GEOTECHNICAL REPORT

SR-20

MP 44.75

Quiet Cove Road Vic. To SR 20 Spur Meadow Creek Bridge

XL-0832

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Prepared by:
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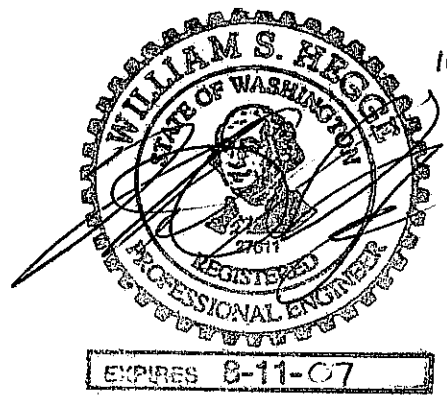

11/8/05

EXPIRES 8-11-07

November 8, 2005

Washington State Department of Transportation
Douglas B. MacDonald
Secretary of Transportation

Environmental & Engineering Programs Division
Materials Laboratory
P.O. Box 47365
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Contents

1. Project Location and Description

This report presents the results from a geotechnical study performed for the Meadow Creek Bridge associated with the SR 20, Quiet Cove Road vic. to SR 20 Spur project. The location of the project site is shown on the Vicinity Map, Figure 1 in Appendix A.

This project involves safety improvements to SR 20 from south of Meadow Creek Bridge to Sharpes Corner. The improvements involve alignment and profile changes, construction of left-turn channelization, lane and shoulder widening, and closure of several intersections. As part of a new alignment, a new bridge will be constructed over Meadow Creek.

Meadow Creek currently passes under SR 20 in a 4-foot diameter culvert. The culvert will be removed, and an open channel constructed to convey Meadow Creek under a new, single-span bridge. As currently proposed, the new bridge will be a pre-cast girder structure wide enough to accommodate three 12-foot lanes and two 8-foot shoulders. A temporary detour will be constructed to the south of the proposed bridge to maintain traffic during bridge construction. The detour will be constructed by extending the existing culvert and building a temporary geosynthetic retaining wall.

Geotechnical recommendations for the temporary detour wall, and the retaining walls to contain the approach fills to the proposed bridge will be provided under a separate cover.

2. Regional Geology

The project site is located in the northern portion of the Puget Sound Lowland geomorphic province. The Puget Sound Lowland is an elongated topographic and structural depression bordered by the Cascade Mountains to the east and the Olympic Mountains to the west. The Puget Lowland owes its present-day geomorphology to the most recent glacial advance and retreat, known as the Vashon Stade of the Fraser Glaciation. This ice sheet filled the Puget Lowlands with as much as 3,000 to 5,000 feet of ice at least four different times during this period.

The Puget Sound area is underlain by a thick, complex sequence of glacial and interglacial sediments. Meltwater flowing from the advancing ice sheet transported a variety of sediment that built a broad outwash plain. Coarse sediment such as sand and gravel was deposited in the high-energy environment near the advancing glacier. Finer sediment such as silt and clay was deposited in the low-energy environment further from the glacier and in ponds and lakes that were formed as the advancing ice sheet blocked meltwater channels. As the ice sheet advanced, these sediments were overridden by hundreds of feet of ice and were compacted to their present condition. Following the last glacial advance and retreat, alluvial (river) and lacustrine (lake-bed) sediments were deposited by runoff from the eastern slopes of the Olympics and western slopes of the Cascades. The more recent portions of these sediments (lower-energy) consist of fine-grained sands, silts, and clays.

A 1989 geologic map prepared by F. Pressl et al titled *Surficial Geologic Map of the Port Townsend 30- by 60-Minute Quadrangle* indicates the project area is underlain by Quaternary Vashon Till and Recessional Outwash. Advance outwash deposits are also mapped in the vicinity of the project.

3. Site Conditions

Meadow Creek conveys water from Lake Campbell to Puget Sound. Meadow Creek currently passes underneath SR 20 via a 4-foot diameter culvert. The side slopes of the embankment supporting SR 20 are generally steeper than 2:1 (Horizontal:Vertical) and vegetated with brush and small trees.

Two water mains serving communities on Whidbey Island are buried in the shoulders of SR 20. A 24-inch main is buried in the north shoulder, and a 10-inch main is buried in the south shoulder. Each of these water mains will be relocated to the new bridge. Other utilities, such as power, phone, and cable TV are located in overhead lines. Several utility poles will require relocation as part of the bridge construction.

4. Field Exploration and Laboratory Testing

Three test holes were drilled in May 2004 to assess soil and groundwater conditions along the bridge alignment. Test holes H-1-04 and H-2-04 were drilled at piers 1 and 2, respectively; test hole H-3-04 was drilled about mid-span, and between the existing alignment and the proposed detour alignment. The locations of the test holes are shown on Figure 2 in Appendix A. Our field exploration was conducted in general accordance with the *WSDOT Geotechnical Design Manual* (M 46-03) and the 2005 *AASHTO LRFD Bridge Design Specifications.*

Geotechnical drilling was performed using a CME 45, skid mounted drill rig. Test holes were advanced to depths up to 101 feet below the ground surface using mud rotary drilling methods. At each location, soil samples were obtained using a SPT (Standard Penetration Test) sampler, in general accordance with ASTM D-1586. SPTs are obtained by driving a 2-inch outside diameter split-spoon sampler 18-inches into the soil with a 140-pound hammer. The number of blows required to achieve each 6 inches of penetration is recorded and the soil's SPT resistance, or N-value, is calculated as the number of blows required to achieve the final 12 inches of penetration. The drill rig is equipped with an automatic trip hammer to drive the split-spoon sampler. The automatic hammer on this drill rig is rated at approximately 80 percent efficiency, as compared to approximately 60 percent for manual hammers.

Appendix B contains copies of the boring logs. All boring logs should be made available to prospective bidders and included in the contract documents.

Laboratory testing was performed on selected samples from the field exploration program. Testing included performing moisture content, grain size analyses, and Atterberg Limits. The tests were done in general accordance with AASHTO T-88 , T-89, and T-90 specifications, respectively. After testing was complete, the samples were classified in general accordance with the Unified Soil Classification System (USCS). Appendix C contains copies of the laboratory testing results.

5. Site Soil Conditions

Based on the results or our field exploration and laboratory testing, two general soil units underlie the project site.

Unit 1 generally consist of very loose to medium dense clayey sand and silty clayey sand. This unit was encountered in the fill of the existing embankment over Meadow Creek. The embankment was likely constructed from surficial alluvial and lacustrine soils from the surrounding area.

Unit 2 consists of dense to very dense glacial deposits. The glacial soils generally consist of poorly graded sand and silty sand. These sands are inferred to be advance outwash deposits. A deposit of hard to very hard lean clay was encountered from 88-feet to 101-feet below the existing ground surface in boring H-2-04. These clay soils are likely a glacially over-ridden lacustrine deposit. These glacially consolidated soils underlie Unit 1 to the limits explored.

6. Surface Water and Groundwater

At the time of drilling, water was recorded approximately 23 feet below the existing ground surface in borings H-1-04 and H-02-04. This corresponds to a groundwater elevation of approximately 37 feet. A piezometer installed in boring H-2-04 was destroyed prior to obtaining long-term readings. The groundwater elevation recorded at the time of drilling is relatively consistent with the water elevation in Meadow Creek. Groundwater elevations are expected to fluctuate with time of year, precipitation, stream levels, and other factors.

7. Seismological Considerations

7.1. Site Seismicity

The seismicity of the area is predominantly influenced by the oblique subduction of the Juan de Fuca Plate under the North American Plate. The convergence between the plates is estimated to be about 4 cm per year. Within this active tectonic environment, three possible sources for seismic events in the Seattle area have been identified. The first two sources are intraplate and are related to plate deformations and stress concentrations within the two plates, as they are deformed by the subduction process. The first source is near surface within the continental crust of the uplifting North American Plate, and the second source is deeper within the subducting Juan de Fuca plate. The third source is off shore near the subduction line between the two plates and is related to movement along the subduction interface. This source has recently been referred to as the Cascadia Subduction Zone.

Shallow crustal seismicity within the North American plate, until recently, was thought to be limited in magnitude, less than 3 on the Richter scale, and unrelated to specific structures within the Puget Sound Lowland. Recent evidence suggests that some geologic structural control may be present and that these structures may be capable of producing shallow crustal seismic events with magnitudes greater than 6 on the Richter scale. One such structure is the inferred Seattle Fault. Evidence suggests that relatively recent activity has occurred along this fault, approximately 1,100 years ago. One of the most recent earthquakes of record from a shallow crustal source was the Richardson Point earthquake on January 28, 1995. The earthquake was a magnitude of 5 on the Richter scale and ground accelerations of 0.07g were recorded. Minor damage and some liquefaction was evident as the result of ground shaking.

Other notable earthquakes within the region have generally been attributed to the intraplate seismicity within the Juan de Fuca plate. On April 13, 1948, a magnitude 7.0 earthquake occurred, on April 29, 1965, a magnitude 6.5 earthquake occurred, and on February 28, 2001 a magnitude 6.9 earthquake occurred. These two quakes are believed to be from this source. Both of the quakes caused damage and liquefaction within the Seattle/Olympia area.

The Cascadia Subduction Zone has not experienced a known earthquake within the last 165 years of seismic record. However, evidence suggests that at various times within the last 3,500 years many coastal estuaries have experienced rapid subsidence as the result of seismic activity

related to this zone. It is generally believed that this source is capable of producing seismic events as large as magnitude 9.

7.2. Design Earthquake Parameters

An acceleration coefficient of 0.27g is recommended for seismic design of the structures on this project in accordance with the *WSDOT Geotechnical Design Manual* (M 46-03). The recommended acceleration coefficient is based on expected ground motion at the project site that has a 90 percent probability of not being exceeded in a 50-year period.

Design response spectra presented in the AASHTO guide specification are considered appropriate for seismic design of the structures on this project. A Type II soil profile response spectrum is recommended for seismic design of the project.

7.3. Liquefaction Potential

The liquefaction potential of saturated soils is evaluated mainly on soil gradation, density, and the depth of the deposit. The potential for liquefaction is highest for loose, fine to medium grained sands and silty sands. Increasing fines content (i.e., silt and clay) decreases the potential for liquefaction. Conversely, clean coarse-grained granular soils are less susceptible to liquefaction due to their high permeability. The potential for liquefaction also decreases with increasing density and depth.

We have evaluated the potential for liquefaction of the project soils based on the SPT data obtained from the field explorations and the percentages of silt. Our analysis indicates that the potential for liquefaction is low.

8. Geotechnical Recommendations

8.1. Approach Slabs

Section 8.6.5.3 of the *WSDOT Geotechnical Design Manual* (M 46-03) requires the use of approach slabs where approach embankments exceed 8 feet in height. We recommend approach slabs be used at both abutments of the Meadow Creek bridge.

8.2. Bridge Foundation Recommendations

Based on results from the field exploration, laboratory testing, and our subsequent analyses, we recommend Meadow Creek bridge be supported on deep foundations. As part of this study, we evaluated a spread footing option, but our findings indicate the abutment soils exhibit insufficient strength to provide an adequate factor of safety for global stability. Our preliminary recommendations provided in our February 11, 2005 memorandum recommended the use of driven piles to support the Meadow Creek Bridge. We understand preliminary design by the Bridge and Structures Office has indicated lateral loads will govern the design of the abutments. The depth of the piles necessary to resist the lateral loads will make piles difficult or impossible to drive. Therefore, we recommend drilled shafts be used to support the bridge.

8.2.1. Drilled Shafts

Enclosed in Appendix D are ultimate capacity charts for strength, service and extreme event limit states. The charts show the load that can be applied at the top of the shaft. The weight of

the shaft has not been deducted from the compressive capacity in the figures and is not included in the uplift. The capacities or loads shown in the figures are those that can be applied at the top of shaft. The net weight of the shaft should be treated as a load applied to the top of the shaft.

The charts are for shafts with 4-, 6-, and 8-foot diameters. Separate plots for ultimate skin friction (Q_s) and ultimate end bearing (Q_b) are provided on the charts. At a given depth on the figures, the factored resistance (Q') can be determined by adding the ultimate skin friction multiplied by its resistance factor (ϕ_s) and the ultimate end bearing multiplied by its resistance factor (ϕ_b) as shown in the following equation:

$$Q' = Q_s \cdot \phi_s + Q_b \cdot \phi_b$$

Shaft capacity at the Service Limit State was based on 1-inch of settlement. Settlement will occur as the loads are applied. Post construction settlement should be negligible.

Table 1 contains resistance factors to be used when evaluating the different limit states.

Table 1

Drilled Shaft Resistance Factors

Limit State	Resistance Factor ϕ		
	Skin Friction Qs	End Bearing Qb	Uplift
Strength	0.55	0.50	0.45
Service	1.00	1.00	N/A
Extreme	1.00	1.00	0.80

8.2.2. Lateral Analysis of Deep Foundations

Lateral analysis of drilled shafts can be evaluated using the LPILE, SIL-SHAFT, or other suitable computer program. Soil parameters for lateral analysis are provided in Appendix E.

For lateral analysis of foundation elements in a group, reduction factors should be used if P-y methods of analysis are used. The values of P should be multiplied by the values, P_m, in Table 3 to modify the P-y curves used in the analysis. The multipliers, P_m, in Table 3 are a function of the center-to-center spacing expressed in multiples of the foundation element diameter (D) as measured along the direction of loading within the group. The values of P_m in Table 3 were developed for vertical elements only. Note that P_m is not applicable if strain wedge theory is used.

Table 2

Load Modifiers, P_m, for Multiple Row Shading (averaged from Hannigan, et al., 1997).

Center-to-Center Spacing In the Direction of Loading	P Multipliers		
	Row 1	Row 2	Row 3 and Higher
3D	0.70	0.50	0.35
5D	1.00	0.85	0.70

Loading direction and spacing are as defined in Figure 1. Note that if the loading direction for a single row is perpendicular to the row (bottom right detail in the figure), a group reduction factor of less than 1.0 should only be used if the spacing is 5D or less, as shown in the detail.

