FILE

Washington State
Department of Transportation

MEMORANDUM

April 2, 2001

TO: D. McCallum/R. Blegen
Eastern Region Project Office

FROM: Tony Allen/David Sowers MS 47365
OSC Geotechnical Branch

SUBJECT: West Trent Avenue Bridge Replacement, OL-1735
SR-290, Milepost 0.47 to 0.66
Geotechnical Report

Attached is the final geotechnical report for the proposed West Trent Avenue Bridge Replacement project along SR-290. This report presents the results of our subsurface exploration program and geotechnical analyses for design and construction of the proposed project. Please contact us if you have any questions or comments regarding the information presented herein.

TMA/DS:ds
Attachment: Geotechnical Report

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GEOTECHNICAL REPORT

West Trent Avenue Bridge 290/4 Replacement

OL-1735, SR 290, Milepost 0.47 to 0.66

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April 2, 2001

Washington State Department of Transportation
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1. INTRODUCTION

1.1. GENERAL

This report presents the results of our geotechnical study for the proposed West Trent Avenue Bridge 290/4 replacement project in Spokane. A vicinity map of the project site is provided on Figure 1 in Appendix A. The project includes removing the existing and deteriorating bridge over the Spokane River and replacing it with a wider, similar style bridge. In addition to the bridge, retaining walls are planned to support cuts and fills for the new approaches and the new pedestrian/bicycle trail alongside and underneath the west abutment. The project site is shown on Figure 2.

The report presented herein contains results from our site reconnaissance, subsurface exploration program, and engineering analyses. The exploratory borings are assumed to be representative of the subsurface conditions at the proposed structure and wall locations. If during construction, subsurface conditions differ from those described in the explorations, we should be advised immediately so that we may reevaluate our recommendations and provide assistance.

Geotechnical recommendations are provided for bridge foundation support, retaining walls, approaches, constructability issues, and seismic considerations.

1.2. PROJECT DESCRIPTION

The existing West Trent Bridge is a Luten Arch bridge. The Luten Arch is a cast-in-place concrete-shelled structure filled with soil. The existing bridge accommodates four travel lanes and sidewalks. According to bridge archives, the four-span bridge is supported on timber piling and spread footings.

As proposed, the existing bridge will be replaced by a cast-in-place post tensioned concrete box girder bridge, similar in architectural style as the Luten Arch bridge. The new bridge will have three-spans (two intermediate piers instead of three) and will be supported on both spread footings and drilled shafts. The 72-feet wide bridge deck will accommodate five lanes and have 6-foot sidewalks on each side.

A future pedestrian/bicycle trail along the west side of the Spokane River is to be included in the design of the west abutment. The planned trail will pass underneath the west abutment and requires the construction of retaining walls along its west side. Feasible retaining wall types include standard and non-standard cantilever walls, where wall heights exceed 6 feet, and rockery walls for heights less than 6 feet.

2. PROJECT SUBSURFACE CONDITIONS

Subsurface conditions at the project site were explored by WSDOT drill crews from October to December 2000. Borehole locations are shown on Figure 2 in Appendix A. A detailed

discussion about our exploration program and results from the test borings is provided in Appendix C. Boring logs should be made available to all prospective bidders and included in the contract documents. Appendix D provides a discussion of the laboratory testing program and applicable test results.

Subsurface conditions at the west abutment were also investigated by Golder Associates, a geophysical services consultant. Golder Associates used available geophysical methods, including ground penetrating radar, seismic refraction and electrical resistivity imaging, to evaluate subsurface contacts between soil and rock at the west abutment. The published results from their study are provided in Appendix F.

2.1. SITE GEOLOGY

A geologic map showing the site, titled *Geologic Map of Spokane Quadrangle, Washington-Idaho* (Joseph, 1990), indicates the project area is underlain glacial flood-channel deposits and Grande Ronde basalt bedrock. The glacial flood-channel deposits consist of a poorly sorted mixture of boulders, cobbles, gravels and sands. This deposit is present throughout the Spokane valley, as the valley was one of the main channels for the outburst flood waters from glacial Lake Missoula. According to the map, the basalt comprising the Grande Ronde formation is aphyric and sparsely phyric, and contains minor amounts of small plagioclase. The basalt flows in this area typically range from 50 to 80 feet thick.

2.2. SITE CONDITIONS

The project site is located on the eastern city limits of Spokane in the alluvial environment of the Spokane River channel. Development around the project area has required the containment and control of the river by using rip rap along the river banks, including both upstream and downstream from the project site. Rip rap generally ranges in size from 2- to 4-man size rock. Some boulders have eroded into the river bottom.

The river bottom is also littered with remnants from original bridge construction. Timber piling, likely cut-off false work supports are found throughout the channel. On the northeast side of the river crossing near proposed Pier 3, a large diameter casing (approximately 5 to 6 feet across) is partially buried.

Rock outcroppings, or ancient basalt flows, can be observed immediately upstream from the project site, lending to the geologic complexity of the site. Despite years of weathering, the rock appears strong and only slightly fractured.

2.3. SOIL CONDITIONS

Based on our test borings, the project site is generally underlain by outburst flood deposits and basalt bedrock, consistent with the geologic map. Sliver fills placed at the approaches during construction of the original bridge were also observed. The fill and outburst flood deposits consist predominantly of loose to dense, well-graded gravel and cobbles with varying amounts of sand. Some localized poorly-graded sand and silt layers were observed within the deposit, but are largely discrete. The flood deposits were observed to the full depth explored in

borings H-3-00 and H-4-00 (Pier 2), and H-7-00 and H-8-00 (Pier 4), or up to 85 feet below the ground surface. While granular in consistency, the outburst flood deposits have not been over-consolidated and consequently have only moderate shear strength characteristics.

Conversely, bedrock was encountered at relatively shallow depths at the west abutment (H-1-00 and H-2-00) of between 7 and 10 feet below the ground surface. At intermediate Pier 3, bedrock was encountered at a depth of between 55 and 60 feet below the bottom of the river, underlying the outburst flood deposits. The bedrock observed is very competent, with very high resistance to shearing and compression.

A generalized geologic cross-section of the project alignment indicating soil units and depths encountered is shown on Figure 3.

2.4. GROUNDWATER

Groundwater was observed in the test holes on the east and west banks of the river at depths that were generally consistent with the level of the Spokane River during drilling. Because of the porosity of the soils along the river bank, groundwater levels in temporary excavations at the abutment locations should directly correlate with the level in the river.

3. SEISMIC CONSIDERATIONS

For seismic design, a peak ground acceleration coefficient of 0.06 is recommended, based on the June 1996 US Geological Survey National Seismic Hazard Map, found in the *Bridge Design Manual*. The recommended acceleration coefficient is based on expected ground motion at the project site that has a 10 percent probability of exceedance in a 50-year period (475-year return period).

Design response spectra presented in the AASHTO guide specifications for seismic design of highway bridges are considered appropriate for seismic design of the proposed bridge. A Type I Soil Profile response spectrum, with a Site Coefficient of 1.0 is recommended for seismic design at the west abutment; a Type II Soil Profile response spectrum, with a Site Coefficient of 1.2 is recommended for the other three piers.

Soil liquefaction is a phenomenon whereby saturated soil deposits temporarily lose strength and behave as a viscous fluid in response to cyclic loading. Soil types considered at the highest risk of liquefaction during a seismic event are loose to medium dense, sandy soils. While these soils do exist at the project site, the cyclical loading from the design earthquake event will not be large enough to cause liquefaction to occur. Consequently, we do not anticipate any ground settlement or lateral spreading to occur following a design seismic event. Deep foundations will not have to be designed to resist the effects of downdrag loading or a reduction in sidewall (skin) friction.

4. GEOTECHNICAL CONCLUSIONS AND RECOMMENDATIONS

4.1. BRIDGE FOUNDATION SUPPORT

4.1.1. General

Selection of foundation types at each of the pier locations was driven by subsurface conditions and construction feasibility. With the exception of Pier 1, where shallow bedrock was encountered during drilling, Piers 2, 3 and 4 are located in loose, non-consolidated alluvial soils. This, coupled with an extremely settlement sensitive structure, required the use of deep foundations to support the bridge.

A review of existing records for projects in the area and the information from the test borings led to a detailed examination of the feasibility of using driven piles or drilled shafts to support the intermediate and east abutment piers. Based on our findings and discussions with the design team, it was concluded that drilled shafts were the preferred foundation alternative at these pier locations. A spread footing will support the planned abutment wall at Pier 1.

The following report section presents recommendations for foundation support of both spread footings and drilled shafts, in accordance with AASHTO Load and Resistance Factor Design (LRFD) methodology.

4.1.2. Drilled Shafts – Axial Support

Drilled shafts capacities for nominal strength (ultimate), service and extreme limit states are provided on charts in Appendix B for Piers 2 and 4. These charts include nominal capacities for end bearing and skin friction resistance for 10-foot diameter shafts (Pier 2) and 5-foot diameter shafts (Pier 4). At Pier 3, capacity charts are not provided because the shafts will be founded directly on bedrock and plots for skin friction and end bearing resistance are not as applicable, as described below. The attached capacity charts do not account for the net weight of the shafts, which should be added as a separate load when sizing the shafts (for both compression and uplift cases).

Resistance factors for bearing capacity and uplift for service, strength, and extreme limit states are shown in the following table. These can apply to shafts founded in both soil and rock.

Table 1. Drilled Shaft Resistance Factors

Limit State	Resistance Factor ϕ		
	Skin Friction	**End Bearing**	**Uplift**
Strength	0.65	0.50	0.55
Service	1.00	1.00	N/A
Extreme	1.00	1.00	0.75

Individual shaft capacities should be adjusted for drilled shafts spaced closer than 6B for both axial and lateral cases. For axial capacities, the reduction factor, ζ, is multiplied by the total shaft capacity, Q_T. The reduction factor, ζ, may be interpolated between 8B, where ζ=1.0, and 3B, where ζ=0.67 (AASHTO, 1998). Group reductions for lateral load cases are presented later in this report.

For the service limit state at Piers 2 and 4, the unfactored bearing capacities are based on 0.75 inches of settlement (with less than 0.50 inches occurring when the super-structure load is applied) and 0.50 inches of settlement, respectively. While service limit state capacity curves are typically for 1 inch of total settlement, the sensitivity of a cast-in-place structure together with having alternating piers founded on rock, required reducing the amount of permissible settlement. It should also be noted that we consider the accuracy of the settlement calculations, particularly for very small deformations, to be approximate. Actual settlement may vary by +/- 50 percent compared to the values presented herein. For this reason, we recommend a comprehensive settlement monitoring program be implemented at the start of construction, as is further discussed in **Section 5.0, Construction Considerations**. Minimum tip elevations for Pier 2 and 4 can be determined using the capacity charts in Appendix B and the required loading for the design limit state.

At Pier 3, ten-foot diameter drilled shafts are considered feasible for foundation support that rest on bedrock encountered between 50 and 60 feet below the channel bottom. The service limit case at this location is not applicable because we assume the shafts tips will be founded on bedrock and the movement (settlement) necessary to mobilize the end bearing and skin friction is negligible. Therefore, presentation of conventional capacity charts are not appropriate for this pier location. Shafts founded on the bedrock for each limit state, strength, extreme and service, can be designed to resist up 288 tons per square foot (which is essentially the compressive strength of 4000 psi concrete). A resistance factor of 0.50 should be used for the strength limit state. Resistance factors for service and extreme limit states are 1.0. Shafts should have minimum tip elevations between 50 and 60 feet below the ground surface. Specifically, the northern shaft in Pier 3 should have a minimum tip elevation of 1809 feet; the southern shaft in Pier 3 should have a minimum tip elevation of 1799 feet; and, the intermediate shaft should have a minimum tip elevation of 1804 feet. Embedment into the rock is not required, provided that a horizontal surface for the shafts to rest upon at these elevations is available. Shafts should not be cast against a surface that slopes more than 10 percent without having the Geotechnical Branch reevaluate the recommendations and capacity charts provided herein.

4.1.3. Drilled Shafts – Lateral Support

We understand lateral analyses of drilled shafts will be evaluated using the LPILE computer program (Reese and Wang, 1989). P-y curve soil parameters used for the LPILE input are presented in Appendix E for Piers 2, 3 and 4. We do not anticipate significant strain-softening will occur during cyclic loading and therefore do not provide separate static and cyclic soil stiffness parameters.

Group reduction factors for lateral load analysis should be used where piles are spaced closer than 5D, where D is pile diameter and spacing is center to center. The reduction factors for "longitudinal direction" described below should be applied to piles that are largely configured in the direction of (parallel to) the applied load; reduction factors for the "transverse direction" are applicable to piles configured in a direction perpendicular to the applied load.

Table 3. Reduction Factors for Group Effects

Pile Spacing	Reduction Factor (Longitudinal Direction)	Reduction Factor (Transverse Direction)
6D	1.0	1.0
5D	0.8	1.0
4D	0.65	0.9
3D	0.5	0.8
2D	0.4	0.6

The above reduction factors should be applied to the modulus of subgrade reaction values shown in Appendix E. Figure 4.4.3-1 from the *Bridge Design Manual* should be used to adjust the friction angle for group effects.

4.1.4. Spread Footings

We understand the existing footing at Pier 1 is founded at approximately elevation 1864 feet. As currently proposed, the new footing will be founded at elevation 1873.95 feet. Because of the skew in the new bridge, this elevational difference is most significant at the southwest corner of the abutment, where approximately 10 feet of backfill would be required to replace the void created with the removal of the existing footing. Towards the northwest end of the abutment, the rock is expected to be encountered at shallower depths, presumably above the new footing elevation (1873.95), depending on the side slopes of the original excavation.

Several feasible scenarios exist for constructing the west abutment footing. One option is to backfill the 10-foot thick zone between 1864 and 1873.95 feet to create a level surface for the new spread footing. In this case, the existing footing should be removed in its entirety and the footing subgrade leveled to create a flat bench for the new backfill to rest upon. This process could be used along the length of the abutment until the base of the new footing would "intersect" rock at elevation 1873.95 feet, whereas the footing would be cast directly on the rock. A second option would be to "step" the footing. This would mean placing the base of the spread footing at two different elevations; at 1864 feet along the southwest one-third of the abutment, and at 1873.95 feet along the northern two-thirds of the abutment. And as a final option, the entire abutment wall footing could be placed at elevation 1864 feet and constructed on a level, bedrock pad. This last scenario would increase the amount of potential blasting

and would add 10 feet to the height of the abutment wall, but would provide a footing (and wall) of uniform depth constructed entirely on rock.

Concrete backfill should consist of Commercial Concrete per Section 6-02.3(2)B of the *2000 WSDOT Standard Specifications for Road, Bridge and Municipal Construction.* Commercial concrete is preferred to soil backfill because it will experience negligible settlement when loaded, similar to the adjacent rock. In addition, soil backfill would be highly susceptible to river erosion and potential undermining of the footing, whereas the concrete backfill would not.

For LRFD design, presentation of conventional capacity charts for service, strength and extreme limit states are not appropriate for foundations on rock or commercial concrete, in part because service limit state settlements will be negligible. The spread footing can be designed for the strength, service and extreme limit states to resist up to 20 kips per square foot. A resistance factor of 0.60 should be used for the strength limit state. Resistance factors for service and extreme limit states are 1.0. The resistance factor against shear resistance to sliding is 0.9.

Outside of the original (existing) abutment excavation, the results of our explorations and geophysical study indicate rock will be encountered between 7.5 feet (elev. 1890) and 12 (elev. 1886) feet below the ground surface below the existing ground surface at the northwest end of the abutment. With any of the above foundation options for construction, excavation of rock will be required to create the footing bench. For estimating excavation characteristics, the in-situ rock above 1873.95 was found to have RQD (rock quality designation) values between 86 and 100. RQD represents a designation of the quality of the rock mass and is computed by dividing the sum of the lengths of intact pieces greater than 4 inch long and dividing it by the length of core advanced. The rock samples retrieved during drilling had unconfined compressive strength values of approximately 13,000 psi. We anticipate controlled blasting will likely be required to excavate the rock.

4.2. RETAINING WALLS

4.2.1. General

We understand retaining walls will be required for abutments, to retain bridge approach fills, and to retain cuts slopes for the pedestrian/bicycle trail. Conventional, cast-in-place cantilevered retaining walls are considered the most feasible and economical type of wall. This includes both WSDOT standard walls (per the *Standard Plans*) and non-standard wall types (special design). We understand the standard plan walls will be designed by the Region and that Bridge and Structures will perform special design for the non-standard walls (typically abutment walls).

