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2-1 Clearing, Grubbing, and Roadside Cleanup

2-1.1 Clearing

2-1.1A General Instructions

Before starting grading operations, it is necessary to prepare the work area by removing all trees, brush, buildings, and other objectionable material and obstructions that may interfere with the construction of the roadway. From the standpoint of roadside appearance and control of erosion on the right of way, it is advantageous to preserve natural growth where possible. If it is not clearly shown in the contract plans, the Project Engineer should discuss with the Landscape Architect the preservation of natural growth which will not interfere with roadway and drainage construction before starting clearing operations. If vegetation outside the clearing limits is damaged during the clearing or grubbing operations, or if pruning is required, the Landscape Architect or State Horticulturist may be contacted for assistance. Areas to be omitted from clearing or extra areas to be cleared should be determined before starting work and an accurate record made during staking operations.

2-1.1B Staking and Measurement

Clearing stakes at least 4 feet long and marked "Clearing" should be set at the proper offset marking the limits of the area to be cleared. These stakes normally should be set at 100-foot intervals on tangents and at shorter intervals on curves, depending on the sharpness of the curve. Where slope treatment is provided, clearing normally should be staked to a distance of 10 feet beyond the limits of the slope treatment with a distance of 5 feet being considered the absolute minimum distance required. Normally, grading stakes should not be set until clearing and grubbing work in a given area is completed. The method of measurement used at interchange areas should be such as to preclude the possibility of duplication or overlapping of measured areas.

When the contract provides for measuring and paying for clearing by the acre, it is the intent of the specifications to measure and pay for all areas actually cleared. Minor uncleared areas within the clearing limits may be included in the pay quantity if they are less than 50 feet long, measured parallel to the centerline and contain an area less than 2,500 square feet. No payment should be made for uncleared areas greater than the area described above.

Small, isolated areas to be cleared, located between areas excluded from measurement and which contain less than 2,500 square feet, shall be measured as containing 2,500 square feet. Where isolated areas occur intermittently, the sum of the areas allowed by this method of measurement shall not exceed the total area (containing the several isolated areas) when measured as continuous clearing. This condition can occur when clearing narrow strips less than 25 feet in width.

2-1.2 Grubbing

2-1.2A General Instructions

Grubbing provides for additional preparation of the work area by removal of remaining stumps, roots, and other obstructions which exist on or in the ground in all areas designated for grubbing. It should be noted that complete grubbing is not required under embankments where the fill height above natural ground, as measured to subgrade or embankment slope elevation, exceeds 5 feet. This exception does not apply to any area where a structure must be built, subdrainage trenches are to be excavated, unsuitable material is to be removed, or where hillsides or existing embankments are to be terraced. Grubbing is important to the structural quality of the roadway and every effort should be made to obtain a thorough job. Grubbing should be completed at least 1,000 feet in advance of grading operations.

2-1.2B Staking and Measurement

Grubbing stakes shall be set at the limits of the slopes as specified. Where slope treatment is required, grubbing shall be extended to the limits of the slope treatment. Accurate records of grubbed areas need to be kept in the form of sketches and measurements. As with "Clearing", it is the intent to pay for all areas grubbed and to omit those areas not grubbed. Measurement will be made in accordance with the specifications and in the same manner outlined above for "Clearing".

2-1.3 Clearing and Grubbing — Combined

2-1.3A General Instructions

When clearing and grubbing is included as a combined item, it is the intent that all areas cleared must also be grubbed. The Contractor may accomplish this in one operation. Complete grubbing under fill heights in excess of 5 feet is not required unless the contract provisions specifically modify Section 2-01.3(2) of the *Standard Specifications*.

2-1.3B Measurement and Payment

Measure and Payment is identified in the *Standard Specifications* or modified in the Special Provisions.

2-1.4 Roadside Cleanup

2-1.4A General Instructions

This work consists of cleaning up, dressing, and shaping the roadside area outside the limits of construction. In advance of completion of other work on the project, the Project Engineer and the Contractor need to determine the work to be done, the equipment and labor necessary, and estimate of the cost of the work. Do not use this item for any work to be paid under "Trimming and Cleanup", or any other item.

Any trees or snags outside the limits of areas to be cleared which may endanger traffic on the roadway itself should be removed under this work. Before removing danger trees outside of the right of way, the matter should be referred to the Regional Office for negotiations with the property owners. If, however, an emergency arises, which endangers traffic, the danger trees may be removed immediately and the Project Engineer shall notify the Region as soon as possible.

The work required in shaping the ends of cuts and fills so they appear natural with the adjacent terrain will be greatly reduced if proper warping of the cut and fill slopes has been accomplished during the grading operations.

2-1.4B Measurement and Payment

Measurement and Payment is identified in the *Standard Specifications* or modified in the Special Provisions.

2-2 Removal of Structures and Obstructions

2-2.1 General Instructions

Buildings, foundations, structures, fences, and other obstructions which are on the right of way and are not designated to remain, shall be removed and disposed of in accordance with the *Standard Specifications*. All salvageable materials designated to remain the property of the Washington State Department of Transportation (WSDOT) shall be removed carefully and stored in accordance with the special provisions. Foundations shall be removed to the designated depth and basement floors shall be broken to provide drainage of water. Basements or cavities left by their removal shall be backfilled as specified, and if the areas are within the roadway prism, care shall be taken to see that the backfill is properly compacted.

When water wells or septic tanks are encountered, the project office needs to ensure they are meeting all the required environmental considerations for leaving in place or abandonment. Contacting the Regional Office for guidance is suggested. Wells having artesian characteristics will require special consideration to avoid water entrapment.

Care shall be taken to see that pavements or other objects which are to remain are not damaged during this operation.

2-2.2 Measurement and Payment

Measurement and Payment is identified in the *Standard Specifications* or modified in the Special Provisions.

2-3 Roadway Excavation and Embankment

2-3.1 Roadway Excavation

2-3.1A General Instructions

Present day earth-moving equipment and practices have accelerated grading operations to the point where the Project Engineer must make every effort to plan ahead and foresee conditions which may require changes in plans, special construction procedures, or specific coordination with subcontractors or other contractors. Delays in work progress are costly both to the Department and to the Contractor, and must be avoided whenever possible.

The Project Engineer needs to become familiar with the soil report and soil profile if they are provided and compare the preliminary soil data with the actual findings. This will allow for adjustments in the work, such as changes in haul to make best usage of better materials, changes in surfacing depth, variations in drainage, or a determination of same or changed conditions from what was expected.

The Project Engineer's Office should examine each newly exposed cut as soon as possible after it is opened in order that necessary changes may be made before excavating equipment has been moved away. This will necessitate an inspection of the cut slopes and the ditch cuts to locate any objectionable foundation materials or faulty drainage conditions which should be corrected. Objectionable materials are those having characteristics which may cause an unstable subgrade. Among the conditions the Project Engineer must watch are soil moisture contents which are so high as to render the subgrade unstable under the designed surfacing, high water table and soils where frost heaving may be serious, such as silts and very fine sands having high capillary attraction. In the event such conditions are discovered, the Project Engineer needs to contact the Regional Materials Engineer for assistance in determining corrective action to ensure a stable subgrade is achieved.

Section 2-03.3(10) of the *Standard Specifications* provides for selecting excavation material for special uses as directed by the Project Engineer. Judicious application of this provision should be made whenever the project will be benefited.

2-3.1B Staking

See Chapter 1-5 Surveying of this manual for listed tolerance and the *Highway Surveying Manual*.