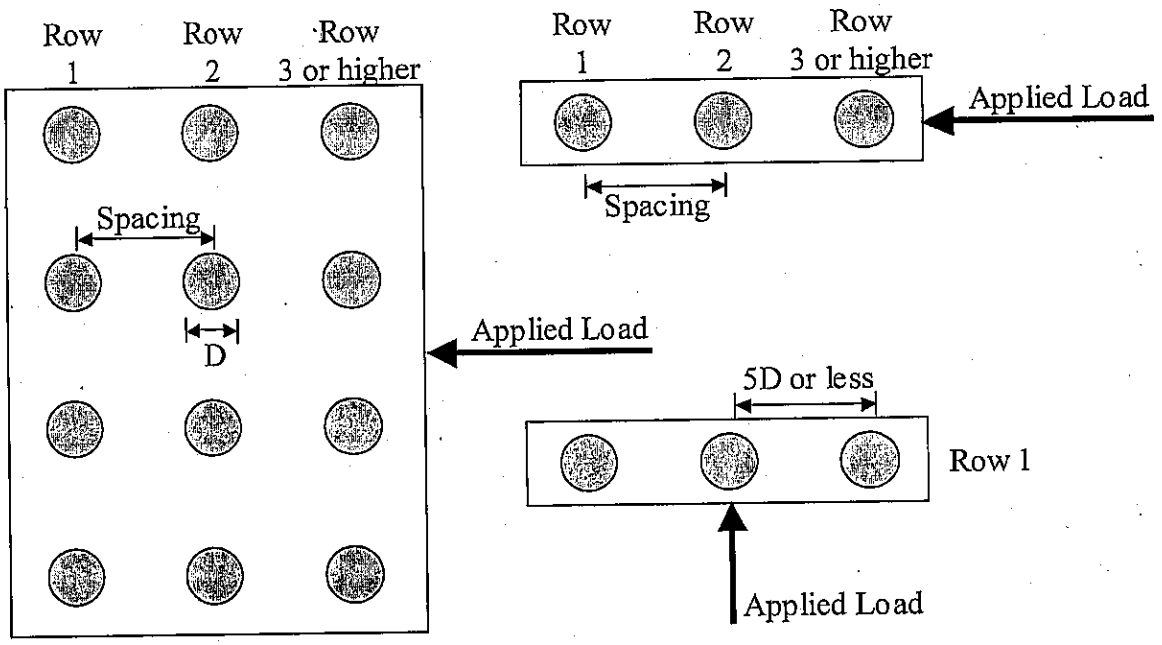

Figure 1. Definition of loading direction and spacing for group effects.

8.2.3. Abutments

Abutment walls should be designed using the lateral earth pressure coefficients and soil parameters provided in Table 3, in conjunction with the design methods presented in the WSDOT *Bridge Design Manual*. We recommend disregarding the upper 2 feet of soil against the front face of the abutment wall when determining passive soil resistance unless pavement is located at the toe. Per the *Bridge Design Manual*, the lateral earth pressure due to traffic

surcharge loading can be calculated by using a uniformly distributed load at the ground surface of 250 psf multiplied by K_a.

Table 3

Lateral Earth Pressure Coefficients and Soil Parameters

Parameter	Value
Unit Weight (γ)	125 pcf
Soil Friction (ϕ_f)	36°
Active Earth Pressure (k_a)	0.26
Seismic Earth Pressure (k_{ae})	0.34
At-rest Earth Pressure (k_o)	0.41

9. Construction Considerations

Seepage is expected in the shaft excavations. The contractor should be prepared to use drilling slurries or casing to control groundwater and maintain sidewall stability. Temporary casing will likely be necessary in the loose Unit 1 soils. At this time, the minimum elevations shown the following table should be required by contract.

Table 4

Casing Limits

Pier	Minimum Casing Tip Elevations (ft)
1	45
2	23

These casing recommendations are being provided for estimating purposes only. We will prepare information regarding the casing requirements and construction limitations for presentation to the WSDOT/Association of Drilled Shaft Contractors (ADSC) Joint Task Force for their recommendations regarding the constructability of shafts and casing for this bridge. Final casing recommendations will be addressed during PS&E preparations.

While not specifically encountered in the borings, cobbles and boulders may be present based on the geologic nature of the soils. The shaft contractor should be prepared to remove cobbles and boulders during shaft construction.

10. Recommended Additional Services

Because the future performance and integrity of the geotechnical elements of this project will depend largely on proper PS&E preparation and diligent construction procedures, we recommend that the Geotechnical Division (GD) in conjunction with the Regional Materials Engineer (RME) provide the following post-report services:

- The GD should prepare the Summary of Geotechnical Conditions to be included in the PS&E as an appendix. The summary should be prepared as part of the PS&E review process.
- The GD/RME should review all construction plans and specifications to verify that the design criteria presented in this report have been interpreted correctly and properly integrated into the design.
- The GD/RME should attend pre-construction conferences with the Construction Project Engineer and Contractor to discuss important geotechnical related construction issues.
- The GD/RME should review Contractor submittals for all shoring walls and other geotechnical elements of this project.
- The RME should observe all exposed subgrades after completion of stripping and excavation to contract elevations. The RME should confirm that suitable soil conditions have been reached and determine appropriate subgrade compaction methods.

In addition to the aforementioned services, the Geotechnical Division can provide inspector training for construction personnel, assist in change of condition claims, and review cost reduction incentive proposals (CRIPs).

11. Intended Report Use and Limitations

This report has been prepared to assist the Washington State Department of Transportation in the engineering design and construction of the subject project. It should not be used, in part or in whole for other purposes without contacting the EEP Geotechnical Division for a review of the applicability of such reuse. This report should be made available to prospective contractors for their information or factual data only and not as a warranty of ground conditions.

The conclusions and recommendations contained in this report are based on the Geotechnical Division's understanding of the project at the time that the report was written and on site conditions that existed at the time of the field exploration. If significant changes to the nature, configuration, or scope of the project occur during the design process, the Geotechnical Division should be consulted to determine the impact of such changes on the recommendations and conclusions presented in this report.

Site exploration and testing describes subsurface conditions only at the sites of subsurface exploration and at the intervals where samples are collected. These data are interpreted by members of the Geotechnical Division who then render an opinion regarding the general subsurface conditions. The distribution, continuity, thickness, and characteristics of identified (and unidentified) subsurface materials may vary considerably from that indicated by the subsurface data. While nothing can be done to prevent such variability, the Geotechnical Division is prepared to work with the Design Team to reduce the impacts of variability on project design, construction, and performance. Periodic geotechnical observation during construction may be beneficial in this respect. This ongoing involvement of the Geotechnical Division throughout the design and project development process will also help to avoid costly mistakes associated with misinterpretation of the contents of this report and resulting shortcomings of project design or contract documents.

The conclusions and recommendations presented in this report assume that surface and subsurface conditions, as observed during field exploration activities are representative of the

site conditions throughout the project area. Because of this assumption, these recommendations should be considered subject to change depending on the actual subsurface conditions encoutnered. Actual subsurface conditions can be discovered only during earthwork and construction operations. Accordingly, the Geotechnical Division should be involved in the construction of the project in order to make appropriate observations and recommendations for alteration in design, as appropriate.

Questions or comments regarding the contents of this report should be directed to Mark Frye at (360) 709-5469 or Tony Allen at (360) 709-5450.

Appendix A

Figures

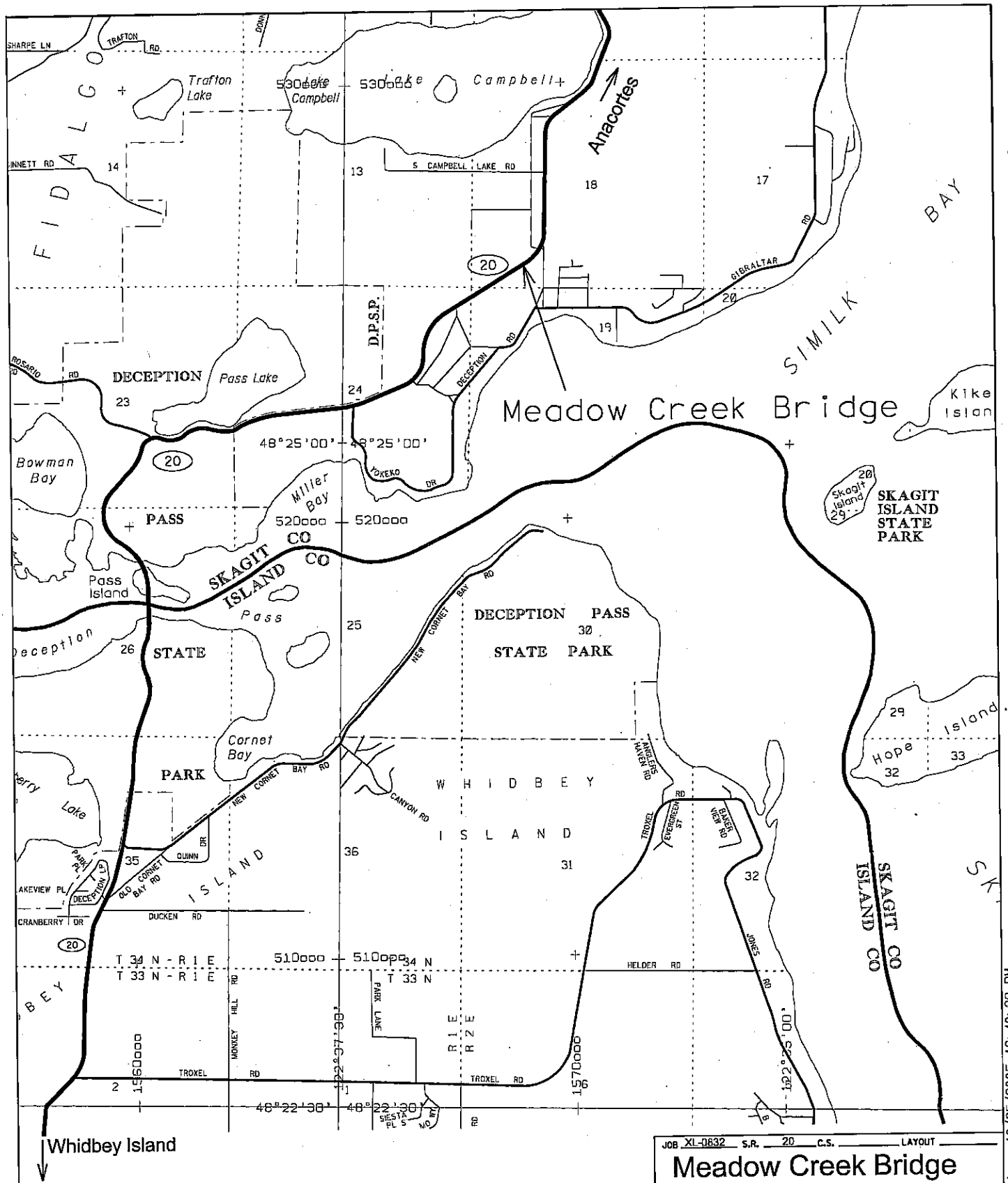

Figure 1: Vicinity Map

JOB XL-0832 S.R. 20 C.S. LAYOUT

Meadow Creek Bridge
Vicinity M.P. 44.75

WASHINGTON STATE TRANSPORTATION COMMISSION
DEPARTMENT OF TRANSPORTATION
MATERIALS BRANCH
T. E. BAKER MATERIALS ENGINEER

DATE 1/2005
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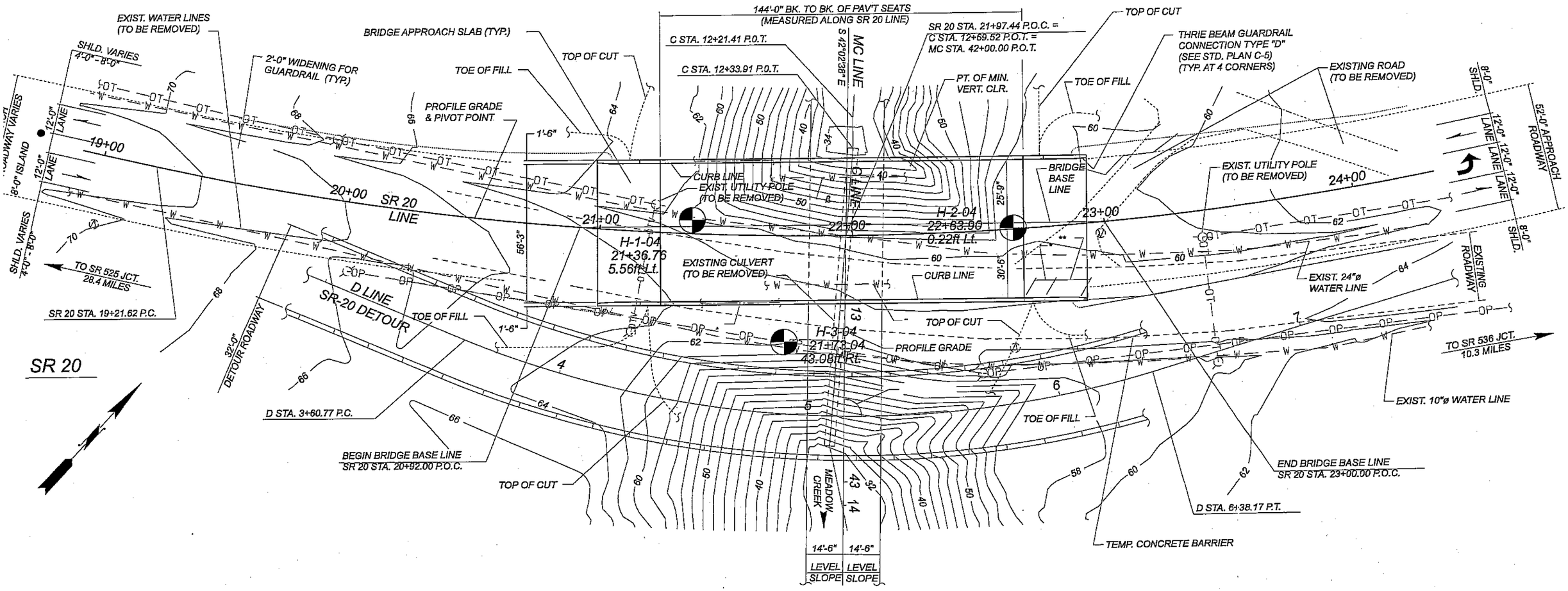

LEGEND

H-1-04 Test Hole Designation and Approximate Location

DATUM
NAVD 1988

Figure 2: Site and Exploration Plan

JOB XL-0832 S.R. 20 C.S.