Wall locations and maximum heights from the preliminary bridge plans are listed below. Wall location limits are shown on Figure 2. At typical wall section is shown on Figure 3.

- WB Line – 13+00 to13+63, Maximum height approximately 13 feet;

- NWB Line – 11+40 to 11+82, Maximum height 14 feet; and
- NWB Line – 12+30 to 12+60, Maximum height between 2 and 5 feet (depending on backslope).
- West Abutment – 13+63 to 14+60 (WB Line), Maximum height approximately 18 feet; and
- Curtain Walls on the East Abutment Approach, Maximum height at 15 feet.

The following sections contain recommendations for lateral earth pressures, allowable bearing pressures and settlement for the design or selection, as appropriate, of cast-in-place walls.

4.2.2. Non-Standard Walls

The following soil parameters can be used to design non-standard walls for application and resistance to lateral loading. Where retaining walls contact rock, soil active pressures can be used for design. Sliding resistances for walls founded on both soil and rock are included in Table 4. The following parameters should be used in accordance with the design methodology presented in the *Bridge Design Manual.*

Table 4. Lateral Earth Pressure Coefficients and Soil Parameters

Parameter	Value
Backfill Unit Weight (γ)	120 pcf
Soil Friction Angle (ϕ_f)	36°
Active Earth Pressure (K_a)	0.26
Passive Earth Pressure (K_p)	8.0
Seismic Coefficient (ΔK_{ae})	0.02
Sliding Coefficient (Concrete against Rock)	0.7
Sliding Coefficient (Concrete against Soil)	0.5

We recommend disregarding the upper two feet of soil against the front face when determining passive soil resistance. A factor of safety of 1.5 should be applied to the passive earth pressure. The sliding coefficients presented above can be applied to both retaining walls and spread footings.

Per the *Bridge Design Manual*, the lateral earth pressure at any depth due to traffic surcharge loading could be calculated using a uniformly distributed load at the ground surface of 250 psf, multiplied by K_a (K_a x 250 psf), or 65 psf.

4.2.3. Standard Plan Walls

Design of cast-in-place concrete retaining wall to support embankment sections can be performed by the Project Office using the *WSDOT Standard Plans*. Based on the results of our exploration program, the in-situ soil and rock can accommodate an allowable bearing pressure of up to 6000 psf (3 tsf). This value can be used for selection of walls at either abutment.

4.2.4. Settlement

The maximum settlement of the in-situ soils caused by placement of the cast-in-place walls is largely a function of the retained backfill height. Based on our findings, walls founded on in-situ soils or proposed gravel borrow can be expected to settle up to 1 inch where the walls are at a maximum height; settlements will be much less for the shorter walls. Walls founded directly on bedrock should be experience no vertical deformation. At each wall location, the majority of settlement is expected to occur during and immediately after construction; long-term, post-construction settlement should be negligible.

4.2.5. Rockery Wall

A retaining wall to support a fill slope at Station 12+30 to 12+60 on the NWB Line has been proposed. We understand the maximum height of the wall will vary between 2 and 5 feet depending on the backslope on the wall. We recommend at this location that a gravity-style wall be used. In keeping with architectural themes of the project, an appropriate option is a rockery retaining wall. Rockery wall construction is described in Section 8-24 of the *2000 WSDOT Standard Specifications* and in the General Special Provisions. The minimum rock size at the base of a 5-foot tall rockery should be three-man rock and it should be keyed in at least one foot below the lowest adjacent grade. The allowable face batter should be 1H:6V or flatter.

4.3. Bridge Approach Slab

The Design Manual Section 1120.03(6) requires all bridges to have approach slabs unless approval for their deletion has been given. For geotechnical reasons, we do not consider approach slabs necessary for the Bridge replacement. Fill embankments and structural elements are not anticipated to settle differentially at the pavement seat. Approach slabs may still be necessary based on non-geotechnical issues such as design speed, average daily traffic, and temperature. Eastern Region should be consulted in making the final decision.

5. CONSTRUCTION CONSIDERATIONS

5.1. TEMPORARY WORK PLATFORM

Based on our exploration program and the results of DOT projects in the immediate vicinity, installation of driven piling to support the work platform and false-work is feasible. Driven piles are expected to encounter existing timber piling, cobbles and occasional boulders which may damage the temporary piling. Removal of existing piling will help facilitate installation of temporary piling and should be required in actual drilled shaft locations (footprint diameter plus 2 feet). Methods of piling removal is at the contractor's discretion; we anticipate a vibrator hammer or clam can remove most of the piling, based on the granular nature (non-cohesive) of the river deposits.

5.2. NEW STRUCTURES

The presence of loose, caving gravels and cobbles in an un-cemented soil matrix necessitates the use of temporary casing for the full depth of the proposed drilled shafts. Installation of such casing was considered by the design team. Based on these discussions, an oscillator or rotator device to install the temporary casing was considered the most appropriate method for casing installation. Oscillators and rotators are ideally suited for installing casing in gravelly soils, and can be performed much quicker and more economically than the conventional sequence of vibrating and auguring until a casing is installed full depth. The presence of timber piling and cobble size material also lends itself well to the use of the oscillator and rotator. Temporary casing elevations are not provided herein as shaft lengths will govern the casing lengths. After shaft tip elevations have been determined, temporary casing tip elevations should be included in the plans or specifications.

Temporary shoring for abutments and retaining walls excavations is likely because of the location of the proposed bridge in relation to the existing structures and pavements. Feasible shoring methods include, but are not limited to, sheet pile walls for the east abutment and gravity block walls, such as ecology blocks, for the west abutment, i.e. sheet pile walls can be used where the rock/soil contact is deep and gravity walls can be used to temporarily retain the soil portion of the excavation on the west side. Rock excavations are expected to stand near vertical. Stability of all temporary excavations is the responsibility of the contractor.

Depending the contractor's equipment and methods, excavation of bedrock at the west abutment using blasting may be preferred over conventional excavation techniques. The contractor should review the boring logs and laboratory test data in order to select the most appropriate rock excavation method. If blasting is desired, the contractor should be required to submit a blasting program to the Geotechnical Branch prior to excavation of the west abutment. Excavation should proceed in accordance with Section 2-03 of the *Standard Specifications*.

Removal of some rock at the base of Pier 3 is also anticipated. The drilled shaft contractor should be prepared for some rock excavation to achieve a relatively level bearing surface for the shafts.

Installation of drilled shafts in the "wet" will require cross-hole sonic logging (CSL) testing.

5.3. SETTLEMENT MONITORING

We strongly recommend the contract documents require the monitoring of pier settlement. This is particularly important at Pier 2 which is founded in loose to medium dense gravels and has adjacent piers founded on bedrock. Settlement should be monitored at several stages during construction of the pier including, 1) an initial reading at the completion of the drilled shafts, 2) a second reading upon completion of the pile cap pour, and 3) a third reading after pouring the pier wall. Settlement readings should then be reviewed by the Geotechnical Branch and an evaluation/estimate of further settlement provided then. If the readings are found to exceed the permissible settlement intended for the "sub-structure" portion of the bridge, measures will be required to mitigate further movements, which may include, but is not limited to, shaft post-grouting methods to improve the sidewall/soil bond.

Settlement can be monitored by installing a reinforcing bar that protrudes from the top of the shaft that will extend above the planned top elevation of the pier wall. The reinforcing bar should be at least a No. 9 bar or larger (diameter-wise). The contractor should then monitor settlement at the top of this bar, while maintaining the integrity of the bar. For redundancy reasons, more that one bar may be installed in each shaft, in the event a bar is damaged or bent and cannot be used.

APPENDIX A - FIGURES

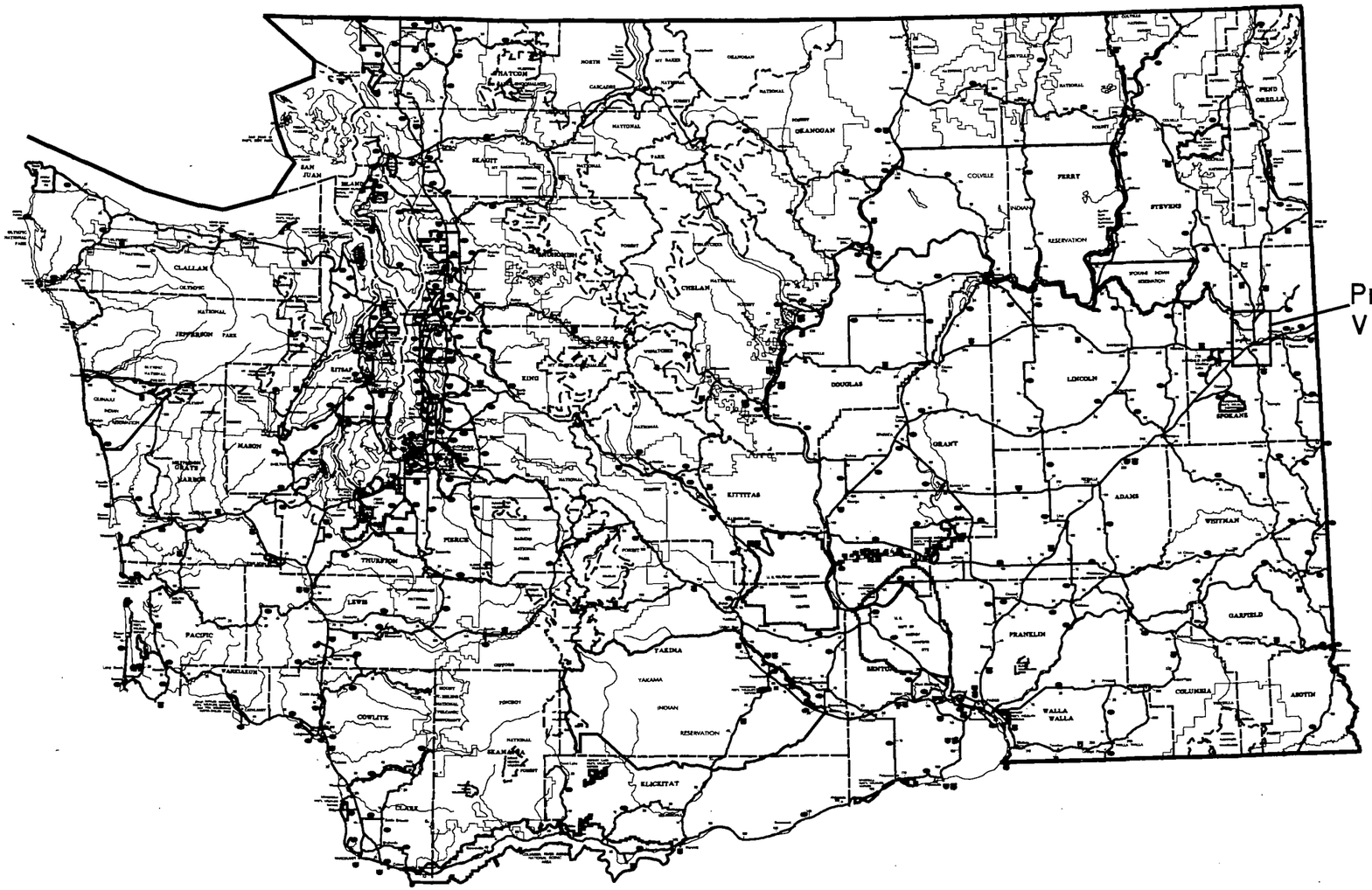

FIGURE 1

JOB OL-1735 S.R. 395 C.S. _____ LAYOUT _____

West Trent Ave. Bridge Replacement

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

DATE 3/2001
SCALE Not to Scale VERT. HORIZ.
SHEET ____ OF ____
DRAWN BY DWG

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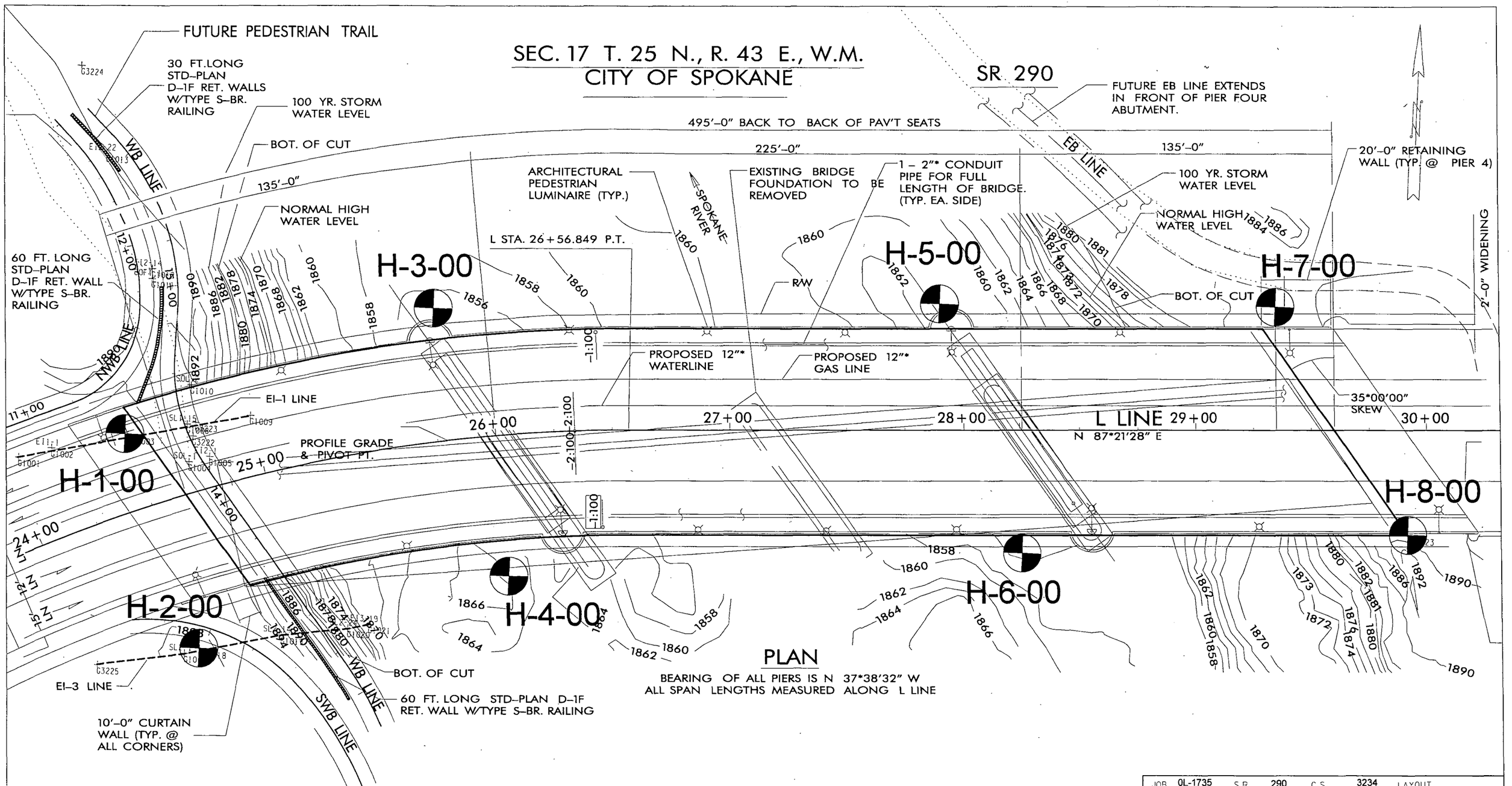