2-3.1C Excavation

a. Roadway excavation is specified in accordance with Section 2-03.1 of the *Standard Specifications* and shall include all materials within the roadway prism, side borrow areas, and side ditches. Borrow, unsuitable excavation, ditches and channels outside the roadway section, and structure excavation are separately designated. Area designations shall not be construed to imply classification based on the type of material involved.

b. Normally, excavation will be made to the neat lines of the roadway section as indicated on the plans. When material shortages occur, additional quantities may be obtained either from borrow sources or from an enlargement of the regular cuttings as designated by the Engineer. Early determination of additional needs is desirable so that necessary enlargement can be made during the original excavation. Should it be necessary to return to a completed cut for additional material, effort should be made to cause no change in the Contractor's normal method of excavation. If the original excavation was dressed to proper slopes, it will be necessary to pay for sloping the second time in accordance with Section 2-03.3(1) of the *Standard Specifications*.

c. When there is a surplus of material which cannot be handled by changing grade or alignment, it shall be disposed of in accordance with Section 2-03.3(7) of the *Standard Specifications*. If the surplus is wasted by widening the embankments, care must be taken to avoid creating a condition conducive to embankment erosion. If possible, the widening should be made in conjunction with the original embankment and placed in accordance with Method A embankment compaction specifications. If this is not possible, it is preferable to waste along low embankments where Method A compaction can be accomplished. Dumping of loose material on high embankment slopes must be avoided.

When the foundation investigation report from the Materials Laboratory indicates settlement is anticipated in embankments at bridge ends, surplus material shall not be wasted by widening embankments or by building up the adjacent ground line near the structure. Wasting material in this manner adjacent to a structure can result in unanticipated and adverse settlement of the structure even if the structure is founded on piling.

In areas where an overload is required, any required contour grading must be done at the time the overload is constructed. When the overload is removed, the material must be removed entirely from the area and not placed on slopes or wasted in the adjacent area.

d. Wasting excavation material and borrowing may be necessary, however, such operations must be kept to an absolute minimum. Carelessness in this respect is expensive and leads to an unsightly job. Careful planning of work and proper selection and mixing of available materials often will eliminate the need to waste and borrow.

e. Where excavation is in solid rock, the excavation shall be completed full width of the roadway to a depth of 0.5 foot below subgrade. Particular attention is directed to the provisions of the specifications regarding drainage of pockets below subgrade in solid rock cuts. Pockets formed by blasting operations must be drained by ditching to the side ditches, and then backfilled with fragmentary rock, gravel, or other suitable material. Silty or clayey soils should not be used.

Most projects involving solid rock cuts will provide for controlled blasting of the faces of the rock slopes to minimize blast damage of the face and overbreak. It is the responsibility of the Engineer to decide which rock faces should be formed by controlled blasting and which ones do not require it. Usually this determination is made at the design stage, but formations may be encountered during the construction which were not anticipated during the design. The Project Engineer should advise the Regional Materials Engineer when rock excavation is in progress so that the Regional Materials Engineer may monitor the progress of the work and check to see that the slopes are suitable for the rock as revealed. The Project Engineer should also contact the Regional Operations/Construction Engineer and Materials Engineer when for any operational reason it appears desirable to change the method proposed.

It is the responsibility of the Contractor to determine the method of controlled blasting to use, but is required to drill and shoot short test sections to see that the method used is producing a satisfactory face and to develop the best methods for the particular rock formation encountered. The Engineer shall check on the results being obtained to see that they are satisfactory, and if they are not, to require the Contractor to make necessary changes in procedures to produce satisfactory results.

Most rock faces will be formed by the preshear method consisting of drilling and blasting a line of holes on the face of the cut ahead of any other blasting. The cushion blasting method consists of blasting and removing the main part of the cut prior to blasting the line of holes on the face of the cut. It is quite important that the blasting for the main part of the rock does not shatter the rock back of the face of the cut. With either method, proper hole alignment is very important. The depth of lifts of rock excavation is dependent upon the depth that the holes can be drilled and maintain proper hole alignment. A setback of about 1 foot minimum is required for each lift of rock since it is impossible to position the drill flush to the wall of the upper bench slope.

The results obtained are dependent not only on the properties of the rock but upon the hole size, spacing, amount and type of explosive, spacing of the explosive in the hole, stemming and the timing of the blast. It is desirable that the Project Engineer keep a record of these procedures used by the Contractor, especially in the early phases of the work while the best methods are being sought.

After excavating the rock cuts, the slopes shall be scaled and dressed to a safe, stable condition by removing all loose spalls and rocks not firmly keyed to the rock slope. Mechanical scaling using dozers, front end loader, etc., as the face is developed, is desirable. Any rock exposures which are felt to be a potential hazard to project personnel should be called to the attention of the Contractor. Loose spalls and rocks lying outside the slope stakes which constitute a hazard to the roadway shall be removed and payment made for their removal in accordance with Section 2-03.3(2) of the *Standard Specifications*. Controlled blasting of rock faces may be measured by running a true profile over the top of the rock at each drill hole and quantities computed using cutoff elevations established for the bottom of the drill hole.

f. Should soft areas exist in the subgrade of a completed earth cut, excavation below grade and replacement shall be accomplished in accordance with Section 2-03.3(3) of the *Standard Specifications*. Particular attention should be given to areas of transition between cut and fill. Top soil and other organic or unsuitable material should be removed from these areas and replaced with material suitable for subgrade in accordance with Section 2-03.3(14) of the *Standard Specifications*.

g. The subgrade of cut sections must be checked for density as it is required and necessary that the entire roadway subgrade meet the compaction requirements specified for the project and set forth in Section 2-03.3(14) of the *Standard Specifications*. Density tests shall be taken for each 500 feet or fraction for each roadway. If the density of the subgrade

is less than the required density, the subgrade material shall be removed, replaced, and compacted in accordance with Section 2-03.3(3) of the *Standard Specifications*.

h. Overbreak, as defined in the *Standard Specifications,* is that portion of the material which is excavated, displaced, or loosened outside of and beyond the slopes or grade as staked or reestablished, excepting such material which occurs as slides, regardless of whether any such overbreak is due to blasting, to the inherent character of any formation encountered, or to any other cause. All overbreak so defined shall be removed by the Contractor at no expense to WSDOT, except as hereinafter described.

Overbreak, as such, should not be paid for in any manner except when the planned roadway excavation is not sufficient to complete the embankment and borrow excavation has not been included in the proposal. With the approval of the Engineer, overbreak material may then be used to complete the embankment and payment made at the unit contract prices for Roadway Excavation and Haul.

When approved by the Engineer, available overbreak material may be used in accordance with Section 2-03.3(12) of the *Standard Specifications*.

In the event that conditions causing the overbreak justify reestablishing the slopes to include part or all of the overbreak section, the material reverts to roadway excavation material and shall be so paid for. Justifiable reason for reestablishing the slopes may be uncontrollable overbreak resulting from the existence of natural cleavage or faults in rock formations, planned slopes resulting in an unsafe and unstable condition, or other such reason. Overbreak may be expected on unstable slope projects involving rock cuts if the reason for the project is the rock cut is unstable. When a question occurs as to justification for reestablishing slopes because of overbreak, the Project Engineer shall consult with the Regional Construction Engineer.

When overbreak is surplus material and reestablishment of slopes is not justified, the materials shall be removed and wasted as provided for "Surplus Materials" under Section 2-03.3(7) of the *Standard Specifications* except that the work shall be at the Contractor's expense, including the cost of hauling and wasting.

Where pay quantities of material are wasted and overbreak is used in lieu thereof, no allowance will be made for such overbreak. Haul in this case will be paid upon the basis of the pay quantities of excavation.

i. The Project Engineer's attention is directed to Section 2-03.3(11) of the *Standard Specifications*, providing for the removal of slides in cut slopes and in embankment slopes. Any slides coming into the roadway after the slopes have been finished by the Contractor shall be removed by the Contractor at the unit contract price per cubic yard for the excavation involved. If the Project Engineer orders the slope to be refinished, payment for refinishing would be eligible for an equitable adjustment as defined in Section 1-09.4 of the *Standard Specifications*.

In case of slides in embankment slopes, the Contractor shall replace the embankment material from sources designated by the Project Engineer at the unit contract prices for the excavation involved.

In the event the slide repair is such that quantities cannot be measured accurately, or if the Contractor must use a different type of equipment for removal than that available on the project, payment may be made as provided in Section 1-09.4 of the *Standard Specifications*.

j. The Project Engineer's attention is directed to Section 1-07.14 of the *Standard Specifications*, providing for the Contractor's responsibility for sloughing and erosion of cut and embankment slopes. The ordinary sloughing and erosion of cut and embankment slopes shall not be considered as slides, and the Contractor is responsible for providing temporary control facilities to prevent this.

