12. Bearing Recess (center recess to beam end): ± $^1/_4$-inch.
13. Beam Ends (deviation from square or designated skew):
    Horizontal: ± $^1/_2$-inch from web centerline to girder flange
    Vertical: ± $^1/_8$-inch per foot of beam depth

14. Precast Prestressed Member Ends (deviation from square or designated skew): ± $^{1}/_{2}$-inch.
15. Bearing Area Deviation from Plane (in length or width of bearing): $^{1}/_{16}$-inch.
16. Stirrup Reinforcing Spacing: ± 1-inch.
17. Stirrup Projection from Top of Beam: ± $^{3}/_{4}$-inch.
18. Mild Steel Concrete Cover: - $^{1}/_{8}$-inch, + $^{3}/_{8}$-inch.
19. Offset at Form Joints (deviation from a straight line extending 5-feet on each side of joint): ± $^{1}/_{4}$-inch.
20. Deviation from Design Camber (Precast Prestressed Member): ± $^{1}/_{4}$-inch per ten feet of member length measured at midspan, but not greater than ± $^{3}/_{4}$-inch total.
21. Differential Camber Between Girders in a Span (measured in place at the job site):

For I, Wide Flange I, bulb tee, and spliced prestressed concrete girders:	$^{1}/_{8}$-inch per 10-feet of beam length.
For deck bulb tee girders:	Cambers shall be equalized by an approved method when the differences in cambers between adjacent girders or stages measured at mid-span exceeds $^{1}/_{4}$-inch.
For PCPS members:	± $^{1}/_{4}$-inch per ten feet of member length measured at midspan, but not greater than ± $^{1}/_{2}$-inch total.
For prestressed concrete tub girders:	± $^{1}/_{4}$-inch per ten feet of member length measured at midspan, but not greater than ± $^{1}/_{3}$-inch total.

22. Position of Inserts for Structural Connections: ± 1-inch.
23. Position of Lifting Loops: ± 3-inches longitudinal, ± 1-inch transverse.
24. Weld plates for bulb tee girders shall be placed ± $^{1}/_{2}$-inch longitudinal and ± $^{1}/_{8}$-inch vertical.
25. Position of post-tensioning ducts at girder and CIP closure ends: ± $^{1}/_{4}$-inch.
26. Position of post tensioning ducts along segments of segmental prestressed concrete girders: ± $^{1}/_{4}$-inch.
27. Deviation from a smooth curve for post-tensioning ducts at closures based on the sum total of duct placement and alignment tolerances: ± $^{3}/_{8}$-inch.

6-02.3(25)J Horizontal Alignment

The Contractor shall check and record the horizontal alignment of both top and bottom flanges of each girder upon removal of the girder from the casting bed. The Contractor shall also check and record the horizontal alignment within a two-week period prior to shipment, but no less than three days prior to shipment. If the girder remains in storage for a period exceeding 120 days, the Contractor shall check and record the horizontal alignment at approximately 120 days. Each check shall be made by measuring the distance between each flange and a chord that extends the full length of the girder. The Contractor shall perform and record each check at a time when the alignment of the girder is not influenced by temporary differences in surface temperature. These records shall be available for the Engineer's inspection and included in the Contractor's Prestressed Concrete Certificate of Compliance.

Immediately after the girder is removed from the casting bed, neither flange shall be offset more than $^1/_8$-inch for each 10-feet of girder length. During storage and prior to shipping, the offset (with girder ends plumb and upright and with no external force) shall not exceed $^1/_4$-inch per 10-feet of girder length. Any girder within this tolerance may be shipped, but must be corrected at the job site to the $^1/_8$-inch maximum offset per 10-feet of girder length before concrete is placed into the diaphragms.

The Engineer may permit the use of external force to correct girder alignment at the plant or job site if the Contractor provides stress calculations and a proposed procedure. If external force is permitted, it shall not be released until after the roadway slab has been placed and cured ten days.

The maximum deviation of the side of the precast prestressed slab, or the edge of the roadway deck slab of the deck double tee girder or the precast prestressed ribbed section, measured from a chord that extends end to end of the member, shall be ± $^1/_8$-inch per 10-feet of member length, but not greater than $^1/_2$-inch total.

A final alignment check shall be performed within three days prior to shipment to the jobsite. All precast prestressed members which exceed the specified horizontal alignment tolerance may be subject to rejection.

6-02.3(25)K Girder Deflection

The Contractor shall check and record the vertical deflection (camber) of each girder upon removal of the girder from the casting bed. If the girder remains in storage for a period exceeding 120 days, the Contractor shall check and record the vertical deflection (camber) within a two-week period prior to shipment, but no less than three days prior to shipment. The Contractor shall perform and record each check at a time when the alignment of the girder is not influenced by temporary differences in surface temperature. These records shall be available for the Engineer's inspection, and in the case of girders older than 120 days, shall be transmitted to the Engineer as soon as practical for evaluation of the effect of long-term storage on the "D" dimension. These records shall also be included in the Contractor's Prestressed Concrete Certificate of Compliance.

The "D" dimensions shown in the Plans are computed girder deflections at midspan based on a time lapse of 40 and 120 days after release of the prestressing strands. A positive (+) "D" dimension indicates upward deflection.

The Contractor shall control the deflection of prestressed concrete girders that are to receive a cast-in-place slab by scheduling fabrication between 40 and 120 days of girder erection.

If it is anticipated that the girders will be older than 120 days at the time of erection, the Contractor shall submit calculations to the Engineer showing the estimated girder deflection at midspan at the age anticipated for erection. This submittal shall also include the Contractor's proposal for accommodating any excess camber in the construction. The Contractor shall not proceed with girder fabrication until this submittal is approved by the Engineer. The actual girder deflection at the midspan may vary from the "D" dimension at the time of slab forming by a maximum of plus $^1/_2$-inch for girder lengths up to 80-feet, and plus 1-inch for girder lengths over 80-feet, but less than or equal to 140-feet, and plus $1^1/_2$-inches for girder lengths over 140-feet.

All costs, including roadway slab form adjustments required to maintain specified steel reinforcing bar clearances and deck profiles, and any additional Contracting Agency engineering expenses, in connection with accommodating excess girder deflection shall be at the Contractor's expense.

6-02.3(25)L Handling and Storage

During handling and storage, each girder shall always be kept plumb and upright, and each precast prestressed member and prestressed concrete tub girder shall always be kept in the horizontal position as shown in the Plans. It shall be lifted only by the lifting devices (strand lift loops or high-strength threaded steel bars) at either end. For strand lift loops, a minimum 2-inch diameter straight pin of a shackle shall be used through the loops. For high-strength threaded steel bars, the lifting hardware that connects to the bars shall be designed, detailed, and furnished by the Contractor. Series W42G, WF42G, W50G, WF50G, W58G, and WF58G girders, and Series W32BTG, W38BTG, W62BTG, and W74G girders up to 145-feet in length, can be picked up at a minimum angle of 60 degrees from the top of the girder. All other prestressed girders shall be picked up within 10 degrees of perpendicular to the top of the girder.

For some girders, straight temporary top flange strands may be specified in the Plans. Pretensioned top temporary strands for full length prestressed concrete girders shall be unbonded over all but the end 10-feet of the girder length. As an alternative for full length prestressed concrete girders, temporary top strands may be post-tensioned prior to shipment. When temporary top strands are specified for spliced prestressed concrete girders, the temporary top strands shall be post-tensioned prior to lifting the assembled girder. When the post-tensioned alternative is used, the Contractor shall be responsible for properly sizing the anchorage plates, and the reinforcement adjacent to the anchorage plates, to prevent bursting or splitting of the concrete in the top flange. Temporary strands shall be cut or released in accordance with Section 6-02.3(25)N.

The Contractor may request permission to use lifting devices, lifting device locations, lifting angles, concrete release strengths, or temporary top strand configurations other than specified in the Plans. The number of temporary top strands may be increased from the number shown in the Plans but shall not be decreased. The request, including calculations showing the adequacy of the proposed lifting method, shall be submitted to the Engineer for approval in accordance with Section 6-01.9. The Contractor's analysis shall conform to Article 5.2.9 of the *PCI Design Handbook, Precast and Prestressed Concrete*, Fifth Edition, or other approved methods. The Contractor's calculations shall verify that the concrete stresses in the prestressed girder do not exceed those listed in Section 6-02.3(25)M. The Contractor shall not begin girder lifting operations under the provisions of the lifting method submittal until receiving the Engineer's written approval of the submittal, and shall perform the girder lifting operations at no additional expense to the Contracting Agency.

If girders are to be stored, the Contractor shall place them on a stable foundation that will keep them in a vertical position. Stored girders shall be supported at the bearing recesses or, if there are no recesses, approximately 18-inches from the girder ends. After prestressing, precast prestressed members shall be supported at points between 1′-0" and 2′-0" from the member ends. After post-tensioning, segmental prestressed concrete girders shall be supported at points between 2′-0" and 5′-0" from the girder ends, unless otherwise shown in the Plans. For long-term storage of girders with initial horizontal curvature, the Contractor may wedge one side of the bottom flange, tilting the girders to control curvature. If the Contractor elects to set girders out of plumb during storage, the Contractor shall have the proposed method analyzed by the Contractor's engineer to ensure against damaging the girder.

6-02.3(25)M Shipping

After the girder has reached its 28-day design strength, and the fabricator believes it to comply with the specification, the girder and a completed Certification of Compliance, signed by a Precast/Prestressed Concrete Institute Certified Technician or a professional engineer, acceptable to the Contracting Agency, shall be submitted to the Engineer for inspection. If the Engineer finds the certification and the girder to be acceptable, the Engineer will stamp the girder "Approved for Shipment."

No double tee girder, deck double tee girder, precast prestressed slab or precast prestressed ribbed section shall be shipped for at least three days after concrete placement. No deck bulb tee girder or prestressed concrete tub girder shall be shipped for at least seven days after concrete placement, except that deck bulb tee girders or prestressed concrete tub girders may be shipped three days after concrete placement when L/(bd) is less than or equal to 5.0, where L equals the shipping length of the girder, b equals the girder top flange width (for deck bulb tee girders) or the bottom flange width (for prestressed concrete tub girders), and d equals the girder depth, all in feet. No other girder shall be shipped for at least ten days after concrete placement.

Girder support during shipping shall be located as follows unless otherwise shown in the Plans:

Type of Girder	Centerline Support Within This Distance From Either End
Precast Prestressed Members	2-feet
Series W42G, WF42G, W50G and WF50G	3-feet
All bulb tee and deck bulb tee girders, except as noted	3-feet
Series W58G, WF58G, and W62BTG	4-feet
Series W74G and WF74G	5-feet
Series W83G and W95G	8-feet
Series WF74PTG, W83PTG, and W95PTG segments	8-feet
Prestressed concrete tub girder segment	4-feet

The Contractor may request permission to use support locations other than those specified. The Contractor shall submit the support location modification proposal, with supporting calculations, to the Engineer for approval in accordance with Section 6-01.9. If the support locations are moved closer to the lateral ends of the girders, the calculations shall demonstrate adequate control of lateral bending during shipping. The calculations shall also show that concrete stresses in the girders will not exceed those listed below.

If the Contractor elects to assemble spliced prestressed concrete girders into components of two or more segments prior to shipment, the Contractor shall submit shipment support location working drawings with supporting calculations to the Engineer in accordance with Section 6-01.9. The calculations shall show that concrete stresses in the assembled girders will not exceed those listed below.

Lateral bracing for shipping is not required for prestressed concrete tub girders and precast prestressed members. Other prestressed concrete girders of lengths equal or shorter than the following will not require lateral bracing for shipping:

Type of Girder	Maximum Length Not Requiring Bracing for Shipping
Series W42G, WF42G, W32BTG, and W38BTG	80-feet
Series W50G and WF50G	100-feet
Series W58G, WF58G, and W62BTG	105-feet
All deck bulb tee girders	120-feet
Series W74G and WF74G	130-feet

For all girders exceeding these lengths, and all Series WF74PTG, W83G, W83PTG, W95G, and W95PTG girders, the Contractor shall provide bracing to control lateral bending during shipping, unless the Contractor furnishes calculations in accordance with Section 6-01.9 demonstrating that bracing is not necessary. External bracing shall be attached securely to the top flange of the girder. The Contractor is cautioned that more conservation guidelines for lateral bracing may be required for some delivery routes. The Contractor shall submit a bracing plan, with supporting calculations, to the Engineer for approval in accordance with Section 6-01.9. The Contractor shall not begin shipping the girders until receiving the Engineer's approval of the bracing plan, and shall perform all bracing operations at no additional cost to the Contracting Agency.

Criteria for Checking Girder Stresses

At the Time of Lifting or Transporting and Erecting

Stresses at both support and harping points shall be satisfied based on these criteria:

1. Allowable compression stress, fc = 0.60f'cm
   a. f'cm = compressive strength at time of lifting or transporting verified by test but shall not exceed design compressive strength (f'c) at 28 days in psi + 1,000 psi
2. Allowable tension stress, ksi
   a. With no bonded reinforcement = 3 times square root (f'cm) ≤ 0.20 ksi
   b. With bonded reinforcement to resist total tension force in the concrete computed on the basis of an uncracked section 6.0 times square root (f'cm). The allowable tensile stress in the reinforcement is 30 ksi (AASHTO M-31, Gr. 60)
3. Prestress losses
   a. 1 day to 1 month = computed losses
   b. 1 month to 1 year = 75 percent of computed final losses
   c. 1 year or more = computed final losses
4. Impact on dead load
   a. Lifting from casting beds = 0 percent
   b. Transporting and erecting = 20 percent

6-02.3(25)N Prestressed Concrete Girder Erection

Before beginning to erect any prestressed concrete girders, the Contractor shall submit to the Engineer for review and shall have received approval for the erection plan and procedure describing the methods the Contractor intends to use. The erection plan and procedure shall provide complete details of the erection process including but not limited to:

1. Temporary falsework support, bracing, guys, deadmen, and attachments to other structure components or objects;
2. Procedure and sequence of operation;
3. Girder stresses during progressive stages of erection;
4. Girder weights, lift points, lifting devices, spreaders, and angle of lifting cables in accordance with Section 6-02.3(25)L, etc.;
5. Crane(s) make and model, mass, geometry, lift capacity, outrigger size and reactions;
6. Girder launcher or trolley details and capacity (if intended for use); and
7. Locations of cranes, barges, trucks delivering girders, and the location of cranes and outriggers relative to other structures, including retaining walls and wing walls.

The erection plan shall include drawings, notes, catalog cuts, and calculations clearly showing the above listed details, assumptions, and dimensions. Material properties and specifications, structural analysis, and any other data used shall also be included. The plan shall be prepared by (or under the direct supervision of) a Professional Engineer, licensed under Title 18 RCW, State of Washington, in the branch of Civil or Structural, and shall carry the engineer's seal and signature, in accordance with Section 6-02.3(16).

The Contractor shall submit the erection plans, calculations, and procedure directly to the Bridge and Structures Office, Construction Support Engineer, in accordance with Section 6-02.3(16). After the plan is approved and returned to the Contractor, all changes that the Contractor proposes shall be submitted to the Engineer for review and approval.

When prestressed girders arrive on the project, the Project Engineer will confirm that they are stamped "Approved for Shipment" and that they have not been damaged in shipment before accepting them.

The concrete in piers and crossbeams shall reach at least 80 percent of design strength before girders are placed on them. The Contractor shall hoist girders only by the lifting devices at the ends, always keeping the girders plumb and upright. Once erected, the girders shall be braced to prevent tipping until the intermediate diaphragms are cast and cured. **When temporary strands in the top flange are used, they shall be cut after the girders are braced and before the intermediate diaphragms are cast**. The Contractor shall place the cast-in-place deck on the girders within 30 calendar days of cutting the temporary strands, except as otherwise approved by the Engineer.

For situations where the Contractor proposes to delay placing the cast-in-place deck on the girders beyond 30 calendar days after cutting the temporary strands, the Contractor shall submit supporting girder camber calculations to the Engineer for approval in accordance with Section 6-01.9. The Contractor shall not cut the temporary strands until receiving the Engineer's approval of the girder camber calculations.

Instead of the oak block wedges shown in the Plans, the Contractor may use Douglas fir blocks if the grain is vertical.

The Contractor shall check the horizontal alignment of both the top and bottom flanges of each girder after girder erection but before placing concrete in the bridge diaphragms as described in Section 6-02.3(25)J.

The Contractor shall fill all block-out holes and patch any damaged area caused by the Contractor's operation, with an approved mix, to the satisfaction of the Engineer.

For precast prestressed concrete slabs, the Contractor shall place the 1¼-inch diameter vertical dowel bars at the top of the pier walls as shown in the Plans. The Contractor shall either form the hole or core drill the hole following the alternatives shown in the Plans. The portion of the dowel bar in the top of the pier walls shall be set with either grout that complies with Section 9-26.3 or type II epoxy bonding agent conforming to Section 9-26.1 following placement of each precast prestressed slab.

6-02.3(25)O Deck Bulb Tee Girder Flange Connection

The Contractor shall submit a method of equalizing deck bulb tee girder (and precast prestressed member) deflections to the Engineer for approval in accordance with Section 6-01.9, except that the submittal shall be made a minimum of 60 days prior to field erection of the deck bulb tee girder. Deflection equalizing methods approved for previous Contracting Agency contracts will be acceptable providing the bridge configuration is similar and the previous method was satisfactory. A listing of the previous Contracting Agency contract numbers for which the method was used shall be included with the submittal. The weld-ties may be used as a component of the equalizing system provided the Contractor's procedure outlines how the weld-ties are to be used, and that the Contractor's submittal includes a list and description of previous bridge projects where the Contractor has successfully used weld-ties as a component of the equalizing system.

The concrete diaphragms for deck bulb tee girders shall attain a minimum compressive strength of 2,500 psi before any camber equalizing equipment is removed.

On deck bulb tee girders, girder deflection shall be equalized utilizing the approved method before girders are weld-tied and before keyways are filled. Keyways between tee girders shall be filled flush with the surrounding surfaces with nonshrink grout, except that keyways for deck bulb tee girders receiving a cast-in-place concrete deck slab need not be filled with grout. This nonshrink grout shall have a compressive strength of 5,000 psi before the equalizing equipment is removed. Compressive strength shall be determined by fabricating and testing cubes in accordance with WSDOT Test Method 813 and testing in accordance with WSDOT FOP for AASHTO T-106.

Welding ground shall be attached directly to the steel plates being welded when welding the weld-ties on bulb tee girders.

No construction equipment shall be placed on the structure, other than equalizing equipment, until the girders have been weld-tied and the keyway grout has attained a compressive strength of 5,000 psi.

6-02.3(26) Cast-in-Place Prestressed Concrete

Unless otherwise shown in the Plans, concrete for cast-in-place prestressed bridge members shall be Class 4000D in the roadway deck, and Class 4000 at all other locations. Air entrainment shall conform to Sections 6-02.3(2)A and 6-02.3(3).

The Contractor shall construct supporting falsework in a way that leaves the superstructure free to contract and lift off the falsework during post-tensioning. Forms that will remain inside box girders to support the roadway slab shall, by design, resist girder contraction as little as possible.

Before tensioning, the Contractor shall remove all side forms from girders. From this point until 48 hours after grouting the tendons, the Contractor shall keep all construction and other live loads off the superstructure and shall keep the falsework supporting the superstructure in place.

Once the prestressing steel is installed, no welds or welding grounds shall be attached to metal forms, structural steel, or reinforcing bars of the structural member.

The Contractor shall not stress the strands until all concrete has reached a compressive strength of at least 4,000 psi (or the strength shown in the Plans). This strength shall be measured on concrete test cylinders made of the same concrete cured under the same conditions as the cast-in-place unit.

All post-tensioning shall be completed before sidewalks and barriers are placed.

6-02.3(26)A Shop Drawings

Before casting the structural elements, the Contractor shall submit:

1. Seven sets of shop drawings for approval by the Bridge and Structures Engineer.

   US Postal Service:

   Washington State Department of Transportation
   Bridge and Structures Engineer
   Construction Support
   PO Box 47340
   Olympia, WA 98504-7340

   FedEx:

   Washington State Department of Transportation
   Bridge and Structures Engineer
   Construction Support
   4500 3rd Avenue SE
   Lacey, WA 98503

2. Two sets of shop drawings to the Project Engineer.

These shop drawings shall show complete details of the methods, materials, and equipment the Contractor proposes to use in prestressing work. The shop drawings shall follow the design conditions shown in the Plans unless the Engineer permits equally effective variations.

In addition, the shop drawings shall show:

1. The method and sequence of stressing.
2. Technical data on tendons and steel reinforcement, anchoring devices, anchoring stresses, types of tendon conduit, and all other data on prestressing operations.
3. Stress and elongation calculations. Separate stress and elongation calculations shall be submitted for each tendon if the difference in tendon elongations exceeds 2 percent.
4. That tendons in the bridge will be arranged to locate their center of gravity as the Plans require.
5. Details of additional or modified reinforcing steel required by the stressing system.
6. Procedures and lift-off forces at both ends of the tendon for performing a force verification lift-off in the event of discrepancies between measured and calculated elongations.

Couplings or splices will not be permitted in prestressing strands. Couplings or splices in bar tendons are subject to the Engineer's approval.

Friction losses used to calculate forces of the post-tensioning steel shall be based on the assumed values used for the design. The assumed anchor set, friction coefficient "μ", and friction wobble coefficient "k" values for design are shown in the Plans. The post-tensioning supplier may revise the assumed anchor set value provided all the stress and force limits listed in Section 6-02.3(26)E are met.

The Contractor shall determine all points of interference between the mild steel reinforcement and the paths of the post-tensioning tendons. Details to resolve interferences shall be submitted with the shop drawings for approval. Where reinforcing bar placement conflicts with post-tensioning tendon placement, the tendon profile shown in the Plans shall be maintained. Mild steel reinforcement for post-tensioning anchorage zones shall not be fabricated until after the post-tensioning shop drawings have been approved by the Engineer.

Approval of these shop drawings will mean only that the Engineer considers them to show a reasonable approach in enough detail. Approval will not indicate a check on dimensions.

The Contractor may deviate from the approved shop drawings only after obtaining the Engineer's approval of a written request that describes the proposed changes. Approval of a change in method, material, or equipment shall not relieve the Contractor of any responsibility for completing the work successfully.

Before physical completion of the project, the Contractor shall provide the Engineer with reproducible originals of the shop drawings (and any approved changes). These shall be clear, suitable for microfilming, and on permanent sheets that measure no smaller than 11 by 17-inches. Alternatively, the shop drawings may be provided in an electronic format with the approval of the Bridge and Structures Engineer.

6-02.3(26)B General Requirements for Anchorages

Post-tensioning reinforcement shall be secured at each end by means of an approved anchorage device, which shall not kink, neck down, or otherwise damage the post-tensioning reinforcement. The anchorage assembly shall be grouted to the Engineer's satisfaction.

The structure shall be reinforced with steel reinforcing bars in the vicinity of the anchorage device. This reinforcement shall be categorized into two zones. The first or local zone shall be the anchorage region that closely surrounds the specific anchorage device. The second or general zone shall be the portion of the anchorage region more remote from the immediate anchorage device.

The steel reinforcing bars required locally for the concrete confinement immediately around the anchorage device (first or local zone) shall be calculated by the post-tensioning system supplier and shall be shown in the shop drawings. The calculations shall be submitted with the shop drawings. The first or local zone steel reinforcing bars shall be furnished and installed by the Contractor, at no additional cost to the Contracting Agency, in addition to the structural reinforcement required by the Plans. The steel reinforcing bars required in the second or general zone shall be as shown in the Plans and are included in the appropriate bid items.

The Contractor shall submit details, certified test reports, and/or supporting calculations, as specified below, which verify the structural adequacy of the anchorage devices for approval by the Engineer. This requirement does not apply where the anchorage devices have been previously approved by the Contracting Agency for the same structure configuration. The Contractor shall also submit any necessary changes to the Contract Plans. The test report shall specify all pertinent test data.

Dead ended anchorages will not be permitted. Dead ended anchorages are defined as anchorages that cannot be accessed during the stressing operations.

Materials and workmanship shall conform to the applicable requirements of Sections 6-03 and 9-06.

Before installing the anchorage device, the Contractor shall submit to the Engineer a Manufacturer's Certificate of Compliance in accordance with Section 1-06.3.

The Contractor's proposed anchorage devices shall meet the requirements listed in either Sections 6-02.3(26)C or 6-02.3(26)D.

6-02.3(26)C Bearing Type Anchorages

Bearing type anchorages shall conform to the following requirements:

1. The allowable bearing stress under P_{jack} prior to seating shall be taken:
   a. If $\rho_s = 0$ percent then $f_{cpi} = 0.5\ f'_{ci}\ (A/A_g)^{1/2} < f'_{ci}$
   b. If $\rho_s \geq 2$ percent then $f_{cpi} = 0.75\ f'_{ci}\ (A/A_g)^{1/2} < 1.5\ f'_{ci}$

   For ρ_s between 0 percent and 2 percent the allowable bearing stress may be linearly interpolated.

   For lightweight concrete the allowable bearing stress shall be reduced by 20 percent.
2. The average concrete bearing stress on the net bearing area at the time of jacking shall not exceed:

   $f_{bi} = P_{jack}/A_{net} < f_{cpi}$
3. The bending stress in bearing plate at P_{jack} shall not exceed:

   $f_s = 3f_{bi}\ (n/t)^2 < 0.8f_{sy}$

   with stiffness $n/t < 0.08\ (E_s/f_{bi})^{1/3}$
4. The allowable bearing stress between bearing plate and wedge plate at P_{jack} shall not exceed:

   $f_{sbi} < 1.5\ f_{sy}$

where:

P_{jack}	=	Jacking force, but not less than 80 percent MUTS
MUTS	=	Acronym for Minimum Ultimate Tensile Strength, MUTS is the force equal to the nominal cross sectional area of strand, or bar, times their nominal tensile stress
AUTS	=	Acronym for Actual Ultimate Tensile Strength, measured as a force
a_x	=	Dimension of distribution area in X direction
a_y	=	Dimension of distribution area in Y direction
$A = a_x\ a_y$	=	Distribution area within concrete support area
b_x	=	Dimension of bearing plate in X direction
b_y	=	Dimension of bearing plate in Y direction

A_b	=	Net bearing area
A_{net}	=	Net bearing plate area after deducting center hole area
$A_g = b_x\ b_y$	=	Gross bearing area
e_{max}, e_{min}	=	Maximum and minimum edge cover of bearing plate in distribution area
f'_{ci}	=	Compressive strength of concrete at time of initial stressing
f'_{cpi}	=	Permissible concrete compressive strength at time of jacking
f_{bi}	=	Average uniform concrete bearing stress under bearing plate prior to seating produced by P_{jack}
f'_c	=	Compressive strength of concrete at 28 days
f'_s	=	Bending stress in steel bearing plate
f_{sbi}	=	Allowable steel bearing stress under P_{jack} between wedge plate and bearing plate
f_{sy}	=	Yield strength of bearing plate or wedge plate material whichever is lower
n	=	Largest distance from outer edge of wedge plate to outer edge of bearing plate
ρ_s	=	Orthogonal reinforcement ratio in each of directions (vertical and horizontal) expressed as a percentage of distribution area
t	=	Thickness of bearing plate

5. The relationship between gross bearing plate area and distribution area shall satisfy the following conditions in the x and y direction:

   If $e_{min} > 0.5\ b$ then $a = 2b$

   If $e_{min} < 0.5\ b$ then $a = (b + 2\ e_{min})$

   but $e_{max} < 4\ e_{min}$

6. For transverse post-tensioning of roadway slabs, the bearing stress shall not exceed 0.9f'c at P_{jack} of all strands (before seating) or 4,000 psi at service load after all losses.

6-02.3(26)D Non-Bearing Type Anchorages

All anchorages that do not conform to Section 6-02.3(26)C shall be defined as non-bearing type anchorages. Except as allowed by Section 6-02.3(26)B, anchorages and post-tensioning systems with non-bearing type anchorages shall be qualified by test.

Anchorage Qualification Test

A minimum of three successful anchorage qualification tests are required for each tendon size. The materials for each qualification test shall be taken from different heats.

Test Block

The test block shall be a square or rectangular prism, depending on the shape of bearing plate. The test block shall conform to the following:

1. The test block width and depth in each direction shall be three inches plus the smaller of the following:
   a. Two times the minimum edge distance from the center of the bearing plate to the face of concrete.
   b. The minimum center-to-center spacing of the bearing plate
2. The length of a test block containing a single anchorage and local zone, loaded in a single machine, shall be at least two times the larger cross-sectional test block dimension.
3. The length of test block with an anchorage and local zone on either end, loaded by stressing a test tendon, shall be at least four times the larger cross-sectional test block dimension.
4. The first or local zone of reinforcement in the test block behind the anchorage for a distance equal to the largest of the two cross-sectional dimensions of the anchorage shall simulate the actual first or local zone of reinforcement used in the structure. For the remaining length of the test block, the reinforcement may be increased as required to prevent failure in that portion.
5. The concrete strength at the time of testing shall not exceed either the minimum strength specified for the system at the time of tensioning, nor 85 percent of the 28-day cylinder strength for normal weight concrete or 70 percent of the 28-day cylinder strength for lightweight concrete.

Test Procedure

The test force shall be applied to the wedge plate, or anchor nut, either in a testing apparatus or through an oversized tendon. The force shall be applied in stages to 40 percent and then to 80 percent of MUTS. At 40 percent MUTS, the force shall be held for 10 minutes to allow inspection for cracks. At 80 percent MUTS, the force shall be held for one hour. Thereafter the force shall be increased to at least 120 percent MUTS, and then either to failure or to the limit of testing equipment.

Acceptance Criteria

For forces up to 40 percent MUTS, the width of concrete cracks shall not exceed 0.002-inch.

After holding the force at 80 percent MUTS for one hour, the width of concrete cracks shall not exceed 0.01-inch.

The test block shall not fail prior to reaching 120 percent MUTS.

Post-Tensioning System Qualification Test

A minimum of one successful system qualification test for each tendon size is required for a representative full size tendon embedded in a concrete test block. The test shall establish that all tendon components, including the spiral, orthogonal, and surface steel reinforcing bars in the local zone, perform as required.

The test block shall conform to the requirements specified above for the anchorage qualification test.

The test procedure shall conform to the requirements specified above for the anchorage qualification test, except as noted. After the test force has been held at 80 percent MUTS for one hour, the force shall be increased to at least 95 percent MUTS.

The acceptance criteria shall be as specified above for the anchorage qualification test.

Wedge Plate Qualification Test

Wedge plates shall meet the following requirements. A minimum of three successful wedge plate tests, each from a different heat, for each tendon size are required:

1. After loading to 95 percent MUTS for the tendon and subsequent force release, the permanent deflection of the wedge plate's top surface shall not exceed $^1/_{600}$ of clear span. The load test shall be performed with the wedge plate support simulating conditions in the anchorage assembly. The force shall be applied by pulling on a sample tendon using the strand system wedges.
2. The wedge plate shall be tested to static load tests, or to the loading capacity of the testing equipment. The tests shall simulate actual tendon forces applied to the wedges. The failure force shall be at least 120 percent MUTS for the tendon.

6-02.3(26)E Ducts

Ducts shall be round, except that ducts for transverse post-tensioning of bridge deck slabs may be rectangular. Ducts shall conform to the following requirements for internal embedded installation and external exposed installation. Elliptical shaped duct may be used if approved by the Engineer.

Ducts for Internal Embedded Installation

For longitudinal tendons, the Contractor shall encase each tendon in a semi-rigid, galvanized, ferrous metal duct. Semi-rigid ducts shall be corrugated, and their minimum wall thickness shall be either 26 gage for ducts less than or equal to $2^5/_8$-inches in diameter, or 24 gage for ducts greater than $2^5/_8$-inches in diameter. For prestressing steel bars preassembled with their ducts, the minimum duct thickness shall be 31 gage. For transverse tendons, the Contractor shall encase each tendon in a rigid plastic duct. This duct shall maintain the required profile within a placement tolerance of plus or minus $^1/_4$-inch for longitudinal tendons and plus or minus $^1/_8$-inch for transverse slab tendons during all phases of the work. The ducts shall be completely sealed to keep out all mortar.

Each duct shall be located to place the tendon at the center of gravity alignment shown in the Plans. To keep friction losses to a minimum, the Contractor shall install ducts to the exact lines and grades shown in the Plans. Once in place, the ducts shall be tied firmly in position before they are covered with concrete. During concrete placement, the Contractor shall not displace or damage the ducts.

The ends of the ducts shall:

1. Permit free movement of anchorage devices, and
2. Remain covered after installation in the forms to keep out all water or debris.

The Contractor shall install vents at high points and drains at low points of the tendon profile (and at other places if the Plans require). Vents and drains shall be $^1/_2$-inch minimum diameter standard steel or polyethylene pipe. Vents shall point upward and remain closed until grouting begins. Drains shall point downward and remain open until grouting begins. Ends of steel vents and drains shall be removed 1-inch inside the concrete surface after grouting has been completed; polyethylene vents and drains may

be left flush to the surface unless otherwise directed by the Engineer. Conduit vents are not required for transverse post-tensioning ducts in the roadway slab unless specified in the Plans.

Immediately after any concrete placement, the Contractor shall force blasts of oil-free, compressed air through the ducts to break up and remove any mortar inside before it hardens. Before deck concrete is placed, the Contractor shall satisfy the Engineer that ducts are unobstructed and contain nothing that could interfere with tendon installation, tensioning, or grouting. If the tendons are in place, the Contractor shall show that they are free in the duct.

In temperatures below 32ºF, ducts shall be kept free from water to avoid damage from freezing.

Strand tendon duct shall have an inside cross-sectional area large enough to accomplish strand installation and grouting. The area of the duct shall be at least 2.5 times the net area of prestressing steel in the duct. The maximum duct diameter shall be $4^1/_2$-inches.

The inside diameter of bar tendon duct shall at least be $^1/_4$-inch larger than the bar diameter. At coupler locations the duct diameter shall at least be $^1/_4$-inch larger than the coupler diameter.

Ducts installed and cast into concrete prior to prestressing steel installation, shall be capable of withstanding at least 10-feet of concrete fluid pressure.

Ducts shall have adequate longitudinal bending stiffness for smooth, wobble free placement. A minimum of three successful duct qualification tests are required for each diameter and type of duct, as follows:

1. Ducts with diameters 2-inches and smaller shall not deflect more than 3-inches under its own weight, when a 10 foot. duct segment is supported at its ends.
2. Ducts larger than 2-inches in diameter shall not deflect more than 3-inches under its own weight, when a 20 foot duct segment is supported at its ends.
3. Duct shall not dent more than $^1/_8$-inch under a concentrated load of 100 pounds applied between corrugations by a #4 steel reinforcing bar.

When the duct must be bent in a tight radius, more flexible duct may be used, subject to the Engineer's approval.

Ducts for External Exposed Installation

Duct shall be high-density polyethylene (HDPE) conforming to ASTM D 3350. The cell classification for each property listed in Table 1 shall be as follow:

Property	Cell Classification
1	3 or 4
2	2, 3, or 4
3	4 or 5
4	4 or 5
5	2 or 3
6	2, 3, or 4

The color code shall be C.

Duct for external tendons, including their splices, shall be water tight, seamless or welded, and be capable of resisting at least 150-psi grout pressure.

Transition couplers between ducts shall conform to either the standard pressure ratings of ASTM D 3505 or the hydrostatic design stresses of ASTM F 714 at 73°F. The inside diameter through the coupled length shall not be less than that produced by the dimensional tolerances specified in ASTM D 3505.

Workers performing HDPE pipe welding shall have satisfactorily completed a certified HDPE pipe welding course and shall have a minimum of five years experience in welding HDPE pipe.

The Contractor shall submit the name and HDPE pipe welding work experience of each HDPE pipe welder proposed to perform this work in the project. The experience submittal for each HDPE pipe welder shall include:

The Engineer may require the HDPE pipe welder to demonstrate test HDPE pipe welding before receiving final approval.

1. The name of the pipe welder.
2. The name, date, and location of the certified HDPE pipe welding course, with the course completion certificate.
3. A list of at least three projects in the last five years where the pipe welder performed HDPE pipe welding, including:
   a. The project name and location, and date of construction.
   b. The Governmental Agency/Owner.
   c. The name, address, and phone number of the Governmental Agency/ Owner's representative.

The Contractor shall not begin HDPE pipe welding operations until receiving the Engineer's approval of the work experience submittal for each HDPE pipe welder performing HDPE pipe welding in the project.

Transitions

Transitions between ducts and wedge plates shall have adequate length to reduce the angle change effect on the performance of strand-wedge connection, friction loss at the anchorage, and fatigue strength of the post-tensioning reinforcement.

6-02.3(26)F Prestressing Reinforcement

All prestressing reinforcement strand shall comply with Section 9-07.10. They shall not be coupled or spliced. Tendon locations shown in the Plans indicate final positions after stressing (unless the Plans say otherwise). No tendon made of 7 wire strands shall contain more than 37 strands of $^1/_2$-inch diameter, or more than 27 strands of 0.6-inch diameter.

All prestressing reinforcement bar shall conform to Section 9-07.11. They shall not be coupled or spliced except as otherwise specified in the Plans or Special Provisions.

Prestressing reinforcement not conforming to either Section 9-07.10 or 9-07.11 will not be allowed except as otherwise noted. Such reinforcement may be used provided it is specifically allowed by the Plans or Special Provisions, it satisfies all material and performance criteria specified in the Plans or Special Provisions, and receives the Engineer's approval.

From the time prestressing reinforcement is manufactured until it is grouted or encased in concrete, the Contractor shall protect it from dirt, grease, rust, corrosives, and all physical damage. The Engineer will reject prestressing reinforcement that shows any sign of damage, rust, or corrosion. If the prestressing reinforcement will not be stressed and grouted for more that ten calendar days after it is placed in the ducts, the Contractor shall place an approved corrosion inhibitor in the ducts.

The feeding ends of the strand tendons shall be equipped with a bullet nosing or similar apparatus to facilitate strand tendon installation.

Strand tendons may be installed by pulling or pushing. Any equipment capable to performing the task may be used, provided it does not damage the strands and conforms to the following:

1. Pulling lines shall have a capacity of at least 2.5 times the dead weight of the tendons when used for essentially horizontal tendon installation.
2. Metal pushing wheels shall not be used.
3. Bullets for checking duct clearance prior to concreting shall be rigid and be $^1/_8$-inch smaller than the inside diameter of the duct. Bullets for checking duct after concreting shall be less than $^1/_4$-inch smaller than the inside diameter of the duct.

6-02.3(26)G Tensioning

Equipment for tensioning post-tensioning reinforcement shall meet the following requirements:

1. Stressing equipment shall be capable to produce a jacking force of at least 80 percent MUTS of the post-tensioning reinforcement.
2. Jacking force test capacity shall be at least 95 percent MUTS of the post-tensioning reinforcement.
3. Wedge seating methods shall assure uniform seating of wedge segments and uniform wedge seating losses on all strand tendons.
4. Accumulation of differential seating losses during tensioning cycling shall be prevented by proper devices.
5. Jacks used for stressing tendons less than 20-feet long shall have wedge power seating capability.

The Contractor shall not begin to tension the tendons until:

1. All concrete has reached a compressive strength of at least 4,000 psi or the strength specified in the Plans (demonstrated on test cylinders made of the same concrete cured under the same conditions as that in the bridge), and
2. The Engineer is satisfied that all strands are free in the ducts.

Tendons shall be tensioned to the values shown in the Plans (or approved shop drawings) with hydraulic jacks. When stressing from both ends of a tendon is specified, it need not be simultaneous unless otherwise specified in the Plans. The jacking sequence shall follow the approved shop drawings.

Each jack shall have a pressure gauge that will determine the load applied to the tendon. The gauge shall display pressure accurately and readably with a dial at least 6-inches in diameter or with a digital display. Each jack and its gauge shall be calibrated as a unit and shall be accompanied by a certified calibration chart. The Contractor shall provide one copy of this chart to the Engineer for use in monitoring. The cylinder extension during calibration shall be in approximately the position it will occupy at final jacking force.

All jacks and gauges must be recalibrated and recertified: (1) at least every 180 days, and (2) after any repair or adjustment. The Engineer may use pressure cells to check jacks, gauges, and calibration charts before and during tensioning.

These stress limits apply to all tendons (unless the Plans set other limits):

1. Maximum service load after all losses: 80 percent of the specified yield point stress of the steel.
2. Maximum tensile stress during jacking: 80 percent MUTS of the tendon.
3. Maximum initial stress at anchorage after seating: 70 percent MUTS of the tendon.

Tendons shall be anchored at initial stresses that will ultimately maintain service loads at least as great as the Plans require.

As stated in Section 6-02.3(26)A, the assumed design friction coefficient "μ" and wobble coefficient "k" shown in the Plans shall be used to calculate the stressing elongation. These coefficients may be revised by the post-tensioning supplier by the following method provided it is approved by the Engineer:

Early in the project, the post-tensioning supplier shall test, in place, two representative tendons of each size and type shown in the Plans, for the purpose of accurately determining the friction loss in a strand and/or bar tendon.

The test procedure shall consist of stressing the tendon at an anchor assembly with load cells at the dead end and jacking end. The test specimen shall be tensioned to 80 percent of ultimate in ten increments. For each increment, the gauge pressure, elongation, and load cell force shall be recorded and the data furnished to the Engineer. The theoretical elongations and post-tensioning forces shown on the post-tensioning shop drawings shall be re-evaluated by the post-tensioning supplier using the results of the tests and corrected as necessary. Revisions to the theoretical elongations shall be submitted to the Engineer for evaluation and approval. The apparatus and methods used to perform the tests shall be proposed by the post-tensioning supplier and be subject to the approval of the Engineer.

All costs associated with testing and evaluating test data shall be included in the unit contract prices for the applicable items of work involved.

As tensioning proceeds, the Engineer will be recording the applied load, tendon elongation, and anchorage seating values.

Elongation measurements shall be made at each stressing location to verify that the tendon force has been properly achieved. If proper anchor set has been achieved and the measured elongation of each strand tendon is within plus or minus 7 percent of the approved calculated elongation, the stressed tendon represented by the elongation measurements is acceptable to the Contracting Agency.

In the event discrepancies greater than 7 percent exist between the measured and calculated elongations, the jack calibration shall be checked and stressing records reviewed for any evidence of wire or strand breakage. If the jack if properly calibrated and there is no evidence of wire or strand breakage, a force verification lift off shall be performed to verify the force in the tendon. The post-tensioning supplier force verification lift off procedure shall provide access for visual verification of anchor plate lift off. The jacking equipment shall be capable of bridging and lifting off the anchor plate. The tendon is acceptable if the verification lift off force is not less than 99 percent of the approved calculated force nor more than 70 percent of the specified minimum ultimate tensile strength of the prestressing steel or as approved by the Engineer.

Elongation measurements shall be recorded for bar tendons to verify proper tensioning only. Acceptance will be by force verification lift off. The bar tendon is acceptable if the verification lift off force is not less than 95 percent nor more than 105 percent of the approved calculated force or as approved by the Engineer.

When removing the jacks, the Contractor shall relieve stresses gradually before cutting the prestressing reinforcement. The prestressing strands shall be cut a minimum of 1-inch from the face of the anchorage device.

6-02.3(26)H Grouting

After tensioning the tendons, the Contractor shall again blow oil-free, compressed air through each duct. All drains shall then be closed and the vents opened. Grout caps shall be installed at tendon ends prior to grouting. After completely filling the duct with grout, the Contractor shall pump the grout from the low end at a pressure of not more than 250 psig, except for transverse tendons in deck slabs the grout pressure shall not exceed 100 psig. Grout shall be continuously wasted through each vent until no more air or water pockets show. At this point, all vents shall be closed and grouting pressure at the injector held between 100 and 200 psig for at least 10 seconds, except for transverse tendons in deck slabs the grouting pressure shall be held between 50 and 75 psig for at least 10 seconds. The Contractor shall leave all plugs, caps, and valves in place and closed for at least 24 hours after grouting.

Grouting equipment shall:

1. Include a pressure gauge with an upper end readout of between 275 and 325 psig;
2. Screen the grout before it enters the pump with an easily reached screen that has clear openings of no more than 0.125-inches;
3. Be gravity fed from an attached, overhead hopper kept partly full during pumping; and
4. Be able to complete the largest tendon on the project in no more than 20 minutes of continuous grouting.

In addition, the Contractor shall have standby equipment (with a separate power source) available for flushing the grout when the regular equipment cannot maintain a one-way flow of grout. This standby equipment shall be able to pump at 250 psig.

The grout shall consist of Portland cement, water, and a water reducing admixture and shall be mixed in the following proportions:

Portland Cement Type I or II	1 Sack
Water	4.5 Gallons Maximum
Water Reducing Admixture	Manufacturer's Recommendation
Fly Ash (Optional)	20 Pounds Maximum

The water reducing admixture shall be limited to AASHTO M 194 Type A or D and shall not contain ingredients that may corrode steel (that is chlorides, fluorides, sulfates, or nitrates). Fly ash may be used at the option of the Contractor.

The Contractor shall proportion the mix to produce a grout with a flow of 11 to 20 seconds as determined by WSDOT Test Method for ASTM C 939, Flow of Grout for Preplaced Aggregate Concrete (Flow Cone Method).

The grout ejected from the end vent shall have a minimum flow of 11 seconds.

The grout mix shall be injected within 30 minutes after the water is added to the cement. Temperature of the surrounding concrete shall be at least 35ºF from the time the grout injecting begins until 2-inch cubes of the grout have a compressive strength of 800 psi. Cubes shall be made in accordance with WSDOT Test Method T 813 and stored in accordance with WSDOT FOP for AASHTO T 23. If ambient conditions are such that the surrounding concrete temperature may fall below 35ºF, the Contractor shall provide

a heat source and protective covering for the structure to keep the temperature of the surrounding concrete above 35ºF. Grout temperature shall not exceed 90ºF during mixing and pumping. If conditions are such that the temperature of the grout mix may exceed 90ºF, the Contractor will make necessary provisions, such as cooling the mix water and/or dry ingredients, to ensure that the temperature of the grout mix does not exceed 90ºF.

6-02.3(27) Concrete for Precast Units

Precast units shall not be removed from forms until the concrete has attained a minimum compressive strength of 70 percent of the specified design strength as verified by rebound number determined in accordance with WSDOT FOP for ASTM C 805.

Precast units shall not be shipped until the concrete has reached the specified design strength as determined by testing cylinders made from the same concrete as the precast units. The cylinders shall be made, handled, and stored in accordance with WSDOT FOP for AASHTO T 23 and compression tested in accordance with AASHTO Test Method T 22 and AASHTO Test Method T 231.

Self compacting concrete (SCC) may be used for precast concrete barrier covered under Section 6-10 and drainage items covered under Section 9-12. If self compacting concrete has been approved for use the requirements of Section 6-02.3(4)C consistency shall not apply. Self compacting concrete is concrete that is able to flow under its own weight and completely fill the formwork, even in the presence of dense reinforcement, without the need of any vibration, while maintaining homogeneity. When using SCC modified testing procedures for air content and compressive strength will be used. The modification shall be that molds will be filled completely in one continuous lift without any rodding, vibration, tamping or other consolidation methods other than lightly taping around the exterior of the mold with a rubber mallet to allow entrapped air bubbles to escape. In addition the fabricators QC testing shall include Slump Flow Test results, which do not indicate segregation. As part of the plants approval for use of SCC the plant fabricator shall cast one barrier, or drainage item and have that barrier or drainage item sawed in half for examination by the Contracting Agency to determine that segregation has not occurred.

6-02.3(28) Precast Concrete Panels

The Contractor shall perform quality control inspection. The manufacturing plant for precast concrete units shall be certified by the Precast/Prestressed Concrete Institute's Plant Certification Program for the type of precast member to be produced, or the National Precast Concrete Association's Plant Certification Program or be an International Congress Building Officials or International Code Council Evaluation Services recognized fabricator of structural precast concrete products, and shall be approved by WSDOT as a Certified Precast Concrete Fabricator prior to the start of production. WSDOT Certification will be granted at, and renewed during, the annual precast plant review and approval process. Products that shall conform to this requirement include noise barrier panels, wall panels, floor and roof panels, marine pier deck panels, retaining walls, pier caps, and bridge deck panels. Precast concrete units that are prestressed shall meet all the requirements of Section 6-02.3(25).

The Contracting Agency intends to perform Quality Assurance Inspection. By its inspection, the Contracting Agency intends only to facilitate the work and verify the quality of that work. This inspection shall not relieve the Contractor of any responsibility for identifying and replacing defective material and workmanship.

Prior to the start of production of the precast concrete units, the Contractor shall advise the Engineer of the production schedule. The Contractor shall give the Inspector safe and free access to the work. If the Inspector observes any nonspecification work or unacceptable quality control practices, the Inspector will advise the plant manager. If the corrective action is not acceptable to the Engineer, the unit(s) will be rejected.

6-02.3(28)A Shop Drawings

Before casting the structural elements, the Contractor shall submit:

1. Seven sets of shop drawings for approval by the Bridge and Structures Engineer, Department of Transportation, Transportation Building, Olympia, WA 98504; and
2. Two sets of shop drawings to the Project Engineer.

These shop drawings shall show complete details of the methods, materials, and equipment the Contractor proposes to use in prestressing/precasting work. The shop drawings shall follow the design conditions shown in the Plans unless the Engineer approves equally effective variations.

The shop drawings shall contain as a minimum:

1. Unit shapes (elevations and sections) and dimensions.
2. Finishes and method of constructing the finish (i.e., forming, rolling, etc.).
3. Reinforcing, joint, and connection details.
4. Lifting, bracing, and erection inserts.
5. Locations and details of hardware attached to the structure.
6. Relationship to adjacent material.

Approval of these shop drawings shall not relieve the Contractor of responsibility for accuracy of the drawings or conformity with the Contract. Approval will not indicate a check on dimensions.

The Contractor may deviate from the approved shop drawings only after obtaining the Engineer's approval of a written request that describes the proposed changes. Approval of a change in method, material, or equipment shall not relieve the Contractor of any responsibility for completing the work successfully.

Before completion of the Contract, the Contractor shall provide the Engineer with reproducible originals of the shop drawings (and any approved changes). These shall be clear, suitable for microfilming, and on permanent sheets that conform with the size requirements of Section 6-01.9.

6-02.3(28)B Casting

Before casting precast concrete units, the Contractor and Fabrication Inspector shall have possession of an approved set of shop drawings.

Concrete shall meet requirements of Section 6-02.3(25)B for annual pre-approval of the concrete mix design, and slump.

Precast units shall not be removed from forms until the concrete has attained a minimum compressive strength of 70 percent of the specified design strength. A minimum compressive strength at other than 70 percent may be used for specific precast units if the fabricator requests and receives approval as part of the WSDOT plant certification process.

Forms may be steel or plywood faced, providing they impart the required finish to the concrete.

6-02.3(28)C Curing

Concrete in the precast units shall be cured by either moist or accelerated curing methods. The methods to be used shall be preapproved in the WSDOT plant certification process.

1. For moist curing, the surface of the concrete shall be kept covered or moist until such time as the compressive strength of the concrete reaches the strength specified for stripping. Exposed surfaces shall be kept continually moist by fogging, spraying, or covering with moist burlap or cotton mats. Moist curing shall commence as soon as possible following completion of surface finishing.
2. For accelerated curing, heat shall be applied at a controlled rate following the initial set of concrete in combination with an effective method of supplying or retaining moisture. Moisture may be applied by a cover of moist burlap, cotton matting, or other effective means. Moisture may be retained by covering the unit with an impermeable sheet.

Heat may be radiant, convection, conducted steam or hot air. Heat the concrete to no more than 100ºF during the first two hours after pouring the concrete, and then increase no more than 25ºF per hour to a maximum of 175ºF. After curing is complete, cool the concrete no more than 25ºF per hour to 100ºF. Maintain the concrete temperature above 60ºF until the unit reaches stripping strength.

Concrete temperature shall be monitored by means of a thermocouple embedded in the concrete (linked with a thermometer accurate to plus or minus 5ºF). The recording sensor (accurate to plus or minus 5ºF) shall be arranged and calibrated to continuously record, date, and identify concrete temperature throughout the heating cycle. This temperature record shall be made available to the Engineer for inspection and become a part of the documentation required.

The Contractor shall never allow dry heat to directly touch exposed unit surfaces at any point.

6-02.3(28)D Contractors Control Strength

The concrete strength at stripping and the verification of design strength shall be determined by testing cylinders made from the same concrete as the precast units. The cylinders shall be made, handled, and stored in accordance with WSDOT FOP for AASHTO T 23 and compression tested in accordance with AASHTO Test Method T 22 and AASHTO Test Method T 231.

For accelerated cured units, concrete strength shall be measured on test cylinders cast from the same concrete as that in the unit. These cylinders shall be cured under time-temperature relationships and conditions that simulate those of the unit. If the forms are heated by steam or hot air, test cylinders will remain in the coolest zone throughout curing. If forms are heated another way, the Contractor shall provide a record of the curing time-temperature relationship for the cylinders for each unit to the Engineer. When two or more units are cast in a continuous line and in a continuous pour, a single set of test cylinders may represent all units provided the Contractor demonstrates uniformity of casting and curing to the satisfaction of the Engineer.

The Contractor shall mold, cure, and test enough of these cylinders to satisfy specification requirements for measuring concrete strength. The Contractor may use 4-inch by 8-inch or 6-inch by 12-inch cylinders. The Contractor shall let cylinders cool for at least one-half hour before testing for release strength.

Test cylinders may be cured in a moist room or water tank in accordance with WSDOT FOP for AASHTO T-23 after the unit concrete has obtained the required release strength. If, however, the Contractor intends to ship the unit prior to standard 28-day strength test, the design strength for shipping shall be determined from cylinders placed with the unit and cured under the same conditions as the unit. These cylinders may be placed in a noninsulated, moisture-proof envelope.

To measure concrete strength in the precast unit, the Contractor shall randomly select two test cylinders and average their compressive strengths. The compressive strength in either cylinder shall not fall more than 5 percent below the specified strength. If these two cylinders do not pass the test, two other cylinders shall be selected and tested.

6-02.3(28)E Finishing

The Contractor shall provide a finish on all relevant concrete surfaces as defined in Section 6-02.3(14), unless the Plans or Special Provisions require otherwise.

6-02.3(28)F Tolerances

The units shall be fabricated as shown in the Plans, and shall meet the dimensional tolerances listed in PCI MNL-116-85, unless otherwise required by the Plans or Special Provisions.

6-02.3(28)G Handling and Storage

The Contractor shall lift all units only by adequate devices at locations designated on the shop drawings. When these devices and locations are not shown in the Plans, Section 6-02.3(25)L shall apply.

Precast units shall be stored off the ground on foundations suitable to prevent differential settlement or twisting of the units. Stacked units shall be separated and supported by dunnage of uniform thickness capable of supporting the units. Dunnage shall be arranged in vertical planes. The upper units of a stacked tier shall not be used as storage areas for shorter units unless substantiated by engineering analysis and approved by the Engineer.

6-02.3(28)H Shipping

Precast units shall not be shipped until the concrete has reached the specified design strength, and the Engineer has reviewed the fabrication documentation for contract compliance and stamped the precast concrete units " Approved for Shipment". The units shall be supported in such a manner that they will not be damaged by anticipated impact on their dead load. Sufficient padding material shall be provided between tie chains and cables to prevent chipping or spalling of the concrete.

6-02.3(28)I Erection

When the precast units arrive on the project, the Project Engineer will confirm that they are stamped "Approved for Shipment." The Project Engineer will evaluate the present units for damage before accepting them.

The Contractor shall lift all units by suitable devices at locations designated on the shop drawings. Temporary shoring or bracing shall be provided, if necessary. Units shall be properly aligned and leveled as required by the Plans. Variations between adjacent units shall be leveled out by a method approved by the Engineer.

6-02.4 Measurement

Except as noted below, all classes of concrete shall be measured in place by the cubic yard to the neat lines of the structure as shown in the Plans.

Exception: concrete in cofferdam seals. Payment for Class 4000W concrete used in these seals will be based on the volume calculated using the neatline dimensions for the seal as shown in the contract plans. For calculated purposes, the horizontal dimension will be increased by 1 foot outside the seal neatline perimeter. The vertical dimension is the distance between the top and bottom neatline elevations. No payment will be made for any concrete that lies outside of these limits to accommodate the Contractor's cofferdam configuration. If the Engineer eliminates the seal in its entirety a contract change order will be issued.

Exception: concrete in a separate lump-sum, superstructure bid item. Any concrete quantities noted under this item in the Special Provisions will not be measured. Although the Special Provisions list approximate quantities for the Contractor's convenience, the Contracting Agency does not guarantee the accuracy of these estimates. Before submitting a bid, the Contractor shall have verified the quantities. Even though actual quantities used may vary from those listed in the Special Provisions, the Contracting Agency will not adjust the lump sum contract price for superstructure (except for approved changes).

The Contracting Agency will pay for no concrete placed below the established elevation of the bottom of any footing or seal.

Lean concrete will be measured by the cubic yard for the quantity of material placed per the producer's invoice, except that lean concrete included in other contract items will not be measured.

No deduction will be made for pile heads, reinforcing steel, structural steel, bolts, weep holes, rustications, chamfers, edgers, joint filler, junction boxes, miscellaneous hardware, ducts or less than 6-inch diameter drain pipes when computing concrete quantities for payment.

All reinforcing steel will be measured by the computed weight of all metal actually in place and required by the Plans or the Engineer. Epoxy-coated bars will be measured before coating. The Contractor shall furnish (without extra allowance):

1. Spreaders, form blocks, wire clips, and other fasteners.
2. Extra steel in splices not shown in the Plans.
3. Extra shear steel at construction joints not shown in the Plans when the Engineer permits such joints for the Contractor's convenience.

The following table shall be used to compute weight of reinforcing steel:

Steel Reinforcing Bar		
Deformed Bar Designation Number	**Nominal Diameter Inches**	**Unit Weight Pounds per Foot**
3	0.375	0.376
4	0.500	0.668
5	0.625	1.043
6	0.750	1.502
7	0.875	2.044
8	1.000	2.670
9	1.128	3.400
10	1.270	4.303
11	1.410	5.313
14	1.690	7.650
18	2.260	13.600

Gravel backfill will be measured as specified in Section 2-09.4.

6-02.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Conc. Class ____", per cubic yard.

"Commercial Concrete", per cubic yard.

All concrete, except in Superstructure when this is covered by a separate bid item, will be paid for at the unit contract price per cubic yard in place for the various classes of concrete.

"Superstructure (name bridge)", lump sum.

All costs in connection with providing holes for vents, for furnishing and installing cell drainage pipes for box girder structures, and furnishing and placing grout and shims under steel shoes shall be included in the unit contract prices for the various bid items involved.

All costs in connection with the construction of weep holes, including the gravel backfill for drains surrounding the weep holes except as provided in Section 2-09.4, shall be included by the Contractor in the unit contract price per cubic yard for "Conc. Class ____".

"Lean Concrete", per cubic yard.

Lean concrete, except when included in another bid item, will be paid for at the unit contract price per cubic yard.

"St. Reinf. Bar", per pound.

"Epoxy-Coated St. Reinf. Bar", per pound.

Payment for reinforcing steel shall include the cost of furnishing, fabricating, and placing the reinforcement. In structures of reinforced concrete where there are no structural steel bid items, such minor metal parts as expansion joints, bearing assemblies, and bolts will be paid for at the unit contract price for "Reinforcing Bar" unless otherwise specified.

"Gravel Backfill for Foundation Class A", per cubic yard.

"Gravel Backfill for Foundation Class B", per cubic yard.

"Gravel Backfill for Wall", per cubic yard.

"Deficient Strength Conc. Price Adjustment", by calculation.

"Deficient Strength Conc. Price Adjustment" will be calculated and paid for as described in Section 6-02.3(5)L. For the purpose of providing a common proposal for all bidders, the Contracting Agency has entered an amount for the item "Deficient Strength Conc. Price Adjustment" in the bid proposal to become a part of the total bid by the Contractor. The item "Deficient Strength Conc. Price Adjustment" covers all applicable classes of concrete.

6-03 STEEL STRUCTURES

6-03.1 Description

This work consists of furnishing, fabricating, erecting, cleaning, and painting steel structures and the structural steel parts of nonsteel structures

6-03.2 Materials

Materials shall meet the requirements of the following sections:

Structural Steel and Related Materials	9-06
Paints	9-08

Structural steel shall be classified as:

1. Structural carbon steel (to be used whenever the Plans do not specify another classification),
2. Structural low alloy steel, and
3. Structural high strength steel.

Unless the Plans or Special Provisions state otherwise, the following shall be classified as structural carbon steel: shims; ladders; stairways; anchor bolts and sleeves; pipe, fittings and fastenings used in handrails; and other metal parts, even if made of other materials, for which payment is not specified.

All AASHTO M 270 material used in what the Plans show as main load-carrying tension members or as tension components of flexural members shall meet the Charpy V-notch requirements of AASHTO M 270 temperature zone 2. All AASHTO M 270 material used in what the Plans show as fracture critical members shall meet the Charpy V-notch requirements of AASHTO M 270, Fracture Critical Impact Test Requirements, temperature zone 2. Charpy V-notch requirements for other steel materials shall be as specified in the Plans and Special Provisions.

The Contractor shall submit for the Engineer's approval a written plan for visibly marking the material so that it can be traced. These marks shall remain visible at least through the fit-up of the main load-carrying tension members. The marking method shall permit the Engineer to verify: (1) material specification designation, (2) heat number, and (3) material test reports to meet any special requirements.

For steel in main load-carrying tension members and in tension components of flexural members, the Contractor shall include the heat numbers on the reproducible copies of the as-built shop plans.

6-03.3 Construction Requirements

Structural steel fabricators of girders, floorbeams, truss members, and stringers, for permanent steel bridges, shall be certified under the AISC Quality Certification Program, Major Steel Bridges Category. When fracture critical members are specified in the contract, structural steel fabricators shall also have an endorsement F, Fracture Critical, under the AISC Quality Certification Program.

6-03.3(1) Vacant

6-03.3(2) Facilities for Inspection

The Contractor shall provide all facilities the Inspector requires to inspect material and workmanship. Inspectors shall be given safe and free access to all areas in the mill and shop.

6-03.3(3) Inspector's Authority

The Inspector may reject materials or workmanship that does not comply with these Specifications. In any dispute, the Contractor may appeal to the Engineer whose decision shall be final.

By its inspection at the mill and shop, the Contracting Agency intends only to facilitate the work and prevent errors. This inspection shall not relieve the Contractor of any responsibility for identifying and replacing defective material or workmanship.

6-03.3(4) Rejections

Even if the Inspector accepts materials or finished members, the Contracting Agency may later reject them if defective. The Contractor shall promptly replace or make good any rejected materials or workmanship.

6-03.3(5) Mill Orders and Shipping Statements

The Contractor shall furnish as many copies of mill orders and shipping statements as the Engineer requires.

6-03.3(6) Weighing

Structural steel need not be weighed unless the Plans or Special Provisions require it. When a weight is required, it may either be calculated or obtained by scales. The Contractor shall furnish as many copies of the calculations or weight slips as the Engineer requires. If scale weights are used, the Contractor shall record separately the weights of all tools, erection material, and dunnage.

6-03.3(7) Shop Plans

The Contractor shall submit for approval all shop detail plans for fabricating the steel. These shall be sent to the Bridge and Structures Engineer, Department of Transportation, Transportation Building, Olympia, WA 98504. If these plans will be submitted directly from the fabricator, the Contractor shall so notify the Project Engineer in writing.

Prints of the plans shall be supplied in these quantities:

1. Eight sets to the Bridge and Structures Engineer (four more sets are required for each affected railroad company on any grade separation structure that carries a railroad over a highway), and
2. Two sets to the Project Engineer.

The Bridge and Structures Engineer will return the plans to the Project Engineer, who will forward copies to the Contractor. If any sheets require correction, the Contractor shall correct and resubmit them in the quantities required above. No material shall be fabricated until: (1) the Bridge and Structures Engineer has approved the plans, and (2) the State Materials Engineer has approved the materials source and the fabricator.

In approving shop plans, the Contracting Agency accepts only the nature and scope of the details without validating any dimensions.

Unless the Engineer permits it in writing, no changes shall be made in any drawing after its approval.

Before physical completion of the project, the Contractor shall furnish the Project Engineer one set of reproducible copies of the as-built shop plans. (One more set is required for each affected railroad company on any grade separation structure that carries a railroad over a highway.) The reproducible copies shall be clear, suitable for microfilming, and on permanent sheets that measure no smaller than 11 by 17-inches. Alternatively, the shop drawings may be provided in an electronic format with the approval of the Bridge and Structures Engineer.

6-03.3(7)A Erection Methods

Before beginning to erect any steel structure, the Contractor shall submit to the Engineer for review and shall have received approval for the erection plan and procedure describing the methods the Contractor intends to use. The Contractor's erection plan and procedure shall be reviewed by the steel fabricator prior to being submitted to the Engineer. The Contractor shall submit evidence that the fabricator has reviewed the erection plans and procedure; and submit the fabricator's review comments to the Engineer along with the erection plan submittal.

The erection plan and procedure shall provide complete details of the erection process including but not limited to:

1. Temporary falsework support, bracing, guys, deadmen, and attachments to other structure components or objects;
2. Procedure and sequence of operation;
3. Girder stresses during progressive stages of erection;
4. Girder masses , lift points, and lifting devices, spreaders, glommers, etc.;
5. Crane(s) make and model, mass, geometry, lift capacity, outrigger size and reactions;
6. Girder launcher or trolley details and capacity (if intended for use); and
7. Locations of cranes, barges, trucks delivering girders, and the location of cranes and outriggers relative to other structures, including retaining walls and wing walls.

The erection plan shall include drawings, notes, catalog cuts, and calculations clearly showing the above listed details, assumptions, and dimensions. Material properties, specifications, structural analysis, and any other data used shall also be included. The plan shall be prepared by (or under the direct supervision of) a Professional Engineer, licensed under Title 18 RCW, State of Washington, in the branch of Civil or Structural, and shall carry the engineer's seal and signature, in accordance with Section 6-02.3(16).

The Contractor shall submit the erection plans, calculations, procedure, and fabricator's comments directly to the Bridge and Structures Office, Construction Support Engineer, in accordance with Section 6-02.3(16). After the plan is approved and returned to the Contractor, all changes that the Contractor proposes shall be submitted to the Project Engineer for review and approval.

6-03.3(8) Substitutions

The Contractor shall not substitute sections that differ from plan dimensions unless the Engineer approves in writing. If the Contractor requests and receives approval to substitute heavier members, the Contracting Agency shall not pay any added cost.

6-03.3(9) Handling, Storing, and Shipping of Materials

Markings applied at the mill shall distinguish structural low alloy steel from structural carbon steel. The fabricator shall keep the two classes of steel carefully separated.

Before fabrication, all material stored at the fabricating plant shall be protected from rust, dirt, oil, and other foreign matter. The Contracting Agency will accept no rust-pitted material.

After fabrication, all material awaiting shipment shall be subject to the same storage requirements as unfabricated material.

All structural steel shall arrive at the job in good condition. As the Engineer requires, steel damaged by salt water shipment shall be thoroughly cleaned by high pressure water flushing, chemical cleaning, or sandblasting, and repainted with the specified shop coat.

All material shall be stored so as to prevent rust and loss of small parts. Piled material shall not rest on the ground or in water but on skids or platforms.

The loading, transporting, unloading, and piling of the structural steel material shall be so conducted that the metal will be kept clean and free from injury from rough handling.

In field assembly of structural parts, the Contractor shall use methods and equipment not likely to twist, bend, deform, or otherwise injure the metal. Any member slightly bent or twisted shall be corrected before it is placed. The Contracting Agency will reject any member with serious handling damage.

Girder sections shall be handled so as to prevent damage to the girders. If necessary, the Contractor shall provide temporary stiffeners to prevent buckling during erection.

6-03.3(10) Straightening Bent Material

If the Engineer permits in writing, plates, angles, other shapes, and built-up members may be straightened. Straightening methods shall not fracture or injure the metal. Distorted members shall be straightened mechanically. A limited amount of localized heat may be applied only if carefully planned and supervised, and only if the Engineer has approved a heat-straightening procedure in writing.

Parts to be heat-straightened shall be nearly free from all stress and external forces except those that result from the mechanical pressure used with the heat.

After straightening, the Contractor will inspect the member for fractures using a method determined by the Contracting Agency.

The Contracting Agency will reject metal showing sharp kinks and bends.

The procedure for heat straightening of universal mill (UM) plates by the mill or the fabricator shall be submitted to the Engineer for approval.

6-03.3(11) Workmanship and Finish

Workmanship and finish shall be first-class, equaling the best practice in modern bridge fabrication shops. Welding, shearing, burning, chipping, and grinding shall be done neatly and accurately. All parts of the work exposed to view shall be neatly finished.

Wherever the Plans show a surface finish symbol, the surface shall be machined.

6-03.3(12) Falsework

All falsework shall meet the requirements of Section 6-02.

6-03.3(13) Fabricating Tension Members

Plates for main load-carrying tension members or tension components of flexural members shall be:

1. Blast cleaned entirely or blast cleaned on all areas within 2-inches of welds to SSPC-SP6, Commercial Blast Cleaning, and
2. Fabricated from plate stock with the primary rolling direction of the stock parallel to the length of the member.

6-03.3(14) Edge Finishing

All rolled, sheared, and thermal cut edges shall be true to line and free of rough corners and projections. Corners along exposed edges shall be rounded to a minimum radius of $^{1}/_{16}$-inch.

Sheared edges on plates more than $^{5}/_{8}$-inch thick shall be planed, milled, ground, or thermal cut to a depth of at least $^{1}/_{8}$-inch.

Re-entrant corners or cuts shall be filleted to a minimum radius of $^{3}/_{4}$-inch.

Exposed edges of main load-carrying tension members or tension components of flexural members shall have a surface roughness no greater than 250 micro-inches as defined by the American National Standards Institute, ANSI B46.1, Surface Texture. Exposed edges of other members shall have surface roughness no greater than 1,000 micro-inches.

The Rockwell hardness of thermal-cut edges of structural low alloy or high-strength steel flanges, as specified in Section 9-06.2 and 9-06.3, for main load-carrying tension members or tension components of flexural members shall not exceed RHC 30. The fabricator shall prevent excessive hardening of flange edges through preheating, post heating, or control of the burning process as recommended by the steel manufacturer and approved by the Engineer.

Hardness testing shall consist of testing thermal-cut edges with an approved portable hardness tester. The hardness tester, and it's operating test procedures, shall be submitted to the Engineer for approval prior to use. The hardness tester shall be convertible to Rockwell C scale values.

At two locations, two tests shall be performed on each thermal-cut edge, one each within $^{1}/_{4}$-inch of the top and bottom surfaces. The tests shall be located $^{1}/_{4}$-the length of each thermal-cut edge from each end of the cut. If one or more readings are greater than RHC 30, the entire length of the edge shall be ground or machined to a depth sufficient to provide acceptable readings upon further retests. If thermal-cutting operations conform to procedures approved by the Engineer, and hardness testing results are consistently within acceptable limits, the Engineer may approve a reduction in the testing frequency.

6-03.3(15) Planing of Bearing Surfaces

Ends of columns that bear on base and cap plates shall be milled to true surfaces and accurate bevels.

When assembled, caps and base plates of columns and the sole plates of girders and trusses shall have full contact. If warped or deformed, the plates shall be heat straightened, planed, or corrected in some other way to produce accurate, even contact. If necessary for proper contact, bearing surfaces that will contact other metal surfaces shall be planed or milled. Surfaces of warped or deformed base and sole plates that will contact masonry shall be rough finished.

On the surface of expansion bearings, the cut of the planer shall be in the direction of expansion.

6-03.3(16) Abutting Joints

Abutting ends of compression members shall be faced accurately so that they bear evenly when in the structure. On built-up members, the ends shall be faced or milled after fabrication.

Ends of tension members at splices shall be rough finished to produce neat, close joints. A contact fit is not required.

6-03.3(17) End Connection Angles

On floorbeams and stringers, end connection angles shall be flush with each other and set accurately in relationship to the position and length of the member. Unless the Plans require it, end connection angles shall not be finished. If, however, faulty assembly requires them to be milled, milling shall not reduce thickness by more than $^{1}/_{16}$-inch.

6-03.3(18) Built Members

The various pieces forming one built member shall be straight and close fitting, true to detailed dimensions, and free from twists, bends, open joints, or other defects.

When fabricating curved girders, localized heat or the use of mechanical force shall not be used to bend the girder flanges about an axis parallel to girder webs.

6-03.3(19) Hand Holes

Hand holes, whether punched or cut with burning torches, shall be true to sizes and shapes shown in the Plans. Edges shall be true to line and ground smooth.

6-03.3(20) Lacing Bars

Unless the Plans state otherwise, ends of lacing bars shall be neatly rounded.

6-03.3(21) Plate Girders

6-03.3(21)A Web Plates

If web plates are spliced, clearance between plate ends shall not exceed $^{3}/_{8}$-inch.

6-03.3(21)B Vacant

6-03.3(21)C Web Splices and Fillers

Web splice plates and fillers under stiffeners shall fit within $^{1}/_{8}$-inch at each end. In lieu of the steel material specified in the Plans or Special Provisions, the Contractor may substitute ASTM A 1008 or ASTM A 1011 steel for all filler plates less than $^{1}/_{4}$-inch thickness, provided that the grade of filler plate steel meets or exceeds that of the splice plates.

6-03.3(22) Eyebars

Eyebars shall be straight, true to size, and free from twists or folds in the neck or head and from any other defect that would reduce their strength. Heads shall be formed by upsetting, rolling, or forging. Dies in use by the manufacturer may determine the shape of bar heads if the Engineer approves. Head and neck thickness shall not overrun by more than $^{1}/_{16}$-inch. Welds shall not be made in the body or head of any bar.

Each eyebar shall be properly annealed and carefully straightened before it is bored. Pinholes shall be located on the centerline of each bar and in the center of its head. Holes in bar ends shall be so precisely located that in a pile of bars for the same truss panel the pins may be inserted completely without driving. All eyebars made for the same locations in trusses shall be interchangeable.

6-03.3(23) Annealing

All eyebars shall be annealed by being heated uniformly to the proper temperature, then cooled slowly and evenly in the furnace. At all stages, the temperature of the bars shall be under full control.

Slight bends on secondary steel members may be made without heat. Crimped web stiffeners need no annealing.

6-03.3(24) Pins and Rollers

Pins and rollers shall be made of the class of forged steel the Plans specify. They shall be turned accurately to detailed dimensions, smooth, straight, and flawless. The final surface shall be produced by a finishing cut.

Pins and rollers 9-inches or less in diameter may either be forged and annealed or made of cold-finished carbon steel shafting.

Pins more than 9-inches in diameter shall have holes at least 2-inches in diameter bored longitudinally through their centers. Pins with inner defects will be rejected.

The Contractor shall provide pilot and driving nuts for each size of pin unless the Plans state otherwise.

6-03.3(24)A Boring Pin Holes

Pin holes shall be bored true to detailed dimensions, smooth and straight, and at right angles to the axis of the member. Holes shall be parallel with each other unless the Plans state otherwise. A finishing cut shall always be made.

The distance between holes shall not vary from detailed dimensions by more than $^{1}/_{32}$-inch. In tension members, this distance shall be measured from outside to outside of holes; in compression members, inside to inside.

6-03.3(24)B Pin Clearances

Each pin shall be $^{1}/_{50}$-inch smaller in diameter than its hole. All pins shall be numbered after being fitted into their holes in the assembled member.

6-03.3(25) Welding and Repair Welding

Welding and repair welding of all steel bridges shall comply with the AASHTO/AWS D1.5M/D1.5:2002 Bridge Welding Code. Welding and repair welding for all other steel fabrication shall comply with the AWS D1.1/D1.1M, latest edition, Structural Welding Code. The requirements described in the remainder of this section shall prevail whenever they differ from either of the above welding codes.

The Contractor shall weld structural steel only to the extent shown in the Plans. No welding, including tack and temporary welds shall be done in the shop or field unless the location of the welds is shown on the approved shop drawings or approved by the Engineer in writing.

Welding procedures shall be submitted for approval with shop drawings . The procedures shall specify the type of equipment to be used, electrode selection, preheat requirements, base materials, and joint details. When the procedures are not prequalified by AWS or AASHTO, evidence of qualification tests shall be submitted.

Welding shall not begin until after the Contractor has received the Engineer's approval of shop plans as required in Section 6-03.3(7). These plans shall include procedures for welding, assembly, and any heat-straightening or heat-curving.

Any welded shear connector longer than 8-inches may be made of two shorter shear connectors joined with full-penetration welds.

In shielded metal-arc welding, the Contractor shall use low-hydrogen electrodes.

In submerged-arc welding, flux shall be oven-dried at 550ºF for at least 2-hours, then stored in ovens held at 250ºF or more. If not used within 4-hours after removal from a drying or storage oven, flux shall be redried before use.

Preheat and interpass temperatures shall conform to the applicable welding code as specified in this section. When welding main members of steel bridges, the minimum preheat shall not be less than 100ºF.

If groove welds (web-to-web or flange-to-flange) have been rejected, they may be repaired no more than twice. If a third failure occurs, the Contractor shall:

1. Trim the members, if the Engineer approves, at least $^{1}/_{2}$-inch on each side of the weld; or
2. Replace the members at no expense to the Contracting Agency.

By using extension bars and runoff plates, the Contractor shall terminate groove welds in a way that ensures the soundness of each weld to its ends. The bars and plates shall be removed after the weld is finished and cooled. The weld ends shall then be ground smooth and flush with the edges of abutting parts.

The Contractor shall not:

1. Weld with electrogas or electroslag methods,
2. Weld nor flame cut when the ambient temperature is below 20ºF, or
3. Use coped holes in the web for welding butt splices in the flanges unless the Plans show them.

6-03.3(25)A Welding Inspection

The Contractor's inspection procedures, techniques, methods, acceptance criteria, and inspector qualifications for welding of steel bridges shall be in accordance with the AASHTO/AWS D1.5M/D1.5:2002 Bridge Welding Code. The Contractor's inspection procedures, techniques, methods, acceptance criteria, and inspector qualifications for welding of steel structures other than steel bridges shall be in accordance with AWS D1.1/D1.1M, latest edition, Structural Welding Code. The requirements described in the remainder of this section shall prevail whenever they differ from either of the above welding codes.

Nondestructive testing in addition to visual inspection shall be performed by the Contractor. Unless otherwise shown in the Plans or specified in the Special Provisions, the extent of inspection shall be as specified in this section. Testing and inspection shall apply to welding performed in the shop and in the field.

Visual Inspection

All welds shall be 100 percent visually inspected. Visual inspection shall be performed before, during, and after the completion of welding.

Radiographic Inspection

Complete penetration tension groove welds in highway bridges shall be 100 percent radiographically inspected. These welds include those in the tension area of webs, where inspection shall cover the greater of these two distances: (a) 15-inches from the tension flange, or (b) one third of the web depth. In addition, edge blocks conforming to the requirements of AASHTO/AWS D1.5M/D1.5:2002 Structural Welding Code Section 6.10.14 shall be used for radiographic inspection.

Ultrasonic Inspection

Complete penetration groove welds on plates thicker than $^{5}/_{16}$-inch in the following welded assemblies or structures shall be 100 percent ultrasonically inspected:

1. Welded connections and splices in highway bridges and earth retaining structures, excluding longitudinal butt joint welds in beam or girder webs.
2. Bridge bearings and modular expansion joints.
3. Sign bridges, cantilever sign structures, and bridge mounted sign brackets excluding longitudinal butt joint welds in beams.
4. Light, signal, and strain pole standards.

The testing procedure and acceptance criteria for tubular members shall conform to the requirements of the AWS D1.1/D1.1M latest edition, Structural Welding Code.

Magnetic Particle Inspection

1. Fillet and partial penetration groove welds:

   At least 30 percent of each size and type of fillet welds (excluding intermittent fillet welds) and partial penetration groove welds in the following welded assemblies or structures shall be tested by the magnetic particle method:

   a. Flange-to-web connections in highway bridges.
   b. End and intermediate pier diaphragms in highway bridges.
   c. Stiffeners and connection plates in highway bridges.
   d. Welded connections and splices in earth retaining structures.
   e. Boxed members of trusses.
   f. Bridge bearings and modular expansion joints.
   g. Sign bridges, cantilever sign structures, and bridge mounted sign brackets.
   h. Light, signal, and strain pole standards.
2. Longitudinal butt joint welds in beam and girder webs:

   At least 30 percent of each longitudinal butt joint weld in the beam and girder webs shall be tested by the magnetic particle method.
3. Complete penetration groove welds on plates $^{5}/_{16}$-inch or thinner shall be 100 percent tested by the magnetic particle method. Testing shall apply to both sides of the weld, if backing plate is not used.
4. The ends of each complete penetration groove weld at plate edges shall be tested by the magnetic particle method.

Where 100 percent testing is not required, the Engineer reserves the right to select the location(s) for testing.

If rejectable flaws are found in any test length of weld in Item 1 or 2 above, the full length of the weld or 5-feet on each side of the test length, whichever is less, shall be tested.

After the Contractor's welding inspection is complete, the Contractor shall allow the Engineer sufficient time to perform quality assurance ultrasonic welding inspection.

The Contractor shall maintain the radiographs and the radiographic inspection report in the shop until the last joint to be radiographed in that member is accepted by the radiographer representing the Contractor. Within two working days following this acceptance, the Contractor shall mail the film and two copies of the radiographic inspection report to the Materials Engineer, Department of Transportation, PO Box 47365, Olympia, WA 98504-7365.

6-03.3(26) Screw Threads

Screw threads shall be U.S. Standard and shall fit closely in the nuts.

6-03.3(27) High Strength Bolt Holes

At the Contractor's option under the conditions described in this section, holes may be punched or subpunched and reamed, drilled or subdrilled and reamed, or formed by numerically controlled drilling operations.

The hole for each high strength bolt shall be $^{1}/_{16}$-inch larger than the nominal diameter of the bolt.

In fabricating any connection, the Contractor may subdrill or subpunch the holes then ream full size after assembly or drill holes full size from the solid with all thicknesses of material shop assembled in the proper position. If the Contractor chooses not to use either of these methods, then the following shall apply:

1. Drill bolt holes in steel splice plates full size using steel templates.
2. Drill bolt holes in the main members of trusses, arches, continuous beam spans, bents, towers, plate girders, box girders, and rigid frames at all connections as follows:
   a. A minimum of 30 percent of the holes in one side of the connection shall be made full size using steel templates.
   b. A minimum of 30 percent of the holes in the second side shall be made full size assembled in the shop.
   c. All remaining holes may be made full size in unassembled members using steel templates.
3. Drill bolt holes in crossframes, gussets, lateral braces, and other secondary members full size using steel templates.

The Contractor shall submit for the Engineer's approval a detailed outline of the procedures proposed to accomplish the work from initial drilling through shop assembly.

6-03.3(27)A Punched Holes

For punched holes, die diameter shall not exceed punch diameter by more than $^{1}/_{16}$-inch. Any hole requiring enlargement to admit the bolt shall be reamed. All holes shall be cut clean with no torn or ragged edges. The Contracting Agency will reject components having poorly matched holes.

6-03.3(27)B Reamed and Drilled Holes

Reaming and drilling shall be done with short taper reamers or twist drills, producing cylindrical holes perpendicular to the member. Reamers and drills shall be directed mechanically, not hand-held. Connecting parts that require reamed or drilled holes shall be assembled and held securely as the holes are formed, then match-marked before disassembly. The Contractor shall provide the Engineer a diagram showing these match-marks. The Contracting Agency will reject components having poorly matched holes.

Burrs on outside surfaces shall be removed. If the Engineer requires, the Contractor shall disassemble parts to remove burrs.

If templates are used to ream or drill full-size connection holes, the templates shall be positioned and angled with extreme care and bolted firmly in place. Templates for reaming or drilling matching members or the opposite faces of one member shall be duplicates. All splice components shall be match-marked unless otherwise approved by the Engineer.

6-03.3(27)C Numerically Controlled Drilled Connections

In forming any hole described in Section 6-03.3(27), the fabricator may use numerically controlled (N/C) drilling or punching equipment if it meets the requirements in this subsection.

The Contractor shall submit for approval a detailed outline of proposed N/C procedures. This outline shall:

1. Cover all steps from initial drilling or punching through check assembly;
2. Include the specific members of the structure to be drilled or punched, hole sizes, locations of the common index and other reference points, makeup of check assemblies, and all other information needed to describe the process fully.

N/C holes may be drilled or punched to size through individual pieces, or may be drilled through any combination of tightly clamped pieces.

When the Engineer requires, the Contractor shall demonstrate that the N/C procedure consistently produces holes and connections meeting the requirements of these Specifications.

6-03.3(27)D Accuracy of Punched, Subpunched, and Subdrilled Holes

After shop assembly and before reaming, all punched, subpunched, and subdrilled holes shall meet the following standard of accuracy. At least 75 percent of the holes in each connection shall permit the passage of a cylindrical pin $^1/_8$-inch smaller in diameter than nominal hole size. This pin shall pass through at right angles to the face of the member without drifting. All holes shall permit passage of a pin $^3/_{16}$-inch smaller in diameter than nominal hole size. The Contracting Agency will reject any pieces that fail to meet these standards.

6-03.3(27)E Accuracy of Reamed and Drilled Holes

At least 85 percent of all holes in a connection of reamed or drilled holes shall show no offset greater than $^1/_{32}$-inch between adjacent thicknesses of metal. No hole shall have an offset greater than $^1/_{16}$-inch.

Centerlines from the connection shall be inscribed on the template and holes shall be located from these centerlines. Centerlines shall also be used for accurately locating the template relative to the milled or scribed ends of the members.

Templates shall have hardened steel bushing inserted into each hole. These bushings may be omitted, however, if the fabricator satisfies the Engineer (1) that the template will be used no more than 5 times, and (2) that use will produce no template wear.

Each template shall be at least $^1/_2$-inch thick. If necessary, thicker templates shall be used to prevent buckling and misalignment as holes are formed.

6-03.3(27)F Fitting for Bolting

Before drilling, reaming, and bolting begins, all parts of a member shall be assembled, well pinned, and drawn firmly together. If necessary, assembled pieces shall be taken apart to permit removal of any burrs or shavings produced as the holes are formed. The member shall be free from twists, bends, and other deformation.

In shop-bolted connections, contacting metal surfaces shall be sandblasted clean before assembly. Sandblasting shall meet the requirements of the SSPC Specifications for Commercial Blast Cleaning (SSPC-SP 6).

Any drifting done during assembly shall be no more than enough to bring the parts into place. Drifting shall not enlarge the holes or distort the metal.

6-03.3(28) Shop Assembly

6-03.3(28)A Method of Shop Assembly

Unless the contract states otherwise, the Contractor shall choose one of the five shop assembly methods described below that will best fit the proposed erection method. The Contractor shall obtain the Engineer's approval of both the shop assembly and the erection methods before work begins.

1. **Full Truss or Girder Assembly.** Each truss or girder is completely assembled over the full length of the superstructure.
2. **Progressive Truss or Girder Assembly.** Each truss or girder is assembled in stages longitudinally over the full length of the superstructure.
   a. For trusses: The first stage shall include at least three adjacent truss panels. Each truss panel shall include all of the truss members in the space bounded by the top and bottom chords and the horizontal distance between adjacent bottom chord Joints.
   b. For girders: The first stage shall include at least three adjacent girder shop sections. Shop sections are measured from the end of the girder to the first field splice or from field splice to field splice.
   c. For trusses and girders: After the first stage has been completed, each subsequent stage shall be assembled to include: two truss panels or girder shop sections of the previous stage and one or more truss panels or girder shop sections added at the advancing end. The previous stages shall be repositioned if necessary, and pinned to ensure accurate alignment. For straight sections of bridges without skews or tapers, girders in each subsequent stage may be assembled to include one girder shop section from the previous stage and one or more girder shop sections at the advancing end.

      If the bridge is longer than 150-feet, each longitudinal stage shall be at least 150-feet long, regardless of the length of individual continuous truss panels or girder shop sections.

      The Contractor may begin the assembly sequence at any point on the bridge and proceed in either or both directions from that point.

      Unless the Engineer approves otherwise, no assembly shall have less than three truss panels or girder shop sections.
3. **Full Chord Assembly.** The full length of each chord for each truss is assembled with geometric angles at the joints. Chord connection bolt holes are drilled/reamed while members are assembled. The truss web member connections are drilled/reamed to steel templates set by relating geometric angles to the chord lines.

   At least one end of each web member shall be milled or scribed at right angles to its long axis. The templates at both ends of the member shall be positioned accurately from the milled end or scribed line.
4. **Progressive Chord Assembly.** Adjacent chord sections are assembled in the same way as specified for Full Chord Assembly, using the procedure specified for Progressive Truss or Girder Assembly.
5. **Special Complete Structure Assembly.** All structural steel members (superstructure and substructure, including all secondary members) are assembled at one time.

6-03.3(28)B Check of Shop Assembly

The Contractor shall check each assembly for alignment, accuracy of holes, fit of milled joints, and other assembly techniques. Drilling or reaming shall not begin until the Engineer has given approval. If the Contractor uses N/C drilling, this approval must be obtained before the assembly or stage is dismantled.

6-03.3(29) Vacant

6-03.3(30) Painting

All painting shall be in accordance with Section 6-07.

6-03.3(30)A Vacant

6-03.3(30)B Vacant

6-03.3(30)C Erection Marks

Erection marks to permit identification of members in the field shall be painted on previously painted surfaces.

6-03.3(30)D Machine Finished Surfaces

As soon as possible and before they leave the shop, machine-finished surfaces on abutting chord splices, column splices, and column bases shall be covered with grease. After erection, the steel shall be cleaned and painted as specified.

All surfaces of iron and steel castings milled to smooth the surface shall be painted with the primer called for in the specified paint system.

While still in the shop, machine-finished surfaces and inaccessible surfaces of rocker or pin-type bearings shall receive the full paint system. Surfaces of pins and holes machine-finished to specific tolerances shall not be painted. But as soon as possible and before they leave the shop, they shall be coated with grease.

6-03.3(31) Alignment and Camber

Before beginning field bolting, the Contractor shall:

1. Adjust the structure to correct grade and alignment,
2. Regulate elevations of panel points (ends of floorbeams), and
3. Delay bolting at compression joints until adjusting the blocking to provide full and even bearing over the whole joint.

On truss spans, a slight excess camber will be permitted as the bottom chords are bolted. But camber and relative elevations of panel points shall be correct before the top chord joints, top lateral system, and sway braces are bolted.

6-03.3(31)A Measuring Camber

The Contractor shall provide the Engineer with a diagram for each truss that shows camber at each panel point. This diagram shall display actual measurements taken as the truss is being assembled.

6-03.3(32) Assembling and Bolting

To begin bolting any field connection or splice, the Contractor shall install and tighten to snug-tight enough bolts to bring all parts into full contact with each other prior to tightening these bolts to the specified minimum tension. “Snug-tight” means either the tightness reached by (l) a few blows from an impact wrench or (2) the full effort of a person using a spud wrench.

As erection proceeds, all field connections and splices for each member shall be securely drift pinned and bolted in accordance with 1 or 2 below before the weight of the member can be released or the next member is added. Field erection drawings shall specify pinning and bolting requirements that meet or exceed the following minimums:

1. **Joints in Normal Structures.** Fifty percent of the holes in a single field connection and fifty percent of the holes on each side of a single joint in a splice plate shall be filled with drift pins and bolts. Thirty percent of the filled holes shall be pinned. Seventy percent of the filled holes shall be bolted and tightened to snug-tight. Once all these bolts are snug-tight, each bolt shall be systematically tightened to the specified minimum tension. "Systematically tightened" means beginning with bolts in the most rigid part, which is usually the center of the joint, and working out to its free edges. The fully tensioned bolts shall be located near the middle of a single field connection or a single splice plate.
2. **Joints in Cantilevered Structures.** 75 percent of the holes in a single field connection and 75 percent of the holes on each side of a single joint in a splice plate shall be filled with drift pins and bolts. Fifty percent of the filled holes shall be pinned. Fifty percent of the filled holes shall be bolted and tightened to snug-tight. Once all these bolts are snug-tight, each bolt shall be systematically tightened to the specified minimum tension. The fully tensioned bolts shall be located near the middle of a single field connection or a single splice plate.

Drift pins shall be placed throughout each field connection and each field joint with the greatest concentration in the outer edges of a splice plate or member being bolted.

To complete a joint following the method listed above, the Contractor shall fill all remaining holes of the field connection or splice plate with bolts and tighten to snug-tight. Once all of these bolts are snug-tight, each bolt shall be systematically tightened to the specified minimum tension. After these bolts are tightened to the specified minimum tension, the Contractor shall replace the drift pins with bolts tightened to the specified minimum tension.

The Contractor may complete a field bolted connection or splice in a continuous operation before releasing the mass of the member or adding the next member. The Contractor shall utilize drift pins to align the connection. The alignment drift pins shall fill between 15 and 30 percent of the holes in a single field connection and between 15 and 30 percent of the holes on each side of a single joint in a splice plate. Once the alignment drift pins are in place, all remaining holes shall be filled with bolts and tightened to snug-tight starting from near the middle and proceeding toward the outer gage lines. Once all of these bolts are snug-tight, the Contractor shall systematically tighten all these bolts to the specified minimum tension. The Contractor shall then replace the drift pins with bolts. Each of these bolts shall be tightened to the specified minimum tension.

All bolts shall be placed with heads toward the outside and underside of the bridge. All high-strength bolts shall be installed and tightened before the falsework is removed.

The Contractor may erect metal railings as erection proceeds. But railings shall not be bolted or adjusted permanently until the falsework is released and the deck placed.

The Contractor shall not begin painting until the Engineer has inspected and accepted field bolting.

6-03.3(33) Bolted Connections

Bolts, nuts, hardened washers, and direct tension indicators shall meet the requirements of Section 9-06.5(3).

All bolted connections are friction type. Painted structures require Type 1 or Type 2 bolts. Unpainted structures require Type 3 bolts. AASHTO M 253 Type 1, 2, and 3 bolts shall not be galvanized or be used in contact with galvanized material.

Hardened washers are required under turned elements for connections using AASHTO M 164 and AASHTO M 253 bolts and, as required in the following:

1. Irrespective of the tightening method, hardened washers shall be used under both the head and the nut when AASHTO M 253 bolts are to be installed in structural carbon steel, as specified in Section 9-06.1.
2. Where the outer face of the bolted parts has a slope greater than 1:20 with respect to a plane normal to the bolt axis, a hardened beveled washer shall be used to compensate for the lack of parallelism.

All galvanized nuts shall be lubricated with a lubricant containing a visible dye so a visual check for the lubricant can be made at the time of field installation. Black bolts shall be "oily" to the touch when installed. Weathered or rusted bolts and nuts shall be cleaned and relubricated prior to installation.

After assembly, bolted parts shall fit solidly together. They shall not be separated by washers, gaskets, or any other material. Assembled joint surfaces, including those next to bolt heads, nuts, and washers, shall be free of loose mill scale, burrs, dirt, and other foreign material that would prevent solid seating.

When all bolts in a joint are tight, each bolt shall carry at least the proof load shown in Table 3 below:

Table 3
Minimum Bolt Tension

Bolt Size (inches)	AASHTO M 164 (pounds)	AASHTO M 253 (pounds)
1/2	12,050	14,900
5/8	19,200	23,700
3/4	28,400	35,100
7/8	39,250	48,500
1	51,500	63,600
1 1/8	56,450	80,100
1 1/4	71,700	101,800
1 3/8	85,450	121,300
1 1/2	104,000	147,500

Tightening may be done by either the turn-of-nut or the direct-tension indicator method. Preferably, the nut shall be turned tight while the bolt is prevented from rotating. However, if required because of bolt entering and/or wrench operational clearances, tightening may be done by turning the bolt while the nut is prevented from rotating. Following are descriptions of the turn-of-nut and direct-tension-indicator methods:

1. **Turn-of-Nut Method.** Hardened steel washers shall be used under the turned elements. After a bolt in a connection or joint splice plate has been tightened to snug-tight and all specified bolting conditions satisfied, it shall be tightened to the specified minimum tension by rotating the amount specified in Table 4. Before final tightening, the Contractor shall match-mark with crayon or paint the outer face of each nut and the protruding part of the bolt. To ensure that this tightening method is followed, the Engineer will (1) observe as the Contractor installs and tightens all bolts and (2) inspect each match-mark.

Table 4
Turn-of-Nut Tightening Method Nut Rotational from Snug-Tight Condition

Bolt Length	Disposition of Outer Faces of Bolted Parts		
	Condition 1	*Condition 2*	*Condition 3*
L <= 4D	$^1/_3$ turn	$^1/_2$ turn	$^2/_3$ turn
4D < L<= 8D	$^1/_2$ turn	$^2/_3$ turn	$^5/_6$ turn
8D < L<= 12D	$^2/_3$ turn	$^5/_6$ turn	1 turn

Bolt length measured from underside of head to top of nut.

Condition 1 — both faces at right angles to bolt axis.

Condition 2 — one face at right angle to bolt axis, one face sloped no more than 1:20, without bevel washer.

Condition 3 — both faces sloped no more than 1:20 from right angle to bolt axis, without bevel washer.

Nut rotation is relative to the bolt regardless of which element (nut or bolt) is being turned. Tolerances permitted plus or minus 30 degrees ($^1/_{12}$ turn) for final turns of $^1/_2$ turn or less; plus or minus 45 degrees ($^1/_8$ turn) for final turns of $^2/_3$ turn or more.

D = nominal bolt diameter of bolt being tightened.

When bolt length exceeds 12D, the rotation shall be determined by actual tests in which a suitable tension device simulates actual conditions.

2. **Direct-Tension-Indicator Method.** DTIs shall not be used under the turned element. Direct-Tension-Indicators (DTIs) shall be placed under the bolt head with the protrusions facing the bolt head when the nut is turned. DTIs shall be placed under the nut with the protrusions facing the nut when the bolt is turned.

   DTIs shall be installed by two or more person crews with one individual preventing the element at the DTI from turning the measuring the gap of the DTI to determine the proper tension of the bolt.

   Three DTIs, per lot, shall be tested in a WSDOT approved bolt tension calibrator. The bolts shall be tensioned to 105 percent of the tension shown in Table 3. The test bolts shall not be tightened such that all of the DTI protrusions are completely crushed (all five openings with zero gap). The DTI gap between all protrusions shall be measured with a tapered feeler gage to the nearest 0.001-inch. All of the non-zero DTI gap measurements for the three test bolts shall be averaged. This average shall be used in the tightening of all the production bolts except as provided below.

All bolts in a connection shall be snug tightened prior to bringing any DTIs in the connection to full load. The maximum gap of the production bolt DTIs shall not be greater than the average test gap established above or 0.005-inch, whichever is less. The minimum gap of the production bolt DTIs may be zero (all five openings with zero gap).

The Contractor shall tension all bolts, inspecting all DTIs with a feeler gage, in the presence of the Engineer.

If a bolt, that has had its DTI brought to full load, loosens during the course of bolting the connection, the bolt shall have a new DTI installed and be retensioned. Reuse of the bolt and nut are subject to the provisions of this section.

AASHTO M 253 bolts and galvanized AASHTO M 164 bolts shall not be reused. Ungalvanized AASHTO M 164 bolts may be reused if approved by the Engineer. All bolts to be reused shall have their threads inspected for distortion by reinstalling the used nut on the bolt and turning the nut for the full length of the bolt threads by hand. Bolts to be reused shall be relubricated. Used bolts shall be subject to a rotational capacity test as specified in Section 6-03.3(33)A Pre-Erection Testing. Touching up or retightening previously tightened bolts which may have been loosened by the tightening of adjacent bolts shall not be considered as reuse, provided the snugging up continues from the initial position and does not require greater rotation, including the tolerance, than that required by Table 4.

6-03.3(33)A Pre-Erection Testing

High strength bolt assemblies (bolt, nut, and washer), black and galvanized, shall be subjected to a rotational capacity test (AASHTO M 164, Section 8.5) prior to any erection activity. Each combination of bolt production lot, nut lot, and washer lot shall be tested as an assembly. All tests shall be performed by the Contractor in the presence of the Engineer. Two specimens per lot shall be tested at the erection site immediately prior to installation, or whenever the Engineer deems it necessary. The bolt assemblies shall meet the following requirements.

1. Go through two times the required number of turns from snug tight condition as indicated in Table 4 of Section 6-03.3(33) without stripping, tensile, or shear failure. Rotation-capacity test shall be performed in a WSDOT approved bolt tension calibrator.
2. The maximum recorded tension shall be equal to or greater than 1.15 times the minimum bolt tension listed in Table 3 of Section 6.03.3(33).
3. The measured torque to produce the minimum bolt tension shall not exceed the value obtained by the following equation.

   Torque = 0.25 PD

   Where: Torque = Calculated Torque (foot-pounds)
   P = Measured Bolt Tension (pounds)
   D = Normal Bolt Diameter (feet)
4. Disassemble the torqued bolt and inspect for signs of failure. Failure is defined as any shear damage to the threads of the bolt or the nut or cracks in the body of the bolt. If either specimen fails, the lot of bolts will be rejected. Elongation of the bolt between the bolt head and the nut is not considered to be a failure.

6-03.3(33)B Bolting Inspection

The Contractor, in the presence of the Engineer, shall inspect the tightened bolt using an inspection torque wrench.

If the bolts to be installed are not long enough to fit in the Contracting Agency furnished tension calibrator, five bolts of the same grade, size, and condition as those under inspection shall be tested using Direct-Tension-Indicators (DTI) to measure bolt tension. This tension measurement test shall be done at least once each inspection day. The Contractor shall supply the necessary DTIs. The DTI shall be placed under the bolt head. A washer shall be placed under the nut, which shall be the element turned during the performance of this tension measurement test. Each bolt shall be tightened by any convenient means to the specified minimum tension as indicated by the DTI. The inspecting wrench shall then be applied to the tightened bolt to determine the torque required to turn the nut 5 degrees (approximately 1-inch at a 12-inch radius) in the tightening direction. The job inspection torque shall be taken as the average of three values thus determined after rejecting the high and low values.

Five bolts (provided by the Contractor) of the same grade, size, and condition as those under inspection shall be placed individually in a Contracting Agency furnished tension calibrator to measure bolt tension. This calibration operation shall be done at least once each inspection day. There shall be a washer under the part turned in tightening each bolt if washers are used on the structure. In the calibrated device, each bolt shall be tightened by any convenient means to the specified tension. The inspecting wrench shall then be applied to the tightened bolt to determine the torque required to turn the nut or head 5 degrees (approximately 1-inch at a 12-inch radius) in the tightening direction. The job-inspection torque shall be taken as the average of three values thus determined after rejecting the high and low values.

Ten percent (at least two) of the tightened bolts on the structure represented by the test bolts shall be selected at random in each connection. The job-inspection torque shall then be applied to each with the inspecting wrench turned in the tightening direction. If this torque turns no bolt head or nut, the Contracting Agency will accept the connection as being properly tightened. But if the torque turns one or more bolt heads or nuts, the job-inspection torque shall then be applied to all bolts in the connection. Any bolt whose head or nut turns at this stage shall be tightened and reinspected. The Contractor may, however, retighten all the bolts in the connection and resubmit it for inspection.

6-03.3(34) Adjusting Pin Nuts

All pin nuts shall be tightened thoroughly. The pins shall be placed so that members bear fully and evenly on the nuts. The pins shall have enough thread to allow burring after the nuts are tightened.

6-03.3(35) Setting Anchor Bolts

Anchor bolts shall be set in masonry as required in Section 6-02.3(18). Anchor bolts shall be grouted in after the shoes, masonry plates, and keeper plates have been set and the span or series of continuous spans are completely erected and adjusted to line and camber.

6-03.3(36) Setting and Grouting Masonry Plates

The following procedure applies to masonry plates for all steel spans, including shoes, keeper plates, and turning racks on movable bridges.

To set masonry plates, the Contractor shall:

1. Set masonry plates on the anchor bolts;
2. Place steel shims under the masonry plates to position pin centers or bearings to line and grade and in relationship to each other. Steel shims shall be no more than $2^1/_2$-inches square and placed under plate webs;
3. Level the bases of all masonry plates;
4. Draw anchor bolt nuts down tight;
5. Recheck pin centers or bearings for alignment; and
6. Leave at least $^3/_4$-inch of space under each masonry plate for grout.

After the masonry plates have been set and the span or series of continuous spans are completely erected and swung free, the space between the top of the masonry and the top of the concrete bearing seat shall be filled with grout. Main masonry plates for cantilever spans shall be set and grouted in before any steel work is erected.

Grout mixture and placement shall be as required in Section 6-02.3(20).

6-03.3(37) Setting Steel Bridge Bearings

Masonry plates, shoes, and keeper plates of expansion bearings shall be set and adjusted to center at a normal temperature of 64ºF. Adjustment for an inaccuracy in fabricated length shall be made after dead-load camber is out.

6-03.3(38) Placing Superstructure

The Contractor shall place no superstructure load on finished piers or abutments until the Engineer allows. Normally, this concrete-hardening interval requires at least 12 days.

6-03.3(39) Swinging the Span

No forms, steel reinforcing bars, or concrete roadway slabs shall be placed on steel spans until the spans swing free on their supports and elevations recorded. No simple span or any series of continuous spans will be considered as swinging free until all temporary supports have been released. Forms, reinforcing steel, or concrete roadway slabs shall not be placed on any simple or continuous span steel girder bridge until all its spans are adjusted and its masonry plates, shoes, and keeper plates grouted. For this specification, the structure shall be considered as continuous across hinged joints.

After the falsework is released (spans swung free) the masonry plates, shoes, and keeper plates are grouted, and before any load is applied, the Engineer will (or, if the Contractor is specified as responsible for surveying, the Contractor shall) measure elevations at the tenth points along the tops of girders and floorbeams.

The Engineer will compare steel mass camber elevations with the elevations measured above, and will furnish the Contractor with new dead-load camber dimensions.

6-03.3(40) Draining Pockets

The Contractor shall provide enough holes to drain all water from pockets in trusses, girders, and other members. Unless shown on approved shop plans, drain holes shall not be drilled without the written approval of the Engineer.

All costs related to providing drain holes shall be included in the unit contract prices for structural or cast steel.

6-03.3(41) Floorbeam Protection

Each floorbeam that supports a concrete slab joint shall be coated on its top and flange edges with a heavy mop of roofing grade asphalt, applied hot. This asphalt shall conform to ASTM D 312 (not mineral stabilized). A protective covering of asphalt coated glass fiber sheet (ASTM D 4601 Type 1 non-perforated) shall be placed over the hot coat of asphalt. This combination coating shall be applied over the shop paint. It shall take the place of the two field coats of paint specified for other parts of the structural steel.

6-03.3(42) Surface Condition

As the structure is erected, the Contractor shall keep all steel surfaces clean and free from dirt, concrete, mortar, oil, paint, grease, and other stain-producing foreign matter. Any surfaces that become stained shall be cleaned as follows:

Painted steel surfaces shall be cleaned by methods required for the type of staining. The method shall be submitted to the Engineer for approval.

Unpainted steel surfaces shall be cleaned by sandblasting. Sandblasting to remove stains on publicly visible surfaces shall be done to the extent that, in the Engineers opinion, the uniform weathering characteristics of the structure are preserved.

6-03.3(43) Castings, Steel Forgings, and Miscellaneous Metals

Castings, steel forgings, and miscellaneous metals shall be built to comply with Section 9-06.

6-03.3(43)A Shop Construction, Castings, Steel Forgings, and Miscellaneous Metals

This section's requirements for structural steel (including painting requirements) shall also apply to castings, steel forgings, and miscellaneous metals.

Castings shall be:

1. True to pattern in form and dimensions;
2. Free from pouring faults, sponginess, cracks, blow holes, and other defects in places that would affect strength, appearance, or value;
3. Clean and uniform in appearance;
4. Filleted boldly at angles; and
5. Formed with sharp and perfect arises.

Iron and steel castings and forgings shall be annealed before any machining, unless the Plans state otherwise.

6-03.4 Measurement

Structural carbon steel, structural low alloy steel, and structural high strength steel will not be measured but will be paid for on a lump sum basis as described in Section 6-03.5.

Cast or forged metal (kind) or copper seals shown in the Plans will be measured by the pound or will be paid for on a lump sum basis, whichever is shown on the proposal.

6-03.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Structural Carbon Steel", lump sum.

The lump sum contract price for "Structural Carbon Steel" shall be full pay for all costs in connection with furnishing all materials, labor, tools, and equipment necessary for the manufacture, fabrication, transportation, erection, and painting of all structural carbon steel used in the completed structure, including the providing of such other protective coatings or treatment as may be shown in the Plans or specified in the Special Provisions.

For steel structures, the estimated weight of the structural carbon steel in the project will be shown in the Plans or in the Special Provisions. In the event any change in the Plans is made which will affect the weight of materials to be furnished, payment for the additional structural carbon steel required as a result of the change in the Plans will be made at a unit price per pound obtained by dividing the Contractor's lump sum bid for structural carbon steel by the total estimated weight of structural carbon steel shown in the Plans or in the Special Provisions.

Reductions in weight due to a change in the Plans will be made at the same rate as determined above and will be deducted from payments due the Contractor.

Prospective bidders shall verify the estimated weight of structural carbon steel before submitting a bid. No adjustment other than for approved changes will be made in the lump sum bid even though the actual weight may deviate from the stated estimated weight.

For concrete and timber structures, where the structural carbon steel is a minor item, no estimated weight will be given for the structural carbon steel. In the event any change in the Plans is necessary which will affect the weight of material to be furnished for this type of structure, the payment or reduction for the revision in quantity will be made at a unit price per pound obtained by dividing the Contractor's lump sum bid for the structural carbon steel by the calculated weight of the original material. The calculated weight will be established by the Engineer and will be based on an estimated weight of 490 pounds per cubic foot for steel.

Any change in the Plans which affects the weight of material to be furnished as provided herein will be subject to the provisions of Section 1-04.4.

"Structural Low Alloy Steel", lump sum.

"Structural High Strength Steel", lump sum.

Payment for "Structural Low Alloy Steel" and "Structural High Strength Steel" will be made on the same lump sum basis as specified for structural carbon steel.

"(Cast or Forged) Steel", lump sum or per pound.

"(Cast, Malleable, or Ductile) Iron", lump sum or per pound.

"Cast Bronze", lump sum or per pound.

Payment for "(Cast or Forged) Steel", "(Cast, Malleable or Ductile) Iron", and "Cast Bronze" will be made at the lump sum or per pound contract prices as included in the proposal.

For the purpose of payment, such minor items as bearing plates, pedestals, forged steel pins, anchor bolts, field bolts, shear connectors, etc., unless otherwise provided, shall be considered as structural carbon steel even though made of other materials.

When no bid item is included in the proposal and payment is not otherwise provided, the castings, forgings, miscellaneous metal, and painting shall be considered as incidental to the construction, and all costs therefore shall be included in the unit contract prices for the payment items involved and shown.

6-04 TIMBER STRUCTURES

6-04.1 Description

This work is the building of any structure or parts of structures (except piling) made of treated timber, untreated timber, or both. The Contractor shall erect timber structures on prepared foundations. The structures shall conform to the dimensions, lines, and grades required by the Plans, the Engineer, and these Specifications.

Any part of a timber structure made of nontimber materials shall comply with the sections of these Specifications that govern those materials.

6-04.2 Materials

Materials shall meet the requirements of the following sections:

Structural Steel and Related Material	9-06
Bolts, Washers, Other Hardware	9-06.22
Paints	9-08
Timber and Lumber	9-09

6-04.3 Construction Requirements

6-04.3(1) Storing and Handling Material

At the work site, the Contractor shall store all timber and lumber in piles. Weeds and rubbish under and around these piles shall have been removed before the lumber is stacked.

Untreated lumber shall be open stacked at least 12-inches above the ground. It shall be piled to shed water and prevent warping.

Treated timber shall be:

1. Cut, framed, and bored (whenever possible) before treatment;
2. Close stacked and piled to prevent warping;
3. Covered against the weather if the Engineer requires it;
4. Handled carefully to avoid sudden drops, broken outer fibers, and surface penetration or bruising with tools; and
5. Lifted and moved with rope or chain slings (without use of cant dogs, peaveys, hooks, or pike poles).

6-04.3(2) Workmanship

The Contractor shall employ only competent bridge carpenters. All their work shall be true and exact. Nails and spikes shall be driven with just enough force to leave heads flush with wood surfaces. The Contractor shall discharge any worker who displays poor workmanship by leaving deep hammer marks in wood surfaces. Workmanship on metal parts shall comply with requirements for steel structures.

6-04.3(3) Shop Details

The Contractor shall provide the Engineer with six sets of shop detail plans for all treated timber. These plans shall show dimensions for all cut, framed, or bored timbers. The Engineer will return to the Contractor one set of approved or corrected plans. No material shall be framed or bored until the Engineer approves the plans. Plans shall be drawn on sheets that conform to the sizes required in Section 1-05.3.

6-04.3(4) Field Treatment of Cut Surfaces, Bolt Holes, and Contact Surfaces

All cut surfaces, bolt holes, and contact surfaces shall be treated in accordance with Section 9-09.3 for all timber and lumber requiring preservative treatment.

All cuts and abrasions in treated piles or timbers shall be trimmed carefully and treated in accordance with Section 9-09.3.

6-04.3(5) Holes for Bolts, Dowels, Rods, and Lag Screws

Holes shall be bored:

1. For drift pins and dowels — with a bit $^{1}/_{16}$-inch smaller in diameter than the pins and dowels.
2. For truss rods or bolts — with a bit the same diameter as the rods or bolts.
3. For lag screws — in two parts: (a) with the shank lead hole the same diameter as the shank and as deep as the unthreaded shank is long; and (b) with the lead hole for the threaded part approximately two thirds of the shank diameter.

6-04.3(6) Bolts, Washers, and Other Hardware

Bolts, dowels, washers, and other hardware, including nails, shall be black or galvanized as specified in the Plans, but if not so specified shall be galvanized when used in treated timber structures.

Washers of the size and type specified shall be used under all bolt heads and nuts that would otherwise contact wood.

All bolts shall be checked by burring the threads after the nuts have been finally tightened. Vertical bolts shall have nuts on the lower ends.

Wherever bolts fasten timber to timber, to concrete, or to steel, the members shall be bolted tightly together at installation and retightened just before the Contracting Agency accepts the work. These bolts shall have surplus threading of at least $^{3}/_{8}$-inch per foot of timber thickness to permit future tightening.

6-04.3(7) Countersinking

Countersinking shall be done wherever smooth faces are required. Each recess shall be treated in accordance with Section 9-09.3.

6-04.3(8) Framing

The Contractor shall cut and frame lumber and timber to produce close-fitting, full-contact joints. Each mortise shall be true to size for its full depth, and its tenon shall fit it snugly. Neither shimmed nor open joints are permitted.

6-04.3(9) Framed Bents

Mudsills shall be of pressure-treated timber, firmly and evenly bedded to solid bearing, and tamped in place.

Concrete pedestals that support framed bents shall be finished so that sills will bear evenly on them. To anchor the sills, the Contractor shall set dowels in the pedestals when they are cast. The dowels shall be at least $^{3}/_{4}$-inch in diameter and protrude at least 6-inches above the pedestal tops. Pedestal concrete shall comply with Section 6-02.

Each sill shall rest squarely on mudsills, piles, or pedestals. It shall be drift-bolted to mudsills or piles with $^{3}/_{4}$-inch diameter or larger bolts that extend at least 6-inches into them. When possible, the Contractor shall remove any earth touching the sills to permit free air circulation around them.

Each post shall be fastened to sills with $^3/_4$-inch diameter or larger dowels that extend at least 6-inches into the post.

6-04.3(10) Caps

Timber caps shall rest uniformly across the tops of posts or piles and cap ends shall be aligned evenly. Each cap shall be fastened with a drift bolt $^3/_4$-inch in diameter or larger that penetrates the post or pile at least 9-inches. The bolt shall be approximately in the center of the pile or post.

If the roadway grade exceeds 2 percent, each cap shall be beveled to match the grade.

6-04.3(11) Bracing

When pile bents are taller than 10-feet, each shall be braced transversely and every other pair shall be braced longitudinally. No single cross-bracing shall brace more than 20-feet of vertical distance on the piles. If the vertical distance exceeds 20-feet, more than one cross-bracing shall be used. Each brace end shall be bolted through the pile, post, or cap with a bolt $^3/_4$-inch in diameter or larger. Other brace/pile intersections shall be bolted or boat-spiked as the Plans require. Cross-bracing shall lap both upper or lower caps and shall be bolted to the caps or sills at each end.

6-04.3(12) Stringers

All stringers that carry laminated decking or vary more than $^1/_8$-inch in depth shall be sized to an even depth at bearing points. Outside stringers shall be butt jointed and spliced. Interior stringers shall be lapped so that each rests over the full width of the cap or floorbeam at each end. Except on sharp horizontal and vertical curves, stringers may cover two spans. In this case, joints shall be staggered and the stringers either toenailed or drift bolted as the Plans require. To permit air circulation on untreated timber structures, the ends of lapped stringers shall be separated. This separation shall be done by fastening across the lapping face a 1-inch by 3-inch wood strip cut 2-inches shorter than the depth of the stringer.

Any cross-bridging or solid bridging shall be neatly and accurately framed, then securely toenailed at each end (with two nails for cross-bridging and four nails for solid bridging). The Plans show bridging size and spacing.

6-04.3(13) Wheel Guards and Railings

Wheel guards and railings shall be built as Section 6-06.3(1) requires.

6-04.3(14) Single-Plank Floors

Single-plank floors shall be made of a single thickness of plank on stringers or joists. Unless the Engineer directs otherwise, the planks shall be:

1. Laid heart side down with tight joints,
2. Spiked to each joist or nailing strip with at least two spikes that are at least 4-inches longer than the plank thickness,
3. Spiked at least $2^1/_2$-inches from the edges,
4. Cut off on a straight line parallel to the centerline of the roadway,
5. Arranged so that no adjacent planks vary in thickness by no more than $^1/_{16}$-inch, and
6. Surfaced on one side and one edge (S1S1E) unless otherwise specified.

6-04.3(15) Laminated Floors

The strips shall be placed on edge and shall be drawn down tightly against the stringer or nailing strip and the adjacent strip and, while held in place, shall be spiked. Each strip shall extend the full width of the deck, unless some other arrangement is shown in the Plans or permitted by the Engineer.

Each strip shall be spiked to the adjacent strip at intervals of not more than 2-feet, the spikes being staggered 8-inches in adjacent strips. The spikes shall be of sufficient length to pass through two strips and at least halfway through the third. In addition, unless bolting is specified in the Plans, each strip shall be toenailed to alternate stringers with 40d common nails and adjacent strips shall be nailed to every alternate stringer. The ends of all pieces shall be toenailed to the outside stringer. The ends of the strips shall be cut off on a true line parallel to the centerline of the roadway. When bolts are used to fasten laminated floors to stringers, the bolts shall be placed at the spacing shown in the Plans, and the pieces shall be drawn down tightly to the bolting strips. The bolt heads shall be driven flush with the surface of the deck. Double nuts or single nuts and lock nuts shall be used on all bolts. The strips shall be spiked together in the same manner as specified above.

6-04.3(16) Plank Subfloors for Concrete Decks

Any plank subfloor shall be laid surfaced side down with close joints at right angles to the centerline of the roadway. Planks shall be spiked in place as required in Section 6-04.3(14).

Floor planks shall be treated in accordance with Section 9-09.3.

6-04.3(17) Trusses

Completed trusses shall show no irregularities of line. From end to end, chords shall be straight and true in horizontal projection. In vertical projection they shall show a smooth curve through panel points that conforms to the correct camber. The Engineer will reject any pieces cut unevenly or roughly at bearing points. Before placement of the hand railing, the Contractor shall complete all trusses, swing them free of their falsework, and adjust them for line and camber (unless the Engineer directs otherwise).

6-04.3(18) Painting

Section 6-07.3(3) governs painting of timber structures.

6-04.4 Measurement

The criteria in Section 6-03.4 will be used to determine the weight of structural metal other than hardware.

Timber and lumber (treated or untreated) will be measured by the 1,000 board feet (MBM), using nominal thicknesses and widths. Lengths will be actual lengths of individual pieces in the finished structure with no deduction for daps, cuts, or splices. To measure laminated timber decking, the Contracting Agency will use the number and after-dressing sizes of pieces required in the Plans. The length of each lamination shall be the length remaining in the finished structure.

6-04.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

1. "Timber and Lumber (untreated or name treatment)", per MBM.
2. "Structural Metal", lump sum.

Where no item for structural metal is included in the proposal, full pay for furnishing and placing metal parts shall be included in the unit contract price per MBM for "Timber and Lumber".

When no bid item is included in the proposal and is not otherwise provided, painting shall be considered as incidental to the construction, and all costs therefore shall be included in the unit contract prices for the payment items involved and shown.

6-05 PILING

6-05.1 Description

This work consists of furnishing and driving piles (timber, precast concrete, cast-in-place concrete, and steel) of the sizes and types the Contract or the Engineer require. This work also includes cutting off or building up piles when required. In furnishing and driving piles, the Contractor shall comply with the requirements of this section, the Contract, and the Engineer.

6-05.2 Materials

Materials shall meet the requirements of the following sections:

Reinforcing Steel	9-07
Prestressing Steel	9-07.10
Timber Piling	9-10.1
Concrete Piling	9-10.2
Cast-in-Place Concrete Piling	9-10.3
Steel Pile Tips and Shoes	9-10.4
Steel Piling	9-10.5

6-05.3 Construction Requirements

6-05.3(1) Piling Terms

Concrete Piles. Concrete piling may be precast or precast-prestressed concrete, or steel casings driven to the ultimate bearing capacity called for in the Contract which are filled with concrete (cast-in-place) after driving.

Steel Piles. Steel piles may be open-ended or closed-ended pipe piles, or H-piles.

Overdriving. Over-driving of piles occurs when the ultimate bearing capacity calculated from the equation in Section 6-05.3(12), or the wave equation if applicable, exceeds the ultimate bearing capacity required in the Contract in order to reach the minimum tip elevation specified in the Contract, or as required by the Engineer.

Maximum Driving Resistance. The maximum driving resistance is either the pile ultimate bearing capacity, or ultimate bearing capacity plus overdriving to reach minimum tip elevation as specified in the Contract, whichever is greater.

Wave Equation Analysis. Wave equation analysis is an analysis performed using the wave equation analysis program (WEAP) with a version dated 1987 or later. The wave equation may be used as specified herein to verify the Contractor's proposed pile driving system. The pile driving system includes, but is not necessarily limited to, the pile, the hammer, the helmet, and any cushion. The wave equation may also be used by the Engineer to determine pile driving criteria as may be required in the Contract.

Ultimate Bearing Capacity. Ultimate bearing capacity refers to the vertical load carrying capacity (in units of force) of a pile as determined by the equation in Section 6-05.3(12), the wave equation analysis, pile driving analyzer and CAPWAP, static load test, or any other means as may be required by the Contract, or the Engineer.

Allowable Bearing Capacity. Allowable bearing capacity is the ultimate bearing capacity divided by a factor of safety. The Contract may state the factor of safety to be used in calculating the allowable bearing capacity from the ultimate bearing capacity. In the absence of a specified factor of safety, a value of three (3) shall be used.

Rated Hammer Energy. The rated energy represents the theoretical maximum amount of gross energy that a pile driving hammer can generate. The rated energy of a pile driving hammer will be stated in the hammer manufacturer's catalog or specifications for that pile driving hammer.

Developed Hammer Energy. The developed hammer energy is the actual amount of gross energy produced by the hammer for a given blow. This value will never exceed the rated hammer energy. The developed energy may be calculated as the ram weight times the drop (or stroke) for drop, single acting hydraulic, single acting air/steam, and open-ended diesel hammers. For double acting hydraulic and air/steam hammers, the developed hammer energy shall be calculated from ram impact velocity measurements or other means approved by the Engineer. For closed-ended diesel hammers, the developed energy shall be calculated from the measured bounce chamber pressure for a given blow. Hammer manufacturer calibration data may be used to correlate bounce chamber pressure to developed hammer energy. For a single acting diesel hammer the developed energy is determined using the blows per minute.

Transferred Hammer Energy. The transferred hammer energy is the amount of energy transferred to the pile for a given blow. This value will never exceed the developed hammer energy. Factors that cause transferred hammer energy to be lower than the developed hammer energy include friction during the ram down stroke, energy retained in the ram and helmet during rebound, and other impact losses. The transferred energy can only be measured directly by use of sensors attached to the pile. A pile driving analyzer (PDA) may be used to measure transferred energy.

Pile Driving Analyzer. A pile driving analyzer (PDA) is a device which can measure the transferred energy of a pile driving system, the compressive and tensile stresses induced in the pile due to driving, the bending stresses induced by hammer misalignment with the pile, and estimate the ultimate capacity of a pile at a given blow.

Pile Driving System. The pile driving system includes, but is not necessarily limited to, the hammer, leads, helmet or cap, cushion and pile.

Helmet. The helmet, also termed the cap, drive cap, or driving head, is used to transmit impact forces from the hammer ram to the pile top as uniformly as possible across the pile top such that the impact force of the ram is transmitted axially to the pile. The term helmet can refer to the complete impact force transfer system, which includes the anvil or striker plate, hammer cushion and cushion block, and a pile cushion if used, or just the single piece unit into which these other components (anvil, hammer cushion, etc.) fit. The helmet does not include a follower, if one is used. For hydraulic hammers, the helmet is sometimes referred to as the anvil.

Hammer Cushion. The hammer cushion is a disk of material placed on top of the helmet but below the anvil or striker plate to relieve impact shock, thus protecting the hammer and the pile.

Pile Cushion. The pile cushion is a disk of material placed between the helmet and the pile top to relieve impact shock, primarily to protect the pile.

Follower. A follower is a structural member placed between the hammer assembly, which includes the helmet, and the pile top when the pile head is below the reach of the hammer.

Pile Driving Refusal. Pile driving refusal is defined as 15 blows per inch for the last 4-inches of driving. This is the maximum blow count allowed during overdriving.

Minimum Tip Elevation. The minimum tip elevation is the elevation to which the pile tip must be driven. Driving deeper in order to obtain the required ultimate bearing capacity may be required.

6-05.3(2) Ordering Piling

The Contractor shall order all piling (except cast-in-place concrete and steel piles) from an itemized list the Engineer will provide. This list, showing the number and lengths of piles required, will be based on test-pile driving (or other) data. The list will show lengths below the cutoff point. The Contractor shall supply (and bear the cost of supplying) any additional length required for handling or driving.

The Contractor shall assume all responsibility for buying more or longer piles than those shown on the list provided by the Engineer. All piles purchased on the basis of the Engineer's list but not used in the finished structure shall become the property of the Contracting Agency. The Contractor shall deliver these as the Engineer directs. The Contractor shall keep pile cutoffs that are 8-feet or under and any longer ones the Contracting Agency does not require.

When ordering steel casings for cast-in-place concrete and steel piling, the Contractor shall base lengths on information derived from driving test piles and from subsurface data. The Contractor shall also select the wall thickness of steel piles or steel casings for cast-in-place piles which will be necessary to prevent damage during driving and handling. The selection of wall thickness for steel piles or steel casings shall also consider the effects of lateral pressures from the soil or due to driving of adjacent piles. Steel piles and steel casings must be strong and rigid enough to resist these pressures without deforming or distorting. The Contractor shall select the wall thickness based on information derived from test piles, subsurface data and/or wave equation analysis. Wave equation analysis is required prior to ordering piling for piles with specified ultimate bearing capacities of 300 tons or greater. If a wave equation analysis is performed, the Contractor shall base the selection of wall thickness on the maximum driving resistance identified in the Contract to reach the minimum tip elevation, if the maximum driving resistance is greater than the specified ultimate bearing capacity and if a minimum tip elevation is specified. The wave equation analysis shall be submitted by the Contractor as required in Section 6-05.3(9)A. The Engineer will not supply any list for piling of these types.

The Contractor shall obtain the Engineer's approval of pile dimensions before any steel casings or steel piles are ordered or shipped.

6-05.3(3) Manufacture of Precast Concrete Piling

Precast concrete piles shall consist of concrete sections reinforced to withstand handling and driving stresses. These may be reinforced with deformed steel bars or prestressed with steel strands. The Plans show dimensions and details. If the Plans require piles with square cross-sections, the corners shall be chamfered 1-inch.

Precast or prestressed piles shall meet the requirements of the Standard Plans.

Temporary stress in the prestressing reinforcement of prestressed piles (before loss from creep and shrinkage) shall be 75 percent of the minimum ultimate tensile strength. (For short periods during manufacture, the reinforcement may be overstressed to 80 percent of ultimate tensile strength if stress after transfer to concrete does not exceed 75 percent of that strength.)

Prestressed concrete piles shall have a final (effective) prestress of at least 1,000 psi.

Unless the Engineer approves splices, all piles shall be full length.

The Contracting Agency intends to perform Quality Assurance Inspection. By its inspection, the Contracting Agency intends only to facilitate the work and verify the quality of that work. This inspection shall not relieve the Contractor of any responsibility for identifying and replacing defective material and workmanship.

6-05.3(3)A Casting and Stressing

Reinforcing bars, hoops, shoes, etc. shall be placed as shown in the Contract, with all parts securely tied together and placed to the specified spacing. No concrete shall be poured until all reinforcement is in place in the forms.

The Contractor shall perform quality control inspection. The manufacturing plant for precast concrete piling shall be certified by the Precast/Prestressed Concrete Institute's Plan Certification Program for the type of precast piling to be produced and shall be approved by WSDOT as a Certified Precast Concrete Fabricator prior to start of production. WSDOT Certification will be established or renewed during the annual precast plant review and approval process.

Prior to the start of production of the piling, the Contractor shall advise the Engineer of the production schedule. The Contractor shall give the Inspector safe and free access to the work. If the Inspector observes any nonspecification work or unacceptable quality control practices, the Inspector will advise the plant manager. If the corrective action is not acceptable to the Engineer, the piling(s) will be rejected.

In casting concrete piles, the Contractor shall:

1. Cast them either vertically or horizontally;
2. Use metal forms (unless the Engineer approves otherwise) with smooth joints and inside surfaces that can be reached for cleaning after each use;
3. Brace and stiffen the forms to prevent distortion;
4. Place concrete continuously in each pile, guarding against horizontal or diagonal cleavage planes;
5. Ensure that the reinforcement is properly embedded;
6. Use internal vibration around the reinforcement during concrete placement to prevent rock pockets from forming; and
7. Cast test cylinders with each set of piles as concrete is placed.

Forms shall be metal and shall be braced and stiffened to retain their shape under pressure of wet concrete. Forms shall have smooth joints and inside surfaces easy to reach and clean after each use. That part of a form which will shape the end surface of the pile shall be a true plane at right angles to the pile axis.

Each pile shall contain a cage of nonprestressed reinforcing steel. The Contractor shall follow the Contract in the size and location of this cage, and shall secure it in position during concrete placement. Spiral steel reinforcing shall be covered by at least $1^1/_2$-inches of concrete measured from the outside pile surface.

Prestressing steel shall be tensioned as required in Section 6-02.3(25)C.

The Plans specify tensioning stress for strands or wires. Tension shall be measured by jack pressure as described in Section 6-02.3(25)C. Mechanical locks or anchors shall temporarily maintain cable tension. All jacks shall have hydraulic pressure gauges (accurately calibrated and accompanied by a certified calibration curve no more than 180 days old) that will permit stress calculations at all times.

All tensioned piles shall be pretensioned. Post-tensioning is not allowed.

The Contractor shall not stress any pile until test cylinders made with it reach a compressive strength of at least 3,300 psi.

6-05.3(3)B Finishing

As soon as the forms for precast concrete piles are removed, the Contractor shall fill all holes and irregularities with 1:2 mortar. That part of any pile that will be underground or below the low-water line and all parts of any pile to be used in salt water or alkaline soil shall receive only this mortar treatment. That part of any pile that will show above the ground or water line shall be given a Class 2 finish as described in Section 6-02.3(14)B.

6-05.3(3)C Curing

Precast Concrete Piles. The Contractor:

1. Shall keep the concrete continuously wet with water after placement for at least ten days with Type I or II Portland cement or at least three days with Type III.
2. Shall remove side forms no sooner than 24 hours after concrete placement, and then only if the surrounding air remains at no less than 50°F for five days with Type I or II Portland cement or three days with Type III.
3. May cure precast piles with saturated steam or hot air, as described in Section 6-02.3(25)D, provided the piles are kept continuously wet until the concrete has reached a compressive strength of 3,300 psi.

Precast-Prestressed Concrete Piles. These piles shall be cured as required in Section 6-02.3(25)D.

6-05.3(4) Manufacture of Steel Casings for Cast-in-Place Concrete Piles

The diameter of steel casings shall be as specified in the Contract. Spiral welded steel pile casings are not allowed for steel pile casings greater that 24-inches in diameter. A full penetration groove weld with a maximum $^{1}/_{16}$-inch offset between welded edges is required.

6-05.3(5) Manufacture of Steel Piles

Steel piles shall be made of rolled steel H-pile sections, steel pipe piles, or of other structural steel sections described in the Contract. Spiral welded steel pile casings are not allowed for steel pipe piles greater that 24-inches in diameter. A full penetration groove weld with a maximum $^{1}/_{16}$-inch offset between welded edges is required.

6-05.3(6) Splicing Steel Casings and Steel Piles

The Engineer will normally permit steel piles and steel casings for cast-in-place concrete piles to be spliced. But in each case, the Contractor must obtain approval on the need and the method for splicing. Welded splices shall be spaced at a minimum distance of 10-feet. Only welded splices will be permitted.

Splice welds shall comply with Section 6-03.3(25) and AWS D1.1 Structural Welding Code. Splicing of steel piles shall be performed in accordance with an approved weld procedure. The Contractor shall submit a weld procedure to the Engineer for approval prior to welding. For ASTM A252 material, mill certification for each lot of pipe to be welded shall accompany the submittal.

Weld splicing of steel casings for cast-in-place concrete piles shall be the Contractor's responsibility. Casings that collapse or are not watertight, shall be replaced at the Contractor's expense.

Steel casing joints shall not be offset more than $^{1}/_{16}$-inch.

6-05.3(7) Storage and Handling

The Contractor shall store and handle piles in ways that protect them from damage.

6-05.3(7)A Timber Piles

Timber piling shall be stacked closely and in a manner to prevent warping. The ground beneath and around stored piles shall be cleared of weeds, brush, and rubbish. Piling shall be covered against the weather if the Engineer requires it.

The Contractor shall take special care to avoid breaking the surface of treated piles. They shall be lifted and moved with equipment, tools, and lifting devices which do not penetrate or damage the piles. If timber piles are rafted, any attachments shall be within 3-feet of the butts or tips. Any surface cut or break shall be repaired as per Section 9-09.3. The Engineer may reject any pile because of a cut or break.

6-05.3(7)B Precast Concrete Piles

The Contractor shall not handle any pile until test cylinders made with the same batch of concrete as the pile reach a compressive strength of at least 3,300 psi.

Storing and handling methods shall protect piles from fractures by impact and undue bending stresses. Handling methods shall never stress the reinforcement more than 12,000 psi. An allowance of twice the calculated load shall be made for impact and shock effects. The method of lifting the piles shall be submitted to the Engineer for approval. The Contractor will take extra care to avoid damaging the surface of any pile to be used in seawater or alkaline soil.

6-05.3(7)C Steel Casings and Steel Piles

The Engineer will reject bent, deformed, or kinked piles that cannot be straightened without damaging the metal.

6-05.3(8) Pile Tips and Shoes

The Contracting Agency prefers that timber piles be driven with squared ends. But if conditions require, they may be shod with metal shoes. Pile tips and shoes shall be securely attached to the piles in accordance with the manufacturer's recommendations.

Where called for in the Contract, conical steel pile tips shall be used when driving steel casings. The tips shall be inside fit, flush-mounted such that the tip and/or weld bead does not protrude more than $^{1}/_{16}$-inch beyond the nominal outside diameter of the steel casing.

If conical tips are not specified, the lower end of each casing shall have a steel driving plate that is thick enough to keep the casing watertight and free from distortion as it is driven. The diameter of the steel driving plate shall not be greater than the outside diameter of the steel casing.

Where called for in the Contract, inside-fit cutting shoes shall be used when driving open-ended steel piles. The cutting shoes shall be flush-mounted such that the shoe and/or weld bead does not protrude more than $^{1}/_{16}$-inch beyond the nominal outside diameter of the steel pile. The cutting shoe shall be of an inside diameter at least $^{3}/_{4}$-inch less than the nominal inside diameter of the steel pile.

Pile tips or shoes shall be of a type denoted in the Qualified Products List. If pile tips or shoes other than those denoted in the Qualified Products List are proposed, the Contractor shall submit shop drawings of the proposed pile tip along with design calculations, specifications, material chemistry and installation requirements, to the Engineer for approval. The Contractor shall also submit evidence of a pile driving

test demonstrating suitability of the proposed pile tip. The test shall be performed in the presence of the Engineer or an acceptable independent testing agency. The test shall consist of driving a pile fitted with the proposed tip. If the pile cannot be visually inspected (see Section 6-05.3(11)F), a sacrificial pile fitted with the proposed tip shall be driven outside the proposed foundation limits. The pile shall be driven to a depth sufficient to develop the required ultimate bearing capacity as called for in the Contract, in ground conditions determined to be equivalent to the ground conditions at the project site. For closed-ended casings or piles, the pile need not be removed if, in the opinion of the Engineer, the pile can be inspected for evidence of damage to the pile or the tip. For open-ended steel casings or piles, timber piles or H-piles, the pile shall be removed for inspection.

6-05.3(9) Pile Driving Equipment

6-05.3(9)A Pile Driving Equipment Approval

Prior to driving any piles, the Contractor shall submit to the Engineer for approval the details of each proposed pile driving system. The pile driving system shall meet the minimum requirements for the various combinations of hammer type and pile type specified in this Section. These requirements are minimums and may need to be increased in order to ensure that the required ultimate bearing capacity can be achieved, that minimum tip elevations can be reached, and to prevent pile damage.

The Contractor shall submit a wave equation analysis for all pile driving systems used to drive piling with required ultimate bearing capacities of greater than 300 tons. The wave equation analysis shall be performed by, and bear the stamp of, a civil engineer licensed in the State of Washington. The wave equation analysis shall be performed in accordance with the requirements of this section and the user's manual for the program. The wave equation analysis shall verify that the pile driving system proposed does not produce stresses greater than 50,000 psi or 90 percent of the yield stress whichever is less, for steel piles, or steel casings for cast-in-place concrete piles.For prestressed concrete piles, the allowable driving stress shall be 3 $\sqrt{f'cm}$ plus prestress in tension, and $0.85f_c'$ minus prestress in compression. For precast concrete piles that are not prestressed, the allowable driving stress shall be 70 percent of the yield stress of the steel reinforcement in tension, and $0.85f_c'$ in compression. The wave equation shall also verify that the pile driving system does not exceed the refusal criteria at the depth of penetration anticipated for achieving the required ultimate bearing capacity and minimum tip elevation. Furthermore, the wave equation analysis shall verify that at the maximum driving resistance specified in the Contract, the driving resistance is 100 blows per foot or less. Unless otherwise specified in the Contract, or directed by the Engineer, the following default values shall be used as input to the wave equation analysis program:

Output option (IOUT)	0
Factor of safety applied to (R_{ult})	1.0
Type of damping	Smith
Residual stress option	No

R_{ult} is the resistance of the pile used in the wave equation analyses. If the ultimate bearing capacity equals the maximum driving resistance, a setup factor of 1.3 may be used in the wave equation analysis to account for pile setup. To use a setup factor in the wave equation analysis, Rult in the analysis is the ultimate bearing capacity divided by 1.3. If the maximum driving resistance exceeds the ultimate bearing capacity, no setup factor should be used, and R_{ult} is equal to the maximum driving resistance of the pile.

Hammer efficiencies:	For Analysis of Driving Resistance	For Analysis of Driving Stresses
Single acting diesel hammers	0.72	0.84
Closed-ended diesel hammers	0.72	0.84
Single acting air/steam hammers	0.60	0.70
Double acting air/steam hammers	0.45	0.53
Hydraulic hammers or other external combustion hammers having ram velocity monitors that may be used to assign an equivalent stroke.	0.85	1.00

Within 15 working days after the Engineer receives the submittal, the Contractor will be notified of the Engineer's acceptance or rejection. If the Contractor wishes to change the pile driving system after the Contractor's proposed system has been approved, the system must be submitted for approval to the Engineer, and up to an additional 10 working days for approval will be required.

6-05.3(9)B Pile Driving Equipment Minimum Requirements

For each drop hammer used, the Contractor shall weigh it in the Engineer's presence or provide the Engineer with a certificate of its weight. The exact weight shall be stamped on the hammer. Drop hammers shall weigh not less than:

1. 3,000 pounds for piles under 50-feet long that have an ultimate bearing capacity of not more than 60 tons, and
2. 4,000 pounds for piles 50-feet and longer or that have an ultimate bearing capacity of 60 to 90 tons.

If a drop hammer is used for timber piles, it is preferable to use a heavy hammer and operate with a short drop.

For each diesel, hydraulic, steam, or air-driven hammer used, the Contractor shall provide the Engineer with the manufacturer's specifications and catalog. These shall show all data needed to calculate the developed energy of the hammer used.

Underwater hammers may be used only with approval of the Engineer.

Drop hammers on timber piles shall have a maximum drop of 10-feet. Drop hammers shall not be used to drive timber piles that have ultimate bearing capacities of more than 60 tons.

When used on timber piles, diesel, hydraulic, steam, or air-driven hammers shall provide at least 13,000 foot-pounds of developed energy per blow. The ram of any diesel hammer shall weigh at least 2,700 pounds.

Precast concrete and precast-prestressed concrete piles shall be driven with a single-acting steam, air, hydraulic, or diesel hammer with a ram weight of at least half as much as the weight of the pile, but never less than the minimums stated below. The ratio of developed hammer energy to ram weight shall not exceed six. Steel casings for cast-in-place concrete, steel pipe, and steel H-piles shall also be driven with diesel, hydraulic, steam, or air hammers. These hammers shall provide at least the following developed energy per blow:

Maximum Driving Resistance (Tons)	Minimum Developed Energy per Blow (ft-lbs)			
	Air or Steam Hammers	Open Ended Diesel Hammers	Closed Ended Diesel Hammers	Hydraulic Hammers
Up to 165	21,500	23,000	30,000	18,500
166 to 210	27,500	29,500	38,000	23,500
211 to 300	39,000	41,500	54,000	33,500
301 to 450	59,000	63,000	81,000	50,500

In addition, the ram of any diesel or hydraulic hammer shall have the following minimum weights:

Maximum Driving Resistance (Tons)	Minimum Ram Weight (lbs)
Up to 165	2,700
166 to 210	4,000
211 to 300	5,000
301 to 450	6,500

These requirements for minimum hammer size may be waived if to the satisfaction of the Engineer a wave equation analysis is performed which demonstrates the ability of the hammer to obtain the required bearing capacity and minimum tip elevation without damage to the pile.

Vibratory hammers may be used to drive piles provided the location and plumbness requirements of this section are met. The required bearing capacity for all piles driven with vibratory hammers will be determined according to 6-05.3(12) by driving the pile at least an additional 2-feet using an impact hammer. This method of determining bearing capacity will be accepted provided the blows per inch are either constant or increasing. If the pile cannot be driven 2-feet, the pile will be considered acceptable for bearing if the pile is driven to refusal.

If water jets are used, the number of jets and water volume and pressure shall be enough to erode the material next to the pile at the tip. The equipment shall include a minimum of two water-jet pipes and two $^{3}/_{4}$-inch jet nozzles. The pump shall produce a constant pressure of at least 100 psi at each nozzle.

6-05.3(9)C Pile Driving Leads

All piles shall be driven with fixed-lead drivers. The leads shall be fixed on the top and bottom during the pile driving operation. Leads shall be long enough to eliminate the need for any follower (except for timber piles as specified in Section 6-05.3(11)E). To avoid bruising or breaking the surface of treated timber piles, the Contractor shall use spuds and chocks as little as possible. In building a trestle or foundation with inclined piles, leads shall be adapted for driving batter piles.

A helmet of the right size for the hammer shall distribute the blow and protect the top of steel piling or casings from driving damage. The helmet shall be positioned symmetrically below the hammer's striking parts, so that the impact forces are applied concentric to the pile top.

Pile driving leads other than those fixed at the top and bottom may be used to complete driving, if approved by the Engineer, when all of the following criteria are met:

1. Each plumb and battered pile is located and initially driven at least 20-feet in true alignment using fixed leads or other approved means.
2. The pile driving system (hammer, cushion and pile) will be analyzed by Pile Driving Analyzer (PDA) to verify driving stresses in the pile are not increased due to eccentric loading during driving, and transferred hammer energy is not reduced due to eccentric loading during driving, for all test piles and at least one production pile per pier. Unless otherwise specified, the cost of PDA testing shall be incidental to the various unit contract prices for driving piles.

6-05.3(10) Test Piles

If the Contract or the Engineer call for it, the Contractor shall drive test piles to determine pile lengths required to reach the required ultimate bearing capacity, penetration, or both. Test piles shall be:

1. Made of the same material and have the same tip diameter as the permanent piles (although test piles for treated timber piles may be either treated or untreated),
2. Driven with pile tips if the permanent piles will have tips,
3. Prebored when preboring is specified for the permanent piles,
4. Identical in cross-section and other characteristics to the permanent piles when the test piles are steel casings for cast-in-place concrete piles, precast concrete, precast-prestressed concrete or steel pipe or H-pile,
5. Long enough to accommodate any soil condition,
6. Driven with equipment and methods identical to those to be used for the permanent piles,
7. Located as the Engineer directs, and
8. Driven before permanent piles in a given pier.

Test piles may also be driven by the Contractor, (at no cost to the Contracting Agency,) as evidence that the pile driving system selected will not damage the pile or result in refusal prior to reaching any specified minimum tip elevation.

Timber test piles shall be driven outside the footing and cut off 1 foot below the finished ground line. Timber test piles shall not be used in place of permanent piles.

Steel and all types of concrete test piles shall become permanent piles. The Contracting Agency has reduced the number of permanent piles by the number of test piles.

The Contractor shall base test pile length on test-hole data in the contract. Any test piles that prove to be too short shall be replaced (or spliced if the Contract allows splicing) at the Contractor's expense.

In foundations and trestles, test piles shall be driven to at least 15 percent more than the ultimate bearing capacity required for the permanent piles, except where pile driving criteria is determined by the wave equation. When pile driving criteria is specified to be determined by the wave equation, the test piles shall be driven to the same ultimate bearing capacity as the production piles. Test piles shall penetrate at least to any minimum tip elevation specified in the Contract. If no minimum tip elevation is specified, test piles shall extend at least 10-feet below the bottom of the concrete footing or ground line, and 15-feet below the bottom of the concrete seal.

When any test pile to be left as a permanent pile has been so damaged by handling or driving that the Engineer believes it unfit for use, the Contractor shall remove and replace the pile at no additional cost to the Contracting Agency. The Engineer may direct the Contractor to overdrive the test pile to more than 15 percent above the ultimate bearing capacity for permanent piles, or if the wave equation is used to determine driving criteria, the Engineer may direct the Contractor to overdrive the test pile above the ultimate bearing capacity. In these cases, the overdriving shall be at the Contractor's expense. But if pile damage results from this overdriving, any removal and replacement will be at the Contracting Agency's expense.

6-05.3(11) Driving Piles

6-05.3(11)A Tolerances

For elevated pier caps, the tops of piles at cut-off elevation shall be within 2-inches of the locations indicated in the Contract. For piles capped below final grade, the tops of piles at cut-off elevation shall be within 6-inches of the horizontal locations indicated in the Contract. No pile edge shall be nearer than 4-inches from the edge of any footing or cap. Piles shall be installed such that the axial alignment of the top 10-feet of the pile is within 4 percent of the specified alignment. No misaligned steel or concrete piles shall be pulled laterally. A properly aligned section shall not be spliced onto a misaligned section for any type of pile. Unless the Contract shows otherwise, all piles shall be driven vertically.

6-05.3(11)B Foundation Pit Preparation

The Contractor shall replace (and bear the cost of replacing) any pile damaged or destroyed before or during driving.

The Contractor shall completely dig all foundation pits (and build any required cofferdams or cribs) before driving foundation piles. The Contractor shall adjust pit depths to allow for upheaval caused by pile-driving, judging the amount of adjustment by the nature of the soil. Before constructing the footing or pile cap, the Contractor shall restore the pit bottom to correct elevation by removing material or by backfilling with granular material.

6-05.3(11)C Preparation for Driving

Treated and untreated timber piles shall be freshly cut square on the butt ends just before they are driven. If piles will be driven into hard material, caps, collars, or bands shall be placed on the butt ends to prevent crushing or brooming. If the head area of the pile is larger than that of the hammer face, the head shall be snipped or chamfered to fit the hammer. On treated piles, the heads shall be snipped or chamfered to at least the depth of the sapwood to avoid splitting the sapwood from the pile body.

The Contractor shall match timber pile sizes in any single bent to prevent sway braces from undue bending or distorting.

When driven, pile faces shall be turned as shown in the Plans or as the Engineer directs.

No precast-prestressed pile shall be driven until test cylinders poured with it reach at least the specified compressive strength shown in the Contract. On all other precast piles, the cylinders must reach a compressive strength of at least 4,000 psi before the piles are driven.

Helmets of approved design shall protect the heads of all precast concrete piles as they are driven. Each helmet shall have fitted into it a cushion next to the pile head. The bottom side of the helmet shall be recessed sufficiently to accommodate the required pile cushion and hold the pile in place during positioning and driving. The inside helmet diameter shall be determined before casting the pile, and the head of the pile shall be formed to fit loosely inside the helmet.

Steel Casing, steel pipe or H-piles shall have square-cut ends.

6-05.3(11)D Achieving Minimum Tip Elevation and Bearing

Once pile driving has started, each pile shall be driven continuously until the required ultimate bearing capacity shown in the contract has been achieved. Pauses during pile driving, except for splicing, mechanical breakdown, or other unforeseen events, shall not be allowed.

If the Contract specifies a minimum tip elevation, the pile shall be driven to at least the minimum tip elevation, even if the ultimate bearing capacity has been achieved, unless the Engineer directs otherwise. If a pile does not develop the required ultimate bearing capacity at the minimum tip elevation, the Contractor shall continue driving the pile until the required bearing capacity is achieved. If no minimum tip elevation is specified, then the piles shall be driven to the ultimate bearing capacity shown in the Contract and the following minimum penetrations:

Pile supporting cross-beams, bents, elevated pile caps elevation	10-feet below final top of ground
Piles supporting foundations	10-feet below bottom of foundation
Piles with a concrete seal	15-feet below bottom of seal

If overdriving is required in order to reach a specified minimum tip elevation, the Contractor shall provide a pile driving system which will not result in damage to the pile or refusal before the minimum tip elevation is reached. The cost of overdriving shall be incidental to the various unit contract prices for furnishing and driving piles.

So long as the pile is not damaged and the embankment or foundation material being driven through is not permanently damaged, the Contractor shall use normal means necessary to:

1. Secure the minimum depth specified,
2. Penetrate hard material that lies under a soft upper layer,
3. Penetrate through hard material to obtain the specified minimum tip elevation, or
4. Penetrate through a previously placed embankment.

Normal means refer to methods such as preboring, spudding, or jetting piles. Blasting or drilling through obstructions are not considered normal means.

Prebored holes and pile spuds shall have a diameter no larger than the least outside dimension of the pile. After the pile is driven, the Contractor shall fill all open spaces between the pile and the soil caused by the preboring or spudding with dry sand, or pea gravel, or controlled density fill as approved by the Engineer.

If water jets are used, the jets shall be withdrawn before the pile reaches its final penetration, and the pile shall then be driven to its final penetration and ultimate bearing capacity. The pile shall be driven a minimum of 2-feet to obtain the ultimate bearing capacity after the jets are withdrawn, or to refusal, whichever occurs first. If the water jets loosen a pile previously driven, it shall be redriven in place or pulled and replaced by a new pile. To check on pile loosening, the Contractor shall attempt to redrive at least one in every five piles, but no less than one pile per bent or pier.

The various unit contract prices for driving piles shall cover all costs related to the use of water jets, preboring, or spudding. The Contracting Agency will not pay any costs the Contractor incurs in redriving piles loosened as a result of using water jets, preboring, or spudding.

If the Engineer requires, the Contractor shall overdrive the pile beyond the ultimate bearing capacity and minimum tip elevation shown in the Contract. In this case, the Contractor will not be required to:

1. Use other than normal means to achieve the additional penetration;
2. Bear the expense of removing or replacing any pile damaged by overdriving; or
3. Bear the expense of overdriving the pile more than 3-feet as specified in Section 6-05.5.

In driving piles for footings with seals, the Contractor shall use no method (such as jetting or preboring) that might reduce friction capacity.

6-05.3(11)E Use of Followers for Driving

Followers shall not be used to drive concrete or steel piles. On timber piles, the Contractor may use steel (not wooden) followers if the follower fits snugly over the pile head. If a follower is used, the Contractor shall, in every group of 10 piles, drive one long pile without a follower, but no less than one pile per bent or pier, to the required ultimate bearing capacity and minimum tip elevation. This long pile shall be used to test the bearing capacity of the piles driven with a follower in the group. The tip elevation of the long pile shall be similar to the elevation of the piles driven with the follower. If the tip elevations are significantly different, as determined by the Engineer, the Contractor shall redrive the remaining piles in the group to the tip elevation of the longer pile.

6-05.3(11)F Pile Damage

The Contractor shall remove and replace (and bear the cost of doing so) any pile that is damaged as determined by the Engineer.

After driving a steel casing for a cast-in-place concrete pile, the Contractor shall leave it empty until the Engineer has inspected and approved it. The Contractor shall make available to the Engineer a light suitable for inspecting the entire length of its interior. The Engineer will reject any casing that is improperly driven, that shows partial collapse that would reduce its ultimate bearing capacity, or that has been reduced in diameter, or that will not keep out water. The Contractor shall replace (and bear the cost of replacing) any rejected casing.