Meadow Creek Bridge
Vicinity M.P. 44.75

WASHINGTON STATE TRANSPORTATION COMMISSION
DEPARTMENT OF TRANSPORTATION
MATERIALS BRANCH
T. E. BAKER MATERIALS ENGINEER

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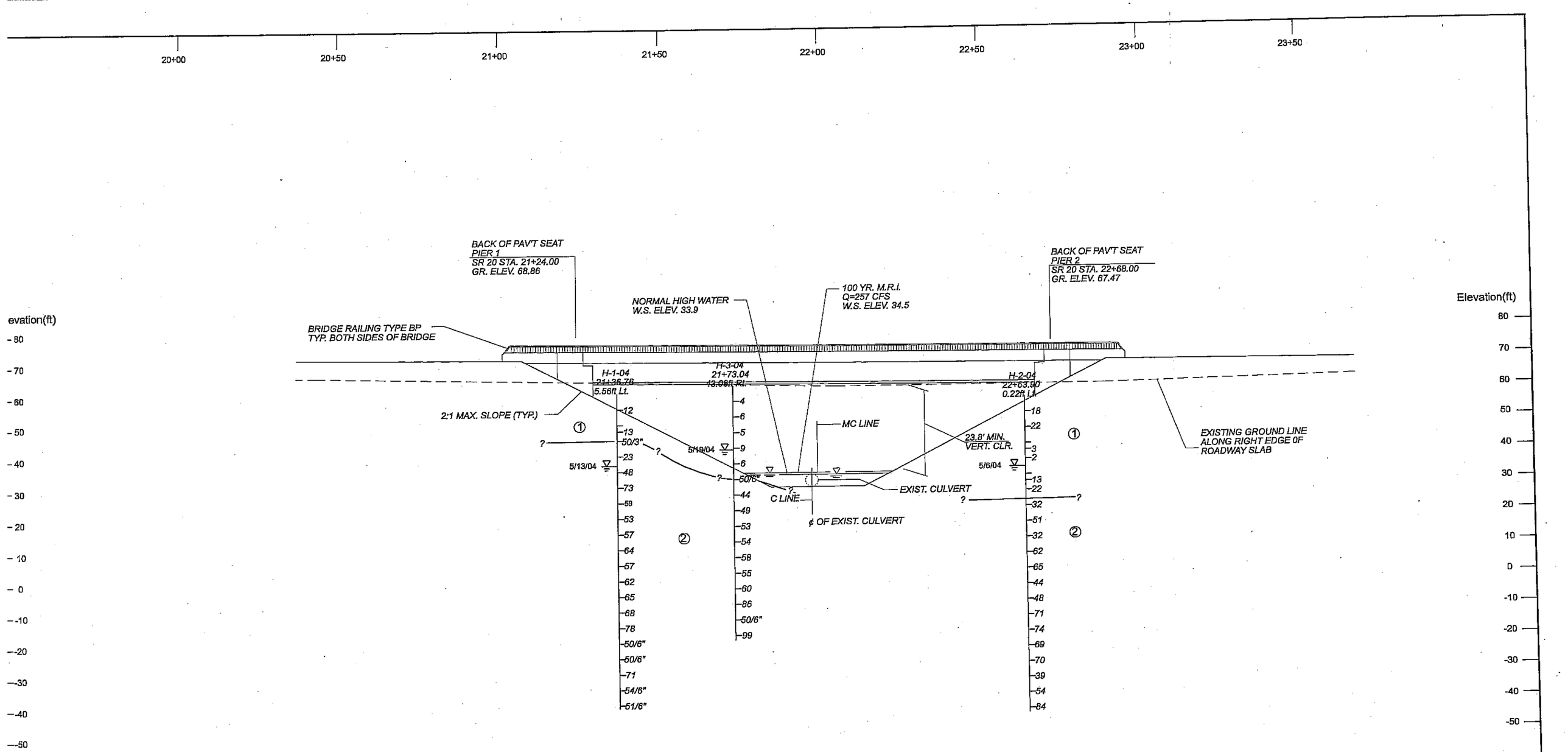

TEST HOLE LEGEND

H-I-98 TEST HOLE NUMBER
110+55 TEST HOLE STATION
26 ft.Rt. TEST HOLE OFFSET

23 STANDARD PENETROMETER TEST (BLOWS PER FOOT)
UNDISTURBED SAMPLE
W.L. 8-6-86 WATER LEVEL & DATE
? INDICATES SOIL/ROCK STRATA BETWEEN TEST HOLES MAY NOT BE CONTINUOUS
INDICATES INTACT ROCK
86% INDICATES CORE SAMPLE TAKEN
ROCK QUALITY DESIGNATION

DATUM
NAVD 1988

SOIL UNITS

1 - FILL - Soft/loose to stiff/medium dense, clayey SAND and silty clayey SAND.

2 - GLACIAL DEPOSITS - Dense to very dense, SAND and silty SAND with gravel, and hard to very hard lean CLAY..

Figure 3: Bridge and Soil Profile

JOB XL-0832 S.R. 20 C.S.

Meadow Creek Bridge
Vicinity M.P. 44.75

WASHINGTON STATE
TRANSPORTATION COMMISSION
DEPARTMENT OF TRANSPORTATION
MATERIALS BRANCH
T. E. BAKER MATERIALS ENGINEER

DATE 1/2005
SCALE 1=30' VERT.
1=30' HORIZ.
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Appendix B

Field Exploration

Washington State Department of Transportation

LOG OF TEST BORING

Start Card S-24005

HOLE No. H-1-04

Sheet 1 of 5

Job No XL-0832 SR 20 Elevation 60.3 ft (18.4 m)

Project Quiet Cove Rd. Vic. to SR 20 Spur

Driller Sean Verlo Lic# 2615

Site Address Vic of SR 20 and lunz rd.

Inspector Dan Reed

Start May 13, 2004 Completion May 13, 2004 Well ID#

Equipment CME 45 w/ autohammer

Station 21+36.76 Offset 5.56' Lt. Casing HW-4.5/HQ-3.5

Method Wet Rotary

Northing Easting Latitude Longitude

County Skagit Subsection NE 1/4 of the NE 1/4 Section 24 Range 1 EWM Township 34N

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
5	1			4 5 7 (12)		D-1		Clayey Sand, angular, trace organics, medium dense, light brown, moist, Disrupted, no HCl reaction, Moisture tin retained in sample bag. Length Recovered 1.5 ft, Length Retained 1.5 ft		
10	3					S-2		Clayey Sand, angular, slightly sandy, medium dense, gray, moist, Homogeneous, no HCl reaction Length Recovered 2.0 ft, Length Retained 2.0 ft		
	4			1 3 10 (13)		D-3	GS MC AL	SC, M.C. = 34%, PI = 23 Clayey SAND, angular, slightly sandy, medium dense, gray, moist, Homogeneous, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft		
15	5			30 50/3 (50/3")		D-4	GS MC	SM, M.C. = 14% Silty SAND, angular, very dense, gray, moist, Homogeneous, no HCl reaction, Moisture tin retained in sample bag. With large gravel as indicated by drilling process. Length Recovered 0.8 ft, Length Retained 0.8 ft		
20	6									

SOIL XL-0832 QUIET COVE RD. VIC. TO SR 20 SPUR.GPJ SOIL.GDT 10/26/05 9:33:38

Washington State Department of Transportation

LOG OF TEST BORING

Start Card S-24005

HOLE No. H-1-04

Job No. XL-0832 SR 20 Elevation 60.3 ft (18.4 m)

Sheet 2 of 5

Project Quiet Cove Rd. Vic. to SR 20 Spur

Driller Sean Verlo Lic# 2615

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				11 14 19 (23)		D-5		Silty SAND with gravel, angular, dense, gray, moist, Disrupted, no HCl reaction, With large gravel as indicated by drilling process. Moisture tin retained in sample bag. Length Recovered 1.5 ft, Length Retained 1.5 ft		
	7								▽ 05/13/2004	
25				19 23 25 (48)		D-6	GS MC	SP-SM, M.C. = 5% Poorly graded SAND with silt, dense, gray, wet, Homogeneous, no HCl reaction, Slightly silty. Length Recovered 1.5 ft, Length Retained 1.5 ft		
	8									
	9									
30			>>	23 23 50 (73)		D-7		Poorly graded SAND with silt, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft		
	10									
35			>>	21 23 36 (59)		D-8		Poorly graded SAND with silt, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft		
	11									
	12									
40			>>	18 25 28 (53)		D-9		Poorly graded SAND with silt, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.2 ft, Length Retained 1.2 ft		
	13									
45			>>							

SOIL XL-0832 QUIET COVE RD. VIC. TO SR 20 SPUR.GPJ SOIL.GDT 10/26/05,9:33:38

Washington State Department of Transportation

LOG OF TEST BORING

Start Card S-24005

HOLE No. H-1-04

Job No. XL-0832 SR 20 Elevation 60.3 ft (18.4 m)

Sheet 3 of 5

Project Quiet Cove Rd. Vic. to SR 20 Spur Driller Sean Verlo Lic# 2615

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	14			21 27 30 (57)		D-10		Poorly graded SAND with silt, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.1 ft, Length Retained 1.1 ft		
	15									
50			>>	23 29 35 (64)		D-11	GS MC	SM, M.C. = 23% Silty SAND, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.2 ft, Length Retained 1.2 ft		
	16									
55			>>	23 27 30 (57)		D-12		Silty SAND, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.1 ft, Length Retained 1.1 ft		
	17									
	18									
60			>>	24 29 33 (62)		D-13		Silty SAND, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.2 ft, Length Retained 1.2 ft		
	19									
65			>>	23 25 40 (65)		D-14		Silty SAND, very dense, gray, wet, Homogeneous, no HCl reaction, Moisture tin retained in sample bag. Length Recovered 1.2 ft, Length Retained 1.2 ft		
	20									
	21									
70			>>							

SOIL XL-0832 QUIET COVE RD. VIC. TO SR 20 SPUR.GPJ SOIL.GDT 10/26/05 9:33:38

Washington State Department of Transportation

LOG OF TEST BORING

Start Card S-24005

HOLE No. H-1-04

Job No. XL-0832 SR 20 Elevation 60.3 ft (18.4 m)

Sheet 4 of 5

Project Quiet Cove Rd. Vic. to SR 20 Spur Driller Sean Verlo Lic# 2615

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				25 26 42 (68)		D-15		Silty SAND, very dense, gray, wet, Stratified, no HCl reaction, Fine to medium sand lenses. Length Recovered 1.1 ft, Length Retained 1.1 ft		
	22									
75			>>	24 28 50 (78)		D-16	GS MC	SM, M.C. = 26% Silty SAND, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.1 ft, Length Retained 1.1 ft		
	23									
	24									
80				33 50/6 (50/6")		D-17		Silty SAND, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft		
	25									
85	26			28 50/6 (50/6")		D-18		Silty SAND, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 0.8 ft, Length Retained 0.8 ft		
	27									
90			>>	23 30 41 (71)		D-19		Silty SAND, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft		
	28									
95			>>							

SOIL XL-0832 QUIET COVE RD. VIC. TO SR 20 SPUR.GPJ SOIL.GDT 10/26/05,9:33:38

Washington State Department of Transportation

LOG OF TEST BORING

Start Card S-24005

HOLE No. H-1-04

Job No. XL-0832 SR 20 Elevation 60.3 ft (18.4 m)

Sheet 5 of 5

Project Quiet Cove Rd. Vic. to SR 20 Spur Driller Sean Verlo Lic# 2615

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	29			33 54/6 (54/6")		D-20		Silty SAND, very dense, gray, moist, Homogeneous, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft		
	30							Silty SAND, very dense, gray, moist, Homogeneous, no HCl reaction. Length Recovered 1.0 ft, Length Retained 1.0 ft		
100			>>	40 51/6 (51/6")		D-21		Silty SAND, very dense, gray, moist, Homogeneous, no HCl reaction. Length Recovered 1.0 ft, Length Retained 1.0 ft		
	31							End of test hole boring at 101 ft below ground elevation.		
								This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
105	32							Water level before bailing was 16.0', Bailed bore hole water level to 41.0', Water level after 10 minutes 39.0', after 20 minutes 37.0', after 30 minutes 34.0', after 40 minutes 30.0', after 60 minutes 27.0', water table stabilized at 23.0' overnight in casing.		
	33									
110										
	34									
115	35									
	36									
120										

SOIL XL-0832 QUIET COVE RD. VIC. TO SR 20 SPUR.GPJ SOIL.GDT 10/26/05,9:33:38

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-62188

HOLE No. H-2-04

Sheet 1 of 5

Job No. XL-0832 SR 20 Elevation 58.0 ft (17.7 m)

Project Quiet Cove Rd. Vic. to SR 20 Spur

Driller Sean Verlo Lic# 2615

Site Address Vic. of SR-161 + Lunz Rd.