The following guidelines are provided to assist in determining responsibility for repairs to eroded areas:

1. Slides

   Slide repair costs will be borne by WSDOT, where there is no evidence of neglect by the Contractor.

2. Erosion of Slopes

   A. In places where water has run over the edge of the roadway and where the Contractor has neglected to provide adequate protection, the Contractor must assume the costs of repair.

   B. Where rain on cut and embankment slopes cause rivulets and wash, the Contractor must assume the cost of repairs except as noted hereinafter.

   C. Where erosion of cut or embankment slopes occur from ground water seepage, WSDOT must assume the cost of repairs.

3. Repairs

   A. In 2 B above, the Contractor must, at no expense to WSDOT, remove eroded material from the toe of slope, ditches, and culverts and restore the eroded areas with this material where practicable. If additional top and/or embankment material is needed or different materials are ordered by the Engineer, it will be furnished and placed by the Contractor at unit contract prices.

   B. In 2 A and 2 B where erosion has occurred and repairs are the Contractor's responsibility, the Contractor must restore the area at no expense to WSDOT, including the seeding, mulching and fertilizing.

   C. In 1 and 2 C where seeding, mulching, and fertilizing have been damaged, payment will be made for restoring same at the unit contract price for seeding, mulching and fertilizing.

K. Discovery of contaminated media (i.e., soil and water) is usually identified during pre-construction investigations and Special Provisions are subsequently developed for its handling and disposal. Occasionally, however, contamination is discovered during excavation and/or dewatering activities where it was not expected through observations such as soil staining, oily sheens in water, and chemical odors.

When physical evidence indicates discovery of contamination, a series of response activities must begin to ensure that appropriate actions are initiated to minimize project delays, additional project costs, and WSDOT liability. Section 1-2.2K provides the appropriate notification and corrective action procedures to follow when unanticipated contamination is discovered. Upon proper notification, WSDOT can direct characterization, removal, and disposal of the contaminated media through one of its On-Call Environmental Consultants or, if preferred, through the Contractor if they have the necessary equipment and certifications. Regardless of who performs the work, the WSDOT Hazardous Materials Program should be notified in order to provide guidance for proper management of the contaminated media.

Discovery of contaminated media will be considered a change as outlined in Section 1-04.4 of the *Standard Specifications* and work associated with removal and disposal of discovered contaminated media will be compensable.

2-3.1D Embankment Foundations

a. The natural ground upon which an embankment is to be constructed may be such that it will impair the stability of the completed roadway. Such conditions must be corrected prior to starting embankment construction. Unsuitable ground such as peat, soft organic clay, and silts must be removed or otherwise stabilized to prevent unequal or excessive roadway settlement or embankment failure. Areas requiring special foundation treatment will be shown in the plans and/or specified in the special provisions with the exception that possible detrimental soil at the transition between cut and fill and under shallow embankments may not be indicated. Particular attention should be given to these areas and in the event that highly compressible or unstable top soil or other undesirable material exists, it should be removed in accordance with Section 2-03.3(14) of the *Standard Specifications*.

In the event that other unsuitable foundation material exists and is not indicated in the contract and is beyond the limits as described in Section 2-03.3(14), the State Construction Office should be contacted through the Region for assistance in reaching a resolution.

Where embankments are built on hillsides or existing embankment slopes, the existing surface soil may form a plane of weakness, unless the slope is terraced or stepped by plowing deeply to key the new embankment to the slope. Keying the embankment to the slope is also important when constructing an embankment across a rather steep draw. This operation is a standard requirement for embankment construction as specified in Section 2-03.3(14) of the *Standard Specifications*.

b. Where specified in the contract plans and/or the special provisions, unsuitable foundation materials shall be removed or otherwise stabilized as required. When removal is required, inspection should determine that the removal is complete to solid foundation. Where water exists in the excavation areas, it should be drained, if possible, by ditching so that excavation and backfilling can be accomplished in the dry. Where backfilling must be done under water, granular material should be used, and special care must be taken to avoid trapping unsuitable material in the backfilled area.

c. Removal of unsuitable foundation material by displacement with or without the use of explosives should be attempted only where specified, or where recommended by the State Materials Engineer and approved by the State Construction Office.

d. Embankment settlement can be accelerated by the use of overloads, vertical sand drains, or by vacuum pumping to lower the water table. These treatments should not be attempted unless specified by the contract provisions or recommended by the State Materials Engineer and approved by the State Construction Office.

e. Settlement indicating devices are occasionally called for on the contract plan and special provisions when it becomes necessary to determine the extent and rate of embankment settlement. Settlement data is necessary for establishing construction schedules for adjoining or adjacent structures where the downward movement of the embankment and its foundation will influence the stability of the structure.

There are several types of settlement indicating devices in current use. The principals of each type and the instructions for installation and monitoring must be understood by all involved project personnel. The Regional Materials Engineer or the State Materials Laboratory personnel should be consulted in these cases.

2-3.2 Embankment Construction

2-3.2A General Instructions

a. It is expected that the Contractor will construct roadway embankments in accordance with the plans and specifications using construction methods and equipment considered suitable for the type of work involved. All operations must be directed toward constructing a uniform, well-compacted embankment true to grade and cross-section.

b. It is sometimes necessary to construct an embankment across wet and swampy ground which will not support the weight of heavy construction equipment. It is the responsibility of the Contractor to select a method of construction and type of equipment which will least disturb the soft foundation. It is permissible to start the embankment by dumping and spreading the first layer to a thickness capable of supporting construction equipment across the soft ground, however, this initial lift should be held to the minimum thickness required for equipment selected in conformance with the above. The remainder of the embankment shall be constructed in layers and compacted as specified. Compaction will be required on initial embankment lifts wherever conditions will permit placement and compaction as specified.

c. Proper compaction of roadway embankments and embankment slopes is of vital importance to the structural quality of the final roadway and strict adherence to specification requirements is essential. The type and thickness of the final surfacing and pavement is designed on the basis of the strength of the underlying materials, and the strength of these materials is affected greatly by their state of compaction, therefore, it is essential that the specified density be obtained. To enable the Project Engineer to determine that embankments are being compacted properly, control test procedures and density standards have been developed for use during construction. It is expected that these aids will be utilized to the fullest extent necessary to determine that all embankments are constructed in accordance with specifications. Complete instructions for making maximum density and optimum moisture content determinations for soils and for making field density control tests are furnished with the appropriate testing equipment and in Chapter 9 of this manual.

d. The Project Engineer and the Inspector should understand thoroughly the elements of the compaction process and compaction control procedures. The following brief resume should be supplemented by study of appropriate publications on this subject and by consultation with the Regional Materials Engineer. In general, it can be stated that each soil has a maximum density to which it can be compacted with a given compactive effort. For this compactive effort, the maximum density will be obtained only at one moisture content. Increases or decreases in moisture cause a reduction in the density obtainable with the given compactive effort. When the moisture content is lower than optimum, additional compactive effort is necessary to achieve the specified density. When the moisture content is above optimum, low densities will result, and a soft, spongy condition may develop during the compaction process. In most cases, the moisture content of the material should be less than optimum when the material is covered, due to the fact that frequently materials are over-compacted by the heavy construction equipment now in use. Once the material is covered with another layer of material, it is very unlikely that the moisture content of the material will decrease.

e. Certain soils, primarily fine grained soils having high silt content, may become unstable by virtue of being over compacted even at moisture contents at or slightly above optimum but within specification limits. When working with these soils, the moisture content should be reduced below the maximum allowed if at all feasible, this may require aeration. Specifications provide for payment for this work. Also the Contractor should be requested to compact only to the minimum requirements; however, this is difficult to control. With modern heavy hauling and compacting units, over-compaction occurs with increasing frequency. When high fills are involved, not only may the subgrade be unstable, but the overall stability of the fill may be reduced to the point that slump failure will occur. When such soil and moisture conditions are encountered, the Project Engineer should recognize the potential danger and notify the Regional Operations/Construction Engineer. Should corrective measures be necessary, one or more of several procedures may be used. When low fills are involved, increasing the surfacing depth, mixing with granular materials available, or allowing the fill to set undisturbed for a period of time may prove satisfactory. When a high fill is to be built, sandwiching layers of free-draining material, incorporating a system of trench drains, or mixing with other materials may prove satisfactory. In all cases, the correction must be aimed at neutralizing the excess pore-water pressure or changing the character of the material. Section 2-03.3(14)J of the *Standard Specifications* provides for the use of gravel borrow material for this type of work.