Pile heads which have been broomed, rolled, or otherwise significantly damaged as determined by the Engineer shall be cut back to undamaged material before proceeding with driving as well as final acceptance of the pile.

6-05.3(11)G Pile Cutoff

The Contractor shall trim the tops of all piles to the true plane shown in the Contract and to the elevation the Engineer requires. If a pile is driven below cutoff elevation without the Engineer's approval, the Contractor shall remove and replace it (and bear the costs of doing so), even if this requires a longer pile. Any pile that rises as nearby piles are driven, shall be driven down again if the Engineer requires.

Any piles under timber caps or grillages shall be sawed to the exact plane of the structure above them and fit it exactly. No shimming on top of timber piles to adjust for inaccurate pile top elevations will be permitted. If a timber pile is driven out of line, it shall be straightened without damage before it is cut off or braced.

Steel casing shall be cut off at least 6-inches below the finished ground line or at the low water line if the casing will be visible as determined by the Engineer.

6-05.3(11)H Pile Driving From or Near Adjacent Structures

The Contractor shall not drive piling from an existing structure unless all of the following conditions are met:

1. The existing structure will be demolished within the contract.
2. The existing structure is permanently closed to traffic, and
3. Working drawings are submitted in accordance with Sections 6-01.9 and 6-02.3(16), showing the structural adequacy of the existing structure to safely support all of the construction loads.

To minimize the detrimental effects of pile driving vibrations on new concrete less than 28 days old, piles shall not be driven closer to the new concrete than the distance determined from the following formula:

D = C times the square root of E

Where: D = distance in feet
E = rated hammer energy in foot-pounds
C = coefficient shown below based on the number ofdays of curing time

Curing Time (days)	Coefficient (C)	Curing Time (days)	Coefficient (C)
1	0.34	6	0.12
2	0.23	7-9	0.11
3	0.18	10-13	0.10
4	0.15	14-20	0.09
5	0.13	21-28	0.08

This distance may be reduced if approved in writing by the Engineer.

6-05.3(12) Determination of Bearing Values

The following formula shall be used to determine ultimate bearing capacities:

$P = F \times E \times Ln(10N)$

Where: P = ultimate bearing resistance, in tons

F = 1.8 for air/steam hammers

= 1.2 for open ended diesel hammers and precast concrete piles

= 1.6 for open ended diesel hammers and steel or timber piles

= 1.2 for closed ended diesel hammers

= 1.9 for hydraulic hammers

= 0.9 for drop hammers

E = developed energy, equal to W times H[1], in ft-kips

W = weight of ram, in kips

H = vertical drop of hammer or stroke of ram, in feet

N = average penetration resistance in blows per inch for the last 4-inches of driving

Ln = the natural logarithm, in base "e"

[1]For closed-end diesel hammers (double-acting), the developed hammer energy (E) is to be determined from the bounce chamber reading. Hammer manufacturer calibration data may be used to correlate bounce chamber pressure to developed hammer energy. For double acting hammer hydraulic and air/steam hammers, the developed hammer energy shall be calculated from ram impact velocity measurements or other means approved by the Engineer. For open ended diesel hammers (single-acting) use the blows per minute to determine the developed energy (E).

The above formula applies only when:

1. The hammer is in good condition and operating in a satisfactory manner;
2. A follower is not used;
3. The pile top is not damaged;
4. The pile head is free from broomed or crushed wood fiber;
5. The penetration occurs at a reasonably quick, uniform rate; and the pile has been driven at least 2-feet after any interruption in driving greater than 1 hour in length.
6. There is no perceptible bounce after the blow. If a significant bounce cannot be avoided, twice the height of the bounce shall be deducted from "H" to determine its true value in the formula.
7. For timber piles, bearing capacities calculated by the formula above shall be considered effective only when it is less than the crushing strength of the piles.
8. If "N" is greater than or equal to 1.0 blow/inch.

If "N" required to achieve the required ultimate bearing capacity using the above formula is less than 1.0 blow/inch, the pile shall be driven until the penetration resistance is a minimum of 1.0 blow/inch for the last 2-feet of driving.

The Engineer may require the Contractor to install a pressure gauge on the inboard end of the hose to check pressure at the hammer.

If water jets are used in driving, bearing capacities shall be determined either: (1) by calculating it with the driving data and the formula above after the jets have been withdrawn and the pile is driven at least 2-feet, or (2) by applying a test load.

6-05.3(13) Treatment of Timber Pile Heads

After cutting timber piles to correct elevation, the Contractor shall thoroughly coat the heads of all untreated piles with two coats of an approved preservative that meets the requirements of Section 9-09 (except concrete-encased piles).

After cutting treated timber piles to correct elevation, the Contractor shall brush three coats of an approved preservative that meets the requirements of Section 9-09 on all pile heads (except those to be covered with concrete footings or concrete caps). The pile heads shall then be capped with alternate layers of an approved roofing asphalt and a waterproofing fabric that conforms to Section 9-11.2. The cap shall be made of four layers of an approved roofing asphalt and three layers of fabric. The fabric shall be cut large enough to cover the pile top and fold down at least 6-inches along all sides of the pile. After the fabric cover is bent down over the pile, its edges shall be fastened with large-head galvanized nails or with three turns of galvanized wire. The edges of the cover shall be neatly trimmed.

On any treated timber pile encased in concrete, the cut end shall receive two coats of an approved preservative that meets the requirements of Section 9-09 and then a heavy coat of an approved roofing asphalt.

6-05.3(14) Extensions and Build-ups of Precast Concrete Piles

The Contractor shall add extensions, or build-ups (if necessary) on precast concrete piles after they are driven to the required ultimate bearing capacity and minimum tip elevation.

Before adding extensions or build-ups to precast-prestressed piles, the Contractor shall remove any spalled concrete, leaving the pile fresh-headed and with a top surface perpendicular to the axis of the pile. The concrete in the build-up shall be Class 5000.

Before adding to non-prestressed precast concrete piles, the Contractor shall cut the pile head away to a depth 40 times the diameter of the vertical reinforcing bar. The final cut shall be perpendicular to the axis of the pile. Reinforcement of the same density and configuration as used in the pile shall be used in the build-up and shall be fastened firmly to the projecting steel. Forms shall be placed to prevent concrete from leaking along the pile. The concrete in the build-up shall be Class 4000.

Just before placing the concrete for extensions or build-ups to precast or precast-prestressed concrete piles, the Contractor shall thoroughly wet the top of the pile. Forms shall remain in place at least three days.

6-05.3(15) Completion of Cast-In-Place Concrete Piles

After approval by the Engineer, driven casings shall be cut off horizontally at the required elevation. They shall be clean and free of water when concrete and reinforcing steel are placed.

These piles shall consist of steel casings driven into the ground, reinforced as specified, and filled with Class 4000P concrete.

6-05.3(15)A Reinforcement

All bars shall be fastened rigidly into a single unit, then lowered into the casing before the concrete is placed. Loose bars shall not be used.

Spiral hooping reinforcement shall be deformed steel bar, plain steel bar, cold-drawn wire, or deformed wire.

6-05.3(15)B Placing Concrete

Before placing concrete, the Contractor shall remove all debris and water from the casing. If the water cannot be removed, the casing shall be removed (or cut off 2-feet below the ground and filled with sand) and a new one driven.

The Contractor shall place concrete continuously through a 5-foot rigid conduit directing the concrete down the center of the pile casing, ensuring that every part of the pile is filled and the concrete is worked around the reinforcement. The top 5-feet of concrete shall be placed with the tip of the conduit below the top of fresh concrete. The Contractor shall vibrate, as a minimum, the top 10-feet of concrete. In all cases, the concrete shall be vibrated to a point at least 5-feet below the original ground line.

6-05.4 Measurement

Measurement for driving (type) pile will be the number of piles driven in place.

In these categories, measurement will be the number of linear feet driven below cutoff or as shown in the Engineer's order list:

1. Furnishing timber piling (untreated or name of treatment).
2. Precast concrete and precast-prestressed concrete piling.

In these categories, measurement will be the number of linear feet driven below cutoff, but no Engineer's order list will be provided:

1. Cast-in-place concrete piling.
2. Furnishing steel piling.

Measurement for furnishing and driving test piles will be the number actually furnished and driven as the Contract requires.

Measurement for steel pile tips or shoes will be by the number of tips or shoes actually installed and driven in place on steel casings or steel piles.

6-05.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Furnishing and Driving (type) Test Pile", per each.

The unit contract price per each for "Furnishing and Driving (type) Test Pile" shall be full pay for furnishing and driving test piles to the ultimate bearing capacity or penetration required by the Engineer, furnishing and installing a pile tip when pile tips are specified for the permanent piles, preboring when preboring is specified for the permanent piles, for pulling the piles or cutting them off as required, and for removing them from the site or for delivery to the Contracting Agency for salvage when ordered by the Engineer. This price shall also include all costs in connection with moving all pile driving equipment or other necessary equipment to the site of the work and for removing all such equipment from the site after the piles have been driven. If, after the test piles have been driven, it is found necessary to eliminate the piling from all or any part of the structure, no additional pay will be allowed for moving the pile driving equipment to and from the site of the work.

"Driving Timber Pile (untreated or name treatment)", per each.

The unit contract price per each for "Driving Timber (type) Pile" shall include any metal shoes which the Contractor has determined to be beneficial to the pile driving.

"Driving Conc. Pile (size)", per each.

"Driving St. Pile", per each.

The unit contract price per each for "Driving (type) Pile (____)" shall be full pay for driving the pile to the ultimate bearing and/or penetration specified. When overdriving piles beyond the ultimate bearing capacity and minimum tip elevation specified in the Contract is required by the Engineer, payment for the first 3-feet of overdriving will be included in the unit contract price for "Driving (type) Pile". Additional penetration beyond the first 3-feet of overdriving will be paid for on the basis of force account work as covered in Section 1-09.6.

"Furnishing Timber Piling (untreated or name treatment)", per linear foot.

"Furnishing Conc. Piling (size)", per linear foot.

"Furnishing St. Piling", per linear foot.

The unit contract price per linear foot for "Furnishing (type) Piling (____)" shall be full pay for furnishing the piling specified. Such price shall also be full pay, when measurement includes, for piling length ordered but not driven.

Precast Concrete Pile Buildup", by force account.

Payment for buildups of precast or precast-prestressed concrete piles will be made on the basis of force account work as covered in Section 1-09.6. No payment will be made for build-ups or additional lengths of build-up made necessary because of damage to the piling during driving. The length of splice for precast concrete piles includes the length cut off to expose reinforcing steel for the splice. The length of splice for precast-prestressed piles includes the length in which holes are drilled and reinforcing bars are grouted.

For the purpose of providing a common proposal for all bidders, the Contracting Agency entered an amount for "Precast Concrete Pile Buildup" in the proposal to become part of the total bid by the Contractor.

"Furnishing Steel Pile Tip or Shoe (size)", per each.

6-06 BRIDGE RAILINGS

6-06.1 Description

This work consists of providing and building bridge railings that meet the requirements of the Plans, these Specifications, and the Engineer.

6-06.2 Materials

Materials shall meet the requirements of the following sections:

Timber Railing	9-09
Metal Railing	9-06.18

6-06.3 Construction Requirements

6-06.3(1) Timber Railings

Wheel guards and railings shall be true to line and grade and framed accurately. The Contractor shall follow Section 6-04 whenever this subsection does not specify a construction method.

Unless the Plans show otherwise, wheel guards shall be:

1. Beveled and surfaced on the roadway side and surfaced on the top edge. They may be surfaced on four sides (S4S).
2. Laid in sections at least 12-feet long.
3. Bolted through the floor plank and outside stringer (or nailing piece) with $^{3}/_{4}$-inch diameter bolts spaced no more than 4-feet apart.

All rails and rail post material shall be S4S and painted as required in Section 6-07. Railing members shall be fastened securely together, with the bolts tightened once at installation and again just before the Contracting Agency's final acceptance of the contract.

6-06.3(2) Metal Railings

Metal railing includes posts, web members, and horizontal members of the sidewalk and roadway railing. Unless the Plans or Special Provisions show otherwise, these shall be made of aluminum alloy or steel.

Before fabricating the railing, the Contractor shall submit six copies of the shop plans for the Engineer's approval. The Contractor may substitute other rail connection details for those shown in the Plans if details of these changes show in the shop plans and if the Engineer approves. In approving shop plans, the Engineer indicates only that they are adequate and complete enough. Approval does not indicate a check on dimensions.

Anchor bolts or wedge anchors shall be positioned with a template to ensure that bolts match the hole spacing of the bottom channels or anchorage plates.

Where specified, cover plates shall fit the bottom channel tightly after being snapped into position.

Metal railings shall be installed true to line and grade (or camber). After first setting the railing, the Contractor shall readjust all or part of it, if necessary, to create an overall line and grade pleasing to the eye.

6-06.4 Measurement

Timber railing will be measured by the thousand board feet (MBM) as shown in Section 6-04.

Metal railing will be measured by the linear foot along the line and slope at the base of the completed railing.

6-06.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Timber and Lumber (untreated or name treatment)", per MBM.

"Bridge Railing Type .____", per linear foot.

In case no item is included in the contract for "Bridge Railing Type ____" and payment is not otherwise provided, all metal railings shall be included in the lump sum contract price for "Structural Carbon St." as specified in Section 6-03.

6-07 PAINTING

6-07.1 Description

This work consists of surface preparation, containing, testing and disposing of surface preparation debris, furnishing and applying paint, shielding adjacent areas from unwanted paint, and cleaning up after painting is completed. The work shall comply with all requirements of the Plans, these Specifications, and the Engineer.

6-07.2 Materials

Paint materials shall comply with the requirements in Section 9-08.

Material used for field abrasive blasting shall meet Military Specification MIL-A-22262A(SH) as listed on QPL-22262-15 as maintained by the Department of the Navy. The Contractor shall provide the Engineer with certified test results from the abrasive blast media manufacturer showing that the abrasive blast material meets the Military Specification. In addition, the Contractor shall blend an additive with the abrasive blast media that renders the blast residual to a non-hazardous waste condition.

6-07.3 Construction Requirements

6-07.3(1) Painting New Steel Structures

All material classified as structural steel shall be painted with a shop applied, inorganic zinc silicate primer, followed by a field applied two coat paint system after field erection, cleaning, and spot priming have been completed. Except as otherwise specified, all steel surfaces shall be painted with three coats of paint. Steel surfaces embedded in concrete and faying (contact) surfaces of bolted connections (including all surfaces internal to the connection and all filler plates) shall receive the prime coat only. Stainless steel surfaces shall not be painted. Galvanized surfaces shall not be painted unless specified in the Plans or Special Provisions. Painting of galvanized surfaces, if so specified, shall be in accordance with Section 6-07.3(4).

The painting system shall consist of three coats as follows:

	Method A	Method B
Primer Coat	inorganic zinc	Inorganic zinc
2nd Coat	epoxy	B-11-99 Field applied
3rd Coat	aliphatic urethane	C-11-99 Field applied

Once a paint system has been selected, that system shall be used throughout the structure.

Terminology used herein is in accordance with the definitions used in Volume 2, Systems and Specifications of the SSPC Steel Structures Painting Manual, current edition.

Prior to any coating materials being utilized, the Contractor shall submit the product data sheets to the Engineer for approval. The product data sheets shall include all application instructions including the mixing and thinning directions, the recommended spray nozzles and pressures, the minimum and maximum drying time between coats, friction coefficient of the faying surface, restrictions on temperature and humidity, and the repair procedures. In addition, the Contractor shall submit to the Engineer for approval an abrasive blast procedure. The procedure shall include the type of equipment and abrasive media to be used.

Paint formulations to be used on faying surfaces shall be Class B coatings with a mean slip coefficient not less than 0.50. The slip coefficient shall be determined by testing in accordance with "Test Method to Determine the Slip Coefficient for Coatings Used in Bolted Joints" as adopted by the Research Council on Structural Connections. Test results and the paint manufacturer's Certificate of Compliance shall be submitted to the Engineer for approval with the structural steel shop drawings.

For contracts in which more than 20,000 pounds of steel are to be painted, the manufacturer of the paint system shall have a technical representative present at the job site for the first day of painting. After the first day of painting the technical representative shall remain available for contact in the event of technical difficulties in applying the paint system.

During fabrication and shop painting, the Contractor shall provide access meeting the approval of the Engineer to permit inspection of the steel. The access shall not mar or damage any freshly painted surfaces.

The Contractor shall select a primer from one of the approved products listed in the Qualified Products List. The field applied primer, the second coat and the third coat shall all be selected from the same manufacturer from one of the approved coating systems listed in the Qualified Products List.

The color for the second coat shall be a contrasting color to the third coat. The color for the third coat shall be as specified in the Special Provisions.

Steel surfaces shall be:

For Method A:

1. Greater than 45ºF and at least 5ºF above the dew point, and
2. Less than 115ºF.

For Method B:

1. Greater than 35ºF and
2. Less than 115ºF

6-07.3(1)A Preparation for Shop Coating

A roughened surface profile shall be provided by an abrasive blasting procedure as approved by the Engineer. The profile shall be one mil minimum or per the paint manufacturer's recommendation, whichever is greater. The steel surfaces shall be cleaned to a near white condition as per SSPC-SP10.

After being thoroughly cleaned by abrasive blasting as specified above, all structural steel shall be primed within the same working day on which abrasive blasting takes place, and before any rust forms, by spraying with a full coat of inorganic zinc silicate paint. The Contractor shall not begin painting until receiving the Engineer's approval of the prepared surface. High strength field bolts need not be painted before erection.

Care shall be taken to protect freshly coated surfaces from subsequent abrasive blast cleaning operations. Primed surfaces which are damaged by abrasive blasting shall be thoroughly wire brushed or, if visible rust occurs, re-blasted to a near-white (SSPC-SP10) condition. The wire brushed or abrasive blast cleaned surfaces shall be vacuumed and re-primed by spraying.

6-07.3(1)B Mixing and Thinning the Shop and Field Coatings

The coating shall be mixed with a high shear mixer in accordance with the manufacturer's written recommendations to a smooth, lump-free consistency. Paddle mixers or paint shakers are not allowed. Mixing shall be done, to the extent possible, in the original containers and shall be continued until all of the metallic powder or pigment is in suspension. The mixed coating shall be kept under continuous agitation up to and during the time of application.

In general, the coatings are supplied for use without requiring thinning. If it is necessary to thin the coating for proper application in cool weather, or to obtain better coverage of the urethane coat, the thinning shall be done in accordance with the manufacturer's written recommendations.

6-07.3(1)C Applying The Shop Coating

After the surface to be coated has been cleaned, and has received the Engineer's approval, the primer coat shall be applied so as to produce a uniform, even coating that has fully bonded with the metal.

The coatings shall be applied with the spray nozzles and pressures recommended by the manufacturer of the paint system, so as to attain the film thicknesses specified.

The top surfaces of the top flanges of the steel girders shall not be primed until the welded shear connectors are placed, unless the welded shear connectors are to be placed in the field. Welded shear connectors are not required to be painted except for the weld area.

If the welded shear connectors are to be placed in the field, the area to be welded shall be cleaned of primer by abrasive grinding just prior to welding. After welding, the ground area and the weld shall be cleaned and primed. Surfaces which are inaccessible for painting after erection shall be painted with the two field coats of paint before erection.

Dry film thickness measurements will be made in accordance with Section 6-07.3(5).

6-07.3(1)D Field Coating After Erection

When the erection work has been completed, including all connections and the straightening of any bent metal, all steel surfaces and bolts shall be prepared for painting. All adhering scale, dirt, grease, form oil, or other foreign matter shall be removed by appropriate means and all rusted or uncoated areas including the bolts, nuts, washers and splice plates shall be abrasive blasted to a near-white (SSPC-SP10) condition. All uncoated areas shall be field primed with an organic zinc paint coating selected from the same approved coating system and paint manufacturer as the other coatings for the structure.

After all field priming has been completed the surfaces shall be prepared to receive the final two field coats. The intermediate coat shall be mixed and applied per the manufacturer's written recommendations. The top coat shall also be mixed and applied per the manufacturer's written recommendations. The minimum drying time between coats shall be as shown in the approved product data sheets, but not less than 12 hours. Depending on site conditions, additional time may be required for proper curing before applying succeeding coats. The Contractor shall determine if the coating has cured sufficiently for proper application of succeeding coats. The maximum time between coats shall be in accordance with the manufacturer's written recommendations. If the

maximum time between coats is exceeded, all newly coated surfaces shall be completely blast-cleaned again to a near white finish (SSPC-SP10) and re-coated at no additional cost to the Contracting Agency.

Dry film thickness measurements will be made in accordance with Section 6-07.3(5).

Temporary attachments or supports for scaffolding or forms shall not damage the coating system. All paint damage that occurs shall be repaired in accordance with the manufacturer's written recommendations and as follows. On bare areas or areas of insufficient primer thickness, the repair shall include the application of the field applied organic zinc primer system, and the final two coats of the Method A or Method B paint system. On areas where the primer is at least equal to the minimum required dry film thickness, the repair shall include the application of the final two coats of the Method A or Method B paint system. If any abrasive blast cleaning is required in the field it shall be done using an abrasive conforming to Section 6-07.2.

6-07.3(2) Repainting Existing Steel Structures

Unless otherwise provided, maintenance painting includes cleaning and painting all metal surfaces of an existing bridge. These include all metal surfaces that do not touch other metal, wooden floor or truss members, concrete or stone masonry, or other surfaces. Cleaning means removing rust, scale, unsound paint, dirt, grease, and other foreign matter. The Contractor shall clean and paint all exposed metal surfaces that may rust.

The Contractor shall abrasive blast all rust spots in accordance with the SSPC-SP6 Specifications for commercial blast cleaning. The edges of cleaned areas shall show no red or yellow rust. The edges of sound paint shall be feathered smooth. After abrasive blasting, the Contractor shall remove all loose rust, dirt, sand, and dust before painting.

6-07.3(2)A Bridge Cleaning

Bird Guano

Bird guano shall be completely removed prior to any other cleaning. All workers involved with bird guano removal operations shall be protected from absorption, inhalation, or ingestion of bird guano particles by wearing protective clothing as specified in the Contractor's Lead Health Protection Program (LHPP). Bird guano shall be removed in the dry to the extent possible. Following dry removal, the Contractor shall apply a 5.25% sodium hypochlorite solution to the remaining bird guano , followed by hand scrubbing, and pressure flushing as specified. The sodium hypochlorite solution shall not be used as an additive to the water used for pressure flushing, but shall be directly applied onto the areas of remaining bird guano. The bird guano shall be collected in a containment system approved by the Engineer and shall not enter any waterway or the surrounding environment. All bird guano shall be removed and disposed of at a land disposal site approved by the Engineer. The Contractor shall provide the Engineer with one copy of the disposal receipt, which shall include a description of the material disposed of.

Fungicide Treatment

The Contractor shall treat all areas of fungus growth. When treating areas of fungus growth the Contractor shall use special cleaning methods before beginning general surface cleaning operations. The Contractor shall apply a 5.25% sodium hypochlorite solution to the bridge in fungus infested areas for a period recommended by the solution manufacturer or as specified by the Engineer. The sodium hypochlorite solution shall not be used as an additive to the water used for pressure flushing, but shall be directly applied onto the areas of fungus growth.

General Cleaning and Surface Preparation

Following fungicide treatment and removal of the bird guano, all steel surfaces to be painted shall be cleaned by either pressure flushing or sweep blasting. The cleaning process shall remove dirt, loose paint, and other material from the steel surfaces to be painted, but shall not remove well bonded paint. The Contractor shall follow the construction requirements of the cleaning method selected.

Spot abrasive blasting of all rusted steel surfaces and unbonded paint shall follow the pressure flushing or sweep blasting in areas designated by the Engineer. The Contractor shall hand clean, to the satisfaction of the Engineer, all surfaces inaccessible to cleaning with pressure flushing and sweep blasting equipment.

Prior to the application of paint the Contractor shall clean the bridge deck surface for the purpose of dust control.

Pressure Flushing

When pressure flushing is used, it shall be done with clean, fresh water only. No detergents, bleach, or other cleaning agents shall be employed. The pressure flushing equipment shall produce (at the nozzle) at least 3,000 psi with a discharge of at least 4 gpm. The nozzle shall have a 25 degree tip and shall be held no more than 9-inches from the surface being washed. The use of a rotating tip nozzle may be allowed provided:

1. The Contractor requests its use in writing.
2. The pressure equipment shall produce at least 3500 psi at the nozzle.
3. There shall be no additional cost to the Contracting Agency
4. The use of the nozzle has been approved in writing by the Engineer.

The Contractor may pressure flush other portions of the bridge for safety purposes, at no additional expense to the Contracting Agency.

All wash water and debris from pressure flushing shall be filtered through a filter fabric capable of collecting all loose debris and particles. A polypropylene, non-woven, needle-punched geotextile or equivalent shall be used as the filter fabric. The fabric shall have the following properties:

Grab tensile (ASTM D4632):	100 lbs. Min.
Apparent opening size (ASTM D4751):	#70 US Sieve
Permittivity (ASTM D4491):	1.0 sec - 1 or better

The fabric shall be supported underneath the structure to hold the contained material and shall be cleaned at intervals frequent enough to prevent clogging, overflow, or collapse. The debris obtained from the pressure water flushing operation shall be collected and tested in accordance with Section 6-07.3(2)C, and disposed off site at a waste disposal facility approved by the Engineer.

Sweep Blasting and Spot Abrasive Blasting

Sweep or spot abrasive blasting shall not begin until the containment system specified in Section 6-07.3(2)B is in place. No sweep or spot abrasive blasting shall begin until the surfaces are thoroughly dry. The abrasives to be used shall conform to Section 6-07.2. Sweep and spot abrasive blasting shall be done in such a manner that adjacent areas of work that have been partially or entirely completed are protected from damage.

Sweep blasting shall comply with the SSPC-SP 7 requirements. Spot abrasive blasting shall comply with the SSPC-SP 6 requirements.

The abrasive blasters shall be equipped with automatic shutoffs that operate by releasing the trigger mechanism. All abrasive blasting shall be directed towards the bridge center and away from the outboard sides, to facilitate catching all the containment waste. After abrasive blasting, all rust debris, dirt, abrasive and paint residue, and dust shall be completely removed before paint is applied.

6.07.3(2)B Containment of Abrasive Blasting

The Contractor shall protect the surrounding environment from all debris or damage resulting from the Contractor's operation. The Contractor shall take all measures necessary to contain and recover debris generated during cleaning, preparation, and coating operations. The Contractor shall design, construct, and maintain containment systems for abrasive blasting operations in accordance with best management practices. Disposal of the collected materials shall be as specified in the Section 6-07.3(2)C.

1. At the pre-construction conference, the Contractor shall submit a written Containment System Plan, including working drawings as appropriate, describing the methods for waste containment, collection, and disposal, to the Engineer for approval. The Contractor shall prepare and submit the Containment System Plan in accordance with Section 6-01.9. The Contractor shall not begin any abrasive blasting operations until receiving the Engineer's approval of the Containment System Plan.
2. The containment system shall not cause any damage to the existing structure.
3. The Contractor shall enclose all portions of the bridge to be blasted by sweep blasting or spot abrasive blasting as specified. The enclosed area shall consist of that portion below the area to be blasted, and extending up the sides of the structure to above the top of the structure. The enclosed length of each bridge span (defined as pier to pier) shall not exceed one half the length of the span. The containment system may remain open at the top.
4. The containment system shall be capable of being removed rapidly in case of high winds. Abrasive blasting operations shall cease if wind conditions prevent capture of blast rebound and paint residue by the containment system. If there is a question on wind conditions, the Engineer will make the final determination on whether blasting operations shall cease and the containment system removed.
5. The containment system shall not endanger the safety and health of the workers. Access to the containment system shall be designed to prevent any confined materials from escaping.
6. To prevent the weight of the confined materials from causing failure to the containment system, all confined materials shall be collected and secured in sealed containers at the end of each shift daily, at a minimum. No confined materials shall escape during transfer from the containment systems to the sealable containers. All confined materials within the containment system shall be removed and secured in sealable containers prior to relocation or removal of the containment system.
7. If failure to the containment system occurs or if signs of failure to the containment system are present, the Contractor shall stop work immediately. Work shall not resume until the failure has been corrected to the satisfaction of the Engineer.

8. The containment structure shall not be removed and painting operations shall not commence until all abrasive blasted surfaces have been inspected and approved for painting by the Engineer.
9. If the containment structure is removed after the abrasive blasting operation and before the coating operation, the Contractor shall install a drip tarp to prevent spillage of paint onto the waterway and ground surface below.

6-07.3(2)C Testing and Disposal of Containment Waste

Containment waste is defined as all paint chips and debris removed from the steel surface, and all abrasive blast media, as contained by the containment system. After all waste from the containment structures has been collected, the Contractor shall have a minimum of three samples of the wastes tested by an accredited analytical laboratory. Each sample shall be taken from a different storage container unless directed otherwise by the Engineer.

The debris shall be tested for metals using the Toxicity Characteristics Leaching Procedure (TCLP), EPA Methods 1311 and 6010. At a minimum, the materials to be analyzed shall include Arsenic, Barium, Cadmium, Chromium Coppers, Lead, Mercury, Nickel, Selenium, Silver and Zinc.

If the average of the tested samples is at or above all threshold limits as stated in the Dangerous Waste Regulation, Chapter 173-303 WAC, the containment waste will be designated as "Dangerous Waste" and shall be disposed of at a permitted hazardous waste repository. If the average of the tested samples is below the threshold limits, the containment waste will be designated as "Solid Waste" and shall be disposed at a permitted sanitary landfill that will accept the waste. Disposal shall be in accordance with Chapter 173-303 WAC for waste designated "Dangerous Waste" or "Extremely Hazardous Waste" and in accordance with Chapter 173-304 WAC for waste designated as "Solid Waste".

The Contractor shall supply (2) two copies of the transmittal documents or bill of lading listing the waste material shipped from the construction site to the waste disposal site. One copy of the shipment list shall show the signature of the Engineer and shall have the waste site operator's confirmation for receipt of the waste.

In the event that the containment wastes are designated as "Dangerous Wastes" or "Extremely Hazardous Waste" under Chapter 173-303 WAC, the Contracting Agency will provide to the Contractor the appropriate EPA identification number.

Unless noted otherwise a waste site will not be provided by the Contracting Agency for the disposal of excess materials and debris.

6-07.3(2)D Drip Tarps

During painting operations the Contractor shall furnish, install, and maintain drip tarps below the areas to be painted to contain all spilled paint, buckets, brushes, and other deleterious material, and prevent such materials from reaching the environment below the bridge. Drip tarps shall be absorbent material and hung to minimize puddling.

The Contractor shall submit to the Engineer for approval, a proposed method for hanging the drip tarps below the paint platforms and connecting them to the bridge, in accordance with Section 6-01.9. After the Contractor has completed painting of the structure, the drip tarps and all connecting hardware shall be removed from the project.

At the pre-construction conference, the Contractor shall submit to the Engineer for approval, a written detailed method for the removal of any accidental spills or drips on traffic that occur during the normal painting operations. A vehicle cleaning station shall be provided.

At the pre-construction conference, the Contractor shall designate, in writing, a supervisory employee of the Contractor who will be on the project at all times and will be fully responsible for taking the required corrective action should any paint damage occur.

6-07.3(2)E Sampling and Testing

The Contractor shall provide the Engineer the following materials and information for testing:

1. One quart of each coating material and of each thinner for testing of each batch or lot that is sampled at the factory at the time of containerizing. The Contracting Agency may, at its discretion, place an Inspector at the site of manufacture.
2. A manufacturer's certificate certifying the test results for each batch of each coat. In addition, if the coating is specified for use on a steel contact surface, the certificate shall certify that the coating material meets the requirements for coefficient of friction.
3. A Product Data Sheet for each coating material and thinner.
4. A Material Safety Data Sheet with the initial sample for each type of coating material and thinner.
5. If the quantity of paint required for each component of the coating system is 20 gallons or less, Item 1 will not apply, and the coating system components will be accepted based on the manufacturer's notarized statement as specified in Section 9-08.3 along with copies of Items 2, 3, and 4.

The following tests will be used to insure that the coating materials meet the requirements of the specifications.

Test	Test Method
Weight-Per-Gallon Determination of Paints and Coatings	ASTM D 1475
Determination of Zinc Dry Films of Paints and Coatings	ASTM D 2371
Coarse Particles in Pigments, Pastes, and Paints	ASTM D 185
Consistency of Paints Using the Stormer Viscometer	ASTM D 562
Fineness of Dispersion of Pigment-Vehicle Systems	ASTM D 1210
Drying, Curing, of Film Formation of Organic Coatings at Room Temperatures	ASTM D 1640
Volatile Content of Paints	ASTM D 2369
Pigment Content of Solvent-Type Paints	ASTM D 2371
Infrared Identification of Vehicle	
Solids From Solvent-Type Paints	ASTM D 2621
Volume Nonvolatile Matter in Clear or Pigmented Coatings	ASTM D 2697
Vehicle Solids (Ordinary Centrifuge)	FTMS 141 Method 4051
Nonvolatile Vehicle Content	FTMS 141 Method 4053

Sampling and testing performed by the Contracting Agency shall not be construed as determining or predicting the performance or compatibility of the individual coating material, or the completed coating system.

The Contractor shall furnish to the Engineer five gallons of finish coat paint in the appropriate color specified in the Special Provisions as a part of this contract. The paint container shall be marked to show the lot number, bridge number and paint name and color number.

6-07.3(2)F Preparing Paint Materials for Use

Coating materials will be rejected if:

a) The material arrives at the application site in other than the original, unopened containers.

b) The container has a break in the lid seal or a puncture.

c) The coating material has begun to polymerize, solidify, gel, or deteriorate in any manner.

d) The recommended shelf life, as stated on the manufacturer's product data sheets, has expired.

e) A skin forms on the surface of the material or on the sides of the container and the volume of the skin exceeds 2 percent of the material. If there is not more than 2 percent skin, the Contractor shall remove and discard only the skin.

Mixing

The Contractor shall thoroughly mix coating materials by mechanical means to ensure a uniform composition. Coating materials shall not be mixed by means of air stream bubbling or boxing. Coating materials shall be mixed in the original containers and mixing shall continue until all pigment or metallic powder is in suspension. Care shall be taken to ensure that the solid coating material that has settled to the bottom of the container is thoroughly dispersed. After mixing, the Contractor shall inspect the coating materials for uniformity and to ensure that no unmixed pigment or lumps are present.

Catalysts, curing agents, hardeners, initiators, or dry metallic powders which are packaged separately shall be added to the base coating material only after the base coating material is thoroughly mixed to achieve a uniform mixture with all particles wetted. The Contractor shall then add the proper volume of curing agent to the correct volume of base and mix thoroughly. The mixture shall be used within the pot life specified by the manufacturer. Unused portions shall be discarded at the end of each work day.

Thinning

The Contractor shall not add additional thinner at the application site except as approved by the Engineer. The amount and type of thinner, if allowed, shall conform to the manufacturer's specifications.

Application Site Tinting

Application site tinting will not be allowed except as approved by the Engineer.

Agitators

When recommended by the manufacturer, the Contractor shall constantly agitate coating materials during application by use of paint pots equipped with mechanical agitators.

6-07.3(2)G Painting Steel Surfaces

The coating system for all steel surfaces shall incorporate three single component moisture-cured polyurethane coats. The first component shall be the primer coat, Standard Formula A-11-99. This coat shall be used as a spot coat in areas that are cleaned down to bare metal. The second coat shall be Standard Formula B-11-99 and third coat shall be Standard Formula C-11-99. The second and third coats shall encapsulate the entire structures.

In addition to the requirements of the Specifications, coating applications shall conform to:

a) The best practices of the trade.

b) The written recommendations of the coating manufacturer.

c) All applicable portions of the SSPC-PA1.

No primer paint shall be applied to any surface until the surface has been inspected and approved by the Engineer. Any area to which primer paint has been applied without the Engineer's inspection and approval will be considered improperly cleaned. The unauthorized application shall be completely removed and the entire area recleaned to the satisfaction of the Engineer. After the area has been recleaned, inspected, and approved, the Contractor may again initiate the painting sequence.

No additional compensation or extension of time in accordance with Section 1-08.8 will be allowed for the removal of any unauthorized paint application and recleaning of the underlying surface.

Surface Condition

The surface to be covered with a coating shall be free of dust, grease, or other substance that would prevent the bond of the succeeding application. The Contractor shall protect freshly coated surfaces from contamination by abrasives, dust, or foreign materials from any other source. The Contractor shall prepare contaminated surfaces to the satisfaction of the Engineer before applying another coat.

Application Methods

The Contractor shall apply coating materials by air or airless spray, brush, roller, any combination of these methods, or as recommended by the coating material manufacturer, unless otherwise specified. All application techniques shall conform to Section 7, SSPC-PA 1.

Each coat shall be applied in a uniform layer, completely covering the preceding coat. Individual coats shall be tinted a sufficiently different shade so that each coat can be easily detected. The Contractor shall correct runs, sags, skips, or other deficiencies before application of succeeding coats. Such corrective work may require recleaning, application of additional coating, or other means as determined by the Engineer at no additional cost to the Contracting Agency.

Painters, using brushes, shall work from pails containing a maximum of two gallons of paint. This is intended to minimize the impact of any spill.

Paint shall be stored and mixed in a secure, contained location to eliminate the potential for spills into State waters, and onto the ground and highway surfaces.

Environmental Conditions

Apply coating materials only during periods when:

1. Air temperature is above 35ºF.
2. Steel surface temperature is between 35ºF and 115ºF.
3. Steel surface does not show wet drops and is not wet.
4. Relative humidity is within the manufacturer's recommended range.

Application will not be allowed if the Engineer determines that conditions are not favorable for proper application and performance of the coating.

During painting operations the area below the bridge shall be protected with a drip tarp as specified in Section 6-07.3(2)D.

If fresh coatings are damaged by the elements, the Contractor shall replace or repair the coating to the satisfaction of the Engineer at no additional cost to the Contracting Agency.

Cleaning of equipment shall not be done in State waters nor shall resultant cleaning runoff be allowed to enter State waters. No paint cans, lids, brushes, or other debris shall be allowed to enter State waters.

Solvents, paints, paint sludge, cans, buckets, rags, brushes, and other waste associated with this project shall be collected and disposed of off site.

Paint products, petroleum products or other deleterious material shall not be wasted into, or otherwise enter, State waters as a result of project activities.

Application of Coatings

After applying the spot prime coat to all areas cleaned to bare metal and before applying the intermediate coat, the Contractor shall apply a stripe coat on all edges, corners, seams, crevices, interior angles, junction of joint members, rivet or bolt heads, nuts and threads, weld lines, and any similar surface irregularities. The stripe coat shall be the same formula as the intermediate coat. The stripe coat shall be of sufficient thickness to completely hide the surface being covered and shall be followed as soon as practical by the application of intermediate coat to its specified thickness. All stripe coats shall be done by brush.

If the spot prime coat leaves unsealed cracks or crevices, these shall be sealed with single component urethane sealant meeting the requirements of Federal specification TT-S-00230C, Type II, Class A (applied per the manufacturer's recommendation) before the intermediate coat is applied.

Coating thickness measurements will be made by the Engineer after the application of each coat and before the application of the succeeding coat. In addition, the Engineer will inspect for uniform and complete coverage and appearance. One hundred percent of all thickness measurements shall be the minimum wet film thickness specified in Section 6-07.3(5). If thickness measurements or visual inspection of coverage do not meet the specified minimum, the Contractor shall make additional applications, as necessary, to achieve thickness and coverage requirements.

In areas where wet film thickness measurements are impractical, dry film thickness measurements will be made using magnetic dry film thickness gauges as specified in Section 6-07.3(5).

If a question arises about an individual coat thickness or coverage, it will be verified by the use of a Tooke gage. If the Tooke gage shows a coat thickness to be less than a minimum dry film thickness of 3.0 mils or indicates a missing intermediate coat, the total coating system will be rejected, even if the thickness of the total system equals or exceeds the total thickness specified.

If roadway or sidewalk planks lie so close to the metal that they prevent proper cleaning and painting, the Contractor shall remove or cut the planks to provide at least a 1-inch clearance. Any plank removal or cutting shall be done as approved by the Engineer. The Contractor shall replace all planks after painting. If removal breaks or damages the planks and makes them unfit for reuse, the Contractor shall replace them at no expense to the Contracting Agency.

6-07.3(3) Painting Timber Structures

6-07.3(3)A Number of Coats and Color

Unless the Plans state otherwise:

1. Rails and rail posts on timber bridges shall receive two coats (with the wheel guard painted only on its top edge and roadway side).
2. Other timber work shall receive three coats (if the Plans or Special Provisions require it to be painted).

Paint color shall be as the Plans, Special Provisions, or Engineer may require.

6-07.3(3)B Application

As it is painted, any wood surface must be thoroughly dry and free from oil and dirt. Paint shall be applied by brush, spread evenly, and worked thoroughly into all seasoning cracks, corners, and recesses. No later coat shall be applied until the full thickness of the previous coat has dried.

Final brush strokes with aluminum paint shall be made in the same direction to ensure that powder particles “leaf” evenly.

If a painted surface has been stained by creosote nearby, it shall be given one or more coats of an approved shellac before repainting.

6-07.3(3)C Painting Treated Timber

Timber treated with creosote or oil-borne, pentachlorophenol preservatives shall normally not be painted.

Timber treated with water-borne preservatives shall be clean and be reduced to no more than 18 percent moisture content before it is painted. Any visible salt crystals on the wood surface shall be washed and brushed away — with the moisture content reduced again to the specified level before painting. Stored timber awaiting painting shall be covered and stacked with spreaders to ensure air circulation.

6-07.3(4) Painting Galvanized Surfaces

All galvanized surfaces specified to be painted shall be prepared for painting in accordance with the ASTM D 2092. The method of preparation shall be as agreed upon by the paint manufacturer and the galvanizer. The Contractor shall not begin painting until receiving the Engineer’s approval of the prepared galvanized surface.

Environmental Conditions

Steel surfaces shall be:

- Greater than 35ºF and
- Less than 115ºF

or per the manufacturer's recommendations, whichever is more stringent.

The Contractor shall paint the dry surface as follows:

	Paint Formulas	Type
First Coat	MIL-P-24441	Epoxy polyamide
Second Coat	C-11-99	Moisture Cured Aliphatic Polyurethane

Each coat shall be dry before the next coat is applied. All coats applied in the shop shall be dried hard before shipment.

6-07.3(5) Paint — Film Thickness

The paint film thickness for the paint system of Section 6-07.3(1) shall be as follows. The dry film thickness of the primer coat on the faying surfaces and on the top flanges where the welded shear connectors have been attached shall not be less than 2.5 mils nor greater than 3.5 mils. On all other areas, the minimum dry film thickness for the primer coat shall be 2.5 mils. The minimum dry film thickness for the intermediate coat shall be 3.5 mils. The minimum dry film thickness for the top coat shall be 1.0 mils.

The paint film thickness for the paint system of Section 6-07.3(2) shall be as follows. The minimum wet film thickness of each coat (primer, intermediate, and finish) shall be 6.0 mils.

If the Contract calls for the use of Formula A-5-61, the dry film thickness shall be between 0.4 and 0.7 mils. (The rapid solvent release in this vinyl pretreatment makes it difficult to measure wet film thickness.)

Any other finish, no matter how applied, shall have a wet thickness of at least 6.0 mils per coat and a dry film thickness of at least 3.0 mils per coat.

If the specified number of coats do not produce a combined dry film thickness of at least the sum of the thicknesses required per coat, the Contractor shall apply another full coat of finish paint.

Film thickness — wet and dry — will be measured by suitable gauges. The dry film thickness will be determined by the use of a magnetic or magnetic flux dry film thickness gauge. The gauge shall be calibrated on the blasted steel with plastic shims the same thickness as the minimum dry film thickness. Wet measurements will be taken immediately after the paint is applied, and dry measurements after the coat is dry and hard.

6-07.3(6) Protection of Public and Private Property

The Contractor shall protect public and private property, traffic, and other parts of the bridge (deck, sidewalks, etc.) from airborne or dripping paint. The Contractor shall supply and install enough canvas or other covering to provide this protection as painting proceeds. If the covering does not adequately protect traffic, the Engineer may require the Contractor to station lookouts who shall stop the painting while vehicles or pedestrians pass.

6-07.4 Measurement

No specific unit of measurement will apply to the lump sum price for cleaning and painting existing steel structures.

6-07.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Cleaning and Painting - _____", lump sum.

The lump sum contract price for "Cleaning and Painting - _____" shall be full pay for all cost in connection with furnishing and placing all necessary staging and rigging, providing material, labor, tools, and equipment, collection and storage of containment waste, collection, storage, testing, and disposal of all containment waste not conforming to the definition in Section 6-07.3(2)C, performing all cleaning and preparation of surfaces to be painted and applying all coats of paint and sealant.

"Containment of Abrasives", lump sum.

The lump sum contract price for "Containment of Abrasives" shall be full payment for all costs incurred by the Contractor in complying with the requirements as specified in Section 6-07.3(2)B to design, construct, maintain, and remove containment systems for abrasive blasting operations.

"Testing and Disposal of Containment Waste", by force account as provided in Section 1-09.6.

All costs in connection with testing containment waste, transporting containment waste for disposal, and disposing of containment waste in accordance with Section 6-07.3(2)C will be paid by force account in accordance with Section 1-09.6. For the purpose of providing a common proposal for all bidders the Contracting Agency has entered an amount for the item "Testing and Disposal of Containment Waste" in the bid proposal to become part of the total bid by the Contractor.

Payment for painting new steel structures and timber structures will be in accordance with Sections 6-03.5 and 6-04.5, respectively.

6-08 WATERPROOFING

6-08.1 Description

This work shall consist of applying waterproofing materials to Portland cement concrete surfaces as required by the Plans, these Specifications, or the Engineer. The application of these waterproofing materials will not be required if a concrete admixture meeting the requirements of 9-23.8 is used.

6-08.2 Materials

Materials shall meet the requirements of the following sections:

Asphalt for Waterproofing	9-11.1
Waterproofing Fabric	9-11.2
Portland Cement Mortar	9-11.3
Waterproofing Admixture	9-23.8

6-08.3 Construction Requirements

6-08.3(1) Storage of Fabric

The fabric shall be stored in a dry, protected place. Rolls shall not be stored standing on end.

6-08.3(2) Preparation of Surface

Concrete surfaces shall be reasonably smooth and without projections or holes that might puncture the waterproofing membrane. The surfaces shall be dry, with all dust and loose material removed. The Contractor shall not apply waterproofing in wet weather or when the air temperature is below 35ºF unless the Engineer approves in writing.

6-08.3(3) Application of Waterproofing

Waterproofing asphalt shall be stirred frequently as it is heated to between 300ºF and 350ºF. Each heating kettle shall have a thermometer.

Each coat of primer or asphalt shall begin at the low point of the surface so that water will run over (not against or along) the laps.

In applying the waterproofing, the Contractor shall:

1. Apply a coat of primer and let it dry before applying the first asphalt coat.
2. Mop hot asphalt on a band about 20-inches wide across the full length of the surface.
3. Immediately roll a starter strip of half-width fabric into the asphalt, pressing it into place to rid it of all air bubbles and to conform it closely to the surface.
4. Mop hot asphalt over the starter strip and an adjacent section of surface so that the fresh asphalt forms a band slightly wider than the full width of the fabric.
5. Immediately roll a full-width strip of fabric into the fresh asphalt, pressing it into place as before.
6. Mop hot asphalt on the latest strip and on an adjacent band of the surface slightly wider than the full width of the fabric.
7. Immediately roll another strip of fabric into the asphalt, lapping the earlier strip by at least 2-inches and pressing it into place as before.
8. Repeat steps 6 and 7 until the entire surface is covered.
9. Mop the entire surface with a final coating of hot asphalt.

The three complete moppings of asphalt shall ensure that no fabric layer ever touches another fabric layer or the concrete surface. The Contractor shall examine all laps and ensure that they are thoroughly sealed down.

Each mopping shall cover completely, with a coat heavy enough to hide the fabric weave and all gray spots from the concrete. On horizontal surfaces, at least 12 gallons of asphalt shall be used for every 100 square feet of finished work. On vertical surfaces, at least 15 gallons per 100 square feet shall be used.

At the end of each day's work, all fabric that was laid shall have received its final mopping of asphalt.

Wherever the membrane ends or is punctured by drains, pipes, etc., the Contractor shall seal the area to prevent water from entering between the waterproofing and the concrete surface.

All flashing (at curbs, against girders, spandrel walls, etc.) shall be made of separate sheets that lap the main membrane by at least 12-inches. Flashing shall be sealed closely: (1) with full metal flashing, or (2) by imbedding its upper edges in a groove poured full of an acceptable joint cement.

At each expansion joint, the membrane shall not be broken but shall be folded to permit movement. At either end of the bridge, the membrane shall run well down abutments and shall allow for expansion and contraction.

6-08.3(4) Protection Course

If the Plans require, the Contractor shall place a layer of mortar at least $1^1/_2$-inches thick over the whole surface of the membrane just after it has cooled to air temperature. This layer shall be a mix of one part Portland cement to two parts sand. It shall be distributed evenly over the membrane, tamped gently into place, finished by hand to a smooth, hard surface, then covered and kept moist for one week.

6-08.4 Measurement

Measurement will be the number of square yards of the surface of the waterproofed area.

6-08.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when it is included in the proposal:

"Waterproofing", per square yard.

Waterproofing of construction joints not shown in the Plans shall be at the Contractor's expense.

6-09 MODIFIED CONCRETE OVERLAYS

6-09.1 Description

This work consists of scarifying concrete bridge decks, preparing and repairing bridge deck surfaces designated and marked for further deck preparation, and placing, finishing, and curing modified concrete overlays.

6-09.2 Materials

Materials shall meet the requirements of the following Sections:

Portland Cement	9-01.2(1)
Fine Aggregate	9-03.1(2)B
Coarse Aggregate	9-03.1(4)C
Burlap Cloth	9-23.5
Admixtures	9-23.6
Fly Ash	9-23.9
Microsilica Fume	9-23.11
Water	9-25.1

Portland cement shall be either Type I or Type II. Type III portland cement will not be allowed.

Fine aggregate shall be Class 1. Coarse aggregate shall be AASHTO grading No. 7 or No. 8.

Fly ash shall be Class F only.

Microsilica admixture shall be either a dry powder or a slurry admixture. Microsilica will be accepted based on submittal to the Engineer of a Manufacturer's Certificate of Compliance conforming to Section 1-06.3. If the microsilica is a slurry admixture, the microsilica content of the slurry shall be certified as a percent by mass.

Latex admixture shall be a non-toxic, film-forming, polymeric emulsion in water to which all stabilizers have been added at the point of manufacture. The latex admixture shall be homogeneous and uniform in composition, and shall conform to the following:

Polymer Type Styrene Butadiene

Stabilizers:

Latex	Non-ionic surfactants
Portland Cement	Polydimethyl siloxane
Percent Solids	46.0 to 49.0
Weight per Gallon	8.4 pounds at 77ºF
Color	White
PH (as shipped)	9 minimum
Freeze/Thaw Stability	5 cycles (5ºF to 77ºF)
Shelf Life	2 years minimum

Latex admixture will be accepted based on submittal to the Engineer of a Manufacturer's Certificate of Compliance conforming to Section 1-06.3.

High Molecular Weight Methacrylate (HMWM) resin for crack and joint sealing shall conform to the following:

Viscosity	<25 cps (Brookfield RVT with UL adaptor, 50rpm at 77F)… California Test 434
Density	8.5 to 8.8 pounds per gallon at 77F… ASTM D 2849
Flash Point	>200F, PMCC (Pinsky-Martens CC)
Vapor Pressure	<0.04-inches Hg at 77F, ASTM D 323
Tg (DSC)	>136F, ASTM D 3418
Gel Time	60 minutes minimum

The promoter/initiator system for the methacrylate resin shall consist of a metal drier and peroxide.

Sand for abrasive finish shall be crushed sand, oven dried, and stored in moisture proof bags. The sand shall conform to the following gradation:

Sieve Size	Percent Passing	
	Minimum	Maximum
U.S. No. 10	98	100
U.S. No. 16	55	75
U.S. No. 20	30	50
U.S. No. 30	8	25
U.S. No. 50	0	5
U.S. No. 100	0	3

All percentages are by weight.

6-09.3 Construction Requirements

6-09.3(1) Equipment

6-09.3(1)A Power Driven Hand Tools

Power driven hand tools may be used for concrete scarification in areas not accessible to scarification machines, and for further deck preparation work, except for the following:

1. Jack hammers more forceful than the nominal 30-pound class.
2. Chipping hammers more forceful than the nominal 15-pound class.

The power driven hand tools shall be operated at angles less than 45 degrees as measured from the surface of the deck to the tool.

6-09.3(1)B Rotary Milling Machines

Rotary milling machines shall be capable of scarifying a minimum width of four feet per pass, have a maximum operating weight of 50,000 pounds, and conform to the requirements in Section 1-07.7.

Machines known to meet these specifications will be specified in the Special Provisions.

6-09.3(1)C Hydro-Demolition Machines

Hydro-demolition machines shall consist of filtering and pumping units operating in conjunction with a remote-controlled robotic device. Hydro-demolition machines shall scarify a minimum width of four feet per pass, using high velocity water jets to remove $^1/_2$-inch of sound concrete with the simultaneous removal of all deteriorated concrete. Hydro-demolition machines shall also clean any exposed reinforcing steel of all rust and corrosion products.

Possible sources of machines known to meet these specifications will be specified in the Special Provisions.

6-09.3(1)D Shot Blasting Machines

Shot blasting machines shall consist of a self contained mobile unit capable of scarifying a minimum width of six feet per pass, using steel abrasive to remove $^1/_2$-inch of sound concrete. The shot blasting machine shall vacuum and store all material removed from the scarified concrete surface into a self contained unit.

Possible sources of machines known to meet these specifications will be specified in the Special Provisions.

6-09.3(1)E Air Compressor

Air compressors shall be equipped with oil traps to eliminate oil from being blown onto the roadway deck during sandblasting and air cleaning.

6-09.3(1)F Vacuum Machine

Vacuum machines shall be capable of collecting all dust, concrete chips, freestanding water and other debris encountered while cleaning during deck preparation. The machines shall be equipped with collection systems that allow the machines to be operated in air pollution sensitive areas and shall be equipped to not contaminate the deck during final preparation for concrete placement.

6-09.3(1)G Water Spraying System

The water spraying system shall include a portable high-pressure sprayer with a separate water supply of potable water. The sprayer shall be readily available to all parts of the deck being overlaid and shall be able to discharge water in a fine mist to prevent accumulation of free water on the deck. Sufficient water shall be available to thoroughly soak the deck being overlaid and to keep the deck wet prior to concrete placement.

The Contractor shall certify that the water spraying system meets the following requirements:

Pressure	2,200 psi minimum
Flow Rate	4.5 gpm minimum
Fan Tip	15° to 25° Range

6-09.3(1)H Mobile Mixer for Latex Modified Concrete

Proportioning and mixing shall be accomplished in self-contained, self-propelled, continuous-mixing units conforming to the following requirements:

1. The mixer shall be equipped so that it can be grounded.
2. The mixer shall be equipped to provide positive measurement of the portland cement being introduced into the mix. An approved recording meter, visible at all times and equipped with a ticket printout, shall be used.

3. The mixer shall be equipped to provide positive control of the flow of water and latex admixture into the mixing chamber. Water flow shall be indicated by an approved flow meter with a minimum readability of one-half gallon per minute, accurate to ± 1 percent. The water system shall have a bypass valve capable of completely diverting the flow of water. Latex flow shall also be indicated by an approved flow meter with a minimum readability of two gallons per minute, accurate to ± 1 percent. The latex system shall be equipped with a bypass valve suitable for obtaining a calibrated sample of admixture.
4. The mixer shall be equipped to be calibrated to automatically proportion and blend all components of the specified mix on a continuous or intermittent basis as required by the finishing operation, and shall discharge mixed material through a conventional chute directly in front of the finishing machine.

Inspection of each mobile mixer shall be done by the Contractor in the presence of the Engineer and in accordance with the following requirements:

1. Check the manufacturer's inspection plate or mix setting chart for the serial number, the proper operating revolutions per minute (rpm), and the approximate number of counts on the cement meter to deliver 94 pounds of cement.
2. Make a general inspection of the mobile mixer to ensure cleanliness and good maintenance practices.
3. Check to see that the aggregate bins are empty and clean and that the bin vibrators work.
4. Verify that the cement aeration system operates, that the vent is open, and that the mixer is equipped with a grounding strap. Check the cement meter feeder to ensure that all fins and pockets are clean and free from accumulated cement. If the operator cannot demonstrate, through visual inspection, that the cement meter feeder is clean, all cement shall be removed from the bin and the cement meter feeder inspected. The aeration system shall be equipped with a gauge or indicator to verify that the system is operating.
5. Verify that the main belt is clean and free of any accumulated material.
6. Check the latex strainer to ensure cleanliness.

The initial calibration shall consist of the following items:

1. Cement Meter
   a. Refer to the truck manufacturer's mix setting chart to determine the specified operating rpm and the approximate number of counts required on the cement meter to deliver 94 pounds of cement.
   b. Place at least 40 bags (about 4,000 pounds) of cement in the cement bin.
   c. Ensure the mixer is resting on a level surface.
   d. Ensure the mixer is grounded.
   e. Adjust the engine throttle to obtain the specified rpm. Operate the unit, discharging cement until the belt has made one complete revolution. Stop the belt. Reset the cement meter to zero. Position a suitable container to catch the cement and discharge approximately one bag of cement. With a stopwatch, measure the time required to discharge the cement. Record the number of counts on the cement meter and determine the weight of the cement in the container. Repeat the process of discharging approximately one bag of cement until six runs have been made. Reset the cement meter to zero for each run.

Example:

Run No.	Cement Counts	Weight of Cement	Time In Seconds
1	66	95	31
2	68	96	31.2
3	67	95.5	31.0
4	66	95	29.8
5	67	95.25	30.5
6	66	95	30.8
TOTAL	400	571.75	184.3

Pounds of cement per count on cement meter:

$$\frac{\text{Weight of Cement}}{\text{No. of Counts}} = \frac{571.75}{400} = 1.43 \text{ LB./Count}$$

Counts per bag (94 pounds):

$$\frac{94}{1.43} = 65.7 \text{ Counts Bag}$$

Pounds of cement discharged per second:

$$\frac{\text{Weight of Cement}}{\text{Time in Seconds}} = \frac{571.75}{184.3} = 3.10 \text{ LB./SEC.}$$

Required time to discharge one bag:

$$\text{Time} = \frac{94}{3.10} = 30.32 \text{ SEC./Bag}$$

2. Latex Throttling Valve
   a. Check to be sure that the latex strainer is unobstructed.
   b. The latex throttling valve shall be adjusted to deliver 3.5 gallons of latex (29.4 pounds) for each bag of cement. From the above calculation 30.32 seconds are required to deliver one bag of cement.
   c. With the unit operating at the specified rpm, discharge latex into a container for 30.3 seconds and determine the weight of latex. Continue adjusting the valve until 29.4 to 29.5 pounds of latex is discharged in 30.3 seconds. Verify the accuracy of this valve setting three times.
3. Water Flow Meter
   a. Set the water flow meter by adjusting it to flow at one-half gallon per minute.

b. Collect and weigh the water discharged during a one minute interval with the equipment operating at the specified rpm. Divide the weight of water by 8.34 to determine the number of gallons.

c. Repeat Items a. and b., above, with the flow meter adjusted to one and one-half gallons per minute.

4. Aggregate Bin Gates

a. Set the gate openings to provide the amount of aggregate required to produce concrete having the specified proportions.

b. Discharge a representative sample of the aggregates through the gates and separate on the U.S. No. 4 sieve. Aggregates shall meet the requirements for proportions in accordance with Section 6-09.3(3)E.

c. Adjust the gate openings if necessary to provide the proper ratio of fine aggregate to total aggregate.

5. Production of Trial Mix

Each mobile mixer shall be operated to produce at least $^1/_2$ cubic yard of concrete, which shall be in compliance with these specifications, prior to acceptance of the mobile mixer for job use. The Engineer will perform yield, slump, and air tests on the concrete produced by each mixer. Calibration of each mobile mixer shall be done by the Contractor in the presence of the Engineer. A complete calibration is required on each mixer on each concrete placement unless, after the initial calibration, the personnel having the responsibility of mixer calibration on subsequent concrete placement were present during the initial calibration of the mixer and during the concrete placement operations and are able to verify the dial settings of the initial calibration and concrete placement.

If these criteria are met, a complete calibration need not be repeated provided that a single trial run verifies the previous settings of the cement meter, latex throttling valve, water flow meter, and aggregate gradations, and that the mixer has not left the project and the Engineer is satisfied that a complete calibration is not needed.

6-09.3(1)I Ready Mix Trucks for Fly Ash Modified and Microsilica Modified Concrete

Ready mix trucks shall conform to Section 6-02.3(4)A.

6-09.3(1)J Finishing Machine

The finishing machine shall meet the requirements of Section 6-02.3(10) and the following requirements:

The finishing machine shall be equipped with a rotating cylindrical double drum screed not exceeding 60-inches in length preceded by a vibrating pan. The vibrating pan shall be constructed of metal and be of sufficient length and width to properly consolidate the mixture. The vibrating frequency of the vibrating pan shall be variable with positive control between 3,000 and 6,000 rpm. A machine with a vibrating pan as an integral part may be proposed and will be considered for approval by the Engineer. Other finishing machines will be allowed subject to approval of the Engineer.

6-09.3(2) Submittals

The Contractor shall submit the following items to the Engineer for approval in accordance with Section 6-01.9:

1. The type of machine (rotary milling, hydro-demolition, or shot blasting) selected by the Contractor for use in this project to scarify concrete surfaces.
2. The axle loads and axle spacing of the rotary milling machine (if used).
3. The Runoff Water Disposal Plan (if a hydro-demolition machine is used). The Runoff Water Disposal Plan shall describe all provisions for the containment, collection, filtering, and disposal of all runoff water and associated contaminants generated by the hydro-demolition process.
4. The method and materials used to contain, collect, and dispose of all concrete debris generated by the scarifying process, including provisions for protecting adjacent traffic from flying debris.
5. The mix design for concrete Class M, and either fly ash modified concrete, microsilica modified concrete, or latex modified concrete, as selected by the Contractor for use in this project in accordance with Section 6-09.3(3).
6. Samples of the latex admixture and the portland cement for testing and compatibility (if latex modified concrete is used).
7. Details of the screed rail support system, including details of anchoring the rails and providing rail continuity.

The Contractor shall not begin scarifying operations until receiving the Engineer's approval of Items 1 through 4 as applicable for the Contractor's scarifying method. The Contractor shall not begin placing modified concrete overlay until receiving the Engineer's approval of Items 5 through 7 as applicable for the Contractor's selected type of modified concrete.

6-09.3(3) Concrete Overlay Mixes

6-09.3(3)A General

For fly ash, microsilica, and latex modified concrete, the Contractor shall adjust the slump to accommodate the gradient of the bridge deck, subject to the maximum slump specified.

For fly ash and microsilica modified concrete, the maximum water/cement ratio shall be calculated using all of the available mix water, including the free water in both the coarse and fine aggregate, and in the microsilica slurry if a slurry is used.

For fly ash and microsilica modified concrete, all water reducing and air entraining admixtures, and superplasticizers, shall be used in accordance with the fly ash supplier's and microsilica admixture supplier's recommendations, respectively, and as approved by the Engineer.

6-09.3(3)B Concrete Class M

Concrete Class M for further deck preparation patching concrete shall be proportioned in accordance with the following mix design:

Portland Cement	705 pounds
Fine Aggregate	1,280 pounds
Coarse Aggregate	1,650 pounds
Water/Cement Ratio	0.37 maximum
Air (± $1^1/_2$ percent)	6 percent
Slump (± 1-inch)	5-inches

The use of a water-reducing admixture conforming to AASHTO M 194 Type A will be required to produce patching concrete with the desired slump, and shall be used in accordance with the admixture manufacturer's recommendations. Air entraining admixtures shall conform to AASHTO M 154 and shall be used in accordance with the admixture manufacturer's recommendations. The use of accelerating admixtures or other types of admixtures is not allowed.

6-09.3(3)C Fly Ash Modified Concrete

Fly ash modified concrete shall be a workable mix, uniform in composition and consistency. Mix proportions per cubic yard shall be as follows:

Portland Cement	611 pounds
Fly Ash	275 pounds
Fine Aggregate	38 percent of total aggregate
Coarse Aggregate	62 percent of total aggregate
Water/Cement Ratio	0.30 maximum
Air (± $1^1/_2$ percent)	6 percent
Slump	7-inches maximum

6-09.3(3)D Microsilica Modified Concrete

Microsilica modified concrete shall be a workable mix, uniform in composition and consistency. Mix proportions per cubic yard shall be as follows:

Portland Cement	658 pounds
Microsilica Fume	52 pounds
Fine Aggregate	1,515 pounds
Coarse Aggregate	1,515 pounds
Water/Cement Ratio	0.33 maximum
Air (± $1^1/_2$ percent)	6 percent
Slump	7-inches maximum

6-09.3(3)E Latex Modified Concrete

Latex modified concrete shall be a workable mix, uniform in composition and consistency. Mix proportions per cubic yard shall be as follows:

Portland Cement	1.00 parts by weight
Fine Aggregate	2.40 to 2.75 parts by weight
Coarse Aggregate	1.75 to 2.00 parts by weight
Latex Admixture	3.50 gallons per bag of cement
Water/Cement Ratio	0.33 maximum
Air Content of Plastic Mix	6 percent maximum
Slump	7inches maximum

The aggregates shall be proportioned such that the amount of aggregate passing the U.S. No. 4 sieve is 65 ± 5 percent of the total aggregate (fine plus coarse). All calculations shall be based on dry weights.

The moisture content of the fine aggregate and coarse aggregate shall be no more than 3.0 and 1.0 percent, respectively, above the saturated surface dry condition.

The water limit for calculating the water/cement ratio shall include the added water, the free water in the aggregates, and 52 percent of the latex admixture.

6-09.3(4) Storing and Handling

6-09.3(4)A Aggregate

Aggregates shall be stored and handled in a manner to prevent variations of more than 1.0 percent in moisture content of the stockpile.

For latex modified concrete, the moisture content of the aggregate at the time of proportioning shall be as specified in Section 6-09.3(3)E.

6-09.3(4)B Latex Admixture

The admixture shall be kept in suitable containers that will protect it from freezing and from exposure to temperatures in excess of 85ºF. Containers of the admixture shall not be stored in direct sunlight for periods in excess of ten days. When stored in direct sunlight the top and sides of the containers shall be covered with insulating blanket material.

Storage of the admixture may extend over a period greater than ten days as long as the conditions specified above are maintained and the latex admixture is agitated or stirred once every ten days. Stirring or agitation of the admixture shall be done mechanically in accordance with the manufacturer's recommendation and as approved by the Engineer. If the ambient temperature is higher than 85ºF at any time during the storage period, the admixture shall be covered by insulated blankets or other means that will maintain the admixture temperature below 85ºF.

The admixture shall be strained through a Number 10 strainer at the time it is introduced into the mixing tank from the storage containers.

6-09.3(4)C High Molecular Weight Methacrylate Resin (HMWM)

The HMWM resin shall be stored in a cool dry place and protected from freezing and exposure to temperature in excess of 100ºF. The promoter and initiator, if supplied separate from the resin, shall not contact each other directly. Containers of promoters and initiators shall not be stored together in a manner that will allow leakage or spillage from one to contact the containers or material of the other.

6-09.3(5) Scarifying Concrete Surface

6-09.3(5)A General

The Contractor shall not begin scarifying a concrete bridge deck surface unless completion of the scarification and concrete overlay can be accomplished within the current construction season.

The Contractor shall not begin scarifying a concrete bridge deck surface until receiving the Engineer's written approval of the machine to be used for scarifying

The Contractor shall protect adjacent traffic from flying debris generated by the scarification process in accordance with Item 4 of Section 6-09.3(2) and as approved by the Engineer.

The Contractor shall collect, contain, and dispose of all concrete debris generated by the scarification process in accordance with Item 4 of Section 6-09.3(2) and as approved by the Engineer.

All areas of the deck that are inaccessible to the selected scarifying machine shall be scarified to remove the concrete surface matrix to a maximum depth of $^1/_2$-inch by a method approved by the Engineer. If these areas are hand-chipped then the equipment shall meet the requirements as specified in Section 6-09.3(1)A.

6-09.3(5)B Testing of Hydro-Demolition and Shot Blasting Machines

A trial area shall be designated by the Engineer to demonstrate that the equipment and methods of operation are capable of producing results satisfactory to the Engineer. The trial area shall consist of two patches each of approximately 30 square feet, one area in sound concrete and one area of deteriorated concrete as determined by the Engineer.

In the "sound" area of concrete, the equipment shall be programmed to remove $^1/_2$-inch of concrete.

Following the test over sound concrete, the equipment shall be located over the deteriorated concrete and using the same parameters for the sound concrete removal, remove all deteriorated concrete. The Engineer will grant approval of the equipment based on successful results from the trial area test.

6-09.3(5)C Hydro-Demolishing

Once the operating parameters of the Hydro-Demolition machine are defined by programming and calibration as specified in Section 6-09.3(5)B, they shall not be changed as the machine progresses across the bridge deck, in order to prevent the unnecessary removal of sound concrete below the required minimum removal depth. The Contractor shall maintain a minimum production rate of 250 square feet per hour during the deck scarifying process.

All water used in the Hydro-Demolition process shall be potable. Stream or lake water will not be permitted.

All bridge drains and other outlets within 100-feet of the Hydro-Demolition machine shall be temporarily plugged during the Hydro-Demolition operation. When scarifying a bridge deck passing over traffic lanes, the Contractor shall protect the traffic below by restricting and containing scarifying operations, and implementing traffic control measures, as approved by the Engineer.

The Contractor shall provide for the collection, filtering and disposal of all runoff water generated by the Hydro-Demolition process, in accordance with the Runoff Water Disposal Plan as approved by the Engineer in accordance with Item 3 of Section 6-09.3(2). The Contractor shall comply with applicable regulations concerning such water disposal.

6-09.3(5)D Shot Blasting

Once the operating parameters of the Shot Blasting machine are defined by programming and calibration, as specified in Section; 6-09.3(5)B, they shall not be changed as the machine progresses across the bridge deck, in order to prevent the unnecessary removal of sound concrete below the required minimum removal depth. The Contractor shall maintain a minimum production rate of 250 square feet per hour during the deck scarifying process.

6-09.3(5)E Rotomilling

The entire concrete surface of the bridge deck shall be scarified to remove the surface matrix to a maximum $^1/_2$-inch depth of the concrete. The operating parameters of the rotary milling machine shall be monitored in order to prevent the unnecessary removal of sound concrete below the $^1/_2$-inch maximum removal depth.

6-09.3(5)F Repair of Steel Reinforcing Bars Damaged by Scarifying Operations

All reinforcing steel damaged due to the Contractor's operations shall be repaired by the Contractor. For bridge decks not constructed under the same contract as the concrete overlay, damage to existing reinforcing steel shall be repaired and paid for in accordance with Section 1-09.6 if the existing concrete cover is $^1/_2$-inch or less. All other reinforcing steel damaged due to the Contractor's operations shall be repaired by the Contractor at no additional expense to the Contracting Agency.

The repair shall be as follows or as directed by the Engineer:

1. Damage to epoxy coating, when present on existing steel reinforcing bars, shall be repaired in accordance with Section 6-02.3(24)H.
2. Damage to bars resulting in a section loss of 20 percent or more of the bar area shall be repaired by chipping out the adjacent concrete and splicing a new bar of the same size. Concrete shall be removed to provide a 3/4-inch minimum clearance around the bars. The splice bars shall extend a minimum of 40 bar diameters beyond each end of the damage.
3. Any bars partially or completely removed from the deck shall have the damaged portions removed and spliced with new bars as outlined in Item 2 above.

6-09.3(5)G Cleanup Following Scarification

After scarifying is completed, the lane or strip being overlaid shall be thoroughly cleaned of all dust, freestanding water and loose particles. Cleaning may be accomplished by using compressed air, water blasting, with a minimum pressure of 5,000 psi, or vacuum machines. Vacuum cleaning shall be used when required by applicable air pollution ordinances.

6-09.3(6) Further Deck Preparation

Once the lane or strip being overlaid has been cleaned of debris from scarifying, the Contractor, under the direction of the Engineer, shall perform an inspection of the completed work and shall mark those areas of the existing bridge deck that require further deck preparation by the Contractor. Further deck preparation will be required when any one of the following conditions is present:

1. Unsound concrete.
2. Lack of bond between existing concrete and reinforcing steel.
3. Exposure of reinforcing steel to a depth of one-half of the periphery of a bar for a distance of 12-inches or more along the bar.
4. Existing non-concrete patches as marked by the Engineer.

If the concrete overlay is placed on a bridge deck as part of the same contract as the bridge deck construction, then all work associated with the further deck preparation shall be performed at no additional expense to the Contracting Agency.

6-09.3(6)A Equipment for Further Deck Preparation

Further deck preparation shall be performed using either hand operated tools conforming to Section 6-09.3(1)A, or hydro-demolishing machines conforming to Section 6-09.3(1)C.

6-09.3(6)B Deck Repair Preparation

All concrete in the repair area shall be removed by chipping, hydro demolishing, or other approved mechanical means to a depth necessary to remove all loose and unsound concrete. If unsound concrete exists around the steel reinforcing bars, or if the bond between concrete and steel is broken, concrete must be removed to provide a 3/4-inch minimum clearance around the steel reinforcing bars.

Care shall be taken in removing the deteriorated concrete to not damage any of the existing deck or steel reinforcing bars that are to remain in place. All removal shall be accomplished by making neat vertical cuts and maintaining square edges at the boundaries of the repair area. Cuts made by using sawing or hydro demolishing machines shall be made after sufficient concrete removal has been accomplished to establish the limits of the removal area. In no case shall the depth of the vertical cut exceed 3/4-inch or to the top of the top steel reinforcing bars, whichever is less.

The exposed steel reinforcing bars and concrete in the repair area shall be sandblasted or hydro-blasted and blown clean just prior to placing concrete. Bridge deck areas outside the repair area or steel reinforcing bar inside or outside the repair area damaged by the Contractor's operations, shall be repaired by the Contractor at no additional expense to the Contracting Agency, and to the satisfaction of the Engineer.

All steel reinforcing bars damaged due to the Contractor's operations shall be repaired in accordance with Section 6-09.3(5)F.

6-09.3(6)C Placing Deck Repair Concrete

Patching concrete for modified concrete overlays shall be either modified concrete or concrete Class M. For small deck repair, and as determined by the Engineer, the Contractor may use the same modified concrete as that used in the overlay.

Before placing any patching concrete, the Contractor shall flush the existing concrete in the repair area with water and make sure that the existing concrete is well saturated. The Contractor shall remove any freestanding water prior to placing the patching concrete. The Contractor shall place the patching concrete other than latex modified concrete onto the existing concrete while it is wet.

If latex, fly ash, or microsilica modified concrete is used as the patching concrete, a thin slurry bond grout shall be scrubbed into the existing concrete surface. The bond grout shall match the overlay type being used as specified in Section 6-09.3(11).

If the Contractor elects to use as a patching material the same modified concrete as that used in the overlay, then the repair areas shall be filled flush with the deck surface sufficiently in advance of the overlay placement so that the material will not roll back under the screeds but shall not be placed more than one hour in advance of the overlay placement.

Areas patched with modified concrete or concrete Class M shall be wet cured for 24 hours in accordance with Section 6-09.3(13). During the curing period, all vehicular and foot traffic shall be prohibited on the repaired area.

6-09.3(7) Surface Preparation For Concrete Overlay

Following the completion of any required further deck preparation the entire lane or strip being overlaid shall be cleaned.

If either a rotary milling machine or a shot blasting machine is used for concrete scarification, then the concrete deck shall be sandblasted or shot blasted, using equipment approved by the Engineer, until sound concrete is exposed. Care shall be taken to ensure that all exposed reinforcing steel and the surrounding concrete is completely blasted. Bridge grate inlets, expansion dams and barriers above the surface to be blasted shall be protected from the blasting.

If a hydro-demolition machine is used for concrete scarification, then the concrete deck shall be cleaned by an approved method of water blasting with 7,000 psi minimum pressure, until sound concrete is exposed.

The final surface of the deck shall be free from oil and grease, rust and other foreign material that may reduce the bond of the new concrete to the old. These materials shall be removed by detergent- cleaning or other method as approved by the Engineer followed by sandblasting.

After all scarifying, chipping, sandblasting and cleaning is completed, the entire lane or strip being overlaid shall be cleaned in final preparation for placing concrete using either compressed air or vacuum machines. Vacuum machines shall be used when warranted by applicable air pollution ordinances.

Scarifying with either rotary milling machines or shot blasting machines, hand tool chipping, sandblasting and cleaning in areas adjacent to a lane or strip being cleaned in final preparation for placing concrete shall be discontinued when final preparation is begun. Scarifying and hand tool chipping shall remain suspended until the concrete has been placed and the requirement for curing time has been satisfied. Sandblasting and cleaning shall remain suspended for the first 24 hours of curing time after the completion of concrete placing.

If the hydro demolishing scarification process is used, scarification may proceed during the final cleaning and overlay placement phases of the work on adjacent portions of the structure so long as the hydro demolisher operations are confined to areas which are a minimum of 100-feet away from the defined limits of the final cleaning or overlay placement in progress. If the hydro demolisher impedes or interferes in any way with the final cleaning or overlay placement as determined by the Engineer, the hydro demolishing work shall be terminated immediately and the hydro demolishing equipment removed sufficiently away from the area being prepared or overlaid to eliminate the conflict. If the grade is such that water and contaminates from the hydro demolishing operation will flow into the area being prepared or overlaid, the hydro demolishing operation shall be terminated and shall remain suspended for the first 24 hours of curing time after the completion of concrete placement.

If, after final cleaning, the lane or strip being overlaid becomes wet, the Contractor shall flush the surface with high-pressure water, prior to placement of the overlay. All freestanding water shall be removed prior to concrete placement. Concrete placement shall begin within 24 hours of the completion of deck preparation for the portion of the deck to be overlaid. If concrete placement has not begun within 24 hours, the lane or strip being overlaid shall be cleaned by a light sand blasting followed by washing with the high-pressure water spray or by cleaning with the high-pressure spray as approved by the Engineer.

Traffic other than required construction equipment will not be permitted on any portion of the lane or strip being overlaid that has undergone final preparation for placing concrete unless approved by the Engineer. To prevent contamination, all equipment allowed on the deck after final cleaning shall be equipped with drip guards.

6-09.3(8) Quality Assurance

6-09.3(8)A Quality Assurance for Microsilica Modified and Fly Ash Modified Concrete Overlays

The Engineer will perform slump, temperature, and entrained air tests for acceptance after the Contractor indicates that the concrete is ready for placement. Concrete from the first truckload shall not be placed until tests for acceptance have been completed by the Engineer and the results indicate that the concrete is within acceptable limits. Sampling and testing will continue for each load until two successive loads meet all applicable acceptance test requirements. Except for the first load of concrete, up to $^1/_2$ cubic yard may be placed prior to testing for acceptance. After two successive tests indicate that the concrete is within specified limits, the sampling and testing frequency may decrease to one for every three truckloads. Loads to be sampled will be selected in accordance with the random selection process outlined in FOP for WAQTC TM2.

When the results of any subsequent acceptance test indicates that the concrete does not conform to the specified limits, the sampling and testing frequency will be resumed for each truckload. Whenever two successive subsequent tests indicate that the concrete is within the specified limits, the random sampling and testing frequency of one for every three truck loads may resume.

The test for determining the slump of the concrete will be conducted in accordance with the WSDOT FOP for AASHTO T 119 and the test for determining the percentage of entrained air will be conducted in accordance with the WAQTC FOP for AASHTO T 152.

The Engineer will test for slump and/or air any load of concrete the Engineer deems necessary.

6-09.3(8)B Quality Assurance for Latex Modified Concrete Overlays

The Engineer will perform operational control testing as the concrete is being placed. The Contractor shall provide the Engineer with a 1/4-cubic yard container and assistance in obtaining and handling samples. The 1/4-cubic yard container shall have a 9-inch minimum depth and shall be placed on a level surface. A minimum of one test per mobile mixer per shift will be conducted. The test will be conducted after eight minutes of mixer operation.

The Engineer will perform slump and air tests as the concrete is being placed. The minimum number of tests will be one slump test and one air test per mobile mixer, beginning with the first charge and every other charge thereafter. The sample will be taken after the first two minutes of continuous mixer operation. The concrete will be sampled as follows:

1. While concrete is being deposited onto the bridge deck, the stream will be diverted into a wheelbarrow or other suitable container. Approximately 1 cubic foot of concrete will be sufficient to conduct one slump test and one air test.
2. Take the sample to the test site. The test site should be located away from the mobile mixer and off the end of the bridge if practical.
3. Allow the sample to stand undisturbed. The fresh concrete sample must be protected from sunlight and wind until the conclusion of the testing. Total time from discharge to time of start of slump testing will not exceed six and one half minutes.

The test for determining the slump of the concrete will be conducted in accordance with WSDOT FOP for AASHTO T 119 and the test for determining the percentage of entrained air will be conducted in accordance with WAQTC FOP for AASHTO T 152.

During the initial proportioning, mixing, placing, and finishing operations, the Engineer may require the presence of a technical representative from the latex admixture manufacturer. The technical representative shall be capable of performing, demonstrating, inspecting, and testing all of the functions required for placement of the latex modified concrete as specified in Section 6-09.3(11) and as approved by the Engineer. This technical representative shall aid in the proper installation of the latex modified concrete. Recommendations made by the technical representative on or off the jobsite, and approved by the Engineer, shall be adhered to by the Contractor at no additional expense to the Contracting Agency. The Engineer will advise the Contractor in writing a minimum of five working days before such services are required.

6-09.3(9) Mixing Concrete For Concrete Overlay

6-09.3(9)A Mixing Microsilica Modified or Fly Ash Modified Concrete

Mixing of concrete shall be in accordance with Section 6-02, with the following exceptions:

1. The mixing shall be done at a batch plant.
2. The volume of concrete transported by truck shall not exceed six cubic yards per truck.

6-09.3(9)B Mixing Latex Modified Concrete

The equipment used for mixing the concrete shall be operated with strict adherence to the procedures set forth by its manufacturer.

A minimum of two mixers will be required at the overlay site for each concrete placement when the total volume of concrete to be placed during the concrete placement exceeds the material storage capacity of a single mixer. Additional mixers may be required if conditions require that material be stockpiled away from the jobsite. The Contractor shall have sufficient mixers on hand to ensure a consistent and continuous delivery and placement of concrete throughout the concrete placement.

Charging the mobile mixer shall be done in the presence of the Engineer. Mixing capabilities shall be such that the finishing operation can proceed at a steady pace.

6-09.3(10) Overlay Profile and Screed Rails

The overlay shall have a thickness of $1^1/_2$-inches or as specified by the Engineer. The thickness shall be verified prior to the placement of concrete by attaching a filler block, having a thickness of $^1/_4$-inch less than the overlay thickness, to the bottom of the screed. The filler block shall pass freely over the surface to be overlaid. With the screed guides in place, the finishing machine shall be passed over the entire surface to be overlaid and the final screed rail adjustments shall be made.

If the overlay thickness does not verify, the profile of the new concrete surface shall be adjusted as approved by the Engineer.

After the overlay thickness has been verified, changes in the finishing machine elevation controls will not be allowed.

Rails upon which the finishing machine travels shall be placed outside of the area to be overlaid, in accordance with Item 7 of Section 6-09.3(2) and as approved by the Engineer. Interlocking rail sections or other approved methods of providing rail continuity are required.

Hold-down devices shot into the concrete are not permitted unless the concrete is to be subsequently overlaid. Hold-down devices of other types leaving holes in the exposed area will be allowed provided the holes are subsequently filled with a sand/cement grout (sand and portland cement in equal proportions by volume). Hold-down devices shall not penetrate the existing deck by more than $^3/_4$-inch.

Rails may be removed at any time after the concrete has taken an initial set. Adequate precautions shall be taken during the removal of the finishing machine and rails to protect the edges of the new surfaces.

The Contractor shall be responsible for setting screed control to obtain the nominal overlay thickness specified as well as the finished surface smoothness requirements.

6-09.3(11) Placing Concrete Overlay

Prior to concrete placement, the Contractor shall review the equipment, procedures, personnel, and previous results with the Engineer. Inspection procedures shall also be reviewed to ensure coordination.

Concrete placement shall be made in accordance with Section 6-02 and the following requirements:

1. After the lane or strip to be overlaid has been prepared and immediately before placing the concrete, it shall be thoroughly soaked and kept continuously wet with water for a minimum period of six hours prior to placement of the concrete. All freestanding water shall be removed prior to concrete placement. During concrete placement, the lane or strip shall be kept moist.

   The concrete shall then be promptly and continuously delivered and deposited on the placement side of the finishing machine.

   If latex modified concrete is used, the concrete shall be thoroughly brushed into the surface and then brought up to final grade. If either microsilica modified concrete or fly ash modified concrete are used, a slurry of the concrete, excluding aggregate, shall be thoroughly brushed into the surface prior to the overlay placement.

Care shall be exercised to ensure that the surface receives a thorough, even coating and that the rate of progress is limited so that the brushed concrete does not become dry before it is covered with additional concrete as required for the final grade. All aggregate which is segregated from the mix during the brushing operation shall be removed from the deck and disposed of by the Contractor.

If either microsilica modified concrete or fly ash modified concrete are used, the Contractor shall ensure that a sufficient number of trucks are used for concrete delivery to obtain a consistent and continuous delivery and placement of concrete throughout the concrete placement operation.

When concrete is to be placed against the concrete in a previously placed transverse joint, lane, or strip, the previously placed concrete shall be sawed back six inches to straight and vertical edges and shall be sandblasted or water blasted before new concrete is placed. The Engineer may decrease the six inch saw back requirement to two inches minimum, if a bulkhead was used during previous concrete placement and the concrete was hand vibrated along the bulkhead.

2. Concrete placement shall not begin if rain is expected. Adequate precautions shall be taken to protect freshly placed concrete in the event that rain begins during placement. Concrete that is damaged by rain shall be removed and replaced by the Contractor at no additional expense to the Contracting Agency, and to the satisfaction of the Engineer.
3. Concrete shall not be placed when the temperature of the concrete surface is less than 45ºF or greater than 75ºF, when the combination of air temperature, relative humidity, fresh concrete temperature, and wind velocity at the construction site produces an evaporation rate of 0.15 pound per square foot of surface per hour as determined from Table 6-02.3(6)-1, or when winds are in excess of 10 mph. If the Contractor elects to work at night to meet these criteria, adequate lighting shall be provided at no additional expense to the Contracting Agency, and as approved by the Engineer.
4. If concrete placement is stopped for a period of one-half hour or more, the Contractor shall install a bulkhead transverse to the direction of placement at a position where the overlay can be finished full width up to the bulkhead. The bulkhead shall be full depth of the overlay and shall be installed to grade. The concrete shall be finished and cured in accordance with these specifications.

   Further placement is permitted only after a period of 12 hours unless a gap is left in the lane or strip. The gap shall be of sufficient width for the finishing machine to clear the transverse bulkhead installed where concrete placement was stopped. The previously placed concrete shall be sawed back from the bulkhead, to a point designated by the Engineer, to straight and vertical edges and shall be sandblasted or water blasted before new concrete is placed.
5. Concrete shall not be placed against the edge of an adjacent lane or strip that is less than 36 hours old.

6-09.3(12) Finishing Concrete Overlay

Finishing shall be accomplished in accordance with the applicable portions of Section 6-02.3(10) and as follows. Concrete shall be placed and struck-off approximately $^1/_2$-inch above final grade and then consolidated and finished to final grade with a single pass (the Engineer may require additional passes) of the finishing machine. Hand finishing may be necessary to close up or seal off the surface. The final product shall be a dense uniform surface.

Latex shall not be sprayed on a freshly placed latex modified concrete surface; however, a light fog spray of water is permitted if required for finishing, as determined by the Engineer.

As the finishing machine progresses along the placed concrete, the surface shall be given a final finish by texturing with a comb perpendicular to the centerline of the bridge. The texture shall be applied immediately behind the finishing machine. The comb shall consist of a single row of metal tines capable of producing $^1/_8$-inch wide striations approximately 0.015-foot in depth at approximately $^1/_2$-inch spacing. The combs may be operated manually or mechanically, either singly or in gangs (several combs placed end to end). This operation shall be done in a manner that will minimize the displacement of the aggregate particles. The texture shall not extend into areas within 2-feet of the curb line. The non-textured concrete within 2-feet of the curb line shall be hand finished with a steel or magnesium trowel.

Screed rails and construction dams shall be separated from the newly placed concrete by passing a pointing trowel along the inside surfaces of the rails or dams. Care shall be exercised to ensure that this trowel cut is made for the entire depth and length of rails or dams after the concrete has stiffened sufficiently that it does not flow back.

After the burlap cover has been removed and the concrete surface has dried, but before opening to traffic, all joints and visible cracks shall be filled and sealed with a high molecular weight methacrylate resin (HMWM). Cracks $^1/_{16}$-inch and greater in width shall receive two applications of HMWM. Immediately following the application of HMWM, the wetted surface shall be coated with sand for abrasive finish.

6-09.3(13) Curing Concrete Overlay

As the texturing portion of the finishing operation progresses, the concrete shall be immediately covered with a single layer of clean, new or used, wet burlap. The burlap shall have a maximum width of six feet. The Engineer will determine the suitability of the burlap for reuse, based on the cleanliness and absorption ability of the burlap. Care shall be exercised to ensure that the burlap is well drained and laid flat with no wrinkles on the deck surface. Adjacent strips of burlap shall have a minimum overlap of six inches.

Once in place the burlap shall be lightly fog sprayed with water. A separate layer of white, reflective type polyethylene sheeting shall immediately be placed over the wet burlap. The concrete shall then be wet cured by keeping the burlap wet for a minimum of 42 hours after which the polyethylene sheeting and burlap may be removed.

Traffic shall not be permitted on the finished concrete until the specified curing time is satisfied and until the concrete has reached a minimum compressive strength of 3,000 psi as verified by rebound number determined in accordance with ASTM C 805.

6-09.3(14) Checking for Bond

After the requirements for curing have been met, the entire overlaid surface shall be sounded by the Contractor, in a manner approved by and in the presence of the Engineer, to ensure total bond of the concrete to the bridge deck. Concrete in unbonded areas shall be removed and replaced by the Contractor with the same modified concrete as used in the overlay at no additional expense to the Contracting Agency. All cracks, except those that are significant enough to require removal, shall be thoroughly filled and sealed as specified in Section 6-09.3(12).

After the curing requirements have been met, the Contractor may use compressed air to accelerate drying of the deck surface for crack identification and sealing.

6-09.4 Measurement

Scarifying concrete surface will be measured by the square yard of surface actually scarified.

Modified concrete overlay will be measured by the cubic foot of material placed. For latex modified concrete overlay, the volume will be determined by the theoretical yield of the design mix and documented by the counts of the cement meter less waste. For both microsilica modified concrete overlay and fly ash modified concrete overlay, the volume will be determined from the concrete supplier's Certificate of Compliance for each batch delivered less waste. Waste is defined as the following:

1. Material not placed.
2. Material placed in excess of six inches outside a longitudinal joint or transverse joint.

Finishing and curing modified concrete overlay will be measured by the square yard of overlay surface actually finished and cured.

When further deck preparation is measured by volume, it will be measured by the cubic foot of material placed. When latex modified concrete overlay is used as the repair material, the volume will be determined by the theoretical yield of the design mix and documented by the counts of the cement meter less waste. When either microsilica modified concrete overlay, fly ash modified concrete overlay, or concrete Class M are used as the repair material, the volume will be determined from the concrete supplier's Certificate of Compliance for each batch delivered less waste.

6-09.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the bid proposal:

"Scarifying Conc. Surface", per square yard.

The unit contract price per square yard for "Scarifying Conc. Surface" shall be full pay for performing the work as specified, including testing and calibration of the machines and tools used, containment, collection, and disposal of all water and abrasives used and debris created by the scarifying operation, measures taken to protect adjacent traffic from flying debris, and final cleanup following the scarifying operation.

"Modified Conc. Overlay", per cubic foot.

The unit contract price per cubic foot for "Modified Conc. Overlay" shall be full pay for furnishing the modified concrete overlay.

"Finishing and Curing Modified Conc. Overlay", per square yard.

The unit contract price per square yard for "Finishing and Curing Modified Conc. Overlay" shall be full pay for performing the work as specified, including placing, finishing, and curing the modified concrete overlay, checking for bond, and sealing all cracks.

"Further Deck Preparation", per cubic foot.

When "Further Deck Preparation" is measured by volume, the unit contract price per cubic foot for "Further Deck Preparation" shall be full pay for performing the work as specified, including removing and disposing of the concrete within the repair area, and furnishing, placing, finishing, and curing the repair concrete.

"Further Deck Preparation", force account.

When "Further Deck Preparation" is not measured by volume, payment for the work required will be by force account in accordance with Section 1-09.6. For the purpose of providing a common proposal for all bidders, the Contracting Agency has entered an amount for the item "Further Deck Preparation" in the bid proposal to become a part of the total bid by the Contractor.

6-10 CONCRETE BARRIER

6-10.1 Description

This Section applies to building precast or cast-in-place cement concrete barriers as required by the Plans, these Specifications, or the Engineer.

This work may also include the removal, storage and resetting of permanent barrier at the locations shown in the Plans or as approved by the Engineer.

6-10.2 Materials

Materials shall meet the requirements of the following sections:

Portland Cement	9-01
Aggregates	9-03
Premolded Joint Fillers	9-04.1
Reinforcing Steel	9-07

Wire rope shall be Class 6 x 19, made of improved plow steel that has been galvanized and preformed. Galvanizing shall meet ASTM A 603. The wire rope shall have right regular lay and a fiber core. It shall be 5/8-inch in diameter and have a minimum breaking strength of 15 tons.

All hardware (connecting pins, drift pins, nuts, washers, etc.) shall be galvanized in keeping with AASHTO M 232.

Connecting pins, drift pins and steel pins for type 3 anchors shall conform to Section 9-06.5(4) and be galvanized in accordance with AASHTO M 232, except that testing for embrittlement after galvanizing is not required. All other hardware shall conform to Section 9-06.5(1) and be galvanized in accordance with AASHTO M 232.

Grout for permanent installations of precast single slope barrier shall be in accordance with Section 6-02.3(20).

6-10.3 Construction Requirements

Single slope barrier shall be cast-in-place or slipformed, except when precast single slope barrier is specified in the Plans or approved by the Engineer. Concrete barrier installed in conjunction with light standard foundations and sign bridge foundations, regardless of the barrier shape, shall be cast-in-place using stationary forms.

Concrete barrier transition Type 2 to bridge f-shape shall be precast.

6-10.3(1) Precast Concrete Barrier

The fabrication plant for precast concrete barriers shall be approved by Contracting Agency prior to the use of barrier and the plant shall perform quality control testing and inspection on all barrier used by the Contracting Agency. The Contractor shall advise the Engineer of the production schedule for the fabrication of barrier.

Test results from the fabricators QC testing shall demonstrate compliance with sections 6-02.3(4)C consistency, 6-02.3(4)D temperature and time of placement, 6-02.3(2)A air content, and compressive strength. All tests will be conducted per section 6-02.3(5)D.

If self-compacting concrete (SCC) has been approved for use the requirements of Section 6-02.3(4)C consistency shall not apply. Self-compacting concrete (SCC) is concrete that is able to flow under its own weight and completely fill the formwork, even in the presence of dense reinforcement, without the need of any vibration, while maintaining homogeneity. When using SCC modified testing procedures for air content and compressive strength will be used. The modification shall be that molds will be filled completely in one continuous lift with out any rodding, vibration, tamping or other consolidation methods other than lightly taping around the exterior of the mold with a rubber mallet to allow entrapped air bubbles to escape. In addition the fabricators QC testing shall include Slump Flow Test results that do not indicate segregation. As part of the plants approval for use of SCC the plant fabricator shall cast one barrier and have that barrier sawed in half for examination by the Contracting Agency to ensure that segregation has not occurred.

The fabricators QC tester conducting the sampling and testing shall be qualified by ACI, Grade I to perform this work. The equipment used shall be calibrated/certified annually.

All test results and certifications shall be kept at the fabricator's facility for review by the Contracting Agency.

The Contracting Agency intends to perform Quality Assurance Inspection. This inspection is for the qualification of the plant QC process. This inspection shall not relieve the Contractor of any responsibility for identifying and replacing defective material and workmanship.

The concrete in precast barrier shall be Class 4000 and comply with the provisions of Section 6-02.3. No concrete barrier shall be shipped until test cylinders made of the same concrete and cured under the same conditions show the concrete has reached 4000 psi.

The Contractor may use Type III Portland cement, but shall bear any added cost.

Precast barrier shall be cast in steel forms. After release, the barrier shall be finished to an even, smooth, dense surface, free from any rock pockets or holes larger than $^1/_4$-inch across. Troweling shall remove all projecting concrete from the bearing surface.

Precast concrete barrier shall be cured in accordance with Section 6-02.3(25)D except that the barrier shall be cured in the forms until a rebound number test, or test cylinders which have been cured under the same conditions as the barrier, indicate the concrete has reached a compressive strength of a least 2500 psi. No additional curing is required once the barrier is removed from the forms.

The barrier shall be precast in sections as the Standard Plans require. All barrier in the same project (except end sections and variable length units needed for closure) shall be the same length. All barrier shall be new and unused. It shall be true to plan dimensions. The manufacturer shall be responsible for any damage or distortion that results from manufacturing.

Only one section less than 10-feet long may be used in any single run of precast barrier, and it must be at least 8-feet long. It may be precast or cast-in-place. Hardware identical to that used with other sections shall interlock such a section with adjacent precast sections.

Barrier connection voids for permanent installations of precast single slope barrier shall be filled with grout.

6-10.3(2) Cast-In-Place Concrete Barrier

Forms for cast-in-place concrete barrier, including traffic barrier, traffic-pedestrian barrier, and pedestrian barrier on bridges and related structures, shall be made of steel or exterior plywood coated with plastic. The Contractor may construct the barrier by the slip-form method.

The barrier shall be made of Class 4000 concrete that meets the requirements of Section 6-02, except that the fine aggregate gradation used for slip form barrier may be either Class 1 or 2. The Contractor may use Portland cement Type III at no additional expense to the Contracting Agency.

In addition to the steel reinforcing bar tying and bracing requirements specified in Section 6-02.3(24) C, the Contractor may also place small amounts of concrete to aid in holding the steel reinforcing bars in place. These small amounts of concrete shall be not more than two cubic feet in volume, and shall be spaced at a minimum of ten-foot intervals within the steel reinforcement cage. These small amounts of concrete shall be consolidated and shall provide two inches minimum clearance to the steel reinforcing bars on the outside face of the barrier. All spattered and excess mortar and concrete shall be removed from the steel reinforcing bars prior to slip-form casting.

Barrier expansion joints shall be spaced at 96-foot intervals, and dummy joints shall be spaced at 12-foot intervals unless otherwise specified in the contract.

Immediately after removing the forms, the Contractor shall complete any finishing work needed to produce a uniformly smooth, dense surface. The surface shall have no rock pockets and no holes larger than $^1/_4$-inch across. The barrier shall be cured and finished in accordance with Section 6-02.3(11)A.

The maximum allowable deviation from a 10-foot straightedge held longitudinally on all surfaces shall be $^1/_4$inch. For single sloped barrier the maximum allowable deviation from a straightedge held along the vertical sloped face of the barrier shall be $^1/_4$-inch.

At final acceptance of the project, the barrier shall be free from stains, smears, and any discoloration.

6-10.3(3) Removing and Resetting Permanent Concrete Barrier

The Contractor shall reset concrete barrier if the Plans or the Engineer require. If resetting is impossible immediately after removal, the Contractor shall store the barrier at Engineer-approved locations.

6-10.3(4) Joining Precast Concrete Barrier to Cast-In-Place Barrier

The Contractor may join segments of cast-in-place barrier to precast barrier where transitions, split barriers, or gaps shorter than 10-feet require it. At each joint of this type, the cast-in-place segment shall include hardware that ties both its ends to abutting precast sections.

6-10.3(5) Temporary Concrete Barrier

For temporary concrete barrier, the Contractor may use new or used precast barrier. This barrier shall comply with Standard Plan requirements and cross-sectional dimensions, except that: (1) it may be made in other lengths than those shown in the Standard Plan, and (2) it may have permanent lifting holes no larger than 4-inches in diameter or lifting loops. The word “temporary” shall be visibly stamped or stencil painted on each barrier segment.

If the contract calls for the removal and resetting of permanent barrier, and the permanent barrier is not required to remain in place until reset, the permanent barrier may be substituted for temporary concrete barrier and will not be stamped or stenciled "temporary". Any of the permanent barrier damaged during its use as temporary barrier will become the property of the contractor and be replaced with permanent barrier at no expense to the Contracting Agency when the permanent barrier is reset to its permanent location.

All barrier shall be in good condition, without cracks, chips, spalls, dirt, or traffic marks. If any barrier segment is damaged during or after placement, the Contractor, at no expense to the Contracting Agency, shall immediately repair it to the Engineer's satisfaction or replace it with an undamaged section.

As soon as the temporary barrier is no longer needed, the Contractor shall remove it from the project. Contracting Agency furnished barrier shall remain Contracting Agency property, and the Contractor shall deliver it to a stockpile site noted in the contract or to locations as approved by the Engineer. Contractor furnished barrier shall remain the property of the Contractor.

6-10.3(6) Placing Concrete Barrier

Precast concrete barrier shall rest on a paved foundation shaped to a uniform grade and section. The foundation surface shall meet this test for uniformity: When a 10-foot straightedge is placed on the surface parallel to the centerline for the barrier, the surface shall not vary more than $^1/_4$-inch from the lower edge of the straightedge. If deviations exceed $^1/_4$-inch, the Contractor shall correct them as required in Section 5-04.3(13).

The Contractor shall align the joints of precast segments so that they offset no more than $^1/_4$-inch transversely and no more than $^3/_4$-inch vertically. Grouting is not permitted, except as previously stated for single slope barrier. If foundation grade and section are acceptable, the Engineer may permit the Contractor to obtain vertical alignment of the barrier by shimming. Shimming shall be done with a polystyrene, foam pad (12 by 24-inches) under the end 12-inches of bearing surface.

Precast barrier shall be handled and placed with equipment that will not damage or disfigure it.

6-10.4 Measurement

Precast concrete barrier will be measured by the linear foot along its completed line and slope.

Temporary concrete barrier will be measured by the linear foot along the completed line and slope of the barrier, one time only for each setup of barrier protected area. Any intermediate moving or resetting will not be measured.

Cast-in-place concrete barrier will be measured by the linear foot along its completed line unless the contract specifies that it be measured per cubic yard for concrete Class 4000 and per pound for steel reinforcing bar (as required in Section 6-02.4).

Cast-in-place concrete barrier light standard section will be measured by the unit for each light standard section installed.

Removing and resetting existing permanent barrier will be measured by the linear foot and will be measured one time only for removing, storage, and resetting. No measure will be made for barrier that has been removed and reset for the convenience of the Contractor.

Concrete barrier transition Type 2 to bridge F-shape will be measured by the linear foot installed.

Single slope concrete barrier light standard foundation will be measured by the unit for each light standard foundation installed.

Traffic barrier, traffic pedestrian barrier, and pedestrian barrier will be measured as specified for cast-in-place concrete barrier.

6-10.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Precast Conc. Barrier Type ____", per linear foot.

"Cast-In-Place Conc. Barrier", per linear foot.

"Conc. Class 4000", per cubic yard.

"St. Reinf. Bar", per pound.

"Removing and Resetting Existing Permanent Barrier", per linear foot.

The unit contract price per linear foot for "Cast-In-Place Conc. Barrier" shall be full pay for excavation, forms, placement, special construction features, and all other materials, tools, equipment, and labor necessary to complete the work as specified; except that when the contract specifies, the unit contract price per cubic yard for "Conc. Class 4000" and the per pound for "St. Reinf. Bar" shall be full pay for excavation, forms, placement, special construction features, and all other materials, tools, equipment, and labor necessary to complete the work as specified.

"Traffic Barrier", per linear foot.

"Traffic Pedestrian Barrier", per linear foot.

"Pedestrian Barrier" per linear foot.

The unit contract price per linear foot for "Traffic Barrier", "Traffic Pedestrian Barrier", and "Pedestrian Barrier" shall be full pay for constructing the barrier on top of the bridge deck, and associated bridge approach slabs, curtain walls and wingwalls, excluding the steel reinforcing bars that extend from the bridge deck, bridge approach slab, curtain walls, and wingwalls.

"Single Slope Concrete Barrier", per linear foot.

The unit contract price per linear foot for "Single Slope Concrete Barrier" shall be full pay for either cast-in-place or precast single slope concrete barrier.

"Conc. Barrier Transition Type 2 to Bridge F-Shape", per linear foot.

The unit contract price per linear foot for "Conc. Barrier Transition Type 2 to Bridge F-Shape" shall be full pay for performing the work as specified, excluding bridge traffic barrier modifications necessary for this installation.

"Single Slope Conc. Barrier Light Standard Foundation", per each.

"Cast-In-Place Conc. Barrier Light Standard Section", per each.

"Temporary Conc. Barrier", per linear foot.

The unit contract price per linear foot for "Temporary Concrete Barrier" shall be full pay for all costs, including furnishing, installing, connecting, anchoring, maintaining, temporary storage, and final removal of the temporary barrier.

Payment for transition sections between different types of barrier shall be made at the unit contract price for the type of barrier indicated in the Plans for each transition section.

6-11 PRECAST CONCRETE RETAINING WALL STEMS

6-11.1 Description

The Contractor may construct Standard Plan Reinforced Concrete Retaining Walls Type 1, 2, 3, and 4 using precast concrete wall stems as specified herein.

6-11.1(1) Submittals

Before proceeding with construction of the retaining walls using precast concrete wall stems, the Contractor shall submit the following to the Engineer for approval in accordance with Section 6-02.3(16):

1. Working drawings for fabrication of the wall stems, showing dimensions, reinforcing steel, joint and joint filler details, lifting devices with the manufacturer's recommended safe working capacity, and material specifications.
2. Falsework plans for the erection of the wall stems showing dimensions, support points, support footing sizes, erection blockouts, member sizes, connections, and material specifications.
3. Calculations for the precast wall, the connection between the precast wall and the cast-in-place footing, and any modifications to the cast-in-place footing. Calculations shall be prepared by a professional civil engineer licensed in the state of Washington.

6-11.2 Materials

Concrete for the precast concrete wall stems shall meet all the requirements for concrete Class 4000 as stated in Section 6-02.3.

Concrete for the cast-in-place footing shall meet all the requirements for concrete Class 4000 as stated in Section 6-02.3.

6-11.3 Construction Requirements

The precast concrete wall stems shall be fabricated in accordance with the dimensions and details shown in the Plans, except as modified in the approved working drawings.

The precast concrete wall stems may be fabricated full height in 8-foot, 16-foot, 24-foot widths.

The precast concrete wall stems shall be constructed with a mating shear key between adjacent panels. The shear key shall have beveled corners and shall be $1^1/_2$-inches in thickness. The width of the shear key shall be $3^1/_2$-inches minimum and $5^1/_2$-inches maximum. The shear key shall be continuous and shall be of uniform width over the entire height of the wall stem.

Rolled on textured finishes shall not be used. Precast stem walls shall be cast in a vertical position if the Plans call for a form liner texture on both sides of the stem wall.

The precast wall panel shall be rigidly held in place during placement and curing of the footing concrete.

To ensure an even flow of concrete under and against the base of the wall, a form shall be placed parallel to the wall stem, above the footing, to allow a minimum 1-foot head to develop in the concrete during concrete placement.

The reinforcing steel shall be shifted to clear the erection blockouts in the wall stem by $1^1/_2$-inches minimum.

All panel joints shall be constructed with joint filler installed on the rear (backfill) side of the wall. The joint filler material shall extend from 2-feet below the final ground level in front of the wall to the top of the wall. The joint filler shall be a nonorganic flexible material and shall be installed to create a waterproof seal at panel joints.

The soil bearing pressure beneath the falsework supports for the wall stems shall not exceed the maximum design soil pressure shown in the Plans for the retaining wall.

The wall stem shall be placed a minimum of 1-inch into the footing to provide a shear key. The base of the stem shall be sloped $^1/_2$-inch per foot to facilitate proper concrete placement.

6-11.3(1) Tolerances

The construction tolerances for the precast retaining wall stems shall be:

Height	$\pm^1/_4$-inch
Width	$\pm^1/_4$-inch
Thickness	$^1/_4$-inch
	$+\!-^1/_8$-inch
Conc. cover for steel	$-^1/_8$-inch
reinforcing bar	$+^3/_8$-inch
Width of panel joints	$\pm^1/_4$-inch
Offset of panels (deviation from a straight line extending 5-feet on each side of panel joint)	$\pm^1/_4$-inch

6-11.4 Measurement

Measurement of the materials involved in constructing the precast concrete retaining wall stems and cast-in-place footing will be in accordance with Section 6-02.4 for the applicable related bid items of work involved in constructing Standard Plan Reinforced Concrete Retaining Walls Type 1, 2, 3, and 4.

6-11.5 Payment

All costs associated with constructing the retaining walls using precast concrete retaining wall stems shall be included in the unit contract prices for the applicable related bid items of work required for construction of Standard Plan Reinforced Concrete Retaining Walls Type 1, 2, 3, and 4.

6-12 NOISE BARRIER WALLS

6-12.1 Description

This work consists of constructing cast-in-place concrete, precast concrete, masonry, and timber noise barrier walls, including those shown in the Standard Plans.

6-12.2 Materials

Materials shall meet the requirements of the following sections:

Cement	9-01
Aggregates for Portland Cement Concrete	9-03.1
Gravel Backfill	9-03.12
Premolded Joint Filler	9-04.1(2)
Bolts, Nuts, and Washers	9-06.5(1)
Steel Reinforcing Bar	9-07.2
Epoxy-Coated Steel Reinforcing Bar	9-07.3
Paints	9-08
Concrete Curing Materials and Admixtures	9-23
Fly Ash	9-23.9
Water	9-25

Other materials required shall be as specified in the Special Provisions.

6-12.3 Construction Requirements

6-12.3(1) Submittals

All noise barrier walls not constructed immediately adjacent to the roadway, and that require construction of access for work activities, shall have a noise barrier wall access plan. The Contractor shall submit the noise barrier wall access plan to the Engineer for approval in accordance with Section 6-01.9. The noise barrier wall access plan shall include, but not be limited to, the locations of access to the noise barrier wall construction sites, and the method, materials, and equipment used to construct the access, remove the access, and recontour and reseed the disturbed ground.

For construction of all noise barrier walls with shafts, the Contractor shall submit a shaft construction plan to the Engineer for approval in accordance with Section 6-01.9, including but not limited to the following information:

1. List and description of equipment to be used to excavate and construct the shafts, including description of how the equipment is appropriate for use in the expected subsurface conditions.
2. The construction sequence and order of shaft construction.
3. Details of shaft excavation methods, including methods to clean the shaft excavation.
4. Details and dimensions of the shaft, and casing if used.
5. The method used to prevent ground caving (temporary casing, slurry, or other means).
6. Details of concrete placement including procedures for deposit through a conduit, tremie, or pump.
7. Method and equipment used to install and support the steel reinforcing bar cage.

For construction of precast concrete noise barrier walls, the Contractor shall submit shop drawings for the precast concrete panels to the Engineer in accordance with Section 6-02.3(28)A. In addition to the items listed in Section 6-02.3(28)A, the precast concrete panel shop drawings shall include the following:

1. Construction sequence and method of forming the panels.
2. Details of additional reinforcement provided at lifting and support locations.
3. Method and equipment used to support the panels during storage, transporting, and erection.
4. Erection sequence, including the method of lifting the panels, placing and adjusting the panels to proper alignment and grade, and supporting the panels during bolting, grouting, and backfilling operations.

The Contractor shall not begin noise barrier wall construction activities, including access construction and precast concrete panel fabrication, until receiving the Engineer's approval of all appropriate and applicable submittals.

6-12.3(2) Work Access and Site Preparation

The Contractor shall construct work access in accordance with the work access plan as approved by the Engineer. The construction access roads shall minimize disturbance to the existing vegetation, especially trees. Only trees and shrubs in direct conflict with the approved construction access road alignment shall be removed. Only one access road into the noise barrier wall from the main roadway and one access road from the noise barrier wall to the main roadway shall be constructed at each noise barrier wall.

Existing vegetation that has been identified by the Engineer shall be protected in accordance with Sections 1-07.16 and 2-01, and the Special Provisions.

6-12.3(3) Shaft Construction

The Contractor shall excavate and construct the shafts in accordance with the shaft construction plan as approved by the Engineer.

The shafts shall be excavated to the required depth as shown in the Plans. The excavation shall be completed in a continuous operation using equipment capable of excavating through the type of material expected to be encountered.

If the shaft excavation is stopped, the Contractor shall secure the shaft by installing a safety cover over the opening. The Contractor shall ensure the safety of the shaft and surrounding soil and the stability of the side walls. A temporary casing, slurry, or other methods approved by the Engineer shall be used as necessary to ensure such safety and stability.

When caving conditions are encountered, the Contractor shall stop further excavation until implementing the method to prevent ground caving as specified in the shaft construction plan approved by the Engineer.

When obstructions are encountered, the Contractor shall notify the Engineer promptly. An obstruction is defined as a specific object (including, but not limited to, boulders, logs, and man made objects) encountered during the shaft excavation operation, which prevents or hinders the advance of the shaft excavation. When efforts to advance past the obstruction to the design shaft tip elevation result in the rate of advance of the shaft drilling equipment being is significantly reduced relative to the rate of advance for the rest of the shaft excavation, then the Contractor shall remove the obstruction under the provisions of Section 6-12.5 as supplemented in the Special Provisions. The method of removal of such obstructions, and the continuation of excavation shall be as proposed by the Contractor and approved by the Engineer.

The Contractor shall use appropriate means to clean the bottom of the excavation of all shafts. No more than two inches of loose or disturbed material shall be present at the bottom of the shaft just prior to beginning concrete placement.

The Contractor shall not begin placing steel reinforcing bars and concrete in the shaft until receiving the Engineer's approval of the shaft excavation.

The steel reinforcing bar cage shall be rigidly braced to retain its configuration during handling and construction. The Contractor shall not place individual or loose bars. The Contractor shall install the steel reinforcing bar cage as specified in the shaft construction plan as approved by the Engineer. The Contractor shall maintain the minimum concrete cover shown in the Plans.

If casings are used, the Contractor shall remove the casing during concrete placement. A minimum five feet head of concrete shall be maintained to balance soil and water pressure at the bottom of the casing. The casing shall be smooth. Where the top of the shaft is above the existing ground, the Contractor shall case the top of the hole prior to placing the concrete.

Concrete for shafts shall conform to Class 4000P. The Contractor shall place concrete in the shaft immediately after completing the shaft excavation and receiving the Engineer's approval of the excavation. The Contractor shall place the concrete in one continuous operation to the elevation shown in the Plans, using a method to prevent segregation of aggregates. The Contractor shall place the concrete as specified in the approved shaft construction plan. If water is present, concrete shall be placed in accordance with Section 6-02.3(6)B.

6-12.3(4) Trench, Grade Beam, or Spread Footing Construction

Where the noise barrier wall foundations exist below the existing ground line, excavation shall conform to Section 2-09.3(4), and to the limits and construction stages shown in the Plans. Foundation soils found to be unsuitable shall be removed and replaced in accordance with Section 2-09.3(1)C.

Where the noise barrier wall foundations exist above the existing ground line, the Contractor shall place and compact backfill material in accordance with Section 2-03.3(14)C.

Concrete for trench, grade beam, or spread footing foundations shall conform to Class 4000.

Cast-in-place concrete shall be formed, placed, and cured in accordance with Section 6-02, except that concrete for trench foundations shall be placed against undisturbed soil.

The excavation shall be backfilled in accordance with item 1 of the Compaction subsection of Section 2-09.3(1)E.

The steel reinforcing bar cage and the noise barrier wall anchor bolts shall be installed and rigidly braced prior to grade beam and spread footing concrete placement to retain their configuration during concrete placement. The Contractor shall not place individual or loose steel reinforcing bars and anchor bolts, and shall not install anchor bolts during or after concrete placement.

6-12.3(5) Cast-In-Place Concrete Panel Construction

Construction of cast-in-place concrete panels for noise barrier walls shall conform to Section 6-11.3(4). For noise barrier walls with traffic barrier, the construction of the traffic barrier shall also conform to Section 6-10.3(2).

The top of the cast-in-place concrete panels shall conform to the top of wall profile shown in the Plans. Where a vertical step is constructed to provide elevation change between adjacent panels, the dimension of the step shall be 2-feet. Each horizontal run between steps shall be a minimum of 48-feet.

6-12.3(6) Precast Concrete Panel Fabrication and Erection

The Contractor shall fabricate and erect the precast concrete panels in accordance with Section 6-02.3(28), and the following requirements:

1. Concrete shall conform to Class 4000.
2. Except as otherwise noted in the Plans and Special Provisions, all concrete surfaces shall receive a Class 2 finish in accordance with Section 6-02.3(14)B.
3. The precast concrete panels shall be cast in accordance with Section 6-02.3(28)B. The Contractor shall cast the precast concrete panels horizontally, with the traffic side surface cast against the form liner on the bottom. The Contractor shall fully support the precast concrete panel to avoid bowing and sagging surfaces.

   After receiving the Engineer's approval of the shop drawings, the Contractor shall cast one precast concrete panel to be used as the sample panel. The Contractor shall construct the sample panel in accordance with the procedure and details specified in the shop drawings approved by the Engineer. The Contractor shall make the sample panel available to the Engineer for approval.

   Upon receiving the Engineer's approval of the sample panel, the Contractor shall continue production of precast concrete panels for the noise barrier wall. All precast concrete panels will be evaluated against the sample panel for the quality of workmanship exhibited. The sample panel shall be retained at the fabrication site until all precast concrete panels have been fabricated and have received the Engineer's approval. After completing precast concrete panel fabrication, the Contractor may utilize the sample panel as a production noise barrier wall panel.
4. In addition to the fabrication tolerance requirements of Section 6-02.3(28)F, the precast concrete panels for noise barrier walls shall not exceed the following scalar tolerances:

   Length and Width: $\pm$ $^1/_8$-inch per five feet, not to exceed $^1/_4$-inch total.

   Thickness: $\pm$ $^1/_4$-inch.

   The difference obtained by comparing the measurement of the diagonal of the face of the panels shall not be greater than $^1/_2$-inch.

   Dimension tolerances for the traffic barrier portion of precast concrete panels formed with traffic barrier shapes shall conform to Section 6-10.3(2).
5. After erection, the precast concrete panels shall not exceed the joint space tolerances shown in the Plans. The panels shall not exceed $^3/_8$-inch out of plumb in any direction.

   The Contractor shall seal the joints between precast concrete panels with a backer rod and sealant system as specified. The Contractor shall seal both sides of the joint full length.

The top of precast concrete panels shall conform to the top of wall profile shown in the Plans. Where a vertical step is constructed to provide elevation change between adjacent panels, the dimension of the step shall be 2-feet. Each horizontal run between steps shall be a minimum of 48-feet.

6-12.3(7) Masonry Wall Construction

Construction requirements for masonry noise barrier wall panels shall be as specified in the Special Provisions.

6-12.3(8) Fabricating and Erecting Timber Noise Barrier Wall Panels

Construction requirements for timber noise barrier wall panels shall be as specified in the Special Provisions.

6-12.3(9) Access Doors and Concrete Landing Pads

The Contractor shall install access doors and door frames as shown in the Plans and Standard Plans. The Contractor shall install the access doors to open toward the roadway side. The door frames shall be set in place with grout conforming to Section 6-02.3(20), with the grout completely filling the void between the door frame and the noise barrier wall panel.

The Contractor shall apply two coats of paint, as specified in the Special Provisions, to all exposed metal surfaces of access doors and frames, except for stainless steel surfaces. Each coat shall be 3 mils minimum wet film thickness.

The Contractor shall construct a concrete landing pad on the roadway side of each access door location as shown in the Plans. The concrete shall conform to Section 6-02.3(2)B.

6-12.3(10) Finish Ground Line Dressing

The Contractor shall contour and dress the ground line on both sides of the noise barrier wall, providing the minimum cover over the foundation as shown in the Plans. The Contractor shall contour the ground adjacent to the barrier to ensure good drainage away from the barrier.

After the access roads are no longer needed for noise barrier wall construction activities, the Contractor shall restore the area to the original condition. The Contractor shall recontour the access roads to match into the surrounding ground and shall reseed all disturbed areas in accordance with the Section 8-01 and the Special Provisions, and the noise barrier wall access plan as approved by the Engineer.

6-12.4 Measurement

Noise barrier wall will be measured by the square foot area of one face of the completed wall panel in place. Except as otherwise noted, the bottom limit for measurement will be the top of the trench footing, spread footing, or shaft cap. For Noise Barrier Type 5, the bottom measurement limit will be the optional construction joint at the base of the traffic barrier. For Noise Barrier Type 7, the bottom measurement limit will be base of the traffic barrier. For Noise Barrier Types 8, 11, 12, 14, 15, and 20, the bottom measurement limit will be the base of the wall panel.

Noise barrier wall access door will be measured once for each access door assembly with concrete landing pad furnished and installed.

6-12.5 Payment

Payment will be made in accordance with Section 1-04.1 for each of the following bid items when they are included in the proposal:

"Noise Barrier Wall Type __", per square foot.

The unit contract price per square foot for "Noise Barrier Wall Type __" shall be full pay for constructing the noise barrier walls as specified, including constructing and removing access roads, excavating and constructing foundations and grade beams, constructing cast-in-place concrete, and masonry wall panels, fabricating and erecting precast concrete, and timber wall panels, applying sealer, and contouring the finish ground line adjacent to the noise barrier walls.

"Noise Barrier Wall Access Door", per each.

The unit contract price per each for "Noise Barrier Wall Access Door" shall be full pay for furnishing and installing the access door assembly as specified, including painting the installed access door assembly and constructing the concrete landing pad.

6-13 STRUCTURAL EARTH WALLS

6-13.1 Description

This work consists of constructing structural earth walls (SEW).

6-13.2 Materials

Materials shall meet the requirements of the following sections:

Cement	9-01
Aggregates for Portland Cement Concrete	9-03.1
Gravel Backfill	9-03.12(2)
Premolded Joint Filler	9-04.1(2)
Steel Reinforcing Bar	9-07.2
Epoxy-Coated Steel Reinforcing Bar	9-07.3
Concrete Curing Materials and Admixtures	9-23
Fly Ash	9-23.9
Water	9-25

Other materials required shall be as specified in the Special Provisions.

6-13.3 Construction Requirements

Proprietary structural earth wall systems shall be as specified in the Special Provisions.

6-13.3(1) Quality Assurance

The structural earth wall manufacturer shall provide a qualified and experienced representative to resolve wall construction problems as approved by the Engineer. The structural earth wall manufacturer's representative shall be present at the beginning of wall construction activities, and at other times as needed throughout construction. Recommendations made by the structural earth wall manufacturer's representative and approved by the Engineer shall be followed by the Contractor.

The completed wall shall meet the following tolerances:

1. Deviation from the design batter and horizontal alignment, when measured along a ten foot straight edge, shall not exceed the following:
   a. Welded wire faced structural earth wall: 2-inches
   b. Precast concrete panel and concrete block faced structural earth wall: $^{3}/_{4}$-inch
2. Deviation from the overall design batter of the wall shall not exceed the following per ten feet of wall height:
   a. Welded wire faced structural earth wall: $1^{1}/_{2}$-inches
   b. Precast concrete panel and concrete block faced structural earth wall: $^{1}/_{2}$-inch
3. The maximum outward bulge of the face between welded wire faced structural earth wall reinforcement layers shall not exceed two inches. The maximum allowable offset in any precast concrete facing panel joint shall be $^{3}/_{4}$-inch. The maximum allowable offset in any concrete block joint shall be $^{3}/_{4}$-inch.
4. The base of the structural earth wall excavation shall be within three inches of the staked elevations, unless otherwise approved by the Engineer.

5. The external structural earth wall dimensions shall be placed within two inches of that staked on the ground.
6. The backfill reinforcement layers shall be located horizontally and vertically within one inch of the locations shown in the structural earth wall working drawings as approved by the Engineer.

At least five working days prior to the Contractor beginning any structural earth wall work at the site, a structural earth wall preconstruction conference shall be held to discuss construction procedures, personnel, and equipment to be used, and other elements of structural earth wall construction. Those attending shall include:

1. (representing the Contractor) The superintendent, on site supervisors, and all foremen in charge of excavation, leveling pad placement, concrete block and soil reinforcement placement, and structural earth wall backfill placement and compaction.
2. (representing the Structural Earth Wall Manufacturer) The qualified and experienced representative of the structural earth wall manufacturer as specified at the beginning of this Section.
3. (representing the Contracting Agency) The Project Engineer, key inspection personnel, and representatives from the WSDOT Construction Office and Materials Laboratory Geotechnical Services Branch.

6-13.3(2) Submittals

The Contractor, or the supplier as the Contractor's agent, shall furnish to the Engineer a Manufacturer's Certificate of Compliance in accordance with Section 1-06.3, certifying that the structural earth wall materials conform to the specified material requirements. This includes providing a Manufacturer's Certificate of Compliance for all concrete admixtures, cement, fly ash, steel reinforcing bars, reinforcing strips, reinforcing mesh, tie strips, fasteners, welded wire mats, backing mats, construction geotextile for wall facing, drainage geosynthetic fabric, block connectors, and joint materials. The Manufacturer's Certificate of Compliance for geogrid reinforcement shall include the information specified in Section 9-33.4(4) for each geogrid roll, and shall specify the geogrid polymer types for each geogrid roll.

A copy of all test results, performed by the Contractor or the Contractor's supplier, which are necessary to assure compliance with the specifications, shall submitted to the Engineer along with each Manufacturer's Certificate of Compliance.

Before fabrication, the Contractor shall submit a field construction manual for the structural earth walls, prepared by the wall manufacturer, to the Engineer for approval in accordance with Section 6-01.9. This manual shall provide step-by-step directions for construction of the wall system.

The Contractor, or the supplier as the Contractor's agent, shall submit detailed design calculations and working drawings to the Engineer for approval in accordance with Section 6-01.9.

The design calculation and working drawing submittal shall include detailed design calculations and all details, dimensions, quantities, and cross-sections necessary to construct the wall. The calculations shall include a detailed explanation of any symbols and computer programs used in the design of the walls. All computer output submitted shall be accompanied by supporting hand calculations detailing the calculation process.

The design calculations shall be based on the current AASHTO Standard Specifications for Highway Bridges including current interims, and also based on the following:

1. The factor of safety for overturning and sliding are 2.0 and 1.5 respectively for AASHTO Load Group I, and 1.5 and 1.1 respectively for AASHTO Load Group VII.
2. The wall surcharge conditions (backfill slope) shown in the Plans.
3. If a highway is adjacent to and on top of the wall, a two foot surcharge shall be used in the design.
4. If the Plans detail a traffic barrier on top of the wall, the barrier and wall shall be capable of resisting a 10,000 pound horizontal load applied at the top of the barrier.
5. The geotechnical design parameters for the wall shall be as specified in the Special Provisions.

A minimum of six sets of working drawings shall be fully detailed and shall include, but not be limited to, the following items:

1. A plan and elevation sheet or sheets for each wall, containing the following:
   a. An elevation view of the wall that includes the following:
      i. the elevation at the top of the wall, at all horizontal and vertical break points, and at least every 50-feet along the wall;
      ii. elevations at the base of welded wire mats or the top of leveling pads and foundations, and the distance along the face of the wall to all steps in the welded wire mats, foundations and leveling pads;
      iii. the designation as to the type of panel, block, or module;
      iv. the length, size, and number of geogrids or mesh or strips, and the distance along the face of the wall to where changes in length of the geogrids or mesh or strips occur; or
      v. the length, size, and wire sizes and spacing of the welded wire mats and backing mats, and the distance along the face of the wall to where changes in length, size, and wire sizes and spacing of the welded wire mats and backing mats occur; and
      vi. the location of the original and final ground line.
   b. A plan view of the wall that indicates the offset from the construction centerline to the face of the wall at all changes in horizontal alignment; the limit of the widest module, geogrid, mesh, strip or welded wire mat, and the centerline of any drainage structure or drainage pipe which is behind or passes under or through the wall.
   c. General notes, if any, required for design and construction of the wall.
   d. All horizontal and vertical curve data affecting wall construction.
   e. A listing of the summary of quantities provided on the elevation sheet of each wall for all items including incidental items.
   f. Cross-section showing limits of construction. In fill sections, the cross-section shall show the limits and extent of select granular backfill material placed above original ground.
   g. Limits and extent of reinforced soil volume.

2. All details including steel reinforcing bar bending details. Bar bending details shall be in accordance with Section 9-07.1.
3. All details for foundations and leveling pads, including details for steps in the foundations or leveling pads, as well as allowable and actual maximum bearing pressures for AASHTO Load Groups I and VII.
4. All modules and facing elements shall be detailed. The details shall show all dimensions necessary to construct the element, all steel reinforcing bars in the element, and the location of reinforcement element attachment devices embedded in the precast concrete facing panel or concrete block.
5. All details for construction of the wall around drainage facilities, sign, signal, luminaire, and noise barrier wall foundations, and structural abutment and foundation elements shall be clearly shown.
6. All details for connections to traffic or pedestrian barriers, coping, parapets, noise barrier walls, and attached lighting shall be shown.
7. All details for the traffic or pedestrian barrier attached to the top of the wall (if shown in the Plans) including interaction with bridge approach slabs.

The Contractor shall not begin wall construction (including precast concrete facing panel or block fabrication) until receiving the Engineer's written approval of the material certifications and test results, design calculations and working drawing submittals.

6-13.3(3) Excavation and Foundation Preparation

Excavation shall conform to Section 2-09.3(4) and to the limits and construction stages shown in the Plans. Foundation soils found to be unsuitable shall be removed and replaced in accordance with Section 2-09.3(1)C. The foundation for the structure shall be graded level for a width equal to or exceeding the length of reinforcing as shown in the structural earth wall working drawings as approved by the Engineer and, for walls with geogrid reinforcing, in accordance with Section 2-12.3. Prior to wall construction, the foundation, if not in rock, shall be compacted as approved by the Engineer.

At the foundation level of the bottom course of precast concrete facing panels and concrete blocks, an unreinforced concrete leveling pad shall be provided as shown in the Plans. The leveling pad shall be cured a minimum of 12 hours and have a minimum compressive strength of 1500 psi before placement of the precast concrete facing panels or concrete blocks.

6-13.3(4) Precast Concrete Facing Panel and Concrete Block Fabrication

Concrete for precast concrete facing panels shall meet the following requirements:

1. Have a minimum 28 day compressive strength of 4,000 pounds per square inch, unless otherwise specified in the Special Provisions for specific proprietary wall systems.
2. Contain a water-reducing admixture meeting AASHTO M 194 Type A, D, F, or G.
3. Be air-entrained, 6 percent ± $1^1/_2$ percent.
4. Have a maximum slump of four inches, or six inches if a Type F or G water reducer is used.

Concrete for dry cast concrete blocks shall meet the following requirements:

1. Have a minimum 28 day compressive strength of 4,000 psi.
2. Conform to ASTM C 1372, except as otherwise specified.
3. The lot of blocks produced for use in this project shall conform to the following freeze-thaw test requirements when tested in accordance with ASTM C 1262. Minimum acceptable performance shall be defined as weight loss at the conclusion of 150 freeze-thaw cycles not exceeding one percent of the block's initial weight for a minimum of four of the five block specimens tested.
4. The concrete blocks shall have a maximum water absorption of one percent above the water absorption content of the lot of blocks produced and successfully tested for the freeze-thaw test specified in item 3 above.

Precast concrete facing panels and concrete blocks will be accepted based on successful compressive strength tests, WSDOT "Approved for Shipment" stamp or tag, and visual inspection at the jobsite. The precast concrete facing panels and concrete blocks shall be considered acceptable regardless of curing age when compressive test results indicate that the compressive strength conforms to the 28-day requirements and when the visual inspection is satisfactorily completed. Fabrication of precast concrete facing panels and blocks shall conform to Section 6-02.3(28). Testing of dry cast concrete blocks shall conform to ASTM C 140.

All precast concrete facing panels shall be five feet square, except:

1. for partial panels at the top, bottom, and ends of the wall, and
2. as otherwise shown in the Plans.

All precast concrete facing panels shall be manufactured within the following tolerances:

1. All dimensions $\pm$ $^{3}/_{16}$-inch.
2. Squareness, as determined by the difference between the two diagonals, shall not exceed $^{1}/_{2}$-inch.
3. Surface defects on smooth formed surfaces measured on a length of 5-feet shall not exceed $^{1}/_{8}$-inch. Surface defects on textured-finished surfaces measured on a length of five feet shall not exceed $^{5}/_{16}$-inch.

All concrete blocks shall be manufactured within the following tolerances:

1. Vertical dimensions shall be $\pm$ $^{1}/_{16}$-inch of the plan dimension, and the rear height shall not exceed the front height.
2. The dimensions of the grooves in the top and bottom faces of the concrete blocks shall be formed within the tolerances specified by the proprietary wall manufacturer, for the fit required for the block connectors.
3. All other dimensions shall be $\pm$ $^{1}/_{4}$-inch of the plan dimension.

Tie attachment devices, except for geosynthetic reinforcement, shall be set in place to the dimensions and tolerances shown in the Plans prior to casting.

The forms forming precast concrete facing panels, including the forms for loop pockets and access pockets, and the forms forming the concrete blocks, shall be removed in accordance with the recommendations of the wall manufacturer, without damaging the concrete.

The concrete surface for the precast concrete facing panel shall have the finish shown in the Plans for the front face and an unformed finish for the rear face. The rear face of the precast concrete facing panel shall be roughly screeded to eliminate open pockets of aggregate and surface distortions in excess of $^1/_4$-inch.

The concrete surface for the front face of the concrete block shall be flat, and shall be a conventional "split face" finish in accordance with the wall manufacturer's specifications. The concrete surface of all other faces shall be Class 2 in accordance with Section 6-02.3(14)B. The finish and appearance of the concrete blocks shall also conform to ASTM C 1372. The color of the concrete block shall be concrete gray, unless otherwise shown in the Plans.

The date of manufacture, production lot number, and the piece-mark, shall be clearly marked on the rear face of each precast concrete facing panel, and marked or tagged on each pallet of concrete blocks.

All precast concrete facing panels and concrete blocks shall be handled, stored, and shipped in accordance with Sections 6-02.3(28)G and 6-02.3(28)H to prevent chipping, cracks, fractures, and excessive bending stresses.

Precast concrete facing panels in storage shall be supported on firm blocking located immediately adjacent to tie strips to avoid bending the tie strips.

6-13.3(5) Precast Concrete Facing Panel and Concrete Block Erection

The precast concrete facing panels shall be placed vertically. During erection, precast concrete facing panels shall be handled by means of a lifting device set into the upper edge of the panels.

Concrete blocks shall be erected in a running bond fashion in accordance with the wall manufacturer's field construction manual, and may be placed by hand. The top surface of each course of concrete blocks, including all pockets and recesses, shall be cleaned of backfill and all extraneous materials prior to connecting the reinforcing strips or geosynthetic reinforcing, and placing the next course of concrete blocks. Concrete blocks receiving geosynthetic reinforcement shall be connected as specified in the Special Provisions. Cap block top courses shall be bonded to the lower course of concrete blocks as specified below. All other concrete blocks shall be connected with block connectors or pins placed into the connector slots.

Precast concrete facing panels and concrete blocks shall be placed in successive horizontal lifts as backfill placement proceeds in the sequence shown in the structural earth wall working drawings as approved by the Engineer.

External bracing is required for the initial lift for precast concrete facing panels.

As backfill material is placed behind the precast concrete facing panels, the panels shall be maintained in vertical position by means of temporary wooden wedges placed in the joint at the junction of the two adjacent panels on the external side of the wall.

Reinforcing shall be placed normal to the face of the wall, unless otherwise shown in the Plans or directed by the Engineer. Prior to placement of the reinforcing, backfill shall be compacted.

Geosynthetic reinforcing shall be placed in accordance with Section 2-12.3 and as follows:

1. The Contractor shall stretch out the geosynthetic in the direction perpendicular to the wall face to remove all slack and wrinkles, and shall hold the geosynthetic in place with soil piles or other methods as recommended by the geosynthetic manufacturer, before placing backfill material over the geosynthetic to the specified cover.
2. The geosynthetic reinforcement shall be continuous in the direction perpendicular to the wall face from the back face of the concrete panel to the end of the geosynthetic or to the last geogrid node at the end of the specified reinforcement length. Geosynthetic splices parallel to the wall face will not be allowed.

At the completion of each course of concrete blocks and prior to installing any block connectors or geosynthetic reinforcement at this level, the Contractor shall check the blocks for level placement in all directions, and shall adjust the blocks by grinding or rear face shimming, or other method as recommended by the structural earth wall manufacturer's representative and as approved by the Engineer, to bring the blocks into a level plane.

For concrete block wall systems receiving a cap block top course, the cap blocks shall be bonded to the lower course with mortar, or with an adhesive capable of bonding the concrete block courses together.

6-13.3(6) Welded Wire Faced Structural Earth Wall Erection

The Contractor shall erect the welded wire wall reinforcement in accordance with the wall manufacturer's field construction manual and as approved by the Engineer. Construction geotextile for wall facing shall be placed between the backfill material within the reinforced zone and the coarse granular material immediately behind the welded wire wall facing, as shown in the Plans and the structural earth wall working drawings as approved by the Engineer.

6-13.3(7) Backfill

Backfill placement shall closely follow erection of each course of welded wire mats and backing mats, precast concrete facing panels, or concrete blocks. Backfill shall be placed in such a manner as to avoid any damage or disturbance to the wall materials or misalignment of the welded wire mats and backing mats, precast concrete facing panels, or concrete blocks. Backfill shall be placed in a manner that segregation does not occur.

The Contractor shall place wall backfill over geosynthetic reinforcement, or construction geotextile for wall facing, in accordance with Section 2-12.3 and as follows:

1. The Contractor shall ensure that six inches minimum of backfill shall be between the geogrid reinforcement, or construction geotextile for wall facing, and any construction vehicle or equipment tires or tracks at all times.

Misalignment or distortion of the precast concrete facing panels or concrete blocks due to placement of backfill outside the limits of this specification shall be corrected in a manner as approved by the Engineer.

The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer of material. The moisture content of all backfill material shall conform to Sections 2-03.3(14)C and 2-03.3(14)D.

Backfill shall be compacted in accordance with Method C of Section 2-03.3(14)C, except as follows:

1. The maximum lift thickness after compaction shall not exceed ten inches.
2. The Contractor shall decrease this lift thickness, if necessary, to obtain the specified density.
3. The Contractor shall not use sheepsfoot rollers or rollers with protrusions for compacting backfill reinforced with geosynthetic layers, or for compacting the first lift of backfill above the construction geosynthetic for wall facing for each layer of welded wire mats. Rollers shall have sufficient capacity to achieve compaction without causing distortion to the face of the wall in accordance with the tolerances specified in Section 6-13.3(1).
4. The Contractor shall compact the zone within three feet of the back of the wall facing panels without causing damage to or distortion of the wall facing elements (welded wire mats, backing mats, construction geotextile for wall facing, precast concrete facing panels, and concrete blocks) by using light mechanical tampers as approved by the Engineer. No soil density tests will be taken within this area.
5. For wall systems with geosynthetic reinforcement, the minimum compacted backfill lift thickness of the first lift above each geosynthetic reinforcement layer shall be six inches.

At the end of each day's operation, the Contractor shall shape the last level of backfill to permit runoff of rainwater away from the wall face. In addition, the Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

Wall materials damaged or disturbed during backfill placement shall be either removed and replaced, or adjusted and repaired, by the Contractor as approved by the Engineer at no additional expense to the Contracting Agency.

6-13.3(8) Guardrail Placement

Where guardrail posts are required, the Contractor shall not begin installing guardrail posts until completing the structural earth wall to the top of wall elevation shown in the Plans. The Contractor shall install the posts in a manner that prevents movement of the precast concrete facing panels or concrete blocks, and prevents ripping, tearing, or pulling of the wall reinforcement.

The Contractor may cut welded wire reinforcement of welded wire faced structural earth walls to facilitate placing the guardrail posts, but only in the top two welded wire reinforcement layers and only with the approval of the Engineer in a manner that prevents bulging of the wall face and prevents ripping or pulling of the welded wire reinforcement. Holes through the welded wire reinforcement shall be the minimum size necessary for the post. The Contractor shall demonstrate to the Engineer prior to beginning guardrail post installation that the installation method will not rip, tear, or pull the wall reinforcement.

The Contractor shall place guardrail posts between the reinforcing strips, reinforcing mesh, and tie strips of the non-geosynthetic reinforced precast concrete panel or concrete block faced structural earth walls. Holes through the reinforcement of geosynthetic reinforced walls, if necessary, shall be the minimum size necessary for the guardrail post.

6-13.3(9) SEW Traffic Barrier and SEW Pedestrian Barrier

SEW traffic barrier and SEW pedestrian barrier shall be constructed in accordance with Sections 6-02.3(11)A and 6-10.3(2), and the details in the Plans and in the structural earth wall working drawings as approved by the Engineer.

6-13.4 Measurement

Structural earth wall will be measured by the square foot of completed wall in place. The bottom limits for vertical measurement will be the bottom of the bottom mat, for welded wire faced structural earth walls, or the top of the leveling pad (or bottom of wall if no leveling pad is present) for precast concrete panel or concrete block faced structural earth walls. The top limit for vertical measurement will be the top of wall as shown in the Plans. The horizontal limits for measurement are from the end of the wall to the end of the wall.

Backfill for structural earth wall including haul will be measured by the cubic yard in place determined by the limits shown in the Plans.

SEW traffic barrier, and SEW pedestrian barrier will be measured as specified in Section 6-10.4 for cast-in-place concrete barrier.

Structure excavation Class B, structure excavation Class B including haul, and shoring or extra excavation Class B, will be measured in accordance with Section 2-09.4.

6-13.5 Payment

Payment will be made in accordance with Section 1-04.1 for each of the following bid items when they are included in the proposal:

"Structural Earth Wall", per square foot.

All costs in connection with furnishing materials for, and constructing, structural earth walls, including constructing leveling pads when specified, shall be included in the unit contract price per square foot for "Structural Earth Wall".

"Backfill for Structural Earth Wall Incl. Haul", per cubic yard.

All costs in connection with furnishing and placing backfill for structural earth wall, including hauling and compacting the backfill, and furnishing and placing the wall facing backfill for welded wire faced structural earth walls, shall be included in the unit contract price per cubic yard for "Backfill for Structural Earth Wall Incl. Haul".

"SEW Traffic Barrier", per linear foot.

"SEW Pedestrian Barrier", per linear foot.

The unit contract price per linear foot for "SEW ___ Barrier" shall be full pay for constructing the barrier on top of the structural earth wall, except that when these bid items are not included in the proposal, all costs in connection with performing the work as specified shall be included in the unit contract price per square foot for "Structural Earth Wall".

"Structure Excavation Class B", per cubic yard.

"Structure Excavation Class B Incl. Haul", per cubic yard.

"Shoring Or Extra Excavation Class B", per square foot.

6-14 GEOSYNTHETIC RETAINING WALLS

6-14.1 Description

This work consists of constructing geosynthetic retaining walls, including those shown in the Standard Plans.

6-14.2 Materials

Materials shall meet the requirements of the following sections:

Gravel Borrow For Geosynthetic Retaining Wall	9-03.14(4)
Construction Geosynthetic	9-33

The requirements specified in Section 2-12.2 for geotextile shall also apply to geosynthetic and geogrid materials used for permanent and temporary geosynthetic retaining walls.

Other materials required shall be as specified in the Special Provisions.

6-14.3 Construction Requirements

Temporary geosynthetic retaining walls are defined as those walls and wall components constructed and removed or abandoned before the physical completion date of the project or as shown in the Plans. All other geosynthetic retaining walls shall be considered as permanent.

6-14.3(1) Quality Assurance

The Contractor shall complete the base of the retaining wall excavation to within plus or minus three inches of the staked elevations unless otherwise directed by the Engineer. The Contractor shall place the external wall dimensions to within plus or minus two inches of that staked on the ground. The Contractor shall space the reinforcement layers vertically and place the overlaps to within plus or minus one inch of that shown in the Plans.

The completed wall(s) shall meet the following tolerances:

	Permanent Wall	Temporary Wall
Deviation from the designbatter and horizontal alignment for the face when measured along a ten foot straight edge at the midpoint of each wall layer shall not exceed:	3-inches	5-inches
Deviation from the overall design batter per ten feet of wall height shall not exceed:	2-inches	3-inches
Maximum outward bulge of the face between backfill reinforcement layers shall not exceed:	4-inches	6-inches

6-14.3(2) Submittals

A minimum of 14 calendar days prior to beginning construction of each wall the Contractor shall submit detailed plans for each wall in accordance with Section 6-01.9. As a minimum, the submittals shall include the following:

1. Detailed wall plans showing the actual lengths proposed for the geosynthetic reinforcing layers and the locations of each geosynthetic product proposed for use in each of the geosynthetic reinforcing layers.

2. The Contractor's proposed wall construction method, including proposed forming systems, types of equipment to be used and proposed erection sequence.
3. Manufacturer's Certificate of Compliance, samples of the retaining wall geosynthetic and sewn seams for the purpose of acceptance as specified.
4. Details of geosynthetic retaining wall corner construction, including details of the positive connection between the wall sections on both sides of the corner.
5. Details of terminating a top layer of retaining wall geosynthetic and backfill due to a changing retaining wall profile.

Approval of the Contractor's proposed wall construction details and methods shall not relieve the Contractor of their responsibility to construct the walls in accordance with the requirements of these Specifications.

6-14.3(3) Excavation and Foundation Preparation

Excavation shall conform to Section 2-09.3(4), and to the limits and construction stages shown in the Plans. Foundations soils found to be unsuitable shall be removed and replaced in accordance with Section 2-09.3(1)C.

The Contractor shall direct all surface runoff from adjacent areas away from the retaining wall construction site.

6-14.3(4) Erection and Backfill

The Contractor shall begin wall construction at the lowest portion of the excavation and shall place each layer horizontally as shown in the Plans. The Contractor shall complete each layer entirely before beginning the next layer.

Geotextile splices shall consist of a sewn seam or a minimum 1'-0" overlap. Geogrid splices shall consist of adjacent geogrid strips butted together and fastened using hog rings, or other methods approved by the Engineer, in such a manner to prevent the splices from separating during geogrid installation and backfilling. Splices exposed at the wall face shall prevent loss of backfill material through the face. The splicing material exposed at the wall face shall be as durable and strong as the material to which the splices are tied. The Contractor shall offset geosynthetic splices in one layer from those in the other layers such that the splices shall not line up vertically. Splices parallel to the wall face will not be allowed, as shown in the Plans.

The Contractor shall stretch out the geosynthetic in the direction perpendicular to the wall face to ensure that no slack or wrinkles exist in the geosynthetic prior to backfilling.

For geogrids, the length of the reinforcement required as shown in the Plans shall be defined as the distance between the geosynthetic wrapped face and the last geogrid node at the end of the reinforcement in the wall backfill.

The Contractor shall place fill material on the geosynthetic in lifts such that six inches minimum of fill material is between the vehicle or equipment tires or tracks and the geosynthetic at all times. The Contractor shall remove all particles within the backfill material greater than three inches in size. Turning of vehicles on the first lift above the geosynthetic will not be permitted. The Contractor shall not end dump fill material directly on the geosynthetic without the prior approval of the Engineer.

Should the geosynthetic be damaged or the splices disturbed, the backfill around the damaged or displaced area shall be removed and the damaged strip of geosynthetic replaced by the Contractor at no expense to the Contracting Agency.

The Contractor shall use a temporary form system to prevent sagging of the geosynthetic facing elements during construction. A typical example of a temporary form system and sequence of wall construction required when using this form are detailed in the Plans. Soil piles or the geosynthetic manufacturer's recommended method, in combination with the forming system shall be used to hold the geosynthetic in place until the specified cover material is placed.

The Contractor shall place and compact the wall backfill in accordance with the wall construction sequence detailed in the Plans and Method C of Section 2-03.3(14)D, except as follows:

1. The maximum lift thickness after compaction shall not exceed ten inches
2. The Contractor shall decrease this lift thickness, if necessary, to obtain the specified density.
3. Rollers shall have sufficient capacity to achieve compaction without causing distortion to the face of the wall in accordance with Section 6-14.3(1).
4. The Contractor shall not use sheepsfoot rollers or rollers with protrusions.
5. The Contractor shall compact the zone within three feet of the back of the wall facing panels without causing damage to or distortion of the wall facing elements (welded wire mats, backing mats, construction geotextile for wall facing, precast concrete facing panels, and concrete blocks) by using light mechanical tampers as approved by the Engineer. No soil density tests will be taken within this area.
6. For wall systems with geosynthetic reinforcement, the minimum compacted backfill lift thickness of the first lift above each geosynthetic reinforcement layer shall be six inches.

The Contractor shall construct wall corners at the locations shown in the Plans, and in accordance with the wall corner construction sequence and method submitted by the Contractor and approved by the Engineer. Wall angle points with an interior angle of less than 150 degrees shall be considered to be a wall corner. The wall corner shall provide a positive connection between the sections of the wall on each side of the corner such that the wall backfill material cannot spill out through the corner at any time during the design life of the wall. The Contractor shall construct the wall corner such that the wall sections on both sides of the corner attain the full geosynthetic layer embedment lengths shown in the Plans.

Where required by retaining wall profile grade, the Contractor shall terminate top layers of retaining wall geosynthetic and backfill in accordance with the method submitted by the Contractor and approved by the Engineer. The end of each layer at the top of the wall shall be constructed in a manner that prevents wall backfill material from spilling out the face of the wall throughout the life of the wall. If the profile of the top of the wall changes at a rate of 1:1 or steeper, this change in top of wall profile shall be considered to be a corner.

6-14.3(5) Guardrail Placement

The Contractor shall install guardrail posts as shown in the Plans after completing the wall, but before the permanent facing is installed. The Contractor shall install the posts in a manner that prevents bulging of the wall face and prevents ripping, tearing, or pulling of the geosynthetic reinforcement. Holes through the geosynthetic reinforcement shall be the minimum size necessary for the post. The Contractor shall demonstrate to the Engineer prior to beginning guardrail post installation that the installation method will not rip, tear, or pull the geosynthetic reinforcement.

6-14.3(6) Permanent Facing

The Contractor shall apply a permanent facing to the surface of all permanent geosynthetic retaining walls as shown in the Plans. Shotcrete facing, if shown in the Plans, shall conform to Section 6-18. Concrete fascia panel, if shown in the Plans, shall conform to Section 6-15.3(9).

6-14.3(7) Geosynthetic Retaining Wall Traffic Barrier and Geosynthetic Retaining Wall Pedestrian Barrier

Geosynthetic wall traffic barrier (single slope and f-shape) and geosynthetic retaining wall pedestrian barrier shall be constructed in accordance with Sections 6-02.3(11)A and 6-10.3(2), and the details in the Plans.

6-14.4 Measurement

Permanent geosynthetic retaining wall and temporary geosynthetic retaining wall will be measured by the square foot of face of completed wall.

Borrow for geosynthetic retaining wall backfill will be measured as specified in Section 2-03.4.

Shotcrete facing and concrete fascia panel will be measured by the square foot surface area of the completed facing or fascia panel, measured to the neat lines of the facing or panel as shown in the Plans.

Geosynthetic wall single slope traffic barrier, geosynthetic wall f-shape traffic barrier, and geosynthetic retaining wall pedestrian barrier will be measured as specified in Section 6-10.4 for cast-in-place concrete barrier.

Structure excavation Class B, structure excavation Class B including haul, and shoring or extra excavation Class B, will be measured in accordance with Section 2-09.4.

6-14.5 Payment

Payment will be made in accordance with Section 1-04.1 for each of the following bid items when they are included in the proposal:

"Geosynthetic Retaining Wall", per square foot.

"Temporary Geosynthetic Retaining Wall", per square foot.

All costs in connection with constructing the temporary or permanent geosynthetic retaining wall as specified shall be included in the unit contract price per square foot for "Geosynthetic Retaining Wall" and "Temporary Geosynthetic Retaining Wall", including compaction of the backfill material and furnishing and installing the temporary forming system.

"Borrow for Geosynthetic Wall Incl. Haul", per ton or per cubic yard.

All costs in connection with furnishing and placing backfill material for temporary or permanent geosynthetic retaining walls as specified shall be included in the unit contract price per ton or per cubic yard for "Borrow for Geosynthetic Wall Incl. Haul".

"Concrete Fascia Panel", per square foot.

All costs in connection with constructing the concrete fascia panels as specified shall be included in the unit contract price per square foot for "Concrete Fascia Panel", including all steel reinforcing bars, premolded joint filler, polyethylene bond breaker strip, joint sealant, PVC pipe for weep holes, exterior surface finish, and pigmented sealer (when specified).

Shotcrete facing will be paid for in accordance with Section 6-18.5.

"Geosynthetic Wall Single Slope Traffic Barrier", per linear foot.

"Geosynthetic Wall F-Shape Traffic Barrier", per linear foot.

"Geosynthetic Retaining Wall Pedestrian Barrier", per linear foot.

The unit contract price per linear foot for "Geosynthetic Wall Single Slope Traffic Barrier", "Geosynthetic Wall F-Shape Traffic Barrier", and "Geosynthetic Retaining Wall Pedestrian Barrier" shall be full pay for constructing the barrier on top of the geosynthetic retaining wall.

"Structure Excavation Class B", per cubic yard.

"Structure Excavation Class B Incl. Haul", per cubic yard.

"Shoring Or Extra Excavation Class B", per square foot.

6-15 SOIL NAIL WALLS

6-15.1 Description

This work consists of constructing soil nail walls.

6-15.2 Materials

Materials shall meet the requirements of the following section:

Prefabricated Drainage Mat 9-33.2(3)

Other materials required, including materials for soil nails, shall be as specified in the Special Provisions.