H-4-00 Boring designation and approximate location

Retaining Wall Location

Figure 2: Site and Exploration Plan

JOB OL-1735 S.R. 290 C.S. 3234 LAYOUT

West Trent Ave. Bridge Replacement

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

DATE 3/2001
SCALE 1"=40' VERT. 1"=40' HORIZ.
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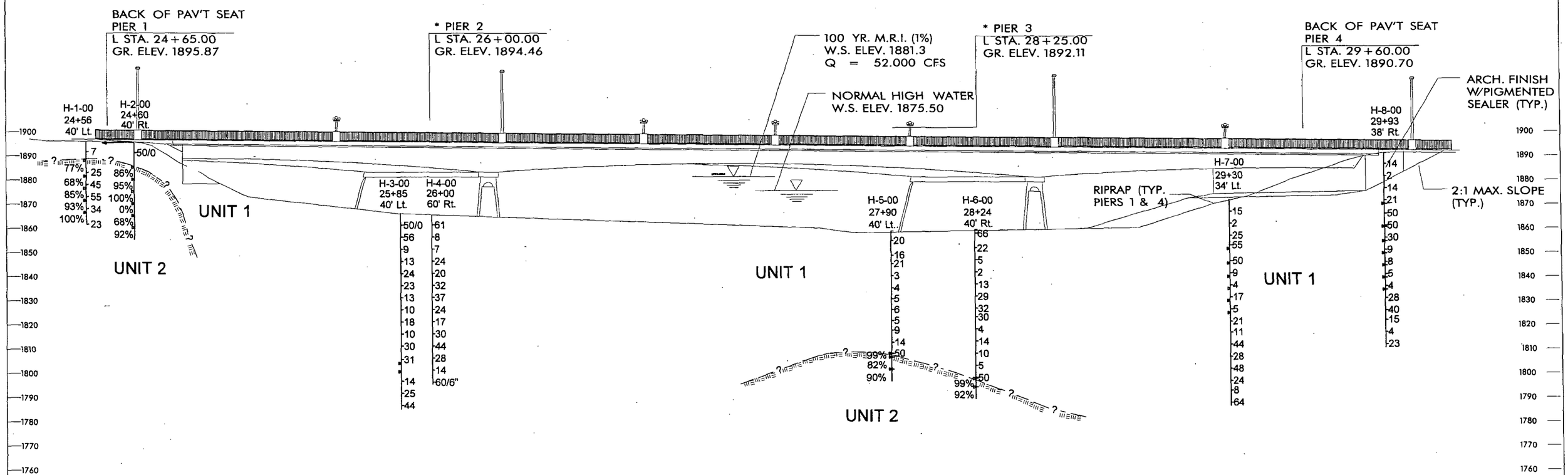

UNIT 1: Loose to dense, well graded GRAVEL with sand (ALLUVIUM)

UNIT 2: Basalt Bedrock

JOB 0L-1735 S.R. 290 C.S. 3234 LAYOUT

West Trent Ave. Bridge Replacement

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

DATE 3/2001
SCALE 1"=40' VERT.
1"=40' HORIZ.
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Figure 3: Generalized Geologic Cross-Section

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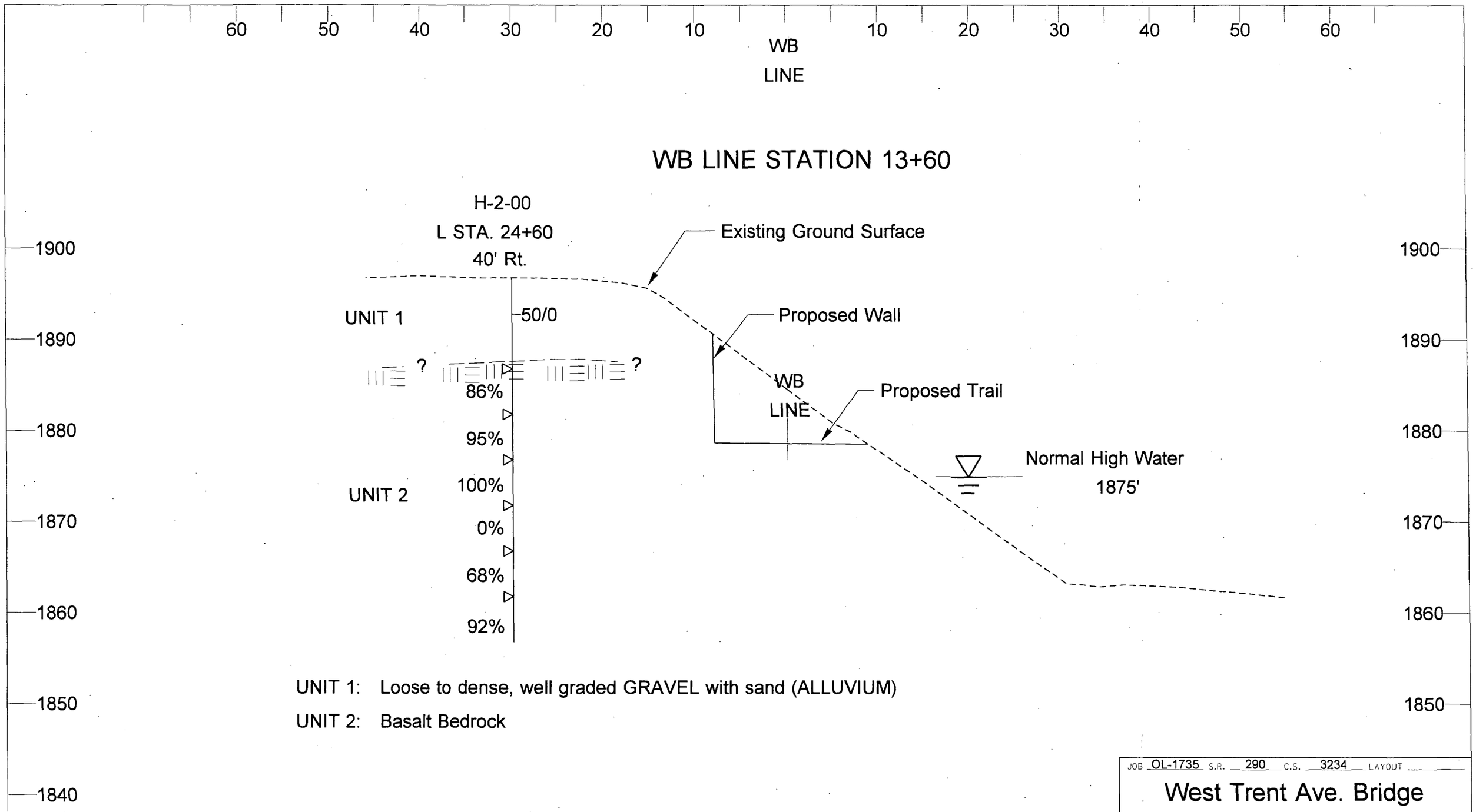

JOB OL-1735 S.R. 290 C.S. 3234 LAYOUT

West Trent Ave. Bridge Replacenment

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

DATE 3/2001
SCALE 1"=10' VERT. 1"=10' HORIZ.
SHEET ___ OF ___
DRAWN BY DWG

Figure 4: Typical Wall Section

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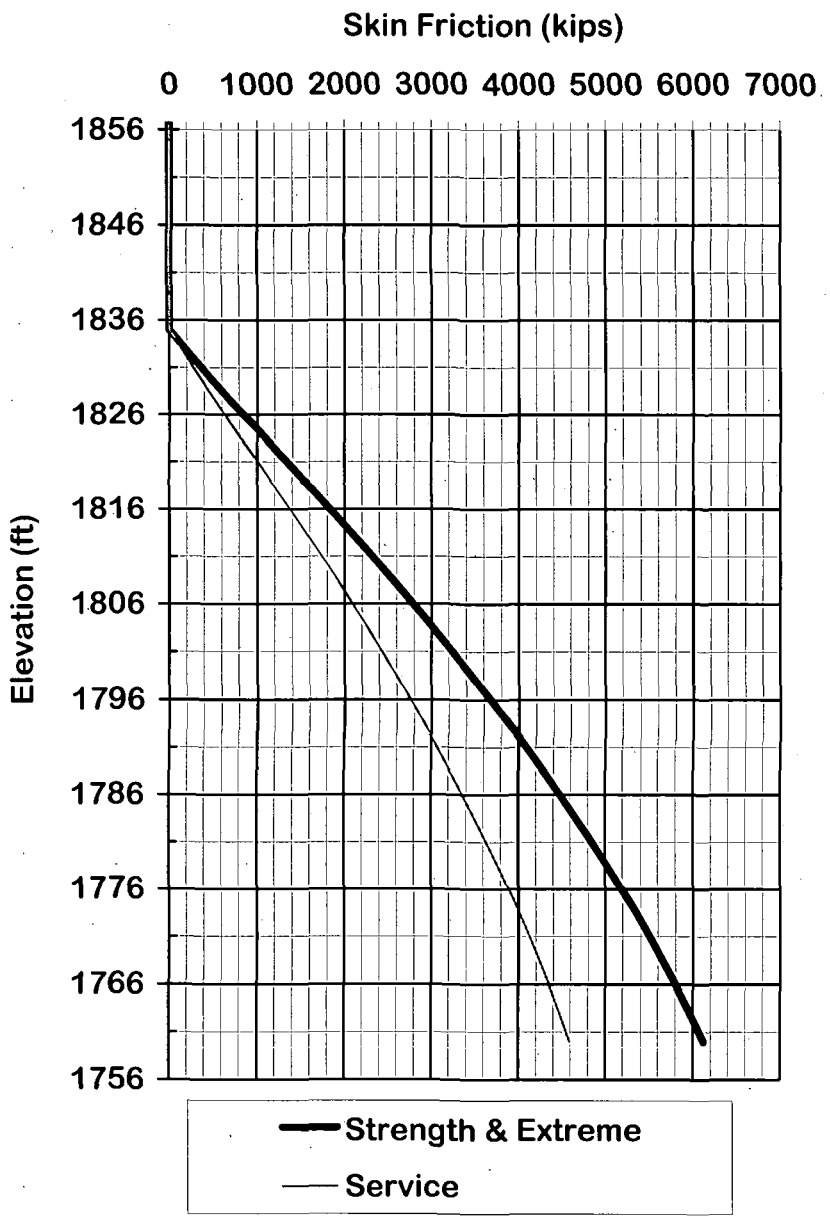
APPENDIX B – DRILLED SHAFT CAPACITY CHARTS

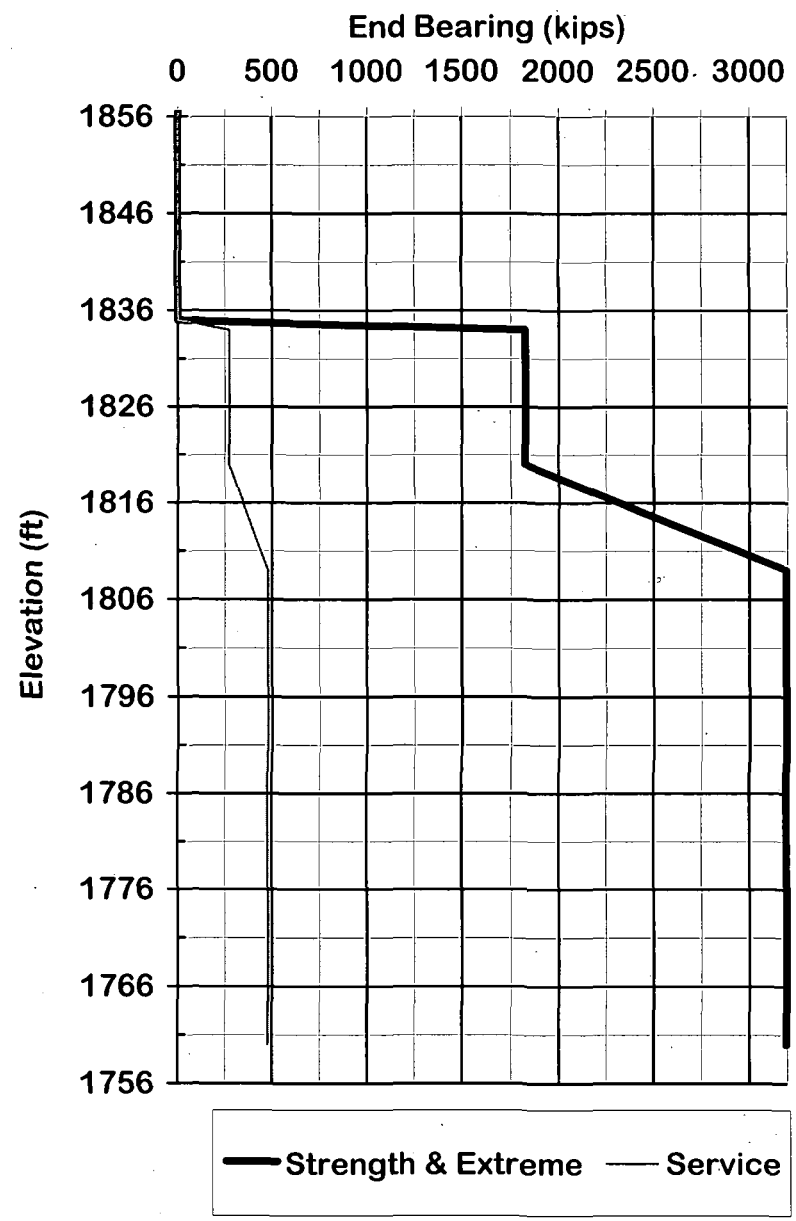
W. TRENT AVE BRIDGE REPLACEMENT

Pier 2

Diameter 9.84 FT **(3 meter)** **0.75** Service Settlement Wb (in)

Casing TEMPORY





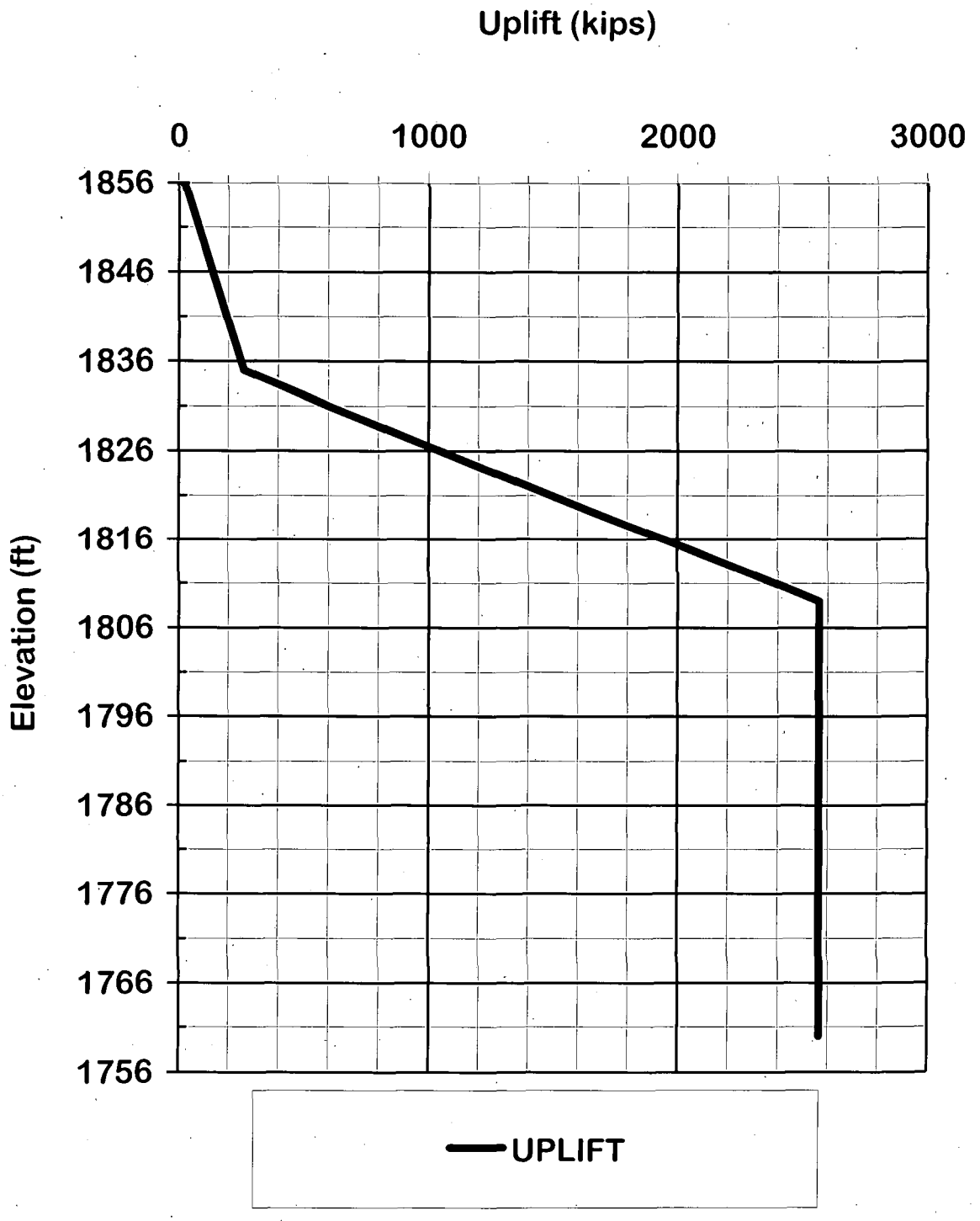
Unfactored Strength Limit State for Uplift Resistance in Drilled Shafts (English Units)