Inspector Dan Reed

Start May 6, 2004 Completion May 6, 2004 Well ID# AHN-822

Equipment CME 45 w/ autohammer

Station 22+63.90 Offset 0.22' Lt. Casing HW-4.5/HQ-3.5

Method Wet Rotary

Northing Easting Latitude Longitude

County Skagit Subsection NE 1/4 of the NE 1/4 Section 24 Range 1 EWM Township 34N

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
5	1			5 9 9 (18)		D-1		Clayey Sand, medium dense, gray, moist, Disrupted, no HCl reaction, With silt and elastic silt lenses. Length Recovered 1.5 ft, Length Retained 1.5 ft		
10	3			3 9 13 (22)		D-2	GS MC AL	SC, M.C. = 31%, PI = 26 Clayey SAND, medium dense, gray, moist, Disrupted, no HCl reaction, With sand lenses within structure. Moisture tin retained in sample bag. Length Recovered 1.5 ft, Length Retained 1.5 ft		
15	5					S-3		Clayey SAND, very loose, gray, wet, Disrupted, no HCl reaction, With sand lenses. Length Recovered 2.0 ft, Length Retained 2.0 ft		
				1 1 2 (3)		D-4	GS MC AL	SC, M.C. = 37%, PI = 17 Clayey SAND, very loose, gray, wet, Disrupted, no HCl reaction, With sand lenses. Length Recovered 1.5 ft, Length Retained 1.5 ft		
20	6									

SOIL XL-0832 QUIET COVE RD. VIC. TO SR 20 SPUR.GPJ SOIL.GDT 10/26/05 9:33:39

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-62188

HOLE No. H-2-04

Job No. XL-0832 SR 20 Elevation 58.0 ft (17.7 m)

Sheet 2 of 5

Project Quiet Cove Rd. Vic. to SR 20 Spur Driller Sean Verlo Lic# 2615

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				1 1 1 (2)		D-5		Clayey SAND, very loose, gray, wet, Homogeneous, no HCl reaction, Moisture tin retained in sample bag. Length Recovered 1.5 ft, Length Retained 1.5 ft		
								05/06/2004	▽	
25	7					S-6		Clayey SAND, medium dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 2.0 ft, Length Retained 2.0 ft		
	8			3 5 8 (13)		D-7		Clayey SAND, medium dense, gray, wet, Homogeneous, no HCl reaction, moisture tin retained in sample bag Length Recovered 1.5 ft, Length Retained 1.5 ft		
30	9			7 11 11 (22)		D-8	GS MC AL	SC, M.C. = 41%, PI = 17 Clayey SAND, medium dense, gray, moist, Stratified, no HCl reaction, sand lenses within soil unit moisture tin retained in sample bag Length Recovered 1.5 ft, Length Retained 1.5 ft		
	10									
35	11			23 16 16 (32)		D-9		Silty SAND, dense, gray, moist, Homogeneous, no HCl reaction, w/cobbles and large gravel as indicated by drilling process Length Recovered 1.2 ft, Length Retained 1.2 ft		
	12		>>							
40				19 23 28 (51)		D-10	GS MC	SM, M.C. = 12% Silty SAND, dense, gray, moist, Homogeneous, no HCl reaction, with large gravel and cobbles as indicated by drilling process Length Recovered 1.5 ft, Length Retained 1.5 ft		
	13									
45										

SOIL XL-0832 QUIET COVE RD. VIC. TO SR 20 SPUR.GPJ SOIL.GDT 10/26/05,9:33:39

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-62188

HOLE No. H-2-04

Job No. XL-0832 SR 20 Elevation 58.0 ft (17.7 m)

Sheet 3 of 5

Project Quiet Cove Rd. Vic. to SR 20 Spur Driller Sean Verlo Lic# 2615

Depth (ft)	Meters (m)	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	14		20 25 27 (32)		D-11		Silty SAND, dense, gray, moist, Homogeneous, no HCl reaction, with large as indicated by drilling process Length Recovered 1.5 ft, Length Retained 1.5 ft		
	15								
50		>>	21 29 33 (62)		D-12	GS MC	SM, M.C. = 22% Silty SAND, very dense, gray, wet, Stratified, no HCl reaction, fine to medium coarse sand lenses Length Recovered 1.5 ft, Length Retained 1.5 ft		
	16								
55		>>	23 30 35 (65)		D-13		Silty SAND, very dense, gray, moist, Stratified, no HCl reaction, fine to medium sand lenses Length Recovered 1.5 ft, Length Retained 1.5 ft		
	17								
	18								
60			6 10 34 (44)		D-14		Silty SAND, dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft		
	19								
65			9 11 37 (48)		D-15		Silty SAND, dense, gray, moist, Homogeneous, no HCl reaction Length Recovered 1.5 ft, Length Retained 1.5 ft		
	20								
	21								
70		>>							

SOIL XL-0832 QUIET COVE RD. VIC. TO SR 20 SPUR.GPJ SOIL.GDT 10/26/05,9:33:39

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-62188

HOLE No. H-2-04

Job No. XL-0832 SR 20 Elevation 58.0 ft (17.7 m)

Sheet 4 of 5

Project Quiet Cove Rd. Vic. to SR 20 Spur

Driller Sean Verlo Lic# 2615

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				20 35 36 (71)		D-16		Silty SAND, trace organics (wood), very dense, gray, moist, Homogeneous, no HCl reaction, fine grained sand Length Recovered 1.5 ft, Length Retained 1.5 ft		
	22									
75	23		>>	24 36 38 (74)		D-17	GS MC	SM, M.C. = 21% Silty SAND, very dense, gray, moist, Homogeneous, no HCl reaction, fine to medium grained sand Length Recovered 1.2 ft, Length Retained 1.2 ft		
	24									
80			>>	28 33 36 (69)		D-18		Silty SAND, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.1 ft, Length Retained 1.1 ft		
	25									
85	26		>>	25 34 36 (70)		D-19		Silty SAND, very dense, gray, moist, Homogeneous, no HCl reaction, slightly silty silt lenses Length Recovered 1.2 ft, Length Retained 1.2 ft		
	27									
90				8 9 30 (39)		D-20		Sandy lean CLAY, hard, gray, moist, Blocky, no HCl reaction, silt stone contact at 87.0' Length Recovered 1.5 ft, Length Retained 1.5 ft		
	28									
95										

SOIL XL-0832 QUIET COVE RD. VIC. TO SR 20 SPUR.GPJ SOIL.GDT 10/26/05,9:33:39

Washington State Department of Transportation

LOG OF TEST BORING

Start Card R-62188

HOLE No. H-2-04

Job No. XL-0832 SR 20 Elevation 58.0 ft (17.7 m)

Sheet 5 of 5

Project Quiet Cove Rd. Vic. to SR 20 Spur

Driller Sean Verlo Lic# 2615

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	29			16 19 35 (54)		D-21	GS MC AL	CL, M.C. = 21%, PI = 13 Sandy lean CLAY, hard, gray, moist, Blocky, no HCl reaction, moisture tin retained in sample bag. Length Recovered 1.5 ft, Length Retained 1.5 ft		
	30									
100			>>	26 35 49 (84)		D-22		Sandy lean CLAY, very hard, gray, moist, Blocky, no HCl reaction, Length Recovered 1.5 ft, Length Retained 1.5 ft		
	31							End of test hole boring at 101.5 ft below ground elevation.		
								This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
105	32							Bailed bore hole water level to 77.0', water level after 10 minutes 74.0', after 20 minutes 67.0', after 30 minutes 62.0', after 40 minutes 58.0', after 60 minutes 52.0', water table stabilized at 22.5' overnight.		
	33									
110										
	34									
115	35									
	36									
120										

SOIL XL-0832 QUIET COVE RD. VIC. TO SR 20 SPUR.GPJ SOIL.GDT 10/26/05,9:33:39

Washington State Department of Transportation

LOG OF TEST BORING

Start Card S-24005

HOLE No. H-3-04

Job No. XL-0832 SR 20 Elevation 62.6 ft (19.1 m)

Sheet 1 of 4

Project Quiet Cove Rd. Vic. to SR 20 Spur

Driller Sean Verlo Lic# 2615

Site Address Vic of SR 20 and lunz rd.

Inspector Dan Reed

Start May 19, 2004 Completion May 19, 2004 Well ID#

Equipment CME 45 w/ autohammer

Station 21+73.04 Offset 43.08' Rt. Casing HW-4.5/HQ-3.5

Method Wet Rotary

Northing Easting Latitude Longitude

County Skagit Subsection NE 1/4 of the NE 1/4 Section 24 Range 1 EWM Township 34N

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
5	1			2 2 2 (4)		D-1		Silty clayey SAND with gravel, very loose, light brown, wet, Disrupted, no HCl reaction, Mixed soil types and colors, (fill material). Length Recovered 0.7 ft, Length Retained 0.7 ft		
10	3			2 3 3 (6)		D-2	GS MC AL	SC-SM, M.C. = 21%, PI = 7 Silty clayey SAND, subrounded, medium dense, gray, wet, Homogeneous, no HCl reaction, With large gravel as indicated by drilling process. Moisture tin retained in sample bag. Length Recovered 0.9 ft, Length Retained 0.9 ft		
15	5			2 3 2 (5)		D-3		Silty clayey SAND with gravel, loose, gray, moist, Disrupted, no HCl reaction, Mixed soil types and colors. Moisture tin retained in sample bag. Length Recovered 1.3 ft, Length Retained 1.3 ft		
20	6									

SOIL XL-0832 QUIET COVE RD. VIC. TO SR 20 SPUR.GPJ SOIL.GDT 10/26/05 9:33:40

Washington State Department of Transportation

LOG OF TEST BORING

Start Card S-24005

HOLE No. H-3-04

Job No. XL-0832 SR 20 Elevation 62.6 ft (19.1 m)

Sheet 2 of 4

Project Quiet Cove Rd. Vic. to SR 20 Spur

Driller Sean Verlo Lic# 2615

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				3 4 5 (9)		D-4		Silty clayey SAND with gravel, loose, gray, moist, Disrupted, no HCl reaction, Mixed soil types and colors. Wood 21.0 to 21.5. Moisture tin retained in sample bag. Length Recovered 1.5 ft, Length Retained 1.5 ft 05/19/2004	▽	
25	7			2 3 3 (6)		D-5		Silty clayey SAND with gravel, loose, gray, wet, Disrupted, no HCl reaction, Mixed soil types and colors. Trace organics (wood). Moisture tin retained in sample bag. Length Recovered 1.2 ft, Length Retained 1.2 ft		
30	8 9			50/6 (50/6")		D-6		Poorly graded SAND with gravel, slightly silty, angular, very dense, gray, wet, Stratified, no HCl reaction, organics (wood). With large gravel as indicated by drilling process. Length Recovered 0.3 ft, Length Retained 0.3 ft		
35	10 11			18 21 23 (44)		D-7		Poorly graded SAND with gravel, dense, gray, moist, Homogeneous, no HCl reaction, With large gravel and cobbles (30.5' to 35.0') as indicated by drilling process. Length Recovered 1.5 ft, Length Retained 1.5 ft		
40	12 13			20 23 26 (49)		D-8		Poorly graded SAND, dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.2 ft, Length Retained 1.2 ft		
45										

SOIL XL-0832 QUIET COVE RD. VIC. TO SR 20 SPUR.GPJ SOIL.GDT 10/26/05,9:33:40

Washington State Department of Transportation

LOG OF TEST BORING

Start Card S-24005

HOLE No. H-3-04

Job No. XL-0832 SR 20 Elevation 62.6 ft (19.1 m)

Sheet 3 of 4

Project Quiet Cove Rd. Vic. to SR 20 Spur

Driller Sean Verlo Lic# 2615

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
			>>	23 25 28 (53)		D-9	GS MC	SP-SM, M.C. = 22% Poorly graded SAND with silt, dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.2 ft, Length Retained 1.2 ft		
	14									
	15									
50			>>	21 25 29 (54)		D-10		Poorly graded SAND, very dense, gray, wet, Homogeneous, no HCl reaction, Moisture tin retained in sample bag. Length Recovered 1.3 ft, Length Retained 1.3 ft		
	16									
55			>>	23 27 31 (58)		D-11		Poorly graded SAND, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.2 ft, Length Retained 1.2 ft		
	17									
	18									
60			>>	19 24 31 (55)		D-12		Poorly graded SAND, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.1 ft, Length Retained 1.1 ft		
	19									
65			>>	21 25 35 (60)		D13		Poorly graded SAND, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.2 ft, Length Retained 1.2 ft		
	20									
	21									
70			>>							

SOIL XL-0832 QUIET COVE RD. VIC. TO SR 20 SPUR.GPJ SOIL.GDT 10/26/05,9:33:40

Washington State Department of Transportation

LOG OF TEST BORING

Start Card S-24005

HOLE No. H-3-04

Job No. XL-0832 SR 20 Elevation 62.6 ft (19.1 m)

Sheet 4 of 4

Project Quiet Cove Rd. Vic. to SR 20 Spur

Driller Sean Verlo Lic# 2615

Depth (ft)	Meters (m)	Profile	Standard Penetration Blows/ft (10 20 30 40)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
				26 35 51 (86)		D-14		Silty SAND, very dense, gray, moist, Laminated, no HCl reaction, fine to medium coarse sand lenses. Moisture tin retained in sample bag. Length Recovered 1.2 ft, Length Retained 1.2 ft		
	22									
75	23			34 50/6 (50/6")		D-15	GS MC	SM, M.C. = 22% Silty SAND, very dense, gray, moist, Laminated, no HCl reaction, fine to medium coarse sand lenses. Moisture tin retained in sample bag. Length Recovered 0.8 ft, Length Retained 0.8 ft		
	24									
80			>>	31 43 56 (99)		D-16		Silty SAND, very dense, gray, moist, Stratified, no HCl reaction, Moisture tin retained in sample bag. Length Recovered 1.5 ft, Length Retained 1.5 ft		
	25							End of test hole boring at 81.5 ft below ground elevation.		
								This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
85	26							Water level before bailing 12.0', bailed bore hole water level to 45.0', water level after 15 minutes 31.0', after 30 minutes 26.0', after 45 minutes 22.5', after 60 minutes 21.7', water table stabilized at 20.5'.		
	27									
90										
	28									
95										

SOIL XL-0832 QUIET COVE RD. VIC. TO SR 20 SPUR.GPJ SOIL.GDT 10/26/05 9:33:40

Appendix C

Laboratory Testing

Job No. **XL-0832** Date **October 26, 2005**

Hole No. **H-1-04** Sheet **1** of **1**

Project **Quiet Cove Rd. Vic. to SR 20 Spur**

Laboratory Summary

Washington State Department of Transportation

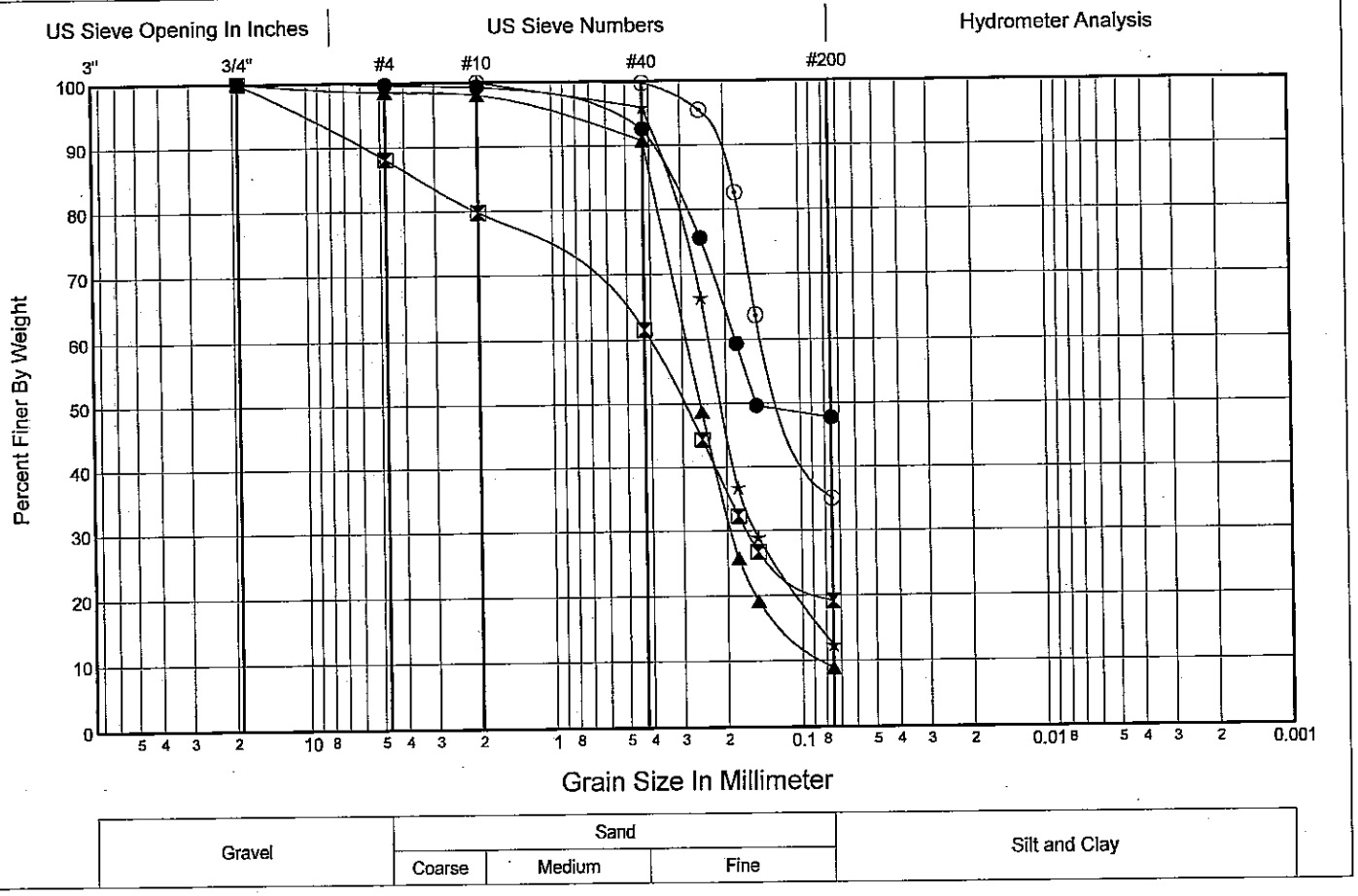
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	12.0	3.66	D-3	SC	See Boring Log	CLAYEY SAND	34	45	22	23
⊠	15.0	4.57	D-4	SM	See Boring Log	SILTY SAND	14			
▲	25.0	7.62	D-6	SP-SM	See Boring Log	POORLY GRADED SAND with SILT	5			
★	50.0	15.24	D-11	SM	See Boring Log	SILTY SAND	23			
⊙	75.0	22.86	D-16	SM	See Boring Log	SILTY SAND	26			

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	0.3	52.0	47.7		
⊠	11.9	69.0	19.1		
▲	1.4	89.7	8.8	1.6	3.6
★	0.0	87.6	12.4	1.5	3.4
⊙	0.0	65.0	35.0		

GRADATION VALUES

	D60	D50	D30	D20	D10
●	0.182	0.15			
⊠	0.406	0.30	0.17	0.08	
▲	0.288	0.25	0.19	0.15	0.081
★	0.233	0.21	0.15	0.10	
⊙	0.137	0.11			



Job No. **XL-0832** Date **October 26, 2005**

Hole No. **H-2-04** Sheet **1** of **2**

Project **Quiet Cove Rd. Vic. to SR 20 Spur**

Laboratory Summary

Washington State Department of Transportation

	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	10.0	3.05	D-2	SC	See Boring Log	CLAYEY SAND	31	51	25	26
⊠	17.0	5.18	D-4	SC	See Boring Log	CLAYEY SAND	37	33	16	17
▲	30.0	9.14	D-8	SC	See Boring Log	CLAYEY SAND	41	33	16	17
★	40.0	12.19	D-10	SM	See Boring Log	SILTY SAND	12			
⊙	50.0	15.24	D-12	SM	See Boring Log	SILTY SAND	22			

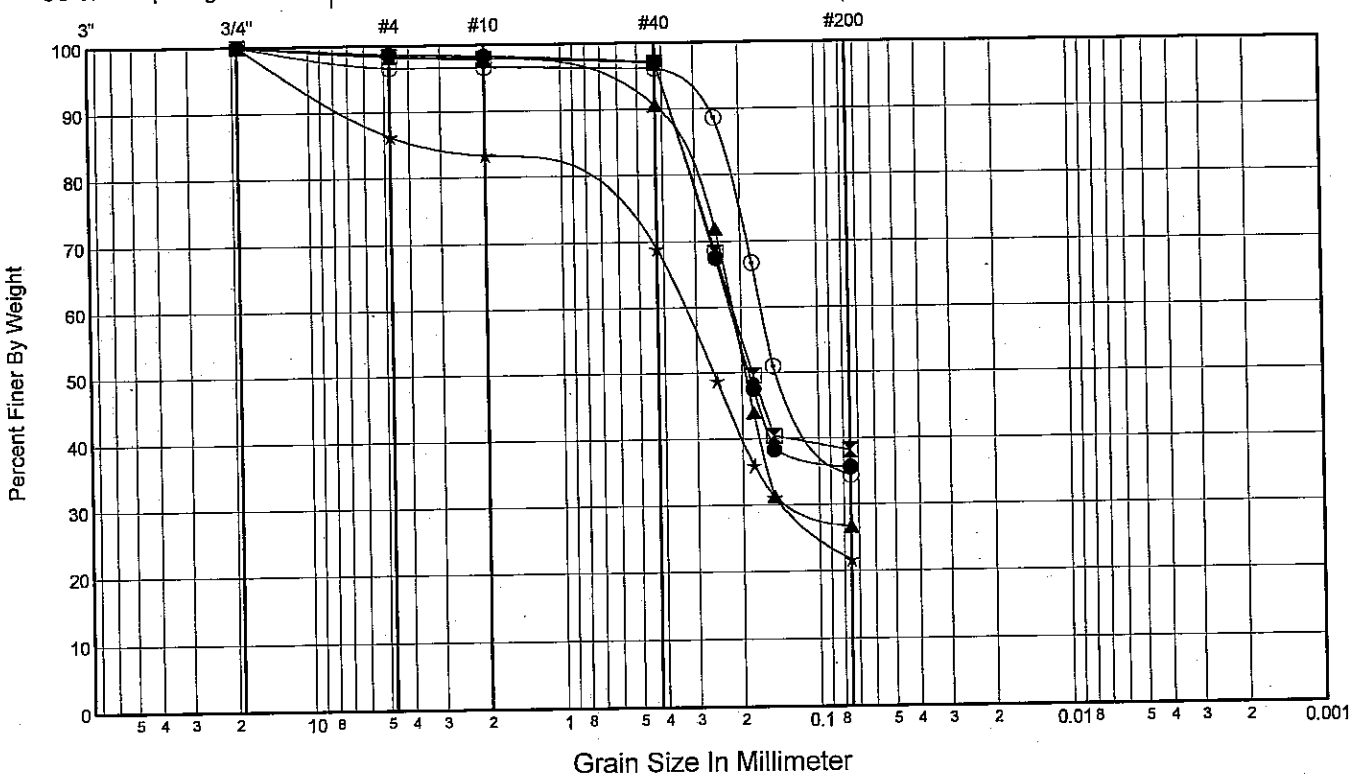
GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	1.3	63.0	35.6		
⊠	1.6	60.2	38.2		
▲	1.7	71.6	26.7		
★	13.8	64.6	21.6		
⊙	3.4	62.2	34.4		

GRADATION VALUES

	D60	D50	D30	D20	D10
●	0.221	0.19			
⊠	0.216	0.18			
▲	0.217	0.19	0.12		
★	0.336	0.26	0.14		
⊙	0.167	0.14			

US Sieve Opening In Inches | US Sieve Numbers | Hydrometer Analysis



Gravel	Sand			Silt and Clay
	Coarse	Medium	Fine	

Job No. **XL-0832** Date **October 26, 2005**

Hole No. **H-2-04** Sheet **2** of **2**

Project **Quiet Cove Rd. Vic. to SR 20 Spur**

Laboratory Summary

Washington State Department of Transportation

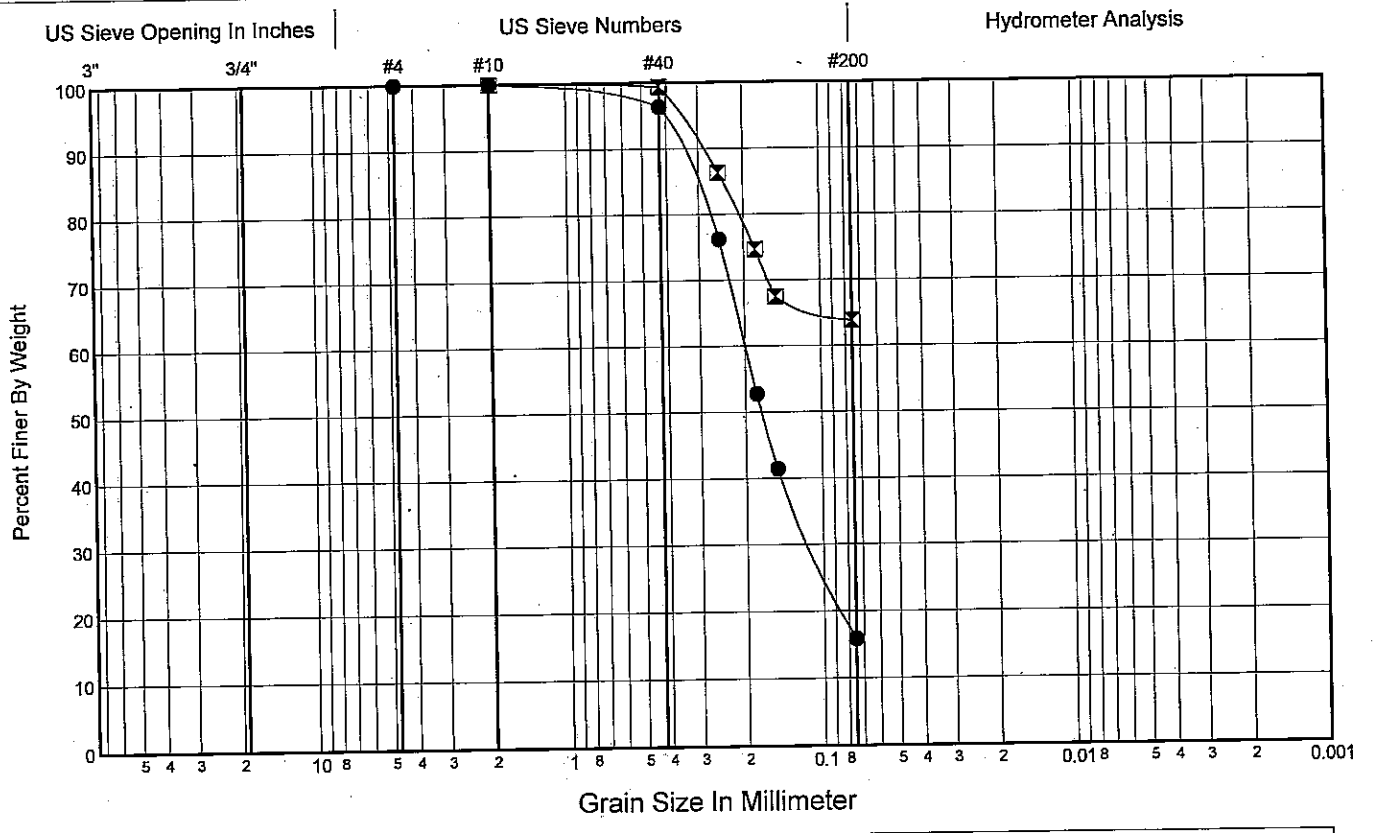
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	75.0	22.86	D-17	SM	See Boring Log	SILTY SAND	21			
⊠	95.0	28.96	D-21	CL	See Boring Log	SANDY LEAN CLAY	21	35	22	13

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	0.0	84.2	15.8		
⊠	0.0	36.2	63.8		

GRADATION VALUES

	D60	D50	D30	D20	D10
●	0.199	0.17	0.11	0.08	
⊠					



Job No. **XL-0832** Date **October 26, 2005**

Hole No. **H-3-04** Sheet **1** of **1**

Project **Quiet Cove Rd. Vic. to SR 20 Spur**

Laboratory Summary

Washington State Department of Transportation

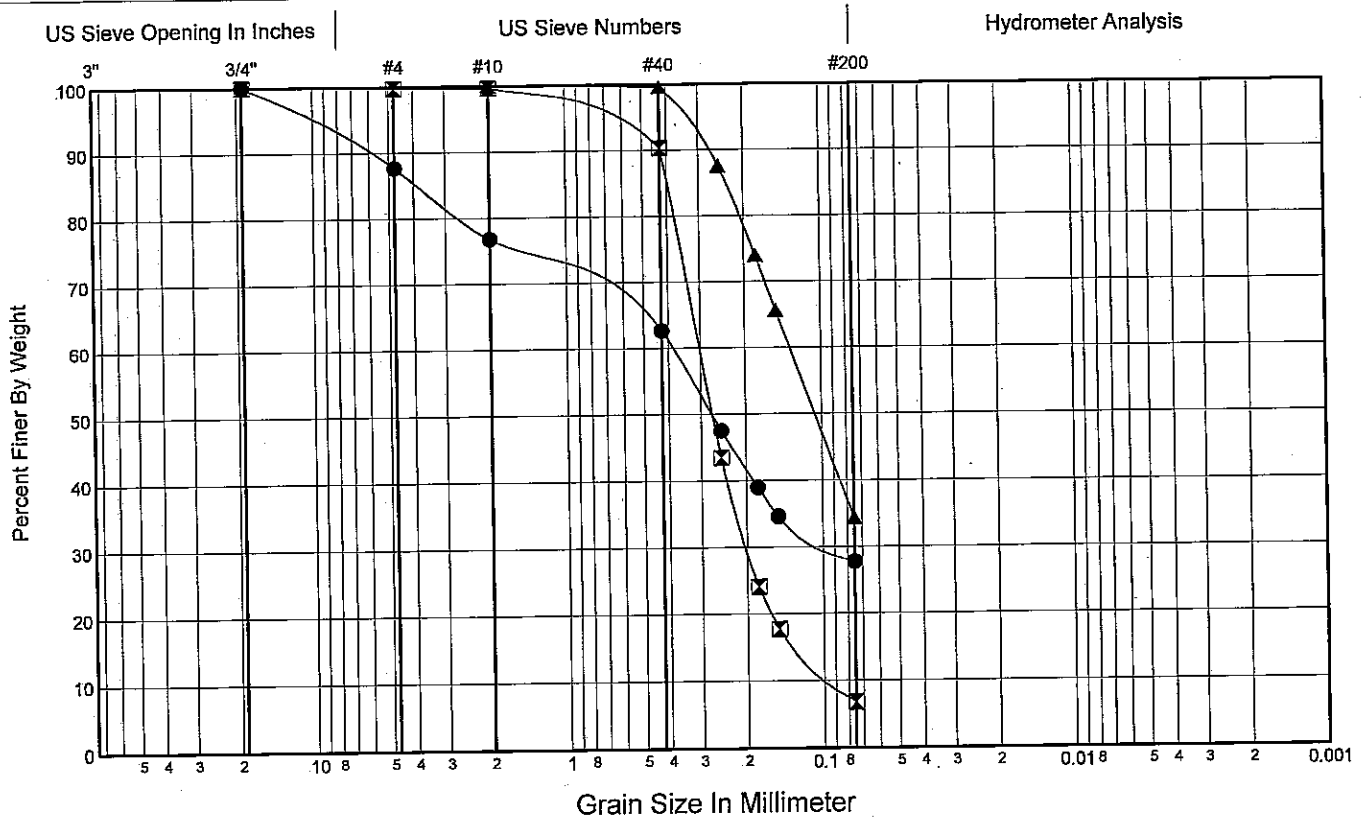
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	10.0	3.05	D-2	SC-SM	See Boring Log	SILTY, CLAYEY SAND	21	27	20	7
⊠	45.0	13.72	D-9	SP-SM	See Boring Log	POORLY GRADED SAND with SILT	22			
▲	75.0	22.86	D-15	SM	See Boring Log	SILTY SAND	22			

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	12.4	59.9	27.7		
⊠	0.2	93.0	6.8	1.4	3.3
▲	0.0	65.7	34.3		

GRADATION VALUES

	D60	D50	D30	D20	D10
●	0.388	0.27	0.09		
⊠	0.302	0.27	0.20	0.16	0.092
▲	0.133	0.11			



Appendix D

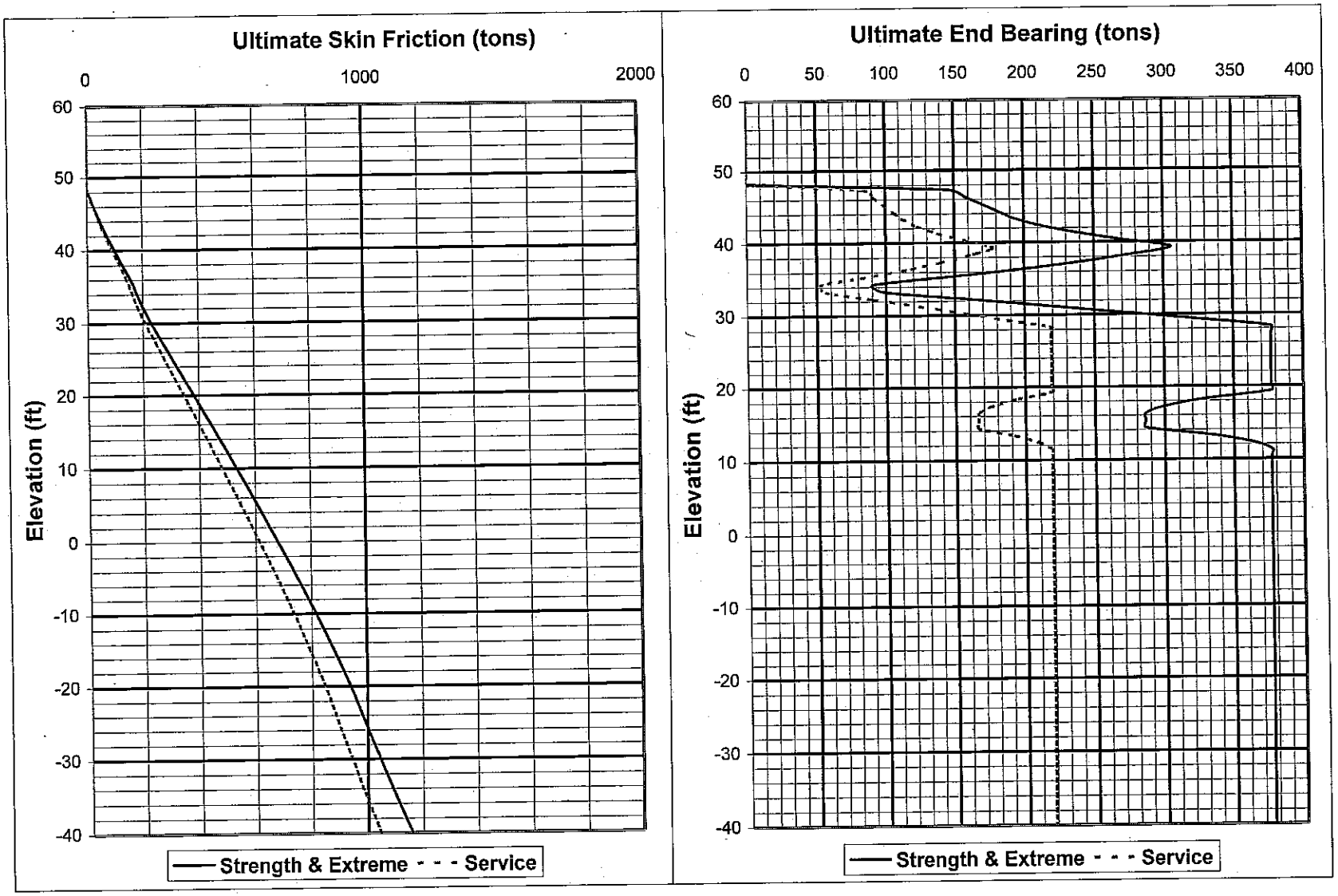
Shaft Capacity Charts

SR 20

Quiet Cove Rd. Vic. to SR 20 Spur - Meadow Creek Bridge

Pier: 1

Shaft Diameter: 4 ft.

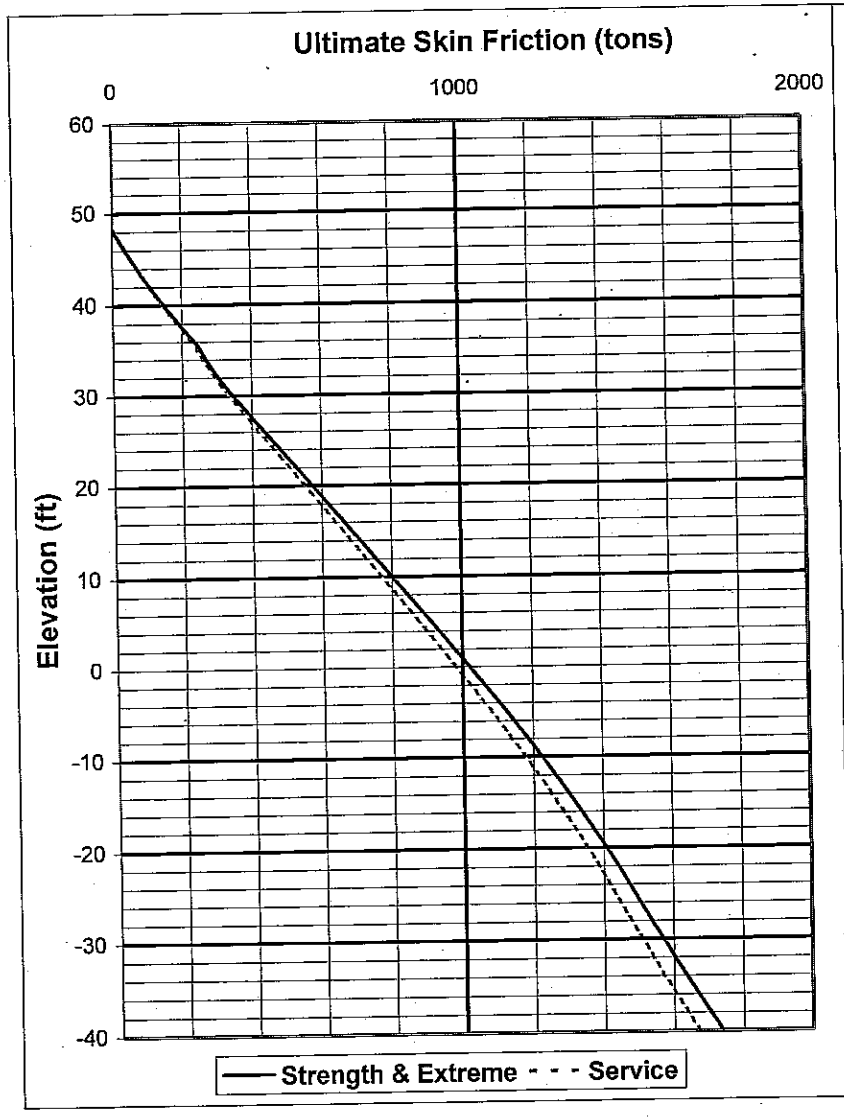


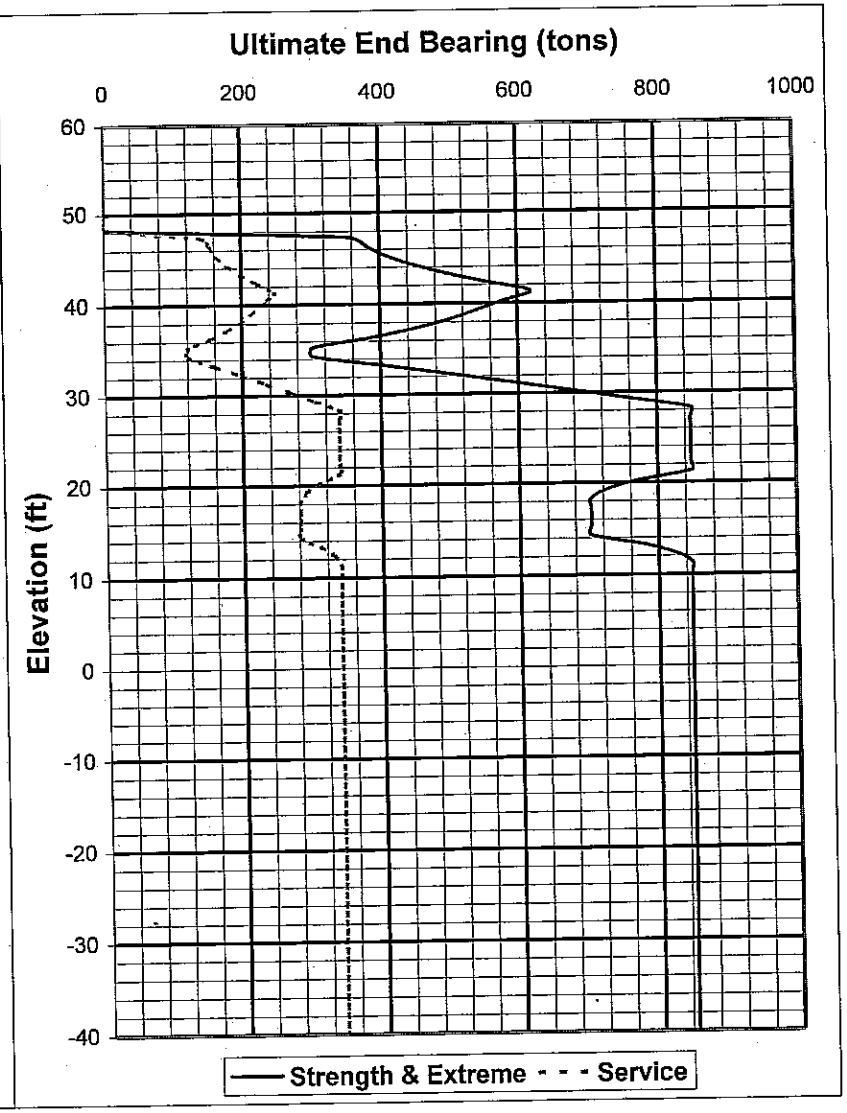
SR 20

Quiet Cove Rd. Vic. to SR 20 Spur - Meadow Creek Bridge

Pier: 1

Shaft Diameter: 6 ft.



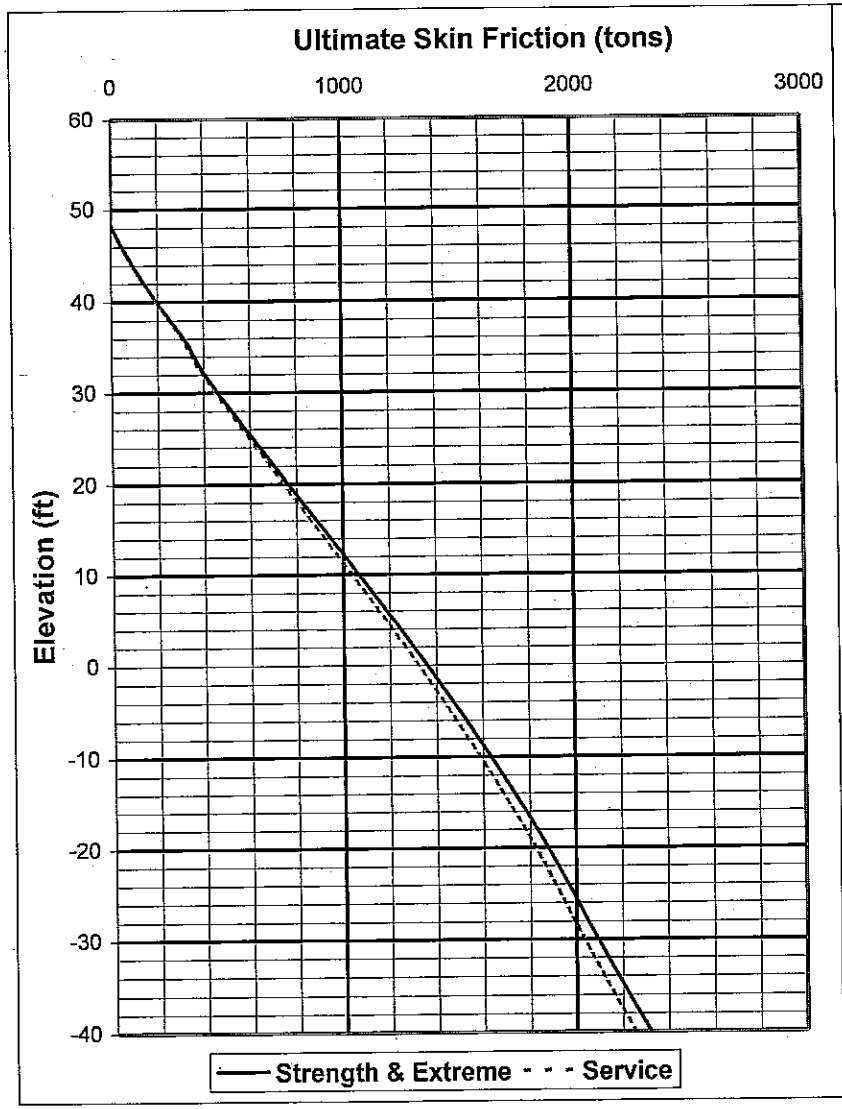


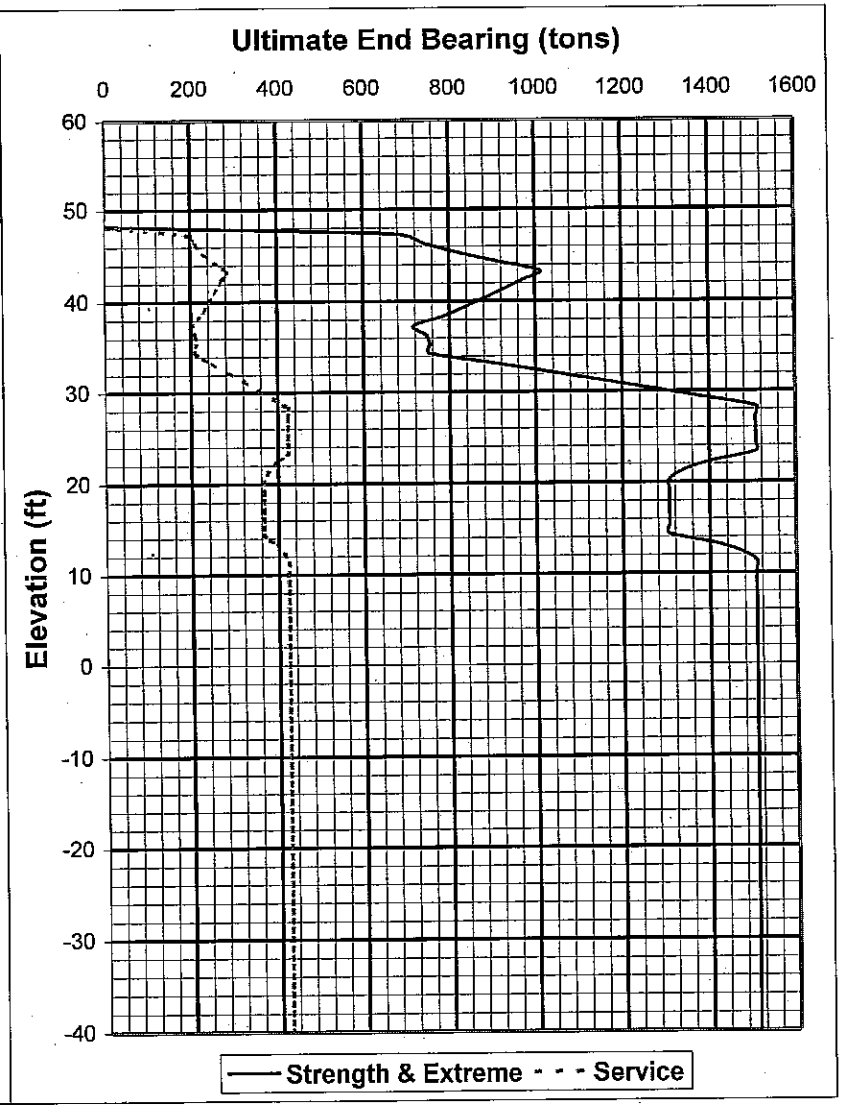
SR 20

Quiet Cove Rd. Vic. to SR 20 Spur - Meadow Creek Bridge

Pier: 1

Shaft Diameter: 8 ft.



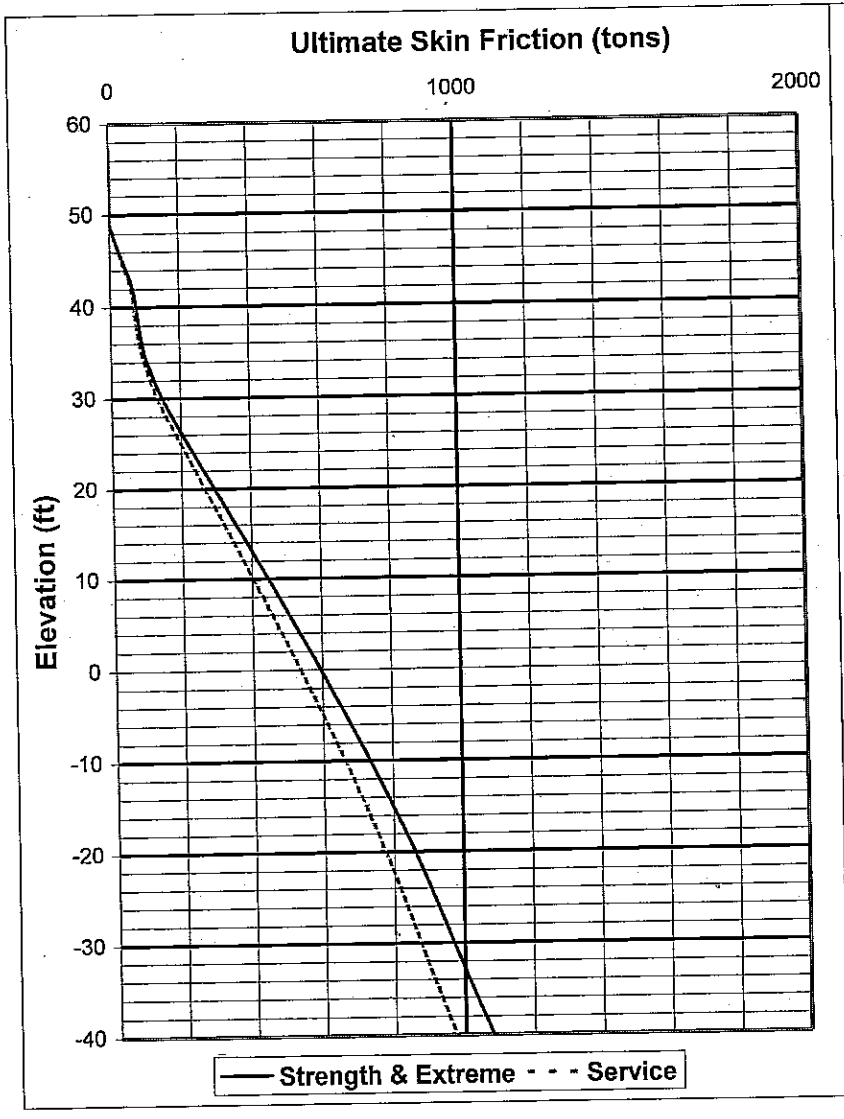


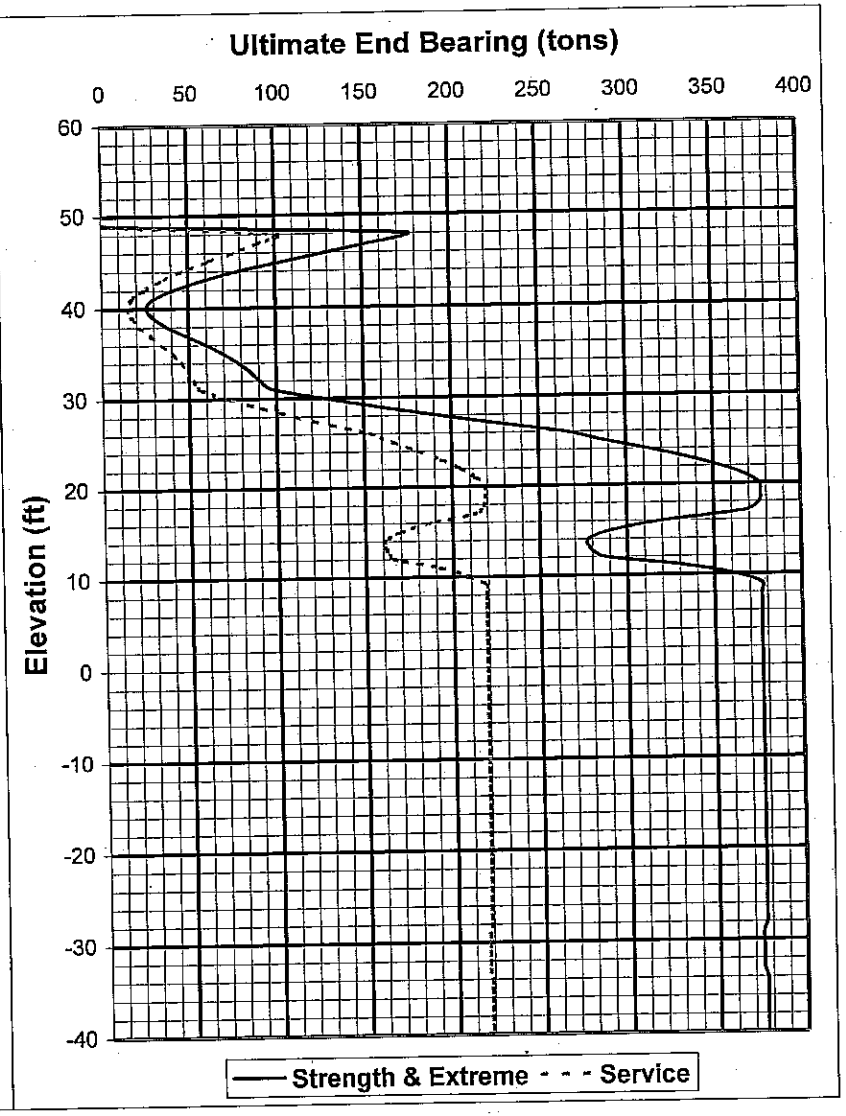
SR 20

Quiet Cove Rd. Vic. to SR 20 Spur - Meadow Creek Bridge

Pier: 2

Shaft Diameter: 4 ft.



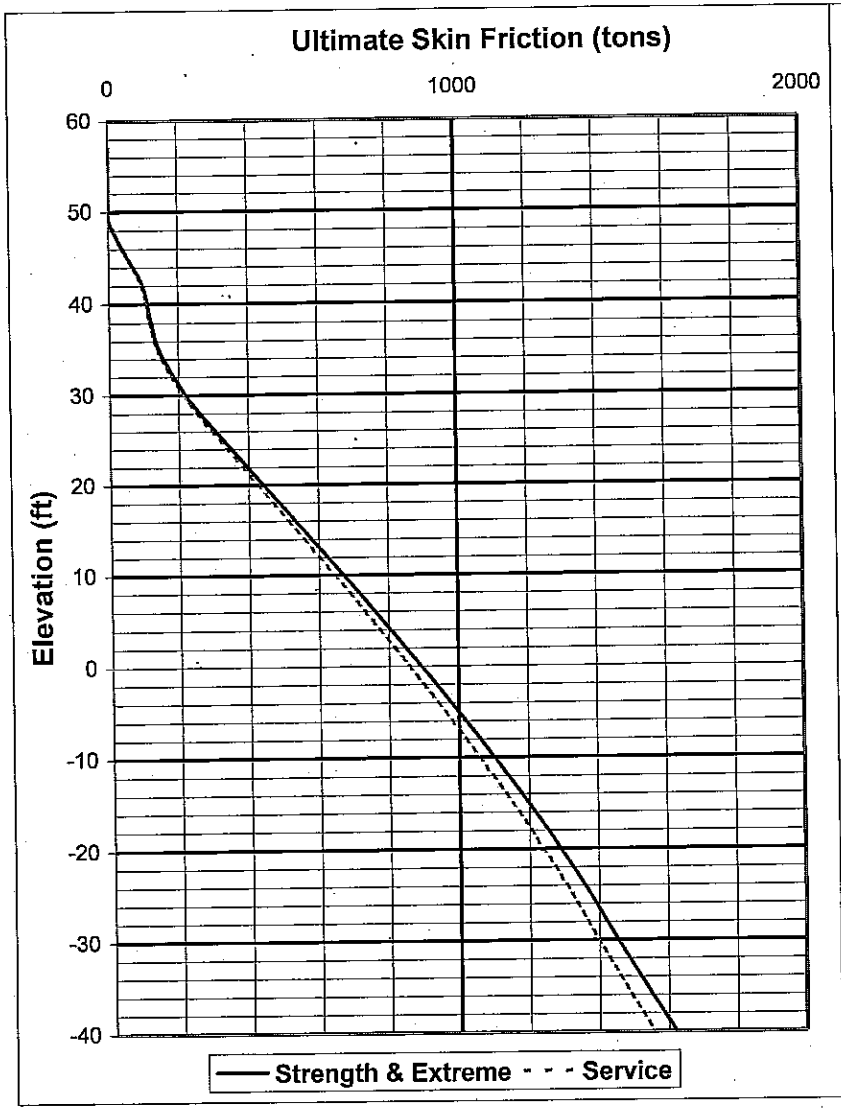


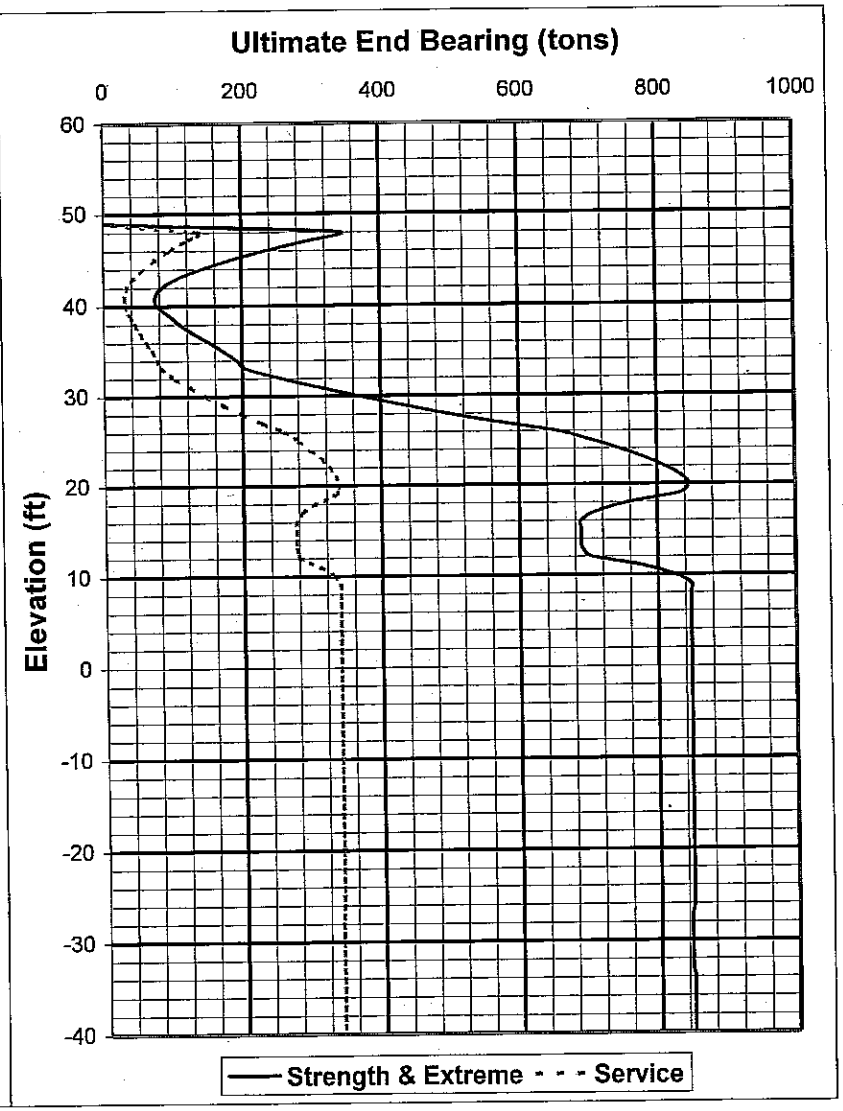
SR 20

Quiet Cove Rd. Vic. to SR 20 Spur - Meadow Creek Bridge

Pier: 2

Shaft Diameter: 6 ft.



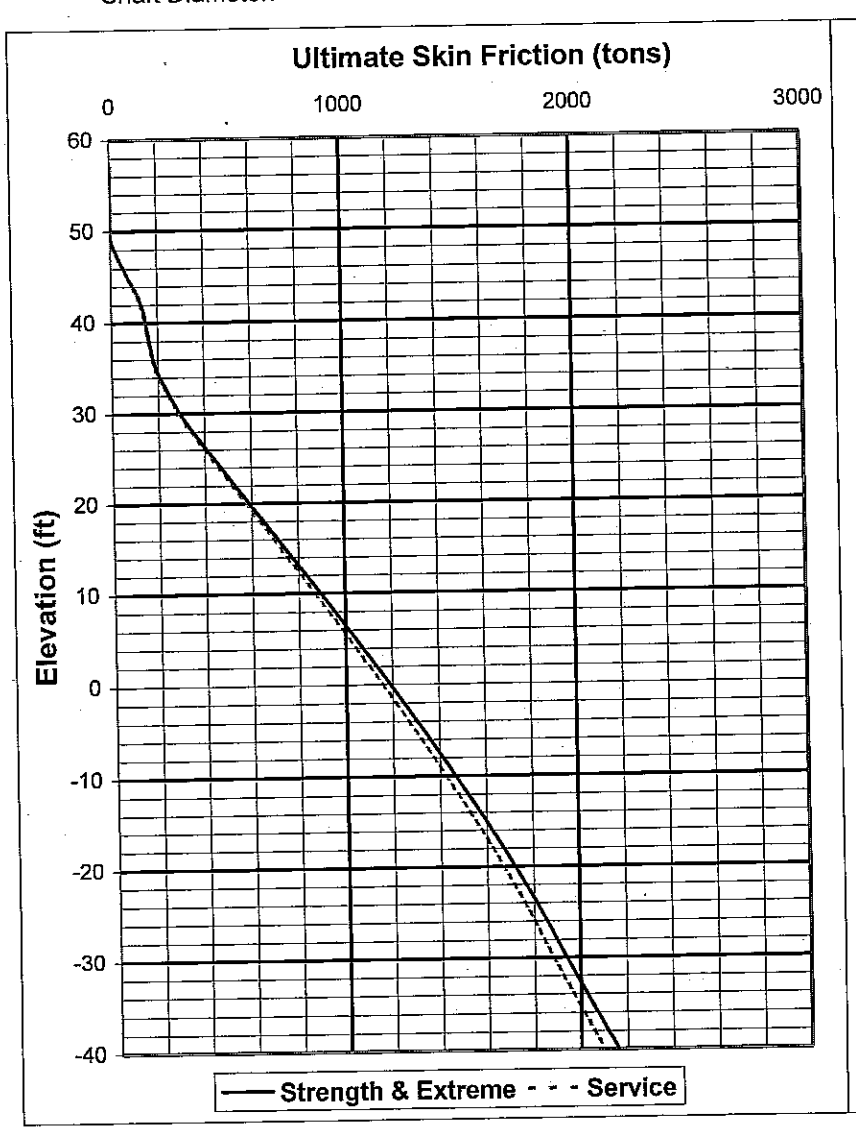


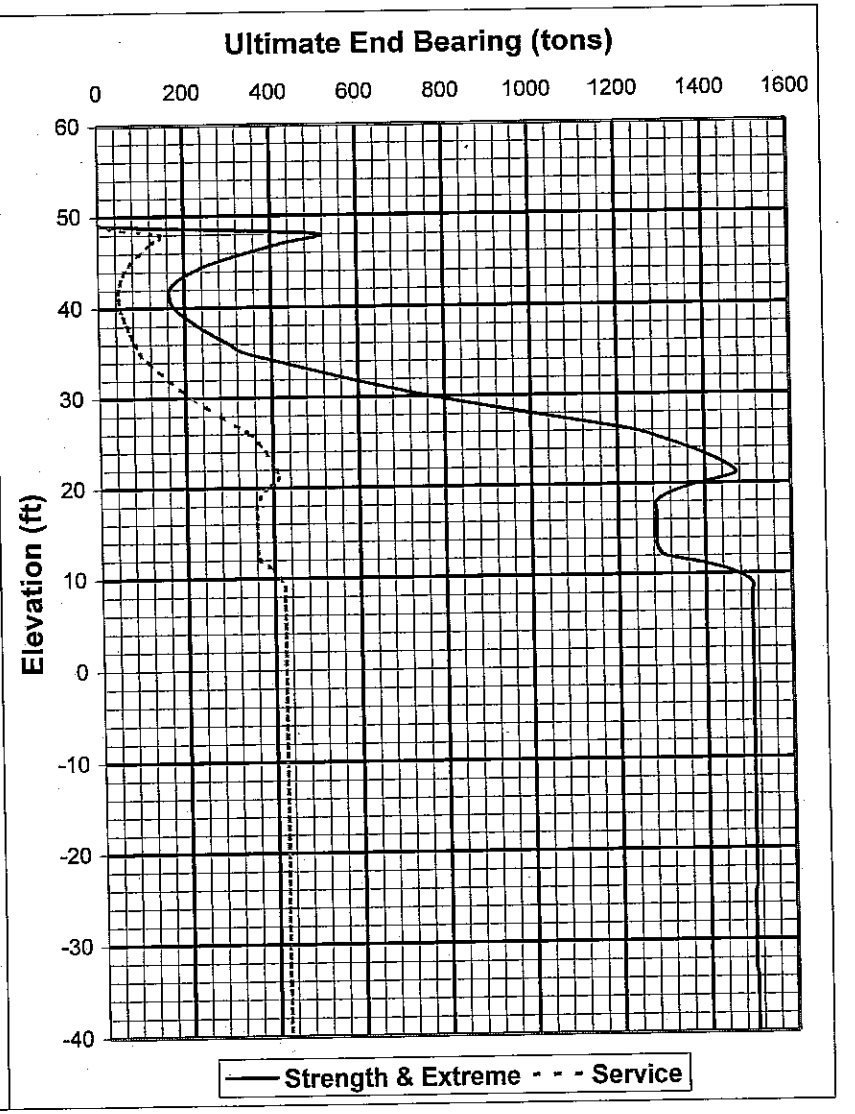
SR 20

Quiet Cove Rd. Vic. to SR 20 Spur - Meadow Creek Bridge

Pier: 2

Shaft Diameter: 8 ft.





Appendix E

Lateral Analysis Parameters

SR 20 - Quiet Cove Rd. Vic. to SR 20 Spur - Meadow Creek Bridge
LPILE Input Parameters

Pier 1
Based on Boring H-1-04

Soil Layer	Elevation	Soil Type	Soil Profile Type (KSOIL)	Effective Unit Weight of Soil	Saturated Undrained Shear Strength, S_u	Axial Strain ε_{50}	Friction Angle ϕ	Modulus of Subgrade Reaction
	(ft)			(pcf)	(psf)	(%)	(deg)	(pci)
1	48 to 60	SAND	4	110	-	-	31	60
2	35 to 48	SAND	4	120	-	-	33	90
3	Below 35	SAND	4	68	-	-	40	140

Pier 2
Based on Boring H-2-04

Soil Layer	Elevation	Soil Type	Soil Profile Type (KSOIL)	Effective Unit Weight of Soil	Saturated Undrained Shear Strength, S_u	Axial Strain ε_{50}	Friction Angle ϕ	Modulus of Subgrade Reaction
	(ft)			(pcf)	(psf)	(%)	(deg)	(pci)
1	43 to 58	SAND	4	120	-	-	33	90
2	33 to 43	SAND	4	110	-	-	28	5
3	18 to 33	SAND	4	68	-	-	33	90
4	Below 18	SAND	4	68	-	-	40	140

Job Title

Input Parameters for Lateral Analysis - SIL-SHAFT

Pier 1
Based on Boring H-1-04

Soil Layer	Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle (deg)	ε_{50} (%)	Soil Cohesion (psf)	s_u at Top of Layer (psf)	s_u at Bottom of Layer (psf)	SPT Corrected Blowcounts	Fines Content (%)	Angularity
1	Sand	12	110	31	1.2				20	48	Sub-Rounded
2	Sand	13	120	33	0.5				21	19	Sub-Rounded
3	Sand	75	68	40	0.2				50	30	Sub-Rounded

Pier 2
Based on Boring H-2-04

Soil Layer	Soil Type	Layer Thickness (ft)	Effective Unit Weight (pcf)	Friction Angle (deg)		Soil Cohesion (psf)	s_u at Top of Layer (psf)	s_u at Bottom of Layer (psf)	SPT Corrected Blowcounts	Fines Content (%)	Angularity
1	Sand	15	120	33	1.2				30	35	Sub-Rounded
2	Sand	10	110	28	1.2				3	38	Sub-Rounded
3	Sand	15	68	33	0.5				23	27	Sub-Rounded
4	Sand	60	68	40	0.2				50	30	Sub-Rounded