6-15.3 Construction Requirements

6-15.3(1) General Description

Soil nailing shall consist of excavating to the layer limits shown in the Plans, drilling holes at the specified angle into the native material, placing and grouting epoxy coated or encapsulated steel reinforcing bars (soil nails) in the drilled holes, placing prefabricated drainage material and steel reinforcement, and applying a shotcrete facing over the steel reinforcement. After completing the wall to full height, the Contractor shall construct the concrete fascia panels as shown in the Plans.

All proprietary items used in the soil nailed structure shall be installed in accordance with the manufacturer's recommendations. In the event of a conflict between the manufacturer's recommendations and these specifications, these specifications shall prevail.

6-15.3(2) Contractor's Experience Requirements

The Contractor or Subcontractor performing this work shall have completed at least five projects, within the last five years, involving construction of retaining walls using soil nails or ground anchors or shall have completed the construction of two or more projects totaling at least 15,000 square feet of retaining wall with a minimum total of 500 soil nails or ground anchors.

The Contractor shall assign an engineer with at least three years of experience in the design and construction of permanently anchored or nailed structures to supervise the work. The Contractor shall not use consultants or manufacturer's representatives in order to meet the requirements of this section. Drill operators and on-site supervisors shall have a minimum of one year experience installing permanent soil nails or ground anchors.

Contractors or Subcontractors that are specifically prequalified in Class 36 work will be considered to have met the above experience requirements.

6-15.3(3) Submittals

Work shall not begin on any soil nail wall system until the Engineer has approved all of the required submittals. The Contractor shall submit the following information in accordance with Section 6-01.9 not less than 30 calendar days prior to the start of wall excavation.

1. A brief description of each project satisfying the Contractors Experience Requirements with the Owner's name and current phone number (this item is not required if the Contractor or Subcontractor is prequalified in Class 36).

2. A list identifying the following personnel assigned to this project and their experience with permanently anchored or nailed structures:
   a. Supervising Engineer
   b. Drill Operators
   c. On-site Supervisors who will be assigned to the project.
3. The proposed detailed construction procedure that includes:
   a. Proposed method(s) of excavation of the soil and/or rock.
   b. A plan for the removal and control of groundwater encountered during excavation, drilling, and other earth moving activities. Include a list of the equipment used to remove and control groundwater.
   c Proposed drilling methods and equipment.
   d. Proposed hole diameter(s).
   e. Proposed method of soil nail installation.
   f. Grout mix design and procedures for placing the grout.
   g. Shotcrete mix design with compressive strength test results.
   h. Procedures for placing the shotcrete (include placement in conditions when ground water is encountered).
   i. Encapsulation system for additional corrosion protection selected for the soil nails and anchorages requiring encapsulation.
4. Detailed working drawings of the method proposed for the soil nail testing that includes:
   a. All necessary drawings and details to clearly describe the proposed system of jacking support, framing, and bracing to be used during testing.
   b. Calibration data for each load cell, test jack, pressure gauge, stroke counter on the grout pump, and master gauge to be used. The calibration tests shall have been performed by an independent testing laboratory, and tests shall have been performed within 60 calendar days of the date submitted. Testing or work shall not commence until the Engineer has approved the load cell, jack, pressure gage, and master pressure gauge calibrations.
5. Certified mill test results and typical stress-strain curves along with samples from each heat, properly marked, for the soil nail steel. The typical stress-strain curve shall be obtained by approved standard practices. The guaranteed ultimate strength, yield strength, elongation, and composition shall be specified.

6-15.3(4) Preconstruction Conference

A soil nail preconstruction conference shall be held at least five working days prior to the Contractor beginning any permanent soil nail work at the site to discuss construction procedures, personnel and equipment to be used. The list of materials specified on the Record of Materials Form (ROM) for this item of work will also be discussed. Those attending shall include:

1. (representing the Contractor) The superintendent, on site supervisors, and all foremen in charge of excavating the soil face, drilling the soil nail hole, placing the soil nail and grout, placing the shotcrete facing, and tensioning and testing the soil nail.
2. (representing the Contracting Agency) The Project Engineer, key inspection personnel, and representatives from the WSDOT Construction Office and Materials Laboratory Geotechnical Services Branch.

If the Contractor's key personnel change, or if the Contractor proposes a significant revision of the approved permanent soil nail installation plan, an additional conference shall be held before any additional permanent soil nail operations are performed.

6-15.3(5) Earthwork

The ground contour above the wall shall be established to its final configuration and slope as shown in the Plans prior to beginning excavation of the soil for the first row of soil nails. All excavation shall conform to Section 2-03.

The excavation shall proceed from the top down in a horizontal lift sequence with the ground level excavated no more than 3-feet below the elevation of the row of nails to be installed in that lift. The excavated vertical wall face should not be left open more than 24 hours for any reason. A lift shall not be excavated until the nail installation and reinforced shotcrete placement for the preceding lift has been completed and accepted. After a lift is excavated, the cut surface shall be cleaned of all loose materials, mud, rebound, and other foreign matter that could prevent or reduce shotcrete bond.

The accuracy of the ground cut shall be such that the required thickness of shotcrete can be placed within a tolerance of plus or minus 2-inches from the defined face of the wall, and over excavation does not damage overlying shotcrete sections by undermining or other causes.

The Contractor should review the geotechnical recommendations report prepared for this project for further information on the soil conditions at the location of each wall. Copies of the geotechnical recommendations report are available for review by prospective bidders at the location identified in the Special Provisions.

6-15.3(6) Soil Nailing

The Contractor shall not handle and transport the encapsulated soil nails until the encapsulation grout has reached sufficient strength to resist damage during handling. The Contractor shall handle the encapsulated soil nails in such a manner to prevent large deflections or distortions during handling. When handling or transporting encapsulated soil nails, the Contractor shall provide slings or other equipment necessary to prevent damage to the soil nails and the corrosion protection. The Engineer may reject any encapsulated nail which is damaged during transportation or handling. Damaged or defective encapsulation shall be repaired in accordance with the manufacturer's recommendations and as approved by the Engineer.

Soil nails shall be handled and sorted in such a manner as to avoid damage or corrosion. Prior to inserting a soil nail in the drilled hole, the Contractor and the Engineer will examine the soil nail for damage. If, in the opinion of the Engineer, the epoxy coating or bar has been damaged, the nail shall be repaired. If, in the opinion of the Engineer, the damage is beyond repair, the soil nail shall be rejected.

If, in the opinion of the Engineer, the epoxy coating can be repaired, the Contractor shall patch the coating with an Engineer approved patching material.

Nail holes shall be drilled at the locations shown in the Plans or as staked by the Engineer. The nails shall be positioned plus or minus 6-inches from the theoretical location shown in the Plans. The Contractor shall select the drilling method and the grouting pressure used for the installation of the soil nail. The drill hole shall be located so that the longitudinal axis of the drill hole and the longitudinal axis of the nail are parallel. At the point of entry the soil nail shall be installed within plus or minus three degrees of the inclination from horizontal shown in the Plans, and the nail shall be within plus or minus three degrees of a line drawn perpendicular to the face of the wall unless otherwise shown in the Plans.

Water or other liquids shall not be used to flush cuttings during drilling, but air may be used. After drilling, the nail shall be installed and fully grouted before placing the shotcrete facing. The nail shall be inserted into the drilled hole with centralizers to the desired depth in such a manner as to prevent damage to the drilled hole, sheathing or epoxy during installation. The centralizers shall provide a minimum of 0.5-inches of grout cover over the soil nail and shall be spaced no further than eight feet apart. When the soil nail cannot be completely inserted into the drilled hole without difficulty, the Contractor shall remove the nail from the drilled hole and clean or redrill the hole to permit insertion. Partially inserted soil nails shall not be driven or forced into the hole. Subsidence, or any other detrimental impact from drilling shall be cause for immediate cessation of drilling and repair of all damages in a manner approved by the Engineer at no additional cost to the Contracting Agency.

If caving conditions are encountered, no further drilling will be allowed until the Contractor selects a method to prevent ground movement. The Contractor may use temporary casing. The Contractor's method to prevent ground movement shall be approved by the Engineer. The casings for the nail holes, if used, shall be removed as the grout is being placed.

Where necessary for stability of the excavation face, a sealing layer of shotcrete may be placed before drilling is started, or the Contractor shall have the option of drilling and grouting of nails through a stabilizing berm of native soil at the face of the excavation. The stabilizing berm shall extend horizontally from the soil face and from the face of the shotcrete a minimum distance of one foot, and shall be cut down from that point at a safe slope, no steeper than 1H:1V unless approved by the Engineer. The berm shall be excavated to final grade after installation and full length grouting of the nails. Nails damaged during berm excavation shall be repaired or replaced by the Contractor, to the satisfaction of the Engineer, at no added cost to the Contracting Agency.

If sections of the wall are constructed at different times than the adjacent soil nail sections, the Contractor shall use stabilizing berms, temporary slopes, or other measures, as approved by the Engineer, to prevent sloughing or failure of the adjacent soil nail sections.

If cobbles and boulders are encountered at the soil face during excavation, the Contractor shall remove all cobbles and boulders that protrude from the soil face into the design wall section and fill the void with shotcrete. All shotcrete used to fill voids created by removal of cobbles and boulders shall be incidental to shotcrete facing.

The grout equipment shall produce a grout free of lumps and undispersed cement. A positive displacement grout pump shall be used. The pump shall be equipped with a pressure gauge near the discharge end to monitor grout pressures. The pressure gauge shall be capable of measuring pressures of at least 150 psi or twice the actual grout pressures used by the Contractor, whichever is greater. The grouting equipment shall be sized to enable the grout to be pumped in one continuous operation. The mixer shall be capable of continuously agitating the grout.

The grout shall be injected from the lowest point of the drilled hole. The grout shall be pumped through grout tubes after insertion of the soil nail. The quantity of the grout and the grout pressures shall be recorded. The grout pressures and grout takes shall be controlled to prevent excessive ground heave.

6-15.3(7) Shotcrete Facing

Prior to placing any shotcrete on an excavated layer, the Contractor shall vertically center prefabricated drainage mat between the columns of nails as shown in the Plans. The prefabricated drainage mat shall be installed in accordance with the manufacturer's recommendations. The permeable drain side shall be placed against the exposed soil face. The prefabricated drainage mat shall be installed after each excavation lift and shall be hydraulically connected with the prefabricated drainage mat previously placed, such that the vertical flow of water is not impeded. The Contractor shall tape all joints in the prefabricated drainage mat to prevent shotcrete intrusion during shotcrete application.

The Contractor shall place steel reinforcing bars and welded wire fabric, and apply the shotcrete facing in accordance with Section 6-18 and the details shown in the Plans.

The shotcrete shall be constructed to the minimum thickness as shown in the Plans. Costs associated with additional thickness of shotcrete due to over excavation or irregularities in the cut face shall be borne by the Contractor.

Each soil nail shall be secured at the shotcrete facing with a steel plate as shown in the Plans. The plate shall be seated on a wet grout pad of a pasty consistency similar to that of mortar for brick-laying. The nut shall then be sufficiently tightened to achieve full bearing surface behind the plate. After the shotcrete and grout have had time to gain the specified strength, the nut shall be tightened with at least 100 foot-pounds of torque.

6-15.3(8) Soil Nail Testing and Acceptance

Both verification and proof testing of the nails is required. The Contractor shall supply all materials, equipment, and labor to perform the tests. The Contractor shall submit all test data to the Engineer.

The testing equipment shall include a dial gauge or vernier scale capable of measuring to 0.001-inch of the ground anchor movement. A hydraulic jack and pump shall be used to apply the test load. The movement-measuring device shall have a minimum travel equal to the theoretical elastic elongation of the total nail length plus 1-inch. The dial gauge or vernier scale shall be aligned so that its axis is within 5 degrees from the axis of the nail and shall be monitored with a reference system that is independent of the jacking system and excavation face.

The jack and pressure gauge shall be calibrated by an independent testing laboratory as a unit. Each load cell, test jack and pressure gauge, grout pump stroke counter, and master gauge, shall be calibrated as specified in Section 6-15.3(3) item 4b. Additionally, the Contractor shall not use load cells, test jacks and pressure gauges, grout pump stroke counters, and master gauges, greater than 60 calendar days past their most recent calibration date, until such items are re-calibrated by an independent testing laboratory.

The pressure gauge shall be graduated in 100 psi increments or less. The pressure gauge will be used to measure the applied load. The pressure gauge shall be selected to place the maximum test load within the middle two-thirds of the range of the gauge. The ram travel of the jack shall not be less than the theoretical elastic elongation of the total length at the maximum test load plus 1-inch. The jack shall be independently supported and centered over the nail so that the nail does not carry the weight of the jack. The Contractor shall have a second calibrated jack pressure gauge at the site. Calibration data shall provide a specific reference to the jack and the pressure gauge.

The loads on the nails during the verification and proof tests shall be monitored to verify consistency of load – defined as maintaining the test load within five percent of the specified value. Verification and proof test loads less than 20,000 pounds or sustained for five minutes or less shall be monitored by the jack pressure gauge alone. Verification and proof test loads equal to or greater than 20,000 pounds and sustained for longer than five minutes shall be monitored with the assistance of an electric or hydraulic load cell. The Contractor shall provide the load cell, the readout device, and a recent calibration curve. The load cell shall be selected to place the maximum test load within the middle two-thirds of the range of the load cell. The load cell shall be mounted between the jack and the anchor plate. The stressing equipment shall be placed over the nail in such a manner that the jack bearing plates, load cell and stressing anchorage are in alignment.

Nails to be tested shall be initially grouted no closer to the excavation face than the dimension shown in the Plans. After placing the grout, the nail shall remain undisturbed until the grout has reached a strength sufficient to provide resistance during testing. Grouting to the excavation face shall be completed after successful testing has been performed. Test nails that are not part of the permanent wall may be left in the ground provided the drill holes for the nails are completely filled with grout or non-structural filler after testing.

Load testing shall be performed against a temporary bearing yoke or reaction frame that bears directly against the existing soil or the shotcrete facing. Temporary bearing pads shall be kept a minimum of 12-inches from the edges of the drilled hole unless a rigid steel plate is used to distribute the stress around the drilled hole. If a steel plate is used, it shall be a minimum of 3-feet square and of sufficient thickness that it will distribute the load evenly to the soil. Where the reaction frame bears directly against the shotcrete, the reaction frame shall be designed to prevent fracture of the shotcrete. No part of the reaction frame shall bear within 12-inches of the edge of the test nail blockout unless otherwise approved by the Engineer.

The soil nail load monitoring procedure for verification and proof test load greater than 20,000 pounds and sustained for longer than five minutes shall be as follows:

1. For each increment of load, attainment of the load shall be initially established and confirmed by the reading taken from the jack gauge.
2. Once the soil nail anchor load has been stabilized, based on the jack gauge reading, the load cell readout device shall immediately be read and recorded to establish the load cell reading to be used at this load. The load cell reading is intended only as a confirmation of a stable soil nail load, and shall not be taken as the actual load on the soil nail.
3. During the time period that the load on the soil nail is held at this load increment, the Contractor shall monitor the load cell reading. The Contractor shall adjust the jack pressure as necessary to maintain the initial load cell reading. Jack pressure adjustment for any other reason will not be allowed.
4. Soil nail elongation measurements shall be taken at each load increment as specified in Sections 6-15.3(8)A and 6-15.3(8)B.
5. Steps 1 through 4 shall be repeated at each increment of load, in accordance with the load sequence specified in Sections 6-15.3(8)A and 6-15.3(8)B.

6-15.3(8)A Verification Testing

Verification testing shall be performed on nails installed within the pattern of production nails to verify the Contractor's procedures, hole diameter, and design assumptions. No drilling or installation of production nails will be permitted in any ground/rock unit unless successful verification testing of anchors in that unit has been completed and approved by the Engineer, using the same equipment, methods, nail inclination, nail length, and hole diameter as planned for the production nails. Changes in the drilling or installation method may require additional verification testing as determined by the Engineer and shall be done at no additional expense to the Contracting Agency. Verification tests may be performed prior to excavation for the soil nail wall.

Successful verification tests are required within the limits as specified in the Special Provisions. Test nail locations within these limits shall be at locations selected by the Engineer.

The design details of the verification testing, including the system for distributing test load pressures to the excavation surface and appropriate nail bar size and reaction plate, shall be developed by the Contractor, subject to approval by the Engineer. The intent is to stress the bond between the grout and the surrounding soil/rock to at least twice the design load transfer.

The bar shall be proportioned such that the maximum stress at 200 percent of the test load does not exceed 80 percent of the yield strength of the steel. The jack shall be positioned at the beginning of the test such that unloading and repositioning of the jack during the test will not be required. The verification tests shall be made by incrementally loading the nails in accordance with the following schedule of hold time:

AL	1 minute
0.25TL	10 minutes
0.50TL	10 minutes
0.75TL	10 minutes
1.00TL	10 minutes
1.25TL	10 minutes
1.50TL	60 minutes
1.75TL	10 minutes
2.00TL	10 minutes

AL = Nail Alignment Load

TL = Nail Test Load

The test load shall be determined by the following equation = Test Load (TL) = Bond Length (BL) X Design Load Transfer (DLT).

The load shall be applied in increments of 25 percent of the test load. Each load increment shall be held for at least 10 minutes. Measurement of nail movement shall be obtained at each load increment. The load-hold period shall start as soon as the load is applied and the nail movement with respect to a fixed reference shall be measured and recorded at 1 minute, 2, 3, 5, 6, 10, 20, 30, 50, and 60 minutes.

The Engineer will evaluate the results of each verification test and make a determination of the suitability of the test and of the Contractor's proposed production nail design and installation system. Tests that fail to meet the design criteria will require additional verification testing or an approved revision to the Contractor's proposed production nail design and installation system. If a nail fails in creep, retesting will not be allowed.

A verification tested nail with a 60 minute load hold at 1.50TL is acceptable if:

1. The nail carries the test load with a creep rate that does not exceed 0.08-inch per log cycle of time and is at a linear or decreasing creep rate.
2. The total movement at the test load exceeds 80 percent of the theoretical elastic elongation of the non-bonded length.

Furthermore, a pullout failure shall not occur for the verification test anchor at the 2.0TL maximum load. Pullout failure load is defined as the load at which attempts to increase the test load result only in continued pullout movement of the test nail without a sustainable increase in the test load.

The nails used for verification tests shall be sacrificial and shall not be used for production. The Contractor shall cut and remove the exposed end of all soil nails used for verification tests a minimum of two feet inside the finished ground line.

6-15.3(8)B Proof Testing

Proof tests shall be performed on production nails at the locations selected by the Engineer. Up to five percent of the production nails will be tested. Prior to testing, only the bond length (BL) portion of the nail shall be grouted. The Contractor shall maintain the side-wall stability of the drill hole for the non-grouted portion during the test. Once proof testing is completed, the remainder of the proof tested nail shall be grouted. The bond length shall be determined from the Nail Schedule and Test Nail Detail shown in the Plans.

Proof tests shall be performed by incrementally loading the nail in accordance with the schedule below. The anchor movement shall be measured and recorded to the nearest 0.001-inch with respect to an independent fixed reference point in the same manner as for the verification tests at the alignment load and at each increment of load. The load shall be monitored in accordance with Section 6-15.3(8). The scheduling of hold times shall be as follows:

AL	1 minute
0.25TL	5 minutes
0.50TL	5 minutes
0.75TL	5 minutes
1.00TL	5 minutes
1.25TL	5 minutes
1.50TL	10 minutes

AL = Nail Alignment Load

TL = Nail Test Load

The maximum load in a proof test shall be held for 10 minutes. The load hold period shall start as soon as the maximum load is applied and the nail movement with respect to an independent fixed reference shall be measured and recorded at 1, 2, 3, 4, 5, 6, and 10 minutes. The nail movement between 1 minute and 10 minutes shall not exceed 0.04-inches. If the nail movement between 1 and 10 minutes exceeds 0.04-inches, the maximum load shall be held an additional 50 minutes. If the load hold is extended, the nail movement shall be recorded at 20, 30, 50, and 60 minutes. If a nail fails in creep, retesting will not be allowed.

A proof tested nail is acceptable if:

1. The nail carries the maximum load with less than 0.04-inches of movement between 1 minute and 10 minutes, unless the load hold extended to 60 minutes, in which case the nail would be acceptable if the creep rate does not exceed 0.08-inches per log cycle of time.
2. The total movement at the maximum load exceeded 80 percent of the theoretical elastic elongation of the non-bonded length.
3 The creep rate is not increasing with time during the load hold period.

Due to the requirement for a non-bonded zone for testing purposes, the Contractor shall develop an installation method which will assure the stability of the non-bonded portion of the hole during testing and will allow for the non bonded zone to be grouted against the ground after testing.

If a proof test fails, the Engineer may direct the Contractor to replace some or all of the installed production nails between the failed test and an adjacent proof test nail that has met the test criteria. The Engineer may also require additional proof testing. All additional proof tests, and all installation of additional or modified nails, shall be performed at no additional expense to the Contracting Agency.

6-15.3(9) Concrete Fascia Panels

The Contractor shall construct the concrete fascia panels in accordance with Section 6-02 and the details in the Plans. The concrete fascia panels shall be cured in accordance with the Section 6-02.3(11) requirements specified for retaining walls. The Contractor shall provide the specified surface finish as noted, and to the limits shown, in the Plans to the exterior concrete surface. When noted in the Plans, the Contractor shall apply pigmented sealer to the limits shown in the Plans.

Asphalt or cement concrete gutter shall be constructed as shown in the Plans and as specified in Section 8-04.

6-15.4 Measurement

Prefabricated drainage mat will be measured by the square yard of material furnished and installed.

Soil nails will be measured per each for each soil nail installed and accepted.

The soil nail verification testing program will not be measured but will be paid for on a lump sum basis.

Shotcrete facing and concrete fascia panel will be measured by the square foot surface area of the completed facing or fascia panel, measured to the neat lines of the facing or panel as shown in the Plans.

6-15.5 Payment

Payment will be made in accordance with Section 1-04.1 for each of the following bid items when they are included in the proposal:

"Soil Nail – Epoxy Coated", per each.

"Soil Nail – Encapsulated", per each.

All costs in connection with furnishing and installing the soil nails as specified shall be included in the unit contract price per each for "Soil Nail - ___", including all drilling, grouting, centralizers, bearing plates, welded shear connectors, nuts, proof testing, and other work required for installation of each soil nail.

"Prefabricated Drainage Mat", per square yard.

"Soil Nail Verification Test", lump sum.

"Concrete Fascia Panel", per square foot.

All costs in connection with constructing the concrete fascia panels as specified shall be included in the unit contract price per square foot for "Concrete Fascia Panel", including all steel reinforcing bars, premolded joint filler, polyethylene bond breaker strip, joint sealant, PVC pipe for weep holes, exterior surface finish, and pigmented sealer (when specified).

Shotcrete facing will be paid for in accordance with Section 6-18.5.

Unless otherwise specified, all costs in connection with excavation in front of the back face of the shotcrete facing shall be included in the unit contract price per cubic yard for "Roadway Excavation" or "Roadway Excavation Incl. Haul" as specified in Section 2-03.5.

6-16 SOLDIER PILE AND SOLDIER PILE TIEBACK WALLS

6-16.1 Description

This work consists of constructing soldier pile walls and soldier pile tieback walls.

6-16.2 Materials

Materials shall meet the requirements of the following sections:

Controlled Density Fill	2-09.3(1)E
Cement	9-01
Aggregates for Portland Cement Concrete	9-03.1
Gravel Backfill	9-03.12
Premolded Joint Filler	9-04.1(2)
Welded Shear Studs	9-06.15
Steel Reinforcing Bar	9-07.2
Epoxy-Coated Steel Reinforcing Bar	9-07.3
Paints	9-08
Timber Lagging	9-09.2
Preservative Treatment for Timber Lagging	9-09.3(1)
Soldier Piles	9-10.5
Concrete Curing Materials and Admixtures	9-23
Fly Ash	9-23.9
Water	9-25
Prefabricated Drainage Mat	9-33.2(3)

Other materials required shall be as specified in the Special Provisions.

6-16.3 Construction Requirements

6-16.3(1) Quality Assurance

The steel soldier piles shall be placed so that the centerline of the pile at the top is within 1-inch of the plan location. The steel soldier pile shall be plumb, to within 0.5 percent of the length based on the total length of the pile.

Welding, repair welding, and welding inspection shall conform to the Section 6-03.3(25) requirements for welding, repair welding, and welding inspection for all other steel fabrication.

6-16.3(2) Submittals

The Contractor shall submit shop plans as specified in Section 6-03.3(7) for all structural steel, including the steel soldier piles and the permanent ground anchors to the Engineer for approval.

The Contractor shall submit the permanent ground anchor grout mix design and the procedures for placing the grout to the Engineer for approval.

The Contractor shall submit forming plans for the concrete fascia panels, as specified in Sections 6-02.3(16) and 6-02.3(17), to the Engineer for approval.

1. Where the lateral pressure from concrete placement, as specified in Section 6-02.3(17)J, is less than or equal to the design earth pressure, the Contractor may tie forms directly to the soldier piles.

2. Where the lateral pressure from concrete placement, as specified in Section 6-02.3(17)J, is greater than the design earth pressure, the Contractor shall follow one of the following procedures:
   a. Tie the forms to strongbacks behind the lagging, or use some other system that confines the pressure from concrete placement between the lagging and the form panels, in addition to the ties to the soldier piles.
   b. Reduce the rate of placing concrete to reduce the pressure from concrete placement to less than or equal to the design earth pressure in addition to the ties to the soldier piles.
   c. Follow a procedure with a combination of a. and b.
3. The Contractor shall design the forms for an appropriate rate of placing concrete so that no cold joints occur, considering the wall thickness and height, and volume of concrete to be placed.

The Contractor shall submit four copies of a shaft installation plan in accordance with Section 6-01.9 not less than 30 calendar days prior to the beginning of shaft construction. In preparing the submittal, the Contractor shall reference the available subsurface data provided in the contract test hole boring logs and the geotechnical report(s) prepared for this project. This plan shall provide at least the following information:

1. An overall construction operation sequence and the sequence of shaft construction.
2. List, description, and capacities of proposed equipment including but not limited to cranes, drills, augers, bailing buckets, final cleaning equipment, and drilling units. The narrative shall describe why the equipment was selected, and describe equipment suitability to the anticipated site and subsurface conditions. The narrative shall include a project history of the drilling equipment demonstrating the successful use of the equipment on shafts of equal or greater size in similar soil/rock conditions.
3. Details of shaft excavation methods including proposed drilling methods, methods for cleanout of the shafts, disposal plan for excavated material and drilling slurry (if applicable), and a review of method suitability to the anticipated site and subsurface conditions.
4. Details of the method(s) to be used to ensure shaft stability (i.e., prevention of caving, bottom heave, etc. using temporary casing, slurry, or other means) during excavation and concrete placement. This shall include a review of method suitability to the anticipated site and subsurface conditions. If temporary casings are proposed, casing dimensions and detailed procedures for casing installation and removal shall be provided. If slurry is proposed, detailed procedures for mixing, using, maintaining, and disposing of the slurry shall be provided. A detailed mix design, and a discussion of its suitability to the anticipated subsurface conditions shall also be provided for the proposed slurry.
5. Details of soldier pile placement including internal support bracing and centralization methods.

6. Details of concrete placement including proposed operational procedures for pumping and/or tremie methods.
7. Details of the device used to prevent unauthorized entry into a shaft excavation.
8. The method to be used to form the horizontal construction joint at the top elevation specified for concrete Class 4000P in the shaft.

Work shall not begin until the Engineer has approved the appropriate submittals in writing.

6-16.3(3) Shaft Excavation

Shafts shall be excavated to the required depth as shown in the Plans. The minimum diameter of the shaft shall be as shown in the Plans. The excavation shall be completed in a continuous operation using equipment capable of excavating through the type of material expected to be encountered.

The Contractor may use temporary telescoping casing to construct the shafts.

If the shaft excavation is stopped the shaft shall be secured by installation of a safety cover. It shall be the Contractor's responsibility to ensure the safety of the shaft and surrounding soil and the stability of the sidewalls. A temporary casing, slurry, or other methods specified in the shaft installation plan as approved by the Engineer shall be used if necessary to ensure such safety and stability.

Where caving in conditions are encountered, no further excavation will be allowed until the Contractor has implemented the method to prevent ground caving as submitted in accordance with item 4 of the Shaft Installation Plan and as approved by the Engineer.

No more than 2-inches of loose or disturbed material, for soldier piles with permanent ground anchors, nor more than 12-inches of loose or disturbed material, for soldier piles without permanent ground anchors, shall be present at the bottom of the shaft just prior to beginning concrete placement.

The excavated shaft shall be inspected and approved by the Engineer prior to proceeding with construction.

When obstructions are encountered, the Contractor shall notify the Engineer promptly. An obstruction is defined as a specific object (including, but not limited to, boulders, logs, and man made objects) encountered during the shaft excavation operation that prevents or hinders the advance of the shaft excavation. When efforts to advance past the obstruction to the design shaft tip elevation result in the rate of advance of the shaft drilling equipment being significantly reduced relative to the rate of advance for the rest of the shaft excavation, then the Contractor shall remove the obstruction under the provisions of Section 6-16.5 as supplemented in the Special Provisions. The method of removal of such obstructions, and the continuation of excavation shall be as proposed by the Contractor and approved by the Engineer.

Excavation of shafts shall not commence until a minimum of 12 hours after the shaft backfill for the adjacent shafts has been placed.

The temporary casings for the shafts shall be removed. A minimum 5 foot head of concrete shall be maintained to balance the soil and water pressure at the bottom of the casing. The casing shall be smooth.

6-16.3(4) Installing Soldier Piles

Soldier piles, if spliced, shall conform to all requirements of Section 6-05.3(6).

The prefabricated steel soldier piles shall be lowered into the drilled shafts and secured in position. Concrete cover over the soldier pile shall be 1-inch minimum.

The steel soldier piles and attachments shall be shop painted after fabrication to the limits shown in the Plans with one coat of inorganic zinc primer. Application of the one coat of primer shall be in accordance with Section 6-07. The welded shear studs may be attached before or after painting. Paint damaged by welding shear studs in place does not require repair.

6-16.3(5) Backfilling Shaft

The excavated shaft shall be backfilled with controlled density fill (CDF), lean concrete, or concrete Class 4000P, as shown in the Plans.

Placement of the shaft backfill shall commence immediately after completing the shaft excavation and receiving the Engineer's approval of the excavation. Concrete Class 4000P and lean concrete shall be placed in one continuous operation to the elevation shown in the Plans. CDF shall be placed in one continuous operation to the top of the shaft. Vibration of shaft backfill is not required.

If water is not present, the shaft backfill shall be deposited by a method that prevents segregation of aggregates. The shaft backfill shall be placed such that the free-fall is vertical down the shaft without hitting the sides of the soldier pile or the excavated shaft. The Contractor's method for depositing the shaft backfill shall have approval of the Engineer prior to the placement of the shaft backfill.

If water is present, the shaft backfill shall be deposited in accordance with Section 6-02.3(6)B.

6-16.3(6) Installing Timber Lagging and Permanent Ground Anchors

The excavation and removal of CDF and lean concrete for the lagging installation shall proceed in advance of the lagging. The bottom of the excavation in front of the wall shall be level. Excavation shall conform to Section 2-03.

For walls without permanent ground anchors, the bottom of excavation shall be not more than three feet below the bottom level of the timber lagging already installed. For walls with permanent ground anchors, the bottom of excavation shall be not more than 3-feet below tieback anchor level until all permanent ground anchors at that level are installed and stressed. Installing, stressing, and testing the permanent ground anchors shall be in accordance with Section 6-17 and the construction sequence specified in the Plans.

Unless otherwise specified, timber lagging in walls with concrete fascia panels shall be untreated. Timber lagging for all other walls shall be treated.

The lagging shall be installed from the top of the pile proceeding downward. The timber lagging shall make direct contact with the soil. Voids shall be filled with gravel backfill for walls, which shall be considered incidental to the installation of the timber lagging.

Where timber lagging and backfill are above the existing or excavated ground line, the lagging and backfill shall be placed concurrently. The backfill layers shall be placed in accordance with Section 2-03.3(14) except that all layers shall be compacted to 90 percent of maximum density.

6-16.3(7) Prefabricated Drainage Mat

For walls with concrete fascia panels, prefabricated drainage mat shall be installed full height of the concrete fascia panel and full width between soldier pile flanges, unless otherwise shown in the Plans.

The prefabricated drainage mat shall be attached to the lagging in accordance with the manufacturer's recommendations. The fabric side shall face the lagging. Splicing of the prefabricated drainage mat shall be in accordance with the manufacturer's recommendations.

The Contractor shall ensure the hydraulic connection of the prefabricated drainage mat to the previously installed material so that the vertical flow of water is not impeded.

The Contractor shall tape all joints in the prefabricated drainage mat to prevent concrete intrusion during concrete fascia panel construction.

6-16.3(8) Concrete Fascia Panel

The Contractor shall construct the concrete fascia panels as shown in the Plans, and in accordance with the forming plan as approved by the Engineer. The concrete fascia panels shall be cured in accordance with the Section 6-02.3(11) requirements specified for retaining walls.

The Contractor shall provide the specified surface finish as noted, and to the limits shown, in the Plans to the exterior concrete surface. When noted in the Plans, the Contractor shall apply pigmented sealer to the limits shown in the Plans.

Asphalt or cement concrete gutter shall be constructed as shown in the Plans.

6-16.4 Measurement

Soldier pile shaft construction will be measured by the linear foot of shaft excavated below the top of ground line for the shaft, defined as the highest existing ground point within the shaft diameter.

Furnishing soldier pile will be measured by the linear foot of pile assembly specified in the Proposal, including adjustments to the Plan quantity made in accordance with Section 1-04.4.

Timber lagging will be measured by the thousand board feet measure (MBM) installed. The quantity will be computed using the nominal thickness and width dimensions of the timber lagging members, and the center-to-center spacing of the soldier piles as the length dimension.

Prefabricated drainage mat will be measured by the square yard of material furnished and installed.

Concrete fascia panel will be measured by the square foot surface area of the completed fascia panel, measured to the neat lines of the panel as shown in the Plans.

6-16.5 Payment

Payment will be made in accordance with Section 1-04.1 for each of the following bid items when they are included in the proposal:

"Shaft - ___ Diameter", per linear foot.

All costs in connection with constructing soldier pile shafts shall be included in the unit contract price per linear foot for "Shaft - ___ Diameter", including shaft excavation, temporary casing if used, CDF, lean concrete, concrete Class 4000P, and installing the soldier pile assembly.

"Furnishing Soldier Pile - ___", per linear foot.

All costs in connection with furnishing soldier pile assemblies shall be included in the unit contract price per linear foot for "Furnishing Soldier Pile - ___", including fabricating and painting the pile assemblies. Payment will be made based on the quantity specified in the Proposal unless changes are made to this quantity in accordance with Section 1-04.4, in which case the quantity specified in the Proposal will be adjusted by the amount of the change and will be paid for in accordance with Section 1-04.4.

"Timber Lagging", per MBM.

All costs in connection with furnishing and installing timber lagging shall be included in the unit contract price per MBM for "Timber Lagging", including preservative treatment when specified, and filling voids behind the lagging with gravel backfill for wall.

"Prefabricated Drainage Mat", per square yard.

"Concrete Fascia Panel", per square foot.

All costs in connection with constructing the concrete fascia panels as specified shall be included in the unit contract price per square foot for "Concrete Fascia Panel", including all steel reinforcing bars, premolded joint filler, polyethylene bond breaker strip, joint sealant, PVC pipe for weep holes, exterior surface finish, and pigmented sealer (when specified).

Unless otherwise specified, all costs in connection with non-shaft excavation, including all excavation required for placement of timber lagging, shall be included in the unit contract price per cubic yard for "Roadway Excavation" or "Roadway Excavation Incl. Haul" as specified in Section 2-03.5.

6-17 PERMANENT GROUND ANCHORS

6-17.1 Description

This work consists of constructing permanent ground anchors.

6-17.2 Materials

Materials required, including materials for permanent ground anchors, shall be as specified in the Special Provisions.

6-17.3 Construction Requirements

The Contractor shall select the ground anchor type and the installation method, and determine the bond length and anchor diameter. The Contractor shall install ground anchors that will develop the load indicated in the Plans and verified by tests specified in Sections 6-17.3(8)A, 6-17.3(8)B, and 6-17.3(8)C.

6-17.3(1) Definitions

Anchor Devices: The anchor head wedges or nuts that grip the prestressing steel.

Bearing Plate: The steel plate that evenly distributes the ground anchor force to the structure.

Bond Length: The length of the ground anchor that is bonded to the ground and transmits the tensile force to the soil or rock.

Ground Anchor: A system, referred to as a tieback or as an anchor, used to transfer tensile loads to soil or rock. A ground anchor includes all prestressing steel, anchorage devices, grout, coatings, sheathings and couplers if used.

Maintaining Consistency of Load: Maintaining the test load within five percent of the specified value.

Minimum Guaranteed Ultimate Tensile Strength (MUTS): The minimum guaranteed breaking load of the prestressing steel as defined by the specified standard.

Tendon Bond Length: The length of the tendon that is bonded to the anchor grout.

Tendon Unbonded Length: The length of the tendon that is not bonded to the anchor grout.

Total Anchor Length: The unbonded length plus the tendon bond length.

6-17.3(2) Contractor Experience Requirements

The Contractor or Subcontractor performing this work shall have installed permanent ground anchors for a minimum of three years. Prior to the beginning of construction, the Contractor shall submit a list containing at least five projects on which the Contractor has installed permanent ground anchors. A brief description of each project and a reference shall be included for each project listed. As a minimum, the reference shall include an individual's name and current phone number.

The Contractor shall assign an engineer to supervise the work with at least three years of experience in the design and construction of permanently anchored structures. The Contractor shall not use consultants or manufacturer's representatives in order to meet the requirements of this section. Drill operators and on-site supervisors shall have a minimum of one year experience installing permanent ground anchors.

Contractors or Subcontractors that are specifically prequalified in Class 36 work will be considered to have met the above experience requirements.

The Contractor shall allow up to 15 calendar days for the Engineer's review of the qualifications and staff as noted above. Work shall not be started on any anchored wall system nor materials ordered until approval of the Contractor's qualifications are given.

6-17.3(3) Submittals

The Contractor shall submit working drawings and structural design calculations in accordance with Section 6-01.9 for the ground anchor system or systems intended for use.

The Contractor shall submit a detailed description of the construction procedure proposed for use to the Engineer for approval.

The Contractor shall submit a ground anchor schedule giving:

1. Ground anchor number
2. Ground anchor design load
3. Type and size of tendon
4. Minimum total bond length
5. Minimum anchor length
6. Minimum tendon bond length
7. Minimum unbonded length

The Contractor shall submit working drawings of the ground anchor tendon and the corrosion protection system. Include details of the following:

1. Spacers and their location
2. Centralizers and their location
3. Unbonded length corrosion protection system, including the permanent rubber seal between the trumpet and the tendon unbonded length corrosion protection.
4. Bond length corrosion protection system
5. Anchorage and trumpet
6. Anchorage corrosion protection system
7. Anchors using non-restressable anchorage devices

The Contractor shall submit shop plans as specified in Section 6-03.3(7) for all structural steel, including the permanent ground anchors to the Engineer for review and approval.

The Contractor shall submit the grout mix designs and the procedures for placing the grout to the Engineer for approval. The Contractor shall also submit the methods and materials used in filling the annulus over the unbonded length of the anchor.

The Contractor shall submit five copies of detailed working drawings in accordance with Section 6-01.9 for the method proposed to be followed for the permanent ground anchor testing to the Engineer for approval prior to the tests. This shall include all necessary drawings and details to clearly describe the method proposed.

The Contractor shall submit to the Engineer calibration data for each load cell, test jack, pressure gauge and master pressure gauge to be used. The calibration tests shall have been performed by an independent testing laboratory and tests shall have been performed within 60 calendar days of the date submitted. The Engineer shall approve or reject the calibration data after receipt of the data. Testing shall not commence until the Engineer has approved the load cell, jack, pressure gauge and master pressure gauge calibrations.

Work shall not begin until the Engineer has approved the appropriate submittals in writing.

6-17.3(4) Preconstruction Conference

A permanent ground anchor preconstruction conference shall be held at least five working days prior to the Contractor beginning any permanent ground anchor work at the site to discuss construction procedures, personnel, and equipment to be used. The list of materials specified on the Record of Materials Form (ROM) for this item of work will also be discussed. Those attending shall include:

1. (representing the Contractor) The superintendent, on site supervisors, and all foremen in charge of drilling the ground anchor hole, placing the permanent ground anchor and grout, and tensioning and testing the permanent ground anchor.
2. (representing the Contracting Agency) The Project Engineer, key inspection personnel, and representatives from the WSDOT Construction Office and Materials Laboratory Geotechnical Services Branch.

If the Contractor's key personnel change, or if the Contractor proposes a significant revision of the approved permanent ground anchor installation plan, an additional conference shall be held before any additional permanent ground anchor operations are performed.

6-17.3(5) Tendon Fabrication

The tendons can be either shop or field fabricated. The tendon shall be fabricated as shown in the approved shop plans.

The Contractor shall select the type of tendon to be used. The tendon shall be sized so the design load does not exceed 60 percent of the minimum guaranteed ultimate tensile strength of the tendon. In addition, the tendon shall be sized so the maximum test load does not exceed 80 percent of the minimum guaranteed ultimate tensile strength of the tendon.

The Contractor shall be responsible for determining the bond length and tendon bond length necessary to develop the design load indicated in the Plans in accordance with Sections 6-17.3(8)A, 6-17.3(8)B, and 6-17.3(8)C. The minimum bond length shall be ten feet in rock and 15-feet in soil.

When the Plans require the tendon bond length to be encapsulated, the tendon bond length portion of the tendon shall be corrosion protected by encapsulating the tendon in a grout-filled PE or PVC tube as specified in Section 6-17.2 as supplemented in the Special Provisions. The tendons can be grouted inside the encapsulation prior to inserting the tendon in the drill hole or after the tendon has been placed in the drill hole. Expansive admixtures can be mixed with the encapsulation grout if the tendon is grouted inside the encapsulation while outside the drill hole. The tendon shall be centralized within the bond length encapsulation with a minimum of 0.20-inches of grout cover. Spacers shall be used along the tendon bond length of multi-element tendons to separate the elements of the tendon so the prestressing steel will bond to the encapsulation grout.

Centralizers shall be used to provide a minimum of 0.5-inches of grout cover over the tendon bond length encapsulation. Centralizers shall be securely attached to the encapsulation and the center-to-center spacing shall not exceed ten feet. In addition, the upper centralizer shall be located a maximum of five feet from the top of the tendon bond length and the lower centralizer shall be located a maximum of one foot from the bottom of the tendon bond length.

The centralizer shall be able to support the tendon in the drill hole and position the tendon so a minimum of 0.5-inches of grout cover is provided and shall permit free flow of grout.

Centralizers are not required on encapsulated, pressure-injected ground anchor tendons if the ground anchor is installed in coarse grained soils (more than 50 percent of the soil larger than the number 200 sieve) using grouting pressures greater than 150 psi.

Centralizers are not required on encapsulated, hollow-stem-augered ground anchor tendons if the ground anchor is grouted through and the hole is maintained full of a stiff grout (eight-inch slump or less) during extraction of the auger.

The minimum unbonded length of the tendon shall be the greater of 15-feet or that indicated in the Plans.

Corrosion protection of the unbonded length shall be provided by a sheath completely filled with corrosion inhibiting grease or grout. If grease is used under the sheath, provisions shall be made to prevent the grease from escaping at the ends of the sheath. The grease shall completely coat the tendon and fill the voids between the tendon and the sheath. The working drawings shall show how the Contractor will provide a transition between the tendon bond length and the unbonded tendon length corrosion protection.

If the sheath is not fabricated from a smooth tube, a separate bond breaker shall be provided. The bond breaker shall prevent the tendon from bonding to the anchor grout surrounding the tendon unbonded length.

The total anchor length shall not be less than that indicated in the Plans or the approved working drawings.

Anchorage devices shall be capable of developing 95 percent of the minimum guaranteed ultimate tensile strength of the prestressing steel tendon. The anchorage devices shall conform to the static strength requirements of Section 3.1 of the Post Tensioning Institute "Specification for Unbonded Single Strand Tendons, First Edition - 1993".

Non-restressable anchorage devices may be used except where indicated in the Plans.

Restressable anchorages shall be provided on those ground anchors that require reloading. The post-tensioning supplier shall provide a restressable anchorage compatible with the post-tensioning system provided.

The bearing plates shall be sized so the bending stresses in the plate do not exceed the yield strength of the steel when a load equal to 95 percent of the minimum guaranteed ultimate tensile strength of the tendon is applied, and the average bearing stress on the concrete does not exceed that recommended in Section 3.1.3 of the Post Tensioning Institute, "Specification For Unbonded Single Strand Tendons, First Edition - 1993".

The trumpet shall have an inside diameter equal to or larger than the hole in the bearing plate. The trumpet shall be long enough to accommodate movements of the structure during testing and stressing. For strand tendons with encapsulation over the unbonded length, the trumpet shall be long enough to enable the tendon to make a transition from the diameter or the tendon in the unbonded length to the diameter of the tendon at the anchor head without damaging the encapsulation. Trumpets filled with corrosion-inhibiting grease shall have a permanent rubber seal, as approved by the Engineer, provided between the trumpet and the tendon unbonded length corrosion protection. Trumpets filled with grout shall have a temporary seal provided between the trumpet and the tendon unbonded length corrosion protection or the trumpet shall overlap the tendon unbonded length corrosion protection.

6-17.3(6) Tendon Storage And Handling

Tendons shall be handled and stored in such a manner as to avoid damage or corrosion. Damage to the prestressing steel as a result of abrasions, cut, nicks, welds and weld splatter will be cause for rejection by the Engineer. The prestressing steel shall be protected if welding is to be performed in the vicinity. Grounding of welding leads to the prestressing steel is forbidden. Prestressing steel shall be protected from dirt, rust, and deleterious substances. A light coating of rust on the steel is acceptable. If heavy corrosion or pitting is noted, the Engineer will reject the affected tendons.

The Contractor shall use care in handling and storing the tendons at the site. Prior to inserting a tendon in the drill hole, the Contractor and the Engineer will examine the tendon for damage to the encapsulation and the sheathing. If, in the opinion of the Engineer, the encapsulation is damaged, the Contractor shall repair the encapsulation in accordance with the tendon supplier's recommendations and as approved by the Engineer. If, in the opinion of the Engineer, the smooth sheathing has been damaged, the Contractor shall repair it with ultra high molecular weight polyethylene (PE) tape. The tape shall be spiral wound around the tendon so as to completely seal the damaged area. The pitch of the spiral shall ensure a double thickness at all points.

6-17.3(7) Installing Permanent Ground Anchors

The Contractor shall select the drilling method, the grouting procedure, and the grouting pressure used for the installation of the ground anchor.

When caving conditions are encountered, no further drilling will be allowed until the Contractor selects a method to prevent ground movement. The Contractor may use a temporary casing. The Contractor's method to prevent ground movement shall be approved by the Engineer. The casings for the anchor holes, if used, shall be removed. The drill hole shall be located so the longitudinal axis of the drill hole and the longitudinal axis of the tendon are parallel. The ground anchor shall not be drilled in a location that requires the tendon to be bent in order to enable the bearing plate to be connected to the supported structure. At the point of entry the ground anchor shall be installed within plus or minus three degrees of the inclination from horizontal shown in the Plans or the approved working drawings. The ground anchors shall not extend beyond the right of way limits.

The tendon shall be inserted into the drill hole to the desired depth. When the tendon cannot be completely inserted without difficulty, the Contractor shall remove the tendon from the drill hole and clean or redrill the hole to permit insertion. Partially inserted tendons shall not be driven or forced into the hole.

The Contractor shall use a grout conforming to Section 6-17.2 as supplemented in the Special Provisions.

The grout equipment shall produce a grout free of lumps and undispersed cement. A positive displacement grout pump shall be used. The pump shall be equipped with a pressure gauge near the discharge end to monitor grout pressures. The pressure gauge shall be capable of measuring pressures of at least 150 psi or twice the actual grout pressures used by the Contractor, whichever is greater. The grouting equipment shall be sized to enable the grout to be pumped in one continuous operation. The mixer shall be capable of continuously agitating the grout.

The grout shall be injected from the lowest point of the drill hole. The grout may be pumped through grout tubes, casing, or drill rods. The grout can be placed before or after insertion of the tendon. The quantity of the grout and the grout pressures shall be recorded. The grout pressures and grout takes shall be controlled to prevent excessive heave in soils or fracturing of rock formations.

After grouting, the tendon shall not be loaded for a minimum of 3 days.

No grout shall be placed above the top of the bond length during the time the bond length grout is placed. The grout at the top of the drill hole shall not contact the back of the structure or the bottom of the trumpet. Except as otherwise noted, only nonstructural filler shall be placed above the bond length grout prior to testing and acceptance of the anchor. The Contractor may place structural grout above the bond length grout prior to testing and acceptance of the anchor subject to the following conditions:

1. The anchor unbonded length shall be increased by eight feet minimum.
2. The grout in the unbonded zone shall not be placed by pressure grouting methods.

The corrosion protection surrounding the unbonded length of the tendon shall extend up beyond the bottom seal of the trumpet or one foot into the trumpet if no trumpet seal is provided. If the protection does not extend beyond the seal or sufficiently far enough into the trumpet, the Contractor shall extend the corrosion protection or lengthen the trumpet.

The corrosion protection surrounding the no load zone length of the tendon shown in the Plans shall not contact the bearing plate or the anchor head during testing and stressing. If the protection is too long, the Contractor shall trim the corrosion protection to prevent contact.

The bearing plate and anchor head shall be placed so the axis of the tendon and the drill hole are both perpendicular to the bearing plate within plus or minus three degrees and the axis of the tendon passes through the center of the bearing plate.

The trumpet shall be completely filled with corrosion inhibiting grease or grout. Trumpet grease can be placed anytime during construction. Trumpet grout shall be placed after the ground anchor has been tested. The Contractor shall demonstrate to the Engineer that the procedure selected by the Contractor for placement of either grease or grout produces a completely filled trumpet.

All anchorages permanently exposed to the atmosphere shall be covered with a corrosion inhibiting grease-filled or grout-filled cover. The Contractor shall demonstrate to the Engineer that the procedures selected by the Contractor for placement of either grease or grout produces a completely filled cover. If the Plans require restressable anchorages, corrosion inhibiting grease shall be used to fill the anchorage cover and trumpet.

6-17.3(8) Testing And Stressing

Each ground anchor shall be tested. The test load shall be simultaneously applied to the entire tendon. Stressing of single elements of multi-element tendons will not be permitted. The Engineer will record test data.

The testing equipment shall consist of a dial gauge or vernier scale capable of measuring to 0.001-inches shall be used to measure the ground anchor movement. The movement-measuring device shall have a minimum travel equal to the theoretical elastic elongation of the total anchor length plus 1-inch. The dial gauge or vernier scale shall be aligned so that its axis is within 5 degrees from the axis of the tieback. A hydraulic jack and pump shall be used to apply the test load. The jack and pressure gauge shall be calibrated by an independent testing laboratory as a unit. Each load cell, test jack and pressure gauge, and master pressure gauge, shall be calibrated as specified in Section 6-17.3(3). Additionally, the Contractor shall not use load cells, test jacks and pressure gauges, and master pressure gauges, greater than 60 calendar days past their most recent calibration date, until such items are re-calibrated by an independent testing laboratory.

The pressure gauge shall be graduated in 100-psi increments or less. The pressure gauge will be used to measure the applied load. The pressure gauge shall be selected to place the maximum test load within the middle two-thirds of the range of the gauge. The ram travel of the jack shall not be less than the theoretical elastic elongation of the total anchor length at the maximum test load plus one inch. The jack shall be independently supported and centered over the tendon so that the tendon does not carry the weight of the jack. The Contractor shall have a second calibrated jack pressure gauge at the site. Calibration data shall provide a specific reference to the jack and the pressure gauge.

The loads on the tiebacks during the performance and verification tests shall be monitored to verify consistency of load as defined in Section 6-17.3(1). Performance test loads, and verification test loads when specified in the Special Provisions, sustained for five minutes or less, and all proof test leads, shall be monitored by the jack pressure gauge alone. Performance test loads, and verification test loads when specified in the Special Provisions, sustained for longer than five minutes shall be monitored with the assistance of an electric or hydraulic load cell. The Contractor shall provide the load cell and a readout device. The load cell shall be mounted between the jack and the anchor plate. The load cell shall be selected to place the maximum test load within the middle two-thirds of the range of the load cell. The stressing equipment shall be placed over the ground anchor tendon in such a manner that the jack, bearing plates, load cell and stressing anchorage are in alignment.

The permanent ground anchor load monitoring procedure for performance test loads, and verification test loads when specified in the Special Provisions, sustained for longer than five minutes shall be as follows:

1. For each increment of load, attainment of the load shall be initially established and confirmed by the reading taken from the jack gauge.
2. Once the permanent ground anchor load has been stabilized, based on the jack gauge reading, the load cell readout device shall immediately be read and recorded to establish the load cell reading to be used at this load. The load cell reading is intended only as a confirmation of a stable permanent ground anchor load, and shall not be taken as the actual load on the permanent ground anchor.
3. During the time period that the load on the permanent ground anchor is held at this load increment, the Contractor shall monitor the load cell reading. The Contractor shall adjust the jack pressure as necessary to maintain the initial load cell reading. Jack pressure adjustment for any other reason will not be allowed.
4. Permanent ground anchor elongation measurements shall be taken at each load increment as specified in Sections 6-17.3(8)A and 6-17.3(8)B.
5. Steps 1 through 4 shall be repeated at each increment of load, in accordance with the load sequence specified in Sections 6-17.3(8)A and 6-17.3(8)B.

6-17.3(8)A Verification Testing

Verification tests will be required only when specified in the Special Provisions.

6-17.3(8)B Performance Testing

Performance tests shall be done in accordance with the following procedures. Five percent of the ground anchors or a minimum of three ground anchors, whichever is greater, shall be performance tested. The Engineer shall select the ground anchors to be performance tested. The first production anchor shall be performance tested.

The performance test shall be made by incrementally loading and unloading the ground anchor in accordance with the following schedule, consistent with the design method (Load Resistance Factor Design - LRFD or Load Factor Design - LFD) specified in the permanent ground anchor general notes in the Plans. The load shall be raised from one increment to another immediately after a deflection reading.

Performance Test Schedule

Load Resistance Factor Design Method (LRFD)	Load Factor Design Method (LFD)
Load	Load
AL	AL
0.25FDL	0.25DL
AL	AL
0.25FDL	0.25DL
0.50FDL	0.50DL
AL	AL
0.25FDL	0.25DL
0.50FDL	0.50DL
0.75FDL	0.75DL
AL	AL
0.25FDL	0.25DL
0.50FDL	0.50DL
0.75FDL	0.75DL
1.00FDL	1.00DL
AL	AL
Jack to lock-off load	0.25DL
	0.50DL
	0.75DL
	1.00DL
	1.25DL
	AL
	0.25DL
	0.50DL
	0.75DL
	1.00DL
	1.25DL
	1.33DL
	Jack to lock-off load

Where: AL - is the alignment load
DL - is the design load
FDL - is the factored design load.

The maximum test load in a performance test shall be held for ten minutes. The load-hold period shall start as soon as the maximum test load is applied and the anchor movement, with respect to a fixed reference, shall be measured and recorded at 1 minute, 2, 3, 4, 5, 6, and 10 minutes. If the anchor movement between one minute and ten minutes exceeds 0.04-inches, the maximum test load shall be held for an additional 50 minutes. If the load hold is extended, the anchor movement shall be recorded at 15 minutes, 20, 25, 30, 45, and 60 minutes. If an anchor fails in creep, retesting will not be allowed. All anchors not performance tested shall be proof tested.

6-17.3(8)C Proof Testing

Proof tests shall be performed by incrementally loading the ground anchor in accordance with the following schedule, consistent with the design method (Load Resistance Factor Design - LRFD or Load Factor Design - LFD) specified in the permanent ground anchor general notes in the Plans. The load shall be raised from one increment to another immediately after a deflection reading. The anchor movement shall be measured and recorded to the nearest 0.001-inches with respect to an independent fixed reference point at the alignment load and at each increment of load. The load shall be monitored with a pressure gauge. At load increments other than the maximum test load, the load shall be held just long enough to obtain the movement reading.

Proof Test Schedule	
Load Resistance Factor Design Method (LRFD)	**Load Factor Design Method (LFD)**
Load	Load
AL	AL
0.25FDL	0.25DL
0.50FDL	0.50DL
0.75FDL	0.75DL
1.00FDL	1.00DL
Jack to lock-off load	1.25DL
	1.33DL
	Jack to lock-off load

Where: AL - is the alignment load
DL - is the design load
FDL - is the factored design load

The maximum test load in a proof test shall be held for ten minutes. The load-hold period shall start as soon as the maximum test load is applied and the anchor movement with respect to a fixed reference shall be measured and recorded at 1 minute, 2, 3, 4, 5, 6, and 10 minutes. If the anchor movement between one minute and ten minutes exceeds 0.04-inches, the maximum test load shall be held of an additional 50 minutes. If the load hold is extended, the anchor movements shall be recorded at 15 minutes, 20, 25, 30, 45, and 60 minutes. If an anchor fails in creep, retesting will not be allowed.

6-17.3(9) Permanent Ground Anchor Acceptance Criteria

A performance or proof tested ground anchor with a ten minute load hold is acceptable if the:

1. Ground anchor carries the maximum test load with less than 0.04-inches of movement between one minute and ten minutes; and
2. Total movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the tendon unbonded length.

A verification, performance or proof tested ground anchor with a 60-minute load hold is acceptable if the:

1. Ground anchor carries the maximum test load with a creep rate that does not exceed 0.08-inches/log cycle of time and is a linear or decreasing creep rate.
2. Total movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the tendon unbonded length.

If the total movement of the ground anchors at the maximum test load does not exceed 80 percent of the theoretical elastic elongation of the tendon unbonded length, the Contractor shall replace the ground anchor at no additional cost to the Contracting Agency. Retesting of a ground anchor will not be allowed.

Ground anchors that have a creep rate greater than 0.08-inches/log cycle of time can be incorporated in the finished work at a load equal to one-half its failure load. The failure load is the load carried by the anchor after the load has been allowed to stabilize for ten minutes.

When a ground anchor fails, the Contractor shall modify the design, the construction procedures, or both. These modifications may include, but are not limited to, installing replacement ground anchors, modifying the installation methods, increasing the bond length or changing the ground anchor type. Any modification that requires changes to the structure shall have prior approval of the Engineer. Any modifications of design or construction procedures shall be at the Contractor's expense.

Upon completion of the test, the load shall be adjusted to the lock-off load indicated in the Plans and transferred to the anchorage device. The ground anchor may be completely unloaded prior to lock-off. After transferring the load and prior to removing the jack a lift-off reading shall be made. The lift-off reading shall be within ten percent of the specified lock-off load.

If the load is not within ten percent of the specified lock-off load, the anchorage shall be reset and another lift-off reading shall be made. This process shall be repeated until the desired lock-off load is obtained.

6-17.4 Measurement

Permanent ground anchors will be measured per each for each permanent ground anchor installed and accepted.

Permanent ground anchor performance tests will be measured per each for each anchor performance tested.

The permanent ground anchor verification testing program will not be measured but will be paid for on a lump sum basis.

6-17.5 Payment

Payment will be made in accordance with Section 1-04.1 for each of the following bid items when they are included in the proposal:

"Permanent Ground Anchor", per each.

All costs in connection with furnishing and installing permanent ground anchors shall be included in the unit contract price per each for "Permanent Ground Anchor", including proof testing of the installed anchor as specified.

"Permanent Ground Anchor Performance Test", per each.

"Permanent Ground Anchor Verification Test", lump sum.

6-18 SHOTCRETE FACING

6-18.1 Description

This work consists of constructing shotcrete facing as shown in the Plans. Shotcrete constructed as concrete slope protection shall be constructed in accordance with Section 8-16.

6-18.2 Materials

Materials shall meet the requirements of the following sections:

Cement	9-01
Aggregates for Portland Cement Concrete	9-03.1
Premolded Joint Filler	9-04.1(2)
Steel Reinforcing Bar	9-07.2
Epoxy-Coated Steel Reinforcing Bar	9-07.3
Concrete Curing Materials and Admixtures	9-23
Fly Ash	9-23.9
Water	9-25

Other materials required, including materials for shotcrete, shall be as specified in the Special Provisions.

6-18.3 Construction Requirements

6-18.3(1) Submittals

The Contractor shall submit the following information to the Engineer at least 14 calendar days prior to beginning construction of the shotcrete facing:

1. The shotcrete mix design with compressive strength test results.
2. Method and equipment used to finish and cure the shotcrete facing.
3. Documentation of the experience of the nozzle operators in applying shotcrete.

The Contractor shall not begin construction of the shotcrete facing until receiving the Engineer's approval of the above submittals.

6-18.3(2) Mix Design

Shotcrete shall be proportioned to produce a 4,000 psi compressive strength at 28 days. The Contractor shall submit the shotcrete mix design, proposed method of placement, and evidence that the proposed design and placement method will produce the desired compressive strength at 28 days, to the Engineer at least 14 calendar days prior to the anticipated beginning of shotcrete placement. Shotcrete placement will not be allowed until the Engineer has approved the mix design and method of placement.

Admixture shall be used only after receiving permission from the Engineer. If admixtures are used to entrain air, to reduce water-cement ratio, to retard or accelerate setting time, or to accelerate the development of strength, the admixtures shall be used at the rate specified by the manufacturer and approved by the Engineer.

6-18.3(3) Testing

The Contractor shall make shotcrete test panels for evaluation of shotcrete quality, strength, and aesthetics. Both preproduction and production test panels, shall be prepared. All cores obtained for the purpose of shotcrete strength testing shall have the following minimum dimensions:

a. The core diameter shall be at least 3 times the maximum aggregate size, but not less than 2-inches.

b. The core height shall be a minimum of 1.5 times the core diameter.

The Contractor shall remove at least three cores from each 36-inch by 36-inch shotcrete test panel in accordance with AASHTO T 24. Cores removed from the panel shall be immediately wrapped in wet burlap and sealed in a plastic bag. Cores shall be clearly marked to identify from where they were taken and whether they are for pre-production or production testing. If for production testing, the section of the wall represented by the cores shall be clearly marked on the cores. Cores shall be delivered to the Engineer within 2 hours of coring. The remainder of the panels shall remain the property of the Contractor.

6-18.3(3)A Pre-production Testing

At least one 36-inch by 36-inch panel for each mix design shall be prepared for evaluation and testing of the shotcrete quality and strength. One 48-inch by 48-inch qualification panel shall be prepared for evaluation and approval of the proposed method for shotcrete installation, finishing, and curing. Both the 36-inch and the 48-inch panels shall be constructed using the same methods and initial curing proposed to construct the shotcrete facing, except that the 36-inch panel shall not include wire reinforcement. The 36-inch panel shall be constructed to the minimum thickness necessary to obtain the required core samples. The 48-inch panel shall be constructed to the same thickness as proposed for the production facing. Production shotcrete work shall not begin until satisfactory test results are obtained and the panels are approved by the Engineer.

6-18.3(3)B Production Testing

The Contractor shall make at least one 36-inch by 36-inch panel for each section of facing shot. A section is defined as one day's placement. The production panels shall be constructed using the same methods and initial curing used to construct the shotcrete wall, but without wire reinforcement. The panels shall be constructed to the minimum thickness necessary to obtain the required core samples. If the production shotcrete is found to be unsuitable based on the results of the test panels, the section(s) of the wall represented by the test panel(s) shall be repaired or replaced to the satisfaction of the Engineer at no additional cost to the Contracting Agency.

6-18.3(4) Qualifications of Contractor's Personnel

All nozzle operators shall have had at least one year of experience in the application of shotcrete. Each nozzle operator will be qualified, by the Engineer, to place shotcrete, after successfully completing one test panel for each shooting position and surface type which will be encountered.

Qualification will be based on a visual inspection of the shotcrete density, void structure, and finished appearance along with a minimum 7-day compressive strength of 2,500 psi determined from the average test results from two cores taken from each test panel.

The Contractor shall notify the Engineer not less than 2 days prior to the shooting of a qualification panel. The mix design for the shotcrete shall be the same as that slated for the wall being shot.

Shotcrete shall be placed only by personnel qualified by the Engineer.

If shotcrete finish Alternative B or C is specified, evidence shall be provided that all shotcrete crew members have completed at least three projects in the last five years where such finishing, or sculpturing and texturing of shotcrete was performed.

6-18.3(5) Placing Wire Reinforcement

Reinforcement of the shotcrete shall be placed as shown in the Plans. The wire reinforcement shall be securely fastened to the steel reinforcing bars so that it will be 1 to 1.5-inches from the face of the shotcrete at all locations, unless otherwise shown in the Plans. Wire reinforcement shall be lapped 1.5 squares in all directions, unless otherwise shown in the Plans.

6-18.3(6) Alignment Control

The Contractor shall install non-corroding alignment wires and thickness control pins to establish thickness and plane surface. The Contractor shall install alignment wires at corners and offsets not established by formwork. The Contractor shall ensure that the alignment wires are tight, true to line, and placed to allow further tightening. The Contractor shall remove the alignment wires after facing construction is complete.

6-18.3(7) Shotcrete Application

A clean, dry supply of compressed air sufficient for maintaining adequate nozzle velocity for all parts for the work and for simultaneous operation of a blow pipe for cleaning away rebound shall be maintained at all times. Thickness, method of support, air pressure, and rate of placement of shotcrete shall be controlled to prevent sagging or sloughing of freshly applied shotcrete.

The shotcrete shall be applied from the lower part of the area upwards. Surfaces to be shot shall be damp, but free of standing water.

The nozzles shall be held at an angle approximately perpendicular to the working face and at a distance that will keep rebound at a minimum and compaction will be maximized. Shotcrete shall emerge from the nozzle in a steady uninterrupted flow. If, for any reason, the flow becomes intermittent, the nozzle shall be diverted from the work until a steady flow resumes.

Surface defects shall be repaired as soon as possible after initial placement of the shotcrete. All shotcrete which lacks uniformity; which exhibits segregation, honeycombing, or lamination; or which contains any dry patches, slugs, voids, or sand pockets, shall be removed and replaced with fresh shotcrete by the Contractor, to the satisfaction of the Engineer at no cost to the Contracting Agency.

Construction joints in the shotcrete shall be uniformly tapered over a minimum distance of twice the thickness of the shotcrete layer. The surface of the joints shall be cleaned and thoroughly wetted before adjacent shotcrete is placed. Shotcrete shall be placed in a manner that provides a finish with uniform texture and color across the construction joint.

The shotcrete shall be cured by applying a clear curing compound in accordance with Section 9-23.2. The curing compound shall be applied immediately after final gunning. The air in contact with shotcrete surfaces shall be maintained at temperatures above 50F for a minimum of 7 days. Curing compounds shall not be used on any surfaces against which additional shotcrete or other cementitious finishing materials are to be bonded unless positive measures such as sandblasting, are taken to completely remove the curing compounds prior to the application of such additional materials.

If field inspection or testing, by the Engineer, indicates that any shotcrete produced, fails to meet the requirements, the Contractor shall immediately modify procedures, equipment, or system, as necessary, and as approved by the Engineer to produce specification material. All substandard shotcrete already placed shall be repaired by the Contractor, to the satisfaction of the Engineer, at no additional cost to the Contracting Agency. Such repairs may include removal and replacement of all affected materials.

6-18.3(8) Shotcrete Finishing

When the shotcrete facing is an interim coating to be covered by a subsequent shotcrete coating or a cast-in-place concrete fascia later under the same contract, the Contractor shall strike off the surface of the shotcrete facing with a roughened surface as specified in Section 6-02.3(12). The grooves of the roughened surface shall be either vertical or horizontal.

When the shotcrete facing provides the finished exposed final surface, the shotcrete face shall be finished using the alternative aesthetic treatment shown in the Plans. The alternatives are as follows:

Alternative A

After the surface has taken its initial set (crumbling slightly when cut), the surface shall be broom finished to secure a uniform surface texture.

Alternative B

Shotcrete shall be applied in a thickness a fraction beyond the alignment wires and forms. The shotcrete shall stiffen to the point where the surface does not pull or crack when screeded with a rod or trowel. Excess material shall be trimmed, sliced, or scraped to true lines and grade. Alignment wires shall be removed and the surface shall receive a steel trowel finish, leaving a smooth uniform texture and color. Once the shotcrete has cured, pigmented sealer shall be applied to the shotcrete face. The shotcrete surface shall be completed to within a tolerance of ½-inch of true line and grade.

Alternative C

Shotcrete shall be hand-sculptured, colored, and textured to simulate the relief, jointing, and texture of the natural backdrop surrounding the facing. The ends and base of the facing shall transition in appearance as appropriate to more nearly match the color and texture of the adjoining roadway fill slopes. This may be achieved by broadcasting fine and coarse aggregates, rocks, and other native materials into the final surface of the shotcrete while it is still wet, allowing sufficient embedment into the shotcrete to become a permanent part of the surface.

6-18.4 Measurement

Shotcrete facing will be measured by the square foot surface area of the completed facing measured to the neat lines of the facing as shown in the Plans.

6-18.5 Payment

Payment will be made in accordance with Section 1-04.1 for each of the following bid items when they are included in the proposal:

"Shotcrete Facing", per square foot.

All costs in connection with constructing shotcrete facing as specified shall be included in the unit contract price per square foot for "Shotcrete Facing" including all steel reinforcing bars, premolded joint filler, polyethylene bond breaker strip, joint sealant, PVC pipe for weep holes, exterior surface finish, and pigmented sealer (when specified).

DIVISION 7
DRAINAGE STRUCTURES, STORM SEWERS, SANITARY SEWERS, WATER MAINS, AND CONDUITS

7-01 DRAINS

7-01.1 Description

This work consists of constructing drain pipe and underdrain pipe in accordance with the Plans, these Specifications and Standard Plans, at the locations staked.

7-01.2 Materials

Materials shall meet the requirements of the following sections:

Gravel Backfill for Drains	9-03.12(4)
Concrete Drain Pipe	9-05.1(1)
Zinc Coated (Galvanized) Corrugated Iron, Aluminum Coated (Aluminized) Corrugated Iron, Zinc Coated (Galvanized) Steel, Aluminum Coated (Aluminized) Steel Drain Pipe	9-05.1(2)
Corrugated Aluminum Alloy Drain Pipe	9-05.1(3)
Polyvinyl Chloride (PVC) Drain Pipe, 8-inch diameter maximum	9-05.1(5)
Corrugated Polyethylene (PE) Drain Pipe, 10-inch diameter maximum	9-05.1(6)
Corrugated Polyethylene (PE) Drain Pipe, 12-inch through 36-inch diameter maximum	9-05.1(7)
Perforated Concrete Underdrain Pipe	9-05.2(2)
Perforated Bituminized Fiber Underdrain Pipe	9-05.2(3)
Zinc Coated (Galvanized) Corrugated Iron, Aluminum Coated (Aluminized) Corrugated Iron, Zinc Coated (Galvanized) Steel, Aluminum Coated (Aluminized) Steel Underdrain Pipe	9-05.2(4)
Perforated Corrugated Aluminum Alloy Underdrain Pipe	9-05.2(5)
Perforated Polyvinyl Chloride (PVC) Underdrain Pipe, 8-inch diameter maximum	9-05.2(6)
Perforated Corrugated Polyethylene (PE) Underdrain Pipe, 10-inch diameter maximum	9-05.2(7)
Perforated Corrugated Polyethylene (PE) Underdrain Pipe, 12-inch through 36-inch diameter maximum	9-05.2(8)

Drain pipes may be concrete, zinc coated (galvanized) corrugated iron, aluminum coated (aluminized) corrugated iron, zinc coated (galvanized) steel, aluminum coated (aluminized) steel, corrugated aluminum alloy, polyvinyl chloride (PVC), or corrugated polyethylene (PE) at the option of the Contractor unless the Plans specify the type to be used.

Underdrain pipe, other than AASHTO M 36 Type III Class IV, shall be perforated. They may be concrete, bituminized fiber, zinc coated (galvanized) corrugated iron, aluminum coated (aluminized) corrugated iron, zinc coated (galvanized) steel, aluminum coated (aluminized) steel, corrugated aluminum alloy, polyvinyl chloride (PVC), or corrugated polyethylene (PE) at the option of the Contractor unless the Plans specify the type to be used.

It is not necessary that all drain or underdrain pipes on any one project be of the same kind of material; however, all contiguous pipe shall be of the same kind.

7-01.3 Construction Requirements

A trench of the dimensions shown in the Plans or as specified by the Engineer shall be excavated to the grade and line given by the Engineer. Drain pipe shall be laid in conformity with the line and grades as shown in the Plans. The drain pipe shall be laid with watertight joints unless otherwise specified.

PVC drain pipe shall be jointed with a bell and spigot joint using a flexible elastomeric seal as described in Section 9-04.8. The bell shall be laid upstream. PE drain pipe shall be jointed with snap on, screw-on, or wraparound coupling bands as recommended by the manufacturer of the tubing.

When underdrain pipe is being installed as a means of intercepting ground or surface water, the trench shall be fine graded in the existing soil 3-inches below the grade of the pipe as shown in the Plans. Gravel backfill shall be used under the pipe. Gravel backfill shall be placed to the depth shown in the Plans or as designated by the Engineer. All backfill shall be placed in 12-inch maximum layers and be thoroughly compacted with three passes of a vibratory compactor for each layer. The Contractor shall use care in placing the gravel backfill material to prevent its contamination.

Concrete drain pipe shall be laid with the bell or larger end upstream.

All perforated pipe shall be laid with the perforations down. Upon final acceptance of the work, all drain pipes shall be open, clean, and free draining.

PVC underdrain pipe shall be jointed using either the flexible elastomeric seal as described in Section 9-04.8 or solvent cement as described in Section 9-04.9, at the option of the Contractor unless otherwise specified in the Plans. The bell shall be laid upstream. PE drainage tubing underdrain pipe shall be jointed with snap on, screw on, or wraparound coupling bands, as recommended by the manufacturer of the tubing.

7-01.4 Measurement

The length of drain or underdrain pipe will be the number of linear feet of completed installation measured along the invert. Pipe placed in excess of the length designated by the Engineer will not be measured or paid for.

Excavation of the trench will be measured as structure excavation Class B or structure excavation Class B including haul by the cubic yard as specified in Section 2-09.

Gravel backfill for drains will be measured by the volume placed within the neatline limits of structure excavation Class B.

7-01.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Drain Pipe ____ In. Diam.", per linear foot.

"Underdrain Pipe ____ In. Diam.", per linear foot.

"Gravel Backfill for Drain", per cubic yard.

"Structure Excavation Class B", per cubic yard.

"Structure Excavation Class B Incl. Haul", per cubic yard.

7-02 CULVERTS

7-02.1 Description

This work consists of constructing culverts of the various types and classes in accordance with the Plans, these Specifications, and the Standard Plans, at the locations staked.

Culverts may be used for transverse drains under the roadway or as conduits for water pipe or other utilities passing under the roadway.

7-02.2 Materials

Materials shall meet the requirements of the following sections:

Plain Concrete Culvert Pipe	9-05.3(1)
Reinforced Concrete Culvert Pipe	9-05.3(2)
Beveled Concrete End Sections	9-05.3(3)
Steel Culvert Pipe and Pipe Arch	9-05.4
Steel Nestable Pipe and Pipe Arch	9-05.4(8)
Steel End Sections	9-05.4(9)
Aluminum Culvert Pipe	9-05.5
Aluminum End Sections	9-05.5(6)
Solid Wall PVC Culvert Pipe	9-05.12(1)
Profile Wall PVC Culvert Pipe	9-05.12(2)
Corrugated Polyethylene Culvert Pipe	9-05.19

Where steel or aluminum are referred to in this Section in regard to a kind of culvert pipe, pipe arch, or end sections, it shall be understood that steel is zinc coated (galvanized) or aluminum coated (aluminized) corrugated iron or steel, and aluminum is corrugated aluminum alloy as specified in Sections 9-05.4 and 9-05.5.

Thermoplastic culvert pipe includes solid wall PVC culvert pipe, profile wall PVC culvert pipe, and corrugated polyethylene culvert pipe. Solid wall PVC culvert pipe and profile wall PVC culvert pipe are acceptable alternates for Schedule A or B culvert pipe. Corrugated polyethylene culvert pipe is an acceptable alternate for Schedule A culvert pipe.

It is not necessary that all culvert pipe on any one project be of the same kind of material. However, all contiguous pipe shall be of the same size, material, thickness, class, and treatment and shall be that required for the maximum height of cover.

Alternate pipe installations shown in the Plans may be constructed provided there is no increase in the cost to the State.

Measurement for payment of the bid items associated with the drainage installation will be based on the diameter of the culvert pipe described by the bid item in the proposal.

If the Contractor elects to use an alternate installation, plans for the alternate shall be submitted to the Engineer for approval prior to procuring or constructing the alternate.

When schedule A, B, C, or D culvert pipe is specified in the Plans, the Contractor shall provide the specified schedule and diameter but has the option of furnishing any of the acceptable materials shown in the Culvert Pipe Schedules Table.

The use of tongue and groove concrete pipe shall only be allowed under side road connections. All tongue and groove pipe shall be joined with cement mortar.

Culvert Pipe Schedules

Schedule (Fill Height)	Diameter in Inches	Concrete	Steel $2^2/_3$" x $^1/_2$"	Aluminum $2^2/_3$" x $^1/_2$"	Thermoplastic PE[1] or PVC[2]
A 2' - 15'	12, 18, 24	Plain or CI. IV	.064" (16 Ga.)	.060" (16 Ga.)	PE or PVC
	30, 36	Class III	.064" (16 Ga.)	.075" (14 Ga.)	PE or PVC
	42, 48	Class III	.064" (16 Ga.)	.105" (12 Ga.)	PE or PVC
B 15' - 25'	12, 18, 24	Class V	.064" (16 Ga.)	.060" (16 Ga.)	PVC
	30, 36	Class V	.064" (16 Ga.)	.075" (14 Ga.)	PVC
	42, 48	Class V	.064" (16 Ga.)	.105" (12 Ga.)	PVC
C 25' - 40'	12, 18, 24	None	.064" (16 Ga.)	.060" (16 Ga.)	None
	30, 36	None	.064" (16 Ga.)	.075" (14 Ga.)	None
	42, 48	None	.064" (16 Ga.)	.105" (12 Ga.)	None
D 40' - 60'	12, 18	None	.064" (16 Ga.)	.060" (16 Ga.)	None
	24	None	.064" (16 Ga.)	.075" (14 Ga.)	None
	30, 36	None	.064" (16 Ga.)	.105" (12 Ga.)	None
	42, 48	None	.079" (14 Ga.)	.135" (10 Ga.)	None

1. Corrugated polyethylene pipe.
2. Polyvinyl chloride pipe. Solid wall or profile wall for diameters through 27". Profile wall for diameters larger than 27".

7-02.3 Construction Requirements

Culverts shall be constructed in accordance with Section 7-08.3.

7-02.3(1) Placing Culvert Pipe — General

A dike or plug of impervious material shall be placed near the intake end of the culvert to prevent piping. The dike shall be 2-feet long and adequately surround the pipe to form an impervious barrier. When suitable impervious materials are not available at the site, suitable backfill shall be obtained as provided in Section 2-09.3(1)E.

The ends of the pipe or pipe arch shall be rigidly supported to prevent movement before and during the construction of end walls or headers.

Culverts shall not be left extending beyond the staked limits unless approved by the Engineer.

All thermoplastic pipe shall be beveled to match the embankment or ditch slope but shall not be beveled flatter than 4:1. The minimum length of each section of pipe that is to be beveled shall be at least 6 times the diameter of the pipe when measured from the toe of the bevel to the joint.

7-02.3(2) Installation of Metal End Sections

Metal end sections shall be installed in accordance with the requirements of the Standard Plans, the Plans, and applicable portions of these Specifications.

When flared metal end sections are installed on concrete pipe, Design B end sections will be used on the inlet end only. Design C end sections will be used on the outlet ends only according to the following schedule:

Concrete Pipe Nominal Dia. in Inches	End Section Nominal Dia. in Inches
12	15
18	24
24	30
30	36
36	42
42	48
48	60
54	66
60	72
66	78
72	84

7-02.3(3) Headwalls

If headwalls are specified in the Plans, they shall be constructed as soon as the embankment has been completed to a sufficient height over the structure to allow the required work. Headwalls shall be constructed in accordance with applicable portions of Section 6-02.

7-02.3(4) Removing and Relaying Culverts

Where shown in the Plans or where designated by the Engineer, existing culverts shall be removed and relaid in accordance with these Specifications. Any culvert damaged by the Contractor's operations shall be replaced by the Contractor at no expense to the Contracting Agency. In the case of concrete pipe, all joints of the pipe before being relaid shall be cleaned so as to be free from all adhering material, including old mortar placed as a collar or seal in the original construction.

All culvert sections removed and not relaid shall become the property of the Contractor.

7-02.3(5) Safety Bars for Culvert Pipe

When shown in the Plans, safety bars for culvert pipe shall be constructed in accordance with the Standard Plans and shall meet the requirements of Section 9-05.18.

7-02.4 Measurement

The length of culvert pipe or pipe arch will be the number of linear feet of completed installation measured along the invert. Pipe placed in excess of the length designated by the Engineer will not be measured or paid for.

Beveled end sections will be considered as part of the culvert pipe and shall be measured as culverts.

Flared steel and aluminum end sections will be measured by the number of integral units of the dimension specified including toe plate extensions if called for in the Plans.

The pipe connector section of end section Design A shall be fabricated as a part of the integral unit of the end section but will be measured as linear feet of pipe or pipe arch of the treatment, thickness and dimensions of pipe to which it is attached. If there is no bid item for pipe of the proper dimensions for the end sections, the pipe connector sections will be considered as part of the integral unit and will not be measured as pipe.

Pipe connector sections of end section Design B will be considered part of the integral unit and measurement will be by number of integral units of the type and dimension specified.

The length of safety bars for culvert pipe will be the number of linear feet of each safety bar installed.

Tapered end section with safety bars will be measured by the unit per each.

7-02.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Schedule ____ Culv. Pipe ____ In. Diam.", per linear foot.

"Plain Conc. Culv. Pipe ____ In. Diam.", per linear feet.

"Cl. ____ Reinf. Conc. Culv. Pipe ____ In. Diam.", per linear foot.

"Plain St. Culv. Pipe ____ In. Th. ____ In. Diam.", per linear foot.

"Tr. ____ St. Culv. Pipe ____ In. Th. ____ In. Diam.", per linear foot.

"Plain St. Culv. Pipe Arch ____ In. Th. ____ In. Span", per linear foot.

"Tr. ____ St. Culv. Pipe Arch ____ In. Th. ____ In. Span", per linear foot.

"Plain Nestable St. Pipe ____ In. Th. ____ In. Diam.", per linear foot.

"Tr. ____ Nestable St. Pipe ____ In. Th. ____ In. Diam.", per linear foot.

"Plain Al. Culv. Pipe ____ In. Th. ____ In. Diam.", per linear foot.

"Plain Al. Culv. Pipe Arch ____ In. Th. ____ In. Span", per linear foot.

"Relaying (type of Pipe and Size)", per linear foot.

"Solid Wall PVC Culv. Pipe ____ In. Diam.", per linear foot.

"Profile Wall PVC Culv. Pipe ____ In. Diam.", per linear foot.

"Corrugated Polyethylene Culv. Pipe ____ In. Diam.", per linear foot.

Where culvert pipes are to be removed but are not to be relaid, all costs in connection with the removal shall be included in the unit contract price per cubic yard for "Structure Excavation Class B" or "Structure Excavation Class B Incl. Haul".

"Flared End Section ____ In. Diam.", per each.

"Flared End Section ____ In. Span", per each.

"Safety Bars for Culvert Pipe Type ____", per linear foot.

"Tapered End Sect. with Type ____ Safety Bars ____ In. Diam.", per each.

7-03 STRUCTURAL PLATE PIPE, PIPE ARCH, ARCH, AND UNDERPASS

7-03.1 Description

This work consists of constructing structural plate pipe, pipe arches, arches, and underpasses of the various types and designs in accordance with the Plans, these Specifications, and the Standard Plans, at the locations and in conformity with the lines and grades staked.

Structural plate pipes shall be full circle of the type, gage or thickness, and diameter specified.

Structural plate pipe arches shall be a multi-centered shape made up of four circular arcs tangent to each other at their junctions and symmetrical about the vertical axis and of the type, gage or thickness, and span specified.

Structural plate arches shall be a single-centered circular arc shape, placed on a reinforced concrete foundation, and of the design, type, gage or thickness, and span as provided for in the Plans.

Structural plate underpasses shall be a multi-centered shape made up of a variable number of circular arcs tangent to each other at their junctions and symmetrical about the vertical axis and of the design, type, gage or thickness, and span specified.

7-03.2 Materials

Materials shall meet the requirements of the following sections:

Concrete Class 3000	6-02
Corrugated Steel	9-05.6(8)
Corrugated Aluminum	9-05.6(8)
Reinforcing Steel	9-07

Alternate installations shown in the proposal may be constructed provided there is no increase in the total cost of the installation or detriment to the Contracting Agency.

Measurement for payment of the bid items associated with the drainage installation will be based on the size of the installation described by the bid item in the proposal.

If the Contractor elects to use an alternate installation, plans for the alternate shall be submitted to the Engineer for approval prior to procuring or constructing the alternate.

7-03.3 Construction Requirements

7-03.3(1) Foundations, General

Structural plate pipes, pipe arches, underpasses, and bases for arches shall be placed on stable foundations prepared to the widths, depth, and grade given by the Engineer. Soft spots encountered in the base shall be excavated to a depth designated by the Engineer and be backfilled with gravel or other suitable material and thoroughly compacted.

Rock, in either ledge or boulder formation, hard pan, or cemented gravel occurring in the base material shall be excavated below grade and backfilled with suitable material so there will be a minimum 8-inch cushion under the pipes, pipe arches, or underpasses.

7-03.3(1)A Structural Plate Pipe, Pipe Arch, and Underpass

The base for structural plate pipes, pipe arches and underpasses shall be shaped to conform to their bottom and shall form firm and uniform bearing throughout their length. Where pipes, pipe arches, or underpasses are to be installed in new embankment, the

embankment shall be constructed to the 1/3 point of structural plate pipes (measured from the invert of the pipe), to the height of maximum horizontal dimension of structural plate pipe arches and as provided for in the Standard Plan or, in the case of a special design, in the Plans for structural plate underpasses, after which the trench shall be excavated and installation made.

7-03.3(1)B Structural Plate Arch

The base for structural plate arches shall be as shown in the Plans.

7-03.3(2) Assembling

Structural plate pipes, pipe arches, arches, and underpasses shall be assembled in place in accordance with the manufacturer's instructions, which shall accompany the shipment of materials and show the position of each plate and the order of assembly.

Bolts and bolted connections shall conform to the requirements of AASHTO M 167 for steel and AASHTO M 219 for aluminum.

7-03.3(3) Backfilling

After the structural plate pipe, pipe arch, arch, or underpass has been placed in position it shall be backfilled in accordance with Section 7-08.3(3).

7-03.3(4) Invert Treatment

Earth, or other material as specified, shall be placed and compacted in the invert of structural plate pipes, pipe arches, or underpasses in conformance with the Plans, Special Provisions, or the Standard Plan.

7-03.3(5) Headwalls

If headwalls are specified in the Plans, they shall be constructed as soon as the embankment has been completed to a sufficient height over the structure to allow the required work. Headwalls shall be constructed in accordance with the applicable portions of Section 6-02.

7-03.3(6) Safety Bars for Culvert Pipe

When shown in the Plans, safety bars for culvert pipe shall be constructed in accordance with the Standard Plans and shall meet the requirements of Section 9-05.18.

7-03.4 Measurement

The length of structural plate pipes, pipe arches, arches, and underpasses will be the number of linear feet of completed installation measured along the invert. Pipe placed in excess of the length designated by the Engineer will not be measured or paid for.

Concrete will be measured by the cubic yard as specified in Section 6-02.

Steel reinforcing bars will be measured by the pound as specified in Section 6-02.

Structure excavation Class B and structure excavation Class B including haul will be measured by the cubic yard as specified in Section 2-09.4.

Gravel backfill for foundation Class A or Class B will be measured by the cubic yard as specified in Section 2-09.4.

Shoring or extra excavation will be measured as specified in Section 2-09.4.

The length of safety bars for culvert pipe will be the number of linear feet of each safety bar installed.

Tapered end Section with safety bars will be measured by the unit per each.

7-03.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"St. Str. Plate Pipe ____ Gage ____ In. Diam.", per linear foot.

"St. Str. Plate Pipe Arch ____ Gage ____ Ft. Span", per linear foot.

"St. Str. Plate Arch ____ Gage ____ Ft. Span", per linear foot.

"Design ____ St. Underpass ____ Gage ____ Ft. Span", per linear foot.

All costs involved in obtaining, hauling, placing, and finishing earth to be placed in the invert of the underpass shall be included in the unit contract price for "Design ____ St. Underpass ____ Gage ____ Ft. ____ In. Span".

"Al. Str. Plate Pipe ____ In. Th. ____ In. Diam.", per linear foot.

"Al. Str. Plate Pipe Arch ____ In. Th. ____ Ft. ____ In. Span", per linear foot.

"Al. Str. Plate Arch ____ In. Th. ____ Ft. ____ In. Span", per linear foot.

"Design ____ Al. Underpass ____ In. Th. ____ Ft. ____ In. Span", per linear foot.

All costs involved in obtaining, hauling, placing, and finishing earth to be placed in the invert of the underpass shall be included in the unit contract price for "Design ____ Al. Underpass ____ In. Th. ____ Ft. ____ In. Span".

"Conc. Class ____", per cubic yard.

The unit contract price per cubic yard for "Conc. Class ____" shall be paid as specified in Section 6-02.

"St. Reinf. Bar", per pound.

The unit contract price per pound for "St. Reinf. Bar" shall be paid as specified in Section 6-02.

"Structure Excavation Class B", per cubic yard.

"Structure Excavation Class B Incl. Haul", per cubic yard.

"Gravel Backfill for Foundation Class ____", per cubic yard.

"Shoring or Extra Excavation Class B", per square foot.

"Safety Bars for Culvert Pipe Type ____", per linear foot.

"Tapered End Section with Type ____ Safety Bars ____ In. Diam.", per each.

"Tapered End Section with Type ____ Safety Bars ____ In. Span", per each.

7-04 STORM SEWERS

7-04.1 Description

This work consists of constructing storm sewer lines in accordance with the Plans, these Specifications, and the Standard Plans, as staked.

7-04.2 Materials

Materials shall meet the requirements of the following sections:

Plain Concrete Storm Sewer Pipe	9-05.7(1)
Reinforced Concrete Storm Sewer Pipe	9-05.7(2)
Steel Spiral Rib Storm Sewer Pipe	9-05.9
Steel Storm Sewer Pipe	9-05.10
Aluminum Storm Sewer Pipe	9-05.11
Solid Wall PVC Storm Sewer Pipe	9-05.12(1)
Profile Wall PVC Storm Sewer Pipe	9-05.12(2)
Aluminum Spiral Rib Storm Sewer Pipe	9-05.17
Corrugated Polyethylene Storm Sewer Pipe	9-05.20

Where steel or aluminum are referred to in this Section in regard to a kind of storm sewer pipe, it shall be understood that steel is zinc coated (galvanized) or aluminum coated (aluminized) corrugated iron or steel and aluminum is corrugated aluminum alloy as specified in Sections 9-05.4 and 9-05.5.

Thermoplastic storm sewer pipe includes solid wall PVC storm sewer pipe, profile wall PVC storm sewer pipe, and corrugated polyethylene storm sewer pipe.

Alternate pipe installations shown in the Plans may be constructed provided there is no increase in the total cost of the installation or detriment to the Contracting Agency.

Measurement for payment of the bid items associated with the storm sewer installation will be based on the diameter of the storm sewer pipe described by the bid item in the Plans.

If the Contractor elects to use an alternate installation, plans for the alternate shall be submitted to the Engineer for approval prior to procuring or constructing the alternate.

It is not necessary that all storm sewer pipe on any one project be of the same kind of material. However, all contiguous pipe shall be of the same size, material, thickness, class, and treatment and shall be that required for the maximum height of cover.

When schedule A or B storm sewer pipe is specified in the Plans, the Contractor shall provide the specified schedule and diameter but has the option of furnishing any of the acceptable materials shown in the Storm Sewer Pipe Schedules Table.

Storm Sewer Pipe Schedules

Schedules (Fill Ht.)	Dia. (In.)	Concrete	PVC[1]	PE[2]	Steel[3] $2^2/_3$" x $^1/_2$" or Spiral Rib	Aluminum $2^2/_3$" x $^1/_2$" Corr. • Tr. 5 • Plain With Gasketed Seams	Aluminum Spiral Rib • Tr. 5 • Plain With Gasketed Seams
A 2′ – 15′	12	Plain or Cl. IV	SW or PW	Allowed	0.064" (16 Ga.)	0.060" (16 Ga.)	0.060" (16 Ga.)
	18	Plain or Cl. IV	SW or PW	Allowed	0.064" (16 Ga.)	0.060" (16 Ga.)	0.060" (16 Ga.)
	24	Plain or Cl. IV	SW or PW	Allowed	0.064" (16 Ga.)	0.060" (16 Ga.)	0.060" (16 Ga.)
	30	Class III	PW	Allowed	0.064" (16 Ga.)	0.075" (14 Ga.)	0.060" (16 Ga.)
	36	Class III	PW	Allowed	0.064" (16 Ga.)	0.075" (14 Ga.)	0.060" (16 Ga.)
	42	Class III	PW	Allowed	0.064" (16 Ga.)	0.105" (12 Ga.)	0.075" (14 Ga.)
	48	Class III	PW	Allowed	0.064" (16 Ga.)	0.105" (12 Ga.)	0.075" (14 Ga.)
B 15′ – 25′	12	Class V	SW or PW		0.064" (16 Ga.)	0.060" (16 Ga.)	0.060" (16 Ga.)
	18	Class V	SW or PW		0.064" (16 Ga.)	0.060" (16 Ga.)	0.060" (16 Ga.)
	24	Class V	SW or PW		0.064" (16 Ga.)	0.060" (16 Ga.)	0.060" (16 Ga.)
	30	Class V	PW		0.064" (16 Ga.)	0.075" (14 Ga.)	0.075" (14 Ga.)
	36	Class V	PW		0.064" (16 Ga.)	0.075" (14 Ga.)	0.105" (12 Ga.)
	42	Class V	PW		0.064" (16 Ga.)	0.105" (12 Ga.)	0.105" (12 Ga.)
	48	Class V	PW		0.064" (16 Ga.)	0.105" (12 Ga.)	0.105" (12 Ga.)

1. PVC = Polyvinyl Chloride Pipe, SW = Solid Wall PVC, PW = Profile Wall PVC
2. PE = Corrugated Polyethylene Pipe
3. Steel pipe options for either $2^2/_3$" x $^1/_2$" corrugations or spiral rib include: Tr. 5 galvanized, Tr. 2 galvanized with gasketed seams, Tr. 5 aluminized, or plain aluminized with gasketed seams.

7-04.3 Construction Requirements

Storm sewers shall be constructed in accordance with Section 7-08.3.

7-04.3(1) Cleaning and Testing

7-04.3(1)A General

The requirements of Section 7-17.3(2)A shall apply to storm sewers.

7-04.3(1)B Exfiltration Test — Storm Sewers

Prior to making exfiltration leakage tests, the Contractor may fill the pipe with clear water to permit normal absorption into the pipe walls.

Leakage shall be no more than 1 gallon per hour per inch of diameter per 100-feet of storm sewer pipe, with a minimum test pressure of 6-feet of water column above the crown at the upper end of the pipe or above the active ground water table, whichever is higher as determined by the Engineer. The length of pipe tested shall be limited so that the pressure on the invert of the lower end of the Section tested shall not exceed 16-feet of water column. For each increase in pressure of 2-feet above a basic 6-feet measured above the crown at the lower end of the test section, the allowable leakage shall be increased by 10 percent.

7-04.3(1)C Infiltration Test — Storm Sewers

Whenever the ground water table is above the crown of the higher end of the pipe section at the time of testing, an infiltration test may be performed in lieu of the exfiltration test upon written permission of the Engineer. The maximum allowable limit for infiltration shall be 0.8 gallon per hour per inch of diameter per 100-feet of length with no allowance for external hydrostatic head.

7-04.3(1)D Other Test Allowances — Storm Sewers

Other allowances for infiltration and exfiltration tests shall be in accordance with Section 7-17.3(2)D.

7-04.3(1)E Low Pressure Air Test for Storm Sewers Constructed of Air-Permeable Materials

When air-permeable pipe is subjected to a low-pressure air test, all of the provisions of Section 7-17.3(2)E shall apply, except that the time in seconds for the pressure drop shall be equal to or greater than the required time as shown in the table below:

Pipe Dia. (in)	Time in Seconds for Pressure Drop Pipe Length (ft)									
	50	100	150	200	250	300	350	400	450	500
4	5	9	14	18	22	27	31	36	40	45
6	10	20	30	40	50	60	70	80	85	85
8	18	36	54	71	89	107	114	114	114	114
10	28	56	84	111	139	142	142	142	143	159
12	40	80	120	160	170	170	170	183	206	228
15	63	125	188	213	213	214	250	286	320	360
18	90	180	255	255	257	310	360	410	460	520
21	123	245	298	298	350	420	490	560	630	700
24	160	320	340	370	460	550	640	730	830	920
27	203	390	390	460	580	700	810	930	1040	1160
30	250	430	430	570	720	860	1000	1140	1290	1430

All time values listed in the table are in seconds. If a section to be tested includes more than one pipe size, the total time required can be found by adding the time values for each size of pipe and its corresponding length. Interpolate between valves for pipe lengths not shown.

Pipe over 30-inches in diameter shall be tested one joint at a time in accordance with ASTM C 1103.

7-04.3(1)F Low Pressure Air Test for Storm Sewers Constructed of Non Air Permeable Materials

When non air-permeable pipe is subjected to a low-pressure air test, all of the provisions of Section 7-17.3(2)E shall apply, except that the time in seconds for the pressure drop shall be equal to or greater than four times the time shown in the table listed in Section 7-04.3(1)E.

Pipe over 30-inches in diameter shall be tested one joint at a time in accordance with ASTM C 1103.

Reaches of thermoplastic pipe containing no joints shall be exempt from testing requirements.

7-04.4 Measurement

The length of storm sewer pipe will be the number of linear feet of completed installation measured along the invert and will include the length through elbows, tees, and fittings. The number of linear feet will be measured from the center of manhole to center of manhole or to the inside face of catch basins and similar type structures.

The length of testing storm sewer pipe in conformance with Section 7-17.3(2)A will be the number of linear feet of completed installation actually tested.

7-04.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Plain Conc. Storm Sewer Pipe ____ In. Diam.", per linear foot.

"Class ____ Reinf. Conc. Storm Sewer Pipe ____ In. Diam.", per linear foot.

"Tr. ____ St. Storm Sewer Pipe ____ In. Th. ____ In. Diam.", per linear foot.

"Tr. ____ Al. Storm Sewer Pipe ____ In. Th. ____ In. Diam.", per linear foot.

"Solid Wall PVC Storm Sewer Pipe ____ In. Diam.", per linear foot.

"Profile Wall PVC Storm Sewer Pipe ____ In. Diam.", per linear foot.

"Corrugated Polyethylene Storm Sewer Pipe ____ In. Diam.", per linear foot.

"Schedule ____ Storm Sewer Pipe ____ In. Diam.", per linear foot.

The unit contract price per linear foot for storm sewer pipe of the kind and size specified shall be full pay for all work to complete the installation, including adjustment of inverts to manholes.

"Testing Storm Sewer Pipe", per linear foot.

7-05 MANHOLES, INLETS, CATCH BASINS, AND DRYWELLS

7-05.1 Description

This work consists of constructing manholes, inlets, drywells, and catch basins and connecting to existing structures of the types and sizes designated in accordance with the Plans, these Specifications, and the Standard Plans, in conformity with the lines and grades staked.

7-05.2 Materials

Materials shall meet the requirements of the following sections:

Concrete	6-02
Crushed Surfacing Base Course	9-03.9(3)
Gravel Backfill for Drywells	9-03.12(5)
Rubber Gaskets	9-04.4
Flexible Plastic Gaskets	9-04.5
Metal Castings	9-05.15
Grate Inlets and Drop Inlets	9-05.16
Reinforcing Steel	9-07
Concrete Blocks	9-12.1
Concrete Brick	9-12.2
Precast Concrete Manhole	9-12.4
Precast Concrete Catch Basins	9-12.5
Precast Concrete Drywells	9-12.7
Underground Drainage Geotextile, Moderate Survivability	9-33.1

7-05.3 Construction Requirements

The excavation for all manholes, inlets, and catch basins shall be sufficient to leave 1 foot in the clear between their outer surfaces and the earth bank.

The excavation for drywells shall be in accordance with the Standard Plans. The drywell and gravel backfill for drywell shall be completely encased in moderate survivability underground drainage geotextile in accordance with the Standard Plans and in conformance with Section 2-12.3. During construction of the drywell, all necessary precautions shall be taken to prevent debris and eroded material from entering the drywell.

The cover or grating of a manhole, catch basin, or inlet shall not be grouted to final grade until the final elevation of the pavement, gutter, ditch, or sidewalk in which it is to be placed has been established, and until permission thereafter is given by the Engineer to grout the cover or grating in place. Covers shall be seated properly to prevent rocking.

The channels in manholes shall conform accurately to the sewer grade.

Ladder rungs shall be grouted in the precast concrete walls. Rungs shall be uniformly spaced at 12-inches and be vertically aligned.

In the event any pipe enters the manhole through the precast concrete units, the Contractor shall make the necessary cut through the manhole wall and steel mesh. The steel shall be cut flush with the face of the concrete and shall be cut in such a manner that it will not loosen the reinforcement in the manhole wall.

The ends of all pipes shall be trimmed flush with the inside walls.

Rubber gaskets or flexible plastic gaskets may be used in tongue and groove joints of precast units. Joints between precast manhole units used for sanitary sewers shall be rubber gasketed. All other joints and all openings cut through the walls shall be grouted and watertight. Mortar shall conform to the requirements of Section 9-04.3.

If gaskets are used, handling of the precast units after the gasket has been affixed shall be done carefully to avoid disturbing or damaging the gasket or contaminating it with foreign material. Care shall be exercised to attain proper alignment before the joints are entirely forced home. During insertion of the tongue or spigot, the units shall be partially supported to minimize unequal lateral pressure on the gasket and to maintain concentricity until the gasket is properly positioned.

Rigid pipes connecting to sanitary sewer manholes shall be provided with a flexible joint at a distance from the face of the manhole of not more than $1^1/_2$ times the nominal pipe diameter or 18-inches, whichever is greater.

Flexible pipes connecting to sanitary sewer manholes shall be provided with an entry coupling or gasket approved by the Engineer. No pipe joint in flexible pipe shall be placed within 10-feet of the manhole.

Backfilling around the work will not be allowed until the concrete or mortar has thoroughly set.

Catch basins, manholes, and inlets shall be watertight.

Catch basin, grate inlet, and drop inlet connections to a sewer shall be so placed that the connecting pipe may be easily rodded over its entire length. After the connections are made, the Contractor shall rod all inlet and outlet pipes. All connections that cannot be successfully rodded shall be removed and new connections made.

Backfilling of manholes, inlets, catch basins, and drywells shall be done in accordance with the provisions of Section 2-09.

Manholes, catch basins, inlets, and drywells shall be constructed on a compacted or undisturbed level foundation. If the Contractor elects to use a separate cast-in-place base, the concrete shall be Class 4000. Upon final acceptance of the work, all manholes, catch basins, inlets, drywells, and other drainage structures shall conform to the requirements of the Standard Plan except as approved by the Engineer.

Any shoring or extra excavation required shall meet the requirements of Section 2-09.3.

7-05.3(1) Adjusting Manholes and Catch Basins to Grade

Where shown in the Plans or where directed by the Engineer, the existing manholes, catch basins, or inlets shall be adjusted to the grade as staked or otherwise designated by the Engineer.

The existing cast iron ring and cover on manholes and the catch basin and inlet frame and grate shall first be removed and thoroughly cleaned for reinstalling at the new elevation. From that point, the existing structure shall be raised or lowered to the required elevation. The materials and method of construction shall conform to the requirements specified above, and the finished structure shall conform to the requirements of the Standard Plan except as approved by the Engineer.

7-05.3(2) Abandon Existing Manholes

Where it is required that an existing manhole be abandoned, the structure shall be broken down to a depth of at least 4-feet below the revised surface elevation, all connections plugged, and the manhole filled with sand and compacted to 90 percent density as specified in Section 2-03.3(14)C. Debris resulting from breaking the upper part of the manhole may be mixed with the sand subject to the approval of the Engineer. The ring and cover shall be salvaged and all other surplus material disposed of.

7-05.3(3) Connections to Existing Manholes

The Contractor shall verify invert elevations prior to construction. The crown elevation of laterals shall be the same as the crown elevation of the incoming pipe unless specified. The existing base shall be reshaped to provide a channel equivalent to that specified for a new manhole.

The Contractor shall excavate completely around the manhole to prevent unbalanced loading. The manhole shall be kept in operation at all times and the necessary precautions shall be taken to prevent debris or other material from entering the sewer, including a tight pipeline bypass through the existing channel if required. Water used for flushing and testing shall not be allowed to enter the sewer.

All damage to the manhole resulting from the Contractor's operation shall be repaired at no expense to the Contracting Agency.

7-05.3(4) Drop Manhole Connection

Drop manhole connections shall be constructed in accordance with the Plans. One length of ductile iron pipe shall be provided outside the manhole.

7-05.4 Measurement

Manholes will be measured per each. In addition to the measurement per each, manholes in excess of 10-feet in height will be measured per linear foot for each additional foot of height over 10-feet. Measurement of manhole heights for payment purposes will be the distance from the flow line of the outlet pipe to the top of the manhole ring measured to the nearest foot.

Catch basins and inlets, will be measured per each.

Adjustment of manholes, catch basins, and inlets will be per each.

Structure excavation Class B and structure excavation Class B including haul will be measured by the cubic yard as specified in Section 2-09.

Abandon existing manholes will be measured per each.

Connections to existing drainage structures will be measured per each.

Shoring or extra excavation will be measured as specified in Section 2-09.4.

Drop manhole connections will be measured per each.

Precast concrete drywell will be measured per each.

7-05.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Manhole ____ In. Diam. Type ____", per each.

"Manhole Additional Height ____ In. Diam. Type ____", per linear foot.

"Catch Basin Type ____", per each.

"Catch Basin Type 2 ____ In. Diam.", per each.

"Grate Inlet Type ____", per each.

"Drop Inlet Type ____", per each.

"Concrete Inlet", per each

All costs associated with furnishing and installing gravel backfill for bedding manholes, inlets and catch basins shall be included in the unit contract price for the item installed.

"Precast Concrete Drywell", per each.

The unit contract price per each for "Precast Concrete Drywell" shall be full pay for furnishing and installing the drywell, including all structure excavation, gravel backfill for drywell, crushed surfacing base course, and drainage geotextile.

"Combination Inlet", per each.

All costs associated with furnishing and installing gravel backfill for bedding manholes, inlets, and catch basins shall be in the unit contract price for the item installed.

"Adjust Manhole", per each.

"Adjust Catch Basin", per each.

"Adjust Inlet, per each.

The unit contract price per each for "Adjust Manhole", "Adjust Catch Basin", or "Adjust Inlet" shall be full pay for all costs necessary to make the adjustment including restoration of adjacent areas in a manner acceptable to the Engineer.

"Structure Excavation Class B", per cubic yard.

"Structure Excavation Class B Incl. Haul", per cubic yard.

Structure excavation for concrete inlets is considered incidental to the cost of the inlets and shall be included in the unit contract price for the concrete inlet.

"Abandon Existing Manhole", per each.

"Connection to Drainage Structure", per each.

"Shoring or Extra Excavation Class B", per square foot.

"Drop Manhole Connection", per each.

The price paid per drop connection is in addition to the price paid for manholes and for the specified sewer pipe that is replaced with ductile iron pipe.

7-06 VACANT

7-07 CLEANING EXISTING DRAINAGE STRUCTURES

7-07.1 Description

This work consists of cleaning, removing, and disposing of all debris and obstructions from existing culvert pipes, storm sewer pipes, drains, inlet structures, manholes, box culverts, grates, trash racks, or other drainage features within the limits of the project.

7-07.2 Vacant

7-07.3 Construction Requirements

All pipes and drainage structures that require cleaning are identified in the Plans. They shall be cleaned by flushing, rodding, or whatever means are necessary to provide unobstructed drainage. All catch basin sumps, manholes, inlet and outlet structures, and debris racks shall also be freed of all dirt, rock, and debris. Existing drainage facilities shall be cleaned as a first order of work to enhance natural drainage off and through the project. They shall be kept clean throughout the life of the project and be clean upon final acceptance of the work.

7-07.4 Measurement

No specific unit of measurement will apply for the lump sum item of cleaning existing drainage structures when shown in the proposal.

7-07.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when it is included in the proposal:

"Cleaning Existing Drainage Structure", lump sum.

The lump sum contract price for "Cleaning Existing Drainage Structure" shall be full pay for performing all work as specified. In the event the contract does not include a bid item for cleaning existing drainage structure, such work, if required, shall be performed by the Contractor at agreed price or on the basis of force account as provided in Section 1-09.6.

7-08 GENERAL PIPE INSTALLATION REQUIREMENTS

7-08.1 Description

This work includes installing culverts, storm sewers, and sanitary sewers. The Contractor shall also follow Section 7-02, 7-04, or 7-17 as it applies to the specific kind of work.

7-08.2 Materials

Gravel Backfill for Foundations	9-03.12(1)
Gravel Backfill for Pipe Zone Bedding	9-03.12(3)

7-08.3 Construction Requirements

7-08.3(1) Excavation and Preparation of Trench

7-08.3(1)A Trenches

The length of trench excavation in advance of pipe laying shall be kept to a minimum. Excavations shall either be closed up at the end of the day or protected per Section 1-07.23(1).

The trench width shall be as specified in Section 2-09.4 and shall be excavated to the depth and grade as staked by the Engineer.

Trenches must be of sufficient width in the pipe zone to permit proper installation and bedding of the pipe and to provide the required compaction of backfill. Above the top of the pipe zone, the Contractor may excavate to any width.

All ledgerock, boulders, and stones shall be removed to provide a minimum of 6-inches clearance under all portions of the pipe.

Placement of bedding material shall precede the installation of all pipe. This shall include necessary leveling of the native trench bottom or the top of the foundation material as well as placement and compaction of required bedding material to a uniform grade so that the entire length of pipe will be supported on a uniformly dense unyielding foundation.

When, after excavating to the foundation level, the material remaining in the trench bottom is determined to be unsuitable by the Engineer, excavation shall be continued to such additional depth and width as required by the Engineer. Unsuitable foundation materials shall be disposed of at an approved site. The trench foundation shall be backfilled to the bottom of the pipe zone with gravel backfill for foundations, gravel backfill for pipe zone bedding, or other suitable material, and compacted to form a uniformly dense, unyielding foundation.

All material excavated from trenches and piled adjacent to the trench shall be maintained so that the toe of the slope is at least 2-feet from the edge of the trench. It shall be piled to cause a minimum of inconvenience to public travel, and provision shall be made for merging traffic where necessary. Free access shall be provided to all fire hydrants, water valves, and meters; and clearance shall be left to enable free flow of storm water in gutters, conduits, or natural watercourses.

If any part of the excavated material meets the specifications of Section 9-03.12(3), the Engineer may require that such material, in the quantity required, be selectively removed, stockpiled separately, and used as pipe bedding instead of quantities of gravel backfill for pipe zone bedding. If material so stockpiled becomes contaminated, the Contractor shall furnish suitable material in an amount equal to that lost by contamination at no expense to the Contracting Agency. All costs involved in storing, protecting, re-handling, and placing the material shall be included in other items of work on the project.

Excavation for manholes and other structures connected to the pipelines shall be sufficient to provide a minimum of 12-inches between their surfaces and the sides of the excavation.

The Contractor shall furnish, install, and operate all necessary equipment to keep excavations above the foundation level free from water during construction, and shall dewater and dispose of the water so as not to cause injury to public or private property or nuisance to the public. Sufficient pumping equipment in good working condition shall be available at all times for all emergencies, including power outage, and shall have available at all times competent workers for the operation of the pumping equipment.

Where pipe is to be placed in a new embankment, the embankment shall be constructed as shown in the Plans or as designated by the Engineer for a distance each side of the pipe location of not less than five times the diameter and to a minimum height equal to one-half of the outside diameter of the pipe. The embankment material shall be compacted to 95 percent density and the moisture content at the time of compaction shall be between optimum and 3 percentage points below optimum as determined by the Compaction Control Tests specified in Section 2-03.3(14)D. The trench shall then be excavated to a width as specified in 2-09.4, and the pipe installed in accordance with the Standard Plan.

7-08.3(1)B Shoring

The Contractor shall provide all materials, labor, and equipment necessary to shore trenches to protect the work, existing property, utilities, pavement, etc., and to provide safe working conditions in the trench. The Contractor may elect to use any combination of shoring and overbreak, tunneling, boring, sliding trench shield, or other method of accomplishing the work consistent with applicable local, State, or Federal safety codes.

If workers enter any trench or other excavation 4-feet or more in depth that does not meet the open pit requirements of Section 2-09.3(3)B, it shall be shored. The Contractor alone shall be responsible for worker safety, and the Contracting Agency assumes no responsibility.

Upon completing the work, the Contractor shall remove all shoring unless the Plans or the Engineer direct otherwise.

Shoring to be removed, or moveable trench shields or boxes, shall be located at least $2^1/_2$ pipe diameters away from metal or thermoplastic pipe if the bottom of the shoring, shield, or box extends below the top of the pipe, unless a satisfactory means of reconsolidating the bedding or side support material disturbed by shoring removal can be demonstrated.

Damages resulting from improper shoring or failure to shore shall be the sole responsibility of the Contractor.

7-08.3(1)C Bedding the Pipe

Pipe zone bedding material shall provide uniform support along the entire pipe barrel, without load concentration at joint collars or bells. All adjustment to line and grade shall be made by scraping away or filling in with bedding material under the body of the pipe and not by blocking or wedging. Bedding disturbed by pipe movement, or by removal of shoring movement of a trench shield or box, shall be reconsolidated prior to backfill.

Pipe zone bedding shall be as specified in the Standard Plan and shall be placed in loose layers and compacted to 90 percent maximum density. Bedding shall be placed, spread, and compacted before the pipe is installed so that the pipe is uniformly supported along the barrel. Lifts of not more than 6-inches in thickness shall be placed and compacted along the sides of the pipe to the height shown in the Standard Plan. Material shall be worked carefully under the pipe haunches and then compacted.

If the Engineer determines that the material existing in the bottom of the trench is satisfactory for bedding the pipe, the bedding material specified in the Standard Plan is not required, provided the existing material is loosened, regraded, and compacted to form a dense, unyielding base.

7-08.3(2) Laying Pipe

7-08.3(2)A Survey Line and Grade

Survey line and grade control hubs will be placed in a manner consistent with accepted practices.

The Contractor shall transfer line and grade into the trench where they shall be carried by means of a laser beam or taut grade line supported on firmly set batter boards at intervals of not more than 30-feet. Not less than three batter boards shall be in use at one time. Grades shall be constantly checked and in the event the batter boards do not line up, the work shall be immediately stopped, the Engineer notified, and the cause remedied before proceeding with the work. Any other procedure shall have the written approval of the Engineer.

7-08.3(2)B Pipe Laying — General

After an accurate grade line has been established, the pipe shall be laid in conformity with the established line and grade in the properly dewatered trench. Mud, silt, gravel, and other foreign material shall be kept out of the pipe and off the jointing surfaces.

All pipe laid in the trench to the specified line and grade shall be kept in longitudinal compression until the backfill has been compacted to the crown of the pipe. All pipe shall be laid to conform to the prescribed line and grade shown in the plans, within the limits that follow.

Pipe shall be laid to a true line and grade at the invert of the pipe and the Contractor shall exercise care in matching pipe joints for concentricity and compatibility. In no case shall two pipes be joined together with ends having the maximum manufacturer's tolerance. The invert line may vary from the true line and grade within the limits stated to develop uniformity, concentricity, and uniform compression of jointing material provided such variance does not result in a reverse sloping invert. The limit of the variance at the invert shall not exceed plus or minus 0.03-feet at the time of backfill. Checking of the invert elevation of the pipe may be made by calculations from measurements on the top of the pipe.

The pipe, unless otherwise approved by the Engineer, shall be laid up grade from point of connection on the existing pipe or from a designated starting point. The pipe shall be installed with the bell end forward or upgrade. When pipe laying is not in progress, the forward end of the pipe shall be kept tightly closed with an approved temporary plug.

Where pipe joints must be deflected within the manufacturer's recommended limits to accommodate required horizontal or vertical curvature, it shall first be joined in straight alignment and then deflected as required.

Where pipe joints must be deflected to an amount greater than the manufacturer's recommended limits to accommodate required horizontal or vertical curvature, the curves shall be achieved with a series of tangents and shop fabricated bends, subject to the approval of the Engineer.

Upon final acceptance of the work, all pipe and appurtenances shall be open, clean, and free draining.

7-08.3(2)C Pipe Laying — Concrete

For concrete pipe with elliptical reinforcement, the markings indicating the minor axis of the reinforcement shall be placed in a vertical plane (top or bottom) when the pipe is laid.

7-08.3(2)D Pipe Laying — Steel or Aluminum

Pipe with riveted or resistance spot welded seams shall be laid in the trench with the outside laps of circumferential joints upgrade and with longitudinal laps positioned other than in the invert, and firmly joined together with approved bands.

Aluminum pipe or pipe arch used in concrete shall be painted with two coats of paint. The aluminum pipe to be painted shall be cleaned with solvent to remove contaminants. After cleaning, the pipe shall be painted with two coats of paint conforming to Federal Specification TT-P-645 (primer, paint, zinc chromate, alkyd vehicle). Aluminized steel pipe will not require painting when placed in Controlled Density Fill (CDF) or when in contact concrete head walls.

All costs of cleaning and painting the aluminum surfaces as specified shall be included in the unit contract price per linear foot for the aluminum pipe or pipe arch.

7-08.3(2)E Rubber Gasketed Joints

In laying pipe with rubber gaskets, the pipe shall be handled carefully to avoid knocking the gasket out of position or contaminating it with foreign material. Any gasket so disturbed shall be removed, cleaned, relubricated if required, and replaced before joining the sections.

The pipe shall be properly aligned before joints are forced home. Sufficient pressure shall be applied in making the joint to ensure that the joint is home, as defined in the standard installation instructions provided by the pipe manufacturer. The Contractor may use any method acceptable to the Engineer for pulling the pipe together, except that driving or ramming by hand or machinery will not be permitted. Any pipe damaged during joining and joint tightening shall be removed and replaced at no expense to the Contracting Agency.

Care shall be taken to properly align the pipe before joints are entirely forced home. During insertion of the tongue or spigot, the pipe shall be partially supported by hand, sling or crane to minimize unequal lateral pressure on the gasket and to maintain concentricity until the gasket is properly positioned. Since most gasketed joints tend to creep apart when the end of the pipe is deflected and straightened, such movement shall be held to a minimum once the joint is home.

Sufficient restraint shall be applied to the line to ensure that joints once home are held so by compacting backfill material under and alongside the pipe or by other acceptable means. At the end of the work day, the last pipe shall be blocked in such a manner as may be required to prevent creep.

7-08.3(2)F Plugs and Connections

Plugs for pipe branches, stubs, or other open ends which are not to be immediately connected shall be made of an approved material and shall be secured in a place with a joint comparable to the main line joint, or stoppers may be of an integrally cast breakout design.

7-08.3(2)G Jointing of Dissimilar Pipe

Dissimilar pipe shall be jointed by use of a factory-fabricated adapter coupling or a pipe collar as detailed in the Standard Plans.

7-08.3(2)H Sewer Line Connections

Storm and sanitary sewer line connections to trunks, mains, laterals, or side sewers shall be left uncovered until after the Engineer has inspected and approved the work. After approval of the connection, the trench shall be backfilled as specified.

7-08.3(2)I Side Sewer Connections

Where a storm or sanitary side sewer is larger than the trunk, main, or lateral to which it is to be connected, the connection shall be made only at a standard manhole unless otherwise provided in the Plans or in the Special Provisions, or unless otherwise authorized by the Engineer.

7-08.3(3) Backfilling

Placement of pipe zone backfill shall be performed in accordance with these requirements and the Standard Plan. Trenches shall be backfilled as soon after the pipe laying as possible.

Pipe zone backfill material shall be clean earth or sand, free from clay, frozen lumps, roots, or moisture in excess of that permitting required compaction. Rocks or lumps larger than 3-inches maximum shall not be used for pipe zone backfill.

Pipe zone backfill shall be placed in loose layers and compacted to 90 percent maximum density. Backfill shall be brought up simultaneously on each side of the pipe to the top of the pipe zone. The pipe shall then be covered to the top of the pipe zone and the materials compacted in a manner to avoid damaging or disturbing the completed pipe.

Backfill above the pipe zone shall be accomplished in such a manner that the pipe will not be shifted out of position nor damaged by impact or overloading. If pipe is being placed in a new embankment, backfill above the pipe zone shall be placed in accordance with Section 2-03.3(14)C. If pipe is being placed under existing paved areas, or roadways, backfill above the pipe zone shall be placed in horizontal layers no more

than 6-inches thick and compacted to 95 percent maximum density. If pipe is being placed in non-traffic areas, backfill above the pipe zone shall be placed in horizontal layers no more than 6-inches thick and shall be compacted to 85 percent maximum density. All compaction shall be in accordance with the Compaction Control Test of Section 2-03.3(14)D. Material excavated from the trench shall be used for backfill above the pipe zone, except that organic material, frozen lumps, wood, rocks, or pavement chunks larger than 6-inches in maximum dimension shall not be used. Materials determined by the Engineer to be unsuitable for backfill at the time of excavation shall be removed and replaced with imported backfill material.

Backfilling of trenches in the vicinity of catch basins, manholes, or other appurtenances will not be permitted until the cement in the masonry has become thoroughly hardened.

When it is required that a blanket of select material or bank run gravel is to be placed on top of the native backfill, the backfill shall be placed to the elevations shown in the Plans, or to the elevations specified by the Engineer. Compaction of the native material shall be as required by the Contracting Agency and shall be performed prior to placing the select material. Surface material shall be loosened to whatever depth is required to prevent bridging of the top layer, but shall in no case be less than 18-inches.

The Contractor shall not operate tractors or other heavy equipment over the top of the pipe until the backfill has reached a height of 2-feet above the top of the pipe.

7-08.3(4) Plugging Existing Pipe

Where shown in the Plans or where designated by the Engineer, existing pipes shall be plugged on the inlet end for a distance of two diameters with commercial concrete. Care shall be used in placing the concrete in the pipe to see that the opening of the pipe is completely filled and thoroughly plugged.

7-08.4 Measurement

Gravel backfill for foundations, or gravel backfill for pipe zone bedding when used for foundations, shall be measured by the cubic yard, including haul, as specified in 2-09.

There will be no specific unit of measure for any material placed in the pipe zone in the installation of culvert, storm sewer, and sanitary sewer pipes.

Plugging pipes will be measured per each, for each plug installed, for pipe diameters up to and including 36-inches. The concrete for plugging pipes in excess of 36-inches in diameter will be measured by the cubic yard. Computations for corrugated metal pipes will be based on the nominal diameter.

Excavation of the trench will be measured as structure excavation Class B or structure excavation Class B including haul, by the cubic yard as specified in Section 2-09. When excavation below grade is necessary, excavation will be measured to the limits ordered by the Engineer.

Embankment construction before pipe placement under the applicable provisions of Section 7-08.3(1)A will be measured in accordance with Section 2-03.

Shoring or extra excavation class B will be measured as specified in Section 2-09.4.

7-08.5 Payment

Payment will be made in accordance with Section 1-04.1 for each of the following bid items that are included in the proposal:

"Gravel Backfill for Foundations Class ____", per cubic yard.

"Gravel Backfill for Pipe Zone Bedding", per cubic yard.

All costs associated with furnishing and installing bedding and backfill material within the pipe zone in the installation of culvert, storm sewer, and sanitary sewer pipes shall be included in the unit contract price for the type and size of pipe installed.

"Plugging Existing Pipe", per each.

"Commercial Concrete", per cubic yard.

"Structure Excavation Class B", per cubic yard.

"Structure Excavation Class B Incl. Haul", per cubic yard.

"Shoring or Extra Excavation Class B", per square foot.

All costs in jointing dissimilar pipe with a coupling or concrete collar shall be included in the unit contract price per foot for the size and type of pipe being jointed.

7-09 WATER MAINS

7-09.1 Description

This work consists of constructing water mains 16-inches in diameter and smaller in accordance with the Plans, these Standard Specifications, the Special Provisions and the Standard Plans, at the location shown on the Plans.

7-09.1(1) Definitions

7-09.1(1)A Trench Widths

Trench width is from trench wall to trench wall, outside of shoring.

7-09.1(1)B Unsuitable Material

Material removed because it is unsatisfactory for foundations is defined as unsuitable foundation material.

Material removed in trenching which is unsuitable for replacement in the backfill is defined as unsuitable backfill material.

7-09.1(1)C Gravel Backfill for Pipe Zone Bedding

Gravel backfill for pipe zone bedding is the method or material used to transmit load from the pipe into the foundation or into the sidewall support.

7-09.1(1)D Pipe Zone Backfill

Pipe zone backfill includes material placed above the gravel backfill for pipe zone bedding up to the depths shown on the Standard Plans.

7-09.1(1)E Trench Backfill

Trench backfill includes materials placed above the pipe zone backfill. Trench backfill within the roadway prism shall extend up to the underside of the pavement or surfacing materials. Trench backfill outside the roadway prism shall extend up to original ground or finished grade.

7-09.2 Materials

Materials shall meet the requirements of the following sections:

Pipe for main line:	9-30.1
Ductile Iron Pipe	9-30.1(1)
Steel Pipe (6-inches and over)	9-30.1(4)A
Polyvinyl Chloride (PVC) Pressure Pipe (4-inches and over)	9-30.1(5)A
Polyvinyl Chloride (PVC) Pressure Pipe (under 4-inches)	9-30.1(5)B
Polyethylene (PE) Pressure Pipe (4-inches and over)	9-30.1(6)
Fittings for Main Lines:	9-30.2
Ductile Iron Pipe	9-30.2(1)
Steel Pipe (6-inches and over)	9-30.2(4)A
Polyvinyl Chloride (PVC) Pipe (4-inches and over)	9-30.2(5)A
Polyvinyl Chloride (PVC) Pipe (under 4-inches)	9-30.2(5)B
Restrained Joints	9-30.2(6)
Bolted, Sleeve – Type Couplings for Plain End Pipe	9-30.2(7)

Restrained Flexible Couplings	9-30.2(8)
Grooved and Shouldered Joints	9-30.2(9)
Polyethylene (PE) Pipe (4-inches and over)	9-30.2(10)
Fabricated Steel Mechanical Slip – Type Expansion Joints	9-30.2(11)
Appurtenances:	
Concrete Blocking	6-02.3(2)B
Detectable Marking Tape	9-15.18
Blow Off Assemblies	9-30.1, 9-30.2, 9-30.3, 9-30.6
Polyethylene Encasement	9-30.1(2)
Steel Pipe (4-inches and under)	9-30.1(4)B
Fittings for Steel Pipe (4-inches and under)	9-30.2(4)B
Aggregates:	
Foundation Material	9-03.17, 9-03.18
Gravel Backfill for Pipe Zone Bedding	9-03.12(3)
Pipe Zone Backfill	9-03.19
Trench Backfill	9-03.15 or 9-03.19

It is not intended that materials listed herein are to be necessarily considered equal or generally interchangeable for all applications. Those suitable for the project shall be specified in the Special Provisions or shown on the Plans.

The pipe manufacturer shall test all pipe and fittings as required by these Standard Specifications and the standards referenced. The pipe manufacturer shall submit to the Engineer two (2) copies of all test results including a written certification that material to be delivered is represented by the samples tested and that such delivered materials meet or exceed the specified requirements. No pipe shall be delivered until test results and certifications are in the hands of the Engineer.

The Engineer shall have free access to all testing and records pertaining to material to be delivered to the job site. The Engineer may elect to be present at any or all material testing operations.

The basis of acceptance shall be a certificate of compliance as described in Section 1-06.3, accompanied by two (2) copies of pressure test results of the pipe or fittings involved.

7-09.3 Construction Requirements

7-09.3(1) General

Trench excavation required for the installation of water mains and appurtenances shall be unclassified. Material excavated from trenches and piled adjacent to the trench or in a roadway or public thoroughfare shall be piled and maintained so that the toe of the slope of the spoil material is at least 2-feet from the edge of the trench. It shall be piled in a manner to prevent surface water from flowing into the excavation and in a manner that will cause a minimum of inconvenience to public travel. Free access shall be provided to all fire hydrants, water valves, and meters; and clearance shall be left to enable the free flow of storm water in gutters, conduits, and natural watercourses.

7-09.3(2) Ungraded Streets

On ungraded streets, when grading is not called for in the Contract, the depth of trench excavation shall be as shown on the Plans and as staked.

Where the Plans show the pipe is to be laid above the existing ground surface, an embankment fill shall be made and compacted to conform with the section shown on the Plans, and the water main trench shall be excavated therein. That portion of the embankment below the bottom of the pipe shall be compacted with rollers or mechanical compactors under controlled moisture conditions as required under Method B of Section 2-03.3(14)C.

7-09.3(3) Clearing and Grubbing in Ungraded Streets

On ungraded streets, where clearing and grubbing is not called for in the Contract, the area to be excavated or filled shall be cleared and grubbed by the Contractor. This work shall consist of the removal and disposal of logs, stumps, roots, brush, and other refuse within 5-feet of the centerline of the pipe. Such material shall be disposed of in accordance with the Special Provisions.

7-09.3(4) Removal of Existing Street Improvements

Removal of existing street improvements and pavement from driveways and sidewalks shall be performed as specified in Section 2-02. Stockpiling of waste materials along the trench shall not be allowed.

7-09.3(5) Grade and Alignment

The location of blow off assemblies and combination air release/air vacuum valves are shown on the Plans.

The Contractor shall verify the locations and establish the depth of the existing water mains at the points where connections are to be made prior to trenching for the pipelines. The profile shall be adjusted so no new high spots or low spots are created between the connection points to the existing water mains.

The depth of trenching for water mains shall be such as to give a minimum cover of 36-inches over the top of the pipe unless otherwise specified in the Special Provisions. Deeper excavation may be required due to localized breaks in grade, or to install the new main under existing culverts or other utilities where necessary. Where the profile of the pipeline and the ground surface is shown on the Plans, the pipeline shall be laid to the elevation shown regardless of depth. The excavation shall be to such depth that the minimum cover over valve operating nuts shall be 1 foot.

7-09.3(6) Existing Utilities

Existing utilities of record, except services, are shown on the Plans. These are shown for convenience only, and the Engineer assumes no responsibility for improper locations or failure to show utility locations on the Plans.

When utility services occupy the same space as the new water main, the Contractor shall complete necessary excavation to fully expose such services. The Contractor shall protect said services, and work around them during excavating and pipe laying operations. Any damages to services resulting from the Contractor's operation shall be reported to the appropriate utility. Such damage shall be repaired at the Contractor's expense.

7-09.3(7) Trench Excavation

The Contractor shall perform excavation of every description and in whatever materials encountered to the depth indicated on the Plans or specified in the Special Provisions. Excavations shall be made by open cut unless otherwise provided for. Trenches shall be excavated to true and smooth bottom grades and in accordance with the lines given by the Engineer or shown on the Plans. The trench bottom shall provide uniform bearing and support for each length of pipe.

Bell holes shall be excavated to the extent necessary to permit accurate work in making and inspecting the joints. The banks of the trenches shall be kept as nearly vertical as soil conditions will permit, and where required to control trench width or to protect adjacent structures, the trench shall be sheeted and braced. Trench widths to 1 foot above the top of the pipe shall not exceed 30-inches maximum or 1½ times the outside diameter of the pipe plus 18-inches whichever is greater. Standard excavating equipment shall be adjusted so as to excavate the narrowest trench possible.

The length of trench excavation in advance of pipe laying shall be kept to a minimum. Excavations shall be either closed up at the end of the day or protected per Section 1-07.23(1).

The Contractor shall exercise sound engineering and construction practices in excavating the trench and maintaining the trench so that no damage will occur to any foundation, structure, pole line, pipe line, or other facility because of slough or slopes, or from any other cause. If, as a result of the excavation, there is disturbance of the ground, which may endanger other property, the Contractor shall immediately take remedial action at no additional expense to the Contracting Agency. No act, representation, or instruction of the Engineer shall in any way relieve the Contractor from liability for damages or costs that result from trench excavation.

Care shall be taken not to excavate below the depth specified. Excavation below that depth shall be backfilled with foundation material and compacted as specified herein.

If workers have to enter any trench or other excavation 4-feet or more in depth that does not meet the open pit requirements of Section 2-09.3(3)B, it shall be shored. The Contractor alone shall be responsible for worker safety, and the Contracting Agency assumes no responsibility.

Upon completing the work, the Contractor shall remove all shoring unless the Plans or the Engineer direct otherwise.

7-09.3(7)A Dewatering of Trench

Where water is encountered in the trench, it shall be removed during pipe-laying operations and the trench so maintained until the ends of the pipe are sealed and provisions are made to prevent floating of the pipe. Trench water or other deleterious materials shall not be allowed to enter the pipe at any time.

7-09.3(7)B Rock Excavation

Rock excavation shall cover the removal and disposal of rock that requires systematic drilling and blasting for its removal, and also boulders exceeding ½ cubic yard. Ledge rock, boulders, or stones shall be removed to provide a minimum clearance of 4-inches under the pipe.

Hardpan, hard clay, glacial till, sandstone, siltstone, shale, or other sedimentary rocks, which are soft, weathered, or extensively fissured will not be classified as rock excavation. Rock is defined as one that has a modulus of elasticity of more than 200,000 psi or unconfined compressive strength at field moisture content of more than 2,000 psi.

Materials removed shall be replaced with gravel backfill for pipe zone bedding, pipe zone backfill or trench backfill as designated by the Engineer.

7-09.3(7)C Extra Trench Excavation

Changes in grades of the water main from those shown on the Plans, or as provided in the Special Provisions, may be necessary because of unexpected utilities, or for other reasons. If, in the opinion of the Engineer, it is necessary to adjust, correct, relocate, or in any way change the line and grade, such changes shall be made by the Contractor under the terms of these Standard Specifications.

When pipeline grade is lowered in excess of 1 foot below the grade indicated on the Plans, the Contractor shall make such extra excavation as necessary.

When the pipeline horizontal alignment is changed by more than 1 foot from the line indicated on the Plans, after the trench has been excavated, the Contractor shall excavate the trench at the changed location and backfill and compact the previous trench.

Additional excavation so required will be classified as extra trench excavation.

7-09.3(8) Removal and Replacement of Unsuitable Materials

Whenever in excavating the trench for water mains, the bottom of the trench exposes peat, soft clay, quicksand, or other unsuitable foundation material, such material shall be removed to the depth directed by the Engineer and backfilled with foundation material. When determined by the Engineer that silty soils or fine sandy soils are encountered, Class C foundation material shall be required. Silty soils or fine sandy soils usually flow in the presence of a stream of water. When determined by the Engineer that clay, peat, or other soft materials are encountered that become saturated with water, but do not break down into fine particles and flow, Class A or Class B foundation material shall be required.

Material removed from the trench that is unsuitable for trench backfill shall be removed and hauled to a waste site. If material is not available within the limits of the project for backfilling the trench, the Contractor shall furnish trench backfill meeting the requirements of Section 9-03.12(3) or 9-03.19 as required.

Unsuitable material shall be loaded directly into trucks and hauled to a waste site obtained by the Contractor. Stockpiling of unsuitable material at the project site shall not be allowed.

7-09.3(9) Bedding the Pipe

Gravel backfill for pipe zone bedding shall be select granular material free from wood waste, organic material, and other extraneous or objectionable materials and shall have a maximum dimension of $1^1/_2$-inches. Gravel backfill for pipe zone bedding shall be placed to the depths shown in the Standard Plans. Gravel backfill for pipe zone bedding shall be rammed and tamped around the pipe to 95 percent of maximum density by approved hand-held tools, so as to provide firm and uniform support for the full length of the pipe, valves, and fittings. Care shall be taken to prevent any damage to the pipe or its protective coating.

7-09.3(10) Backfilling Trenches

Prior to backfilling, form lumber and debris shall be removed from the trench. Sheeting used by the Contractor shall be removed just ahead of the backfilling.

Backfill up to 12-inches over the top of the pipe shall be evenly and carefully placed. Materials capable of damaging the pipe or its coating shall be removed from the backfill material. The remainder of the material shall be placed by dumping into the trench by any method at the option of the Contractor, and shall be compacted as specified hereinafter.

A minimum 3-inch sand cushion shall be placed between the water main and existing pipelines or other conduits when encountered during construction.

7-09.3(11) Compaction of Backfill

Backfill shall be compacted to at least 95 percent of maximum density as specified in Section 2-03.3(14)D.

At locations where paved streets, roadway shoulders, driveways, or sidewalks will be constructed or reconstructed over the trench, the backfill shall be spread in layers and be compacted by mechanical tampers. In such cases, the backfill material shall be placed in successive layers not exceeding 6-inches in loose thickness, and each layer shall be compacted with mechanical tampers to the density specified herein. Mechanical tampers shall be of the impact type as approved by the Engineer.

7-09.3(12) General Pipe Installation

Pipe shall be installed in accordance with the manufacturer's printed specifications and instructions, and to the standards of the AWWA for installing the type of pipe used. The Contractor shall provide tools and equipment, including any special tools required for installing each particular type of pipe used.

Short lengths of pipe supplied by the manufacturer shall be used whenever possible to provide the proper spacing of valves, tees, or special fittings.

7-09.3(13) Handling of Pipe

Pipe shall be handled in a manner that will prevent damage to the pipe, pipe lining, or coating. Pipe and fittings shall be loaded and unloaded using hoists and slings in a manner to avoid shock or damage, and under no circumstances shall they be dropped, skidded, or rolled against other pipe. If any part of the coating or lining is damaged, repair thereof shall be made by the Contractor at no additional expense to the Contracting Agency and in a manner satisfactory to the Engineer. Damaged pipe shall be rejected, and the Contractor shall immediately place damaged pipe apart from the undamaged and shall remove the damaged pipe from the site within 24 hours.

Threaded pipe ends shall be protected by couplings or other means until laid.

Pipe and fittings shall be inspected for defects.

Dirt or other foreign material shall be prevented from entering the pipe or pipe joint during handling or laying operations, and any pipe or fitting that has been installed with dirt or foreign material in it shall be removed, cleaned, and re-laid. At times when pipe laying is not in progress, the open ends of the pipe shall be closed by a watertight plug or by other means approved by the Engineer to ensure cleanliness inside the pipe.

7-09.3(14) Cutting Pipe

Whenever it becomes necessary to cut a length of pipe, the cut shall be made by abrasive saw or by a special pipe cutter. Pipe ends shall be square with the longitudinal axis of the pipe and shall be reamed and otherwise smoothed so that good connections can be made. Threads shall be cleanly cut. Oxyacetylene torch cutting of ductile iron pipe shall not be allowed.

7-09.3(15) Laying of Pipe on Curves

7-09.3(15)A Ductile Iron Pipe

Long radius curves, either horizontal or vertical, may be laid with standard pipe lengths by deflecting the joints. If the pipe is shown curved on the Plans and no special fittings are shown, the Contractor can assume that the curves can be made by deflecting the joints with standard lengths of pipe. If shorter lengths are required, the Plans will indicate maximum lengths that can be used. The amount of deflection at each pipe joint when pipe is laid on a horizontal or vertical curve shall not exceed the manufacturer's printed recommended deflections.

Where field conditions require deflection or curves not anticipated by the Plans, the Engineer will determine the methods to be used. No additional payment will be made for laying pipe on curves as shown on the Plans, or for field changes involving standard lengths of pipe deflected at the joints. When special fittings not shown on the Plans are required to meet field conditions, additional payment will be made for special fittings as provided in Section 1-09.6.

When rubber gasketed pipe is laid on a curve, the pipe shall be jointed in a straight alignment and then deflected to the curved alignment. Trenches shall be made wider on curves for this purpose.

7-09.3(15)B Polyvinyl Chloride (PVC) Pipe (4-Inches and Over)

PVC pipe may be bent to allow for slight changes in direction. The minimum bending radius shall be as follows:

Size	Minimum Bending Radius
4-inch	125-feet
6-inch	175-feet
8-inch	225-feet
10-inch	275-feet
12-inch	325-feet
14-inch	400-feet

Axial deflection at the pipe joints shall not be allowed.

For 16-inch diameter pipe, changes in direction may be accomplished by axial deflection of the pipe joint. The maximum axial deflection allowed at each joint is one degree. For changes in direction greater than one degree per pipe joint, fittings shall be used.

7-09.3(16) Cleaning and Assembling Joint

The pipe ends, couplings, fittings, and appurtenances shall be cleaned to remove oil, grit, or other foreign matter from the joint. Care shall be taken to keep the joint from contacting the ground.

Pipe not furnished with a depth mark shall be marked before assembly to ensure visual observation of the work.

7-09.3(17) Laying Ductile Iron Pipe with Polyethylene Encasement

Where shown on the Plans, the Contractor shall lay ductile iron pipe with a polyethylene encasement. Pipe and polyethylene encasement shall be installed in accordance with AWWA C105.

7-09.3(18) Coupled Pipe 4-inches in Diameter and Larger

Joints for steel pipe shall be bell and spigot or welded as specified in the Special Provisions.

Component parts of couplings, rings, and bells shall receive a protective coating in the same manner as specified for the steel pipe. Bolts and nuts, exposed edges, and flanges shall, after installation, be covered with coal-tar protective coating conforming to AWWA C203 or other coating approved by the Engineer.

Steel pipe 4-inches and larger for aboveground service shall be coupled with flanges, compression type or grooved type couplings.

Pipe for outdoor service above ground shall be protected with a coal-tar protective coating conforming to AWWA C203 or other coating approved by the Engineer.

7-09.3(19) Connections

7-09.3(19)A Connections to Existing Mains

Connections to the existing water main shall not be made without first making the necessary scheduling arrangements with the Engineer in advance. Work shall not be started until all the materials, equipment, and labor necessary to properly complete the work are assembled on the site.

Existing water mains shall be cut by the Contractor unless otherwise specified in the Special Conditions. The Contractor shall remove the portions of pipe to provide for the installation of the required fittings at the points of connection. Damage caused by the Contractor's operations to existing joints in piping to remain in-service shall be repaired by the Contractor at no additional expense to the Contracting Agency. The Contractor shall determine the exact length of the existing water main that must be removed. The pipe ends shall be beveled to prevent damage to the transition coupling gasket during installation of the coupling. The exterior of the existing pipe end shall be cleaned to a sound, smooth finish before installation of the coupling.

Transition couplings shall be installed by the Contractor and shall be provided with a plastic film wrap. The plastic film wrap shall be wrapped loosely around the pipe, fittings, and couplings, and secured with 2-inch-wide polyethylene adhesive tape. Pipelines in which the couplings are installed shall be wrapped a minimum of 3-feet on each side of the coupling. Joints or seams in the plastic film wrap shall be made using the 2-inch-wide polyethylene adhesive tape. The plastic film wrap need not be watertight, but no part of the pipe or coupling shall be exposed to the backfill. Care shall be exercised during backfilling to prevent the plastic film wrap from being punctured or otherwise damaged. Plastic film wrap and its installation shall conform to AWWA C105 except as modified herein.

Once work is started on a connection, it shall proceed continuously without interruption and as rapidly as possible until completed. No shutoff of mains will be permitted overnight, over weekends, or on holidays.

If the connection to the existing system involves turning off the water, the Contractor shall be responsible for notifying the residents affected by the shutoff. The Engineer will advise which property owners are to be notified.

The Contractor may be required to perform the connection during times other than normal working hours. The Contractor shall not operate any valves on the existing system without specific permission of the Engineer.

The types of connections are varied and suggested piping arrangements have been shown on the Plans. For the installation of these connections, the surfaced portion of the roadway shall not be penetrated unless the connecting point is directly under it. For connection by any other method, the Contractor shall furnish a detailed sketch for approval not less than two weeks prior to the expected construction.

7-09.3(19)B Maintaining Service

Where existing services are to be transferred from old to new mains, the Contractor shall plan and coordinate its work with that of the Utility so that service will be resumed with the least possible inconvenience to customers.

To supply customers with water during the construction of a water main project where any section of the pipe has passed satisfactory hydrostatic and bacteriological tests, the Utility reserves the right to tap corporation stops into the section of new pipe and install service connections at such locations as the Utility may elect. The installation of any such service connections by the Utility shall not be construed by the Contractor as an acceptance by the Contracting Agency of any part of the work required under the Contract.

7-09.3(20) Detectable Marking Tape

Detectable marking tape shall be installed over nonmetallic water lines including services lines. The tape shall be placed approximately 1 foot above the top of the line and shall extend its full length. Detectable marking tape shall meet the requirements of Section 9-15.18.

7-09.3(21) Concrete Thrust Blocking

Concrete thrust blocking, as detailed on the Plans, shall be placed at bends, tees, dead ends, and crosses. Blocking shall be commercial concrete meeting the requirement of Section 6-02.3(2)B poured in place.

Concrete blocking shall bear against solid undisturbed earth at the sides and bottom of the trench excavation and shall be shaped so as not to obstruct access to the joints of the pipe or fittings.

7-09.3(22) Blowoff Assemblies

Blowoff Assemblies shall be constructed at the locations shown on the Plans and in accordance with the Standard Plans.

7-09.3(23) Hydrostatic Pressure Test

Water main appurtenances and service connections to the meter setter shall be tested in sections of convenient length under a hydrostatic pressure equal to 150 psi in excess of that under which they will operate or in no case shall the test pressure be less than

225 psi. Pumps, gauges, plugs, saddles, corporation stops, miscellaneous hose and piping, and measuring equipment necessary for performing the test shall be furnished and operated by the Contractor.

Sections to be tested shall normally be limited to 1,500-feet. The Engineer may require that the first section of pipe, not less than 1,000-feet in length, installed by each of the Contractor's crews, be tested in order to qualify the crew and the materials. Pipe laying shall not be continued more than an additional 1,000-feet until the first section has been tested successfully.

The pipeline shall be backfilled sufficiently to prevent movement of the pipe under pressure. Thrust blocks shall be in place and time allowed for the concrete to cure before testing. Where permanent blocking is not required, the Contractor shall furnish and install temporary blocking and remove it after testing.

The mains shall be filled with water and allowed to stand under pressure a sufficient length of time to allow the escape of air and allow the lining of the pipe to absorb water. The Contracting Agency will furnish the water necessary to fill the pipelines for testing purposes at a time of day when sufficient quantities of water are available for normal system operation.

The test shall be accomplished by pumping the main up to the required pressure, stopping the pump for 15 minutes, and then pumping the main up to the test pressure again. During the test, the section being tested shall be observed to detect any visible leakage.

A clean container shall be used for holding water for pumping up pressure on the main being tested. This makeup water shall be sterilized by the addition of chlorine to a concentration of 50 mg/l.

The quantity of water required to restore the pressure shall be accurately determined by pumping through a positive displacement water meter. The meter shall be approved by the Engineer. Acceptability of the test will be determined as follows:

$$L = \frac{SD\sqrt{P}}{266{,}400}$$

The quantity of water lost from the main shall not exceed the number of gallons per hour as determined by the formula:

in which

L = allowable leakage, gallons/hour

D = nominal diameter of the pipe in inches

P = test pressure during the leakage test (psi)

S = gross length of pipe tested, feet

There shall not be an appreciable or abrupt loss in pressure during the 15 minute test period.

Pressure gauges used in the test shall be accompanied with certifications of accuracy from a testing laboratory approved by the Engineer.

Any visible leakage detected shall be corrected by the Contractor regardless of the allowable leakage specified above. Should the tested section fail to meet the pressure test successfully as specified, the Contractor shall, at no additional expense to the Contracting Agency, locate and repair the defects and then retest the pipeline.

Tests shall be made with the hydrant auxiliary gate valves open and pressure against the hydrant valve. Each valve shall be tested by closing each in turn and relieving the pressure beyond. This test of the valve will be acceptable if there is no immediate loss of pressure on the gauge when the pressure comes against the valve being checked. The Contractor shall verify that the pressure differential across the valve does not exceed the rated working pressure of the valve.

Prior to calling out the Engineer to witness the pressure test, the Contractor shall have all equipment set up completely ready for operation and shall have successfully performed the test to ensure that the pipe is in satisfactory condition.

Defective materials or workmanship, discovered as a result of hydrostatic field test, shall be replaced by the Contractor at no additional expense to the Contracting Agency. Whenever it is necessary to replace defective material or correct the workmanship, the hydrostatic test shall be re-run at the Contractor's expense until a satisfactory test is obtained.

7-09.3(23)A Testing Extensions From Existing Mains

When an existing water main is extended with new pipe to a new valve and the distance from the existing pipe to the new valve is 18-feet or less, the section of new pipe installed between the new valve and the end of the existing main shall be made with pretested, prechlorinated pipe, and no hydrostatic test will be required. When the required hydrostatic tests are conducted in the new main section beyond the installed new valve in the closed position, the normal pressure of the existing main may be present against the other side of the new valve.

Where the distance between the end of an existing water main pipe extension to the new valve is more than 18-feet, the connection of the new pipe to existing pipe shall not be made until after hydrostatic tests have been made to the required pressure in both directions against the new valve. This shall be accomplished by a temporary cap or plug installed on the end of the new pipe, beyond the new valve, as close as possible to the existing pipe for testing purposes.

The short length of pipe between the temporary cap or plug end with the new valve in the closed position, with no hydrostatic pressure active on the opposite side of the valve, shall be subjected to the required test pressure. The same test shall be made against the other side of the new valve when that section of pipe is tested with no hydrostatic pressure active in the short section of pipe toward the existing main. The final connection to the existing main shall be made with pretested prechlorinated pipe.

7-09.3(23)B Testing Section with Hydrants Installed

When hydrants are included with the section of main pipe to be tested, the testing shall be conducted in three separate tests as follows:

Test No. 1 – Water main gate valves and hydrant auxiliary gate valves closed, with the hydrant operating stem valves and hose ports wide open.

Test No. 2 – Water main gate valves and the hydrant operating the stem valves tightly closed but the hydrant auxiliary gate valves and hose ports wide open.

Test No. 3 – Each hydrant shall be tested to the pressure indicated in Section 7-09.3(23) with the hydrant auxiliary gate valve and hose ports closed and the hydrant operating stem valve wide open.

7-09.3(23)C Testing Hydrants Installed on Existing Mains

For hydrants installed and connected to an existing main, the hydrant connection including hydrant tee, connection pipe, and auxiliary gate valves, shall be installed with pretested materials.

Before the hydrant connection is made to the existing main, the hydrant installation shall be subjected to the hydrostatic Test No. 3 as specified in Section 7-09.3(23)B. Hydrants installed and connected to an existing main shall have a satisfactory bacteriological sample obtained following the hydrostatic test.

7-09.3(24) Disinfection of Water Mains

Before being placed into service, new water mains and repaired portions of, or extensions to, existing mains shall be chlorinated and a satisfactory bacteriological report obtained. In the event two unsatisfactory bacteriological reports are obtained on a section of pipe, the Contractor shall revise his method of disinfection and the form of applied chlorine.

7-09.3(24)A Flushing

Sections of pipe to be disinfected shall first be flushed to remove any solids or contaminated material that may have become lodged in the pipe. If a hydrant is not installed at the end of the main, then a tap shall be provided large enough to develop a flow velocity of at least 2.5 fps in the water main.

Taps required by the Contractor for temporary or permanent release of air, chlorination or flushing purposes shall be provided by the Contractor as part of the construction of water mains.

Where dry calcium hypochlorite is used for disinfection of the pipe, flushing shall be done after disinfection.

The Contractor shall be responsible for disposal of treated water flushed from mains and shall neutralize the wastewater for protection of aquatic life in the receiving water before disposal into any natural drainage channel. The Contractor shall be responsible for disposing of disinfecting solution to the satisfaction of the Contracting Agency and local authorities. If approved by the Engineer, disposal may be made to an available sanitary sewer provided the rate of disposal will not overload the sewer.

7-09.3(24)B Requirement of Chlorine

Before being placed into service, new mains and repaired portions of, or extensions to, existing mains shall be chlorinated so that a chlorine residual of not less than 25 mg/l remains in the water after standing 24 hours in the pipe. The initial chlorine content of the water shall be not less than 50 mg/l.

7-09.3(24)C Form of Applied Chlorine

Chlorine shall be applied by one of the methods which follow, to give a dosage of not less than 50 mg/l of available chlorine.

7-09.3(24)D Dry Calcium Hypochlorite

As each length of pipe is laid, sufficient high-test calcium hypochlorite (65-70% chlorine) shall be placed inside the pipe to yield a dosage of not less than 50 mg/l available chlorine, calculated on the volume of the water that the pipe and appurtenances will contain.

The number of grams of 65% test calcium hypochlorite required for a 20-foot length of pipe equals

$0.008431 \times d^2$,

in which "d" is the diameter in inches.

7-09.3(24)E Liquid Chlorine

A chlorine gas-water mixture shall be applied by means of a solution-feed chlorinating device, or the dry gas may be fed directly through proper devices for regulating the rate of flow and providing effective diffusion of the gas into the water within the pipe being treated. Chlorinating devices for feeding solutions of the chlorine gas, or the gas itself, must provide means for preventing the backflow of water into the chlorine.