The gravel borrow may be mixed with the embankment material by placing a layer of the embankment material on a layer of gravel borrow and mixing the two materials using aeration equipment. The materials shall be mixed and the moisture content reduced to a satisfactory level. During drying weather, the gravel borrow material will tend to speed the reduction in moisture of the embankment material. After the moisture has been reduced to a satisfactory level, the layer of material must be compacted to the required density before another layer of material is placed. It is quite important that the moisture be reduced to a satisfactory level or the advantage of mixing with the gravel borrow will be lost.

An alternate method is to intersperse layers of gravel borrow throughout the embankment to reduce the pumping action of the soil and provide drainage for excess moisture. This method is preferred over mixing. The embankment material must be uniformly graded and sloped to the outside of the embankment so any excess moisture will have a chance to drain off. Care must be taken in placing the layer of gravel borrow so ruts or pockets are not formed in the embankment material which will trap moisture and prevent its draining off. The depth of the layers of embankment materials that will maintain the desired embankment stability shall be determined by field tests.

Drainage problems occur quite frequently when an existing embankment is widened, if there is moisture present in the existing embankment, through capillary action, subterranean drainage, or otherwise. If the new embankment traps the water in the existing embankment, usually the moisture saturates the embankment to a point that slump failure occurs. Whenever an existing embankment that could receive moisture is to be widened, drainage must be provided through the new embankment area. If the new embankment material is not free draining, one method of providing drainage is to layer the new embankment with gravel borrow layers at approximately 10-foot intervals vertically. Where seepage is noted, the Regional Materials Engineer should be consulted so that an adequate drainage system is provided.

f. When it is anticipated that certain cuts or borrow areas will contain considerable amounts of material with moisture content in excess of the optimum for proper compaction of embankments, aeration equipment may be included in the proposal for the project.

The inclusion of aeration equipment in the proposal will not relieve the Contractor of the responsibility of employing sound and workmanlike procedures in the prosecution of the work which are effective in constructing embankments with wet materials. Ditches to remove surface or subterranean drainage should be constructed whenever they can be effective and preferably in advance of excavation, thus permitting time for drainage.

The function of aeration equipment is to provide thin, loose layers of material from which moisture can evaporate. Most soils tend to form a crust which retards the evaporation of moisture. Unless this material is worked to break up this crust, evaporation is quite slow. During good drying weather, a sheepsfoot roller is quite effective in certain soils in breaking up the surface of the soil and, in thin lifts of material, leaves large surface areas of soil exposed to the air. However, no separate payment for a sheepsfoot roller will be made and the costs of same are incidental to embankment compaction.

If the material has a considerable amount of moisture above the optimum for proper compaction of embankments, it may be necessary to operate aeration equipment in the excavation areas as well as the embankment areas to increase the amount of material exposed for evaporation. The amount of moisture that will evaporate from the material is dependent on the prevailing weather conditions, the surface area of material exposed and the length of time the material is exposed to the air.

It must be kept in mind that thin, loose layers of material will also soak up large amounts of moisture if it rains, so the surface of the materials must be sealed and sloped to drain off moisture whenever rain is imminent. It is the responsibility of the Contractor to seal the material against rain and in many cases this will have to be done at the end of work each day to protect against sudden, unexpected storms.

g. The maximum density and optimum moisture content for a soil are determined by testing the soil in accordance with WSDOT Test Method No. 606 or AASHTO T 99 Method A as prescribed in Section 2-03.3(14)D of the *Standard Specifications* and described in Chapter 9 of this manual. This data is used to establish the density required by specifications. Each different soil may, and probably will, have a different maximum density and optimum moisture content, and it is necessary that tests be performed in the field for each different soil encountered. As each of the materials is being tested, a representative sample should be taken and placed in a sealed sample jar to serve as a future reference for identifying the materials on the grade during construction. It is the responsibility of the Project Engineer to arrange for all field testing necessary to supplement data furnished with the soils report.

Noncohesive sandy and gravelly soils and surfacing aggregate cannot be tested by the above-noted test method. Samples of these materials must be sent to the Regional Materials Engineer with a request for maximum density determination. This test method is described in Chapter 9 of this manual. A gradation vs. density curve will be established for use by the Inspector during construction.

h. To determine if the embankments are being compacted properly, in-place density tests must be taken at frequent intervals. Results of these tests are compared to the density standard established for the soil (noncohesive granular material) being compacted, and are used as the basis for accepting or rejecting the work of the Contractor. Each lift of embankment should be tested before subsequent lifts are placed. When loose free draining sandy material is used for embankment construction, the Inspector should dig down 1 foot and run a density test on the undisturbed material.

In selecting an area to be tested, the Inspector should choose sites where the least compactive effort has been applied. A continuous record of the Contractor's method of compaction should be kept and compared to test results to assist in selecting a routine procedure which will yield required results. Compaction is required to the neat lines of the embankment, which include the shoulders and slopes. Proper compaction of embankment slopes will tend to minimize slope surface erosion which occurs often on newly constructed embankments.

Care must be taken to see that uniform density is obtained throughout each fill rather than to have some areas compacted greatly in excess of the density requirements, while other areas are below requirements. In order to achieve uniform density, it is essential that the water content be uniform since the density obtainable with a given soil is a function of the water content for any one compactive effort. In most cases, the required density can be obtained with the least effort if the water content is very close to, but less than, the optimum established by standard moisture-density test. Noncohesive granular soils usually compact most easily when wetted to near saturation. The Contractor should be encouraged to establish a definite routine for compaction that will result in uniform compactive effort. When a considerable amount of grading equipment is concentrated in a small embankment area, it is difficult to maintain uniform compaction methods on each lift and the Inspector must be especially alert. When the size of the embankment area can be increased, uniform compaction methods can be more readily established, thinner lifts of material can be placed and moisture content can be better controlled.

The Speedy Moisture Tester is a good tool for the Inspector to use to check the moisture content of the material while it is being worked in the embankment. This will quickly tell the Inspector whether moisture must be removed or added before the layer is covered with additional material. The Inspector must be cautioned that due to the small amount of material used in the speedy moisture tester, it is essential that the sample used is actually representative of the material being worked. If the moisture content of the material being worked is quite uniform, this does not present too much of a problem.

When embankment construction is first started, the Inspector should give particular attention to the compaction methods and take more than the minimum number of density tests to determine the most advantageous compaction pattern that will give the desired compaction results. After a satisfactory compaction pattern has been established for the type of material being placed, the density testing may be reduced to the minimum rate specified.

Where it is necessary to add water for compacting, this may be done either in the cut (or borrow pit) or on the fill. Water must not be added to material obtained from a borrow pit before weighing when payment is by weight. Addition of water in the cut allows the scrapers and hauling equipment to mix the water into the soil so that rolling can proceed immediately after spreading. Sprinkling should be done on a rough loose surface rather than on one which is smooth and tight because the water will not be so apt to run off or form ponds.

Daily compaction reports shall be submitted on Form 351-015. If there are questions concerning operational procedure on moisture-density tests, in-place tests, and reporting of results on the above form, consult the Regional Materials Engineer for advice and assistance.

Special attention shall be given to compaction around structures and bridge ends, where rollers cannot operate. Mechanical tampers or other approved compactors are to be used in these areas. Sufficient density tests shall be taken to ensure that compaction is continued on each lift until the specified density is attained. Failure to do so can result in settlement near the structure.