W. TRENT AVE BRIDGE REPLACEMENT

Piers 2 and 3

Diameter 9.84 FT (3 meter)

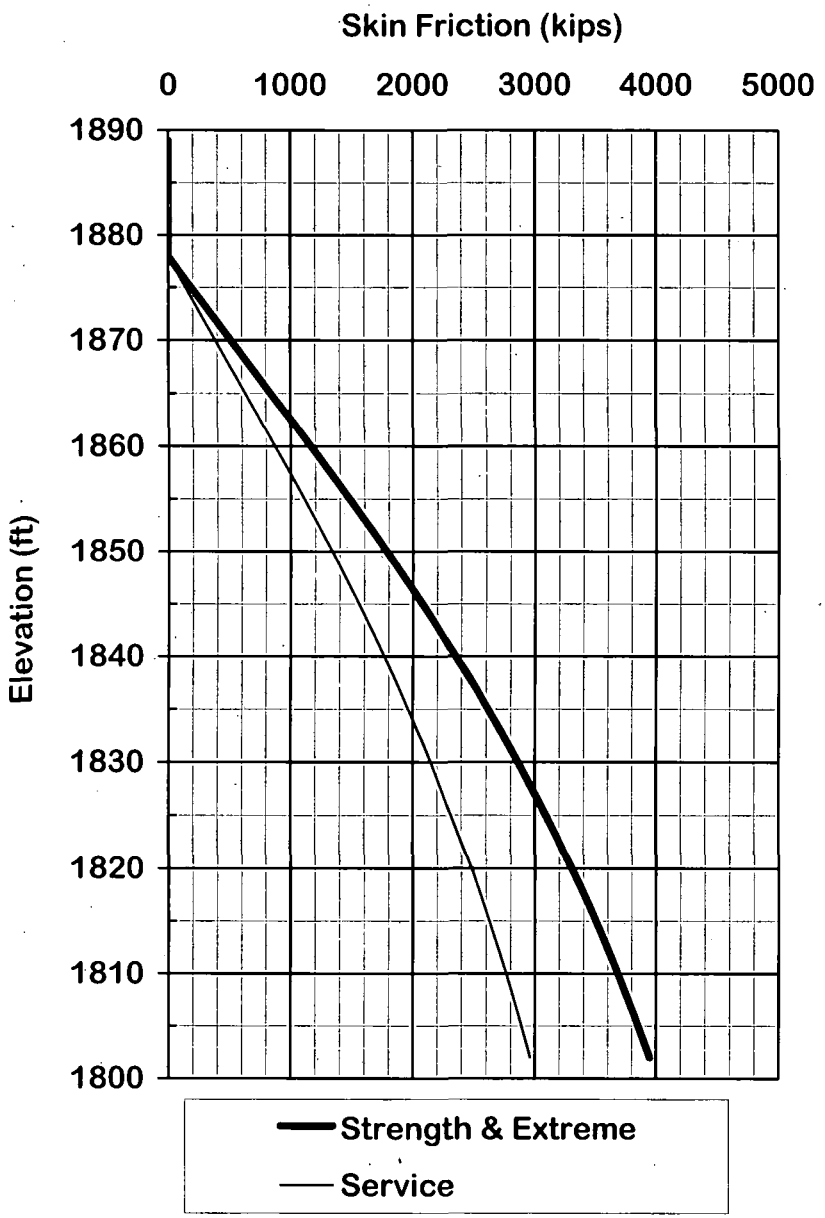
Casing TEMPORY

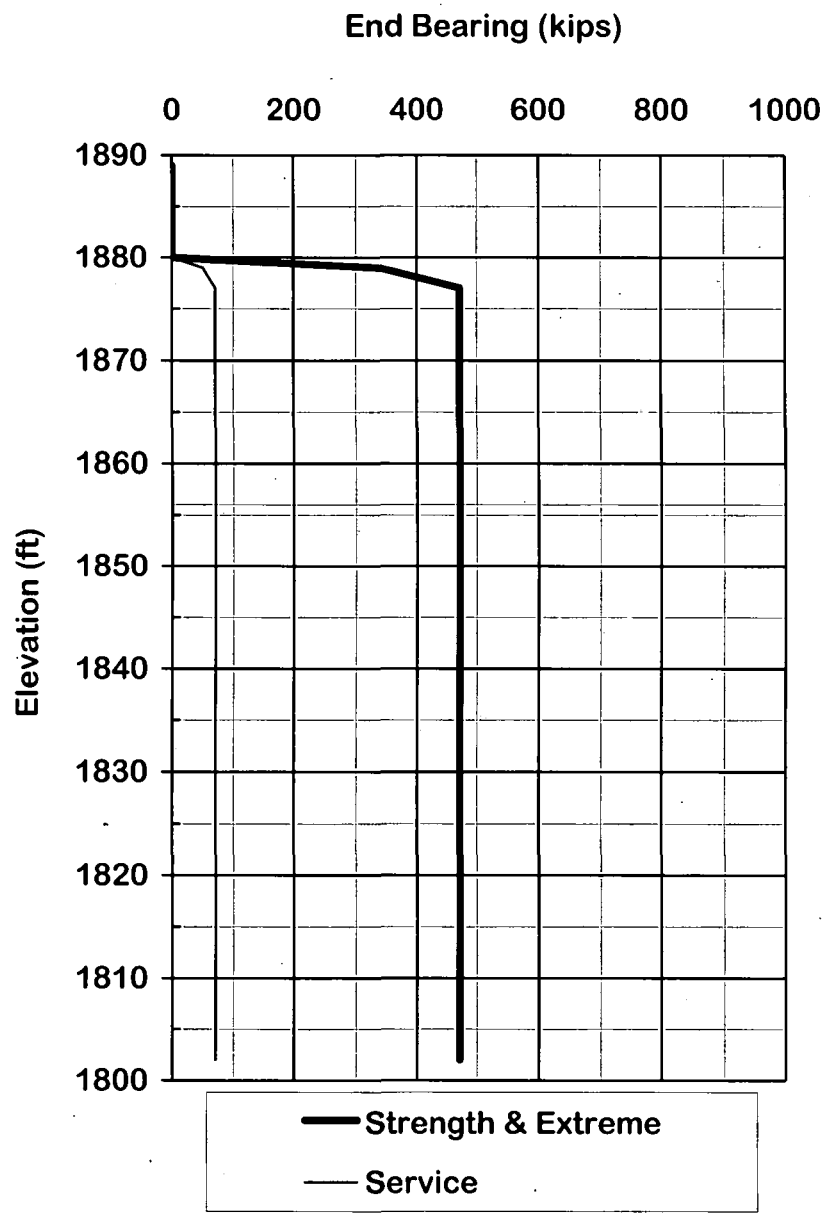


W. TRENT AVE BRIDGE REPLACEMENT

Pier 4
Diameter 5 FT
Casing TEMPORY

0.5 Service Settlement Wb (in)





Unfactored Strength Limit State Uplift Resistance for Drilled Shafts (English Units)

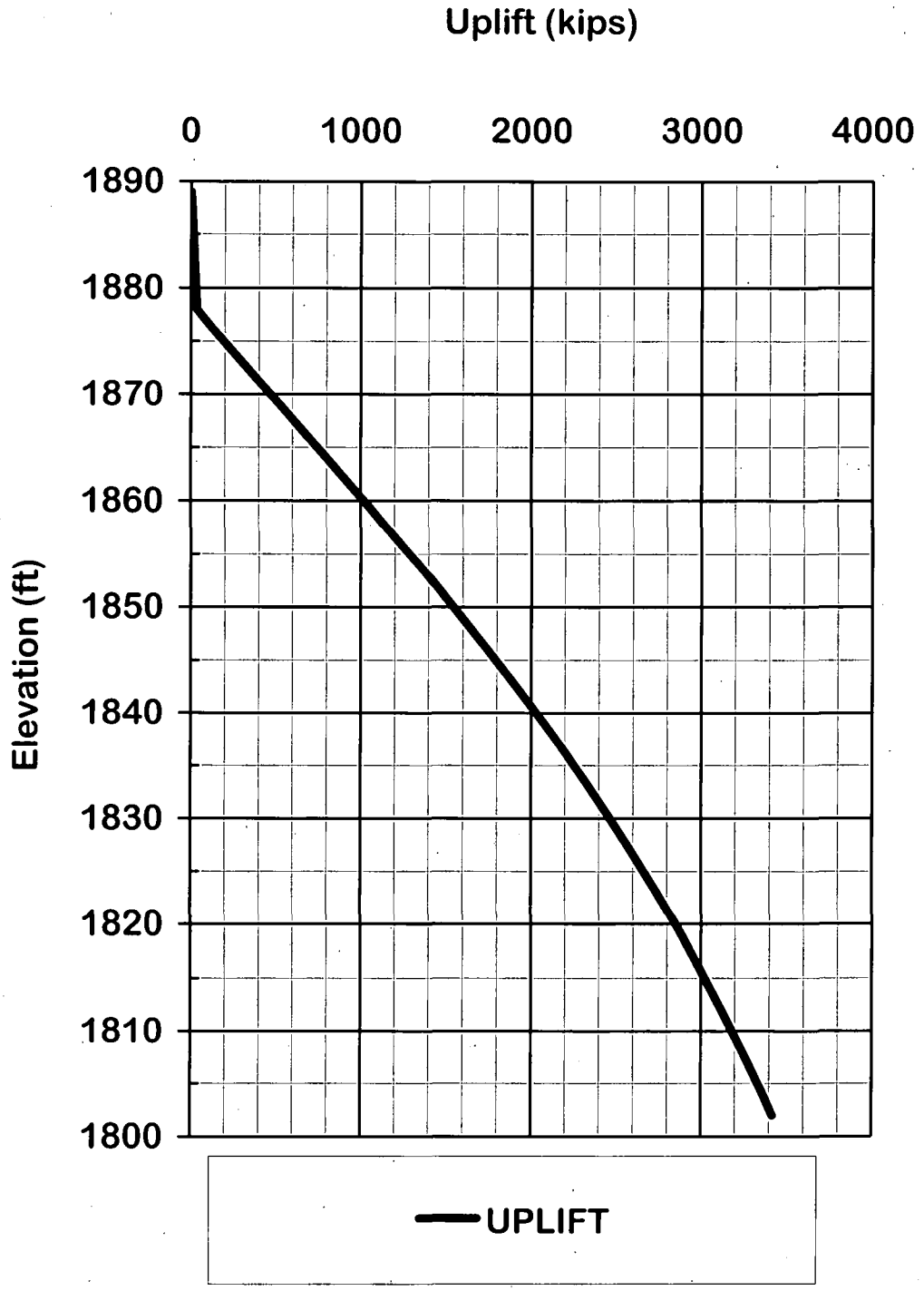
W. TRENT AVE BRIDGE REPLACEMENT

Pier 4

Diameter 5 FT

Casing TEMPORY

0.5 Service Settlement Wb (in)



APPENDIX C – FIELD EXPLORATION PROGRAM

FIELD EXPLORATIONS

The field exploration program for the project consisted of drilling 8 exploratory borings. The approximate exploration locations are shown on Figure 2. Logs of test borings from the current study, as well as from previous studies are attached. All boring logs should be included in the contract documents.

Geotechnical drilling performed as part of this study was accomplished using a CME 45 skid-mounted drilling rig. For the over-water test holes, the skid rig was mounted to barge. Test holes were advanced to depths between 34 and 85 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, or from rock core barrel tubes. SPTs are obtained by driving a 50 mm (2-inch) outside diameter split-spoon sampler 450 mm (18-inches) into the soil with a 63-kg (140-pound) hammer. The number of blows required to achieve each 150 mm (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 300 mm (12 inches) of penetration. Each drill rig is equipped with an automatic trip hammer to drive the split-spoon sampler. The automatic hammers on these two rigs are rated at approximately 75 percent efficiency, as compared to approximately 60 percent for manual hammers.

Rock coring was used to sample both the overburden soils and the underlying basalt bedrock. In bedrock zones, rock quality designations (RQD) for the core runs are provided on the boring logs. RQD represents a designation of the quality of the rock mass and is computed by dividing the sum of the lengths of intact pieces greater than 4 inch long and dividing it by the length of core advanced. In the overburden soils, rock coring was performed because the conventional 2-inch diameter SPT sampler could not capture the larger gravel and cobble-size materials.

The exploratory borings are assumed to be representative of the subsurface conditions at the proposed structure and wall locations. If during construction, subsurface conditions differ from those described in the explorations, we should be advised immediately so that we may reevaluate our recommendations and provide assistance.

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-1-00**

PROJECT **West Trent Ave. Bridge Replacement** Job No. **OL-1735**

Spokane S.R. **290**

Station **24+56** Offset **40' Lt** C.S. **3234**

Equipment **CME 45 w/ autohammer** Casing **HQx37** Ground El **1897.7 (578.42 m)**

Method of Boring **Wet Rotary**

Start Date **December 5, 2000** Completion Date **December 6, 2000** Sheet **1** of **2**

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			1 5 2 (7)		D-1		No Recovery		
10	2			RQD 77 FF .77		C-2		Basalt, fine grained, fresh, very strong rock, no HCl reaction. Discontinuities are moderately spaced and in good condition, Percent Recovered 86.0%		
15	3			25						
	4			RQD 68 FF 1.8		C-3		Basalt, fine grained, slightly weathered, strong rock, no HCl reaction. Discontinuities are closely spaced and in good condition, Percent Recovered 100.0%		
20	5			45						
	6			RQD 85		C-4		Basalt, fine grained, slightly weathered, strong rock, no HCl reaction. Discontinuities are closely spaced and in		

SOIL OL1735-1.GPJ SOIL.GDT 3/29/01 03:31:42 P3

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-1-00**

Sheet **2** of **2**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**

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
				FF 1.4				good condition, slightly weathered to fresh rock., Percent Recovered 100.0%		
			>>	55						
	7									
				RQD 93 FF .4		C-5		12/06/2000	▽	
25										
	8									
				34						
				RQD 100 FF .2		C-6		Basalt, fine grained, fresh, very strong rock, no HCl reaction. Discontinuities are widely spaced and in execellent condition, Percent Recovered 100.0%		
30	9									
	10									
				23						
35								End of test hole boring at 34 ft below ground elevation.		
	11									
								This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
	12									
40										
	13									
45										

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-2-00**

PROJECT **West Trent Ave. Bridge Replacement** Job No. **OL-1735**

Spokane S.R. **290**

Station **24+60** Offset **40' RT** C.S. **3234**

Equipment **CME 45 w/ autohammer** Casing **HQx 43** Ground El **1897.9 (578.48 m)**

Method of Boring **Wet Rotary**

Start Date **December 5, 2000** Completion Date **December 6, 2000** Sheet **1** of **2**

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			50/0 (50)		D-1		No Recovery		
5	2									
10	3			RQD 86 FF .8		C-3		Basalt, fine grained, slightly weathered, strong rock, no HCl reaction. Discontinuities are moderately spaced and in good condition, Percent Recovered 100.0%		
	4									
15	5			RQD 95 FF .8		C-4		Basalt, fine grained, fresh, very strong rock, no HCl reaction. Discontinuities are moderately spaced and in good condition, Percent Recovered 100.0%		
20	6									

SOIL OL1735 LOG SOILLOG1 3/29/01 13:31:57 P3

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-2-00**

Sheet **2** of **2**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**

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
				RQD 100 FF .6		C-5		Basalt, fine grained, fresh, strong rock, no HCl reaction. Discontinuities are moderately spaced and in good condition, There is soil infilling in one fracture., Percent Recovered 100.0%	12/06/2000	
	7									
25				RQD 0 FF 10		C-6		Basalt w/soil innerbed between basalt flows., fine grained, moderately weathered, strong rock, no HCl reaction. Discontinuities are very closely spaced and in good condition, at approx. 26' we encountered a soil zone inner bedded between basalt flows. The last 8" we encountered basalt again, recovering only 1' of the entire 5' run., Percent Recovered 20.0%		
	8									
	9									
30				RQD 68 FF 1		C-7		Basalt w/ some soil innerbedding, fine grained, slightly weathered, strong rock, no HCl reaction. Discontinuities are closely spaced and in good condition, the top 9" was all broken up with soil infilling in the fractures., Percent Recovered 88.0%		
	10									
35				RQD 92 FF .6		C-8		Basalt, fine grained, fresh, very strong rock, no HCl reaction. Discontinuities are moderately spaced and in execellent condition, the top 1' had some soil infilling and a 2" clay seam. The top 4' was one solid stick of basalt., Percent Recovered 100.0%		
	11									
	12									
40								End of test hole boring at 40 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.		
	13									
45										