7-09.3(24)F Chlorine-Bearing Compounds in Water

A mixture of water and high-test calcium hypochlorite (65-70% Cl) may be substituted for the chlorine gas-water mixture. The dry powder shall first be mixed as a paste and then thinned to a 1 percent chlorine solution by adding water to give a total quantity of 7.5 gallons of water per pound of dry powder. This solution shall be injected in one end of the section of main to be disinfected while filling the main with water.

7-09.3(24)G Sodium Hypochlorite

Sodium hypochlorite, commercial grade (12.5% Cl) or in the form of liquid household bleach (5-6% Cl), may be substituted for the chlorine gas-water mixture. This liquid chlorine compound may be used full strength or diluted with water and injected into the main in correct proportion to the fill water so that dosage applied to the water will be at least 50 mg/l.

7-09.3(24)H Point of Application

The point of application of the chlorinating agent shall be at the beginning of the pipeline extension or any valved section of it, and through a corporation stop inserted in the horizontal axis of the pipe. The water injector for delivering the chlorine-bearing water into the pipe should be supplied from a tap on the pressure side of the gate valve controlling the flow into the pipeline extension. Alternate points of applications may be used when approved by the Engineer.

7-09.3(24)I Rate of Application

Water from the existing distribution system, or other source of supply, shall be controlled to flow very slowly into the newly-laid pipeline during application of the chlorine. The rate of chlorine gas-water mixture or dry gas feed shall be in such proportion to the rate of water entering the newly-laid pipe that the dosage applied to the water will be at least 50 mg/l.

7-09.3(24)J Preventing Reverse Flow

No connections shall be made between the existing distribution system and pipelines not disinfected that are constructed under this Contract without a State Department of Health approved backflow preventer installed in the connecting line.

7-09.3(24)K Retention Period

Treated water shall be retained in the pipe at least 24 hours. After this period, the chlorine residual at pipe extremities and at other representative points shall be at least 25 mg/l.

7-09.3(24)L Chlorinating Valves, Hydrants, and Appurtenances

In the process of chlorinating newly laid pipe, valves, hydrants, and other appurtenances shall be operated while the pipeline is filled with the chlorinating agent and under normal operating pressure.

7-09.3(24)M Chlorinating Connections to Existing Water Mains and Water Service Connections

The chlorinating procedure to be followed shall be as specified in AWWA Standard C651. All closure fittings shall be swabbed with a very strong chlorine solution at least as strong as liquid household bleach (5-6% Cl).

7-09.3(24)N Final Flushing and Testing

Following chlorination, treated water shall be flushed from the newly-laid pipe until the replacement water throughout its length shows, upon test, the absence of chlorine. In the event chlorine is normally used in the source of supply, then the tests shall show a residual not in excess of that carried in the water supply system.

A sample tap shall be located ahead of the flushing hose for convenience and for sanitary sampling.

Before placing the lines into service, a satisfactory report shall be received from the local or State Health Department on samples collected from representative points in the new system. Samples will be collected and bacteriological tests obtained by the Engineer.

7-09.3(24)O Repetition of Flushing and Testing

Should the initial treatment result in an unsatisfactory bacteriological test, the original chlorination procedure shall be repeated by the Contractor until satisfactory results are obtained. Failure to get a satisfactory test shall be considered as failure of the Contractor to keep the pipe clean during construction, or to properly chlorinate the main.

7-09.4 Measurement

Measurement for payment of pipe for water mains will be by the linear foot of pipe laid and tested and shall be measured along the pipe through fittings, valves, and couplings.

Measurement for payment of blowoff assembly will be per each.

No measurement shall be made for clearing and grubbing, removal of existing street improvements, protection of existing utilities and services, trench excavation and pipe zone backfill, pipe zone bedding, and compaction of backfill.

When listed as a pay item, rock excavation will be measured in its original position by volume in cubic yards. The quantity measured for payment will include only the material excavated from within the limits hereinafter defined. Any additional excavation outside of these limits will be considered as having been made for the Contractor's benefit, and all costs in connection with such excavation shall be included in the unit contract prices for the various items of work.

The horizontal limits for measuring rock excavation will be the sides of the trench, except no payment will be made for material removed outside of vertical planes extended beyond the maximum trench widths, as specified in Section 7-09.3(7). Vertical distances shall be measured from the upper surface of the rock to an elevation 6-inches below the underside of the pipe barrel, or to the lower surface of the rock, whichever is less. Boulders exceeding one cubic yard in volume shall be paid for according to their measured volume.

Removal of the extra trench excavation as defined in Section 7-09.3(7)C will be measured by the cubic yard. The depth shall be the actual depth removed for the changed line or grade in accordance with Section 7-09.3(5) or as ordered by the Engineer in accordance with Section 1-04.4. The width shall be the actual width removed for the changed line or grade, but in no case shall the measured width exceed the allowable widths specified in Section 7-09.3(7).

Removal and replacement of unsuitable material will be measured by the cubic yard. The depth shall be the actual depth removed below the depth specified in Section 7-09.3(5). The width shall be the actual width removed, but in no case shall the measured width exceed the allowable widths specified in Section 7-09.3(7).

Measurement of bank run gravel for trench backfill will be by the cubic yard measured in trucks at the point of delivery.

Shoring or extra trench excavation will be measured as specified in Section 2-09.4 for shoring or extra excavation Class B.

7-09.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"_____Pipe for Water Main_____ In. Diam.", per linear foot.

The unit contract price per linear foot for each size and kind of "_____ Pipe for Water Main _____ In. Diam." shall be full pay for all work to complete the installation of the water main including but not limited to trench excavation, bedding, laying and jointing pipe and fittings, backfilling, concrete thrust blocking, testing, flushing, disinfecting the pipeline, and cleanup.

Payment for restoration will be made under the applicable items shown in the Proposal. If no pay items for restoration are included in the Proposal, restoration shall be considered incidental to the work of constructing the water main, and all costs thereof shall be included in the unit contract price bid for "_____ Pipe for Water Main ____ In. Diam."

"Rock Excavation", per cubic yard.

If no pay item is listed, rock excavation shall be considered incidental to the work to construct the water main and all costs shall be included in other items of work specified in Section 7-09.5.

"Extra Trench Excavation", per cubic yard.

"Removal and Replacement of Unsuitable Material", per cubic yard.

"Bank Run Gravel for Trench Backfill", per cubic yard.

No separate payment will be made for clearing and grubbing, removal of existing street improvements, furnishing and installing sand cushion, protection of existing utilities and services, trench excavation and backfill, bedding the pipe, and compacting the backfill. These items shall all be considered as incidental to the work of constructing the water main, and all costs thereof shall be included in the payment as specified in Section 7-09.5.

"Shoring or Extra Excavation Trench", per square foot.

"Blowoff Assembly", per each.

The unit contract price bid per each for "Blowoff Assembly" shall be full pay for all work to install the blowoff assembly, including but not limited to excavating, backfilling, laying and jointing pipe, tapping the main, corporation stop, pipe and fittings, gate valve, meter box, and cover and cleanup.

7-10 VACANT

7-11 VACANT

7-12 VALVES FOR WATER MAINS

7-12.1 Description

Valves for water mains shall be suitable for ordinary waterworks service, intended to be installed in a normal position on buried pipelines for water distribution systems.

Valves shall open counterclockwise and shall be equipped with a 2-inch square AWWA standard operating nut. Unless otherwise specified, all valves shall be the nonrising stem type.

7-12.2 Materials

Materials shall meet the requirements of the following sections:

Gate Valves (3-inches to 16-inches)	9-30.3(1)
Butterfly Valves	9-30.3(3)
Valve Boxes	9-30.3(4)
Valve Marker Posts	9-30.3(5)
Combination Air Release/Air Vacuum Valves	9-30.3(7)
End Connections	9-30.5(1)
Tapping Sleeve and Valve Assembly	9-30.3(8)

The valves shall be standard pattern of a manufacturer whose products are approved by the Engineer and shall have the name or mark of the manufacturer, year valve casting was made, size and working pressure plainly cast in raised letters on the valve body.

The valve bodies shall be cast iron, ductile iron, or other approved material mounted with approved noncorrosive metals. All wearing surfaces shall be bronze or other approved noncorrosive material, and there shall be no moving bearing or contact surfaces of iron in contact with iron. Contact surfaces shall be machined and finished in the best workmanlike manner, and all wearing surfaces shall be easily renewable.

7-12.3 Construction Requirements

All valves shall be inspected upon delivery in the field to ensure proper working order before installation. They shall be set and jointed to the pipe in the manner as set forth in the AWWA Standards for the type of connecting ends furnished. The valves shall also be carefully inspected for injury to the outer protective coatings. At all places where the coating has been ruptured or scraped off, the damaged area shall be cleaned to expose the iron base installation, and the cleaned area shall then be recoated with two or more field coats of approved protective coating.

Upon delivery at the work site, all valves shall be opened to prevent the collection of water in the valve. Valves shall have the interiors cleaned of all foreign matter and shall be inspected both in open and closed position prior to installation. Valves and valve boxes shall be set plumb and valve boxes shall be placed over the valve or valve operator in a manner that the valve box does not transmit shock or stress to the valve. The lower casting of the unit is installed first, in a manner as to be supported by a minimum backfill or by a Styrofoam collar not less than 2-inches in thickness. The casting shall not rest directly upon the body of the valve or upon the water main. Backfill shall be carefully tamped around the valve box to a distance of 3-feet on all sides or to the undisturbed face of the trench if it is closer. The cast iron valve box cover shall be set flush with the roadbed or finished paved surface.

The combination air release/air vacuum valves shall be installed as shown in the Plans. All piping shall be sloped to permit escape of any entrapped air. Backfilling and compaction shall be as specified in Section 7-09.

After installation, all valves shall be subjected to field testing and disinfected as outlined in Section 7-09. Should any defects in design, materials, or workmanship appear during these tests, the Contractor shall correct such defects with the least possible delay and to the satisfaction of the Engineer.

7-12.3(1) Installation of Valve Marker Post

Where required, a valve marker post shall be furnished and installed with each valve. Valve marker posts shall be placed at the edge of the right-of-way opposite the valve and be set with 18-inches of the post exposed above grade. The exposed portion of the valve marker posts shall be painted with two coats of concrete paint in a color selected by the Engineer, and then the size of the valve and the distance in feet and inches to the valve shall be stenciled with black paint on the face of the post, using a stencil which will produce letters 2-inches high.

7-12.4 Measurement

Measurement of valves shall be per each for each type and size actually installed.

7-12.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Gate Valve ____ In.", per each.

"Butterfly Valve ____ In.", per each.

"Comb. Air Release/Air Vacuum Valve Assembly ____ In.", per each.

"Tapping Sleeve and Valve Assembly ____ In.", per each.

The unit contract price per each for the valve specified shall be full pay for all work to furnish and install the valve complete in place on the water main, including trenching, jointing, blocking of valve, painting, disinfecting, hydrostatic testing, valve box, and marker post.

7-13 VACANT

7-14 HYDRANTS

7-14.1 Description

This Section covers the installation of dry barrel fire hydrants intended for ordinary water works service.

7-14.2 Materials

Materials shall meet the requirements of the following sections:

Hydrants	9-30.5
End Connections	9-30.5(1)
Hydrant Dimensions	9-30.5(2)
Hydrant Extensions	9-30.5(3)
Hydrant Restraint	9-30.5(4)
Traffic Flange	9-30.5(5)
Guard Posts	9-30.5(6)

7-14.3 Construction Requirements

7-14.3(1) Setting Hydrants

Where shown in the Plans, hydrants shall be installed in accordance with the Standard Plans. In addition, a minimum 3-foot radius unobstructed working area shall be provided around all hydrants. The sidewalk flange shall be set 2-inches above finished grade.

All hydrants shall be set on concrete blocks as shown in the Standard Plans. The hydrant barrel drain shall waste into a pit of porous gravel material situated at the base of the hydrant as shown in the Standard Plans.

All hydrants shall be inspected upon delivery in the field to ensure proper working order. After installation, fire hydrants, auxiliary gate valves, and other appurtenances thereto shall be subjected to a hydrostatic test and disinfection procedures as specified in Section 7-09.

After all installation and testing is complete, the exposed portion of the hydrant shall be painted with one field coat. The type and color of paint will be designated by the Engineer.

Any hydrant not in service shall be identified by covering with a burlap or plastic bag properly secured.

7-14.3(2) Hydrant Connections

Hydrant laterals shall consist of one continuous section of 6-inch ductile iron pipe from the main to the hydrant and shall include an auxiliary gate valve set vertically and placed in accordance with the Standard Plan.

7-14.3(2)A Hydrant Restraints

The thrust created in the hydrant lateral shall be restrained as shown in the Standard Plans. If applicable, shackle rods, after installation, shall be cleaned and painted with two coats of asphalt varnish, or with such other bituminous coating as may be approved by the Engineer.

7-14.3(2)B Auxiliary Gate Valves and Valve Boxes

Auxiliary gate valves and valve boxes shall be installed in accordance with Section 7-12 except that the end connections shall be provided with lugs for shackling, or the bells shall provide sufficient clearance between the body of the valve and the hub to permit the installation of shackles.

7-14.3(2)C Hydrant Guard Posts

Hydrant guard posts shall be constructed at the locations shown in the Plans. The exposed portion of each guard post shall be painted with one coating of the type and color designated by the Engineer.

7-14.3(3) Resetting Existing Hydrants

Where existing hydrants are shown in the Plans for adjustments to conform to a new street alignment or grade or both, the hydrant shall be relocated without disturbing the location of the hydrant lateral tee at the main.

The method for thrust restraint for the hydrant lateral shall be determined by the conditions found in the field and shall be constructed as ordered by the Engineer at no additional cost to the Contracting Agency.

This work shall conform to Section 7-14.3(1).

7-14.3(4) Moving Existing Hydrants

Existing hydrants shall be moved where shown in the Plans. When the existing hydrant lateral tee does not accommodate a new hydrant location, a new hydrant lateral tee shall be installed in the main. The existing hydrant lateral tee shall be removed from the main (if said main is to remain active), and a new section of pipe inserted into the water main in place of the existing hydrant lateral tee. Where the existing main to which the existing hydrant lateral tee is connected, and is to be abandoned or temporarily activated after the existing hydrant is moved, the open end of the hydrant lateral pipeline shall be plugged (and temporary thrust restrain provided if temporarily reactivated). All work shall meet the requirements of Section 7-14.3(1).

7-14.3(5) Reconnecting Existing Hydrants

Existing hydrants shall be reconnected where shown in the Plans. The location and elevation of the existing hydrant shall remain unchanged, but the existing hydrant connection is changed to connect with a new hydrant tee provided in a new main.

Where existing hydrants were not shackled to the old main, the new connection shall be shackled with steel rods as shown in the Standard Plans, or by such other shackling method as approved by the Engineer.

Hydrant reconnections shall meet the requirements of Sections 7-14.3(1) and 7-14.3(2).

7-14.3(6) Hydrant Extensions

The Contractor shall furnish and install hydrant extensions where required. The hydrant extensions, operating stems for the hydrant main valves, and sidewalk flanges shall conform to AWWA C502. After installation, the extended fire hydrant shall be subjected to a hydrostatic pressure test and disinfection procedure as specified in Section 7-09.

7-14.4 Measurement

Measurement of hydrant assembly, resetting existing hydrants, moving existing hydrants, and reconnecting existing hydrants will be made per each. Measurement of hydrant extension will be made per linear foot.

7-14.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Hydrant Assembly", per each.

The unit contract price per each for "Hydrant Assembly" shall be full pay for all work to furnish and install fire hydrant assemblies, including all costs for auxiliary gate valve, shackles, tie rods, concrete blocks, gravel, and painting required for the complete installation of the hydrant assembly as specified, except the pipe connecting the hydrant to the main and the hydrant lateral tee will be paid for as specified in Section 7-09.5.

"Resetting Existing Hydrants", per each.

The unit contract price per each for "Resetting Existing Hydrant" shall be full pay for all work to reset the existing hydrant, including shackling, painting, and reconnecting to the main. New pipe required from the main to the hydrant will be paid as specified in Section 7-09.5.

"Moving Existing Hydrants", per each.

The unit contract price per each for "Moving Existing Hydrant" shall be full pay for all work to move the existing hydrant, including new hydrant lateral tee, shackling, painting, and reconnecting to the main. New pipe for hydrant connections will be paid for as specified in Section 7-09.5.

"Reconnecting Existing Hydrants", per each.

The unit contract price per each for "Reconnecting Existing Hydrant" shall be full pay for all work to reconnect the existing hydrant, excepting however, that new pipe used for the connection will be paid as specified in Section 7-09.5.

"Hydrant Extensions", per linear foot.

The unit contract price per linear foot for "Hydrant Extension" shall be full pay for all work to extend the hydrant vertically.

7-15 SERVICE CONNECTIONS

7-15.1 General

This work consists of installing 2-inch and smaller service connections from the main to and including the meter setter for the premises served. Service connections larger than 2-inches shall be installed as detailed on the Plans or as described in the Special Provisions.

7-15.2 Materials

Materials shall meet the requirements of the following sections:

Saddles	9-30.6(1)
Corporation Stops	9-30.6(2)
Service Pipe	9-30.6(3)
Service Fittings	9-30.6(4)
Meter Setters	9-30.6(5)
Bronze Nipples and Fittings	9-30.6(6)
Meter Boxes	9-30.6(7)

7-15.3 Construction Requirements

All service connections to water mains, except to ductile iron pipe Class 52 or stronger, shall be made using saddles as specified and be of the size and type suitable for use with the pipe being installed. Ductile iron pipe Class 52 or stronger may be direct tapped for corporation stops in accordance with the recommendations of DIPRA; unless direct taps are prohibited by the Special Provisions. Service pipelines shall be installed perpendicular to the main, unless shown otherwise in the Plans.

The depth of trenching for service connection piping shall provide a minimum of 3-feet of cover over the top of the pipe. Particular care shall be exercised to ensure that the main is not damaged by the work undertaken to install the service. Excavating and backfilling for service connections shall be as specified in Section 7-09, except that the service pipeline shall be installed under pavement, curbs, and sidewalks by boring methods approved by the governmental agency having jurisdiction over the roadway.

Service pipes shall be cut using a tool or tools specifically designed to leave a smooth, even, and square end on the piping material to be cut. Cut ends shall be reamed to the full inside diameter of the pipe. Pipe ends to be connected using couplings which seal to the outside surface of the pipe shall be cleaned to a sound, smooth finish before the couplings are installed. The meter box shall be adjusted to the finished grade after the surface has been acceptably restored.

Where shown in the Plans, existing service connections shall be reconnected to the new mains. The location of existing service connections shall be verified in the field by the Contractor. The Contractor shall notify affected customers of the service interruption at least 24 hours prior to service interruption.

Pipe materials used to extend or replace existing service connections beyond the meter box shall be copper or polyethylene pipe. Insulating couplings shall be used at any connection between galvanized steel or iron pipe and copper pipe. All fittings, appurtenances, and other miscellaneous materials on the sections of existing pipe that have been removed shall become the property of the Contractor.

7-15.3(1) Flushing and Disinfection

All service pipe and appurtenances shall be prechlorinated prior to installation. After installation, the service connection shall be flushed prior to connecting the meter.

7-15.4 Measurement

Service connections will be measured per each for each size of service connection installed.

7-15.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when it is included in the proposal:

"Service Connection ____ In. Diam.", per each.

The unit contract price per each for "Service Connection ____ In. Diam." shall be full pay for all work to install the service connection, including but not limited to, excavating, tapping the main, laying and jointing the pipe and fittings and appurtenances, backfilling, testing, flushing, and disinfection of the service connection.

7-16 VACANT

7-17 SANITARY SEWERS

7-17.1 Description

This work consists of constructing sanitary sewer lines in accordance with the Plans, these Specifications, and the Standard Plans, as staked.

7-17.2 Materials

Pipe used for sanitary sewers may be:

Rigid	Thermoplastic
Concrete	ABS Composite
Vitrified Clay	PVC (Polyvinyl Chloride)
Ductile Iron	

All sanitary sewer pipe shall have flexible gasketed joints unless otherwise specified.

It is not intended that materials listed are to be considered equal or generally interchangeable for all applications. The Engineer shall determine from the materials listed those suitable for the project, and shall so specify in the specifications or the Plans.

Materials shall meet the requirements of the following sections.

Plain Concrete Storm Sewer Pipe	9-05.7(1)
Reinforced Concrete Storm Sewer Pipe	9-05.7(2)
Vitrified Clay Sewer Pipe	9-05.8
Solid Wall PVC Sanitary Sewer Pipe	9-05.12(1)
Profile Wall PVC Sanitary Sewer Pipe	9-05.12(2)
Ductile Iron Sewer Pipe	9-05.13
ABS Composite Sewer Pipe	9-05.14

All pipe shall be clearly marked with type, class, and thickness. Lettering shall be legible and permanent under normal conditions of handling and storage.

7-17.3 Construction Requirements

Sanitary sewers shall be constructed in accordance with Section 7-08.3.

7-17.3(1) Protection of Existing Sewerage Facilities

All existing live sewers including septic tanks and drain fields shall be kept in service at all times. Provision shall be made for disposal of sewage flow if any existing sewers are damaged. Damage to existing sewers shall be repaired by the Contractor, at no expense to the Contracting Agency, to a condition equal to or better than their condition prior to the damage.

Water accumulating during construction shall be removed from the new sewers but shall not be permitted to enter the existing system. The Contractor shall be responsible for flushing out and cleaning any existing sewers into which gravel, rocks, or other debris has entered as a result of their operations, and shall repair lift stations or other facilities damaged by the Contractor's operations.

The physical connection to an existing manhole or sewer shall not be made until authorized by the Engineer. Such authorization will not be given until all upstream lines have been completely cleaned, all debris removed, and where applicable, a pipe temporarily placed in the existing channel and sealed.

7-17.3(2) Cleaning and Testing

7-17.3(2)A General

Sewers and appurtenances, where required in the Plans, shall be cleaned and tested after backfilling by either the exfiltration or low pressure air method at the option of the Contractor, except where the ground water table is such that the Engineer may require the infiltration test.

All work involved in cleaning and testing sewer lines between manholes or rodding inlets as required shall be completed within fifteen working days after backfilling of sewer lines and structures. Any further delay will require the written consent of the Engineer. The Contractor shall furnish all labor, materials, tools, and equipment necessary to make the test, clean the lines, and perform all incidental work. The Contractor shall perform the tests under the direction and in the presence of the Engineer. Precautions shall be taken to prevent joints from drawing during tests, and any damage resulting from these tests shall be repaired by the Contractor at no expense to the Contracting Agency. The manner and time of testing shall be subject to approval by the Engineer.

All wyes, tees, and stubs shall be plugged with flexible jointed caps, or acceptable alternate, securely fastened to withstand the internal test pressure. Such plugs or caps shall be readily removable, and their removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.

Testing side sanitary sewers shall be for their entire length from the public sewer in the street to the connection with the building's plumbing. Their testing shall be as required by the local sanitary agency but in no case shall it be less thorough than that of filling the pipe with water before backfilling and visually inspecting the exterior for leakage. The decision of the Engineer as to acceptance of the side sanitary sewer shall be final.

If any sewer installation fails to meet the requirements of the test method used, the Contractor shall determine, at no expense to the Contracting Agency, the source or sources of leakage and shall repair or replace all defective materials or workmanship at no expense to the Contracting Agency. The complete pipe installation shall meet the requirements of the test method used before being considered acceptable.

7-17.3(2)B Exfiltration Test

Prior to making exfiltration leakage tests, the Contractor may fill the pipe with clear water to permit normal absorption into the pipe walls provided, however, that after so filling the pipe, the Contractor shall complete the leakage test within 24 hours after filling. When under test, the allowable leakage shall be limited according to the provisions that follow. Specified allowances assume pre-wetted pipe.

Leakage shall be no more than 0.28 gph per inch diameter per 100-feet of sewer, with a hydrostatic head of 6-feet above the crown at the upper end of the test section, or above the natural ground water table at the time of test, whichever is higher. The length of pipe tested shall be limited so that the pressure at the lower end of the Section tested does not exceed 16-feet of head above the invert, and in no case shall be greater than 700-feet or the distance between manholes when greater than 700-feet.

Where the test head is other than 6-feet, the maximum leakage shall not exceed the amount determined from the following equation:

Maximum leakage (in gallons per hour) $= 0.28 \times (\sqrt{H} / \sqrt{6}) \times D \times (L / 100)$

where: D = diameter (in.)
L = length of pipe (ft.)
H = test head (ft.)

When the test is to be made one joint at a time, the leakage per joint shall not exceed the computed allowable leakage per length of pipe.

7-17.3(2)C Infiltration Test

Where the natural ground water head over the pipe is 2-feet or less above the crown of pipe at the upper end of the test section, the infiltration test leakage shall not exceed 0.16-gallons per hour per inch of diameter per 100-feet of pipe length. The length of pipe tested shall not exceed 700-feet or the distance between manholes when greater than 700-feet.

Where the natural ground water head is greater than 2-feet, the maximum leakage shall not exceed the amount determined from the following equation:

Maximum leakage (in gallons per hour) $= 0.16 \times (\sqrt{H} / \sqrt{2}) \times D \times (L / 100)$

where: D = diameter (in.)
L = length of pipe (ft.)
H = natural ground water head (ft.)

When a suitable head of ground water exists above the crown of the pipe and when the pipe is large enough to work inside, acceptance may be based on the repair of visible leakage by means satisfactory to the Engineer.

7-17.3(2)D Other Test Allowances

For either the infiltration or exfiltration test, all lateral or side sewer branches included in the test section shall be taken into account in computing allowable leakage. An allowance of 0.2 gallons per hour per foot of head above invert shall be made for each manhole included in a test section.

Upon final acceptance of the work all sewers, side sewers and fittings shall be open, clean, and free draining.

7-17.3(2)E Low Pressure Air Test for Sanitary Sewers Constructed of Air Permeable Materials

Air permeable materials include concrete and vitrified clay. Low pressure air testing may be used for air permeable pipes 30-inches in diameter and smaller.

The test equipment to be used shall be furnished by the Contractor and shall be inspected and approved by the Engineer prior to use. The Engineer may at any time require a calibration test of gauges or other instrumentation that is incorporated into the test equipment. Calibration tests shall be certified by an independent testing laboratory.

Plugs used to close the pipe for the air test must be securely braced to prevent the unintentional release of a plug, which can become a high velocity projectile. Gauges, air piping manifold, and valves shall be located at the top of the ground. No one shall be permitted to enter a manhole or catch basin where a plugged pipe is under pressure. Air testing apparatus shall be equipped with a pressure release device, such as a rupture disk or a pressure relief valve, designed to activate when the pressure in the pipe exceeds 2 psig above the required test pressure.

If the pipe to be tested is submerged by groundwater, the backpressure on the pipe created by the groundwater submergence must be determined. All gauge pressures described in the test shall be increased by that amount.

The first section of pipe installed by each crew shall be tested in order to qualify the crew and material. A successful test for the section shall be a prerequisite to further installation by that crew. Following the initial test, pipes shall be tested from manhole to manhole, catch basin to catch basin, or such shorter lengths as determined by the Contractor.

Air shall be slowly supplied to the plugged pipe section until the internal air pressure reaches 4 psig. Wait at least two minutes to allow for pressure and temperature stabilization to occur within the pipe.

When the pressure decreases to 3.5 psig, the air pressure test shall begin. The test shall consist of measuring the time in seconds for the pressure in the pipe to drop from 3.5 psig to 2.5 psig. The pipe shall be considered acceptable if the time in seconds for the pressure drop is equal to or greater than the required time as calculated below:

$K = 0.0111d^2L$

$C = 0.0003918dL$

If $C_T \leq 1$, then time = K_T

If $1 < C_T < 1.75$, then time = K_T/C_T

If $C_T \geq 1.75$, then time = $K_T/1.75$

where:
- d = Pipe diameter (inches)
- L = Pipe length (feet)
- K = value for each length of pipe of a specific diameter
- C = value for each length of pipe of a specific diameter
- K_T = sum of all K values
- C_T = sum of all C values

This method was developed based on an allowable air loss rate of .003 cubic feet per minute (cfm) per square foot of internal pipe surface, with the total air loss rate not less than 2 cfm nor greater than 3.5 cfm. At the Contractor's option, the pipe may be tested without pre-wetting; however, the allowable air loss rate assumes pre-wetted pipe.

Pipe over 30-inches in diameter shall be tested one joint at a time in accordance with ASTM C1103.

7-17.3(2)F Low Pressure Air Test for Sanitary Sewers Constructed of Non Air Permeable Materials

Non air permeable materials include ductile iron, ABS composite, polyvinyl chloride (PVC), and polyethylene (PE). When non air permeable pipe is subjected to a low-pressure air test, all of the provisions of Section 7-17.3(2)E shall apply, except that the time in seconds for the pressure drop shall be equal to or greater than four times the required time calculated in Section 7-17.3(2)E.

Pipe over 30-inches in diameter shall be tested one joint at a time in accordance with ASTM C 1103.

Reaches of thermoplastic pipe containing no joints shall be exempt from testing requirements.

7-17.3(2)G Deflection Test for Thermoplastic Pipe

Sanitary sewers constructed of thermoplastic pipe shall be tested for deflection not less than 30 days after the trench backfill and compaction has been completed. The test shall be conducted by pulling a properly sized "go-nogo" mandrel through the completed pipeline. Testing shall be conducted on a manhole-to-manhole basis and shall be done after the line has been completely flushed out with water.

The mandrel shall be a rigid, nonadjustable mandrel having an effective length of not less than its normal diameter and an odd-number of legs (9 legs minimum). Minimum diameter at any point along the full length of the mandrel shall be 95 percent of the base inside diameter of the pipe being tested.

Base inside diameter is derived by subtracting a statistical tolerance package from the average inside diameter. The tolerance package is defined as the square root of the sum of squared manufacturing tolerances. The tolerance package for controlled outside diameter pipe consists of (1) outside diameter tolerance specified in applicable ASTM Standard, (2) 12 percent of one wall thickness specified in applicable ASTM Standard, and (3) out of roundness tolerance listed in appendix of applicable ASTM Standard. The items in the tolerance package for controlled inside diameter pipe consists of (1) inside diameter tolerance listed in appendix of applicable ASTM Standard and (2) out of roundness tolerance listed in appendix of applicable ASTM Standard. When out of roundness tolerance is not listed, use 3 percent of average inside diameter.

The average inside diameter for pipe with controlled outside diameter shall be equal to the average outside diameter as specified in applicable ASTM Standard minus two minimum wall thicknesses as specified in applicable ASTM Standard and minus two times excess wall tolerance of 6 percent. The average inside diameter for pipes with controlled inside diameter shall be the average inside diameter as specified in applicable ASTM Standard.

The Contractor shall be required, at no expense to the Contracting Agency, to locate and uncover any sections failing to pass the test and, if not damaged, reinstall the pipe. The use of a vibratory re-rounding device or any process other than removal or reinstallation shall not be acceptable. The Contractor shall retest the section after replacement of the pipe.

Pipe large enough to work inside of may be accepted on the basis of direct measurement.

7-17.3(2)H Television Inspection

The Engineer may require any or all sanitary sewer lines be inspected by the use of a television camera before final acceptance. The costs incurred in making the initial inspection shall be borne by the owner of the sanitary sewer.

The Contractor shall bear all costs incurred in correcting any deficiencies found during television inspection including the cost of any additional television inspection that may be required by the Engineer to verify the correction of said deficiency.

The Contractor shall be responsible for all costs incurred in any television inspection performed solely for the benefit of the Contractor.

7-17.4 Measurement

The length of sewer pipe will be the number of linear feet of completed installation measured along the invert and will include the length through elbows, tees and fittings. The number of linear feet will be measured from the center of manhole to center of manhole or to the inside face of catch basins and similar type structures.

The length of testing sewer pipe in conformance with Section 7-17.3(2) will be the number of linear feet of completed installation actually tested.

7-17.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Plain Conc. or V.C. Sewer Pipe ____ In. Diam.", per linear foot.

"Cl. ____ Reinf. Conc. Sewer Pipe ____ In. Diam.", per linear foot.

"PVC Sanitary Sewer Pipe ____ In. Diam.", per linear foot.

"Ductile Iron Sewer Pipe ____ In. Diam.", per linear foot.

"ABS Composite Sewer Pipe ____ In. Diam.", per linear foot.

The unit contract price per linear foot for sewer pipe of the kind and size specified shall be full pay for furnishing, hauling, and assembling in place the completed installation including all wyes, tees, special fittings, joint materials, bedding and backfill material, and adjustment of inverts to manholes for the completion of the installation to the required lines and grades.

"Testing Sewer Pipe", per linear foot.

The unit contract price per linear foot for "Testing Sewer Pipe" shall be full pay for all labor, material and equipment required to conduct the leakage tests required in Section 7-17.3(2).

"Removal and Replacement of Unsuitable Material", per cubic yard.

The unit contract price per cubic yard for "Removal and Replacement of Unsuitable Material" shall be full pay for all work to remove unsuitable material and replace and compact suitable material as specified in Section 7-08.3(1)A.

7-18 SIDE SEWERS

7-18.1 Description

This work shall consist of constructing side sewers in accordance with the Plans, these Specifications, and the Standard Plans, at locations staked, on both the right of way and private property between the main sanitary sewer line and the stubout from a residence or other building.

7-18.2 Materials

Materials shall be the same as required for sanitary sewers in Section 7-17.

7-18.3 Construction Requirements

7-18.3(1) General

The construction requirements for sanitary sewers in Section 7-17 shall apply to the construction of side sewers.

Side sewers shall not be backfilled prior to inspection.

Side sewers shall be constructed with a maximum joint deflection not to exceed the manufacturer's printed recommendations and in no case shall exceed 2-inches per foot in any joint. Larger changes in direction shall be made by use of standard $^{1}/_{8}$ bends.

7-18.3(2) Fittings

Side sewers shall be connected to the tee, wye, or riser provided in the public sewer, where such is available, utilizing approved fittings or adapters. Where no tee, wye, or riser is provided or available, connection shall be made by machine made tap and approved saddle.

7-18.3(3) Testing

All side sewers shall be tested after backfilling.

All side sewers constructed in conjunction with the main sewer shall, for purposes of testing as specified in Section 7-17, have a 6-inch tee fitting pipe placed at the point where the side sewer crosses the street or other public right of way margin. The tee opening shall be positioned perpendicular to the side sewer slope, unless otherwise directed by the Engineer.

When side sewers are not tested simultaneously with the testing of the main sewer, the Contractor, at no expense to the Contracting Agency, shall furnish and place an additional tee in the first pipe out of the main sewer tee or wye branch, so that an inflatable rubber ball can be inserted for sealing off the side sewer and thus permit separate tests.

7-18.3(4) Extending Side Sewers Into Private Property

Side sewers shall not be constructed on private property prior to completion and acceptance of the main line and side sewer on public right of way or easement unless approved in writing by the Engineer.

7-18.3(5) End Pipe Marker

The location of side sewers at the property line shall be marked by the Contractor with a 2 by 4 wooden stake 4-feet long buried in the ground a depth of 3-feet. The low end shall have a 2 by 4 cleat nailed to it to prevent withdrawal of the stake. The exposed end shall be painted traffic white and the depth to the side sewer or tee shall be indicated in black paint on the 2 by 4. In addition, a length of 12 gage galvanized wire shall be provided to extend from the plugged end of the side sewer or tee. The upper end shall emerge at the 4-foot stake, but shall not be fastened to it.

7-18.4 Measurement

Measurement shall be as specified in Section 7-17.4.

7-18.5 Payment

Payment shall be made in accordance with Section 1-04.1, for each of the bid items shown in Section 7-17.5 that are included in the proposal.

The unit contract price per linear foot for sewer pipe of the various kind and size specified shall be full pay for all work required for the completion of the installation including fittings and end pipe marker.

7-19 SEWER CLEANOUTS

7-19.1 Description

This work consists of constructing sanitary sewer cleanouts in accordance with the Plans, these Specifications, and the Standard Plans as staked.

7-19.2 Materials

All materials incorporated into the total cleanout structure shall meet the requirements of the various applicable sections of these Specifications.

7-19.3 Construction Requirements

A cleanout shall be provided for each total change of 90 degrees of grade or alignment and in no case shall the spacing of cleanouts exceed 100-feet. No cleanout will be required at the connection of the side sewer to a riser on the public sewer. A suitably located cleanout in the house piping or plumbing may be considered as a cleanout for the side sewer. Cleanouts shall consist of a wye branch in the side sewer.

All cleanouts located in public rights of way shall be extended to grade.

The extension of cleanouts to grade on private property will be optional with the property owner. When extended to grade, cleanouts shall be full side sewer diameter and shall be extended to a point not less than 6-inches nor more than 12-inches below the finished ground surface and shall be plugged with a removable stopper which will prevent passage of dirt or water. When specified, the Contractor shall install an approved casting to provide ready access to the cleanout stopper. A $^{1}/_{8}$-bend shall be used to deflect the side sewer upward as a cleanout where the terminal end of the side sewer lies upstream from the last point of connection.

7-19.4 Measurement

Measurement for cleanouts shall be determined by the count of the actual number installed.

7-19.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when listed in the proposal:

"Sewer Cleanout", per each.

The unit contract price per each for cleanouts shall be full pay for furnishing and placing the wye, pipe, pipe bends, pipe plug, castings, and collar as specified herein and as shown on the Standard Plan.

DIVISION 8
MISCELLANEOUS CONSTRUCTION

8-01 EROSION CONTROL AND WATER POLLUTION CONTROL

8-01.1 Description

This work consists of furnishing, installing, maintaining, removing and disposing of water pollution and erosion control items in accordance with these Specifications and as shown in the Plans or as designated by the Engineer.

8-01.2 Materials

Materials shall meet the requirements of the following sections:

Seed	9-14.2
Fertilizer	9-14.3
Mulch and Amendments	9-14.4
Erosion Control Devices	9-14.5
Construction Geotextile	9-33
Quarry Spalls	9-13

8-01.3 Construction Requirements

8-01.3(1) General

Controlling pollution, erosion, runoff, and related damage requires the Contractor to perform temporary work items including but not limited to:

1. Providing ditches, berms, culverts, and other measures to control surface water;
2. Building dams, settling basins, energy dissipaters, and other measures, to control downstream flows;
3. Controlling underground water found during construction; or
4. Covering or otherwise protecting slopes until permanent erosion-control measures are working.

To the degree possible, the Contractor shall coordinate this temporary work with permanent drainage and erosion control work the contract requires.

The Engineer may require additional temporary control measures if it appears pollution or erosion may result from weather, the nature of the materials, or progress on the work.

When natural elements rut or erode the slope, the Contractor shall restore and repair the damage with the eroded material where possible, and clean up any remaining material in ditches and culverts. When the Engineer orders replacement with additional or other materials, unit contract prices will cover the quantities needed.

If the Engineer anticipates water pollution or erosion, the Contractor shall schedule the work so that grading and erosion control immediately follows clearing and grubbing. The Engineer may also require erosion control work to be done with or immediately after grading. Clearing, grubbing, excavation, borrow, or fill within the right of way shall never expose more erodible earth than as listed below, without written approval by the Engineer:

Area	Date	Location
17 Acres	April 1 - October 31	East of the Summit of the Cascade Range
	May 1 - September 30	West of the Summit of the Cascade Range
5 Acres	November 1 - March 31	East of the Summit of the Cascade Range
	October 1 - April 30	West of the Summit of the Cascade Range

The Engineer may increase or decrease the limits in light of project conditions.

Erodible earth is defined as any surface where soils, grindings, or other materials are capable of being displaced and transported by rain, wind, or surface water runoff.

In western Washington, erodible soil not being worked, whether at final grade or not, shall be covered within the following time period, using an approved soil covering practice, unless authorized otherwise by the Engineer:

October 1 through April 30 2 days maximum

May 1 to September 30 7 days maximum

If the Engineer, under Section 1-08.6, orders the work suspended for an extended time, the Contractor shall, before the Contracting Agency assumes maintenance responsibility, make every effort to control erosion, pollution, and runoff during shutdown. Section 1-08.7 describes the Contracting Agency's responsibility in such cases.

Nothing in this section shall relieve the Contractor from complying with other contract requirements.

8-01.3(1)A Submittals

When a temporary erosion and sediment control (TESC) plan is included in the plans, the Contractor shall either adopt or modify the existing TESC plan. The Contractor shall provide a schedule for TESC plan implementation and incorporate it into the Contractor's progress schedule. The Contractor shall obtain the Engineer's approval of the TESC plan and schedule before any work begins. The TESC plan shall cover all areas the Contractor's work may affect inside and outside the limits of the project (including all Contracting Agency-provided sources, disposal sites, and haul roads, and all nearby land, streams, and other bodies of water).

The Contractor shall allow at least five working days for the Engineer's review of any original or revised plan. Failure to approve all or part of any such plan shall not make the Contracting Agency liable to the Contractor for any work delays.

8-01.3(1)B Erosion and Sediment Control (ESC) Lead

The Contractor shall identify the ESC Lead at the preconstruction discussions. The ESC Lead shall have, for the life of the contract, a current Certificate of Training in Construction Site Erosion and Sediment Control from a course approved by WSDOT's Statewide Erosion Control Coordinator.

The ESC Lead shall implement the Temporary Erosion and Sediment Control (TESC) plan. Implementation shall include, but is not limited to:

1. Installing and maintaining all temporary erosion and sediment control Best Management Practices (BMPs) included in the TESC plan to assure continued performance of their intended function. Damaged or inadequate TESC BMPs shall be corrected immediately.

2. Inspecting all on-site erosion and sediment control BMPs at least once every five working days and each working day there is a runoff event. Inspections shall occur within 24 hours of the runoff event. A TESC Inspection Report shall be prepared for each inspection and shall be included in the TESC file. A copy of each TESC Inspection Report shall be submitted to the Engineer no later than the end of the next working day following the inspection. The report shall include, but not be limited to:
   a. When, where and how BMPs were installed, maintained, modified, and removed;
   b. Observations of BMP effectiveness and proper placement;
   c. Recommendations for improving future BMP performance with upgraded or replacement BMPs when inspections reveal TESC plan inadequacies.
3. Updating and maintaining a TESC file on site that includes, but is not limited to:
   a. TESC Inspection Reports.
   b. Temporary Erosion and Sediment Control (TESC) plan narrative.
   c. National Pollutant Discharge Elimination System construction permit (Notice of Intent).
   d. Other applicable permits.

Upon request, the file shall be provided to the Engineer for review.

8-01.3(1)C Water Management

1. Ground Water

   When ground water is encountered in an excavation, it shall be treated and discharged as follows:
   a. When the ground water conforms to Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201A WAC), it may bypass detention and treatment facilities and be routed directly to its normal discharge point at a rate and method that will not cause erosion.
   b. When the turbidity of the ground water is similar to the turbidity of the site runoff, the ground water may be treated using the same detention and treatment facilities being used to treat the site runoff and then discharged at a rate that will not cause erosion.
   c. When the turbidity is greater than the turbidity of the site runoff, the ground water shall be treated separately until the turbidity is similar to or better than the site runoff, and then may be combined and treated as in B, above.
2. Process Water

   All water generated on site from construction or washing activities that is more turbid than site runoff shall be treated separately until the turbidity is the same or less than the site runoff, and then may be combined and treated as in 1B, above. Water may be infiltrated upon the approval of the Engineer.

3. Offsite Water

The Contractor shall, prior to disruption of the normal watercourse, intercept the offsite stormwater and pipe it either through or around the project site. This water shall not be combined with onsite stormwater and shall be discharged at its pre-construction outfall point in such a manner that there is no increase in erosion below the site. The method for performing this work shall be submitted by the Contractor for the Engineer's approval.

8-01.3(1)D Dispersion/Infiltration

Water shall be conveyed only to dispersion or infiltration areas designated in the TESC plan or to sites approved by the Engineer. Water shall be conveyed to designated dispersion areas at a rate that when runoff leaves the area, turbidity standards are achieved. Water shall be conveyed to designated infiltration areas at a rate that does not produce runoff.

8-01.3(1)E Detention/Retention Pond Construction

Whether permanent or temporary, ponds shall be constructed before beginning other grading and excavation work in the area that drains into that pond. Temporary conveyances shall be installed concurrently with grading in accordance with the TESC plan so that newly graded areas drain to the pond as they are exposed.

8-01.3(2) Seeding, Fertilizing, and Mulching

8-01.3(2)A Preparation For Application

Seeding

Areas to be cultivated are shown in the Plans or specified in the Special Provisions. The areas shall be cultivated to the depths specified to provide a reasonably firm but friable seedbed. Cultivation shall take place no sooner than two weeks prior to seeding.

All areas to be seeded, including excavated slopes shall be compacted and prepared unless otherwise specified or ordered by the Engineer. A cleated roller, crawler tractor, or similar equipment, approved by the Engineer that forms longitudinal depressions at least 2-inches deep shall be used for compaction and preparation of the surface to be seeded.

The entire area shall be uniformly covered with longitudinal depressions formed perpendicular to the natural flow of water on the slope. The soil shall be conditioned with sufficient water so the longitudinal depressions remain in the soil surface until completion of the seeding.

Prior to seeding, the finished grade of the soil shall be 1-inch below the top of all curbs, junction and valve boxes, walks, driveways, and other structures. The soil shall be in a weed free and bare condition.

Temporary Seeding

A cleated roller, crawler tractor, or similar equipment, approved by the Engineer that forms longitudinal depressions at least 2-inches deep shall be used for compaction and preparation of the surface to be seeded. The entire area shall be uniformly covered with longitudinal depressions formed perpendicular to the natural flow of water on the slope. The soil shall be conditioned with sufficient water so the longitudinal depressions remain in the soil surface until completion of the seeding.

8-01.3(2)B Seeding and Fertilizing

Seed or seed and fertilizer shall be placed at the rate, mix and analysis specified in the Special Provisions or as designated by the Engineer. The Contractor shall notify the Engineer not less than 24 hours in advance of any seeding operation and shall not begin the work until areas prepared or designated for seeding have been approved. Following the Engineer's approval, seeding of the approved slopes shall begin immediately.

Seeding shall not be done during windy weather or when the ground is frozen, excessively wet, or otherwise untillable. Seed or seed and fertilizer may be sown by one of the following methods:

1. An approved hydro seeder that utilizes water as the carrying agent, and maintains continuous agitation through paddle blades. It shall have an operating capacity sufficient to agitate, suspend, and mix into a homogeneous slurry the specified amount of seed and water or other material. Distribution and discharge lines shall be large enough to prevent stoppage and shall be equipped with a set of hydraulic discharge spray nozzles that will provide a uniform distribution of the slurry.
2. Approved blower equipment with an adjustable disseminating device capable of maintaining a constant, measured rate of material discharge that will ensure an even distribution of seed at the rates specified.
3. Helicopters properly equipped for aerial seeding.
4. Approved power-drawn drills or seeders.
5. Areas in which the above methods are impractical may be seeded by approved hand methods.

When seeding by hand, the seed shall be incorporated into the top 1/4-inch of soil by hand raking or other method that is approved by the Engineer.

The seed applied using a hydroseeder shall have a tracer added to visibly aid uniform application. This tracer shall not be harmful to plant and animal life. If wood cellulose fiber is used as a tracer, the application rate shall not exceed 250 pounds per acre.

Seed and fertilizer may be applied in one application provided that the fertilizer is placed in the hydro seeder tank no more than one hour prior to application.

8-01.3(2)C Liming

Agricultural lime shall be applied at the rates specified in the Special Provisions.

The method of application shall be in conformance with all air and water pollution regulations and shall be approved by the Engineer.

8-01.3(2)D Mulching

Mulch of the type specified in the Special Provisions shall be furnished, hauled, and evenly applied at the rates indicated and shall be spread on seeded areas within 48 hours after seeding unless otherwise specified.

Distribution of straw mulch material shall be by means of an approved mulch spreader that utilizes forced air to blow mulch material on seeded areas.

Mulch may be applied with seed and fertilizer West of the summit of the Cascade Range. East of the summit of the Cascade Range, seed and fertilizer shall be applied in one application followed by the application of mulch. Mulch shall be suitable for application with a hydro seeder as specified in Section 8-01.3(2)B.

Temporary seed applied outside the application windows established in 8-01.3(2)F, shall be covered with a mulch containing either BFM or MBFM, as designated by the Engineer.

Mulch sprayed on signs or sign structures shall be removed the same day.

Areas not accessible by mulching equipment shall be mulched by approved hand methods.

8-01.3(2)E Tacking Agent and Soil Binders

Tacking Agents

Tacking agents shall be applied in accordance with the manufacturer's recommended requirements.

Soil Binders

Soil binders shall be applied in accordance with the manufacturer's recommended requirements.

Soil Binding Using Polyacrylamide (PAM)

The PAM shall be completely dissolved and mixed in water prior to being applied to the soil. PAM shall be applied only on bare soil at a rate of not more than 0.5 pounds per 1M gallons of water per acre. A minimum of 200 pounds per acre of cellulose fiber mulch treated with a non-toxic dye shall be applied with the PAM.

PAM shall be applied only to areas that drain to completed sedimentation control BMPs in accordance with the TESC plan. PAM shall not be applied to the same area more than once in a 48 hour period, or more than 7 times in a 30 day period.

PAM shall not be applied during rainfall or to saturated soils.

Soil Binding Using Bonded Fiber Matrix (BFM)

The BFM shall be hydraulically applied in accordance with the manufacturer's installation instructions.

Soil Binding Using Mechanically-Bonded Fiber Matrix (MBFM)

The MBFM shall be hydraulically applied in accordance with the manufacturer's installation instructions and recommendations.

8-01.3(2)F Dates for Application of Final Seed, Fertilizer, and Mulch

Unless otherwise approved by the Engineer, the final application of seeding, fertilizing, and mulching of slopes shall be performed during the following periods:

West of the summit of the Cascade Range - March 1 to May 15 and September 1 to October 1. Where contract timing is appropriate, seeding, fertilizing, and mulching shall be accomplished during the fall period listed above. Written permission to seed after October 1 will only be given when physical completion of the project is imminent and the environmental conditions are conducive to satisfactory growth.

East of the summit of the Cascade Range - October 1 to November 15. Seeding, fertilizing, and mulching shall be accomplished during this fall period only.

All roadway excavation and embankment slopes, including excavation and embankment slopes that are partially completed to grade, shall be prepared and seeded during the first available seeding window. When environmental conditions are not conducive to satisfactory results, the Engineer may suspend work until such time that the desired results are likely to be obtained.

The Contractor will be responsible to ensure a healthy stand of grass, otherwise, the Contractor will, restore eroded areas, clean up eroded materials, and reseed, fertilize and mulch, at no additional cost to the Contracting Agency.

When environmental conditions are conducive to satisfactory results, the Contractor may elect to perform seeding operations outside of the time periods specified. Inspection of seeding performed at the Contractor's option outside of the time periods specified will be made after one growing season has elapsed. Acceptance will be based on a uniform stand of grass at the time of inspection. The Contractor shall restore eroded areas, clean up eroded materials, and reseed, fertilize, and mulch, at no additional cost to the Contracting Agency, the areas failing to show a uniform stand of grass.

Temporary seeding may be performed at any time approved by the Engineer.

8-01.3(2)G Protection and Care of Seeded Areas

The Contractor shall be responsible to ensure a healthy stand of grass, otherwise, the Contractor shall, restore eroded areas, clean up eroded materials, and reapply the seed, fertilizer, and mulch, at no additional cost to the Contracting Agency.

In addition to the requirements of Section 1-07.13(1), the Contractor shall be responsible for performing the following duties:

1. Areas, which have been damaged through any cause prior to final inspection, and areas failing to receive a uniform application at the specified rate, shall be reseeded, refertilized, and remulched at the Contractor's expense.
2. Seeded areas within the planting area shall be considered part of the planting area. Weeds within the seeded areas shall be controlled in accordance with Section 8-02.3(3).

8-01.3(2)H Inspection

Inspection of seeded areas will be made upon completion of seeding, fertilizing, temporary seeding, and mulching. The work in any area will not be measured for payment until a uniform distribution of the materials is accomplished at the specified rate. Areas not receiving a uniform application of seed, fertilizer, or mulch at the specified rate, as determined by the Engineer, shall be reseeded, refertilized, or remulched at the Contractor's expense prior to payment.

8-01.3(2)I Mowing

When the proposal contains the bid item "Mowing" or mowing areas are defined, the Contractor shall mow all grass growing areas and slopes 2.5 (H) to 1 (V) or flatter except for naturally wooded and undergrowth areas. Trimming around traffic facilities, structures, planting areas, or other features extending above ground shall be accomplished preceding or simultaneously with each mowing by use of power driven or hand operated machinery and tools to achieve a neat and uniform appearance.

Each mowing shall be considered as one coverage of all grass areas to be mowed within a defined area. Prospective bidders shall verify the estimated acreage, the topography, irregularity of the area, slopes involved, and access limitations to determine the appropriate equipment to use for mowing. Equipment and tools shall be provided such as, but not limited to, tractor operated rotary or flail-type grass cutting machines and tools or other approved equipment. Power driven equipment shall not cause ruts or deformation of improved areas. Sickle type grass cutters will be permitted only on slopes of drainage ditches, berms, or other rough areas. The equipment and tools shall be in

good repair and maintained so that a clean, sharp cut of the grass will result at all times. The Engineer will determine the actual number of mowings. The height of mowing will be 4 to 6-inches or as designated in the Plans or in the Special Provisions.

Mowing equipment shall be operated and equipped with suitable guards to prevent throwing rocks or debris onto the traveled way or off the right of way. Equipment, which pulls or rips the grass or damages the turf in any manner will not be permitted. The Engineer will be the sole judge of the adequacy of the equipment, safeguards, and methods of use. The Contractor will not be required to collect or remove clippings from the project except on the traveled way, shoulder, walkway, or other areas designated by the Engineer.

8-01.3(3) Placing Erosion Control Blanket

The slope rating of the blanket, as specified by the manufacturer, shall be appropriate for the intended slope and installed according to the Standard Plans. Temporary erosion control blankets as defined in 9-14.5, having an open area of 60% or greater, may be installed prior to seeding. Blankets with less than 60% open space shall be installed immediately following the seeding and fertilizing operation.

8-01.3(4) Placing Compost Blanket

Compost blanket shall be placed to a depth of 3-inches over bare soil. Compost blanket shall be placed before seeding or other planting.

Compost used for compost blanket shall meet the requirements of 9-14.4(8).

8-01.3(5) Placing Plastic Covering

Plastic meeting the requirements of Section 9-14.5(3) shall be placed with at least a 12-inch overlap of all seams.

Clear plastic covering shall be used to promote growth of vegetation. Black plastic covering shall be used for stockpiles or other areas where vegetative growth is unwanted.

The cover shall be maintained tightly in place by using sandbags on ropes in a 10-foot, maximum, grid. All seams shall be weighted down full length.

8-01.3(6) Check Dams

Check dams shall be installed as soon as construction will allow, or when designated by the Engineer. The Contractor may substitute a different check dam for that specified with approval of the Engineer. Check dams shall be placed in ditches perpendicular to the channel. Check dams shall be of sufficient height to maximize detention, without causing water to leave the ditch.

8-01.3(6)A Geotextile-Encased Check Dam

The geotextile-encased check dam shall meet the requirements in Section 9-14.5(4) Geotextile-Encased Check Dam.

Installation of geotextile-encased check dams shall be in accordance with the Plans, and shall be anchored to hold it firmly in place under all conditions.

8-01.3(6)B Rock Check Dam

The rock used to construct rock check dams shall meet the requirements for quarry spalls, in accordance with Section 9-13.6.

8-01.3(6)C Sandbag Check Dam

Sandbags shall be placed so that the initial row makes tight contact with the ditch line for the length of the dam. Subsequent rows shall be staggered so the center of the bag is placed over the space between bags on the previous lift.

8-01.3(6)D Wattle Check Dam

Wattles used to construct wattle check dams shall meet the requirements for 8-01.3(10).

8-01.3(6)E Coir Log

Coir logs shall meet the requirements of 9-14.5(7) Coir Log . Install coir log as shown in the Plans.

8-01.3(7) Stabilized Construction Entrance

Temporary stabilized construction entrance shall be constructed in accordance with the Plans, prior to beginning any clearing, grubbing, earthwork or excavation.

When the stabilized entrance no longer prevents track out of sediment or debris, the Contractor shall either rehabilitate the existing entrance to original condition, or construct a new entrance.

When the contract requires a tire wash in conjunction with the stabilized entrance, the Contractor shall include details for the tire wash and the method for containing and treating the sediment-laden runoff as part of the TESC plan. All vehicles leaving the site shall stop and wash sediment from their tires.

8-01.3(8) Street Cleaning

Self-propelled pickup street sweepers shall be used, whenever required by the Engineer, to prevent the transport of sediment and other debris off the project site. Street sweepers shall be designed and operated to meet air quality standards.

Street washing with water will require approval by the Engineer.

8-01.3(9) Sediment Control Barriers

Sediment control barriers shall be installed in accordance with TESC plan or manufacturer's recommendations in the areas of clearing, grubbing, earthwork or drainage prior to starting those activities.

The sediment control barriers shall be maintained until the soils are stabilized.

8-01.3(9)A Silt Fence

Silt fence shall be installed in accordance with the Plans.

When backup support is used, steel wire shall have a maximum mesh spacing of 2-inches by 4-inches, and the plastic mesh shall be as resistant to ultraviolet radiation as the geotextile it supports.

The geotextile shall be attached to the posts and support system using staples, wire, or in accordance with the manufacturer's recommendations.

The geotextile shall be sewn together at the point of manufacture, or at a location approved by the Engineer, to form geotextile lengths as required. All sewn seams and overlaps shall be located at a support post.

Posts shall be either wood or steel. Wood posts shall have minimum dimensions of $1^{1}/_{4}$-inches by $1^{1}/_{4}$-inches by the minimum length shown in the Plans. Steel posts shall consist of U, T, L, or C shape posts with a minimum weight of 0.90 lbs/ft, or other steel posts having equivalent strength and bending resistance to the posts listed.

When sediment deposits reach approximately one-third the height of the silt fence, the deposits shall be removed and stabilized in accordance with Section 8-01.3(16).

8-01.3(9)B Gravel Filter, Wood Chip or Compost Berm

The gravel filter berm shall be a minimum of one foot in height and shall be maintained at this height for the entire time they are in use.

The wood chip berm shall be a minimum of two feet in height and shall be maintained at this height for the entire time they are in use. Wood chips shall meet the requirements in Section 9-14.4(3).

The Compost Berm shall be constructed in accordance with the detail in the Standard Plans. Compost shall be Coarse Compost in accordance with Section 9-14.4(8).

8-01.3(9)C Straw Bale Barrier

Straw shall conform to Section 9-14.4(1).

8-01.3(9)D Inlet Protection

Inlet protection can be performed below and above the inlet grate, or as a prefabricated cover. All devices shall be installed prior to clearing, grubbing or earthwork activities and shall be as shown in the Plans.

Geotextile fabric in all prefabricated inlet protection devices shall meet or exceed the requirements of Table 1 for Moderate Survivability, and the minimum filtration properties of Table 2, in Section 9-33.2.

When the depth of accumulated sediment and debris reaches approximately one-half the height of an internal device or one-third the height of the external device (or less when so specified by the manufacturers), the deposits shall be removed and stabilized on site in accordance with Section 8-01.3(16).

Below Inlet Grate

Below Inlet Grate devices shall be prefabricated units specifically designed for inlet protection and shall remain securely attached to the drainage structure when fully loaded with sediment and debris, or at the maximum level of sediment and debris specified by the manufacturer.

Above Inlet Grate

Above Inlet Grate devices may be silt fence, sandbags, or prefabricated units specifically designed for inlet protection.

The device shall remain securely in place around the drainage structure under all conditions.

Inlet Grate Cover

Inlet Grate Cover devices shall be prefabricated units specifically designed for inlet protection and have the following features:

1. Be a sewn geotextile fabric unit fitted to the individual grate and completely enclosing the grate.
2. Have built-in lifting devices to allow manual access of the stormwater system.
3. Utilize an orange monofilament geotextile fabric.

Check dams or functionally equivalent devices may be used as inlet protection devices with the approval of the Engineer.

8-01.3(10) Wattles

Wattles shall be installed as soon as construction will allow or when designated by the Engineer. Trench construction and wattle installation shall begin from the base of the slope and work uphill. Excavated material shall be spread evenly along the uphill slope and compacted using hand tamping or other method approved by the Engineer. On gradually sloped or clay-type soils trenches shall be 2 to 3-inches deep. On loose soils, in high rainfall areas, or on steep slopes, trenches shall be 3 to 5-inches deep, or half the thickness of the wattle.

8-01.3(11) Vacant

8-01.3(12) Compost Sock

The Contractor shall exercise care when installing compost sock to ensure that the method of installation minimizes disturbance of waterways and prevents sediment or pollutant discharge into streambed.

Compost socks shall be laced together end-to-end with coir rope to create a continuous length. Loose ends of the continuous length shall be buried three to five feet laterally into the bank. The upper surface of the compost sock shall be parallel to the slope. Finished grades shall be of a natural appearance with smooth transitions.

The compost sock shall be secured with wood stakes and live stakes of species as indicated in the Plans.

Wood stakes for compost socks shall be installed and driven into place centered on the top of the compost sock and spaced 3-feet on center throughout the length of the compost sock.

Compost socks shall meet the requirements of Section 9-14.5(6).

8-01.3(13) Temporary Curb

Temporary curbs may consist of asphalt, concrete, sand bags, compost socks, wattles, or geotextile/plastic encased berms of soil, sand or gravel, or as approved by the Engineer.

Temporary curbs shall be installed along pavement edges to prevent runoff from flowing onto erodible slopes. The redirected water shall flow to a BMP designed to convey concentrated runoff. The temporary curbs shall be 4-inches in height.

8-01.3(14) Temporary Pipe Slope Drain

Pipe slope drain shall be constructed in accordance with the Plans and shall meet the requirements of Section 9-05.1(6).

Water interceptor dikes or temporary curbs shall be used to direct water into pipe slope drain. The entrance to the drain may consist of a prefabricated funnel device specifically designed for application, rock, sand bags, or as approved by the Engineer.

Pipe shall be securely fastened together and have gasketed watertight fittings, and secured to the slope with metal “T” posts, wood stakes, sand bags, or as approved by the Engineer.

The water shall be discharged to a stabilized conveyance, sediment trap, stormwater pond, rock splash pad, vegetated strip, or as approved by the Engineer.

Placement of drain shall not pond water on road surface.

8-01.3(15) Maintenance

Erosion and sediment control BMP's shall be maintained so they properly perform their function until the Engineer determines they are no longer needed.

The BMP's shall be inspected on the schedule outlined in Section 8-01.3(1)B for damage and sediment deposits. Damage to or undercutting of BMP's shall be repaired immediately.

Unless otherwise specified, when the depth of accumulated sediment and debris reaches approximately one-third the height of the BMP the deposits shall be removed. Debris or contaminated sediment shall be disposed of in accordance with Section 2-03.3(7)C. Clean sediments may be stabilized on site using approved best management practices when the Engineer approves.

Erosion and sediment control BMP's that have been damaged shall be repaired or replaced immediately by the Contractor, in accordance with Section 1-07.13(4).

8-01.3(16) Removal

When the Engineer determines that an erosion control BMP is no longer required, the Contractor shall remove the BMP and all associated hardware from the project limits. When the materials are biodegradable the Engineer may approve leaving the temporary BMP in place.

The Contractor shall permanently stabilize all bare and disturbed soil after removal of erosion and sediment control BMP's. If the installation and use of the erosion control BMP's have compacted or otherwise rendered the soil inhospitable to plant growth, such as construction entrances, the Contractor shall take measures to rehabilitate the soil to facilitate plant growth. This may include, but is not limited to, ripping the soil, incorporating soil amendments, or other horticultural practices.

8-01.4 Measurement

ESC lead will be measured per day for each day that an inspection is made and a report is filed.

Compost blanket, erosion control blanket and plastic covering will be measured by the square yard of surface area covered and accepted.

Check dams will be measured by the linear foot along the ground line of the completed check dam.

Stabilized construction entrance will be measured by the square yard for each entrance constructed.

Tire wash facilities will be measured per each for each wash installed.

Street cleaning will be measured by the hour for the actual time spent cleaning pavement, as authorized by the Engineer. Time to move the equipment to or from the area on which street cleaning is required will not be measured.

Inlet protection will be measured per each for each initial installation at a drainage structure.

Silt fence, gravel filter, compost, and wood chip berms, and will be measured by the linear foot along the ground line of completed barrier.

Straw bale barrier will be measured per each for each bale placed.

Wattle and compost sock will be measured by the linear foot.

Temporary curb will be measured by the linear foot.

Temporary Pipe slope drain will be measured by the linear foot.

Seeding, fertilizing, liming, mulching and mowing will be measured in acres by ground slope measurement or through the use of design data.

Seeding and fertilizing by hand will be measured by the square yard. No adjustment in area size will be made for the vegetation free zone around each plant.

8-01.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"ESC Lead", per day.

"___ Erosion Control Blanket", per square yard.

"Compost Blanket", per square yard.

"Plastic Covering", per square yard.

"Check Dam", per linear foot.

"Stabilized Construction Entrance", per square yard.

"Tire Wash", per each.

The unit contract price per each for tire wash shall include all costs associated with constructing, operating, maintaining, and removing the tire wash.

"Street Cleaning", per hour.

"Inlet Protection", per each.

"Silt Fence", per linear foot.

"Gravel Filter Berm", per linear foot.

"Wood Chip Berm", per linear foot.

"Compost Berm", per linear foot.

"Straw Bale" , per each.

"Wattle", per linear foot.

"Compost Sock", per linear foot.

"Erosion/Water Pollution Control", by force account as provided in Section 1-09.6.

Maintenance and removal of erosion and water pollution control devices including removal and disposal of sediment, stabilization and rehabilitation of soil disturbed by these activities, and any additional work deemed necessary by the Engineer to control erosion and water pollution will be paid by force account in accordance with Section 1-09.6.

To provide a common proposal for all bidders, the Contracting Agency has entered an amount in the proposal to become a part of the Contractor's total bid.

"Temporary Curb", per linear foot.

The unit contract price per linear foot for temporary curb shall include all costs to install, maintain, remove, and dispose the temporary curb.

"Temporary Pipe Slope Drain", per linear foot.

The unit contract per linear foot shall be full pay for all work to complete and remove the installation of the pipe slope drain as shown in the Plans. All materials shall become the property of the Contractor after removal.

"Mulching", per acre
"Mulching with PAM", per acre
"Mulching with BFM", per acre.
"Mulching with MBFM", per acre.
"Temporary Seeding", per acre.
"Seeding, Fertilizing and Mulching", per acre.
"Seeding and Fertilizing", per acre.
"Seeding and Fertilizing by Hand", per square yard.
"Second Application of Fertilizer", per acre.
"Liming", per acre.

8-02 ROADSIDE RESTORATION

8-02.1 Description

This work consists of furnishing and placing topsoil, compost, and soil amendments, and furnishing and planting bare root plants, container plants, balled and burlapped plants, cuttings, fascines, live stakes, live poles, rhizomes, tubers, lawn installation, and soil bioengineering in accordance with these Specifications and as shown in the Plans or as directed by the Engineer.

Trees, whips, shrubs, ground covers, cuttings, live stakes, live poles, rhizomes, tubers, rootstock, and seedlings will hereinafter be referred to collectively as "plants" or "plant material."

8-02.2 Materials

Materials shall meet the requirements of the following sections:

Soil	9-14.1
Fertilizer	9-14.3
Erosion Control Blanket	9-14.5
Plant Materials	9-14.6
Stakes, Guys, and Wrapping	9-14.7
Irrigation Water	9-25.2

Botanical identification and nomenclature of plant materials shall be based on descriptions by Hitchcock and Cronquist in "Flora of the Pacific Northwest". Botanical identification and nomenclature of plant material not found in "Flora" shall be based on Bailey in "Hortus Third" or superseding editions and amendments or as referenced in the Plans.

8-02.3 Construction Requirements

8-02.3(1) Responsibility During Construction

The Contractor shall ensure adequate and proper care of all plant material and work done on this project until all plant establishment periods required by the contract are complete or until physical completion of the project, whichever is last. Existing vegetation shall not be disturbed unless required by the Contract or approved by the Engineer.

Adequate and proper care shall include, but is not limited to, keeping all plant material in a healthy, growing condition by watering, cultivating, pruning, and spraying. Plant material crowns, runners, and branches shall be kept free of mulch at all times. This work shall include keeping the planted areas free from insect infestation, weeds or unwanted vegetation, litter, and other debris along with retaining the finished grades and mulch in a neat uniform condition.

The Contractor shall have sole responsibility for the maintenance and appearance of the roadside restoration.

8-02.3(2) Roadside Work Plan

Before starting any work that disturbs the earth and as described in Sections 8-01, 8-02 and 8-03, the Contractor shall submit a roadside work plan for approval by the Engineer. The roadside work plan shall define the work necessary to provide all contract requirements, including: clearing and grubbing, roadway excavation and embankment, planting area preparation, seeding, planting, plant replacement, irrigation, and weed control in narrative form.

The Roadside Work Plan shall also include the following:

Progress Schedule

In accordance with Section 1-08.3, the Progress Schedule shall include the planned time periods for work necessary to provide all contract requirements covered in Sections 8-01, 8-02, and 8-03. Where appropriate, notes on the schedule shall indicate the calendar dates during which these activities must occur.

Weed Control Plan

The Weed Control Plan shall be submitted and approved prior to starting any work defined in Section 8-02.3(2).

The weed control plan shall show the scheduling of all weed control measures required under the Contract including, hand weeding, rototilling, applications of herbicides, noxious weed control, mowing, and shoulder slope weed control. Target weeds and unwanted vegetation to be removed shall be identified and listed in the weed control plan.

The plan shall be prepared and signed by a licensed Commercial Pest Control Consultant when chemical pesticides are proposed. The plan shall include methods of weed control; dates of weed control operations; and the name, application rate, and Material Safety Data sheets of all proposed herbicides. In addition, the Contractor shall furnish the Engineer with a copy of the current product label for each pesticide and spray adjuvant to be used. These product labels shall be submitted with the weed control plan for approval.

Plant Establishment Plan

The Plant Establishment Plan shall be prepared in accordance with Section 8-02.3(13), submitted and approved prior to initial planting acceptance in accordance with Section 8-02.3(12). The Plan shall show the proposed scheduling of activities, materials, equipment to be utilized for the first year plant establishment, and an emergency contact person. The Plan shall include the management of the irrigation system, when applicable. Should the plan become unworkable at any time during the first year plant establishment, the Contractor shall submit a revised plan prior to proceeding with further work.

Before starting any work described in Sections 8-02 and 8-03, the Contractor shall submit a roadside work plan for approval by the Engineer. The roadside work plan shall define the work necessary to provide all contract requirements, including: planting area preparation, seeding, planting, plant replacement, irrigation, and weed control in narrative form.

8-02.3(2)A Chemical Pesticides

Application of chemical pesticides shall be in accordance with the label recommendations, the Washington State Department of Ecology, local sensitive area ordinances, and Washington State Department of Agriculture laws and regulations. The applicator shall be licensed by the State of Washington as a Commercial Applicator or Commercial Operator with additional endorsements as required by the Special Provisions or the proposed weed control plan. The Contractor shall furnish the Engineer evidence that all operators are licensed with appropriate endorsements, and that the pesticide used is registered for use by the Washington State Department of Agriculture. All chemicals shall be delivered to the job site in the original containers. The licensed applicator or operator shall complete a Commercial Pesticide Application Record (DOT Form 540-509) each day the pesticide is applied, and furnish a copy to the Engineer by the following business day.

The Contractor shall use extreme care to ensure confinement of the chemicals within the areas designated. The use of spray chemical pesticides shall require the use of anti-drift and activating agents, and a spray pattern indicator unless otherwise allowed by the Engineer.

The Contractor shall assume all responsibility for rendering any area unsatisfactory for planting by reason of chemical application. Damage to adjacent areas, either on or off the highway right of way, shall be repaired to the satisfaction of the Engineer or the property owner, and the cost of such repair shall be borne by the Contractor.

8-02.3(2)B Weed Control

Those weeds specified as noxious by the Washington State Department of Agriculture, the local Weed District, or the County Noxious Weed Control Board and other species identified by the Contracting Agency shall be controlled on the project in accordance with the weed control plan.

8-02.3(3) Planting Area Weed Control

All planting areas shall be prepared so that they are weed and debris free at the time of planting and until completion of the project. The planting areas shall include the entire ground surface, regardless of cover, all planting beds, areas around plants, and those areas shown in the Plans.

All applications of post-emergent herbicides shall be made while green and growing tissue is present. Should unwanted vegetation reach the seed stage, in violation of these Specifications, the Contractor shall physically remove and bag the seed heads. All physically removed vegetation and seed heads shall be disposed of off site at no cost to the Contracting Agency.

8-02.3(4) Topsoil

Topsoil shall be evenly spread over the specified areas to the depth shown in the Plans or as otherwise ordered by the Engineer. The soil shall be cultivated to a depth of 1-foot or as specified in the Special Provisions or the Plans. After the topsoil has been spread, all large clods, hard lumps, and rocks 3-inches in diameter and larger, and litter shall be raked up, removed, and disposed of by the Contractor.

Topsoil shall not be placed when the ground or topsoil is frozen, excessively wet, or in the opinion of the Engineer, in a condition detrimental to the work.

8-02.3(4)A Topsoil Type A

Topsoil Type A shall be as specified in the Special Provisions.

8-02.3(4)B Topsoil Type B

Topsoil Type B shall be native topsoil taken from within the project limits and shall meet the requirements of Section 9-14.1(2).

Topsoil Type B shall be taken from areas designated by the Engineer to the designated depth and stockpiled at locations that will not interfere with the construction of the project, as approved by the Engineer. Areas beyond the slope stakes shall be disturbed as little as possible in the above operations.

When topsoil Type B is specified, it shall be the Contractor's responsibility to perform the excavation operations in such a manner that sufficient material is set aside to satisfy the needs of the project.

Upon physical completion of the work, topsoil Type B remaining and not required for use on the project shall be disposed of by the Contractor at no expense to the Contracting Agency in accordance with Section 2-03.3(7)C.

Should a shortage of topsoil Type B occur, and the Contractor has wasted or otherwise disposed of topsoil material, the Contractor shall furnish topsoil Type C at no expense to the Contracting Agency.

Topsoil Type B will not be considered as selected material, as defined in Section 2- 03.3(10), and the conditions of said section shall not apply.

Materials taken from roadway excavation, borrow, stripping, or other excavation items, and utilized for topsoil, will not be deducted from the pay quantities for the respective items.

8-02.3(4)C Topsoil Type C

Topsoil Type C shall be native topsoil obtained from a source provided by the Contractor outside of the Contracting Agency-owned right of way. Topsoil Type C shall meet the requirements of Section 8-02.3(4)B and Section 9-14.1(2).

8-02.3(5) Planting Area Preparation

The work involved in preparing planting areas shall be conducted so the flow lines in drainage channels are maintained. Material displaced by the Contractor's operations, which interferes with drainage, shall be removed from the channel and disposed of as approved by the Engineer.

Before planting and final grading takes place, the area shall be cultivated when specified in the Plans or the Special Provisions.

The areas shall be brought to a uniform finished grade, 1-inch, or the specified depth of mulch plus 1-inch, below walks, curbs, junction and valve boxes, catch basins, and driveways, unless otherwise specified. All excess material and debris, stumps, and rocks larger than 3-inches, shall be removed and disposed of off the project site or as approved by the Engineer.

8-02.3(6) Soil Amendments

Soil amendments of the type, quality, and quantities specified shall be applied where shown in the Plans or as specified in the Special Provisions.

8-02.3(7) Layout of Planting

All location layout and staking shall be the responsibility of the Contractor, subject to approval of the Engineer before planting of each area begins.

The Engineer will make only the field measurements necessary to calculate and verify quantities for payment.

All trees to be planted in mowable grass areas shall be located a minimum of 10-feet from the edge of planting beds, other trees, fence lines, and bottom of ditches unless otherwise specified.

Tree locations shown in the Plans shall be considered approximate unless shown with stationing and offset distance. In irrigated areas, trees shall be located so their trunk is a minimum of $^1/_3$ of the spray radius away from the nearest sprinkler head.

Unless otherwise shown, planting beds located adjacent to roadways shall begin at the shoulder subgrade.

8-02.3(8) Planting

No plant material shall be planted until it has been inspected and approved for planting by the Engineer. Rejected material shall be removed from the project site immediately. All plants for the project or a sufficient quantity to plant one acre of the site, whichever is less, shall be received on site prior to the Engineer beginning inspection of the plants.

Under no circumstances will planting during freezing weather or in frozen ground be permitted. All planting shall be accomplished during the following periods:

1. Nonirrigated Plant Material
   October 1 to March 1.
2. Irrigated Plant Material

In irrigated areas, plant material shall not be installed until the irrigation system is fully operational.

Plants shall not be placed in areas that are below the finished grade.

Planting hole sizes for plant material shall be in accordance with the details shown in the Plans. Any glazed surface of the planting hole shall be removed by hand methods.

Plant material supplied in containers shall not be removed from the containers until the time of planting at the planting location. Roots of bare root stock shall not be bunched, curled, twisted, or unreasonably bent when placed in the planting hole. All bare root plant material shall be dormant at the time of planting.

After placing balled and burlapped plants, all inorganic, plastic, or treated burlap and all string or wire lacing shall be completely removed. A burlap-lined wire basket container may be used in lieu of laced burlap. The top $^1/_2$ of the basket shall be removed after the plant is positioned in the planting hole.

The plant material shall be handled in such a manner that the root systems are kept covered and damp at all times. The root systems of all bare root plant material shall be dipped in a slurry of silt and water immediately prior to planting. The root systems of container plant material shall be moist at the time of planting. In their final position, the plants shall have the same relationship to the finished grade as when growing in the nursery or container. After planting, the backfill material and root ball shall be thoroughly watered in within 24 hours.

8-02.3(9) Pruning, Staking, Guying, and Wrapping

Plants shall be pruned at the time of planting, if needed, to remove minor broken or damaged twigs, branches or roots. Pruning shall be done with a sharp tool and shall be done in such a manner as to retain or to encourage natural growth characteristics of the plants.

Trees shall only be staked when so noted in the Plans. Each tree shall be staked or guyed before completion of the backfilling in accordance with the details shown in the Plans.

All staking and guying shall be completely removed at the end of the first year of plant establishment, unless otherwise approved by the Engineer.

8-02.3(10) Fertilizers

Fertilizers shall be applied in the form specified in the Special Provisions. Application procedures shall be in accordance with the manufacturer's recommendations or as specified in the Special Provisions. The Contractor shall submit for approval a guaranteed fertilizer analysis label for the selected product.

8-02.3(11) Bark or Wood Chip Mulch

Bark or wood chip mulch of the type and depth specified shall be applied where shown in the Plans or as specified in the Special Provisions. Any contamination of the mulch due to the Contractor's operations shall be corrected to its former condition at the Contractor's expense. Mulch shall be feathered to the base of the plant and 1-inch below the top of junction and valve boxes, curbs, and pavement edges. All plant crowns shall be free of mulch. Mulch placed to a thickness greater than specified shall be at no additional cost to the Contracting Agency.

8-02.3(12) Completion of Initial Planting

Upon completion of the initial planting within a designated area, the Engineer will make an inspection of all plant material and notify the Contractor, in writing, of any replacements or corrective action necessary to meet the Contract Provisions. The Contractor shall replace all materials rejected or missing and correct unsatisfactory conditions.

Completion of the initial planting within a designated area includes the following:

1. 100 percent of each of the plant material categories shall be installed as shown in the Contract Plans. A minimum of 95% shall be in a healthy and vigorous growing condition, as described in Section 8-02, on May 31st.
2. Planting Area cleanup.
3. Repairs completed for the entire project, including but not limited to full operation of the irrigation system, complete mulch coverage, and all weeds controlled.
4. Approval of plant establishment plan.

8-02.3(13) Plant Establishment

Plant establishment shall consist of caring for all plants planted on the project and caring for the planting areas within the project limits. The provisions of Section 1-07.13(2) and 1-07.13(3) do not apply to this section.

The Contractor shall submit a first year plant establishment plan, for approval by the Engineer. The first year of plant establishment shall begin immediately upon written notification from the Engineer of the completion of initial planting for the project. The first year plant establishment period shall be a minimum of one calendar year.

During the first year plant establishment period, it shall be the Contractor's responsibility to perform all work necessary to ensure the resumption and continued growth of the transplanted material. This care shall include, but not be limited to, labor and materials necessary for removal of foreign, dead, or rejected plant material, maintaining a weed-free condition, and the replacement of all unsatisfactory plant material planted under the contract. If plants are stolen or damaged by the acts of others, the Contracting Agency will pay invoice cost only for the replacement plants with no mark-up and the Contractor will be responsible for the labor to install the replacement plants.

The Contractor shall meet with the Engineer for the purpose of joint inspection of the planting material on the closest working day to the first day of the month. The Contractor shall correct all conditions unsatisfactory to the Engineer within a 10-day period immediately following the inspection. Failure to comply with corrective steps as outlined by the Engineer shall constitute justification for the Contracting Agency to take corrective steps and to deduct all costs thereof from any monies due the Contractor. At the end of the plant establishment period, plants that do not show normal growth shall be replaced.

All automatic irrigation systems shall be operated fully automatic during the plant establishment period and until final acceptance of the contract. Payment for water used to water in plants, or hand watering of plant material or lawn areas unless otherwise specified, is the responsibility of the contractor during the first year plant establishment period.

Subsequent year plant establishment periods, when included in the contract, shall begin immediately at the completion of the preceding year's plant establishment period. Each subsequent year plant establishment period shall be one full calendar year in duration.

During the ____ year plant establishment periods, whichever may apply, the Contractor shall maintain all plant establishment areas in a condition that is free of unwanted vegetation. Weeds and unwanted vegetation shall not be allowed to reach seed stage. The Contractor shall perform all other work necessary to the continued healthy and vigorous growth of all plant material as ordered by the Engineer. The Contractor shall perform this work on a force account basis at the direction of the Engineer.

8-02.3(14) Plant Replacement

The Contractor shall be responsible for growing or providing enough plants for replacement of all plant material rejected through first year plant establishment. All rejected plant material shall be replaced at dates approved by the Engineer.

All replacement plants shall be of the same species and quality as the plants they replace. Plants may vary in size reflecting one season of growth should the Contractor elect to hold plant material under nursery conditions for an additional year to serve as replacement plants.

8-02.3(15) Live Fascines

Live fascines are constructed of live and dead cuttings bundled together with a minimum diameter of 8-inches. Live cuttings shall be as shown in the Plans. Dead branches may be cuttings from any woody, non-invasive plant, native to the project area. Dead branches may be placed on the inside of the live fascine and on the side exposed to the surface. Live branches shall be placed in contact with the soil along their entire length. Each live fascine must contain a minimum of 8 live branches. Dead branches shall constitute no more than 40% of the total fascine content.

The total length of each live fascine shall be a minimum of 5-feet. Branches shall be bound with biodegradable twine spaced at 1-foot intervals along the entire length of the live fascine. Twine shall meet the requirements of Section 9-33.1 Table 3. Live fascines shall be installed in a trench whose depth shall be one-half the diameter of the live fascine. Secure the live fascine with live stakes 3-feet in length and ¾-inch in diameter placed at 18 -inch intervals. A minimum of 3 live stakes shall be used per fascine. Live stakes shall be driven through the live fascine vertically into the slope. The ends of live fascines shall be woven together so that no gap remains between the two sections of the live fascine.

8-02.3(16) Lawn Installation

8-02.3(16)A Lawn Installation

In irrigated areas, lawn installation shall not begin until the irrigation system is fully operational.

Seed mix and rate of application shall be as specified in the Special Provisions.

Unless otherwise approved by the Engineer, seeded lawn installation shall be performed during the following time periods at the location shown:

West of the summit of the Cascade Range - March 1 to October 1.

East of the summit of the Cascade Range - April 15 to October 1.

The Contractor shall have the option of sodding in lieu of seeding for lawn installation at no additional expense to the Contracting Agency. Seeding in lieu of sodding will not be allowed.

Topsoil for seeded or sodded lawns shall be placed at the depth and locations shown in the Plans. The topsoil shall be cultivated to the specified depth, raked to a smooth even grade without low areas to trap water and compacted, all as approved by the Engineer.

Sod strips shall be placed within 48 hours of being cut. Placement shall be without voids and have the end joints staggered. The sod shall be rolled with a smooth roller following placement.

Barriers shall be erected, with warning signs where necessary, to preclude pedestrian traffic access to the newly placed lawn during the establishment period.

8-02.3(16)B Lawn Establishment

Lawn establishment shall consist of caring for all new lawn areas within the limits of the project.

The lawn establishment period shall begin immediately after the lawn planting has been accepted by the Engineer and shall extend to the end of four mowings or 20 working days which ever is longer. The mowings shall be done in accordance with 8-02.3(16)C.

During the lawn establishment period, it shall be the Contractor's responsibility to ensure the continuing healthy growth of the turf. This care shall include labor and materials necessary to keep the project in a presentable condition, including but not limited to, removal of litter, mowing, trimming, removal of grass clippings, edging, fertilization, insecticide and fungicide applications, weed control, watering, repairing the irrigation system, and repair and reseeding any and all damaged areas. Lawn mowing shall be performed once each week, or as ordered by the Engineer, during the lawn establishment period with no additional compensation.

Temporary barriers shall be removed only on written permission from the Engineer.

All work performed under lawn establishment shall comply with established turf management practices.

Acceptance of lawn planting as specified shall be based on a uniform stand of grass and a uniform grade at the time of final inspection. Areas that are bare or have a poor stand of grass, and areas not having a uniform grade through any cause before final inspection, shall be recultivated, regraded, reseeded, or resodded and refertilized as specified at no additional cost to the Contracting Agency.

8-02.3(16)C Lawn Mowing

Lawn mowing shall begin immediately after the lawn establishment period has been accepted by the Engineer and shall extend to the end of the contract or the first year plant establishment, whichever is last.

The Contractor shall accomplish the following minimum requirements:

1. Mowing, trimming, and edging shall be done as often as conditions dictate. Maximum height of lawn shall not exceed 3-inches. The cutting height shall be 2-inches. Cuttings, trimmings, and edgings shall be disposed of off the project site. When the Engineer approves the use of a mulching mower, trimmings may be left in place.
2. Watering shall be as often as conditions dictate depending on weather and soil conditions.
3. Provide fertilizer, weed control, and other measures as necessary to maintain a healthy stand of grass.

8-02.4 Measurement

Topsoil, mulch and soil amendments will be measured by the cubic yard in the haul conveyance at the point of delivery.

Brush layer will be measured by the linear foot.

Live pole will be measured per each.

Live stake row will be measured by the linear foot

Fascine will be measured by the linear foot

Live brush mattress will be measured by the surface square yard.

Compost will be measured by the cubic yard in the haul conveyance at the point of delivery.

The quantity of topsoil Type B used on the project will not be deducted from the total quantity of roadway excavation, borrow, strippings, or other excavation for which haul is being paid.

The pay quantities for plant materials will be determined by count of the number of satisfactory plants in each category accepted by the Engineer.

Weed barrier mat will be measured per each

Fertilizer will be measured in pounds

Water will be measured in accordance with Section 2-07.4. Measurement will be made of only that water hauled in tank trucks or similar equipment.

Seeded lawn, sod installations, and lawn mowing will be measured along the ground slope and computed in square yards of actual lawn completed, established, and accepted.

8-02.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following listed bid items that are included in the proposal:

"Topsoil Type ____", per cubic yard.

The unit contract price per cubic yard for "Topsoil Type ____" shall be full pay for providing the source of material for topsoil Type A and C, for pre-excavation weed control, excavating, loading, hauling, intermediate windrowing, stockpiling, weed control on stockpiles or windrows, and removal, placing, spreading, processing, cultivating, and compacting topsoil Type A, Type B, and Type C.

"Plant Selection ___", per each.

"PSIPE ___", per each. (PSIPE is Plant Selection Including Plant Establishment.)

The unit contract price for "Plant Selection ___", per each, and "PSIPE ___", per each, shall be full pay for all materials, labor, tools, equipment, and supplies necessary for weed control within the planting area, planting area preparation, fine grading, planting, cultivating, and cleanup for the particular items called for in the Plans.

As the plants that include plant establishment are obtained, propagated, and grown, partial payments shall be made as follows after inspection by the Engineer:

Payment of 5 percent of the unit contract price, per each, when the plant materials have been contracted, propagated, and are growing under nursery conditions. The Contractor shall provide the Engineer with certification that the plant material has been procured or contracted for delivery to the project for planting within the time limits of the project. The certification shall state the location, quantity, and size of all material.

Payment shall be increased to 15 percent of the unit contract price, per each, upon completion of the initial weed control work.

Payment shall be increased to 60 percent of the unit contract price per each for the contracted plant material in a designated unit area when planted.

Payment shall be increased to 70 percent of the unit contract price per each for contracted plant material at the completion of the initial planting.

Payment shall be increased to the appropriate percentage upon accomplishment of the following phases of plant establishment.

3 months after completion of initial planting	80%
6 months after completion of initial planting	90%
Completion of 1st year plant establishment	100%

As the plants that do not include plant establishment are obtained, propagated, and grown, partial payments shall be made as follows:

Payment of 15 percent of the unit contract price per each when the plant materials have been contracted, propagated, and are growing under nursery conditions. The Contractor shall provide the Engineer with certification that the plant material has been procured or contracted for delivery to the project for planting within the time limits of the project. The certification shall state the location, quantity, and size of all material.

Payment shall be increased to 90 percent of the unit contract price per each for contracted plant material at the completion of the initial planting.

Payment shall be increased to 100 percent at the physical completion of the contract.

All partial payments shall be limited to the actual number of healthy vigorous plants that meet the stage requirements, limited to plan quantity. Previous partial payments made for materials rejected or missing will be deducted from future payments due the Contractor.

"Live Pole", per each.

"Live Stake Row", per linear foot.

"Live Brush Mattress", per square yard.

"Plant Establishment - ___ Year", will be paid in accordance with Section 1-09.6.

"Brush Layer", per linear foot.

"Fascines", per linear foot.

"Weed Barrier Mat", per each

The unit contract price per each for "Weed Barrier Mat" shall be full pay to provide and install the weed barrier mat as specified, to maintain the mat in place throughout the plant establishment period, and to remove the mat when ordered by the Engineer.

"Fine Compost ", per cubic yard.

"Coarse Compost", per cubic yard.

The unit contract price per cubic yard for "Fine Compost" or "Coarse Compost" shall be full pay for furnishing and spreading the compost onto the existing soil.

"Fertilizer", per pound.

"Weed Control", when included as a separate bid item, will be paid in accordance with Section 1-09.6.

"Pesticide Application", will be paid in accordance with Section 1-09.6.

For the purpose of providing a common proposal for all bidders, the Contracting Agency entered an amount for "Plant Establishment - ___ Year", "Weed Control", and "Pesticide Application" in the proposal to become a part of the total bid by the Contractor.

"Soil Amendment", per cubic yard.

"Bark or Wood Chip Mulch", per cubic yard.

"Water", per M Gal.

"Seeded Lawn Installation", per square yard.

"Sod Installation", per square yard.

"Lawn Mowing", per square yard.

The unit contract price per square yard for "Seeded Lawn Installation" or "Sod Installation" shall be full pay for all costs necessary for weed control within the seeding or sodding area, to prepare the area, plant or sod the lawn, erect barriers, and establish lawn areas and for furnishing all labor, tools, equipment, and materials necessary to complete the work as specified and shall be paid in the following sequence for healthy, vigorous lawn:

Completion of Lawn Planting	60 percent of individual areas
Mid Lawn Establishment (after 2 mowings)	85 percent of individual areas
Completion of Lawn Establishment (after 4 mowings)	100 percent of individual areas

8-03 IRRIGATION SYSTEMS

8-03.1 Description

This work consists of installing an irrigation system in accordance with these Specifications and the details shown in the Plans or as staked.

The irrigation system has been designed using the products as shown in the Sprinkler Legend/Performance Data table and the irrigation details. If approved by the Engineer, the Contractor may supply different manufacturer products, but only if the products are of equal performance and material quality as shown in the Plans.

8-03.2 Materials

Materials shall meet the requirements of Sections 9-15 and 9-29.

8-03.3 Construction Requirements

Location of pipe, tubing, sprinkler heads, emitters, valves, and other equipment shall be as shown in the Plans and shall be of the size and type indicated. No changes shall be made except as approved by the Engineer.

Potable water supplies shall be protected against cross connections in accordance with applicable Contracting Agency rules and regulations.

Water service connections shall be made by the Contractor as indicated in the Plans and Special Provisions and such installations and equipment shall conform to the requirements set forth by the supplying agency.

Construction of electrical systems shall conform to applicable portions of Sections 8-20 and 9-29.

8-03.3(1) Layout of Irrigation System

The Contractor shall stake the irrigation system following the schematic design shown in the Plans, before the construction begins. Alterations and changes in the layout may be expected in order to conform to ground conditions and to obtain full and adequate coverage of plant material with water; however, no changes in the system as planned shall be made without the prior authorization of the Engineer.

Irrigation Potholing

Existing underground irrigation casing pipe ends shall be located by potholing, as specified by the Engineer.

8-03.3(2) Excavation

Pipe trenches shall be no wider at any point than is necessary to lay the pipe or install equipment. The top 6-inches of topsoil, when such exists, shall be kept separate from subsoil and shall be replaced as the top layer when backfill is made. Trench bottoms shall be relatively smooth and consist of sand or other suitable material free from rocks, stones, or any material that might damage the pipe. Trenches in rock or other material unsuitable for trench bottoms shall be excavated 6-inches below the required depth and shall be backfilled to the required depth with sand or other suitable material free from rocks or stones.

The Contractor shall exercise care when excavating trenches near existing trees to minimize damage to tree roots. Where roots are 2-inches and greater in diameter, except in the direct path of the pipe, the pipe trench shall be hand excavated and tunneled. When large roots are exposed, they shall be wrapped with heavy burlap for protection and to prevent excessive drying. Trenches dug by machines adjacent to trees having roots

2-inches and less in diameter shall have the sides hand trimmed making a clean cut of the roots. Trenches having exposed tree roots shall be backfilled within 24-hours unless adequately protected by moist burlap or canvas as approved by the Engineer.

Detectable marking tape shall be placed in the trench 6-inches directly above, parallel to, and along the entire length of all nonmetallic water pipes and all nonmetallic and aluminum conduits placed under existing or future pavement. The width of the tape shall be as recommended by the manufacturer.

8-03.3(3) Piping

All lines shall be a minimum of 18-inches below finished grade measured from the bottom of the pipe or as shown in the Plans. All live mains to be constructed under existing pavement shall be placed in steel casing jacked under pavement as shown in the plans. All PVC pipe installed under areas to be paved shall be placed in irrigation conduit. Irrigation conduit shall extend a minimum of 1-foot beyond the limits of pavement. All jacking operations shall be performed in accordance with an approved jacking plan. Where possible, mains and laterals or section piping shall be placed in the same trench. All lines shall be placed a minimum of 3-feet from the edge of concrete sidewalks, curbs, guardrail, walls, fences, or traffic barriers.

Mainlines and lateral lines shall be defined as follows:

Mainlines: All supply pipe and fittings between the water meter and the irrigation control valves.

Lateral Lines: All supply pipe and fittings between the irrigation control valves and the connections to the irrigation heads. Swing joints, thick walled poly pipe, flexible risers, rigid pipe risers, and associated fittings are not considered part of the lateral line but incidental components of the irrigation heads.

Pipe pulling will not be allowed for installation and placement of irrigation pipe.

8-03.3(4) Jointing

During construction, pipe ends shall be plugged or capped to prevent entry of dirt, rocks, or other debris.

All galvanized steel pipe shall have sound, clean cut, standard pipe threads well fitted. All pipes shall be reamed to the full diameter and burrs removed before assembly. Threaded galvanized steel joints shall be constructed using either a nonhardening, nonseizing multipurpose sealant or Teflon tape or paste as recommended by the pipe manufacturer. All threaded joints shall be made tight with wrenches without the use of handle extensions. Joints that leak shall be cleaned and remade with new material. Caulking or thread cement to make joints tight will not be permitted.

PVC pipe, couplings, and fittings shall be handled and installed in accordance with the manufacturer's recommendation. The outside of the PVC pipe shall be chamfered to a minimum of $^{1}/_{16}$-inch at approximately 22-degrees. Pipe and fittings shall be joined by solvent welding. Solvents used must penetrate the surface of both pipe and fitting which will result in complete fusion at the joint. Use solvent and cement only as recommended by the pipe manufacturer.

Threaded PVC joints shall be assembled using Teflon tape as recommended by the pipe manufacturer.

On plastic to metal connections, work the metal connection first. Use a nonhardening compound on threaded connections. Connections between metal and plastic are to be threaded utilizing female threaded PVC adapters with threaded schedule 80-PVC nipple only.

Polyethylene pipe and fittings shall be installed in accordance with the manufacturer's recommendations. The ends of the polyethylene pipe shall be cut square and inserted to the full depth of the fitting. Clamps for insert fittings shall be stainless steel.

8-03.3(5) Installation

Galvanized pipe shall be used from the water meter or service connection through the cross connection control device.

Final position of turf heads shall be between 1/2-inch and 1-inch above finished grade measured from the top of the sprinkler. All sprinklers adjacent to walks, curbs, and pavement shall be placed as shown in the Plans.

Shrub heads, unless otherwise specified, shall be placed on risers approximately 12-inches above finished grade.

Final position of valve boxes, capped sleeves, and quick coupler valves shall be between 1/2-inch and 1-inch above finished grade or mulch.

Drip irrigation emitters shall be installed in accordance with the manufacturer's recommendations.

8-03.3(6) Electrical Wire Installation

Wiring between the automatic controller and automatic valves shall be direct burial and may share a common neutral. Separate control conductors shall be run from the automatic controller to each valve. When more than one automatic controller is required, a separate common neutral shall be provided for each controller and the automatic valve which it controls. Wire shall be installed adjacent to or beneath the irrigation pipe. Plastic tape or nylon tie wraps shall be used to bundle wires together at 10-foot intervals, and the wire shall be "snaked" from side to side in the trench. When necessary to run wire separate from the irrigation pipe, the wire shall be bundled and placed under detectable marking tape. When lateral pipelines have less than 18-inches of cover, direct burial wire shall not be adjacent to pipes but shall be placed at a minimum depth of 18-inches.

Wiring placed under pavement and walls, or through walls, shall be placed in irrigation casing. Irrigation casing shall not be less than 1-inch in diameter, Class 200-PVC.

Splices will be permitted only at junction boxes, valve boxes, pole bases, or at control equipment. A minimum of 2-feet of excess conductor shall be left at all splices, terminal and control valves to facilitate inspection and future splicing.

All 120-volt electrical conductors and conduit shall be installed by a certified electrician including all wire splices and wire terminations.

For all 24 volt direct burial circuits, the continuity test, ground test, and functional test shall be performed. The Megger test confirming insulation resistance of not less than 2 megohms to ground in accordance with Section 8-20.3(11) is required.

All wiring shall be tested in accordance with Section 8-20.3(11).

8-03.3(7) Flushing and Testing

All gauges used in the testing of water pressures shall be certified correct by an independent testing laboratory immediately prior to use on the project. Gauges shall be retested when ordered by the Engineer.

Automatic controllers shall be tested by actual operation for a period of two weeks under normal operating conditions. Should adjustments be required, the Contractor shall do so according to the manufacturer's direction and test until operation is satisfactory.

Main Line Flushing

All main supply lines shall receive two fully open flushings, to remove debris that may have entered the line during construction: the first before placement of valves; the second after placement of valves and prior to testing.

Main Line Testing

All main supply lines shall be purged of air and tested with a minimum static water pressure of 150-psi for 60-minutes without introduction of additional service or pumping pressure. Testing shall be done with one pressure gauge installed on the line, where ordered by the Engineer. An additional pressure gauge shall be installed at the pump when ordered by the Engineer. Lines that show loss of pressure exceeding 5-psi at the ends of specified test periods will be rejected.

The Contractor shall correct rejected installations and retest for leaks as specified herein.

Lateral Line Flushing

All lateral lines shall receive one fully open flushing prior to placement of sprinkler heads, emitters, and drain valves. The flushing shall be of sufficient duration to remove any dirt or debris that has entered the lateral lines during construction.

Lateral Line Testing

All lateral lines shall be purged of air and tested in place at operating line pressure with a pressure gauge and with all fittings capped or plugged. The operating line pressure shall be maintained for 30 minutes with valves closed and without introduction of additional pressure. Lines that show leaks or loss of pressure exceeding 5-psi at the end of specified test periods will be rejected.

The Contractor shall correct and retest lateral line installations that have been rejected. Throughout the life of the Contract, the Contractor shall repair, flush, and test, all main and lateral lines that have sustained a break or disruption of service. Upon restoration of the water service, the affected lines shall be brought up to operating pressure. The Contractor shall then conduct a thorough inspection of all sprinkler heads, emitters, etc., located downstream of the break, disruption of service, and repair. This inspection is required to ensure that the entire irrigation system is operating properly.

8-03.3(8) Adjusting System

Before final inspection, the Contractor shall adjust and balance all sprinklers to provide adequate and uniform coverage. Spray patterns shall be balanced by adjusting individual sprinkler heads with the adjustment screws or replacing nozzles to produce a uniform pattern. Unless otherwise specified, sprinkler spray patterns will not be permitted on pavement, walks, or structures.

8-03.3(9) Backfill

Backfill shall not be started until all piping has been inspected, tested, and approved by the Engineer, after which backfilling shall be completed as soon as possible. All backfill material placed within 6-inches of the pipe shall be free of rocks, roots, or other objectionable material that might cut or otherwise damage the pipe. Backfill from the bottom of the trench to approximately 6-inches above the pipe shall be by continuous compacting in a manner that will not damage pipe or wiring and shall proceed evenly on both sides of the pipe. The remainder of the backfill shall be thoroughly compacted, except that heavy equipment shall not be used within 18-inches of any pipe. The top 6-inches of the backfill shall be of topsoil material or the first 6-inches of material removed in the excavation.

8-03.3(10) As Built Plans

Upon physical completion of the work, the Contractor shall submit As Built Plans consisting of corrected shop drawings, schematic circuit diagrams, or other details necessary to show the work as constructed including the actual installed locations of the irrigation system(s) equipment including, but not limited to, water meters, cross connection control devices, electrical services, pipe and wire runs, splice boxes, controllers, valves, heads, and other equipment. These drawings shall be on sheets conforming in size to the provisions of Section 1-05.3. All drawings must be complete and legible.

Any corrections and additions ordered by the Engineer shall be made by the Contractor prior to acceptance. The Contractor shall provide the Engineer with three copies of parts lists, catalog cuts, and service manuals for all equipment installed on the project.

8-03.3(11) System Operation

The irrigation system shall be completely installed, tested, and automatically operable prior to planting in a unit area except where otherwise specified in the Plans or approved by the Engineer. The Contractor shall be fully responsible for all maintenance, repair, testing, inspecting, and automatic operation of the entire system until all work is considered complete as determined by the final inspection specified in Section 1-05.11. The final inspection of the irrigation system will coincide with the end of the contract or first year plant establishment which ever is later.

This responsibility shall include, but not be limited to, draining the system prior to winter and reactivating the system in the spring and at other times as ordered by the Engineer.

For the life of the contract, the Contractor shall be responsible for having annual inspections and tests performed on all cross connection control devices as required and specified by the Washington State Department of Social and Health Services. Inspections and tests shall be conducted at the time of initial activation and each spring prior to reactivating the irrigation system. Potable water shall not flow through the cross-connection control device to any downstream component until tested and approved for use by the serving utility.

In the spring, when the drip irrigation system is in full operation, the Contractor shall make a full inspection of all emitters. This shall involve visual inspection of each emitter under operating conditions. All adjustments, flushings, or replacements to the system shall be made at this time to ensure the proper operation of all emitters.

8-03.3(12) Cross Connection Control Device Installation

Cross connection control devices shall be installed, inspected, and tested by the serving utility or designee in accordance with applicable portions of the Washington Administrative Code (WAC-246-290-490) and other applicable regulations as set forth by the Washington State Department of Social and Health Services and the Washington State Department of Transportation.

During the life of the Contract, these devices shall be inspected and tested annually, or more often if successive inspections indicate repeated failures. Inspections and tests shall be conducted at the time of initial installation, after repairs, and each spring prior to reactivation of the irrigation system. These inspections and tests shall be completed and the results recorded by a licensed Backflow Assembly Device Tester (BADT) Operator or by a Contracting Agency Certified Water Works Operator with a CCS 1 or CCS 2 Classification and shall document that the devices are in good operating condition prior to flushing and testing of any downstream water lines. Devices that are defective shall be repaired or replaced.

Inspection and test results shall be recorded on Department of Transportation Form No. DOT 540-020 and other forms as may be required by the serving utility. The completed forms shall be submitted to the appropriate health authority and to the serving utility when applicable.

8-03.3(13) Irrigation Water Service

The Contracting Agency has arranged for a water meter installation(s) for the irrigation system at no cost to the Contractor at the locations and sizes as shown in the plans. The water meter(s) will be installed by the serving utility. It shall be the Contractor's responsibility to contact the Engineer to schedule the water meter installation performed by the servicing utility. The Contractor shall provide a minimum of 60 calendar days prior notice to the Engineer for the desired date for installation to ensure no service installation delays work.

Construction activities for irrigation water service connections will be in accordance with the serving utility's Service Agreement. A copy of the Service Agreement may be obtained from the Engineer.

8-03.3(14) Irrigation Electrical Service

The Contracting Agency has arranged for electrical service connection(s) for operation of the automatic electrical controller(s) at the locations as shown in the Plans. The Contractor shall splice and run conduit and wire from the electrical service connection(s), or service cabinet, which ever may apply, to the automatic electrical controller and connect the conductors to the circuit(s) as shown in the Plans.

The installation of conduit and wire for the electrical power service shall be in accordance with the serving utility's Service Agreement and these specifications. A copy of the Service Agreement may be obtained from the Engineer.

8-03.4 Measurement

No unit of measure shall apply to the lump sum price for irrigation system.

8-03.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid items when included in the proposal:

"Irrigation System", lump sum.

All costs for furnishing and installing plastic valve boxes, irrigation system equipment and components where indicated and as detailed in the Plans, all costs of initial and annual inspections and tests performed on cross connection control devices and electrical wire testing during the life of the contract and As Built Plans shall be included in the lump sum price for the complete irrigation system as shown in the Plans or as otherwise approved by the Engineer.

The Contracting Agency shall, at no cost to the contractor, provide water and electrical services needed for installation and operation of the irrigation system for the life of the contract.

As the irrigation system is installed, the payment schedule will be as follows:

Payment will be made in proportion to the amount of work performed up to 90 percent of the unit contract price for irrigation system when the irrigation system is completed, tested, inspected, and fully operational.

Payment shall be increased to 95-percent of the unit contract price for irrigation system upon completion and acceptance of initial planting and submittal of As Built Plans.

Payment shall be increased to 100 percent of the unit contract price for irrigation system upon completion and acceptance of the first year plant establishment. When there is no first year plant establishment or when the contract is completed, payment will be increased to 100 percent of the unit contract price for irrigation system upon completion of As Built Plans.

8-04 CURBS, GUTTERS, AND SPILLWAYS

8-04.1 Description

This work consists of the construction of cement concrete curbs, curbs and gutters, gutters, spillways, hot mix asphalt curbs, gutters, spillways, and metal spillways, of the kind and design specified, at the locations shown in the Plans or where designated by the Engineer in accordance with these Specifications and in conformity to the lines and grades as staked.

8-04.2 Materials

Materials shall meet the requirements of the following sections:

Portland Cement	9-01
Aggregates	9-03
Premolded Joint Filler	9-04.1
Drain Pipe	9-05.1
Steel Culvert Pipe and Pipe Arch	9-05.4
Aluminum Culvert Pipe	9-05.5
Structural Steel and Related Materials	9-06
Reinforcing Steel	9-07
Hand Placed Riprap	9-13.2

Hot Mix Asphalt (HMA) curbs, gutters, and spillways shall be constructed of an HMA mix that will have a dense, uniform surface and will fully retain its shape, grade, and line after placement. The mix components shall meet applicable requirements for asphalt concrete specified in Section 5-04 and shall be approved by the Engineer.

8-04.3 Construction Requirements

8-04.3(1) Cement Concrete Curbs, Gutters, and Spillways

Cement concrete curb, curb and gutter, gutter, and spillway shall be constructed with air entrained concrete Class 3000 conforming to the requirement of Section 6-02 except at driveway entrances. Cement concrete curb or curb and gutter along the full width of a driveway entrance shall be constructed with air entrained concrete Class 4000 conforming to the requirements of Section 6-02.

The foundation for curbs, gutters, and spillways shall be thoroughly compacted and required side forms shall rest throughout their length on firm ground. Side forms for straight sections shall be full depth of the curb. They shall be either metal of suitable gage for the work or surfaced “construction” grade lumber not less than 2-inches (commercial) in thickness. Forms used more than one time shall be thoroughly cleaned and any forms that have become worn, splintered, or warped shall not be used again.

The foundation shall be watered thoroughly before the concrete is placed, and the concrete shall be well tamped and spaded or vibrated in the forms. The exposed surfaces shall be finished full width with a trowel and edger. Within 24 hours after the concrete is placed, the forms of the roadway face of curbs shall be removed, and the concrete treated with a float finish. The top and face of the curb shall receive a light brush finish, and the top of the gutter shall receive a broom finish.

Expansion joints in the curb or curb and gutter shall be spaced at 15-foot intervals, the beginning and ends of curb returns, drainage structures, bridges, and cold joints with existing curbs and gutters. The expansion joint shall be filled to full cross-section with $^3/_8$-inch premolded joint filler. When curb or curb and gutter is placed adjacent to Portland Cement Concrete Pavement, a $^1/_4$-inch thick, 6-inch deep premolded joint filler shall be installed between the two vertical surfaces to prevent cracking. When noted in the Plans, the Contractor shall install the catch basin gutter pan at drainage structures abutting the curb and gutter.

The concrete shall be cured for 72-hours by one of the methods specified for cement concrete pavement in Section 5-05.

At the option of the Contractor, the curb and gutter may be constructed using approved slip-form equipment. The curb and gutter shall be constructed to the same requirements as the cast-in-place curb and gutter.

A water-reducing admixture conforming to the requirements of Section 9-26 may be used provided the finished curb and gutter shall retain its line and shape.

8-04.3(1)A Extruded Cement Concrete Curb

Extruded cement concrete curb shall be placed, shaped, and compacted true to line and grade with an approved extrusion machine. The extrusion machine shall be capable of shaping and thoroughly compacting the concrete to the required cross section.

The pavement shall be dry and cleaned of loose and deleterious material prior to curb placement. Cement concrete curbs shall be anchored to the existing pavement by placing steel tie bars 1-foot on each side of every joint.

Tie bars shall meet the dimensions shown in the Standard Plans.

Joints in the curb shall be spaced at 10-foot intervals. Joints shall be cut vertically and to the depth shown in the Standard Plans.

All other requirements for cement curb and cement concrete curb and gutter shall apply to extruded cement concrete curb.

The Contractor may substitute extruded cement concrete curb for extruded HMA concrete curb upon receiving written permission from the Engineer. There will be no change in unit contract price if this substitution is allowed.

8-04.3(2) Extruded Asphalt Concrete Curbs, and Gutters

Asphalt concrete curbs, gutters, and spillways shall be constructed of Commercial HMA as specified in Section 5-04. The HMA will have a dense, uniform surface and will fully retain it's shape, grade, and line after placement.

Set forms will not be required for forming gutter if slip-form equipment of a type approved by the Engineer is used. Gutter shall be shaped and compacted to the required line, grade, and cross section. Connections to any type of outlet shall be constructed so as to form a watertight joint.

8-04.3(3) Vacant

8-04.3(4) Metal Spillways

Round metal spillways shall be plain metal drain pipe 8-inch diameter and when specified in the contract, the joints shall be sealed with rubber gaskets conforming to the requirements of Section 9-04.4(4). Half round metal spillways shall be half round metal culvert pipe of the size, kind, and thickness shown in the Plans.

In the construction of metal spillways, sufficient bands, elbows, and joints shall be furnished and placed by the Contractor to permit the construction and connection of the spillways as indicated in the Plans so as to carry the drainage from gutters to the inlets and spillways without percolation of the water under and around the structure.

Spillway pipe shall be laid in a trench in the embankment slope and shall not be placed until after the embankment slopes have been completed and dressed to the lines prescribed by the Engineer. The lower end of the pipe spillway shall be adequately protected and supported by hand placed riprap, concrete, or by other means as may be shown in the Plans. After the spillway pipe has been placed and connected, the trench shall be backfilled, thoroughly compacted, and the embankment slopes restored to their original condition.

8-04.3(5) Spillways at Bridge Ends

Where spillways are required to be constructed at bridge ends, they shall be constructed in the embankment slopes as described above and arranged so that they will connect to the bridge drains. The pipe shall be plain metal drain pipe 8-inch diameter and the joints shall be sealed with rubber gaskets conforming to the requirements of Section 9-04.4(4).

8-04.4 Measurement

All curbs, gutters, and spillways will be measured by the linear foot along the line and slope of the completed curbs, gutters, or spillways, including bends. Measurement of cement concrete curb and cement concrete curb and gutter, when constructed across driveways, will include the width of the driveway.

Except for metal spillways, excavation for these structures shall be incidental to the items involved. Structure excavation required for the installation of metal spillways will be measured in accordance with the provisions of Section 2-09.

Hand placed riprap will be measured in accordance with Section 8-15.4.

8-04.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Cement Conc. Traffic Curb and Gutter", per linear foot.

"Cement Conc. Traffic Curb", per linear foot.

"Mountable Cement Conc. Traffic Curb", per linear foot.

"Dual-Faced Cement Conc. Traffic Curb and Gutter", per linear foot.

"Dual-Faced Cement Conc. Traffic Curb", per linear foot.

"Cement Conc. Pedestrian Curb", per linear foot.

"Roundabout Truck Apron Inner Cement Conc. Curb", per linear foot.

"Roundabout Truck Apron Outer Cem. Conc. Curb and Gutter", per linear foot.

"Extruded Curb", per linear foot.

"Cement Conc. Gutter", per linear foot.

"Cement Conc. Spillway", per linear foot.

"Asphalt Conc. Gutter", per linear foot.

"Asphalt Conc. Spillway", per linear foot.

"Drain Pipe ___ In. Diam.", per linear foot.

"Half Round Plain St. Culv. Pipe ___ In. Th. ___ In. Diam.", per linear foot.
"Half Round Tr. 1 St. Culv. Pipe ___ In. Th. ___ In. Diam.", per linear foot.
"Half Round Plain Al. Culv. Pipe ___ In. Th. ___ In. Diam.", per linear foot.
"Half Round Tr. 1 Al. Culv. Pipe ___ In. Th. ___ In. Diam.", per linear foot.
"Hand Placed Riprap", per cubic yard.

Hand placed riprap will be paid for as provided in Section 8-15.5.

When catch basin gutter pans are required in the Plans, all costs for providing the widened area of gutter pan shall be included in the curb and gutter bid item.

8-05 VACANT

8-06 CEMENT CONCRETE DRIVEWAY ENTRANCES

8-06.1 Description

This work shall consist of constructing the types of cement concrete driveway entrances shown in the Plans and in accordance with these Specifications and the Standard Plans. The widths of the entrances shall be as noted in the Plans. When no width is noted in the Plans, the entrance shall be constructed to the minimum dimensions shown in the Standard Plans.

8-06.2 Materials

Materials shall meet the requirements of the following sections:

Portland Cement	9-01
Aggregates	9-03
Premolded Joint Filler	9-04.1

Cement concrete driveway approaches shall be constructed with air entrained concrete Class 4000 conforming to the requirements of Section 6-02 or Portland Cement Concrete Pavement conforming to the requirements of Section 5-05.

8-06.3 Construction Requirements

Driveway entrance concrete may be placed, compacted, and finished using hand methods. The tools required for these operations shall be approved by the Engineer. After troweling and before edging, the surface of the driveway entrance shall be brushed in a transverse direction with a stiff bristled broom. Curing of the concrete shall be in accordance with Section 5-05.3(13). The driveway entrances may be opened to traffic in accordance with Section 5-05.3(17).

When noted in the Plans, the Contractor shall construct the driveway entrance in two or more segments to permit access to an existing driveway. At these locations, the Contactor shall provide a well-graded and drained temporary approach suitable for vehicular traffic from the abutting roadway to the existing driveway and a firm surface for pedestrians crossing the approach. When the concrete in this segment of the entrance has reached the desired compressive strength, the Contractor shall route traffic over it, remove the temporary approach, and construct the remaining driveway entrance segment or segments. The joints between segments shall be filled to full cross-section with $^{3}/_{8}$-inch premolded joint filler.

8-06.4 Measurement

Cement concrete driveway entrances will be measured by the square yard of finished surface.

8-06.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when it is included in the proposal:

"Cement Conc. Driveway Entrance Type ___", per square yard.

All costs in constructing the driveway entrance in segments and installing and removing the temporary approach shall be included.

8-07 PRECAST TRAFFIC CURB AND BLOCK TRAFFIC CURB

8-07.1 Description

This work consists of furnishing and installing precast traffic curb, block traffic curb, sloped mountable curb, or dual faced sloped mountable curb of the design and type specified in the plans in accordance with these Specifications and in conformity to the Standard Plans and the locations indicated in the plans or as ordered by the Engineer by the Engineer in accordance with Section 1-04.4.

8-07.2 Materials

Materials shall meet the requirements of the following sections:

Paint Formulas General	9-08.2
Precast Traffic Curb	9-18.1
Block Traffic Curb	9-18.3
Water Repellent Compound	9-18.4
Sodium Metasilicate	9-18.5

8-07.3 Construction Requirements

8-07.3(1) Installing Curbs

The curb shall be firmly bedded for its entire length and breadth on a mortar bed composed of one part Portland cement and two parts of concrete sand. The anchor grooves in the bottom of the curb shall be entirely filled with the mortar.

Before the cement mortar bed is laid, all dirt shall be cleaned from the pavement surface by washing.

All old pavements and any portion of new pavements constructed under this contract, which are covered with oil or grease within the curb limits, shall be further cleaned as follows:

1. The pavement shall be flushed with water.
2. While the pavement is still wet, sodium metasilicate, complying with the requirements as specified elsewhere herein, shall be evenly distributed over the pavement surface at a rate of 1 to 2 pounds per 100 square feet of pavement surface.
3. The sodium metasilicate shall remain on the pavement for at least 15-minutes. Where patches of oil, tar, or grease occur, these areas shall be scrubbed with a brush or broom.
4. The pavement surface shall then be thoroughly rinsed.

All joints between adjacent pieces of curb except joints for expansion and/or drainage as designated by the Engineer shall be filled with mortar composed of one part Portland cement and two parts sand.

The joints between adjacent units of block traffic curb will not require mortaring.

The alignment and the top surface of adjoining sections of curb shall be true and even with a maximum tolerance of $^{1}/_{16}$-inch.

For both types of curb, nosing pieces, connecting dividers, and radial sections, as detailed in the Plans, will be required at the ends of the curb lines, at transitions from Type C traffic curb to Type A traffic curb, and at Type A traffic curb installation with radii less than 10-feet.

For sloped mountable curb installed in curves, the units shall be either curved blocks precast to the radii shown in the plans or tangent blocks sawn to the dimensions shown in the Standard Plans to conform to the specified radii.

8-07.3(2) Painting of Curbs

Concrete curbing shall be painted with two full coats of paint conforming to Section 9-34.2, as shown in the Plans or as designated by the Engineer. The paint can be applied by brush or spray. The second coat shall have glass traffic paint beads sprinkled in the wet paint at the rate of 12-pounds per 100 linear foot of curbing. The beads shall conform to the requirements of Section 9-34.4.

8-07.4 Measurement

Type A precast traffic curb and Type A block traffic curb will be measured by the linear foot along the front face of the curb and return. Type C precast traffic curb and Type C block traffic curb will be measured by the linear foot along the axis of the curb. Type A nosing pieces and dividers will be measured as Type A curb, and Type C nosing pieces will be measured as Type C curb.

Sloped mountable curb will be measured by the linear foot along the front face of the curb. Dual faced sloped mountable curb will be measured by the linear foot of tapered block and nosing block installed. Only one face of dual faced curb will be measured.

8-07.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Type A Precast Traffic Curb", per linear foot.

"Type C Precast Traffic Curb", per linear foot.

"Type A Block Traffic Curb", per linear foot.

"Type C Block Traffic Curb", per linear foot.

"Precast Sloped Mountable Curb", per linear foot.

"Precast Dual Faced Sloped Mountable Curb", per linear foot.

8-08 RUMBLE STRIPS

8-08.1 Description

This work consists of constructing centerline and shoulder rumble strips by grinding hot mix asphalt or cement concrete pavement. The work shall include cleanup and disposal of cuttings and other resultant debris. The Standard Plans show the patterns and construction details for the centerline rumble strip and the four types of shoulder rumble strips.

8-08.2 Vacant

8-08.3 Construction Requirements

The equipment shall have a rotary type cutting head or series of cutting heads capable of grinding one or more recesses in the hot mix asphalt or cement concrete as detailed in the Standard Plans. The difference in the surface texture between the high and low surfaces from the grinding shall not exceed $^1/_8$-inch.

Rumble strips shall not be constructed on bridge decks, bridge approach slabs, or cement concrete surfaces. In areas where monuments, drainage structures, induction loop lead-ins, pavement markings or other features will not allow the rumble strips to be constructed as detailed, the rumble strips shall be eliminated or relocated as approved by the Engineer.

The traveled lanes shall be kept free of cuttings and other construction debris at all times. Immediately upon completion of rumble strip grinding, all cuttings, grinding debris, dust, and other loose materials shall be removed from the rumble strips and shoulder areas. All cuttings and other debris shall be disposed of as designated by the Engineer or shall become the property of the Contractor and be disposed of outside the project limits. Cuttings and other debris shall not be allowed to enter any waterways.

When shown in the Plans, the rumble strips shall be fog sealed in accordance with the requirements of Section 5-04.3(19) following the completion of the shoulder rumble strip. All pavement markings, junction boxes, drainage structures, and similar objects located in the shoulder shall not be fog sealed.

The accumulative error in the longitudinal spacing of the rumble strips and the gaps, when required, shall not exceed plus or minus 5 percent.

8-08.4 Measurement

Centerline and shoulder rumble strips will be measured to the nearest 0.01-mile along the mainline roadway for centerline or each shoulder. No deductions will be made for required gaps shown on the Standard Plans or for the elimination of rumble strips across bridge decks, bridge approach slabs, cement concrete areas, or other areas approved by the Engineer.

Fog sealing, when shown in the Plans, will be measured as asphalt for fog seal in accordance with Section 5-04.4.

8-08.5 Payment

"Shoulder Rumble Strip Type __", per mile.

"Centerline Rumble Strip", per mile

Layout of the rumble strip pattern on the centerline or shoulders for grinding purposes is the responsibility of the Contractor. All costs involved in this work shall be included in the appropriate bid item.

Payment for fog sealing the shoulder, when shown in the Plans, shall be paid as asphalt for fog seal in accordance with Section 5-04.5.

8-09 RAISED PAVEMENT MARKERS

8-09.1 Description

This work shall consist of furnishing and installing pavement markers of the type specified in the Plans, in accordance with these Specifications, and at the locations indicated in the Plans or where designated by the Engineer. The color of pavement markers shall conform to the color of the marking for which they supplement, substitute for, or serve as a positioning guide for.

8-09.2 Materials

Raised pavement marker (RPM) shall meet the requirements of the following sections:

RPM Type 1	9-21.1
RPM Type 2	9-21.2
RPM Type 3	9-21.3
Adhesive	9-02.1, 9-26.2

8-09.3 Construction Requirements

8-09.3(1) Surface Preparation

All sand, dirt, and loose extraneous material shall be swept or blown away from the marker location and the cleaned surface prepared by one of the following procedures:

When deemed necessary by the Engineer all surface dirt within areas to receive markers shall be removed. Large areas of tar, grease, or foreign materials may require sandblasting, steam cleaning, or power brooming to accomplish complete removal.

When markers are placed on new cement concrete pavement, any curing compound shall be removed in accordance with the requirements of this section and Section 5-05.3(13)A.

The pavement shall be surface dry. When applying Epoxy Adhesives in cool weather the pavement surface shall be heated by intense radiant heat (not direct flame) for a sufficient length of time to warm the pavement areas of marker application to a minimum of 70ºF.

Application of markers shall not proceed until final authorization is received from the Engineer.

8-09.3(2) Marker Preparation

Type 2 markers may be warmed prior to setting by heating to a maximum temperature of 120°F for a maximum of 10 minutes.

8-09.3(3) Adhesive Preparation

Epoxy adhesive shall be maintained at a temperature of 60ºF to 85ºF before use and during application.

Component A shall be added to component B just before use and mixed to a smooth uniform blend. The unused mixed adhesive shall be discarded when polmerization has caused stiffening and reduction of workability.

Bituminous pavement marker adhesive shall be indirectly heated in an applicator with continuous agitation or recurring circulation. Adhesive temperature shall not exceed the maximum safe heating temperature stated by the manufacturer. The Contractor shall provide the Engineer with manufacturers written instruction for application temperature and maximum safe heating temperature.

8-09.3(4) Application Procedure

8-09.3(4)A Epoxy Adhesives

The marker shall be affixed to the prepared pavement area with sufficient adhesive so as to squeeze out a small bead of adhesive around the entire periphery of the marker. The required amount of adhesive per marker will normally be in the range of 20 to 40 grams.

The sequence of operations shall be as rapid as possible. Adhesive shall be in place and the marker seated in not more than 30 seconds after the removal of the pavement preheat or warm air blast. The marker shall not have cooled more than one minute before seating.

The length of the pavement preheat or warming shall be adjusted so as to ensure bonding of the marker in not more than 15 minutes. Bonding will be considered satisfactory when adhesive develops a minimum bond strength in tension of not less than 800 grams per square inch or a total tensile strength of 25 pounds

Markers shall be spaced and aligned as shown in the Standard Plans and as specified by the Engineer. A displacement of not more than $^1/_2$-inch left or right of the established guide line will be permitted. The Contractor shall remove and replace at no expense to the Contracting Agency all improperly placed markers.

Markers shall not be placed over longitudinal or transverse joints in the pavement surface.

On roadway sections which are not open to public traffic, the preheating of the markers by dry heating before setting will not be required provided the adhesive develops the required bond strength of 800 grams per square inch in less than three hours. If the roadway section is carrying public traffic during the installation of the markers, the 15 minute set-to-traffic provision will be enforced, and necessary flagging and traffic control will be required.

8-09.3(4)B Asphalt Adhesives

Thermoplastic Type 1 markers shall be installed only with a hot melt bitumen adhesive. At the option of the Contractor, a hot melt bitumen adhesive may be used to cement other types of markers to the pavement in lieu of epoxy adhesive. The bitumen adhesive shall conform to the requirements of Section 9-02.1(8).

Bituminous adhesive shall be applied at temperatures recommended by the manufacturer.

Markers shall be placed immediately after application of the adhesive.

8-09.3(5) Recessed Pavement Marker

The Contractor shall grind the pavement marker recess in accordance with the dimensions shown in the Standard Plans. Markers shall be installed in the recess in accordance with the Standard Plans and the Plans.

8-09.4 Measurement

Measurement of markers will be by units of one hundred for each type of marker furnished and set in place.

8-09.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Raised Pavement Marker Type 1", per hundred.

"Raised Pavement Marker Type 2", per hundred.

"Raised Pavement Marker Type 3-_____ In.", per hundred.

"Recessed Pavement Marker", per hundred.

The unit contract price per hundred for "Raised Pavement Marker Type 1", "Raised Pavement Marker Type 3_____ In.", and "Recessed Pavement Marker" shall be full pay for furnishing and installing the markers in accordance with these Specifications including all cost involved with traffic control except for reimbursement for other traffic control labor, and for flaggers and spotters in accordance with Section 1-10.5.

8-10 GUIDE POSTS

8-10.1 Description

This work shall consist of furnishing and placing flexible guide posts of the type specified in the Plans in accordance with these Specifications and the Standard Plans, at the locations indicated in the Plans or where designated by the Engineer.

8-10.2 Materials

Flexible guide posts and reflective sheeting shall be selected from approved materials listed in the Special Provisions or the Qualified Products List. Flexible guide posts shall be pre-approved in accordance with Section 9-17 prior to use on a project. If a producer lacks access to a regularly conducted State Materials Laboratory test, the producer may submit for consideration, performance data gained from independent testing attested by a registered Engineer. Acceptance of independent data or repetition of selected or total tests, shall be the prerogative of the State Materials Laboratory.

Adhesives for surface mounted guide posts shall meet the requirements of Sections 9-02.1(8) or 9-26.2. Other bonding agents may be approved by the Engineer.

8-10.3 Construction Requirements

Flexible guide posts shall be installed as shown in the Standard Plans or as specified by the Engineer. The posts shall be installed plumb, plus or minus $1^1/_2$ degrees.

Guide posts shall be of such length as to provide a height of 48-inches, plus or minus 3-inches, above the nearest edge of traveled pavement surface. Surface mounted guide posts shall be bonded to the pavement surface. The final guide posts lengths will be determined or verified by the Engineer at the request of the Contractor.

Flexible guide posts shall be installed according to the manufacturer's recommendations. A reasonable time prior to installation, the Contractor shall provide the Engineer with the manufacturer's recommended installation procedures. Only one type of ground mount or guardrail mount flexible guide post shall be used on each project.

If the ground adjacent to the posts is disturbed in any manner, it shall be backfilled to the level of the existing surface and thoroughly compacted. The surface of the ground adjacent to the post shall be replaced with like materials, including bituminous treatment if previously existent.

8-10.4 Measurement

Flexible guide posts will be measured by the unit for each post furnished and installed.

8-10.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when included in the proposal:

"Flexible Guide Post", per each.

8-11 GUARDRAIL

8-11.1 Description

This work consists of constructing, modifying, removing, and resetting guardrail and anchors of the kind and type specified in accordance with the Plans, these Specifications, and the Standard Plans in conformity with the lines and grades as staked.

8-11.2 Materials

Materials shall meet the requirements of the following sections:

Beam Guardrail	9-16.3
Rail Element	9-16.3(1)
Posts and Blocks	9-16.3(2)
Galvanizing	9-16.3(3)
Hardware	9-16.3(4)
Anchors	9-16.3(5)
Weathering Steel Beam Guardrail	9-16.8

8-11.3 Construction Requirements

8-11.3(1) Beam Guardrail

8-11.3(1)A Erection of Posts

The posts shall be set to the true line and grade of the highway and spaced as shown in the Plans. When the Plans require that the ends of a section of guardrail be curved outward or downward, the posts shall be set to accommodate the curve. End treatment shall be in accordance with the appropriate Standard Plans or as shown in the Plans.

The length of post installed shall be as shown in the Standard Plans unless long posts are indicated. The length of posts for beam guardrail Type 1 with long posts shall be as specified in the Plans.

Posts may be placed in dug or drilled holes. Ramming or driving will be permitted only if approved by the Engineer and if no damage to the pavement, shoulders, and adjacent slopes results there from.

In broken rock embankments, the pre-punching of holes will be permitted only prior to final shoulder or median compaction, surfacing, and paving.

The posts shall be protected from traffic at all times by attaching the rail elements or by a method approved by the Engineer.

8-11.3(1)B Vacant

8-11.3(1)C Erection of Rail

All metal work shall be fabricated in the shop. No punching, cutting, or welding shall be done in the field, except that holes necessary when additional posts are required or for special details in exceptional cases may be drilled in the field when approved by the Engineer. The rail shall be erected so that the bolts at expansion joints will be located at the centers of the slotted holes.

Rail plates shall be assembled with the splice joints lapping in the direction of the traffic.

When nested W-beam or thrie beam is specified, two sections of guardrail, one set inside of the other shall be installed. The inside and outside rail elements shall not be staggered.

Galvanized and weathering steel rail plates shall be fastened to the posts with galvanized bolts, washers, and nuts of the size and kind shown in the Plans.

All bolts, except where otherwise required at expansion joints, shall be drawn tight. Bolts through expansion joints shall be drawn up as tight as possible without being tight enough to prevent the rail elements from sliding past one another longitudinally. Bolts shall be sufficiently long to extend at least $^1/_4$-inch beyond the nuts. Except where required for adjustments, bolts shall not extend more than $^1/_2$-inch beyond the nuts.

After complete installation of weathering steel beam guardrail, the Contractor shall wash the rail with clean water under high pressure. If the rail is contaminated by oil or grease, sandblasting shall be used as necessary to clean the rail.

8-11.3(1)D Terminal and Anchor Installation

All excavation and backfilling required for installation of anchors shall be performed in accordance with Section 2-09, except that the costs thereof shall be incidental to and included in the unit contract price for the type of anchor installed.

Bolts shall be tightened to the tension specified. The anchor cable shall be tightened sufficiently to eliminate all slack. When tightening, the anchor cable shall be restrained to prevent twisting of the cable.

When foundation tubes used with the Wood Breakaway Post are driven, they shall be driven prior to installing the wood post.

Type 2 concrete anchors may either be precast or cast-in-place at the option of the Contractor.

Assembly and installation of Beam Guardrail Flared Terminals and Beam Guardrail Non-flared Terminals shall be supervised at all times by a manufacturer's representative, or an installer who has been trained and certified by the manufacturer. A copy of the installer's certification shall be provided to the Engineer prior to installation. Assembly and installation shall be in accordance with the manufacturer's recommendations.

8-11.3(1)E Plans

The Contractor shall submit for approval of the Engineer such additional detailed plans and shop drawings of rail punching, fittings, and assemblies as may be required by the Engineer.

8-11.3(2) Guardrail Construction Exposed to Traffic

Any section of beam guardrail that is removed for modification shall be back in place within five calendar days of the date the guardrail is removed.

The Contractor's operations shall be conducted in such a manner that fixed objects and beam guardrail posts shall be protected from traffic at all times by attachment of the rail elements and all associated hardware or by a method approved by the Engineer.

At the end of each day, guardrail sections having an exposed end toward oncoming traffic shall have a Type G terminal end section bolted securely in place.

8-11.3(3) Access Control Gates

Access control gates shall be placed to line and grade as shown in the Plans or as staked. After the posts have been set, the holes shall be backfilled with suitable material and the material thoroughly tamped.

8-11.3(4) Removing Guard Rail

Removal of the various types of guardrail and anchors shall include removal of the rail, cable elements, hardware, posts, concrete bases, and steel tubes. All holes resulting from the removal of the guardrail posts and anchors shall be backfilled with granular material in layers no more than 6-inches thick and compacted to the satisfaction of the Engineer. The removed guardrail items shall become the property of the Contractor unless stated otherwise in the Special Provisions.

8-11.3(5) Raising Guardrail

Guardrail shall be raised to the height shown in the Plans, measured from the top of the rail to the finished shoulder surface. The material around each post shall be tamped to prevent settlement of the raised rail.

8-11.4 Measurement

Measurement of beam guardrail and beam guardrail Type 1 long posts will be by the linear foot measured along the line of the completed guardrail, including expansion sections, and will also include the end section for F connections.

Measurement of beam guardrail transition sections will be per each for the type of transition section installed. End sections, except for F connections, will be considered part of the transition section and will be included in the measurement of the transition section.

Measurement of beam guardrail _____ terminal and beam guardrail buried terminal Type 1 will be per each for the completed terminal.

Measurement of beam guardrail buried terminal Type 2 will be per linear foot for the completed terminal.

Measurement of beam guardrail placement-25 foot span will be per each for the completed span.

Measurement of beam guardrail anchors of the type specified will be per each for the completed anchor, including the attachment of the anchor to the guardrail.

Access control gates will be measured per each.

Measurement of removal of guardrail will be by the linear foot measured along the line of guardrail removed including transition sections, expansion sections, and terminal sections.

Measurement of removal of guardrail anchors will be per each.

Measurement of raising beam guardrail and removing and resetting beam guardrail will be by the linear foot measured along the line of guardrail actually raised or removed and reset. This will include transition sections, expansion sections, and terminal sections.

8-11.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Beam Guardrail Type ____", per linear foot.

"Beam Guardrail Type 1- ____ Ft. Long Post", per linear foot.

"Weathering St. Beam Guardrail Type ____", per linear foot.

The unit contract price per linear foot for "Beam Guardrail Type ____", "Beam Guardrail Type 1- ____ Ft. Long Post", or "Weathering St. Beam Guardrail Type ____" shall include all CRT posts, additional rail elements when nested rail is required, and connection to concrete masonry structures.

"Beam Guardrail Anchor Type ____", per each.

"Beam Guardrail Transition Section Type ____", per each.

The unit contract price per each for "Beam Guardrail Transition Section Type ____" shall include posts, end sections, and connection to masonry structures.

"Beam Guardrail ____ Terminal", per each.

"Beam Guardrail Buried Terminal Type 1", per each.

"Beam Guardrail Buried Terminal Type 2", per linear foot.

The unit contract price for "Beam Guardrail ___ Terminal", "Beam Guardrail Buried Terminal Type 1" and "Beam Guardrail Buried Terminal Type 2" shall include the posts, rail, end section, and anchor.

"Beam Guardrail Placement - 25' Span", per each.

The unit contract price per each for "Beam Guardrail Placement - 25' Span", shall include all CRT posts, Type 1 guardrail posts and blocks and all nested w-beam rail elements.

"Access Control Gate", per each.

"Removing and Resetting Beam Guardrail", per linear foot.

"Raising Existing Beam Guardrail", per linear foot.

"Removing Guardrail", per linear foot.

"Removing Guardrail Anchor", per each.

8-12 CHAIN LINK FENCE AND WIRE FENCE

8-12.1 Description

This work consists of furnishing and constructing chain link fence and wire fence of the types specified in accordance with the Plans, these Specifications, and the Standard Plans at the locations shown in the Plans and in conformity with the lines as staked.

Chain link fence shall be of diamond woven wire mesh mounted on steel posts.

Wire fence shall be of barbed wire or barbed wire combined with wire mesh fastened to posts. Steel posts and steel braces, or wood posts and wood braces may be used, provided only one type shall be selected for use in any contract.

Gates shall consist of a steel frame or frames covered with chain link or wire mesh.

8-12.2 Materials

Materials shall meet the requirements of the following sections:

Concrete	6-02
Chain Link Fence and Gates	9-16.1
Wire Fence and Gates	9-16.2

8-12.3 Construction Requirements

Clearing of the fence line will be required. Clearing shall consist of the removal and disposal of all trees, brush, logs, upturned stumps, roots of down trees, rubbish, and debris.

For chain link type fences, the clearing width shall be approximately 10-feet. For wire type fences, the clearing width shall be approximately 3-feet. Grubbing will not be required except where short and abrupt changes in the ground contour will necessitate removal of stumps in order to properly grade the fence line. All stumps within the clearing limits shall be removed or close cut.

Grading of the fence line sufficient to prevent short and abrupt breaks in the ground contour that will improve the aesthetic appearance of the top of the fencing when installed shall be required. It is expected that in the performance of this work, machine operations will be required for chain link fencing, and handwork will be required for wire fencing except where sufficient width exists for machine work.

The fence shall be constructed close to and inside the right of way line unless otherwise directed by the Engineer or shown in the Plans. Deviations in alignment to miss obstacles will be permitted only when approved by the Engineer and only when such deviation will not be visible to the traveling public or adjacent property owners.

8-12.3(1) Chain Link Fence and Gates

8-12.3(1)A Posts

Posts shall be placed in a vertical position and, except where otherwise directed by the Engineer, shall be spaced at 10-foot centers. Spacing will be measured parallel to the slope of the ground.

All posts, except line posts for Type 3 fence, shall be set in concrete to the dimensions shown in the Plans. All concrete footings shall be crowned so as to shed water. Line posts on Type 3 fence shall be set in undisturbed earth either by driving or drilling, except as specified. Driving shall be accomplished in such a manner as not to damage the post. Voids around the post shall be backfilled with suitable material and thoroughly tamped.

Concrete footings shall be constructed to embed the line posts on Type 3 fence at grade depressions where the tension on the fence will tend to pull the post from the ground.

Where solid rock is encountered without an overburden of soil, line posts shall be set a minimum depth of 14-inches, and end, corner, gate, brace, and pull posts a minimum of 20-inches into the solid rock. The holes shall have a minimum width 1-inch greater than the largest dimension of the post section to be set. The posts shall be cut before installation to lengths that will give the required length of post above ground, or if the Contractor so elects, an even length of post set at a greater depth into the solid rock may be used.

After the post is set and plumbed, the hole shall be filled with grout consisting of one part Portland cement and three parts clean, well graded sand. The grout shall be thoroughly worked into the hole so as to leave no voids. The grout shall be crowned to carry water from the post.

Where solid rock is covered by an overburden of soil or loose rock, the posts shall be set to the full depth shown in the Plans unless penetration into solid rock reaches the minimum depths specified above, in which case the depth of penetration may be terminated. Concrete footings shall be constructed from the solid rock to the top of the ground. Grouting will be required on the portion of the post in solid rock.

Pullposts shall be spaced at 1,000-foot maximum intervals for Type 1, 3, and 6 fence, and at 500-foot maximum intervals for Type 4 fence.

End, gate, corner, and pull posts shall be braced to the adjacent brace post(s) in the manner shown in the Standard Plans. Changes in line amounting to 2-foot tangent offset or more between posts shall be considered as corners for all types of fence.

Steep slopes or abrupt topography may require changes in various elements of the fence. It will be the responsibility of the Contractor to provide all posts of sufficient length to accommodate the chain link fabric and ornamental tops adapted to receive the top rail.

All posts for chain link fence Types 1 and 6 shall be fitted with an approved top designed to fit securely over the post and carry the top rail. All round posts for chain link fence Types 3 and 4 shall have approved tops fastened securely to the posts. The base of the top fitting for round posts shall carry an apron around the outside of the posts.

8-12.3(1)B Top Rail

Top rails shall pass through the ornamental tops of the line posts, forming a continuous brace from end to end of each stretch of fence. Lengths of tubular top rail shall be joined by sleeve couplings. Top rails shall be securely fastened to terminal posts by pressed steel fittings or other appropriate means.

8-12.3(1)C Tension Wire

One continuous length of tension wire shall be used between pull posts. Sufficient tension shall be applied to avoid excess sag between the posts. Tension wires shall be tied or otherwise fastened to end, gate, corner, or pull posts by methods approved by the Engineer.

8-12.3(1)D Chain Link Fabric

Chain link fabric on Type 1, 3, 4, and 6 fence shall be placed on the face of the post away from the highway, except on horizontal curves where it shall be placed on the side designated by the Engineer.

Chain link fabric on Type 1, 3, 4, and 6 fences shall be placed approximately 1-inch above the ground and on a straight grade between posts by excavating high points of ground. Filling of depressions will be permitted only upon approval of the Engineer.

The fabric shall be stretched taut and securely fastened to the posts. Fastening to end, gate, corner, and pull posts shall be with stretcher bars and fabric bands spaced at intervals of 15-inches or less or by weaving the fabric into the fastening loops of roll formed posts. Fastening to line posts shall be with tie wire, metal bands, or other approved method attached at 14-inch intervals. The top and bottom edge of the fabric shall be fastened with the wires spaced at 24-inch intervals to the top rail, or top and bottom tension wires as may be applicable.

Rolls of wire fabric shall be joined by weaving a single strand into the ends of the rolls to form a continuous mesh.

8-12.3(1)E Chain Link Gates

Chain link fabric shall be fastened to the end bars of the gate frame by stretcher bars and fabric bands and to the top and bottom bars of the gate frames by tie wires in the same manner as specified for the chain link fence fabric, or by other standard methods if approved by the Engineer.

Welded connections on gate frames where the galvanized coating has been burned shall be thoroughly cleaned by wire brushing and all traces of the welding flux and loose or cracked galvanizing removed. The clean areas shall then be painted with two coats of galvanizing repair paint, Formula A-9-73.

The drop bar locking device for the wire gates shall be provided with a 12-inch round by 18-inch deep footing of commercial concrete, crowned at the top and provided with a hole to receive the locking bar. The depth of the penetration of the locking bar into the footing shall be as specified by the manufacturer of the locking device.

8-12.3(2) Wire Fence and Gates

8-12.3(2)A Posts

Line posts shall be spaced at intervals not to exceed 14-feet. All intervals shall be measured center to center of posts. In general, in determining the spacing of posts, measurements will be made parallel to the slope of the existing ground, and all posts shall be placed in a vertical position except where otherwise directed by the Engineer.

Line posts may be driven in place provided the method of driving does not damage the post. Steel corner, gate, and pull posts shall be set in commercial concrete footings to the dimensions shown in the Plans and crowned at the top to shed water.

Concrete footings shall be constructed to embed the lower part of steel line posts, and wood anchors shall be placed on wood posts at grade depressions wherever the tension on the line wires will tend to pull the post from the ground. The concrete footings shall be 3-feet deep by 12-inches in diameter and crowned at the top.

Where solid rock is encountered without an overburden of soil, line posts shall be set a minimum depth of 14-inches and end, corner, gate, and pull posts a minimum depth of 20-inches into the solid rock. The hole shall have a minimum dimension 1-inch greater than the largest dimension of the post section to be set. The posts shall be cut before

installation to lengths that will give $4^1/_2$-feet of post above ground, or if the Contractor so elects, 6-foot posts set 18-inches into the solid rock may be used.

After the post is set and plumbed, the hole shall be filled with grout consisting of one part Portland cement and three parts clean, well graded sand. The grout shall be thoroughly worked into the hole so as to leave no voids. The grout shall be crowned to carry water away from the post. Where posts are set in the above manner, anchor plates and concrete footings will not be required.

Where solid rock is covered by an overburden of soil or loose rock, the posts shall be set to the full depth of $2^1/_2$-feet unless the penetration into solid rock reaches the minimum depths specified above, in which case the depth of penetration may be terminated. When the depth of the overburden is greater than 12-inches, anchor plates will be required on the steel line posts, and concrete footings shall be constructed from the solid rock to the top of the ground on steel end, gate, corner, and pull posts. When the depth of overburden is 12-inches or less, anchor plates and concrete footings will not be required. Grouting will be required on the portion of the post in solid rock.

Steel braces shall be anchored to soil or loose rock with a commercial concrete footing not less than 18-inches on any one side and set in solid rock to a minimum depth of 10-inches in the same manner as specified above for posts. The braces shall be set on the diagonal as shown in the Plans and connected to the post with an approved connection.

Wood braces shall be dapped $^1/_4$-inch into the posts and shall be fastened to each post with three 20d galvanized nails.

Wire braces shall consist of a 9-gage wire passed around the wood posts to form a double wire. The wire shall be fastened to each post with two staples and fastened together to form a continuous wire. The wires shall then be twisted together until the wire is in tension.

Where the new fence joins an existing fence, the two shall be attached in a manner satisfactory to the Engineer, end or corner posts being set as necessary.

Pull posts shall be spaced not more than 1,000-feet apart, but spacing shall be such as to use standard rolls of wire mesh with a minimum of cutting and waste.

Changes in alignment of 30 degrees or more shall be considered as corners, and corner posts shall be installed. Where it is deemed by the Engineer that a change in alignment of less than 30 degrees will materially lessen the strength of the fence, the line post at the angle shall be supported by the addition of braces or wires in a manner satisfactory to the Engineer.

8-12.3(2)B Barbed Wire and Wire Mesh

After the pull posts have been placed and securely braced, the barbed wire and mesh shall be pulled taut to the satisfaction of the Engineer, and each longitudinal wire shall be cut and securely fastened to the pull post with devices customarily used for the purpose. Wire or mesh shall not be carried past a pull post, but shall be cut and fastened to the pull post independently for the adjacent spans.

After the tensioning of the wire or mesh between two pull posts, all longitudinal wires shall be properly fastened at proper height to each intervening line post.

Wire mesh and barbed wire shall be placed on the face of the post which is away from the highway, except that on horizontal curves, the mesh and wires shall be fastened to the face on the outside of the curve unless otherwise directed by the Engineer.

Where unusual ground depressions occur between posts, the fence shall be guyed to the ground by means of a 9-gage galvanized wire attached to a deadman of approximately 100-pounds buried 2-feet in the ground. The guy wire shall be securely attached to each strand of barbed wire and to the top and bottom wires of the wire mesh fabric in a manner to maintain the entire fence in its normal shape. If necessary to guy the fence in solid rock, the guy wire shall be grouted in a hole 2-inches in a diameter and 10-inches deep. The operation of guying shall leave the fence snug with the ground.

8-12.3(2)C Vertical Cinch Stays

Vertical cinch stays shall be installed midway between posts on both types of fence. The wire shall be twisted in such a manner as to permit weaving into the horizontal fence wires to provide rigid spacing. All barbed wires and the top, middle, and bottom wire of the wire mesh shall be woven into the stay.

8-12.3(2)D Wire Gates

The wire mesh fabric shall be taut and securely tied to the frame and stays in accordance with recognized standard practice for wire gate construction.

Welded connections on gate frames shall be treated as specified for chain link fence gates.

The drop bar locking device for double wire gates shall be provided with a footing of commercial concrete 12-inches in diameter and 12-inches deep, crowned on top and provided with a hole to receive the locking bar. The diameter and depth of the hole in the footing shall be as specified by the manufacturer of the locking device.

8-12.4 Measurement

Chain link fence and wire fence will be measured by the linear foot of completed fence, along the ground line, exclusive of openings.

End, gate, corner, and pull posts for chain link fence will be measured per each for the posts furnished and installed complete in place.

Gates will be measured by the unit for each type of gate furnished and installed.

8-12.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Chain Link Fence Type ____", per linear foot.

Payment for clearing of fence line for "Chain Link Fence Type ____" shall be in accordance with Section 2-01.5.

"End, Gate, Corner, and Pull Post for Chain Link Fence", per each.

"Double 14 Ft. Chain Link Gate", per each.

"Double 20 Ft. Chain Link Gate", per each.

"Single 6 Ft. Chain Link Gate", per each.

"Wire Fence Type ____", per linear foot.

Payment for clearing of fence line for wire fence shall be in included in the unit contract price per foot for "Wire Fence Type ____".

"Single Wire Gate 14 Ft. Wide", per each.

"Double Wire Gate 20 Ft. Wide", per each.

8-13 MONUMENT CASES

8-13.1 Description

This work consists of furnishing and placing monument cases and covers, in accordance with the Standard Plans and these Specifications, in conformity with the lines and locations shown in the Plans or as staked.

8-13.2 Materials

Materials shall meet the requirements of the following sections:

Concrete	6-02
Monument Cases and Covers	9-22.1

8-13.3 Construction Requirements

The concrete base shall be placed on a well compacted foundation. The placing of the monument case and base shall be performed in a manner that will not disturb the monument.

The monument case shall be installed by the Contractor after the final course of surfacing has been placed. After the monument case has been in place for a minimum of three days, the roadway surface shall be patched in a workmanlike manner.

When the monument case and cover are placed in cement concrete pavement, the concrete base will not be required.

The monument will be furnished and set by the Engineer.

8-13.4 Measurement

Measurement of monument case and cover will be by the unit for each monument case and cover furnished and set.

8-13.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when included in the proposal:

"Monument Case and Cover", per each.

8-14 CEMENT CONCRETE SIDEWALKS

8-14.1 Description

This work consists of constructing cement concrete sidewalks in accordance with details shown in the Standard Plans and these Specifications and in conformity to lines and grades shown in the Plans or as established by the Engineer.

8-14.2 Materials

Materials shall meet the requirements of the following sections:

Portland Cement	9-01
Aggregates	9-03
Premolded Joint Filler	9-04.1
Concrete Curing Materials and Admixtures	9-23

The concrete in the sidewalks shall be air entrained concrete Class 3000 in accordance with the requirements of Section 6-02.

8-14.3 Construction Requirements

8-14.3(1) Excavation

Excavation shall be made to the required depth and to a width that will permit the installation and bracing of the forms. The foundation shall be shaped and compacted to a firm even surface conforming to the section shown in the Plans. All soft and yielding material shall be removed and replaced with acceptable material.

8-14.3(2) Forms

Forms shall be of wood or metal and shall extend for the full depth of the concrete. All forms shall be straight, free from warp, and of sufficient strength to resist the pressure of the concrete without springing. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal. After the forms have been set to line and grade, the foundation shall be brought to the grade required and thoroughly wetted approximately 12 hours before placing the concrete.

8-14.3(3) Placing and Finishing Concrete

The concrete shall be placed in the forms and struck off with an approved straightedge. As soon as the surface can be worked, it shall be troweled smooth with a steel trowel.

After troweling and before installing the contraction joints or perimeter edging, the walking surfaces of the sidewalk and ramps shall be brushed in a transverse direction with a stiff bristled broom as shown in the Standard Plans.

Expansion and contraction joints shall be constructed as shown in the Standard Plans. When the sidewalk abuts a cement concrete curb or curb and gutter, the expansion joints in the sidewalk shall have the same spacing as the curb. The expansion joint shall be filled to full cross-section of the sidewalk with $^{3}/_{8}$-inch premolded joint filler.

Sidewalk ramps shall be of the type specified in the Plans. The detectable warning pattern shall have the truncated dome shape shown in the Standard Plans and may be installed using a manufactured material before or after the concrete has cured, or by installing masonry or ceramic tiles. Embossing or stamping the wet concrete to achieve the truncated dome pattern or using a mold into which a catalyst hardened material is applied shall not be allowed. Acceptable manufacturers' products are shown on the Qualified Products List.

When masonry or ceramic tiles are used to create the detectable warning pattern, the Contractor shall block out the detectable warning pattern area to the depth required for installation of the tiles and finish the construction of the concrete ramp. After the concrete has set and the forms have been removed, the Contractor shall install the tiles using standard masonry practices.

The two-foot wide detectable warning pattern area on the ramp shall be yellow and shall match Federal Standard 595a, color number 33538. When painting the detectable warning pattern is required, paint shall conform to Section 9-34.2(1).

8-14.3(4) Curing

Concrete sidewalks shall be cured for at least 72 hours. Curing shall be by means of moist burlap or quilted blankets or other approved methods. During the curing period, all traffic, both pedestrian and vehicular, shall be excluded. Vehicular traffic shall be excluded for such additional time as the Engineer may specify.