2-3.2B Rock Embankments

As established compaction tests cannot be applied to coarse granular material with any degree of accuracy, embankment construction has been divided into two classes: rock embankments and earth embankments, as defined in Section 2-03.3(14) of the *Standard Specifications*. It should be noted that this designation is made for the fundamental purpose of determining the method of embankment construction and compaction control to be used, and that it depends only upon the gradation of the excavation material. It is not necessary that an embankment be built entirely of rock material to be designated as rock embankment. Rock embankment is defined as "all, or any part, of an embankment in which the material contains 25 percent or more by volume of gravel or stone 4 inches or greater in diameter." The Inspector shall make visual inspection of the embankment material to ascertain whether it contains 25 percent or more of material 4 inches or greater in diameter. For rock embankment, in lieu of controlling compaction by performing tests, a given amount of compactive effort is specified in Section 2-03.3(14)A of the *Standard Specifications*. Where the stability of a rock embankment is in question, moisture and density control as specified in Section 2-03.3(14)B and C of the *Standard Specifications* shall pertain. It is considered that uniform compaction to the full width of the embankment normally will not be achieved by routing hauling equipment over the roadway. Rolling equipment shall be required as specified whenever it is possible to operate such equipment on the material being placed. Decision to require or delete the use of rollers as specified shall be based on feasibility of operation rather than on an arbitrary estimate of benefits achieved, as this factor is very difficult to evaluate without conducting extensive and expensive tests.

2-3.2C Earth Embankments

a. Procedures for constructing earth embankments are described in Section 2-03.3(14)B of the *Standard Specifications*. Compaction in accordance with one of three methods designated as Method A, Method B, or Method C as specified in Section 2-03.3(14)C shall be utilized. Unless otherwise specified in the special provisions, Method B will apply. The basic requirements of all three methods are the same in that each requires lift construction, uniform compaction throughout the embankment width and depth, control of moisture content to not more than 3 percent above optimum, and the addition of moisture should it be necessary for proper compaction. The difference between the three methods lies in the thickness of lifts specified, the degree and control of compaction required, and the degree of control of moisture below optimum. The use of suitable compaction units is required for Method B and Method C, although routing of hauling units may be used to obtain partial compaction.

b. Method A normally will not be specified for state highway work, but may be applied on county or city projects or on certain secondary state highway projects. Embankment lifts up to 2 feet in thickness may be placed, and compaction is achieved by routing the hauling equipment over the entire width of the embankment. Inspection should determine that the routing schedule is such that all parts of the fill receive the same amount of compaction, including the outer edges of the fill. Drying of soil or addition of moisture may be required, if necessary.

c. Method B will be used on all state highway projects except where other methods are specified. This method requires that the embankment be constructed in lifts not exceeding 8 inches in loose thickness except that lifts in the upper 2 feet shall not exceed 4 inches in loose thickness. Ninety percent of maximum density is required throughout the embankment except that 95 percent of maximum density is required in the upper 2 feet. Control density tests must be performed to verify compliance with specifications. The Contractor shall be required to dry soil or add moisture as necessary to ensure proper, uniform compaction. The selection of compaction equipment or methods is the responsibility of the Contractor; however, the use of any method or equipment that does not achieve the required density within a reasonable time may be ordered discontinued. The entire embankment, including the side slopes, shall be compacted to specification requirements.

d. Method C will be required when it is considered essential to the structural quality of the embankment that the entire fill be compacted to a high density. This method differs from Method B in that the entire embankment must be compacted to 95 percent of maximum density. Also, a limit is specified for minimum moisture content in addition to the maximum to ensure moisture content uniformity. In all other respects, the two methods are the same, and each requires a high standard of compaction control.

2-3.3 Borrow Pits

The material in borrow pits must be satisfactory for the use it is intended. If the character of the materials is not readily visible, adequate sampling and testing should be done to verify the quality and the quantity of material available. The Project Engineer should check the records to see that this determination has been made, and if any doubt exists to the adequacy of the source, the Regional Materials Engineer should be contacted to see if further testing is indicated. This detail could save considerable time, expense, and future problems if it is determined that a pit is unsatisfactory before extensive work is performed in opening the pit and then discovering that the material is not acceptable.

Sections 2-03.3(14)K, 9-03.20, and 9-03.21 of the *Standard Specifications* provide for the use of select and common borrow for use in construction of embankments. Materials which meet these specifications are intended for use where it is not necessary to strictly control the strength properties of the borrow. Select or common borrow materials should not be used as backfill for mechanically stabilized earth walls, to backfill unsuitable material excavation below groundwater, or as foundation material for any structure, unless specifically approved for use by the State Geotechnical Engineer. The material requirements for select and common borrow will not ensure that the materials will be workable and able to be compacted under inclement weather conditions. Because select or common borrow materials may be subject to moisture sensitivity as described above and in Chapter 2-3.2A(e), compaction of these materials may require control as specified in Section 2-3.3(14)D of the *Standard Specifications*.

Common borrow, as specified by Section 9-03.14(3) of the *Standard Specifications*, may be virtually any soil or aggregate, either naturally occurring or processed, which is substantially free of organics or other deleterious material, and is nonplastic. The specification allows for the use of more plastic (clayey) common borrow when approved by the Engineer. The use of more plastic (clayey) material may require approval of the Regional Materials Engineer or the State Materials Lab. The 3 percent maximum organic material requirement for common borrow may be determined visually, or, as necessary, by one of the following test methods: AASHTO T 194 (Organic Content by the Wet Combustion Method) or AASHTO T 267 (Organic Content by Loss on Ignition). The correct test method is determined based on the type of organic material present in the soil sample. The Regional Materials Engineer should be consulted as to the appropriate test method. The sample may be field determined to be nonplastic if the fraction of the material which passes the U.S. No. 40 sieve cannot be rolled into a thread at any moisture content using that portion of AASHTO Test Method T 90 (Determination of the Plastic Limit of Soils) which describes rolling the thread.

The requirements of Section 2-03.3(13) of the *Standard Specifications* must be observed in the operation and cleanup of borrow pits. With the requirement for reclamation of all pits, a plan must be developed to meet the requirements of the specifications and special provisions and approved before the start of pit operations. See Chapter 3-3 of this manual.

2-3.4 Temporary Water Pollution/Erosion Control

Section 8-01 of the *Standard Specifications* covers the requirements for controlling erosion and water pollution on the project. These provisions limit the area of erodible earth material which may be exposed at one time and provide that the Contractor will be paid for construction of water pollution/erosion control work.

During the project development phase, WSDOT creates a Temporary Erosion and Sediment Control (TESC) plan for the project. The Contractor shall adopt it as shown and provide a schedule for implementation, or request modifications to the plan. Any modifications to the plan shall be submitted, reviewed, and approved as specified in Section 8-01.3(1)A of the *Standard Specifications*, prior to the beginning of work. This modified plan should be reviewed to see that the Contractor anticipated all the erosion and water pollution risks in light of the construction approach and that the plan will adequately minimize them. If the plan appears to be adequate, acceptance shall be given by the Project Engineer after receiving concurrence from the Regional Environmental Office.

Preplanned or obviously required temporary water pollution/erosion control measures should be included in the required progress schedule and updated as necessary to cover each phase of the project as the work progresses. Where appropriate, they should be keyed to project schedule activities.Temporary and permanent erosion control shall be implemented at the earliest time practical and shown in the required progress schedule for the project.

Since the Contractor and WSDOT are responsible for any erosion or pollution damage which may occur on the project, both parties must work together to anticipate potential erosion and pollution problems and propose methods to take care of the problems. Any reasonable proposed method should be carefully reviewed and implemented if necessary to prevent erosion damage or pollution from occurring. Temporary water pollution/erosion control needs that cannot be predicted may be outlined as procedures that will be used if certain conditions develop.