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-3-00**

PROJECT **West Trent Ave. Bridge Replacement** Job No. **OL-1735**

Spokane S.R. **290**

Station **25+85** Offset C.S. **3234**

Equipment **CME 45 w/ autohammer** Casing **HW-2,HQ-61.6,NQ** Ground El **1856.0 (565.71 m)**

Method of Boring **Wet Rotary**

Start Date **October 31, 2000** Completion Date **November 7, 2000** Sheet **1** of **4**

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			50/0" (50)		D-1		No Recovery		
10	2, 3		>>	3 26 30 (56)		D-3		Well graded GRAVEL with sand, subrounded, very dense, gray, wet, Stratified, no HCl reaction Length Recovered 0.5 ft, Length Retained 0.5 ft		
15	4, 5			7 5 4 (9)		D-4		Well graded SAND with gravel, loose, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.7 ft, Length Retained 0.7 ft		
20	6									

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-3-00**

Sheet **2** of **4**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**

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
				7 5 8 (13)		D-5		Well graded GRAVEL with sand, subrounded, medium dense, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.4 ft, Length Retained 0.4 ft		
	7									
25				11 12 12 (24)		D-6		Well graded GRAVEL with sand, subrounded, medium dense, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.1 ft, Length Retained 0.1 ft		
	8									
	9									
30				5 7 16 (23)		D-7		Well graded GRAVEL with sand, subrounded, medium dense, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.6 ft, Length Retained 0.6 ft		
	10									
35				7 6 7 (13)		D-8		Well graded GRAVEL with sand, subrounded, medium dense, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.6 ft, Length Retained 0.6 ft		
	11									
	12									
40				3 3 7 (10)		D-9		Well graded GRAVEL with sand, subrounded, loose, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.3 ft, Length Retained 0.3 ft		
	13									
45										

SOIL OL1735-1.GPJ SOIL.GDT 3/29/01 13:32:20 P3

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-3-00**

Sheet **3** of **4**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**

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			25 11 7 (18)		D-10		Well graded GRAVEL with sand, subrounded, medium dense, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.5 ft, Length Retained 0.5 ft		
	15									
50				7 4 6 (10)		D-11		Well graded GRAVEL with sand, subrounded, loose, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.4 ft, Length Retained 0.4 ft		
	16									
55										
	17			9 14 16 (30)		D-12		Well graded GRAVEL with sand, subrounded, dense, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.8 ft, Length Retained 0.8 ft		
	18									
60				13 14 17 (31)		D-13		Well graded GRAVEL with sand, subrounded, dense, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.6 ft, Length Retained 0.6 ft		
	19					C-14		Well graded GRAVEL with sand, cobbles, subrounded, very dense, gray, wet, Stratified, no HCl reaction Length Recovered 2.1 ft, Length Retained 2.1 ft		
65										
	20					C-15		Well graded SAND with gravel, medium dense, grayish brown, wet, Stratified, no HCl reaction Length Recovered 1.4 ft, Length Retained 1.4 ft		
	21									
70				2		D-16		Well graded GRAVEL with sand, subrounded, medium		

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-3-00**

Sheet **4** of **4**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**

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
				8 6 (14)				dense, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.6 ft, Length Retained 0.6 ft		
	22									
75	23			12 12 13 (25)		D-17		Well graded GRAVEL with sand, subrounded, dense, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.8 ft, Length Retained 0.8 ft		
	24									
80				25 19 25 (44)		D-18		Well graded GRAVEL with sand, subrounded, dense, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.6 ft, Length Retained 0.6 ft		
	25							End of test hole boring at 81 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									
	27									
90	28									
95										

SOIL OL1735-1.GPJ SOIL.GDT 3/29/01 13:32:22 P3

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-4-00**

PROJECT **West Trent Ave. Bridge Replacement** Job No. **OL-1735**

Spokane S.R. **290**

Station **26+00** Offset **60' RT** C.S. **3234**

Equipment **CME 45 w/ autohammer** Casing **HWTX47' HQX87'** Ground El **1864.0 (568.15 m)**

Method of Boring **Wet Rotary**

Start Date **November 8, 2000** Completion Date **December 6, 2000** Sheet **1** of **4**

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		>>	17 36 25 (61)		D-1		Well graded GRAVEL with sand, subrounded, very dense, gray, wet, Stratified, no HCl reaction Length Recovered 0.7 ft		
10	3			3 4 4 (8)		D-2		Well graded SAND with gravel, loose, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.5 ft		
15	4, 5			8 4 3 (7)		D-3		Well graded GRAVEL with sand, subrounded, loose, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.6 ft		
20	6			10 12		D-4		Well graded GRAVEL with sand, subrounded, medium dense, gray, wet, Stratified, no HCl reaction		

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-4-00**

Sheet **2** of **4**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**

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
				12 (24)				Length Recovered 0.2 ft		
	7									
25				14 10 10 (20)		D-5		Well graded GRAVEL with sand, subrounded, medium dense, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 0.3 ft		
	8									
30	9			10 16 16 (32)		D-6		Well graded GRAVEL with sand, subrounded, dense, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 0.5 ft		
	10									
35				17 18 19 (37)		D-7		Well graded GRAVEL with sand, subangular, dense, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 0.6 ft		
	11									
40	12			9 14 10 (24)		D-8		Well graded GRAVEL with sand, subangular, medium dense, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 0.8 ft		
	13									
45				11 10		D-9		Well graded GRAVEL with sand, subrounded, medium dense, dark gray, wet, Homogeneous, no HCl reaction		

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-4-00**

Sheet **3** of **4**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**

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
				7 (17)				Length Recovered 0.4 ft		
	14									
	15			15 15 15 (30)		D-10		Well graded GRAVEL with sand, subangular, dense, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 1.2 ft		
50										
	16									
				17 21 23 (44)		D-11		Well graded GRAVEL with sand, subrounded, dense, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 1.3 ft		
55	17									
	18			12 12 16 (28)		D-12		Well graded GRAVEL with sand, subrounded, dense, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 0.7 ft		
60										
	19									
				26 7 7 (14)		D-13		Well graded GRAVEL with sand, subrounded, medium dense, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 0.5 ft		
65	20									
	21		>>	50 60/6"		D-14		Well graded GRAVEL with sand, silt, subrounded, very dense, dark grayish brown, wet, Homogeneous, no HCl		
70										

SOIL OL1735~1.GPJ SOIL.GDT 3/29/01 03:32:52 P3

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-4-00**

Sheet **4** of **4**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**

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
				(60)				reaction Length Recovered 0.7 ft		
	22							End of test hole boring at 70.5 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.		
75	23									
	24									
80	25									
85	26									
	27									
90	28									
95										

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-5-00**

PROJECT **West Trent Ave. Bridge Replacement** Job No. **OL-1735**

Spokane S.R. **290**

Station **27+90** Offset C.S. **3234**

Equipment **CME 45 w/ autohammer** Casing **HW-10,HQ-50,NQ** Ground El **1862.0 (567.54 m)**

Method of Boring **Wet Rotary**

Start Date **October 25, 2000** Completion Date **October 26, 2000** Sheet **1** of **3**

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									
5				9 12 8 (20)		D-1		Well graded GRAVEL with sand, subrounded, medium dense, gray, moist, Stratified, no HCl reaction Length Recovered 0.4 ft, Length Retained 0.4 ft		
	2									
10	3			6 10 6 (16)		D-2		Well graded SAND with gravel, cobbles, medium dense, gray, wet, Stratified, no HCl reaction Length Recovered 0.4 ft, Length Retained 0.4 ft		
	4									
15				7 14 7 (21)		D-3		No Recovery		
	5									
	6			1 2 1		D-4		Well graded SAND with gravel, very loose, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.5 ft, Length Retained 0.5 ft		
20										

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-5-00**

Sheet **2** of **3**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**

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)						
	7			4 2 2 (4)		D-5		Well graded SAND with gravel, very loose, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.4 ft, Length Retained 0.4 ft		
25										
	8			3 3 2 (5)		D-6		Well graded GRAVEL with sand, subrounded, very loose, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.3 ft, Length Retained 0.3 ft		
	9									
30										
	10			3 3 3 (6)		D-7		Well graded SAND with gravel, loose, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.5 ft, Length Retained 0.5 ft		
35										
	11			3 3 2 (5)		D-8		Well graded GRAVEL with sand, subrounded, loose, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.6 ft, Length Retained 0.6 ft		
	12									
40				5 5 4 (9)		D-9		Well graded GRAVEL with sand, subrounded, loose, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.3 ft, Length Retained 0.3 ft		
	13									
45										

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-5-00**

Sheet 3 of 3

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**

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			8 7 7 (14)		D-10		Well graded GRAVEL with sand, subrounded, medium dense, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.6 ft, Length Retained 0.6 ft		
	15									
50				50/1" (50) RQD 99 FF 1 RQD 82 FF 1		D-11 C-12 C-13		No Recovery basalt, fine grained, slightly weathered, strong rock, no HCl reaction. Discontinuities are closely spaced and in fair condition, Percent Recovered 100.0% basalt, fine grained, slightly weathered, strong rock, no HCl reaction. Discontinuities are closely spaced and in fair condition, Percent Recovered 100.0%		
	16									
55										
	17			RQD 90 FF 1		C-14		basalt, fine grained, slightly weathered, strong rock, no HCl reaction. Discontinuities are closely spaced and in fair condition, Percent Recovered 100.0%		
	18									
60										
	19							End of test hole boring at 62.1 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.		
65										
	20									
	21									
70										

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-6-00**

PROJECT **West Trent Ave. Bridge Replacement** Job No. **OL-1735**

Spokane S.R. **290**

Station **28+24** Offset C.S. **3234**

Equipment **CME 45 w/ autohammer** Casing **HW-16.5,HQ,NQ** Ground El **1858.0 (566.32 m)**

Method of Boring **Wet Rotary**

Start Date **October 17, 2000** Completion Date **October 24, 2000** Sheet **1** of **4**

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
			>>	4 16 50 (66)		D-1		Well graded SAND with gravel, cobbles, very dense, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft		
				32 16 6 (22)		D-2		Well graded GRAVEL with sand, cobbles, subrounded, medium dense, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.7 ft, Length Retained 0.7 ft		
				4 3 2 (5)		D-3		Well graded GRAVEL with sand, subrounded, loose, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.4 ft, Length Retained 0.4 ft		
				2 1 1 (2)		D-4		Well graded SAND with gravel, very loose, gray, wet, Stratified, no HCl reaction Length Recovered 0.5 ft, Length Retained 0.5 ft		

Depth (ft): 5, 10, 15, 20. Meters (m): 1, 2, 3, 4, 5, 6.

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-6-00**

Sheet **2** of **4**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**

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 6 7 (13)		D-5		Well graded GRAVEL with sand, subrounded, medium dense, grayish brown, moist, Stratified, no HCl reaction Length Recovered 0.5 ft, Length Retained 0.5 ft		
25	7									
	8			2 15 14 (29)		D-6		Well graded GRAVEL with sand, subrounded, dense, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.7 ft, Length Retained 0.7 ft		
30	9									
	10			24 17 15 (32)		D-7		Well graded SAND with gravel, dense, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.6 ft, Length Retained 0.6 ft		
35	11			20 15 15 (30)		D-8		Silty SAND with gravel, dense, grayish brown, wet, Stratified, no HCl reaction Length Recovered 0.6 ft, Length Retained 0.6 ft		
40	12									
	13			3 2 2 (4)		D-9		Well graded GRAVEL with sand, subrounded, very loose, gray, wet, Stratified, no HCl reaction Length Recovered 0.5 ft, Length Retained 0.5 ft		
45										

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-6-00**

Sheet **3** of **4**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**

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			4 8 6 (14)		d-10		Well graded GRAVEL with sand, subrounded, medium dense, gray, wet, Stratified, no HCl reaction Length Recovered 0.4 ft, Length Retained 0.4 ft		
50	15									
				12 4 6 (10)		D-11		Well graded GRAVEL with sand, subrounded, loose, gray, wet, Stratified, no HCl reaction Length Recovered 0.5 ft, Length Retained 0.5 ft		
	16									
55										
	17			2 2 3 (5)		D-12		Well graded GRAVEL with sand, subrounded, loose, gray, wet, Homogeneous, no HCl reaction Length Recovered 0.4 ft, Length Retained 0.4 ft		
	18									
60										
				50/0" (50/0") RQD 99 FF 1		D13 C-14		No Recovery BASALT, fine grained, moderately weathered, strong rock, no HCl reaction. Discontinuities are closely spaced and in fair condition, Percent Recovered 100.0%		
	19									
65				RQD 92 FF 1		C-15		BASALT, fine grained, slightly weathered, strong rock, no HCl reaction. Discontinuities are closely spaced and in fair condition, Percent Recovered 100.0%		
	20									
	21									
70										

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-6-00**

Sheet **4** of **4**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**

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
								End of test hole boring at 70 ft below ground elevation.		
	22							This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data.		
75										
	23									
	24									
80										
	25									
85										
	26									
	27									
90										
	28									
95										

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-7-00**

PROJECT **West Trent Ave. Bridge Replacement** Job No. **OL-1735**

Spokane S.R. **290**

Station **29+30** Offset **34' LT** C.S. **3234**

Equipment **CME 45 w/ autohammer** Casing **HW-52' HQ-87'** Ground El **1882.9 (573.91 m)**

Method of Boring **Wet Rotary**

Start Date **November 7, 2000** Completion Date **November 28, 2000** Sheet **1** of **4**

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			3 4 11 (15)		D-1		Silty GRAVEL with sand, subangular, medium dense, very dark brown, wet, Homogeneous, no HCl reaction Length Recovered 0.8 ft		
10	3–4			0 1 1 (2)		D-2		ORGANIC SOIL, soft, very dark brown, moist, Homogeneous, no HCl reaction, [soil change] at 8'. The entire sample was wood organics. Length Recovered 0.7 ft		
15	5			8 9 16 (25)		D-3		Well graded GRAVEL with sand, subrounded, dense, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 0.7 ft	11/28/2000	
20	6		>>	55/6" (55)		D-4		Well graded GRAVEL with sand, subangular, very dense, grayish brown, wet, Homogeneous, no HCl reaction		

LOG OF TEST BORING

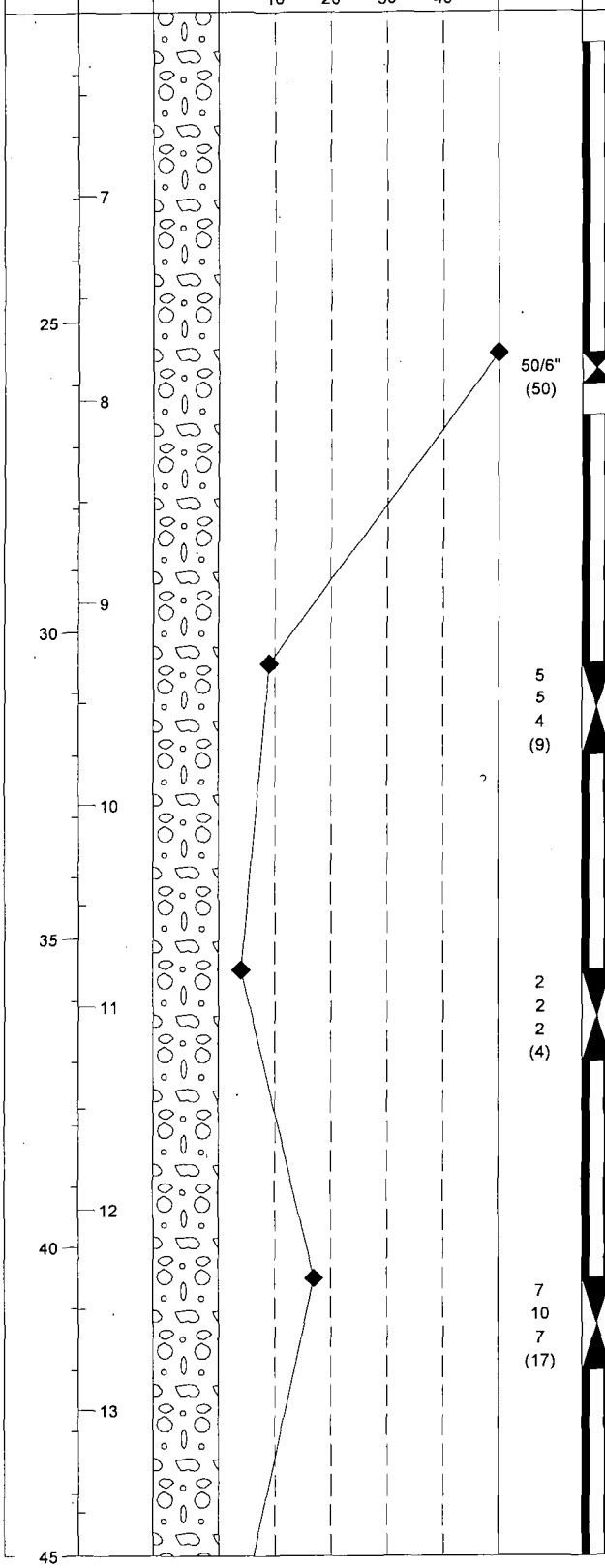
Washington State Department of Transportation

HOLE No. **H-7-00**

Sheet **2** of **4**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**



Depth (ft)	Meters (m)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
						Length Recovered 0.5 ft		
				C-5		Well graded GRAVEL, subrounded, very dense, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 2.5 ft		
25	7							
	8	50/6" (50)		D-6		Well graded GRAVEL with sand, cobbles, subangular, very dense, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.5 ft, Length Retained 0.5 ft		
				C-7		*Well graded GRAVEL, cobbles, subrounded, dense,* grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 1.2 ft		
30	9							
		5 5 4 (9)		D-8		Well graded GRAVEL, subrounded, loose, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.8 ft, Length Retained 0.8 ft		
				C-9		No Recovery		
35	10							
	11	2 2 2 (4)		D-10		No Recovery		
				C-11		Well graded GRAVEL, subrounded, loose, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft		
40	12							
		7 10 7 (17)		D-12		Well graded GRAVEL with sand, subrounded, medium dense, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.7 ft		
	13			C-13		Well graded GRAVEL, subrounded, medium dense, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft		
45								

LOG OF TEST BORING

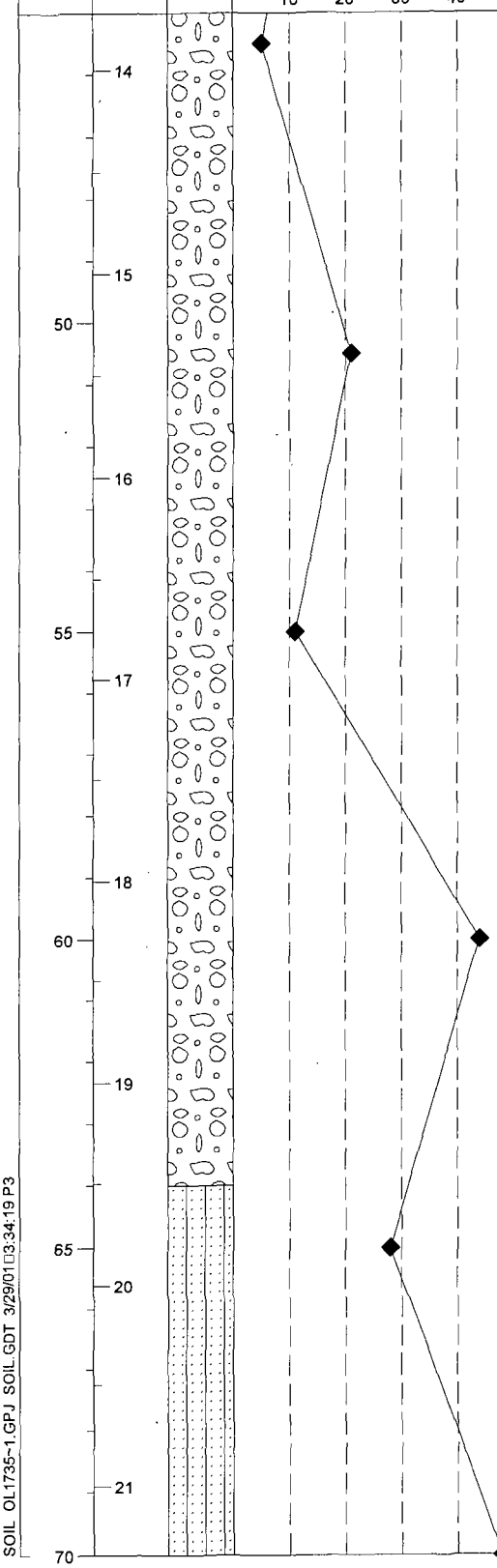
Washington State Department of Transportation

HOLE No. **H-7-00**

Sheet **3** of **4**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**



SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
5 2 3 (5)		D-14		Well graded GRAVEL, subrounded, loose, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 0.2 ft		
		C-15		Well graded GRAVEL, subrounded, medium dense, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 1.3 ft, Length Retained 1.3 ft		
15 12 9 (21)		D-16		Well graded GRAVEL with sand, subrounded, medium dense, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 0.7 ft, Length Retained 0.7 ft		
4 5 6 (11)		D-17		Well graded GRAVEL with sand, subrounded, medium dense, gray, wet, Homogeneous, no HCl reaction, cobblesand boulders demonstrated by drilling. Length Recovered 0.4 ft		
16 21 23 (44)		D-18		Well graded GRAVEL with sand, boulder, subangular, dense, dark brown, wet, Homogeneous, no HCl reaction, encountered a boulder from 57' to approx. 58.4'. Length Recovered 0.4 ft, Length Retained 0.4 ft		
20 17 11 (28)		D-19		Silty SAND with gravel, dense, dark brown, wet, Homogeneous, no HCl reaction, cobbles demonstrated by drilling. Length Recovered 0.2 ft, Length Retained 0.2 ft		

LOG OF TEST BORING

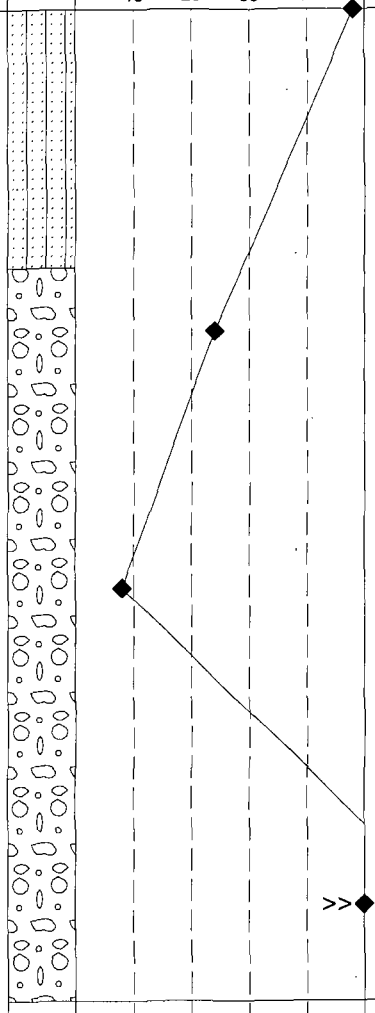
Washington State Department of Transportation

HOLE No. **H-7-00**

Sheet **4** of **4**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**



Depth (ft)	Meters (m)	SPT Blows/6" (N)	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	22	23 33 15 (48)		D-20		Silty SAND with gravel, cobbles, dense, dark brown, wet, Homogeneous, no HCl reaction, cobbles demonstrated by drilling Length Recovered 0.8 ft, Length Retained 0.8 ft		
75	23	8 8 8 (24)		D-21		Well graded GRAVEL with sand, subrounded, medium dense, brown, wet, Homogeneous, no HCl reaction Length Recovered 0.5 ft, Length Retained 0.5 ft		
	24	4 3 5 (8)		D-22		Well graded GRAVEL with sand, subrounded, loose, dark grayish brown, wet, Homogeneous, no HCl reaction, 7:00 A.M. 11/28/2000 the water table inside the casing after sitting several days was at 14.5'. Length Recovered 0.7 ft, Length Retained 0.7 ft		
80	25							
		>> 16 41 23 (64)		D-23		Well graded GRAVEL with sand, subrounded, very dense, dark grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 1.2 ft, Length Retained 1.2 ft		
85	26							
						End of test hole boring at 85.5 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.		
	27							
90								
	28							
95								

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-8-00**

PROJECT **West Trent Ave. Bridge Replacement** Job No. **OL-1735**

Spokane S.R. **290**

Station **29+93** Offset **38'RT** C.S. **3234**

Equipment **CME 45 w/ autohammer** Casing **HWT-50' HQ-82'** Ground El **1890.0 (576.07 m)**

Method of Boring **Wet Rotary**

Start Date **October 24, 2000** Completion Date **November 3, 2000** Sheet **1** of **4**

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 5 9 (14)		D-1		Silty GRAVEL with sand, subangular, medium dense, very dark grayish brown, wet, Stratified, no HCl reaction, mottled with brown, black, orange. Color change the last 2" to gray with well graded gravel with sand. Length Recovered 0.7 ft		
10	3			1 1 1 (2)		D-2		Well graded SAND with gravel, very loose, very dark grayish brown, wet, Homogeneous, no HCl reaction, mottled with brown, black, and orange. Encountered some cobbles during drilling. Length Recovered 0.5 ft		
15	4, 5			4 9 5 (14)		D-3		Well graded GRAVEL with sand, subangular, medium dense, very dark gray, wet, Homogeneous, no HCl reaction Length Recovered 1.2 ft		
20	6			13		D-4		Well graded GRAVEL, subrounded, medium dense, very		

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-8-00**

Sheet **2** of **4**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**

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
				8 13 (21)		C-5		dark grayish brown, wet, Homogeneous, no HCl reaction, the top 2" of the sample was granite. Encountered a boulder at approx. 18'3" to 19'6". We started coring at 21'. Length Recovered 0.8 ft	11/03/2000 10/25/2000	
25	7			50/0 (50)		D-6		No Recovery		
30	8			50/6" (50)		D-8 C-9		Well graded GRAVEL, subrounded, very dense, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.5 ft Well graded GRAVEL, cobbles, subangular, dense, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 3.0 ft		
35	9			5 16 14 (30)		D-10 C-11		Poorly graded SAND with gravel, dense, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 0.5 ft Well graded GRAVEL, subrounded, medium dense, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 2.0 ft		
40	10			15 5 4 (9)		D-12 C-13		Well graded GRAVEL, subangular, loose, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 0.8 ft Well graded GRAVEL, cobbles, subrounded, loose, dark gray, wet, Stratified,Homogeneous, no HCl reaction Length Recovered 2.0 ft		
45	11									

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-8-00**

Sheet **3** of **4**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**

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
				7 4 4 (8)		D-14		Well graded GRAVEL, subangular, loose, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 0.5 ft		
14						C-15		Well graded GRAVEL, cobbles, subrounded, loose, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 2.5 ft		
15										
50				4 3 2 (5)		D-16		Well graded GRAVEL with sand, subrounded, loose, dark grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.3 ft		
						C-17		Well graded GRAVEL, subrounded, loose, dark grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 2.0 ft		
16										
55				6 2 2 (4)		D-18		Poorly graded SAND, very loose, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.5 ft		
17						C-19		Well graded GRAVEL, subrounded, medium dense, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 2.0 ft		
18										
60				12 11 17 (28)		D-20		Well graded GRAVEL, subrounded, dense, grayish brown, wet, Homogeneous, no HCl reaction, Changed to the HQ advancer at 61.5'. Length Recovered 0.8 ft		
19										
65				15 18 22 (40)		D-21		Well graded GRAVEL with sand, subrounded, dense, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft		
20										
21				3 7		D-22		Well graded GRAVEL, subangular, medium dense, dark gray to grayish brown, wet, Homogeneous, no HCl		
70										

LOG OF TEST BORING

Washington State Department of Transportation

HOLE No. **H-8-00**

Sheet **4** of **4**

PROJECT **West Trent Ave. Bridge Replacement**

Job No. **OL-1735**

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
				8 (15)				reaction Length Recovered 1.0 ft		
	22									
75	23			3 2 2 (4)		D-23		Well graded GRAVEL, subrounded, very loose, dark gray, wet, Homogeneous, no HCl reaction Length Recovered 0.5 ft		
	24			39 10 13 (23)		D-24		Well graded GRAVEL with sand, subangular, medium dense, grayish brown, wet, Homogeneous, no HCl reaction Length Recovered 0.4 ft		
80										
	25							End of test hole boring at 80.5 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									
	27									
90	28									
95										

APPENDIX D – LABORATORY TESTING

LABORATORY TESTING

Laboratory testing was performed on selected samples from the field exploration program. Testing included performing moisture content, grain size, and unconfined compressive strength tests. The tests were done in general accordance with AASHTO T-88, T-89 and T-22 guide specifications, respectively. After the testing was complete, the samples were classified in general accordance with the Unified Soil Classification System (USCS). Results from these tests are included herein.

Job No. **OL-1735** Date **December 18, 2000**

Hole No. **H-3-00** Sheet **1** of **1**

Project **West Trent Ave. Bridge Replacement**

Laboratory Summary

Washington State Department of Transportation

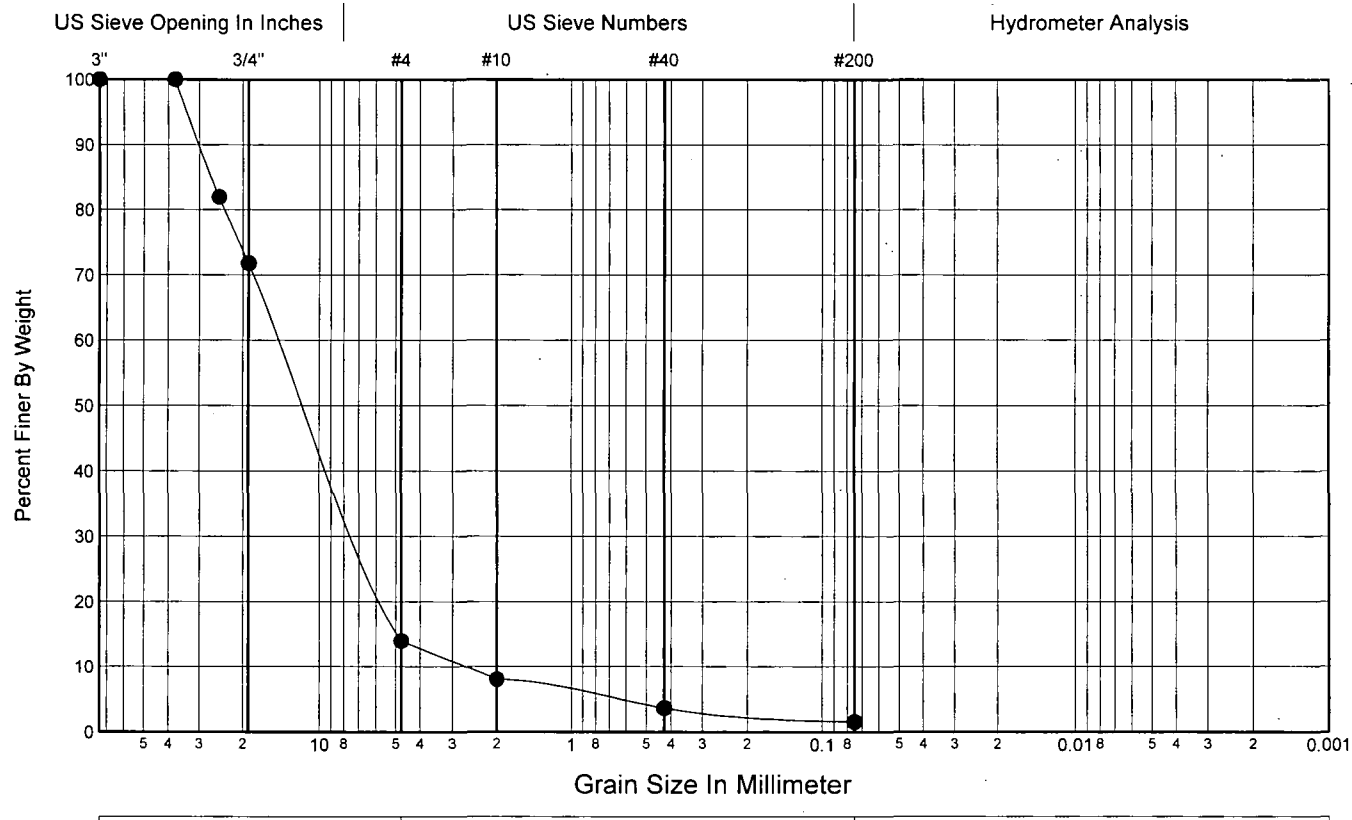
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**20.5**	**6.25**	**D-5**	**GW**	**See Boring Log**	**WELL-GRADED GRAVEL**	**9**	**NP**	**NP**	**NP**

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	**86.0**	**12.4**	**1.5**	**1.3**	**5.4**

GRADATION VALUES

	D60	D50	D30	D20	D10
●	**14.32**	**11.27**	**6.98**	**5.49**	**2.67**



Job No.	**OL-1735**	Date	**December 18, 2000**
Hole No.	**H-4-00**	Sheet	**1** of **1**
Project	**West Trent Ave. Bridge Replacement**		

Laboratory Summary

Washington State Department of Transportation

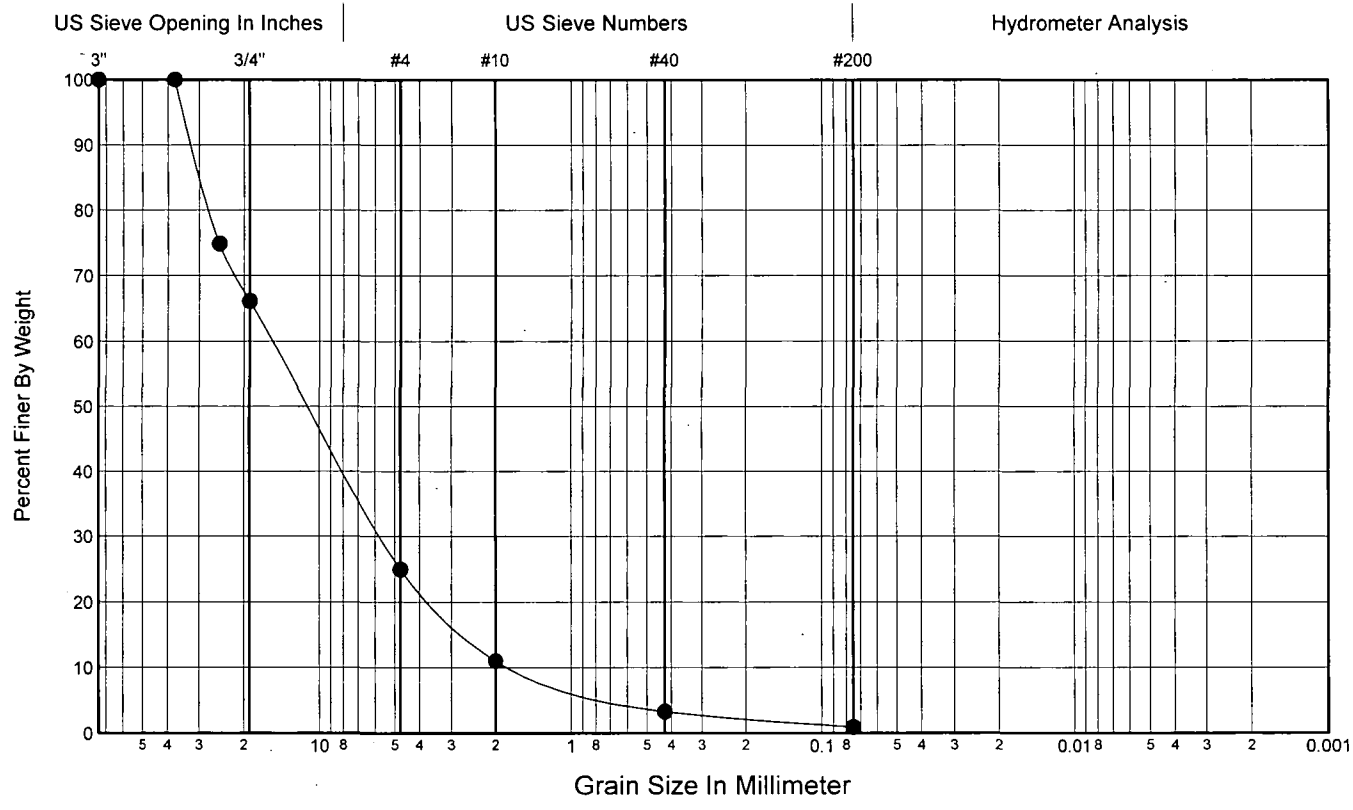
	Depth (ft)	Depth (m)	Sample No.	USCS	Color	Description	MC%	LL	PL	PI
●	**14.0**	**4.27**	**D-3**	**GW**	**See Boring Log**	**WELL-GRADED GRAVEL with SAND**	**10**	**NP**	**NP**	**NP**

GRADATION FRACTIONS

	%Gravel	%Sand	%Fines	Cc	Cu
●	**75.1**	**24.0**	**0.9**	**1.3**	**9.5**

GRADATION VALUES

	D60	D50	D30	D20	D10
●	**15.46**	**11.04**	**5.63**	**3.49**	**1.63**



WASHINGTON STATE DEPARTMENT OF TRANSPORTATION - MATERIALS LABORATORY
PO BOX 167 OLYMPIA, WA. 98507-0167/1655 SO. 2ND AVE TUMWATER, WA. 98512

Physical Testing Section
PCC Compressive Strength Test Report
Test Method AASHTO T 22

Work Order No. **0L1735**
Lab ID No. **J-0000257759**

Transmittal No. **163709**
Bid Item No.
Org. Code **462501**
F.A. No.

Date Received: **01/18/2001**
S.R. No.: **290**
County:
Section:
Contractor:

==========

Cement: Type: Mill Test No.:

Mixing Plant Location: Cert. No.:

Admixtures		**Mix Data**
Air Entrainment	Per 100 Wt.:	Cement lb/cy:
Water Reducer	Per 100 Wt.:	Gravel Source:
High-Range Water Reducer	Per 100 Wt.:	Sand Source:
Water	Per 100 Wt.:	Approx. Slump:
Water/Cement Ratio	W/C :	Percent of Air:

Class: **ROCK CORES**

Date Made: **01/18/2001** Date Tested: **01/18/2001** Test Age: **0** Days

Concrete Placement Location: **H-1-00 C-27.8',H-2-00 C-2 4.5'**

Cylinder No.	1	2
Diameter (in.)	2.37	2.39
Cross-Section Area (sq. in.)	4.41	4.49
Original Length (in.)	5.31	5.22
Original Weight (lbs.)	2.20	2.26
lbs/cf	162.3	166.6
L/D Ratio	2.24	2.18
Correction Factor	1.00	1.00
Maximum Load (lbf)	58,685	58,680
Compressive Strength (psi)	13,310	13,070
Fracture Type	Shear	Columnar

Avg. Comp Strength (psi) 13,190

==========

Distribution:

Materials File		X
Regional Administrator	46	X
Project Engineer:		
D. SOWERS		X(2)

Results: **INFORMATIONAL**
Remarks:
ROCK CORES

THOMAS E. BAKER, P.E.
MATERIALS ENGINEER
D.W. BROUILLARD By:
Date: 01/22/2001
Phone: (360)709-5446

T46E- T46H- **2.0** T46Y-
T46N- **2.0** T46X-

cylinder.dfr

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION - MATERIALS LABORATORY
PO BOX 167 OLYMPIA, WA. 98507-0167 1655 SO. 2ND AVE TUMWATER, WA. 98512

Physical Testing Section
PCC Compressive Strength Test Report
Test Method AASHTO T 22

Work Order No. **0L1735**
Lab ID No. **J-0000257759**

Transmittal No. **163709**
Bid Item No.
Org. Code **462501**
F.A. No.

Date Received: **01/18/2001**
S.R. No.: **290**
County:
Section:
Contractor:

==========

Cement: Type: Mill Test No.:

Mixing Plant Location: Cert. No.:

Admixtures		**Mix Data**
Air Entrainment	Per 100 Wt.:	Cement lb/cy:
Water Reducer	Per 100 Wt.:	Gravel Source:
High-Range Water Reducer	Per 100 Wt.:	Sand Source:
Water	Per 100 Wt.:	Approx. Slump:
Water/Cement Ratio	W/C :	Percent of Air:

Class: **ROCK CORES**

Date Made: **01/18/2001** Date Tested: **01/18/2001** Test Age: **0** Days

Concrete Placement Location: **H-1-00 C-27.8',H-2-00 C-2 4.5'**

Cylinder No.	1	2
Diameter (in.)	2.37	2.39
Cross-Section Area (sq. in.)	4.41	4.49
Original Length (in.)	5.31	5.22
Original Weight (lbs.)	2.20	2.26
lbs/cf	162.3	166.6
L/D Ratio	2.24	2.18
Correction Factor	1.00	1.00
Maximum Load (lbf)	58,685	58,680
Compressive Strength (psi)	13,310	13,070
Fracture Type	**Shear**	**Columnar**

Avg. Comp Strength (psi) **13,190**

==========

Distribution:

Materials File		X
Regional Administrator	46	X
Project Engineer:		
D. SOWERS		X(2)

Results: **INFORMATIONAL**
Remarks:
ROCK CORES

THOMAS E. BAKER, P.E.
MATERIALS ENGINEER
D.W. BROUILLARD By:
Date: 01/22/2001
Phone: (360)709-5446

T46E- T46H- **2.0** T46Y-
T46N- **2.0** T46X-

cylinder.dfr

APPENDIX E - P-Y CURVE PARAMETERS

W. TRENT AVENUE BRIDGE REPLACEMENT

P-Y Curve Parameters

PIER 1 - Spread Footing (see report text)

PIER 2

Assumed Ground Surface Elevation = 1858 ft

				STATIC ANALYSIS						
Soil Layer	Depth Below Ground Surface	Soil Type	Soil Profil Type (KSOIL)	Effective Unit Weight of Soil		Saturated Undrained Strength, S_u		Axial Strain ε_{50}	Friction Angle ϕ	Modulus f Subgrade Reaction
	feet			pci	pcf	psi	psf		(deg)	pci
1	1858 to 1775	SAND	4	0.039	68	0.0	0.0	-	35	100

PIER 3

Assumed Ground Surface Elevation = 1860 ft

				STATIC ANALYSIS						
Soil Layer	Depth Below Ground Surface	Soil Type	Soil Profil Type (KSOIL)	Effective Unit Weight of Soil		Saturated Undrained Strength, S_u		Axial Strain ε_{50}	Friction Angle ϕ	Modulus f Subgrade Reaction
	feet			pci	pcf	psi	psf		(deg)	pci
1	1860 to 1845	SAND	4	0.039	68	0.0	0.0	-	35	100
2	1845 to 1805	SAND	4	0.036	63	0.0	0.0	-	32	60
3	Below 1805	CLAY	2	0.063	108	4000.0	576000	0.0002	-	100000

PIER 4

Assumed Ground Surface Elevation = 1890 ft

				STATIC ANALYSIS						
Soil Layer	Depth Below Ground Surface	Soil Type	Soil Profil Type (KSOIL)	Effective Unit Weight of Soil		Saturated Undrained Strength, S_u		Axial Strain ε_{50}	Friction Angle ϕ	Modulus f Subgrade Reaction
	feet			pci	pcf	psi	psf		(deg)	pci
1	1890 to 1870	SAND	4	0.075	130	0.0	0.0	-	35	150
2	1870 to 1800	SAND	4	0.039	68	0.0	0.0	-	35	100

** Elevations are based on Preliminary Bridge Plan contours, and should be considered preliminary.

APPENDIX F – GEOPHYSICAL STUDY RESULTS

Geophysical Survey at the Trent Avenue Bridge Spokane, Washington

Prepared for:
Washington Department of Transportation

February 2001

Golder Associates Inc.

18300 NE Union Hill Road, Suite 200
Redmond, WA 98052-3333
Telephone (425) 883-0777
Fax (425) 882-5498

Golder Associates

February 15, 2001

Our ref: 013-1375.000

WSDOT
Field Operations Support Service Center
Materials Laboratory
1655 S. 2nd Avenue
Tumwater, Washington 98512

ATTENTION: Mr. David Sowers

RE: GEOPHYSICAL SURVEY AT THE
TRENT AVENUE BRIDGE
SPOKANE, WASHINGTON

Dear Mr. Sowers:

On January 30 and 31, 2001, Golder Associates Inc. conducted a Geophysical survey at the west end of the Trent Avenue Bridge in Spokane, Washington. The objectives of the survey were to try to locate the depth to bedrock along the west bank of the Spokane River, where a proposed new bridge, wing walls, and underpass sidewalk are to be constructed.

To meet the project objectives, ground penetrating radar (GPR), seismic refraction, and electrical resistivity imaging (ERI) methods were used. This report describes the instrumentation and methods, field procedures, and results of the survey. The survey lines are shown in Figure 1.

INSTRUMENTATION AND METHODS

Ground Penetrating Radar

The GPR survey was conducted with a GSSI SIR System-8 with 100, 200, and 400 MHz frequency antennas. The data were displayed on an EPC Model 8700 thermal graphic recorder.

The GPR method uses electromagnetic pulses directed into the ground to map subsurface geology along the survey transect. As the antenna is pulled along the survey transect the GPR continuously transmits radar pulses. The pulses are reflected from subsurface features, received by the antenna and are processed by the radar console. The processed

data are displayed on the graphic recorder as an electrical profile of the subsurface. Depth is determined by calibration to an object of known depth or assigning a typical velocity for the type of subsurface materials present. When crossing a known grid point a fiducial mark is made on the radar record, making it possible to map and relocate interpreted features observed on the records.

The reflections from subsurface features are produced where there is a change in electrical properties of the material. These changes can occur at the interface between soil types, at the water table, or at discrete objects such as pipes, drums, storage tanks, and miscellaneous debris. The GPR interpretation is presented in cross-sectional view as annotated GPR records or on a plan view map of the site.

The maximum depth of penetration of the GPR signal is dependent on the frequency of the antenna used and the electrical properties of the soils. The presence of water and fine-grained sediments, such as silts and clays, may reduce the depth of penetration to a few feet. However, in coarse-grained sediments, sand and gravel, up to 50 feet of penetration can be obtained.

Seismic Refraction

The seismic refraction survey was conducted using a Geometrics Strataview 24-channel digital seismograph. The sensors consisted of 24 Mark Products 14-Hz vertical geophones. The seismic energy source was Remington 300-grain black powder shotgun shells.

The seismic refraction method uses seismic waves introduced into the ground by an explosive or weight-drop source. As the seismic wave propagates through the earth, its direction and speed are changed by the materials through which it passes. Geophones placed at selected intervals along the ground surface detect the ground motion and send an electrical signal, via a cable, to the seismograph. The seismograph digitizes, amplifies, filters and records the incoming signals. Analysis of the arrival times of the refracted wave provides a means for modeling the seismic velocity and depths to subsurface layers.

Electrical Resistivity Imaging

An AGI Sting RI earth resistivity meter with a Swift multi-channel electrode switching unit and cables were used for this survey.

The ERI technique maps differences in the electrical properties of geologic materials. These differences can result from variations in lithology, water content, pore-water chemistry, and the presence of buried debris. The method involves transmitting an electric current into the ground between two electrodes and measuring the voltage between two other electrodes. The measured point is called a sounding. The sounding is an apparent resistivity of the area beneath the electrodes. Deeper soundings are measured by increasing the electrode spacing. Rapid collection of multiple soundings are achieved using the Swift electrode system, with up to 56 electrodes for each spread.

A 2-D geo-electric cross-section is then interpreted using inversion software (RES2DINV). The result is presented as a color-contoured cross-section that highlights stratigraphic features or other information (presence of contaminants, groundwater, bedrock, etc.) that represent variations in resistivity.

FIELD PROCEDURES

Ground Penetrating Radar

Ground penetrating radar data were collected along four survey transects, using the three different antenna frequencies to obtain the best resolution and maximum depth penetration. Three transects were run along the north side of the road and one on the south side of the road.

The first transect was located along the sidewalk, perpendicular to Trent Avenue, starting at the bridge and extending north approximately 150 feet. The second survey transect is parallel to the roadway, and adjacent to the R/W stakes in the field. This line runs from the top of the riverbank to the west for 75 feet. A borehole (H-01-00) is located on this line at 27 feet west from the top of the riverbank. The third survey transect started from the top of the riverbank on the south side of Trent Avenue, ran along the R/W stakes to the west for 80 feet. The borehole (H-02-00) on the south side of the river is located at approximately 35 feet from the top of the riverbank along the fourth survey transect.

Seismic Refraction

Two seismic refraction profile lines 1 and 2 were collected along the north and south R/W's respectively. The seismic refraction spreads were 75 feet long. The lines were started approximately 10 feet from the river, ran up the slope and along the R/W stakes (adjacent to GPR lines 2 and 3).

Electrical Resistivity Imaging

Three ERI profiles were collected. The fist two were on the north side of Trent Avenue and the third on the south. The first ERI profile, 89 feet in length, was collected along the same line as GPR transect 2, and seismic line 1. The second ERI profile, 180 feet in length, was collected along the riverbank, starting at the north edge of Trent Avenue extending to the north. The third ERI profile, 118 feet in length, collected along the same line as GPR transect 3 and seismic line 2.

Results and Discussions

The seismic refraction data was not useful at this site, because the surface frozen layer resulted in velocity inversion. There were also some operational difficulties with the electrical imaging system because of the frozen ground and boulders. The frozen ground, and boulders, increase the contact resistance at the electrode and affects the

current dispersion from the electrode into ground. This was most pronounced on the south side of the bridge, where there were numerous boulders on the abutment. These conditions resulted in noisy electrical data on EI-3. However, the integration of the GPR and electrical data made it possible to map the soil/bedrock contact.

The interpreted depths to bedrock on the north side of the bridge, along lines EI-1 and EI-2 are shown in Figure 2 and 3, respectively. The EI-2 section shows a conductive layer below what is interpreted to be the basalt unit.

On the south side of the bridge, the interpreted depths to the bedrock along EI-3 are shown in Figure 4. Because the EI data were very noisy due to poor current dispersion in boulders and frozen surface layer the interpreted contact between the soil and bedrock is uncertain.

LIMITATIONS

The geophysical information in this report is based on geophysical measurements obtained by generally accepted methods and procedures and our interpretation of the data. Individual values may in some instances, be erroneous due to frozen layer and poor current dispersion in boulders. In general, the errors in the interpreted depths related to the resolution of the technique is about ±15% of the true depths.

Sincerely,

GOLDER ASSOCIATES INC.

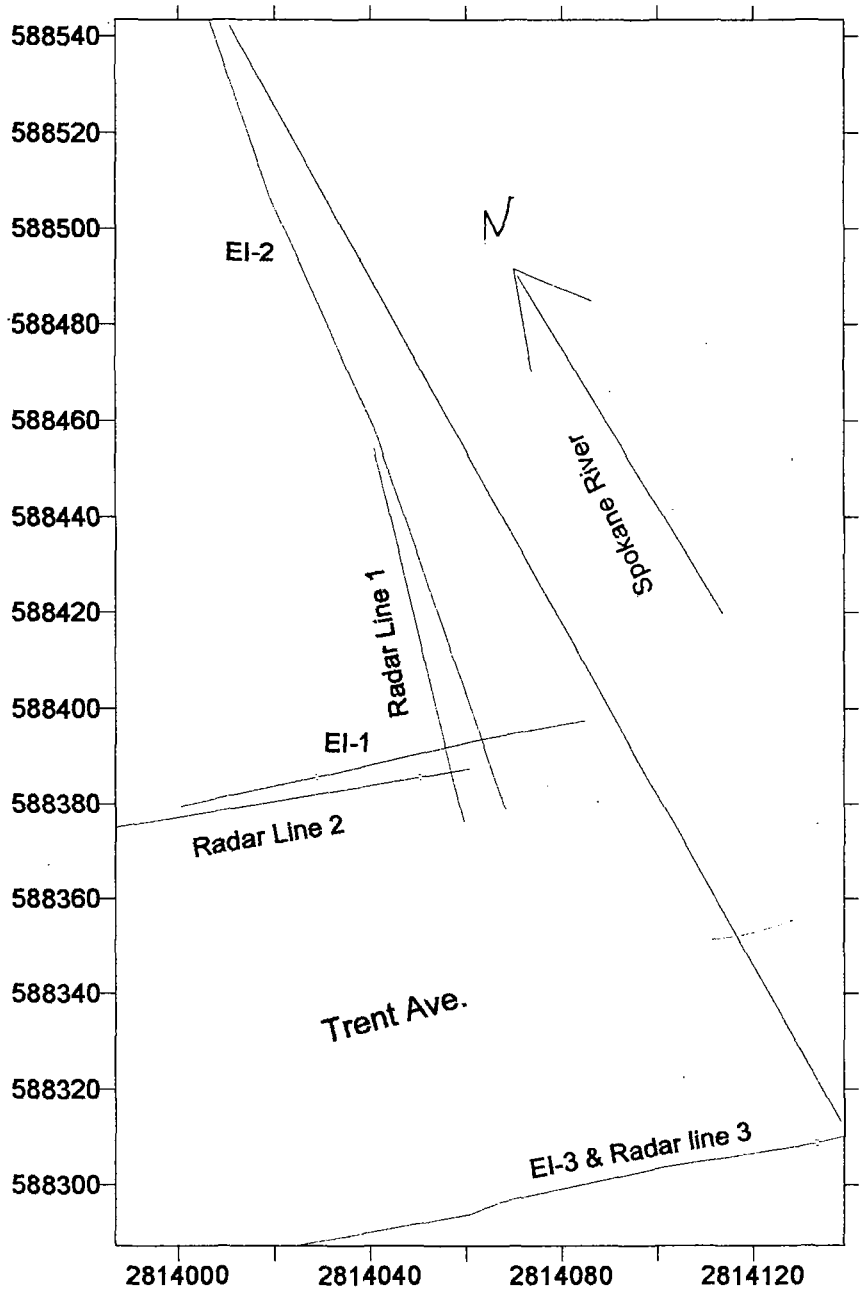
Shannon Cuesta
for Dick Sylwester

Richard E. Sylwester
Associate Geophysicist

John Liu, Ph.D.
Project Geophysicist

RES/JL/rls
0215jl1.doc

FIGURES

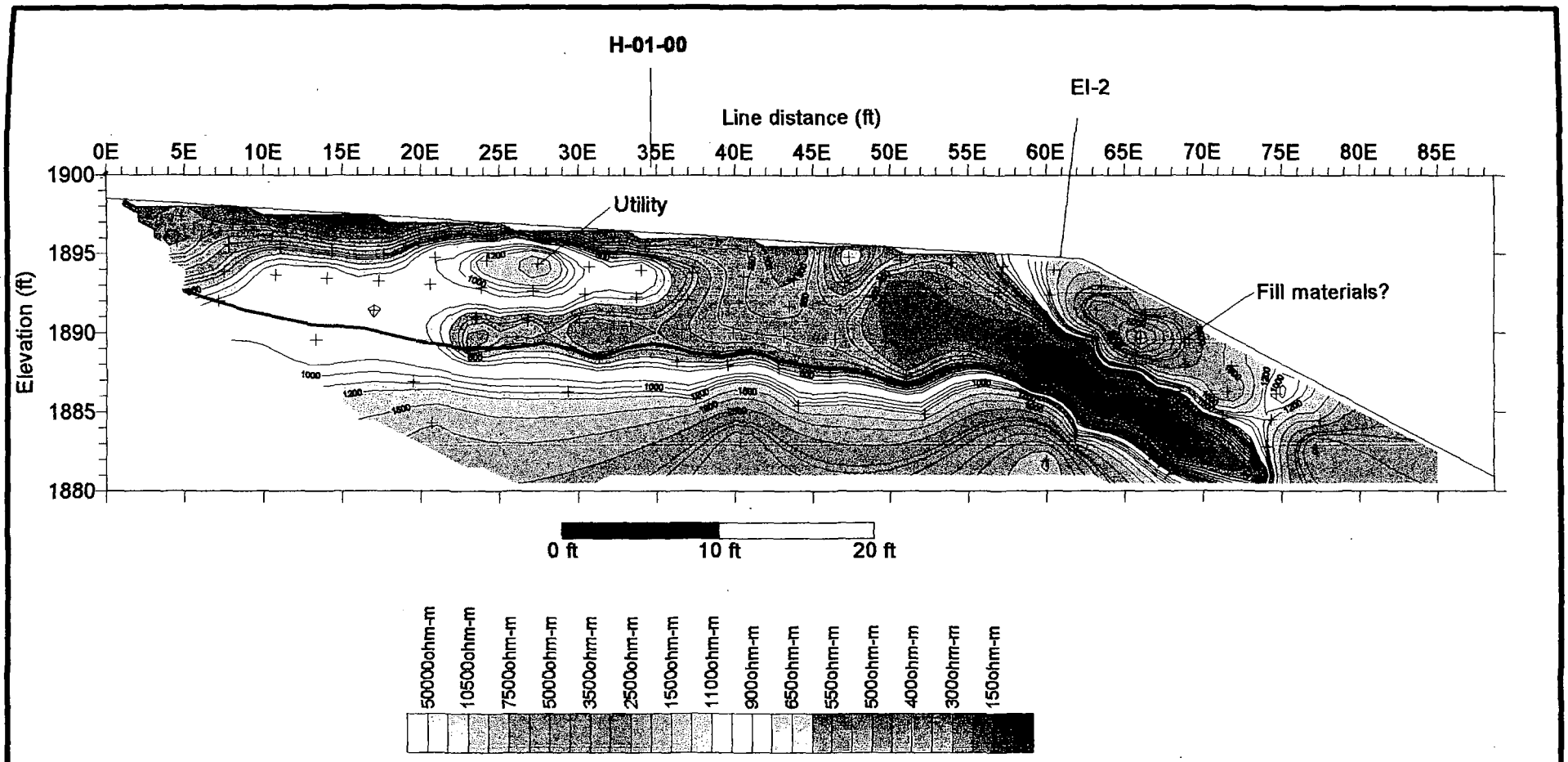


GEOPHYSICAL SURVEY
TRENT AVENUE BRIDGE, SPOKANE, WA

SITE PLAN

GOLDER ASSOCIATES INC.
REDMOND, WA

DATE: January 2001	013-1376	FIG. 1



LEGEND

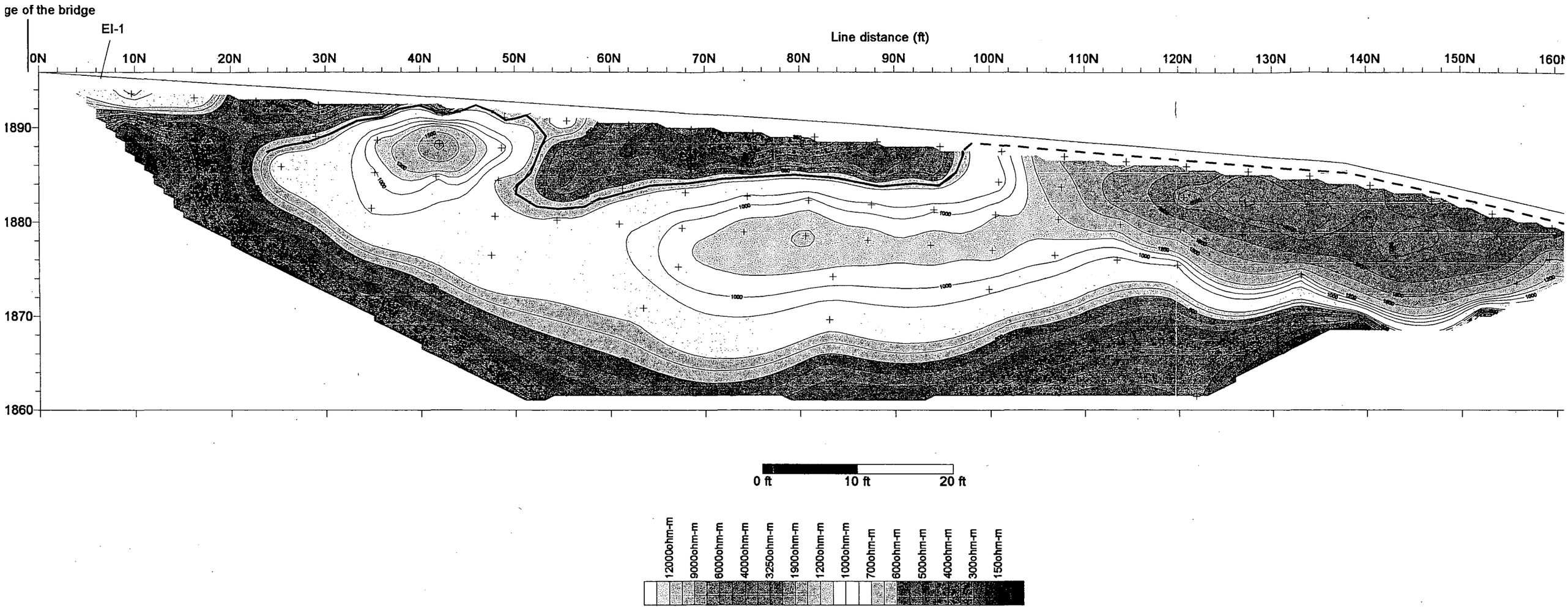
Interpreted bedrock surface

ELECTRICAL IMAGING SURVEY
TRENT AVENUE BRIDGE, SPOKANE, WA

INVERTED ELECTRICAL IMAGING DATA
EI-1

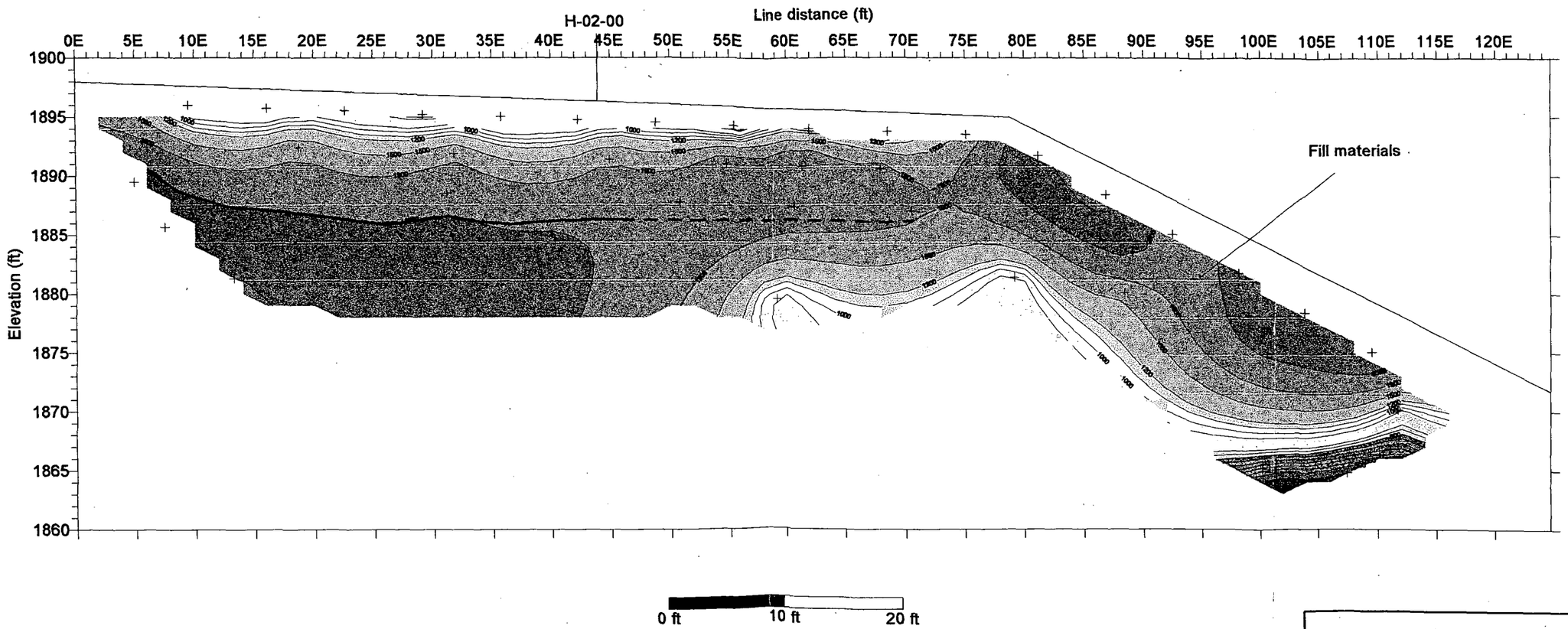
GOLDER ASSOCIATES INC.
REDMOND, WA

DATE: January 2001	013-1376	FIG. 2



LEGEND

Interpreted bedrock surface



ELECTRICAL IMAGING SURVEY
TRENT AVENUE BRIDGE, SPOKANE, WA

INVERTED ELECTRICAL IMAGING DATA
EI-3

GOLDER ASSOCIATES INC.
REDMOND, WA

DATE: January 2001	013-1375	FIG. 4