8-14.3(5) Ramp Detectable Warning Retrofit

Where shown in the plans, the Contractor shall retrofit existing cement concrete sidewalk ramps by installing a detectable warning pattern having the truncated dome shape shown in the Standard Plans. The warning pattern shall be the width of the ramp and cover the bottom two feet of the ramp. The truncated dome pattern shall be perpendicular to the long axis of the ramp.

The Contractor shall use one of the detectable warning pattern products listed in the Qualified Products List or submit another manufacturer's product for approval by the Engineer. The warning pattern shall be capable of being bonded to an existing cement concrete surface. The surface of the warning pattern, excluding the domes, shall not be more than $^{3}/_{8}$-inch above the surface of the concrete after installation.

8-14.4 Measurement

Cement concrete sidewalks will be measured by the square yard of finished surface and will not include the surface area of the sidewalk ramps. Measurement of sidewalk ramps will be by the unit for each complete ramp type.

Ramp detectable warning retrofit will be measured by the square foot of truncated dome material installed on the existing ramp.

8-14.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid items when included in the proposal:

"Cement Conc. Sidewalk", per square yard.

"Cement Conc. Sidewalk with Raised Edge", per square yard.

"Monolithic Cement Conc. Curb and Sidewalk", per square yard.

"Cement Conc. Sidewalk Ramp Type ___", per each

Payment for excavation of material not related to the construction of the sidewalk but necessary before the sidewalk can be placed, when and if shown in the Plans, will be made in accordance with the provisions of Section 2-03. Otherwise, the Contractor shall make all excavations including haul and disposal, regardless of the depth required for constructing the sidewalk to the lines and grades shown, and shall include all costs thereof in the unit contract price per square yard for "Cement Conc. Sidewalk.", "Cement Conc. Sidewalk with Raised Edge", or "Monolithic Cement Conc. Curb and Sidewalk".

"Ramp Detectable Warning Retrofit", per square foot.

8-15 RIPRAP

8-15.1 Description

This work consists of furnishing and placing riprap protection of the type specified at the locations and in conformity with the lines and dimensions shown in the Plans or established by the Engineer.

Riprap will be classified as heavy loose riprap, light loose riprap, hand placed riprap, and sack riprap.

8-15.2 Materials

Materials shall meet the requirements of the following sections:

Filter Blanket ____ (shall meet the gradation requirements for Shoulder Ballast)	9-03.9(2)
Gravel Backfill for Drains	9-03.12(4)
Heavy Loose Riprap	9-13.1(1)
Light Loose Riprap	9-13.1(2)
Hand Placed Riprap	9-13.2
Sack Riprap	9-13.3
Quarry Spalls	9-13.6

8-15.3 Construction Requirements

8-15.3(1) Excavation for Riprap

The foundation for riprap shall be excavated below probable scour or to the elevation shown in the Plans, and no stone shall be laid or concrete placed until the footing is approved by the Engineer. Excavation below the level of the intersection of the slope to be protected and the adjacent original ground or the channel floor or slope shall be classified, measured, and paid for as ditch excavation in accordance with Section 2-10. All excavation or backfill above the level of the above described intersection and all dressing of the slope to be protected shall be included in the contract price for the class of riprap to be placed. Before placing riprap, the slopes shall be dressed to the lines and grades as staked.

8-15.3(2) Loose Riprap

Loose riprap shall be placed in such a manner that all relatively large stones shall be essentially in contact with each other, and all voids filled with the finer materials to provide a well graded compact mass. The stone shall be dumped on the slope in a manner that will ensure the riprap attains its specified thickness in one operation. When dumping or placing, care shall be used to avoid disturbing the underlying material. Placing in layers parallel to the slope will not be permitted. A 12-inch tolerance for loose riprap will be allowed from slope plane and grade line in the finished surface.

8-15.3(3) Hand Placed Riprap

The stones shall be laid by hand on prepared slopes to such thickness as may be ordered by the Engineer. The riprap shall be started at the toe of the embankment by digging a trench and placing a course of the largest stones therein. Each stone shall be placed so that it shall rest on the slope of the embankment and not wholly on the stone below, and it shall be thoroughly tamped or driven into place. The exposed face of all hand placed riprap shall be made as smooth as the shape and size of the stones will permit and shall not vary more than 3-inches from a plane surface on the required slope.

8-15.3(4) Sack Riprap

Sack riprap conforming to the requirements of Section 9-13.3 shall be deposited in the trench and on the slope of the embankment to be protected in accordance with the Plans or as ordered by the Engineer in accordance with Section 1-04.4.

The concrete shall be placed in the sacks to a uniform volume leaving sufficient room for effectively tying the sacks. The sacks shall then be placed in longitudinal rows in the trench and on the slope to lie parallel with the slope. In placing the sacks on the slope, their outside faces shall be laid against a heavy timber header or screed so that each layer will be true to line and grade. The tied end of the sack shall be turned under and the sack firmly pressed into place against the header or screed. Sacks in the longitudinal rows shall be placed with the bottom of one sack adjacent to the top of the next sack. Joints shall be staggered in succeeding rows. Sack riprap shall not be placed in freezing weather, and work damaged by frost shall be removed and replaced at the Contractor's expense.

8-15.3(5) Vacant

8-15.3(6) Quarry Spalls

Quarry spalls shall be placed in ditches and on slopes to be protected, in accordance with the Plans or as staked by the Engineer. After placement, the quarry spalls shall be compacted to be uniformly dense and unyielding.

8-15.3(7) Filter Blanket

When required, a filter blanket shall be placed on the prepared slope or area to the full thickness specified in the Plans using methods which will not cause segregation of particle sizes within the bedding. The surface of the finished layer shall be even and free from mounds or windrows. Additional layers of filter material, when required, shall be placed using methods that will not cause mixing of the materials in the different layers.

8-15.4 Measurement

Loose riprap will be measured by the ton or per cubic yard of riprap actually placed.

Hand placed riprap will be measured by the cubic yard of riprap actually placed.

Filter blanket will be measured by the ton or cubic yard of filter blanket actually placed.

Sack riprap will be measured by the cubic yard. The number of cubic yards of sack riprap placed shall be computed from the number of sacks of cement actually used in the concrete mix and the yield per batch of concrete as determined by the Engineer from actual predetermined measurement.

Quarry spalls will be measured by the ton or per cubic yard of spalls actually placed.

Ditch excavation will be measured by the cubic yard as specified in Section 2-10.

Excavation for toe walls and trenches will be measured by the cubic yard as ditch excavation in accordance with the provisions of Section 2-10.

8-15.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Heavy Loose Riprap", per ton or per cubic yard.

"Light Loose Riprap", per ton or per cubic yard.

"Hand Placed Riprap", per cubic yard.

"Sack Riprap", per cubic yard.

The unit contract price per ton or per cubic yard for the class or kind of riprap specified above shall be full pay for furnishing all labor, tools, equipment, and materials required to construct the riprap protection, except for excavation. When it is necessary to dump and sort individual loads, payment will be made only for that portion accepted by the Engineer.

"Quarry Spalls", per ton or per cubic yard.

The unit contract price per ton or per cubic yard for "Quarry Spalls" shall be full pay for all costs in furnishing, placing, and compacting spalls.

"Ditch Excavation", per cubic yard.

"Filter Blanket", per cubic yard or per ton.

8-16 CONCRETE SLOPE PROTECTION

8-16.1 Description

This work consists of constructing concrete slope protection, in accordance with these Specifications and the details shown in the Plans, at the locations and in conformity with the lines, grades, and dimensions as staked.

Concrete slope protection shall consist of reinforced cement concrete poured or pneumatically placed upon the slope with a rustication joint pattern or semi-open concrete masonry units placed upon the slope closely adjoining each other.

8-16.2 Materials

Materials shall meet the requirements of the following sections:

Concrete Class 3000	6-02
Concrete Slope Protection	9-13.5
Semi-Open Concrete Masonry Units Slope Protection	9-13.5(1)
Poured Portland Cement Concrete Slope Protection	9-13.5(2)
Pneumatically Placed Portland Cement Concrete Slope Protection	9-13.5(3)

8-16.3 Construction Requirements

8-16.3(1) Footing and Preparation of Slope

The footing for the slope protection shall be constructed in accordance with Sections 2-09 and 6-02.

The construction of the footing will be incidental to the slope protection, and no separate measurement or payment will be made.

The surface on which application is to be made shall be thoroughly compacted and neatly trimmed to line and grade as necessary to conform to the detail in the Plans.

8-16.3(2) Placing Semi-Open Concrete Masonry Units

The concrete masonry units shall be placed in a uniform plane and in such a manner that they rest firmly and evenly against the slope with no rocking. The concrete masonry units shall be placed in horizontal parallel courses, and successive courses shall break joints with the preceding course to form a running bond.

8-16.3(3) Poured in Place Cement Concrete

The wire mesh shall lap a minimum of one mesh spacing, and laps shall be securely fastened at the ends. During the placement of the concrete, the reinforcement shall be held so as to provide a minimum of $1^{1}/_{4}$-inch of cover.

Where Class 3000 cement concrete is to be placed upon the slope, the method of depositing and compacting shall result in a compact, dense, and impervious concrete which will show a uniform plane surface.

The newly constructed concrete shall be finished by means of a wood float and shall be striated with a rustication joint as shown in the Plans.

Curing shall be performed in accordance with Section 5-05.3(13).

8-16.3(4) Pneumatically Placed Concrete

Workers. Only workers experienced in pneumatically placed concrete shall be employed; and satisfactory evidence of such experience shall be furnished when requested by the Engineer.

Equipment. The Contractor shall furnish the Engineer with two copies of the manufacturer's specifications and operating instructions for the equipment used. Before placement of any portion of the slope protection, the type of equipment and method of operation shall be approved by the Engineer.

Proportions of Materials. The sand/cement ratio shall be $4^1/_2$-parts sand to 1 part cement based on loose dry volume.

Water shall be maintained at a constant pressure that shall be at least 15 psi above atmospheric pressure at the nozzle. For lengths of hose up to 100-feet, pneumatic pressure at the gun shall be 45 psi or greater. Pressure shall be increased 5 psi for each additional 5-feet of hose required. A steady pressure shall be maintained.

Method of Application. Portland cement and sand shall be mixed dry, passed through a cement gun and conveyed by air through a flexible tube, hydrated at a nozzle at the end of the flexible tube, and deposited in place by air pressure.

All surfaces are to be wetted, but application shall not be made on any surface on which free water exists.

Reinforcement. The wire mesh shall lap a minimum of one mesh spacing, and laps shall be securely fastened at the ends. During the placement of the concrete, the reinforcement shall be held so as to provide a minimum of $1^3/_4$-inch of cover at the recess.

Finishing. The newly constructed concrete shall be finished by means of a wood float and shall be striated with a rustication joint as shown in the Plans.

Curing. Curing shall be in accordance with Section 5-05.3(13).

Protection of Facilities. During the construction, the Contractor shall protect all retaining walls, columns and structures from concrete splash or overspray. Suitable covering shall be provided if such protection is deemed necessary by the Engineer.

Test Cylinders. Two test cylinders shall be made for each full day's operation. The Contractor shall furnish cylinders 6-inches in diameter and 12-inches high made of $^3/_4$-inch mesh hardware cloth. The test cylinder shall be filled with concrete by utilizing the same pneumatic application described above.

The cylinders shall develop a minimum compressive strength of 3,000 psi at the age of 28-days.

8-16.4 Measurement

Measurement for concrete slope protection will be by the square yard and will include the actual area of the slope covered excluding the footings. The area will be computed on the basis of slope measurements.

8-16.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when included in the proposal:

"Conc. Slope Protection", per square yard.

8-17 IMPACT ATTENUATOR SYSTEMS

8-17.1 Description

This work consists of furnishing, constructing, repairing, and removing permanent and temporary impact attenuator systems selected from the approved list shown in the Plans.

8-17.2 Materials

Sand for inertial barrier systems shall not contain more than 5% water by weight. Commercial grade urea shall be thoroughly mixed with the sand in an amount equal to 5 percent, by weight, of the sand.

Undamaged sand barrel impact attenuators that have been previously utilized may be utilized in a temporary impact attenuator array only, if inspected and approved by the Engineer prior to use.

8-17.3 Construction Requirements

The assembly and installation of all attenuator systems, except those utilizing sand barrels, shall be supervised at all times by either a manufacturer's representative or an installer who has been trained and certified by the manufacturer of the system. If the supervision is provided by a trained installer, a copy of the installer certification shall be provided to the Engineer prior to installation.

Assembly and installation shall be in accordance with the manufacturer's recommendations. This work shall include the connection to a concrete barrier, bridge abutment or a transition section identified in the Plans, construction of a steel reinforced concrete pad or concrete backup, and anchorage to the pavement, if required by the manufacturer's assembly and installation procedures.

The Contractor shall have a complete set of replacement parts on the jobsite for each type of temporary impact attenuator in use on the project and shall repair all damaged impact attenuators immediately.

When the Engineer determines that a temporary impact attenuator is no longer needed, then the Contractor shall remove that attenuator from the project. The removed equipment shall remain the property of the Contractor.

8-17.4 Measurement

Temporary and permanent impact attenuators will be measured per each for each installation.

Resetting impact attenuators will be measured per each for each installation that is adjusted or reset to a new location on the project. The Contracting Agency will not measure resetting impact attenuators when it is for the benefit of the Contractor's operations.

8-17.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid items when they are included in the proposal:

"Temporary Impact Attenuator", per each.

The unit contract price for "Temporary Impact Attenuator" shall be full pay for all work associated with the installation, maintenance, and the final removal of the temporary impact attenuator.

"Permanent Impact Attenuator", per each.

The unit contract price for "Permanent Impact Attenuator" shall be full pay for all work associated with furnishing, installing and all other costs involved with installing the impact attenuator in accordance with the manufacturer's recommendations.

"Resetting Impact Attenuator", per each.

The unit contract price for "Resetting Impact Attenuator" shall be full pay for all work associated with the removing, transporting, and resetting an impact attenuator.

If an impact attenuator is damaged, it will be repaired in accordance with Section 1-07.13(4) under the bid item "Reimbursement For Third Party Damage". No payment will be made for repair of impact attenuators damaged by the Contractor's operations.

8-18 MAILBOX SUPPORT

8-18.1 Description

This work consists of removing, maintaining in temporary locations during construction, and reinstalling in permanent locations, all mailboxes affected by construction work in accordance with the Plans, these Specifications, and the Standard Plans.

8-18.2 Materials

Materials shall meet the requirements of the following sections:

Steel Posts	9-32.1
Bracket, Platform, and Anti-Twist Plate	9-32.2
Type 2 Mailbox Support	9-32.7
Timber Sign Posts	9-28.14(1)
Fasteners	9-32.5
Snow Guard	9-32.6
Concrete Base	9-32.8
Steel pipe	9-32.9
U-Channel Post	9-32.10

Mailboxes will be furnished by others.

8-18.3 Construction Requirements

During construction the mailboxes shall be moved to a temporary location where their usefulness will not be impaired. The boxes shall be reinstalled at the original location or at locations determined by the Engineer in accordance with the Standard Plans.

The existing mailboxes shall be reinstalled on new mailbox supports, in accordance with the Standard Plans, within 24 hours of being removed. The existing mailbox posts shall be removed and disposed of off the project site.

Excavation for new mailbox supports shall be backfilled with adjacent native material and compacted to the satisfaction of the Engineer.

When a newspaper tube is attached to an existing mailbox installation, it shall be removed and attached under the mailbox on the new support, to the satisfaction of the Engineer.

8-18.3(1) Type 3 Mailbox Support

The concrete base shall be constructed using commercial concrete, with the pipe set to the dimensions shown in the Standard Plans. The base shall be crowned so as to shed water. The concrete may be mixed on the jobsite as specified in Section 6-02.3(4)B.

The U-channel post may be driven in place provided the method of driving does not damage the post.

With the Engineer's consent, a Type 3 Mailbox Support design, made of steel or other durable material, that meets the NCHRP 350 crash test criteria may be used in place of the design shown in the Standard Plans. In which case, the manufacturer's recommendations concerning installation shall be followed; however, the mailbox itself shall be positioned on the roadway according to the dimensions shown in the Standard Plans.

8-18.4 Measurement

Mailbox supports will be measured by the unit for each kind of mailbox support furnished and installed in its permanent location.

8-18.5 Payment

Payment will be made in accordance with Section 1-04.1, for the following bid item when it is included in the proposal:

"Mailbox Support, Type ____", per each.

All costs for the snow guard shall be included in the unit contract price per mailbox support involved.

8-19 VACANT

8-20 ILLUMINATION, TRAFFIC SIGNAL SYSTEMS, AND ELECTRICAL

8-20.1 Description

This work consists of furnishing, installing and field testing all materials and equipment necessary to complete in place, fully functional system(s) of any or all of the following, types including modifications to an existing system all in accordance with approved methods, the Plans, the Special Provisions and these Specifications:

1. Traffic Signal System
2. Illumination System
3. Traffic Data Accumulation and Ramp Metering System

Unless otherwise noted, the location of signals, controllers, standards, and appurtenances shown in the Plans are approximate; and the exact location will be established by the Engineer in the field.

8-20.1(1) Regulations and Code

All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA), Electric Utility Service Equipment Requirements Committee (EUSERC), and California Department of Transportation document entitled Transportation Electrical Equipment Specifications (TEES). Traffic signal control equipment shall conform to the contract and these Standard Specifications: EIA Electronic Industries Alliance, IEEE Institute of Electrical and Electronics Engineers, the American Society for Testing and Materials (ASTM), the American Association of State Highway and Transportation Officials (AASHTO), the American National Standards Institute (ANSI), whichever is applicable, and to other codes listed herein. In addition to the requirements of these Specifications, the Plans, and the Special Provisions, all material and work shall conform to the requirements of the National Electrical Code, hereinafter referred to as the Code, and any WACs and local ordinances, which may apply.

Wherever reference is made in these Specifications or in the Special Provisions to the Code, the rules, or the standards mentioned above, the reference shall be construed to mean the code, rule, or standard that is in effect at the date of advertising of the project.

In accordance with RCW 39.06.010, the Contractor need not be registered or licensed if the Contractor has been prequalified as required by RCW 47.28.070.

Safe wiring labels normally required by the Department of Labor and Industries will not be required on electrical work within the Rights-of-Way of Contracting Agency Highways as allowed in RCW 19.28.141.

Persons performing electrical work shall be certified in accordance with RCW 19.28.161. Proof of certification shall be supplied to the Engineer prior to the performance of the work.

8-20.1(2) Industry Codes and Standards

The following electrical industry codes and standard procedures are listed for reference purposes:

Air Movement and Control Association (AMCA), 30 West University Dr. Arlington Heights, Illinois 60004.

American Association of State Highway and Transportation Officials (AASHTO), 444 North Capitol Street N.W., Suite 225, Washington, D.C. 20001.

American National Standards Institute (ANSI), 70 East 45th Street, New York, New York.

American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Pennsylvania.

American Wood Preservers' Association (AWPA), 836 Seventeenth Street, Washington, D.C.

Bell Company Research and Evaluation (Bellcore) 31220 La Baya DR Westlake Village CA 91362.

Edison Electric Institute (EEI), 420 Lexington Avenue, New York, New York.

Electronics Industries Alliance (EIA) 101 Pennsylvania Ave. Washington D. C.

Electric Utility Service Equipment Requirements Committee (EUSERC)

Federal Communications Commission (FCC) 445 12th SW Washington D C 20554.

International Municipal Signal Association (IMSA), P.O. Box 539, 1115 North Main Street, Newark, New York. 14513.

Institute of Electrical and Electronics Engineers (IEEE), 17th Floor, New York, NY 10016

International Telephony Communications Union (ITU) Place des Nations CH 1211 Geneva 20 Switzerland.

Institute of Transportation Engineers (ITE), 2029 K Street, Washington, D.C.20005.

Insulated Power Cable Engineers' Association (IPCEA), 283 Valley Road, Montclair, New Jersey.

National Electrical Manufacturers' Association (NEMA), 155 East 44th Street, New York, New York.

National Fire Protection Association - National Electrical Code (NEC), 470 Atlantic Avenue, Boston, Massachusetts.

National Television Standards Committee (NTSC) 445 12th SW Washington D.C. 20554.

National Transportation Communications for ITS Protocol (NTCIP).

Rural Utilities Service (RUS) 1400 Independence Ave. Washington D C.

Underwriters' Laboratories (UL), 207 East Ohio Street, Chicago, Illinois.

8-20.2 Materials

Materials shall meet the requirements of Section 9-29. Unless otherwise indicated in the Plans or specified in the Special Provisions, all materials shall be new.

Where existing systems are to be modified, the existing material shall be incorporated in the revised system, salvaged, or abandoned as specified in the contract documents, or as ordered by the Engineer.

8-20.2(1) Equipment List and Drawings

Within twenty days following execution of the Contract, the Contractor shall submit to the Engineer a completed "Request for Approval of Material" that describes the material proposed for use to fulfill the Plans and specifications.

If required to do so, the Contractor shall submit supplemental data, sample articles, or both, of the material proposed for use. Supplemental data (six copies required) would include such items as catalog cuts, product specifications, shop drawings, wiring diagrams, etc. Any material purchased or labor performed prior to such approval shall be at the Contractor's risk. The Contractor must receive all approvals by the Engineer before materials will be allowed on the job site.

If the luminaries are not listed in the Qualified Products List, the Contractor shall submit six copies of the following information for each different type of luminaire required on the contract:

1. Isocandela diagrams showing vertical light distribution, vertical control limits, and lateral light distribution classification.
2. Details showing the lamp socket positions with respect to lamp and refractor for each light distribution type. This requires that the State know what the light pattern available are and the light distribution.

The Contractor shall submit for approval six sets of shop drawings for each of the following types of standards called for on this project:

1. Light standards without pre-approved plans.
2. Signal standards with or without pre-approved plans.

The Contractor will not be required to submit shop drawings for approval for light standards conforming to the pre-approved plans listed in the Special Provisions.

The Engineer's approval of any submitted documentation shall in no way relieve the Contractor from compliance with the safety and performance requirements as specified herein.

Submittals required shall include but not be limited to the following:

1. A material staging plan, should the Contractor propose Contracting Agency-owned property for staging areas.
2. A cable vault installation plan showing the exact proposed installation location by roadway station, offset and the scheduled sequence for each cable vault installation.
3. A pit plan, for each boring pit, which bears the seal and signature of a licensed professional engineer licensed under title 18 RCW, state of Washington, qualified in civil engineering. The pit plan shall depict the protection of traffic and pedestrians, pit dimensions, shoring, bracing, struts, walers, sheet piles, conduit skids and means of attachment, casing type and casing size.
4. The proposed boring plan which bears the seal and signature of a licensed professional engineer, licensed under title 18 RCW, state of Washington, qualified in civil engineering. The proposed boring plan shall depict the boring system and entire support system.

8-20.3 Construction Requirements

8-20.3(1) General

All workmanship shall be complete and in accordance with the latest accepted standards of the industry.

Existing electrical systems, traffic signal or illumination, or approved temporary replacements, shall be kept in effective operation during the progress of the work, except when shutdown is permitted to allow for alterations or final removal of the system.

Illumination system shutdowns shall not interfere with the regular lighting schedule, unless permitted by the Engineer. The Contractor shall notify the Engineer prior to performing any work on existing systems.

Work shall be so scheduled that each electrical system is operational prior to opening the corresponding section of roadway to traffic.

Traffic signals shall not be placed in operation for use by the public until all required channelization, pavement markings, illumination, signs, and sign lights are substantially complete and operational unless otherwise allowed by the Project Engineer.

All costs incurred by the Contractor for providing effective operation of existing electrical systems shall be included in the associated electrical bid items.

8-20.3(2) Excavating and Backfilling

The excavations required for the installation of conduit, foundations, poles and other-accessories shall be performed in a manner that prevents damage to the streets, sidewalks, and other improvements. The trenches shall not be excavated wider than necessary for the proper installation of the electrical accessories and foundations. Excavating shall not be performed until immediately before installation of conduit and other accessories. The material from the excavation shall be placed where the least interference to vehicular and pedestrian traffic, and to surface drainage, will occur.

All surplus excavated material shall be removed and disposed of by the Contractor in accordance with Section 2-03, or as ordered by the Engineer in accordance with Section 1-04.4.

The excavations shall be backfilled in conformance to the provisions in Section 2-09, Structure Excavation.

At the end of each day's work and at all other times when construction operations are suspended, all equipment and other obstructions shall be removed from that portion of the roadway open for use by public traffic.

Excavations in the street or highway shall be performed in such a manner that not more than one traffic lane is restricted in either direction at any time unless otherwise approved by the Engineer.

8-20.3(3) Removing and Replacing Improvements

Improvements such as sidewalks, curbs, gutters, Portland cement concrete and hot mix asphalt pavement, bituminous surfacing, base material, and any other improvements removed, broken, or damaged by the Contractor, shall be replaced or reconstructed with the same kind of materials as found on the work or with other materials satisfactory to the Engineer.

Whenever a part of a square, slab, or section of existing concrete sidewalk, curb, gutter or driveway is broken or damaged, the entire square, slab or section, curb, gutter, driveway shall be removed and the concrete reconstructed as specified above.

The outline of all areas to be removed in Portland cement concrete sidewalks and pavements and hot mix asphalt pavements shall be cut to a minimum depth of 3-inches with a saw prior to removing the sidewalk, driveway, slabs and pavement material. The cut for the remainder of the required depth may be made by a method satisfactory to the Engineer. Cuts shall be neat and true with no shatter outside the removal area.

8-20.3(4) Foundations

Foundation concrete shall conform to the requirements for the specified class, be cast-in-place concrete and be constructed in accordance with Section 6-02.2, and 6-02.3. Concrete for posts, standards, pedestals, and cabinets shall be constructed of concrete Class 3000. Concrete that will fall 5-feet or more shall be placed using an approved tremie, except that a tremie will not be required for placing concrete for a standard 3-foot diameter by 4.5-foot deep luminaire foundation. Steel reinforcing bars for foundations shall conform to Section 9-07.

The bottom of concrete foundations shall rest on firm ground.

Foundations shall be cast in one operation where practicable. The exposed portions shall be formed to present a neat appearance.

The top edges of the luminaire foundation, traffic signal standard foundations, electrical service foundations, traffic signal controller cabinets, Transformer cabinets, ITS Standards, and ITS cabinets shall have a three fourth inch ($^3/_4$-inch) chamfer on the top edge of the foundation. Where one or more of the above foundations directly abut each other, no chamfer shall be permitted.

The foundations shown in the Plans shall be extended if conditions require additional depth, and galvanized culvert pipe, of the correct size shall be installed for forming purposes where soil conditions are poor. Such additional work, if ordered by the Engineer, will be paid for as extra work as provided in Section 1-04.4.

When slip bases are installed the conduit, anchor bolts, and other obstructions shall terminate at a height below the elevation of the top of the bottom slip plate. The galvanized surfaces of the slip plates, the keeper plate and the luminaire base plate shall be smooth, without irregularities, to reduce friction and to prevent slacking of bolt tension due to flattening of the irregularities. Slip base luminaire foundations shall have a maximum conduit size of 1-inch.

Forms shall be true to line and grade. Tops of foundations for posts and standards, except special foundations, shall be finished to ground line or sidewalk grade, unless otherwise noted in the Plans.

Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be plumbed and rigidly placed in proper position and to proper height prior to placing concrete and shall be held in place by means of a template until the forms are removed.

Anchor bolts shall be installed so that two full threads extend above the top of the top heavy-hex nut, except that slip base anchor bolt extensions shall conform to the specified slip base clearance requirements. Anchor bolts shall be installed plumb, plus or minus 1 degree.

See Standard Specifications Section 8-20.3(9) for additional grounding requirements.

Plumbing of standards shall be accomplished by adjusting leveling nuts. Shims or other similar devices for plumbing or raking will not be permitted except on power installed hot dipped galvanized steel luminaire foundations.

The top heavy-hex nuts of light standards and signal standards shall be tightened in accordance with Section 6-03.3(33), and as follows:

1. The top heavy-hex nuts for all clamping bolts of slip base light standards and Type RM and FB signal standards, shall be tightened using a torque wrench to the torque specified in Sections 8-20.3(13)A and 8-20.3(14)E, respectively.
2. The top heavy-hex nuts for all anchor bolts shall be tightened by the Turn-Of-Nut Tightening Method to minimum rotation of $^1/_4$ turn and a maximum rotation of $^1/_3$ turn past snug tight. Permanent marks shall be set on the base plate and nuts to indicate nut rotation past snug tight.

Both forms and ground which will be in contact with the concrete shall be thoroughly moistened before placing concrete; however, excess water in the foundation excavation will not be permitted. Foundations shall have set at least 72 hours prior to the removal of the forms.

Class 2 surface finish shall be applied to exposed surfaces of concrete in accordance with the requirements of Section 6-02.3(14)B.

Where obstructions prevent construction of planned foundations, the Contractor shall construct an effective foundation satisfactory to the Engineer.

The combined height of the light standard concrete foundation plus the anchor bolt stub height shall not exceed 4-inches above the ground line.

8-20.3(5) Conduit

Installation of conduit shall conform to appropriate articles of the Code and these Specifications.

The size of conduit used shall be as shown in the Plans. Conduits smaller than 1-inch electrical trade size shall not be used unless otherwise specified, except that grounding conductors at service points may be enclosed in $^1/_2$-inch diameter conduit.

It shall be the option of the Contractor, at no expense to the Contracting Agency, to use larger size conduit if desired, and where larger size conduit is used, it shall be for the entire length of the run from outlet to outlet. Reducing couplings will not be permitted.

The ends of all conduits, metallic and non-metallic shall be reamed to remove burrs and rough edges. Field cuts shall be made square and true. Slip joints or running threads will not be permitted for coupling metallic conduit; however, running threads will be permitted in traffic signal head spiders and RGS outerduct. When installing rigid galvanized steel conduit and standard coupling cannot be used, an approved 3-piece coupling shall be used. The threads on all conduit shall be rust-free, clean. All couplings shall be tightened so that a good electrical connection will be made throughout the entire length of the conduit run. If the conduit has been moved after assembly, it shall be given a final tightening from the ends prior to backfilling. Non-metallic conduit shall be assembled using the solvent cement specified in Section 9-29.1. Where the coating on galvanized conduit has been damaged in handling or installing, such damaged areas shall be thoroughly painted with galvanizing repair paint, Formula A-9-73. Conduit ends shall be capped (do not glue non metallic caps). Metallic conduit ends shall be threaded and capped with standard threaded conduit caps until wiring is started. When conduit caps are removed, the threaded ends shall be provided with approved conduit bushings or end bells (do not glue in place) for nonmetallic conduit

Conduit stubs from controller cabinet foundations shall extend to the nearest junction box in that system.

Metallic conduit bends, shall have a radius consistent with the requirements of Article 344.24 and other articles of the Code. Where factory bends are not used, conduit

shall be bent, using an approved conduit bending tool employing correctly sized dies, without crimping or flattening, using the longest radius practicable.

Nonmetallic conduit bends, where allowed, shall conform to Article 352.24 of the Code.

Conduit shall be laid so that the top of the conduit is a minimum depth of:

1. 24-inches below the subgrade including asphalt or concrete shoulder areas and asphalt or concrete sidewalk areas.
2. 48-inches below the bottom of ties under railroad tracks unless otherwise specified by the railroad company.
3. 18-inches below the finish grade in all other areas.

Galvanized steel conduit shall be installed at the following locations:

1. All open cut roadway crossings.
2. All railroad crossings.
3. All runs installed at traffic signal installations unless nonmetallic is specified in the contract.
4. All pole risers, except when as otherwise required by owning utilities.
5. All runs externally attached to structures.
6. All runs installed in barrier that is constructed by slip forming.

Nonmetallic conduit may be employed as an alternate to metallic conduit at other locations unless specified otherwise in the contract. Where nonmetallic conduit is installed, care shall be used in excavating, installing, and backfilling, so that no rocks, wood, or other foreign material will be left in a position to cause possible damage.

Metallic and nonmetallic conduit installation shall include equipment grounding conductor and shall conform to requirements noted in the Standard Plans.

Liquid tight flexible metal conduit is allowed only at locations called for in the plans.

Aluminum conduit will be an alternate to galvanized steel conduit subject to the following:

1. The use of aluminum conduit shall be restricted to above ground locations.
2. Aluminum conduit shall not be placed in concrete.

Conduit shall be placed under existing pavement by approved directional boring, jacking or drilling methods, at locations approved by the Engineer. The pavement shall not be disturbed unless allowed in the Plans, or with the approval of the Engineer in the event obstructions or impenetrable soils are encountered.

Where boring with casing is called for the casing shall be placed using an auger inside of the casing to remove the soil as the casing is jacked forward. The auger head shall proceed no more than 4-inches ahead of the pipe being jacked. Boring operations shall be conducted to prevent caving ahead of the pipe. Installed casing pipe shall be free from grease, dirt, rust, moisture and any other deleterious contaminants.

The space between the conduit and casing shall be plugged with sand bags and a grout seal 12-inches thick at each end of the casing. Casing abandoned due to an encountered obstruction shall be grout sealed in the same manner. Grout shall obtain a minimum of 4000 PSI compressive strength at 7 days.

In lieu of sand bags and grout, unopened of prepackaged concrete may be used to seal the casing.

Material shall not be removed from the boring pit by washing or sluicing.

All joints shall be welded by a Washington State certified welder. Welding shall conform to AWS D 1.1-80 Structural Welding Code, Section 3, Workmanship.

Directional boring for electrical installations shall be supervised by a licensed electrical contractor in accordance with Section 8-20.1(1). Where directional boring is called for, conduit shall be installed using a surface launched, steerable drilling tool. Drilling shall be accomplished using a high-pressure fluid jet toolhead. The drilling fluid shall be used to maintain the stability of the tunnel, reduce drag on the conduit and provide backfill between the conduit and tunnel. A guidance system that measures the depth, lateral position and roll shall be used to guide the toolhead when creating the pilot hole. Once the pilot hole is established a reamer and swivel shall be used to install the conduit. Reaming diameter shall not exceed 1.5 times the diameter of the conduit being installed. Conduit that is being pulled into the tunnel shall be installed in such a manner so the conduit is not damaged during installation. The pullback force on the conduit shall be controlled to prevent damage to the conduit. A vacuum spoils extraction system shall be used to remove any excess spoils generated during the installation. Excess drilling fluid and spoils shall be disposed of. The method and location used for disposal of excess drilling fluid and spoils shall be subject to the Engineers approval. Drilling fluid returns (caused by fracturing of formations) at locations other than the entry and exit points shall be minimized. Any drilling fluid that surfaces through fracturing shall be cleaned up immediately. Mobile spoils removal equipment capable of quickly removing spoils from entry or exit pits and areas with returns caused by fracturing shall be used as necessary during drilling operations.

Conduit installed using the directional boring method shall be UL listed High Density Polyethylene (HDPE) schedule 80 or rigid galvanized steel. The connection between HDPE conduit and conduit routed to associated junction boxes shall be made with an approved mechanical coupler.

Bore pits shall be backfilled and compacted in accordance with Section 2-09.3(1)E. Directional boring, and jacking or drilling pits shall be kept 2-feet from the edge of any type of pavement wherever possible. Excessive use of water that might undermine the pavement or soften the subgrade will not be permitted.

When approved by the Engineer, small test holes may be cut in the pavement to locate obstructions. When the Contractor encounters obstructions or is unable to install conduit because of soil conditions, as determined by the Engineer, additional work to place the conduit will be paid in accordance with Section 1-04.4.

When open trenching is allowed, trench construction shall conform to the following:

1. The pavement shall be sawcut a minimum of 3-inches deep. The cuts shall be parallel to each other and extend 2-feet beyond the edge of the trench.
2. Pavement shall be removed in an approved manner.
3. Trench depth shall provide 2-feet minimum cover over conduits.
4. Trench width shall be 4-inches or the conduit diameter plus 2-inches, whichever is larger.
5. Trenches located within paved roadway areas shall be backfilled with Controlled density fill (CDF) meeting the requirements of Section 2-09.3(1)E. The controlled density fill shall be placed level to, and at the bottom of the existing pavement. The pavement shall be replaced with paving material that matches the existing pavement.

On new construction, conduit shall be placed prior to placement of base course pavement.

Conduit terminating in foundations shall extend a maximum of 2-inches above the foundation vertically including grounded end bushing or end bell.

Conduit entering through the bottom of a junction box shall be located near the end walls to leave the major portion of the box clear. At all outlets, conduit shall enter from the direction of the run, terminating 6 to 8-inches below the junction box lid and within 3-inches of the box wall nearest its entry location.

Galvanized rigid steel conduit entering cable vaults shall extend 2-inches for the installation of grounded end bushing and bonding. PVC conduit entering cable vaults and pull boxes shall terminate flush with the inside walls of the structure. All conduit ends shall be terminated with termination kits.

When conduit or casing is to be placed under pavement it shall be placed prior to the placement of a surfacing, and pavement.

Innerduct conduit ends shall be terminated with termination kits. Galvanized rigid steel conduit ends shall be terminated with grounded end bushings. PVC conduit ends shall be terminated with bell ends.

Fittings shall be installed in accordance with the current electrical codes.

All covered underground conduit shall be cleaned with an approved sized mandrel and blown out with compressed air prior to pulling wire.

Conduits installed for future use shall be prepared as follows: After final assembly in place, the conduit shall be blown clean with compressed air. Then, in the presence of the Engineer, a cleaning mandrel correctly sized for each size of conduit shall be pulled through to ensure that the conduit has not been deformed. As soon as the mandrel has been pulled through, both ends of the conduit shall be sealed with conduit caps. All conduits scheduled for future use shall originate in a foundation or junction box as detailed in the plans and terminate in a junction box. All equipment grounding conductors, and the bonding conductor for metallic conduits shall be bonded in all junction boxes in accordance with Standard Specification 8-20.3(9).

Where surface mounting of conduit is required, supports shall consist of stainless steel channel with stainless steel or galvanized two-hole clamps sized for the conduit. Support spacing shall comply with the Code or shall be as noted in the contract. Approved expansion fittings shall be installed at all expansion joints. Approved deflection fittings shall be installed at the joint between the bridge end and the retaining wall end and the transition point from the bridge attachment to the underground section. PVC conduit shall not be installed on concrete surfaces or on bridge under-decks.

Spacing of stainless steel channel supports for conduit shall not exceed 5-feet. Conduit clamps shall attach to the supports on both sides of the conduit with bolts and associated hardware. The minimum distance between adjacent clamps and between the clamp and the end of the supports shall be one inch. Channel supports shall be installed with stops, to prevent clamps from sliding out of the ends. Channel installations shall provide for future conduit installation. Channel shall be at least 1-foot longer than required.

Existing conduit in place scheduled to receive new conductors shall have any existing conductors removed and a cleaning mandrel sized for the conduit shall be pulled through.

Conduit runs shown in the Plans are for bidding purposes only and may be changed, with approval of the Engineer, to avoid obstructions.

Conduit with innerduct shall be installed as shown in the Plans encased in controlled density fill. A maximum of 1000-feet of continuous open trench will be allowed, unless otherwise approved by the Engineer. All conduit with innerduct exposed above grade level, or on any elevated structures, or as noted in the plans shall be galvanized rigid steel conduit.

Innerduct warning tape shall be placed above all innerduct installed in trenches. The warning tape shall be polyethylene with a metallic backing. The polyethylene shall have a minimum 4 mils thicknesses and be 3-inches wide. The polyethylene shall be orange in color and printed in black with the words conveying message of Fiber Optic Cable Buried Below.

Location 14 AWG stranded orange USE insulated wire shall be placed directly above all innerduct installed in trenches. Splices shall be crimped using a non- insulated butt splice, soldered and covered with moisture blocking heat shrink.

After final assembly in place, all innerducts shall be blown clean with compressed air. Then, in the presence of the Engineer, a cleaning mandrel, correctly sized for the innerduct, shall be pulled through to ensure that the conduit has not been deformed. As soon as the mandrel has been pulled through, a 200 lb. minimum tensile strength pull string shall be installed in each innerduct and attached to duct plugs at both ends of the innerduct.

At all innerduct conduit terminus points, including those in cable vaults and pull boxes, removable and reusable mechanical plugs shall be employed as follows:

Outerduct conduits shall be plugged using a quadplex expansion plug inside the conduit around the innerduct. Duct plugs shall be installed in all unused innerducts (those that are specified as empty) at the time of conduit installation. Duct plugs shall be installed in all used innerducts (as specified in the plans) at the time of conduit installation, unless cable pulling for those innerducts will commence within 48 hours.

Innerduct containing one cable shall be plugged using an expandable split plug. Innerducts with multiple cables shall be sealed with self-expanding waterproof foam. The waterproof foam shall not be placed more than 2-inches into the innerduct.

8-20.3(6) Junction Boxes ,Cable Vaults, and Pull boxes

Standard junction boxes, pull boxes and cable vaults shall be installed at the locations shown in the Plans. The Contractor may install, at no expense to the Contracting Agency, such additional boxes as may be desired to facilitate the work. Junction box installation shall conform to details in the Standard Plans.

Cable vaults and pull boxes shall be installed accordance with the following:

1. Excavation shall be performed in accordance with Section 2-09.
2. Cable vaults and pull boxes shall be installed on 6-inches of crushed surfacing top course, per Section 9-03.9(3), placed on a compacted or undisturbed level foundation.
3. All openings around conduits shall be sealed and filled with grout in accordance with Section 6-02.3(20), to prevent water and debris from entering the vaults or pull boxes.
4. Backfilling around the work shall not be allowed until the concrete or mortar has set.

5. Pull boxes shall be installed in accordance with plans and details.
6. Pull boxes shall be configured such that the tensile and bending limitations of the fiber optic and other cables are not compromised. Pull boxes shall be configured to mechanically protect the fiber optic and other cables against installation force as well as inert forces after cable pulling operations.
7. Upon acceptance of work, cable vaults, and pull boxes shall be free of debris and ready for cable installation. All grounding requirements shall be met prior to cable installation.
8. Where installed near steel casings, the pull boxes and cable vaults shall be offset 3-feet, minimum from the centerline of the casing. Factory bends shall be used to route the conduits to the cable vault or pull box.

Adjustments involving raising or lowering the junction boxes shall require conduit modification if the resultant clearance between the top of the conduit and the junction box lid becomes less than 6-inches or more than 8-inches in accordance with the Plans.

Cable vaults and pull boxes shall be adjusted to final grade using risers or rings manufactured by the cable vault and pull box manufacturer. Cable vaults and pull boxes with traffic bearing lids shall be raised to final grade using ring risers to raise the cover only. All voids resulting from the adjustment shall be backfilled with materials matching adjacent surfacing material and compacted in accordance with Section 2-09.3(1)E.

Damage to the junction boxes, pull boxes, cable vaults and the associated conduit system, or wiring resulting from the Contractor's operations, shall be repaired to the Engineer's satisfaction at no additional cost to the Contracting Agency.

Both existing and new junction boxes, pull boxes, and cable vaults shall be adjusted to be flush with the finished grade as well as with the grade during the various construction stages proposed in the contract.

Where conduit and junction boxes are placed in barrier, the Prime Contractor shall coordinate the work of the Contractor constructing the barrier and the electrical Contractor so that each junction box placed in the barrier is placed in correct alignment with respect to the barrier, with the face of the box flush or uniformly chamfered within $^1/_2$-inch of the barrier surface. If any point on the surface of the junction box placed in barrier is recessed more than $^1/_2$-inch from the surface of the barrier, the Contractor shall install a box extension meeting the Engineer's approval and grout around the extension or remove and replace the entire section of barrier.

8-20.3(7) Messenger Cable, Fittings

Messenger cable shall be secured to steel strain poles by means of pole bands, and to timber poles by means of single strand guy eye bolts. Pole bands and eyebolts shall be installed as detailed in the Plans.

Messenger cable shall be secured to eye bolts or strain clamps at poles by the use of approved self-locking cable clamp type dead-ending devices. Messenger cable shall be secured to bull rings and anchors by two approved U-bolt connectors and guy thimbles.

Traffic signal control cable shall be secured to the messenger cable by cable ties. The ties shall be black nylon with ultraviolet protection and rated at 120 pound minimum unlocking strength.

Down guy assemblies shall be installed as detailed in the Standard Plans.

8-20.3(8) Wiring

All underground wiring shall be installed in conduit unless specifically noted otherwise in the contract. All wiring in conduit shall be installed with a lubricant recommended by cable/ conductor manufacturer.

With the exception of induction loop circuits, magnetometer circuits and illumination circuits, all wiring shall run continuously, without splices, from a terminal located in a cabinet, compartment, pedestrian push button assembly, or signal head to a similarly located terminal. Illumination circuit terminals and traffic circuit signal terminals located below grade will not be allowed. Video detection systems cable installation shall follow manufacturer's specification, except no below grade terminals will be allowed.

All splices in underground illumination circuits, induction loops circuits, and magnetometer circuits shall be installed in junction boxes. The only splice allowed in induction loop circuits and magnetometer circuits shall be the splice connecting the induction loop lead in conductors or magnetometer lead in conductors to the shielded lead in cable. Splices for induction loop circuits and magnetometer circuits shall be: heat shrink type with moisture blocking, material sized for conductors, epoxy filled clear rigid mold splice kits or rigid re-enterable type splice kits. Conductors for rigid mold kits shall be centered in the splice mold prior to installation of the encapsulation material. Magnetometer and induction loop splices shall be soldered. All connections with #10 and smaller wire shall use copper crimped connectors installed with a positive action (ratchet) tool, except where setscrew connections are allowed for quick disconnects as described in Section 9-29.7. The non-insulated die shall be an indent type and insulated die shall be of a smooth shape capable of crimping pre-insulated terminals and connectors. The tool shall be compound lever type with a ratchet mechanism to ensure positive closure for full crimping cycle. The tool shall be field adjustable to proper calibration with common tools and materials. All connectors installed in splices shall be wrapped with two layers of electrical tape. All epoxy splice kits shall be physically separated from other splices and wiring within the junction box to avoid damage from heat during the casting process.

Aerial illumination splices shall employ vice or crimp type pressure connectors. Splice insulation may be epoxy, heat shrink, or tape. Tape splice insulation, where allowed, shall consist of thermoplastic electrical insulating tape equivalent to the original wire insulation rating. It shall be well lapped over the original insulation, and there shall be a coating of moisture resistant varnish applied and allowed to dry. Two layers of friction tape will then be applied, and the splice shall be finished with a second complete coating of moisture resistant varnish.

Quick disconnect connectors, fused or unfused as required, shall be installed at all poles supporting a luminaire. Installation shall conform to details in the Standard Plans.

Pole and bracket cable shall be installed between the disconnects and the luminaire.

Sufficient slack wire shall be installed at each junction box to allow any conductor, cable, or splice within the junction box to be raised a minimum of 18-inches outside of the box.

Insulated neutral conductors shall be identified in accordance with the NEC requirements. Every conductor at every wire termination, connector, or device shall have an approved, (9-29.13(7)B & C) wire marking sleeve bearing as its legend, the circuit number indicated in the contract. All terminal strips shall also bear the circuit number consistent with the contract.

At all illumination circuit splices, each wire entering the splice shall have an approved wire marking sleeve bearing as its legend the circuit number indicated in the contract.

All wiring, exclusive of the previously mentioned illumination circuits, at junction boxes and at the controller cabinet shall have an approved tag with legends as follows:

1. Individual conductors — the circuit number indicated in the contract.
2. Multiconductor cable — the numbers of the signal heads and/or pedestrian push buttons served.
3. Loop lead-in cable — the numbers of the loops served.
4. Magnetometer cable — the numbers of the magnetometers served.
5. Camera lead-in cable — The numbers of the phases the camera served.

Drip loops shall be provided on all aerial conductors where they enter poles, signal heads, or weather heads.

When conductors, either cable or single, are being installed, care shall be exercised to not exceed tension limitations recommended by the manufacturer. Conductors may be pulled directly by hand. However, if conductors are pulled by any mechanical means, a dynamometer with drop-needle hand shall be used on every mechanical pull.

On mechanical pulls, insulation shall be stripped off the individual conductor and the conductor formed into a pulling eye and firmly taped, or a cable grip shall be used. The maximum pulling force applied directly to the conductor; i.e., when pulling eyes are used or when the conductor is formed into a loop, shall be limited to that shown in the following table for copper conductor. When a cable grip is applied over nonmetallic sheathed cables, the maximum pulling force shall be limited to 1,000 pounds provided this is not in excess of the force as calculated above.

Conductor	Pounds
8	132
6	210
4	334
3	421
2	531
1	669
1/0	845
2/0	1,065
3/0	1,342
4/0	1,693

To limit the sidewall pressure at bends in duct and conduit runs, the pulling force in pounds shall not exceed 100 times the radius of the bend in feet. Adequate lubrication of the proper type to reduce friction in conduit and duct pulls shall be utilized as necessary. The grease and oil-type lubricants used on lead sheathed cables shall not be used on nonmetallic sheathed cables.

When wiring is noted for future connection, the ends of each wire or cable shall be sealed with an approved heat shrink end cap.

If loop lead splices are not installed immediately after the installation of the loop leads into the adjacent junction box, the ends of the two conductor "home run" cable shall be sealed with heat shrink end caps to prevent entry of moisture into the two conductor cable. All coaxial cables shall have heat shrink end caps installed prior to aerial or underground installation of the cables to prevent moisture entry into the cable.

Multiconductor cable for signal displays shall be installed entirely through the mounting fitting to a point a minimum of 1-inch inside the signal display housing before the outer insulation is stripped back for the connection of individual conductors to the terminal block.

8-20.3(9) Bonding, Grounding

All metallic appurtenances containing electrical conductors (luminaires, light standards, cabinets, metallic conduit, etc.) shall be made mechanically and electrically secure to form continuous systems, that shall be effectively grounded.

Where conduit is installed, the installation shall include an equipment ground conductor, in addition to the conductors noted in the contract. Bonding jumpers and equipment grounding conductors shall be installed in accordance with Section 9-29.3 and NEC. The equipment ground conductor between the isolation switch and the sign lighter fixtures shall be a minimum of a 14 AWG stranded copper conductor. Where parallel circuits are enclosed in a common conduit, the equipment-grounding conductor shall be sized by the largest overcurrent device serving any circuit contained within the conduit.

Junction boxes with metallic lids shall have one 4-foot long tinned braided copper equipment bonding strap with full circle connector lugs installed from each metallic junction box lid(s) to the junction box frame. A non-insulated 8 AWG minimum stranded copper conductor, with a full circle crimp on connector (crimped with a manufacturer recommended crimper) shall be connected to the junction box frame or frame bonding stud, the other end shall be crimped to the equipment bonding conductor, using a "C" type crimp connector. The equipment ground conductor shall not be cut or spliced except at junction boxes.

Supplemental grounding shall be provided at luminaire, signal standards, cantilever and sign bridge structures. Steel sign posts which support signs with sign lighting or flashing beacons shall also have supplemental grounding. The grounding conductor shall be a non-insulated 4 AWG stranded copper conductor, which shall be connected to the foundation rebar (all rebar crossings shall be wire tied) by means of a listed grounding connector identified for use in concrete, and lead up directly adjacent to a conduit installed within the foundation. The free end of the conductor shall be terminated to the ground terminal, with an approved clamp, within the pole. If no ground terminal is provided, bond to standard or post. Three feet of slack shall be provided inside the standard.

All connectors between bonding jumpers and equipment grounding conductors shall be installed in accordance with the NEC. Identification of the equipment grounding conductor shall conform to all code requirements.

Bonding of the equipment grounding system and neutral at the service point shall be accomplished as required under the NEC. Grounding of the neutral shall be accomplished only at the service or at a separately derived system.

Two service grounds shall be installed at each electrical service installation and at each separately derived power source. Each service ground shall conform to the detail in the Standard Plans for "Service Ground." If soil conditions make vertical ground

rod installation impossible see NEC as an alternate installation procedure. The service ground installations shall be located a minimum of 6-feet apart. The first service ground rod shall be connected to a continuous grounding electrode conductor running to the service neutral bus. The second service ground rod shall be connected to the same continuous grounding electrode conductor connected to the first ground rod. Ground electrodes shall be bonded copper, ferrous core materials and shall be solid rods not less than 10-feet in length if they are $^1/_2$-inch in diameter or not less than 8-feet in length if they are $^5/_8$-inch or larger in diameter.

The connection of the grounding electrode conductor to the grounding electrode shall be made with two approved ground clamps.

Messenger cable shall be bonded to steel strain poles by means of a bond strap connected between an approved U-bolt connector and a bonding lug on the pole.

At points where shields or shielded conductors are grounded, the shields shall be neatly wired and terminated on grounding terminal strip.

8-20.3(10) Services transformer, Intelligent Transportation System Cabinet

Power sources shown in the Plans are approximate only; exact location will be determined in the field.

Aerial fed transformer cabinets and type A, type B, or type C service cabinets shall include a timber pole, as specified in Section 9-29.6(3), a meter base, installed in accordance with serving utility requirements, a two or three wire service breaker of size noted in the Plans, the necessary conduit risers and ground assembly as noted in the standard plan. The timber pole shall be set at a depth of 10% of the total pole length plus 2-feet. Modified type B, type D and type E services shall be installed per contract plan, and service description in standard plans. Pad mounted transformer cabinets shall be installed per contract plans.

The service breaker shall be a standard thermal circuit breaker encased in a raintight housing that can be padlocked.

Upon request of the Contractor, the Engineer will make the necessary arrangements with the serving utility to complete the service connections. Electrical energy used prior to completion of the contract will be charged to the Contractor, except that the cost of energy used for public benefit, when the Engineer orders such operation, will be borne by the Contracting Agency.

The service, transformer and ITS cabinets shall be marked with the service agreement letters and numbers as noted in the plans. The markings shall be installed on the outside cabinet door near the top of the cabinet. The markings shall be series C using stencils and black enamel alkyd gloss paint conforming to Federal Specification TT-E-489F.

8-20.3(11) Testing

The Contractor shall conduct the following tests on all electrical circuits with nominal operating voltage between 115 volts and 600 volts, in the presence of the Engineer:

1. Test the continuity of each circuit.
2. Test for grounds in each circuit, which shall consist of the physical examination of the installation to ensure that all required ground jumpers, devices, and appurtenances do exist and are mechanically firm.

3. Using a megohm meter, a 500 volt test on each new circuit between the conductor and ground with all switch boards, panel boards, fuse holders, switches, receptacles, and overcurrent devices in place. All readings shall be recorded. The Contractor shall furnish the Engineer with three copies of the test results identifying observed readings with their respective circuits.

   The insulation resistance shall not be less than 50 megohms between the conductor and ground on new circuits with a total single conductor length of 2,500-feet and over, nor less than 50 megohms on new circuits with single conductor length of less than 2,500-feet.

   Any change in the above stated minimum readings must be approved in writing by the Engineer. Only those factors based on dialectric properties of conductor insulations, splicing insulations, terminal strip castings, etc., will be cause for consideration of a variance.
4. A functional test in which it is demonstrated that each and every part of the system functions as specified.

For those new circuits below 115 volts nominal, except induction loop circuits and test direct burial circuits, the circuits shall be tested with a 500 volt megger for continuity, ground, and a test to demonstrate the circuit functions as specified. The megger test shall show an insulation resistance of not less than 8 megohms to ground.

Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the Contractor in a manner approved by the Engineer, and the same test shall be repeated until no fault appears.

When the project includes a traffic signal system, the Contractor shall conduct tests noted in Section 8-20.3(14)D. The Contractor shall provide the Engineer a minimum of five days advance written notice of the proposed traffic signal turn-on date and time. The traffic signal turn-on procedure shall not begin until all required channelization, pavement markings, illumination, signs, and sign lights are substantially complete and operational unless otherwise allowed by the Engineer. The Contractor shall provide traffic control to stop all traffic from entering the intersection. The Contracting Agency electronics technician will program the controller and enter the timing data, then turn the traffic signal system to its flash mode to verify proper flash indications. The Contracting Agency electronics technician will then conduct functional tests to demonstrate that each part of the traffic signal system, illumination system, or other electrical system, functions as specified. These demonstrations shall be conducted in the presence of a Contracting Agency electronic technician, the Contracting Agency electrical inspector, and Regional Traffic Engineer or his/her designee. The Contracting Agency electronics technician will then turn the traffic signal to stop and go operation for no less than one full cycle. Based on the results of the turn-on, the Engineer will direct the Contracting Agency electronics technician to either turn the traffic signal on to normal stop and go operation, to turn the signal to flash mode for a period not to exceed five calendar days, or to turn the signal off and require the Contractor to cover all signal displays and correct all deficiencies.

If the Contractor is directed to turn off the traffic signal, the Contractor shall schedule a new turn-on date with the Engineer in accordance with the previously mentioned procedures.

Unless approved by the Engineer no change to signal stop and go operation will be allowed between 6 AM to 10 AM and 2 PM to 7 PM on Monday through Thursday, nor will signal operation changes be allowed on Friday, weekends, holidays, or the day preceding a holiday.

8-20.3(12) Painting

All painting required shall be done in conformance with applicable portions of Section 6-07.

8-20.3(13) Illumination Systems

8-20.3(13)A Light Standards

Light standards shall be handled when loading, unloading, and erecting in such a manner that they will not be damaged. Any parts that are damaged due to the Contractor's operations shall be repaired or replaced at the Contractor's expense.

Light standards shall not be erected on concrete foundations until foundations have set at least 72 hours or attained a compressive strength of 2,400 psi, and shall be raked sufficiently to be plumb after all load has been placed.

Slip base installation shall conform to the following:

1. The slip plane shall be free of obstructions such as protruding conduit or anchor bolts. The anchor bolts, and other obstructions shall terminate at a height below the elevation of the top of the slip plate. Conduit shall extend a maximum of 2-inches above the top of the foundation, including grounding end bushing.
2. Washers in the slip plane shall be placed between the slip plate and the keeper plate
3. Anchor bolts shall extend through the top heavy-hex nut two full threads to the extent possible while conforming to the specified slip base clearance requirements. Anchor bolts shall be tightened by the Turn-Of-Nut Tightening Method in accordance with Sections 6-03.3(33) and 8-20.3(4).
4. Clamping bolts shall be tightened in accordance with Sections 6-03.3(33) and 8-20.3(4). The clamping bolts shall be tightened to the specified torque, plus or minus 2 percent, in two stages using an accurately calibrated torque wrench before erecting the light standard. Except as otherwise specified, the Contractor shall install 1-inch diameter clamping bolts in all slip bases to a torque of 95 foot-pounds.
5. The galvanized surfaces of the slip plates, the keeper plate and the luminaire base plate shall be smooth, without irregularities, to reduce friction and to prevent slackening of bolt tension due to flattening of the irregularities.
6. Anchor bolts damaged after the foundation concrete is placed shall not be repaired by bending or welding. The Contractor's repair procedure is to be submitted to the Engineer for approval prior to making any repairs. The procedure is to include removing the damaged portion of the anchor bolt, cutting threads on the undamaged portion to remain, the installation of an approved threaded sleeve nut and stud, and repairing the foundation with epoxy concrete. Epoxy concrete shall meet the requirements of Section 9-26.3(1)B.
7. The grout pad shall not extend above the elevation of the bottom of the anchor plate.
8. Wiring for slip base installation shall conform to details in the Standard Plans.

Breakaway coupling installation shall conform to the following:

1. At existing foundations, the anchor nuts, pole, grout pad, and leveling nuts shall be removed. Conduits shall be cut to a maximum height of 2-inches above the foundation including grounding end bushing or bell end. Galvanizing repair paint, conforming to Formula A-9-73 in Section 9-08.2, shall be applied to the cut conduit that has been threaded. Anchor bolts that are damaged shall be repaired with approved sleeve nuts as noted under slip base installation procedures.
2. All existing anchor bolts shall be cut off $2^1/_2$ to 3-inches above the foundation. At new foundations, the anchor bolts shall be installed with top of bolt $2^1/_2$ to 3-inches above the foundation.
3. Couplings shall be installed to within $^1/_8$ to $^3/_8$-inch of the foundation. Couplings shall then be leveled.
4. The pole shall be set and plumbed; and washers, nuts, and skirt installed per manufacturer's recommendations.
5. The conduit installed in a luminaire foundation shall not exceed 1-inch, trade size.

Slip base insert installations shall conform to details in the Standard Plans, and shall conform to items 1 through 8 above for slip base installation, except that the specified torque for the $^7/_8$-inch diameter clamping bolts shall be 50 foot-pounds.

Prior to installation all relocated metal light standards shall have existing painted identification markings removed. Manufactures Identification tag shall not be removed. Damaged surfaces and coatings shall be repaired with material matching the existing coating.

All new light standards shall have an approved metal tag riveted to the pole above the handhole. The information provided on the tag shall be as noted on the pre-approved drawings.

All new and relocated metal light standards shall be numbered for identification using painted series C numbers installed 3-feet above the base facing the traveled way. Paint shall be black enamel alkyd gloss conforming to Federal Specification TT-E-489. The following information shall be provided as shown in the plans:

1. Luminaire number.
2. Luminaire wattage.
3. Luminaire voltage.
4. Service number

In setting timber poles, the Contractor shall provide a minimum burial of 10 percent of the total pole length plus 2-feet and shall rake the poles as shown in the Plans.

8-20.3(13)B Vacant

8-20.3(13)C Luminaires

The Contractor shall mark the installation date on the inside of the luminaire ballast housing using a permanent marking pen.

All luminaires shall be mounted level, both transverse and longitudinally, as measured across points specified by the manufacturer. Leveling and orientation shall be accomplished after pole plumbing.

8-20.3(13)D Sign Lighting

Where indicated in the Plans, the Contractor shall furnish and install external sign illumination equipment. Sign illumination equipment shall include fixtures, brackets, conduit, electrical wire, and other material required to make the sign lighting system operable. Sign illumination fixtures shall be fused and circuit breakers installed per the table in Section 9-29.7. The Contractor shall intercept electrical conductors and make approved conductor splices at the nearest junction box or other source of power as noted in the Plans.

8-20.3(13)E Sign Lighting Luminaires

Sign lighting luminaires shall meet the requirements of Section 9-29.10.

The sign lighting luminaire shall be supported by a lighting bracket assembly as detailed in the Plans. If the sign structure includes a maintenance walkway, the luminaire fixture mounting plate shall be bolted to the walkway grating.

An isolation switch shall be provided in the line side conductors, mounted over the shoulder to de-energize all luminaires for maintenance purposes. The switch shall be single pole, single throw, or double-pole, single throw as necessary to open all conductors to the luminaires other than neutral and ground conductors. The switch shall contain 600 volt terminal strips on the load side with solderless box lugs as required plus four spare lugs per strip. The switch enclosure shall be rated NEMA 3R.

8-20.3(14) Signal Systems

8-20.3(14)A Signal Controllers

All control cabinets and control equipment shall be factory wired ready for operation. Field work will be limited to placing cabinets and equipment and connecting the field wiring to field terminal strips. All controller cabinets shall be installed on a silicone seal pad.

Controllers for portable traffic signal systems shall conform to the requirements of Section 9-29.13(7).

8-20.3(14)B Signal Heads

Unless ordered otherwise by the Engineer, signal heads shall not be installed at any intersection until all other signal equipment is installed and the controller is in place, inspected, and ready for operation at that intersection, except that the signal heads may be mounted if the faces are covered to clearly indicate the signal is not in operation.

Three section displays mounted on type M mounts shall have the plumbizer between the top and second display. Four and five section vertical displays mounted on type M mounts shall have the plumbizer between the second and third display.

8-20.3(14)C Induction Loop Vehicle Detectors

Induction loops shall be constructed as detailed in the Contract and the following:

1. Loop wire shall conform to Section 9-29.3.
2. When Type 2 or 6’ round (R) loops are grouped at the stop line, the front edge of the first loop shall be one foot behind the stop line. Each additional loop installed in the lane shall be on 15-foot centers.
3. Lead-in cable shall conform to Section 9-29.3.

4. All loops shall be installed after grinding or prior to paving the final lift of asphalt designated in the Contract. Loop conductors shall be held at the bottom of the saw cut by high temperature backer rod (sized to fit snugly in the saw cut). Two inch long pieces of the backer rod shall be installed on 24-inch centers along the entire loop and home run(s) and at the entrance and exit of all turns greater than 45 degrees. If new loops are installed over existing the old loops shall be removed by grinding and the grinding shall be deep enough to destroy any existing operational loop conductors. If not listed as incidental to another item or paid for under another bid item the additional work to remove the existing loops shall be paid in accordance with Section 1-04.4.
5. Each loop shall be the size and number of turns indicated in the Plans.
6. No loop installation will be done in rainy weather or when the pavement is wet.
7. All sawcuts shall be cleaned with a high-pressure washer and dried with 100 psi minimum air pressure, to the satisfaction of the Engineer. If traffic is allowed over the sawcut prior to wire installation, the sawcuts shall be cleaned again.
8. Wiring shall be installed with a blunt-nosed wooden wedge.
9. Prior to the installation of the high temperature backer rod all slack shall be removed from the wiring. Kinks in wiring or folding back of excess wiring will not be allowed.
10. High temperature backer rod, sized for snug fit shall be installed in the saw cut on 2' centers and at all sharp turns.
11. Install sealant as per contract or as approved by the Engineer.
12. Sealant shall be applied such that air bubbles or foam will not be trapped in the sawcut.

8-20.3(14)D Test for Induction Loops and Lead-in Cable

All tests shall be performed by the Contractor in the presence of the Engineer for each loop. The tests shall be performed at the amplifier location after complete installation of the loop. All costs associated with testing shall be included in the unit contract prices of the respective bid items.

Test A — The DC resistance between the two lead-in cable wires will be measured by a volt ohmmeter. The resistance shall not exceed 10 ohms.

Test B — A megohm meter test at 500 volts DC shall be made between the lead-in cable shield and grounding, prior to connection to grounding. The resistance shall equal or exceed 100 megohms.

Test C — A megger test shall be made between the loop circuit and grounding. The resistance shall equal or exceed 100 megohms.

Test D — An inductance test to determine the inductance level of each inductance loop. The Contractor shall record the inductance level of each inductance loop installed on the project and shall furnish the findings to the Engineer. An inductance level below 150 microhenries is considered a failure for a Type 1 loop, any one round loop and an inductance level below 75 microhenries is considered a failure for a Type 2 loop.

If any of the installations fails to pass all tests, the loop installation or lead-in cable shall be repaired and replaced and then retested.

8-20.3(14)E Signal Standards

Traffic signal standards shall be furnished and installed in accordance with the methods and materials noted in the contract and the following:

1. All dimensions and orientations will be field verified by the Engineer prior to fabrication.
2. The signal standard component identification shall conform to details in the Plans.
3. Disconnect connectors complete with pole and bracket cable shall be installed in any signal standard supporting a luminaire. Illumination wiring installation shall conform to details in the Plans for slip base wiring.
4. No field drilling will be allowed on signal mast arms except for the installation of any required pre-empt indicators , pre-empt detectors, microwave detector, or type "N" signal mountings. The maximum diameter shall be 1-inch.
5. All pole entrances required for pole-mounted signal heads, cabinets, signs, pedestrian push button assemblies, etc., shall be field drilled.
6. Damage to the galvanized pole surface resulting from field drilling shall be repaired with approved zinc rich paint.
7. Field welding will not be allowed, except as shown in the Plans.
8. All tenons shall be factory installed.
9. All welding shall be completed prior to galvanizing.
10. Foundations shall be constructed to provide the pole orientation noted in the Plans. Anchor bolts shall be tightened in accordance with Sections 6-03.3(33) and 8-20.3(4).
11. Slip base installation for Type RM and FB signal standards shall conform to the slip base installation requirements specified in Section 8-20.3(13)A, except that the specified torque for the $^{3}/_{4}$-inch diameter clamping bolts shall be 50 foot-pounds.
12. The pole shall be plumbed after signal heads are installed.
13. The space between the bottom base plate and the top of foundation shall be filled with grout with a $^{3}/_{8}$-inch plastic drain tube.

Signal standards shall not be erected on concrete foundations until the foundations have attained 60 percent of its design strength or 14 days. Signal standards without mast arms may be erected after 72 hours. Type IV and V strain pole standards may be erected but the messenger cable (span wire) shall not be placed until the foundation has attained 60 percent of its design strength or 14 days.

Signal supports used with portable traffic signal systems shall provide a minimum of two signal displays, spaced a minimum of 8-feet apart.

When portable traffic signals are used to provide alternating one-way control, a minimum of one of the signal displays shall be suspended over the traveled way. The minimum vertical clearance to the traveled way for this signal display is 16-feet 6-inches.

Timber strain poles shall be set a burial depth of 10% of the total length plus 2-feet and shall be raked as noted in the Plans.

8-20.3(15) Grout

Grout shall conform to the requirements of Section 6-02.3(20).

8-20.3(16) Reinstalling Salvaged Material

When the contract requires salvaged electrical equipment to be reinstalled, the Contractor shall furnish and install all necessary materials and equipment, including anchor bolts, nuts, washers, concrete, etc., required to install the salvaged equipment.

8-20.3(17) "As Built" Plans

Upon physical completion of the work, the Contractor shall submit corrected shop drawings, schematic circuit diagrams, or other drawings necessary for the Engineer to prepare corrected plans to show the work as constructed.

These drawings shall be on sheets conforming in size to the provisions of Section 1-05.3.

8-20.4 Measurement

When shown as lump sum in the Plans or in the proposal as illumination, traffic data accumulation and ramp metering, or traffic signal system no specific unit of measurement will apply, but measurement will be for the sum total of all items for a complete system to be furnished and installed.

Conduit of the kind and diameter specified will be measured by the linear foot for the actual neat line length in place, unless the conduit is included in an illumination system, signal system, Intelligent Transportation (ITS) or other type of electrical system lump sum bid item.

Casing – will be measured by the linear foot for the actual length of casing placed, unless the casing is included in an illumination, signal or other electrical system lump sum bid item.

Directional boring will be measured by the linear foot for the length of the boring tunnel.

8-20.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Illumination System ____", lump sum.

"Traffic Signal System ____", lump sum.

"Traffic Data Accumulation and Ramp Metering System____", lump sum.

The lump sum contract price for "Illumination System, ____", "Traffic Signal ____", "Traffic Data Accumulation and Ramp Metering System_____", shall be full pay for the construction of the complete electrical system, modifying existing systems, or both, including sign lighting systems, as described above as shown in the Plans and herein specified including excavation, backfilling, concrete foundations, conduit, wiring, restoring facilities destroyed or damaged during construction, salvaging existing materials, and for making all required tests. All additional materials and labor, not shown in the plans or called for herein and which are required to complete the electrical system, shall be included in the lump sum contract price.

"Conduit Pipe ____ In. Diam.", per linear foot.

The unit contract price per linear foot for "Conduit ____ In. Diam." shall be full pay for furnishing all pipe, pipe connections, elbows, bends, caps, reducers, conduits, and unions; for placing the pipe in accordance with the above provisions, including all excavation, jacking or drilling required, backfilling of any voids around casing, conduits, pits or the trenches, restoration of native vegetation disturbed by the operation, chipping of pavement, and bedding of the pipe; and all other work necessary for the construction of the conduit, except that when conduit is included on any project as an integral part of an illumination, traffic signal, or ITS systems and the conduit is not shown as a pay item, it shall be included in the lump sum price for the system shown.

All costs for installing conduit containing both signal and illumination wiring shall be included in the contract prices for the signal system.

All costs for installing junction boxes containing both illumination and signal wiring shall be included in the contract prices for the signal system.

"Casing", per linear foot.

The unit contract price per linear feet for "casing" shall be full payment for boring, jacking or drilling for installing casing, and backfilling any voids around the casing and pits or back filling of the trenches required to install the casing. This cost will also include any restoration of native vegetation disturbed by the operation.

"Directional Boring", per linear foot

The unit contract price per linear foot for "Directional Boring", shall be full pay for furnishing all labor, materials, equipment and electrical supervision associated with the directional boring.

8-21 PERMANENT SIGNING

8-21.1 Description

This work consists of furnishing and installing permanent signing, sign lighting, sign removal, sign relocation, and refacing existing signs in accordance with the Plans, these Specifications, and the Standard Plans at the locations shown in the Plans or where designated by the Engineer.

8-21.2 Materials

Signing materials and fabrication of signs shall meet the requirements of Section 9-28. Materials for roadside sign structures shall meet the requirements of Section 9-06.16. Materials for sign mounting shall conform to Section 9-28.11. Materials for sign bridges, cantilever sign structures, and bridge mounted sign brackets shall conform to Section 9-28.14(2).

8-21.3 Construction Requirements

8-21.3(1) Location of Signs

Signs are located in the Plans by station numbers. These are tentative locations subject to change by the Engineer. The post lengths specified in the Plans are estimated for bid purposes only. Final lengths of timber posts will be determined or verified by the Engineer at the request of the Contractor prior to fabrication. Final lengths of steel posts will be determined by the Engineer prior to fabrication.

8-21.3(2) Placement of Signs

All reflectorized signs located less than 30-feet from the edge of the lane should be turned out approximately 3-degrees from the pavement edge of oncoming traffic lanes, and those located 30-feet or more from the edge of the lane should be turned in approximately 3-degrees from the pavement edge of oncoming traffic lanes. All sign posts shall be plumb and signs level. The signs shall be inspected at night by the Engineer and, if specular glare occurs from failure to install at 3-degrees as stipulated, the Contractor shall reinstall the signs at no expense to the Contracting Agency. The post holes shall be of sufficient dimensions to allow placement and thorough compaction of selected backfill material completely around the post. Selected backfill material shall consist of earth or fine sandy gravel free from organic matter with no individual particles exceeding $1^1/_2$-inches in diameter.

8-21.3(3) Sign Covering

When notified by the Engineer, the Contractor shall cover or uncover certain signs to facilitate and control the operation of the project. The covering shall consist of 4-mils minimum thickness black polyethylene sheeting of sufficient size to entirely cover the sign, unless otherwise approved by the Engineer, and shall extend over the edges of the sign and fastened on the back. The Contractor shall not use any type of adhesive tape on the face of the signs. Other methods of covering may be considered if approved by the Engineer.

8-21.3(4) Sign Removal

Where shown in the Plans or ordered by the Engineer, the existing signs and, if so indicated, the sign structures shall be removed by the Contractor. Where indicated, the Contractor shall remove concrete pedestals to a minimum of 2-feet below subgrade or finished ground elevation and backfill the hole to the satisfaction of the Engineer. Where an existing sign post is located within a sidewalk area, the Contractor shall remove the post and finish the area so as to make the sidewalk continuous. Aluminum signs, wood signs, wood sign posts, wood structures, metal sign posts, windbeams, and other metal structural members shall become the property of the Contractor and shall be removed from the project. Salvage value of the removed signs and sign structure members shall be reflected in the Contractor's bid price for other items of work.

8-21.3(5) Sign Relocation

Where shown in the Plans, the existing signs and, if so indicated, the sign structures shall be relocated by the Contractor to the location noted. Where the existing sign structure is mounted on concrete pedestals, the Contractor shall remove the pedestal to a minimum of 12-inches below finished grade and backfill the remaining hole with material similar to that surrounding the hole. Where the existing structure is to be relocated, the Contractor shall provide necessary materials, labor, and hardware, and if so indicated, electrical conduit, conductors, etc., electrical services, and connections so as to erect and provide an operable unit to the satisfaction of the Engineer. All materials damaged by the Contractor shall be replaced at no cost to the Contracting Agency. Unless otherwise allowed, relocation of each existing sign and structure shall be accomplished during the day in which it was removed. Relocation of overhead signs and structures shall be accomplished during the hours between 12 midnight and 4:00 a.m. or as approved by the Engineer.

8-21.3(6) Sign Refacing

Where indicated in the Plans or in the Special Provisions, the Contractor shall reface existing signs with sheet aluminum overlay panels. Unless otherwise indicated in the Plans or allowed by the Engineer, all work shall be accomplished while the existing sign is in place. Modifications to each sign shall be completed during the same day in which the work is commenced.

Prior to the installation of overlay panels, the existing legend (message and border) shall be removed. The aluminum overlay panels shall be butt jointed. Aluminum or stainless steel screws, a minimum of $^1/_2$-inch in length, shall be used to attach overlay panels to existing plywood signs. In addition to the screws, two $^1/_4$-inch diameter by 1-inch-long aluminum or stainless steel bolts shall be installed through the top of each panel and the plywood sign. Aluminum blind rivets shall be used to attach overlay panels to existing aluminum signs. Screws or rivets shall be installed at 24-inch centers. Unless otherwise noted, sign background material shall be in accordance with Section 9-28.

After installation of overlay panels, the existing legend shall be reinstalled or, where indicated in the Plans, new legend or portions thereof shall be furnished and installed by the Contractor. Direct applied legend shall be applied to the new face prior to resurfacing. Layout and letter spacing shall be in accordance with Contracting Agency standards unless otherwise approved by the Engineer. New legend components shall be of the same type and size as the existing materials, and it shall be the Contractor's responsibility to verify material type and size. Materials damaged by the Contractor shall be replaced at no expense to the Contracting Agency.

8-21.3(7) Sign Message Revision

Where indicated in the Plans or in the Special Provisions, the Contractor shall revise existing sign messages or layouts. The Contractor shall remove and reinstall portions of or all of the existing message or furnish and install new message components as necessary to provide the revised message as indicated. Prior to installing the revised message, the Contractor shall thoroughly clean the sign face and plug all existing rivet holes with aluminum blind rivets painted the same color as the sign background. Plugging screw holes in plywood signs will not be required. Modifications to the sign shall be completed during the same day in which work is commenced and while the sign is in place. All new materials necessary to accomplish this work shall be the same type and size as the existing components, and it shall be the Contractor's responsibility to verify such component type and size. Materials damaged by the Contractor shall be replaced at no expense to the Contracting Agency. Existing materials not reinstalled shall become the property of the Contractor and shall be removed from the project.

8-21.3(8) Sign Cleaning

Signs shall be cleaned after relocation or installation to the satisfaction of the Engineer. The Contractor shall not use cleaning solvents that would be harmful to the sign finish.

8-21.3(9) Sign Structures

8-21.3(9)A Fabrication of Steel Structures

Fabrication and erection shall conform to the applicable requirements of Section 6-03 and 9-06. All welded connections of sign bridge and cantilever sign structure posts, arms, and beams, including base and connection plates, shall be cleaned prior to welding to remove all mill scale from within two inches of the weld. As an alternative to the blast cleaning requirements of Section 6-03.3(13), the Contractor may perform the cleaning using power hand tools as approved by the Engineer. Unless otherwise specified in the Plans or Special Provisions, metal surfaces shall not be painted.

8-21.3(9)B Vacant

8-21.3(9)C Timber Posts

Timber sign posts shall conform to the requirements of Section 9-28.14(1).

8-21.3(9)D Aluminum Structures

Welding of aluminum shall be in accordance with Section 9-28.14(3).

8-21.3(9)E Bridge Mounted Sign Brackets

The Contractor shall fabricate and install sign supports for mounting signs on bridge structures at the locations and as shown in the Plans, including inserts and anchor bolts. Fabrication and installation shall be in accordance with applicable requirements of Sections 6-03 and 9-06. Metal surfaces shall not be painted.

The quantity of structural carbon steel shown in the contract is listed only for the convenience of the Contractor in determining the volume of work involved and is not guaranteed to be accurate. The prospective bidders shall verify this quantity before submitting a bid. No adjustments other than for approved changes will be made in the lump sum contract price for the bridge mounted sign brackets, even though the actual quantity of structural carbon steel required may deviate from that listed.

8-21.3(9)F Bases

Sign structures shall not be erected on concrete foundations until foundations have attained a compressive strength of 2,400 psi.

The excavation and backfill shall be in conformance with the applicable requirements of Section 2-09.

Foundation concrete shall conform to the requirements for the specified class, be cast-in-place concrete and be constructed in accordance with Section 6-02.2 and 6-02.3. Concrete for roadside sign structure post shall be Class 3000, concrete for sign bridge and cantilever sign structure foundations shall be Class 4000, except as otherwise specified. Where water is present in the shaft excavations for Type 1 foundations for sign bridges and cantilever sign structures, the shaft concrete shall be Class 4000P placed in accordance with Section 6-02.3(6)B.

Spiral steel reinforcing bars for roadside sign structures post shall conform to AASHTO M32. All other steel reinforcing bars for sign structure foundations shall conform to Section 9-07.

The bottom of concrete foundations shall rest on firm ground.

Foundations shall be cast in one operation where practicable. The exposed portions shall be formed to present a neat appearance.

The foundations shown in the Plans shall be extended if conditions require additional depth, and such additional work, if ordered by the Engineer, will be paid for as extra work as provided in Section 1-04.4.

Forms shall be true to line and grade. Tops of foundations for roadside sign structures shall be finished to ground line, unless otherwise shown in the Plans or directed by the Engineer. Tops of foundations for sign bridges and cantilever sign structures shall be finished to the elevation shown in the Plans.

Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be plumbed and rigidly placed in proper position and to proper height prior to placing concrete and shall be held in place by means of a template until the forms are removed.

All bolts and anchor bolts shall be installed so that two full threads extend beyond the top of the top heavy-hex nut. Anchor bolts shall be installed plumb, plus or minus 1 degree.

Plumbing of sign bridges and cantilever sign structures shall be accomplished by adjusting leveling nuts. Shims or other similar devices for plumbing or raking will not be permitted.

Slip base and hinge connection nuts of roadside sign structures shall be tightened using a torque wrench to the torque, and following the procedure, specified in the Standard Plans.

The top heavy-hex nuts of sign bridges and cantilever sign structures shall be tightened in accordance with Section 6-03.3(33), and by the Turn-Of-Nut Tightening Method to a minimum rotation of $^1/_4$ turn and a maximum rotation of $^1/_3$ turn past snug tight. Permanent marks shall be set on the base plate and nuts to indicate nut rotation past snug tight.

Both forms and ground which will be in contact with the concrete shall be thoroughly moistened before placing concrete; however, excess water in the foundation excavation will not be permitted. Forms shall not be removed until the concrete has set at least three days.

Class 2 surface finish shall be applied to exposed surfaces of concrete in accordance with the requirements of Section 6-02.3(14)B.

Where obstructions prevent construction of planned foundations, the Contractor shall construct an effective foundation satisfactory to the Engineer.

8-21.3(9)G Identification Plates

When sign structures are constructed, the Contractor shall attach sign structure identification plates to the sign structures. The identification plates will be supplied by the Engineer. When sign structures are removed, the Contractor shall remove the sign structure identification plates from the sign structures and give them to the Engineer.

8-21.3(10) Vacant

8-21.3(11) Multiple Panel Signs

After installation of multiple panel signs, the Contractor shall furnish and install an approved reinforced aluminized tape on the reverse side of the sign to prevent visible light through the seam. The tape shall be pressure sensitive and a minimum of 2-inches wide and 2 mils thick. In lieu of tape, the Contractor may use 1-inch-wide aluminum sheeting riveted to the sign back. The aluminum shall be a minimum of 0.032-inch thick. Rivet heads shall match the sign face color.

8-21.3(12) Steel Sign Posts

Steel sign posts shall be connected to concrete bases using the following procedure:

1. Remove all galvanized runs and beads from washer area.
2. Assemble sign post to stub post with bolts, using one flat washer on each bolt between plates.
3. Shim as required to plumb sign posts.
4. Tighten bolts in a systematic order to required torque while not over tightening.
5. Loosen each bolt and retighten to required torque in the same order as initial tightening.
6. After Contracting Agency inspection of bolt torque, burr threads with center punch to prevent loosening.

8-21.4 Measurement

When shown as lump sum in the Plans or in the proposal as permanent signing, sign bridge No. ____, cantilever sign structure No. ____ or bridge mounted sign bracket No. ____, no specific unit of measurement will apply, but measurement will be for the sum total of all items to be furnished and installed.

Sign covering will be measured in square feet of the area of the sign covered.

8-21.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Permanent Signing", lump sum.

"Sign Bridge No. ____", lump sum.

"Cantilever Sign Structure No. ____", lump sum.

"Bridge Mounted Sign Bracket No. ____", lump sum.

"Sign Covering", per square foot.

8-22 PAVEMENT MARKING

8-22.1 Description

This work consists of furnishing, installing, and removing pavement markings upon the roadway surface in accordance with the Plans, Standard Plans, and these Specifications, at locations shown in the Contract or as ordered by the Engineer in accordance with Section 1-04.4.

Pavement markings are defined as follows:

Long Line Markings

Skip Center Line

A BROKEN YELLOW line 4-inches wide. The broken pattern shall be based on a 40-foot unit consisting of a 10-foot line and a 30-foot gap. Skip center line is used as center line delineation on multilane, two way highways.

Double Yellow Center Line

Two SOLID YELLOW lines, each 4-inches wide, separated by a 4-inch or 12-inch space. Double yellow center line is used as center line delineation on multilane, two way highways and for channelization.

Edge Line

A SOLID line, 4-inches wide, used on the edges of the traveled way. Edge lines shall be WHITE except that on roadways with one way travel, the left edge line in the direction of travel shall be YELLOW.

Dotted Extension Line

A BROKEN LINE, 4-inches wide used to guide vehicles through an interchange or intersection. The broken pattern will be based on an 8-foot unit consisting of a 2-foot line and a 6-foot gap. Dotted extension line shall be the same color as the line it is extending.

Wide Line

A SOLID WHITE line, 8-inches wide, used for delineation at ramp connections, to separate left and right turning movements from through movements, to separate high occupancy vehicle lanes from general purpose lanes, to separate general purpose lanes from bicycle lanes, for traffic islands, hash marks, chevrons and other applications.

Dotted Wide Line

A BROKEN WHITE line, 8-inches wide, used for high occupancy vehicle lane applications on arterials and for bicycle lane delineation. The broken line pattern shall be based on an 8-foot unit consisting of a 2-foot line with a 6-foot gap.

Skip Wide Line

A BROKEN WHITE line, 8-inches wide, used for high occupancy vehicle lane applications on freeways. The skip wide broken line pattern shall be based on a 40-foot unit consisting of a 10-foot line with a 30-foot gap.

Lane Line

A BROKEN WHITE line, 4-inches wide, used to delineate adjacent lanes traveling in the same direction. The broken pattern shall be based on a 40-foot unit consisting of a 10-foot line and a 30-foot gap.

Drop Lane Line

A BROKEN WHITE line, 8-inches wide, used to delineate a lane that ends at an off ramp. The broken pattern shall be based on a 15-foot unit consisting of a 3-foot line and a 12-foot gap.

No-Pass Line

A SOLID YELLOW line, 4-inches wide, separated from a skip center line by a 4-inch space where passing is prohibited from the lane bounded by the no-pass line. Where passing is prohibited in both directions, no-pass lines shall be two SOLID YELLOW lines, each 4-inches wide, separated by a 4-inch or 12-inch space.

Reversible Lane Line

Two BROKEN YELLOW lines, each 4-inches wide, separated by a 4-inch space. The broken pattern shall be based on a 40-foot unit consisting of a 10-foot line and a 30-foot gap.

Two Way Left Turn Line

A SOLID YELLOW line, 4-inches wide, with a BROKEN YELLOW line, 4-inches wide, separated by a 4-inch space. The broken pattern shall be based on a 40-foot unit consisting of a 10-foot line and a 30-foot gap . The solid line shall be installed to the right of the broken line in the direction of travel.

Barrier Line

A SOLID YELLOW line, 18-inches wide.

Transverse Markings

Crosswalk Line

A series of SOLID WHITE lines, 24-inches wide and 8-feet long, conforming to details in the Standard Plans.

Stop Line

A SOLID WHITE line, 18-inches wide unless noted otherwise in the Contract**.**

Symbol Markings

Traffic Arrow

A WHITE marking conforming to details in the Standard Plans.

Traffic Letter

A WHITE marking conforming to the FHWA publication *Standard Alphabet for Highway Signs and Pavement Markings* for proportion.

With the exception of the traffic letters forming parts of the railroad crossing symbol, all traffic letters shall be 8-feet high.

Access Parking Space Symbol

A WHITE marking conforming to details in the Standard Plans that is used to designate restricted parking access.

HOV Lane Symbol

A WHITE marking conforming to details in the Standard Plans that is used to designate a high occupancy vehicle (HOV) lane.

Railroad Crossing Symbol

A WHITE marking that includes a symbol, two letters, and two 24-inches transverse lines, conforming to details in the Standard Plans. The letters included in the railroad crossing symbol shall conform to the FHWA publication *Standard Alphabet for Highway Signs and Pavement Markings* for proportion.

Drainage Marking

A WHITE marking conforming to the details in the Standard Plans for the identification of a cross culvert, catch basin or grate inlet.

Aerial Surveillance Marker

A WHITE marking conforming to details in the Standard Plans.

Bicycle Lane Symbol

A WHITE marking that includes a symbol and one traffic arrow conforming to details in the Standard Plans.

Access Parking Space Symbol with Background

A WHITE marking with, a BLUE background and WHITE border conforming to details in the Standard Plans that is used to a designate restricted parking stall on cement concrete pavement surfaces.

Yield Line Symbol

A series of WHITE markings conforming to details in the Standard Plans forming a transverse line across a vehicle path and used to designate the point when vehicles shall yield before entering a traffic lane.

Yield Ahead Symbol

A WHITE marking conforming to details in the Standard Plans that is used in advance of a yield line.

Speed Bump Symbol

WHITE marking used to identify a speed bump placed in a traffic lane.

8-22.2 Materials

Material for pavement marking shall be paint or plastic as noted in the bid item meeting the requirements of Section 9-34.

8-22.3 Construction Requirements

8-22.3(1) Preliminary Spotting

The Engineer will provide necessary control points at intervals agreed upon with the Contractor to assist in preliminary spotting of the lines before marking begins. The Contractor shall be responsible for preliminary spotting of the lines to be marked. Approval by the Engineer is required before marking begins. Preliminary spotting to guide the striping machine is required for all longitudinal lines except where a clearly visible separation is present. Preliminary spotting shall be provided at a spacing of 100-feet maximum on tangents and 25-feet maximum on curves. The color of the material used for spotting shall match the color of the permanent marking.

8-22.3(2) Preparation of Roadway Surfaces

For the application of paint the pavement surface temperature and ambient temperature shall be 50° F and rising. New and existing HMA pavement shall be dry, clean and free of contaminants such as surface oils. Portland cement concrete pavement shall have a minimum compressive strength of 2500 psi and shall be dry, clean and free of contaminants. Contaminants shall be removed by approved mechanical means.

For the application of plastic pavement marking material surface temperature and ambient temperature shall be 50° F and rising. New and existing HMA pavement shall be dry, clean, and free of contaminants such as surface oils and existing pavement marking materials. Portland cement concrete pavement shall also be free of contaminants including curing agents. Contaminants shall be removed by approved mechanical means.

Pavement surfaces shall be prepared for plastic marking application in accordance with the previous paragraph and the pavement marking material manufacturer's recommendations. Manufacturers of Type D material also require a pavement cure period prior to application. Typically, Type D material applied on hot mix asphalt pavement requires a pavement cure period of 21 days. Typically, Type D material applied on portland cement concrete pavement requires a pavement cure period of 28 days. These cure periods may be reduced if the manufacturer performs a successful bond test.

Existing pavement marking material shall be removed, measured, and paid for in accordance with the provisions in this section of the Standard Specifications.

8-22.3(3) Marking Application

Lane line and right edge line shall be white in color. Center line and left edge line shall be yellow in color. All temporary pavement markings shall be retroreflective. Paint and sprayed or extruded plastic material shall be applied with a top dressing of glass breads. Two applications of paint will be required to complete all paint markings. The time period between paint applications will vary depending on the type of pavement and paint (low VOC waterborne, high VOC solvent, or low VOC solvent) as follows:

Pavement Type	Paint Type	Time Period
Bituminous Surface Treatment	Low VOC Waterborne	4 hours min., 48 hours max.
Hot Mix Asphalt Pavement	Low VOC Waterborne	4 hours min., 30 days max.
Cement Concrete Pavement	Low VOC Waterborne	4 hours min., 30 days max.
Bituminous Surface Treatment	High and Low VOC Solvent	40 min. min., 48 hrs. max.
Hot Mix Asphalt Pavement	High and Low VOC Solvent	40 min. min., 30 days max.
Cement Concrete Pavement	High and Low VOC Solvent	40 min. min., 30 days max.

Where paint is applied on centerline on two-way roads with bituminous surface treatment or centerline rumble strips, the second paint application shall be applied in the opposite direction as the first application.

The second application of paint shall be squarely on top of the first pass.

Lines with skip patterns, paint or plastic, shall be applied so they are in cycle with existing skip pattern lines on at least one end of the project.

Glass beads shall be applied to all spray applied paint material. The bead application system shall provide a uniform bead distribution over the entire surface of the marking. The minimum application rate shall be 7 pounds of beads per gallon of paint.

Pavement markings shall be applied at the following base line thickness measured above the pavement surface in thousandths of an inch (mils):

Marking Material Application		HMA	PCC	BST
Paint-first coat	spray	10	10	10
Paint- second coat	spray	15	15	15
Type A - flat/transverse & symbols	extruded	125	125	125
Type A - flat/long line & symbols	spray	90	90	120
Type A - with profiles	extruded	90	90	120
Type A - embossed	extruded	160	160	160
Type A - embossed with profiles	extruded	160	160	160
Type B - flat/transverse & symbols	heat fused	125	125	125
Type C - flat/transverse & symbols	adhesive	90	90	NA
Type C - flat/long line	adhesive	60	60	NA
Type C - inset/long line	adhesive	60	60	NA
Type D - flat/transverse & symbols	spray	120	120	120
Type D - flat/transverse & symbols	extruded	120	120	120
Type D - flat/long line	spray	90	90	120
Type D - flat/long line	extruded	90	90	120
Type D - profiled/long line	extruded	90	90	120
Type D - inset/long line	extruded	260	260	260

Liquid pavement marking material yield per gallon depending on thickness shall not exceed the following:

Mils thickness	Feet of 4” line/gallon	Square feet/gallon
10	483	161
15	322	108
30	161	54
45	107	36
60	81	27
90	54	18
90 with profiles	30	10
120	40	13
120 with profiles	26	9
260	19	7

Solid pavement marking material (Type A) yield per 50 pound bag shall not exceed the following:

Mils thickness	Feet of 4” line/50# bag	Square feet/50# bag
30 - flat	358	120
45 - flat	240	80
60 - flat	179	60
90 - flat	120	40
90 - flat with profiles	67	23
120 - flat	90	30
120 - flat with profiles	58	20
125 - embossed	86	29
125 - embossed with profiles	58	20
260 - flat inset	42	14

Profiles are defined as that portion of the plastic line that is applied at a greater thickness than the base line thickness. Profiles shall be applied using the extruded method in the same application as the base line. See the Standard Plans for details.

Embossed plastic lines are defined as a plastic line applied with a transverse groove. Embossed plastic lines may be applied with profiles. See the Standard Plans for details.

All inset plastic lines shall be applied into a slot cut into the pavement. The slot shall be cut with equipment to produce a smooth square slot 4-inches wide. The slot depth for Type C material shall be 40 mils, plus or minus 5 mils. The slot depth for Type A or D material shall be 250 mils minimum. Slots for Type A or D material shall be filled to 10-mils above the pavement surface. The edges of the slot for Type A or D material shall be overfilled 0.125-inch on each side resulting in a 4.25-inch wide line.

8-22.3(4) Tolerances for Lines

Allowable tolerances for lines are as follows:

Length of Line: The longitudinal accumulative error within a 40-foot length of skip line shall not exceed plus or minus 1-inch.

Width of Line: The width of line shall not vary more than plus or minus $^1/_4$-inch.

Lane Width: The lane width, which is defined as the lateral width from the edge of pavement to the center of the lane line or between the centers of successive lane lines, shall not vary from the widths shown in the Contract by more than plus or minus 4-inches.

Thickness: A thickness tolerance not exceeding plus 10 percent will be allowed for thickness or yield in paint and plastic material application.

Parallel Lines: The gap tolerance between parallel lines is 0.5-inches.

8-22.3(5) Installation Instructions

Installation instructions for plastic markings shall be provided for the Engineer. All materials shall be installed according to the manufacturer’s recommendations. A manufacturer’s technical representative shall be present at the initial installation of plastic material to approve the installation procedure.

8-22.3(6) Removal of Pavement Markings

Pavement markings to be removed shall be obliterated until blemishes caused by the pavement marking removal conform to the coloration of the adjacent pavement. If, in the opinion of the Engineer, the pavement is materially damaged by pavement marking removal, such damage shall be repaired by the Contractor in accordance with Section 1-07.13(1). Sand or other material deposited on the pavement as a result of removing lines and markings shall be removed as the work progresses to avoid hazardous conditions. Accumulation of sand or other material which might interfere with drainage will not be permitted.

8-22.4 Measurement

Skip center line, skip center line with no pass line, double yellow center line, edge line, dotted extension line, lane line, double no-pass line, reversible lane line, and two-way left turn line will be measured by the completed linear foot as "Paint Line", "Plastic Line", "Embossed Plastic Line", "Profiled Plastic Line", "Profiled Embossed Plastic Line" or "Inset Plastic Line".

The measurement for "Paint Line" will be based on a marking system capable of simultaneous application of three 4-inch lines with two 4-inch spaces. No deduction will be made for the unmarked area when the marking includes a skip line such as skip center line, dotted extension line, skip center line with no-pass line, lane line, reversible lane line, or two-way left turn line. No additional measurement will be made when more than one line can be installed on a single pass such as skip center line with no-pass line, double yellow center line, double no-pass line, reversible lane line, or two-way left turn line.

The measurement for "Plastic Line", "Embossed Plastic Line", "Profiled Plastic Line", "Profiled Embossed Plastic Line" or "Inset Plastic Line" will be based on the total length of each 4-inch wide plastic line installed. No deduction will be made for the unmarked area when the marking includes a skip line, such as skip center line, dotted extension line, skip center line with no-pass line, lane line, reversible lane line, or two-way left turn line.

Painted wide line, plastic wide line, profiled plastic wide line, painted dotted wide line, plastic dotted wide line, profiled dotted wide line, painted skip wide line, plastic skip wide line, profiled plastic skip wide line, painted drop lane line, plastic drop lane line, profiled plastic drop lane line, barrier line, and stop line will be measured by the completed linear foot of each marking type. No deduction will be made for the unmarked area when the marking includes a gap such as painted dotted wide line, plastic dotted wide line, profiled plastic dotted wide line, painted skip wide line, plastic skip wide line, profiled plastic skip wide line, painted drop lane line, plastic drop lane line, or profiled plastic drop lane line.

No additional measurement for payment will be made for the required second application of paint. No additional measurement for payment will be made for additional applications required to meet thickness requirements for plastic markings.

Removal of lines, 4-inches, 8-inches and 18-inches in width will be measured by the linear foot, with no deduction being made for the unmarked area when the marking includes a gap.

Removal of traffic arrows, traffic letters, access parking space symbol, HOV lane symbol, railroad crossing symbol, bicycle lane symbols, drainage markings, aerial surveillance full and 1/2 markers will be measured per each as "Removing ___ Traffic Marking Removal of crosswalk lines will be measured by the square foot of lines removed as "Removing _____ Crosswalk Line".

8-22.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Paint Line", per linear foot.
"Plastic Line", per linear foot.
"Embossed Plastic Line", per linear foot.
"Profiled Plastic Line", per linear foot.
"Profiled Embossed Plastic Line", per linear foot.
"Inset Plastic Line", per linear foot.
"Painted Drop Lane Line", per linear foot.
"Plastic Drop Lane Line", per linear foot.
"Profiled Plastic Drop Lane Line", per linear foot.
"Painted Wide Line", per linear foot.
"Plastic Wide Line", per linear foot.
"Profiled Plastic Wide Line", per linear foot.
"Painted Dotted Wide Line", per linear foot.
"Plastic Dotted Wide Line", per linear foot.
"Profiled Plastic Dotted Wide Line", per linear foot.
"Painted Skip Wide Line", per linear foot.
"Plastic Skip Wide Line", per linear foot.
"Profiled Plastic Skip Wide Line", per linear foot.
"Painted Barrier Line", per linear foot.
"Plastic Barrier Line", per linear foot.
"Painted Crosswalk Line", per square foot.
"Plastic Crosswalk Line", per square foot.
"Painted Stop Line", per linear foot.
"Plastic Stop Line", per linear foot.
"Painted Traffic Arrow", per each.
"Plastic Traffic Arrow", per each.
"Painted Traffic Letter", per each.
"Plastic Traffic Letter", per each.
"Painted Access Parking Space Symbol", per each.
"Plastic Access Parking Space Symbol", per each
"Painted HOV Lane Symbol Type ____", per each.
"Plastic HOV Lane Symbol Type ____", per each.
"Painted Railroad Crossing Symbol", per each.
"Plastic Railroad Crossing Symbol", per each.

"Painted Bicycle Lane Symbol", per each.
"Plastic Bicycle Lane Symbol", per each.
"Painted Drainage Marking", per each.
"Plastic Drainage Marking", per each.
"Painted Aerial Surveillance Full Marker", per each.
"Plastic Aerial Surveillance Full Marker", per each.
"Painted Aerial Surveillance $^1/_2$ Marker", per each.
"Plastic Aerial Surveillance $^1/_2$ Marker", per each.
"Removing Paint Line", per linear foot.
"Removing Plastic Line", per linear foot.
"Removing Painted Traffic Marking", per each .
"Removing Plastic Traffic Marking", per each .
"Removing Painted Crosswalk Line", per square foot.
"Removing Plastic Crosswalk Line", per square foot.
"Painted Access Parking Space Symbol with Background", per each.
"Plastic Access Parking Space Symbol with Background", per each.
"Painted HOV Lane Symbol", per each.
"Plastic HOV Lane Symbol", per each.
"Painted Yield Line Symbol", per each.
"Plastic Yield Line Symbol", per each.
"Painted Yield Ahead Symbol", per each.
"Plastic Yield Ahead Symbol", per each.
"Painted Speed Bump Symbol", per each.
"Plastic Speed Bump Symbol", per each.

8-23 TEMPORARY PAVEMENT MARKINGS

8-23.1 Description

The work consists of furnishing and installing temporary pavement markings. Temporary pavement markings shall be provided where noted in the Plans and for all lane shifts and detours resulting from construction activities. Temporary pavement markings shall also be provided when permanent markings are eliminated because of construction operations. Temporary pavement markings shall be maintained in serviceable condition throughout the project until permanent pavement markings are installed. Temporary pavement markings that are damaged shall be repaired or replaced immediately. Temporary painted center lines, edge lines, or lane lines and temporary raised pavement markers that are, in the opinion of the Engineer, damaged due to normal wear by traffic, will be replaced. Any temporary line marked with tape shall be repaired immediately when it no longer provides the intended use.

Temporary pavement marking installations are defined as follows:

Temporary Center Line

A BROKEN line used to delineate adjacent lanes of traffic moving in opposite directions. The broken pattern shall be based on a 40-foot unit, consisting of a 4-foot line with a 36-foot gap if paint or tape is used. If temporary raised pavement markers are used, the pattern shall be based on a 40-foot unit, consisting of a grouping of three temporary raised pavement markers, each spaced 3-feet apart, with a 34-foot gap.

Temporary Edge Line

A SOLID line used on the edges of traveled way. The line shall be continuous if paint or tape is used. If temporary raised pavement markers are used, the line shall consist of markers installed continuously at 5-foot spacings.

Temporary Lane Line

A BROKEN line used to delineate adjacent lanes with traffic traveling in the same direction. The broken pattern shall be based on a 40-foot unit, consisting of a 4-foot line with a 36-foot gap, if paint or tape is used. If temporary raised pavement markers are used, the pattern shall be based on a 40-foot unit, consisting of a grouping of three temporary raised pavement markers, each spaced 3-feet apart, with a 34-foot gap.

Lane line and right edge line shall be white in color. Center line and left edge line shall be yellow in color. Edge Lines shall be installed only if specifically required in the contract. All temporary pavement markings shall be retroreflective.

8-23.2 Materials

Materials for temporary markings shall be paint, tape, or raised pavement markers and selected from approved materials listed in the Qualified Products List.

8-23.3 Construction Requirements

8-23.3(1) Preliminary Spotting and Removal

All preliminary layout and marking in preparation for application and the application and removal of temporary pavement markings shall be the responsibility of the Contractor.

Temporary flexible raised pavement markers are required for bituminous surface treatment operations.

Temporary pavement markings consisting of paint or tape may be paved over, but temporary raised pavement markers or removable tape shall be removed prior to paving.

Any temporary pavement markings that are required on the wearing course prior to construction of permanent pavement markings and are not a part of the permanent markings shall be completely removed concurrent with or immediately subsequent to the construction of the permanent pavement markings. Temporary flexible raised pavement markers on bituminous surface treatment pavements shall be cut off flush with the surface if their location conflicts with the alignment of the permanent pavement markings.

All damage to the permanent work caused by removing temporary pavement markings shall be repaired by the contractor at no additional cost to the contracting agency.

8-23.3(2) Beading and Tolerances

Beading shall be in accordance with Section 8-22.3(3). Line tolerances shall be in accordance with Section 8-22.3(4).

8-23.4 Measurement

Temporary center line, temporary edge line, temporary lane line, and temporary raised pavement markers will be measured by the linear foot of each installed line or grouping of markers, with no deduction for gaps in the line or markers.

Reinstalled paint markings and raised pavement markers, when ordered by the Engineer due to normal wear by traffic, will be measured again, each time ordered. Repair, for any reason, of temporary markings made with tape shall not be measured.

Removing temporary center line, temporary edge line, temporary lane line, and temporary raised pavement markers will be measured by the linear foot of each line or grouping of markers removed, with no deduction for gaps in the line or markers.

8-23.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the Proposal:

"Temporary Pavement Marking," per linear foot.

The unit contract price per linear foot for "Temporary Pavement Marking" shall be full pay for constructing and maintaining temporary lines and markers as specified. Unless a bid item has been included in the proposal to pay for removal of temporary pavement markings, all costs for removal of temporary pavement markings shall be included in the unit contract price per linear foot for "Temporary Pavement Marking." No additional compensation will be allowed when the Contractor is required to repair temporary taped markings that have been damaged or worn.

"Removing Temporary Pavement Marking," per linear foot.

8-24 ROCK AND GRAVITY BLOCK WALL AND GABION CRIBBING

8-24.1 Description

This work consists of constructing rock and gravity block wall(s), and gabion cribbing in accordance with the Plans, Special Provisions, these Specifications, or as designated by the Engineer.

8-24.2 Materials

Materials shall meet the requirements of the following Sections:

Rock for Rock Wall and Chinking Material	9-13.7(1)
Backfill for Rock Wall	9-13.7(2)
Gabion Cribbing	9-27.3
Wire Mesh Fabric	9-27.3(1)
PVC Coating for Welded Wire Mesh Fabric	9-27.3(2)
Gabion Basket Fasteners	9-27.3(4)
Stone	9-27.3(6)
Construction Geotextile	9-33

Materials for gravity block walls shall be as specified in the Special Provisions.

8-24.3 Construction Requirements

8-24.3(1) Rock Wall

8-24.3(1)A Geometric Tolerances

The completed wall shall meet the following tolerances:

1. Wall batter shall be 6:1 or flatter as specified in the Plans.
2. The exterior slope plane and grade in the finished surface of the wall shall be plus or minus 6-inches.
3. The maximum void between adjacent rocks shall be 6-inches as measured at the smallest dimensions of the void within the thickness of the wall.

8-24.3(1)B Excavation

Excavation shall conform to Section 2-09.3(4), and to the limits and construction stages shown in the Plans.

The Contractor shall restrict the excavation limits to the length of rock wall that can be constructed in one day's work, except as otherwise noted. The Engineer may permit excavation beyond the limits that can be completed in one day's work provided the Contractor either demonstrates that the excavation will remain stable until the rock wall is completed, or shores the excavation in accordance with Section 2-09.3(4).

Slope above the rock wall shall be established prior to excavating for the wall.

8-24.3(1)C Foundation Preparation

The foundation for the wall shall be graded as shown in the Plans.

Prior to rock placement, the foundation, if not in rock, shall be compacted as approved by the Engineer. Any foundation soils found to be unsuitable shall be removed and replaced in accordance with Section 2-09.3(1)C.

Base course rocks shall have full contact with the foundation soils. If necessary, the excavation shall be shaped to fit the rocks. Rocks may be dropped to shape the ground provided the rocks do not crack. Cracked rocks shall be replaced and the foundation regraded to fit the replacement rock.

8-24.3(1)D Construction Geotextile

Construction geotextile shall be of the type, and shall be placed, as shown in the Plans.

8-24.3(1)E Rock Placement and Backfill

Rocks shall be placed so there are no continuous joint planes in either the vertical or lateral direction.

Where possible, rocks shall be placed so that the rock shall bear on at least two rocks below it. Rocks shall be oriented so that flat surface contact points between adjacent rocks are maximized. Point-to-point contact between adjacent rocks shall be minimized. Each rock in a course shall be arranged so that the natural irregularities in the rocks key the rocks together and so that the courses are keyed together.

Rocks shall increase in size from the top of the wall to the bottom at a uniform rate. The minimum rock sizes, as referenced from the top of the wall, shall be as follows:

Depth from Top of Wall (feet)	Minimum Rock Size at Depth from Top of Wall
6	Three Man
9	Four Man
12	Five Man

Rocks at the top of the wall shall be Two Man or larger.

Where voids larger than 6-inches are present, chinking rock shall be keyed between the rocks to fill the void.

Backfill for the rock wall shall be placed behind each course and tamped to provide a stable condition prior to placing rocks for the next successive course.

For rock walls constructed in fills, the fill shall be overbuilt and cut back to construct the wall.

8-24.3(2) Gravity Block Wall

Excavation shall conform to Section 2-09.3(4), and to the limits and construction stages shown in the Plans. Foundation soils found to be unsuitable shall be removed and replaced in accordance with Section 2-09.3(1)C. Slope above the gravity block wall shall be established prior to beginning any excavation for the wall.

Gravity block walls are defined as a wall of modular blocks acting as a gravity wall to retain soil. The modular blocks may have features designed to interlock the blocks together. However there shall be no reinforcement of the retained soil nor any reinforcement connection between the modular blocks and the retained soil.

Gravity block walls shall be constructed as specified in the Special Provisions and as shown in the Plans.

8-24.3(3) Gabion Cribbing

8-24.3(3)A Foundations

Before placing any gabion cribbing, the Contractor shall excavate the foundation or bed to the specified grade in accordance with Section 2-09.3(4). Foundation soils found to be unsuitable shall be removed and replaced in accordance with Section 2-09.3(1)C.

8-24.3(3)B Baskets

Baskets may be fabricated from either woven or welded steel wire; however, a gabion structure shall not include both. Baskets may be assembled with either lacing wire or clip fasteners; however, a perimeter or diaphragm edge shall not include both.

8-24.3(3)C Dimensions

The Contractor shall supply gabion baskets in the lengths and heights the Plans require. Each length shall be a multiple (double, triple, or greater) of horizontal width. Horizontal width shall be 36-inches. All baskets from the same manufacturer shall be the same width and shall be within a tolerance of 5 percent of the manufacturer's stated sizes.

8-24.3(3)D Fabrication of Baskets

Gabions shall be made so that the sides, ends, lid, and diaphragms can be assembled into rectangular baskets of the required sizes at the construction site. Common-wall construction may be used in gabion structures up to 12-feet high. Common-wall construction includes any basket where its top serves as the bottom of the one above it, or where one wall also serves an adjacent basket. When gabion structures are more than 12-feet high, the baskets shall have independent sides, ends, top, and bottom.

Each gabion shall be divided by diaphragms into cells the same length as horizontal basket width. Diaphragms shall be made of the same mesh and gage as the basket body.

All perimeter and diaphragm edges shall be laced or clipped together so that joints are at least as strong as the body of the mesh itself. The ends of the lacing shall be anchored by three tight turns around the selvage wire.

8-24.3(3)E Filling Baskets

Baskets shall be filled with stone. The stone shall be placed and compacted to meet the unit weight requirements of Section 8-24.3(3)F.

The stone shall be placed in compacted layers not more than 14-inches deep. If cross-connecting wires are required, the Contractor shall adjust the number and depth of layers so that wires occur between the compacted layers of stone.

8-24.3(3)F Unit Weight Requirements and Test

The unit weight of the filled gabion basket shall be at least 100 pounds per cubic foot. Should the unit weight be less than 100 pounds per cubic foot, the gabion will be rejected and the Engineer will require the Contractor to conduct and pass additional unit weight tests before completing other gabions.

The Contractor shall conduct either of the following unit weight tests to prove the density of completed gabions:

1. A filled gabion basket shall be selected from the completed structure and weighed.
2. A gabion basket shall be filled with stone from a loaded truck that has been weighed. After filling, the truck and unused stone shall be weighed again. The difference between the two weights shall be used to determine the weight per cubic foot of the stone in the gabion.

The Contractor shall conduct one unit weight test for each 500 cubic yards of gabions placed. The Engineer may reduce the specified frequency of these tests provided the specified minimum unit weight has been consistently achieved.

In conducting unit weight test 1 or 2, the Contractor shall provide and use scales conforming to Section 1-09.2.

8-24.3(3)G Gabion Cribbing Erection

Each row or tier of baskets shall be reasonably straight and shall conform to alignment and grade. Hexagonal mesh baskets shall be stretched endwise before filling. The stone shall be carefully placed in layers, then tamped or vibrated. The last layer of stones shall fill each basket completely so that the secured lid will rest upon the stones. Each basket shall be laced securely to all adjacent baskets and its lid then laced or clipped to the sides, ends, and diaphragms.

All selvage wires of ends of adjacent baskets shall be laced together. The bottom selvage of the basket being constructed on a previously constructed basket shall be laced to the top of that basket.

Backfilling behind or around gabions shall conform to Section 2-09.3(1)E.

8-24.4 Measurement

Rock for rock walls and backfill for rock walls will be measured by the ton of rock actually placed.

Gabion cribbing will be measured by the calculated neat line volume of gabion baskets in place, using the manufacturer's stated dimensions.

Gravity block wall will be measured by the square foot of completed wall in place. The vertical limits for measurement are from the bottom of the bottom layer of blocks to the top of the top layer of blocks. The horizontal limits for measurement are from the end of wall to the end of wall.

Construction geotextile will be measured by the square yard for the surface area actually covered.

Structure excavation Class B, structure excavation Class B including haul, and shoring or extra excavation Class B, will be measured in accordance with Section 2-09.4.

8-24.5 Payment

Payment will be made in accordance with Section 1-04.1 for each of the following bid items that are included in the proposal:

"Rock for Rock Wall", per ton.

The unit contract price per ton for "Rock for Rock Wall" shall also include furnishing and installing chinking materials.

"Backfill for Rock Wall", per ton.

"Gabion Cribbing", per cubic yard.

"Gravity Block Wall", per square foot.

"Construction Geotextile", per square yard.

"Structure Excavation Class B", per cubic yard.

"Structure Excavation Class B Incl. Haul", per cubic yard.

"Shoring or Extra Excavation Class B", per square foot.

8-25 GLARE SCREEN

8-25.1 Description

This work consists of furnishing and constructing glare screen of the types specified, in accordance with the Plans, these Specifications, the Standard Plans, and as ordered by the Engineer in accordance with Section 1-04.4.

Glare screen consists of diamond woven wire mesh fence of aluminum, galvanized or aluminum coated steel wire, fabricated and placed to reduce glare from headlights of opposing traffic or other adjacent light sources.

8-25.2 Materials

Materials shall meet the requirements of Section 9-16.6.

8-25.3 Construction Requirements

8-25.3(1) Glare Screen Fabric

Glare screen fabric shall be placed on the face of the posts designated by the Engineer. On curves, the fabric shall be placed on the face of the post that is on the outside of the curve.

The fabric shall be stretched taut and securely fastened to the posts. Fastening to end, brace, and pull posts shall be with stretcher bars and fabric bands spaced at 1-foot intervals. The fabric shall be cut and each span attached independently at all pull and corner posts. Fabric shall be securely fastened to line posts with tie wires, metal bands, or other approved methods, attached at 14-inch intervals. The top and bottom of the fabric shall be fastened to the tension cable and tension wire with hog rings spaced at 24-inch intervals.

Rolls of wire fabric shall be joined by weaving a single strand into the end of the rolls to form a continuous mesh.

8-25.3(2) Slats

The slats shall be fastened into the weave by using staples, screws, or other methods as approved by the Engineer. Allowing the tension of the mesh to hold the slats in place will not be permitted.

Slats broken or split during construction shall be removed and replaced by the Contractor at no expense to the Contracting Agency.

8-25.3(3) Posts

Posts, other than for Type 1 Design A, shall be constructed in accordance with the Standard Plans and applicable provisions of Section 8-12.3(1)A.

Posts for Type 1 Design A shall be bolted to the beam guardrail posts as detailed in the Standard Plans. Drilling of the guardrail posts shall be done in such a manner to ensure that the glare screen posts are set plumb and centered over the guardrail posts unless otherwise directed.

All round posts for Type 1 Design B and Type 2 glare screen shall be fitted with a watertight top securely fastened to the post. Line posts shall have tops designed to carry the top cable.

8-25.3(4) Tension Wire

Tension wires shall be attached to the posts as detailed in the Standard Plans or as approved by the Engineer.

8-25.3(5) Tension Cables

The tension cable shall pass through the line post top, and one continuous length of cable shall be used between the pull posts. Sufficient tension shall be applied to the cable to allow a maximum sag of 1/4-inch between posts after the chain link mesh has been attached to the cable. The Contractor shall provide temporary bracing on pull posts when applying tension to one length of cable at a time to prevent undue stresses on the pull post.

The cable shall be fastened to the top of the pull post with an eye bolt through the post and a turnbuckle connecting the eye bolt to the cable. Pull posts shall be braced to the bottom of the end or anchor posts with a short length of cable or tension wire as shown in the Standard Plans. All turnbuckles shall have a minimum of 1-inch take-up clearance after tensioning.

The ends of all cables shall be seized with annealed iron wire for a distance of at least 1-inch.

8-25.3(6) Fittings, Attachments and Hardware

A lead washer shall be placed against the shoulder of the eye nut, eye bolt, or backup nut, and a lead washer backed by the steel washer placed between the pipe and lock washer, and the nut tightened sufficiently to seal the hole in the pipe.

A galvanized iron strap 1/4-inch in thickness by 12-inches in width, formed as shown in the Standard Plans, shall be provided for the attachment of eye bolts to the base of the H column post in order to take the strain of the cable tension off the web of the H column.

8-25.4 Measurement

Measurement of glare screen will be by the linear foot of completed glare screen for the particular type and design specified.

8-25.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Glare Screen Type 1 Design ____", per linear foot.

"Glare Screen Type 2", per linear foot.

8-26 VACANT

8-27 VACANT

8-28 VACANT

8-29 WIRE MESH SLOPE PROTECTION

8-29.1 Description

This work consists of constructing wire mesh slope protection in accordance with these Specifications and the details shown in the Standard Plans and in conformity with the lines and dimensions shown in the Plans or established by the Engineer.

8-29.2 Materials

Materials shall meet the requirements of Section 9-16.4.

8-29.3 Construction Requirements

8-29.3(1) Anchors

The Contractor shall install anchors of the type shown in conformance to the layout shown in the Plans. The spacing and number of the anchors and wire ropes as shown in the Plans are approximate only, and the Engineer will arrange the spacing in such a manner as to hold the wire mesh against the slope. Backfill material shall be thoroughly compacted.

8-29.3(2) Wire Rope Assembly

The wire rope assembly shall be in place before the wire mesh is attached. The bottom wire rope shall not be tensioned. No wire rope splicing will be allowed.

8-29.3(3) Wire Mesh

The wire mesh shall be fastened to the completed wire rope assembly as shown in the Plans. Hog rings on the vertical lap splices shall be placed in a single row centered on the splice. Horizontal splices joining two rolls of mesh shall be made by removing a horizontal end wire and reweaving through the ends of the fabric to form a continuous mesh. All top and bottom laps shall be made by folding the mesh to the outside, away from the slope, to avoid the possibility of falling material hanging up in the folds. The bottom of the mesh shall be located so that material dislodged under the mesh can drain freely from the bottom, yet will not flow or bounce onto the roadway. The ends of all tie wires shall be secured to the mesh with a minimum of $1^1/_2$-turns.

The wire mesh shall not be tensioned in any direction, but is to remain loose so as to increase its dampening effect on rolling rocks. The Contractor shall use care in the handling and installing of the wire mesh and wire rope. Any mesh or wire rope damaged due to the Contractor's operations shall be replaced by the Contractor at no expense to the Contracting Agency.

8-29.4 Measurement

Measurement of anchors will be per each for the completed anchor. Anchor types will not be differentiated.

Galvanized wire mesh will be measured by the square foot of the completed area.

Galvanized wire rope will be measured by the linear foot of wire rope actually used in the completed project.

8-29.5 Payment

Payment will be made in accordance with Section 1-04.1, for each of the following bid items that are included in the proposal:

"Wire Mesh Slope Protection Anchor", per each.

"Galvanized Wire Mesh", per square foot.

"Galvanized Wire Rope", per linear foot.

DIVISION 9
MATERIALS

9-00 DEFINITIONS AND TESTS

9-00.1 Fracture

"Fractured aggregate is defined as an angular, rough, or broken surface of an aggregate particle created by crushing, or by other means. A face is considered a "fractured face" whenever one-half or more of the projected area, when viewed normal to that face, is fractured with sharp and well-defined edges: this excludes small nicks.

9-00.2 Wood Waste

Wood waste is defined as all material which, after drying to constant weight, has a specific gravity of less than 1.0.

9-00.3 Test for Mass of Galvanizing

At the option of the Engineer, the weight of zinc in ounce per square foot required by the various galvanizing specifications may be determined by an approved magnetic thickness gage suitably checked and demonstrated for accuracy, in lieu of the other methods specified.

9-00.4 Sieve Analysis of Aggregates

Sieve analysis for acceptance of aggregate gradation shall be performed by procedures described in the WAQTC FOP for AASHTO T 27/11.

9-00.5 Dust Ratio

The dust ratio is defined as the percent of material passing the U.S. No. 200 sieve divided by the percent of material passing the U.S. No. 40 sieve.

9-00.6 Sand/Silt Ratio

The sand/silt ratio is defined as the percent of material passing the U.S. No. 10 sieve divided by the percent of material passing the U.S. No. 200 sieve.

9-00.7 Galvanized Hardware, AASHTO M 232

An acceptable alternate to hot-dip galvanizing in accordance with AASHTO M 232 will be zinc coatings mechanically deposited in accordance with AASHTO M 298, providing the minimum thickness of zinc coating is not less than thats pecified in AASHTO M 232, and the process will not produce hydrogen embrittlement in the base metal. Sampling and testing will be made by the Engineer in accordance with commonly recognized national standards and methods used in the laboratory of the Department of Transportation.

9-00.8 Sand Equivalent

The sand equivalent will be the average of duplicate determinations from a single sample. The sand equivalent sample will be prepared in accordance with the WSDOT Field Operating Procedure (FOP) for AASHTO T 176.

For acceptance of processed material, there must be a clear line of demarcation. If no clear line of demarcation has formed at the end of the specified 20 minute sedimentation period, the material will be considered as failing to meet the minimum specified sand equivalent.

9-00.9 Field Test Procedures

Field test procedures may be either a WSDOT Standard Operating Procedure (SOP) or a Field Operating Procedure (FOP) for an AASHTO, ASTM, or WAQTC test procedure. A Field Operating Procedure is a technically equivalent abridged version of an AASHTO, ASTM or WAQTC test procedure for use in field conditions. References to manuals containing all of these tests and procedures can be found in Section 1-06.2(1).

9-01 PORTLAND CEMENT

9-01.1 Types of Cement

Cement shall be classified as Portland cement or blended hydraulic cement.

9-01.2 Specifications

9-01.2(1) Portland Cement

Portland cement shall conform to the requirements for Types I, II, or III cement of the Standard Specifications for Portland Cement, AASHTO M 85 or ASTM C 150, except that the content of alkalis shall not exceed 0.75 percent by weight calculated as Na_20 plus 0.658 K_20 and except that the content of Tricalcium aluminate (C_3A) shall not exceed 8 percent by weight calculated as $2.650A1_20_3$ minus $1.692Fe_20_3$. The total amount of processing additions used shall not exceed 1% of the weight of portland cement clinker. The type and amount of processing additions used shall be shown on mill test reports.

The time of setting shall be determined by the Vicat Test method, AASHTO T 131 or ASTM C 191.

9-01.2(3) Low Alkali Cement

When the Special Provisions state that low alkali cement shall be used, the percentage of alkalis in the cement shall not exceed 0.60 percent by weight calculated as Na20 plus 0.658 K20. This limitation shall apply to all types of Portland cement.

9-01.2(4) Blended Hydraulic Cement

Blended hydraulic cement shall be either Type IP (MS), Type I (SM) (MS) or Type I (PM) (MS) cement conforming to AASHTO M 240 and meet the following additional requirements:

1. Type IP(MS) Portland - Pozzolan Cement with moderate sulfate resistance.

   This product shall be limited to Portland Cement and Pozzolan. Pozzolan shall be limited to fly ash or ground granulated blast furnace slag. Fly ash is limited between 15 percent and 35 percent by weight of the cementitious material. Ground granulated blast furnace slag is limited between 15 percent and 25 percent by weight of the cementitious material.

2. Type I(SM) (MS) Slag Modified Portland Cement with moderate sulfate resistance.

   This product shall be limited to Portland Cement and ground granulated blast furnace slag. The addition of ground granulated blast furnace slag shall be limited to a maximum of 25 percent by weight of the cementitious material.

3. Type I(PM)(MS) Pozzolan – Modified Portland Cement with moderate sulfate resistance.

   The product shall be limited to Portland Cement and pozzolan. The pozzolan shall be limited to fly ash or ground granulated blast furnace slag at a maximum of 15 percent by weight of the cementitious material.

The source and weight of the fly ash or ground granulated blast furnace slag shall be certified on the cement mill test certificate and shall be reported as a percent by weight of the total cementitious material. The fly ash or ground granulated blast furnace slag constituent content in the finished cement will not vary morethan plus or minus 5 percent by weight of the finished cement from the certified value.

Fly ash shall meet the requirements of Section 9-23.9 of these Standard Specifications.

Ground granulated blast furnace slag shall meet the requirements of Section 9-23.10 of these Standard Specifications.

9-01.3 Tests and Acceptance

Cement may be accepted by the Engineer based on the Manufacturer's Mill Test Report number indicating full conformance to the Specifications. All shipments of the cement to the Contractor or concrete supplier shall identify the applicable Mill Test Report Number. The concrete supplier or Contractor shall provide mill test identification on all concrete deliveries.

Each mixing facility or plant utilizing Portland cement shall be equipped with a suitable means or device for obtaining a representative sample of the cement. The device shall enable the sample to be readily taken in proximity to the cement weigh hopper and from a container or conveyor holding only cement.

Cement may be tested using samples taken at the job site by the Engineer for submission to the State Materials Laboratory for testing.

9-01.4 Storage on the Work Site

The cement shall be stored on the site in a manner as to permit easy access for inspection and identification.

Cement shall be adequately protected at all times from rain and dampness. Cement which, in the opinion of the Engineer, contains lumps that will not be pulverized in the mixer shall be rejected.

Type III Portland cement stored by the Contractor for a period longer than 30 days, or Types I or II Portland cement stored by the Contractor for a period longer than 60 days, shall be held for retest. If the cement has lost strength during the period of storage, as shown by tests of the Contracting Agency, sufficient additional cement shall be added to the mix at the Contractor's expense to overcome such loss, or the cement may be rejected. The amount of cement to be added to the mix shall be determined by the Engineer.

9-02 BITUMINOUS MATERIALS

9-02.1 Asphalt Material, General

Asphalt furnished under these Specifications shall not have been distilled at a temperature high enough to injure by burning or to produce flecks of carbonaceous matter, and upon arrival at the work, shall show no signs of separation into lighter and heavier components.

9-02.1(1) Vacant

9-02.1(2) Medium Curing (MC) Liquid Asphalt

Characteristics		AASHTO Test Method	MC-70	MC-250	MC-800	MC-3000
Kinematic Viscosity at 140ºF cSt		T 201	70-140	250-500	800-1600	3000-6000
Flash Point (Tag Open Cup)	Min. F	T 79	100	150	150	150
Water Content	Min. %	T 55	0.2	0.2	0.2	0.2
Distillation: volume % of total distillate to 680ºF		T 78				
to 437ºF			0-20	0-10	---	---
to 500ºF			20-60	15-55	0-35	0-15
to 600ºF			65-90	60-87	45-80	15-75
Residue of 680ºF distillation % volume by difference	Min.		55	67	75	80
Properties of residue from distillation to 680ºF Absolute viscosity at 140ºF, poise		T 202	300-1200	300-1200	300-1200	300-1200
[1]Ductility, 5 cm/min. at 77ºF, cm	Min.	T 51	100	100	100	100
Solubility in trichloroethylene	Min. %	T 44	99.0	99.0	99.0	99.0

[1]If the ductility at 77ºF is less than 100, the material will be acceptable if its ductility at 60ºF is more than 100.

The material shall not foam when heated to the application temperature recommended in Section 5-02.3(3).

9-02.1(3) Rapid Curing (RC) Liquid Asphalt

Characteristics		AASHTO Test Method	RC-70	RC-250	RC-800	RC-3000
Kinematic Viscosity at 140ºF cSt		T 201	70-140	250-500	800-1600	3000-6000
Flash Point (Tag Open Cup)	Min. F	T 79	---	80	80	80
Water Content	Min. %	T 55	0.2	0.2	0.2	0.2
Distillation: volume % of total distillate to 680ºF		T 78				
to 374ºF	Min.		10	---	---	---
to 473ºF	Min.		50	35	15	---
to 500ºF	Min.		70	60	45	25
to 600ºF	Min.		85	80	75	70
Residue of 680ºF distillation % volume by difference	Min.		55	65	75	80
Properties of residue from distillation to 680ºF Absolute viscosity at 140ºF, poise		T 202	600-2400	600-2400	600-2400	600-2400
Ductility, 5 cm/min. at 77ºF	Min.	T 51	100	100	100	100
Solubility in trichloroethylene	Min. %	T 44	99.0	99.0	99.0	99.0

The material shall not foam when heated to application temperature recommended in Section 5-02.3(3).

9-02.1(4) Asphalt Binders

Asphalt binder meeting the requirements of AASHTO M 320 of the grades specified in the contract shall be used in the production of HMA.

9-02.1(4)A Performance Graded Asphalt Binder

Performance Grade	PG58			PG64			PG70			PG76	
	-22	-28	-34	-22	-28	-34	-22	-28	-34	-22	-28
Original Binder											
Flash point temp, AASHTO T48 Minimum °C	230										
Viscosity, AASHTO T316 Maximum 3 Pa·s, test temp, °C	135										
Dynamic shear, AASHTO T315 G*/sinδ, minimum 1.00 kPa Test temp. @ 10 rad/s, °C	58			64			70			76	
Rolling Thin Film Oven Residue (AASHTO T240)											
Mass Change, Maximum, percent	1.00										
Dynamic shear, AASHTO T315 G*/sinδ, minimum 2.20 kPa Test temp. @ 10 rad/s, °C	58			64			70			76	
Pressure Aging Vessel Residue (AASHTO R28)											
PAV aging temperature, °C	100										
Dynamic shear, AASHTO T315 G*sinδ, maximum 5000 kPa Test temp. @ 10 rad/s, °C	22	19	16	25	22	19	28	25	22	31	28
Creep stiffness, AASHTO T313 S, maximum 300 MPa, m - value, minimum 0.300 Test temp. @ 60 s, °C	-12	-18	-24	-12	-18	-24	-12	-18	-12	-12	-18

All Performance Grade asphalt binders not included in this chart shall be determined by Table 1-Performance Graded Asphalt Binder Specification in AASHTO M320.

Grade	Type AASHTO Test Method	Cationic Emulsified Asphalt: Rapid Setting CRS-1 Min.	CRS-1 Max	CRS-2 Min.	CRS-2 Max.	Medium Setting CMS-2S Min.	CMS-2S Max.	CMS-2 Min.	CMS-2 Max.	CMS-2h Min.	CMS-2h Max.	Slow Setting CSS-1 Min.	CSS-1 Max.	CSS-1h Min.	CSS-1h Max.	Special Tack STE-1 Min.	STE-1 Max.
Tests on Emulsions:																	
Viscosity Saybolt Furol S @ 77ºF (25 °C)	T 59	—	—	—	—	—	—	—	—	—	—	20	100	20	100	—	30
Viscosity Saybolt Furol S @ 122ºF (50 °C)	T 59	20	100	150	400	50	450	50	450	50	450	—	—	—	—	—	—
Storage stability test 1 day %	T 59	—	1	—	1	—	1	—	1	—	1	—	1	—	1	—	1
Demulsibility 35 ml 0.8% sodium dioctyl sulfosuccinate, %[a]	T 59	40	—	40	—	—	—	—	—	—	—	—	—	—	—	25	—
Coating ability & water resistance:																	
Coating, dry aggregate	T 59	—	—	—	—	Good	—	Good	—	Good	—	—	—	—	—	—	—
Coating, after spraying	T 59	—	—	—	—	Fair	—	Fair	—	Fair	—	—	—	—	—	—	—
Coating, wet aggregate	T 59	—	—	—	—	Fair	—	Fair	—	Fair	—	—	—	—	—	—	—
Coating, after spraying	T 59	—	—	—	—	Fair	—	Fair	—	Fair	—	—	—	—	—	—	—

Cationic Emulsified Asphalt (Continued)

Grade	Type AASHTO Test Method	Rapid Setting CRS-1 Min.	Rapid Setting CRS-1 Max	Rapid Setting CRS-2 Min.	Rapid Setting CRS-2 Max	Medium Setting CMS-2S Min.	Medium Setting CMS-2S Max	Medium Setting CMS-2 Min.	Medium Setting CMS-2 Max	Medium Setting CMS-2h Min.	Medium Setting CMS-2h Max	Slow Setting CSS-1 Min.	Slow Setting CSS-1 Max	Slow Setting CSS-1h Min.	Slow Setting CSS-1h Max	Special Tack STE-1 Min.	Special Tack STE-1 Max
Particle charge test	T 59	Pos		Pos		Pos		Pos		Pos		Pos[b]		Pos[b]		Pos	
Sieve Test, %	T 59	—	0.10	—	0.10	—	0.10	—	0.10	—	0.10	—	0.10	—	0.10	—	0.10
Cement mixing test, %	T 59	—	—	—	—	—	—	—	—	—	—	—	2.0	—	2.0	—	—
Distillation:																	
Oil distillate by vol. of emulsions %	T 59	—	3	1.5	3	—	20	—	12	—	12	—	—	—	—	—	5
Residue, %	T 59	60	—	65	—	60	—	65	—	65	—	57	—	57	—	45	—
Tests on residue from distillation tests:																	
Penetration, 77ºF (25° C)	T 49	100	250	100	250	100	250	100	250	40	90	100	250	40	90	100	200
Ductility, 77ºF (25° C) 5 cm/min., cm	T 51	40	—	40	—	40	—	40	—	40	—	40	—	40	—	40	—
Solubility in trichloroethylene, %	T 44	97.5	—	97.5	—	97.5	—	97.5	—	97.5	—	97.5	—	97.5	—	97.5	—

[a]The demulsibility test shall be made within 30 days from date of shipment.

[b]If the particle charge test for CSS-1 and CSS-1h is inconclusive, material having a maximum pH value of 6.7 will be acceptable.

9-02.1(5) Vacant

9-02.1(6) Cationic Emulsified Asphalt

See table. Pages 9-9 and 9-10.

9-02.1(6)A Polymerized Cationic Emulsified Asphalt CRS-2P

The asphalt CRS-2P shall be a polymerized cationic emulsified asphalt. The polymer shall be milled into the asphalt or emulsion during the manufacturing of the emulsion. The asphalt CRS-2P shall meet the following specifications:

	AASHTO Test Method	Specifications	
		Minimum	Maximum
Viscosity @122ºF, SFS	T 59	100	400
Storage Stability 1 day %	T 59	---	1
Demulsibility 35 ml. 0.8% Dioctyl Sodium Sulfosuccinate	T 59	40	---
Particle Charge	T 59	positive	---
Sieve Test %	T 59	---	0.30
Distillation			
Oil distillate by vol. of emulsion %	T 59[note 1]	0	3
Residue	T 59	65	---
Test on the Residue From Distillation			
Penetration @77ºF	T 49	100	250
Torsional Recovery %	[note 2]	18	---
or			
Toughness/Tenacity in-lbs	[note 3]	50/25	---

[note 1]Distillation modified to use 300 grams of emulsion heated to 350ºF ± 9ºF and maintained for 20 minutes.

[note 2]The Torsional Recovery test shall be conducted according to the California Department of Transportation Test Method No. 332.

[note 3]Benson method of toughness and tenacity; Scott tester, inch-pounds at 77ºF, 20 in. per minute pull. Tension head $^{7}/_{8}$ in. diameter.

At the option of the supplier the Benson Toughness/Tenacity test can be used in lieu of Torsional Recovery based on type of modifier used. If the Benson Toughness/Tenacity method is used for acceptance the supplier must supply all test data verifying specification conformance.

9-02.1(7) Asphalt for Sub-Sealing

Asphalt for sub-sealing shall conform to the requirements of ASTM D 3141 except that the minimum softening point shall be 170ºF.

9-02.1(8) Flexible Bituminous Pavement Marker Adhesive

Flexible bituminous pavement marker adhesive is a hot melt thermoplastic bituminous material used for bonding raised pavement markers and recessed pavement markers to the pavement.

The adhesive material shall conform to the following requirements:

Property	Test Method	Requirement
Penetration, 77ºF, 100g, 5 sec, dmm	AASHTO T 49	30 Max.
Softening Point, F	AASHTO T 53	200 Min.
Rotational Thermosel Viscosity, cP, #27 spindle, 20 RPM, 400ºF	AASHTO T 316	5000 Max.
Ductility, 77ºF, 5 cm/minute, cm	AASHTO T 51	15 Min.
Ductility, 39.2ºF, 1 cm/minute, cm	ASTM D 51	5 Min.
Flexibility, 1", 20ºF, 90 deg. Bend, 10 sec., $^1/_8$"× 1" × 6" specimen	ASTM D 3111 NOTE 1	Pass

Flexible bituminous adhesive shall develop bond pull-off strength greater than 50 psi when tested in accordance with WSDOT T-426.

Note 1: Flexibility test is modified by bending specimen through an arc of 90 degrees at a uniform rate in 10 seconds over a 1-inch diameter mandrel.

9-02.1(9) Coal Tar Pitch Emulsion

The coal tar pitch emulsions shall conform to the requirements found in ASTM D 5727. The emulsion shall be homogeneous and shall show no separation or coagulation of components that cannot be overcome by moderate stirring. It shall be capable of being applied completely by squeegee, brush, or other approved mechanical methods to the surface of bituminous pavements when spread at the specified rates.

9-02.2 Sampling and Acceptance

9-02.2(1) Certification of Shipment

Bituminous materials may be accepted by the Engineer based on the asphalt binder supplier's Certification of Compliance incorporated in their Bill of Lading. The Certification will include a statement certifying specification compliance for the product shipped. Failure to provide this Certification with the shipment shall be cause for rejection of the material. The following information is required on the Bill of Lading:

1. Date
2. Contract Number and/or Project Name
3. Grade of Commodity and Certification of Compliance
4. Anti-strip Type
5. Percent Anti-strip
6. Mass (Net Tons)
7. Volume (Gross Gallons)
8. Temperature of Load (F)
9. Bill of Lading Number

10. Consignee and Delivery Point
11. Signature of Supplier's Representative
12. Supplier (Bill of Lading Generator)
13. Supplier's Address
14. Refiner
15. Refiner's Location

The Bill of Lading shall be supplied at the time of shipment of each truck load, truck and trailer, or other lot of asphalt binder. In addition to the copies the Contractor requires, one copy of the Bill of Lading including the Certification Statement shall be sent with the shipment for agency use.

9-02.2(2) Samples

When requested by the Engineer, the asphalt supplier shall ship, by prepaid express or U.S. mail, samples of asphalt that represent current production.

9-02.3 Temperature of Asphalt

The temperature of paving asphalts in storage tanks when loaded for transporting shall not exceed the maximum temperature recommended by the asphalt binder manufacturer.

9-02.4 Anti-Stripping Additive

When directed by the Engineer, heat-stable anti-stripping additive shall be added to the asphalt mix. At the option of the Contractor, the anti-stripping additive can be either added to the liquid asphalt or sprayed on the aggregate on the cold feed. Once the process and type of anti-stripping additive proposed by the Contractor have been approved by the State Materials Laboratory, the process, brand, grade, and amount of anti-stripping additive shall not be changed without approval of the Engineer.

When liquid anti-stripping additive is added to the liquid asphalt, the amount will be designated by the Engineer, but shall not exceed 1 percent by weight of the liquid asphalt.

When polymer additives are sprayed on the aggregate, the amount will be designated by the Engineer, but shall not exceed 0.67 percent by weight of the aggregate.

The use of another process or procedure for adding anti-stripping additive to the asphalt mix will be considered based on a proposal from the Contractor.

9-03 AGGREGATES

9-03.1 Aggregates for Portland Cement Concrete

9-03.1(1) General Requirements

Portland cement concrete aggregates shall be manufactured from ledge rock, talus, or sand and gravel in accordance with the provisions of Section 3-01.

Aggregates tested in accordance with AASHTO T 303 or ASTM C 1260 with expansion greater than 0.20 percent are Alkali Silica Reactive (ASR) and will require mitigating measures. Aggregates tested in accordance with ASTM C 1293 with expansion greater than 0.04 percent are Alkali Silica Reactive (ASR) and will require mitigating measures.

Aggregates for use in Commercial Concrete as defined in 6-02.3(2)B shall not require mitigation.

Mitigating measures for aggregates with expansions from 0.21 to 0.45 percent, when tested in accordance with AASHTO T 303 or ASTM C 1260, may be accomplished by using low alkali cement as per 9-01.2(3) or by using 25% Class F fly ash by total weight of the cementitious materials. The Contractor may submit an alternative mitigating measure through the Project Engineer to the State Materials Laboratory for approval along with evidence in the form of test results from AASHTO T 303 or ASTM C 1260 that demonstrate the mitigation when used with the proposed aggregate controls expansion to 0.20 percent or less. The agency may test the proposed ASR mitigation measure to verify its effectiveness. In the event of a dispute, the agency's results will prevail.

Mitigating measures for aggregates with expansions greater than 0.45 percent when tested in accordance with AASHTO T-303 or ASTM C-1260 shall include the use of low alkali cement per 9-01.2(3) and may include the use of fly ash, lithium compound admixtures, ground granulated blast furnace slag or other material as approved by the Engineer. The Contractor shall submit evidence in the form of test results from ASTM C 1260 or AASHTO T 303 through the Project Engineer to the State Materials Laboratory that demonstrate the proposed mitigation when used with the aggregates proposed will control the potential expansion to 0.20 percent or less before the aggregate source may be used in concrete. The agency may test the proposed ASR mitigation measure to verify its effectiveness. In the event of a dispute, the agency's results will prevail.

Passing petrographic analysis (ASTM C 295) accepted by WSDOT prior to August 1, 2005, is acceptable as proof of mitigation until the aggregate source is reevaluated.

ASTM C 1293 sampling and testing must be coordinated through the WSDOT State Materials Laboratory, Documentation Section utilizing the ASA (Aggregate Source Approval) process. Cost of sampling, testing, and processing will be borne by the source owner.

9-03.1(2) Fine Aggregate for Portland Cement Concrete

Fine aggregate shall consist of sand or other inert materials, or combinations thereof, approved by the Engineer, having hard, strong, durable particles free from adherent coating. Fine aggregate shall be washed thoroughly to remove clay, loam, alkali, organic matter, or other deleterious matter.

9-03.1(2)A Deleterious Substances

The amount of deleterious substances in the washed aggregate shall not exceed the following values:

1. Particles of specific gravity less than 1.95 ..... 1.0 percent by weight.
2. Organic matter, by colorimetric test, shall not be darker than the reference standard color (organic plate No. 3) AASHTO T 21 unless other tests prove a darker color to be harmless.

9-03.1(2)B Grading

Fine aggregate shall be graded to conform to the following requirements expressed as percentages by weight:

	Class 1 Percent Passing		Class 2 Percent Passing	
Sieve Size	Min.	Max.	Min.	Max.
⅜″ square	100		100	
U.S. No. 4	95	100	95	100
U.S. No. 8	68	86	---	---
U.S. No. 16	47	65	45	80
U.S. No. 30	27	42	---	---
U.S. No. 50	9	20	10	30
U.S. No. 100	0	7	2	10
U.S. No. 200	0	2.5	0	2.5

For fine aggregate Class 1, individual test variations under the minimum or over the maximum will be permitted as follows, provided the average of three consecutive tests is within the specification limits:

Sieve Size	Permissible Percent of Variation in Individual Tests
U.S. No. 30 and coarser	2
U.S. No. 50 and finer	0.5

Within the gradation limits for fine aggregate Class 2, uniformity of gradation shall be limited to a range of plus or minus 0.20 of the reference fineness modulus. The reference fineness modulus shall be determined from a representative sample from the proposed source as submitted by the Contractor.

9-03.1(2)C Use of Substandard Gradings

Fine aggregate with more than the maximum percentage passing any sieve may be accepted provided the cement content of the finished concrete is increased at the Contractor's expense, $^1/_3$ percent for each 1 percent the fine aggregate passing each sieve is in excess of the maximum.

Under no circumstances shall fine aggregate Class 1 be used which has a grading finer than the following:

Sieve Size	Percent Passing
U.S. No. 8	95
U.S. No. 16	80
U.S. No. 30	60
U.S. No. 50	25
U.S. No. 200	2.5

All percentages are by weight.

9-03.1(3) Vacant

9-03.1(4) Coarse Aggregate for Portland Cement Concrete

Coarse aggregate for concrete shall consist of gravel, crushed stone, or other inert material or combinations thereof having hard, strong, durable pieces free from adherent coatings. Coarse aggregate shall be washed to remove clay, silt, bark, sticks, alkali, organic matter, or other deleterious material.

9-03.1(4)A Deleterious Substances

The amount of deleterious substances shall not exceed the following values:

Amount finer than U.S. No. 200	1.00 percent by weight
Pieces of specific gravity less than 1.95	2.00 percent by weight
Clay lumps	0.50 percent by weight
Shale	2.00 percent by weight
Wood waste	0.05 percent by weight

For coarse aggregate with a minimum single face fracture content of 25 percent by weight, the material finer than the U.S. No. 200 sieve may increase to a maximum of 1.5 percent by weight. The fracture requirement shall be at least one fractured face and will apply to the combined aggregate retained on the U.S. No. 4 sieve in accordance with FOP for AASHTO PT 61.

9-03.1(4)B Wear in Los Angeles Machine

Coarse aggregate shall not have a percentage of wear in Los Angeles machine in excess of 35 after 500 revolutions.

9-03.1(4)C Grading

Coarse aggregate for Portland cement concrete when separated by means of laboratory sieves shall conform to one or more of the following gradings as called for elsewhere in these Specifications, Special Provisions, or in the Plans:

Passing	AASHTO Grading No. 467		AASHTO Grading No. 57		AASHTO Grading No. 67		AASHTO Grading No. 7		AASHTO Grading No. 8	
Sieve Size	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
2″ square	100	—	—	—	—	—	—	—	—	—
1½″ square	95	100	100	—	—	—	—	—	—	—
1″ square	—	—	95	100	100	—	—	—	—	—
¾″ square	35	70	—	—	90	100	100	—	—	—
½″ square	—	—	25	60	—	—	90	100	100	—
⅜″ square	10	30	—	—	20	55	40	70	85	100
U.S. No. 4	0	5	0	10	0	10	0	15	10	30
U.S. No. 8	—	—	0	5	0	5	0	5	0	10
U.S. No. 16	—	—	—	—	—	—	—	—	0	5

All percentages are by weight.

In individual tests, a variation of four under the minimum percentages or over the maximum percentages will be permitted, provided the average of three consecutive tests is within the specification limits. Coarse aggregate shall contain no piece of greater size than two times the maximum sieve size for the specified grading measured along the line of greatest dimension.

When the Engineer approves, the coarse aggregate may be blended from other sizes if:

1. The resulting aggregate meets all requirements for the approved grading;
2. Each size used makes up at least 5 percent of the blend; and
3. The Contractor supplies the Engineer with gradings for the proposed sizes, along with their proper proportions.

9-03.1(5) Combined Aggregate Gradation for Portland Cement Concrete

As an option to using Coarse and Fine graded aggregates for Portland Cement Concrete, aggregate gradation may consist of a combined gradation. Aggregates shall consist of sand, gravel, crushed stone, or other inert material or combinations thereof, having hard, strong durable particles free from adherent coatings. Aggregates shall be washed to remove clay, loam, alkali, organic matter, silt, bark, sticks, or other deleterious matter.

9-03.1(5)A Deleterious Substances

The amount of deleterious substances in the washed aggregate shall not exceed the following values:

1. Particles of specific gravity less than 1.95 — 2.0 percent by weight
2. Organic matter, by colorimetric test, shall not be darker than the reference Standard color (organic plate No. 3) AASHTO T21 unless other tests prove a darker color to be harmless.

3. Aggregates retained on the U.S. No. 4 sieve shall not have a percentage of wear in Los Angeles machine in excess of 35 after 500 revolutions.
4. Clay lumps — 0.3 percent by weight
5. Shale — 1.00 percent by weight
6. Wood Waste — 0.03 percent by weight
7. Amount finer than U.S. No. 200 sieve — 2.0 percent by weight

9-03.1(5)B Grading

If a nominal maximum aggregate size is not specified, the Contractor shall determine the nominal maximum aggregate size, using ACI 211.1 as a guide. In no case will the maximum aggregate size exceed one-fifth of the narrowest dimension between sides of the forms, one-third the depth of slabs, nor three-fourths of the minimum clear spacing between individual reinforcing bars, bundles of bars, or pretensioning strands.

The combined aggregate shall conform to the following requirements based upon the nominal maximum aggregate size.

Nominal Maximum Aggregate Size	1-1/2	1	3/4	1/2	3/8	No. 4
2″ square	100					
1 1/2″ square	87-100*	100				
1″ square		82-100*	100			
3/4″ square	62-88		87-100*	100		
1/2″ square		57-83		81-100*	100	
3/8″ square	43-64		60-88		86-100*	100
U.S. No. 4	29-47	34-54	41-64	48-73		68-100*
U.S. No. 8	19-34	22-39	27-47	31-54	39-73	
U.S. No. 16	12-25	14-29	17-34	20-39	24-54	28-73
U.S. No. 30	7-18	8-21	9-25	11-29	13-39	16-54
U.S. No. 50	3-14	3-15	4-18	5-21	6-29	7-39
U.S. No. 100	0-10	0-11	0-14	0-15	0-21	0-29
U.S. No. 200	0-2.0	0-2.0	0-2.0	0-2.0	0-2.0	0-2.0

* = Nominal Maximum Size

All percentages are by weight.

Nominal maximum size for concrete aggregate is defined as the smallest standard sieve opening through which the entire amount of the aggregate is permitted to pass. Standard sieve sizes shall be those listed in ASTM C 33.

The Contracting Agency may sample each component aggregate prior to introduction to the weigh batcher or as otherwise determined by the Engineer. Each separate component will be sieve analyzed alone per AASHTO Test Method T-11/27. All material components will be mathematically re-combined by proportions (Weighted Average), supplied by the Contractor.

9-03.2 Vacant

9-03.3 Vacant

9-03.4 Aggregate for Bituminous Surface Treatment

9-03.4(1) General Requirements

Aggregate for bituminous surface treatment shall be manufactured from ledge rock, talus, or gravel, in accordance with Section 3-01, which meets the following test requirements:

Los Angeles Wear, 500 Rev.	35% max.
Degradation Factor	30 min.

9-03.4(2) Grading and Quality

Aggregate for bituminous surface treatment shall conform to the requirements in the table below for grading and quality. The particular type or grading to be used shall be as shown in the Plans. All percentages are by weight.

The material shall meet the requirements for grading and quality when placed in hauling vehicles for delivery to the roadway, or during manufacture and placement into a temporary stockpile. The exact point of acceptance will be determined by the Engineer.

	Crushed Cover Stone Percent Passing	Crushed Screening Percent Passing				
		¾″-½″	⅝″-US No. 4	½″-US No. 4	⅜″- US NO. 10	US No. 4-0″
1″ square	---	100	---	---	---	---
¾″ square	100	95-100	100	---	---	---
⅝″ square	95-100	---	95-100	100	---	---
½″ square	---	0-20	---	95-100	100	---
⅜″ square	---	0-5	---	---	90-100	100
U.S. No. 4	20-45	---	0-10	0-15	30-56	76-100
U.S. No. 10	---	---	0-3	0-3	0-10	30-60
U.S. No. 200	0-7.5	0-1.5	0-1.5	0-1.5	0-1.5	0-10.0
% fracture, by weight, min.	75	75	75	75	75	75
Sand equivalent min.	40	---	---	---	---	---
Static Stripping Test	Pass	Pass	Pass	Pass	Pass	Pass

All percentages are by weight.

The fracture requirement shall be at least one fractured face and will apply to the combined aggregate retained on the U.S. No. 4 sieve in accordance with FOP for AASHTO PT 61.

The finished product shall be clean, uniform in quality, and free from wood, bark, roots, and other deleterious materials.

Crushed screenings shall be substantially free from adherent coatings. The presence of a thin, firmly adhering film of weathered rock shall not be considered as coating unless it exists on more than 50 percent of the surface area of any size between successive laboratory sieves.

The portion of aggregate for bituminous surface treatment retained on a U.S. No. 4 sieve shall not contain more than 0.1 percent deleterious materials by weight.

9-03.5 Vacant

9-03.6 Aggregates for Asphalt Treated Base (ATB)

9-03.6(1) General Requirements

Aggregates for asphalt treated base shall be manufactured from ledge rock, talus, or gravel, in accordance with the provisions of Section 3-01, that meet the following test requirements:

Los Angeles Wear, 500 Rev.	30% max.
Degradation Factor	15 min.

9-03.6(2) Grading

Aggregates for asphalt treated base shall meet the following requirements for grading:

Sieve Size	Percent Passing
2″ square	100
½″ square	56-100
U.S. No. 4	32-72
U.S. No. 10	22-57
U.S. No. 40	8-32
U.S. No. 200	2.0-9.0

All percentages are by weight.