To meet the requirements of the specifications at the beginning of the project while the Contractor is preparing a CPM project schedule, the Contractor may submit a letter covering the erosion control implementation and schedule for the initial phase of the construction. The following are some of the features that should be covered in the Contractor's proposal:

a. Time period initial earthwork is to be accomplished (by date).

b. Station limits of earthwork related items.

c. Mobilization effort and scheduling of adequate personnel, equipment, and material.

d. Outline of basic earthwork construction features.

e. Outline of specific problem areas and methods to take care of them.

f. Applicable contract plan sheets marked in red.

On smaller projects, this letter schedule may be adequate in fulfilling the contract requirements.

Where erosion is likely to be a problem, the specifications limit the area of erodible earth material that may be exposed at one time by clearing and grubbing to the area, time frame and location described in Section 8-01.3(1), without the approval of the Engineer. If clearing is done separately from the grubbing work, erosion may not be a problem and therefore, the area of clearing would not have to be limited, but the area of grubbing would if the area is erodible. If the Contractor feels that the area limitation for grubbing is too restrictive to accommodate the grading operations, a request

should be submitted for approval to open a larger area and outline the proposed plan and schedule for all temporary or permanent pollution/erosion control that may be necessary.

Evaluation of the Contractor's request for increased areas should be done in consultation with Region Environmental staff. It should be recognized that the job progress is of critical importance and should not be impeded except when clear probability of detrimental erosion potential exists or where permit constraints may be violated.

The area of excavation, borrow, and embankment operations in progress is also limited by the specifications to the area, time frame and location. Erodible soil not being worked, whether at final grade or not, shall be covered within the limitations outlined in Section 8-01.3(1). Approval to extend clearing and coverage limitations may be granted by the Engineer if weather and site conditions permit. Sites with soils more resistant to erosion that do not drain to surface waters may be eligible. Approval should only be granted if the Contractor can demonstrate that WSDOT will not be exposed to unacceptable risk of erosion problems and that the contractor can stabilize the site prior to a storm event if weather forecasts change. Consult Region Environmental, and in some cases Ecology, to ensure that permit requirements are not violated. The limitations must also be commensurate with the Contractor's capability and progress in keeping the finish grading, seeding, mulching, and other erosion control measures in accordance with the approved schedule.

In the Fall months, prior to the "rainy season" or a winter shutdown, the Project Engineer must schedule an on-site review of the project with the Contractor for the specific purpose of identifying appropriate erosion prevention measures that can be taken, such as constructing temporary ditches, sumps, pipes, ditch lining, slope cover, etc., which will reduce and minimize the potential for erosion during the winter months.

Any pollution/erosion control work provided in the plans, shall be paid as specified in the contract. Other water pollution/erosion control work performed in accordance with the approved plan or ordered by the Engineer will be paid for as detailed below:

1. WSDOT Provided Haul Roads, WSDOT Provided Sources, and Haul Roads for WSDOT Provided Sources.

Such water pollution/erosion control work which does not differ materially from specified contract work shall be measured and paid for at unit contract prices.

Such water pollution/erosion control work not covered by contract items will be paid for on a force account basis in accordance with Section 1-09.6 of the *Standard Specifications*.

2. Contractor Provided Equipment Storage Sites, Contractor Provided Sources, and Haul Roads for Contractor Provided Sources.

All temporary water pollution/erosion control requirements as detailed in the specifications will apply.

All work will be performed by the Contractor and will not be measured for payment.

3. Commercial Sources.

The exception to Contractor provided sources will be commercial sources. All water pollution control requirements are the responsibility of the owner and/or operator of any commercial sources.

To further clarify areas of payment and nonpayment, the following examples are listed:

1. Operational expenses incurred on water pollution control facilities will be paid for by force account. This shall include servicing and cleaning settling basins, diversion ditches, and temporary culverts.

2. Maintaining settlement ponds constructed for control of pollution while dewatering of excavations or cofferdams is eligible for payment. Constructing these settling ponds may also be eligible for payment unless the construction of the pond is paid for by a bid item included in the contract. Temporary water pollution control measures required as a result of stream diversion to allow construction of permanent facilities are also eligible for payment.

3. Any temporary erosion and water pollution control work that is required due to the Contractor's negligence, carelessness, or failure to install permanent controls as part of the work as scheduled, shall be constructed by the Contractor at no expense to WSDOT.

These are but a few examples and it is realized that isolated circumstances will arise that are not described above. Any questions should be referred to the Regional Operations/ Construction Engineer and if necessary, to the State Construction Office.

2-3.5 Measurement and Payment

2-3.5A General Instructions

Quantities and items involved in grading operations including compaction of embankments shall be measured and paid for in accordance with Sections 2-03.4 and 2-03.5 of the *Standard Specifications*, and Chapter 10 of this manual.

2-3.5B Computer Generated Quantities

Utilizing the current programs available through the department, the personal computer (PC) may be used to determine earthwork quantities, finished roadway or subgrade elevations, slope stake data, and haul quantities.

The type and size of the project and the amount of time that can be saved will be considerations in how much information should be generated by the use of the PC.

All applicable records of computed data shall be kept and become a part of the final records. If the computer was not used in the design stage of the project, it may still be convenient and economical to prepare data to submit for construction quantities.

2-3.5C Use of Photogrammetry Service

The photogrammetry service may be used to create a 3D Digital Terrain Model (DTM) files for use with the department's current design software in order to produce cross sections, contours, and quantity information. Photogrammetry can also provide Digital Ortho Photos as a by product instead of the DTM files. The Ortho Photo has the same accuracy characteristics as a map but without the elevation data. The type and size of the project and the amount of time that can be saved will be considerations in the selection of the method of obtaining the ground line cross-sections. The Project Engineer must also ascertain that the work schedule of the Photogrammetry Section will permit them to provide the DTM files and Digital Ortho Photos by the time they are required. If proper ground control was established on the project during the design stage, considerable savings in time may be realized by using this service.

It is recommended that the State Photogrammetry Office be contacted at the earliest possible date when it is determined that this service may be needed, since the process requires significant time and the weather and position of the sun (angle of the sun's rays) in Washington can affect Photogrammetric mapping schedules by weeks or even months.

The 3D DTM files and Ortho Photos are obtained from aerial photographs and will show the ground as it existed at the time the photographs were taken. This data is measured in the Stereo plotter and transferred to computer files. The State Photogrammetry Office will design each photo mission and mapping process to best fit the needs of the project as defined by the Project Engineer. The State Photogrammetry Office maintains an active archive of each new project's files and all DTM data produced since 1989. It is easily accessible via WSDOT LAN on a file server type computer. Contact the State Photogrammetry Office for specific information on past projects and archived data.

2-4 Haul

2-4.1 General Instructions

Haul is the transportation of excavated material. Measurement and payment for haul is made on material hauled.

The measurement of haul is expressed as a unit of one hundred cubic yards hauled 100 feet.

Haul quantities can be computed using the PC and associated programs on all earthwork projects and the limits of each segment of haul and the "Haul" units can be identified.

Haul shall be calculated and included in the section from which the material is hauled. Haul on roadway quantities, including borrow obtained by the widening of cuts and including waste deposited along roadway embankment slopes, will be computed on the basis of transporting material along the centerline or base line of the highway.

2-4.2 Vacant

2-4.3 Haul on Borrow or Waste

Quantities of material hauled from a borrow site to the roadway or from the roadway to a waste site are computed normal to the long axis of the borrow or waste site. When computing the amount of haul, determination of the direction of movement of the mass and the distance it is transported requires good, practical judgment by the Engineer. The size and shape of a borrow pit and egress from the pit to the highway improvement must be considered in the proper determination of the amount of haul. The same conditions are true in the case of waste sites. Instructions herein for computing haul from borrow pits shall be applicable to computing haul to waste sites.

The long axis of the borrow pit should be used for the base line of the cross-section which, theoretically, would pass through the centers of gravity of the sections; however, the base line may approximate the centers of gravity of the sections. Borrow pits which are provided by widening of the roadway cuts would be an exception to this since the *Standard Specifications* define them as "Roadway Excavation" and not "Borrow."