9-03.6(3) Test Requirements

When the aggregates are combined within the limits set forth in Section 9-03.6(2) and mixed in the laboratory with the designated grade of asphalt, the mixture shall be capable of meeting the following test values:

% of Theoretical Maximum Specific Gravity (GMM) (approximate)	93@ 100 gyrations
Modified Lottman Stripping Test	Pass

The sand equivalent value of the mineral aggregate for asphalt treated base shall not be less than 35.

9-03.7 Vacant

9-03.8 Aggregates for Hot Mix Asphalt

9-03.8(1) General Requirements

Aggregates for hot mix asphalt shall be manufactured from ledge rock, talus, or gravel, in accordance with the provisions of Section 3-01. The material from which they are produced shall meet the following test requirements:

Los Angeles Wear, 500 Rev.	30% max.
Degradation Factor, Wearing Course	30 min.
Degradation Factor, Other Courses	20 min.

Aggregates shall be uniform in quality, substantially free from wood, roots, bark, extraneous materials, and adherent coatings. The presence of a thin, firmly adhering film of weathered rock will not be considered as coating unless it exists on more than 50 percent of the surface area of any size between consecutive laboratory sieves.

Aggregate removed from deposits contaminated with various types of wood waste shall be washed, processed, selected, or otherwise treated to remove sufficient wood waste so that the oven dried material retained on a U.S. No. 4 sieve shall not contain more than 0.1 percent by weight of material with a specific gravity less than 1.0.

9-03.8(2) HMA Test Requirements

Aggregate for HMA shall meet the following test requirements:

1. Vacant
2. The fracture requirements for the combined coarse aggregate shall apply to the material retained on the U.S. No. 4 sieve and above, when tested in accordance with FOP for AASHTO PT 61.

ESAL's (millions)	# Fractured Faces	% Fracture
< 10	1	90
≥ 10	2	90

3. The uncompacted void content for the combined fine aggregate is tested in accordance with WSDOT Test Method for AASHTO T 304, Method A. The minimum percent voids shall be as required in the following table:

Traffic	HMA Evaluation	
ESAL's (millions)	Statistical & Nonstiatistical	Commercial
< 3	40	40
≥ 3	44	40

4. The minimum sand equivalent for the aggregate shall be 45.

The mix design shall produce HMA mixtures when combined within the limits set forth in Section 9-03.8(6) and mixed in the laboratory with the designated grade of asphalt binder, using the Superpave gyratory compactor in accordance with WSDOT FOP for AASHTO T 312, and at the required gyrations for N initial, N design, and N maximum with the following properties:

	HMA Class							
	3/8-inch		1/2-inch		3/4-inch		1-inch	
Mix Criteria	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**
Voids in Mineral Aggregate (VMA), %	15.0		14.0		13.0		12.0	
Voids Filled with Asphalt (VFA), %								
ESAL's (millions)	VFA							
< 0.3	70	80	70	80	70	80	67	80
0.3 to < 3	65	78	65	78	65	78	65	78
3 to < 10	73	76	65	75	65	75	65	75
10 to < 30	73	76	65	75	65	75	65	75
≥ 30	73	76	65	75	65	75	65	75
Dust/Asphalt Ratio	0.6	1.6	0.6	1.6	0.6	1.6	0.6	1.6
Modified Lottman Stripping Test	Pass		Pass		Pass		Pass	

	ESAL's (millions)	N initial	N design	N maximum
% Gmm	< 0.3	≤ 91.5	96.0	≤ 98.0
	0.3 to < 3	≤ 90.5	96.0	≤ 98.0
	≥ 3	≤ 89.0	96.0	≤ 98.0
Gyratory Compaction (number of gyrations)	< 0.3	6	50	75
	0.3 to < 3	7	75	115
	3 to < 30	8	100	160
	≥ 30	9	125	205

The mix criteria VMA and VFA only apply to HMA accepted by statistical evaluation.

When material is being produced and stockpiled for use on a specific contract or for a future contract, the uncompacted void content, fracture, and sand equivalent requirements shall apply at the time of stockpiling. When material is used from a stockpile that has not been tested as provided above, the specifications for uncompacted void content, fracture, and sand equivalent shall apply at the time of its introduction to the cold feed of the mixing plant.

9-03.8(3) Grading

9-03.8(3)A Gradation

The Contractor may furnish aggregates for use on the same contract from multiple stockpiles. The gradation of the aggregates shall be such that the completed mixture complies in all respects with the pertinent requirements of Section 9-03.8(6).

Acceptance of the aggregate gradation shall be based on samples taken from the final mix.

9-03.8(3)B Gradation — Recycled Asphalt Pavement and Mineral Aggregate

Asphalt concrete planings or old asphalt concrete utilized in the production of HMA shall be sized prior to entering the mixer so that a uniform and thoroughly mixed HMA is produced in the mixer. If there is evidence of the old asphalt concrete not breaking down during the heating and mixing of the HMA, the Engineer may elect to modify the maximum size entering the mixer. No contamination by deleterious materials will be allowed in the old asphalt concrete used.

The gradation for the new aggregate used in the production of the HMA shall be the responsibility of the Contractor, and when combined with recycled material, the combined material shall meet the gradation specification requirements for the specified Class HMA as listed in Section 9-03.8(6) or as shown in the Special Provisions. The new aggregate shall meet the general requirements listed in Section 9-03.8(1) and Section 9-03.8(2).

9-03.8(4) Blending Sand

Blending sand shall be clean, hard, sound material, either naturally occurring sand or crusher fines, and must be material which will readily accept an asphalt coating. The exact grading requirements for the blending sand shall be such that, when it is mixed with an aggregate, the combined product shall meet the requirements of Section 9-03.8(6) for the class of material involved. Blending sand shall meet the following quality requirement:

Sand Equivalent	30 Minimum

9-03.8(5) Mineral Filler

Mineral filler, when used in HMA mix, shall conform to the requirements of AASHTO M 17.

9-03.8(6) HMA Proportions of Materials

The materials of which HMA is composed shall be of such sizes, grading, and quantity that, when proportioned and mixed together, they will produce a well graded mixture within the requirements listed below.

The aggregate percentage refers to completed dry mix, and includes mineral filler when used.

	Aggregate Gradation Control Points			
Sieve Sizes Percent Passing:	**3/8 In.**	**1/2 In.**	**3/4 In.**	**1 In.**
1 1/2" square				100
1" square			100	90-100
3/4" square		100	90-100	90 Maximum
1/2" square	100	90 - 100	90 Maximum	
3/8" square	90 - 100	90 Maximum		
U.S. No. 4	90 Maximum			
U.S. No. 8	32-67	28-58	23-49	19-45
U.S. No. 200	2.0-7.0	2.0-7.0	2.0-7.0	1.0-7.0

9-03.8(7) HMA Tolerances and Adjustments

1. **Job Mix Formula Tolerances.** The constituents of the mixture at the time of acceptance shall conform to the following tolerances:

	Statistical Evaluation	Nonstatistical Evaluation	Commercial Evaluation
Aggregate, percent passing			
1", 3/4", 1/2" and 3/8" sieves	± 6%	± 6%	± 8%
U.S. No. 4 sieve	± 5%	± 6%	± 8%
U.S. No. 8 sieve	± 4%	± 6%	± 8%
U.S. No. 200 sieve	± 2.0%	± 2.0%	± 3.0%
Asphalt binder	± 0.5%	± 0.5%	± 0.7%

VMA	1.5% below minimum value in Section 9-03.8(2)
VFA	minimum and maximum as listed in Section 9-03.8(2)
Va	2.5% minimum and 5.5% maximum

These tolerance limits constitute the allowable limits as described in Section 1-06.2. The tolerance limit for aggregate shall not exceed the limits of the control points, except the tolerance limits for sieves designated as 100% passing will be 99-100. The tolerance limits on sieves shall only apply to sieves with control points. The tolerances for VMA, and Va are for mix design verification and acceptance of the test section. The tolerances for VFA are for mix design verification only. VMA and VFA only apply to HMA accepted by statistical evaluation.

2. Job Mix Formula Adjustments. An adjustment to the aggregate gradation or asphalt binder content of the JMF requires approval of the Project Engineer. Adjustments to the JMF will only be considered if the change produces material of equal or better quality and may require the development of a new mix design if the adjustment exceeds the amounts listed below.
   A. **Aggregates.** The maximum adjustment from the approved mix design shall be 2 percent for the aggregate passing the 1½", 1", ¾", ½", ⅜", and the U.S. No. 4 sieves, 1 percent for aggregate passing the U.S. No. 8 sieve, and 0.5 percent for the aggregate passing the U.S. No. 200 sieve. The adjusted JMF shall be within the range of the control points in Section 9-03.8(6).
   B. **Asphalt Binder Content.** The Project Engineer may order or approve changes to asphalt binder content. The maximum adjustment from the approved mix design for the asphalt binder content shall be 0.3 percent.

9-03.9 Aggregates for Ballast and Crushed Surfacing

9-03.9(1) Ballast

Ballast shall consist of crushed, partially crushed, or naturally occurring granular material from approved sources manufactured in accordance with the provisions of Section 3-01.

The material from which ballast is to be manufactured shall meet the following test requirements:

Los Angeles Wear, 500 Rev	40% max.
Degradation Factor	15 min.

Ballast shall meet the following requirements for grading and quality when placed in hauling vehicles for delivery to the roadway or during manufacture and placement into a temporary stockpile. The exact point of acceptance will be determined by the Engineer.

Sieve Size	Percent Passing
2½″ square	100
2″ square	65-100
1″ square	50-85
U.S. No. 4	26-44
U.S. No. 40	16 max.
U.S. No. 200	9.0 max.
Dust Ratio:	⅔ max.
Sand Equivalent	35 min.

All percentages are by weight.

The portion of ballast retained on U.S. No. 4 sieve shall not contain more than 0.2 percent wood waste.

9-03.9(2) Shoulder Ballast

Shoulder ballast shall meet the requirements of Section 9-03.9(1) for ballast except for the following special requirements.

The grading and quality requirements are:

Sieve Size	Percent Passing
2½″ square	100
2″ square	65-100
¾″ square	40-80
U.S. No. 4	5 max.
U.S. No. 100	0-2
% Fracture	75 min.

All percentages are by weight.

The sand equivalent value and dust ratio requirements do not apply.

The fracture requirement shall be at least one fractured face and will apply the combined aggregate retained on the U.S. No. 4 sieve in accordance with FOP for AASHTO PT 61.

9-03.9(3) Crushed Surfacing

Crushed surfacing shall be manufactured from ledge rock, talus, or gravel in accordance with the provisions of Section 3-01. The materials shall be uniform in quality and substantially free from wood, roots, bark, and other extraneous material and shall meet the following quality test requirements:

Los Angeles Wear, 500 Rev.	35% max.
Degradation Factor — Top Course	25 min.
Degradation Factor — Base Course	15 min.

Crushed surfacing of the various classes shall meet the following requirements for grading and quality when placed in hauling vehicles for delivery to the roadway, or during manufacture and placement into a temporary stockpile. The exact point of acceptance will be determined by the Engineer.

Sieve Size	Base Course	Top Course and Keystone
	Percent Passing	
1¼″ square	100	
1″ square	80-100	
¾″ square		100
⅝″ square	50-80	
½″ square		80-100
U.S. No. 4	25-45	46-66
U.S. No. 40	3-18	8-24
U.S. No. 200	7.5 max.	10.0 max.
% Fracture	75 min.	75 min.
Sand Equivalent	40 min.	40 min.

All percentages are by weight.

The fracture requirement shall be at least one fractured face and will apply to the combined aggregate retained on the U.S. No. 4 sieve in accordance with FOP for AASHTO PT 61.

The portion of crushed surfacing retained on a U.S. No. 4 sieve shall not contain more than 0.15 percent wood waste.

9-03.9(4) Maintenance Rock

Maintenance rock shall meet all requirements of Section 9-03.9(3) for crushed surfacing top course except that it shall meet the following specifications for grading:

Sieve Size	Percent Passing
⅝″ square	100
½″ square	90-100
U.S. No. 4	45-66
U.S. No. 40	10-25
U.S. No. 200	7 max.

All percentages are by weight.

9-03.10 Aggregate for Gravel Base

Gravel base shall consist of granular material, either naturally occurring or processed. It shall be essentially free from various types of wood waste or other extraneous or objectionable materials. It shall have such characteristics of size and shape that it will compact readily and shall meet the following test requirements:

Stabilometer "R" Value	72 min.
Swell pressure	0.3 psi max.

The maximum particle size shall not exceed ⅔ of the depth of the layer being placed.

Gravel base shall meet the following requirements for grading and quality when placed in hauling vehicles for delivery to the roadway or during manufacture and placement into a temporary stockpile. The exact point of acceptance will be determined by the Engineer.

Sieve Size	Percent Passing
2″ square	75-100
U.S. No. 4	22-100
U.S. No. 200	0-10
Dust Ratio:	⅔ max.
Sand Equivalent	30 min.

All percentages are by weight.

Gravel base material retained on a U.S. No. 4 sieve shall contain not more than 0.20 percent by weight of wood waste.

9-03.11 Vacant

9-03.12 Gravel Backfill

Gravel backfill shall consist of crushed, partially crushed, or naturally occurring granular material produced in accordance with the provisions of Section 3-01.

9-03.12(1) Gravel Backfill for Foundations

9-03.12(1)A Class A

Gravel backfill for foundations, Class A, shall conform to the requirements of Section 9-03.9 for ballast or Section 9-03.9(3) for crushed surfacing base course.

9-03.12(1)B Class B

Gravel backfill for foundations, Class B, shall conform to the requirements of Section 9-03.10 except that the requirements for stabilometer "R" value and swell pressure do not apply.

9-03.12(2) Gravel Backfill for Walls

Gravel backfill for walls shall consist of free draining granular material, essentially free from various types of wood waste or other extraneous or objectionable materials. It shall meet the following requirements for grading and quality when placed in hauling vehicles for delivery to the roadway or during manufacture and placement into a temporary stockpile. The exact point of acceptance will be determined by the Engineer.

Sieve Size	Percent Passing
4″ square	100
2″ square	75-100
U.S. No. 4	22-66
U.S. No. 200	5.0 max.
Dust Ratio: $\frac{\text{\% Passing U.S. No. 200}}{\text{\% Passing U.S. No. 40}}$	⅔ max.
Sand Equivalent	60 min.

All percentages are by weight.

That portion of the material retained on a U.S. No. 4 sieve shall contain not more than 0.20 percent by weight of wood waste.

9-03.12(3) Gravel Backfill for Pipe Zone Bedding

Gravel backfill for pipe zone bedding shall consist of crushed, processed, or naturally occurring granular material. It shall be free from various types of wood waste or other extraneous or objectionable materials. It shall have such characteristics of size and shape that it will compact and shall meet the following specifications for grading and quality:

Sieve Size	Percent Passing
1½″ square	100
1″ square	75-100
⅝″ square	50-100
U.S. No. 4	20-80
U.S. No. 40	3-24
U.S. No. 200	10.0 max.
Sand Equivalent	35 min.

All percentages are by weight.

If, in the opinion of the Engineer, the native granular material is free from wood waste, organic material, and other extraneous or objectionable materials, but otherwise does not conform to the specifications for grading and Sand Equivalent, it may be used for pipe bedding for rigid pipes, provided the native granular material has a maximum dimension of 1½-inches.

9-03.12(4) Gravel Backfill for Drains

Gravel backfill for drains shall conform to the following gradings:

Sieve Size	Percent Passing
1″ square	100 - —
¾″ square	80-100
⅜″ square	0-40
U.S. No. 4	0-4
U.S. No. 200	0-2

Alkali silica reactivity testing is not required.

9-03.12(5) Gravel Backfill for Drywells

Gravel backfill for drywells shall conform to the following gradings:

Sieve Size	Percent Passing
1½″ square	100
1″ square	50-100
¾″ square	0-20
⅜″ square	0-2
U.S. No. 200	0-1.5

Alkali silica reactivity testing is not required.

9-03.13 Backfill for Sand Drains

Backfill for sand drains shall conform to the following grading:

Sieve Size	Percent Passing
½″ square	90-100
U.S. No. 4	57-100
U.S. No. 10	40-100
U.S. No. 50	3-30
U.S. No. 100	0-4
U.S. No. 200	0-3.0

All percentages are by weight.

9-03.13(1) Sand Drainage Blanket

Aggregate for the sand drainage blanket shall consist of granular material, free from wood, bark, or other extraneous material and shall meet the following requirements for grading:

Sieve Size	Percent Passing
2½″ square	90-100
U.S. No. 4	24-100
U.S. No. 10	14-100
U.S. No. 50	0-30
U.S. No. 100	0-7.0
U.S. No. 200	0-3.0

All percentages are by weight.

That portion of backfill for sand drains and sand drainage blanket retained on a U.S. No. 4 sieve shall contain not more than 0.05 percent by weight of wood waste.

9-03.14 Borrow

9-03.14(1) Gravel Borrow

Aggregate for gravel borrow shall consist of granular material, either naturally occurring or processed, and shall meet the following requirements for grading and quality:

Sieve Size	Percent Passing
4″ square[1]	100
2″ square	75-100
U.S. No. 4	50-80
U.S. No. 40	30 max.
U.S. No. 200	7.0 max.
Sand Equivalent	50 min.

All percentages are by weight.

[1]For geosynthetic reinforced walls or slopes, 100 percent passing 1¼-inch square sieve and 90 to 100 percent passing 1-inch square sieve.

Ballast may be substituted for gravel borrow for embankment construction.

9-03.14(2) Select Borrow

Material for select borrow shall consist of granular material, either naturally occurring or processed, and shall meet the following requirements for grading and quality:

Sieve Size	Percent Passing
6″ square[1,2]	100
3″ square	75-100
U.S. No. 40	50 max.
U.S. No. 200	10.0 max.
Sand Equivalent	30 min.

All percentages are by weight.

[1]For geosynthetic reinforced walls or slopes, 100 percent passing 1¼-inch square sieve and 90 to 100 percent passing 1-inch square sieve.

[2]100 percent shall pass 4-inch square sieve and 75 to 100 percent shall pass 2-inch square sieve when select borrow is used in the top 2-feet of embankments or where Method C compaction is required.

9-03.14(3) Common Borrow

Material for common borrow shall consist of granular or nongranular soil and/or aggregate which is free of deleterious material and is nonplastic.

Deleterious material includes wood, organic waste, coal, charcoal, or any other extraneous or objectionable material.

The material shall be considered nonplastic if the percent by weight passing the U.S. No. 200 sieve does not exceed 15 percent, or if the soil fraction passing the U.S. No. 40 sieve cannot be rolled, at any moisture content, into a thread as prescribed in Section 4 of AASHTO Test Method T 90. If requested by the Contractor, the plasticity may be increased with the approval of the Engineer if it is determined that an increased plasticity will be satisfactory for the specified embankment construction.

The material shall not contain more than 3 percent organic material by weight.

9-03.14(4) Gravel Borrow for Geosynthetic Retaining Wall

All backfill material used in the reinforced soil zone of the geosynthetic retaining wall shall conform to requirements of Section 9-03.14(1) and shall be free draining, free from organic or otherwise deleterious material. The material shall be substantially free of shale or other soft, poor durability particles, and shall not contain recycled materials, such as glass, shredded tires, portland cement concrete rubble, or asphaltic concrete rubble. The backfill material shall meet the following requirements:

Property	Test Method	Allowable Test Value
Los Angeles Wear, 500 rev.	AASHTO T 96	35 percent max.
Degradation	WSDOT Test Method 113	15 min.
pH	AASHTO T 289-91	**

** 4.5 to 9 for permanent walls and 3 to 10 for temporary walls

Wall backfill material satisfying these gradation, durability and chemical requirements shall be classified as nonaggressive.

9-03.15 Native Material for Trench Backfill

Trench backfill outside the roadway prism shall be excavated material free of wood waste, debris, clods or rocks greater than 6-inches in any dimension.

9-03.16 Vacant

9-03.17 Foundation Material Class A and Class B

Foundation material Class A and Class B shall conform to the following gradations:

	Percent Passing	
Sieve Size	Class A	Class B
2½″ square	98-100	95-100
2″ square	92-100	75-100
1½″ square	72-87	30-60
1¼″ square	58-75	0-15
¾″ square	27-47	0-1
⅜″ square	3-14	---
U.S. No. 4	0-1	---

All percentages are by weight.

9-03.18 Foundation Material Class C

Foundation material Class C shall consist of clean bank run sand and gravel, free from dirt, roots, topsoil, and debris and contain not less than 35 percent retained on a U.S. No. 4 sieve and with all stones larger than 2-inches in the longest dimension removed.

9-03.19 Bank Run Gravel for Trench Backfill

Trench backfill material shall consist of aggregate for gravel base, as specified in Section 9-03.10, excepting however, that 100 percent of the material shall pass a 2½-inch square screen.

9-03.20 Test Methods for Aggregates

The properties enumerated in these Specifications shall be determined in accordance with the following methods of test:

Title	Test Method
Sampling	WSDOT FOP for AASHTO T 2
Organic Impurities	AASHTO T 21
Clay Lumps in Aggregates	AASHTO T 112
Abrasion of Coarse Aggregates by Use of the Los Angeles Machine	AASHTO T 96
Material Finer than U.S. No. 200 Sieve in Aggregates	AASHTO T 11
Percent of Fracture in Aggregates	WSDOT FOP for AASHTO PT 61
Sieve Analysis of Fine and Coarse Aggregates and Aggregates in HMA	WAQTC FOP for T 27/11
Sand Equivalent Test for Surfacing Materials	WSDOT FOP for AASHTO T 176
Determination of Degradation Value	WSDOT T 113
Determination of Fineness Modulus	AASHTO T 27
Particle Size Analysis of Soils	AASHTO T 88
Stabilometer R Value, Untreated Materials	WSDOT T 611
Swell Pressure and Permeability	WSDOT T 611
Stabilometer S Value, Treated Materials	WSDOT T 703
Determining Stripping of HMA	WSDOT T 718
Compressive Strength of Concrete	WSDOT FOP for AASHTO T 22
Flexural Strength of Concrete	WSDOT T 802

9-03.21 Recycled Material

9-03.21(1) General Requirements

Recycled materials that are identified below may be used as, or blended uniformly with, naturally occurring materials for aggregates. The final blended product shall meet the requirements for the specified type of aggregate. In addition, each recycled material component included in a blended product, shall meet the specific requirements listed below.

Recycled materials obtained from the Contracting Agency's roadways will not require testing and certification for toxicity testing or certification for toxicity characteristics.

For recycled materials that are imported to the job site, the Contractor shall certify that the recycled material is not a Washington State Dangerous Waste per the Dangerous Waste Regulations WAC 173-303. Sampling and testing for toxicity shall be at a frequency of one per 10,000 tons prior to combining with other materials and not less than one sample from any single source.

9-03.21(2) Recycled Hot Mix Asphalt

Recycled asphalt concrete pavement may be uniformly blended with the following materials, to the extent that the specified maximum bitumen content in the final product shall not exceed the following:

		Maximum Bitumen Content (Percent)
Fine Aggregate for Portland Cement Concrete	9-03.1(2)	0
Coarse Aggregates for Portland Cement Concrete	9-03.1(4)	0
Aggregates for Asphalt Treated Base (ATB)	9-03.6	See 5-04.2
Aggregates for Hot Mix Asphalt	9-03.8	See 5-04.2
Ballast	9-03.9(1)	1.2
Shoulder Ballast	9-03.9(2)	1.2
Crushed Surfacing	9-03.9(3)	1.2
Aggregate for Gravel Base	9-03.10	1.2
Gravel Backfill for Foundations – Class A	9-03.12(1)A	1.2
Gravel Backfill for Foundations – Class B	9-03.12(1)B	1.2
Gravel Backfill for Walls	9-03.12(2)	0
Gravel Backfill for Pipe Zone Bedding	9-03.12(3)	0
Gravel Backfill for Drains	9-03.12(4)	0
Gravel Backfill for Drywells	9-03.12(5)	0
Backfill for Sand Drains	9-03.13	0
Sand Drainage Blanket	9-03.13(1)	0
Gravel Borrow	9-03.14(1)	1.2
Select Borrow	9-03.14(2)	1.2
Select Borrow (greater than 3-feet below subgrade and side slopes)	9-03.14(2)	8.0
Common Borrow	9-03.14(3)	1.2
Common Borrow - (greater than 3-feet below subgrade and side slopes)	9-03.14(3)	8.0
Foundation Material Class A and Class B	9-03.17	0
Foundation Material Class C	9-03.18	0
Bank Run Gravel for Trench Backfill	9-03.19	0

The following field operating procedures will determine total bitumen content:

AASHTO T 308

WSDOT TM 6

The Contractor shall verify the asphalt content for the blended mix. A statewide average of 0.70 may be used as a calibration factor for AASHTO T-308.

9-03.21(3) Recycled Portland Cement Concrete Rubble

Recycled portland cement concrete rubble may be uniformly blended with the following materials, to the extent that the specified maximum concrete rubble content in the final product shall not exceed the following:

		Maximum Concrete Rubble (Percent)
Fine Aggregate for Portland Cement Concrete	9-03.1(2)	0
Coarse Aggregates for Portland Cement Concrete	9-03.1(4)	0
Aggregates for Asphalt Treated Base (ATB)	9-03.6	0
Aggregates for Hot Mix Asphalt	9-03.8	0
Ballast	9-03.9(1)	100
Shoulder Ballast	9-03.9(2)	100
Crushed Surfacing	9-03.9(3)	100
Aggregate for Gravel Base	9-03.10	100
Gravel Backfill for Foundations – Class A	9-03.12(1)A	100
Gravel Backfill for Foundations – Class B	9-03.12(1)B	100
Gravel Backfill for Walls	9-03.12(2)	100
Gravel Backfill for Pipe Zone Bedding	9-03.12(3)	100
Gravel Backfill for Drains	9-03.12(4)	100
Gravel Backfill for Drywells	9-03.12(5)	0
Backfill for Sand Drains	9-03.13	100
Sand Drainage Blanket	9-03.13(1)	100
Gravel Borrow	9-03.14(1)	100
Select Borrow	9-03.14(2)	100
Common Borrow	9-03.14(3)	100
Foundation Material Class A and Class B	9-03.17	100
Foundation Material Class C	9-03.18	100
Bank Run Gravel for Trench Backfill	9-03.19	100

9-03.21(4) Recycled Glass Aggregates

Recycled glass may be uniformly blended with the following materials, to the extent that the maximum recycled glass content in the final product shall not exceed the following:

		Maximum Recycled Glass (Percent)
Fine Aggregate for Portland Cement Concrete	9-03.1(2)	0
Coarse Aggregates for Portland Cement Concrete	9-03.1(4)	0
Aggregates for Asphalt Treated Base (ATB)	9-03.6	0
Aggregates for Hot Mix Asphalt	9-03.8	0
Ballast	9-03.9(1)	15
Shoulder Ballast	9-03.9(2)	15
Crushed Surfacing	9-03.9(3)	15
Aggregate for Gravel Base	9-03.10	15
Gravel Backfill for Foundations – Class A	9-03.12(1)A	15
Gravel Backfill for Foundations – Class B	9-03.12(1)B	15
Gravel Backfill for Walls	9-03.12(2)	15
Gravel Backfill for Pipe Zone Bedding	9-03.12(3)	15
Gravel Backfill for Drains	9-03.12(4)	100
Gravel Backfill for Drywells	9-03.12(5)	100
Backfill for Sand Drains	9-03.13	100
Sand Drainage Blanket	9-03.13(1)	100
Gravel Borrow	9-03.14(1)	100
Select Borrow	9-03.14(2)	100
Common Borrow	9-03.14(3)	100
Foundation Material Class A and Class B	9-03.17	100
Foundation Material Class C	9-03.18	100
Bank Run Gravel for Trench Backfill	9-03.19	100

The product supplier shall perform total lead content testing quarterly. Tests shall include a minimum of five samples. Sample collection shall be conducted according to ASTM D 75. Total lead content testing will be conducted according to EPA Method 3010/6010.

A test shall not exceed 250 ppm using a total lead analysis EPA Test Method 6010. In addition, the Toxicity Characteristics Leaching Procedure, EPA Test Method 1311 shall be used and a test shall not exceed 5.0 ppm. The product supplier shall keep all test results on file.

9-03.21(5) Steel Furnace Slag

Steel furnace slag may be uniformly blended with the following materials, to the extent that the specified maximum steel furnace slag content in the final product shall not exceed the following:

		Maximum Steel Furnace Slag (Percent)
Fine Aggregate for Portland Cement Concrete	9-03.1(2)	0
Coarse Aggregates for Portland Cement Concrete	9-03.1(4)	0
Aggregates for Asphalt Treated Base (ATB)	9-03.6	20
Aggregates for Hot Mix Asphalt	9-03.8	20
Ballast	9-03.9(1)	20
Shoulder Ballast	9-03.9(2)	20
Crushed Surfacing	9-03.9(3)	20
Aggregate for Gravel Base	9-03.10	20
Gravel Backfill for Foundations – Class A	9-03.12(1)A	20
Gravel Backfill for Foundations – Class B	9-03.12(1)B	20
Gravel Backfill for Walls	9-03.12(2)	20
Gravel Backfill for Pipe Zone Bedding	9-03.12(3)	20
Gravel Backfill for Drains	9-03.12(4)	0
Gravel Backfill for Drywells	9-03.12(5)	0
Backfill for Sand Drains	9-03.13	0
Sand Drainage Blanket	9-03.13(1)	0
Gravel Borrow	9-03.14(1)	20
Select Borrow	9-03.14(2)	20
Select Borrow (greater than 3-feet below subgrade and side slopes)	9-03.14(2)	20
Common Borrow	9-03.14(3)	20
Common Borrow (greater than 3-feet below subgrade and side slopes)	9-03.14(3)	20
Foundation Material Class A and Class B	9-03.17	20
Foundation Material Class C	9-03.18	20
Bank Run Gravel for Trench Backfill	9-03.19	20

The Contractor shall notify the Engineer the proposed steel furnace slag blends that will be used in the final product prior to use.

9-04 JOINT AND CRACK SEALING MATERIALS

9-04.1 Premolded Joint Fillers

9-04.1(1) Asphalt Filler for Contraction and Longitudinal Joints in Concrete Pavements

Premolded joint filler for use in contraction and longitudinal joints shall be ⅛-inch in thickness and shall consist of a suitable asphalt mastic encased in asphalt saturated paper or asphalt saturated felt. It shall be sufficiently rigid for easy installation in summer months and not too brittle for handling in cool weather. It shall meet the following test requirements:

When a strip 2-inches wide and 24-inches long is freely supported 2-inches from each end and maintained at a temperature of 70 F, it shall support a weight of 100 grams placed at the center of the strip without deflecting downward from a horizontal position more than 2-inches within a period of 5 minutes.

9-04.1(2) Premolded Joint Filler for Expansion Joints

Premolded joint filler for use in expansion (through) joints shall conform to the specifications for "Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction," AASHTO M 213, except the requirement for water absorption which is deleted.

9-04.1(3) Vacant

9-04.1(4) Elastomeric Expansion Joint Seals

Premolded elastomeric expansion joint seals shall conform to the requirements of AASHTO M 220 and shall be formed by an extrusion process with uniform dimensions and smooth exterior surfaces. The cross-section of the seal shall be shaped to allow adequate compressed width of the seal, as approved by the Engineer.

9-04.2 Joint Sealants

9-04.2(1) Hot Poured Joint Sealants

Hot poured joint sealants shall meet the requirements of AASHTO M 173 Concrete Joint Sealer, Hot Poured Elastic Type and be sampled in accordance with ASTM D 5167. In addition, the sealant shall have a C.O.C. Flash Point (AASHTO T 48) of 205°C minimum. In lieu of the specified bond test in M 173, the bond test shall be in accordance with WSDOT Test Method 412.

9-04.2(2) Poured Rubber Joint Sealer

The physical properties of the joint sealer, when mixed in accordance with the manufacturer's recommendations, shall be as follows:

1. Color: Gray or black.
2.[1] Viscosity: Must be pourable and self-leveling at 50ºF.
3.[1] Application Life: Not less than 3 hours at 72ºF and 50 percent relative humidity.
4. Set to Touch: Not more than 24 hours at 72ºF and 50 percent relative humidity.
5. Curing Time: Not more than 96 hours at 72ºF and 50 percent relative humidity.
6. NonVolatile Content: Not less than 92 percent.
7. Hardness Rating (Durometer "Shore A"): 5-35.
8. Resiliency: Not less than 80 percent.

9. Bond test methods shall be in accordance with WSDOT Test Method No. 412.

[1]Viscosity and application life may be waived providing the material is mixed and placed by a pump and mixer approved by the Engineer.

Suitable primer, if required by the manufacturer, shall be furnished with each joint sealer. The primer shall be suitable for brush or spray application at 50ºF or higher and shall cure sufficiently at 50ºF to pour the joint within 24 hours. It shall be considered as an integral part of the sealer system. Any failure of the sealer in the test described herein, attributable to the primer, shall be grounds for rejection or re-testing of the sealer.

Acceptance of joint sealing compound for use on a project shall be on the basis of laboratory tests of samples representative of each batch of material to be used on the job. A period of at least two weeks shall be allowed for completion of tests. Each container of the compound shall be clearly identified as to batch number.

9-04.3 Joint Mortar

Mortar for hand mortared joints shall consist of one part Portland cement, three parts fine sand, and sufficient water to allow proper workability.

Cement shall conform to the requirements of AASHTO M 85, Type I or Type II.

Sand shall conform to the requirements of AASHTO M 45.

Water shall conform to the requirements of Section 9-25.1.

9-04.4 Pipe Joint Gaskets

9-04.4(1) Rubber Gaskets for Concrete Pipes and Precast Manholes

Rubber gaskets for use in joints of concrete culvert or storm sewer pipe and precast manhole sections shall conform to the applicable requirements of AASHTO M 198.

9-04.4(2) Vacant

9-04.4(3) Gaskets for Aluminum or Steel Culvert or Storm Sewer Pipe

Rubber gaskets for use with metal culvert or storm sewer pipe shall be continuous closed cell, synthetic expanded rubber gaskets conforming to the requirements of ASTM D 1056, Grade 2B3. Butyl rubber gaskets for use with metal culvert or storm sewer pipe shall conform to the applicable requirements of AASHTO M 198.

9-04.4(4) Rubber Gaskets for Aluminum or Steel Drain Pipe

Gaskets for metal drain pipe shall be self-adhering, butyl-based, scrim-supported type. The gaskets shall be as described in the Standard Plan when specified.

9-04.4(5) Protection and Storage

Rubber gasket material shall be stored in a clean, cool place, protected from sunlight and contaminants. They shall be protected from direct sunlight at all times except during actual installation. Pipes with gaskets affixed shall be installed in the line within 28 days.

9-04.5 Flexible Plastic Gaskets

The gasket material shall be produced from blends of refined hydrocarbon resins and plasticizing materials reinforced with inert mineral filler and shall contain no solvents. It shall not depend on oxidizing, evaporating, or chemical action for adhesive or cohesive strength. It shall be supplied in extruded rope form of such cross section and size as to adequately fill spaces between the precast sections.

The gasket material shall be protected by a suitable removable two-piece wrapper so designed as to permit removing one half, longitudinally, without disturbing the other. Its composition and properties shall conform to those set forth below.

	Test Method	Minimum	Maximum
Bitumen (Petroleum plastic content)	ASTM D 4	50	70
Ash-inert Mineral Matter	AASHTO T 11	30	50
Penetration	ASTM D 217		
32ºF (300gm) 60 sec		75	---
77ºF (150gm) 5 sec		50	120
115ºF (150gm) 5 sec		---	150
Softening Point	AASHTO T 53	320ºF	---
Specific Gravity at 77ºF	AASHTO T 229	1.20	1.35
Weight per gallon, lb.		10.0	11.3
Ductility at 77ºF (cm)	ASTM D 113	5.0	---
Flash Point COC, F	AASHTO T 73	600	---
Fire Point COC, F	AASHTO T 48	625	---
Volatile Matter	AASHTO T 47	---	2.0

9-04.6 Expanded Polystyrene

Expanded polystyrene shall be of a cellular molded type with a density of 1.5 plus or minus 0.25 pounds per cubic foot.

9-04.7 Expanded Rubber

Closed cell expanded rubber joint filler shall conform to ASTM D 1056, Grade No. 2B3.

9-04.8 Flexible Elastomeric Seals

Flexible elastomeric seals for PVC drain pipe and underdrain pipe shall conform to the requirements of ASTM D 3212.

9-04.9 Solvent Cements

Solvent cements for PVC underdrain pipe shall conform to the requirements of ASTM D 2564.

9-04.10 Crack Sealing — Rubberized Asphalt

Crack sealing material shall meet the requirements of Section 9-04.2(1), except no bond test is required.

9-04.11 Butyl Rubber

Butyl rubber shall conform to ASTM D 2000, M1 BG 610. If the Engineer determines that the butyl rubber is utilized in an area that will not be exposed to petroleum products, it shall conform to ASTM D 2000, M1 BA 610.

9-05 DRAINAGE STRUCTURES, CULVERTS, AND CONDUITS

9-05.0 Acceptance by Manufacturer's Certification

Certain drainage materials may be accepted by the Engineer based on a modified acceptance procedure when materials are furnished from the manufacturer's list in the Qualified Products List (QPL) or by a Manufacturer's Certificate of Compliance. The modified acceptance procedure is defined in the QPL for each material. These materials are as follows:

Metal drain and under drain pipe;

PVC and corrugated polyethylene drain pipe and under drain pipe;

Metal culvert and storm sewer pipe and pipe arch;

Metal culvert end sections;

Corrugated metal structural plate pipe, pipe arch, and under passes; and

Ductile iron pipe.

Corrugated polyethylene culvert and storm sewer pipe up to and including 60-inch diameter.

Profile wall PVC culvert and storm sewer pipe up to and including 48-inch diameter.

9-05.1 Drain Pipe

9-05.1(1) Concrete Drain Pipe

Concrete drain pipe shall meet the requirements of ASTM C 118M, heavy duty drainage pipe.

9-05.1(2) Zinc Coated (Galvanized) or Aluminum Coated (Aluminized) Corrugated Iron or Steel Drain Pipe

Zinc coated (galvanized) or aluminum coated (aluminized Type 2) corrugated iron or steel drain pipe shall meet the requirements of AASHTO M 36. The steel sheet thickness shall be 0.064-inch for 6-inch diameter and larger drain pipe. Zinc coated steel shall meet the material requirements of AASHTO M 218 (ASTM A929). Aluminum coated steel shall meet the material requirements of AASHTO M-274 (ASTM A929).

9-05.1(2)A Coupling Bands

Coupling bands for zinc coated (galvanized) or aluminum coated (aluminized) corrugated iron or steel drain pipe shall meet the requirements of coupling bands for Type I pipe of AASHTO M 36, except that bands using projections (dimples) shall not be permitted. The bands shall be fabricated of the same material as the pipe, and with the same metallic protective treatment as the pipe.

Acceptable coupling bands are the two piece helically corrugated band with nonreformed ends and integrally formed flanges and those bands meeting the requirements of Section 9-05.4(7).

9-05.1(3) Corrugated Aluminum Alloy Drain Pipe

Corrugated aluminum alloy drain pipe shall meet the requirements of AASHTO M 196, without perforations.

9-05.1(3)A Coupling Bands

Coupling bands for corrugated aluminum alloy drain pipe shall meet the requirements of coupling bands for Type I pipe of AASHTO M 196, except that bands using projections (dimples) shall not be permitted. The bands shall be fabricated of the same material as the pipe.

Acceptable coupling bands are the two piece helically corrugated band with nonreformed ends and integrally formed flanges and those bands meeting the requirements of Section 9-05.5(5).

9-05.1(4) Vacant

9-05.1(5) PVC Drain Pipe

PVC drain pipe shall meet the requirements of AASHTO M 278. The maximum size pipe shall be 8-inches in diameter.

9-05.1(6) Corrugated Polyethylene Drainage Tubing Drain Pipe

Corrugated polyethylene drainage tubing drain pipe shall meet the requirements of AASHTO M 252. The maximum size pipe shall be 10-inches in diameter.

9-05.1(7) Corrugated Polyethylene Drain Pipe

Corrugated polyethylene drain pipe, 12-inch through 36-inch diameter maximum, shall meet the minimum requirements of AASHTO M 294 Type S.

9-05.2 Underdrain Pipe

9-05.2(1) Vacant

9-05.2(2) Perforated Concrete Underdrain Pipe

Perforated concrete underdrain pipe shall meet the requirements of AASHTO M 175, Type I, except the perforations shall be approximately ½-inch in diameter. Strength requirements shall be as shown in Table I of AASHTO M 86.

9-05.2(3) Perforated Bituminized Fiber Underdrain Pipe

Perforated bituminized fiber underdrain pipe shall meet the requirements of AASHTO M 177.

9-05.2(4) Zinc Coated (Galvanized) or Aluminum Coated (Aluminized) Corrugated Iron or Steel Underdrain Pipe

Zinc coated (galvanized) or aluminum coated (aluminized type 2) corrugated iron or steel underdrain pipe shall meet the fabrication requirements of AASHTO M 36, except that perforations required in Class I, II, and III pipe may be located anywhere on the tangent of the corrugations provided the other perforation spacing requirements remain as specified. Zinc coated steel shall meet the material requirements of AASHTO M 218 (ASTM A929). Aluminum coated steel shall meet the material requirements of AASHTO M-274 (ASTM A929).

The pipe may conform to any one of the Type III pipes specified in AASHTO M 36, and perforations in Class I, II, and III pipe may be drilled or punched. The sheet thickness shall be 0.064-inch for 6-inch and larger diameter underdrain pipe.

9-05.2(4)A Coupling Bands

Coupling bands for zinc coated (galvanized) or aluminum coated (aluminized) corrugated iron or steel underdrain pipe shall meet the requirements of coupling bands for Type III pipe of AASHTO M 36. The bands shall be fabricated of the same material as the pipe and with the same metallic protective treatment as the pipe, if metallic bands are used.

Acceptable coupling bands are the two piece helically corrugated band with nonreformed ends and integrally formed flanges, universal bands (dimple bands), a smooth sleeve type coupler, and those bands meeting the requirements of Section 9-05.4(7). Smooth sleeve type couplers may be either plastic or steel suitable for holding the pipe firmly in alignment without the use of sealing compound or gaskets.

9-05.2(5) Perforated Corrugated Aluminum Alloy Underdrain Pipe

Perforated corrugated aluminum alloy underdrain pipe shall meet the requirements of AASHTO M 196, except that the perforations may be located anywhere on the tangent of the corrugations providing the other perforation spacing requirements remain as specified.

9-05.2(5)A Coupling Bands

Coupling bands for corrugated aluminum alloy underdrain pipe shall meet the requirements of coupling bands for Type III pipe of AASHTO M 196. The bands shall be fabricated of the same material of the pipe, if metallic bands are used.

Acceptable coupling bands are the two piece helically corrugated band with nonreformed ends and integrally formed flanges, universal bands (dimple bands), a smooth sleeve type coupler, and those bands meeting the requirements of Section 9-05.5(5). Smooth sleeve type couplers may be either plastic or aluminum alloy suitable for holding the pipe firmly in alignment without the use of sealing compound or gaskets.

9-05.2(6) Perforated PVC Underdrain Pipe

Perforated PVC underdrain pipe shall meet the requirements of AASHTO M 278. The maximum size pipe shall be 8-inches in diameter.

9-05.2(7) Perforated Corrugated Polyethylene Drainage Tubing Underdrain Pipe

Perforated corrugated polyethylene drainage tubing underdrain pipe shall meet the requirements of AASHTO M252, Type CP or Type SP. Type CP shall be Type C pipe with Class 2 perforations and Type SP shall be Type S pipe with either Class 1 or Class 2 perforations. Additionally, Class 2 perforations shall be uniformly spaced along the length and circumference of the pipe. The maximum size pipe shall be 10-inch diameter.

9-05.2(8) Perforated Corrugated Polyethylene Underdrain Pipe

Perforated corrugated polyethylene underdrain pipe, 12-inch through 48-inch diameter maximum, shall meet the requirements of AASHTO M 294 Type CP or Type SP. Type CP shall be Type C pipe with Class 2 perforations and Type SP shall be Type S pipe with either Class 1 or Class 2 perforations. Additionally, Class 2 perforations shall be uniformly spaced along the length and circumference of the pipe.

9-05.3 Concrete Culvert Pipe

9-05.3(1) Plain Concrete Culvert Pipe

Plain concrete culvert pipe shall be round and shall conform to the requirements of AASHTO M 86, Class 2.

9-05.3(1)A End Design and Joints

All bell and spigot concrete culvert pipe shall be joined with rubber gaskets. The joints and gasket material shall meet the requirements of AASHTO M 198. Gasket material shall be handled and stored in accordance with Section 9-04.4(5).

The plans of the ends of the pipes shall be perpendicular to their longitudinal axes.

9-05.3(1)B Basis for Acceptance

The basis for acceptance of plain concrete culvert or drain pipe shall be on the results of three edge bearing tests performed at the manufacturer's plant within the 90 day period immediately preceding shipment of the pipe.

9-05.3(1)C Age at Shipment

Plain concrete culvert pipe may be shipped when it meets all test requirements. Unless it is tested and accepted at an earlier age, it shall not be considered ready for shipment sooner than 28 days after manufacture when made with Type II Portland cement, nor sooner than 7 days when made with Type III Portland cement.

9-05.3(2) Reinforced Concrete Culvert Pipe

Reinforced concrete culvert pipe shall be round and conform to the requirements of AASHTO M 170 except as herein provided.

The wall thickness and steel area for all classes of pipe which are of a diameter not set forth in AASHTO M 170, but within the maximum and minimum diameter limits set forth therein, shall be determined by interpolation from data given in the tables for pipes of diameters next smaller and next larger, respectively.

For all classes of pipe, except Class I, which are of a diameter less than the minimum for the particular class set forth in AASHTO M 170, the minimum wall thickness shall be 1¾-inch and the steel area shall not be less than 0.06 square inch per linear foot of pipe barrel length.

9-05.3(2)A End Design and Joints

Section 9-05.3(1)A will apply to reinforced concrete culvert pipe.

9-05.3(2)B Basis for Acceptance

The basis for acceptance of reinforced concrete pipe 60-inches in diameter and smaller shall be determined by the results of the three edge bearing test for the load to produce a 0.01-inch crack, and testing to the ultimate load will ordinarily not be required, except as necessary to obtain samples for making the absorption test. In lieu of broken pieces of pipe obtained as above provided, 4-inch diameter cores from pipe sections selected by the Engineer may be furnished for performing the absorption test. Sections of pipe which have been tested to the actual 0.01-inch crack will ordinarily not be further load tested; and such sections which meet or exceed the required strength and workmanship standards may be accepted for use on the project.

Acceptance of reinforced concrete pipe larger than 60-inches in diameter shall be based on inspection of the size and placement of the reinforcing steel, and, at the option of the Engineer, on compressive strength tests of 4-inch diameter cores cut from the pipe, or on compressive strength of representative test cylinders cast with and cured with the pipe.

9-05.3(2)C Age at Shipment

Reinforced concrete culvert pipe may be shipped when it meets the requirements of Section 9-05.3(1)C.

9-05.3(2)D Elliptical Reinforcement

In lieu of marking circular pipe with elliptical reinforcement in accordance with AASHTO M 170, the location of the top of the pipe shall be indicated by 3-inch, waterproof, painted stripes on the inside and outside of the pipe for a distance of 2-feet from each end of the section. At the option of the Contractor, a lift hole or lift holes may be provided at the top of the pipe in lieu of the painted stripes. If one lift hole is provided, it shall be at the balance point of the pipe; and if two lift holes are provided, they shall be spaced equidistant each side of the balance point. Such holes shall not interfere with the reinforcement. After placing, open lift holes shall be filled with mortar or concrete plugs before backfilling.

In addition to the requirements as set forth in AASHTO M 170, it will be required on all pipe 30-inches and over in diameter with elliptical steel reinforcement that the manufacturer expose the reinforcement in not less than one of three lengths of pipe manufactured. A hole exposing the steel shall be cut on the inside of the pipe at top or bottom and a second hole on the outside, 90 degrees from the top or bottom position. After placing, holes exposing the reinforcement shall be filled with mortar or concrete plugs before backfilling.

9-05.3(3) Beveled Concrete End Sections

Beveled concrete end sections shall be plain concrete conforming to AASHTO M 86 or reinforced concrete conforming to the applicable sections of AASHTO M 170 with the design requirements as listed in Table 2, Wall B, Circular Reinforcement in circular pipe, and the Standard Plan.

9-05.4 Steel Culvert Pipe and Pipe Arch

Steel culvert pipe and pipe arch shall meet the fabrication requirements of AASHTO M 36, Type I and Type II. . Zinc coated steel shall meet the material requirements of AASHTO M 218 (ASTM A929). Aluminum coated steel shall meet the material requirements of AASHTO M-274 (ASTM A929).

9-05.4(1) Elliptical Fabrication

When elongated pipes are specified, circular pipes shall be fabricated 5 percent out of round to form an elliptical section. The vertical or longer axis of the elliptical section shall be clearly marked before shipping.

9-05.4(2) Mitered Ends

The ends of steel culvert pipe or pipe arch shall not be beveled unless called for in the plans. If beveled ends are specified, the ends of culvert pipe over 30-inches in diameter shall be mitered to conform to the slope of the embankment in which the culvert is to be placed whether the culvert is constructed normal to or at an angle with the centerline of the roadway.

Beveled steel pipe end sections 12-inches through 30-inches in diameter shall be of the same material and thickness and have the same protective coating as the pipe to which they are attached. Beveled pipe ends of these dimensions shall be constructed in conformance with the Standard Plan.

9-05.4(3) Protective Treatment

Steel pipe and pipe arch culverts shall be coated by one of the following protective treatments, when such treatment is specified:

Treatment 1	Coated uniformly inside and out with asphalt as per 9-05.4(4) (AASHTO M190 Type A) or with polymer as per 9-05.4(6).
Treatment 2	Coated uniformly inside and out with asphalt and with an asphalt paved invert (AASHTO M 190 Type C) or with polymer as per 9-05.4(6).
Treatment 3	This treatment is no longer available.
Treatment 4	This treatment is no longer available.
Treatment 5	Coated inside and out with asphalt and a 100 percent periphery inside spun asphalt lining (AASHTO M 190 Type D).
Treatment 6	This treatment is no longer available.

9-05.4(4) Asphalt Coatings and Paved Inverts

Asphalt for asphalt coatings and paved inverts shall meet the requirements of AASHTO M 190, Section 4. The coatings for Treatments 1, 2, and 5 shall be uniform, inside and out, and applied in accordance with the following requirements:

The metal shall be free from grease, dirt, dust, moisture, or other deleterious contaminants. Either process described below may be used for application.

1. **Pipe Not Preheated**. The temperature of the asphalt at the time of pipe immersion shall be 400ºF (plus or minus 3 degrees), and the duration of the immersion shall conform to the following schedule:

Thickness in inches Steel	Minimum Immersion Time Minutes
0.064	2.5
0.079	3.0
0.109	5.0
0.138	6.5
0.168	8.0

2. Pipe Preheated. The asphalt shall have a temperature of 380ºF (plus or minus 3 degrees), and the pipe shall be brought to a temperature of 300ºF to 350ºF before immersion.

   The paved invert for Treatment 2 shall consist of bituminous material applied in such a manner that one or more smooth pavements will be formed in the invert filling the corrugations for at least 40 percent of the circumference. The pavement shall have a minimum thickness of $^{1}/_{8}$-inch above the crest of

the corrugations except where the upper edges intercept the corrugation. The pavements shall be applied following the coating with asphalt . Treatment 5 may be substituted for Treatment 2, at the option of the Contractor.

9-05.4(5) Polymer Protective Coating

Polymer coated steel pipe and pipe-arch shall meet the fabrication requirements of AASHTO M 36 (ASTM A760). Polymer protective coatings shall meet the material requirements of AASHTO M 246 (ASTM A742). Polymer coating shall be mill applied to galvanized steel coils before fabrication and shall measure 10 mils thick on each side.

9-05.4(6) Spun Asphalt Lining

Asphalt for spun linings over 100 percent periphery shall conform to AASHTO M 190, Section 4. Asphalt spun linings shall provide a smooth surface for the full interior of the pipe by completely filling the corrugations to a minimum thickness of ⅛-inch above the crests. The interior lining shall be applied by centrifugal or other approved methods. The interior shall be free from sags or runs, but slight residual corrugations due to cooling shrinkage of the lining will not be cause for rejection. At the three sheet laps, an interior nonuniformity equal to the thickness of the sheet is allowable. The thickness of the lining shall be maintained to the ends of the pipe.

The thickness of the lining over the crest of the corrugation shall not vary by an amount in excess of ½-inch over the entire area of the spun lining.

In the case of helical corrugated pipe manufactured with a continuous lock seam, an interior nonuniformity over the lock seam equal to the thickness of two culvert sheets is allowable.

9-05.4(7) Coupling Bands

Coupling bands for steel pipe shall be as shown in the Standard Plans and shall be fabricated of the same material as the pipe. Bands may be up to three nominal thicknesses thinner than used for the pipe, but not thinner than 0.064-inches or thicker than 0.109-inches. Bands shall be coated with the same metallic protective treatment as the pipe but shall not be coated with any asphalt protective treatment. Bands shall be made by the same manufacturer as the steel pipe selected for installation.

Corrugations on the bands shall be the same size and shape as those on the pipes to be connected. Steel bolts and nuts for coupling bands shall meet the requirements of ASTM A 307 and shall be galvanized in accordance with AASHTO M 232. Steel angles, when required for coupling bands, shall meet the requirements of AASHTO M 36. When annular corrugated bands are used to connect helically corrugated lock-seam pipe, the seam shall be welded at the pipe ends prior to recorrugating to prevent unraveling of the seam. All welds shall develop the full strength of the parent metal.

Bands shall conform to the corrugations of the pipe and shall meet all applicable requirements of AASHTO M 36, with the following exceptions:

Coupling bands for all sizes of steel pipe arch with 3-inch by 1-inch corrugations shall be 24-inches wide.

Type K coupling bands shall only be used on circular culvert pipe when extending an existing culvert. Rubber gaskets shall be used and shall conform to the requirements of Section 9-04.4(3), match the width of the band, and have a minimum thickness of 1-inch.

Type K coupling bands are allowed for use on all sizes of steel pipe arch with 3-inch by 1-inch corrugations. Type K bands for this application shall be 24-inches wide. Rubber gaskets shall be used and shall conform to the requirements of Section 9-04.4(3), match the width of the band, and have a minimum thickness of 1-inch. When Type K bands are used, pipe arch ends are not required to be recorrugated.

Gaskets are required for all culvert installations and shall meet the requirements of 9-05.10(1).

9-05.4(8) Steel Nestable Pipe

Steel nestable pipe shall meet the requirements for steel pipe of these Specifications except in the method of fabrication. Circular pipe shall be fabricated in two semicircles.

Nestable pipe may be either the stitch-type as hereinafter described or the flange-type in accordance with Military Designation MIL-P-236. One longitudinal edge of each half of the stitch-type nestable circular pipe shall be notched to provide interlocking seams which will form the two segments into the full section when it is erected in the field. Hook and eye bolts, or other approved means, shall be provided to hold the segments firmly together.

Individual plates shall be a minimum of 2-feet in length except for short or half sections required to complete the end section of the culvert.

When protective treatment is specified in the Plans, nestable pipe shall be coated with one of the treatments as provided in Section 9-05.4(3).

9-05.4(9) Steel End Sections

The applicable provisions of AASHTO M 36 shall apply to the construction of steel end sections, except that the end sections shall be fabricated of the same material with the same metallic protective treatment as the pipe.

Asphalt coating shall not be used on steel end sections.

9-05.4(9)A Fabrication

The shape, thickness, dimensions, and number of pieces shall conform to the Standard Plan for the size and shape of pipe shown in the Plans. They shall be manufactured as integral units or so formed that they can be readily assembled and erected in place. When bolts are used for assembly, they shall be ⅜-inch diameter or larger and shall be galvanized. No field welding or riveting will be permitted.

9-05.4(9)B Galvanized Hardware

Bolts, nuts, and miscellaneous hardware shall be galvanized in accordance with the provisions of AASHTO M 232.

9-05.4(9)C Toe Plate Extensions

Toe plate extensions shall be furnished only when so designated in the Plans. When required, the toe plate extensions shall be punched with holes to match those in the lip of the skirt and fastened with ⅜-inch or larger galvanized nuts and bolts. Toe plate extensions shall be the same material and thickness as the end section and shall be fabricated of the same material with the same metallic protective treatment as the end section.

9-05.5 Aluminum Culvert Pipe

Aluminum culvert pipe shall conform to the applicable requirements of AASHTO M 196M.

9-05.5(1) Elliptical Fabrication

Section 9-05.4(1) shall apply to aluminum pipes.

9-05.5(2) Mitered Ends

Section 9-05.4(2) shall apply to aluminum pipes.

9-05.5(3) Vacant

9-05.5(4) Vacant

9-05.5(5) Coupling Bands

Bands shall be fabricated of the same material as the pipe and shall meet all applicable requirements of AASHTO M 196, except the band thickness shall not be more than 0.105-inches or less than 0.060-inches. All other requirements of Section 9-05.4(7) shall apply.

9-05.5(6) Aluminum End Sections

The applicable provisions of AASHTO M 196 shall apply to the construction of end sections and toe plate extensions for aluminum pipes. In addition, they shall conform to the requirements of Section 9-05.4(9).

Asphalt coating shall not be used on aluminum end sections.

9-05.6 Structural Plate Pipe, Pipe Arch, Arch, and Underpass

9-05.6(1) General

Structural plate pipes shall be full circle of the type, gage or thickness, and diameter specified.

Structural plate pipe arches shall be a multi-centered shape, made up of four circular arcs tangent to each other at their junctions and symmetrical about the vertical axis, and of the type, gage or thickness, and span specified.

Structural plate arches shall be a single-centered circular arc shape placed on a reinforced concrete foundation, and of the design, type, gage or thickness, and span as provided for in the Plans.

Structural plate underpasses shall be a multi-centered shape, made up of a variable number of circular arcs tangent to each other at their junctions and symmetrical about the vertical axis, and of the design, type, gage or thickness, and span specified.

9-05.6(2) Fabrication

The plates at longitudinal and circumferential seams shall be connected by bolts; the bolt holes shall be staggered in rows 2-inches apart, one hole being punched in the valley and one in the crest of each corrugation along both edges of each plate. Bolt holes on circumferential seams shall be spaced at approximate 12-inch intervals. No hole shall be closer to the edge of the plate than twice the diameter of the bolt.

The ends of structural plate pipes, pipe arches, arches, or underpasses shall not be mitered unless called for in the Plans, Special Provisions, or Standard Plan. If mitered ends are specified, the slope shall conform to the slope of the embankment in which the culvert is to be placed. The miter on pipe arches shall be limited to the top arc only.

9-05.6(3) Elliptical Fabrication

When elongated structural plate pipes are specified, they shall be fabricated 5 percent out of round to form an elliptical cross-section. The vertical axis (the longer axis of the elliptical section) shall be clearly marked on the plates before shipping.

9-05.6(4) Structural Plate Pipe Arch

Plates for structural plate pipe arches shall be formed so that the top shall be an arc of not more than 180 degrees nor less than 155 degrees; the bottom shall be an arc of not more than 50 degrees nor less than 10 degrees; and the top shall be joined at each end to the bottom by an arc having a radius between 18-inches and 31-inches and of not more than $87^{1}/_{2}$ degrees nor less than 75 degrees.

9-05.6(5) Structural Plate Arch

Structural plate arches and their foundations shall be as shown in the Plans.

9-05.6(6) Structural Plate Underpass

Structural plate underpasses shall be as provided for in the Standard Plans, or, in the case of a special design, as provided for in the Plans.

9-05.6(7) Concrete

Concrete required for constructing structural plate arch foundations shall be Class 3000 concrete in conformance with the requirements of Section 6-02.

Steel reinforcing bars shall conform to the requirements of Section 9-07.1.

9-05.6(8) Plates

9-05.6(8)A Corrugated Steel Plates

Galvanized corrugated steel plates for constructing structural plate pipe, pipe arches, arches, and underpasses, and nuts and bolts used in their assembly shall conform to the requirements of AASHTO M 167 except that the minimum mass of spelter coating on the plates shall be 3 ounces of zinc per square foot of double exposed surface. If the average spelter coating as determined from the required samples is less than 3 ounces, or if any one specimen shows less than 2.7 ounces, the lot samples shall be rejected. Nuts, bolts, and miscellaneous hardware shall be galvanized in accordance with AASHTO M 232.

9-05.6(8)B Corrugated Aluminum Plates

Aluminum alloy plates and fasteners intended for use in the construction of structural plate pipe, pipe arches, arches, and underpasses shall conform to the requirements of AASHTO M 219. Nuts, bolts, and miscellaneous hardware shall be galvanized in accordance with AASHTO M 232.

9-05.7 Concrete Storm Sewer Pipe

9-05.7(1) Plain Concrete Storm Sewer Pipe

Plain concrete storm sewer pipe shall conform to the requirements of AASHTO M 86, Class 2.

9-05.7(1)A Basis for Acceptance

The basis for acceptance of plain concrete storm sewer pipe shall be the same as specified in Section 9-05.3(1)B.

9-05.7(2) Reinforced Concrete Storm Sewer Pipe

Reinforced concrete storm sewer pipe shall conform to the requirements of AASHTO M 170 and shall be of the class noted in the Plans or in the Special Provisions. Section 7.3.1 of AASHTO M 170 shall be amended to require that both bells and spigots shall be reinforced in pipe 30-inches in diameter and greater.

The identification of the minor axis of elliptical reinforcement shall be in accordance with Section 9-05.3(2)D.

9-05.7(2)A Basis for Acceptance

The basis for acceptance of reinforced concrete storm sewer pipe shall be the same as specified in Section 9-05.3(2)B.

9-05.7(3) Concrete Storm Sewer Pipe Joints

All concrete storm sewer pipe shall be joined with rubber gaskets. The joints and gasket material shall meet the requirements of AASHTO M 198. Gasket material shall be handled and stored in accordance with Section 9-04.4(5).

9-05.7(4) Testing Concrete Storm Sewer Pipe Joints

When a particular type of pipe joint design, material or joining method has not previously been tested and approved, the following test shall be made on one test length of the assembled storm sewer pipe to qualify the design, material or method of joining the pipe. At the option of the Engineer, additional testing may be requested if subsequent field testing of installed pipe indicates difficulty in obtaining properly joined pipe. The tests will be conducted at the manufacturer's yard, and the manufacturer will be required to make such space and facilities available as required to conduct the tests in an efficient and workmanlike manner.

9-05.7(4)A Hydrostatic Pressure on Pipes in Straight Alignment

Hydrostatic pressure tests on pipes in straight alignment shall be made in accordance with the procedure outlined in paragraph 8(a) of AASHTO M 198, except that they shall be performed on an assembly consisting of not less than three nor more than five pipe sections selected from stock by the Engineer and assembled in accordance with standard installation instructions issued by the manufacturer. The end sections shall be bulkheaded and restrained against internal pressure.

9-05.7(4)B Hydrostatic Pressure Tests on Pipes in Maximum Deflected Position

Upon completion of the test for pipe in straight alignment, the test section shall be deflected until at least two of the joints have been deflected to the maximum amount shown in the manufacturer's standard installation instructions. When thus deflected, there shall be no leakage at the joints from an applied internal hydrostatic pressure of 5 psi.

9-05.7(4)C Hydrostatic Pressure Test on 15-inch Diameter and Larger Pipe Under Differential Load

The test sections shall be suitably supported so that one of the pipes of the test assembly is suspended freely between adjacent pipes, bearing only on the joints. The suspended pipe shall then be loaded, at its midpoint, in addition to the mass of the pipe, in accordance with the following schedule:

Diameter	Load
15-inches	7,400 lbs.
18-inches	8,800 lbs.
21-inches	10,000 lbs.
24-inches and over	11,000 lbs.

While under this load, the stressed joints shall show no leakage when subjected to an internal hydrostatic pressure of 5 psi. At the option of the manufacturer, $^1/_2$ of the load may be applied on the bell end of the suspended pipe in lieu of the full load on the center of the suspended pipe.

9-05.8 Vitrified Clay Sewer Pipe

This material shall not be used in Washington State Department of Transportation projects unless specified in the special provisions.

Vitrified clay sewer pipe shall conform to ASTM C 700, and all joints shall be factory manufactured in accordance with ASTM C 425.

9-05.9 Steel Spiral Rib Storm Sewer Pipe

Steel spiral rib storm sewer pipe shall meet the fabrication requirements of AASHTO M 36 and these Specifications. Zinc coated steel shall meet the material requirements of AASHTO M 218 (ASTM A929). Aluminum coated steel shall meet the material requirements of AASHTO M-274 (ASTM A929). The size, coating, metal, and protective treatment, if any, shall be as shown in the Plans or in the specifications.

The manufacturer of spiral rib storm sewer pipe shall furnish the Engineer a Manufacturer's Certificate of Compliance stating that the materials furnished comply in all respects with these Specifications. The Engineer may require additional information or tests to be performed by the Contractor at no expense to the Contracting Agency.

Unless otherwise specified, spiral rib storm sewer pipe shall be furnished with pipe ends cut perpendicular to the longitudinal axis of the pipe. Pipe ends shall be cut evenly. Spiral rib pipe shall be fabricated by using a continuous helical lock seam.

Spiral rib storm sewer pipe shall have helical ribs that project outwardly, be formed from a single thickness of material, and conform to one of the following configurations:

1. $^3/_4$-inch wide by $^3/_4$inch deep ribs at $7^1/_2$-inches on center.
2. $^3/_4$-inch wide by 1-inch deep ribs at $11^1/_2$-inches on center.
3. $^3/_4$-inch wide by $^5/_8$-inch deep ribs at 12-inches on center.

Pipe shall be fabricated with ends that can be effectively jointed with coupling bands.When it is required, spiral rib pipe shall be furnished with bituminous or polymer protective treatment 1 or 2 treated or paved. The bituminous treatment for spiral rib pipe shall conform to the requirements of Sections 9-05.4(3) and 9-05.4(4). Polymer coating shall conform to Section 9-05.4(5).

9-05.9(1) Continuous Lock Seam Pipe

Pipes fabricated with a continuous helical seam parallel to the rib may be used for full circle pipe. The seam shall be formed in the flat between ribs and shall conform to Sections 7.5.1 through 7.5.3 of AASHTO M 36.

9-05.9(1)A Basis for Acceptance

The basis for acceptance will be a qualification test, conducted by the State Materials Laboratory, for each manufacturer of spiral rib lock seam steel pipe. Only those specific pipe sizes and gasket materials, if any, approved under the qualification test will be accepted.

Continuous lock seam pipe shall be sampled and tested in accordance with AASHTO T 249.

9-05.9(2) Vacant

9-05.9(3) Coupling Bands

Coupling bands shall be of the same material as the pipe. Coupling bands and gaskets shall conform to Section 9-05.10(1).

9-05.10 Steel Storm Sewer Pipe

Steel storm sewer pipe shall conform to the requirements of Section 9-05.4 for steel culvert pipe, except that protective coating shall be Treatment 1 or 5, and be constructed of helically corrugated lock seam pipe. When gasketed helically corrugated lock seam steel pipe is called for, and the pipe is properly sized to meet hydraulic requirements, Treatment 5 is not required.

9-05.10(1) Coupling Bands

Coupling bands shall be as shown in the Standard Plans. Bands shall be fabricated of the same material as the pipe and shall meet all applicable requirements of AASHTO M 36. Bands may be up to three nominal thicknesses thinner than used for the pipe, but not thinner than 0.064-inches or thicker than 0.109-inches. Bands shall be coated with the same metallic protective treatment as the pipe but shall not be coated with any asphalt treatment. Bands shall be made by the same manufacturer as the steel pipe selected for installation.

Corrugations on the bands shall be the same size and shape as those on the pipe to be connected. Steel bolts and nuts for coupling bands shall meet the requirements of ASTM A 307 and shall be galvanized in accordance with AASHTO M 232. Steel angles, when required for coupling bands, shall meet the requirements of AASHTO M 36. When annular corrugated bands are used to connect helically corrugated lock-seam pipe, the seam shall be welded at the pipe ends prior to recorrugating to prevent unraveling of the seam. All welds shall develop the full strength of the parent metal.

Gaskets are required for all storm sewer installations. Gasket material for coupling bands shall meet the requirements of Section 9-04.4(3). Gaskets for Type D bands shall match the width of the band and have a minimum thickness of $^{3}/_{8}$-inch. O-ring gaskets for Type F bands shall have a cross-sectional diameter of $^{13}/_{16}$-inch for pipe diameters of 36-inches or smaller and $^{7}/_{8}$-inch for larger pipe diameters.

Type K coupling bands are not allowed for storm sewer applications.

9-05.10(2) Basis for Acceptance

The basis for acceptance of steel storm sewer pipe will be the same as specified in Section 9-05.4, except when gasketed helically corrugated lock seam steel pipe is called for. A qualification test conducted by the State Materials Laboratory will be required for each manufacturer of gasketed helically corrugated lock seam steel pipe. Only those specific pipe sizes and gasket materials approved under the qualification test will be accepted.

9-05.11 Aluminum Storm Sewer Pipe

Aluminum storm sewer pipe shall conform to the requirements of Section 9-05.5 for aluminum culvert pipe, and the pipe shall be constructed of helically corrugated lock seam aluminum pipe.

9-05.11(1) Coupling Bands

Coupling bands for aluminum pipe shall be as shown in the Standard Plans. Bands shall be fabricated of the same material as the pipe and shall meet all applicable requirements of AASHTO M 196, except the band thickness shall not be more than 0.105-inches or less than 0.060-inches. All other requirements of Section 9-05.10(1) shall apply.

9-05.11(2) Basis for Acceptance

The basis for acceptance of aluminum storm sewer pipe will be the same as specified in Section 9-05.0, except when gasketed helically corrugated lock seam aluminum pipe is called for. A qualification test, conducted by the State Materials Laboratory, will be required for each manufacturer of gasketed helically corrugated lock seam aluminum pipe. Only those specific pipe sizes and gasket materials approved under the qualification test will be accepted.

9-05.12 Polyvinyl Chloride (PVC) Pipe

9-05.12(1) Solid Wall PVC Culvert Pipe, Solid Wall PVC Storm Sewer Pipe, and Solid Wall PVC Sanitary Sewer Pipe

Solid wall PVC culvert pipe, solid wall PVC storm sewer pipe, and solid wall PVC sanitary sewer pipe and fittings shall be solid wall construction and shall conform to the requirements of ASTM D 3034 SDR 35 for pipe up to 15-inch diameter and ASTM F 679, Type 1 only, for pipe sizes 18- to 27-inch diameter.

Joints for solid wall PVC pipe shall conform to ASTM D 3212 using elastomeric gaskets conforming to ASTM F 477.

Fittings for solid wall PVC pipe shall be injection molded, factory welded, or factory solvent cemented.

9-05.12(2) Profile Wall PVC Culvert Pipe, Profile Wall PVC Storm Sewer Pipe, and Profile Wall PVC Sanitary Sewer Pipe

Profile wall PVC culvert pipe and profile wall PVC storm sewer pipe shall meet the requirements of AASHTO M 304 or ASTM F 794 Series 46. Profile wall PVC sanitary sewer pipe shall meet the requirements of ASTM F 794 Series 46. The maximum pipe diameter shall be as specified in the Qualified Products List.

Joints for profile wall PVC culvert pipe shall conform to ASTM D 3212 using elastomeric gaskets conforming to ASTM F 477, or as approved through the State Materials Laboratory.

Qualified producers are identified in the Qualified Products List. Qualification for each producer requires joint system conformation to ASTM D 3212 using elastomeric gaskets conforming to ASTM F 477 and a formal quality control plan for each plant proposed for consideration.

A producer's Certificate of Compliance shall be required and shall accompany the materials delivered to the project. The certificate shall clearly identify production lots for all materials represented. The Contracting Agency may conduct verification tests of pipe stiffness or other properties as it deems appropriate.

Fittings for profile wall PVC pipe shall meet the requirements of AASHTO M 304 or ASTM F 794 Series 46.

9-05.13 Ductile Iron Sewer Pipe

This material shall not be used in Washington Department of Transportation projects unless specified in the special provisions.

Ductile iron pipe shall conform to ANSI A 21.51 or AWWA C 151 and shall be cement mortar lined, push-on joint, or mechanical joint. The ductile iron pipe shall be Class 50 or the class indicated on the Plans or in the Special Provisions.

Joints for ductile iron pipe shall be rubber gasketed conforming to the requirements of ANSI A 21.11 or AWWA C-111.

Cast iron fittings may be used with ductile iron pipe. Saddles fastened to pipe with external bands shall not be acceptable on any new system. Normally, all fittings shall be the same material as the pipe being connected, except that fittings using other materials or constructed with more than one material may be used subject to the approval of the Engineer. Fittings shall have sufficient strength to withstand handling and load stresses normally encountered.

9-05.14 ABS Composite Sewer Pipe

This material shall not be used in Washington Department of Transportation projects unless specified in the special provisions.

ABS composite pipe shall meet the requirements of AASHTO M 264.

ABS composite pipe shall be provided with Type OR (flexible gasketed) joints. Rubber gasketed joints shall conform to applicable provisions of ASTM C 443.

Fittings for ABS composite pipe shall be specifically designed for connection to ABS composite pipe with solvent cement. Normally, all fittings shall be the same material as the pipe being connected, except that fittings using other materials or constructed with more than one material may be used subject to the approval of the Engineer. Fittings shall have sufficient strength to withstand handling and load stresses normally encountered.

9-05.15 Metal Castings

Metal castings for drainage structures shall not be dipped, painted, welded, plugged, or repaired.

Porosity in metal castings for drainage structures shall be considered a workmanship defect subject to rejection by the Engineer.

9-05.15(1) Manhole Ring and Cover

Castings for manhole rings shall be gray-iron conforming to the requirements of AASHTO M 105, Grade 30B. Covers shall be ductile iron conforming to ASTM A 536, Grade 80-55-06.

All covers shall be interchangeable within the dimensions shown in the Standard Plans. Manhole rings and covers shall meet the strength requirements of Federal Specification RR-F-621E. All mating surfaces shall be machine finished to ensure a nonrocking fit.

The horizontal surface and inside vertical recessed face of the ring, and the horizontal seating surface and vertical outside edge of the cover, shall be machine finished to the following tolerances:

Ring	+3/32-inch to -3/32-inch
Cover	+3/32-inch to -3/32-inch

All manhole rings and covers shall be identified by the name or symbol of the manufacturer and country of casting origin. This identification shall be in a plainly visible location when the ring and cover are installed. Ductile iron shall be identified by the following, "DUC" or "DI." The manufacturer's identification and material identification shall be adjacent to each other and shall be minimum ½-inch to maximum 1-inch high letters, recessed to be flush with the adjacent surfaces.

9-05.15(2) Metal Frame, Grate and Solid Metal Cover for Catch Basins or Inlets

Castings for metal frames for catch basins and inlets shall be cast steel, gray iron, or ductile iron as specified in Sections 9-06.8, 9-06.9, or 9-06.14, and as shown in the Standard Plans. Castings shall meet the strength requirements of Federal Specification RR-F-621E.

Castings for grates and solid metal covers for catch basins and inlets shall be cast steel or ductile iron as specified in Sections 9-06.8 or 9-06.14, and as shown in the Standard Plans. Castings shall meet the strength requirements of Federal Specifications RR-F-621E. The foundry name and material designation shall be embossed on the top of the grate. The material shall be identified by the following: "CS" for cast steel or "DUC" or "DI" for ductile iron and shall be located near the manufacturer's name.

Grates and covers shall be seated properly to prevent rocking, including the replacement of existing covers with solid metal covers. After seating, the frame and grate or frame and cover shall be maintained as a unit. Alternate designs are acceptable provided they conform to the manufacturer's shop drawings approved prior to award of the contract.

9-05.15(3) Cast Metal Inlets

The castings for cast metal inlets shall be cast steel or ductile iron as specified in Section 9-06.8 or Section 9-06.14 and as shown in the Standard Plans. Alternate plans are acceptable provided they conform to the fabricator's shop drawings approved prior to award of contract.

9-05.16 Grate Inlets and Drop Inlets

Steel in grates, angles, and anchors for grate inlets shall conform to ASTM A 36, except structural tube shall conform to ASTM A 500, Grade B, and structural shapes may conform to ASTM A 992. After fabrication, the steel shall be galvanized in accordance with AASHTO M 111, or galvanized with a hot-sprayed (plasma flame applied) 6 mil minimum thickness plasma coating.

Steel grating shall be fabricated by weld connections. Welds, welding procedures, and welding materials shall conform with the AWS D1.1/D1.1M, latest edition, Structural Welding Code.

Alternate grate designs will be permitted, with the approval of the Engineer, providing the hydraulic capacity is not decreased, the overall dimensions are the same allowing the grate to be interchangeable, and the strength is essentially equal to the grate shown in the Standard Plan or the Plans.

The Contractor has the option of furnishing either cast-in-place or precast inlets unless otherwise shown in the Plans. Alternate designs are acceptable provided they conform to the fabricator's shop drawings approved prior to award of the contract.

9-05.17 Aluminum Spiral Rib Storm Sewer Pipe

Aluminum spiral storm sewer pipe shall meet the fabrication requirements of AASHTO M 196 and these Specifications. Aluminum alloy shall meet the material requirements of AASHTO M 97 (ASTM B744). The size and corrugation shall be as shown in the Plans or in the Specifications. The size, metal, and protective treatment shall be as shown in the Plans or in the Specifications.

The manufacturer of spiral rib storm sewer pipe shall furnish to the Engineer a Manufacturer's Certificate of Compliance stating that the materials furnished comply in all respects with these Specifications. The Engineer may require additional information or tests to be performed by the Contractor at no expense to the Contracting Agency.

Unless otherwise specified, spiral rib storm sewer pipe shall be furnished with pipe ends cut perpendicular to the longitudinal axis of the pipe. Pipe ends shall be cut evenly. Spiral rib pipe shall be fabricated by using a continuous helical lock seam.

Spiral rib storm sewer pipe shall have helical ribs that project outwardly, be formed from a single thickness of material, and conform to one of the following configurations:

1. $^{3}/_{4}$-inch wide by $^{3}/_{4}$-inch deep ribs at $7^{1}/_{2}$-inches on center.
2. $^{3}/_{4}$-inch wide by 1-inch deep ribs at $11^{1}/_{2}$-inches on center.
3. $^{3}/_{4}$-inch wide by $^{5}/_{8}$-inch deep ribs at 12-inches on center.

9-05.17(1) Continuous Lock Seam Pipe

Pipes fabricated with a continuous helical lock seam parallel to the rib may be used for full circle pipe. The lock seam shall be formed in the flat between ribs and shall conform to Sections 13.2.1 through 13.2.5 of AASHTO M 196.

9-05.17(1)A Basis for Acceptance

The basis for acceptance will be a qualification test, conducted by the State Materials Laboratory, for each manufacturer of spiral rib lock seam pipe. Only those specific pipe sizes and gasket materials, if any, approved under the qualification test, will be accepted.

Continuous lock seam pipe shall be sampled and tested in accordance with AASHTO T 249.

9-05.17(2) Coupling Bands

Coupling bands shall be of the same material as the pipe. Coupling bands and gaskets shall conform to Section 9-05.10(1).

9-05.18 Safety Bars for Culvert Pipe

Steel pipe used as safety bars and steel pipe used as sockets shall conform to ASTM A 53, Grade B. Steel tubing used as safety bars shall conform to ASTM A 500, Grade B. Steel plate shall conform to ASTM A 36. All parts shall be galvanized after fabrication in accordance with AASHTO M 111.

9-05.19 Corrugated Polyethylene Culvert Pipe

Corrugated polyethylene culvert pipe shall meet the requirements of AASHTO M 294 Type S or D for pipe 12-inch to 60-inch diameter.

Joints for corrugated polyethylene culvert pipe shall be made with either a bell/bell or bell and spigot coupling and shall incorporate the use of a gasket conforming to the requirements of ASTM D 1056, ASTM F 477, or ASTM D 5249. All gaskets shall be factory installed on the coupling or on the pipe by the producer. Qualified producers and approved joints are listed in the Qualified Products Lists.

Qualification for each producer of corrugated polyethylene culvert pipe requires an approved joint system and a formal quality control plan for each plant proposed for consideration.

A producer's Certificate of Compliance shall be required and shall accompany the materials delivered to the project. The certificate shall clearly identify production lots for all materials represented. The Contracting Agency may conduct verification tests of pipe stiffness or other properties as it deems appropriate.

9-05.20 Corrugated Polyethylene Storm Sewer Pipe

Corrugated polyethylene storm sewer pipe and fittings shall meet the requirements of AASHTO M 294 Type S or D. The maximum pipe diameter for corrugated polyethylene storm sewer pipe shall be the diameter for which a producer has submitted a qualified joint. Qualified producers are listed in the Qualified Products List. Fittings shall be blow molded, rotational molded, or factory welded.

All joints for corrugated polyethylene storm sewer pipe shall be made with a bell/bell or bell and spigot coupling and shall conform to ASTM D 3212 using elastomeric gaskets conforming to ASTM F 477. All gaskets shall be factory installed on the pipe in accordance with the producer's recommendations.

Qualification for each producer or corrugated polyethylene storm sewer pipe requires joint system conformance to ASTM D 3212 using elastomeric gaskets conforming to ASTM F 477 and a formal quality control plan for each plant proposed for consideration.

A producer's Certificate of Compliance shall be required and shall accompany the materials delivered to the project. The certificate shall clearly identify production lots for all materials represented. The Contracting Agency may conduct verification tests of pipe stiffness or other properties as it deems appropriate.

9-06 STRUCTURAL STEEL AND RELATED MATERIALS

9-06.1 Structural Carbon Steel

Structural carbon steel shall conform to AASHTO M 270, Grade 36, except as otherwise noted.

9-06.2 Structural Low Alloy Steel

Structural low alloy steel shall conform to AASHTO M 270, Grade 50 or 50W as specified in the Plans or Special Provisions, except as otherwise noted.

9-06.3 Structural High Strength Steel

Structural high strength steel shall be high yield strength, quenched and tempered structural steel conforming to AASHTO M 270, Grades 70W, 100, or 100W as specified in the Plans or Special Provisions, except as otherwise noted.

9-06.4 Vacant

9-06.5 Bolts

9-06.5(1) Unfinished Bolts

Unfinished bolts (ordinary machine bolts) shall conform to the specification requirements of ASTM A 307 Grade A or B. Nuts shall comply with ASTM A 563 Grade A requirements. Washers, unless otherwise specified, shall meet ASTM F 844 specifications.

The Contractor shall submit a Manufacturer's Certificate of Compliance for the bolts, nuts, and washers prior to installing any of them.

9-06.5(2) Vacant

9-06.5(3) High Strength Bolts

High strength bolts for structural steel joints shall conform to the requirements of AASHTO M 164 or M 253 Type 1, 2, or 3.

Bolts conforming to AASHTO M 164, having an ultimate tensile strength above 145 ksi and are galvanized in accordance with AASHTO M 232, shall be tested for embrittlement. Embrittlement testing shall be conducted after galvanization in accordance with ASTM F 606, Section 7. The Manufacturer's Certificate of Compliance for the lot provided shall show the ultimate tensile strength test results. Bolts conforming to AASHTO M 253 shall not be galvanized. AASHTO M 253 Type 1 and 2 bolts shall be painted with two coats of zinc rich paint, formula A-9-73, consisting of a minimum dry film thickness of 2 mils per coat.

Unpainted and nongalvanized bolts shall conform to AASHTO M 164 and M 253 Type 3.

Nuts for high strength bolts shall meet the following requirements:

AASHTO M 164 Bolts	
Black or galvanized Type 1	AASHTO M 291 Grade C, C3, DH, and DH3
AASHTO M 292 Grade 2H	
Black weathering Type 3	AASHTO M 291 Grade C3 and DH3
Galvanized Type 1	AASHTO M291 Grade DH AASHTO M 292 Grade 2H
AASHTO M 253 Bolts	
Black Type 1 and 2	AASHTO M 291 Grade DH, DH3 AASHTO M 292 Grade 2H
Black weathering Type 3	AASHTO M 291 Grade DH3

Nuts that are to be galvanized shall be tapped oversized the minimum required for proper assembly. The amount of overtap shall be such that the nut will assemble freely on the bolt in the coated condition and shall meet the mechanical requirements of AASHTO M 291 and the rotational capacity test specified in AASHTO M 164.

Galvanized nuts shall be lubricated in accordance with AASHTO M 291 including supplementary requirement S2. Documentation shall include the name, method of application, and dilution of the lubricant applied to the nuts.

Washers for AASHTO M 164 Type 1 and 3 bolts; and AASHTO M 253 Type 1, 2, and 3 bolts shall meet the requirements of AASHTO M 293. The surface condition and weathering characteristics of the washers shall be the same as for the bolts being specified.

Direct Tension Indicators shall conform to the requirements of ASTM F 959 and may be used with either AASHTO M 164 or M 253 bolts. Direct tension indicators shall be galvanized by mechanical deposition in accordance with AASHTO M 298 class 55. Hot dip galvanizing will not be allowed.

All bolts, nuts, and direct tension indicators shall be marked and identified as required in the pertinent specifications.

Lock-pin and collar fasteners which meet the materials, manufacturing, and chemical composition requirements of AASHTO M 164 or AASHTO M 253, and which meet the mechanical property requirements of the same specification in full size tests, and which have a body diameter and bearing areas under lock-pin head and collar not less than those provided by a bolt and nut of the same nominal size may be used. The Contractor shall submit a detailed installation procedure to the Engineer for approval. Approval to use a lock-pin and collar fasteners will be given by the Engineer prior to use on these types of fasteners.

The Contractor shall provide Manufacturer's Certificate of Compliance for all bolts, nuts, washers, and load indicators. The Manufacturer's Certificate of Compliance shall include certified mill test reports and test reports performed on the finished bolt confirming that all of the materials provided meet the requirements of the applicable AASHTO or ASTM specification. The documentation shall also include the name and address of the test laboratory, the date of testing, the lot identification of the bolts and nuts, and coating thickness for galvanized bolts and nuts. Shipping containers (not lids) shall be marked with the lot identification of the item contained therein.

Bolts shall be sampled prior to incorporating into a structure. For the purposes of selecting samples, a lot of bolts shall be the quantity of bolts of the same nominal diameter and same nominal length in a consignment shipped to the project site. The minimum number of samples from each lot shall be as follows:

Lot Size	Sample Size[1,2]
0 to 50	*
51 to 150	4
151 to 1,200	6
1,201 to 10,000	10
10,001 to 35,000	16
35,001 and over	24

*Manufacturer's Certificate of Compliance — samples not required.

[1]If bolts are galvanized, increase the sample size by 1.5 times the table value for the number of bolts being sampled.

[2]Nuts, washers, and load indicator devices shall be sampled at the same frequency as the bolts.

All testing of bolts, nuts, washers, and load indicating devices shall be performed on specimens as they are to be installed.

All samples shall include a Manufacturer's Certificate of Compliance for each lot of bolts provided as defined in Section 1-06.3.

9-06.5(4) Anchor Bolts

Anchor bolts shall meet the requirements of ASTM A 449 or AASHTO M 164. Galvanized anchor bolts having an ultimate tensile strength above 145 ksi shall be tested for embrittlement in accordance with ASTM A 143 unless the length is less than five times the nominal bolt diameter, then they shall be tested in accordance with ASTM F 606, Section 7. The Manufacturer's Certificate of Compliance for the lot provided shall show the ultimate tensile strength test results.

Nuts for ASTM A 449 black anchor bolts shall conform to AASHTO M 291, Grade C. Nuts for ASTM A 449 galvanized bolts shall conform to AASHTO M 291, Grade DH and shall conform to the lubrication requirements in Section 9-06.5(3). Nuts for AASHTO M 164 black anchor bolts shall conform to AASHTO M 291, Grade C, C3, DH, and DH3 or AASHTO M 292, Grade 2H. Nuts for AASHTO M 164 galvanized anchor bolts shall conform to AASHTO M 291, Grade DH or AASHTO M 292, Grade 2H. Washers for ASTM A 449 anchor bolts shall conform to AASHTO M 293. Washers for AASHTO M 164 anchor bolts shall conform to ASTM F 436.

The bolts shall be tested by the manufacturer in accordance with the requirements of the pertinent specification and as specified in these Specifications. Anchor bolts, nuts, and washers shall be inspected prior to shipping to the project site. The Contractor shall submit to the Engineer for approval a Manufacturer's Certificate of Compliance for the anchor bolts, nuts, and washers, as defined in Section 1-06.3. If the Engineer deems it appropriate, the Contractor shall provide a sample of the anchor bolt, nut, and washer for testing.

All bolts, nuts, and washers shall be marked and identified as required in the pertinent specification.

9-06.6 Vacant

9-06.7 Vacant

9-06.8 Steel Castings

Steel castings shall conform to the requirements of AASHTO M 103, Mild to Medium Strength Carbon Steel Castings for General Application, grade 70-36, unless otherwise designated in the Plans or in the Special Provisions.

9-06.9 Gray Iron Castings

Gray iron castings shall conform to the requirements of AASHTO M 105. The class of castings to be furnished shall be that designated in the Plans or in the Special Provisions.

9-06.10 Malleable Iron Castings

Malleable iron castings shall conform to the requirements of ASTM A 47.

9-06.11 Steel Forgings and Steel Shafting

Steel forgings shall conform to the requirements of AASHTO M 102. The classes of forgings to be furnished shall be those specified in the Plans or in the Special Provisions.

Steel shafting shall conform to the requirements of AASHTO M 169, Grade Designation 1016 to 1030 inclusive, unless otherwise specified.

9-06.12 Bronze Castings

Bronze castings shall conform to the requirements of AASHTO M 107, Bronze Castings for Bridges and Turntables.

9-06.13 Copper Seals

Copper sheets for seals shall conform to the requirements of AASHTO M 138. They shall be UNS C12500, light cold rolled, and furnished in flat sheets each not less than 0.018-inch in thickness.

All splices or joints shall be carefully brazed or soldered to produce a continuous watertight seal for the full length of each unit.

9-06.14 Ductile Iron Castings

Ductile iron castings shall conform to the requirements of ASTM A 536, Grade 80-55-06, unless otherwise specified in the Plans or in the Special Provisions.

9-06.15 Welded Shear Connectors

Welded shear studs shall be made from cold drawn bar stock conforming to the requirements of AASHTO M 169. Grades 1010 through 1020, inclusive, either semi-killed or killed deoxidation.

The material shall conform to the following mechanical properties:

Tensile Strength	60,000 psi min.
Yield Strength	50,000 psi min.
Elongation	20% min.
Reduction of Area	50% min.

Mechanical properties shall be determined in accordance with AASHTO Methods and Definitions T 244.

At the manufacturer's option, mechanical properties of the studs shall be determined by testing either the steel after cold finishing, or the full diameter finished studs.

9-06.16 Roadside Sign Structures

All bolts, nuts, washers, cap screws, and coupling bolts shall conform to AASHTO M 164 and Section 9-06.5(3). All connecting hardware shall be galvanized after fabrication in accordance with AASHTO M 232.

Posts for single post sign structures shall meet the requirements of ASTM A 500 Grade B or ASTM A 53 Grade B, Type E or S.

Posts for multiple post sign structures shall conform to either ASTM A 36 or ASTM A 992. Posts conforming to either ASTM A 588 or ASTM A 572 Grade 50 may be used as an acceptable alternate to the ASTM A 36 and ASTM A 992 posts. All steel not otherwise specified shall conform to either ASTM A 36 or ASTM A 992.

Triangular base stiffeners for one-directional multi-post sign posts shall conform to either ASTM A 588 or ASTM A 572, Grade 50.

All steel, including posts, base plates, and base stiffeners, shall be galvanized after fabrication in accordance with AASHTO M111.

Base connectors for multiple directional steel breakaway posts shall conform to the following:

Brackets	Aluminum Alloy 6061 T-6
Bosses for Type 2B Brackets	ASTM A 582
Anchor Ferrules	Type 304 stainless steel for threaded portion. AISI 1038 steel rod and AISI 1008 coil for cage portion.

Anchor couplings for multiple directional steel breakaway posts shall conform to AMS 6378D with a tensile breaking strength range as follows:

Type 2A	17,000 to 21,000 lb.
Type 2B	47,000 to 57,000 lb.

For multi-directional breakaway base connectors, shims shall conform to ASTM A 653, SS Grade 33, Coating Designation G 165. For one-directional breakaway base connectors, single post or multi-post, shims shall be fabricated conforming to ASTM B 36.

9-06.17 Vacant

9-06.18 Metal Bridge Railing

Metal bridge railing shall conform to the type and material specifications set forth in the Plans and Special Provisions. Steel used for metal railings, when galvanized after fabrication in accordance with AASHTO M 111, shall have a controlled silicon content of either 0.00 to 0.04 percent or 0.15 to 0.25 percent. Mill test certificates verifying the silicon content of the steel shall be submitted to both the galvanizer and the Engineer prior to beginning galvanizing operations.

Section 8, part (b) of the Aluminum Association Standard Specifications for Aluminum Railing Posts Alloy A 344-T4 is hereby revised to provide that no X-ray inspection will be required after a foundry technique has been established for each mold which will ensure production of castings which are free from harmful defects. Inspection for approval of castings will be made by the Engineer after the finished castings have been anodized as noted in the Plans.

Welding of aluminum shall be in accordance with Section 9-28.14(3).

9-06.19 Vacant

9-06.20 Vacant

9-06.21 Vacant

9-06.22 Bolts, Washers, and Other Hardware

Ordinary machine bolts and flat head bolts shall be made from commercial bolt stock meeting the specifications of ASTM A 307, and shall be grade A. Drift bolts and dowels may be either wrought iron or medium steel. Washers may be cast iron or malleable iron or may be cut from medium steel or wrought iron plate.

All bolts and other hardware which are to be galvanized and which require bending or shaping shall be hot forged to the required shape before galvanizing. Cold bending of such material will not be permitted because of the tendency toward embrittlement during the galvanizing process. Galvanizing shall be in accordance with AASHTO M 232.

Split rings for log cribbing of 4-inches inside diameter shall be manufactured from hot rolled, low carbon steel conforming to ASTM A 711 AISI, Grade 1015. Each ring shall form a true circle with the principle axis of the cross section of the ring metal parallel to the geometric axis of the ring. The thickness of the metal section shall be 0.195-inch plus or minus 0.010-inch and the section shall be beveled from the central portion toward the edges to a thickness of 0.145-inch plus or minus 0.010-inch. It shall be cut through in one place in its circumference to form a tongue and slot. Split ring connectors shall be galvanized in accordance with AASHTO M 232.

Spike-grid timber connectors shall be manufactured according to ASTM A 47 for malleable iron castings. They shall consist of 4 rows of opposing spikes forming a 4⅛-inch square grid with 16 teeth which are held in place by fillets which are diamond shaped in cross section.

Nails shall be round wire of standard form. Spikes shall be wire spikes or boat spikes, as specified in the Plans. Bolts, dowels, washers, and other hardware, including nails, shall be black or galvanized as specified in the Plans, but if not so specified shall be galvanized when used in treated timber structures.

9-07 REINFORCING STEEL

9-07.1 General

9-07.1(1) Acceptance by Manufacturer's Certification

Reinforcing steel may be accepted by the Engineer based on the Manufacturer's Certificate of Compliance.

9-07.1(1)A Acceptance of Materials

Steel reinforcing bar manufacturers use either an English or a Metric size designation while stamping rebar. The actual size of the bar, whether stamped with an English or a Metric size designation is acceptable. The contract plans and the standard plans will continue to use an English size designation. The table below shows the comparable reinforcing steel bar size designations in the both units of measure:

English Designation	Bar Diameter	Metric Designation
#3	(0.375-inches)	#10
#4	(0.500-inches)	#13
#5	(0.625-inches)	#16
#6	(0.750-inches)	#19
#7	(0.875-inches)	#22
#8	(1.000-inches)	#25
#9	(1.128-inches)	#29
#10	(1.270-inches)	#32
#11	(1.410-inches)	#36
#14	(1.690-inches)	#43
#18	(2.260-inches)	#57

9-07.1(2) Bending

Steel reinforcing bars shall be cut and bent by careful and competent workmen. They shall be bent cold to templates, which shall not vary appreciably from the shape and dimension shown in the Plans.

Hooks and bends of steel reinforcing bars shall be bent to the following inside diameters unless shown otherwise in the Plans:

Bar Size	Stirrups and Ties	All Other Bars
No. 3	1½″	6 bar diameters
No. 4	2″	6 bar diameters
No. 5	2½″	6 bar diameters
No. 6	4½″	6 bar diameters
No. 7	5¼″	6 bar diameters
No. 8	6″	6 bar diameters
No. 9 through No. 11		8 bar diameters
No. 14 through No. 18		10 bar diameters

The supplementary requirements of AASHTO M 31 for bend tests shall apply to size No. 14 and No. 18 steel reinforcing bars which have hooks or bends.

9-07.1(3) Lengths

Net lengths of bent bars shown in the "LENGTH" column of the bar list in the plans are rounded to the nearest inch. Net length is the length of bar after all bend deductions are subtracted from the gross length.

The following bend deductions per 90 degrees bend have been subtracted from the gross length:

Bar Size	Stirrups and Ties	All Other Bars
No. 3	¾″	1″
No. 4	1″	1¼″
No. 5	1¼″	1½″
No. 6	1⅞″	1⅞
No. 7	2¼″	2¼″
No. 8	2½″	2½″
No. 9		3⅜″
No. 10		3¾″
No. 11		4⅛″
No. 14		5¾″
No. 18		7⅝″

For bends other than 90 degrees, a direct proportion of these deductions will be used. The bend deductions listed will apply, except where bending radii are shown in the Plans.

For standard hooks on the ends of bars, the following hook lengths, in addition to the out to out detailed dimension, have been provided:

	Length Added for One Hook				
	180° Hook	135° Hook		90° Hook	
Bar Size	All Bars	Seismic Ties	All Other Bars	Stirrup and Ties	All Other Bars
No. 3	5⅛″	4⅞″	3⅝″	2⅞″	5⅛″
No. 4	6″	6½″	4½″	3½″	6¾″
No. 5	6⅞″	8″	5⅜″	4⅜″	8½″
No. 6	8¼″	10¾″	7¾″	10⅛″	10⅛″
No. 7	9⅝″	1′-0½″	9″	11⅞″	11⅞″
No. 8	11″	1′-2¼″	10¼″	1′-1½″	1′-1½″
No. 9	1′-2⅞″				1′-3⅞″
No. 10	1′-4⅝″				1′-5⅞″
No. 11	1′-6½″				1′-7⅞″
No. 14	2′-1⅞″				2′-0¾″
No. 18	2′-10½″				2′-9⅛″

9-07.1(4) Vacant

9-07.2 Deformed Steel Bars

Deformed steel bars for concrete reinforcement shall conform to the requirements of AASHTO M 31, Deformed and Plain Billet Steel Bars for Concrete Reinforcement, Grade 60, or ASTM A 706, Low Alloy Steel, Deformed Bars for Concrete Reinforcement. However, in computing the ultimate unit tensile stress from test data, the area may be corrected for mass per linear foot of the bar within the weight tolerances listed. No such correction for mass shall be used in calculating the yield stress; the nominal area of the bar, as given in Table 1 of AASHTO M 31 or ASTM A 706, shall be used in this computation.

Deformed steel bars are referred to in the Plans and specifications by number: for example, No. 3, No. 4, No. 5, etc.

9-07.3 Epoxy Coated Steel Reinforcing Bars

Epoxy coated rebar shall be coated according to AASHTO M 284 with the additional following modifications:

1. The list of steel reinforcing bars acceptable for coating shall include ASTM A 706.
2. The Contractor shall furnish a written certification that properly identifies the material, the number of each batch of coating material used, quantity represented, date of manufacture, name and address of manufacturer, and a statement that the supplied coating material meets the requirements of AASHTO M 284.
3. Prior to coating the bars, the Contractor shall submit to the Engineer for review, the coating material manufacturer's recommendation on the proper use and application requirements of the coating material. For Pre Approved Epoxy Coating Facilities this information will be available to the Fabrication Inspector upon request.
4. A certification stating that all bars have been coated in accordance with the coating material manufacturer's recommendations and these Specifications shall be furnished with each shipment. This certification shall include for each bar size the preheat temperatures, cure times, thickness checks, holidays detected, and test results. Two copies of these certifications shall be furnished to the Engineer.
5. The Contractor shall give advance notice to the Engineer of the coating schedule in the coating plant so that Contracting Agency inspection may be provided. The Engineer may inspect the coated bars at the coating plant for approval.
6. The patching material, compatible with the coating material and inert in concrete, shall be supplied with each shipment.
7. For projects where epoxy coated steel reinforcing bars are used in the top mat of bridge decks only, the maximum amount of damage to the coating shall not exceed 0.25 percent of the surface area of each bar.
8. The thickness of epoxy coating shall be 10 mils plus or minus 2 mils.
9. Samples, when required, shall be shipped to the Washington State Department of Transportation, Materials Laboratory, 1655 South 2nd Ave, Tumwater, Washington 98504.

9-07.4 Plain Steel Bars

Where plain steel bars are specified, they shall conform to the chemical and physical properties of AASHTO M 31, Grade 60, unless specifically noted otherwise. Plain steel bars are indicated in the Plans and specifications by fractions of an inch; for example, ⅜-inch Ø, ½-inch Ø, ⅝-inch Ø, etc.

9-07.5 Dowel Bars (For Cement Concrete Pavement)

Dowel bars shall be plain steel bars of the dimensions shown in the Standard Plans. They shall conform to AASHTO M 31, Grade 60 or AASHTO M 255, Grade 60, and shall be coated in accordance with AASHTO M 284. The ends of the bars shall be coated to a minimum of 4 mils. In addition, the requirements of Section 9-07.3, Items 2, 3, 4, 5, 6, 8, and 9 shall apply.

9-07.6 Tie Bars (For Cement Concrete Pavement)

Tie bars shall conform to the requirements of the Standard Specifications for Deformed Billet Steel Bars for Concrete Reinforcement, AASHTO M 31, Grade 60 and shall be coated in accordance with AASHTO M 284.

The form of the deformed bar shall be subject to approval by the Engineer.

Tie bars shall be free from dirt, grease, or other defects affecting the strength or bond with the concrete.

9-07.7 Wire Mesh

Wire mesh for concrete reinforcement shall conform to the requirements of AASHTO M 55, Welded Steel Wire Fabric for Concrete Reinforcement or AASHTO M 221, Welded Deformed Steel Wire Fabric for Concrete Reinforcement. All wire mesh shall be of an approved kind and quality of manufacture.

9-07.8 Deformed Wire

Deformed wire shall conform to the requirements of AASHTO M 225, Deformed Steel Wire for Concrete Reinforcement.

Deformed wire is noted in the Plans and specifications by the letter D, followed by a number indicating the cross sectional area of the wire; for example, D2, D5, D20, etc.

9-07.9 Cold Drawn Wire

Cold drawn wire shall conform to the requirements of AASHTO M 32, Cold Drawn Steel Wire for Concrete Reinforcement.

Cold drawn wire is noted in the Plans and specifications by the letter W followed by a number indicating the cross sectional area of the wire; for example, W2, W5, W20, etc.

9-07.10 Prestressing Reinforcement Strand

Prestressing reinforcement shall be ½-inch diameter for precast-prestressed concrete piles and ½-inch or 0.6-inch diameter for pretensioned concrete girders, post-tensioned segmental precast concrete girders, or cast-in-place prestressed concrete.

Prestressing reinforcement shall be mill bright high tensile strength seven wire low relaxation strand conforming to the requirements of AASHTO M 203, Grade 270.

All prestressing reinforcement furnished for a given structural member shall have a maximum elongation differential of 3 percent at stress of 0.8 of the ultimate strength of the prestressing steel. Each reel of prestressing reinforcement shall be accompanied by a Manufacturer's Certificate of Compliance, a mill certificate, and a test report. The mill

certificate and test report shall include the chemical composition, the yield and ultimate strengths, elongation at rupture, modulus of elasticity, and the stress strain curve for the actual prestress reinforcing intended for use. All values certified shall be based on test values and actual sectional areas of the material being certified.

For every 5 reels furnished, one sample, not less than 5-feet long, shall be sent to the Engineer for testing. Samples of the furnished reels with Manufacturer's Certificate of Compliance, a mill certificate, and test report may be shipped directly by the manufacturer to the Engineer. An independent inspector, approved by the Contracting Agency, shall be present during sampling and shall provide a written certification to the Engineer.

9-07.11 Prestressing Reinforcement Bar

High-strength steel bars shall conform to AASHTO M 275, Type II.

Nuts shall conform to either ASTM A 29 Grade C1045, or ASTM A 536 Grade 100-70-03, and shall be capable of developing the larger of either 100 percent of the minimum ultimate tensile strength (MUTS), or 95 percent of the actual ultimate tensile strength (AUTS), of the bar. The anchor nuts shall conform to the specified strength requirement while permitting a maximum 5 degree misalignment between the nut and the bearing plate. A minimum of three tests, each from a different heat, are required.

Couplers, if required, shall be AASHTO M 169 Grade 1144, or equivalent steel, developing the larger of either 100 percent of the MUTS, or 95 percent of the AUTS, of the bar. The test shall be performed with the coupler having a one inch unengaged segment between the two coupled bars. A minimum of three tests, each from a different heat, are required.

For unbonded bars under dynamic loading, the connections shall withstand at least 500,000 cycles from 60 percent to 66 percent MUTS followed by at least 50 cycles between 40 percent MUTS and 80 percent MUTS. A minimum of three tests, each from a different heat, are required.

The Contractor shall supply a Manufacturer's Certificate of Compliance in accordance with Section 1-06.3 for each bar. The Contractor shall supply a Manufacturer's Certificate of Compliance in accordance with Section 1-06.3 for all nuts and couplers confirming compliance with the specified strength requirement.

For each heat of steel for high-strength steel bar, the Contractor shall submit two samples, each not less than 5-feet long, to the Engineer for testing.

9-08 PAINTS

9-08.1 Raw Materials

The acceptance of particular lots of raw materials shall in no way obligate the Engineer to accept lots of finished paint that do not conform to the requirements of these Specifications. When not specifically detailed, the raw materials shall meet the requirements of the applicable Federal Specification in effect at the time of manufacture. Products not covered by State or Federal Specifications shall be of top quality, meeting prevailing commercial standards. Raw materials for paints shall conform to the requirements of the specifications listed below.

Alkyd resin solution, Federal TT-R-266, Type I or Type II.

Aluminum paste, ASTM D 962, Type 2, Class B. Paints made with the paste shall be smooth and highly lustrous.

Anti-skinning agent shall have no deleterious effect on the drying time of the finished paint. It shall effectively prevent skinning when added in the amounts specified in each formula and tested in accordance with Federal Test Std. No. 141a, Method 3021.

Aromatic petroleum thinner — water white low aniline petroleum solvent Kauri-Butanol value ..... 70 (min.)

Barium sulfate pigment, ASTM D 602.

Chrome oxide green, ASTM D 263. The tinting properties shall be such that the standard color of the formulas using chrome oxide green can be produced without departing from the limits of composition given in those formulas.

Chrome yellow pigment and paste, ASTM D 211, Type III.

Fibrous magnesium silicate (talc), ASTM D 605.

Lampblack pigment and paste, ASTM D 209.

Liquid drier, ASTM D 600.

Mineral spirits, ASTM D 235.

Raw linseed oil, ASTM D 234.

Red iron oxide pigment, ASTM D3721, D3722 & D3724.

Silica shall be finely ground amorphous or crystalline material. It shall have a maximum oil absorption of 50 when tested in accordance with ASTM D 281.

Soya lecithin shall be pure.

Spar varnish, Federal TT-V-119.

Titanium pigments, ASTM D 476. Titanium dioxide for use in exterior white paints shall conform to Type II. Titanium pigments used in tinted paints and enamels shall be exterior chalk resistant, Type III.

Turpentine shall be gum spirits of turpentine, ASTM D 13.

Yellow iron oxide, hydrated, ASTM D 768.

Zinc oxide pigment and paste, ASTM D 79.

Zinc yellow (zinc chromate), ASTM D 478.

Raw materials not specifically covered shall meet current Federal specifications for said material.

9-08.2 Paint Formulas — General

All paints shall be made from materials meeting the requirements specified in Section 9-08.1. The paint shall be made in accordance with the following formulas and shall meet the requirements set forth above as well as the special requirements set forth for each formula. The formulas are stated in terms of dry pigment. Each formula shall contain the specified raw materials which shall be proportioned to give the compositions in percentages by weight or parts by weight, as shown in the formulas that follow.

Formula A-5-61 — Vinyl Pretreatment

The primer shall meet the requirements of Federal Specification MIL-P-15328B or MIL-P-15328C, Primer Pretreatment (Formula 117B for Metals).

Vinyl Wash Primer shall be mixed by adding 1 volume of acid component (diluent) to 4 volumes of resin component (base solution) slowly and with constant stirring. The material shall be used within 8 hours of mixing. The wash primer coat shall be spray applied to all surfaces at a coverage rate of 250 to 300 square feet per gallon to yield a dry film of 0.5 to 0.9 mils thickness. If necessary to maintain a wet spray, additional thinning with normal Butanol or 99 percent Isopropanol will be allowed. Acid component above the required amount shall not be used for thinning. A drying time of one hour is required before recoating.

1. Butanol shall meet Federal Specification TT-B-846b Butyl Alcohol; Normal.
2. Isopropanol (99 percent) shall conform to ASTM D 770 Isopropyl Alcohol.

Formula A-9-73 — Galvanizing Repair Paint, High Zinc Dust Content

The galvanizing repair paint shall meet the requirements of Federal Specification MIL-P-21035 (Ships) Paint, High Zinc Dust Content, Galvanizing Repair.

Formula C-6-90 — Green Phenolic Finish Coat for Steel

Zinc chromate (dry pigment)	13.8 parts
Chrome green oxide (dry pigment)	16.1 parts
Titanium dioxide (dry pigment)	16.7 parts
Yellow iron oxide (dry pigment)	1.3 parts
Fibrous magnesium silicate (dry pigment)	5.0 parts
Aluminum stearate (dry pigment)	0.2 parts
Spar varnish	22.1 parts
Raw linseed oil	21.4 parts
Driers	1.0 parts
Anti-skinning agent	0.1 parts
Mineral spirits	2.3 parts
Weight per gallon (minimum)	12.5 lbs.
Viscosity at 70ºF	80 ± 8 K.U.
Grind (minimum)	6
Set to touch	4 hours
Dry hard	18 hours
Sag Index	7 min.

Test Requirements: Prior to shipment.
Viscosity Adjustment: Mineral spirits to be added at the factory to achieve the specified viscosity.

The proportions of tinting pigments may be varied to achieve the desired color. The color of the paint when dry must match the color of a standard C-6-90 color chip. Additional tinting pigments may be required.

Formula C-9-90 — Phenolic Finish Coat for Steel

Zinc Oxide (dry pigment)	10.0 parts
Titanium Dioxide (dry pigment)	21.0 parts
Fibrous Magnesium Silicate (dry pigment)	3.2 parts
Barium Sulfate (dry pigment)	12.8 parts
Tinting Pigments	5.9 parts
Treated Bentonite Clay (dry pigment)	0.2 parts
Anti-Sag Agent	1.9 parts
Raw Linseed Oil	12.6 parts
Spar Varnish	29.0 parts
Anti-Skin Agent	0.1 parts
Driers	1.0 parts
Mineral Spirits	1.8 parts
Xylene	0.5 parts
Weight per gallon (minimum)	12.3 lbs.
Viscosity 70ºF	80 ± 8 K.U.
Dry Hard (maximum)	18 hours
Set to Touch (maximum)	4 hours
Grind (N.S.) (minimum)	5
Sag Index (minimum)	4
Total Solids by Weight	80 ± 5%

Test Requirements: Prior to shipment.

Adjustments for tinting pigments and talc, solvents and chemical additives shall be made at the factory to achieve the desired color and physical characteristics. A fungicide, N-(Trichloromethylthio) phthalimide shall be added at the rate of 3 pounds per 100 gallons.

C-10-83 — Vinyl Finish Coat

Vinyl Finish Coat shall conform to the following specifications:

Pigment (12 Percent Minimum by Mass)

A combination of titanium dioxide and colored pigments or a combination of colored pigments such that the resultant paint when dry matches the color sample available at the Project Engineer's office.

Vehicle (88 Percent Maximum by Mass)

Vinyl Resin Type II[1]	9.1 parts
Vinyl Resin Type III[2]	9.1 parts
Tricresyl Phosphate	3.4 parts
Methyl Isobutyl Ketone	39.2 parts
Toluene	39.2 parts
	100.0

[1]Vinyl Resin Type II shall be hydroxyl containing vinyl chloride-acetate copolymer. It shall contain 89.5 to 91.5 percent (by weight) vinyl chloride, 2.0 to 5.5 percent vinyl acetate and 5.3 to 7.0 percent vinyl alcohol. It shall produce results in the specified formulations equal to the Bakelite Corporation Vinylite resin VAGH.

[2]Vinyl Resin Type III shall be a vinyl chloride-acetate co-polymer of medium average molecular weight and shall contain 85 to 88 percent vinyl chloride and 12 to 15 percent vinyl acetate by weight. It shall produce in the specified formulations results equal to Bakelite Corporation Vinylite resin VYHH.

Lampblack shall be ground in the Vinyl Finish Coat vehicle to yield a smooth well ground paint, Black Vinyl Tinting Paste, satisfactory for tinting either the Vinyl-Red Lead Primer or Vinyl Finish Coat.

The Vinyl Finish Coat and Vinyl Tinting Paste shall be ground to a fineness of not less than 5 when testing in accordance with Federal Test Method Standard No. 141b, Method 4411.1.

Vinyl Thinner shall be composed of the following materials:

Toluene	90 percent by volume
Methyl Isobutyl Ketone	10 percent by volume

The paints as received will require thinning with from 20 to 35 percent by volume of Vinyl Thinner to maintain a wet spray.

Formula D-1-57 — Aluminum Paint

Aluminum paste Type 2 Class B	2.0 lbs.
Spar Varnish	1.0 gallon

Aluminum paint shall be mixed on the job site, and only enough for one day shall be mixed at a time. The weighed amount of paste shall be placed in a suitable mixing container and the measured volume of vehicle then poured over it. The paste shall be incorporated by vigorous stirring with a paddle.

Test Requirements: Prior to mixing.

Formula D-4-57 — Black Enamel

The enamel shall meet the requirements of Federal TT-E-529 Black Enamel, Synthetic, Semi Gloss.

Test Requirements: This enamel will be sampled and tested in the ready-mixed form.

Formula D-5-83 — White Guardrail Paint (Alkyd Vehicle)

Titanium dioxide (dry pigment)	28.1 parts
Zinc oxide (dry pigment)	10.9 parts
Fibrous magnesium silicate (dry pigment)	4.3 parts
Aluminum stearate (dry pigment)	0.5 parts
Alkyd vehicle	37.0 parts
24% lead naphthenate drier	0.4 parts
6% Cobalt naphthenate drier	0.2 parts
6% Manganese naphthenate drier	0.2 parts
Anti-skinning agent	0.2 parts
Mineral spirits	18.2 parts
Weight per gallon (minimum)	11.0 lbs.
Viscosity at 70ºF	80-90 K.U.
Nonvolatile content (minimum)	70.2%
Grind (minimum)	4
Hiding power (maximum scale reading)	30
Set to touch	4 hours
Dry hard	18 hours
Sag Index	7 min.

Test Requirements: Prior to shipment.
Viscosity Adjustment: Mineral spirits will be added at the factory to achieve the specified viscosity.

This formula is to be used over primed or previously painted surfaces.

Formula E-1-57 — White for Wood Structures

The material shall conform to Federal TT-P-102, Class A.

Test Requirements: This paint will be sampled and tested in the ready-mixed form.

Primer: Turpentine may be added to the above paint in quantities not to exceed 1½ pints per gallon of paint for use as a primer.

Formula E-2-62 — Primer for Wood

The primer shall be a ready mixed priming paint for use over unpainted wood surfaces. It shall meet the requirements of Federal Specification TT-P-25 Primer, Paint, Exterior.

Test Requirements: This paint shall be sampled and tested in the ready-mixed form.

Formula F-3-64 — Orange Equipment Enamel

The enamel shall meet the requirements for Enamel, Alkyd, Gloss, Federal Specification TT-E-489, except that the Sag Index shall be seven minimum. The color, when dry, shall match that of Federal Standard No. 595, color 12246.

Test Requirements: When manufactured on Contract or Purchase Order for maintenance use, the enamel will be sampled and tested in the ready-mix form. No factory inspection will be required; however, a 1 pint sample representing the batch must be submitted to the Materials Laboratory for approval before use.

For factory application to individual items of new equipment, samples of the enamel will not be required; however, the equipment manufacturer must match the color and certify the quality of enamel used.

Formula H-1-83 — Primer for Concrete

Titanium dioxide	5.0 parts
Calcium carbonate	19.7 parts
Fibrous magnesium silicate	6.8 parts
Silica	6.8 parts
Spar varnish	52.3 parts
Mineral spirits	9.4 parts
Weight per gallon (minimum)	9.8 lbs.
Drying time (for testing purposes only)	18 hours
Viscosity at 70ºF	65-75 K.U.

Consistency: The paint shall not thicken after manufacture to an extent sufficient to impair its brushing qualities.

Test Requirements: Prior to shipment.

Formula K-1-83 — Exterior Acrylic Latex Paint-White

This paint shall meet the requirements of Federal Specification TT-P-19, Paint, Acrylic Emulsion, Exterior, except that the viscosity shall be 75-85 K.U.

This paint may be used self-primed in multiple coats over salts treated wood and on interior and exterior masonry surfaces.

Test Requirements: This paint will be sampled and tested in the ready-mixed form.

Formula K-2-83 — Traffic Signal Yellow Enamel

Traffic signal yellow enamel shall meet the provision of Federal Specification TT-E-489 — Enamel, Alkyd, Gloss — and shall match the color of "Standard Interstate Yellow."

Formula A-11-99 — Primer, Zinc Filled Single Component, Moisture-Cured Polyurethane

Zinc rich primer shall meet the following requirements:

Vehicle Type: Moisture-cured polyurethane

Pigment Content: 80% minimum zinc by weight in dry film.

Volume Solids: 60% plus or minus 3%.

Minimum wt./gal. 22.0 pounds.

Formula B-11-99 — Intermediate and Stripe Coat, Single Component, Moisture Cured Polyurethane

Vehicle Type: Moisture-cured polyurethane

Pigment: A minimum of 3.0 lbs. of micaceous iron oxide per gallon.

Intermediate and any stripe coat shall meet the following requirements:

Minimum volume solids 50%.

A minimum of 3.0 lbs./gal. of micaceous iron oxide.

The intermediate coating must be certified by the manufacturer to be able to be recoated by the top coat in a minimum of 4 days.

When used as a universal primer on previously painted surfaces, the intermediate coat must not lift the undercoats and must adhere well to the painted surface, to bare steel, aluminum, or galvanized surfaces.

Formula C-11-99 — Top Coat Single Component, Moisture Cured Polyurethane

Vehicle Type: Moisture-cured aliphatic polyurethane

Color: Match Federal Standard 595a

The Top Coat shall meet the following requirements:

The resin must be an aliphatic urethane.

Minimum volume solids 50%.

The top coat shall be a gloss.

Any evidence of aromatic rings, or more than 0.7% free isocyanate monomer as a percent of total solids will not be accepted.

9-08.3 Inspection Requirements General

The manufacturer shall notify the Engineer of the date on which manufacture will be started, and the Engineer shall have the right to inspect all details of the manufacturing process.

Quantities of 20 gallons or less of the above formulas will be accepted without inspection upon the manufacturer's notarized certificate. This certificate shall contain a statement by the manufacturer to the effect that the material meets the formula specification, and shall include a list of materials and quantities used. One copy of the certificate shall accompany the paint when shipped and one copy with a sample of the paint shall be sent to the Materials Laboratory. The paint may be used at once without further release from the Materials Laboratory.

9-08.4 Process of Manufacture

The following process of manufacture shall be used for each paint except aluminum paint. Pigments shall be ground thoroughly in appropriate portions of the specified vehicle to form a paste meeting the requirements set forth in Section 9-08.4(6).

The grinding shall be done in a mill approved by the Engineer. The use of the "colloid" type of mill will not be approved. Weighed quantities of the paste and weighed or measured quantities of the vehicles shall then be mixed thoroughly and strained, if necessary, to form a paint free from skins, lumps, and foreign materials.

9-08.4(1) Viscosity Adjustment

The volatile thinner content of the paint shall be adjusted at the factory to meet the required viscosity, but in no case shall the resultant weight per gallon and nonvolatile content of the paint be below that specified in the formula.

9-08.4(2) Weight Variations

The weight per gallon of the paint in any lot shall not be less than that stated in the formula. A "lot" as used in this section shall be the quantity of paint ground at one time by any one mill.

9-08.4(3) Drying Time and Quantity of Drier

The paint shall dry within the length of time stated in each formula but shall not contain sufficient quantities of drier to cause the paint to dry to a nonuniform or nonelastic film. The manufacturer will be permitted to vary the quantity of drier given in the formula sufficiently to accomplish the above results.

9-08.4(4) Working Properties

The paint shall contain no caked material that cannot be broken up readily by stirring. When applied to a clean vertical surface, the paint shall dry without running, streaking, or sagging.

9-08.4(5) Storage Properties

Paints manufactured under these Specifications shall show no skin over the surface after 48 hours in a partially filled container, when tested as outlined in Federal Test Method Standard No. 141. A slight amount of skin or gel formation where the surface of the paint meets the side of the container may be disregarded. Variable percentages of anti-skinning agents are shown in those formulas set forth above that are susceptible to undesirable skin formation. The manufacturer will be allowed to vary the amount of anti-skinning agent given in the formulas provided the above results are accomplished and provided the paint does not dry to a nonuniform or nonelastic film.

9-08.4(6) Fineness of Grinding

The paint shall be ground so that all particles of pigment will be dispersed and be coated with vehicle, and the residue on a 325 sieve will not exceed 1 percent by weight of the pigment.

9-08.4(7) Standard Colors

When the paint is required to match a standard color, the manufacturer may obtain a sample of the required color without cost upon application to the Materials Laboratory, P.O. Box 47365, Olympia, Washington 98504-7365.

9-08.4(8) Containers

Each container shall be filled with paint and sealed airtight. Each container shall be filled with the amount of paint required to yield the specified quantity when measured at 70ºF.

All paint shall be shipped in new suitable containers having a capacity not greater than 5 gallons. Each container shall be marked with a suitable number to identify the particular batch from which it was filled.

9-08.5 Test Methods

As set forth in Section 9-08.2, all paints shall meet the special requirements set forth for each formula. The test methods used to check those special requirements shall be as specified in the Washington State Department of Transportation *Materials Manual* or the corresponding test method covered by Federal Test Method Standard No. 141. When test methods are not covered by the above, applicable ASTM methods shall be followed.

9-08.6 Shipping

Except for lots of paint in quantities of 20 gallons or less which are accepted upon the manufacturer's certificate, the manufacturer shall not ship any lot of paint until the paint has been tested and released by the Washington State Department of Transportation State Materials Laboratory. This release will not constitute final acceptance of the paint. Final acceptance will be based on inspection or testing of job site samples as determined by the Engineer.

9-08.7 Field Samples

Because of the volatility of the solvents used in the paint, the upper limit on viscosity shall be waived on all paint samples taken in the field.

9-09 TIMBER AND LUMBER

9-09.1 General Requirements

All timber and lumber for structures shall be Douglas Fir-Larch, unless specified otherwise in the contract. The allowable species of timber and lumber for guardrail posts, signposts, and mileposts shall be Douglas Fir-Larch or Hem Fir. Timber and lumber for sawed fence posts and mailbox posts shall be Western Red Cedar, Douglas Fir-Larch, or Hem Fir.

9-09.2 Grade Requirements

Timber and lumber shall conform to the grades and usage listed below. Grades shall be determined by the current standards of the West Coast Lumber Inspection Bureau (WCLIB) or the Western Wood Products Association (WWPA).

Structures

Timber and lumber, unless specified otherwise in the contract, shall conform to the following:

Materials 2″ to 4″ nominal thick, 5″ nominal and wider (Structural Joists and Planks)	No. 1 and better, grade (Section 123-b of WCLIB) or (Section 62.11 of WWPA)
Materials 5″ nominal and thicker (Beams and Stringers)	No. 1 and better, grade (Section 130-b of WCLIB) or (Section 70.11 of WWPA)

Timber lagging for soldier pile walls shall be Douglas Fir-Larch, grade No. 2 or better or Hem-Fir No. 1.

Guardrail Posts

Timber and lumber for guardrail posts (classified as Posts and Timbers) shall conform to the species and grades listed below.

Douglas Fir	No. 1 and better, grade (Section 131-b WCLIB) or (Section 80.11 WWPA)
Hem Fir	Select Structural, grade (Section 131-a WCLIB) or (Section 80.10 WWPA)

Sign Posts, Mileposts, Sawed Fence Posts, and Mailbox Posts

Sign posts, mileposts, sawed fence posts, and mailbox posts shall conform to the grades shown below.

4 × 4	Construction grade (Light Framing, Section 122-b WCLIB) or (Section 40.11 WWPA)
4 × 6	No. 1 and better, grade (Structural Joists and Planks, Section 123-b WCLIB) or (Section 62.11 WWPA)
6 × 6, 6 × 8, 8 × 10	No. 1 and better, grade (Posts and Timbers, Section 131-b WCLIB) or (Section 80.11 WWPA)
6 × 10, 6 × 12	No. 1 and better, grade (Beams and Stringers, Section 130-b WCLIB) or (Section 70.11 WWPA)

9-09.2(1) Surfacing and Seasoning

All timber and lumber shall be sized as indicated in the plans.

All timber and lumber to be painted shall be surfaced on all sides. All timber and lumber to be painted shall be thoroughly air or kiln dried to an equilibrium moisture content and shall be stored in such a manner as to remain in a thoroughly dry condition until placed into the work.

9-09.2(2) Vacant

9-09.2(3) Inspection

Timber and lumber must be marked with a certified lumber grade stamp provided by one of the following agencies:

West Coast Lumber Inspection Bureau (WCLIB)

Western Wood Products Association (WWPA)

Pacific Lumber Inspection Bureau (PLIB)

Any lumber grading bureau certified by the American Lumber Standards Committee

For Structures:

A grading certificate must accompany each order of timber and lumber for use in structures as specified in Section 9-09.2. The certificate shall be issued by either the grading bureau whose stamp is shown on the material, or by the lumber mill, which must be under the supervision of one of the grading bureaus listed above. The certificate shall include the following:

Name of the mill performing the grading

The grading rules being used

Name of the person doing the grading with current certification

Signature of a responsible mill official

Date the lumber was graded at the mill

Grade, dimensions, and quantity of the timber or lumber

When the material is delivered to the project, the Engineer shall check the order for the appropriate grade stamp. The invoice and grading certificate accompanying the order must be accurate and complete with the information listed above. The grading certificate and grade markings shall not constitute final acceptance of the material. The Engineer may reject any or all of the timber or lumber that does not comply with the specifications or has been damaged during shipping or upon delivery.

For Guardrail Posts and Blocks, Sign Posts, Mileposts, Sawed Fence Posts, and Mailbox Posts:

When the material is delivered to the project, the Engineer shall check the order for the appropriate grade stamp. The grade markings shall not constitute final acceptance of the material. The Engineer may reject any or all of the timber or lumber that does not comply with the specifications or has been damaged during shipping or upon delivery.

9-09.3 Preservative Treatment

9-09.3(1) General Requirements

All timber and lumber requiring preservative treatment shall be treated in accordance with AASHTO M 133. As specified by AASHTO M 133, the American Wood-Preservers' Association (AWPA) standards shall govern the specifications. These specifications include: storing and curing the timber and lumber, the wood preservatives, the preservative treatment process, documenting the results of the treatment, inspection, testing, and the identification of properly treated timber. Unless otherwise specified in the contract, all timber and lumber shall be treated in accordance with Section C-14 of the latest addition of the AWPA standards.

All cutting, boring, chamfering, routing, surfacing, and trimming shall be done prior to treating. Any field drilling or cutoffs shall be treated by two liberal applications of a compatible preservative. The applications shall be in accordance with the requirements of AWPA Standard M-4 entitled, "Standard for the Care of Pressured Treated Wood Products".

All charges shall consist of pieces of the same species that are similar in form, size, moisture content, and receptivity to treatment. The pieces in the charge shall be separated to ensure contact of treating medium with all surfaces. The method of determining the retention of the preservatives shall be by assay.

As specified in the contract, all orders of treated timber and lumber will be stamped "WSDOT Approved for Shipment" or accompanied by a Certificate of Treatment record. The Certificate of Treatment shall include the following information:

Name and location of the wood preserving company

Customer identification

Date of treatment and charge number

Type of chemical used and amount of retention

Treating process and identification of the specification used

Description of material that was treated

Signature of a responsible plant official

In addition to the Certificate of Treatment, all orders of treated timber or lumber that are not stamped "WSDOT Approved for Shipment", shall be accompanied by a Grading Certificate in accordance with Section 9-09.2(3). Such certification or approved for shipment tag shall not constitute final acceptance of the material. The Engineer may reject any or all of the timber or lumber that does not comply with the specifications or has been damaged during prolonged storage, shipping, or upon delivery.

All timber and lumber to be used in aquatic environments, unless specified otherwise in the contract, shall be chemically treated using Best Management Practices (BMPs). The producer of the chemically treated products shall supply a written certification that the BMPs were utilized, including a description and appropriate documentation of the BMPs used. This information may be included on the Certificate of Treatment record.

9-10 PILING

9-10.1 Timber Piling

Timber piling shall be untreated or treated with the preservatives specified in the Plans and completely described in Section 9-09.3.

Timber piles shall have the following limiting diameters:

Length in Feet	Min. Butt Dia. 3-feet Above Butt in inches	Max. Butt Dia. 3-feet Above Butt in inches	Min. Tip Dia. in inches
Under 40	12	20	7
40-54	12	20	7
55-74	13	20	7
Over 74	14	20	7

Timber piles shall be strapped with at least three straps: one approximately 18-inches from the butt, one approximately 24-inches from the butt, and one approximately 12-inches from the tip. Additional straps shall be provided at approximately 15-foot centers between the butt and tip. Strapping shall encircle the pile once and be tensioned as tightly as possible. Straps shall be 1¼-inches wide, 0.31-inch thick, cold rolled, fully heat treated, high tensile strapping, painted, and waxed, with an ultimate tensile strength of 5,100 pounds. The seal shall be 2¼-inches long, 20 gage, crimped with a notch type sealer to furnish a joint yielding 80 percent of the strap tensile strength. Treated timber piles shall be strapped after treatment.

9-10.1(1) Untreated Piling

Except where specifically provided otherwise, untreated timber piling shall be Douglas Fir, Western Red Cedar, or Larch. Piling for foundations shall be Douglas Fir. Piling shall be cut from sound, live trees and shall contain no unsound knots. Sound knots will be permitted, provided the diameter of the knot does not exceed 4-inches, or $^1/_3$ of the small diameter of the pile at the point where they occur, whichever is smaller. Any defect or combination of defects which will impair the strength of the pile more than the maximum allowable knot will not be permitted.

Piling shall be cut above the butt swell and shall have a uniform taper from butt to tip. A line drawn from the center of the tip to the center of the butt shall not fall outside the center of the pile at any point more than one percent of the length of the pile. A spiral grain or twist in excess of $^1/_4$ turn in 10-feet of length will be cause for rejection.

Untreated timber trestle piling shall have an average of at least five annual rings per inch measured radially over a distance of 3-inches at the butt, beginning at a point 3½-inches from the heart. At least 9-inches of heartwood shall show at the butt.

Ring count requirements for untreated timber foundation piling and detour trestle piling will be waived.

9-10.1(2) Creosote Treated Piling

For creosote treated piling, Douglas Fir timber shall be used. All other requirements shall be the same as for untreated piling, except that the ring count requirement will be waived.

9-10.1(3) Timber Composite Piling

Timber composite piling shall consist of a pile made up of two timber sections. The lower section shall be untreated, and the upper section shall be creosote treated.

The treated and untreated sections of timber composite pile shall meet the respective requirements specified above for full length of treated and untreated timber piling.

9-10.1(4) Peeling

Untreated and creosote treated piles shall be peeled by removing all of the rough bark and at least 80 percent of the inner bark. No strip of inner bark remaining on the pile shall be over ¾-inch wide or over 8-inches long, and there shall be at least 1-inch of clean wood surface between any two such strips. Not less than 80 percent of the surface on any circumference shall be clean wood. All knots shall be trimmed close to the body of the pile.

9-10.2 Concrete Piling

9-10.2(1) Concrete

Cement meeting the requirements of Section 9-01 shall be used in all precast concrete piles.

The concrete for precast-prestressed piles shall conform to the requirements of Section 9-19.1. The concrete for prestressed piles shall have a minimum compressive strength of 6,000 psi at the age of 28 days. The minimum compressive strength of concrete at the transfer of prestress shall be 3,300 psi.

The concrete for other precast piles shall be Class 4000. Mixing, transporting, and placing concrete shall be in accordance with the provisions of Section 6-02.3.

The Contractor shall mold and test a sufficient number of concrete test cylinders to determine the strength of the concrete as required by the specifications. Under the surveillance of the Engineer, the test cylinders shall be molded, cured, and tested in accordance with the procedures established by the State Materials Laboratory.

In the event that a sufficient number of concrete test cylinders are not molded to satisfy all testing required on any one pile, cores measuring 4-inches in diameter by 5-inches in height shall be taken and tested by the Contractor. If the strength of the core meets the required compressive strength of the concrete, the pile may be accepted. The coring and testing of the core shall be done under the surveillance of the Engineer.

9-10.2(2) Reinforcement

Reinforcement shall meet the requirements of .

9-10.3 Cast-in-Place Concrete Piling

Reinforcement for cast-in-place concrete piles shall conform to the requirements of AASHTO M 31 Grade 40 or Grade 60.

9-10.4 Steel Pile Tips and Shoes

Steel pile tips and shoes shall be fabricated of cast steel conforming to ASTM A 148 Grade 60-90 [620-415] or ASTM A 27 Grade 65-35 [450-240] and be free from any obvious defects. Pile tips shall be accompanied by a mill test report stating the chemical and physical properties (tensile and yield) of the steel.

9-10.5 Steel Piling

The material for steel piling and pile splices shall conform to ASTM A 36 or ASTM A 992, except the material for steel pipe piling and splices shall conform to the requirements of ASTM A 252, Grade 2. Steel soldier piles, and associated steel bars and plates, shall conform to ASTM A 36 or ASTM A 992, except as otherwise noted in the Plans. All steel piling may be accepted by the Engineer based on the Manufacturer's Certification of Compliance.

9-11 WATERPROOFING

9-11.1 Asphalt for Waterproofing

Asphalt for waterproofing shall conform to the requirements of ASTM D 312, Type 4.

The material used as primer shall conform to the requirements of ASTM D 41, Primer for Use with Asphalt in Dampproofing and Waterproofing.

Acceptance shall be as provided in Section 9-02.2(1).

9-11.2 Waterproofing Fabric

Waterproofing fabric shall be a saturated cotton fabric meeting the requirements of ASTM D 173, Woven Cotton Fabrics Saturated with Bituminous Substances for Use in Waterproofing.

9-11.3 Portland Cement Mortar

Portland cement and sand for the mortar protection course shall conform to the following requirements:

Portland Cement	Section 9-01
Sand	Section 9-03

9-12 MASONRY UNITS

9-12.1 Concrete Blocks

Concrete blocks for manholes and catch basins shall conform to the requirements of ASTM C 139.

Concrete blocks for building construction shall conform to the requirements of ASTM C 90.

9-12.2 Concrete Brick

Concrete brick shall conform to the requirements of ASTM C 55.

9-12.3 Vacant

9-12.4 Precast Concrete Manholes

Precast concrete manholes shall meet the requirements of AASHTO M 199.

The joints may be the tongue and groove type or the shiplap type, sufficiently deep to prevent lateral displacement.

Manufacturers may reinforce the concrete mix with synthetic fibers as an alternate to conventional secondary reinforcement in 48-inch diameter by 3-foot high eccentric or concentric cone sections. The synthetic fiber, either nylon multifilament fibers or polypropylene fibrillated fibers, shall meet the requirements of ASTM C 1116 , Section 4.1.3 and Note 3 and ICC ES AC 32, Sections 4.1.1 and 4.1.2. Synthetic fibers shall be added at a rate of 1.0 pound of Nylon Multifilament fibers per cubic yard of concrete or 1.5 pounds of Polypropylene Fibrillated fibers per cubic yard of concrete and shall be thoroughly mixed with the concrete before placement in the forms. The synthetic fibers shall be a minimum of 0.75-inches and a maximum of 2-inches in length. A minimum of two hoops of W2 wire shall be placed in the 48-inch end of each cone. No steel is required in the remainder of the cone. Precast concrete units shall be furnished with knockouts or cutouts.

9-12.5 Precast Concrete Catch Basins

Precast concrete catch basins shall conform to the requirements of Section 9-12.4, except that the dimensions shall be as set forth in the Standard Plan.

As an alternate, Type 1, Type 1L and Type 1P, Catch Basins may be fabricated using synthetic fiber reinforcement, either nylon multifilament fibers or polypropylene fibrillated fibers, meeting the requirements of ASTM C 1116 Section 4.1.3 and Note 3 and ICC ES AC 32, Sections 4.1.1 and 4.1.2. Synthetic fibers shall be added at the rate of 1.0 pound of Nylon Multifilament fibers per cubic yard of concrete or 1.5 pounds of Polypropylene Fibrillated fibers per cubic yard of concrete, and shall be thoroughly mixed with the concrete before placement. A minimum amount of steel reinforcement shall be used to reinforce the area around the knockouts. Steel reinforcing shall consist of a No. 3 horizontal hoop reinforcing bar located above the knockouts, and a No. 3 vertical reinforcing bar in each corner, extending a minimum of 18-inches below the top surface of the catch basin.

Knockouts or cutouts may be placed on all four sides and may be round or D shaped.

9-12.6 Precast Concrete Inlets

Precast concrete inlets shall conform to the requirements of Section 9-12.4 except that the dimensions shall be as set forth in the Standard Plan.

9-12.7 Precast Concrete Drywells

Precast concrete drywells shall meet the requirements of Section 9-12.4. Seepage port size and shape may vary per manufacturer. Each seepage port shall provide a minimum of 1 square inch and a maximum of 7 square inches for round openings and 13 square inches for rectangular openings. The ports shall be uniformity spaced with at least one port per 8-inches of drywell height and 15-inches of drywell circumference.

9-13 RIPRAP, QUARRY SPALLS, SLOPE PROTECTION, AND ROCK WALLS

Riprap shall consist of broken stone, broken concrete rubble, or concrete in sacks. Quarry spalls shall consist of broken stone or broken concrete rubble. Riprap and quarry spalls consisting of broken stone or concrete rubble shall be free from segregation, seams, cracks, and other defects tending to destroy its resistance to weather and shall conform to the following requirements for quality.

Degradation Factor	15 minimum
Los Angeles Wear, 500 Rev.	50% maximum
Specific Gravity	2.55 minimum

9-13.1 Loose Riprap

Loose riprap shall be free of rock fines, soil, or other extraneous material.

Should the riprap contain insufficient spalls, as defined in Section 9-13.6, the Contractor shall furnish and place supplementary spall material from a source approved by the Engineer, at the Contractor's expense.

The grading of the riprap shall be determined by the Engineer by visual inspection of the load before it is dumped into place, or, if so ordered by the Engineer, by dumping individual loads on a flat surface and sorting and measuring the individual rocks contained in the load.

9-13.1(1) Heavy Loose Riprap

Heavy loose riprap shall meet the following requirements for grading:

	Minimum Size	Maximum Size
40% to 90%	1 ton ($^1/_2$ cubic yd.)	
70% to 90%	300 lbs. (2 cu. ft.)	
10% to 30%	3-inch	50 lbs. (spalls)

9-13.1(2) Light Loose Riprap

Light loose riprap shall meet the following requirements for grading:

	Size Range	Maximum Size
20% to 90%	300 lbs. to 1 ton (2 cu. ft. to $^1/_2$ cu. yd.)	
15% to 80%	50 lbs. to 1 ton ($^1/_3$ cu. ft. to $^1/_2$ cu. yd.)	
10% to 20%	3-inch	50 lbs. (spalls)

9-13.2 Hand Placed Riprap

Hand placed riprap shall be as nearly rectangular as possible, 60 percent shall have a volume of not less than 1 cubic foot. No stone shall be used which is less than 6-inches thick, nor which does not extend through the wall.

9-13.3 Sack Riprap

Sack riprap shall consist of concrete placed in sacks made of at least 10-ounce burlap and having a capacity of approximately 2.5 cubic feet. Each sack shall be filled

with approximately 1 cubic foot of concrete having a consistency in conformance with Section 6-02.3(4)C for nonvibrated concrete.

Concrete for sack riprap exposed to fresh water and salt water shall be Class 3000 as specified in Section 6-02.3.

The cement and fine and coarse aggregates shall conform to the requirements for cement and fine and coarse aggregate of Sections 9-01 and 9-03.1, respectively.

9-13.4 Vacant

9-13.5 Concrete Slope Protection

Concrete slope protection shall consist of reinforced Portland cement concrete poured or pneumatically placed upon the slope with a rustication joint pattern or semi-open concrete masonry units placed upon the slope closely adjoining each other.

9-13.5(1) Semi-Open Concrete Masonry Units Slope Protection

Precast cement concrete blocks shall conform to the requirements of ASTM C 90.

9-13.5(2) Poured Portland Cement Concrete Slope Protection

Cement concrete for poured concrete slope protection shall be Class 3000 in conformance with Section 6-02.3.

Wire mesh reinforcement shall conform to the provisions of Section 9-07.7.

9-13.5(3) Pneumatically Placed Portland Cement Concrete Slope Protection

Cement: This material shall be Portland cement as specified in Section 9-01.

Aggregate: This material shall meet the requirements for fine aggregate as specified in Section 9-03.1. The moisture content of the fine aggregate at the time of use shall be between 3 percent and 6 percent by weight.

Reinforcement: Wire mesh reinforcement shall conform to the provisions of Section 9-07.7.

Water: Water shall conform to the provisions of Section 9-25.1.

9-13.6 Quarry Spalls

Quarry spalls shall meet the following requirements for grading:

Sieve Size	Percent Passing
8″	100
3″	40 max.
3/4″	10 max.

9-13.7 Rock for Rock Wall

9-13.7(1) Rock for Rock Walls and Chinking Material

Rock for rock walls and chinking material shall be hard, sound and durable material, free from seams, cracks, and other defects tending to destroy its resistance to weather, and shall meet the following minimum requirements:

Test	Test Method	Requirements
Specific Gravity	AASHTO T-85	2.55 min.
LA Wear	AASHTO T-96	50% max.
Degradation	WSDOT 113	15 min.
Absorption	AASHTO T-85	3% max.

Rock for rock wall sizes are approximately as follows:

Rock Size	Rock Weight (lbs.)	Average Dimension (in.)
One Man	50 - 200	12 - 18
Two Man	200 - 700	18 - 28
Three Man	700 - 2,000	28 - 36
Four Man	2,000 - 4,000	36 - 48
Five Man	4,000 - 6,000	48 - 54
Six Man	6,000 - 8,000	54 - 60

Chinking material shall be a minimum of 4-inches average dimension.

9-13.7(2) Backfill for Rock Wall

Backfill for rock walls shall be shot rock ranging in size from a minimum of 2-inches to a maximum of 6-inches.

Acceptance shall be based on visual inspection by the Engineer.

9-14 EROSION CONTROL AND ROADSIDE PLANTING

9-14.1 Soil

9-14.1(1) Topsoil Type A

Topsoil Type A shall be as specified in the Special Provisions.

9-14.1(2) Topsoil Type B

Topsoil Type B shall be native topsoil taken from within the project limits either from the area where roadway excavation is to be performed or from strippings from borrow, pit, or quarry sites, or from other designated sources. The general limits of the material to be utilized for topsoil will be indicated in the Plans or in the Special Provisions. The Engineer will make the final determination of the areas where the most suitable material exists within these general limits. The Contractor shall reserve this material for the specified use. Material for Topsoil Type B shall not be taken from a depth greater than 1-foot from the existing ground unless otherwise designated by the Engineer.

In the production of Topsoil Type B, all vegetative matter, less than 4-feet in height, shall become a part of the topsoil. Prior to topsoil removal, the Contractor shall reduce the native vegetation to a height not exceeding 1-foot. Noxious weeds, as designated by authorized State and County officials, shall not be incorporated in the topsoil, and shall be removed and disposed of as designated elsewhere or as approved by the Engineer.

9-14.1(3) Topsoil Type C

Topsoil Type C shall be native topsoil meeting the requirements of Topsoil Type B but obtained from a source provided by the Contractor outside of the Contracting Agency owned right of way.

9-14.2 Seed

Grasses, legumes, or cover crop seed of the type specified shall conform to the standards for "Certified" grade seed or better as outlined by the State of Washington Department of Agriculture "Rules for Seed Certification," latest edition. Seed shall be furnished in standard containers on which shall be shown the following information:

(1) Common and botanical names of seed,
(2) Lot number,
(3) Net weight,
(4) Percentage of purity,
(5) Percentage of germination (in case of legumes percentage of germination to include hard seed), and Percentage of weed seed content and inert material clearly marked for each kind of seed in accordance with applicable State and Federal laws.

All seed installers must have a business license issued by the Washington State Department of Licensing with a "seed dealer" endorsement. Upon request, the contractor shall furnish the Engineer with copies of the applicable licenses and endorsements.

Upon request, the Contractor shall furnish to the Engineer duplicate copies of a statement signed by the vendor certifying that each lot of seed has been tested by a recognized seed testing laboratory within six months before the date of delivery on the project. Seed which has become wet, moldy, or otherwise damaged in transit or storage will not be accepted.

9-14.3 Fertilizer

Fertilizer shall be a standard commercial grade of organic or inorganic fertilizer of the kind and quality specified. It may be separate or in a mixture containing the percentage of total nitrogen, available phosphoric acid, and water-soluble potash in the amounts specified. All fertilizers shall be furnished in standard unopened containers with weight, name of plant nutrients, and manufacturer's guaranteed statement of analysis clearly marked, all in accordance with State and Federal laws.

Fertilizer shall be supplied in one of the following forms:

(1) A dry free-flowing granular fertilizer, suitable for application by agricultural fertilizer spreader.

(2) A soluble form that will permit complete suspension of insoluble particles in water, suitable for application by power sprayer.

(3) A homogeneous pellet, suitable for application through a ferti-blast gun.

(4) A tablet or other form of controlled release with a minimum of a 6 month release period.

9-14.4 Mulch and Amendments

All amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's guaranteed chemical analysis and name. In lieu of containers, amendments may be furnished in bulk. A certificate from the manufacturer or supplier indicating the above information shall accompany each delivery. Compost and other organic amendments shall be accompanied with all applicable health certificates and permits.

9-14.4(1) Straw

All straw material shall be in an air dried condition free of noxious weeds and other materials detrimental to plant life. Straw mulch so provided shall be suitable for spreading with mulch blower equipment.

9-14.4(2) Wood Cellulose Fiber

Fiber shall be produced from natural or recycled (pulp) fiber, such as wood chips or similar wood materials, or from newsprint, corrugated cardboard, or a combination of these processed materials. The fibers shall not contain any rock, metal, or plastic. It shall be treated with a nontoxic green dye non toxic to plant or animal life to facilitate inspection of the placement of the material. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material will become uniformly suspended to form a homogenous slurry. When hydraulically sprayed on the ground, the material shall allow the absorption and percolation of moisture.

During the request for approval of the material source process, a letter of certification shall be submitted which certifies that the product contains less than 250 parts per million boron, and shall be otherwise nontoxic to plant or animal life. The organic matter content shall be at least 90 percent on an oven-dry basis as determined by ASTM D 586. The moisture content shall be no more than 15 percent as determined by oven dried weight.

Each package of the cellulose fiber shall be marked by the manufacturer to show the dried weight.

9-14.4(3) Bark or Wood Chips

Bark or wood chip mulch shall be derived from Douglas fir, pine, or hemlock species. It shall be ground so that a minimum of 95 percent of the material will pass through a 1½-inch sieve and no more than 55 percent, by loose volume, will pass through a U.S. No. 4 sieve. The mulch shall not contain resin, tannin, or other compounds in quantities that would be detrimental to plant life.

9-14.4(4) Sawdust

Sawdust mulch shall be free of chips, chunks, and large splinters, and shall not contain resin, tannin, or other compounds in quantities that would be detrimental to plant life.

9-14.4(5) Lime

Agriculture lime shall be of standard manufacture, flour grade or in pelletized form, meeting the requirements of ASTM C-602.

9-14.4(6) Gypsum

Gypsum shall consist of Calcium Sulfate (CaSO42H2O) in a pelletized or granular form. 100% shall pass through a U.S. No. 8 sieve.

9-14.4(7) Tackifier

Tackifiers used as a tie-down for seed and mulch shall be applied in quantities sufficient to equal the retention properties of guar when applied at the rate of 60 pounds per acre for slopes less than 2:1 and 120 pounds per acre for slopes greater than 2:1. Tackifier shall contain no growth or germination inhibiting materials nor significantly reduce infiltration rates. Tackifier shall hydrate in water and readily blend with other slurry materials. Tackifier options include:

Type A — Organic tackifier derived from natural organic plant sources.

Type B — Synthetic tackifier having an MSDS sheet that demonstrates to the satisfaction of Engineer that the product is not harmful to aquatic life.

9-14.4(8) Compost

Compost products shall be the result of the biological degradation and transformation of plant-derived materials under controlled conditions designed to promote aerobic decomposition. Compost shall be stable with regard to oxygen consumption and carbon dioxide generation. Compost shall be mature with regard to its suitability for serving as a soil amendment or an erosion control BMP as defined below. The compost shall have a moisture content that has no visible free water or dust produced when handling the material.

Compost production and quality shall comply with Chapter 173-350 WAC.

Compost products shall meet the following physical criteria:

1. Compost material shall be tested in accordance with the U.S. Composting Council, Testing Methods for the Examination of Compost and Composting (TMECC) Test Method 02.02-B, “Sample Sieving for Aggregate Size Classification”.

   Fine Compost shall meet the following:

	Min.	Max.
Percent passing 2”	100%	
Percent passing 1”	90%	100%
Percent passing ¾”	70%	100%
Percent passing ¼”	40%	75%

Maximum particle length of 6-inches
Coarse Compost shall meet the following:

	Min.	Max.
Percent passing 3”	100%	
Percent passing 1”	90%	100%
Percent passing ¾”	70%	100%
Percent passing ¼”	40%	60%

Maximum particle length of 6-inches

2. The pH shall be between 6.0 and 8.5 when tested in accordance with TMECC 04.11-A, “1:5 Slurry pH”.
3. Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 0.5 percent on a dry weight or volume basis, whichever provides for the least amount of foreign material.
4. Minimum organic matter shall be 40 percent dry weight basis as determined by TMECC 05.07A, “Loss-On-Ignition Organic Matter Method”.
5. Soluble salt contents shall be less than 6.0 mmhos/cm tested in accordance with TMECC 04.10-A, “1:5 Slurry Method, Mass Basis”.
6. Maturity greater than 80% in accordance with TMECC 05.05A, “Germination and Root Elongation”.
7. Stability 8 or below in accordance with TMECC 05.08-B, Carbon Dioxide Evolution Rate”.
8. The compost product must originate a minimum of 65 percent by volume from recycled plant waste as defined in WAC 173-350 as “Type 1 Feedstocks.” A maximum of 35 percent by volume of other approved organic waste and/or biosolids may be substituted for recycled plant waste. The supplier shall provide written verification of feedstock sources.

The compost supplier will test all compost products within 30 calendar days prior to initial application with samples taken from the material stockpiled by the supplier for project use. Samples will be taken using the Seal of Testing Assurance (STA) sample collection protocol. (The sample collection protocol can be obtained from the U.S. Composting Council, 4250 Veterans Memorial Highway, Suite 275, Holbrook, NY 11741 Phone: 631-737-4931). The sample shall be sent to an independent STA Program approved lab. The compost supplier will pay for the test. A copy of the approved independent STA Program laboratory test report shall be submitted to the Contracting Agency prior to initial application of the compost.

Compost not conforming to the above requirements or taken from a source other than those tested and accepted shall be immediately removed from the project and replaced at no cost to the Contracting Agency.

The contractor shall either select a compost supplier from the Qualified Products List, or submit the following information to the Engineer for approval:

1. A Request for Approval of Material Source.
2. A copy of the Solid Waste Handling Permit issued to the supplier by the Jurisdictional Health Department as per WAC 173-350 (Minimum Functional Standards for Solid Waste Handling).
3. The supplier shall verify in writing, and provide lab analyses that the material complies with the processes, testing, and standards specified in WAC 173-350 and these specifications. The analysis shall be performed by an independent STA Program certified laboratory.
4. A list of the feedstock by percentage present in the final compost product.
5. A copy of the producers Seal of Testing Assurance certification as issued by the U.S. Composting Council.

Acceptance will be based upon a satisfactory Test Report from an independent STA program certified laboratory.

9-14.4(9) Bonded Fiber Matrix (BFM)

The BFM shall be a hydraulically-applied blanket/mulch/covering composed of long strand, thermally processed wood fibers and crosslinked, hydro-colloid tackifier. The BFM may require a 24-48 hour curing period to achieve maximum performance. Once cured, the BFM forms an intimate bond with the soil surface to create a continuous, absorbent, flexible erosion resistant blanket that allows for rapid germination and accelerated plant growth.

9-14.4(10) Mechanically-Bonded Fiber Matrix (MBFM)

The MBFM shall be a hydraulically-applied, flexible erosion control blanket/mulch/covering composed of long strand, thermally processed wood fibers, crimped, interlocking fibers and performance enhancing additives. The MBFM shall require no curing period and upon application forms an intimate bond with the soil surface to create a continuous, porous, absorbent and erosion resistant blanket that allows for rapid germination and accelerated plant growth.

9-14.5 Erosion Control Devices

9-14.5(1) Polyacrylamide (PAM)

Polyacrylamide (PAM) products shall meet ANSI/NSF Standard 60 for drinking water treatment with an AMD content not to exceed 0.05%. PAM shall be anionic or non-ionic and shall be linear, and not cross-linked. The minimum average molecular weight shall be greater than 5 Mg/mole. The product shall contain at least 80% active ingredients and have a moisture content not exceeding 10% by weight.

9-14.5(2) Erosion Control Blanket

Organic temporary erosion control blanket shall meet the following requirements:

1. Made of natural plant fibers.
2. Have a minimum weight of 8 oz./sq. yd. and a minimum limiting shear stress of 0.45 lb./sq. ft.
3. Netting, if present, shall be biodegradable or photodegradable.

Permanent erosion control blanket shall meet the following requirements:

1. Consist of UV stabilized[1] fibers, filaments, and netting.
2. Have a minimum weight of 8 oz./sq. yd. and a minimum limiting shear stress of 1.5 lb./sq. ft.

[1]UV stability (minimum 80 percent tensile retained) ASTM D4355 (1,000 hour exposure).

9-14.5(3) Clear Plastic Covering

Clear plastic covering shall meet the requirements of the NIST Voluntary Product Standard, PS 17-69, for polyethylene sheeting having a minimum thickness of 6 mils.

9-14.5(4) Geotextile-Encased Check Dam

The geotextile-encased check dam shall be a urethane foam core encased in geotextile material. The minimum length of the unit shall be 7-feet.

The foam core shall be a minimum of 8-inches in height, and have a minimum base width of 16-inches. The geotextile material shall overhang the foam by at least 6-inches at each end, and shall have apron type flaps that extend a minimum of 24-inches on each side of the foam core. The geotextile material shall meet the requirements for silt fence in Section 9-33.

9-14.5(5) Wattles

Wattles shall consist of cylinders of biodegradable plant material such as straw, coir, or wood shavings encased within biodegradable or photodegradable netting. Netting shall meet the requirements of Section 9-14.5. Rolls shall be at least 6-inches in diameter, unless otherwise specified.

9-14.5(6) Compost Sock

Biodegradable burlap fabric for compost sock and compost wattle shall be clean, evenly woven, and free of encrusted concrete or other contaminating materials and shall be free from cuts, tears, broken or missing yarns and thin, open, or weak places. Fabric for compost sock shall consist of extra heavy weight biodegradable burlap fiber which has not been treated with any type of preservative. Compost for compost socks shall meet the material requirements as specified in Section 9-14.4(8), and shall be compost Type 2.

Wood stakes for compost sock and wattles shall be made from Douglas-Fir, Hemlock, or Pine species. Wood stakes shall be 2-inch by 2-inch nominal dimension and 36-inches in length, unless otherwise indicated in the Plans.

9-14.6 Plant Materials

9-14.6(1) Description

Seedlings are plants grown from cuttings, seeds, tissue culture, or other standard nursery propagation methods. Measurement is by height in 3-inch increments or by age and number of times transplanted.

Whips are bareroot, broadleaf trees, generally unbranched and between 2-feet and 6-feet in height. Measurement is by 1-foot height increments.

Broadleaf trees are branched, over 6-feet in height and measured by caliper and/or height.

Coniferous trees are over 2-feet in height and measured in height and occasionally spread.

Shrubs and ground covers begin to show form characteristic to their normal habit of growth and are measured by height and/or spread.

Container sizes may be specified in addition to other measurements, however, the other measurements shall govern.

Cuttings are live plant material without a previously developed root system. Source plants for cuttings shall be dormant when cuttings are taken. All cuts shall be made with a sharp instrument. Written permission shall be obtained from property owners and provided to the Engineer before cuttings are collected. The Contractor shall collect cuttings in accordance with applicable sensitive area ordinances. For cuttings, the requirement to be nursery grown or held in nursery conditions does not apply. Cuttings include the following forms:

A. Live branch cuttings shall have flexible top growth with terminal buds and may have side branches. The rooting end shall be cut at an approximate 45 degree angle.

B. Live stake cuttings shall have a straight top cut immediately above a bud. The lower, rooting end shall be cut at an approximate 45-degree angle. Live stakes are cut from one to two year old wood. Live stake cuttings shall be cut and installed with the bark intact with no branches or stems attached, and be ½ to 1 $^{1}/_{2}$-inch in diameter.

C. Live pole cuttings shall have a minimum 2-inch diameter and no more than three branches which shall be pruned back to the first bud from the main stem.

D. Rhizomes shall be a prostrate or subterranean stem, usually rooting at the nodes and becoming erect at the apex. Rhizomes shall have a minimum of two growth points.

E. Tubers shall be a thickened and short subterranean branch having numerous buds or eyes.

9-14.6(2) Quality

All plant material furnished shall meet the grades established by the latest edition of the American Standard for Nursery Stock, (ASNS) ANSI Z60.1 shall conform to the size and acceptable conditions as listed in the contract, and shall be free of all foreign plant material.

All plant material shall comply with State and Federal laws with respect to inspection for plant diseases and insect infestation.

Live woody or herbaceous plant material, except cuttings, rhizomes, and tubers, shall be vigorous, well formed, with well developed fibrous root systems, free from dead branches, and from damage caused by an absence or an excess of heat or moisture, insects, disease, mechanical or other causes detrimental to good plant development. Evergreen plants shall be well foliated and of good color. Deciduous trees that have solitary leaders shall have only the lateral branches thinned by pruning. All conifer trees shall have only one leader (growing apex) and one terminal bud, and shall not be sheared or shaped. Trees having a damaged or missing leader, multiple leaders, or Y-crotches shall be rejected.

Root balls of plant materials shall be solidly held together by a fibrous root system and shall be composed only of the soil in which the plant has been actually growing. The ball shall be securely wrapped with jute burlap or other packing material not injurious to the plant life. Root balls shall be free of weed or foreign plant growth.

Plant materials shall be nursery grown stock. Plant material, with the exception of cuttings, gathered from native stands shall be held under nursery conditions for a minimum of one full growing season, shall be free of all foreign plant material, and meet all of the requirements of these Specifications, the Plans, and the Special Provisions.

Container grown plants must be plants transplanted into a container and grown in that container sufficiently long for new fibrous roots to have developed so that the root mass will retain its shape and hold together when removed from the container. Plant material which is root bound, as determined by the Engineer, shall be rejected.

Container sizes for plant material of a larger grade than provided for in the container grown specifications of the ASNS shall be determined by the volume of the root ball specified in the ASNS for the same size plant material.

All bare root plant materials shall have a heavy fibrous root system and must be dormant at the time of planting.

Average height to spread proportions and branching shall be in accordance with the applicable sections, illustrations, and accompanying notes of the ASNS.

Plants specified or identified as “Street Tree Grade” shall be trees with straight trunks, full and symmetrical branching, central leader, and be developed, grown, and propagated with a full branching crown. A “Street Tree Grade” designation requires the highest grade of nursery shade or ornamental tree production which shall be supplied.

Trees with improperly pruned, broken, or damaged branches, trunk, or root structure shall be rejected. In all cases, whether supplied balled and burlapped or in a container, the root crown (top of root structure) of the tree shall be at the top of the finish soil level. Trees supplied and delivered in a nursery fabric bag will not be accepted.

Plants, which have been determined by the Engineer to have suffered damage as the result of girdling of the roots, stem, or a major branch; have deformities of the stem or major branches; have a lack of symmetry; have dead or defoliated tops or branches; or have any defect, injury, or condition which renders the plant unsuitable for its intended use, shall be rejected.

Plants that are grafted shall have roots of the same genus as the specified plant.

9-14.6(3) Handling and Shipping

Handling and shipping shall be done in a manner that is not detrimental to the plants.

The nursery shall furnish a notice of shipment in triplicate at the time of shipment of each truck load or other lot of plant material. The original copy shall be delivered to the Project Engineer, the duplicate to the consignee and the triplicate shall accompany the shipment to be furnished to the Inspector at the job site. The notice shall contain the following information:

1. Name of shipper.
2. Date of shipment.
3. Name of commodity. (Including all names as specified in the contract.)
4. Consignee and delivery point.
5. State contract number.
6. Point from which shipped.
7. Quantity contained.
8. Certificate of Grade. (Statement that material conforms to the specifications.)
9. Size. (Height, runner length, caliper, etc. as required.)
10. Statement of root pruning. (Date pruned and size of pruning.)
11. Signature of shipper by authorized representative.

To acclimate plant materials to Northwest conditions, all plant materials used on a project shall be grown continuously outdoors north of the 42nd Latitude (Oregon-California border) from not later than August 1 of the year prior to the time of planting.

All container grown plants shall be handled by the container.

All balled and burlapped plants shall be handled by the ball.

Plant material shall be packed for shipment in accordance with prevailing practice for the type of plant being shipped, and shall be protected at all times against drying, sun, wind, heat, freezing, and similar detrimental conditions both during shipment and during related handling. Where necessary, plant material shall be temporarily heeled in. When transported in closed vehicles, plants shall receive adequate ventilation to prevent sweating. When transported in open vehicles, plants shall be protected by tarpaulins or other suitable cover material. Antidesiccant material shall be applied before shipment.

9-14.6(4) Tagging

Plants delivered as a single unit of 25 or less of the same size, species, and variety, shall be clearly marked and tagged. Plants delivered in large quantities of more than 25 must be segregated as to variety, grade, and size; and one plant in each 25, or fraction thereof, of each variety, grade, and size shall be tagged.

9-14.6(5) Inspection

The Contracting Agency will make an inspection of plant material at the source when requested by the Engineer. However, such preliminary approval shall not be considered as final acceptance for payment. Final inspection and approval (or rejection) will only occur when the plant material has been delivered to the contract site. The Contractor shall notify the Engineer, not less than 48 hours in advance, of plant material delivery to the project.

9-14.6(6) Substitution of Plants

No substitution of plant material, species or variety, will be permitted unless evidence is submitted in writing to the Engineer that a specified plant cannot be obtained and has been unobtainable since the award of the contract. If substitution is permitted, it can be made only with written approval by the Engineer. The nearest variety, size, and grade, as approved by the Engineer, shall then be furnished.

Container or balled and burlapped plant material may be substituted for bare root plant material. Container grown plant material may be substituted for balled and burlapped plant materials. Container size shall be determined by the volume of the root ball that is specified. These substitutions shall be approved by the Engineer and be at no cost to the Contracting Agency.

9-14.6(7) Temporary Storage

Plants stored under temporary conditions shall be the responsibility of the Contractor.

Plants stored on the project shall be protected at all times from extreme weather conditions by insulating the roots, root balls, or containers with sawdust, soil, compost, bark or wood chips, or other approved material and shall be kept moist at all times prior to planting.

Cuttings to be stored for periods longer than one week shall be taken while the plants are dormant. Cuttings to be stored for later installation shall be bundled, laid horizontally, and completely buried under 6-inches of water, moist soil or placed in cold storage at a temperature of 34°F and 90% humidity. Cuttings that are not planted within 24 hours of cutting shall be soaked in water for 24 hours prior to planting. Cuttings taken when the temperature is higher than 50°F shall not be stored for later use.

Cuttings shall continually be shaded and protected from wind. Cuttings must be protected from drying at all times and shall be heeled into moist soil or placed in water if not installed within 8 hours of cutting.

9-14.6(8) Sod

The available grass mixtures on the current market shall be submitted to the Engineer for selection and approval.

The sod shall be field grown one calendar year or older, have a well developed root structure, and be free of all weeds, disease, and insect damage.

Prior to cutting, the sod shall be green, in an active and vigorous state of growth, and mowed to a height not exceeding 1-inch.

The sod shall be cut with a minimum of 1-inch of soil adhering.

9-14.7 Stakes, Guys, and Wrapping

Stakes shall be installed as shown in the Plans.

Commercial plant ties may be used in lieu of hose and wire guying upon approval of the Engineer. The minimum size of wire used for guying shall be 12 gage, soft drawn.

Hose for guying shall be nylon, rubber, or reinforced plastic and shall have an inside diameter of at least 1-inch.

Tree wrap shall be a crinkled waterproof paper weighing not less than 4.0-pounds per 100 square feet and shall be made up of two sheets cemented together with asphalt.

9-15 IRRIGATION SYSTEM

All materials and equipment incorporated in the system shall be new, undamaged, of standard quality, and shall be subject to testing as specified.

9-15.1 Pipe, Tubing, and Fittings

Pipe shall be copper, galvanized iron, PVC, or polyethylene, as specified in the Plans or in the Special Provisions.

Copper pipe or tubing shall be a minimum of Type L rating and shall meet the requirements of Section 9-30.6(3)A.

Threaded cast brass or bronze fittings shall meet the requirements of Section 9-30.6(6).

9-15.1(1) Galvanized Pipe and Fittings

Pipe shall be standard weight, hot-dip galvanized iron or steel pipe, threaded and coupled. Pipe shall meet the requirements of ASTM A 53.

All pipe fittings shall be standard threaded galvanized malleable iron fittings.

9-15.1(2) Polyvinyl Chloride Pipe and Fittings

PVC pipe and fittings shall be of PVC compound Type 1, Grade 1, conforming to ASTM D 1784 specifications. The pipe and fittings shall be approved and certified by the National Sanitation Foundation. Pipe and fittings shall be free from defects in materials, workmanship, and handling. The Engineer may require dimensional and quick burst tests of pipe and fittings after arrival at the job site. Acceptance of the materials shall be subject to passing the designated tests per ASTM Standards.

PVC solvent weld pipe shall be of PVC 1120 material and shall have 200-psi minimum pressure rating with SDR 21 walls which conform to ASTM D 2241. PVC pipe with walls heavier than SDR 21 shall be installed when noted in the Plans and specified in the Special Provisions. PVC threaded pipe shall be of PVC 1120 material and shall be schedule 80 which conforms to ASTM D 1785.

PVC pipe fittings shall conform to ASTM D 2466, Type I, Grades 1 or 2. Pipe may be belled on one end with the dimensions of the tapered bell conforming to ASTM D 2672.

Each length of PVC pipe is to be marked with an identifying extrusion “run” number and the manufacturer’s name or trade name plus the pipe size and schedule.

9-15.1(3) Polyethylene Pipe

Polyethylene pipe shall be Class 80, SDR 15, medium density polyethylene pipe, meet the requirements of ASTM D 2239, conform to U.S. Commercial Standard CS-255, and be National Sanitation Foundation (NSF) approved.

Thick walled polyethylene (poly) pipe shall be used in conjunction with fittings recommended by the manufacturer of the poly pipe to produce a flexible swing joint assembly between the lateral line and the irrigation head. The pipe shall be manufactured from high quality, low density virgin polyethylene material and have a minimum wall thickness of 0.10-inch and a minimum inside diameter of 0.49-inch. The pipe shall be capable of withstanding 80-psi operating water pressure at 110°F. The length of thick walled poly pipe at each flexible swing joint assembly shall be 18-inches minimum to 36-inches maximum.

9-15.2 Drip Tubing

Drip tubing shall be manufactured from specially formulated, chemical resistant, low to medium density virgin polyethylene or polybutylene selected for excellent weatherability and stress cracking resistance and designed specifically for use in drip irrigation systems. Drip tubing shall have a minimum wall thickness of 0.045-inch.

9-15.3 Automatic Controllers

Automatic controller pedestals or container cabinets shall be installed on a concrete base as shown in the Plans. The automatic controller clock shall be an electrically timed device for automatically opening and closing control valves for predetermined periods of time and mounted so that all normal adjustments will be conveniently located for use by the operator. The automatic controller clock shall be enclosed in a weatherproof, painted, metal housing fabricated from 16 gage sheet aluminum alloy 6061-T6, or from 16 gage sheet steel metal.

The automatic controller clock housing shall have hasp and lock or locking device. All locks or locking devices shall be master keyed and three sets of keys provided to the Engineer. The controller shall be compatible with and capable of operating the irrigation system as designed and constructed and shall include the following operating features:

1. Each controller station shall be adjustable for setting to remain open for any desired period of time, from five minutes or less to at least one hour.
2. Adjustments shall be provided whereby any number of days may be omitted and whereby any one or more positions on the controller can be skipped. When adjustments are made, they shall continue automatically within a 14-day cycle until the operator desires to make new adjustments.
3. Controls shall allow any position to be operated manually both on or off whenever desired.
4. Controls shall provide for resetting the start of the irrigation cycle at any time and advancing from one position to another.
5. Controllers shall contain an on-off switch and fuse assembly.

9-15.4 Spray Heads

Spray heads shall be of the type, pattern, and coverage shown in the Plans at rated operating pressure specified, discharging not more than the amount of gallons per minute listed.

Sprinkler heads shall be designed so that spray adjustments can be made by either an adjustment screw or interchangeable nozzles. Watering cores shall be easily removed without removing the housing from the pipe.

9-15.5 Valve Boxes and Protective Sleeves

All automatic control valves, flow control valves, and pressure reducing valves shall be provided with valve boxes. Valve boxes shall conform to the Plans and shall be extendible to obtain the depth required. All manual drain valves and manual control valves shall be equipped with a protective sleeve and cap as shown in the Plans.

9-15.6 Gate Valves

Gate valves when called for in the Plans shall be heavy duty bronze conforming to the requirements of ASTM B 62. Valves shall be of the same size as the pipes on which they are placed and shall have union or flange connections. Service rating (for nonshock cold water) shall be 150-psi. Valves shall be of the double disk, taper seat type, with rising stem, union bonnet and hand wheel or suitable cross wheel for standard key operation. Manufacturer's name, type of valve, and size shall be cast on the valve.

9-15.7 Control Valves

9-15.7(1) Manual Control Valves

Manual valves shall be bronze or brass, angle type with hex brass union. Service rating shall be not less than 150-psi nonshock cold water. Valves shall be designed for underground installation with suitable cross wheel for operation with a standard key. The Contractor shall furnish three suitable operating keys per contract. Valves shall have removable bonnet and stem assembly with adjustable packing gland and shall house long acme threaded stem to ensure full opening and closing. Valve discs shall be full floating with replaceable seat washers.

9-15.7(2) Automatic Control Valves

Automatic remote control valves shall be globe pattern with flanged or screwed connections as required. The valve shall be constructed so as to allow all internal parts to be removable from the top of the valve without disturbing the valve installation.

Valves shall be of a normally closed design and shall be electric solenoid operated, having maximum rating of 6.5 watts utilizing 24 volt AC power. Solenoids shall be directly attached to the valve bonnets or body with all control parts completely internal. Valves shall be of 150-psi brass or bronze, or iron body bronze mounted combination. The opening and closing speed of the valve shall be a minimum of five seconds for closure and a minimum of three seconds for opening with a constant rate of opening and closing. A manual control bleed cock shall be included on the valve to operate the valve without the requirement of electric current. A manual shutoff stem with cross handle for wrench operation is required for manual adjustment from fully closed to wide open. Once the manual adjustment is set, the valve shall operate automatically in the adjusted position. Water flow shall be completely stopped when the control valve is closed either manually or automatically. Automatic control valves and automatic controllers need not be from the same manufacturer.

9-15.7(3) Automatic Control Valves With Pressure Regulator

The automatic control valve with pressure regulator shall be similar to the automatic control valve and shall also reduce the inlet pressure to a constant lower pressure regardless of supply fluctuations. The regulator must be fully adjustable.

9-15.8 Quick Coupling Equipment

Quick coupler valves shall have a service rating not less than 125-psi for nonshock cold water. The body of the valves shall be of cast leaded semi-red brass alloy No. C84400 conforming to ASTM B 584. The base of the valve shall have standard female pipe threads. The design of the valve shall be such that it will open only upon inserting a coupler key and will close as the coupler is removed from the valve. Leakage of water between the coupler and valve body when in operation will not be accepted. The valve body receiving the coupler shall be designed with double worm slots to allow smooth

action in opening and closing of the valve with a minimum of effort. Slots shall be notched at the base to hold the coupler firmly in the open position. Couplers shall be of the same material as the valve body with stainless steel double guide lugs to fit the worm slots. Couplers shall be of one piece construction with steel reinforced side handles attached. All couplers shall have standard male pipe threads at the top. Couplers shall be furnished with all quick coupler valves unless otherwise specified.

9-15.9 Drain Valves

Drain valves shall be $^1/_2$ or $^3/_4$-inch in size and shall be of bronze or brass, manual angle globe type, with rising stem, hex brass union, removable bonnet and stem, and adjustable packing gland. Valves shall be designed for underground installation with suitable cross wheel for operation with a standard key, and shall have a service rating of not less than 150-psi nonshock cold water. The Contractor shall furnish three standard operating keys per contract.

On potable systems, drain valves shall be allowed only in the downstream side of approved cross connection control devices.

9-15.10 Hose Bibs

Hose bibs shall be constructed of bronze or brass, angle type threaded to accommodate a $^3/_4$-inch hose connection, and shall be key operated. Design shall be such as to prevent operation by wrench or pliers.

9-15.11 Cross Connection Control Devices

Atmospheric vacuum breaker assemblies (AVBAs), pressure vacuum breaker assemblies (PVBAs), double check valve assemblies (DCVAs), and reduced pressure backflow devices (RPBDs), shall be of a manufacturer and product model approved for use by the Washington State Department of Social and Health Services, Olympia, Washington.

9-15.12 Check Valves

Adjustable spring check valves shall be PVC and shall be pressure rated at 200-psi. Valves shall be adjustable from 5 to 15-pounds spring tension, but shall not cause pressure loss in excess of 5-psi for flows up to 30-gpm. Valves shall have angled seats, Buna-N seals and threaded connections, and shall be installed in 6-inch Schedule 40 PVC sleeves with removable caps or 6-inch round plastic valve boxes.

9-15.13 Pressure Regulating Valves

Pressure regulating valves shall have a minimum of 150 psi working pressure with an adjustable outlet range of 20 to 70-psi. The valves shall be factory set as shown in the Plans. Pressure regulating valves shall be rated for safe operation at 175-psi nonshock cold water.

9-15.14 Three-Way Valves

Three-way valves shall be tight closing, three port, ball or plug type, constructed to permit straight through and 90 degree flow only. The valve shall be of bronze or approved corrosion resistant body materials and shall have a minimum of 150-psi working pressure. The head of the valve, or handle when applicable, shall be permanently marked to indicate port position. Whenever handles are included as an integral part of the valve, the Contractor shall remove the handles and give them to the Engineer for ultimate distribution to the Maintenance Division.

9-15.15 Flow Control Valves

Valve body materials shall be plastic or metal. Internal parts shall be stainless steel. Valves shall be factory set to plan flows. Valves shall have no external adjustment and be tamper-proof when installed. One-quarter inch and smaller flow control valves shall have a minimum pressure absorption range of 2 to 32-psi. One and one half inch and larger flow control valves shall have a minimum pressure absorption range of 3 to 50-psi.

Flow shall be controlled to 5 percent of plan volumes.

9-15.16 Air Relief Valve

The air relief valve shall automatically relieve air and break a vacuum in the serviced pipe. Body materials shall be installed exactly at all high points.

9-15.17 Electrical Wire and Splices

Electrical wire used between the automatic controller and automatic control valves shall be copper AWG No. 14 minimum size, Type USE Chemically Cross Linked Polyethylene , Type UF, and shall be color coded or marked with number identification.

Low voltage splices shall be made with a kit containing a “T” shaped open cell centering device and a plastic bag of urethane and hardener which is mixed at the time of installation or heat shrinkable insulating tubing. Heat shrinking insulating tubing shall consist of a mastic lined heavy wall polyolefin cable sleeve. The resin used with the “T” shaped open cell centering device shall be a quick curing flexible compound with an approximate set-up time of 4 minutes at 72°F.

9-15.18 Detectable Marking Tape

Detectable marking tape shall consist of inert polyethylene plastic that is impervious to all known alkalis, acids, chemical reagents, and solvents likely to be encountered in the soil, with a metallic foil core to provide the most positive detection and pipeline locators.

The tape shall be color coded and shall be imprinted continuously over its entire length in permanent black ink. The message shall convey the type of line buried below and shall also have the word “Caution” prominently shown. Color coding of the tape shall be as follows:

Utility	Tape Color
Water	Blue
Sewer	Green
Electrical	Red
Gas/Oil	Yellow
Telephone/CATV	Orange

The width of the tape shall be as recommended by the manufacture for the depth of installation.

9-15.19 Wye Strainers

Wye strainers shall be bronze or brass with screwed end connections, 20 mesh Monel or stainless steel screen, and standard tapped bronze retainer cap and closure plug. Service rating shall be not less than 150-psi nonshock cold water.

9-16 FENCE AND GUARDRAIL

9-16.1 Chain Link Fence and Gates

9-16.1(1) General

All material used in the construction of chain link fence and gates shall be new. Iron or steel material shall be galvanized unless specified otherwise. Material upon which serious abrasions of galvanizing occur shall not be acceptable.

9-16.1(1)A Post Material for Chain Link Fence

Except as noted otherwise, post material shall conform to the requirements of AASHTO M 181, Type I (zinc-coated steel), Grade 1 or 2, and shall be understood to include all round and roll-formed material (brace rails, top rails, line posts, brace posts, end posts, corner posts and pull posts).

Grade 1 post material shall conform to the weight per linear foot, minimum wall thickness and detail requirements of Standard Plan L-2. Grade 1 post material that exceeds the maximum wall thickness requirement of Standard Plan L-2 may be accepted, provided it does not interfere with the proper construction of the fence.

Grade 2 post material shall meet the organic exterior coatings requirements of AASHTO M 181 (Section 33) and the additional requirement that the interior coated surface shall be capable of resisting 300 hours of exposure to salt fog with a maximum of 5% red rust when tested in accordance with ASTM B 117.

- Round Post Material

  Round post material shall be Grade 1 or 2.
- Roll Form Material

  Roll-formed post material shall be Grade 1. Roll-formed end, corner, and pull posts shall have integral fastening loops to connect to the fabric for the full length of each post. Top rails and brace rails shall be open rectangular sections with internal flanges as shown in Standard Plan L-2.

9-16.1(1)B Chain Link Fence Fabric

Chain link fabric shall consist of 11 gage wire for Types 3, 4, and 6 fence, and 9 gage wire for Type 1 fence. The fabric shall be zinc-coated steel wire conforming to AASHTO M 181, Class C.

The wire shall be woven into approximately 2-inch diamond mesh. The width and top and bottom finish of the fabric shall be as specified in AASHTO M 181.

9-16.1(1)C Tension Wire

Tension wire shall meet the requirements of AASHTO M 181. Tension wire galvanizing shall be Class 1.

9-16.1(1)D Fittings and Hardware

Except where indicated, fittings shall be malleable cast iron or pressed steel and shall conform to the requirements of ASTM F626 or AASHTO M232, whichever is applicable. Fittings for any particular fence shall be those furnished by the manufacturer of the fence.

Tension truss rods shall be $^{3}/_{8}$-inch round galvanized rods with drop forged turnbuckles or other approved type of adjustment. Couplings for tubular sections shall be outside sleeve type and shall be at least 6-inches long.

Eye bolts for attaching tension wire shall be $^{3}/_{8}$-inch diameter and of sufficient length to fasten to the type of post being used.

Tension bars shall be $^{3}/_{16}$-inch by $^{3}/_{4}$-inch nominal and cross sectional area shall be 0.141 in^2 +/- 5%.

Hog rings shall be 12 gage galvanized steel wire. Tie wire shall be 9 gage galvanized steel wire or 9 gage aluminum wire meeting the requirements of ASTM F626.

9-16.1(1)E Chain Link Gates

Gate frames shall be constructed of not less that $1^{1}/_{2}$-inch (I.D.) hot-dipped galvanized pipe conforming to AASHTO M 181 Type I, Grade 1 or 2 as specified in Section 9-16.1(1)A. The corners of the gate frame shall be fastened together and reinforced with a malleable iron or pressed steel fitting designed for the purpose, or they may be welded. Welding shall conform to the requirements of Section 6-03.3(25). All welds shall be ground smooth and painted with an A-9-73 or A-11-99 primer meeting the requirements of Section 9-08.2. The paint shall be applied in one or more coats to provide a minimum dry film thickness of 3.5 mils.

Chain link fence fabric for filling the gate frame shall meet the requirements of Section 9-16.1(1)B for the fence type being furnished.

Cross trussing shall be $^{5}/_{16}$-inch steel adjustable rods galvanized in accordance with Section 9-16.1(1)D.

Each gate shall be furnished complete with necessary hinges, latch, and drop bar locking device designed for the type of gate posts and gate used on the project. Gates shall have positive type latching devices with provisions for padlocking. Hinges, latches, and locking devices shall be galvanized in accordance with Section 9-16.1(1)D.

Gate frames constructed of steel sections, other than pipe, that are fabricated in such a manner as to form a gate of equal or better rigidity may be used provided they are approved by the Engineer.

9-16.1(1)F Concrete

All concrete for chain link fence shall be as specified in Section 6-02.3(2)B.

9-16.1(2) Approval

Approval of materials for chain link fence shall be by evaluation of independent test results from a certified testing laboratory or by QPL. Independent test results for evaluation shall be submitted to the State Materials Engineer in Tumwater WA.

9-16.2 Wire Fence and Gates

9-16.2(1) General

All materials used in the construction of the wire fence shall be new. All iron or steel material shall be galvanized. Material upon which serious abrasions of galvanizing occur will not be acceptable.

9-16.2(1)A Steel Post Material

- **Round Post Material**

  Round post material shall conform to AASHTO M 181, Type I, Grade 1.

- **Angle Post Material** (Channel, T, U, Y, or Other Approved Style)

  All angle post material shall be hot-dipped galvanized in accordance with the requirements of AASHTO M 111 grade 75. Galvanizing shall be 1.7 oz/ft^2 of surface area. Angle post used for end, corner, gate and pull post and brace shall have a minimum weight of 3.1 lb/ft.

Posts shall be not less than 7-feet in length. A tolerance of -5% on the weight of individual posts, braces or anchor plates will be permitted. One type of line post shall be used throughout the project. Line posts shall be studded, slotted, or properly adapted for attaching either wire or mesh in a manner that will not damage the galvanizing of posts, wire or mesh during the fastening. Line posts shall have a minimum weight of 1.33 lbs/ft and shall be provided with a tapered galvanized steel anchor plate. The anchor plate shall be securely attached and have a surface area of 20 +/-2 in^2, a minimum weight of 0.67 pounds and 1.7 oz/ft^2 galvanizing.

9-16.2(1)B Wood Fence Posts and Braces

Douglas fir, Western red cedar, hemlock, or larch shall be used in the construction of wood fence posts and braces. The material shall be of good quality and approved by the Engineer before use. Peeler cores shall not be used for round posts. Wood fencing materials shall have sufficient sapwood in the outer periphery to obtain the specified penetration of preservative. Western red cedar will not require preservative treatment. Fencing materials shall be cut to the correct length before pressure treatment.

Line posts shall be 3-inch minimum diameter round posts or nominal 3-inch by 3-inch square sawed posts. If the posts are to be pointed for driving, they shall be pointed before treatment. Line posts shall be at least 7-feet in length.

Pull posts and brace posts shall be 6-inch diameter round posts or nominal 6-inch by 6-inch material not less than 7-feet in length.

End, gate, and corner posts, and posts at an intersecting fence shall be 6-inch diameter round posts or nominal 6-inch by 6-inch material not less than 7-feet 10-inches in length.

All sawed posts and timbers shall meet the requirements in the table under Section 9-09.2.

The preservatives used to pressure treat wood fencing materials shall meet the requirements of Section 9-09.3.

The retention and penetration of the preservative shall be as follows:

Minimum Retention in Pounds Per Cubic Foot		
Preservative	**Sawed Posts**	**Round Posts**
Creosote	10.00	8.00
Pentachlorophenol	0.50	0.40
ACA	0.40	0.40
ACZA	0.40	0.40
CCA	0.40	0.40

Minimum Penetration

for material 5” or less - 0.40-inches penetration and 90% of sapwood

for material 5” or greater - 0.50-inches penetration and 90% of sapwood

9-16.2(1)C Brace Wire

Brace wire shall be 9 gage wire galvanized to meet the requirements of AASHTO M 279, Type Z, Class 1.

9-16.2(1)D Staples and Wire Clamps

The staples used to attach the wire fencing to wood posts shall be 9 gage wire, $1^1/_2$-inches long, galvanized to meet the requirements of AASHTO M 279, Type Z, Class 1.

The wire clamps used to attach the wire fencing to steel posts shall be 11 gage wire, galvanized to meet the requirements of AASHTO M 279, Type Z, Class 1.

9-16.2(1)E Barbed Wire

Barbed wire shall conform to the requirements of AASHTO M 280, Type Z and shall consist of two strands of $12^1/_2$ gage wire, twisted with four point 14 gage barbs with barbs spaced 5-inches apart (Design 12-4-5-14R). Galvanizing shall be Class 3.

9-16.2(1)F Wire Mesh

Wire mesh shall conform to the requirements of AASHTO M 279, Type Z and shall consist of eight horizontal wires with vertical stays spaced 6-inches apart. The top and bottom wires shall be 10 gage, and the intermediate wires and vertical stays shall be $12^1/_2$ gage. The mesh shall have a total width of 32-inches (Design 832-6-$12^1/_2$). Galvanizing shall be Class 3.

The zinc coated wire as represented by the test specimens shall be capable of being wrapped in a close helix at a rate not exceeding 15 turns/minute around a cylindrical steel mandrel having a diameter the same as the specimen being tested, without cracking or flaking the zinc coating to such an extent that any zinc can be removed by rubbing with the bare fingers.

9-16.2(1)G Vertical Cinch Stays

Vertical cinch stays shall be 10 gage galvanized wire meeting the requirements of AASHTO M 279, Type Z, Class 1.

9-16.2(1)H Miscellaneous Hardware

Bolts, nuts, hinges, latches and other miscellaneous hardware shall be galvanized in accordance with AASHTO M 232.

9-16.2(1)I Wire Gates

Gate frames shall be constructed of galvanized pipe with a nominal diameter of not less than 1-inch. The pipe shall conform to the requirements of AASHTO M 181 Type I, Grade 1. Wire gates shall be not less than 48-inches in height and shall be designed to fit openings of the width called for in the Plans or as indicated by the bid items. Each gate shall be provided with two upright braces of the same material as the frame, spaced at $^1/_3$ points in the gate. All gates shall be provided with adjustable $^5/_{16}$-inch diameter galvanized diagonal truss rods from corner to corner. Galvanizing shall be in accordance with Section 9-16.2(1)H.

The gate frame shall be provided with wire mesh conforming to the requirements specified in Section 9-16.2(1)F, except that it shall consist of 10 horizontal wires and have a total width of 47-inches.

Each gate shall be furnished complete with necessary galvanized hinges and latch designed for use with the type of gate posts used on the project. The hinges shall be so designed as to be securely attached to the gate post and to enable the gate to be swing back against the fence. Double gates shall be hinged in the same manner as single gates and shall be provided with an approved galvanized drop bar locking device. Galvanizing for hinges, latches, and locking devices shall be in accordance with Section 9-16.2(1)H.

9-16.2(1)J Concrete

All concrete for wire fence shall be as specified in Section 6-02.3(2)B.

9-16.2(2) Approval

Approval of materials for wire fence shall be by evaluation of independent test results from a certified testing laboratory or by QPL. Independent test results for evaluation shall be submitted to the State Materials Engineer in Tumwater WA.

9-16.3 Beam Guardrail

9-16.3(1) Rail Element

The W-beam or thrie beams rail elements, backup plates, reducer sections, and end sections shall conform to "A Guide to Standardized Highway Barrier Hardware" published by AASHTO, AGC, and ARTBA. All rail elements shall be formed from 12 gage steel except for thrie beam reducer sections, thrie beams used for bridge rail retrofits, and Design F end sections, which shall be formed from 10 gage steel.

The rail splices shall have a minimum total ultimate strength of 80,000 pounds at each joint.

The 6-inch channel rails and splice plates shall conform to ASTM A 36, except that the channel rails may conform to ASTM A 992. All fabrication shall be complete before galvanizing.

The holes in the plate shall be slotted to facilitate erection and to permit expansion and contraction. The edges of the rail shall be rolled or rounded so they will present no sharp edges. Where the rail is on a curve, the plates at the splice shall make contact throughout the area of splice. When the radius of curvature is less than 150-feet, the rail shall be shaped in the shop.

9-16.3(2) Posts and Blocks

Posts and blocks may be of creosote treated timber, pentachlorophenol treated timber, waterborne chromated copper arsenate (CCA), ammoniacal copper arsenate (ACA), or ammoniacal copper zinc arsenate (ACZA), treated timber or galvanized steel; except only treated timber posts and blocks may be used for weathering steel beam guardrail.Blocks made from alternate materials that meet the NCHRP Report 350 criteria may be used in accordance with the manufacturer's recommendations. Except for terminal or anchor assemblies, all posts for any one project shall be of the same type (wood or steel). Posts and blocks shall be of the size and length shown in the Plans and meet the requirements of these Specifications. Posts and blocks may be S4S or rough sawn.

Timber posts and blocks shall conform to the grade specified in Section 9-09.2, except pine lumber No. 1 grade may be used for the blocks. Timber posts and blocks shall be fabricated as specified in the Plans before being treated. Timber posts and blocks shall be treated by the empty cell process to provide a minimum retention, depending on the treatment used, according to the following:

Creosote oil	12.0 lbs. pcf.
Pentachlorophenol	0.60 lbs. pcf.
ACA	0.50 lbs. pcf.
ACZA	0.50 lbs. pcf.
CCA	0.50 lbs.pcf.

Treatment shall be in accordance with Section 9-09.3.

Steel posts, blocks, and base plates, where used, shall conform to either ASTM A 36 or ASTM A 992, and shall be galvanized in accordance with AASHTO M 111. Welding shall conform to Section 6-03.3(25). All fabrication shall be completed prior to galvanizing.

9-16.3(3) Galvanizing

Beam rail elements and terminal sections shall be galvanized in accordance with AASHTO M-180, Class A, Type 2, except that the rail shall be galvanized after fabrication, with fabrication to include forming, cutting, shearing, punching, drilling, bending, welding, and riveting. In addition, the minimum average mass of zinc coating shall be 2 ounces per square foot of surface (not sheet), the average to be determined on the basis of three individual tests, no one of which may be less than 1.8 ounces per square foot of surface (not sheet). The aluminum content of the zinc bath during actual galvanizing operations shall not exceed 0.01 percent. Channel rails, splice plates, WF steel posts, and base plates shall be galvanized in accordance with ASTM A 123. Anchor cables shall be galvanized in accordance with Federal Specification RR-W-410, Table II, galvanized at finished size. Bolts, nuts, washers, plates, rods, and other hardware shall be galvanized in accordance with ASTM A 153.

9-16.3(4) Hardware

Bolts, unless otherwise specified, shall comply with ASTM A 307 Grade A specifications. High strength bolts shall conform to the requirements of AASHTO M 164. Nuts, unless otherwise specified, shall comply with ASTM A 563 Grade A specifications. Washers, unless otherwise specified, shall meet ASTM F 844 specifications. The Contractor shall submit a manufacturer's certificate of compliance for high strength bolts, nuts, and washers prior to installing any of the hardware. A307 Bolts will be accepted by field verification and documentation that bolt heads are stamped 307A.

9-16.3(5) Anchors

Welding shall conform to Section 6-03.3(25).

All welding shall be equal in strength to the parent metal.

All fabrication shall be complete and ready for assembly before galvanizing. No punching, drilling, cutting, or welding will be permitted after galvanizing unless authorized by the Engineer.

Foundation tubes shall be fabricated from steel conforming to the requirements of ASTM A 500, Grade B or ASTM A 501.

The anchor plate assembly shall develop a minimum tensile strength of 40,000 pounds.

The anchor plate, W8 x 18, and metal plates shall be fabricated of steel conforming to the specifications of ASTM A 36, except that the W8 x 18 may conform to ASTM A 992.

Anchor cable shall be ¾-inch preformed, 6 × 19 wire strand core or independent wire rope core (IWRC), galvanized, right regular lay manufactured of improved plow steel with a minimum breaking strength of 42,800 pounds. Two certified copies of mill test reports of the cable used shall be furnished to the Engineer.

Swaged cable fittings shall develop 100 percent of the specified breaking strength of the cable. One swaged fitting attached to 3-feet of cable shall be furnished to the Engineer for testing.

The swaged fitting and stud assembly shall be of steel conforming to the requirements of American Iron and Steel Institute C-1035 and shall be annealed and galvanized suitable for cold swaging.

All metal components of the anchor and cable assembly and not less than the top 14-inches of the W8 × 18 for the Type 2 anchor shall be hot-dip galvanized in accordance with Section 9-16.3(3).

Cement concrete shall conform to the requirements of Section 6-02.3(2)B.

Cement grout shall consist of one part Portland cement and two parts sand.

9-16.3(6) Inspection and Acceptance

The Contractor shall give notice to the Engineer before the rail elements are fabricated in order that inspections may be provided. The Contractor shall arrange for all facilities necessary for the inspection of material and workmanship at the point of fabrication of the rail element, and inspectors shall be allowed free access to necessary parts of the premises.

The Inspector shall have the authority to reject materials or workmanship which do not fulfill the requirements of these Specifications. In cases of dispute, the Contractor may appeal to the Engineer, whose decision will be final.

The Inspector may accept a mill test report certifying that the steel used in fabricating the rail element meets the requirements of the specifications. The Contracting Agency reserves the right, however, to require the Contractor to furnish samples of the steel proposed for use and to determine to its satisfaction that the steel meets the specification requirements. Steel rail elements, fittings, end section hardware, and bolts may be accepted by the Engineer based on the Manufacturer's Certification of Compliance.

9-16.4 Wire Mesh Slope Protection

9-16.4(1) General

All metal material used in the construction of wire mesh slope protection shall be new and galvanized. Imperfectly galvanized material or material upon which serious abrasion of galvanizing occurs will not be acceptable.

9-16.4(2) Wire Mesh

The galvanized wire mesh shall consist of No. 9 gage (0.148-inch diameter) commercial quality zinc coated steel wire, 3½-inches × 5½-inches diamond mesh chain link conforming to the requirements of AASHTO M 181. Galvanizing shall conform to the requirements of ASTM A 392 except the weight of zinc coating shall be 0.80 ounce per square foot minimum, of uncoated wire surface. Galvanizing shall be done before weaving.

The wire mesh fabric shall have knuckled selvages.

Alternate wire mesh for slope protection shall be double twisted mesh. The mesh shall be of nonraveling construction and consist of a uniform double twisted hexagonal mesh of hot-dip galvanized steel wire having a diameter of 0.120-inch after galvanization. The wire shall be galvanized prior to weaving into the mesh and shall conform to ASTM A 641, Class 3, Finish 5, Soft temper. The minimum tensile strength shall be 60,000 psi when tested in accordance with ASTM A 370. Openings shall be hexagonal in shape and uniform in size measuring not more than 3¼-inches by 4½-inches, approximately 9 square inches. Lacing wire shall be the same specifications as the wire used in the wire mesh except that its diameter shall be 0.0866-inch after galvanization.

Edges shall be mechanically selvaged in such a manner as to prevent unraveling, and shall develop the full strength of the mesh. The wire used for the selvage shall have a nominal diameter of 0.1535-inch.

9-16.4(3) Wire Rope

Wire rope shall be ⅝-inch diameter zinc coated steel structural wire rope conforming to the requirements of ASTM A 603, Class A.

9-16.4(4) Hardware

All rings shall be drop-forged steel, heat treated after forging. Lightweight wire rope thimbles weighing approximately 13.8 pounds per hundred shall be used with the ½-inch diameter wire rope. Wire rope clips may be drop-forged steel or cast steel for use with ½-inch wire rope. All rings, thimbles, wire rope clips, and U-bolts shall be galvanized in accordance with AASHTO M 232, Class C, except castings shall be Class A, and forgings shall be Class B.

9-16.4(5) Hog Rings and Tie Wire

Hog ring fasteners and tie wire shall be manufactured of 9 gauge steel wire meeting Federal specification QQ-W-461 (AISI numbers 1010 and 1015) finish 5; medium hardness and tensile strength; Class 3 coating.

9-16.4(6) Grout

When required, grout for anchors shall consist of one part Portland cement and three parts of clean sand. The Portland cement shall conform to the requirements of Section 9-01.2(1).

9-16.4(7) Anchor Rods

Anchor rods shall be of good quality steel. The eye may be drop forged or formed with a full penetration weld and shall develop 100 percent of the rod strength. The anchor rod shall be galvanized in accordance with ASTM A 153.

9-16.5 Vacant

9-16.6 Glare Screen

9-16.6(1) General

All material used in the construction of the fence shall be new. Iron or steel material shall be galvanized or aluminum coated as specified. Imperfectly galvanized or aluminum coated material, or material upon which serious abrasions of galvanizing or aluminum coating occur, will not be acceptable.

9-16.6(2) Glare Screen Fabric

Glare screen fabric shall consist of diamond woven wire mesh. The fabric wire may be 0.148-inch diameter aluminum alloy complying with the Aluminum Association requirements for alloy 6061T94, or it may be 0.148-inch diameter (9 gage) iron or steel wire which shall meet all of the requirements of ASTM A 392 galvanized or A 491 for aluminum coated, except that galvanizing of Type 2 glare screen fabric shall be not less than 0.8 ounce per square foot and shall be done before weaving. Aluminum coating shall be Class II.

Type 1 glare screen mesh size shall be approximately a 1-inch diamond. Type 2 glare screen mesh size shall be a maximum of 3½-inch vertical and 5½-inch horizontal. The design shall permit the slats to be installed in a vertical position as shown in the Plans without distortion of the slats.

9-16.6(3) Posts

Line posts for Type 1 glare screen shall be 1.5-inches by 1.875-inches hot-dip galvanized steel H column with a minimum weight of 2.8 pounds per linear foot. Line posts for Type 2 glare screen shall be 1.95-inches by 2.25-inches hot-dip galvanized steel H column with a minimum weight of 4.0 pounds per linear foot, or 2-inch inside diameter hot-dip galvanized steel pipe with a nominal weight of 3.65 pounds per linear foot provided only one type shall be used on any one project.

End, corner, brace, and pull posts shall be 2-inch inside diameter hot-dip galvanized steel pipe with nominal weight of 3.65 pounds per linear foot. Intermediate pull posts (braced line posts) shall be H column as specified for line posts. Brace post sleeves shall be 2½-inch inside diameter hot-dip galvanized steel pipe with nominal weight of 5.79 pounds per linear foot.

The base material for the manufacture of steel pipes used for posts shall conform to the requirements of ASTM A 53, except the weight tolerance on tubular posts shall be applied as provided below. The base material for the manufacture of steel H columns shall meet the requirements of ASTM A 675.

Posts provided for glare screen will have an acceptance tolerance on the weight per linear foot, as specified, equal to plus or minus 5 percent for tubular and H-section posts. This tolerance will apply to each individual post.

All posts, braces, and top rails shall be hot-dip galvanized. They shall have a minimum average of 1.8 ounces zinc coating per square foot of surface area with no individual test being below 1.6 ounces zinc coating per square foot of surface area. In the case of members made from pipe, this area is defined as the total area inside and outside. A sample for computing the average of mass of coating is defined as a 12-inch piece cut from each end of the galvanized member.

9-16.6(4) Tension Wire

Top and bottom tension wire shall be 7 gage coil spring steel wire of good commercial quality and shall have a zinc coating averaging 0.8 ounces per square foot of surface area.

9-16.6(5) Cable

The tension cable shall be ¼-inch diameter aluminum coated or hot-dip galvanized, 7 wire strand steel cable conforming to the requirements of ASTM A 474 for aluminum coated or A 475 for galvanized, High-Strength Grade. Galvanizing shall be Class A.

9-16.6(6) Cable and Tension Wire Attachments

All tension wire and cable attachments shall be hot-dip galvanized steel conforming to the requirements of AASHTO M 232 unless otherwise specified. Eye bolts shall have either a shoulder or a back-up nut on the eye end and be provided with an eye nut where needed or standard hex nut and lock washer and be ⅝-inch diameter for tension cable and ⅜-inch diameter for tension wire and of sufficient length to fasten to the type of posts used. Where the eye bolt is to be installed through a pipe section, two lead washers and one steel washer shall also be provided. Turnbuckles shall be of the shackle end type, ½-inch diameter, with standard take-up of 6-inches and provided with ⅜-inch diameter pins. Thimbles shall be light weight wire rope thimbles for use with ¼-inch diameter cable. Wire rope clips shall have a U-bolt diameter of 5⁄16-inch for use with ¼-inch diameter cable. Anchor shackles shall be ⅜-inch diameter with a minimum distance between eyes of 1 1⁄16-inches and a pin diameter of 7⁄16-inch. Seizing shall be 0.032-inch diameter galvanized annealed iron wire.

9-16.6(7) Slats

9-16.6(7)A Wood Slats

Wood slats shall be ⅜-inch by 2⅜-inch by the height designation of the fence. Material shall be finished and treated cedar or redwood and shall be free from loose knots, cracks, and other imperfections. A dimensional tolerance of plus or minus 1⁄16-inch in width or thickness is allowed provided that the maximum space between slats does not exceed ¾-inch.

9-16.6(7)B Plastic Slats

Plastic slats shall be ⅜-inch by 2⅜-inch by the height designation of the fence. They shall be manufactured from tubular polyethylene color pigmented material consisting of high density virgin polyethylene and color pigments, designed to retard ultraviolet penetration. The material shall have a minimum wall thickness of 0.0030-inch plus or minus 0.0003-inch and shall remain flexible without distortion and without becoming brittle through a temperature range of -70ºF to + 250ºF. Tensile strength shall be at least 3,600 psi and the melt index shall not exceed 0.25.

Plastic slats shall be retained in place by means of U-shaped retainer members at the bottom and top of the fence. Retainer members shall be of the same material as the slats.

The color for plastic slats will be approved by the Engineer from samples submitted by the Contractor or supplier.

9-16.6(8) Fittings

Fittings shall be malleable cast iron or pressed steel and galvanized in accordance with the requirements of AASHTO M 232.

Fittings for any particular fence shall be those furnished by the manufacturer of the fence.

9-16.6(9) Fabric Bands and Stretcher Bars

Fabric bands shall be ⅛-inch by 1-inch nominal and stretcher bars 3⁄16-inch by ¾-inch nominal. Nominal shall be construed to be the area of the cross section of the shape obtained by multiplying the specified width by thickness. A variation of minus 5 percent from this theoretical area shall be construed as “nominal” size. Both shall be hot-dip galvanized to meet the requirements of ASTM F 626.

9-16.6(10) Tie Wire

Tie wire shall be 9 gage aluminum wire complying with the ASTM B 211 for alloy 1100 H14 or 9 gage galvanized wire meeting the requirements of AASHTO M 279. Galvanizing shall be Class 1.

9-16.7 Vacant

9-16.8 Weathering Steel Beam Guardrail

9-16.8(1) Rail and Hardware

Steel for rail elements and terminal sections shall conform to ASTM A 606 or ASTM A 607. Bolts, nuts, and washers for installation of weathering steel shall meet the requirements of Section 9-16.3(4), and be galvanized in accordance with Section 9-16.3(3). If required, 6-inch channels and fittings shall conform to ASTM A 242. In addition, all steel for the guardrail components shall conform to one of the following chemical compositions, percent (ladle):

Composition

	C	Mn	P	S	Si	Cu	Cr	Ni	Zr
No. 1	0.12 Max.	0.20 to 0.50	0.07 to 0.15	0.05 Max.	0.25 to 0.75	0.25 to 0.55	0.30 to 1.25	0.65 Max.	
No. 2	0.12 Max.	0.50 to 1.00	0.12 Max.	0.05 Max.	0.20 to 0.90	0.50 Max.	0.40 to 1.00	1.00 Max.	0.10 Max.

Blast cleaning or pickling to remove mill scale will not be required. All fabricated steel parts shall be handled with care to avoid gouges, scratches, and dents. The steel shall be kept clean of all foreign material, such as paint, grease, oil, chalk marks, crayon marks, concrete spatter, or other deleterious substances. Natural oxidation of the steel will not be considered foreign material. Storage in transit, in open cars and trucks, for an extended period will not be permitted. Steel parts stored outside in yards or at job sites shall be positioned to allow free drainage and air circulation.

9-16.8(2) Anchors

Guardrail anchors may either be furnished as provided in Section 9-16.3(5) or they may be nongalvanized and fabricated from steel conforming to ASTM A 242 with the exception that all Type 1 anchors shall have galvanized cable and fittings as specified in Section 9-16.3(5).

9-17 FLEXIBLE GUIDE POSTS

9-17.1 General

Flexible guide posts shall be made of a flexible, nonwarping, nonmetallic, durable plastic material; shall be resistant to damage due to impact, ultraviolet light, ozone, hydrocarbons, and other effects of atmospheric weathering; shall resist stiffening with age; and shall exhibit good workmanship and be free of burns, discoloration, contamination and other objectionable marks or defects that affect appearance or serviceability. The portion of ground mounted guide post installed below ground may be the same material as the portion above ground or other durable material suitable for firmly anchoring the post in the ground. When iron or steel are used for the in ground portion, galvanize in accordance with AASHTO M 111. The top of tubular posts shall be closed to prevent moisture or debris from entering. Surface mounted guide posts shall be mounted on a base made of a rigid high impact resistant material and be resistant to ultraviolet light, ozone, and hydrocarbons. The post shall mount directly into or onto the base in a tamper proof manner and shall allow for easy replacement. Guardrail mounted guide posts shall be the same as ground mounted guide posts except the length shall be adjusted to meet the mounting height requirements in the Standard Plans. Appropriate holes shall be provided for fastening the guide post to the guard rail post.

The material composition of flexible guide posts subsequently furnished shall not vary from that of the samples upon which the State Materials Laboratory pre-approval is based. If analysis by the Materials Laboratory determines there is a change in material composition, such change shall constitute grounds for rejection and/or removal from the Qualified Products List.

The post system shall be designed for permanent installation to resist overturning, twisting, and displacement from wind and impact forces.

Each flexible guide post shall be permanently identified with the manufacturer's name, and the month and year of fabrication. Ground mounted guide posts shall have a permanent a mark indicating the recommended burial depth. The letters shall be solvent resistant, a minimum of ¼-inch in height, and permanently affixed to the post.

Unless otherwise specified, the color of the guide post shall be white or brown as indicated in the Plans.

The reflective panel on a flat or elliptical guide post shall have a minimum width of 3-inches facing traffic. The reflective sheeting shall have a minimum area of 24 square inches (3-inches by 8-inches). The reflective panel on a round guide post shall have an 8-inch minimum band of reflective sheeting visible for 360 degrees.

9-17.1(1) Dimensions

1. Flat Type – The post has a minimum width of 3-inches of continuous flat surface with no curvature for the entire length of the post. This will allow for ridges on the outer edges and back of post intended for structural support.
2. Tubular Type – The post is tubular or round/circular in shape. This allows for a tubular post with a minimum diameter of 3-inches or a tubular post with a minimum diameter of 2-inches with a flat or flattened oval surface at least 3-inches wide and 12-inches long measured from the top for mounting reflective sheeting.

3. Non-flat and Non-tubular Type – This includes all post that do not fit into the two types indicated above. This would include convex, w-shape, oval, and other post designs. The post shall be wide enough to accept a 3-inch wide reflective sheeting. Any curvature or rounding shall not significantly reduce the brightness value of the reflective sheeting.
4. Surface Mount Guide Post Base – The base for surface mount guide posts shall be approximately 8-inches in diameter with a maximum height of 2-inches.
5. Guide posts shall be of such length to provide the required mounting height above the pavement surface in accordance with the Standard Plans.

9-17.1(2) Reflective Sheeting

Reflective sheeting for guide posts shall be Type III, IV, V, or VII conforming to Section 9-28.12. The reflective panel on a flat or elliptical guidepost shall have a minimum width of 3-inches facing traffic. The reflective sheeting shall have a minimum area of 24 square inches (3-inches by 8-inches). The reflective panel on a round guidepost shall have an 8-inch minimum band of reflective sheeting visible for 360 degrees. Mount the reflective sheeting on the guide post as detailed in the Standard Plans. Sheeting shall remain in place during the life of the post.

9-17.2 Ultraviolet Resistance Test Procedure (Laboratory Test)

Two posts will be tested initially for tensile strength and elongation according to ASTM D-638 and again after 1,000 hours QUV weatherometer exposure (ASTM G53).

Six bow tie specimens shall be prepared from the delineator post samples submitted for the purpose of ultraviolet (UV) exposure. The specimens shall be cycled at 1,000 hours in a weatherometer in accordance with ASTM G 53 (3 hr. 60C UV, 3 hr. 50C CON). Three of each type shall be used for control purposes. The remaining three shall be subjected to 1000 hours of UV exposure in the QUV weatherometer. Specimen dimensions conform to those outlined below.

The laboratory test data shall summarize the tensile strength of each, and the average tensile strength for both control and weathered samples. The data shall also summarize the elongation of each, and the average elongation for both control and weathered samples. The average values shall be used to show the percent change in tensile and elongation.

9-17.2 (1) Acceptance

The specimens shall show no signs of delamination, distress, or discoloration. Physical properties of tensile strength and rigidity shall be maintained within 80 percent of the unconditioned values.

9-17.3 Field Impact Test Procedure

Sample size of eight units will be tested the following way:

Flexible Ground Mounted Posts

Eight flexible ground mounted posts installed by the manufacturer (four installed manually and four installed mechanically). The delineators will be hit ten times (four posts for glancing bumper hits and four posts for wheel hits). A standard sedan with a bumper height of approximately 18” while traveling at a speed of 55 ± 2 mph will be used for impact testing. Five of the impacts will be at an ambient temperature of 32 ± 5°F and the remaining five impacts at an ambient temperature of 85 ± 5°F. The test vehicle shall impact four of the posts at an angle perpendicular to the front of the post

and shall impact the remaining posts at an angle of 25 degrees clockwise from the angle perpendicular to the front of the posts. The same test samples will be used for the ten hits. Two flexible posts will be used for weatherometer testing. A glancing hit is defined as one on the bumper near the vehicle headlight. The delineators shall be installed a minimum of eight hours prior to being hit.

Flexible Surface Mounted Posts

Eight flexible surface mounted posts installed by the manufacturer will be hit ten times (four posts for glancing bumper hits and four posts for wheel hits). A standard sedan with a bumper height of approximately 18" while traveling at a speed of 55 ± 2 mph will be used for impact testing. Five of the impacts will be at an ambient temperature of 32 ± 5°F and the remaining five impacts at an ambient temperature of 85 ± 5°F. The test vehicle shall impact four of the posts at an angle perpendicular to the front of the post and shall impact the remaining posts at an angle of 25 degrees clockwise from the angle perpendicular to the front of the posts. The same test samples will be used for the ten hits. Two flexible posts will be used for weatherometer testing. A glancing hit is defined as one on the bumper near the vehicle headlight. The delineators shall be installed a minimum of eight hours prior to being hit.

9-17.3 (1) Test Observations

Inspect each post after each impact and document the following:

1. Any splits, cracks, breaks or other forms of deformation or distress;
2. The percent list to vertical two minutes after each impact;
3. The approximate percentage of the reflective area that is damaged after each impact to an extent it no longer performs as intended;
4. Any problems or comments associated with the installation and removal of the posts and bases. The testing agent will document any special equipment or techniques required for installing or removing the posts and bases.
5. Any problems or comments associated with the performance of each ground mounted flexible delineator post that would be of interest to the states;
6. Type of soil and impact surface.

9-17.3 (2) Acceptance

A failure is defined as any of the following:

1. A minimum of 50 percent of the reflective sheeting shall be retained undamaged. An area of damage greater than 50 percent is considered a failure.
2. If the guide post leans more than 10 degrees from vertical it is considered a failure.
3. Any cracking, other than surface cracking evident on only one face of the post, is considered a failure.
4. Pullout in excess of 3-inches is considered a failure.

At least six of the guide posts must pass each criteria in the 55 ± 2 miles per hour series of impacts to be acceptable

9-17.4 Pre-approval

In order for a particular model of flexible guide post to become pre-approved, the following conditions must be met:

1. The manufacturer must submit a written request for pre-approval along with samples for each model to be tested to: State Materials Engineer, Department of Transportation Materials Laboratory, P.O. Box 47365, Olympia, WA 98504-7365. Requests shall identify the model for which approval is being requested. Samples shall be complete with reflective panel attached, and shall be accompanied by the manufacturer's written installation procedures.
2. The guide posts will be field impact tested by the State Materials Laboratory to verify compliance with these specifications.
3. In lieu of State Materials Laboratory testing, the Lab will accept the results of pre-approved testing performed by the manufacturer or other agencies under the following conditions:
    a. The State Materials Laboratory is informed of the pre-approval testing sufficiently in advance in order to attend and observe. Attendance will be at the discretion of the Materials Laboratory.
    b. The results of the testing shall be reported in sufficient detail to enable the State Materials Laboratory to evaluate compliance with these specifications.
4. The manufacturer must submit a certified test report, including test data developed by an approved testing laboratory, which demonstrates that the guide post complies with the requirements of these specifications. Certified test data supplied by the manufacturer shall be subject to verification by appropriate tests conducted by the State Materials Laboratory.

Frequency of field testing, evaluation, and pre-approval updating shall be at the sole discretion of the State Materials Laboratory.

9-18 PRECAST TRAFFIC CURB AND BLOCK TRAFFIC CURB

9-18.1 Precast Traffic Curb

9-18.1(1) Aggregates and Proportioning

The cement, fine and coarse aggregate, and reinforcing steel to be used in the manufacture of precast concrete traffic curb shall meet the following requirements:

1. Portland cement shall conform to the requirements of Section 9-01 except that it may be Type I Portland cement conforming to AASHTO M 85.
2. Aggregates shall conform to the requirements of Section 9-03 except that they shall be uniformly graded up to a maximum size of $^{3}/_{8}$-inch and shall contain sufficient fine fractions to permit securing the type of surface finish specified herein. The aggregate shall be approved by the Materials Laboratory before it is used.
3. Reinforcing steel shall conform to the requirements of Section 9-07.1.
4. The cement concrete mix shall be composed of not less than 1 part Portland cement to approximately 2 parts of fine aggregate and $3^{1}/_{4}$ parts of coarse aggregate adjusted to secure proper workability. The Contractor will be allowed to use a different concrete mix if approved by the Engineer, provided that it develops not less than 4,000 psi compressive strength when tested at the age of 28 days.

9-18.1(2) Mixing

The mixers shall be kept in good repair and be equipped with an automatic timing device and a positive device for regulating the quantity of water added to each batch. Such a device must be approved by the Engineer before use.

After all materials, including water, have been placed in the mixer, the materials shall be mixed for a period of not less than $1^{3}/_{4}$ minutes, or as much longer as may be necessary to produce a thorough and uniform mixture of the concrete. No water shall be added to any batch after the completion of the initial mixing period. Each batch of concrete shall be completely emptied from the mixer before placing more materials in it. A batch which has not been placed within 30 minutes from the time water was first added shall not be used.

The amount of water in the concrete shall be kept at a minimum consistent with the manufacture of dense curb, free from air bubbles and surface defects in excess of the tolerance limits specified.

9-18.1(3) Forms

Forms shall be of concrete or steel. The use of forms or molds made of plaster of paris, wood, or other absorptive material will not be permitted.

Bulkheads shall be tight fitting so that there is no leakage of mortar between the bulkhead and form.

The materials and methods used for lubricating the forms shall be such that they will not result in discoloration of the curb at any time. A minimum quantity of lubricant shall be used and all excess lubricant shall be removed.

9-18.1(4) Placing Concrete

The concrete shall be consolidated by external vibration, or by other means if approved by the Engineer, to produce a dense concrete throughout, having a minimum of air bubbles and honeycombing.

Reinforcing steel shall be placed and maintained in its proper position as shown in detail drawings.

Curb or buttons shall not be manufactured in an atmospheric temperature of less than 50ºF.

9-18.1(5) Removal of Forms

The curb shall be removed from the molds or forms in accordance with the instructions or by some other method acceptable to the Engineer.

The loosening of the curb from the molds shall be carefully performed to avoid excessive shock and straining of the curb. When, in the opinion of the Engineer, undue shock is required to remove the curb from the molds, the stripping operation shall be deferred until such time as the curb may be removed without breakage.

9-18.1(6) Curing Concrete

Immediately after the concrete has been placed and consolidated in the mold, each unit shall be placed in a curing room fitted with water sprays and maintained at a relative humidity of not less than 90 percent and a temperature of not less than 60ºF, nor more than 100ºF. Each unit shall remain in the curing room for a period of not less than 10 days, except that if Type III cement is used, the period in the curing room may be reduced to 5 days.

9-18.1(7) Finish

The curb shall have a smooth, glassy finish on all exposed surfaces.

Excess honeycombing in the back of the curb may be cause for rejection of the curb. Honeycombing areas in the back of the curb which, in the opinion of the Engineer, are not detrimental to the curb need not be patched. The workmanship of the bottom finish shall be such that no mechanical interlocking of the mortar bed and the curb bottom or anchor groove will occur.

9-18.1(8) Surface Treatment

As soon as the units have been taken out of the curing room and thoroughly surface dried to a depth of at least $^1/_4$-inch, two coats of a water repellent compound, meeting the requirements of Section 9-18.4, shall be brush applied. When the first coat has dried, the second coat of water repellent compound shall be applied.

9-18.1(9) Dimensions and Shape

The curb shall conform to the dimensions and shape shown in the Plans within a tolerance of $^1/_4$-inch in length and $^1/_8$-inch in alignment.

9-18.1(10) Curb Lengths

Curb lengths shall be in accordance with the Standard Plans, except in special cases where different lengths are specified. Circular curbing shall be made only for such radii as called for in the detail plans.

9-18.1(11) Defective Curb

Not more than 2 percent of the top area in any one piece of curb shall be defective, and not more than 5 percent of the total length of the top corners of reflecting faces in any one piece of curb shall be broken or rounded. There shall be not more than 50 holes in any linear foot of curb. All curb having defects in excess of any of the above will be rejected immediately upon inspection after removal from the forms. However, failure to reject the curb at that time will not ensure its final acceptance. Ninety percent of the curb laid shall not have more than 10 percent of the maximum allowable number of defects specified above.

An air hole shall be defined as any hole $^1/_8$-inch or larger in diameter or depth.

All defects within the limits permitted, apparent upon removal of forms, shall be repaired immediately.

The sum of the length of the lines of discoloration caused by a cracked mold in any one piece of curb shall not exceed 50 percent of the length of the curb, and the maximum length of any single line of discoloration shall not exceed 18-inches. 75 percent of the curb laid shall be entirely free from lines of discoloration. The employment of heat to obliterate lines of discoloration will not be permitted. The process used to obliterate lines of discoloration shall be subject to the approval of the Engineer.

The repairing of molds which are chipped or broken shall be done in a manner that the broken or chipped areas will not be apparent on the curb made in those molds.

All curb in which surface checking develops during the first five days after manufacture will be rejected.

Hidden air holes at or immediately below the exposed surface of the curb, in excess of the limits specified that are disclosed by testing the surface by means of a rubber hammer will be cause for rejection of the curb.

All curb in which cracking is in evidence immediately after removal from the molds will be rejected. A crack is defined as any separation of the concrete of a continuous length greater than 3-inches.

All curb which varies in dimensions, alignment, or surface contour in excess of the tolerance specified will be rejected.

Failure to comply with the plans, specifications, or instructions of the authorized representative of the Contracting Agency in the manufacture and laying of any curb will be cause for rejection of such curb.

9-18.1(12) Repairing Curb

Curb having defects which are not sufficient cause for its rejection shall be neatly repaired immediately after removal from the molds in a manner subject to the approval of the Engineer. However, no patching or other repairs shall be made without the permission of the Engineer. Patches shall be undercut if, in the opinion of the Engineer, this operation is necessary to achieve a satisfactory patch.

All holes larger than $^1/_{16}$-inch diameter in the exposed surface of acceptable curb or buttons shall be filled with cement mortar.

9-18.1(13) Identification Marking

The date of manufacture, the length, and identification number corresponding to the detail layout shall be marked in black paint on the back or end of each piece of curb.

Rejected curb shall be marked on the back or end surfaces in a practical and semi-permanent manner to identify each cause of rejection.

9-18.1(14) Shipping

No unit of curb shall be shipped from the manufacturing plant prior to 21 days after manufacture, except, however, that if Type III cement has been used, the units may be shipped 14 days after manufacture.

9-18.1(15) Sampling and Inspection

The Contractor shall submit, for the approval of the Engineer, an advance sample of curb which shall be at least equivalent in color, surface texture, and bottom finish to the standard as set forth in these Specifications. No repairing of any kind shall be done on the advance sample. Upon approval, the advance sample shall be stored at the plant or site of manufacture in a location readily accessible to the Inspector where there is adequate daylight for examination. The advance sample shall be protected from damage and discoloration and shall be used as a standard of comparison for color, surface texture, and bottom finish for all curb manufactured. All curb furnished shall be equivalent in the foregoing respects.

The inspection at the plant will be made just prior to shipment, at which time examination will be made of the alignment, contour, color, cracks, surface damage or discoloration, broken corners or edges, and any other defects which may have developed, and to check the laboratory test reports for strength. However intermediate inspections may be made to determine surface checking and hidden air holes if it is impractical to examine for these defects at the final inspection.

9-18.2 Vacant

9-18.3 Block Traffic Curb

In construction of the block traffic curb, the Contractor shall have the option of using either length block shown in the plans, provided the same length block is used throughout the entire project.

The curb units shall be made from Portland cement and high quality sand and gravel, the proportions of which will be left to the discretion of the producer as long as the unit develops a minimum compressive strength of 1,600 psi at 28 days when tested for end loading.

The proportions of sand, gravel, and cement, the type of forms used, and the method of compacting the concrete in the forms shall all be such that as dense, smooth, and uniform a surface as is practicable for a concrete masonry unit is obtained on the finished curb units. The faces that are to be exposed shall be free from chips, cracks, air holes, honeycomb, or other imperfections except that if not more than 5 percent of the curb units contain slight cracks, small chips not larger than $^1/_2$-inch, or air holes not more than $^1/_2$-inch in diameter or depth, this shall not be deemed grounds for rejection. The units used in any contiguous line of curb shall have approximately the same color and surface characteristics.

9-18.4 Water Repellent Compound

The water repellent compound shall be a clear, penetrating type, silicone resin base compound containing no filler or other material which will leave a film on the surface of the masonry after it is applied. It shall be of such consistency that it can be applied readily by brush or spray to the masonry at atmospheric temperature down to -20ºF.

The average absorption of three test specimens treated with the water repellent compound, when tested in accordance with the methods used in the State Materials Laboratory, shall not exceed 2 percent after being partially immersed in water for 72 hours immediately after curing.

The average moisture vapor transpiration (breathing) of three test specimens, when tested in accordance with the methods used in the State Materials Laboratory, shall be not less than 50 percent at seven days.

The water repellent compound shall be approved by the State Materials Laboratory before it is used.

9-18.5 Sodium Metasilicate

Sodium metasilicate shall comply with ASTM D 537.

9-19 PRESTRESSED CONCRETE GIRDERS

9-19.1 Aggregates and Proportioning

The concrete for prestressed girders shall have the minimum compressive strengths as specified in the Plans. Aggregates used in the mix shall conform to the following: Coarse aggregate shall be in accordance with Section 9-03.1(4); and fine aggregate shall be in accordance with Section 9-03.1(2), Class I or Class II. The manufacturer may revise the grading of the coarse aggregate provided that the concrete mix design is qualified with the modified gradation.

The Contractor shall submit for approval a proposed mix design for each design strength. Included shall be evidence satisfactory to the Engineer that the proposed mix design will meet design requirements. Approval of the mix design will not preclude any requirements for the concrete placed in the girders.

The concrete mix shall be prepared and placed in accordance with the appropriate sections of Section 6-02.

Water used in mixing the concrete shall conform to the requirements of Section 9-25.1.

Cement shall conform to the requirements of Section 9-01.

Chemical admixtures shall conform to the provisions of Section 9-23.7.

The total chloride ion (C1-) content of the mixed concrete, expressed as a percent by mass of cement, shall not exceed 0.06 percent.

9-19.2 Reinforcement

Reinforcement shall meet the requirements of Section 9-07 and shall be placed in accordance with the requirements of Section 6-02.3(24).

9-20 CONCRETE PATCHING MATERIAL

9-20.1 Patching Material

Concrete patching material will be prepackaged mortar extended with aggregate. The amount of aggregate for extension shall conform to the manufacturer's recommendation.

9-20.2 Specifications

Patching mortar and patching mortar extended with aggregate shall contain cementitious material and meet the requirements of Sections 9-20.2(1) and 9-20.2(2). The Manufacturer shall use the services of a laboratory that has an equipment calibration verification system and a technician training and evaluation process per AASHTO R-18 to perform all tests specified in Section 9-20.

9-20.2(1) Patching Mortar

Patching mortar shall conform to the following requirements:

Patching Mortar	ASTM Test Method	Specification
Compressive Strength		
at 3 hours	C 39	Minimum 3,000 psi
at 24 hours	C 39	Minimum 5,000 psi
Length Change		
at 28 days	C 157	0.15 percent maximum
Total Chloride Ion Content	C 1218	1 lb/yd3 maximum
Bond Strength		
at 24 hours	C 882 (As modified by C 928, Section 8.5)	Minimum 1,000 psi
Scaling Resistance (at 25 cycles of freezing and thawing)	C 672 (As modified by C 928, Section 8.4)	1 lb/ft2 maximum

9-20.2(2) Patching Mortar Extended with Aggregate

Patching mortar extended with aggregate shall meet the following requirements:

Patch Mortar Extended with Aggregate	ASTM Test Method	Specification
Compressive Strength		
at 3 hours	C 39	Minimum 3,000 psi
at 24 hours	C 39	Minimum 5,000 psi
Length Change		
at 28days	C 157	0.15 percent maximum
Bond Strength		
at 24 hours	C 882 (As modified by ASTM C 928, Section 8.5)	Minimum 1,000 psi
Scaling Resistance (at 25 cycles of freezing and thawing)	C 672	2 Maximum Visual Rating
Freeze thaw	C 666	Maximum expansion 0.10% Minimum durability 90.0%

9-20.2(3) Aggregate

Aggregate used to extend the patching mortar shall meet the requirements of Section 9-03.1(4) and be AASHTO Grading No. 8. A Manufacturers Certificate of Compliance shall be required showing the aggregate source and the gradation. Mitigation for Alkali Silica Reaction (ASR) will not be required for the extender aggregate used for concrete patching material.

9-20.2(4) Water

Water shall meet the requirements of Section 9-25.1. The quantity of water shall be within the limits recommended by the manufacturer

9-21 RAISED PAVEMENT MARKERS (RPM)

9-21.1 Raised Pavement Markers Type 1

Markers Type 1 shall be plastic or thermoplastic markers composed of thermosetting resins, pigments, and inert ingredients and be of uniform composition. Markers shall not contain glass.

9-21.1(1) Physical and Chemical Properties

The markers shall be of uniform composition and free from surface irregularities, cracks, checks, chipping, peeling, spalling, crazing, and other physical damage interfering with appearance, application, or durability.

The markers shall be precast in the form of a single based spheroidal segment terminating in a rounded or squared shoulder. Markers shall be white or yellow.

The markers shall meet the following requirements:

Property	Unit	Thermoplastic Markers	Plastic Markers
Mass	grams	N/A	125 min.
Height	inches	0.65-0.78	0.65-0.78
Diameter/Width	inches	3.85-4.05	3.85-4.05
Shoulder height	inches	0.08-0.22	0.08-0.22
Planeness of base:			
Concavity	inches	0.05 max.	0.05 max.
Convexity	inches	0.05 max.	0.05 max.
Reflectance (white only)	%MgO	80 min.	80 min.
Impact resistance	inch-pound	15 min.	15 min.
Titanium Dioxide (white only)	% by weight	N/A	21 min.

The markers passing laboratory tests will be field tested for approval. The field tests will include installation with control markers to determine relative adhesion and durability characteristics.

9-21.2 Raised Pavement Markers Type 2

The marker housing shall contain reflective faces as shown in the Plans to reflect incident light from either a single or opposite directions.

9-21.2(1) Physical Properties

The markers shall be not less than 4.0-inches nor more than 5.0-inches in width, and not more than 0.75-inch in height.

The outer surface of the marker housing shall be smooth except for the purpose of identification.

The base of the markers shall be substantially free from gloss or substances that may reduce its bond to adhesive.

The markers passing laboratory tests will be field tested for approval. The field tests will include installation with control markers to determine relative adhesion and durability characteristics.

9-21.2(2) Optical Requirements

1. **Definitions:** Horizontal entrance angle shall mean the angle in the horizontal plane between the direction of incident light and the normal to the leading edge of the marker.

   Observation angle shall mean the angle at the reflector between observer's line of sight and direction of the light incident on the reflector.

   Specific intensity (S.I.) shall mean candle power of the returned light at the chosen observation and entrance angles for each foot-candle of illumination at the reflector on a plane perpendicular to the incident light.

2. **Optical Requirements:** The specific intensity of each reflecting surface at 0.2 degrees observation angle shall be not less than the following when the incident light is parallel to the base of the marker.

Hor. Ent. Angle	S.I.
0	3.0
20	1.2

   Yellow reflectors shall be not less than 60 percent and red reflectors not less than 25 percent of the above values.

3. Optical Testing Procedure: a random lot of markers will be tested. The markers to be tested shall be located with the center of the reflecting face at a distance of 5-feet from a uniformly bright light source having an effective diameter of 0.2-inch.

   The photocell width shall be 0.05-inch. It shall be shielded to eliminate stray light. The distance from light source center to the photocell center shall be 0.21-inch. If a test distance of other than 5-feet is used, the source and receiver dimensions and the distance between source and receiver shall be modified in the same proportion as the test distance.

   Failure of more than 4 percent of the samples shall be cause for rejection of the lot.

9-21.2(3) Strength Requirements

Markers shall support a load of 2,000 pounds as applied in the following manner:

A marker shall be centered over the open end of a vertically positioned hollow metal cylinder. The cylinder shall be 1-inch high with an internal diameter of 3-inches and wall thickness of $^1/_4$-inch. The load shall be slowly applied to the top of the marker through a 1-inch diameter by 1-inch high metal plug centered on the top of the marker.

Failure shall constitute either a breakage or significant deformation of the marker at any load of less than 2,000 pounds.

9-21.3 Raised Pavement Markers Type 3

Raised pavement markers Type 3 shall be extruded from high impact thermoplastic material which has been ultra-violet radiation stabilized and shall meet the following requirements:

Impact resistance	15-inch-lbs., min.
Reflectance (White Only)	80% min.
Concavity & Convexity	
Transverse	$^{1}/_{16}$-inch, max.
Longitudinal	$^{1}/_{8}$-inch, max
Base Width	4″
Length	6″, 8″, 10″ or 12″
Height	0.60-0.75″
Shoulder height	0.08-0.20

The ends shall be beveled from the top of the shoulder edge at a slope of 1:1 nominal.

9-22 MONUMENT CASES

9-22.1 Monument Cases, Covers, and Risers

Castings for monument cases, covers, and risers shall be gray iron castings conforming to the requirements of AASHTO M 105, Class 30B. The cover and seat shall be machined so as to have perfect contact around the entire circumference and full width of bearing surface. Dipping, painting, welding, plugging, or repairing defects will not be permitted.

9-23 CONCRETE CURING MATERIALS AND ADMIXTURES

9-23.1 Sheet Materials for Curing Concrete

Sheet materials for curing concrete shall meet the requirements of AASHTO M 171, Sheet Materials for Curing Concrete, except that only white reflective type shall be used.

9-23.2 Liquid Membrane-Forming Concrete Curing Compounds

Liquid membrane-forming compounds for curing concrete shall conform to the requirements of AASHTO M 148 (ASTM C 309) Type 1D or 2, Class A or B, except that the moisture loss when tested in accordance with WSDOT Test Method 814 shall be 2.50 grams for all applications.

Each lot of liquid membrane-forming curing compound shall be sampled at the project site and tested for acceptance. Liquid membrane-forming curing compound shall not be used in the absence of satisfactory test results.

9-23.3 Vacant

9-23.4 Vacant

9-23.5 Burlap Cloth

Burlap cloth shall meet the requirements of AASHTO M 182, Class 4.

9-23.6 Admixture for Concrete

Admixtures for use in concrete shall meet the following specifications:

Admixture	Specification	
Air-entraining	AASHTO M 154	ASTM C 260
Water Reducing	AASHTO M 194 Type A	ASTM C 494 Type A
Set Retarding	AASHTO M 194 Type B	ASTM C 494 Type B
* Accelerating	AASHTO M 194 Type C	ASTM C 494 Type C
Water Reducing/ Set Retarding	AASHTO M 194 Type D	ASTM C 494 Type D
* Water Reducing/	AASHTO M 194 Type E	ASTM C 494 Type E
Accelerating High Range Water Reducing	AASHTO M 194 Type F and G	ASTM C 494 Type F and G

* Accelerating admixtures are only allowed in Portland Cement Concrete Pavement per Section 5-05, Cement Concrete Pavement and Section 5-05.3(1) Concrete Mix Designs for Paving.

In addition to the above specifications, admixtures proposed for use shall contain less than one percent chloride ion (Cl-) by weight of admixture and only non-chloride accelerating admixtures shall be used.

Acceptance of admixtures will be based on Manufacturer's Certificate of Compliance.

If required by the Engineer, admixtures shall be sampled and tested before they are used.

Samples shall be submitted for testing 10 days prior to use.

9-23.7 Air Entraining and Chemical Admixtures for Precast Prestressed Concrete

Air entraining admixture shall meet the requirements of AASHTO M 154. Acceptance will be on the basis of a Manufacturer's Certification of Compliance.

If required by the Engineer, the air entraining admixture shall be sampled and tested by the Materials Laboratory before use.

Chemical admixtures shall conform to the requirements of AASHTO M 194, Type A, B, D, or F. Approval of specific admixture products shall be required as a part of the annual approval of prestressed fabricators. Chloride ion content of chemical admixtures shall not exceed one percent by weight.

Acceptance will be on the basis of a Manufacturer's Certification of Compliance.

If required by the Engineer, the admixture shall be sampled and tested by the Materials Laboratory before use.

9-23.8 Waterproofing

Concrete made with waterproofing admixtures shall have a percent absorption after immersion and boiling of less than 5.0 percent at seven days and a volume of permeable voids less than 11.0 percent at seven days per ASTM C 642. The Contractor shall submit evidence in the form of test results showing compliance with these specifications, when they submit their concrete mix design.

If the concrete requires air entrainment, the Contractor shall also submit evidence to the Engineer that the admixture will not adversely effect the air void system of the hardened concrete. Test results complying with ASTM C 457 shall be provided as evidence to satisfy this requirement.

9-23.9 Fly Ash

Fly ash shall conform to the requirements of AASHTO M 295 Class C or F including optional chemical requirements as set forth in Table 2 and with a further limitation that the loss on ignition shall be a maximum of 1.5 percent.

9-23.10 Ground Granulated Blast Furnace Slag

Ground granulated blast furnace slag shall meet the requirements of AASHTO M 302, Grade 100 or Grade 120. The grade of the ground granulated blast furnace slag, the source, and type of manufacturing facility shall be certified on the cement mill test certificate.

9-23.11 Microsilica Fume

Microsilica Fume shall conform to the requirements of AASHTO M 307. The optional physical requirement for Reactivity with Cement Alkalies set forth in Table 3 will be required when Microsilica Fume is being used as an ASR mitigation measure.

9-24 PLASTIC WATERSTOP

9-24.1 Material

The waterstops shall be fabricated from a plastic compound, the basic resin of which shall be polyvinyl chloride. The compound shall contain any additional resins, plasticizers, inhibitors, or other material such that when the material is compounded, it shall meet the performance requirements given in these Specifications.

Single-pass reworked material of the same composition generated from the fabricator's waterstop production may be used. No reclaimed polyvinyl chloride shall be used.

All waterstops shall be molded or extruded in such a manner that any cross section will be dense, homogeneous, and free from porosity and other imperfections.

The waterstops shall be symmetrical in shape, nominal 4-inches in width, by $^{3}/_{16}$-inch thick, and a minimum of four ribs on each side of the bulb. The bulb thickness and diameter shall be as noted in the plans.

9-24.1(1) Tests of Material

The waterstops shall meet all of the physical and other test requirements of this material as defined in the Corps of Engineers Specifications for Polyvinyl Chloride Water Stop CRD-C572, except that the tear resistance of the material shall be not less than 160 pounds per inch. The Contractor shall furnish such sample material as required by the Engineer for the purpose of making tests.

9-25 WATER

9-25.1 Water for Concrete

Water for mortar or concrete shall be clear and apparently clean. If the water contains substances that cause discoloration, unusual or objectionable smell or taste, or other suspicious content, the Engineer may require the Contractor to provide test results documenting that the water meets the physical test requirements and chemical limits described in ASTM C94M Section 5.1.3, Tables 2 and 3.

Water from mixer washout operations may be used in concrete provided it meets or exceeds the above criteria as well as the following additional requirements:

1. Concrete with water from mixer washout operations shall not be used in bridge roadway deck slabs, flat slab bridge superstructures, modified concrete overlays, or prestressed concrete.
2. Specific Gravity shall not exceed 1.07.
3. Alkalies, expressed as [Na2O+0.658 K2O], shall not exceed 600 ppm.
4. Shall be free of coloring agents.
5. If the wash water contains admixtures from different manufacturers, the Contractor shall provide evidence that the combination of admixtures are compatible and do not adversely affect the air void system of the hardened concrete as per Section 6-02.3(3).
6. All tests to verify that the physical and chemical requirements are met, shall be conducted on the following schedule:
   a. The physical requirements shall be tested on weekly intervals for four weeks and thereafter on monthly intervals.
   b. The chemical requirements shall be tested on monthly intervals.
   c. The specific gravity shall be determined daily in accordance with ASTM D 1429, Test Method D.

The Contractor shall use the services of a Laboratory that has a equipment calibration/verification system, and a technician training and evaluation process per AASHTO R-18 to conduct all tests. The laboratory shall use testing equipment that has been calibrated/verified at least once within the past 12 months to meet the requirements of each test procedure in accordance with the appropriate section of AASHTO R-18. Documentation of tester qualifications and equipment verification records shall be maintained and available for review by the Contracting Agency upon request. Agency reviews of the laboratory facility, testing equipment, personnel, and all qualification, calibration, and verification records will be conducted at the Contracting Agency's discretion.

9-25.2 Water for Plants

Water for plants shall not contain dissolved or suspended matter which will be harmful to the plant material on which it is to be used.

9-26 EPOXY RESINS

9-26.1 Epoxy Bonding Agents

9-26.1(1) General

Epoxy bonding agents shall be 2-component epoxy resin-base systems that meet the requirements of ASTM C 881, shall be furnished in the type, grade, and class specified, and shall meet the requirements below. When not specified, an appropriate grade and class shall be selected for the particular application. Epoxy bonding agents for patching external concrete shall be concrete-gray in color.

9-26.1(1)A Type I and Type IV

Epoxy bonding agents used for bonding hardened concrete to hardened concrete and other materials shall be Type I for non-load bearing applications and Type IV for load bearing applications.

9-26.1(1)B Type II and Type V

Epoxy bonding agents used for bonding freshly mixed concrete to hardened concrete shall be Type II for non-load bearing applications and Type V for load bearing applications.

9-26.1(1)C Type III

Epoxy bonding agents used for bonding skid-resistant materials to hardened concrete and as a binder in epoxy mortars and epoxy concretes used on traffic bearing surfaces shall be Type III.

9-26.1(2) Packaging and Marking

The components of the epoxy system furnished under these Specifications shall be supplied in separate containers that are non-reactive with the materials contained. The contents of each container shall be such that when the container contents are combined, a properly proportioned final mixture results.

Containers shall be identified as “Component A” (Contains the Epoxy Resin) and “Component B” (Contains the Curing Agent) and shall show the type, grade, class and mixing directions as defined by these Specifications. Each container shall be marked with the name of the manufacturer, the lot or batch number, the date of packaging, and the quantity contained in pounds or gallons.

Potential hazards shall be so stated on the package in accordance with the Federal Hazardous Products Labeling Act and State of Washington, Department of Labor and Industries Regulations for Shipment of Hazardous Products.

9-26.1(3) Certification

If requested by the Contracting Agency, the manufacturer of the epoxy system shall certify that components A and B meet the requirements of this specification before a sample will be accepted for testing by the Contracting Agency. The Manufacturer’s Certificate of Compliance shall be furnished in accordance with Section 1-06.3.

9-26.1(4) Rejection

Except as noted otherwise, the entire lot of both components may be rejected if samples submitted for test fail to meet any requirements of this specification.

9-26.1(5) Acceptance

Acceptance of the Epoxy Bonding Agents for use on the project shall be based on a passing test report from the State Materials Laboratory.

9-26.2 Epoxy Adhesive for Lane Markers

9-26.2(1) General

Epoxy adhesives for lane markers shall meet the requirements of AASHTO M 237 for Type II - Standard Setting, High Viscosity, Epoxy Adhesive. In lieu of the square base test specimen molds for the Slant Shear Strength test specified in AASHTO M, cylindrical molds in accordance with ASTM D882 may be used.

9-26.2(2) Packaging and Marking

Packaging and Marking of Epoxy Adhesive for Lane Markers shall meet the requirements of Section 9-26.1(2).

9-26.2(3) Certification

Certification of Epoxy Adhesive for Lane Markers shall meet the requirements of Section 9-26.1(3).

9-26.2(4) Rejection

Rejection of Epoxy Adhesive for Lane Markers shall meet the requirements of Section 9-26.1(4).

9-26.2(5) Acceptance

Acceptance of each lot of the Epoxy Adhesive for Lane Markers for use on the project shall be based on a Manufacturer's Certificate of Compliance.

9-26.3 Epoxy Grout/Mortar/Concrete

9-26.3(1) General

This specification shall apply to epoxy grout, epoxy mortar and epoxy concrete for traffic and non-traffic bearing applications. Epoxy grout/mortar/concrete shall consist of an epoxy bonding agent and an aggregate component.

Prepackaged epoxy grout/mortar/concrete shall be prepared from a ready-to-mix epoxy bonding agent/aggregate system supplied by a manufacturer in kit form.

Non-prepackaged epoxy grout/mortar/concrete shall be prepared from an epoxy bonding agent and an aggregate component that is clean, surface dry and inert and that is of a quality and gradation suitable for Portland cement mortar or concrete. Aggregate meeting the requirements of Section 9-03.1(2) will be satisfactory. Epoxy grout/mortar/concrete for patching external concrete shall be concrete-gray in color.

9-26.3(1)A Traffic Bearing Applications

Epoxy grout/mortar/concrete for traffic bearing applications shall have a seven-day compressive strength of not less than 2500 psi when tested in accordance with ASTM C579. Epoxy bonding agent shall be Type III as described in Section 9-26.1(1)C.

9-26.3(1)B Non-Traffic Bearing Applications

Epoxy grout/mortar/concrete for non-traffic bearing applications shall have a seven-day compressive strength of not less than 4000 psi when tested in accordance with ASTM C579. Epoxy bonding agent shall be Type I, II, IV, or V as appropriate for intended use as described in Section 9-26.1(1)A and Section 9-26.1(1)B.

9-26.3(2) Packaging and Marking

Packaging and Marking of the epoxy bonding agent component of epoxy grout/mortar/concrete shall meet the requirements of Section 9-26.1(2).

9-26.3(3) Certification

Certification of the epoxy bonding agent component of epoxy grout/mortar/concrete shall meet the requirements of Section 9-26.1(3).

9-26.3(4) Rejection

Rejection of the epoxy bonding agent component of epoxy grout/mortar/concrete shall meet the requirements of Section 9-26.1(4).

9-26.3(5) Acceptance

Acceptance of the epoxy grout/mortar/concrete material for use on the project shall be based on a passing test report from the State Materials Laboratory.

9-27 CRIBBING

9-27.1 Vacant

9-27.2 Vacant

9-27.3 Gabion Cribbing

9-27.3(1) Gabion Fabric

Gabions may be fabricated from either hexagonal twisted wire mesh or from welded wire mesh. Only one type of mesh and protective coating shall be used throughout a structure.

Baskets shall be furnished in the required dimensions with a dimensional tolerance of plus or minus 5 percent.

Wire for construction of gabions shall be either galvanized steel wire conforming to ASTM A 641, Class 3, Soft Temper, or aluminized steel wire conforming to ASTM A 809, Soft Temper. The wire shall have a minimum tensile strength of 60,000 psi when tested in accordance with ASTM A 370.

9-27.3(2) Gabion Baskets

Gabion baskets 1-foot or greater in the vertical dimension shall have mesh openings with nominal dimensions not to exceed $4^1/_2$-inches and the maximum area of any mesh opening shall not exceed 10 square inches.

1. Hexagon Twisted Wire Mesh
   a. Wire for galvanized or aluminized hexagonal twisted wire mesh shall be nominal sized 0.120-inch galvanized steel wire or aluminized steel wire.
   b. Hexagonal wire mesh be formed from galvanized or aluminized wire in a uniform hexagonal pattern with nonraveling double twist. The perimeter edges of the mesh for each panel shall be tied to a selvage wire of the same composition as the body mesh and have a minimum diameter of 0.150-inch so that the selvage is at least the same strength as the body of the mesh.
2. Welded Wire Mesh
   a. Welded wire mesh shall be fabricated from galvanized steel wire having a diameter of 0.106-inch. Wire shall be galvanized prior to fabrication.
   b. Welded wire mesh shall be formed in a uniform square pattern with openings 3-inches by 3-inches with a resistance weld at each connection in accordance with ASTM A 185.
   c. If required, a PVC coating shall be fusion bonded onto the welded wire mesh to provide a nominal coating thickness of 0.0216-inch per side with a minimum of 0.0150-inch.
3. PVC Coating (for welded wire mesh only)

   Acceptance of PVC coating material shall be by certified test reports of an independent laboratory. The initial properties of PVC coating material shall have a demonstrated ability to conform to the following requirements:
   a. Specific Gravity — In the range of 1.2 to 1.4, when tested according to ASTM D 792.

b. Tensile Strength — Not less than 2,275 psi, when tested according to ASTM D 638.

c. Modulus of Elasticity — Not less than 1,980 psi at 100 Strain, when testing according to ASTM D 638.

d. Hardness — Shore "A" not less than 75 when tested according to ASTM D 2240.

e. Brittleness Temperature — Not higher than 15ºF when tested according to ASTM D 746.

f. Resistance to Abrasion — The percentage of the mass loss shall be less than 12 percent when tested according to ASTM D 1242, Method B at 200 cycles, CSI-A Abrader Tape, 80 Grit.

g. Salt Spray Exposure and Ultraviolet Light Exposure – The PVC shall show no effect after 3,000 hours of salt spray exposure according to ASTM B 117. The PVC shall show no effect of exposure to ultraviolet light with test exposure of 3,000 hours using apparatus Type E and 63°C, when tested according to Practice D 1499 and Practice G 23. After the salt spray test and exposure to ultraviolet light as specified above, the PVC coating shall not show cracks, blister, split, nor show a noticeable change of color. In addition, the specific gravity, tensile strength, modulus of elasticity, and resistance to abrasion shall not change more than 6, 25, 25, and 10 percent respectively from their initial values.

9-27.3(3) Gabion Mattresses

Gabion baskets less than 1-foot in the vertical dimension shall have mesh openings with nominal dimensions not to exceed 3.3-inches, and the maximum area of any mesh opening shall not exceed 6 square inches.

1. Hexagonal Twisted Wire Mesh

   a. Wire for galvanized or aluminized hexagonal twisted wire mesh shall be nominal sized 0.086-inch galvanized steel wire or aluminized steel wire.

   b. Hexagonal wire mesh shall be formed from galvanized or aluminized wire in a uniform hexagonal pattern with nonraveling double twisted. The perimeter edges of the mesh for each panel shall be tied to a selvage wire of the same composition as the body mesh and have a minimum diameter of 0.1062-inch so that the selvage is at least the same strength as the body of the mesh.

2. Welded Wire Mesh

   a. Welded wire mesh shall be fabricated from galvanized steel wire having a diameter of 0.080-inch. Wire shall be galvanized prior to fabrication.

   b. Welded wire mesh shall be formed in a uniform rectangular pattern with openings $1^1/_2$-inches by 3-inches with a resistance weld at each connection in accordance with ASTM A 185.

   c. If required, a PVC coating shall be fusion bonded onto the welded wire mesh to provide a nominal coating thickness of 0.0216-inch per side with a minimum of 0.0150-inch. The PVC coating shall be in conformance with Section 9-27.3(2).

9-27.3(4) Fasteners for Basket Assembly

The lacing wire shall be a nominal sized 0.0866-inch galvanized steel wire or aluminized steel wire. Lacing wire shall have the same coating as the basket mesh.

Spiral binders, if used for joining welded wire panels shall be formed from 0.106-inch nominal diameter steel wire with a 3-inch pitch having the same specifications and coating as the wire mesh. Lacing wire may be used in lieu of spiral binders.

Alternate fasteners for basket assembly shall remain closed when subjected to a 600 pound tensile force when confining the maximum number of wires to be confined. Installation procedures and test results for alternate fasteners shall be submitted for approval.

Internal connecting wires shall be the same as required for lacing wire. Alternate stiffeners acceptable to the gabion manufacturer may be used.

9-27.3(5) Nonraveling Construction

The wire mesh shall be fabricated in a manner to be nonraveling. This is defined as the ability to resist pulling apart at any of the connections forming the mesh when a single strand in a section of mesh is cut.

9-27.3(6) Stone

Stone for filling gabions shall have a Degradation Factor of at least 30. The stone shall be dense enough to pass the unit weight test described in Section 8-24.3(3)F. Stone shall meet the following requirements for gradation:

Sieve Size	Percent Passing
8″ square	100
6″ square	75-90
4″ square	0-10
% Fracture	75 min.

All percentages are by weight.

9-28 SIGNING MATERIALS AND FABRICATION

9-28.1 General

Unless noted otherwise in the Plans, permanent signs shall be constructed of sheet aluminum. Permanent signs which measure 36-inches or less on a side and are to be mounted on a single post may be constructed of single 0.135-inch fiberglass reinforced plastic panels. Sign overlay panels may be either 0.050-inch aluminum or 0.075-inch fiberglass reinforced plastic panels. All signs, except internally illuminated signs, shall be reflectorized.

See ASTM D 4956 for reflective sheeting type designations. Standard control signs and guide sign borders, letters, numerals, symbols, shields, and arrows shall be in accordance with the "Washington State Sign Fabrication Manual."

All STOP, YIELD, DO NOT ENTER, WRONG WAY, FREEWAY ENTRANCE, and HIGHWAY ENTRANCE signs shall be constructed entirely of Type III or IV reflective sheeting. All M series, I series, and D-10 series signs and all signs with blue or brown backgrounds shall be constructed entirely of Type II reflective sheeting unless otherwise specified. Background reflective sheeting for all other signs shall be as noted in the Plans. Sign legends for all other signs shall be constructed of Type III or IV reflective sheeting. Sign legends include: borders, letters, numerals, symbols, shields, and arrows. Reflective legend sheeting types shall not be mixed on individual signs.

9-28.1(1) Basis for Acceptance

Reflective sheeting shall be accepted on the basis of inclusion of the material/product on the Qualified Product List or by approval of a Request for Approval of Materials. The sign fabricator shall have available for inspection a copy of the Manufacturer's Certificate of Compliance for each lot of reflective sheeting. This certificate shall verify that the reflective sheeting meets all the requirements of Section 9-28.12.

The basis for acceptance of aluminum sign blanks and panels shall be a mill test certificate from the aluminum manufacturer attesting to the correct alloy and temper of the metal supplied. At the option of the Engineer, laboratory tests may also be performed to confirm metallurgical data.

It is expressly understood that the furnishing of certificates of compliance will not relieve the Contractor from the obligation to replace materials found defective after delivery to the project, nor will they prevent the Engineer from sampling material when it arrives on the project and subjecting it to such laboratory tests as they may deem appropriate or significant.

9-28.1(2) Inspection

All signs will be inspected at the fabricator's plant before shipment to the project. The inspection shall not be made until all materials have been tested and approved. Signs without a "FABRICATION APPROVED" decal will not be installed on the project with the exception of double-faced signs which do not receive decals or fabricator's stickers.

9-28.2 Manufacturer's Identification and Date

All signs shall show the manufacturer's name and date of manufacture on the back. In addition, the width and height dimension, in inches, and the number of the sign as it appears in the Plans shall be placed using 3-inch series C black letters on the back of destination, distance, and large special signs. Hand painted numbers are not permitted.

9-28.3 Corner Radius

All regulatory and warning signs shall have rounded corners with the exception of stop signs. Information and guide signs may have square cut corners. Borders for signs having square cut corners shall have a corner radius approximately $^1/_8$ of the lesser side dimension of the sign up to a maximum radius of 12-inches. For signs with rounded corners, the borders shall be concentric with the rounded corners.

9-28.4 Extruded Windbeams and "Z" Bar

All multiple post and multiple panel signs shall be constructed and installed with horizontal extruded windbeams and "Z" bar, when required, as shown in the Plans or the Standard Plan. All bolt and rivet heads visible on the sign face shall be anodized or painted to match the sign area immediately surrounding the bolt or rivet head. Extruded windbeams and "Z" bar shall be accepted on the basis of a certificate of compliance from the manufacturer. Materials shall be as designated in Section 9-28.11.

9-28.5 Letter and Spacing Formula

Letter and arrow sizes shall be as specified in the Plans. Spacing formulas shall be those furnished by the manufacturer of the letters.

9-28.6 Destination Sign Messages

Destination sign messages, borders, shields, and symbols shall be direct applied unless otherwise noted in the sign plans. All message components shall be one piece construction unless the least dimension exceeds available sheeting widths. All components shall have smooth, sharp cut edges. Components which are torn, wrinkled, or exhibit poor workmanship, will not be permitted.

9-28.7 Process Colors

Transparent and opaque process colors used in silk screening sign messages shall be as recommended by the manufacturer. When properly applied, process colors shall perform satisfactorily for the expected life of the sheeting. Applied colors shall present a smooth surface, free from foreign material, and all messages and borders shall be clear and sharp. Sheeting shall conform to the retroreflective minimum values and color limits established for its type and color without regard to whether the color is integral to the sheeting or achieved by applying transparent colors to silver/white sheeting. There shall be no variations in color, and overlapping of colors will not be permitted.

Properly applied and cured process colors shall exhibit no blistering, bubbling, or loss of color or transparency when cleaned with a mild non-abrasive detergent solution. Minor loss of color may be detected when solvents such as kerosene, mineral spirits, heptane, or VM&P Naphtha are used to clean severely contaminated signs; e.g., paint vandalism. However, the colors shall not blister, bubble, peel, or be easily removed.

9-28.8 Sheet Aluminum Signs

Sheet aluminum signs shall be constructed of material conforming to ASTM B 209 alloy 6061-T6 or alloy 5052-H36 or H38. Alloy 5005-H34 may be used for sign overlays.

After the sheeting has been fabricated, the sheeting for all multiple panel signs shall be degreased, etched by immersion for a minimum of 5 minutes in a 6-ounce per gallon caustic etch solution at 120°F, followed, in order, by a water rinse, de-oxidation, water rinse, hot water rinse, and drying. The etching process shall produce a dull aluminum finish on both sides of the panel which will last the life of the sign. The treated panel

surface shall be compatible with the opaque and reflective sheeting to be applied in accordance with the specifications. The Contractor may use an Alodine 1200 application for single panel signs in lieu of the above treatment. Aluminum signs over 12-feet wide by 5-feet high shall be comprised of vertical panels in increments of 2, 3, or 4-feet wide. No more than one 2-foot and/or 3-foot panel may be used per sign. The Contractor shall use the widest panels possible. All parts necessary for assembly shall be constructed of aluminum, galvanized, or stainless steel in accordance with the plans. Sheet thickness shall be as follows:

Maximum Horizontal Dimension	Sheet Aluminum Thickness
Overlay panels	0.050-inch
Up to 20-inches	0.063-inch
20-inches to 36-inches, inclusive	0.080-inch
Over 36-inches (Permanent Signs)	0.125-inch

The side dimension for a diamond shaped warning sign is considered to be the maximum horizontal dimension.

Before placing aluminum in contact with untreated steel, the steel surfaces shall be protected by proper cleaning and painting with one coat of Zinc Primer A-9-73 or A-11-99 and two coats of aluminum paint D-1-57.

Metal shall be handled by device or clean canvas gloves between all cleaning and etching operations and the application of reflective sheeting.

9-28.9 Fiberglass Reinforced Plastic Signs

Fiberglass reinforced plastic signs and overlay panels shall be constructed of a fiberglass reinforced thermoset polyester laminate. The sign panel shall be acrylic modified and UV stabilized for outdoor weathering ability.

The sign panel shall be stabilized to prevent the release of migrating constituents (such as solvents, monomers, etc.) over the expected life of the sign. The sign panel shall contain no residue release agents on the surface of the laminate so neither migrating constituents or release agents will be present in amounts which will interfere with any subsequent bonding operations.

The sign panel shall not contain visible cracks, pinholes, foreign inclusions, or surface wrinkles that would affect implied performance, alter the specific dimensions of the panel, or otherwise affect its serviceability.

The sign panel surface shall be wiped clean with a slightly water dampened cloth before applying reflective sheeting.

9-28.9(1) Mechanical Properties

All mechanical properties are stated as minimum requirements. The mechanical properties are measured in both the line direction of the panel and at 90 degrees to the line as noted in the appropriate ASTM test referenced.

Mechanical Property	Ave. Min. Requirement	ASTM Test
Tensile Strength	10.0 psi × 103	D638
Tensile Modulus	1.2 psi × 106	D638
Flexural Strength	20.0 psi × 103	D790
Flexural Modulus	1.2 psi × 106	D790
Compression Strength	32.0 psi × 103	D695
Compression Modulus	1.4 psi × 106	D695
Punch Shear	13.0 psi × 103	D732

9-28.9(2) Physical Properties

Sign Panels are to be 0.135-inch thick. Overlay panels are to be 0.075-inch thick. Panel thickness tolerance shall be plus or minus 0.005-inch. Panel tolerance on nominal length and width shall be plus or minus ⅛-inch for dimensions of 12-feet or less and shall be within ⅛-inch of square per 12-feet of length when measured in accordance with ASTM D 3841.

Panels shall be manufactured with smooth surfaces on both top and bottom of the panel.

Panel flatness of a 30-inch by 30-inch panel shall be measured by hanging the panel diagonally in suspension. The maximum deflection measured diagonally, parallel and perpendicular to the panel by lines drawn through the center of the panel, shall not exceed ½-inch. The panel shall then be hung diagonally in suspension in an oven for 48 hours at 180°F. The maximum deflection shall again be measured as previously noted and shall not exceed ½-inch. All measurements shall be made when panels are at ambient temperature.

Panels shall be pigmented to a visually uniform gray color within the MunselR range of N.7.5/to N.8.5/.

Panels shall have a maximum coefficient of lineal thermal expansion of 1.8×10^{-5} in/in/°F. when tested in accordance with ASTM D696.

Panels shall be classified as to a minimum Grade II (weather resistant) panel as specified in ASTM D 3841 following 3,000 plus or minus 100 hour weatherometer test.

Panels shall contain additives designed to be less responsive to fire ignition and flame propagation. As such, the extent of burning shall not exceed 1.0-inch when tested in accordance with ASTM D 635.

Panels shall resist the impact energy of 20 foot-pounds applied with a hemispherical tipped object 1-inch in diameter.

The panels thermal stability for strength and impact resistance qualities shall not be appreciably affected over a temperature range of -65ºF to 212°F.

Fiberglass reinforced plastic panels for signs shall be accepted on the basis of a certificate of compliance from the manufacturer as outlined in Section 1-06.3.

9-28.10 Vacant

9-28.11 Hardware

Bolts, nuts, locknuts, and washers shall be of the same material for each attachment. Bolts, nuts, locknuts, and washers for signs mounted on overhead sign structures (i.e. sign bridges, cantilevers sign structures, and bridge mounted sign brackets) shall be stainless steel only.

Hardware	Specification
Bolts	ASTM F 468 2024-T4 Aluminum ASTM A 307 Steel ASTM F 593 Group 1, Condition A Stainless Steel, or ASTM A 193, Grade B8, Class 1 Stainless Steel
U-bolts	ASTM A 276 Type 304 Stainless Steel
Washers	ASTM B 209 2024-T4 Aluminum ASTM F 844 Steel ANSI B.18.22.1 Stainless Steel Alloy 304
Nuts	ASTM F 467 2024-T4 Aluminum ASTM A 563 Grade A Steel ASTM F 594 Group 1 Stainless Steel, or ASTM A 194 Grade 8 or 8A Stainless Steel
Locknuts (with nylon insert unless otherwise in the Plans)	ASTM F 467 2024-T4 Aluminum ASTM A 563 Grade A Steel ASTM F 594 Group 1 Stainless Steel, or noted ASTM A 194 Grade 8 or 8A Stainless Steel
Rivets	ASTM B 316 5052 Aluminum Alloy ASTM B 316 5056 Aluminum Alloy
Post Clips	ASTM B 179 356-T6 Aluminum
Windbeams	ASTM B 221 6061-T6 Aluminum
Angle and “Z” Bar	ASTM B 221 6061-T6 Aluminum ASTM A 36 or ASTM A 992 Steel
Strap and Mounting Bracket	ASTM A 666, Type 201 Stainless Steel

All steel parts shall be galvanized per AASHTO M 111. Steel bolts and related connecting hardware shall be galvanized per AASHTO M 232.

9-28.12 Reflective Sheeting

Type I and Type II reflective sheeting shall consist of spherical lens elements embedded within a transparent plastic having a smooth, flat outer surface. Type III and Type IV reflective sheeting shall consist of spherical or prismatic lens elements adhered to a synthetic resin and encapsulated by a flexible, transparent, weatherproof plastic having a smooth outer surface. Type V reflective sheeting shall consist of metallized microprismatic lens bonded to a flexible, smooth-surfaced, weather resistant polymeric film. Type VI reflective sheeting shall consist of unmetallized microprismatic lens formed on a flexible vinyl material. Type VII, VIII, IX and Type X Fluorescent Orange reflective sheeting shall consist of unmetallized microprismatic lens formed in a synthetic

resin and encapsulated by a flexible, transparent, weatherproof plastic having a smooth outer surface. All sheeting shall be weather resistant and have a protected pre-coated adhesive backing. Type II reflective sheeting shall contain an identifying marking, such as a water mark, which is visible after sheeting application. The marking shall not adversely affect the performance or life of the sheeting.

The reflective sheeting shall have the following minimum coefficient of retroreflection values at 0.2 degrees and 0.5 degrees observation angle expressed as average candelas per foot-candle, per square foot of material. Measurements shall be conducted in accordance with ASTM E 810.

Type I Glass Bead Retroreflective Element Material

Obs. Angle	Entrance Angle	SILVER WHITE	YELLOW	ORANGE	GREEN	RED	BLUE	BROWN
0.2°	-4°	70	50	25	9.0	14	4.0	1.0
0.2°	+30°	30	22	7.0	3.5	6.0	1.7	0.3
0.5°	-4°	30	25	13	4.5	7.5	2.0	0.3
0.5°	+30°	15	15	4.0	2.2	3.0	0.8	0.2

Type II Glass Bead Retroreflective Element Material

Obs. Angle	Entrance Angle	WHITE	YELLOW	ORANGE	GREEN	RED	BLUE	BROWN
0.2°	-4°	140	100	60	30	30	10	5.0
0.2°	+30°	60	36	22	10	12	4.0	2.0
0.5°	-4°	50	33	20	9.0	10	3.0	2.0
0.5°	+30°	28	20	12	6.0	6.0	2.0	1.0

Type III Glass Bead Retroreflective Element Material

Obs. Angle	Entrance Angle	SILVER WHITE	YELLOW	ORANGE	GREEN	RED	BLUE	BROWN
0.2°	-4°	250	170	100	45	45	20	12
0.2°	+30°	150	100	60	25	25	11	8.5
0.5°	-4°	95	62	30	15	15	7.5	5.0
0.5°	+30°	65	45	25	10	10	5.0	3.5

Type IV Micro Prismatic Retroreflective Element Material

Obs. Angle	Entrance Angle	WHITE	YELLOW	GREEN	RED	BLUE	BROWN
0.2°	-4°	250	170	35	35	20	7.0
0.2°	+30°	80	54	9	9	5.0	2.0
0.5°	-4°	135	100	17	17	10	4.0
0.5°	+30°	55	37	6.5	6.5	3.5	1.4

Type V Metallized Micro Prismatic Retroreflective Element Material							
Obs. Angle	Entrance Angle	WHITE	YELLOW	ORANGE	GREEN	RED	BLUE
0.2°	-0.4°	700	470	280	120	120	56
0.2°	+30°	400	270	160	72	72	32
0.5°	-0.4°	160	110	64	28	28	13
0.5°	+30°	75	51	30	13	13	6.0

Type VI Vinyl Micro Prismatic Retroreflective Element Material							
Obs. Angle	Entrance Angle	WHITE	YELLOW	ORANGE	GREEN	RED	BLUE
0.2°	-0.4°	250	170	70	30	35	20
0.2°	+30°	95	64	26	11	13	7.6
0.5°	-0.4°	200	136	56	24	28	18
0.5°	+30°	60	40	17	7.2	8.4	4.8

Type VII Micro Prismatic Retroreflective Element Material							
Obs. Angle	Entrance Angle	WHITE	YELLOW	ORANGE	GREEN	RED	BLUE
0.2°	-0.4°	750	560	280	75	150	34
0.2°	+30°	430	320	160	43	86	20
0.5°	-0.4°	240	180	90	24	48	11
0.5°	+30°	135	100	50	14	27	6.0

Type VIII Micro Prismatic Retroreflective Element Material								
Obs. Angle	Entrance Angle	WHITE	YELLOW	ORANGE	GREEN	RED	BLUE	BROWN
0.2°	-0.4°	700	525	265	70	105	42	21
0.2°	+30°	325	245	120	33	49	20	10
0.5°	-0.4°	250	190	94	25	38	15	7.5
0.5°	+30°	115	86	43	12	17	7	3.5

Type IX Micro Prismatic Retroreflective Element Material							
Obs. Angle	Entrance Angle	WHITE	YELLOW	ORANGE	GREEN	RED	BLUE
0.2°	-0.4°	380	285	145	38	76	17
0.2°	+30°	215	162	82	22	43	10
0.5°	-0.4°	240	180	90	24	48	11
0.5°	+30°	135	100	50	14	27	6.0
1.0	-0.4°	80	60	30	8.0	16	3.6
1.0	+30°	45	34	17	4.5	9.0	2.0

Type X Micro Prismatic Retroreflective Element Material		
Obs. Angle	Entrance Angle	FLUORESCENT ORANGE
0.2°	-0.4°	200
0.2°	+30°	90
0.5°	-0.4°	70
0.5°	+30°	26

The wet performance measurements on unweathered sheeting shall be conducted in accordance with one of the following methods:

1. The standard rainfall test specified in Federal Specification LS 300C and the brightness of the reflective sheeting totally wet by rain shall not be less than 90 percent of the above values.
2. Samples shall be submerged in a tank of clean water (approximately 72°F) for a period of 5 minutes. Reflex-reflective performance of the sheeting shall be viewed in a darkened room by reflected light through the surface of the water or through a transparent plane surface of the tank parallel to the sample surface. Light source shall be such as a hand flashlight held close to the eye. The wet sheeting shall show no apparent loss of reflective performance as compared to dry material.

The sheeting shall conform to the applicable daytime color and luminance factor requirements of ASTM D 4956 when tested instrumentally in accordance with Section 8.4 of that specification; OR, the diffuse day color of the reflective sheeting shall be visually evaluated by comparison with the applicable Highway Color Tolerance Chart. Color comparison shall be made under north daylight or a scientific daylight having a color temperature from 6500 degrees to 7500 degrees Kelvin. Daytime color evaluation shall be illuminated at 45 degrees and viewed at 90 degrees. There shall be no significant color shift when viewed under nighttime (retroreflective) conditions.

The reflective sheeting shall have a pre-coated pressure sensitive adhesive (Class 1) or a heat-activated adhesive (Class 2) either of which will adhere to flat, clean surfaces without necessity of additional adhesive coats on the reflective sheeting or application surface. Chemical activators shall not be used to activate Class 2 adhesive. The pre-coated adhesive shall be protected by an easily removed liner which, when removed, shall not have a staining effect on the reflective sheeting and shall be mildew resistant. The protective liner attached to the adhesive shall be removable by peeling without soaking

in water or other solvents and shall be easily removed after storage for 4 hours at 150ºF under weight of 215-psi. The sheeting with liner removed, conditioned for 24 hours at 72°F and 50 percent relative humidity, shall be sufficiently flexible to show no cracking when bent around a 1.2-inch diameter mandrel with the adhesive side contacting the mandrel. For ease of testing, talcum powder may be spread on the adhesive to prevent sticking to the mandrel. The sheeting surface shall be smooth and flat to facilitate self-cleaning in the rain, regular cleaning, and wet performance, and exhibit 85 degrees glossmeter rating of not less than 50 when tested in accordance with ASTM D 523. The sheeting surface shall be readily processed and compatible with transparent and opaque process colors and show no loss of the color coat with normal handling, cutting, and application. The sheeting shall permit cutting and color processing at temperatures of 60°F to 100°F and 20 to 80 percent RH. The sheeting shall be heat resistant and permit force curing without staining of unapplied sheeting or applied sheeting at temperatures recommended by the manufacturer not to exceed 150°F for unapplied sheeting or 200°F for applied sheeting. The sheeting surface shall be solvent resistant to permit cleaning by wiping with a clean soft cloth dampened with VM&P Naphtha or mineral spirits.

The adhesive shall form a durable bond to smooth, corrosion and weather resistant surfaces and permit the reflective sheeting to adhere securely, 48 hours after application at temperatures of -30°F to 200°F. The adhesive bond shall be sufficient to render the applied sheeting vandal-resistant and prevent its shocking off when subjected to an impact energy of 20 ft. lbs. applied with a hemispherical tipped object 1-inch in diameter at -0°F. The test specimen shall be applied to aluminum backing not less than 0.080-inch thick and having a dimension of not less than 4-inches square. During testing, the specimen shall be supported on a 3-inch diameter ring.

The adhesion test shall conform to ASTM D 4956 with the addition of the temperatures noted above.

The resistance to accelerated weathering shall be as described in ASTM D 4956 except the weathering apparatus and procedure shall be in accordance with ASTM G 154.

The reflective sheeting shall be sufficiently flexible to be cut to shape easily and permit application over, and conform to, moderate shallow embossing characteristic of certain sign borders and symbols. The tensile strength of the sheeting shall be 5 to 20 pounds per square inch width when conditioned for 48 hours in accordance to ASTM D 685 and tested in accordance with ASTM D 828. Following liner removal, the reflective sheeting shall not shrink more than $^{1}/_{32}$-inch in ten minutes nor more than $^{1}/_{8}$-inch in 24 hours in any dimension per 9-inch square at 72°F and 50 percent relative humidity.

The sheeting, when applied according to manufacturer's recommendations to cleaned and etched 0.020-inch x 2-inch x 8-inch aluminum, conditioned (24 hours) and tested at 72°F and 50 percent relative humidity, shall be sufficiently flexible to show no cracking when bent around a $^{3}/_{4}$-inch diameter mandrel.

9-28.12(1) Application

The reflective sheeting shall be applied in the manner specified by the sheeting manufacturer. The applied sign face shall not have bubbles, wrinkles, or foreign material beneath the reflective sheeting.

9-28.12(2) Edge Treatment

All edges and splices of reflective sheeting signs shall be coated with an edge sealer when recommended by the manufacturer of the reflectorized sheeting.

9-28.12(3) Splices and Color Matching

Splicing of reflective sheeting shall not be permitted on signs or panels with dimensions up to and including 48-inches in height or width unless the reflective sheeting specified does not come in this width, then the widest width material shall be used. When sheeting joints are required, they shall be lap-jointed with the top sheet overlapping the bottom sheet by no less than 3/16-inch. The fabricator shall endeavor to use the least number of seams possible with the horizontal lap preferable. Roller applied or reverse screened sheeting may be butt-jointed with joint gap not to exceed 1/32-inch. Color matching of adjacent sheets of reflective sheeting comprising a sign shall be accomplished without a noticeable difference in color. No borders shall be spliced other than the splice of the tangent border to the corner radius.

9-28.13 Demountable Prismatic Reflectorized Message and Borders

The letters, digits, and alphabet accessories shall consist of embossed 0.040-inch thick sheet aluminum frames conforming to ASTM B 209 grade 3003-H14 in which prismatic reflectors are installed to prevent their displacement in handling or service. Letters in which reflectors are assembled by means of tape are unacceptable. The plastic reflectors face shall be colorless and be entirely smooth to present a water repellent and dirt resistant surface. The area indicating the letter shape that is not reflectorized shall be white for maximum daytime contrast with the sign background. All letters shall be free of any imperfections and shall present a high quality appearance. Demountable prismatic border shall be comprised of a minimum length of 2-feet with allowance of one shorter section between each corner radius.

Letters shall be fastened to the sign with aluminum screws or blind rivets conforming to ASTM B 209 grade 2024-T4.

The coefficient of retroreflection of each reflex reflector intended for use in cutout letters, symbols, and accessories shall be equal to or exceed the following minimum values with measurements made with reflectors spinning.

Observation Angle (degrees)	Entrance Angle (degrees)	Coefficient of Retroreflection Candle Power/Square inch/ Foot Candle
0.1	0	14.0
0.1	20	5.6

Failure to meet the specific minimum values shall constitute failure of the reflector being used. Upon failure of more than two of the 50 samples tested, a resample of 100 reflectors shall be tested. Failure of more than four of these samples shall be cause for rejection of the lot.

9-28.14 Sign Support Structures

All sign support structures shall be constructed as shown in the Plans.

9-28.14(1) Timber Sign Posts

At the Contractor's options, timber sign posts and mileposts shall be treated Douglas Fir or treated Hem-Fir meeting the grades specified in Section 9-09.2. Douglas Fir and Hem-Fir posts shall be given a treatment in accordance with Section 9-09.3(1). Preservative retention shall be as shown in Section 9-16.2 for sawn posts.

9-28.14(2) Steel Structures and Posts

Truss chords, struts, and diagonals, end posts, and end post struts and diagonals for sign bridge structures and cantilever sign structures shall conform to either ASTM A 36 or ASTM A 53 Grade B Type E or S. The nominal pipe diameter and the pipe wall thickness shall be as shown in the Plans or Standard Plans. All other structural steel for sign bridge structures and cantilever sign structures shall conform to either ASTM A 36 or ASTM A 992. Truss member connection hardware shall conform to Section 9-06.5(3).

Pipe members for bridge mounted sign brackets shall conform to ASTM A 53 Grade B Type E or S, and shall be Schedule 40 unless otherwise specified. All other structural steel for bridge mounted sign brackets shall conform to either ASTM A 36 or ASTM A 992. U bolts, and associated nuts and washers, shall be stainless steel conforming to Section 9-28.11, and shall be fabricated hot.

Anchor rods for sign bridge and cantilever sign structure foundations shall conform to ASTM F 1554 Grade 105, including Supplemental Requirements S2, S3, and S5. Nuts and washers for sign bridge and cantilever sign structure foundations shall conform to AASHTO M 291 Grade DH and AASHTO M 293, respectively.

Steel sign structures and posts shall be galvanized after fabrication in accordance with AASHTO M 111, unless noted otherwise in the Plans. All bolts, nuts, and washers shall be galvanized after fabrication in accordance with AASHTO M 232. Unless otherwise specified in the Plans or Special Provisions, metal surfaces shall not be painted.

Except as otherwise noted, steel used for sign structures and posts shall have a controlled silicon content of either 0.00 to 0.04 percent or 0.15 to 0.25 percent. If the Plans or Special Provisions specify painting of the galvanized steel surfaces, then the controlled silicon content requirement does not apply for those steel members. Mill test certificates verifying the silicon content of the steel shall be submitted to both the galvanizer and the Engineer prior to beginning galvanizing operations.

Minor fabricating and modifications necessary for galvanizing will be allowed if not detrimental to the end product as determined by the Engineer. If such modifications are contemplated, the Contractor shall submit to the Engineer, for approval, six copies of the proposed modifications, prior to fabrication.

9-28.14(3) Aluminum Structures

Welding of aluminum shall be in accordance with Section 6.9 of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, Fourth Edition, 2001.

Aluminum materials shall conform to ASTM B 209 grades as follows: the filler alloy shall be 4043, 5365, or 5556 for welding base metals 6061 or 6063 to 6061, 6063, 356, or A356. Filler alloy for welding base metal 5086 shall be 5356 or 5556.

9-28.15 Vacant

9-29 ILLUMINATION, SIGNAL, ELECTRICAL

9-29.1 Conduit, Innerduct, and Outerduct

Rigid metal conduit, liquidtight flexible metal conduit, and associated couplings and connectors shall conform to National Electrical Code. PVC conduit shall conform to National Electrical Code and to NEMA specification TC-2 (Conduit), TC-3 (Fittings-UL 514), and UL 651 (standard for rigid nonmetallic conduit). Fiberglass conduit and fittings shall be UL listed and shall comply with ANSI/NEMA standards TC-14A (filament wound reinforced thermosetting resin conduit and fittings) and ASTM D-2996.

Exterior and interior surfaces of all steel conduit, except threaded ends, shall be uniformly and adequately zinc coated by a hot-dip galvanizing process. The average weight of zinc coating shall be not less than 0.80 ounces of zinc per square foot of single surface area as determined by tests on 12-inch samples taken from each end of a standard length of conduit of each size. The weight of zinc coating on any individual test specifications shall be not less than 0.70 ounces of zinc per square foot of single surface area. The weight of zinc coating will be determined in accordance with AASHTO T 65. Determinations and nominal weights shall conform to the requirements of the Underwriters Laboratory (latest edition). In addition, the exterior as well as the interior conduit samples shall withstand four dips in the PREECE test in accordance with ASTM A 239.

Couplings for rigid metal type conduits may be either hot-dip or electroplated galvanized.

Grounding end bushings shall comply with the following:

1. Full standard threads, around the entire 360 degree circumference.
2. Malleable iron material.
3. Hot-dip galvanized, per AASHTO M 111.
4. Copper, tinned copper, stainless steel or integral lug.
5. Stainless steel clamping screw, mounting screw and set screw.

Every length of rigid metal conduit shall bear the label of Underwriters Laboratories, Inc. or the label of the Canadian Standards Association if affected items of Canadian manufacture are approved for use on the project. Installation shall conform to appropriate articles of the Code.

Conduit bodies and fittings for rigid steel conduit systems shall be UL/CSA listed for wet locations, hot dip galvanized malleable iron. Conduit bodies shall have tapered threads, and include a bolt on cover with stainless steel screws and a neoprene gasket seal against moisture.

Liquidtight flexible metal conduit shall consist of single strip continuous flexible interlocked steel galvanized inside and out forming a smooth internal wiring channel with a liquid tight covering of sunlight resistant flexible polyvinyl chloride. Liquid-tight connectors shall be UL/CSA listed for wet locations, insulated throat type.

Conduit clamps shall be two hole type straps, stainless steel or hot dip galvanized, except in marine environments, where Type 316 stainless steel shall be used.

Conduit supports for surface mounted conduit shall be hot dipped galvanized or Type 304 stainless steel channel type using Type 304 stainless steel bolts and spring nuts. Type 316 stainless steel shall be used in marine and other highly corrosive environments.

All types of conduit shall be free from defects, including out of round, foreign inclusions, etc. Conduit shall be uniform in color, density, and physical properties. Conduit shall be straight and the ends shall be cut square to the inside diameter. All conduit shall display the Underwriters Laboratory certification (UL Listed).

PVC solvent cement shall meet ASTM D 2564 including note 8 (label to show pipe sizes for which the cement is recommended).

Drilling fluid used for directional boring shall be inert mixture of water and bentonite clay, conforming to the drilling equipment manufacturers recommendations.

Rigid galvanized steel conduit is required for all surface mounted conduit, with the exception of Electrical service utility poles, upon the approval of the serving Utility company only.

Galvanized steel conduit outerduct shall be hot-dipped galvanized inside and out. The conduit shall be smooth and free from burrs. Conduit shall be supplied and shipped with thread protectors.

Expansion, and Deflection Fittings

Expansion fittings for rigid galvanized steel conduit shall be weather tight, with hot dipped galvanized malleable or ductile iron end couplings and body and shall allow for 4-inches of movement minimum (2-inches in each direction). Expansion fittings for rigid galvanized steel conduit shall have an external tinned copper bonding jumper. As an alternative to the external tinned copper bonding jumper, an expansion fitting with an internal tinned copper bonding jumper may be used. The internal tinned copper bonding jumper shall not reduce the conduit conductor capacity.

Expansion fittings for rigid galvanized steel conduit outerduct with innerduct shall be weather tight, with hot dipped galvanized ductile iron or bronze end couplings, with molded neoprene sleeve and internal tinned copper bonding jumper and shall allow for 8-inches of movement (4-inches in each direction) minimum.

Deflection fittings for rigid galvanized steel conduit shall be weather tight, with hot dipped galvanized ductile iron or bronze end couplings, with molded neoprene sleeve, stainless steel bands and internal tinned copper bonding jumper. Deflection fittings shall provide for conduit movement of $^{3}/_{4}$-inch, in all directions and angular movement of 30 degree in any direction.

A combination deflection and expansion fitting for rigid galvanized steel conduit shall be made from a deflection fitting and an expansion fitting as listed above, with the addition of an external tinned copper bonding jumper. The external tinned copper bonding jumper shall be of sufficient length to be installed on the conduit run and bypass the combination deflection/expansion fitting. As an alternative to the external tinned copper bonding jumper that is installed to bypass the combination deflection/expansion fitting, an expansion fitting with an internal tinned copper bonding jumper may be used. The internal tinned copper bonding jumper shall not reduce the conduit conductor capacity. This combination deflection and expansion fitting shall be installed as noted in the plans.

All rigid galvanized steel conduits attached to bridges shall be equipped with expansion fittings placed on alignment with bridge expansion joints and approximately parallel to the longitudinal movement of the bridge. A deflection fitting shall be placed at each conduit transition from bridge attachment to the underground section.

PVC Outerduct with innerduct and PVC conduit shall have a combination deflection and expansion fitting (as described above) placed at each conduit transition from bridge attachment to the underground section. The external tinned copper bonding jumper may be omitted on PVC outerduct with innerduct and PVC conduit.

The coupling body for the innerduct shall be factory assembled in the bell end of the outerduct and shall be manufactured from a high impact engineered thermoplastic. The coupling body face shall be supplied with lead-ins to facilitate assembly.

Inner and Outer duct

Each section of steel outerduct shall be supplied with one reversing spin coupling that allows straight sections and fittings to be joined without spinning the conduit. The reversing coupling shall be galvanized and have three setscrews or a lock nut ring to lock the coupling in place. Setscrews or lock nut ring shall be corrosion resistant and insure continuous electrical ground. The coupling shall be galvanized steel with the same material properties as the conduit.

The innerduct system shall be factory-installed and shall be designed so that expansion and contraction of the innerducts takes place in the coupling body to eliminate compatibility problems.

The conduit coupling body shall have a factory-assembled gasket that is multi-stage and anti-reversing, sealing both the outerduct and innerducts. A secondary mid body O-ring gasket shall be seated into the coupling body and shall hold the coupling body firmly in the steel outerduct.

The conduit system shall be designed so that assembly of components can be accomplished in the following steps:

1. Loosen setscrews or lock nut ring on coupling and spin back to allow for insertion.
2. Spin coupling mating sections forward to bottom.
3. Tighten set screws on lock nut ring.

Innerduct for Straight Sections of PVC and Rigid Galvanized Steel Conduits

The 4-inch PVC outerduct shall be equipped with four innerducts. The innerducts shall have a minimum outside diameter of $1^1/_4$-inch a minimum inside diameter of $1^1/_5$-inch. Larger diameter innerducts may be provided if the wall thickness and diameter tolerances are met. The tolerance for inside and outside diameters shall be 0.0005-inch. The innerducts shall have a minimum wall thickness of 0.006-inch. Innerduct shall be color coded. The color coding shall be three gray and one white. Alternate color codes are permitted as long as the color codes are contiguous between adjacent junctions boxes. The innerducts shall be factory installed in the outerduct.

Dynamic coefficient of friction of innerducts shall be tested in accordance with Telcordia GR-356-CORE procedure. The coefficient of friction shall be less than 0.30 between medium density polyethylene jacketed fiber optic cable and the prelubricated innerduct. The coefficient of friction shall be less than 0.10 between the $^1/_4$-inch diameter polypropylene rope (suitable for fiber optic cable pulling) and the prelubricated innerduct. Pull rope used for testing (meeting the 0.10 coefficient of friction requirement) shall be the same type as the pull rope used for cable installation. The Contractor shall provide, as part of the conduit submittals, a certificate of compliance with Section 1-06.3 stating that the conduit meets the coefficient of friction requirements detailed above.

The innerduct shall have a smooth, non-ribbed interior surface, with a factory prelubricated coating. The coating shall provide the required dynamic coefficient of friction.

Innerduct shall be extruded polyvinyl chloride (PVC) or polyethylene (PE).

PVC Outerduct

Protective outerduct for PVC schedule 40 and PVC schedule 80 conduit outerduct shall be 4-inch with a minimum 5-inch extended integral "bell end" and shall be gray in color. The outerduct minimum wall thickness shall be 0.23-inch for Schedule 40 PVC and 0.32-inch for Schedule 80 PVC.

Conduit and fittings for PVC outerduct shall be supplied with an ultraviolet inhibitor.

The coupling body for PVC outerduct shall include a factory-assembled, multi-stage gasket that is anti-reversing, sealing both the outer and innerducts. A secondary mid body gasket shall be seated at the shoulder of the bell to assure air and water integrity of the system. The bell end and the coupling body assembly shall accept a minimum of 5-inches of the spigot end.

The conduit system shall be designed so that straight sections and fittings will assemble without the need for lubricants or cement.

Bends for 4-inch PVC Conduit with Innerducts

All bend radii shall be 36-inches or greater. The conduit system shall provide a complete line of fixed and flexible sweeps with system compatible bell and spigot ends. The bends shall contain high-temperature burn-through-resistant innerducts manufactured from PVC, PE, or Nylon-66. The innerducts shall meet all other requirements for innerduct per Innerduct for Straight Sections of PVC Conduits.

Prefabricated fixed Bends (for Innerducts)

The prefabricated standard fixed PVC bends provided shall have a radius between 4-feet and 9-feet and sweep angles of 11.25 degree, 22.5 degree, 45 degree, or 90 degree.

Direction changes shall not exceed 90 degree.

Flexible bends shall be supplied in two lengths to meet field requirements. Conduit lengths shall be 10-feet 6-inches and 16-feet 6-inches. These conduits may be field bent to a uniform radius no less than 4-feet. The field bend shall be no greater than 90 degree. Grounding shall be continuous in flexible bends. Outerduct for flexible bends shall be manufactured from reinforced PVC.

All outerduct shall be marked with data traceable to plant location.

PVC outerduct shall have a longitudinal print-line that denotes "Install This Side Up" for proper innerduct alignment. PVC outer-ducts shall have a circumferential ring on the spigot end of duct to provide a reference point for ensuring the proper insertion depth when connecting conduit ends. The line shall be a minimum of 5-inches from the end of the conduit.

All fittings, adapters, and bends (sweeps) shall be provided and shall be manufactured from the same materials and manufacturing process as the conduit, except as specified otherwise. The conduit system shall be a complete system with the following accessories:

Manhole Terminator Kits
Deflection Fittings
Offset Fittings
Expansion/Contraction Fittings
Repair Kits
Conduit and Innerduct Plugs
Pull string
Pull rope
Conduit spacers

Split internal expansion plugs shall be supplied to suit various cable sizes. Duct plugs shall be polypropylene and be equipped with a neoprene or polyurethane gasket. Plugs shall be equipped with an attachment to secure the pull rope in the innerduct. The plug shall withstand 5 psi.

Steel casing material shall conform to ASTM A 252 Grade 1, 2, or 3 or casing as approved by the engineer. The Contractor shall furnish pipe of adequate thickness to withstand the forces exerted by the boring operation as well as those forces exerted by the earth during installation and shall be a minimum of $^{3}/_{8}$-inch thick.

All joints shall be welded by a qualified welder. Qualified in accordance with AWS D1.1 structural welding code, section 3, workmanship.

9-29.2 Junction Boxes

Junction boxes shall conform to the requirements set forth in the contract.

9-29.2(1) Standard Junction Box

Standard junction boxes shall be concrete junction boxes conforming to details in the Standard Plans, or approved non-concrete junction boxes.

Concrete junction boxes shall have a minimum compressive strength of 6000 psi when reinforced with a welded wire hoop and 4000 psi when reinforced with welded wire fabric or fiber reinforcement. The frame shall be anchored to the box by welding the wire fabric to the frame or by welding headed studs $^{3}/_{8}$-inch X 3-inches long, as specified in Section 9-06.15, to the frame. The wire fabric shall be attached to the studs and frame with standard tie practices. The box shall contain ten studs located near the centerline of the frame and box wall. The studs shall be placed one anchor in each corner, one at the middle of each width and two equally spaced on each length of the box. The steel frame, lid support, and lid shall be painted with a black paint containing rust inhibiters or painted with a shop applied, inorganic zinc primer in accordance with Section 6-07.3 or hot dip galvanized in accordance with ASTM A 111.

Material for concrete junction boxes shall conform to the following:

Concrete	Section 6-02
Reinforcing Steel	Section 9-07
Fiber Reinforcing	ASTM C 1116, Type III
Lid	ASTM A786 diamond plate steel
Frame	ASTM A786 diamond plate steel or ASTM A36 flat steel
Lid Support & Handle	ASTM A36 steel
Anchors (studs)	Section 9-06.15

Non-concrete junction boxes shall be gray in color and shall have an open bottom design with approximately the same inside dimensions as concrete junction boxes. Non-concrete junction box lids shall include a pull slot and shall be secured with two ½-inch stainless steel hex-head bolts factory coated with anti-seize compound and recessed into the cover. The tapped holes for the securing bolts shall extend completely through the box to prevent accumulation of debris. Bolts shall conform to ASTM F 593, stainless steel.

Non-concrete junction boxes shall have a vertical load strength of 15,000 pounds applied uniformly through a 10-inch x 10-inch x 1-inch steel plate centered on the cover. The junction box will be considered to have withstood the test load if:

1. The lid is fully functional.
2. There is no vertical or horizontal displacement of the lid frame.
3. The junction box holds its shape.

When requested, a test report from an independent materials testing facility shall be provided showing compliance with the load test.

9-29.2(2) Vacant

9-29.2(3) Structure Mounted Junction Box

Surface mounted junction boxes and junction boxes installed in cast in place structures shall be stainless steel NEMA 4X.

Junction boxes installed in structures constructed by slip forming shall be stainless steel NEMA 3R and shall be adjustable for depth, with depth adjustment bolts, which are accessible from the front face of the junction box with the lid installed.

NEMA stainless steel junction boxes and cover screws shall conform to ASTM A 304. Junction boxes installed on exterior of structures shall have an external hinge. Junction boxes shall be labeled with the appropriate designation.

Polyethylene drain tubes for junction boxes mounted in structures shall be $^{3}/_{8}$-inch diameter with a wall thickness of 0.062-inches and shall be rated for a 110 psi working pressure at 73° F.

The size of NEMA 4X junction boxes and NEMA 3R junction boxes shall be as shown in the plans.

9-29.2(4) Cover Markings

Junction boxes with metallic lids shall be marked with the appropriate legend in accordance with the bead weld details in the Standard Plans. Non-metallic lids shall be embossed with the appropriate legend and a non-skid surface. Legends for metallic lids and non-metallic lids shall be 1-inch nominal height.

Junction boxes shall be marked or embossed for use in accordance with the plans and following schedule:

System Type	Legend
Traffic Signal Interconnect (6pr)	COMM
Fiber Optic Trunk Lines	ITS
HUB to TC (25pr)	ITS
Fiber Optic Laterals to CC	ITS
TC to DS (6pr)	ITS
TC to HAR (6pr) SC&DI	ITS
TC to CC (6pr)	ITS
TC to VMS (6pr)	ITS
TC to WSTA (6pr)	ITS
All other lateral 6pr (i.e. neon control, etc)	TS
CC to camera (coax, control cables, old style)	ITS
CC to camera (fiber, new style)	ITS
HAR to antenna (coax)	ITS
VMS to sign (control cables)	ITS
WSTA to temp sensor, weather station	ITS
DS to loops (2cs)	ITS
DS to ramp meter (5c)	ITS
Flashing Beacons	ITS
Neon Power	ITS
Transformers to Cabinets	ITS
Service to Transformers	LT
All power for lighting	LT
Signal Controller to Displays	TS
Signal Controller to Loops	TS
Signal Controller to emergency preempt	TS
Telephone Service Drop	TEL
Telephones at Flyer Stops, Park & Rides, Etc.	TEL

9-29.3 Conductors, Cable

For the purpose of this specification, the neutral conductor is defined as a current carrying conductor with zero potential. For the purpose of this specification, equipment grounding conductor is defined as the conductor used to connect the noncurrent-carrying metal parts of equipment, raceways, and other enclosures to the system grounded conductor and/or the grounding electrode conductor at the service equipment or at the source of a separately derived system.

Conductors and cable shall conform to the applicable specifications as follows:

1. All current carrying single conductors shall be stranded copper conforming to ASTM B3 and B8. Insulation shall be 600 volt. Except as allowed in item 3, chemically cross-linked polyethylene or EPR Type USE insulation of code thickness is required for all current carrying single conductors in underground electrical systems. Grounding electrode conductor and bonding jumpers shall be bare or insulated stranded copper, 8 AWG minimum or larger as required by the NEC. Equipment grounding conductors shall be insulated, stranded copper with type XHHW, THWN, or USE insulation, non jacketed 8 AWG minimum or larger as required by the NEC. Insulated Grounding Electrode conductors, bonding jumpers and equipment grounding conductors, shall have continuous green color or green color with one or more yellow stripes.
2. Two and three conductor signal control cable shall consist of three No. 14 stranded copper conductors. Each conductor shall have 20-mil polyethylene insulation and a 10-mil PVC jacket. The cable shall be rated at 600 volts minimum. The cable assembly shall be covered with a polyester tape applied with a 10 percent minimum lap. The overall jacket shall be 45-mil PVC.

   Four conductor through 10 conductor signal control cable shall conform to International Municipal Signal Association (IMSA) signal cable specification 20-1 except the conductor sequence color code as shown in the following table. IMSA specification cables shall use 14 AWG stranded copper conductors. Individual conductors shall be cabled together in accordance with the following:

Conductor Number	Color Code	Color Trace	Use
1	R	Red	Red or Don't Walk
2	O	Orange	Yellow or Spare
3	G	Green	Green or Walk
4	W	White	Neutral
5	B	Black	Ped Call or Spare
6	Wb	White/Black	Neutral or Spare
7	Bl	Blue	Ped Call or Spare
8	Rb	Red/Black	Red or Don't Walk
9	Ob	Orange/Black	Yellow or Spare
10	Gb	Green/Black	Green or Walk

3. All single conductors employed in traffic control shall be Class B or Class C stranded copper. The minimum wire size shall be 12 AWG. Insulation shall be THW or USE, except loop wire.
4. Triplex or Quadraplex type ACSR neutral self-supporting aerial conductors of the appropriate size for aluminum conductors shall be used where required in the contract. The neutral conductor shall be the same size as the insulated conductor. All current carrying conductors shall be stranded.
5. Pole and bracket cable shall be a two-conductor cable rated for 600 volts. The individual conductors shall be one red and one black 19-strand No. 10 AWG copper, assembled parallel. The conductor insulation shall be 45-mil polyvinyl chloride or a 600 volt rated cross-linked polyethylene. The Jacketing shall be polyethylene or polyvinyl chloride not less than 45-mils thick. If luminaires with remote ballasts are specified in the contract, this same cable shall be used between luminaire and ballast for both timber and ornamental pole construction. If the luminaire requires fixture wire temperatures greater than 75°C, the outer jacket shall be stripped for that portion of the cable inside the luminaire. The single conductors shall then be sheathed with braided fiberglass sleeving of the temperature rating recommended by the luminaire manufacturer.
6. Vacant
7. Two conductor shielded (2CS) cable shall have 18 AWG (minimum) conductors and shall conform to IMSA specification No. 50-2.
8. Detector loop wire may be 12 or 14 AWG stranded copper wire, IMSA 51-3
9. Four conductor shielded cable (4CS) shall consist of a cable with four 18 AWG conductors with polypropylene insulation, an aluminized polyester shield, water blocking material in the cable interstices, and a 26-mil minimum outer jacket of polyethylene. The four-conductor assembly shall be twisted 6 turns per foot. Each conductor shall have a different insulation color. Overall cable diameter shall be 0.25-inch maximum. Capacitance between adjacent pairs shall be 18 pf per foot and 15 pf per foot between diagonal pairs. The capacitances shall not vary more than 10 percent after a 10-day immersion test with ends exposed in a saturated brine solution.
10. Three-conductor shielded cable (3CS) for the detector circuit for optical fire preemption receivers shall consist of three 20 AWG conductors with aluminized mylar shield and one No. 20 drain wire, all enclosed with an outer jacket. All wires shall be 7 X 28 stranded tinned copper material. Conductor insulation shall be rated 75°C, 600 volt. The drain wire shall be uninsulated. Conductor color coding shall be yellow, blue, and orange. DC resistance of any conductor or drain wire shall not exceed 11 ohms per 1,000-feet. Capacitance from one conductor to the other two conductors and shield shall not exceed 48 pf per foot. The jacket shall be rated 80 degree C, 600 volt, with a minimum average wall thickness of 0.045-inch. The finished outside diameter of the cable shall be 0.3-inch maximum.
11. Six pair communications cable (6PCC) shall meet RUS specification 1755.390 and shall have six pair 22 AWG wires with 0.008-inch FPA/MPR coated aluminum shielding. The cable shall have a petroleum compound completely filling the inside of the cable.

12. Sign light conductors between the hand hole and the isolation switch shall be a two conductor stranded 10 AWG pole and bracket cable, per Section 9-29.3 item 5, and an 8 AWG equipment grounding conductor insulated to 600 volts between conductors. The conductors between the isolation switch and the sign lighting luminaire shall be either code sized individual conductors with cross linked polyethylene type USE insulation or three conductor control cable, stranded copper 14 AWG cable rated at a minimum of 600 volts.

9-29.3(1) Fiber Optic Cable

Each fiber optic cable shall be suitable for placement in an underground duct.

All fibers in the cable shall be usable fibers and shall be sufficiently free of surface imperfections and inclusions to meet or exceed the optical, mechanical, and environmental requirements contained in this specification.

Cables shall be all dielectric cable (with no armoring) and shall be jacketed (sheathed) with medium density polyethylene. The minimum nominal jacket thickness shall be 71 mils. Jacketing material shall be applied directly over the tensile strength members. The polyethylene shall contain carbon black to provide ultra-violet light protection, and it shall not promote the growth of fungus.

The jacket or sheath shall be free of any holes, splits, or blisters.

The cable shall contain at least one ripcord under the sheath for easy sheath removal.

The shipping, storage, and operating temperature range of the cable shall be -40 degree F to +160 degree F. The installation temperature range of the cable shall be -20 degree F to +160 degree F.

The fiber optic cable shall withstand a maximum pulling tension of 600 pounds (lbs.) during installation (short term) with no damage and 135 pounds (long term).

Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding.

Void areas around the individual buffer tubes shall be protected with a moisture resistant compound as a block against moisture migration.

All cables shall be free of material or manufacturing defects and dimensional non-uniformity that would:

1. Interfere with the cable installation using accepted cable installation practices.
2. Degrade the transmission performance and environmental resistance after installation.
3. Inhibit proper connection to interfacing elements.
4. Otherwise yield an inferior product.

The outer jacket material shall be a medium density polyethylene (MDPE) conforming to ASTM D 1248, Type II, Class C, Category 4 or 5, Grade J4. The light absorption coefficient, when measured in accordance with ASTM D 3349, shall be a minimum of 400 at a wavelength of 375 nanometers.

The outer jacket material used in construction of this cable shall be fungus inert as described in ASTM G 21.

Fibers shall contain no factory splices.

The fiber optic cables shall be shipped on wooden reels in lengths as specified in the purchase order with a maximum overage of 10%. The diameter of the drum shall be at least 20 times the diameter of the cable.

9-29.3(1)A Singlemode Fiber Optic Cable

Singlemode fibers utilized in the cables specified herein shall be fabricated from 100 kpsi proof stress glass and primarily composed of silica which shall provide a matched clad index of refraction (n) profile and the following physical and performance characteristics:

Maximum Attenuation: 0.4/0.3 dB/km at 1310/1550 nanometers, respectively.

Typical Core Diameter: 8.3 microns

Cladding Diameter: 125 micron

Core-to-Cladding Offset:< 0.8 microns.

(The core center and the cladding center offset is defined as the distance between the core center and the cladding center.)

Cladding Non-Circularity: < 2.0%. Defined as:

{[1-(minimum cladding diameter - maximum cladding diameter)] X 100.}

Coating Diameter of 250 microns +/- 15 microns with a minimum coating thickness at any point of not less than 50 microns.

The coating shall be a dual-layered, UV-cured acrylate applied by the fiber manufacturer.

The coating shall be mechanically or chemically strippable without damaging the fiber.

9-29.3(2) Twisted-Pair (TWP) Copper Cable

The TWP cable installed for outside plant (OSP) applications shall contain the amount of twisted, 22 AWG, copper pairs as specified in the Plans. This cable shall be constructed for installation in an underground conduit environment with a sheath consisting of a double coated aluminum shield over which a medium density polyethylene jacket is extruded, in accordance with Rural Utilities Service (RUS) Standard 1755.390. This cable shall be filled with a gel compound to resist water penetration and migration.

The TWP copper cable for OSP applications shall contain no faulty pairs and shall be capable of the transmission of 9600 b/s VF data over distances greater than 7.5 miles.

9-29.4 Messenger Cable, Fittings

Messenger cable shall be $^{3}/_{8}$-inch, 7-wire strand messenger cables conforming to ASTM A 475, extra-high-strength grade, 15,400 pounds minimum breaking strength, Class A galvanized.

Strain insulators shall be wet process, porcelain, conforming to EEI-NEMA Class 54-2 standards for 12,000 pound ultimate strength.

Down guy assembly shall consist of an eight-way steel expanding anchor, having a minimum area of 300 square inches, made of pressed steel, coated with asphalt or similar preservative, and fitted with a $^{3}/_{4}$-inch minimum guy eye anchor rod 8-feet long. As an alternate to expanding anchors, screw type anchors with two 8-inch helix, 3 1/2-inch-pitch, 1-inch by 7 foot guy anchor rod, and rated for 7,000 pound maximum torque may be installed.

All pole hardware, bolts, plate rods, hangers, clips, wire guards, and pole bands shall be hot-dipped galvanized in conformance with the requirements of AASHTO M 232.

9-29.5 Vacant

9-29.6 Light and Signal Standards

Light and signal standards shall be in accordance with the details shown in the Plans, as specified in the Special Provisions and as outlined herein, provided that only one type of light or signal standard shall be used throughout the project.

Fabrication of light and signal standards shall conform to the applicable requirements of Section 6-03.3(14).

Light standard, signal standards, slip base hardware and foundation hardware shall be hot-dipped galvanized in accordance with AASHTO M 111 and AASHTO M 232.

9-29.6(1) Steel Light and Signal Standards

Steel plates and shapes for light and signal standards shall conform to ASTM A 36, except that structural shapes may conform to ASTM A 992. Shafts for light and signal standards, except Type PPB signal standards, shall conform to ASTM A 572 Grade 50. Shafts and caps for Type PPB signal standards, slipfitters for type PS I, FB, and RM signal standards, and all pipes shall conform to ASTM A 53 Grade B. Base plates for light standards shall conform to ASTM A 572, Grade 50, except as otherwise noted in the Standard Plans for fixed base light standards. Base plates for signal standards shall conform to ASTM A 36. Connecting bolts shall conform to AASHTO M 164. Fasteners for handhole covers, bands on lighting brackets, and connector attachment brackets shall conform to ASTM F 593.

Light and signal standards shall be hot-dipped galvanized in accordance with AASHTO M 111 and AASHTO M 232.

Steel used for light and signal standards shall have a controlled silicon content of either 0.00 to 0.04 percent or 0.15 to 0.25 percent. Mill test certificates verifying the silicon content of the steel shall be submitted to both the galvanizer and the Engineer prior to beginning galvanizing operations.

9-29.6(1)A Vacant

9-29.6(2) Slip Base Hardware

Slip plates and anchor plates for light standards and for Type FB and RM signal standards shall conform to the requirements of ASTM A 572 Grade 50. The keeper plate shall be 28 gage, conforming to ASTM A 653 coating designation G 90. Clamping bolts for slip base assemblies and slip base adapters shall conform to AASHTO M 164. Studs and bolts for slip base adapters shall conform to AASHTO M 164. Nuts shall conform to AASHTO M 291 Grade DH. Hardened washers shall conform to AASHTO M 293. Plate washers shall conform to ASTM A 36.

Galvanized bolts shall meet standard specification 9-06.5(4).

9-29.6(3) Timber Light Standards, Timber Strain Poles, Timber Service Supports

All timber poles used in illumination or traffic signal systems shall be Douglas fir, machine shaved, roof sawed, conforming to the latest ANSI Specifications and Dimensions for Wood Poles.

All timber poles shall be gained according to industry standards. A dated nail or metallic date plate shall be set in the gain evidencing the year of treatment of the timber pole.

All poles shall be treated with pentachlorophenol in accordance with Section 9-09.3(1).

Tops shall be sawed before treatment. Where holes are bored in poles to accommodate hanging bolts for brackets, transformers, guy assemblies, or other accessories, such holes shall be painted with a solution of the above preservative.

9-29.6(4) Welding

Welding of steel structures shall be in accordance with Section 5.15 of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, Fourth Edition-2001.

9-29.6(5) Foundation Hardware

Anchor bolts for Type PPB, PS, I, FB, and RM signal standards shall conform to the requirements of ASTM A 307. Nuts shall meet the requirements of AASHTO M 291. Washers shall meet the requirements of ASTM F 844.