The measurement of the distance from the pit to the center line of the roadway should originate at the center of mass as measured in the pit and be computed via the most direct and feasible route to the nearest practical point on the center line of the roadway.

The route of haul will be indicated on the plans, and, where possible, will be via existing roads. If no road exists, provision will be made in the plans for constructing a haul road and for rights therefor.

If the Contractor chooses to haul over a route shorter than the computed or designated route, payment for haul will be based on the length of the actual haul route. If the Contractor chooses to haul over a longer route than the computed or designated route, payment for haul will be based on the length of the computed or designated route.

2-5 Slope Treatment

2-5.1 General Instructions

Earth cuts, soft or decomposed rock cuts, and overburden in all rock cuts shall have the tops of the slope rounded in accordance with *Standard Plan* H-8 to produce an aesthetic and pleasing appearance. The slope treatment shall be constructed at the time of excavation so the material resulting from the rounding of the slopes may be disposed of along with the excavation from the cut.

The Project Engineer should go over the slope treatment procedure with the Contractor at the beginning of the excavation operation to ascertain that proper rounding is being constructed and reduce extensive reworking.

2-5.2 Measurement and Payment

Slope treatment shall be measured and paid for in accordance with Section 2-03.3(5) of the *Standard Specifications*.

2-6 Subgrade Preparation

2-6.1 General Instructions

The subgrade shall be constructed in accordance with the lines, grades, and typical sections shown on the plans or as established by the Engineer and the *Standard Specifications*.

The entire subgrade should be uniformly compacted to the density specified. The subgrade shall meet the tolerance in Chapter 1-6 of this manual. On some separate grading projects where the surfacing Contractor will be required to or elects to trim the subgrade with an automatically controlled mechanical trimmer, the tolerances for the subgrade must be changed to provide material for the subgrade trimmer to trim, but the trimmed subgrade must meet the tolerance stated above.

After the subgrade is prepared, the Contractor shall maintain it in the required condition until the next course of work is performed.

2-6.2 Measurement and Payment

The quantities of work involved in constructing and maintaining the subgrade shall be measured and paid for in accordance with the provisions of Section 2-06.5 of the *Standard Specifications*.

2-7 Watering

2-7.1 General Instructions

Water shall be applied as ordered by the Engineer, in accordance with the specifications, uniformly to the material so that all of the material will have approximately the same moisture content. It is more economical and effective to apply water at night or in the early morning hours when loss from evaporation is lower. In many instances, this is the only time that it is possible to increase the moisture content to that required.

The Inspector should be alert to see that the subgrade is not damaged from too much water being applied or that more water is being applied than is necessary. Usually light applications applied more frequently are more advantageous than heavy applications. The water should not be applied on surfacing materials with such force that it will wash the fine particles off the coarser ones causing segregation.

If water is a pay item, the Project Engineer shall verify the size of the water truck by measuring or weighing and if gauges are used, he should also verify the accuracy of the gauge. A record of measurements or weights, and calculations must be made for future references.

A Daily Delivery Record, Form 422-024, showing the time of each load and where it was placed should be maintained on the project. The Inspector will issue a ticket for the amount of water used.

2-7.2 Measurement and Payment

Water shall be measured and paid for in accordance with the provisions of Sections 2-07.4 and 2-07.5 of the *Standard Specifications*.

2-8 Vacant

2-9 Structure Excavation

2-9.1 General Instructions

Before starting structure excavation, stakes should be set to locate the structure and cross-sections should be taken to determine the quantities of material involved.

During the progress of excavation, the character of material being removed and exposed should be examined to determine if it is suitable for use as backfill and to ensure that acceptable foundation conditions exist. This should be done especially on streams subject to high velocity flood water and which carry drift. Open pit excavation or "glory holes" are not allowed without permission. This specification is of special importance in application to the construction of foundations in or adjacent to running streams, where the approval of the State Construction Office should be secured.

Material obtained from structure excavation may be used for backfilling over and around the structures, for building embankments, or it may be wasted. When this material is stockpiled for backfilling, the Contractor is required to protect it from contamination and the elements. If not properly protected, the Contractor must replace the lost material with acceptable backfill material at no expense to WSDOT. The backfilling of openings made for structures must be made with acceptable material from the excavation, other acceptable backfill materials indicated in the plans and special provisions, or as specified in Section 2-09.3(1)E of the *Standard Specifications*.

When specified in the Contract or approved by the Engineer, acceptable material may include Controlled Density Fill (CDF) – also known as Controlled Low-Strength Material (CLSM).

Before the CDF is placed, the Contractor is required to develop a mix design in accordance with *Standard Specification* Section 2-09.3(1)E and to submit the CDF mix design in writing to the Project Engineer on WSDOT Form 350-040. Section 2-09.3(1)E requires the Contractor to utilize ACI 229 and testing methods ASTM D 4832, ASTM D 6023 and WSDOT FOP for AASHTO T 119 in developing the CDF mix design. The ASTM and AASHTO tests required in Section 2-09.3(1)E are for use by the Contractor in developing the CDF mix design, and with the exception of providing the 28 day compressive strength test results on WSDOT Form 350-040, the test results are not required as part of the CDF mix design submittal. The Project Engineer must review the mix design before placement of the CDF will be allowed.

The Inspector should verify and document that each truckload of CDF is accompanied by the producer supplied Certificate of Compliance, meeting the requirements of *Standard Specification* Section 6-02.3(5)B. The Inspector

should also verify that the components, as listed on the Certificate of Compliance, conform to the mix design per *Standard Specification* 6-02.3(5)C. Acceptance of the CDF will be based upon an acceptable Certificate of Compliance. In accordance with *Standard Specification* Section 1-05.2, the Inspector may reject any load of CDF that does not conform to the mix design.

When water is encountered in the excavation area, it must be removed before backfilling. Cost for accomplishing this is considered incidental and is done at the Contractor's expense unless otherwise provided for in the contract.

All excavation 4 feet or more in depth shall be shored, or protected by cofferdams or shall meet the open-pit requirements of Section 2-09.3(3)B of the *Standard Specifications*. The Contractor must submit his shoring plans in accordance with Section 2-09.3(3)D of the *Standard Specifications*. The shoring design shall be in compliance with the WSDOT *Geotechnical Design Manual* (M46-03), and be designed for site specific conditions, which must be shown and described in the working drawings. These drawings must be approved before construction begins. WSDOT's approval, however, does not relieve the Contractor of responsibility of satisfactory results.

The contractor shall submit working drawings and calculations for open-pit excavation, showing the geometry and construction sequencing of the proposed excavation slopes in accordance with Section 2-09.3(3)B of the *Standard Specifications*. The excavation stability design shall be conducted in accordance with the WSDOT *Geotechnical Design Manual* (M46-03) and must be designed for site specific conditions, which must be shown and described in the working drawings. These drawings must be approved before construction begins.

The Contractor shall submit detailed plans of cofferdams for approval as required in the *Standard Specifications*, Section 2-09.3(3)D when their use is required. This requirement shall be strictly followed. When a cofferdam is required on a railroad right of way, excavation must not be commenced before the plans have been approved by the railroad company. The Contractor should be notified of this requirement well in advance of starting such work, as it usually takes several weeks to get plans approved by the railroads. See Chapter 6-1.5 of this manual for the number of copies to submit and distribution of approved plans.

Cofferdams, in general, must be removed to the bed of the stream, or to below the low water mark. In some cases, it may be advisable to leave the cofferdam in place. The Cofferdam is, however, the property of the Contractor.

Sheet piling, designed in accordance with the USS Steel *Sheet Piling Design Manuals*, may be used for shoring walls that do not support other structures and that are 15 feet in height or less. When sheet piles are used for cofferdams, the Project Engineer shall see that the sheets are held tightly together during driving and placing, so that no cracks or holes are left, through which water can flow. If timbers are used in the cofferdam, the use of wood preservatives needs to be monitored to be sure that all environmental constraints are met. Cofferdams should be built slightly larger than the neat size shown on the plans. This is to allow for inaccuracy of driving sheet piles.

Where bearing piles are to be driven, the excavation should be carried deeper to allow for upheaval of soil due to pile driving. This extra depth will depend on the character of the material. Usually in sand and gravel from 6 inches to 1 foot and in a river or tide mud from 1 foot to 1.5 feet is sufficient. Such over-excavation is the Contractor's responsibility. Over-excavation shall be backfilled with gravel backfill to the footing elevation if the upheaval is less than anticipated.

In soft mud, when the driving of piles tends to liquefy the foundation material, it is sometimes necessary to excavate below plan grade and backfill with gravel before concrete is placed. When the Engineer considers this to be necessary and approval of the State Construction Office has been secured, the additional excavation shall be paid for at the unit contract price for structure excavation and the gravel backfill shall be paid for on force account basis or at an agreed price.

Excavations shall be carried to the elevation shown on the plans or as established by the Engineer. The Project Engineer should take into consideration the fact that when a clamshell bucket is used, it is very difficult to clean the hole to an exact given elevation. For direct-bearing footings, the corners and sides of the excavation should be cleaned out as well as possible and there should not be an excess of loose material left in the bottom. If the character of the material found at plan elevation is questionable, consult the Regional Materials Engineer.

When the excavation for the footing has been completed, elevations to establish the footing elevation shall be taken in the corners of any footing and recorded in the project records.

The material on which spread footings are to be constructed must be adequate to support the design soil pressure per square foot (meter) shown in the plans. The Regional Materials Engineer should be consulted to review the foundation conditions if the bottom of the footing is materially different than what is identified in the contract plans. If a change of design or the lowering of a footing appears to be advisable, the State Construction Office must be advised.

Occasionally, foundations adjacent to large piers are founded at a higher elevation than the large pier foundation. In these cases, the Contractor must carry on operations so that the foundation at the higher elevation will not be disturbed when excavation is made for the lower pier.

Backfilling holes made for piers and column bents up to the surface of the surrounding ground may be done at any time after the forms are removed, providing the backfilling is brought up evenly on all sides of the pier or column.

Backfilling around piers and bents in streams shall be done carefully with material suitable to resist scour, and be brought up to a height not less than the original bed of the stream. Embankment backfill against abutments, piers, walls, culverts, or other structures shall not be placed until the concrete has attained 90 percent of its design strength and has cured for at least 14 days or as otherwise specified in the contract.

It is very important that drainage be provided in back of retaining walls, tunnels, and structures having wing walls or abutments to eliminate excessive soil pressure. Weep holes shall be placed as shown on the plans and as low as possible. Gravel backfill for walls or other suitable materials shall be placed directly behind the structure. If drainage is a major problem, it may be necessary to also construct perforated drain pipe or French drains behind the structure.

The construction of embankments and backfill around bridge ends shall be in accordance with Section 2-03.3(14)I of the *Standard Specifications*. The fill around bridge ends shall be brought up equally on all sides of the bracing, columns, and bulkheads to avoid distortion and displacement of these members.

In addition, Section 2-03.3(14)I of the *Standard Specifications* requires that the superstructure be in place before the backfill behind an abutment can be placed. It further states that this requirement can be waived by the Engineer provided the Contractor submits abutment stability calculations to back up their proposal. When designing the bridge, the designers check the abutment stability using the final condition which includes the dead load of the superstructure. This superstructure dead load increases the resistance to sliding and reduces the overturning moment of the abutment. Since placement of the backfill prior to placement of the superstructure is a condition not analyzed by our designers, we require that stability calculations be submitted for each bridge by the Contractor to reflect this unchecked condition. These stability calculations need to include a surcharge load of at least 2 feet to account for the live loading due to the backfill equipment weight.

Around structures and bridge ends, where rollers cannot operate, compaction shall be obtained by the use of mechanical tampers. Density tests shall be taken frequently enough to ensure that compaction is continued on each lift until the specified density is attained.

Structure excavation is classified into two classes. The excavation necessary for the construction of bridge footings, pile caps, seals, wing walls, and retaining walls is classified as Structure Excavation Class A. All other Structure Excavation is classified as Structure Excavation Class B. See Sections 2-09.3(2), 2-09.3(3), and 2-09.3(4) of the *Standard Specifications*.

2-9.2 Measurement and Payment

Structure excavation shall be measured and paid for in accordance with the provisions of Sections 2-09.4 and 2-09.5 of the *Standard Specifications*.

2-10 Ditch and Channel Excavation

2-10.1 General Instructions

Areas where open ditches are to be constructed shall be cleared and grubbed the same as areas for roadway excavation.

The excavated material may be used for the construction of dikes, berms, or otherwise disposed of as shown on the plans or as directed by the Engineer. The materials should not be placed in embankments unless it is suitable for embankment construction.

2-10.2 Measurement and Payment

Ditch and channel excavation shall be measured and paid for in accordance with the provisions of Sections 2-10.4 and 2-10.5 of the *Standard Specifications*.

2-11 Trimming and Cleanup

2-11.1 General Instructions

This work shall consist of dressing and trimming the entire roadway or roadways improved under the contract. The shoulders, ditches, and back slopes shall be trimmed to the specified cross-section to produce a neat and pleasing appearance. All channels, ditches, and gutters shall be opened up and cleaned to ensure designed drainage. This includes existing drainage within the project limits specified in the contract.

2-11.2 Measurement and Payment

Trimming and cleanup will be measured and paid for in accordance with the provisions of Sections 2-11.4 and 2-11.5 of the *Standard Specifications*.

2-12 Construction Geotextile

2-12.1 General Instructions

Construction geotextile fabric needs to be fully covered at all times until placement. It should be stored in a protected area off the ground and away from items that can cause damage such as sunlight, heat, precipitation, chemicals flames including welding sparks and any other environmental condition that may damage the physical properties of the fabric.

The area to be covered should be graded to a smooth, uniform condition free from ruts, holes, and protruding objects such as rocks and sticks. The fabric needs to be placed immediately ahead of the covering operation with as few wrinkles as possible. The material should not be dragged through the mud nor over sharp or protruding objects which could damage the material.

The cover material is to be placed in front of the placing equipment. This equipment should be sized to minimize the rutting that may occur during the placement. Turning of vehicles on the first lift of material may cause damage to the fabric and should not be allowed.

Sewing of seams is described in Section 2-12.3 of the *Standard Specifications*.

Fabric damaged during placement needs to be repaired as soon as possible. The backfill material needs to be removed and the fabric repaired either as recommended by the manufacture or as listed in the contract. Visible evidence of damaged material may include subgrade pumping, intrusion of subgrade, or roadbed distortion.

2-12.2 Placement

Section 2-12.3 of the *Standard Specifications* lists the required placing and lapping requirements for each type of use of construction geotextile. Following is a short explanation for the placement types.

1. Underground Drainage — The fabric is used as a wrap around the drain rock and the pipe to not only separate the backfill material from the drainage material but also to act as a filter of fine sands and silts. This prevents the fines from flowing into the drain rock and clogging the drainage system.

2. Separation — The fabric is placed directly on a subgrade that contains a large amount of fine sand and silts. Normally the subgrade can be constructed during fair weather, however, almost any amount of moisture can make working on the grade impossible.

3. Soil Stabilization — Soft subgrade that cannot support the weight of equipment constructing the roadbed, is usually removed, a fabric placed and covered with backfill. This allows a stable enough surface to continue construction. Here the fabric not only separates the two materials but also adds strength to the roadbed.

4. Permanent Erosion Control and Ditch Lining — The fabric is utilized to reduce or minimize the ground surface's exposure to erosion. The material is placed directly on the surface to be protected and then backfill is placed over the fabric. Rock surfacing should not be placed in a lined ditch under the fabric as this would allow the water to erode the ground under the fabric thus eliminating its effectiveness.

5. Temporary Silt Fences — As the title states, the fabric is used to trap silt and other fine particles from continuing from the project site to open water.

2-12.3 Measurement and Payment

Construction geotextile will be measured and paid for in accordance with the provisions of Sections 2-12.4 and 2-12.5 of the *Standard Specifications*.