Anchor bolts for Type II, III, IV, and V signal standards and luminaire poles shall meet the requirements of ASTM A 449. Nuts shall be heavy hex meeting the requirements of AASHTO M 291, Grade C, D, or DH. Washers shall meet the requirements of AASHTO M 293.

All foundation hardware shall be 100% hot-dipped galvanized in accordance with AASHTO M 111 and AASHTO M 232. Galvanized bolts shall be tested for embrittlement in accordance with ASTM A 143.

9-29.7 Luminaire Fusing and Electrical Connections at Light Standard Bases, Cantilever Bases and Sign Bridge Bases

Unfused quick-disconnect connectors shall conform to the following requirements:

1. A copper pin and a copper receptacle both of at least 90 percent conductivity shall be crimped or a stainless steel allen head screw and lug connection to the cable. If the allen head screw is used, the allen head screw shall be torqued to the manufactures recommendations. All crimped connections shall use a copper connector installed with a positive action (ratchet) tool. The receptacle shall establish contact pressure with the pin through the use of a copper beryllium sleeve spring and shall be equipped with a disposable mounting pin. The pin shall be of at least half-hard material and the crimping portion shall be fully annealed while the rest of the pin is maintained in its original state of hardness. The receptacle shall be fully annealed. Both the copper pin and receptacle shall have a centrally located recessed locking area adapted to be complementarily filled and retained by the rubber housing.
2. A plug and a receptacle housing shall be made of water resistant synthetic rubber which is capable of burial in the ground or installation in sunlight. Each housing shall provide a section to form a water-seal around the cable, have an interior arrangement to suitably and complementarily receive and retain the copper pin or receptacle, and a section to provide a water-seal between the two housings at the point of disconnection.

Fused quick-disconnect kits shall provide waterproof in-line fuse protection. The kit shall provide three cutoff sections on both lines and load side to accommodate various wire sizes. All connections shall be as described in item “1” above. Upon disconnect, the fuse shall remain in the load side of the kit.

Fuses furnished for all lighting circuits shall be capable of handling the operating voltage of the circuit involved and shall have the following characteristics:

1. Fuses shall be capable of indefinitely supporting 110 percent of the rated load.
2. Fuses shall be capable of supporting 135 percent of the rated load for approximately 1 hour.
3. A load of 200 percent of rated load shall effectively cause instantaneous blowing of the fuse.
4. Fuses shall be rated as listed below and shall be sized to fit the fuse containers furnished on this project, according to the manufacturer's recommendations therefore.
5. Fuses shall be UL Listed.

Luminaire	Service Voltage		
Size	480V	240V	120V
1,000W	10A	15A	30A
750W	5A	10A	20A
700W	5A	10A	20A
400W	5A	10A	15A
310W	5A	5A	10A
250W	5A	5A	10A
200W	4A	5A	10A
175W	4A	5A	10A
150W	3A	4A	5A
100W	2A	3A	4A
70W	2A	2A	2A
50W	2A	2A	2A

9-29.8 Vacant

9-29.9 Ballast, Transformers

Each ballast shall have a name plate attached permanently to the case listing all electrical data.

Certificates of compliance, to manufactures specifications and these specifications, shall be submitted by the manufacturer with each type of luminaire ballast.

Ballasts shall be designed for continuous operation at ambient air temperatures from 20 degree F without reduction in ballast life. Ballasts shall have a design life of not less than 100,000 hours. Ballasts shall be designed to operate for at least 180 cycles of 12 hours on and 12 hours off, with the lamp circuit in an open or short-circuited condition and without measurable reduction in the operating requirements. All ballasts shall be high power factor (90%).

Ballasts shall be tested in accordance with the requirements of current ANSI C 82.6, Methods of Measurement of High-Intensity-Discharge Lamp Ballasts. Starting aids for ballasts of a given lamp wattage shall be interchangeable between ballasts of the same wattage and manufacturer without adjustment.

Ballast assemblies shall consist of separate components, each of which shall be capable of being easily replaced. A starting aid will be considered as a single component. Each component shall be provided with screw terminals, NEMA tab connectors or a single multi-circuit connector. All conductor terminals shall be identified as to the component terminal to which they connect.

Heat-generating components shall be mounted to use the portion of the luminaire upon which they are mounted as a heat sink. Capacitors shall be located as far as practicable from heat-generating components or shall be thermally shielded to limit the fixture temperature to 160 degree F.

Ballasts for high-pressure sodium lamps shall have a ballast characteristic curve which will intersect both of the lamp-voltage limit lines between the wattage limit lines and remain between the wattage limit lines throughout the full range of lamp voltage. This requirement shall be met not only at the rated input voltage of the ballast, but also the lowest and highest input voltage for which the ballast is rated. Throughout the lifetime of the lamp, the ballast curve shall fall within the specified limits of lamp voltage and wattage.

All luminaires ballasts shall be located within the luminaire housing. The only exception shall be ballasts to be mounted on lowering assemblies and shall be external to, and attached to the fixture assembly.

No capacitor, transformer, or other device shall employ the class of compounds identified as polychlorinated biphenyls (PCB) as dielectric, coolants, or for any other purpose.

Ballast Characteristics for High Pressure Sodium (HPS) and Metal Halide (MH) Sources shall be:

Source	Line Volt.	Lamp Wattage	Ballast Type	Input Voltage Variation	Lamp Wattage Variation
HPS	any	70 400	Mag. Reg. Lag	10%	18%
HPS	any	750 1000	Auto Reg. Lead CWA	10%	30%
MH	any	175 400	Mag. Reg. Lag	10%	18%
MH	any	1000	Auto Reg. Lead CWA	10%	30%

Transformers and inductors shall be resin-impregnated for protection against moisture. Capacitors, except those in starting aids, shall be metal cased and hermetically sealed.

The transformers to be furnished shall be indoor/outdoor dry type transformers rated as shown in the Plans. The transformer coils, buss bar, and all connections shall be copper. Transformers, 7.5 KVA and larger shall be supplied with two full capacity taps, one at 5% and one at 10% below the normal full capacity.

9-29.10 Luminaires

If not listed on the Qualified Products List (QPL) a Certificate of Compliance shall be submitted by the manufacturer with each type of luminaire. The certificate shall state that the lot of luminaires meets this specification:

A. All luminaires shall be of the IES distribution type and wattage indicated in the contract. Luminaires shall be installed with HPS lamps rated at 24,000 hours, unless otherwise specified in the contract or this specification.

B. Conventional highway luminaires shall provide a full cut-off distribution and a high pressure sodium light source.

C. Horizontal luminaires shall attach to 2-inch pipe tenons on mast arms. Vertical mounted luminaires shall be appropriately sized for their respective pole top tenons.

D. All luminaires shall have their component secured to the luminaire frame with AISI, 300 series chrome-nickel grade stainless steel, zinc dichromate coated steel or ceramic coated steel hardware for corrosion resistant and chemical bonding resistant attachment to the cast aluminum housing or doors. The luminaire slip-fitter bolts shall be either stainless steel, hot-dip galvanized steel, zinc dichromate coated steel, or ceramic coated steel. All internal luminaire assemblies shall be assembled on or fabricated from either stainless steel or galvanized steel. The housing, complete with integral ballast, shall be weathertight. The ballast and lamp housing shall be on the same level.

E. All luminaires shall be mounted level, both transverse and longitudinally, as measured across points specified by the manufacturer. Leveling and orientation shall be accomplished after pole plumbing. Highway and decorative luminaires shall have slip-fitters capable of adjusting through a 5-degree axis for the required leveling procedure.

F. Refractors shall be formed from heat resistant, high impact, molded borosilicate glass. Flat lens shall be formed from heat resistant, high impact borosilicate or tempered glass.

H. High pressure sodium cobra head luminaires shall be capable of accepting a 150, 200, 250, 310, or 400 watt lamp complete with ballast. Metal halide fixtures shall be capable of accepting a 175, 250 or 400 watt lamp complete with ballast. Mercury vapor fixtures shall be capable of accepting a 175, 250, 400 watt lamp complete with ballast. Metal halide fixture shall accept a 175 watt mercury vapor lamp complete with ballast. Each luminaire shall consist of a housing, a reflector, lens, a lamp socket, an integral ballast, a terminal strip and lamp.

G. Housings shall be fabricated from aluminum. Painted housings shall be painted flat gray, Federal Standard 595B color chip No. 26280. Housings that are painted shall withstand a 1,000-hour salt spray test as specified in ASTM B 117.

All luminaires to be mounted on horizontal mast arms, shall be capable of withstanding cyclic loading in:

1. A vertical plane at a minimum peak acceleration level of 3.0 g's peak-to-peak sinusoidal loading (same as 1.5 g's peak) with the internal ballast removed, for a minimum of 2 million cycles without failure of any luminaire parts, and
2. A horizontal plane perpendicular to the direction of the mast arm at a minimum peak acceleration level of 1.5 g's peak to peak sinusoidal loading (same as 0.75 g's peak) with the internal ballast installed, for a minimum of 2 million cycles without failure of any luminaire parts.

The temperature rating of all wiring internal to the luminaire housing, excluding the pole and bracket cable, shall equal or exceed 200 degree F.

All luminaires shall be provided with markers for positive identification of light source type and wattage. Markers shall be 3-inches square with Gothic bold, black 2-inch legend on colored background. Background color shall be gold for sodium, blue for mercury, and red for metal halide light sources. Legends shall be sealed with transparent film resistant to dust, weather, and ultraviolet exposure.

Legends shall correspond to the following code:

Lamp	Wattage Legend
70	7
100	10
150	15
175	17
200	20
250	25
310	31
400	40
700	70
750	75
1,000	XI

9-29.10(1) Cobra Head Luminaires

Conventional highway luminaires shall be IES Type III cut off type distribution cobra head configuration with horizontal lamp. The ballast shall be mounted on a separate exterior door, which shall be hinged to the luminaire and secured, in the closed position to the luminaire housing by means of an automatic type of latch (a combination hex/slot stainless steel screw fastener may supplement the automatic type latch). The reflector of all luminaires shall be of a snap-in design or be secured with screws. The reflector shall be manufactured of polished aluminum or molded from prismatically formed borosilicate glass. The refractor or lens shall be mounted in a doorframe assembly which shall be hinged to the luminaire and secured in the closed position to the luminaire by means of automatic latch. The refractor or lens and doorframe assembly, when closed, shall exert pressure against a gasket seat. The refractor lens shall not allow any light output above 90 degrees nadir. Gaskets shall be composed of material capable of withstanding temperatures involved and shall be securely held in place.

Each housing shall be provided with a slipfitter capable of mounting on a 2-inch pipe tenon. Vertical mounted luminaires shall be appropriately sized for their respective pole top tenon and capable of being adjusted within 5 degrees from the axis of the tenon. The clamping bracket(s) and the cap screws of the slipfitter shall not bottom out on the housing bosses when adjusted within the ±5 degree range.

No part of the slipfitter mounting brackets on the luminaires shall develop a permanent set in excess of 0.2-inch when the cap screws used for mounting are tightened to a torque of 32 pounds feet.

9-29.10(2) Decorative Luminaires

Decorative fixture shall provide for a 150 - 400 watt HPS lamp fully enclosed fixture with mogul lamp socket, adjustable where required to alternate cutoff distributions.

The fixture shall be a one piece, box shaped, raintight, dustight and corrosion resistant, integral unit. The unit shall consist of an accessible ballast compartment and a sealed housing which permits filtered pressure equalization.

The ballast housing shall be fabricated of close tolerance extruded aluminum with heat resistant vinyl finish. The housing shall be adequately constructed to contain ballasts for 150 - 400 watt alternate high intensity discharge sources.

Each housing shall consist of an integral Alzak reflector, containing a mogul based high intensity discharge lamp, a rigid box type lamp holder assembly, a reflector assembly with a lamp vibration damper, and a one piece heat and shock resistant, clear tempered lens mounted in a gasketed, hinged, and baffled extruded aluminum frame. The housing shall have vinyl heat resistant finish. One fourth inch stainless steel, series 300 fasteners shall secure the lens frame to the housing.

The auxiliary equipment compartment for ballast terminals shall be separated from the lamp compartment by a metal heat barrier. The chassis shall be designed to provide effective heat sinking from the ballast cores. Capacitors shall be mounted at least 5-inches from the core and coil components.

Fixtures shall be finished alternately with paint or epoxy primer and either acrylic enamel; vinyl clad aluminum or powdered polyester baked on paint. Aluminum compatible epoxy primer shall be applied. The finish coat shall be dark bronze in color matching Federal Standard 595B or as shown in the contract.

Without chipping or flaking, the finish shall withstand 5 foot pounds direct or indirect impact from a falling cylindrical steel rod
$^{7}/_{8}$-inch diameter, a hemispheric nose and shall be salt spray resistant after 300 hours exposure in accordance with ASTM B 117 shall not cause blistering, peeling, corrosion or loss of adhesion.

Decorative fixtures shall be mounted using a reinforced mounting arm, milled to provide a smooth fit between fixture and arm. A slipfitter assembly shall be provided for leveling purposes, between fixture and tenon. Two $^{7}/_{16}$-inch or larger stainless steel bolts, series 300, shall be used to mount the fixture to the tenon. An approved gasket shall be utilized to seal against weather. A smooth wireway shall be provided.

All decorative fixtures shall be of the same manufacturer and external appearance.

9-29.10(3) High Mast Luminaires and Post Top Luminaires

High mast and post top luminaires shall comply with the requirements of the contract and Section 9-29.9 except the unit lamp shall utilize a vertically positioned lamp. High mast luminaires shall be 400 watt HPS full 90 degree nadir cut off, capable of types 2, 3, 5 distribution or as shown in the contract. When installed at heights between 50 and 70-feet the bottom of the fixture shall be closed, at heights from 70 to 85-feet the bottom shall be open. High Mast luminaires poles with mounting heights greater than 50-feet shall have approved fixture lowering device installed and a remote control unit, to operate the lowering device. The remote control unit shall be capable of operating the lowering device while permitting the operator to stand clear of the lights being lowered.

Post top luminaires shall have the ballast located directly below the vertical installed HPS lamp. All post top luminaires shall be capable of accepting 70, 100, 200, 250, 400 watt HPS lamps complete with ballast assembly.

Housings shall be fabricated from aluminum. All housings shall be painted flat gray, Federal Standard 595B color chip No. 26280. All housings shall withstand a 1,000-hour salt spray test as specified in ASTM B 117.

9-29.10(4) Underdeck and Wall Mount Luminaires

Underdeck luminaires shall be weatherproof and corrosion resistant. Light distribution shall be as shown on the contract. Each flush-mounted underdeck luminaire shall consist of a metal body, a prismatic refractor mounted in a doorframe, a prismatic glass or specular anodized aluminum reflector, a ballast, and a ceramic lamp socket and be supplied complete with all fasteners. The body shall have provisions for anchoring to concrete. The refractor shall be glass and shall be clearly identified as to "street side." The doorframe assembly shall be hinged, gasketed and secured to the body.

Each wall-mounted luminaire shall consist of a metal body, a prismatic refractor mounted in a doorframe, an aluminum reflector with a specular anodized finish, an integral ballast and a ceramic lamp socket and supplied with all fasteners. The refractor shall be glass. A gasket shall be provided between the refractor and the body of the fixture.

All lamp sockets shall be positioned to locate the light center of the lamp within $^1/_2$-inch of the light center location for which the luminaire is designed.

Ballasts for underdeck and wall luminaires shall conform to the provisions in Section 9-29.9. Ballasts for underdeck and wall mount luminaires shall be installed in the luminaire housing.

9-29.10(5) Sign Lighting Luminaires

Sign lighting luminaires shall be either Mercury Vapor or Induction.

9-29.10(5)A Sign Lighting Luminaires – Mercury Vapor

Sign lighting luminaires shall have a cast aluminum housing and door assembly with a polyester paint finish.

The housing shall encase a reflector, lamp socket, and ballast. It shall have a front entry (the side facing the sign) suitable for $^1/_2$-inch conduit and mounting holes for attaching to a fixture mounting plate. Any additional entries shall have suitable plugs. The sign lighting luminaire shall be supported by a lighting bracket assembly as detailed in the plans. If the sign structure includes a maintenance walkway, the luminaire fixture mounting plate shall be bolted to the walkway grating. Condensation drain holes shall be provided as recommended by the manufacturer.

The door shall be hinged to the housing on the side of the fixture away from the sign panel and shall be provided with two captive devices. The door shall be provided with the means to allow the door to be locked in the open position 70 degree to 90 degree from the plane of the door opening. The juncture of the door and housing shall be gasketed to provide a rain tight and dust tight joint.

Refractors shall be manufactured from heat resistant borosilicate glass. The refractor shall be shielded so that no light source is visible from the sign viewing approach. The shield shall be an integral part of the door assembly. When called for in the plans, fixtures shall be provided with a wire guard to prevent damage to the refractor.

The light source shall be a 175 watt deluxe phosphor coated mercury vapor lamp. The lamp socket shall be porcelain enclosed mogul type containing integral lamp grips to ensure electrical contact under conditions of normal vibration. The center contact shall be spring loaded. The shell and center contact shall be rated for 1500 watts, 600 volts.

An isolation switch shall be installed in a NEMA 3R stainless steel terminal cabinet per standard specification 9-29.25. The terminal cabinet shall be installed in accordance to the Standard Plans. The switch shall be either single pole, single throw, or double pole single throw as necessary to open all conductors to the luminaires other than neutral and ground conductors. The switch shall contain 600 volt alternating current (VAC) terminal strips on the load side with solderless lugs as required for each load carrying conductor plus four spare lugs per strip.

Each fixture shall be provided with a fusible terminal block. Fuses shall be 10 amp, 250 VAC for 120 VAC circuits and 5 amp 600 VAC for 240 VAC and 480 VAC circuits. The primary voltage shall be as indicated in the plans. Photometric performance shall be as follows:

A. The ratio of the maximum to minimum illuminance level on a panel 10-feet high by 16-feet wide shall not numerically exceed 5:1 approaching 1:1. In addition, the illuminance gradient shall not numerically exceed 2:1, illuminance gradient being defined as the ratio of the minimum illuminance of a square panel 1-foot on a side to that of any adjacent panel of the same size. This performance shall be obtained when the fixture is mounted 1-foot below the bottom edge of the sign and 5-feet out from the sign face.

B. The average to minimum uniformity ratio for a panel as dimensioned above shall not numerically exceed 3:1. Average initial illuminance shall exceed 10 foot candles for a mercury vapor lamp of 175 watts as specified.

9-29.10(5)B Sign Lighting Fixtures-Induction

Induction sign lighting fixture shall conform to the provisions for mercury sign lighting fixtures except as modified by this section.

Each fixture shall consist of a housing, a reflector, refractor or lens, lamp socket, lamp, power coupler, a high frequency (HF) generator and a fuse block, door, front entry (the side facing the sign) suitable for $^1/_2$-inch conduit and mounting holes for attaching to a fixture mounting plate. Any additional entries shall have suitable plugs. The sign lighting luminaire shall be supported by a lighting bracket assembly as detailed in the plans. The door shall be hinged to the housing on the side of the fixture away from the sign panel and shall be provided with two captive devices. The door shall be provided with the means to allow the door to be locked in the open position 70 degree to 90 degree from the plane of the door opening. The juncture of the door and housing shall be gasketed to provide a rain tight and dust tight joint.

Refractors or lens shall be manufactured from heat resistant glass. The refractor or lens shall be shielded so that no light source is visible from the sign viewing approach. The shield shall be an integral part of the door assembly. When called for in the plans, fixtures shall be provided with a wire guard to prevent damage to the refractor.

The ratio of the maximum to minimum illuminance level on a panel 10-feet high by 16-feet wide shall not numerically exceed 9:1 approaching 1:1. In addition, the illuminance gradient shall not numerically exceed 2:1, illuminance gradient being defined as the ratio of the minimum illuminance of a square panel 1-foot on a side to that of any adjacent panel of the same size. This performance shall be obtained when the fixture is mounted 1-foot below the bottom edge of the sign and 5-feet out from the sign face.

The average to minimum uniformity ratio for a panel as dimensioned above shall not numerically exceed 4:1. Average initial illuminance shall exceed 10 foot candles for an induction lamp of 85 watts as specified.

The system lifetime shall be rated at 60 000 hours with a failure rate of less than 10 percent. The system shall be rated at a nominal wattage of 87 W, 120/240 or 480V(ac). The power factor of the system shall be greater than 90 percent and the total harmonic distortion (THD) shall be less than 10 percent. The system shall be UL approved for wet locations and be FCC Class a listed.

The mounting assembly shall be either cast aluminum, hot-dip galvanized steel plate or steel plate that has been galvanized and finished with a polymeric coating system or the same finish that is used for the housing. The overall weight of the fixture shall not exceed 44 pounds. The manufacturer's brand name, trademark, model number, serial number and date of manufacture shall be located on the packaged assembly and on the outside and inside of the housing.

Housing

The housing shall have a door designed to hold a refractor or lens. The housing door shall be designed to be opened without the use of tools. The housing and door shall have polyester paint finish of a gray color resembling unfinished fabricated aluminum.

Reflector

The reflector may be designed to be removed as a unit that includes the lamp and power coupler.

Lamp

Each fixture shall be furnished with an 85-W induction lamp. The interior lamp walls shall be fluorescent phosphor coated. Lamp light output shall be not less than 70 percent at 60,000 hours. Lamps shall have a color-rendering index (CRI) of not less than 80. Lamps shall be rated at a color temperature of 4,000 K. Lamps shall be removable without the use of tools.

Power Coupler

The power coupler shall consist of a construction base with antenna, heat sink and electrical connection cable. The power coupler shall be designed so that it can be removed with no more than common hand tools.

High Frequency Generator

High frequency (HF) generators shall provide reliable lamp starting and operation at ambient temperatures down to -15°F for the rated life of the lamp.

The generator output frequency shall be 2.65 MHz +/- 10 percent. The generator radio frequency interference shall meet the requirements of Part 18 of the FCC.

High frequency generators shall be designed for continuous operation at ambient air temperatures from -5°F to 80°F without reduction in generator life. High frequency generators shall have a design life of not less than 100,000 hours at130° F.

A Certificate of Compliance, conforming to the provisions in Section 1-06.3. "Certificates of Compliance," and a copy of the high frequency generator test methods and results shall be submitted by the manufacturer with each lot of sign lighting fixtures. The certificate shall state that the high frequency generators meet, in every respect, the above requirements and the generator specifications of the lamp manufacturer. High frequency generators shall also conform to the following:

A. High frequency generators shall be capable of being easily replaced. All conductor terminals shall be identified as to the component terminal to which they connect.

B. High frequency generators shall be mounted so as to use the portion of the sign lighting fixture upon which they are mounted as a heat sink.

9-29.11 Control Equipment

Illumination circuits shall be controlled by a combination of photoelectric controls and lighting contactors or mercury relays as noted in the contract.

9-29.11(1) Time Clock Controls

Time clocks, when specified in the contract, shall be solid state and shall have a battery backup. The clock shall provide four functions and shall be enclosed within a dust tight mounting case. The unit shall be mounted on vibration dampened fittings.

The unit shall be push button programmable with 15 events per week, selectable by day of week and time of day to the nearest minute.

The clock shall be accurate to plus or minus 15 seconds per month through a humidity variation of 0 to 95 percent and a temperature variation of 0ºF to 150ºF. The clock shall be within plus or minus 10 seconds after 10 hours of battery backup operation. The backup battery shall operate for 24 hours minimum.

Contacts shall be rated at 5 amps tungsten load for up to 100,000 cycles. Each clock function shall operate a 120 VAC normally open and normally closed set of contacts.

9-29.11(2) Photoelectric Controls

The photoelectric control shall be the twistlock type and the light sensitive element shall be a solid state photo diode. The control shall be designed to turn on at 3 foot-candles (32 lux) and turn off at 1.8 foot-candles (20 lux). The lighting control shall not drift by more than 1 percent over a 10-year period.

The output control relay shall have a 45-second time delay to prevent false turn-off caused by momentary brightness. This output relay shall be rated 1,000 watts incandescent or 15 amps inductive load. The contacts shall be normally closed. The unit shall be designed to not continuously pulse the output relay if the photo control bypass switch is energized.

The lighting control shall have a built in metal oxide varistor (MOV) rated 180 joules for lightning and transient protection. The control shall also have secondary zener diode and transient filter. The printed circuit board shall be coated to prevent corrosion. The normal operating voltage range will be 105 to 285 VAC.

9-29.12 Electrical Splice Materials

Splicing in illumination circuits will be permitted only at junction boxes. With the exception of lead-in cable to loop wire or magnetometer sensing probe splices, no splices will be allowed in traffic signal circuitry. All other traffic signal circuitry will be terminated at a load, at control equipment, or at a terminal.

9-29.12(1) Illumination Circuit Splices

Aerial splices may employ split bolt connectors. Splices and taps on underground circuits shall be made with solderless crimp connectors to securely join the wires both mechanically and electrically. Aerial splices may employ split bolt connectors. Two way inline splices meeting Mil Spec I 230053 at or below grade locations shall employ

moisture blocking heat shrink, Mil Spec I-23053 or be epoxy resin cast type insulation employing clear rigid plastic molds. Clear mylar sheet bonded to butyrate webbing forming a flexible mold shall be used for four-way or more splices. The material used shall be compatible with the insulation material utilized. Equipment and methods shall be as recommended by the manufacturer of the splicing materials. The component materials of the resin insulation shall be packaged form ready for convenient mixing without removing from the package. Only one conductor or one multi conductor cable per wire entrance will be allowed in any rigid mold splice.

9-29.12(2) Traffic Signal Splice Material

Induction loop splices and magnetometer splices shall be either moisture blocking two-way (in line) heat shrink, meeting Mil Spec I-23053, or epoxy resin cast type with clear rigid plastic molds or re-enterable type with semi-hardening epoxy filling compound that remains semi-flexible enclosed in a re-enterable rigid mold with end cap seals.

9-29.13 Traffic Signal Controllers

A controller shall consist of a complete electrical mechanism for controlling the operations of traffic control signals including the timing mechanism and all necessary auxiliary equipment, mounted in a cabinet.

The Contractor shall furnish to the Contracting Agency all guarantees and warranties furnished as a normal trade practice for all control equipment that is provided.

The fabricator of the controller shall perform quality control (QC) inspections based on their QC program. Their QC program shall be submitted and approved by WSDOT at least annually. The fabricator of the controller shall certify that the controller meets all requirements of the Standard Specifications and Special Provisions for the specific application.

The QC program shall include, but not be limited to, the following:

1. Quality Statement
2. Individual responsible for quality (organizational chart)
3. Fabrication procedures
4. Test procedures
5. Documented inspection reports
6. Documented test reports
7. Certification package

Control equipment includes all equipment used to control the operations of traffic control signals, programmable message signs, illumination system's and other associated control systems. Control equipment includes all devices including auxiliary equipment mounted in a cabinet.

The traffic signal control equipment shall conform to the contract specifications and these standard specifications.

All control equipment shall be as specified below:

A. NEMA control and all auxiliary equipment shall conform to current NEMA specifications.

B. Type 170E control equipment and all auxiliary equipment, shall conform to the California Department of Transportation document entitled "Transportation Electrical Equipment Specifications" dated November 19, 1999.

C. The 170E/HC-11 controller and auxiliary equipment shall conform to the current Oregon Department of Transportation Specification for model 170E/HC-11 controller and auxiliary equipment. The 170E shall be compatible with Type 170E controllers and the current revision of the software specified in the contract.

D. 170 ATC controller and auxiliary equipment shall conform to the current Oregon Department of Transportation Specification for model 170 ATC controller and auxiliary equipment.

E. Type 2070 controller and all auxiliary equipment shall conform to the current California Department of Transportation Specification for Model 2070 and auxiliary equipment.

F. Type 2070 Lite controller and auxiliary equipment shall conform to the current Oregon Department of Transportation Specification for model 2070 Lite controller and auxiliary equipment.

All traffic signal control equipment shall be tested as follows. The supplier shall:

1. Seven days prior to shipping, arrange appointment for controller cabinet assembly, and testing at the WSDOT Materials Laboratory or the facility designated in the Special Provisions.
2. Assembly shall be defined as but not limited to tightening all screws, nuts and bolts, verifying that all wiring is clear of moving parts and properly secured, installing all pluggables, connecting all cables, Verify that all contract required documents are present, proper documentation is provided, and all equipment required by the contract is installed.
3. The assembly shall be done at the designated WSDOT facility in the presence of WSDOT personnel.
4. The supplier shall demonstrate that all of the functions required by this specification and the contract Plans and Special Provisions perform as intended. Demonstration shall include but not be limited to energizing the cabinet and verifying that all 8 phases, 4 pedestrian movements, 4 overlaps (as required by the Contract Provisions) operate per Washington State Standard Specifications Section 9-29.13. The supplier shall place the controller in minimum recall with interval timing set at convenient value for testing purposes. Upon a satisfactory demonstration the controller assembly will then be accepted by WSDOT for testing.
5. If the assembly, and acceptance for testing is not complete within 5 working days of delivery, the Project Engineer may authorize the return of the assembly to the supplier, with collect freight charges to the supplier.
6. The Contractor will be notified when the testing is complete, and where the assembly is to be picked-up for delivery to the project.
7. The supplier has 5 working days to repair or replace any components that fail during the testing process at no cost to the Contracting Agency. A failure shall be defined as a component that no longer functions as intended under the conditions required or does not meet the requirements of the Contract Specifications and is at the soul discretion of WSDOT.
8. Any part or component of the controller assembly, including the cabinet that is rejected shall not be submitted for use by WSDOT or any City or County in the State of Washington.

9-29.13(1) Vacant

9-29.13(2) Flashing Operations

All traffic signals shall be equipped for flashing operation of signal displays. Controllers shall be programmed for flashing red displays for all approaches. During flash display, all pedestrian circuits shall be de-energized.

Actuated traffic signal control mechanisms shall be capable of entry into flash operation and return to normal operation as follows:

1. Terminal Strip Input (Remote Flash). When called as a function of a terminal strip input, the controller shall provide both sequenced entry into flash and sequenced return to normal operation consistent with the requirements of the latest edition of the Manual on Uniform Traffic Control Devices.
2. Police Panel Switch. When the flash-automatic switch located behind the police panel door is turned to the flash position, the signals shall immediately revert to flash; however, the controller shall "STOP TIME." When the switch is placed on automatic, the signals shall immediately time an 8-10 second all red period then resume normal cyclic operations at the beginning of major street green.
3. Controller Cabinet Switches. When the flash-automatic switch located inside the controller cabinet is placed in the flash position, the signals shall immediately revert to flash; however, the controller shall continue to function. When the flash-automatic switch is placed in the automatic position, the controller shall immediately resume normal cyclic operation at the beginning of the artery green. Adjacent to the flash-automatic switch shall be a controller on-off switch. If the flash-automatic switch is in the automatic position and the controller on-off switch is placed in the OFF position, the signals shall immediately revert to flash.
4. Power Interruption. On "NEMA" controllers any power interruption longer than 475 plus or minus 25 milliseconds, signals shall re-energize consistent with No. 2 above to ensure an 8-second flash period prior to the start of major street green. A power interruption of less than 475 plus or minus 25 milliseconds shall not cause resequencing of the controller and the signal displays shall re-energize without change. Type 170 controllers shall re-energize consistent with No. 2 above after a power interruption of 1.75 plus or minus 0.25 seconds. The 8-second flash period will not be required.
5. Conflict Monitor. Upon sensing conflicting signals or unsatisfactory operation voltages, the conflict monitor shall immediately cause the signal to revert to flash; however, the controller shall stop time at the point of conflict. After the conflict monitor has been reset, the controller shall immediately take command of the signal displays at the beginning of major street green.

9-29.13(3) Emergency Preemption

Immediately after a valid call has been received, the preemption controls shall cause the signals to display the required clearance intervals and subsequent preemption intervals. Preemption shall sequence as noted in the contract. Preemption equipment shall be installed so that internal wiring of the controller, as normally furnished by the manufacturer, is not altered. Termination of the preemption sequence shall place a call on all vehicle and pedestrian phases. Preemption indicators, if required, shall turn on when

the controller reaches the preempted phase. NEMA controller shall energize the pre-emption indicators when the controller is in the pre-emption phase(s). For the type 170, 2070, ATC, 2070 Lite controllers, the pre-emption indicators shall be energized when the pre empt detector registers the pre empt request call.

9-29.13(4) Wiring Diagrams

Schematic wiring diagrams of the controllers and auxiliary equipment shall be submitted when the controllers are delivered. The diagram shall show in detail all circuits and parts. The parts shall be identified by name or number in a manner readily interpreted. One reproducible mylar or two microfilms and four copies of the cabinet wiring diagram and component wiring diagrams shall be furnished with each cabinet and if requested by the Engineer on a high density disk or CD. The schematic drawing shall consist of a single sheet, detailing all circuits and parts, not to exceed 52-inches by 72-inches The cabinet wiring diagram shall indicate and identify all wire terminations, all plug connectors, and the locations of all equipment in the cabinet. Included in the diagram shall be an intersection sketch identifying all heads, detectors, and push buttons and a phase diagram.

9-29.13(5) Vacant

9-29.13(6) Radio Interference Suppressers

All traffic signal controllers, flashers, or other current-interrupting devices shall be equipped with radio interference suppressers installed at the input power point. Interference suppressers shall be of a design which will minimize interference in both broadcast and aircraft frequencies, and shall provide a minimum attenuation of 50 decibels over a frequency range of 200 kilohertz to 75 megahertz when used in connection with normal installations. The interference filters furnished shall be hermetically sealed in a substantial case filled with a suitable insulating compound. Terminals shall be nickel plated, 10-24 brass studs of sufficient external length to provide space to connect two 8 AWG wires, and shall be so mounted that they cannot be turned in the case.

Ungrounded terminals shall be insulated from each other and shall maintain a surface leakage distance of not less than $^1/_2$-inch between any exposed current conductor and any other metallic parts with an insulation factor of 100-200 megohms dependent on external circuit conditions.

Suppressers shall be designed for operations on 50 amperes, 125 volts, 60 cycles, single wire circuits, and shall meet standards of the Underwriters' Laboratories and the Radio Manufacturers Association.

9-29.13(7) Traffic-Actuated Controllers

All traffic signal controllers shall operate with industry standard operating software installed that at a minimum has the following:

1. Defined phases, minimum of 8 each.
2. Has manufacturer designed single or 2 ring operation minimum.
3. A minimum of four overlaps.
4. Defined intervals, min green, walk, flash don't walk, passage, gap, minimum gap, simultaneous gap out, volume density, yellow clearance, all red clearance, Maximum I, Maximum II.

Traffic-actuated controllers shall be electronic devices which, when connected to traffic detectors or other means of actuation, or both, shall operate the electrical traffic signal system at one or more intersections.

All solid-state electronic traffic-actuated controllers and their supplemental devices shall employ digital timing methods.

Control equipment shall conform to 9-29.13.

Actuated traffic signal controllers shall be 8-phase minimum control units. Volume-density timing features shall be provided on all controllers.

Every pin of every connecting plug shall be utilized as described within the NEMA requirement, except that those pins identified as "spare" or "future" shall remain unused. Controller interchangeability between NEMA controllers of any and all approved makes is mandatory, as is interchangeability of any and all approved makes of 170E, 2070, and 2070 Lite controllers every pin of every connecting plug shall be utilized as described within the 1999 Caltrans Specification.

Overlaps for NEMA controllers may be accomplished by programming of software or by use of NEMA overlap boards. If a manufacturer elects to utilize the software method, they may be required to furnish an overlap board with each signal controller which will allow substitution of controllers using the alternated method of overlaps.

NEMA controllers shall provide indications for vehicle call and pedestrian call that can be viewed simultaneously with indications for timing intervals. Controllers shall provide indications for timing intervals in both rings that can be viewed simultaneously. Reason for green termination shall be displayed simultaneously with other timing data.

All controllers shall provide a "simultaneous gap out" feature. This feature allows retiming a gap from a green rest upon an actuation.

9-29.13(7)A Environmental, Performance, and Test Standards for Solid-State Traffic Controllers

The scope of this specification includes the controller assembly of solid-state design installed in a weatherproof controller cabinet. The controller assembly includes the cabinet, controller unit, load switches, signal conflict monitoring circuitry, accessory logic circuitry, AC line filters, vehicle detectors, coordination equipment and interface, and preemption equipment. NEMA control assemblies shall meet or exceed current NEMA TS 1 Environmental Standards. Normal operation will be required while the control assembly is subjected to any combination of high and low environmental limits (i.e. low voltage at high temperature with high repetition noise transients). All other control equipment testing shall be tested to Caltrans Transportation Electrical Equipment Specifications (TEES) dated November 19, 1999.

9-29.13(7)B Auxiliary Equipment for NEMA Controllers

The following auxiliary equipment shall be furnished and installed in each cabinet for NEMA traffic-actuated controllers:

1. A solid-state Type 3 NEMA flasher with flash-transfer relay which will cut in the flasher and isolate the controller from light circuits. See Section 9-29.13(2) for operational requirements.
2. Modular solid state relay load switches of sufficient number to provide for each vehicle phase (including future phases if shown in the plans), each pedestrian phase and preemption sequence indicated in the contract. Type P &

R cabinets shall include a fully wired 16-position back panel. Solid-state load switches shall conform to NEMA standards except only optically isolated load switches will be allowed. Load switches shall include indicator lights on the input circuits. The controller cabinet shall have all cabinet wiring installed for eight vehicle phases, four pedestrian phases, four emergency pre-empts, four overlaps (OL A, B, C, D).

3. A power panel with:
   a. A control-display breaker sized to provide 125 percent overload protection for all control equipment and signal displays, 30 ampere minimum.
   b. A 20 ampere accessory breaker wired parallel to the control display breaker. The breaker will carry accessory loads, including vent fan, cabinet light, plug receptacle, etc.
   c. A busbar isolated from ground and unfused for the neutral side of power supply.
   d. A radio interference suppresser to the output side of the control display breaker. See Section 9-29.13(6) for other requirements.
   e. A transient voltage protection device connected to the controller power circuit for protection against voltage abnormalities of 1 cycle or less duration. The protector shall be a solid state high energy circuit containing no spark gap, gas tube, or crow bar component. The current rating of the device shall be 15 amps minimum. The device shall provide transient protection between neutral and ground, line and ground, as well as line and neutral. If the protection circuits fail, they shall fail to an open circuit condition. The device shall meet all requirements of UL standard 1449. The suppressed voltage rating shall be 600 volts or less when subjected to an impulse of 6,000 volts, 3,000 amp source impedance, 8.0/20 microsecond waveform as described in UL 1449. In addition, the device shall withstand, without failure or permanent damage, one full cycle at 264 volts RMS. The device shall contain circuitry to prevent self-induced regenerative ringing. There shall be a failure warning indictor light which shall illuminate when the device has failed and is no longer operable.
   f. Cabinet ground busbar independent (150K ohms minimum) of neutral.
4. A police panel located behind the police panel door with a flash automatic switch and a control-display power line on-off switch. See Section 9-29.13(2) for operational requirements.
5. An auxiliary control panel located inside the controller cabinet with a flash-automatic switch and a controller on-off switch. See Section 9-29.13(2) for operational requirements. A three wire 15 ampere plug receptacle with grounding contact and 20 ampere ground fault interrupter shall also be provided on the panel.
6. A conflict monitor conforming to NEMA standards. See Section 9-29.13(2) for operational requirements. The unit shall monitor conflicting signal indications at the field connection terminals. The unit shall be wired in a manner such that the signal will revert to flash if the conflict monitor is removed from service.

   Supplemental loads not to exceed 10 watts per monitored circuit or other means, shall be provided to prevent conflict monitor actuation caused by dimming or lamp burn-out. Supplemental loads shall be installed on the control

side of the field terminals. Conflict monitors shall include a minimum of one indicator light for each phase used. The monitoring capacity of the unit shall be compatible with the controller frame size. Conflict monitors shall include a program card.

7. A "Display Panel" when noted in the contract. The display panel shall depict a generic eight-phase operation. The panel shall be mounted on the inside of the front cabinet door and the mounting shall be of a design that allows positioning of the panel in four orientations 90 degrees from each other. The mounting shall be removable without use of any tools. Incandescent red, yellow, green, walk and don't walk indicator lights shall be provided for each phase. The indicator lights shall be connected to the associated field terminals. The connecting cable shall be long enough to allow for any mounting orientation. No diodes will be allowed in the display panel. A means of disconnecting all wiring entering the panel shall be provided. Switches shall be provided on the panel with labels and functions as follows:
   a. Display On — Signal indicator lamps will display the operation of the intersection.
   b. Test — All indicator lamps shall be energized.
   c. Display Off — all signal indicator lamps shall be de-energized.

   A "Detector Panel", as specified in Standard Specification Section 9-29.12(7)D, shall be installed. The panel shall be mounted on the inside of the front cabinet door. The detector panel shall be constructed as a single unit. Detector switches with separate operate, test, and off positions shall be provided for each field detector input circuit. A high intensity light emitting diode (LED) shall be provided for each switch. The lamp shall energize upon vehicle, pedestrian or test switch actuation. The test switch shall provide a spring loaded momentary contact that will place a call into the controller. When in the OFF position, respective detector circuits will be disconnected. In the operate position, each respective detector circuit shall operate normally. Switches shall be provided on the panel with labels and functions as follows:
   a. Display On — Detector indicator lights shall operate consistent with their respective switches.
   b. Display Off — detector indicator lights shall be de-energized.

   A means of disconnecting all wiring entering the panel shall be provided. The disconnect shall include a means to jumper detection calls when the display panel is disconnected. All switches on the panel shall be marked with its associated plan detector number. All markers shall be permanent.

8. Insulated terminal blocks of sufficient number to provide a termination for all field wiring. A minimum of 12 spare terminals shall be provided. Field wire connection terminal blocks shall be 600 volt, heavy duty, barrier type, except loop detector lead-ins, which may be 300 volt. The 600 volt type-terminal strips shall be provided with a field-side and a control-side connector separated by a marker strip. The 300 volt type shall have a marker strip, installed on the right side of vertical terminal strips or below horizontal terminal strips. The marker strip shall bear the circuit number indicated in the plans and shall be engraved. Each connector shall be a screw type with No. 8 post capable of accepting no less than three 12 AWG wires fitted with spade tips.

9. A vent fan with adjustable thermostat. The minimum CFM rating of the fan shall exceed three times the cabinet volume.
10. An incandescent or fluorescent interior cabinet light mounted at the top of the enclosure with door switch to automatically energize when the door opens. The light shall be installed a minimum of 12-inches from the vent fan thermostat. The switch shall be labeled "light."
11. All wiring within the cabinet, exclusive of wiring installed by the signal controller manufacturer, shall have insulation conforming to the requirements of Section 9-29.3. Cabinet wiring shall be trimmed to eliminate all slack and shall be laced or bound together with nylon wraps or equivalent. All terminals, shall be numbered and permanently identified with PVC or polyolefin wire marking sleeve consistent with the cabinet wiring diagram provided by the signal controller manufacturer and the contract. The cabinet will be completely wired so that the only requirement to make a field location completely operational is to attach field power and ground wiring. Internal cabinet wiring shall not utilize the field side connections of the terminal strip intended for termination of field wires.
12. One reproducible mylar or two microfilms and four copies of the cabinet wiring diagram and component wiring diagrams shall be furnished with each cabinet. Each cabinet shall be equipped with a, shelf mounted roll out drawer mounted directly below the controller to house one or more cabinet wiring diagrams. The cabinet wiring diagram shall indicate and identify all wire terminations, all plug connectors, and the locations of all equipment in the cabinet. Included in the diagram shall be an intersection sketch identifying all heads, detectors, and push buttons; and a phase diagram.
13. Each vehicle detector amplifier, video detection out put channel pedestrian call isolation unit, phase selector, discriminator, and load switch shall be identified with semi-permanent stick-on type label. The following information shall be included:
    a. Vehicle Detector Amplifier Channel
        1. Loop number
        2. Assigned phase(s)
    b. Ped Call Isolation Unit
        1. Push button number
        2. Assigned phase(s)
    c. Load Switches
        1. Signal head number
        2. Assigned phase(s)
    d. Phase Selectors
        1. Circuit Letter
        2. Phase(s) called

    The label shall be placed on the face of the unit. It shall not block any switch, light, or operational words on the unit. The lettering on this label shall be neat, legible, and easily read from a distance of approximately 6-feet.

9-29.13(7)C Auxiliary Equipment for Type 170E, 2070, 2070 Lite Assemblies

The following requirements apply to required auxiliary equipment furnished with Type 170E, 170E-HC-11, 2070, 2070 Lite, ATC controller cabinets:

A. Flashers, flash transfer relays, conflict monitor, AC isolators, DC isolators, discriminator modules, program modules, modem modules, load switches, breakers, buses, police panel switches, receptacle requirement, vent fan and auxiliary control panel switches shall conform to the requirements noted in the California Department of Transportation document entitled "Traffic Signal Control Equipment Specifications" specified in Section 9-29.13(7).

B. Flashing operation shall conform to Section 9-29.13(2), except the 8-second flash period described in Item 2 of that section will not be required. Emergency preemption shall conform to Section 9-29.13(3).

The requirements for radio interference suppressor, transient voltage protection, terminal blocks, cabinet light (florescent only), cabinet wiring, wiring diagram and equipment labeling are the same as previously noted for the NEMA control assemblies.

C. Input and output terminals shall be installed with a marking strip with field wire numbers noted in the contract embossed on the strip. All cabinet and field conductor shall have a PVC or polyolefin wire marking sleeve installed, matching the input and output terminals above.

D. The input panel terminal blocks TB 2 through TB 9 and associated cable to the input files as described in California Department of Transportation document entitled "Traffic Signal Control Equipment Specifications" dated November 19, 1999 shall be provided in all control assemblies. The alternate raceway specified in Chapter 18 will not be allowed.

E. Supplemental load requirements to prevent conflict monitor actuation on lamp burnout are the same as previously noted for NEMA control assemblies.

F. A "Display Panel", conforming to the requirements previously noted for the NEMA control assemblies shall be provided when noted in the contract.

G. A "Detection Panel" conforming to the requirements previously noted for the NEMA control assemblies shall be provided except the panel shall be a separate unit from the "Display Panel." The panel shall be rack mounted above the controller and shall conform to details in the contract.

H. A "Detector Termination and Interface Panel" shall be provided. When viewing the cabinet from the back, the panel shall be located on the upper left hand side of the cabinet. The panel shall be electrically located between the "Detector Panel" and the C-1 connector. The panel shall utilize insulated terminal blocks and each connector shall be a screw type with post.

I. A print holder rollout drawer shall be provided. The drawer shall be rack mounted below the controller.

J. A "DB-9" socket shall be mounted on the rack facing the front door of the cabinet and shall be easily accessible when the front door is open. The socket shall provide a communication interface between a personal computer and the C-20S connector on the back of the controller. The appropriate cable and C-20 plug connector shall be part of this assembly to provide ease of connection to the controller.

K. A C-2 plug with 6-feet of 22 AWG 4 conductor shielded cable shall be provided in each cabinet. The cable shall be terminated on positions 3, 4, and 6 of the TB terminal block.

L. An "Absence Of Red Programming Assembly" shall be provided. There shall be provided on the back panel of the output file, 16 accessible jumper plug attachment areas, made up of three male pins per position (one set of three, for each conflict monitor channel). Each jumper plug shall be a three position Molex style connector, using crimped wire pins. Two female pins shall be installed in each jumper plug, one attached to each end of a single wire. These pins shall be installed in the connector, one on the center position and one in either outer position of the plug. It shall be possible, by inserting and positioning one of the 16 jumper plugs on the right two pins on the monitor board, to apply 120 VAC into a corresponding channel of the conflict monitor red channels. The connection between the absence of red programming board and the 210 plus conflict monitor shall be accomplished via a 20 pin ribbon cable and the industry standard P-20 connector, that attaches on the front panel of the monitor. It shall be possible, by inserting and positioning one of the 16 jumper plugs on the two left pins on the monitor board, to enable the red monitor on the corresponding channel (phase).There shall be installed on the absence of red programming assembly a red enable disconnect relay, that controls the 120 VAC red enable signal into the 210 plus monitor. During normal operation, the normally closed contacts of this relay shall supply 120 VAC into the red enable input of the monitor. When energized, this red enable signal shall be removed from the input disabling red monitoring. The relay shall be energized by the corresponding Cl pin connection, as required by the local software, to indicate that the assembly is in processor flash.

M. Seven AC – copper neutral bars shall be installed in each 332, 336 controller cabinet, four 4 on the right side and three 3 on the left side. All of the neutral bars shall be secured per the current Caltrans Specification. All neutral bars shall be at the same electrical potential.

9-29.13(7)D NEMA Controller Cabinets

Each traffic-actuated NEMA controller shall be housed in a weatherproof cabinet conforming to the following requirements:

1. Construction shall be of 0.073-inch minimum thickness series 300 stainless steel or 0.125 minimum thickness 5052 H32 ASTM B209 alloy aluminum. The stainless steel shall be annealed or one-quarter-hardness complying with ASTM A666 stainless steel sheet. Cabinets may be finished inside with an approved finish coat of exterior white enamel. If no other coating is specified in the Contract Provisions the exterior of all cabinets shall be bare metal. All controller cabinets shall be furnished with front and rear doors.
2. The cabinet shall contain shelving, brackets, racks, etc., to support the controller and auxiliary equipment. All equipment shall set squarely on shelves or be mounted in racks and shall be removable without turning, tilting, or rotating or relocating one device to remove another. A 24 slot rack or racks shall be installed. The rack(s) shall be wired for 2 channel loop detectors and as follows. Slots 1 & 2 phase 1 loop detectors. Slots 3, 4, & 5 phase 2 loop detectors. Slots 6 & 7 phase 3 loop detectors. Slots 8, 9, & 10 phase 4 loop

detectors. Slots 11 & 12 phase 5 loop detectors. Slots 13, 14, & 15 phase 6 loop detectors. Slots 16 & 17 phase 7 loop detectors. Slots 18, 19 & 20 phase 8 loop detectors. Slot 21 upper phase 1 loop detector. Slot 21 lower phase 5 detector. Slot 22 wired for a 2 channel discriminator channels A, C. Slot 23 wired for a 2 channel discriminator, channels B, D. Slot 24 wired for a 4 channel discriminator, wired for channel A, B, C, and D. All loop detector slots shall be wired for presence/pulse detection/extension. If an external power supply is required in order for the entire racks(s) to be powered it shall be installed. All rack(s) slots shall be labeled with engraved identification strips.

3. Additional detection utilizing the "D" connector shall be installed in accordance with the contract. The cabinet shall be of adequate size to properly house the controller and all required appurtenances and auxiliary equipment in an upright position with a clearance of at least 3-inches from the vent fan and filter to allow for proper air flow. In no case shall more than 70 percent of the cabinet volume be used. There shall be at least a 2-inch clearance between shelf mounted equipment and the cabinet wall or equipment mounted on the cabinet wall.
4. The cabinet shall have an air intake vent on the lower half of the front door, with a 12-inch by 16-inch by 1-inch removable throw away filter, secured in place with a spring-loaded framework.
5. The cabinet door(s) shall be provided with:
   a. Spring loaded construction core locks capable of accepting a Best type CX series six segment (core installed by others) shall be installed in each door with the exception of the police panel door. Cabinet doors shall each have a three point latch system.
   b. A police panel assembly shall be installed in the front door and shall have a stainless steel hinge pin and a police panel lock. Two police keys with shafts a minimum of $1^{3}/_{4}$-inches long shall be provided with each cabinet.
   c. All doors and police panel door shall have one piece, closed cell, neoprene gaskets.
   d. A two position doorstop assembly. Front and rear interior light control switches.

9-29.13(7)E Type 170E, 170E-HC-11, 2070, 2070 Lite, ATC Controller Cabinets

The above controllers shall be housed in a Models 332, Double 332, 336, 336S, 303 ITS/ATC cabinets, or as specified in the contract. Each door shall be furnished with a construction core lock conforming to Standard Specifications 9-29.13 (7)D 5a, b and c above. A police panel with door, stainless steel hinge pin and lock shall be provided. Two police keys with shafts a minimum of $1^{3}/_{4}$" long shall be provided with each cabinet. Each of these cabinets shall be furnished with auxiliary equipment described in Standard Specification 9-29.13(7)C. Type 334 cabinets for traffic data station controller furnished shall meet current Caltrans 170E specifications, as stated in Section 9-29.13(7) and as follows. Camera control and DMS local control cabinets shall contain the equipment shown in the Plans. The cabinet shall have the same external physical dimensions and appearance of Model 334 cabinets.

1. The cabinet shall be fabricated of stainless steel or sheet aluminum in accordance with Section 9-29.13(7)D, Item number 1. Painted steel, painted or anodized aluminum is not allowed.
2. Cabinet doors shall have a three-point latch and two-position stop assembly with spring loaded construction core lock capable of accepting a Best lock company type, with 6-pin CX series core. The Contractor shall supply construction cores. Upon contract completion, the Contractor shall deliver two master keys to the Engineer.
3. Field wire terminals shall be labeled in accordance with the Field Wiring Chart.
4. A shatterproof fluorescent interior cabinet lights with self-starting ballast shall be furnished, one fixture mounted on the rear rack near the top and the second mounted at the top of the front rack. Door switches shall automatically turn on both lights when either door is opened.
5. One controller unit shelf, which attaches to the front rails of the EIA rack, shall be provided in lieu of the two controller unit support angles. The shelf shall be fabricated from aluminum and shall be installed such that it does not interfere with access to any terminal block. The shelf shall contain a rollout flip-top drawer for storage of wiring diagrams and manuals.

A disposable paper filter element of at least 180 square inches shall be provided in lieu of a metal filter.

All traffic data and ramp meter cabinets shall include the following accessories:

1. Each cabinet shall be equipped with a fully operable controller equipped as specified in the Contract Provisions.
2. Two input files, except on Type 303 and 336 cabinet shall be supplied, each using 133 millimeters of rack height.
3. Power Distribution Assembly shall be PDA #3 as detailed in the January 1989 Caltrans 170 specification, with all current amendments.

   The PDA #3 shall contain three Model 200 Load Switches.

   A transient voltage protection device shall be provided, which plugs into the controller unit receptacle and in turn accepts the controller plug and meets the electrical requirements of Section 9-29.13(7)B(3) item e.

   A second transfer relay, Model 430, shall be mounted on the rear of the PDA #3 and wired as shown in the Plans.
4. Police Panel shall contain only one DPDT toggle switch. The switch shall be labeled POLICE CONTROL, ON-OFF.

5. Display Panel

A. General

Each cabinet shall be furnished with a display panel. The panel shall be mounted, showing and providing detection for inputs and specified controller outputs, at the top of the front rack above the controller unit. The display panel shall be fabricated from brushed aluminum and constructed according to the detail in the Plans.

B. Text

All text on the display panel shall be black in color and silk screened directly to the panel except the Phenolic detector and cabinet nameplates.

A nameplate for each loop shall be engraved with a $^{1}/_{4}$-inch nominal text according to the ITS Field Wiring Charts. The nameplates shall be permanently affixed to the display panel.

C. LEDs

The LEDs for the display panel shall meet the following specifications:

Case size	T 1-3/4
Viewing angle	50° minimum
Brightness	8 Milli candelas

LEDs with RED, YELLOW or GREEN as part of their labels shall be red, yellow or green in color. All other LEDs shall be red. All LEDs shall have tinted diffused lenses.

D. Detector Display Control Switch

Each display panel shall be equipped with one detector display control switch on the panel with labels and functions as follows:

ON

Detector display LEDs shall operate consistent with their separate switches.

OFF

All detector indicator LEDs shall be de-energized. Detector calls shall continue to reach the controller.

TEST

All detector indicator LEDs shall illuminate and no calls shall be placed to the controller.

E. Advance Warning Sign Control Switch

Each display panel shall be equipped with one advance warning sign control switch on the panel with labels and functions as follows:

AUTOMATIC

Sign Relay shall energize upon ground true call from controller.

SIGN OFF

Sign Relay shall de-energize.

SIGN ON

Sign Relay shall energize.

F. Sign Relay

The sign relay shall be plugged into a socket installed on the rear of the display panel. The relay shall be wired as shown in the Plans. The relay coil shall draw (or sink) 50 milliamperes ± 10% from the 170E controller and have a DPDT contact rating not less than 10 amperes. A 1N4004 diode shall be placed across the relay coil to suppress voltage spikes. The anode terminal shall be connected to terminal #7 of the relay as labeled in the Plans. The relay shall energize when the METERING indicator LED is lit.

G. Detector Input Indicators

One display LED and one spring-loaded two-position SPST toggle switch shall be provided for each of the 40 detection inputs. These LEDs and switches shall function as follows:

TEST

When the switch is in the test position, a call shall be placed to the controller and energize the associated LED. The switch shall automatically return to the run position when it is released.

RUN

In the run position the LEDs shall illuminate for the duration of each call to the controller.

H. Controller Output Indicators

The display panel shall contain a series of output indicator LEDs mounted below the detection indicators. The layout shall be according to the detail in the Plans. These LEDs shall illuminate upon a ground true output from the controller via the C5 connector.

The output indicator LEDs shall have resistors in series to drop the voltage from 24 volts DC to their rated voltage and limit current below their rated current. The anode connection of each LED to +24 VDC shall be wired through the resistor.

I. Connectors

Connection to the display panel shall be made by three connectors, one pin (labeled P2) and one socket (labeled P1) and one labeled C5. The P1 and P2 connectors shall be 50-pin cannon D series, or equivalent 50 pin connectors and shall be compatible such that the two connectors can be connected directly to one another to bypass the input detection. Wiring for the P1, P2 and C5 connectors shall be as shown in the Plans.

The Contractor shall install wire connectors P1, P2, C1P, C2, C4, C5 and C6 according to the pin assignments shown in the Plans.

6. Model 204 Flasher Unit

Each Model 334 ramp meter cabinet shall be supplied with one Model 204 sign flasher unit mounted on the right rear side panel. The flasher shall be powered from T1-2. The outputs from the flasher shall be wired to T1-5 and T1-6.

7. Fiber Optic Patch Panel

The Contractor shall provide and install a rack-mounted fiber optic patch panel as identified in the Plans.

Cabinet Wiring

Terminal blocks TB1 through TB9 shall be installed on the Input Panel. Layout and position assignment of the terminal blocks shall be as noted in the Plans.

Terminals for field wiring in traffic data and/or ramp metering controller cabinet shall be labeled, numbered and connected in accordance with the following:

Terminal Block Pos.	Terminal and Wire Numbers	Connection Identification
TBS	501-502	AC Power, Neutral
T1-2	641	Sign on
T1-4	643	Sign off
T1-5	644	Flasher Output NC
T1-6	645	Flasher Output NO
T4-1	631	Lane 3 - Red
T4-2	632	Lane 3 - Yellow
T4-3	633	Lane 3 - Green
T4-4	621	Lane 2 - Red
T4-5	622	Lane 2 - Yellow
T4-6	623	Lane 2 - Green
T4-7	611	Lane 1 - Red
T4-8	612	Lane 1 - Yellow
T4-9	613	Lane 1 - Green

Loop lead-in cables shall be labeled and connected to cabinet terminals according to the ITS Field Wiring Chart. This chart will be provided by the Engineer within 20 days of the Contractor's request.

9-29.14 Vacant

9-29.15 Flashing Beacon Control

Flashers shall conform to the latest NEMA publication, and shall be solid state. When used as a beacon control, they shall be jack mounted and installed in raintight aluminum or hot dipped galvanized steel cabinet.

9-29.16 Vehicular Signal Heads

Each signal head shall be of the adjustable, vertical type with the number and type of lights detailed in the contract; shall provide a light indication in one direction only; shall be adjustable through 360 degrees about a vertical axis; and shall be mounted at the location and in the manner shown in the plans. Except for optically programmed signal heads, all vehicular signal heads at any one intersection shall be of the same make and type.

9-29.16(1) Optically Programmed, Adjustable Face, 12-inch Traffic Signal

The signal shall permit the visibility zone of the indication to be determined optically and require no hoods or louvers. The projected indication may be selectively visible or veiled anywhere within 15 degrees of the optical axis. No indication shall result from external illumination, nor shall one light unit illuminate a second. The display shall be maintained from 85 VAC to 130 VAC.

9-29.16(1)A Optical System

The components of the optical system shall comprise:

1. Lamp,
2. Lamp Collar,
3. Optical Limiter-Diffuser, and
4. Objective Lens.

The lamp shall be nominal 150 watt, 120 volt AC, three prong, sealed beam having an integral reflector with stippled cover and an average rated life of at least 6,000 hours. The lamp shall be coupled to the diffusing element with a collar including a specular inner surface. The diffusing element may be discrete or integral with the convex surface of the optical limiter.

The optical limiter shall provide an accessible imaging surface at focus on the optical axis for objects 900 to 1,200-feet distant, and permit an effective veiling mask to be variously applied as determined by the desired visibility zone. The optical limiter shall be provided with positive indexing means and composed of heat-resistant glass.

The objective lens shall be a high resolution planar incremental lens hermetically sealed within a flat laminant of weather resistant acrylic or approved equal. The lens shall be symmetrical in outline and may be rotated to any 90 degree orientation about the optical axis without displacing the primary image.

The optical system shall accommodate projection of diverse, selected indicia to separate portions of the roadway such that only one indication will be simultaneously apparent to any viewer after optically limiting procedures have been accomplished. The projected indication shall conform to ITE transmittance and chromaticity standards.

9-29.16(1)B Construction

Die cast aluminum parts shall conform to ITE alloy and tensile requirements and have a chromate preparatory treatment. The exterior of the signal case, lamp housing, and mounting flanges shall be finished with a high quality, baked enamel prime and finish paint.

The lens holder and interior of the case shall be optical black.

Signal case and lens holder shall be predrilled for backplates and visors. Hinge and latch pins shall be stainless steel. All access openings shall be sealed with weather resistant rubber gaskets.

Backplates shall conform to ITE material requirements and include a chromate preparatory treatment and optical black on all surfaces.

9-29.16(1)C Mounting

The signal shall mount to standard $1^1/_2$-inch fittings as a single section, as a multiple section face, or in combination with other signals. The signal section shall be provided with an adjustable connection that permits incremental tilting of at least 0 degree to 10 degree above or below the horizontal while maintaining a common vertical axis through couplers and mounting. Terminal connection shall permit external adjustment about the mounting axis in five degree increments. The signal shall be mountable with ordinary tools and capable of being serviced with no tools.

Attachments such as visors, backplates, or adapters shall conform and readily fasten to existing mounting surfaces without affecting water and light integrity of the signal.

9-29.16(1)D Electrical

The lamp fixture shall be comprised of a separately accessible housing and integral lamp support, indexed ceramic socket, and self-aligning, quick release lamp retainer. The electrical connection between case and lamphousing shall be accomplished with an interlock assembly which disconnects lamp holder when opened. Each signal section shall include a covered terminal block for clip or screw attachment of lead wires. Concealed 18 AWG-AWM, stranded and coded wires shall interconnect all sections to permit field connection within any section.

9-29.16(1)E Photo Controls

Each signal section shall include integral means for regulating its intensity between limits as a function of individual background illumination. Lamp intensity shall not be less than 97 percent of uncontrolled intensity at 1,000 ft-c ambient and shall reduce to 15 plus or minus 2 percent of maximum at less than 1 ft-c ambient. Response shall be proportional and essentially instantaneous to any detectable increase of illumination from darkness to 1,000 ft-c ambient and damped for any decrease from 100 ft–c ambient.

The intensity controller shall comprise an integrated, directional light, sensing and regulating device interposed between lamp and line wires. It shall be compatible with 60 Hz input and responsive within the range 105 VAC to 135 VAC. Output may be phase controlled, but the device shall provide a nominal terminal impedance of 1,200 ohms open circuit and a corresponding holding current.

9-29.16(1)F Installation

The signal shall be installed, directed, and veiled in accordance with published instructions and the project visibility requirement. Each section of the signal shall be masked with prescribed materials in an acceptable and workmanlike manner.

9-29.16(2) Conventional Traffic Signal Heads

9-29.16(2)A Optical Units

Light Emitting Diode (LED) light sources are required for all red, yellow and green arrow or ball displays. LED light sources must conform to the current Vehicle Traffic Control Signal Heads, Part 2 (VTCSH2) ITE Specification dated January 13, 2004 and the following requirements: LED shall have a 50 degree min. viewing angle

1. Wattage (Maximum): 12-inch red, yellow and green ball displays - 25 W
   12-inch red, yellow and green arrow displays - 15W
   8-inch red, yellow and green ball displays - 15W
2. Voltage: The operation voltages shall be between 85 VAC and 130VAC.
3. The LED display shall be a module type and shall replace the lens, socket, bail, reflector and be directly connected to the terminal strip in the signal head.
4. Label: A label shall be provided on the LED housing. The contractor shall mark the label with a permanent marker to note the installation date.

Incandescent light sources shall conform to the current Vehicle Traffic Control Signal Heads (VTCSH) ITE Specification and the following requirements:

1. Light Source: (8-inch Clear Bulb, A21/TS with brass medium base), (67 - 69 Watts), (12-inch clear bulb, P25/TS with brass medium base), (1650 lumens).
2. Voltage: 120 VAC.
3. Rated Initial Lumens at 120 VAC: (8-inch – 550), (12-inch- 1750).

4. Minimum Initial Lumens at 120 VAC: (8-inch – 550), (12-inch –1650).
5. Light Center: (8-inch, $2^{7}/_{16}$-inch), (12-inch, 3-inch).
6. Minimum Life: 8,000 hours.
7. Orientation: the bulb shall be installed with the opening between the filaments up.
6. Operation: The bulb shall operate properly form (-40°F to 170°F)
7. Lens: the lens material shall be prismed glass. The lens shall be secured to the housing with four noncorrosive clips and 4 No. 10 brass screws. The lens shall have a neoprene gasket making the display weather and dust tight.
10. Reflector: The reflector shall be specular aluminum with anodic coating.
11. Reflector Support: The reflector support shall be pivoted to the housing, and shall be designed so that it can be swung out or easily removed without the use of any tools.

9-29.16(2)B Signal Housing

The signal head housing, or case, shall consist of an assembly of separate sections, expandable type for vertical mounting, substantially secured together in a weathertight manner to form a unit of pleasing appearance. Each section shall house an individual optical unit.

Each section shall be complete with a one-piece, corrosion-resistant aluminum alloy die cast door and shall have a nominal 8-inch or 12-inch diameter opening for the lens. Each door shall be of the hinged type having two integrally cast hinge lugs and latch jaw. The door shall be attached to the housing by means of two noncorrosive, stainless steel hinge pins that are removable without the use of a special press or tool. A noncorrosive, stainless steel, threaded latch bolt and matching wing nut shall provide for opening and closing the door without the use of any special tools. Each door shall have a cellular neoprene gasket around the entire outer edge of the door, which, when the door is closed, shall make a positive weather and dust-tight seal. Each door shall have four tapped holes spaced about the circumference of the lens opening with four noncorrosive screws to accommodate the signal head visors. Each door shall have some device such as washers, clips, or keys, or be constructed so as to keep it from dismounting from the housing accidentally when it is open.

The body of each signal section shall consist of a one piece corrosion resistant, die cast aluminum alloy. Each section shall have serrated rings top and bottom so when used with proper brackets, each section may be adjustable in respect to an adjoining section, and the hangers may be locked securely to prevent moving. Cast integrally with the housing shall be two hinge lugs and one latch jaw. The top and bottom of the housing shall have an opening to accommodate standard $1^{1}/_{2}$-inch pipe brackets. The sections shall be so designed that when assembled, they interlock with one another forming one continuous weathertight unit. The sections shall be interchangeable and shall be dust and weathertight when assembled with the door and appropriate furnished hardware.

A terminal block of an approved type shall be mounted inside at the back of the housing. All sockets shall be so wired that a white wire will be connected to the shell of the socket and a wire, the color of the lens, to the bottom, or end terminal of the socket. These wires shall in turn be connected to the terminal block mounted in the housing, in the proper manner. The terminal block shall have sufficient studs to terminate all field wires and lamp wires independently to the block with separate screws. The terminals to which field wires are attached shall be permanently identified to facilitate field work.

Each face shall be protected with a removable visor. The visor shall be tunnel type unless noted otherwise in the contract. Tunnel, cap, and cut away type visors shall be molded using ultraviolet and heat stabilized polycarbonate plastic or be constructed of 0.050-inch corrosion resistant aluminum material throughout as specified in the contract, or as ordered by the Engineer in accordance with Section 1-04.4. Visors shall be flat black in color inside and shall be flat black or dark green on the outside. Visors shall have attaching ears for installation to the housing door. The signal display shall have square doors. End caps shall be made from aluminum or plastic material and shall be installed with fittings to provide a watertight seal. A bead of silicone sealant shall be applied around the perimeter of all top end cap openings prior to installation of the end cap assembly. Plastic end caps shall utilize a threaded stud with seal and wing nut. Plastic end caps utilizing a metal screw that may damage the cap if overtightened will not be allowed. Plastic end caps shall have the same color as the signal housing.

9-29.16(2)C Louvered Visors

Where noted in the Contract, louvered tunnel visors shall be furnished and installed. Directional, Geometrically Programmed louvers shall be constructed to have a snug fit in the signal visor. Louvers shall be flat black, constructed of aluminum or ABS and polycarbonate plastic. Dimensions and arrangement of louvers shall be as shown in the contract.

9-29.16(2)D Back Plates

Back plates shall be furnished and attached to the signal heads. Back plates shall be constructed of 5-inch wide .050-inch thick corrosion resistant flat black finish, louvered aluminum or as specified in the contract.

9-29.16(2)E Painting Signal Heads

Traffic signal heads shall be finished with two coats of factory applied dark green (Federal Standard 595B) baked enamel or shall be finished with a dark green oven baked powder coating comprised of resins and pigments. Aluminum end caps shall be painted to match the color of the signal housing.

9-29.16(3) Polycarbonate Traffic Signal Heads

Polycarbonate signal heads shall be provided only when specifically identified in the contract. With the exception of top and bottom bracket mountings, polycarbonate signal heads shall be installed with approved reinforcing plates located in signal sections adjacent to the mounting hardware.

9-29.16(3)A 8-inch Polycarbonate Traffic Signal Heads

Polycarbonate employed in traffic signal fabrication shall tolerate an elongation prior to break in excess of 90 percent. The green color shall be molded throughout the head assembly. Glass lenses shall be employed in the signal heads. The optical system shall be of the fixed focus type for 67 to 69 watt bulbs. The entire optical system shall be sealed by a single neoprene gasket. Alzak aluminum reflectors will be permitted in polycarbonate traffic signal head assemblies. The signal head shall be formed to be used with standard signal head mounting accessories. The optical system shall be consistent with ITE requirements. All hinge pins, latch assemblies and reflector assemblies shall conform to 9-29.16(2)B.

9-29.16(3)B 12-inch Polycarbonate Traffic Signal Heads

Twelve inch polycarbonate signal heads shall conform to all requirements of the 8-inch polycarbonate signal heads except the optical system shall be designed for a 1750 lumen traffic signal lamp.

9-29.17 Signal Head Mounting Brackets and Fittings

Vehicle and pedestrian signal head mountings shall be as detailed in the Standard Plans. Material requirements for signal head mounts are as follows:

Aluminum

1. Hinge fittings for Type E mount.
2. Arms and slotted tube fittings for Type N mount.
3. Tube clamp and female clamp assembly for Type N mount.

Bronze

1. Terminal compartments for Type A, B, C, F, H, and K mounts.
2. Collars for Type C, D, and F mounts.
3. Ell fittings for Type L and LE mounts.
4. Plumbizer for type M mounts
5. Messenger hanger and wire entrance fittings for Type P, Q, R, and S mounts.
6. Balance adjuster for Type Q, R, and S mounts.

Galvanized Steel

1. Washers for Type A, B, C, D, F, H, and K mounts.
2. Fasteners for Type A, B, E, H, and K mounts.

Stainless Steel

1. All set screws and cotter Keys.
2. Bands for Type N mount.
3. Hinge pins for Type E mount.
4. Bolts, nuts and washers for Type M mount.
5. Bolt, nut and washers for Type L mount.
6. Bolts, nuts, washers, and screw buckle swivels.

Steel

1. Center pipes, nipples, elbow and tee fittings for Type A, B, C, F, H, and K mounts.
2. Multi-head mounting assemblies and spider assemblies for Type Q, R, and S mounts.
3. Nipples for Type L, LE, P, Q, R, and S mounts.

Fittings for Type N mounts shall be installed unpainted. All other hardware for other mounts shall be painted with two coats of factory applied traffic signal green baked enamel.

Pins for messenger hanger fittings shall be a minimum of $^1/_2$-inch in diameter.

Terminal compartments for Type A, B, C, F, H, and K mounts shall contain a 12 section terminal block.

9-29.18 Vehicle Detector

Induction loop detectors and magnetometer detectors shall comply with current NEMA specifications when installed with NEMA control assemblies and shall comply with the current California Department of Transportation document entitled "Transportation Electrical Equipment Specifications," specified in Section 9-29.13(7) when installed with Type 170 2070, 2070 Lite, ITS/ATC control assemblies.

9-29.18(1) Induction Loop Detectors

When required in the contract, amplifier units shall be provided with supplemental timing features identified as follows:

1. Delay Timing. When delay timing is required, the unit shall delay detector output for up to 15 seconds minimum, settable in one second maximum intervals.
2. Delay Timing With Gate. When delay timing with gate is required, the unit shall provide delay timing features as noted above with the additional capability of inhibiting delay timing when an external signal is applied.
3. Extension Timing. When extension timing is required, the unit shall extend the detector output for up to 7 seconds minimum, settable in 0.5 second minimum intervals.
4. Delay and Extension Timing With Gate. When delay and extension timing with gate is required, the unit shall provide both delay and extension timing features as noted above with the additional capability of inhibiting delay while enabling extension upon application of an external signal. Without external signal, the unit shall inhibit extension and enable delay.

9-29.18(2) Magnetometer Detectors

Magnetometer detector units and sensors shall conform to the following specifications:

1. Operation. The magnetometer detector unit shall respond to changes in the earth's local magnetic field caused by the passage of a vehicle containing iron or steel over the sensor unit.
2. Environmental Requirements. Satisfactory operation shall be attained over the ambient temperature range from -30°F to 160°F. Operation shall be unaffected by temperature change, water, ice, pavement deterioration, or electromagnetic noise.
3. Modes of Operation. Each detector channel shall be capable of functioning in any of four front-panel selectable modes:
   a. Presence. Time of detection shall be unlimited.
   b. Extended Presence. The detection output shall extend for a timer set value of up to 5 seconds after the detection zone has cleared.
   c. Pulse. A single 30 to 50 millisecond pulse will be generated per detection actuation.
   d. Inhibited Pulse. The detection output will be inhibited for a time set value of up to 5 seconds after the detection zone has cleared.

4. Response Time. Pick up and drop out times shall be consistently within 10 milliseconds.
5. Approach Speed. The unit shall be capable of detecting vehicles traveling from 0 to 80 miles per hour.
6. Sensor Probes. Each channel of the detector unit shall be capable of operating up to three sensing probes.

9-29.19 Pedestrian Push Buttons

Where noted in the contract, pedestrian push buttons of substantially tamper-proof construction shall be furnished and installed. They shall consist of a 2-inch nominal diameter plunger and a momentary contact switch assembled with the push button sign shown in the plans. The switch may have magnetic, or piezoelectric switch, or actuated by a three bladed beryllium copper spring, and shall be rated 10 amperes, 125 volts.

The plunger may have an LED to indicate that a pedestrian call has been registered.

The pedestrian push-button assembly shall be constructed and mounted as detailed in the contract.

9-29.20 Pedestrian Signals

Pedestrian signals shall be either neon-grid type, or LED as specified in the contract. Pedestrian signals shall conform to ITE Standards (Standard for Adjustable Face Pedestrian Signal Heads, 1975).

The Pedestrian signal heads shall be on the QPL or A Certificate of Compliance shall be submitted by the manufacturer with each type of signal head. The certificate shall state that the lot of pedestrian signal heads meets the following requirements:

A. All pedestrian signal heads shall be Neon Grid type or Light Emitting Diode (LED) or LED Walk/Don't Walk module.
B. All pedestrian displays shall comply with ITE publication ST 011B, VTCSH2 or current ITE specification, and the current draft or adopted Caltrans pedestrian LED displays and following requirements:
   (1) All pedestrian signals supplied to any one project shall be from the same manufacturer and type but need not be from the same manufacturer as the vehicle heads.
   (2) Word messages, when specified, shall provide letters a minimum of $4^1/_2$-inches high. Symbol messages, when specified, shall be a minimum of 12-inches high and 7-inches in width.
   (3) Housings shall be green polycarbonate or die-cast aluminum and the aluminum housings shall be painted with two coats of factory applied traffic signal green enamel (Federal Standard 595B). All hinges and latches and interior hardware shall be stainless steel.

9-29.20(1) LED Pedestrian Displays

Optical units for traffic signal displays shall conform to the following:

1. Light emitting diode (LED) light sources are required for 12-inch Portland Orange Hand and may be installed for the Lunar White Walking Man. LED displays shall conform to the following:
   a. Wattage (Maximum): 12-inch Portland Orange Hand 15 watts 12-inch Lunar White walking Man 15 watts

b. Voltage: The operating voltages shall be between 85 VAC and 135 VAC.
c. Temperature: Temperature range shall be -35° F to +165° F.
d. LEDs shall be driven at no more than 50% of their rated amperage.
e. 12-inch Portland Orange Hand Circuit Configuration:
   1. LEDs shall be connected to form multiple series circuits, with a minimum of 2 circuits. All series circuits shall be interconnected at intervals forming subcircuits not exceeding 15 LEDs each. These subcircuits shall limit the number of extinguished LEDs to no more than 10% of the total on the display in the event of a single LED failure.
f. 12-inch Lunar White Walking Man 1 Circuit Configuration: LEDs shall be connected to form multiple series circuits, with a minimum of 1 circuits. All series circuits shall be interconnected at intervals forming subcircuits not exceeding 15 LEDs each. These subcircuits shall limit the number of extinguished LEDs to no more than 10% of the total on the display in the event of a single LED failure.
g. Color testing shall be conducted after 30 minutes of continuous operation.
h. LED pedestrian heads shall be supplied with Z crate visors. Z crate visors shall have 21 members at 45 degrees and 20 horizontal members.

9-29.20(2) Neon Grid Type

Neon grid pedestrian heads shall be solid state type and shall be supplied with Z crate visors. Z crate visors shall have 21 members at 45 degrees and 20 horizontal members.

Neon tubing shall be enclosed and shock-mounted inside a rugged plastic module. The unit shall be $1^1/_2$-inches deep. Members shall be constructed of 0.03-inch thick black polycarbonate plastic.

A combination switch/fuse holder shall be provided for each transformer. Each unit shall provide a grounding terminal.

Transformers shall provide recessed secondary contacts and integral Pyrex glass electrode housing.

9-29.21 Flashing Beacon

Flashing beacons shall be installed as detailed in the Plans, as specified in the Special Provisions, and as described below:

Controllers for flashing beacons shall be as specified in Section 9-29.15.

Beacons shall consist of single section, 8-inch or 12-inch traffic signal heads, three or four-way adjustable, meeting all of the applicable requirements of Section 9-29.16. Displays (red or yellow) may be either LED type or incandescent. 12-inch yellow displays shall be dimmed 50% after dark.

Mounting brackets, mountings, and installation shall meet all applicable requirements of Section 9-29.17.

Lenses shall be either red or amber, glass or polycarbonate as noted in the Plans.

9-29.22 Vacant

9-29.23 Vacant

9-29.24 Service Cabinets

In addition to the requirements for service cabinets indicated in the contract, the following requirements shall apply:

A. All electrical conductors, buss bars, and conductor terminals shall be copper. Conductor insulation shall be either THW, XHHW, USE, or SIS.

B. If field wiring larger than that which the contactors or breakers will accommodate is required by the contract, a terminal board shall be supplied for use as a splicing block.

C. The minimum size of all other load carrying conductors used within the service cabinets shall be based on the National Electrical Code ampacity tables for not more than three conductors in a raceway or cable.

D. Type B, B Modified, C, D, and E Cabinets shall have ventilation louvers on the lower sides complete with screens. Type D, and E shall also have rain-tight cabinet vents with screens at the top. Cabinet vents shall be gasketed.

E. The Type B modified cabinets shall have one future use double pole circuit breaker. Type D, and E cabinets shall have two future use double pole circuit breakers. The dead front cover shall have cutouts with for all circuits. The receptacle shall be ground fault interrupter equipped.

F. The minimum size of control circuit conductors used in service cabinets shall be 14 AWG stranded copper.

All electrical contactors shall have the loadside terminals toward the front (door side) of the service cabinet.

G. The lighting contactors used shall be specifically rated for tungsten fluorescent and mercury arc lamp loads.

H. All service enclosures shall be fabricated from steel or aluminum. If aluminum, they shall be fabricated from 0.125-inch (minimum) 5052 H 32 ASTM designator or B209 aluminum. If steel, they shall be fabricated from 12 gage (minimum) steel, hot dipped galvanized per AASHTO M 111.

I. All doors and dead front panels installed in service cabinets shall incorporate a hinge placed in a vertical plane. Service doors shall be sealed with closed cell gasket material. The side opposite the hinge shall be secured with quarter turn screws or slide latch. No electrical devices shall be connected to the dead front panel. However, every switch serviced through the dead front panel shall be appropriately identified with its respective circuit designation by means of a screwed or riveted engraved name plate. Such circuit identification shall be submitted for approval together with the appropriate fabrication drawings. Dead front panels shall be intended to provide security only to the switching segment of the service enclosure and shall not cover the electrical contactor portion.

J. A typed index of all circuits shall be mounted on the cabinet door. Each index shall show an entire panel section without folding. Index holders shall have metal returns on the sides and bottom. A schematic of the main panel, any subpanels, circuits, and control circuits shall be provided. The schematic shall be plastic coated and secured in a metal holder.

9-29.24(1) Vacant

9-29.24(2) Electrical Circuit Breakers and Contactors

Lighting contactors shall be rated 240 volts maximum line to line, or 277 volt maximum line to neutral voltage for tungsten and ballasted lamp loads on 120/240/277 volt circuits, whichever is applicable, or they shall be rated 480 volt maximum line to line voltage for higher than 277 volt circuited tungsten or ballasted lamp loads.

As an alternate to the lighting contactor, the Contractor may furnish a double contact mercury relay. The relay ampere rating shall equal or exceed the rating noted in the contract. The relay shall be normally open and shall be rated for up to 480 VAC resistive. The unit shall have a molded coil enclosure rated for 120 VAC. The contacts shall be evacuated, backfilled with an inert gas and shall be hermetically sealed. The electrode shall be one piece with Teflon wear rings on the internal plunger assembly. All contact terminals and coil connection clamps shall be U.L. approved.

Circuit breakers shall be 240 or 277 volt maximum rated for 120/240/277 volt circuits, whichever is applicable, and shall have an interrupting capacity (R.M.S. — symmetrical) of not less than 10,000 amperes. They shall have not less than 480 volt rated for circuits above 277 volts and shall have an interrupting capacity (R.M.S. — symmetrical) of not less than 14,000 amperes. Circuit breakers shall be bolt-on type.

9-29.25 Amplifier, Transformer, and Terminal Cabinets

Amplifier, terminal, and transformer cabinets shall conform to the contract, NEMA 4 requirements and the following:

1. All cabinets shall be constructed of welded 14 gage (minimum) hot dipped galvanized sheet steel, 14 gage, minimum type 316 stainless steel or 0.125-inch, minimum 5052 alloy aluminum H32 ASTM designator minimum.
2. Nominal cabinet dimensions shall be:

		Depth	Height	Width
a.	Terminal	8”	16”	12”
b.	Terminal	8”	24”	18”
c.	Transformer Up to 3.0 KVA	12”	18”	18”
	Transformer 23.1 to 12.5 KVA	20”	40”	24”
	Transformer 12.6 to 35 KVA	30”	60”	32”

3. Cabinet doors shall be gasketed with a one-piece closed cell neoprene gasket and shall have a stainless steel piano hinge. The door shall also be provided with a three point latch and a spring loaded construction core lock capable of accepting a Best six pin CX series core. The locking mechanism shall provide a tapered bolt. The contractor shall supply construction cores with two master keys. The keys shall be delivered to the engineer.
4. All seams shall be continuously welded.
5. All cabinets shall provide a door flange.
6. Transformer cabinets shall provide a 9 square inch minimum louvered vent.
7. One spare 12-position terminal block shall be installed in each terminal cabinet and amplifier cabinet.
8. Each Terminal, Amplifier and Transformer cabinet shall have $^{1}/_{8}$-inch drain holes in back corners.

9. Mounting shall be as noted in the contract.
10. Transformer cabinets shall have two separate compartments, one for the transformer and one for the power distribution circuit breakers. Each compartment shall be enclosed with a dead front. Each breaker shall be labeled with the device name.

9-30 WATER DISTRIBUTION MATERIALS

This specification addresses pipe and appurtenances 16-inches in diameter and smaller. Water distribution material incorporated in the work shall be new.

The Contractor shall provide to the Engineer the names of the manufacturer(s) of the water distribution materials proposed for inclusion in the work, which materials shall conform in every respect to these specifications. If so required by the Special Provisions, the Contractor shall provide to the Engineer in addition to the names of the manufacturer(s) of the water distribution materials, a Manufacturer's Certificate of Compliance meeting the provisions of Section 1-06.3, for the materials proposed for inclusion in the work. As used in this specification, the term "lot of material delivered to the work" shall mean a shipment of the water distribution materials as it is delivered to the work.

The Engineer shall have free access to all testing and records pertaining to material to be delivered to the job site. The Engineer may elect to be present at any or all material testing operations.

9-30.1 Pipe

All pipe shall be clearly marked with the manufacturer's name, type, class, and thickness as applicable. Lettering shall be legible and permanent under normal conditions of handling and storage.

9-30.1(1) Ductile Iron Pipe

1. Ductile iron pipe shall be centrifugally cast and meet the requirements of AWWA C151. Ductile iron pipe shall have a cement mortar lining meeting the requirements of AWWA C104. Ductile iron pipe to be joined using bolted flanged joints shall be Standard Thickness Class 53. All other ductile iron pipe shall be Standard Thickness Class 50 or the thickness class as shown in the Plans.
2. Nonrestrained joints shall be rubber gasket, push on type, or mechanical type meeting the requirements of AWWA C111.
3. Restrained joints shall be as specified in Section 9-30.2(6).

9-30.1(2) Polyethylene Encasement

Polyethylene encasement shall be tube-form meeting the requirements of ANSI/AWWA C105 and shall be high-density, cross-laminated polyethylene film, natural or black color.

9-30.1(3) Vacant

9-30.1(4) Steel Pipe

9-30.1(4)A Steel Pipe (6-inches and Over)

Steel pipe 6-inches in diameter and larger shall conform to AWWA C200. The type of protective coating and lining and other supplementary information required by AWWA C200 shall be included in the Special Provisions.

9-30.1(4)B Steel Pipe (4-inches and Under)

Steel pipe 4-inches in diameter and smaller shall be hot-dip galvanized inside and out and meet the requirements of ASTM A 53.

9-30.1(5) Polyvinyl Chloride (PVC)

9-30.1(5)A Polyvinyl Chloride (PVC) Pipe (4-inches and Over)

PVC pipe for water mains shall meet the requirements of ANSI/AWWA C900 or ANSI/AWWA C905. PVC pipe shall have the same outside dimensions as ductile iron pipe. PVC pipe for distribution pipelines shall be a minimum of SDR 18. Pipe shall be listed by Underwriters' Laboratories, Inc.

PVC pipe shall be considered flexible conduit. Joints shall meet the requirements of ASTM D 3139 using a restrained rubber gasket conforming to ASTM F 477. Solvent welded pipe joints are not permitted.

9-30.1(5)B Polyvinyl Chloride (PVC) Pipe (Under 4-inches)

Polyvinyl chloride (PVC) under 4-inches shall meet the requirements of ASTM D 2241. Pipe material shall be PVC 1120, PVC 1220, or PVC 2120, and shall have minimum wall thickness equal or greater than a standard dimension ratio (SDR) of 21. Pipe shall bear the National Sanitation Foundation Seal for use to transport potable water. Pipe shall be considered flexible conduit. Joints shall meet the requirements of ASTM D 3139 using a restrained rubber gasket meeting the requirements of ASTM F 477.

9-30.1(6) Polyethylene (PE) Pressure Pipe (4-inches and Over)

PE pressure pipe for water mains shall meet the requirements of ANIS/AWWA C906. Pipe materials shall be high-density polyethylene PE3408 conforming to a minimum cell class 345464 C, D or E per ASTM D 3350. Pipe diameter shall be either iron pipe size per Table 3 and Table 5 or ANSI/AWWA C906. Pipe pressure class shall be as listed in Table 9 of ANSI/AWWA C906 for DR 9 PE3408 material.

9-30.2 Fittings

Bolts, nuts, and washers used for securing fittings shall be of similar materials. Steel bolts shall meet the requirements of ASTM A 307 or ASTM F 568 for carbon steel or ASTM F 593 or ASTM F 738 for stainless steel. Nuts shall meet the requirements of ASTM A 563 or ASTM A 563 for carbon steel or ASTM F 594 or ASTM F 836 for stainless steel. Iron bolts and nuts shall meet the requirements of ASTM A 536, grade 65-45-12.

9-30.2(1) Ductile Iron Pipe

Fittings for ductile iron pipe shall meet the requirements of AWWA C110 or AWWA C153. Joints shall meet the requirements of AWWA C111. Fittings shall be cement mortar lined, meeting the requirements of AWWA C104. Gaskets for flat faced or raised faced flanges shall be $\frac{1}{8}$-inch thick neoprene having a durometer of 60 plus or minus 5 or $\frac{1}{16}$ cloth inserted. The type, material, and identification mark for bolts and nuts shall be provided.

9-30.2(2) Vacant

9-30.2(3) Vacant

9-30.2(4) Steel Pipe

9-30.2(4)A Steel Pipe (6-inches and Over)

Fittings for steel pipe 6-inches and larger shall be bell and spigot or welded to match the pipe joints. Welded joints shall conform to AWWA C206. Field couplings shall be bolted, sleeve-type for plain-end pipe conforming to AWWA C219. Expansion joints shall be fabricated steel mechanical slip-type conforming to AWWA C221.

When flanges are required, they shall conform to AWWA C207. Linings and coatings for fittings shall be the same as specified for the adjacent pipe.

9-30.2(4)B Steel Pipe (4-inches and Under)

Fittings for steel pipe 4-inches and under shall be malleable iron threaded type with a pressure rating of 150 psi. Dimensions shall meet the requirements of ANSI B16.3. Threading shall meet the requirements of ANSI B2.1. Material shall meet requirements of ASTM A 47M, Grade 32510. Fittings shall be banded and hot-dip galvanized inside and out.

9-30.2(5) Polyvinyl Chloride (PVC) Pipe

9-30.2(5)A Polyvinyl Chloride (PVC) Pipe (4-inches and Over)

Fittings for PVC pipe shall be the same as specified for ductile iron pipe.

9-30.2(5)B Polyvinyl Chloride (PVC) Pipe (Under 4-inches)

Fittings for PVC pipe under 4-inches shall meet the requirements of ASTM D 2466.

9-30.2(6) Restrained Joints

The restraining of ductile iron pipe, fittings, and valves shall be accomplished by the use of either a bolted or boltless system. Any device utilizing round point set screws shall not be permitted.

All couplings installed underground to connect ductile iron or PVC pipe shall be manufactured of ductile iron.

9-30.2(7) Bolted, Sleeve-Type Couplings for Plain End Pipe

Bolted, sleeve-type couplings, reducing or transition couplings, and flanged coupling adapters used to join plain-end pipe shall meet the requirements of AWWA C219. Buried couplings to connect ductile iron, gray cast iron, or PVC pipe shall be ductile iron. Buried couplings for connecting steel pipe to steel pipe shall be steel.

9-30.2(8) Restrained Flexible Couplings

Restrained flexible couplings shall be locking type couplings in accordance with the Plans or Special Provisions. Any couplings that utilize set screws tightened against the outside pipe wall are not acceptable. Coupling shall be epoxy coated.

9-30.2(9) Grooved and Shouldered Joints

Grooved and shouldered joints shall conform to AWWA C606. Rigid or flexible grooved or shouldered joints shall be as specified in the Special Provisions.

9-30.2(10) Polyethylene (PE) Pipe (4-inches and Over)

Fittings for PE pipe shall meet the requirement of ANSI/AWWA C906. Pipe material shall be high-density polyethylene PE3408 conforming to minimum cell class 345464 C, D or E per ASTM D 3350. Pipe diameter shall be either iron pipe size per Table 3 and Table 5 of ANSI/AWWA C906 or ductile iron pipe size per Table 7 and Table 8 of ANSI/AWWA C 906. Pipe pressure class shall be as listed in Table 9 of ANSI/AWWA C 906 for DR 9 PE3408 material.

9-30.2(11) Fabricated Steel Mechanical Slip-Type Expansion Joints

Fabricated steel mechanical slip-type expansion joints shall meet the requirements of ANSI/AWWA C 221. Buried Expansion joints to connect ductile iron or PVC pipe shall be ductile iron. Buried expansion joints for connecting steel pipe to steel pipe shall be steel.

9-30.3 Valves

Valves shall be provided with hand wheels or operating nuts as designated. Where operating nuts are called for, a standard 2-inch operating nut shall be furnished. Valves shall be nonrising stem type, open counterclockwise, and be equipped with an O ring stuffing box.

9-30.3(1) Gate Valves (3-inches to 16-inches)

Gate valves shall meet the requirements of AWWA C509 or AWWA C515. Gate valves 16-inches in size shall be arranged for operation in the horizontal position by enclosed bevel gearing.

Prior to shipping, three certified copies of performance tests, as specified in Section 6 of AWWA C509 or Sections 5 and 6 of AWWA C515, shall be submitted to the Engineer for review.

9-30.3(2) Vacant

9-30.3(3) Butterfly Valves

Butterfly valves shall be rubber seated and shall meet the requirements of AWWA C504, Class 150B. Butterfly valves shall be suitable for direct burial.

Valve operators shall be of the traveling nut or worm gear type, sealed, gasketed, and permanently lubricated for underground service. Valve operators shall be constructed to the standard of the valve manufacturer to withstand all anticipated operating torques and designed to resist submergence in ground water.

The Contractor shall provide an affidavit of compliance stating that the valve furnished fully complies with AWWA C504.

9-30.3(4) Valve Boxes

Valve boxes shall be installed on all buried valves. The box shall be of cast iron, two piece slip type standard design with a base corresponding to the size of the valve. The box shall be coal tar painted by the manufacturer using its standard. The cover shall have the word “WATER” cast in it.

9-30.3(5) Valve Marker Posts

Posts shall have a 4-inch minimum square section and a minimum length of 42-inches, with beveled edges and shall contain at least one No. 3 bar reinforcing steel.

The exposed portion of the marker posts shall be coated with two coats of concrete paint in a color selected by the Contracting Agency.

The size of the valve and the distance in feet and inches to the valve shall be stenciled on the face of the post, using black paint and a stencil which will produce letters 2-inches high.

9-30.3(6) Valve Stem Extensions

Valve stem extensions shall have a 2-inch square operating nut and self-centering rockplate support. Valves with an operating nut more than 4-feet below grade shall have a valve stem extension to raise the operating nut to within 36-inches of the ground surface.

9-30.3(7) Combination Air Release/Air Vacuum Valves

Combination air release/air vacuum valves shall be designed to operate with potable water under pressure to permit discharging a surge of air from an empty line when filling and relieve the vacuum when draining the system. The valves shall also release an accumulation of air when the system is under pressure. This shall be accomplished in a single valve body designed to withstand 300 psi.

The body and cover shall be cast iron conforming to ASTM A 48, Class 30. Floats shall be stainless steel conforming to ASTM A 240 and designed to withstand 1,000 psi. Seats shall be Buna N rubber. Internal parts shall be stainless steel or bronze.

9-30.3(8) Tapping Sleeve and Valve Assembly

Tapping valves shall be furnished with flanged inlet end connections. The outlet ends shall conform in dimensions to the AWWA Standards for hub or mechanical joint connections, except that the outside of the hub shall have a large flange for attaching a drilling machine. The seat opening of the valve must permit a diameter cut no less than ½-inch smaller than the valve size. Valves specifically designed for tapping meeting the requirements of AWWA C500, and valves meeting the requirements of AWWA C509, will be permitted. Tapping valves shall be of the same type as other valves on the project. Tapping sleeves shall be cast iron, ductile iron, stainless steel, epoxy coated steel, or other approved material.

9-30.4 Vacant

9-30.5 Hydrants

Fire hydrants shall conform to AWWA C502 and shall be of standard manufacture and of a pattern approved by the Contracting Agency.

9-30.5(1) End Connections

The end connections shall be mechanical joint or flanged, meeting the requirements of AWWA C110 and C111.

9-30.5(2) Hydrant Dimensions

Hydrant connection pipes shall be 6-inches inside diameter with 6-inch auxiliary gate valves. Barrels shall have a 7-inch minimum inside diameter. Hydrant length, measured from the bottom of the hydrant to the sidewalk ring, shall provide proper cover at each installed location. Valve openings shall be 5¼-inches minimum diameter. Hydrants shall have two 2½-inch hose nozzles and one pumper nozzle to match Contracting Agency's connection requirements.

Nozzles shall be fitted with cast iron threaded caps with operating nuts of the same design and proportions as the hydrant stem nuts. Caps shall be threaded to fit the corresponding nozzles and shall be fitted with suitable neoprene gaskets of positive water tightness under test pressures. The direction of opening shall be counterclockwise and shall be clearly marked on the operating nut or hydrant top. Hydrants shall be with O ring stem seals. The hydrant shall be painted with two coats of paint to match the owner's existing hydrants.

9-30.5(3) Hydrant Extensions

Hydrant extensions shall have a 6¾-inch minimum inside diameter and shall be gray cast iron or ductile iron and shall conform to the AWWA Standards for such castings. The drillings of the connecting flanges on the extensions shall match the drillings of the flanges on the hydrant.

Hydrant extensions shall also include the necessary hydrant operating stem extensions.

9-30.5(4) Hydrant Restraints

Shackle rods shall be ¾-inch diameter with threaded ends, and shall be ASTM A 36 steel. Shackle rods shall be coated with two coats of asphalt varnish. If a restrained joint system is used, it shall meet the requirements of Section 9-30.2(6).

9-30.5(5) Traffic Flange

Hydrants shall be provided with a traffic flange and shall be equipped with breaking devices at the traffic flange which will allow the hydrant barrel to separate at this point with a minimum breakage of hydrant parts in case of damage. There shall also be provided at this point, a safety stem coupling on the operating stem that will shear at the time of impact.

9-30.5(6) Guard Posts

Guard posts for hydrants shall be provided where shown in the Plans. Guard posts shall be reinforced concrete having a compressive strength of 3,500 psi and shall be 6-feet in length by 9-inches in diameter. Reinforcing shall consist of a minimum of five No. 3 deformed steel bars.

9-30.6 Water Service Connections (2-inches and Smaller)

9-30.6(1) Saddles

Saddles shall be ductile iron, bronze, brass, or stainless steel.

Saddles used for ¾-inch and 1-inch services shall be single strap and may be either AWWA tapered thread or female iron pipe thread outlet. Saddles used for 1½-inch and 2-inch services shall be double strap and shall be female iron pipe thread outlet. Saddles used on PVC pipe shall be formed for PVC pipe and have flat, stainless steel straps.

9-30.6(2) Corporation Stops

Corporation stops shall be made of bronze or brass alloy.

Corporation stops for direct tapping shall have AWWA tapered thread inlet and an outlet connections compatible with either copper or polyethylene tubing.

Corporation stops used with ¾-inch and 1-inch outlet saddles shall have either AWWA tapered thread or male iron pipe thread inlets and outlet connections compatible with either copper or polyethylene tubing. Thread patterns for the saddle outlet and corporation stop inlet shall be the same.

Corporation stops used with 1½-inch and 2-inch outlet saddles shall have male iron pipe thread inlets and outlet connections compatible to connecting service pipes or have male iron pipe thread outlets.

9-30.6(3) Service Pipes

9-30.6(3)A Copper Tubing

Copper tubing shall be annealed, seamless, and conform to the requirements of ASTM B 88M, Type K.

9-30.6(3)B Polyethylene Tubing

Polyethylene tubing shall meet the requirements of AWWA C901. Tubing shall be high molecular mass with a 200 psi rating. Tubing used for ¾-inch and 1-inch shall be either SIDR 7 (iron pipe size) or SDR 9 (copper tube size). Tubing used for 1½-inches and 2-inches shall be SDR 9 (copper tube size).

9-30.6(4) Service Fittings

Fittings used for service connections shall be made of bronze or brass alloy.

Fittings used for copper tubing shall be either compressions or flare type.

Fittings used for polyethylene tubing shall be either compression or stab type. Stab type fittings shall utilize an internal grip ring and O ring seal. Stainless steel liners shall be used when utilizing compression fittings on polyethylene tubing.

9-30.6(5) Meter Setters

Meter setters shall be manufactured and tested in accordance with all applicable parts of AWWA C800.

Meter setters shall have an angle meter stop with drilled padlock wing, an angle check valve, measure 12-inches in height, and shall have an inlet and outlet threads compatible with fittings connecting to service pipes.

Meter setters for 5/8-inch by ¾-inch,¾-inch, and 1-inch services shall have meter saddle nuts for installation and removal of the meter.

Meter setters for 1½-inch and 2-inch services shall be equipped with a locking bypass.

9-30.6(6) Bronze Nipples and Fittings

Bronze threaded nipples and fittings shall meet the requirements of ANSI B-16.15, ASA 125 pound class.

9-30.6(7) Meter Boxes

Meter boxes and covers located in the non-traffic areas shall be constructed of either reinforced concrete or high-density polyethylene. High-density polyethylene meter boxes and covers shall have a tensile strength conforming to ASTM D 638. Meter box covers shall include a reading lid.

Meter boxes located in traffic areas shall be constructed of reinforced concrete, cast iron, or ductile iron. Traffic covers shall be constructed of aluminum, steel, cast iron, or ductile iron. Meter boxes and covers shall be designed for H-20 loading.

9-31 ELASTOMERIC BEARING PADS

9-31.1 Requirements

Elastomeric bearing pads shall conform to the requirements of AASHTO M 251. The elastomer shall not contain any form of wax.

All bearing pads shall be individually cast with fully molded edges. Corners and edges of molded pads may be rounded at the option of the Contractor. Radius at corners shall not exceed ⅜-inch, and radius of edges shall not exceed ⅛-inch.

Shims contained in laminated bearing pads shall be mill rolled steel sheets not less than 20 gage in thickness with a minimum cover of elastomer on all edges of:

⅛-inch for pads less than or equal to 3-inches thick.

¼-inch for pads greater than 3-inches and less than or equal to 7-inches thick, and

½-inch for pads greater than 7-inches thick.

Steel shims shall conform to ASTM A 1011, Grade 36, unless otherwise noted.

The shims shall be spaced to divide the pad thickness into equal laminations. The bond between the elastomer and metal shims shall be such that, when a sample is tested for separation, failure shall occur within the elastomer and not between the elastomer and the metal shim.

The shear modulus at 73º F or the durometer hardness of the bearing pads shall be as noted in the contract. If durometer hardness is noted, the following shear modulus shall be applicable for shear modulus testing purposes: 50 durometer - 112 psi, 60 durometer - 165 psi, 70 durometer - 250 psi. Elastomer shall be Grade 3.

Elastomeric bearing pads shall be manufactured with the following tolerances:

Overall vertical dimensions:

Design thickness 1¼-inches or less	-0, +⅛-inch
Design thickness over 1¼-inches	-0, +¼-inch

Overall horizontal dimensions:

36-inches and less	-0, +¼-inch
Over 36-inches	-0, +½-inch

9-32 MAILBOX SUPPORT

9-32.1 Steel Posts

The post shall be 2-inches outside diameter, 14 gage, mechanical tubing, and shall conform to ASTM A 513. Galvanizing shall conform to G 90 coating as defined in ASTM A 653, or an approved equal.

Any damage to galvanized paint surfaces shall be treated with two coats of formula A 9-73, Galvanizing Repair Paint, High Zinc Dust Content as specified in Section 9-08.2

9-32.2 Bracket, Platform, and Anti-Twist Plate

The bracket, platform, and anti-twist plate shall be 16 gage sheet steel, conforming to ASTM A 36.

9-32.3 Vacant

9-32.4 Wood Posts

Wood posts shall meet the requirements of Section 9-28.14(1) or Western Red Cedar.

9-32.5 Fasteners

Unless otherwise specified, bolts and nuts shall be commercial bolt stock, galvanized in accordance with ASTM A 153. Washers, unless otherwise specified, shall be malleable iron, or cut from medium steel or wrought iron plate. Washers and other hardware shall be galvanized in accordance with AASHTO M 111.

9-32.6 Snow Guard

Snow guard shall be fabricated in accordance with ASTM F 1071 for expanded metal bulkhead panel, to the dimensioning shown on the Standard Plan. After fabrication, the snow guard shall be galvanized in accordance with AASHTO M 111.

9-32.7 Type 2 Mailbox Support

Type 2 mailbox supports shall be 2", 14 gage steel tube and shall meet the NCHRP 350 crash test criteria. Type 2 mailbox supports shall be installed in accordance with the manufacturer's recommendations.

9-32.8 Concrete Base

The concrete in the concrete base shall meet or exceed the requirements of Section 6-02.3(2)B.

9-32.9 Steel pipe

The requirements for commercially available, Schedule 40, galvanized steel pipe, elbows, and couplings shall be met for all parts not intended to be bent or welded. Welded and bent parts shall be galvanized after fabrication in accordance with AASHTO M 111.

9-32.10 U-Channel Post

U-channel posts shall meet the requirements of ASTM A 29, weigh a minimum of 3 pounds per linear foot, and shall be galvanized according to AASHTO M 111.

9-33 CONSTRUCTION GEOTEXTILE

9-33.1 Geosynthetic Material Requirements

The term geosynthetic shall be considered to be inclusive of geotextiles, geogrids, and prefabricated drainage mats.

Geotextiles, including geotextiles attached to prefabricated drainage core to form a prefabricated drainage mat, shall consist only of long chain polymeric fibers or yarns formed into a stable network such that the fibers or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the material shall be polyolefins or polyesters. The material shall be free from defects or tears. The geotextile shall also be free of any treatment or coating which might adversely alter its hydraulic or physical properties after installation.

Geogrids shall consist of a regular network of integrally connected polymer tensile elements with an aperture geometry sufficient to permit mechanical interlock with the surrounding backfill. The long chain polymers in the geogrid tensile elements, not including coatings, shall consist of at least 95 percent by mass of the material of polyolefins or polyesters. The material shall be free of defects, cuts, and tears.

Prefabricated drainage core shall consist of a three dimensional polymeric material with a structure that permits flow along the core laterally, and which provides support to the geotextiles attached to it.

The geosynthetic shall conform to the properties as indicated in Tables 1 through 8 in Section 9-33.2, and additional tables as required in the Standard Plans and Special Provisions for each use specified in the Plans. Specifically, the geosynthetic uses included in this section and their associated tables of properties are as follows:

Geotextile Application	Applicable Property Tables
Underground Drainage, Low Survivability, Classes A, B, and C	Tables 1 and 2
Underground Drainage, Moderate Survivability, Classes A, B, and C	Tables 1 and 2
Separation	Table 3
Soil Stabilization	Table 3
Permanent Erosion Control, Moderate Survivability, Classes A, B, and C	Tables 4 and 5
Permanent Erosion Control, High Survivability Classes A, B, and C	Tables 4 and 5
Ditch Lining	Table 4
Temporary Silt Fence	Table 6
Permanent Geosynthetic Retaining Wall	Table 7 and Std. Plans
Temporary Geosynthetic Retaining Wall	Tables 7 and 10
Prefabricated Drainage Mat	Table 8
Table 10 will be included in the Special Provisions.	

Geogrid and geotextile reinforcement in geosynthetic retaining walls shall conform to the properties specified in the Standard Plans for permanent walls, and Table 10 for temporary walls.

For geosynthetic retaining walls that use geogrid reinforcement, the geotextile material placed at the wall face to retain the backfill material as shown in the Plans shall conform to the properties for Construction Geotextile for Underground Drainage, Moderate Survivability, Class A.

Thread used for sewing geotextiles shall consist of high strength polypropylene, polyester, or polyamide. Nylon threads will not be allowed. The thread used to sew permanent erosion control geotextiles, and to sew geotextile seams in exposed faces of temporary or permanent geosynthetic retaining walls, shall also be resistant to ultraviolet radiation. The thread shall be of contrasting color to that of the geotextile itself.

9-33.2 Geosynthetic Properties

9-33.2(1) Geotextile Properties

Table 1: Geotextile for underground drainage strength properties for survivability.

Geotextile Property	Test Method[2]	Geotextile Property Requirements[1]	
		Low Survivability Woven/Nonwoven	Moderate Survivability Woven/Nonwoven
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D4632	180 lbs./115 lbs. min.	250 lbs./160 lbs. min.
Grab Failure Strain, in machine and x-machine direction	ASTM D4632	<50%/>50%	<50%/>50%
Seam Breaking Strength	ASTM D4632[3]	160 lbs./100 lbs. min.	220 lbs./140 lbs. min.
Puncture Resistance	ASTM D4833	67 lbs./40 lbs. min.	80 lbs./50 lbs. min.
Tear Strength, min. in machine and x-machine direction	ASTM D4533	67 lbs/40 lbs. min.	80 lbs./50 lbs. min.
Ultraviolet (UV) Radiation stability	ASTM D4355	50% strength retained min., after 500 hrs. in weatherometer	50% strength retained min., after 500 hrs. in weatherometer

Table 2: Geotextile for underground drainage filtration properties.

Geotextile Property	Test Method[2]	Geotextile Property Requirements[1]		
		Class A	Class B	Class C
AOS	ASTM D4751	#40 US sieve (0.43 mm) max.	#60 US sieve (0.25 mm) max.	#60 US sieve (0.18 mm) max.
Water Permittivity	ASTM D4491	.5 sec^{-1} min.	.4 sec^{-1} min.	.3 sec^{-1} min.

Table 3: Geotextile for separation or soil stabilization.

Geotextile Property	Test Method[2]	Geotextile Property Requirements[1]	
		Separation Woven/ Nonwoven	Soil Stabilization Woven/Nonwoven
AOS	ASTM D4751	#30 US sieve (0.60 mm) max.	#40 US sieve (0.43 mm) max.
Water Permittivity	ASTM D4491	.02 sec^{-1} min.	.10 sec^{-1} min.
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D4632	250 lbs./160 lbs. min.	315 lbs./200 lbs. min.
Grab Failure Strain, in machine and x-machine direction	ASTM D4632	<50%/>50%	<50%/>50%
Seam Breaking Strength	ASTM D4632[2]	220 lbs./140 lbs. min.	270 lbs./180 lbs. min.
Puncture Resistance	ASTM D4833	80 lbs./50 lbs. min.	112 lbs./79 lbs. min.
Tear Strength, min. in machine and x-machine direction	ASTM D4533	80 lbs/50 lbs. min.	112 lbs./79 lbs. min.
Ultraviolet (UV) Radiation stability	ASTM D4355	50% strength retained min., after 500 hrs. in weatherometer	50% strength retained min., after 500 hrs. in weatherometer

Table 4: Geotextile for permanent erosion control and ditch lining.

Geotextile Property	Test Method[2]	Geotextile Property Requirements[1] Moderate Survivability Woven/Nonwoven	Permanent Erosion Control High Survivability Woven/Nonwoven	Ditch Lining Woven/Nonwoven
AOS	ASTM D4751	See Table 5	See Table 5	#30 US sieve (0.60 mm) max.
Water Permittivity	ASTM D4491	See Table 5	See Table 5	.02 sec^{-1} min.
Grab Tensile Strength,	ASTM D4632	250 lbs./160 lbs. min.	315 lbs./200 lbs. min.	250 lbs./160 lbs. min. min. in machine and x-machine direction
Grab Failure Strain, in machine and x-machine direction	ASTM D4632	15%-50%/>50%	15%-50%/>50%	<50%/>50%
Seam Breaking Strength	ASTM D4632[2]	220 lbs./140 lbs. min.	270 lbs./180 lbs. min.	220 lbs./140 lbs. min.
Burst Strength	ASTM D3785	400 pse/190 psi min.	500 psi/320 psi min.	
Puncture Resistance	ASTM D4833	80 lbs./50 lbs. min.	112 lbs./79 lbs. min.	80 lbs./50 lbs. min.
Tear Strength, min. in machine and x-machine direction	ASTM D4533	80 lbs/50 lbs. min.	112 lbs./79 lbs. min.	80 lbs./50 lbs. min.
Ultraviolet (UV) Radiation stability	ASTM D4355	70% strength retained min., after 500 hrs. In weatherometer	70% strength retained min., after 500 hrs. In weatherometer	70% strength retained min., after 500 hrs. In weatherometer

Table 5: Filtration properties for geotextile for permanent erosion control.

Geotextile Property	Test Method[2]	Geotextile Property Requirements[1]		
		Class A	Class B	Class C
AOS	ASTM D4751	#40 US sieve (0.43 mm) max.	#60 US sieve (0.25 mm) max.	#70 US sieve (0.22 mm) max.
Water Permittivity	ASTM D4491	.7 sec^{-1} min.	.4 sec^{-1} min.	.2 sec^{-1} min.

Table 6: Geotextile for temporary silt fence.

Geotextile Property	Test Method[2]	Geotextile Property Requirements[1]	
		Unsupported Between Posts	Supported Between Posts with Wire or Polymeric Mesh
AOS	ASTM D4751	#30 US sieve (0.60 mm) max. for slit film wovens #50 US sieve (0.30 mm) max. for all other geotextile types #100 US sieve (0.15 mm) min.	#30 US sieve (0.60 mm) max. for slit film wovens #50 US sieve (0.30 mm) max. for all other geotextile types #100 US sieve (0.15 mm) min.
Water Permittivity	ASTM D4491	.02 sec^{-1} min.	.02 sec^{-1} min.
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D4632	180 lbs. min. in machine direction, 100 lbs. min. in x-machine direction	100 lbs. min.
Grab Failure Strain, in machine and x-machine direction	ASTM D4632	30% max. at 180 lbs. or more	
Ultraviolet (UV) Radiation stability	ASTM D4355	70% strength retained min., after 500 hrs. in weatherometer	70% strength retained min., after 500 hrs. in weatherometer

[1]All geotextile properties in Tables 1 through 6 are minimum average roll values (i.e., the test result for any sampled roll in a lot shall meet or exceed the values shown in the table).

[2]The test procedures used are essentially in conformance with the most recently approved ASTM geotextile test procedures, except for geotextile sampling and specimen conditioning, which are in accordance with WSDOT Test Methods 914 and 915, respectively. Copies of these test methods are available at the State Materials Laboratory in Tumwater.

[3]With seam located in the center of 8-inch long specimen oriented parallel to grip faces.

9-33.2(2) Geosynthetic Properties For Retaining Walls and Reinforced Slopes

All geotextile properties provided in Table 7 are minimum average roll values. The average test results for any sampled roll in a lot shall meet or exceed the values shown in the table. The test procedures specified in the Table are in conformance with the most recently approved ASTM geotextile test procedures, except for geotextile sampling and specimen conditioning, which are in accordance with WSDOT Test Methods 914 and 915, respectively.

Table 7: Minimum properties required for geotextile reinforcement used in geosynthetic reinforced slopes and retaining walls.

Geotextile Property	Test Method	Geotextile Property Requirements Woven/Nonwoven
Water Permittivity	ASTM D4491	.02 sec.$^{-1}$ min.
AOS	ASTM D4751	#20 US sieve (0.84 mm) max.
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D4632	200 lbs/120 lbs min.
Grab Failure Strain, in machine and x-machine direction	ASTM D4632	< 50% / > 50%
Seam Breaking Strength[1]	ASTM D46322	160 lbs/100 lbs min.
Puncture Resistance	ASTM D4833	63 lbs/50 lbs min.
Tear Strength, min. in machine and x-machine direction	ASTM D4533	63 lbs/50 lbs min.
Ultraviolet (UV) Radiation Stability	ASTM D4355	70% (for polypropylene and polyethylene) and 50% (for polyester) Strength Retained min., after 500 Hr. in weatherometer

[1]Applies only to seams perpendicular to the wall face.

[2]With seam located in the center of 8-inch long specimen oriented parallel to grip faces.

The ultraviolet (UV) radiation stability, ASTM D4355, shall be a minimum of 70% strength retained after 500 hours in the weatherometer for polypropylene and polyethylene geogrids and geotextiles, and 50% strength retained after 500 hours in the weatherometer for polyester geogrids and geotextiles.

9-33.2(3) Prefabricated Drainage Mat

Prefabricated drainage mat shall have a single or double dimpled polymeric core with a geotextile attached and shall meet the following requirements:

Table 8: Minimum properties required for prefabricated drainage mats.

Property	Test Method	Prefabricated Drainage Material/Geotextile Property Requirements
Width		12-inches min.
Thickness	ASTM D 5199	0.4-inches min.
Compressive Strength at Yield	ASTM D 1621	100 psi min.
In Plan Flow Rate	ASTM D 4716	
Gradient = 0.1, Pressure = 5.5 psi		5.0 gal. /min./ft.
Gradient = 1.0, Pressure = 14.5 psi		15.0 gal. /min./ft.
Geotextile - AOS	ASTM D 4751	#60 US Sieve max.
Geotextile - Permittivity	ASTM D 4491	> 0.4 SEC -1
Geotextile - Grab Strength	ASTM D 4632	Nonwoven - 110 lb. min.

Prefabricated drainage mats will be accepted based on the manufacturer's certificate of compliance that the material furnished conforms to these specifications. The Contractor shall submit the manufacturer's certificate of compliance to the Engineer in accordance with Section 1-06.3.

9-33.3 Aggregate Cushion of Permanent Erosion Control Geotextile

Aggregate cushion for permanent erosion control geotextile, Class A shall meet the requirements of Section 9-03.9(2). Aggregate cushion for permanent erosion control geotextile, Class B or C shall meet the requirements of Section 9-03.9(3) and 9-03.9(2).

9-33.4 Geosynthetic Approval and Acceptance

9-33.4(1) Source Approval

The Contractor shall submit to the Engineer the following information regarding each geosynthetic proposed for use:

Manufacturer's name and current address,

Full product name,

Geotextile structure, including fiber/yarn type,

Geosynthetic polymer type(s) (for temporary and permanent geosynthetic retaining walls), and

Proposed geotextile use(s).

If the geosynthetic source has not been previously evaluated, or is not listed in the current WSDOT Qualified Products List (QPL), a sample of each proposed geosynthetic shall be submitted to the State Materials Laboratory in Tumwater for evaluation. After the sample and required information for each geosynthetic type have arrived at the State Materials Laboratory in Tumwater, a maximum of 14 calendar days will be required for this testing. Source approval will be based on conformance to the applicable values from Tables 1 through 8 in Section 9-33.2 and additional tables as specified in the Special Provisions. Source approval shall not be the basis of acceptance of specific lots of material unless the lot sampled can be clearly identified and the number of samples tested and approved meet the requirements of WSDOT Test Method 914.

Geogrid and geotextile products that are qualified for use in permanent geosynthetic retaining walls and reinforced slopes (Classes 1, 2, or both) are listed in the current WSDOT QPL.

For geogrid and geotextile products proposed for use in permanent geosynthetic retaining walls or reinforced slopes that are not listed in the current QPL, the Contractor shall submit test information and the calculations used in the determination of T_{al} performed in accordance with WSDOT Standard Practice T925 to the State Materials Laboratory in Tumwater for evaluation. The Contracting Agency will require up to 30 calendar days after receipt of the information to complete the evaluation.

9-33.4(2) Vacant

9-33.4(3) Acceptance Samples

Samples will be randomly taken by the Engineer at the job site to confirm that the geosynthetic meets the property values specified.

Approval will be based on testing of samples from each lot. A "lot" shall be defined for the purposes of this specification as all geosynthetic rolls within the consignment (i.e., all rolls sent the project site) that were produced by the same manufacturer during a continuous period of production at the same manufacturing plant and have the same product name. After the samples have arrived at the State Materials Laboratory in Tumwater, a maximum of 14 calendar days will be required for this testing.

If the results of the testing show that a geosynthetic lot, as defined, does not meet the properties required for the specified use as indicated in Tables 1 through 8 in Section 9-33.2, and additional tables as specified in the Special Provisions, the roll or rolls which were sampled will be rejected. Geogrids and geotextiles for temporary geosynthetic retaining walls shall meet the requirements of Table 7, and Table 10 in the Special Provisions. Geogrids and geotextiles for permanent geosynthetic retaining wall shall meet the requirements of Table 7, and Table 9 in the Special Provisions, and both geotextile and geogrid acceptance testing shall meet the required ultimate tensile strength Tult as provided in the current QPL for the selected product(s). If the selected product(s) are not listed in the current QPL, the result of the testing for Tult shall be greater than or equal to Tult as determined from the product data submitted and approved by the State Materials Laboratory during source approval.

Two additional rolls for each roll tested which failed from the lot previously tested will then be selected at random by the Engineer for sampling and retesting. If the retesting shows that any of the additional rolls tested do not meet the required properties, the entire lot will be rejected. If the test results from all the rolls retested meet the required properties, the entire lot minus the roll(s) that failed will be accepted. All geosynthetic that has defects, deterioration, or damage, as determined by the Engineer, will also be rejected. All rejected geosynthetic shall be replaced at no additional expense to the Contracting Agency.

9-33.4(4) Acceptance by Certificate of Compliance

When the quantities of geosynthetic proposed for use in each geosynthetic application are less than or equal to the following amounts, acceptance shall be by Manufacturer's Certificate of Compliance:

Application	Geotextile Quantity
Underground Drainage	600 sq. yards
Soil Stabilization and Separation	1,800 sq. yards
Permanent Erosion Control	1,200 sq. yards
Temporary Silt Fence	All quantities
Temp. or Perm. Geosynthetic Retaining Wall	Not required
Prefabricated Drainage Mat	All quantities

The Manufacturer's Certificate of Compliance shall include the following information about each geosynthetic roll to be used:

Manufacturer's name and current address,
Full product name,
Geosynthetic structure, including fiber/yarn type,
Polymer type
(for all temporary and permanent geosynthetic retaining walls only),
Geosynthetic roll number,
Proposed geosynthetic use(s), and
Certified test results.

9-33.4(5) Approval of Seams

If the geotextile seams are to be sewn in the field, the Contractor shall provide a section of sewn seam that can be sampled by the Engineer before the geotextile is installed.

The seam sewn for sampling shall be sewn using the same equipment and procedures as will be used to sew the production seams. If production seams will be sewn in both the machine and cross-machine directions, the Contractor must provide sewn seams for sampling which are oriented in both the machine and cross-machine directions. The seams sewn for sampling must be at least 2 yards in length in each geotextile direction. If the seams are sewn in the factory, the Engineer will obtain samples of the factory seam at random from any of the rolls to be used. The seam assembly description shall be submitted by the Contractor to the Engineer and will be included with the seam sample obtained for testing. This description shall include the seam type, stitch type, sewing thread type(s), and stitch density.

9-34 PAVEMENT MARKING MATERIAL

9-34.1 General

Pavement marking materials in this section consist of paint, plastic, tape or raised pavement markers as described in section 8-22 and 8-23 as listed below:

High VOC Solvent Based Paint
Low VOC Solvent Based Paint
Low VOC Waterborne Paint
Temporary Pavement Marking Paint
Type A – Liquid Hot Applied Thermoplastic
Type B – Pre-formed Fused Thermoplastic
Type C – Cold Applied Pre-formed Tape
Type D – Liquid Cold Applied Methyl Methacrylate
Glass Beads
Temporary Pavement Marking Tape
Temporary Raised Pavement Markings

9-34.2 Paint

Paint shall comply with the specifications for high volatile organic compound (VOC) solvent based paint, low VOC solvent based paint or low VOC waterborne paint.

9-34.2(1) High VOC Solvent Based Paint

High VOC solvent based paint material requirements are as follows:

Abrasion Resistance – ASTM D 968

125 liters minimum of falling sand on a 3 mil dry film thickness.

Accelerated Settling – ASTM D 869, modified as follows:

Paint shall be placed in a motor driven machine that raises and lowers a sample tray providing a shock to the sample which accelerates pigment settling. The samples shall be placed in the machine for one week, 24 hours per day, at a temperature of 77 degrees F. The samples shall show no more than 0.25-inch of clear material over the opaque portion of the paint and there shall be no settling below a rating of eight.

Bleeding over asphalt – ASTM D 969, modified as follows:

The reflectance measurement of the paint over asphalt paper shall be at least 90% of the reflectance measurement of the paint over a taped (non-bleeding) surface.

Color – Yellow

Paint draw-downs shall be prepared in accordance with ASTM D 823. The paint shall match Federal Standard 595a, color number 33538 and the tolerance of color variation shall match that shown in the FHWA "Highway Yellow Color Tolerance Chart (PR Color #1)"

Contrast Ratio at 5 mils wet film thickness – ASTM D 2805

White-92% minimum

Yellow-88% minimum

Daylight Reflectance – WSDOT Test Method 314

White paint shall have a minimum reflectance of 86% with a green filter on a 10 mil wet film thickness

Density – ASTM D 1475, at 70 degrees F

White – 12.00 pounds/gallon minimum

Yellow – 12.10 pounds/gallon minimum

Fineness of Dispersion – ASTM D 1210

2 minimum (Hegman Scale)

Flexibility – ASTM D 522

The paint shall be applied at a wet film thickness of 5 mils to a 3x5-inch tin panel that has been solvent cleaned and lightly buffed with steel wool. With the panel kept in a horizontal position, the paint shall be allowed to dry for 18 hours at 75 +/- 5 degrees F then baked for 3 hours at 212 +/- 4 degrees F. The panel shall be cooled to 75 +/- 5 degrees F for at least 30 minutes, bent over a 0.5-inch mandrel and then examined without magnification. The paint shall show no cracking, flaking or loss of adhesion.

No Track Time – (Dry to No-Pick-Up Time)

The paint, when applied in a line at a rate of 10 mils wet film thickness with 7 pounds of glass beads (Section 9-34.4) per gallon of paint added to the paint surface, shall "dry to no-pick-up" in 35 seconds maximum. The test line shall be applied over a 30 day old (approximate), non-beaded state standard paint line. The test line shall be applied using a striper capable of maintaining the 10 mil wet film thickness specified. The glass beads shall be blown onto the line during paint application. The test shall be conducted on dry pavement when the pavement temperature is between 50 and 100 degrees F and the relative humidity is less than 85%. The "dry to no-pick-up" tests shall be performed by having a standard size sedan or equivalent test vehicle coast across the paint line with no turning or accelerating at a speed of approximately 40 mph no more than 35 seconds after the test line is applied to the pavement. A successful test will be considered one in which at least three out of four line crossings show no visible paint from the line tracked onto the adjacent pavement when viewed standing 50-feet from the point where the test vehicle crossed the line.

Nonvolatile Content – ASTM D 2369

65%-68%

Pigment Specifications

Medium Chrome Yellow (yellow paint) – ASTM D 211 Type III

Titanium Dioxide (white paint) – ASTM D 476 Type II, III, or IV

The inert or filler pigments shall be first quality paint grade products.

Pigment Content – ASTM D 2371

53% maximum

Re-dissolve

A 15 mil wet film thickness of paint shall be applied to a glass panel. The paint shall be air dried for 16 hours at 77 degrees F then baked for 4 hours at 140 degrees F. The panel shall be cooled to room temperature and placed in a quart container that is half filled with the same paint being tested. The container shall be sealed and left undisturbed for 18 hours. After removing the panel from the container, a wooden spatula shall be drawn lightly over the painted surface. The immersed portion of the paint film shall be completely dissolved with no evidence of dried paint remaining on the panel.

Retroreflectance – ASTM D 6359

Newly applied pavement markings shall have a minimum initial coefficient of retroreflective luminance of 250 mcd/m²/lux for white and 175 mcd/m²/lux for yellow in accordance with ASTM D 6359 when measured with a 30-meter retroreflectometer. WSDOT will measure retroreflectivity for compliance with a Delta LTL-X retroreflectometer.

Settling – ASTM D 869

The test shall be run for a period of six months. There shall be no settling below a rating of eight.

Storage Stability

Samples shall show no settling as received by the Materials laboratory and only slight soft settling after the sample has aged undisturbed for one month. No hard caking in the bottom of the container shall be permitted. The paint shall not show evidence of heavy caking or settling which requires mechanical means to return the product to usable condition for a period of one year from the date of manufacture. There shall be no viscosity increase in excess of 10 Krebs Units over the originally reported viscosity after aging in the container for six months, and there shall be no evidence of corrosion of the container or decomposition of the product. Field examination of previously un-opened containers shall not disclose evidence of undissolvable gelatinous vehicle separation, heavy skin formation or corrosion of the container on samples in storage one year or less.

Vehicle Composition

The vehicle may be any combination of natural or synthetic resinous materials, except those that dry by the process of oxidation and/or polymerization (such as alkyd resins which are specifically excluded). All resins used must be permanently capable of re-dissolving in the solvent combination used in the paint.

Viscosity – ASTM D 562

86 Krebs units maximum at 50 degrees F

70-75 Krebs units at 70 degrees F

66 Krebs units minimum at 122 degrees F

9-34.2(2) Low VOC Solvent Based Paint

Low VOC solvent based paint material requirements are as follows:

Bleeding over asphalt – ASTM D 969, modified as follows:

The reflectance measurement of the paint over asphalt paper shall be at least 90% of the reflectance measurement of the paint over a taped (non-bleeding) surface.

Chromium Content – ASTM D 3718

< 50 ppm

Color – Yellow

Paint draw-downs shall be prepared in accordance with ASTM D 823. The paint shall match Federal Standard 595a color number 33538 and the tolerance of color variation shall match that shown in the FHWA "Highway Yellow Color Tolerance Chart (PR Color #1)".

Directional Reflectance – WSDOT Test Method 314

White paint shall have a minimum reflectance of 80%.

Density – ASTM D 1475, at 70 degrees F

11.8 pounds/gallon minimum

Flexibility – ASTM D 522

The paint shall be applied at a wet film thickness of 6 mils to a 3x5-inch panel that has been solvent cleaned and lightly buffed with steel wool. With the panel kept in a horizontal position, the paint shall be allowed to dry for 18 hours at 75 +/- 5 degrees F then baked for 3 hours at 140 +/- 4 degrees F. The panel shall be cooled to 75 +/- 5 degrees F for at least 30 minutes, bent over a 0.25-inch mandrel and then examined without magnification. The paint shall show no cracking, flaking or loss of adhesion.

No Track Time – (Dry to No-Pick-Up Time)

The paint, when applied in a line at a rate of 15 mils wet film thickness with 7 pounds of glass beads (Section 9-34.4) per gallon of paint added to the paint surface shall "dry to no-pick-up" in 90 seconds maximum. The test line shall be applied over a 30 day old (approximate), non-beaded state standard paint line. The test line shall be applied using a striper capable of maintaining the 15 mil wet film thickness specified. The glass beads shall be blown onto the line during paint application. The test shall be conducted on dry pavement when the pavement temperature is between 50 and 100 degrees F and the relative humidity is less than 85%. The "dry to no-pick-up" tests shall be performed by having a standard size sedan or equivalent test vehicle coast across the paint line with no turning or accelerating at a speed of approximately 40 mph no more than 90 seconds after the test line is applied to the pavement. A successful test shall be considered one in which at least three out of four line crossings show no visible paint from the line tracked onto the adjacent pavement when viewed standing 50-feet from the point where the test vehicle crossed the line.

Lead Content – ASTM D 3335

0.06% maximum

Nonvolatile Content – ASTM D 2369

65% minimum

Package Stability – ASTM D 1849

6 rating minimum for all criteria

Pigment Content – ASTM D 2371

53% maximum

Re-dissolve

A 15 mil wet film thickness of paint shall be applied to a glass panel. The paint shall be air dried for 16 hours at 77 degrees F then baked for 4 hours at 140 degrees F. The panel shall be cooled to room temperature and placed in a quart container that is half filled with the same paint being tested. The container shall be sealed and left undisturbed for 18 hours. After removing the panel from the container, a wooden spatula shall be drawn lightly over the painted surface. The immersed portion of the paint film shall be completely dissolved with no evidence of dried paint remaining on the panel.

Retroreflectance – ASTM D 6359

Newly applied pavement markings shall have a minimum initial coefficient of retroreflective luminance of 250 mcd/m²/lux for white and 175 mcd/m²/lux for yellow in accordance with ASTM D 6359 when measured with a 30-meter retroreflectometer. WSDOT will measure retroreflectivity for compliance with a Delta LTL-X retroreflectometer.

Skinning

The paint shall not skin within 48 hours in a 3/4 filled tightly closed container.

Settling Properties during Storage – ASTM D 1309

The sample shall show no more than 0.5-inch of clear material over the opaque portion of the paint and there shall be no settling below a rating of seven.

Titanium Dioxide (Rutile Type II) ASTM D 476

White – 1.0 pounds per gallon minimum. (ASTM D 4563)

Yellow – 0.2 pounds per gallon maximum. (ASTM D 4563)

Viscosity – ASTM D 562

105 Krebs units maximum at 50 degrees F

75-85 Krebs units at 70 degrees F

65 Krebs units minimum at 120 degrees F

Volatile Organic Compound Content – ASTM D 3960

1.25 pounds per gallon maximum

9-34.2(3) Low VOC Waterborne Paint

Low VOC waterborne paint material requirements are as follows:

Binder – ASTM D 3168

The binder shall be 100% acrylic.

Chromium Content – ASTM D 3718

<50 ppm

Color – Yellow

Paint draw-downs shall be prepared in accordance with ASTM D 823. The paint shall match Federal Standard 595a color number 33538 and the tolerance of color variation shall match that shown in the FHWA "Highway Yellow Color Tolerance Chart (PR Color #1)"

Contrast Ratio at 15 mils wet film thickness – ASTM D 2805

White – 98% minimum

Yellow – 96% minimum

Directional Reflectance – WSDOT Test Method 314

White paint shall have a minimum reflectance of 88% on a 15 mil wet film thickness

Fineness of Dispersion – ASTM D 1210

3 minimum (Hegman Scale)

Flash Point – ASTM D 93

100 degrees F minimum

Freeze Thaw – ASTM D 2243

5 cycles minimum

No Track Time – (Dry to No-Pick-Up Time)

The paint, when applied in a line at a rate of 15 mils wet film thickness with 7 pounds of glass beads (Section 9-34.4) per gallon of paint added to the paint surface shall "dry to no-pick-up" in 90 seconds maximum. The test line shall be applied over a 30 day old (approximate), non-beaded state standard paint line. The test line shall be applied using a striper capable of maintaining the 15 mil wet film thickness specified. The glass beads shall be blown onto the line during paint application. The test shall be conducted on dry pavement when the pavement temperature is between 50 and 100 degrees F and the relative humidity is less than 85%. The "dry to no-pick-up" tests shall be performed by having a standard size sedan or equivalent test vehicle coast across the paint line with no turning or accelerating at a speed of approximately 40 mph no more than 90 seconds after the test line is applied to the pavement. A successful test shall be considered one in which at least three out of four line crossings show no visible paint from the line tracked onto the adjacent pavement when viewed standing 50-feet from the point where the test vehicle crossed the line.

Lead Content – ASTM D 3335

0.06% maximum

Nonvolatile Content – ASTM D 2369

60% minimum

Nonvolatile Vehicle – ASTM D 2369, ASTM D 3723

Nonvolatile vehicle is calculated from the Nonvolatile content as determined in ASTM D2369 and the Pigment content as determined in ASTM D 3723.

%Nonvolatile vehicle = 100 – (100 - %Nonvolatile content) - %Pigment

Shall be 36% minimum by weight.

pH – ASTM E 70

9.5 minimum

Retroreflectance – ASTM D 6359

Newly applied pavement markings shall have a minimum initial coefficient of retroreflective luminance of 250 mcd/m²/lux for white and 175 mcd/m²/lux for yellow in accordance with ASTM D 6359 when measured with a 30-meter retroreflectometer. WSDOT will measure retroreflectivity for compliance with a Delta LTL-X retroreflectometer.

Scrub Resistance – ASTM D 2486

500 cycles minimum

Static Heat Stability

A one pint lined container shall be filled with approximately 15 fluid ounces of paint. The container shall be sealed with tape and put in an oven maintained at 135 +/-1 degrees F for seven days. The paint shall be removed from the oven and equilibrated at standard conditions (ASTM D 3924). The paint shall be mixed thoroughly with gentle stirring. The viscosity shall be determined. The paint shall show no increase in viscosity greater than 10 Krebs units over the viscosity at 77 degrees F (see Viscosity below) nor shall the paint show any coagulation, lumps or coarse particles.

Viscosity – ASTM D 562

100 Krebs units maximum at 77 degrees F

Volatile Organic Compound Content – ASTM D 3960

1.25 pounds per gallon maximum

9-34.2(4) Temporary Pavement Marking Paint

Paint used for temporary pavement marking shall conform to the requirements of Section 9-34.2 and shall be applied in one application at a thickness of 15 mils or 107 square feet per gallon.

9-34.3 Plastic

Plastic pavement marking materials shall comply with the specifications for:

Type A – Liquid hot applied thermoplastic

Type B – Pre-formed fused thermoplastic

Type C – Cold applied pre-formed tape

Type D – Liquid cold applied methyl methacrylate

9-34.3(1) Type A – Liquid Hot Applied Thermoplastic

Type A material consists of a mixture of pigment, fillers, resins and glass beads that is applied to the pavement in the molten state by extrusion or by spraying. The material can be applied at a continuously uniform thickness or it can be applied with a profiled pattern. Glass beads, intermixed and top dress, shall conform to the manufacturer's recommendations necessary to meet the retroreflectance requirements. Type A material shall conform to the requirements of AASHTO M 249 and the following:

Resin – The resin shall be alkyd or hydrocarbon.

Retroreflectance – ASTM D 6359

Newly applied pavement markings shall have a minimum initial coefficient of retroreflective luminance of 250 mcd/m²/lux for white and 175 mcd/m²/lux for yellow in accordance with ASTM D 6359 when measured with a 30-meter retroreflectometer. WSDOT will measure retroreflectivity for compliance with a Delta LTL-X retroreflectometer.

Skid Resistance – ASTM E 303

45 BPN units minimum

9-34.3(2) Type B – Pre-formed Fused Thermoplastic

Type B material consists of a mixture of pigment, fillers, resins and glass beads that is factory produced in sheet form. The material is applied by heating the pavement and top heating the material. The material shall contain intermixed glass beads. The material shall conform to AASHTO M 249, with the exception of the relevant differences for the materials being applied in the pre-formed state and the following:

Resin – The resin shall be alkyd or hydrocarbon.

Retroreflectance – ASTM D 6359

Newly applied pavement markings shall have a minimum initial coefficient of retroreflective luminance of 250 mcd/m²/lux for white and 175 mcd/m²/lux for yellow in accordance with ASTM D 6359 when measured with a 30-meter retroreflectometer. WSDOT will measure retroreflectivity for compliance with a Delta LTL-X retroreflectometer.

Skid Resistance – ASTM E 303

45 BPN units minimum

9-34.3(3) Type C – Cold Applied Pre-formed Tape

Type C material consists of plastic pre-formed tape that is applied cold to the pavement. The tape shall be capable of adhering to new and existing hot mix asphalt or cement concrete pavement. If the tape manufacturer recommends the use of a surface primer or adhesive, use a type approved by the pavement marking manufacturer. The tape shall also be capable of being inlaid into fresh hot mix asphalt during the final rolling process. The material is identified by the following designations: Type C-1 tape has a surface pattern with retroreflective elements exposed on the raised areas and faces and intermixed within its body and shall conform to ASTM D 4505, Reflectivity Level I, Class 2 or 3, Skid Resistance Level A. Type C-2 tape has retroreflective elements exposed on its surface and intermixed within its body and shall conform to the requirements of ASTM D 4505, Reflectivity Level II, Class 2 or 3, Skid Resistance Level A, and the following:

Retroreflectance – ASTM D 6359 modified as follows: (units are millicandelas/meter^2/lux)

Reflectivity Level I

White – 500 measured with a 30-meter instrument

Yellow – 300 measured with a 30-meter instrument

Reflectivity Level II

White – 250 measured with a 30-meter instrument

Yellow – 175 measured with a 30-meter instrument

9-34.3(4) Type D – Liquid Cold Applied Methyl Methacrylate

Type D material consists of a two part mixture of methyl methacrylate and a catalyst that is applied cold to the pavement. The material can be applied at a continuously uniform thickness or it can be applied with profiles (bumps). The material is classified by Type designation, depending upon the method of application. Type D-1 material is be applied by hand operated extrusion device, pouring or hand troweling. Type D-2 and D-5 material shall be applied by spraying. Type D-3 and D-4 material shall be applied by machine extrusion. Glass beads, intermixed and top dress, shall conform to the manufacturer's recommendations necessary to meet the retroreflectance requirements. Type D-1, D-2, D-3, and D-4 material shall have intermixed glass beads in the material prior to application. Type D-5 material shall have glass beads injected in to the material at application and a second coating of top dressing beads applied immediately after material application. Type D material shall conform to the following:

Adhesion

Asphalt substrate – substrate failure

Portland Cement Concrete substrate – 200 psi.

Chemical Resistance

The material shall show no effect after seven day immersion in anti-freeze, motor oil, diesel fuel, gasoline, calcium chloride, sodium chloride or transmission fluid.

Composition

Type D-1 – One gallon of methyl methacrylate and 3 fluid ounces of benzoyl peroxide powder.

Type D-2, D-3, D-4, and D-5 – Four parts methyl methacrylate and one part liquid benzoyl peroxide.

Elongation – ASTM D 638

20% minimum

Hardness – ASTM D 2240 (Shore Durometer Type D)

55 minimum after 24 hours

No Track Time – ASTM D 711, modified as follows:

15 minutes at 40 mils.

Retroreflectance – ASTM D 6359

Newly applied pavement markings shall have a minimum initial coefficient of retroreflective luminance of 250 mcd/m²/lux for white and 175 mcd/m²/lux for yellow in accordance with ASTM D 6359 when measured with a 30-meter retroreflectometer. WSDOT will measure retroreflectivity for compliance with a Delta LTL-X retroreflectometer.

Skid Resistance – ASTM E 303

45 BPN units minimum

Tensile Strength – ASTM D 638

125 psi minimum at break

Viscosity – ASTM D 2196 Method B, LV Model at 50 rpm.

Type D-1 – 11,000 to 15,000 cps, spindle #7

Type D-2 – 26,000 to 28,000 cps, spindle #7

Type D-3 – 17,000 to 21,000 cps, spindle #7

Type D-4 – 8,000 to 10,000 cps, spindle # 4

Type D-5 White – 5,000 to 8,000 cps, spindle #4

Type D-5 Yellow – 7,000 to 11,000 cps, spindle #4

Ultraviolet Light

No effect

9-34.4 Glass Beads

Glass beads for paint shall conform AASHTO M 247-81, Type 1. All glass beads shall have a moisture resistant coating. Glass beads for high VOC and low VOC solvent based paint shall have a silane coating to enhance adherence with solvent based paint. Glass beads for waterborne paint shall have a dual coating of silicone and silane that provides both anti-wetting and adherence properties.

9-34.5 Temporary Pavement Marking Tape

Temporary pavement marking tape shall be pressure sensitive, reflective type, conforming to ASTM D 4592, designed for application on asphalt or concrete pavement. Biodegradable tape with paper backing shall not be allowed. Surface preparation and application shall be in conformance with all the manufacturer's recommendations. Pavement marking masking tape shall conform to ASTM D 4592 Type 1 (removable), except that material shall be black, non-retroreflective and non-glaring.

9-34.6 Temporary Raised Pavement Markers

Temporary flexible raised pavement markers shall consist of an L-shaped body with retroreflective tape on the top of one face for one-way traffic and reflective tape on the top of both faces for two-way traffic. The marker body shall be made from 0.060-inch minimum thick polyurethane. The top of the vertical leg shall be between 1.75 and 2.0-inches high and shall be approximately 4-inches wide. The base width shall be approximately 1.125-inches wide. The base shall have a pressure sensitive adhesive material, a minimum of 0.125-inch thick with release paper. The reflective tape shall be a minimum of 0.25-inch high by 4.0-inches wide. The reflective tape shall have a minimum reflectance of 3.5 candlepower per foot-candle for white and 2.5 candlepower per foot-candle for yellow measured at 0.2° observation angle and 0° entrance angle. When temporary flexible raised pavement markers are used for bituminous surface treatment operations, the markers shall be supplied with a protective cover made of clear polyvinyl chloride. The cover shall be removed after spraying asphaltic material.

Temporary raised pavement markers other than temporary flexible raised pavement markers shall conform to the requirements of Section 8-09.2.

9-34.7 Field Testing

Field testing is required for all pavement marking materials. The material shall be applied in the field by the manufacturer and shall be monitored to determine durability and appearance characteristics. At the Department's discretion, field performance data gained from independent testing may be submitted in lieu of field testing. Acceptance of independent testing shall be the prerogative of the State Material Laboratory.

9-35 TEMPORARY TRAFFIC CONTROL MATERIALS

9-35.0 General Requirements

Temporary traffic control materials in this section consist of various traffic communication, channelization and protection items described in Section 1-10 and listed below:

Stop/Slow Paddles
Construction Signs
Wood Sign Posts
Sequential Arrow Signs
Portable Changeable Message Signs
Barricades
Traffic Safety Drums
Barrier Drums
Traffic Cones
Tubular Markers
Warning Lights and Flashers
Truck-Mounted Attenuator

The basis for acceptance of temporary traffic control devices and materials shall be visual inspection by the Engineer's representative. No sampling or testing will be done except that deemed necessary to support the visual inspection. Requests for Approval of Material and Qualified Products List submittals are not required. Certification for crashworthiness according to NCHRP 350 will be required as described in Section 1-10.2(3).

"MUTCD," as used in this section, shall refer to the latest WSDOT adopted edition of the *Manual on Uniform Traffic Control Devices for Streets and Highways*. In the event of conflicts between the MUTCD and the contract provisions, then the provisions shall govern.

9-35.1 Stop/Slow Paddles

Paddles shall conform to the requirements of the MUTCD, except that the minimum width shall be 24-inches.

9-35.2 Construction Signs

Construction signs shall conform to the requirements of the MUTCD and shall meet the requirements of NCHRP Report 350 for Category 2 devices. Except as noted below, any sign/sign stand combination that satisfies these requirements will be acceptable.

Where aluminum sheeting is used to fabricate signs, it shall have a minimum thickness of 0.080-inches and a maximum thickness of 0.125-inches.

All orange background signs shall be fabricated with Type X reflective sheeting. All post-mounted signs with Type X sheeting shall use a nylon washer between the twist fasteners (screw heads, bolts or nuts) and the reflective sheeting.

Any fabric sign which otherwise meets the requirements of this section and was purchased prior to July 1, 2004, may be utilized until December 31, 2007. If a fabric sign is used, it shall have been fabricated with Type VI reflective sheeting.

9-35.3 Wood Sign Posts

Post sizes for construction signs shall be as follows:

One Post Installation

Post Size	Min. Sign Sq. Ft.	Max. Sign Sq. Ft.
4x4	-	16.0
4x6	17.0	20.0
6x6	21.0	25.0
6x8	26.0	31.0

Two Post Installation

(For signs 5-feet or greater in width)

Post Size	Min. Sign Sq. Ft.	Max. Sign Sq. Ft.
4x4	-	16.0
4x6	17.0	36.0
6x6	37.0	46.0
6x8	47.0	75.0 *

* The Engineer shall determine post size for signs greater than 75 square feet.

Sign posts shall conform to the grades and usage listed below. Grades shall be determined by the current standards of the West Coast Lumber Inspection Bureau (WCLIB) or the Western Wood Products Association (WWPA).

4 x 4	Construction grade (Light Framing, Section 122-b WCLIB) or (Section 40.11 WWPA)
4 x 6	No. 1 and better, grade (Structural Joists and Planks, Section 123-b WCLIB) or (Section 62.11 WWPA)
6 x 6, 6 x 8, 8 x 10	No. 1 and better, grade (Posts and Timbers, Section 131-b WCLIB) or (Section 80.11 WWPA)
6 x 10, 6 x 12	No. 1 and better, grade (Beams and Stringers, Section 130-b WCLIB) or (Section 70.11 WWPA)

9-35.4 Sequential Arrow Signs

Sequential Arrow Signs shall meet the requirements of the MUTCD supplemented with the following:

Sequential arrow signs furnished for stationary lane closures on this project shall be Type C.

The color of the light emitted shall be yellow.

The dimming feature shall be automatic, reacting to changes in light without a requirement for manual adjustment.

9-35.5 Portable Changeable Message Signs

Portable Changeable Message Signs (PCMS) shall meet the requirements of the MUTCD and the following:

The PCMS shall employ one of the following technologies:

1. Fiber optic/shutter
2. Light emitting diode
3. Light emitting diode/shutter
4. Flip disk

Regardless of the technology, the PCMS shall meet the following general requirements:

1. Be light emitting and must not rely solely on reflected light. The emitted light shall be generated using fiber optic or LED technology.
2. Have a display consisting of individually controlled pixels no larger than $2^1/_2$-inch by $2\ ^1/_2$-inch. If the display is composed of individual character modules, the space between modules must be minimized so alphanumeric characters of any size specified below can be displayed at any location within the matrix.
3. When activated, the pixels shall display a yellow or orange image. When not activated, the pixels shall display a flat black image that matches the background of the sign face.
4. Be capable of displaying alphanumeric characters that are a minimum of 18-inches in height. The width of alphanumeric characters shall be appropriate for the font. The PCMS shall be capable of displaying three lines of eight characters per line with a minimum of one pixel separation between each line.
5. The PCMS message, using 18-inch characters, shall be legible by a person with 20/20 corrected vision from a distance of not less than 800-feet centered on an axis perpendicular to the sign face.
6. The sign display shall be covered by a stable, impact resistant polycarbonate face. The sign face shall be non-glare from all angles and shall not degrade due to exposure to ultraviolet light.
7. Be capable of simultaneously activating all pixels for the purpose of pixel diagnostics. Any sign that employs flip disk or shutter technology shall be programmable to activate the disks/shutters once a day to clean the electrical components. This feature shall not occur when the sign is displaying an active message.
8. The light source shall be energized only when the sign is displaying an active message.

The PCMS panels and related equipment shall be permanently mounted on a trailer with all controls and power generating equipment.

The PCMS shall be operated by a controller that provides the following functions:

1. Select any preprogrammed message by entering a code.
2. Sequence the display of at least five messages.
3. Blank the sign.
4. Program a new message, which may include animated arrows and chevrons.
5. Mirror the message currently being displayed or programmed.

9-35.6 Barricades

Barricades shall conform to the requirements of the MUTCD supplemented by the further requirements of the Standard Plans.

9-35.7 Traffic Safety Drums

Traffic safety drums shall conform to the requirements of the MUTCD and shall have the following additional physical characteristics:

Material	Fabricated from low-density polyethylene that meets the requirements of ASTM D 4976 and is UV stabilized.
Overall Width	18-inch minimum in the direction(s) of traffic flow.
Shape	Rectangular, hexagonal, circular, or flat-sided semi-circular.
Color	The base color of the drum shall be fade resistant safety orange.

The traffic safety drums shall be designed to accommodate at least one portable light unit. The method of attachment shall ensure that the light does not separate from the drum upon impact.

Drums and light units shall meet the crashworthiness requirements of NCHRP 350 as described in Section 1-10.2(3).

When recommended by the manufacturer, drums shall be treated to ensure proper adhesion of the reflective sheeting.

9-35.8 Barrier Drums

Barrier drums shall be small traffic safety drums, manufactured specifically for traffic control purposes to straddle a concrete barrier and shall be fabricated from low-density polyethylene that meets the requirements of ASTM D 4976 and is UV stabilized.

The barrier drums shall meet the following general specifications:

Total height	22 in., ± 1 in.
Cross-section	hollow oval 10 in. X 14 in., ± 1 in.
Formed support legs length	13 in., ± 1 in.
Space between legs (taper to fit conc. barrier)	$6^{1}/_{4}$ in. min.
Weight	33 lb. ± 4 lb. with legs filled with sand.
Color	Fade resistant safety orange.

Barrier drums shall have three 4-inch reflective white stripes, (one complete and two partial). Stripes shall be fabricated from Type III or Type IV reflective sheeting.

When recommended by the manufacturer, barrier drums shall be treated to ensure proper adhesion of the reflective sheeting.

9-35.9 Traffic Cones

Cones shall conform to the requirements of the MUTCD, except that the minimum height shall be 28-inches.

9-35.10 Tubular Markers

Tubular markers shall conform to the requirements of the MUTCD, except that the minimum height shall be 28-inches.

Pavement-mounted tubular markers shall consist of a surface-mounted assembly that uses a separate base with a detachable tubular marker held in place by means of a locking device.

9-35.11 Warning Lights and Flashers

Warning lights and flashers shall conform to the requirements of the MUTCD.

9-35.12 Truck-Mounted Attenuator

The Truck-Mounted Attenuator (TMA) shall be selected from the approved units listed on the Qualified Products List. The TMA shall be mounted on a vehicle with a minimum weight of 15,000 pounds and a maximum weight in accordance with the manufacturer's recommendations. Ballast used to obtain the minimum weight requirement, or any other object that is placed on the vehicle shall be securely anchored such that it will be retained on the vehicle during an impact. The Contractor shall provide certification that the unit complies with NCHRP 230 or 350 requirements. Units fabricated after 1998 must comply with NCHRP 350 requirements.

The TMA shall have an adjustable height so that it can be placed at the correct elevation during usage and to a safe height for transporting. If needed, the Contractor shall install additional lights to provide fully visible brake lights at all times.

The TMA unit shall have a chevron pattern on the rear of the unit. The standard chevron pattern shall consist of 4-inch yellow stripes, alternating non-reflective black and reflective yellow sheeting, slanted at 45 degrees in an inverted "V" with the "V" at the center of the unit.

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SUGGESTIONS: