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SR 305 IMPROVEMENTS
SCL OF POULSBO TO BOND ROAD
POULSBO, WASHINGTON

HWA Project No. 98179

December 28, 1999

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TUMWATER DESIGN

Prepared for:

Skillings Connolly, Inc.

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TUMWATER DESIGN

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December 28, 1999
HWA Project No. 98179

Skillings Connolly, Inc.
5016 Lacey Blvd. NE
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Attention: Mr. Steve Thomas, P.E.

Subject: **GEOTECHNICAL REPORT**
SR 305 Improvements
SCL of Poulsbo to Bond Road
Poulsbo, Washington

Dear Mr. Thomas :

In accordance with your request, HWA GeoSciences Inc. completed a geotechnical engineering study in support of the proposed SR 305 Improvements project in Poulsbo, Washington. The results of our study are presented in the accompanying report. We appreciate the opportunity to provide geotechnical engineering services on this project. Should you have any questions or comments concerning our report, or if we may be of further service, please do not hesitate to call.

Sincerely,

HWA GEOSCIENCES, INC.

L.A. (Lorne) Balanko
Senior Geotechnical Engineer

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GEOLOGY
GEOENVIRONMENTAL SERVICES
HYDROGEOLOGY
GEOTECHNICAL ENGINEERING
TESTING & INSPECTION

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GEOTECHNICAL REPORT
SR 305 IMPROVEMENTS PROJECT
SCL OF POULSBO TO BOND ROAD
POULSBO, WASHINGTON

1.0 INTRODUCTION

1.1 GENERAL

This report summarizes the results of geotechnical engineering services completed by HWA GeoSciences Inc. (HWA) for the proposed SR 305 Improvements from the South City Limits (SCL) of Poulsbo to Bond Road (MP 10.69 ± to MP 12.82 ±) in Poulsbo, Washington. The project location and general alignment layout are shown on the Vicinity Map (Figure 1) and Site and Exploration Plan (Figures 2A to 2E), respectively. The purpose of this geotechnical study is to explore and evaluate surface and subsurface conditions along the project alignment and, based on the conditions observed, provide recommendations pertaining to the geotechnical aspects of the project.

1.2 AUTHORIZATION AND SCOPE OF WORK

A proposed scope of work and budget estimate for the performance of our geotechnical services was submitted by HWA to Skillings Connolly, Inc. Mr. Thomas Skillings, of Skillings Connolly, Inc., subsequently authorized a Professional Services Agreement on February 1, 1999 for the performance of our services. Our work was completed in general accordance with the scope of services outlined in the above-referenced documents and included collecting and reviewing readily-available geotechnical information, drilling and sampling 31 exploratory borings, performing laboratory testing on selected samples, performing geotechnical engineering analyses, and preparing this geotechnical report.

1.3 PROJECT DESCRIPTION

Our understanding of the project is based on discussions with Messrs. Jim Bush and Steve Thomas of Skillings Connolly. We understand the project includes constructing improvements for an approximately 3.5-km section of SR 305 from the SCL of Poulsbo to Bond Road in Poulsbo, Washington. The proposed improvements include widening the existing roadway from 2 to 4 lanes and adding a left turn lane between Hostmark and Little Valley Road. Corresponding intersection improvements will be made including lane configuration and signal modifications. Additionally, bike lanes and sidewalks will be constructed along portions of the alignment.

Widening of the road will require significant cuts and fills. Cuts as high as 4.3 meters are proposed, mostly along the south portion of the project alignment. Proposed fills will generally be 2.0- to 4.0-meters thick with maximum thicknesses of 6.5 to 7.0 meters and will be made along the central and northern portions of the project alignment. Rockeries and retaining walls will be used at many of the cuts and fills to reduce encroachment onto adjacent properties and sensitive land areas, particularly along the low lying portions of the alignment between Bond Road and Liberty Road. Portions of South Fork Dogfish Creek may be realigned to accommodate the road widening and further reduce impacts to sensitive areas. Several culverts may be replaced to accommodate widening of SR 305 and to facilitate natural drainage along the alignment. Pavement in the existing travel lanes will be rehabilitated, probably through placement of an overlay. Recommendations for pavement rehabilitation and construction will be provided by WSDOT.

2.0 FIELD AND LABORATORY PROGRAMS

2.1 Site Explorations

The subsurface exploration program was conducted between October 12, and November 9, 1999 under fulltime observation of an HWA geotechnical engineer. The subsurface exploration program consisted of drilling and sampling 31 exploratory borings (designated BH-9 through BH-39) in the vicinity of the proposed SR 305 improvements. Four of these borings (BH-9 through BH-12) were drilled in the vicinity of proposed retention ponds and ranged in depth from 7.3 to 8.1 meters. Twelve borings (BH-13 through BH-24) were drilled in the vicinity of proposed signal standards and ranged in depth from 5.0 to 8.1 meters. Four borings (BH-25 through BH-28) were drilled in the vicinity of proposed culvert replacements and ranged in depth from 6.6 to 8.1 meters. Eleven borings (BH-29 through BH-39) were drilled along the proposed retaining walls and ranged in depth from 3.5 to 15.7 meters. Eight borings (BH-1 through BH-8) were drilled previously for the Preliminary Geotechnical Report (HWA, 1999) and were located at relatively uniform intervals along the project alignment.

The approximate locations of the borings are presented on the Site and Exploration Plan, Figures 2A to 2E. The locations of borings BH-1 through BH-8 and BH-13 through BH-24 were determined by survey. Borings BH-9 through BH-12, and BH-25 through BH-39 have not been surveyed at this time and their locations and elevations, as indicated on Figure 2 and the boring logs, should be considered approximate.

All borings were performed by WSDOT drilling crews. Standard Penetration Tests (SPT) were performed using automatic trip hammers. Disturbed and relatively undisturbed samples were obtained at selected intervals in each of the explorations, placed in relatively airtight plastic bags and taken to our Lynnwood, Washington

laboratory for further examination and testing. During the explorations, a geotechnical engineer from HWA recorded pertinent information including soil sample depths, stratigraphy, soil engineering characteristics, and ground water occurrence. The soils were classified in general accordance with the classification system described in Figure A-1, which also provides a key to the exploration logs. A more detailed description of field exploration methods and summary boring logs are presented in Appendix A.

2.2 Laboratory Testing

Laboratory tests were conducted on selected soil samples obtained from the explorations to characterize relevant engineering (physical) properties of the on-site soils. Laboratory testing included grain-size distribution, Atterberg Limits, consolidation characteristics, and pH and resistivity. Each of the soil samples obtained from the borings was tested for natural moisture content. The results of these analyses are provided in Appendix B, and indicated on the borings logs as appropriate.

3.0 SITE CONDITIONS

3.1 General

SR 305 is a major two-lane highway running north-south between SR 3 and Bainbridge Island. Along the project alignment, left turn lanes are located at the signalized intersections with Hostmark Street, Lincoln Drive, Liberty Road, Little Valley Road, and Bond Road. Existing shoulder widths along the alignment range from approximately 1 to 3 meters, with the narrower shoulders generally in areas of cut or fill. Ditches are located on both sides of SR 305 along much of the alignment. Traffic along the alignment consists of a combination of vehicles passing through the area and those making trips to retail stores and restaurants along the alignment. Structures along the project alignment generally consist of single story, stand-alone, buildings and strip-malls.

The northern and central portion of the alignment is located in a sensitive area characterized by low-lying wet terrain with grass and occasional deciduous tress. South Fork Dogfish Creek parallels much of the alignment. Toward the southern portion of the alignment, SR 305 climbs slightly to higher and drier terrain and traverses slopes that dip gradually to the west. Several retail stores and restaurants are located directly off SR 305 along this portion of the alignment. At the south end of the alignment, SR 305 enters a more rural, forested, residential area.

3.2 PAVEMENT

Pavement sections encountered in our explorations consist of asphaltic concrete pavement (ACP) with a varying thickness of crushed stone top course (CSTC). The thicknesses of ACP and CSTC encountered in our borings are summarized in Table 1 and can be found on the summary boring logs.

Table 1: Existing Pavement Section Thickness

Borehole	Station and Offset (m)	ACP Thickness (mm)	CSTC Thickness (mm)
BH-1	18+134.56 -3.73	100	100
BH-2	18+673.61 -3.20	150	100
BH-3	18+971.73 6.53	65	0
BH-4	19+163.63 -5.99	150	150
BH-5	19+371.84 -5.04	100	0
BH-6	19+572.99 7.34	40	100
BH-7	19+795.52 -4.22	115	100
BH-8	19+946.89 8.47	50	150
BH-23	19+244 18.5	60	N/A
BH-28	19+775 10.0	75	N/A

Bore holes 5 and 28 were located within SR 305 travel lanes. The remaining borings listed in Table 1 were located on the shoulders of SR 305 rather than in actual travel lanes. Pavement sections encountered in the borings may reflect shoulder-pavement sections, and may not represent the sections of the travel lane pavement. Detailed pavement analysis and evaluation is being conducted by WSDOT and is beyond the scope of this report.

3.3 REGIONAL GEOLOGIC CONDITIONS

According to the geologic map reviewed (Deeter, 1979), the project alignment is located in an area underlain by recent alluvium and Vashon-age glacial deposits. Recent alluvium comprises highly variable sediments deposited in streams, lakes and swamps, and consists of clay, silt, peat, sand and gravel. Recent alluvium generally exhibits low shear strength and high compressibility characteristics. Vashon-age glacial deposits along the project alignment may include recessional outwash, glacial till and

undifferentiated glacial drift. Undifferentiated glacial drift may consist of a variety of materials including advance outwash, glacial till, and glaciolacustrine deposits.

3.4 Subsurface Conditions

3.4.1 Soils Along Alignment

Our interpretations of subsurface conditions are based on the results of a review of available geologic and geotechnical data and our site reconnaissance and subsurface exploration program. Subsurface explorations indicate that the project alignment is underlain by a varying sequence of fill, recent alluvium, and Vashon-age glacial deposits consisting of advance outwash and glaciolacustrine deposits. Localized areas of soft organic soils were encountered along the lower-lying portions of the alignment. The observed soil units are listed in order of deposition, beginning with the most recent, and are referenced to existing grades at the boring locations at the time of exploration.

- Fill - Fill was encountered in 24 borings and extended to depths ranging from 0.6 to 4.0 meters. Fill was generally encountered in the culvert, signal, and preliminary borings, which were advanced through the existing roadway embankment. Fill depths were generally greatest near the Dogfish Creek crossing and other culvert locations. The fill generally consists of loose to dense, slightly gravelly, sand to silty sand. SPT N-values in the fill soils ranged from 1 to 37 blows per 300mm. A majority of the fill was likely placed during construction of the SR 305 alignment. The fill soils encountered are expected to exhibit varying engineering characteristics, with most soils having low to moderate strength and compressibility.

- Recent Alluvium – Recent alluvium was encountered in 27 borings and extended to depths ranging from 2.7 to 9.6 meters. Recent alluvium was generally encountered in borings located along lower-lying portions of the site north of NE Lincoln Drive. The recent alluvium generally consists of loose to medium dense, silty sand with occasional gravel and organic matter, and very soft to medium stiff, silt and clay with occasional organic matter. SPT N-values in the recent alluvium soils ranged from 1 blow per 450 mm to over 50 blows per 300 mm. Recent alluvium is a post-glacial deposit that forms in water environments such as lakes and streams, and typically exhibits low to moderate shear strength and moderate to high compressibility characteristics.

- Glacial Advance Outwash – Glacial advance outwash was encountered in 33 borings at depths ranging from the ground surface to 5.8 meters. Glacial outwash was generally encountered at or near the ground surface along the south end of the alignment. Twenty-five of the borings that encountered advance outwash were terminated in advance outwash; eight were terminated in glaciolacustrine deposits.

The glacial outwash encountered generally consists of dense to very dense, silty sand with occasional gravel to hard sandy silt. SPT N-values ranged from 20 to over 50 blows per 300 mm. Glacial advance outwash is deposited by meltwater streams flowing from an advancing glacier and typically exhibits moderate to high shear strength, low to moderate compressibility, and moderate to high permeability characteristics due to being over-ridden by the advancing glacier.

- Glaciolacustrine Deposits - Glaciolacustrine deposits were encountered in 10 borings at depths ranging from 3.5 to 12.5 meters. Glaciolacustrine deposits were generally encountered along the central and north end of the alignment. Eight of the borings that encountered glaciolacustrine deposits were terminated in these deposits; two were terminated in underlying advance outwash. Glaciolacustrine deposits encountered generally consisted of very stiff to hard silt and clay. SPT N-values ranged from 21 to over 50 blows per 300 mm. These deposits typically exhibit high shear strength, low compressibility and very low permeability characterisitics.

3.4.2 Ground Water

Ground water seepage was encountered in borings BH-2 through BH-7 at depths ranging from 2.0 to 5.2 meters. Ground water seepage was not observed in borings BH-1, BH-8 through BH-10, BH-22, and BH-25. The remaining borings were drilled using mud rotary methods and ground water observations were not able to be made. Ground water conditions observed in exploratory borings generally vary slightly from the static ground water level because it often takes hours or days for ground water levels to stabilize after drilling. The ground water conditions reported above are for the specific dates and locations indicated and, therefore, may not necessarily be indicative of other times and/or locations, nor are they necessarily representative of stabilized levels.

Ground water conditions will vary depending on the season, local subsurface conditions, and other factors. Based on our observations of the aquatic vegetation, surface water conditions, and experience with similar terrain, we anticipate that ground water levels along the low-lying portions of the alignment will generally remain at or near the existing ground surface throughout the year. Excavation below the bottom of existing ditches and channels may require dewatering.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 General

Based on the results of our site reconnaissance, field exploration, laboratory testing, and engineering analyses, it is our opinion that the proposed rockery and cantilever concrete retaining walls, embankment widening, culvert replacement, and signal pole foundations

are feasible from a geotechnical perspective. However, MSE walls between Sta.19+400 Right and 19+720 Right may become unstable during construction and will require special considerations. MSE wall stability is discussed in **Section 4.7.2.1.** The recommendations presented in the following sections should be incorporated in design and construction.

4.2 Site Preparation

4.2.1 General

Prior to any fill placement, all deleterious material such as vegetation, sod and buried logs should be removed from beneath the proposed widened portion of the roadway. This includes organic matter and muck that may have accumulated in the existing drainage ditches. Stripped soil materials may be used in areas to be landscaped, provided that they are not excessively soft/fluid; otherwise they should be removed from the site.

In areas where grade changes do not allow the existing pavement section to be incorporated into the proposed roadway limits, we recommend the existing pavement section be removed, unless a minimum of 300 mm of roadbed fill can be placed over the existing pavement. The existing pavement section should be removed, or broken into pieces no larger than 100 mm, if covering with roadbed fill is considered to interfere with future utility maintenance or installations. During construction, and especially during wet weather conditions, we recommend the existing pavement sections be left in place as long as practical to protect the potentially moisture sensitive native soils.

After stripping, we recommend the supporting capacity of the exposed subgrade soils be evaluated by thoroughly proofrolling with rubber-tired construction equipment such as a fully loaded dump truck or, heavy self-propelled, vibratory roller. We recommend that all loose or soft areas that exhibit yielding be compacted to a dense and unyielding condition in accordance with Section 2-03.3(14)C (Compacting Earth Embankments) and/or Section 2-06.3(1) (Subgrade for Surfacing) of the 1998 *Washington State Department of Transportation, Standard Specifications for Road, Bridge, and Municipal Construction* (1998 WSDOT Standard Specifications). It may be necessary to moisture condition the soils to achieve adequate compaction. If the subgrade cannot be adequately compacted, or if the work is performed during wet weather, all soft or loose zones should be removed and replaced with structural fill to the depth determined by the geotechnical engineer, and conforming to the requirements of **Section 4.3** of this report. The excavated material may be used in areas to be landscaped, if suitable, or removed from the site.

The on site soils may be particularly sensitive to disturbance from construction traffic during wet weather. Compaction and proofrolling of the subgrade soils in these areas

must, therefore, be carefully monitored so that soils are not unduly disturbed. We recommend that subgrade preparation be observed by the geotechnical engineer to verify that exposed subgrade soils are not unduly disturbed, and preparation conditions are adequate.

Existing utilities, which may underlie the proposed retaining walls and/or MSE wall reinforcement, should be relocated prior to wall construction.

4.2.2 Low-Lying Wet Areas

In the low-lying wet areas, such as from Bond Road to Lincoln Street, the larger brush and vegetation should be removed and disposed off-site. Grasses and the root zone should not be stripped or disturbed unless over-excavation of soft soils and replacement with structural fill is required for embankments or retaining walls. It will not generally be practical to proofroll these subgrade soils, but this should be re-evaluated if the earthwork occurs during a period of extended dry weather and the water table in these areas drops to at least 1 meter below the ground surface. Equipment size and traffic on the subgrade should be limited to minimize disturbance when working on soft soils that will not be removed.

If the soft compressible soils are not overexcavated from below new fill embankment areas, we recommend that a geotextile fabric conforming to Section 9-33, Construction Geotextile, of the 1998 WSDOT Standard Specifications be placed as a separator between the native soils and new embankment fill. Geotextile separators should be selected from the Washington State Department of Transportation Qualified Products List.

If fill is to be placed under water, quarry spalls conforming to Section 9-13.6 of the 1998 WSDOT Standard Specifications should be placed until the fill pad is raised at least 600 mm above the water table. The quarry spalls need not be compacted, but should be choked with a layer of shoulder ballast conforming to Section 9-03.9(2) of the 1998 WSDOT Standard Specifications above the water table to provide an adequate base for the placing of subsequent structural fill.

4.3 Structural Fill

4.3.1 Materials

Material used to construct roadbeds, embankments, or placed under structures for support purposes is classified as structural fill for the purpose of this report. Structural fill should consist of clean, free-draining, sand and gravel free from organic matter or other deleterious materials as described in Section 9-03.14(1), Gravel Borrow, of the 1998 WSDOT Standard Specifications. Such material should be less than 100 mm in maximum dimension, with less than 7 percent non-plastic fines (Material Passing the

U.S. No. 200 sieve size). A maximum particle size greater than 150 mm may be acceptable, but should be approved by the geotechnical engineer prior to use. The maximum particle size should be limited to 31.5 mm when the material is used with geosynthetic applications such as separators and reinforcement layers for slopes and walls. In addition, soils with a higher fines content may be suitable if the earthwork is performed during relatively dry weather, and the contractor's methods are conducive to proper compaction of the soil. The use of material with a fines content higher than 7 percent should be approved by the geotechnical engineer on a case-specific basis.

The existing on-site recessional outwash and fill soils may be suitable for use as structural fill during dry weather conditions only. Existing base course fill may also be employed as structural fill and/or may be reused for similar purposes in the new pavement provided it meets the requirements of Section 9-03.10, Aggregate for Gravel Base, of the 1998 WSDOT Standard Specifications. Pulverized asphalt from the existing pavement section may be used as structural fill, provided the maximum dimension is less than 80 mm and the material is placed deeper than 300 mm below the bottom of the pavement section. The pavement section should incorporate adequate drainage and should account for the type and drainage characteristics of underlying soils. Soils with an appreciable fines content and recycled asphalt are anticipated to exhibit relatively poor drainage characteristics.

4.3.2 Compaction Criteria

We recommend that earth embankments be compacted in accordance with Section 2-03.3(14)C of the 1998 WSDOT Standard Specifications. We recommend that subgrade for surfacing be compacted in accordance with Section 2-06.3(1) of the 1998 WSDOT Standard Specifications.

For constructing embankments on soft clays, we recommend placing a geotextile separator (as discussed in **Section 4.2.2**) and placing 0.6 meters of fill prior to compaction of the first lift. The weight of compaction equipment should be limited and non-vibratory compaction performed initially to minimize disturbance and potential pumping of underlying soils. Subsequent lifts should be thin enough to achieve the required compaction with lighter equipment and minimal vibration. Requirements for initial lift thicknesses and compaction should be adopted on a location specific basis, as directed by the geotechnical engineer.

All backfill placed behind retaining walls should be compacted as recommended in **Section 4.7**. Quarry spalls placed in excavations below the water table need only be compacted to the extent practical.

The procedure to achieve proper density of a compacted fill depends on the size and type of compaction equipment, the number of passes, thickness of the layer being compacted, and soil moisture-density properties. Generally, structural fill should be placed in horizontal lifts less than 200 mm thick and compacted to the required relative compaction level. When the size of the construction area restricts the use of heavy equipment, smaller equipment can be used, but the soil may need to be placed in thinner lifts to achieve the required compaction. We recommend the appropriate lift thickness, and the adequacy of subgrade preparation and structural fill compaction be evaluated by the geotechnical engineer during construction. Additionally, a sufficient number of in-place density tests should initially be performed to determine that the contractor's compaction methods and equipment are appropriate for the specific site and soil conditions. Further in-place-density tests should be performed on an ongoing basis to confirm that the relative compaction requirements are met as soil conditions and/or contractor's compaction methods vary.

Generally, loosely compacted soils are a result of poor construction technique or improper moisture content. Soils with a high percentage of fines are particularly susceptible to becoming too wet to adequately compact. Soils with a moisture content too high for adequate compaction should be dried, moisture conditioned by mixing with drier materials, or other methods, as necessary. If possible, preparation of areas to receive fill, and fill placement and compaction, should be performed during dry weather conditions

4.4 Wet Weather Earthwork

As discussed above, the on-site native and existing fill soils are moisture sensitive and may be difficult to compact and/or traverse with construction equipment, particularly during periods of wet weather or when the local ground water table is near the ground surface. General recommendations relative to earthwork performed in wet weather or in wet conditions are presented below. These recommendations should be incorporated into the contract specifications.

- Earthwork should be performed in small areas to reduce exposure to wet weather. Excavation or removal of unsuitable soil should be followed promptly by the placement and compaction of clean structural fill. It may be necessary to limit the size and type of construction equipment and operation methodology to prevent soil disturbance.

- The allowable fines content of the structural fill materials should be reduced to no more than 5 percent by weight based on that portion of the fill material passing the ¾-inch sieve. The fines should be non-plastic.

- The ground surface within the construction area should be graded to promote run-off of surface water and prevent ponding.

- On completion of the fill and/or at the end of a work shift, the ground surface within the construction area should be sealed by rolling with a smooth drum vibratory roller, or equivalent, and under no circumstances should soil be left uncompacted such that moisture infiltration potential is increased.

4.5 Seismic Design Considerations

4.5.1 Recommended Seismic Design parameters

Based on the Standard Specifications for Highway Bridges (AASHTO, 1996), and in consideration of the project location, a coefficient of horizontal acceleration of 0.32g should be used for design purposes. This recommendation is associated with a 10 percent probability of exceedance in 50 years. Using AASHTO guidelines, we consider Soil Profile Type II to be appropriate for use in design along the project alignment. The corresponding site coefficient is 1.2.

4.5.2 Liquefaction Potential

Seismically induced liquefaction typically occurs in saturated, loose, fine granular soils with low fines content. Limited thicknesses of saturated, loose, fill and recent alluvium of a liquefiable nature are present along the alignment, particularly between NE Lincoln Drive and Bond Road. Although detailed liquefaction analyses are beyond our scope of work, based on our experience with similar conditions, it appears that certain loose sandy soil zones at the site may liquefy during a strong seismic event. Due to the relatively limited thicknesses of the potentially liquefiable soils, we do not anticipate catastrophic damage to the highway embankments if liquefaction at the site should occur. However, deformations and possible failure of localized portions of the roadway due to subsidence and lateral spreading may occur during a strong seismic event. In our opinion, liquefaction mitigation measures would be relatively expensive, compared to the costs of rehabilitating the roadway embankment should moderate damage occur, and are not warranted as a result.

4.5.3 Lateral Earth Pressures During Seismic Loading

During a seismic event, active earth pressure acting on retaining walls will increase. A concomitant decrease in passive earth pressure also occurs. To determine the change in lateral earth pressures under seismic loading, the Mononobe-Okabe analysis was used, as formulated and discussed by Richards and Elms (1992). For use in design of free-standing walls under seismic conditions, a triangularly distributed, seismic pressure of 2.9H kPa (where H = Height of retaining wall in meters) or 10H psf (where H = Height

of retaining wall in feet) should be used, in addition to the recommended active earth pressures discussed in **Section 4.7**. For passive earth restraint, the pressures determined utilizing the parameters provided in Table 6 must be reduced by 9H kPa; or 188H psf under seismic loading conditions. These values are based on a horizontal soil surface at the front and back of the wall. For sloping ground conditions, active and passive soil pressures must be adjusted for static and seismic loading conditions.

4.6 EMBANKMENTS

Embankments will be constructed adjacent to the existing SR 305 alignment at selected locations in order to achieve the proposed widened grades without constructing retaining walls. The proposed locations of the larger embankments are: Sta. 17+420 to 17+500, Sta. 17+980 to 18+092, Sta. 18+734 to 19+040 and Sta. 20+300 to 20+56. As proposed, fill thicknesses range from less than 1 meter to approximately 2½ meters and embankment slopes range from 2H:1V to 4H:1V(horizontal:vertical). The steeper embankments are generally located in areas underlain by medium dense to dense advance outwash sands. Relatively shallow recent alluvium deposits consisting of loose to medium dense sand and stiff clay may be encountered at the embankments near Sta. 20+300, which are anticipated to be less than 1 meter high.

Based on the anticipated soils conditions and proposed embankment heights and slopes, it is our opinion that embankments will be stable and will not undergo excessive post-construction settlement, provided that embankments are constructed in accordance with the following recommendations.

Roadway excavation and embankments should be completed in accordance with Section 2-03 of the 1998 WSDOT Standard Specifications.

Fill placed within the top 0.5 meter of earth embankments shall be compacted to at least 95 percent of the maximum dry density as detailed in Section 2-03.3(14)D of the 1998 WSDOT Standard Specifications. All material below the top 0.5 meter shall be compacted to at least 90 percent of the maximum dry density as detailed in Section 2-3.3(14)D of the 1998 WSDOT Standard Specifications. Embankments should be terraced when constructed on the sides of existing embankments, hillsides, and in transitions from cuts to fills as detailed in Section 2-03.3(14) of the 1998 WSDOT Standard Specifications.

Permanent slopes must be hydroseeded or otherwise protected from erosion. Temporary erosion control measures will be necessary until permanent vegetation is established.

4.7 Retaining Walls

4.7.1 General

In order to reduce encroachment and impacts on adjacent sensitive areas, permanent retaining walls will be constructed along portions of the project alignment. Table 2 presents a summary of the larger of the proposed retaining walls. Additional shorter walls, which are not tabulated, are planned near the intersections of SR 305 and Hostmark Street and NE Lincoln Road. In general, wall types will comprise rockery, cantilevered cast-in-place concrete and mechanically stabilized earth (MSE).

The recommended retaining wall types and design parameters presented in this report are based in part on the design concepts summarized above. Should the retaining wall configurations or maximum heights change significantly from those listed in Table 2, the project geotechnical engineer should review the proposed changes and revise the retaining wall recommendations as appropriate. A summary of the anticipated soil conditions at the proposed retaining walls is presented in Table 3. Anticipated soil and ground water conditions are based on conditions encountered in the borings located nearest each wall. Additional discussion of each wall type is presented in **Sections 4.7.2** through **4.7.4**.

Table 2: Proposed Retaining Wall Locations and Types

Wall Designation	Approximate Location (Cut or Fill)	Approx. Length (meters)	Maximum Height (meters)	Finish Grade Conditions	
				Top of Wall	Base of Wall
Rockery Wall 1	17+082 to 17+413 Right (Cut)	331	2.9	Ascending Slope	Level
Rockery Wall 2	17+591 to 17+858 Right (Cut)	267	4.3	Ascending Slope to Level	Level
Rockery Wall 3	17+890 to 18+030 Right (Cut)	140	2.6	Ascending Slope to Level	Level
Cantilever Wall 1	18+095 to 18+210 Left (Fill)	115	6.5	Level	Level
Rockery/ MSE	18+645 to 18+670 Right (Fill)	25	2.5	Level	Descending Slope to Level
Cantilever Wall 2	18+662 to 18+690 Left (Fill)	28	7.0	Level	Level
MSE Wall 1	19+090 to 19+170 Left (Fill)	80	2.5	Level	Level – Ditch
MSE Wall 2	19+360 to 19+650 Left (Fill)	290	2.0	Level	Level – Ditch
MSE Wall 3	19+292 to 19+807 Right (Fill)	515	3.4	Level	Level – Ditch
MSE Wall 4	19+710 to 19+790 Left (Fill)	80	1.7	Level	Level – Ditch
Cantilever Wall 3	19+790 to 20+290 Left (Fill)	500	4.0	Level	Level – Ditch
MSE Wall 5	19+856 to 20+310 Right (Fill)	454	3.5	Level	Level – Ditch

Table 3: Summary of Anticipated Geologic Conditions at Retaining Walls

Wall Designation	Approximate Location (Cut or Fill)	Anticipated General Geologic Conditions
Rockery Wall 1	17+082 to 17+413 Right (Cut)	Dense advance outwash sand and gravel.
Rockery Wall 2	17+591 to 17+858 Right (Cut)	Dense advance outwash sand and gravel.
Rockery Wall 3	17+890 to 18+030 Right (Cut)	Dense advance outwash sand and gravel.
Cantilever Wall 1	18+095 to 18+210 Left (Fill)	Fill and recent alluvium over advance outwash. Dense sand and gravel at approx. El. 37 to 39 m.
Rockery/ MSE	18+645 to 18+670 Right (Fill)	Fill over recent alluvium and advance outwash. Dense sand and gravel at approx. El. 31 m.
Cantilever Wall 2	18+662 to 18+690 Left (Fill)	Fill over advance outwash. Dense sand and gravel at approx. El. 30 m.
MSE Wall 1	19+090 to 19+170 Left (Fill)	Fill and recent alluvium over glaciolacustrine. Medium dense sand at approx. El. 15 m.
MSE Wall 2	19+360 to 19+650 Left (Fill)	Fill over recent alluvium. Very soft to medium stiff clay and silt.
MSE Wall 3	19+292 to 19+807 Right (Fill)	Fill over recent alluvium. Very soft to medium stiff clay.
MSE Wall 4	19+710 to 19+790 Left (Fill)	Fill over recent alluvium. Soft to very stiff clay and silt.
Cantilever Wall 3	19+790 to 20+290 Left (Fill)	Fill and recent alluvium over advance outwash. Dense sand and gravel at approx. El. 8 to 10 m.
MSE Wall 5	19+856 to 20+310 Right (Fill)	Fill and recent alluvium over glaciolacustrine and advance outwash. Medium dense sand and stiff silt at approx. El. 7 to 11 m.

4.7.2 Mechanically Stabilized Earth (MSE) Walls

MSE walls or reinforced soil retaining walls are often a cost-effective method for support of fill embankments. Reinforced soil retaining walls consist of alternating layers of backfill soil and reinforcing material with anchoring or retaining facing elements. Commonly used reinforcing elements include steel strips and various geosynthetic products such as geogrid and geotextile sheets. The vertical spacing of the reinforcing

elements is typically on the order of 0.3 to 1.5 meters, depending on the reinforcing material specified and other parameters. Design of such wall systems must be based on site-specific conditions and geotechnical parameters. Pre-cast concrete members (panels or blocks) are widely used as facing elements, but gabions and rockeries can be used as facing when the wall is constructed with an appropriate batter.

Many MSE wall systems are available as proprietary wall systems. If geosynthetic reinforcement products are selected, long-term creep characteristics should be taken into consideration in product selection. MSE walls are often a cost-effective method for supporting fill embankments. Principal advantages of MSE walls include relatively low unit cost and tolerance of relatively large differential settlements.

WSDOT currently has four pre-approved proprietary wall types; ARES by Tensar Earth Technologies, Inc., Reinforced Earth by Reinforced Earth Company, Retained Earth by L.B. Foster Company, and Reinforced Soil by Hilfiker Retaining Walls. These wall systems are preapproved for heights up to 33 feet, and soil surcharge slopes above the wall, provided such slopes are 2H:1V or flatter.

In our opinion, MSE walls are suitable for support of embankments along the low-lying portions of the project alignment. However, construction may require over-excavation of soft foundation soils and replacement with properly compacted structural fill to provide a stable base for the footing elements supporting the wall facing. Depth/breadth of subgrade excavation will vary in response to footing support requirements and should be specifically developed for the wall selected and/or the manufacturer's specifications as appropriate. Further geotechnical design input can be provided when wall details are finalized.

We recommend the design parameters summarized in Table 4 for use in design of MSE walls. The values shown assume the backfill soil and the retained soil are compacted in accordance with applicable portions of the 1998 WSDOT *Standard Specifications*, as discussed in **Section 4.3**.

Table 4: Recommended Design Parameters for MSE Walls

Soil Properties	Wall Backfill*	Retained Soil**	Foundation Soil
Unit Weight (kN/m^3)	19.6	19.6	18.5
Friction Angle (Degrees)	38	36	28
Cohesion (kPa)	0	0	0
		AASHTO Load Group I	AASHTO Load Group VII
Allowable Bearing Capacity (kPa)		190	285
Acceleration Coefficient (g)		N/A	0.28

**Gravel Borrow*, WSDOT 9-03.14(1), or *Gravel Backfill for Walls*, WSDOT 9-03.12(2)

***Common Borrow*, WSDOT 9-03.14(3), or existing fill soils

Minimum foundation embedment of MSE retaining walls should be 0.7 meters or 10 percent of the total wall height, whichever is greater. The minimum foundation embedment should be maintained below the scour line or, alternatively, the foundation must be protected by suitable armoring or rip rap to prevent scour and allow foundation placement at higher levels, if applicable. For overall stability, the reinforcing element length should be at least 75 percent of the wall height. MSE walls should be designed for a minimum factor of safety of 2.0 and 1.5 against overturning and sliding, respectively, for AASHTO Load Group I, and 1.5 and 1.1 against overturning and sliding, respectively, for AASHTO Load Group VII. If proprietary wall systems are used, the wall supplier is responsible for design of the wall to satisfy adequate internal stability. However, we recommend that proprietary wall system designs be reviewed by a qualified geotechnical engineer to verify that valid assumptions were made relative to material properties and other factors.

Retaining walls subjected to surcharge loading (for example, traffic loading) within a horizontal distance equal to the height of the wall should be designed for the additional horizontal pressure using an appropriate design method. However, a common practice is to assume a surcharge loading equivalent to 0.6 meters of additional fill to simulate traffic loading; we consider this method appropriate for typical situations. Where large surcharge loads such as applied by heavy trucks, cranes, or other construction equipment are anticipated in close proximity to the retaining walls, the walls should also be designed to accommodate the additional lateral pressures resulting from these concentrated loads.

Under bearing pressures appropriate to the anticipated maximum wall heights (as summarized in Table 2) we estimate settlements for MSE walls to be in the range of 25 to 50 mm These values represent settlement at the base of MSE Walls 1 through 5. The settlement estimates assume that compressible soils directly beneath the proposed MSE wall locations will be removed and replaced with properly compacted structural fill.

4.7.2.1 Global (Overall) Wall/Slope Stability

Slope stability analyses were performed using the GSLOPE computer program, which utilizes a two-dimensional limiting equilibrium method to calculate the factor of safety. The stability model incorporates search routines to identify the most critical potential circular-failure surfaces for the cases analyzed, although non-circular failure surfaces can also be modeled. Factors of safety were calculated using the Modified Bishop's method. Seismic force was also incorporated into our analyses using a quasi-static approach, which applies a horizontal force equivalent to an earthquake acceleration times the mass of the potential sliding soils. As a state of normal practice, for quasi-static slope stability analysis, it is common to use an earthquake acceleration about 50% of peak ground acceleration for a given seismic event. Therefore, an earthquake acceleration of 0.16g, or half of the peak ground acceleration as discussed in **Section 4.5** of this report, was used in our slope stability analyses.

The stability analyses were applied in 7 areas where stability issues appeared to be most critical, which include selected cross sections at MSE Walls 2, 3 and 5 at locations of maximum wall height. In respect to overall stability conditions at these locations, the recent alluvium supporting the embankment sections is the most critical soil unit. Parametric analyses indicated that factors of safety for many wall sections are very sensitive to changes in the undrained cohesion of the recent alluvium. To obtain a more precise estimate of wall stability, undrained direct shear tests were performed on a relatively undisturbed sample of the recent alluvium. Based on the test results, an undrained cohesion of 9.6kPa (200psf) was assigned to the soft recent alluvium. Fill soils in the reinforced zone of the proposed walls were assigned a low but insignificant cohesion value to prevent surficial failures from occurring and being highlighted in the analyses. This allowed the deeper (global) failure conditions to be examined.

Stability analyses were performed for 3 critical stages; end of construction, long-term static and long-term seismic conditions. Results of our analyses are summarized in Table 5, and are also graphically depicted in Appendix A. Analyses performed resulted in factors of safety ranging from about 0.7 to 1.6 and from 1.3 to 1.8 for static conditions short-term (end of construction) and long term, respectively, provided that the length of reinforcing elements is at least 75 percent of the wall height. For quasi-static (seismic) loading conditions the factors of safety were determined to range from 1.0 to 1.5 for the long term case.

As evident from Table 5, a failure condition is indicated for MSE Wall 3 at Sta.19+566, which is not acceptable. For MSE Wall 3 at Sta.19+720, the factor of safety for end-of-construction conditions is 1.2 and is low, but is acceptable as the long-term static and seismic stability levels are adequate. For MSE Wall 3 at Sta. 19+400 and 19+480, the factors of safety for end-of-construction conditions are 1.2 and 1.1, and are low but

otherwise acceptable. However, the long-term static factor of safety is 1.3 for both sections, and the factors of safety for long-term seismic stability are 1.0 and 1.1 respectively, which are considered unacceptable.

In an effort to increase both short-term (end of construction) and long term wall stability, sections of MSE Wall 3 at Sta. 19+480 and 19+566 were analyzed assuming lightweight fill and staged construction. When using lightweight fill, the short-term factor of safety at Sta.19+566 remained at or below 1.0. Consequently, we do not recommend use of lightweight fill to increase short-term stability. Lightweight fill may be used to increase long term stability of walls where desirable.

Staged construction involves placing the wall fill in stages and allowing excess pore water pressures to dissipate prior to placing each successive stage. A strength increase is typically realized in soils below the fill as a result of consolidation during the staged construction. However, successful staged construction requires accurate measurement of pore pressures in the underlying clays to determine when excess pore pressures have dissipated. Reliable estimation of the time required to allow pore pressure dissipation is difficult in the highly variable recent alluvium soil. Furthermore, the incremental strength increase due to staged construction is difficult to predict, and in our opinion, may not provide the strength gains necessary to increase short-term wall stability to acceptable levels.

Sand drains or geocomposite wick drains may be considered as a means of expediting pore pressure dissipation and consolidation during staged construction. However, drains would have to be spaced closely to ensure sufficient pore pressure dissipation and would be costly as a result. In addition, our analyses indicate that pore pressure reduction may not result in adequate short-term stability, and that an increase in undrained cohesion is necessary to this. Therefore, use of drains without staged construction may not provide adequate stability and is not recommended at this time, in view of cost considerations.

In view of the unacceptable short-term stability (0.7), we recommend further exploration/testing to determine the undrained insitu strength and extent of very soft soils near Sta. 19+566 Right and 19+480 Right. Based on our parametric analysis, an undrained cohesion of approximately 15 kPa (315 psf) would be adequate to provide a short-term factor of safety of approximately 1.2, and confirmation of operational soil strength is desirable. Furthermore, the very soft soils encountered near Sta. 16+566 Right (BH-6) were encountered closer to the existing ground surface than at other locations. Further exploration may reveal a more limited extent of very soft soils, thereby justifying use of more favorable soil profiles in analyses.

Table 5: Summary of Global Stability Analyses

Wall Designation	Section Analyzed	Factor of Safety (Static Condition)		Factor of Safety (Seismic Condition)
		End of Construction	Long-term	
MSE Wall 2	Sta. 19+480 Left	1.4	1.8	1.4
MSE Wall 3	Sta. 19+320 Right	1.6	1.8	1.5
MSE Wall 3	Sta. 19+400 Right	1.2	1.3	1.0
MSE Wall 3	Sta. 19+480 Right	1.1	1.3	1.1
MSE Wall 3	Sta. 19+566 Right	0.7	1.4	1.1
MSE Wall 3	Sta. 19+720 Right	1.2	2.0	1.5
MSE Wall 5	Sta. 19+867 Right	1.4	1.7	1.3

4.7.3 Concrete Cantilever Retaining Walls

Concrete cantilever retaining walls are readily installed without specialized equipment, and are usually economical to construct up to heights on the order of 3 to 5 meters. The principal disadvantage of conventional cast-in-place concrete retaining walls is that such rigid walls have relatively low tolerance of differential settlement.

The proposed concrete cantilever retaining wall locations are underlain by a combination of fill, recent alluvium, glaciolacustrine and advance outwash deposits. Accordingly, the proposed cantilever walls should be founded on the less-compressible and more competent glaciolacustrine or advance outwash deposits. Approximately 1 to 2 meters of over-excavation should be anticipated along Cantilever Wall 1 to remove moderately compressible fill and recent alluvium deposits. The proposed foundation elevations of Cantilever Walls 2 and 3 are at or near the anticipated elevation of glaciolacustrine or advance outwash deposits and, therefore, limited to no over-excavation is anticipated.

Lateral earth pressures against concrete retaining walls depend upon the inclination (slope) of the retained soil, degree of wall restraint, type of backfill, method of backfill placement, degree of backfill compaction, drainage provisions, and magnitude and location of any adjacent surcharge loads. It is anticipated that concrete cantilever retaining walls will be unrestrained, or free to rotate at the top.

Preliminary design parameters are given in Table 6, for conditions of level soil surface at the toe and top of the wall, and for compacted dense granular fill (*Gravel Borrow*, WSDOT 9-03.14(1)) behind the wall. The design parameters presented in the table are based on the assumption that temporary open cut excavations will be used to facilitate construction of the concrete retaining walls. As such, the design lateral pressure is highly dependent on the characteristics of the backfill material, and less on the in-situ soil conditions. The active lateral earth pressures recommended in the table were determined assuming a fully-drained granular backfill material with a friction angle of 38 degrees and a unit weight of 19.6 kN/m^3. Surcharge loads should be included in wall pressure evaluations, and are not included in the parameters.

Table 6: Recommended Earth Pressures for Design of Cantilever Retaining Walls

Soil Conditions	Equivalent Fluid Density for Active Earth Pressures (kN/m^3)	Equivalent Fluid Density for Passive Earth Pressures (kN/m^3)
Dense Compacted Granular Backfill	5.0	78

The passive pressure at the toe of the retaining walls should not be considered in evaluating resistance to lateral loading unless the backfill at the toe of the wall is carefully placed and adequately compacted. Where the toe of the wall is cast directly against undisturbed glacial soils or properly compacted fill materials, design lateral restraint loads may be evaluated using passive pressures based on the equivalent fluid density tabulated. For walls located adjacent to ditches or channels, the potential for scour should be accounted for when considering passive restraint. The values listed above represent unfactored conditions and a suitable factor of safety should be applied as appropriate. For passive restraint considerations, a minimum factor of safety of 3 is recommended for static loading to limit deflections. For seismic conditions a reduced factor of safety is appropriate.

For foundations on undisturbed dense glacial materials, an allowable bearing pressure of 290 kPa may be utilized, with a minimum footing embedment of 0.7 m below the potential scour line; or alternatively, the foundation must be protected by suitable armoring or rip rap to prevent scour and allow foundation placement at higher levels, if applicable. A sliding coefficient of 0.45 may be used for determining friction at the base of footings. Settlement along Cantilever Walls 1 through 3 is anticipated to be negligible, provided the walls are founded on relatively undisturbed dense glacial soils, or properly compacted structural fill, and the foundation soils are not disturbed during construction. For seismic design, we recommend that the allowable bearing pressures and recommended sliding coefficient be increased by a factor of 1.5. Drainage behind

concrete retaining walls should conform to Section 6-02.3(22) of the 1998 WSDOT *Standard Specifications.*

4.7.4 Rockery Walls

Soils encountered at the proposed rockery wall locations consist of dense advance outwash sand and gravel. Consequently, rockery walls are considered feasible for the locations designated as Rockery Walls 1 through 3. Rockery walls are generally considered suitable for support and protection of cut slopes in dense glacial deposits up to about 4 meters in height, provided slopes above the rockery walls are no steeper than 2H:1V.

The primary benefit of a rockery is that it provides protection against surficial erosion of material behind the wall that is inherently stable and in need of little or no retention. However, a carefully designed and constructed rockery will provide some support for the soils being retained. For the purpose of the design recommendations presented below, it was assumed that rockery foundation soils will have an allowable bearing pressure of 385 kPa for AASHTO Load Group I, and 575 kPa for AASHTO Load Group VII. If used on this project, rockery walls should be constructed in accordance with Section 8-24 of the 1998 WSDOT *Standard Specifications for Road, Bridge, and Municipal Construction.*

The rockery walls should be founded on relatively undisturbed glacial soils or structural fill compacted in accordance with the WSDOT *Standard Specifications*. If soft, compressible soils are encountered in the rockery foundation zone of influence, it will be necessary to remove and replace the soft soils to depths determined by the geotechnical engineer in the field. Fill materials and placement should be in accordance with the recommendations presented in this report. A drainage system should be provided behind the base of the rockery wall to prevent buildup of hydrostatic pressures. The recommended drain should consist of 100-mm diameter perforated PVC pipe, encased in crushed drain rock wrapped in filter fabric and sloped to a storm drain or appropriate outlet. A minimum 0.3 meters wide free-draining sand and gravel layer should be placed directly behind the rockery and in contact with the geotextile-enveloped drain at the wall base.

Rock quality is critical to wall performance. Rockery wall failures can occur because of degradation of poor-grade rocks under freeze-thaw and weathering conditions. It is difficult to determine rock quality visually. The contractor and/or rock supplier should verify the rocks used are hard, sound, durable and relatively free from seams and cracks or other defects tending to reduce the resistance to weathering. Rocks should be placed so that the vertical contact seam between two adjacent rocks is not above or below the vertical contact seam for the upper and lower courses (i.e. each rock should overlap at

least two different rocks in the course below). The long axis of each rock should be placed perpendicular to the slope. The rock surfaces between individual courses should be relatively flat, and should in no case slope downward away from the wall. All rocks used in the uppermost course should be 2-man rocks to reduce the potential for vandalism or accidental dislodging.

4.8 CULVERTS

4.8.1 General

Culverts will be replaced along portions of the project alignment to accommodate widening of SR 305. Four borings, designated BH-25 through BH-28, were drilled in the vicinity of the proposed culverts. Table 7 summarizes soil conditions encountered at the locations of the proposed culvert replacements.

Table 7: Summary of Anticipated Geologic Conditions at Culverts

Approximate Culvert Location	Representative Borings	Anticipated General Geologic Conditions at Base of Culvert
SR 305 Sta. 18+660	BH-25, BH-2, BH-39	Recent Alluvium over dense advance outwash sand and gravel.
NE Lincoln Road Sta. 0+080	BH-26	Dense advance outwash sand and gravel.
SR 305 Sta. 19+480	BH-27	Soft to medium stiff silty clay.
SR 305 Sta. 19+780	BH-28	Dense advance outwash sand and gravel.

Culverts should be constructed in accordance with Section 7-02 of the 1998 WSDOT Standard Specifications. Fill placement over compressible soils may result in differential settlement and potential reduction of flow capacity and/or culvert damage. To reduce the potential for differential settlement related damage, we recommend that any loose/soft compressible soils encountered along the culvert alignments be removed and replaced with compacted structural fill or quarry spalls (suitable for placing below the water table). The width of the over-excavation should be at least three times the diameter/width of the culvert. The portion of the excavation below the water table (if any) should be backfilled as described in **Section 4.3.2**. Over-excavation of soft silty clay below the culvert at Sta. 19+480 may be impractical. Accordingly, we recommend over-excavating and placing a minimum of 1 meter of fill below the bottom of this culvert. Furthermore, we

recommend use of a relatively flexible culvert such as corrugated metal, provided that corrosion potential is not excessive.

4.8.2 Corrosion of Below-Grade Metallic Elements

Culverts, piping, and other metallic elements in contact with soils exhibiting low resistivity and low pH will be subject to corrosion. In order to determine the general likelihood for corrosion of underground elements of this project, soil samples obtained at various locations along the alignment and at the proposed culvert locations were tested for determination of soil pH and minimum resistivity. Results of the testing performed are presented in Appendix B, Figure B-26. These test results may be used in selecting appropriate construction materials and thicknesses. The test data may also be used to determine if cathodic protection will be required.

4.9 Signal Standard Foundations

We understand new signal standards are planned for intersections along the project alignment. The proposed signal standards are to be Type II or III with a maximum "XYZ" value (wind load) of 1,720 cubic feet. Soils encountered at the intersections along the project alignment varied from soft recent alluvial silts and clays to dense, advance outwash sand and gravel. We anticipate that some signal standards can be designed using standard design practices provided in Chapter 850-05(1)(i) of the 1994 WSDOT *Design Manual*, while some standards will require special design. Table 8 summarizes anticipated soil conditions and recommended allowable lateral bearing pressure for the proposed signal standards.

Soil conditions encountered during construction should be observed by the project geotechnical engineer to verify that suitable bearing soils are exposed. Care should be taken during construction to minimize disturbance of the shaft sides and bottom. Shafts drilled through loose sands and soft silts and clays will be prone to caving and sloughing, particularly below the ground water table. Casing should be used for shaft installation below the ground water table and concrete should be poured using the tremmie method.

Table 8: Summary of Anticipated Geologic Conditions and Recommended Allowable Lateral Bearing Pressures at Signal Standards

Signal Standard Location	Related Borings	Anticipated General Geologic Conditions at Signal Standard	Allowable Lateral Bearing Pressure
SR 305 and Hostmark	BH-13 BH-24	Dense advance outwash sand and gravel.	120 kPa (2,500 psf)
SR 305 and NE Lincoln Road	BH-14 BH-15	Medium dense fill and dense advance outwash sand and gavel.	70 kPa (1,500 psf)
SR 305 and Liberty Road SW and SE Corners	BH-16 BH-23	Soft clay and loose sand, to a depth of 3 meters, over medium stiff to stiff silt and medium dense to dense sand.	70 kPa (1,500 psf) for portion of shafts below El. 13 meters. Shafts must be founded below El. 13 meters.
SR 305 and Liberty Road NW and NE Corners	BH-17 BH-32	Very soft clay and very loose to medium dense sand.	Requires special design.
SR 305 and Little Valley Road (Forrest Rock Lane)	BH-18 BH-19 BH-20	Medium stiff to very stiff silt and clay and loose to medium dense sand.	50 kPa (1,000 psf) Shafts must be founded below El. 10 meters.
SR 305 and Bond Road NE	BH-21 BH-22	Very soft silt and loose sand over dense sand and gravel.	120 kPa (2,500 psf) for portion of shafts below El. 8 meters. Shafts must be founded below El. 8 meters.

4.10 Retention Ponds

Four borings, BH-9 through BH-12, were drilled in the vicinity of proposed retention ponds. Soils encountered in borings BH-9 and BH-10, near Sta. 17+500, consisted of approximately 4 meters of medium stiff to very stiff silt overlying dense advance outwash sand. Soil encountered in borings BH-11 and BH-12, near Sta. 20+520, consisted of approximately 2 meters of medium dense gravel fill over dense advance outwash sand. The silt deposits are expected to exhibit low permeability characteristics and the sand and gravel deposits are expected to exhibit relatively high permeability characteristics. Ground water observations in the retention pond borings could not be performed due to mud rotary drilling techniques, and ground water conditions at these located have not been evaluated in respect to pond design/construction.

Based on our observations in our borings and laboratory test results, it is our view that retention ponds are feasible at the proposed locations. Soils in the vicinity of BH-9 and BH-10 exhibit relatively impermeable soils conditions to depths on the order of 4 meters, and little infiltration or water loss is expected. The upper soils are stiff to very stiff silt

and will provide for relatively stable pond slopes for recommended inclinations of 2H:1V or flatter. Near borings BH-11and BH-12, however, infiltration and water loss into the more pervious gravel fill and outwash sand may be expected. If this is undesirable, consideration should be given to a liner system. Slopes of 2H:1V, or flatter, are also recommended, for ponds in these locations. However, if liner systems are required, slope inclinations should be reviewed by the geotechnical engineer. Infiltration testing and detailed infiltration analyses were beyond our scope of work for this project.

4.11 Temporary and Permanent Cut Slopes

Maintenance of safe working conditions, including temporary excavation stability, is the responsibility of the contractor and all excavations must comply with current federal, state, and local requirements. Cuts greater than 1.2 meters in height should be sloped or shored. For cost and quantity estimation purposes, we recommend that temporary cut slopes in recent alluvium be inclined no steeper than 1.5H:1V. Permanent cut slopes in the native glacial soils or compacted fill embankment soils should be inclined no steeper than 2H:1V. These recommendations are applicable to excavations above the water table only; flatter side slopes and/or shoring will be required for excavations below the water table, such as may be necessary for placement of culvert extensions or overexcavation and replacement of soft soils in the low-lying wet areas. If "non-engineered" fill is encountered in cut slopes, the geotechnical engineer should evaluate the allowable temporary and permanent slope inclinations based on the conditions encountered.

5.0 REPRESENTATION AND LIMITATIONS

We have prepared this report for Skillings Connolly, Inc. and the Washington State Department of Transportation for use in design of a portion of this project. This report should be provided in its entirety to prospective contractors for bidding and estimating purposes; however, the conclusions and interpretations presented in this report should not be construed as a warranty of the subsurface conditions. Experience has shown that soil and ground water conditions can vary significantly over small distances. Inconsistent conditions may exist between explorations and may not be detected by a geotechnical study. If, during future site operations, subsurface conditions are encountered which vary appreciably from those described herein, HWA should be notified for review of the recommendations of this report, and revision of such if necessary.

We recommend that HWA be retained to review the plans and specifications to verify that our recommendations have been interpreted and implemented as intended. Sufficient geotechnical monitoring, testing and consultation by our firm should be provided during construction to confirm that the conditions encountered are consistent with those indicated by our exploration, to provide recommendations for design changes should

conditions revealed during construction differ from those anticipated, and to verify that the geotechnical aspects of construction comply with the contract plans and specifications.

Within the limitations of scope, schedule and budget, HWA attempted to execute these services in accordance with generally accepted professional principles and practices in the fields of geotechnical engineering and engineering geology in the area at the time the report was prepared. No warranty, express or implied, is made. The scope of our work did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous or toxic substances in the soil, surface water, or ground water at this site.

We appreciate the opportunity to work with you on this project. Should you have any questions concerning this report, please do not hesitate to call.

Sincerely,
HWA GEOSCIENCES INC.

Marcus B. Byers
Marcus B. Byers
Geotechnical Engineer

L.A. (Lorne) Balanko
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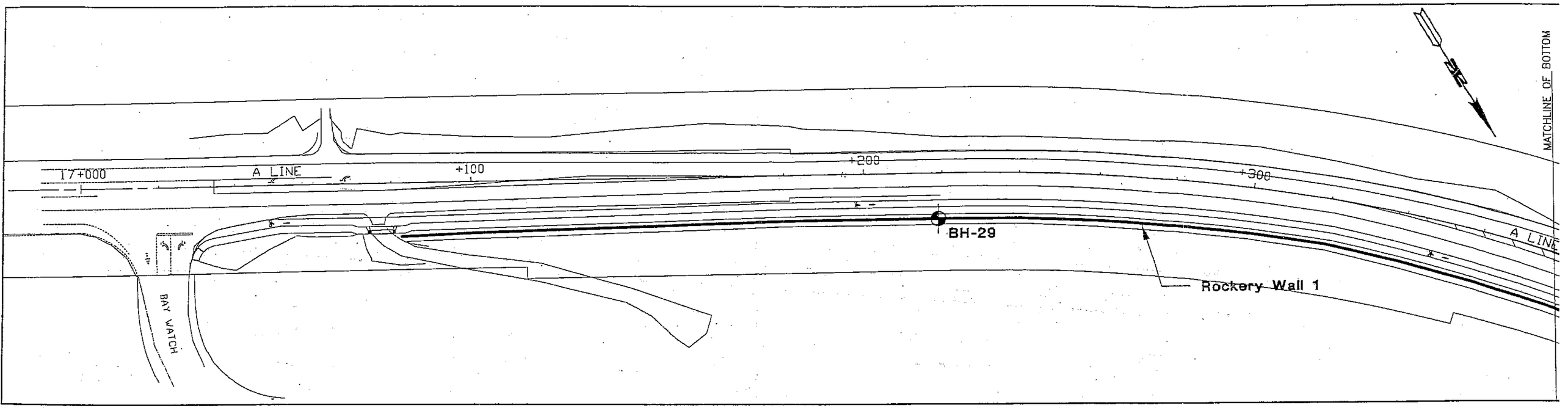

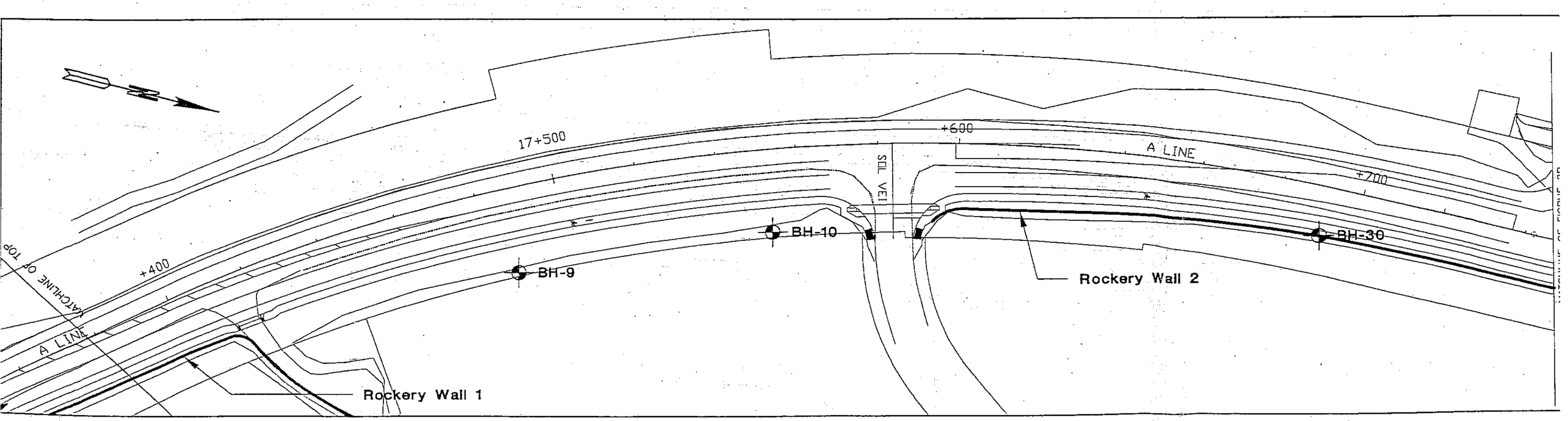

LEGEND

BH-1 BORING DESIGNATION AND APPROXIMATE LOCATION

0M 10M 20M 40M
SCALE: 1CM =10 M

REFERENCE: Base map provided by Skillings Connolly.
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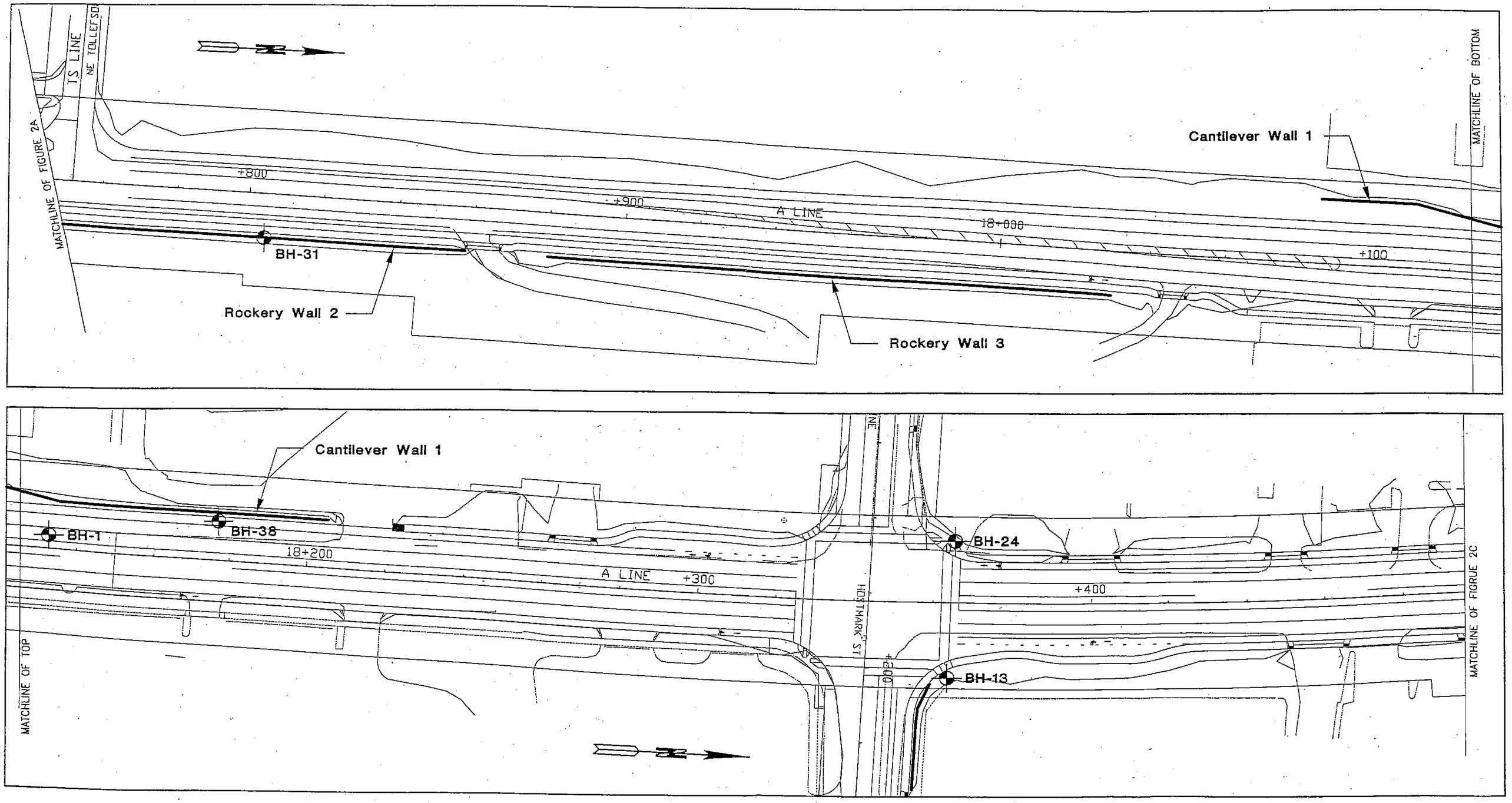
HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

SITE AND EXPLORATION PLAN
STA 17+000 TO 17+740

DRAWN BY HC	FIGURE NO. 2
CHECKED BY MB	
DATE 12.5.99	PROJECT NO. 981



LEGEND

BH-1 BORING DESIGNATION AND APPROXIMATE LOCATION

0' 10' 20' 40'
SCALE: 1" =10'

REFERENCE: Base map provided by Skillings Connolly.

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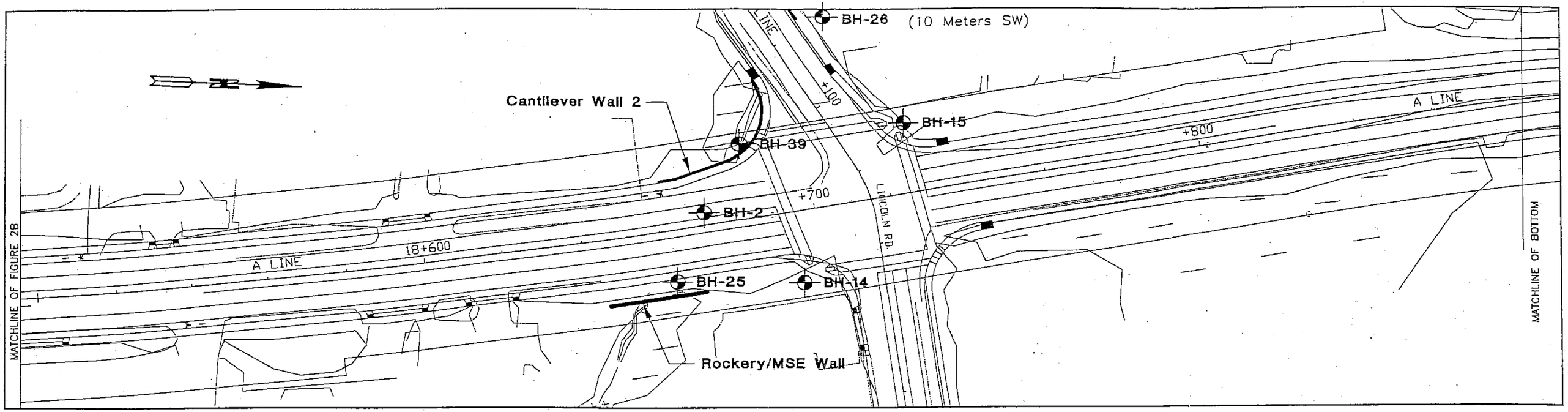
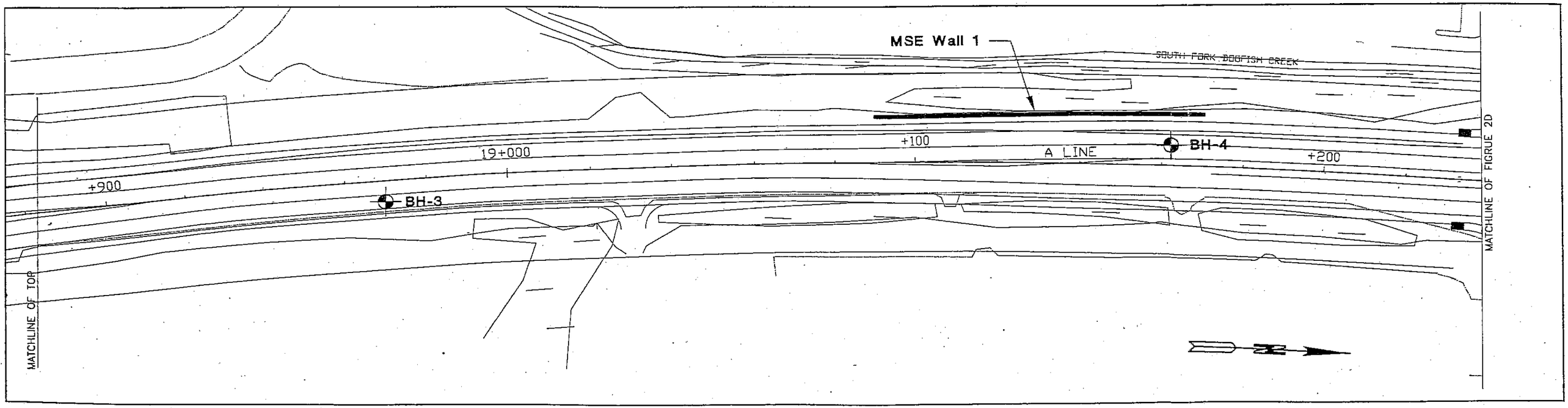
HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

SITE AND EXPLORATION PLAN
STA 17+740 TO 18+500

DRAWN BY HC	FIGURE NO. 2B
CHECKED BY MB	
DATE 12.5.99	PROJECT NO. 98179





LEGEND

BH-1 BORING DESIGNATION AND APPROXIMATE LOCATION

0" 10" 20" 40"
SCALE: 1" =10 "

REFERENCE: Base map provided by Skillings Connolly.
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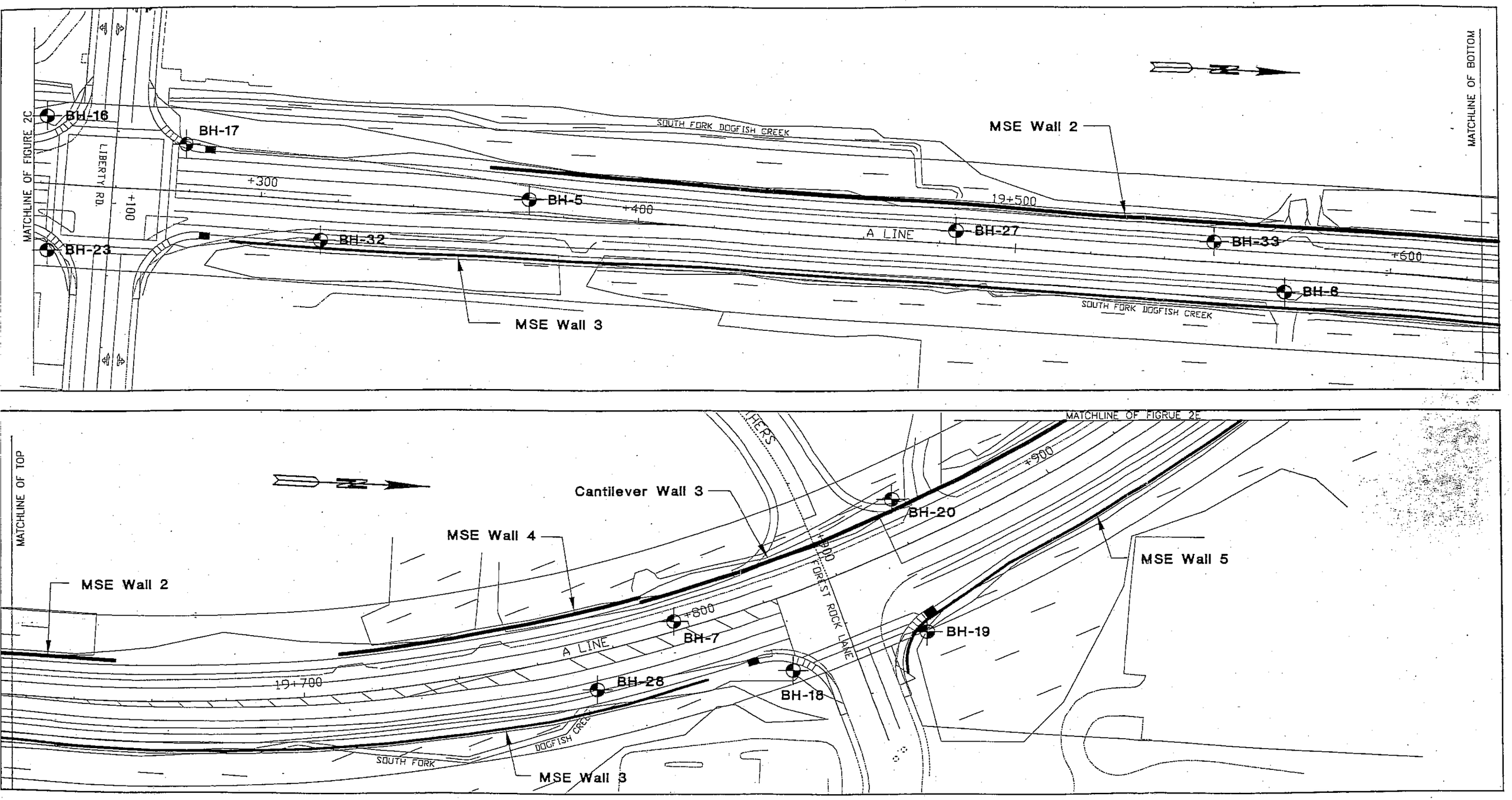
HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

SITE AND EXPLORATION PLAN
STA 18+500 TO 19+240

DRAWN BY HC	FIGURE NO. 2C
CHECKED BY MB	
DATE 12.5.99	PROJECT NO. 9817



LEGEND

BH-1 BORING DESIGNATION AND APPROXIMATE LOCATION

0M 10M 20M 40M
SCALE: 1CM =10 M

REFERENCE: Base map provided by Skillings Connolly.

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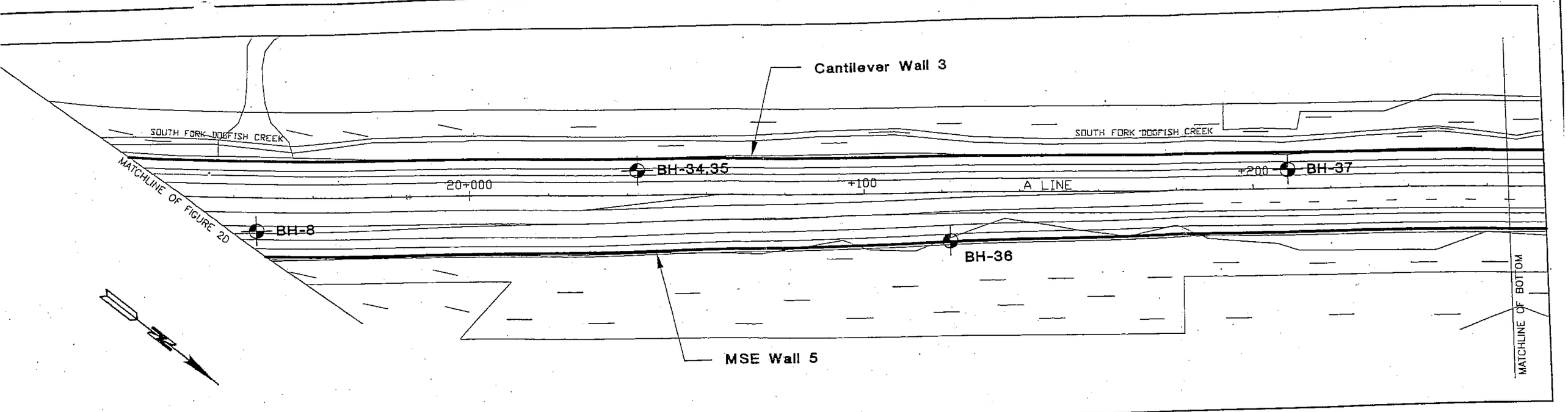
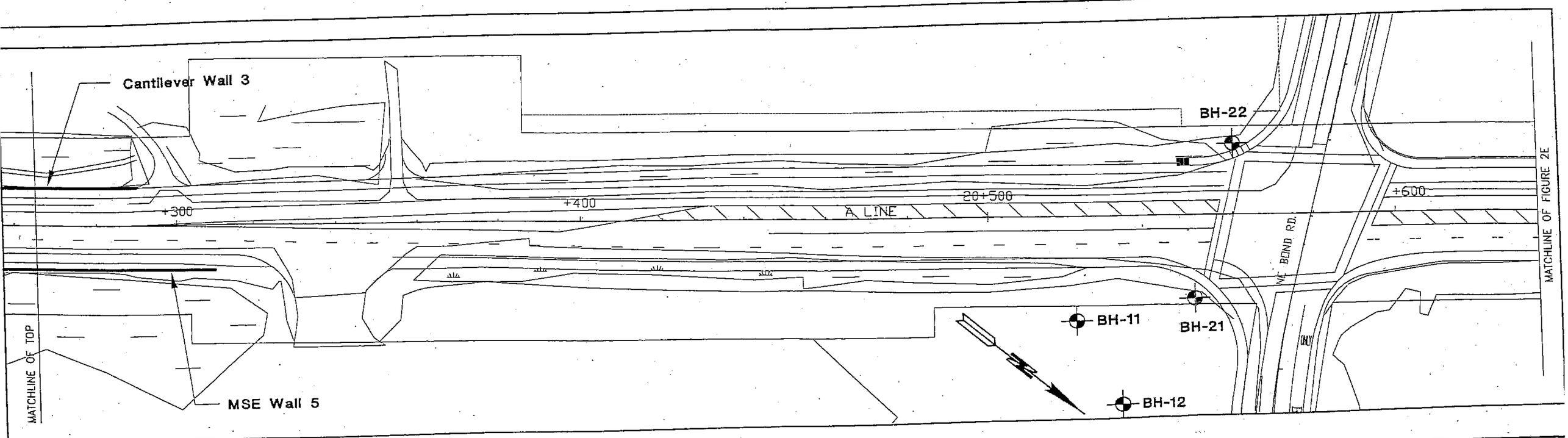
HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

SITE AND EXPLORATION PLAN
STA 19+240 TO 19+920

DRAWN BY HC	FIGURE NO. 2D
CHECKED BY MB	
DATE 12.5.99	PROJECT NO. 98179





LEGEND

BH-1 BORING DESIGNATION AND APPROXIMATE LOCATION

0M 10M 20M 40M
SCALE: 1CM =10 M

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SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

SITE AND EXPLORATION PLAN
STA 19+920 TO 20+620

DRAWN BY HC	FIGURE NO. 2E
CHECKED BY MB	
DATE 12.5.99	PROJECT NO. 9817

REFERENCE: Base map provided by Skillings Connolly.

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APPENDIX A

FIELD EXPLORATION

APPENDIX A

FIELD EXPLORATION

The field exploration program was conducted between October 12, and November 9, 1999 under fulltime observation of an HWA geotechnical engineer. The program consisted of drilling and sampling 31 exploratory borings (designated BH-9 through BH-39) in the vicinity of the proposed SR 305 improvements. Four borings (designated BH-9 through BH-12) were drilled in the vicinity of proposed retention ponds and ranged in depth from 7.3 to 8.1 meters. Twelve borings (designated BH-13 through BH-24) were drilled in the vicinity of proposed signal standards and ranged in depth from 5.0 to 8.1 meters). Four borings (designated BH-25 through BH-28) were drilled in the vicinity of proposed culvert replacements and ranged in depth from 6.6 to 8.1 meters. Eleven borings (designated BH-29 through BH-39) were drilled along the proposed retaining walls and ranged in depth from 3.5 to 15.7 meters. Eight borings (designated BH-1 through BH-8) were drilled previously for the Preliminary Geotechnical Report (HWA, 1999) and were located at relatively uniform intervals along the project alignment.

All borings were drilled by WSDOT crews operating either truck, track or skid-mounted drill rigs. Borings BH-1 through BH-10, BH-22 and BH-25 were drilled using continuous flight, hollow-stem, auger. The remaining borings were drilled using mud rotary techniques. Standard Penetration Test (SPT) sampling was performed at selected intervals within the borings using a 50-mm outside diameter split-spoon sampler and a 63-kg automatic trip hammer. In the SPT, a sample is obtained by driving the sampler 300 mm into the soil with a hammer free-falling 760 mm per blow. The number of blows required for each 150 mm of penetration is recorded. The SPT Resistance (N-Value) of the soil is calculated as the number of blows required for the final 300 mm of penetration. The N-Value provides an indication of the relative density of granular soils and the relative consistency of cohesive soils.

During drilling, an HWA geotechnical engineer recorded pertinent information including soil sample depths, stratigraphy, soil engineering characteristics, and ground water observations. Soil samples were classified in the field and representative portions were placed in relatively airtight plastic bags. These samples were taken to our Lynnwood, Washington laboratory for further examination and testing. A description of the soil classification system and a legend of the terms and symbols used on the exploration logs is presented on Figure A-1. Summary boring logs are presented on Figures A-2 through A-40.

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N-VALUE

COHESIONLESS SOILS			COHESIVE SOILS		
Density	N (blows/ft)	Approximate Relative Density(%)	Consistency	N (blows/ft)	Approximate Undrained Shear Strength (psf)
Very Loose	0 to 4	0 - 15	Very Soft	0 to 2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Medium Dense	10 to 30	35 - 65	Medium Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	over 50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	over 30	>4000

USCS SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP DESCRIPTIONS	
Coarse Grained Soils	Gravel and Gravelly Soils	Clean Gravel (little or no fines)	GW	Well-graded GRAVEL
			GP	Poorly-graded GRAVEL
	More than 50% of Coarse Fraction Retained on No. 4 Sieve	Gravel with Fines (appreciable amount of fines)	GM	Silty GRAVEL
			GC	Clayey GRAVEL
More than 50% Retained on No. 200 Sieve Size	Sand and Sandy Soils	Clean Sand (little or no fines)	SW	Well-graded SAND
			SP	Poorly-graded SAND
	50% or More of Coarse Fraction Passing No. 4 Sieve	Sand with Fines (appreciable amount of fines)	SM	Silty SAND
			SC	Clayey SAND
Fine Grained Soils	Silt and Clay	Liquid Limit Less than 50%	ML	SILT
			CL	Lean CLAY
			OL	Organic SILT/Organic CLAY
50% or More Passing No. 200 Sieve Size	Silt and Clay	Liquid Limit 50% or More	MH	Elastic SILT
			CH	Fat CLAY
			OH	Organic SILT/Organic CLAY
Highly Organic Soils			PT	PEAT

TEST SYMBOLS

%F	Percent Fines
AL	Atterberg Limits: PL = Plastic Limit, LL = Liquid Limit
CBR	California Bearing Ratio
CN	Consolidation
DD	Dry Density (pcf)
DS	Direct Shear
GS	Grain Size Distribution
K	Permeability
MD	Moisture/Density Relationship (Proctor)
MR	Resilient Modulus
PID	Photoionization Device Reading
PP	Pocket Penetrometer Approx. Compressive Strength (tsf)
SG	Specific Gravity
TC	Triaxial Compression
TV	Torvane Approx. Shear Strength (tsf)
UC	Unconfined Compression

SAMPLE TYPE SYMBOLS

- 2.0" OD Split Spoon (SPT) (140 lb. hammer with 30 in. drop)
- Shelby Tube
- 3.0" OD Split Spoon with Brass Rings
- Small Bag Sample
- Large Bag (Bulk) Sample
- Core Run
- Non-standard Penetration Test (with split spoon sampler)

GROUNDWATER SYMBOLS

- Groundwater Level (measured at time of drilling)
- Groundwater Level (measured in well or open hole after water level stabilized)

COMPONENT DEFINITIONS

COMPONENT	SIZE RANGE
Boulders	Larger than 12 in
Cobbles	3 in to 12 in
Gravel	3 in to No 4 (4.5mm)
Coarse gravel	3 in to 3/4 in
Fine gravel	3/4 in to No 4 (4.5mm)
Sand	No. 4 (4.5 mm) to No. 200 (0.074 mm)
Coarse sand	No. 4 (4.5 mm) to No. 10 (2.0 mm)
Medium sand	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine sand	No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and Clay	Smaller than No. 200 (0.074mm)

COMPONENT PROPORTIONS

PROPORTION RANGE	DESCRIPTIVE TERMS
< 5%	Clean
5 - 12%	Slightly (Clayey, Silty, Sandy)
12 - 30%	Clayey, Silty, Sandy, Gravelly
30 - 50%	Very (Clayey, Silty, Sandy, Gravelly)

Components are arranged in order of increasing quantities.

MOISTURE CONTENT

DRY	Absence of moisture, dusty, dry to the touch.
MOIST	Damp but no visible water.
WET	Visible free water, usually soil is below water table.

NOTES: Soil classifications presented on exploration logs are based on visual and laboratory observation.
Soil descriptions are presented in the following general order:

Density/consistency, color, modifier (if any) GROUP NAME, additions to group name (if any), moisture content. Proportion, gradation, and angularity of constituents, additional comments. (GEOLOGIC INTERPRETATION)

Please refer to the discussion in the report text as well as the exploration logs for a more complete description of subsurface conditions.

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LEGEND OF TERMS AND SYMBOLS USED ON EXPLORATION LOGS

PROJECT NO.: 98179

FIGURE: A-1

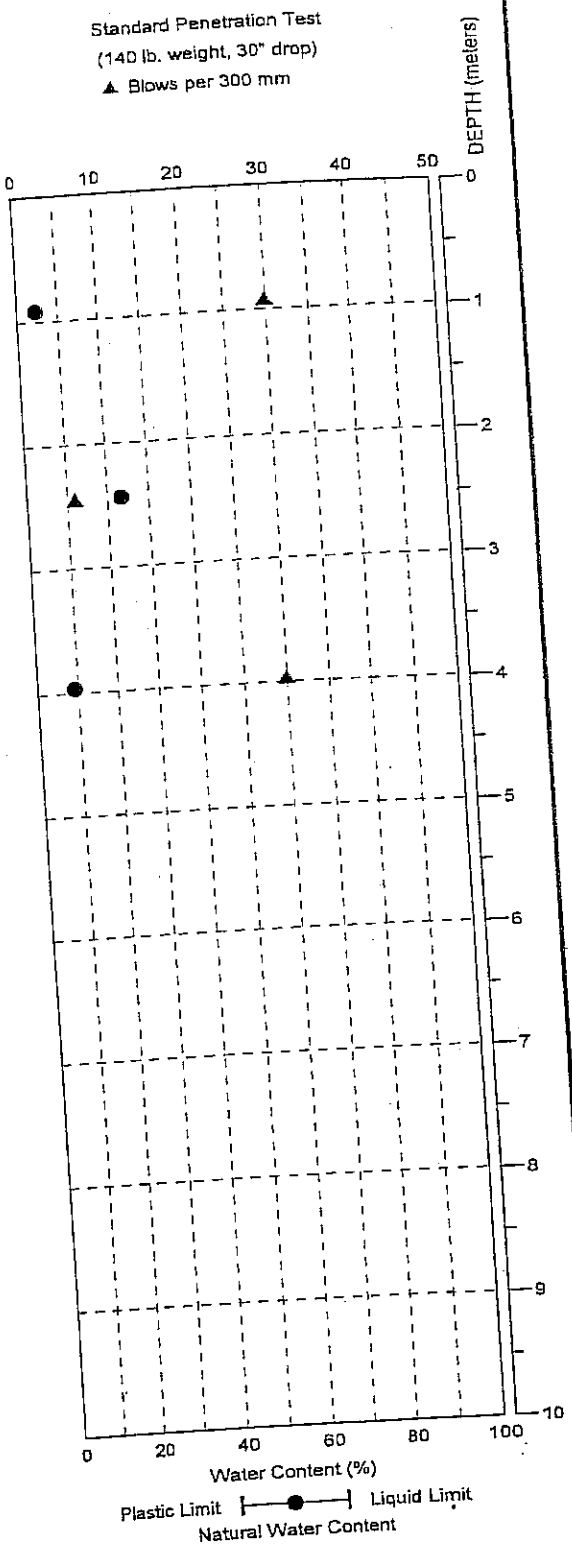
ILLING COMPANY: WSDOT
ILLING METHOD: CME 55, HSA
AMPLING METHOD: SPT, AUTOHAMMER
URFACE ELEVATION: 43 ± meters

LC ION: See Figure 2B
DATE STARTED: 12/10/98
DATE COMPLETED: 12/10/98
LOGGED BY: M. Byers

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0			100 mm asphalt over 100 mm CSTC.				
		SP SM	Medium dense to dense, dark grayish brown, slightly silty, gravelly, fine to coarse SAND, moist. Fine to coarse subrounded gravel. Very hard drilling to 8 feet. (FILL)	S-1	13-14-16	GS	
2		SM	Grades from loose, dark grayish brown, silty, fine SAND to dark brown, sandy SILT, moist. Some organics, wood fragments, roots. (RECENT ALLUVIUM)	S-2	1-3-3	pH	
4		SM	Dense, dark gray, gravelly, silty, fine to coarse SAND, moist. Fine to coarse subrounded gravel. (ADVANCE OUTWASH)	S-3	10-14-16		

End of borehole at 4.4 meters.

No groundwater seepage observed at time of boring.



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

BORING: BH- 1

PAGE: 1 of 1

HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

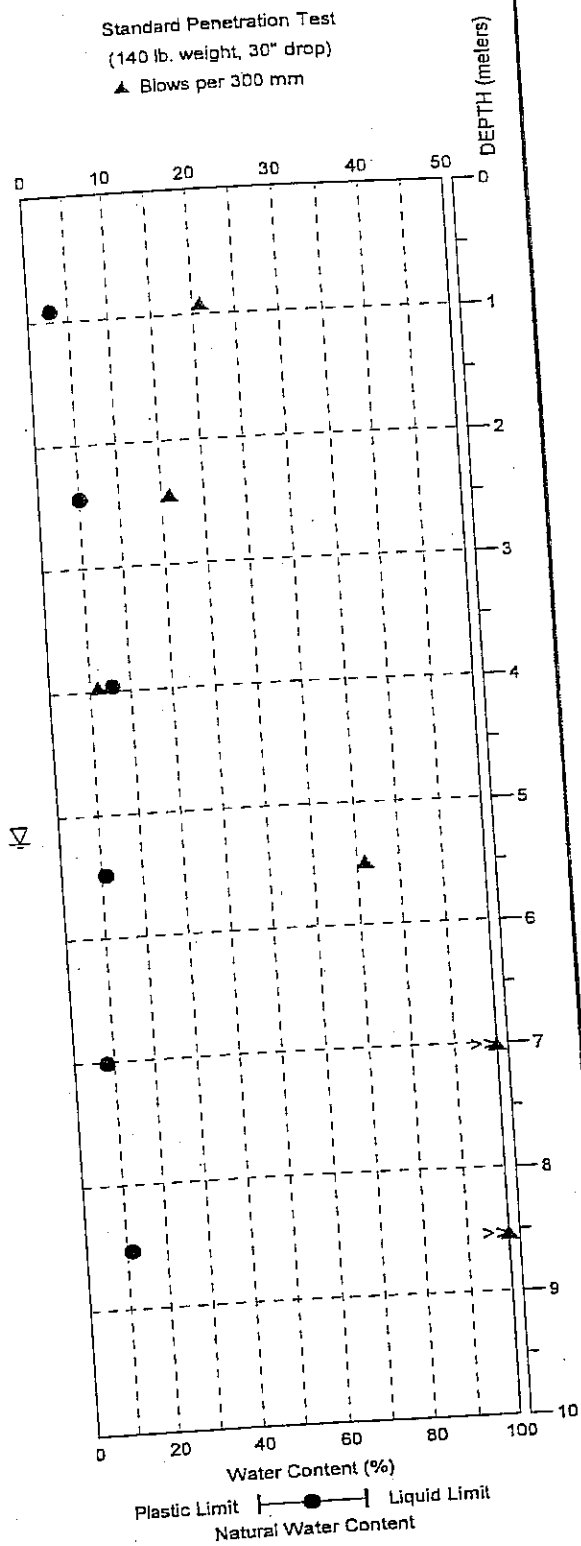
PROJECT NO.: 98179

FIGURE: A-2

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, HSA
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 37 ± meters

TION: See Figure 2C
DATE STARTED: 12/2/98
DATE COMPLETED: 12/2/98
LOGGED BY: M. Byers

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0			150 mm asphalt over 100 mm dense, dark grayish brown, fine to coarse, subrounded GRAVEL, moist.				
		SM	Medium dense, grayish brown, silty, gravelly, fine to medium SAND, moist. Fine to coarse subrounded gravel. (FILL)	S-1	9-13-8		
1		SP SM	Medium dense, dark grayish brown, slightly gravelly, slightly silty, fine to coarse SAND, moist. Fine to coarse subrounded gravel. Some wood fragments and very dark brown silty sand.	S-2	18-7-9	GS pH	
2							
3				S-3	3-3-3		
4		SM	Loose, dark gray, silty, fine SAND, moist. (RECENT ALLUVIUM)				
5				S-4	5-11-25		
6		SM	Dense to very dense, dark olive brown to dark gray, slightly gravelly, silty, fine to coarse SAND, wet. Fine subrounded gravel. (ADVANCE OUTWASH)				
7				S-5	27-43 50/125mm		
8				S-6	23 50/150mm		
9			End of borehole at 8.8 meters.				
10			Groundwater seepage observed at 5.2 meters at time of boring.				



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

BORING: BH- 2

PAGE: 1 of 1

HWA GEOSCIENCES INC.

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POULSBO, WASHINGTON

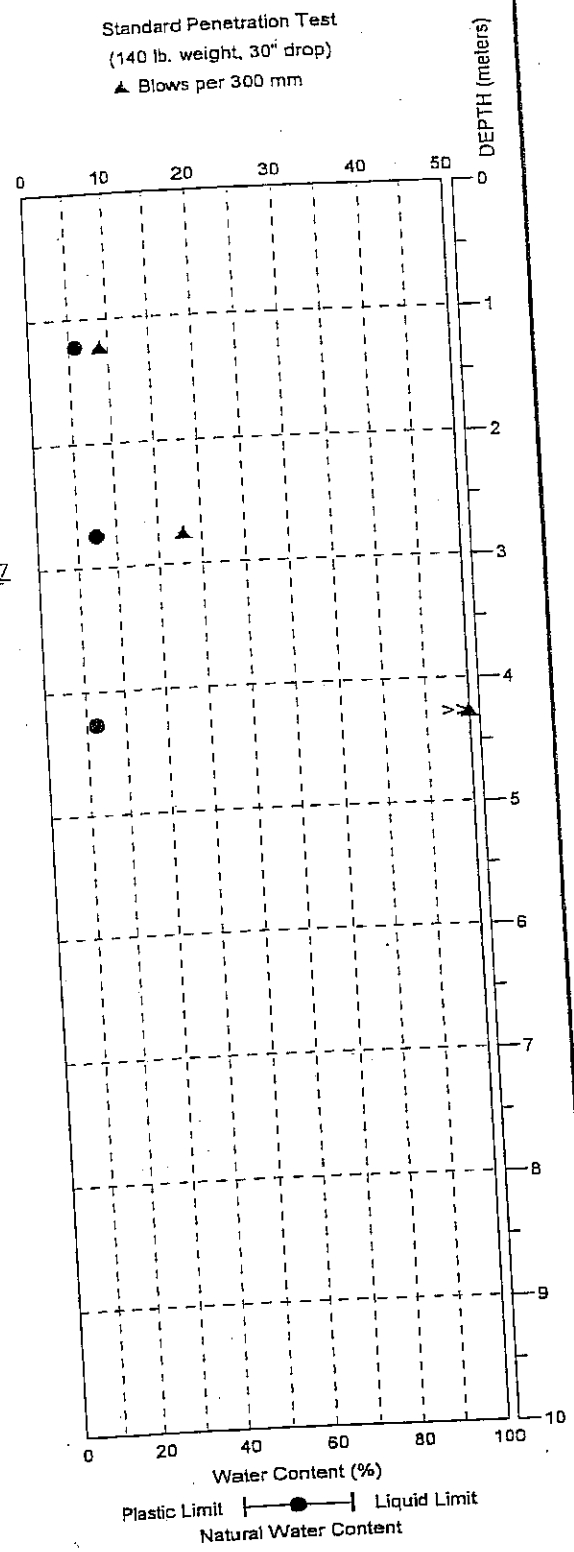
PROJECT NO.: 98179

FIGURE: A-3

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, HSA
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 24 ± meters

LOCATION: See Figure 2C
DATE STARTED: 12/10/98
DATE COMPLETED: 12/10/98
LOGGED BY: M. Byers

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		SM	55 mm asphalt. Medium dense, grayish brown, slightly gravelly, silty, fine to medium SAND, moist. Fine to coarse subrounded gravel. (FILL)				
1		SM	Loose to medium dense, very dark grayish brown to very dark brown, silty, fine to medium SAND, moist. (RECENT ALLUVIUM)	S-1	7-5-4	GS	
2		SM	Medium dense, olive gray, slightly gravelly to gravelly, silty, fine to coarse SAND, moist to wet. Fine to coarse subrounded gravel.	S-2	2-8-10	pH	▽
3		SM	Very dense, olive gray, slightly gravelly to gravelly, silty, fine to coarse SAND, wet. Fine to coarse subrounded gravel. (ADVANCE OUTWASH)	S-3	37 50/50mm		
4							
5			Refusal on cobble at 4.7 meters, borehole terminated.				
6			Groundwater seepgae observed at 3.1 meters at time of boring.				
7							
8							
9							
10							



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

BORING: BH- 3

PAGE: 1 of 1

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POULSBO, WASHINGTON

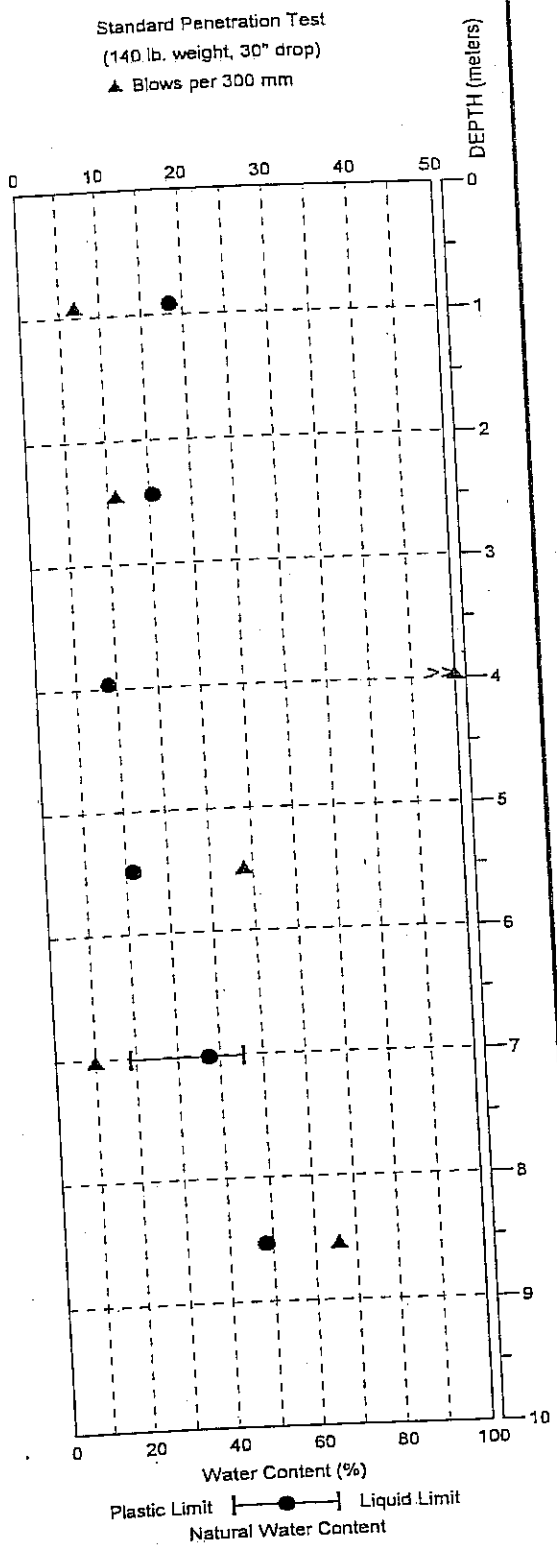
PROJECT NO.: 98179

FIGURE: A-4

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, HSA
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 18 ± meters

L[illegible]ION: See Figure 2
DATE STARTED: 12/2/98
DATE COMPLETED: 12/3/98
LOGGED BY: M. Byers

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0			150 mm asphalt over 150 mm CSTC.				
		SM	Medium dense, grayish brown, silty fine to medium SAND, moist. Fine subrounded to subangular gravel. (FILL)				
		ML	Soft, very dark brown, SILT, moist.	S-1	3-4-3		
1		SM	Loose to medium dense, dark gray, silty, fine to medium SAND, moist. Trace organics, wood, roots. (RECENT ALLUVIUM)				
2			Becomes wet at 2.1 meters.	S-2	3-4-7	pH	▽
3		SM	Very dense to medium dense, dark gray, slightly gravelly, silty, fine to medium SAND, wet.	S-3	12-19-37	GS	
4							
5				S-4	9-11-13		
6		CL	Soft, dark gray, CLAY, moist.	S-5	0-1-2-3	AL	
7							
8		ML	Hard, dark gray, sandy SILT, moist. Fine sand. (GLACIOLACUSTRINE)	S-6	5-16-17		
9							
10							



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

BORING: BH- 4

PAGE: 1 of 2

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SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

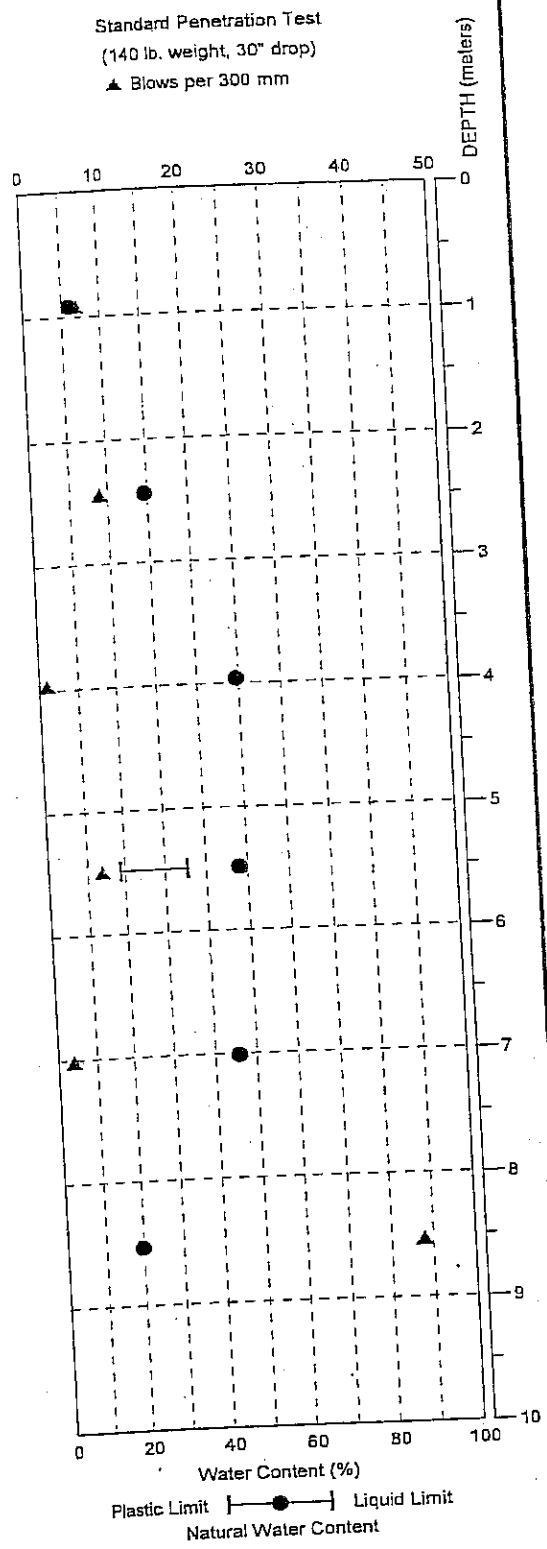
PROJECT NO.: 98179

FIGURE: A-5

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, HSA
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 16 ± meters

LOCATION: See Figure 2D
DATE STARTED: 12/8/98
DATE COMPLETED: 12/8/98
LOGGED BY: M. Byers

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0			100 mm asphalt.					
		SM	Dense to loose, dark grayish brown, slightly gravelly, silty, fine to medium SAND, moist. Fine to coarse subrounded gravel. (FILL)					
1		SM	Loose to medium stiff, dark brown to dark gray, silty, fine to medium SAND to sandy SILT, moist to wet. Occasional fine to coarse subrounded gravel. Some organics, roots, grass. (RECENT ALLUVIUM)		S-1	4-2-5	pH	
2					S-2	2-6-3	GS	▽
3		CL	Very soft to medium stiff, dark gray, CLAY, wet. One 50 mm thick fine silty sand layer in S-3.		S-3	1/500mm		
4								
5			Two silty sand layers 25 and 50 mm thick in S-4.		S-4	1/300mm-7	AL	
6								
7			Very soft, dark gray, CLAY, wet. Some 3 mm thick fine sand layers in S-5.		S-5	1-1-1		
8		ML	Hard, dark gray, sandy SILT, wet. Fine sand. Trace organics, wood. Driller noted hard conditions at 7.9 meters. (GLACIOLACUSTRINE)		S-6	11-19-25		
9			End of borehole at 9.0 meters. Groundwater seepage encountered at 2.1 meters at time of boring.					
10								



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BORING: BH- 5

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PROJECT NO.: 98179

FIGURE: A-6

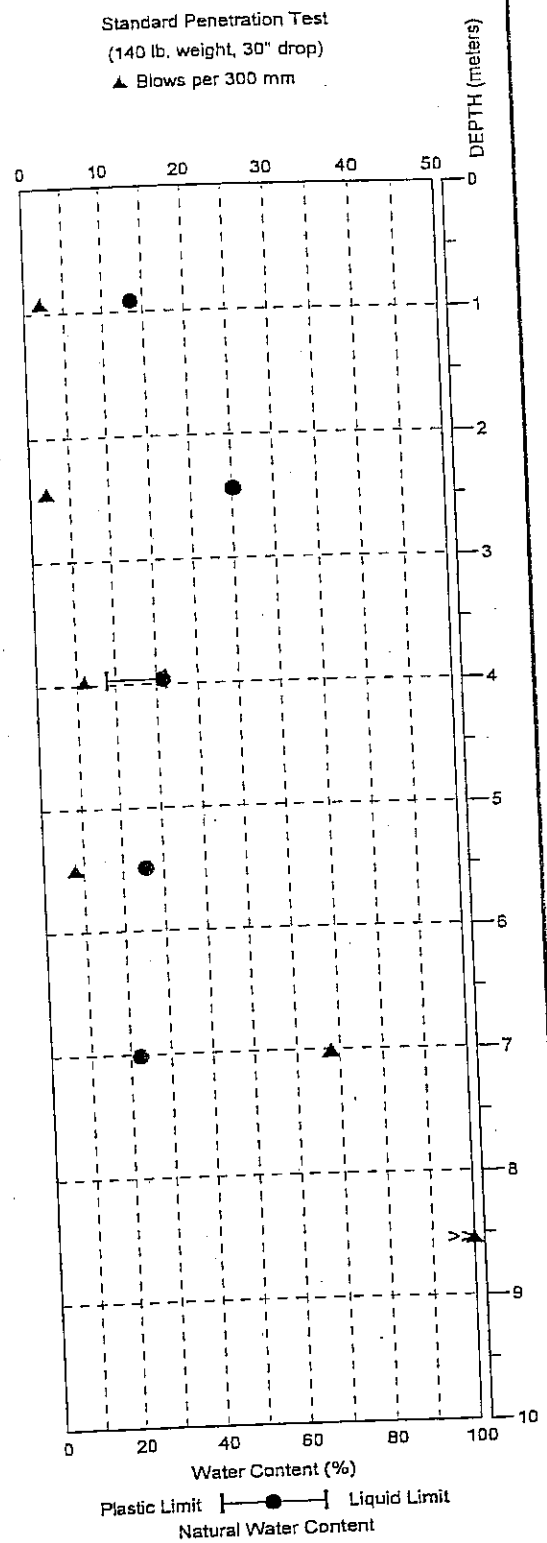
DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, HSA
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 15 ± meters

LOCATION: See Figure 2D
DATE STARTED: 12/3/98
DATE COMPLETED: 12/3/98
LOGGED BY: M. Byers

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0			40 mm asphalt over 100 mm CSTC.				
		SM	Medium dense, dark grayish brown, slightly gravelly, silty, fine to medium SAND, moist. Fine to coarse subrounded gravel. (FILL)				
1		CL	Very soft, dark gray, CLAY, moist. Some fine sand pockets. Some organics, wood fragments, grass. (RECENT ALLUVIUM)	S-1	1-1-1	pH	
2				S-2	1/300mm -1		▽
3		CL	Medium stiff, dark gray, CLAY, wet. Some sand lenses to 3 mm thick.	S-3	4-3-3	AL GS	
4							
5				S-4	4-2-2		
6							
7		ML	Very stiff, gray, sandy SILT, wet. Fine sand. One 25 mm thick clay layer. (GLACIOLACUSTRINE)	S-5	4-4-17		
8		SM	Very dense, dark gray, silty, fine SAND, wet. (ADVANCE OUTWASH)	S-6	8-22-30		
9							
10							

End of borehole at 9.0 meters.

Groundwater seepage observed at 2.1 meters at time of boring.



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

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SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

BORING: BH- 6

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PROJECT NO.: 98179

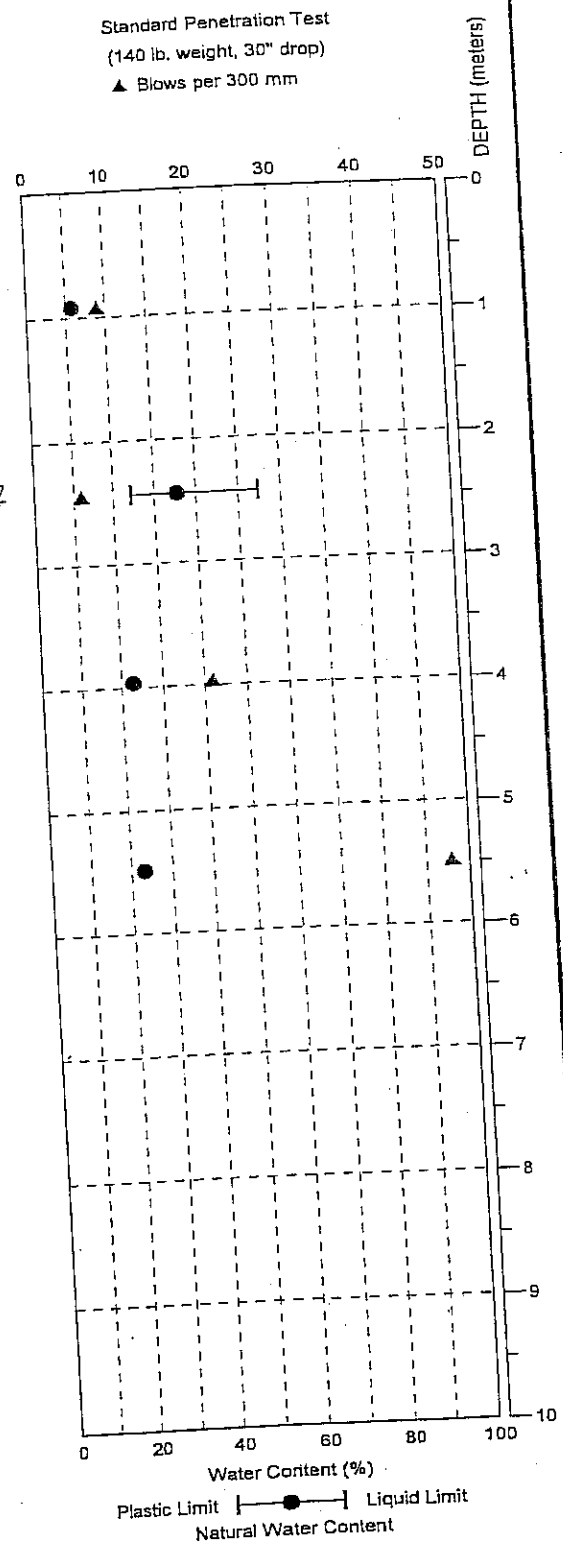
FIGURE: A-7

BORING 98179.GPJ 12/6/99

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, HSA
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 14 ± meters

LOCATION: See Figure 2D
DATE STARTED: 12/7/98
DATE COMPLETED: 12/7/98
LOGGED BY: M. Byers

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0			115 mm asphalt over 100 mm SCBC.				
		SM	Loose, grayish brown, slightly gravelly, silty, fine to medium SAND, moist. Fine subrounded gravel. Some iron stains. (FILL)	S-1	5-5-4	pH GS	
2		CH	Medium stiff, mottled dark gray and dark grayish brown, CLAY, moist to wet. Some organics, wood, grass, roots. (RECENT ALLUVIUM)	S-2	2-2-4	AL	▽
4		ML	Very stiff to hard, dark gray, sandy SILT, wet. Fine sand. One 1mm thick fine sand lense. (GLACIOLACUSTRINE)	S-3	5-7-14		
5				S-4	9-20-28		
6			End of borehole at 5.9 meters.				
7			Groundwater seepage observed at 2.4 meters at time of boring.				
8							
9							
10							



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HWA GEOSCIENCES INC.

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FIGURE: A-8

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, HSA
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 14 ± meters

LOCATION: See Figure 2E
DATE STARTED: 12/7/98
DATE COMPLETED: 12/7/98
LOGGED BY: M. Byers

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0			50 mm asphalt over 150 mm CSTC.				
		SM	Medium dense, dark gray, slightly gravelly, silty, fine to medium SAND, moist. Fine subrounded gravel. (FILL)	S-1	9-9-5		
1		CL	Medium stiff, dark grayish brown, CLAY, moist. Trace roots, wood fragments. (RECENT ALLUVIUM)				
2		SM	Very loose, dark grayish brown, slightly gravelly, fine to medium SAND, wet. Fine subrounded to subangular gravel.	S-2	2 1/300mm	pH	
3		ML	Stiff, grayish brown, sandy SILT, wet. Fine sand.	S-3	1-5-8		
4							
5				S-4	5-14-16		
		ML	Hard, grayish brown, sandy SILT, wet. (GLACIOLACUSTIRNE)				
6							
7		SM	Very dense, grayish brown to dark gray, silty fine to medium SAND, wet. (ADVANCE OUTWASH)	S-5	12-23-33	GS	
8				S-6	11-21-27		
9							
10							

End of borehole at 9.0 meters.

No groundwater seepage observed at time of boring.

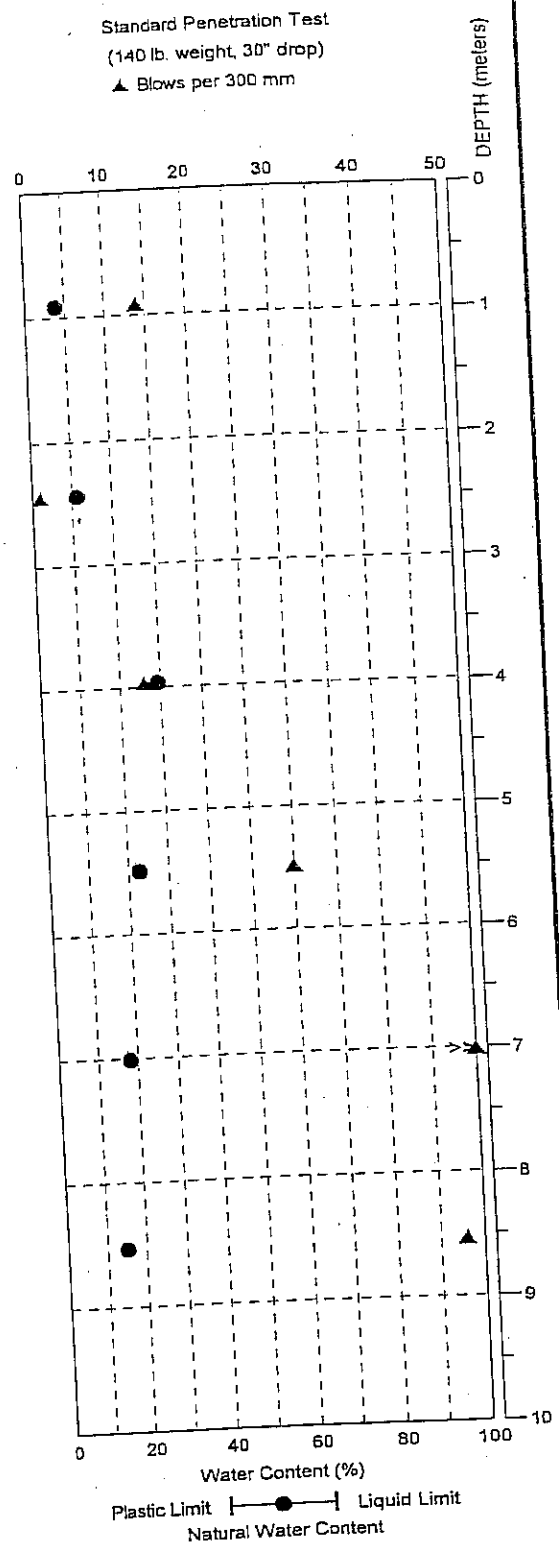

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FIGURE: A-9

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 850, HSA
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 24 ± meters

LL ION: See Figure 2A
DATE STARTED: 10/26/99
DATE COMPLETED: 10/26/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		ML	Stiff, brown, slightly sandy, slightly gravelly, SILT, moist. Some organics and roots. Fine sand, fine subrounded gravel. (RECENT ALLUVIUM)	S-1	7-7-7		
1		ML	Stiff, brown and gray mottled, SILT, moist.	S-2	6-6-9		
2				S-3	5-6-5		
3		SP	Very dense, olive brown, gravelly, fine to coarse SAND, dry. Fine to coarse, subround gravel. (ADVANCE OUTWASH)	S-4	18-18-46		
4		SM	Dense, olive brown, silty, very gravelly, fine to coarse SAND, moist. Fine to coarse, subrounded gravel.	S-5	9-20-21	GS	
5							
6				S-6	8-13-18		
7							
8							
9							
10							

End of borehole at 7.3 meters.

No groundwater seepage observed.

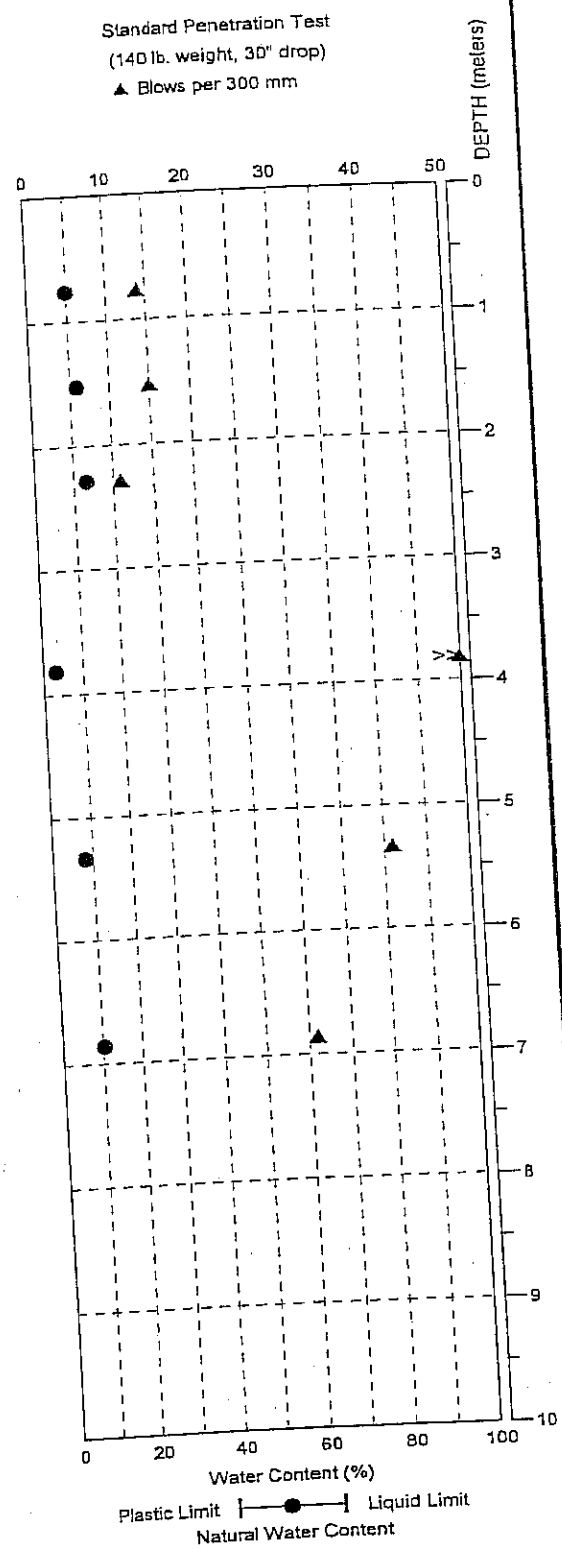

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FIGURE: A-10

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 850, HSA
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 25 ± meters

L TION: See Figure 2A
DATE STARTED: 10/27/99
DATE COMPLETED: 10/27/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		ML	Medium stiff to very stiff, brown, slightly gravelly, slightly sandy, SILT, moist. Fine sand, fine subround gravel. Some organics. Oxide stains at 1.8 meters. (RECENT ALLUVIUM)	S-1	2-2-3		
1				S-2	3-6-13		
2			Abundant organics at 3 meters.	S-3	4-15-9		
3							
4		SP	Very dense, brown, very gravelly, fine to coarse SAND, moist. Fine to coarse subrounded gravel. (ADVANCE OUTWASH)	S-4	18-30-43	GS	
5							
6				S-5	14-20-32		
7				S-6	29-44-50		
8			End of borehole at 7.8 meters. No groundwater seepage obseved at time of boring.				
9							
10							

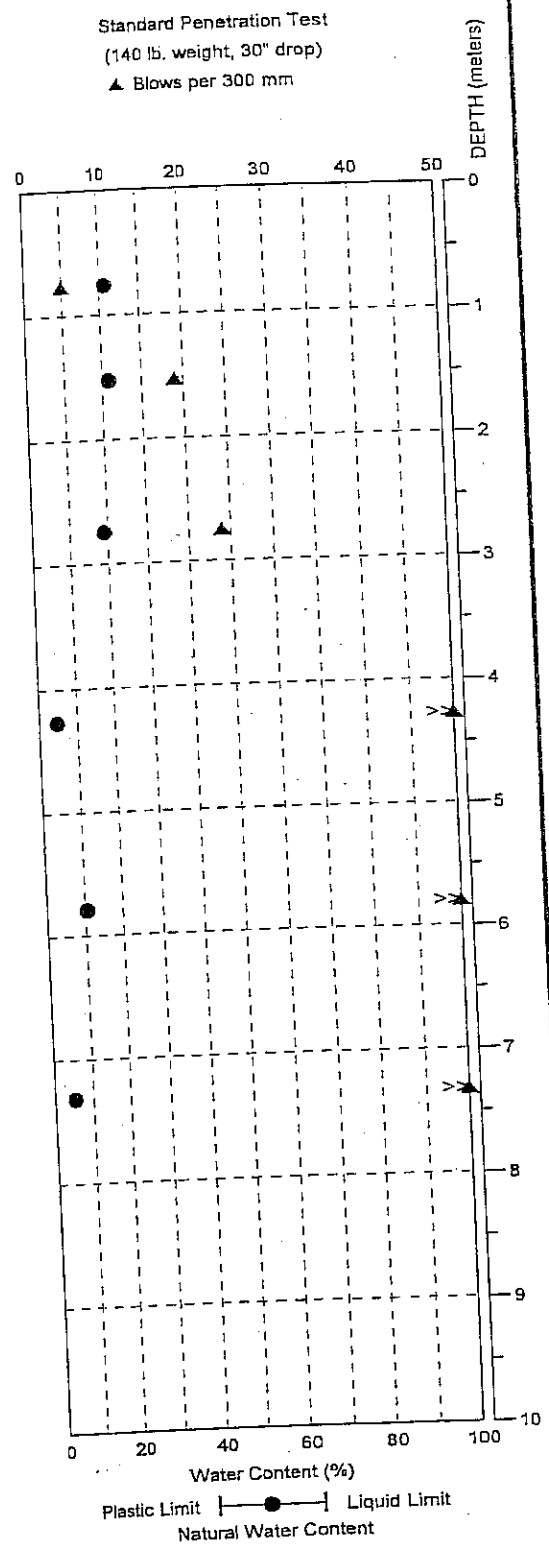

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FIGURE: A-11

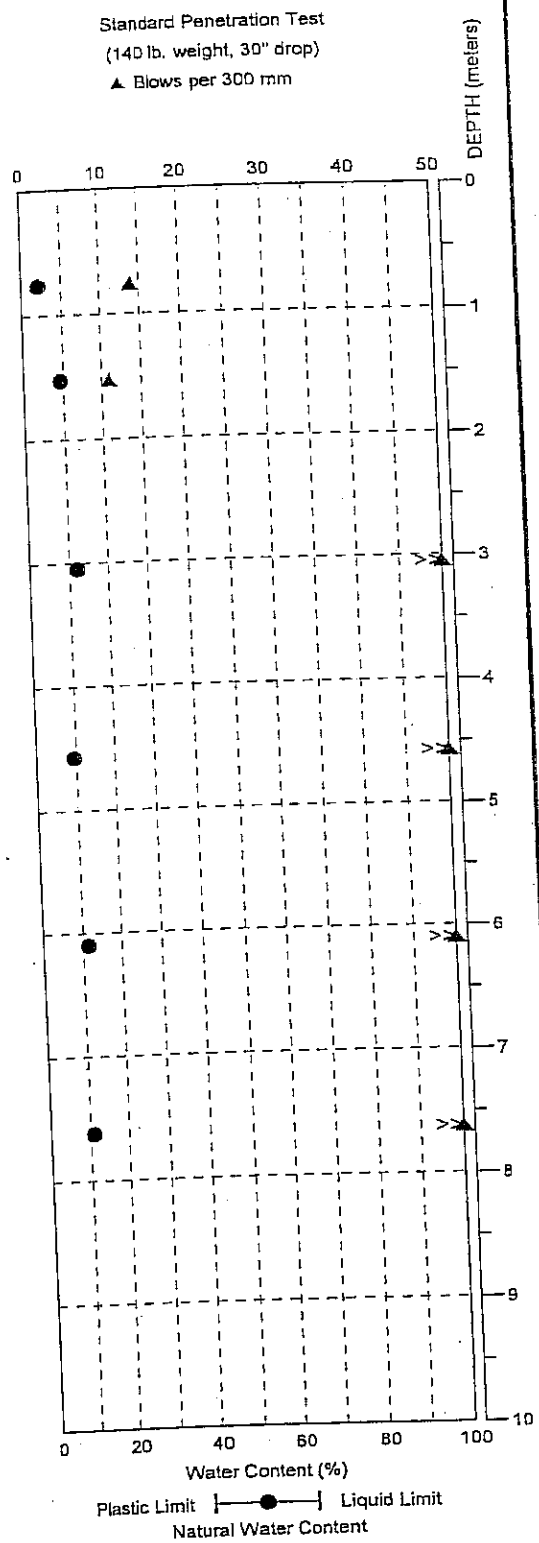
DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 10 ± meters

LOCATION: See Figure 2E
DATE STARTED: 10/21/99
DATE COMPLETED: 10/21/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		GP	Medium dense, brown, slightly sandy, slightly silty, fine GRAVEL, moist to wet. Fine to coarse sand. (FILL)		S-1	7-7-7		
					S-2	4-4-7		
2		SM	Very dense, olive gray, very silty, fine to medium SAND, wet. (ADVANCE OUTWASH)		S-3	46-50/75mm	GS	
4					S-4	50/100mm		
		SM	Very dense, dark gray, slightly gravelly, silty, fine SAND, wet. Fine, subrounded gravel.		S-5	50/125mm		
6					S-6	50/125mm		
8								
9								
10								

End of borehole at 8.1 meters.

No groundwater seepage observed due to drilling method.



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HWA GEOSCIENCES INC.

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FIGURE: A-12

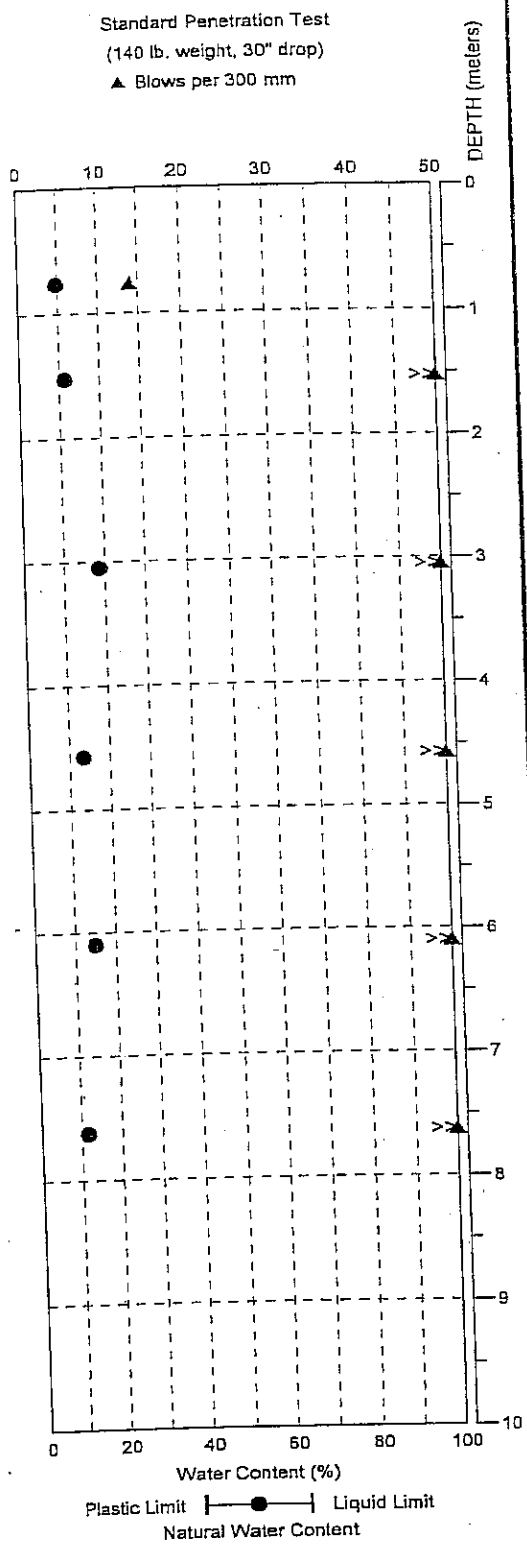
DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 10 ± meters

L ..ION: See Figure 2E
DATE STARTED: 10/21/99
DATE COMPLETED: 10/21/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		GP	Grades top to bottom from medium dense, brown, silty, sandy, fine, subrounded GRAVEL to gray, gravelly, sandy, SILT, wet. Fine sand. (FILL)	S-1	6-7-7		
		SM	Dense to very dense, olive brown to olive gray, gravelly, silty, fine to medium SAND, moist. Fine to coarse subrounded gravel. (ADVANCE OUTWASH)	S-2	15-44 50/125mm	GS	
				S-3	40-44 50/125mm		
				S-4	50/150mm		
				S-5	39-46 50/100mm	GS	
				S-6	50/125mm		

End of borehole at 8.1 meters.

No groundwater seepage observed due to drilling method.



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HWA GEOSCIENCES INC.

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FIGURE: A-13

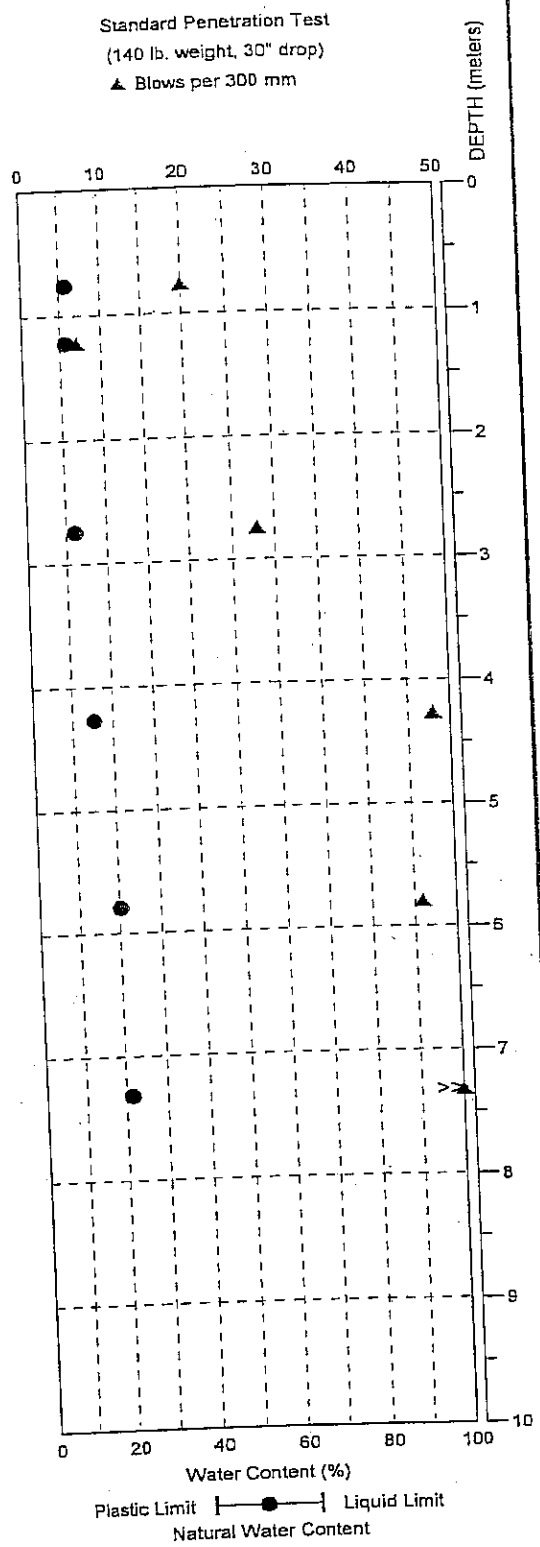
DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 43 ± meters

LOCATION: See Figure 2B
DATE STARTED: 10/14/99
DATE COMPLETED: 10/14/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		SP SM	Loose to medium dense, brown, slightly silty, gravelly, fine to medium SAND, moist. Fine to coarse, subrounded gravel. (FILL)	S-1	8-10-10		
1				S-2	6-4-3		
2				S-3	12-13-15	GS	
3		SP SM	Dense, olive gray, slightly silty, slightly gravelly, fine to coarse SAND, moist. Fine to coarse, subround gravel. (ADVANCE OUTWASH)	S-4	17-21-27	GS	
4							
5		SM	Dense, gray, silty SAND to sandy SILT, moist. Fine sand.	S-5	14-18-28		
6							
7		ML	Hard, gray, SILT, moist. (GLACIOLACUSTRINE)	S-6	14-23-35		
8							
9							
10							

End of borehole at 7.8 meters.

No groundwater seepage observed due to drilling method.



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HWA GEOSCIENCES INC.

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POULSBO, WASHINGTON

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FIGURE: A-14

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 36 ± meters

LOCATION: See Figure 2C
DATE STARTED: 10/15/99
DATE COMPLETED: 10/15/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		SP	Loose, grayish brown, slightly gravelly, fine to medium SAND, moist. Some oxidation stains noted in sample. Fine, subrounded gravel. (FILL)	S-1	1-2-3		
1		SM	Medium dense, grayish brown, slightly gravelly, silty, fine to medium SAND, moist. Oxidation stains noted throughout sample. Fine, subrounded gravel.	S-2	3-5-8		
2							
3				S-3	7-9-11	GS	
4		SP SM	Very dense, grayish brown, slightly silty, gravelly, fine to coarse SAND, moist. Fine to coarse subround gravel. (ADVANCE OUTWASH)	S-4	6-23-34		
5							
6		GP GM	Very dense, grayish brown, slightly silty, sandy, fine to coarse, subrounded to subangular GRAVEL, moist. Fine to coarse sand.	S-5	23-47-44		
7							
8							
9							
10							

End of borehole at 6.6 meters.

No groundwater seepage observed due to drilling method.

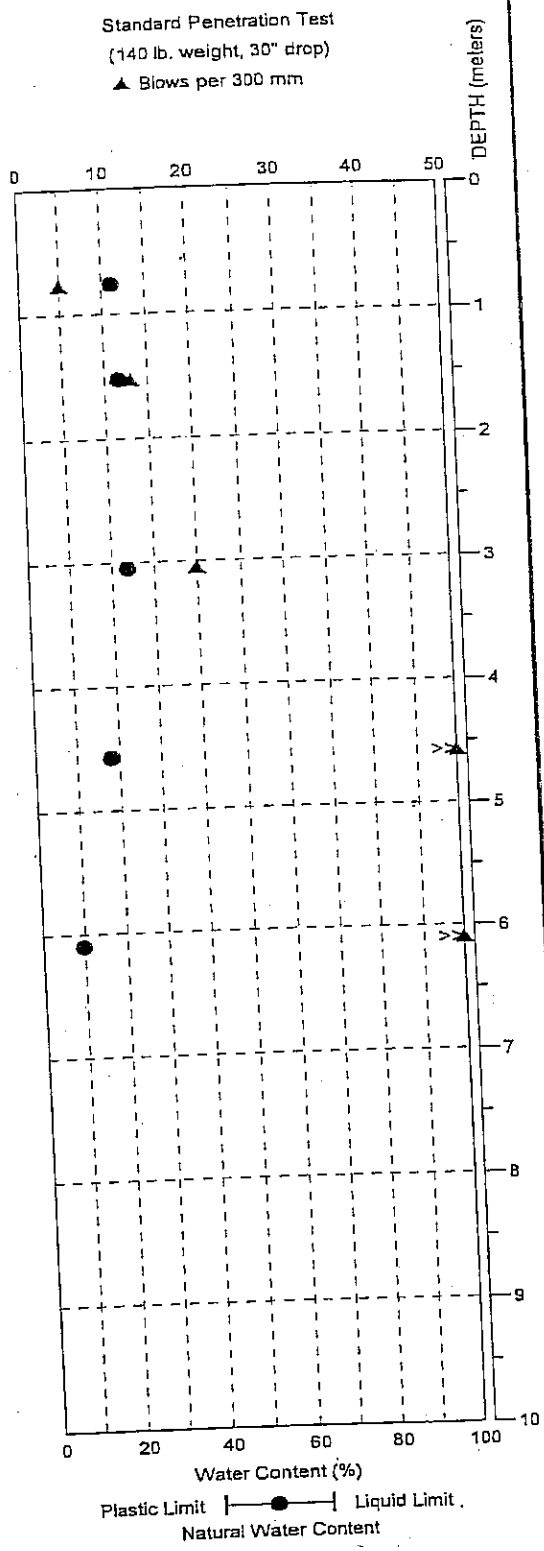

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FIGURE: A-15

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 34 ± meters

L TION: See Figure 2C
DATE STARTED: 10/15/99
DATE COMPLETED: 10/15/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		SP	Medium dense, brown, fine to medium SAND, moist. (FILL)		S-1	3-5-5		
1					S-2	4-5-7		
2								
3		SP SM	Medium dense, brown, slightly silty, fine to medium SAND, moist. Grades finer with depth. (ADVANCE OUTWASH)		S-3	6-9-11	%F	
4		SP	Medium dense, olive brown, very gravelly, fine to coarse SAND, moist. Fine to coarse, subrounded gravel.		S-4	11-14-13	GS	
5								
6		SP	Dense to very dense, grayish brown, fine to coarse SAND, moist.		S-5	11-16-19		
7					S-6	15-27-31		
8								
9								
10								

End of borehole at 8.1 meters.

No groundwater seepage observed due to drilling method.

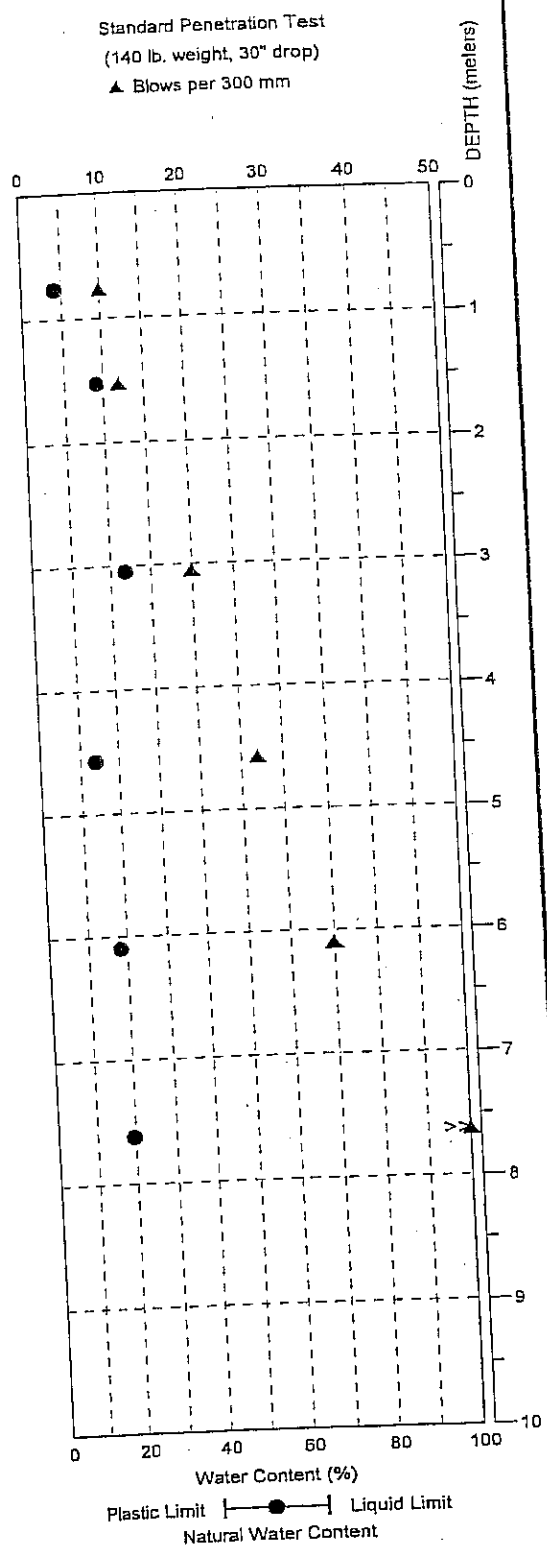

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FIGURE: A-16

BORING 98179.GPJ 12/6/99

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 16 ± meters

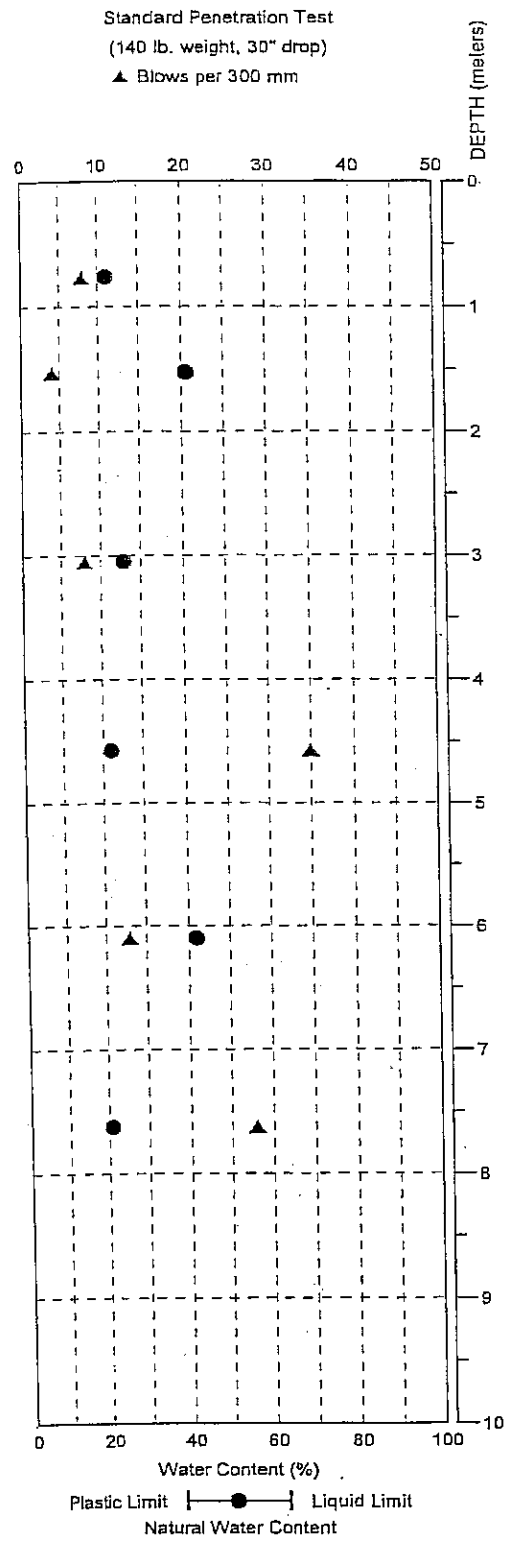
LOCATION: See Figure 2D
DATE STARTED: 10/12/99
DATE COMPLETED: 10/12/99
LOGGED BY: B. Hawkins

DEPTH (meters)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS
0	GP	Loose, gray, sandy, fine to coarse, subrounded GRAVEL, moist. (FILL)	S-1	1-3-5	
1	CL	Soft, grayish brown, slightly gravelly, CLAY. Trace organics. (RECENT ALLUVIUM)	S-2	1-2-2	
2	OL	Soft, dark brown, slightly gravelly, organic SILT, moist. Abundant organics, wood.			
3	SM	Loose, gray, very silty, fine SAND, moist.	S-3	2-4-4	%F
4	SM	Dense, gray, very silty, fine SAND, moist.	S-4	4-15-20	
5					
6	ML	Medium stiff, gray, SILT, moist.	S-5	4-4-9	
7					
8	SM	Medium dense, gray, silty, fine to medium SAND, moist. Several silt lenses.	S-6	4-8-20	
9					
10					

End of borehole at 8.1 meters.

No groundwater seepage observed due to drilling method.

GROUNDWATER



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PROJECT NO.: 98179 FIGURE: A-17

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 16 ± meters

L TION: See Figure 2D
DATE STARTED: 10/12/99
DATE COMPLETED: 10/12/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		SM	Dense, grayish brown, gravelly, silty, fine to coarse SAND, moist. Fine to coarse, subrounded to subangular gravel. (FILL)	S-1	8-19-16		
2		SM	Very loose, dark brown, very silty SAND, wet. Abundant organics, wood fibers, present. (RECENT ALLUVIUM)	S-2	0/450mm	%F	
3		SM	Medium dense, gray, very silty, fine SAND, wet.	S-3	7-13-11	%F	
5		CL	Very soft, dark gray, sandy, CLAY, moist.	S-4	0/300mm 3/150mm		
6				S-5		AL	
				S-6	2-9-8		
7		ML	Medium dense, gray, sandy, SILT, wet. Fine sand.				

End of borehole at 7.2 meters.

No groundwater seepage observed due to drilling method.

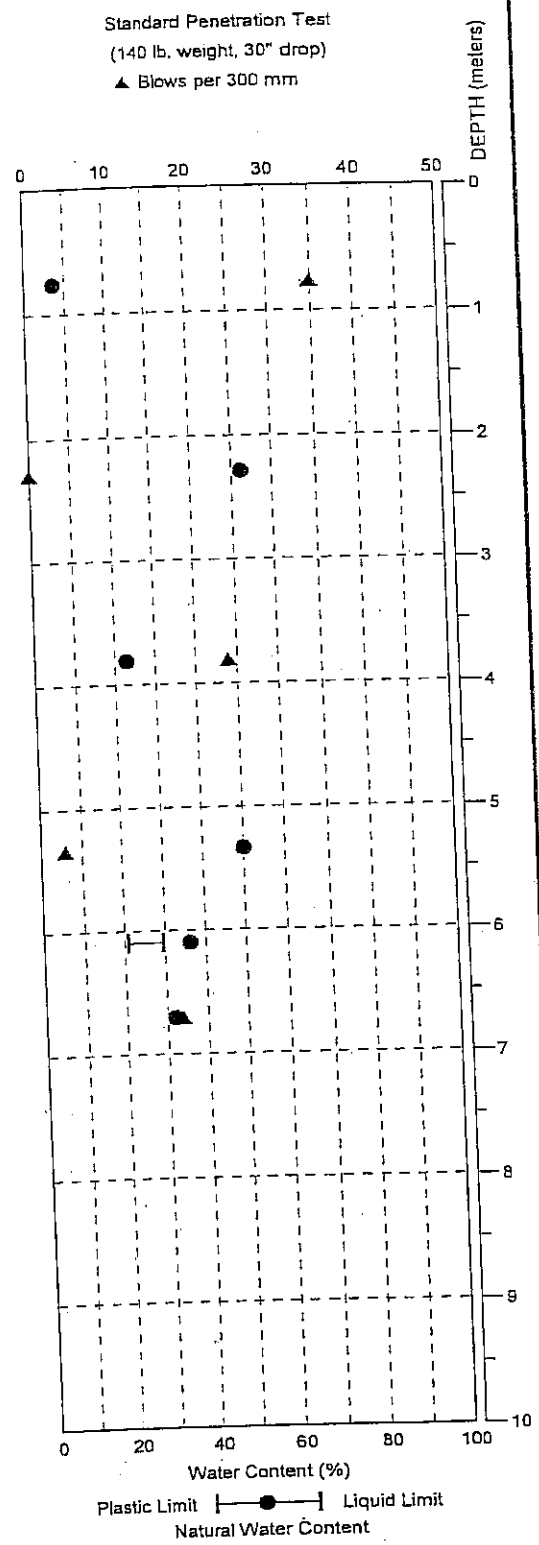

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FIGURE: A-18

BORING 98179.GPJ 12/6/99

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 13 ± meters

L ION: See Figure 2D
DATE STARTED: 10/15/99
DATE COMPLETED: 10/15/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		CL	Medium stiff, dark brown, gravelly CLAY, wet. Fine, subrounded gravel. (RECENT ALLUVIUM)	S-1	3-4-4		
1							
		SM	Loose to medium dense, dark gray, very silty, fine to medium SAND, moist. Some organics present.	S-2	1-3-3	GS	
2							
3				S-3	4-6-6		
4				S-4	16-22-25	%F	
		SM	Very dense, grayish brown, very silty, fine to medium SAND, moist. (ADVANCE OUTWASH)				
5							
6				S-5	15-23-32		
7							
8				S-6	18-26-30		
9							
10							

End of borehole at 8.1 meters.

No groundwater seepage observed due to drilling method.

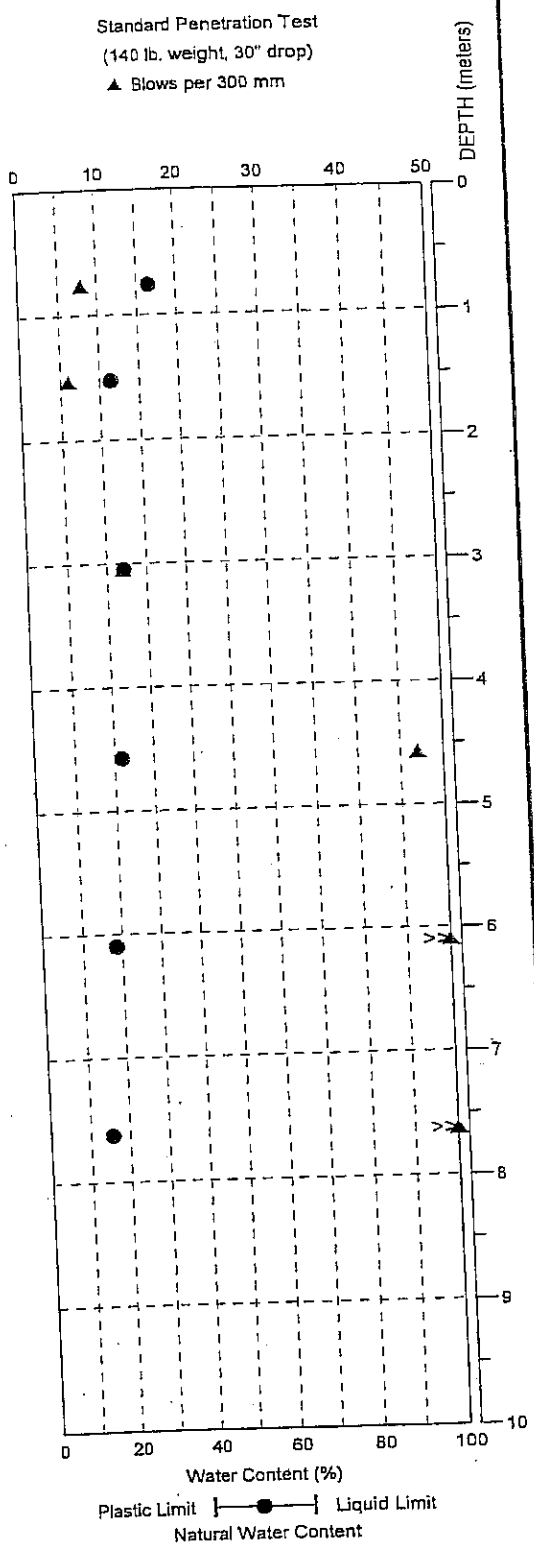

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FIGURE: A-19

BORING 98179.GPJ 12/6/99

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 12 ± meters

LOCATION: See Figure 2D
DATE STARTED: 10/19/99
DATE COMPLETED: 10/19/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		ML	Medium stiff, dark gray, very sandy SILT, moist. Fine to medium sand. Trace organics. (RECENT ALLUVIUM)		S-1	2-2-3		
1					S-2	5-2-3	%F	
2		CL ML	Very stiff, dark gray, sandy, SILTY CLAY, wet. Fine to medium sand.		S-3	7-8-11	AL	
3		SM	Very dense, gray, slightly silty, fine to medium SAND, wet. (ADVANCE OUTWASH)		S-4	17-21-32		
4								
5								
6								
7								
8								
9								
10								

End of borehole at 5.0 meters.

No groundwater seepage observed due to drilling method.

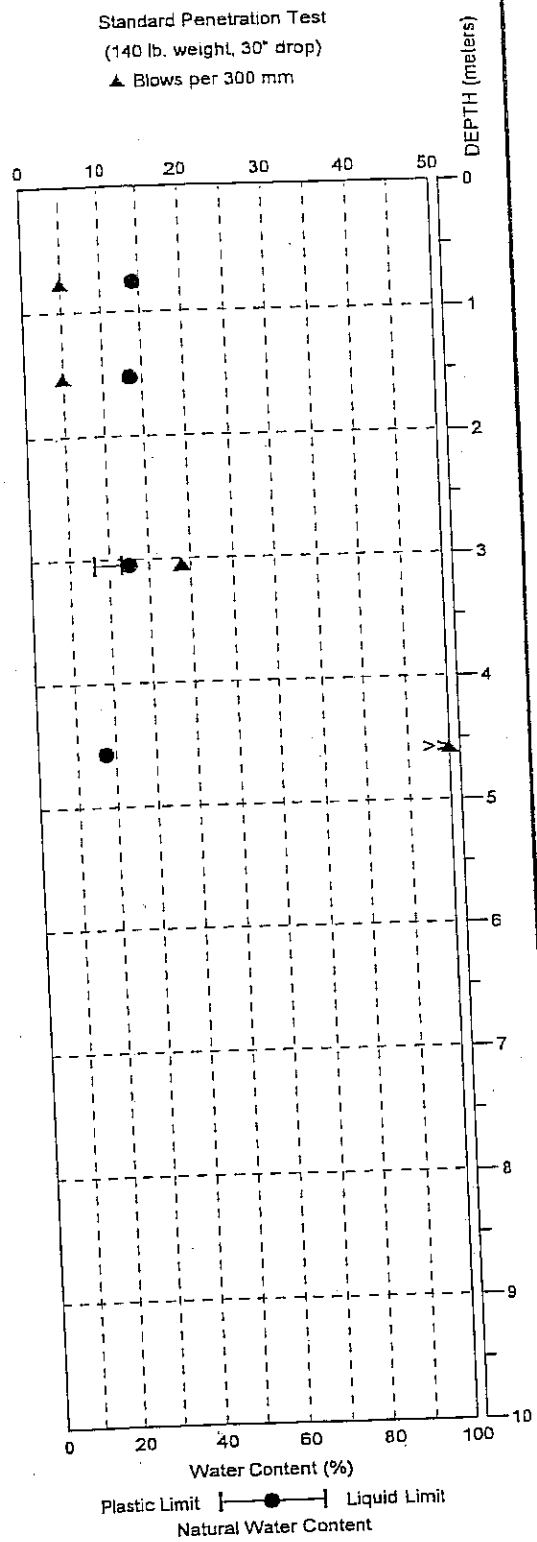

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FIGURE: A-20

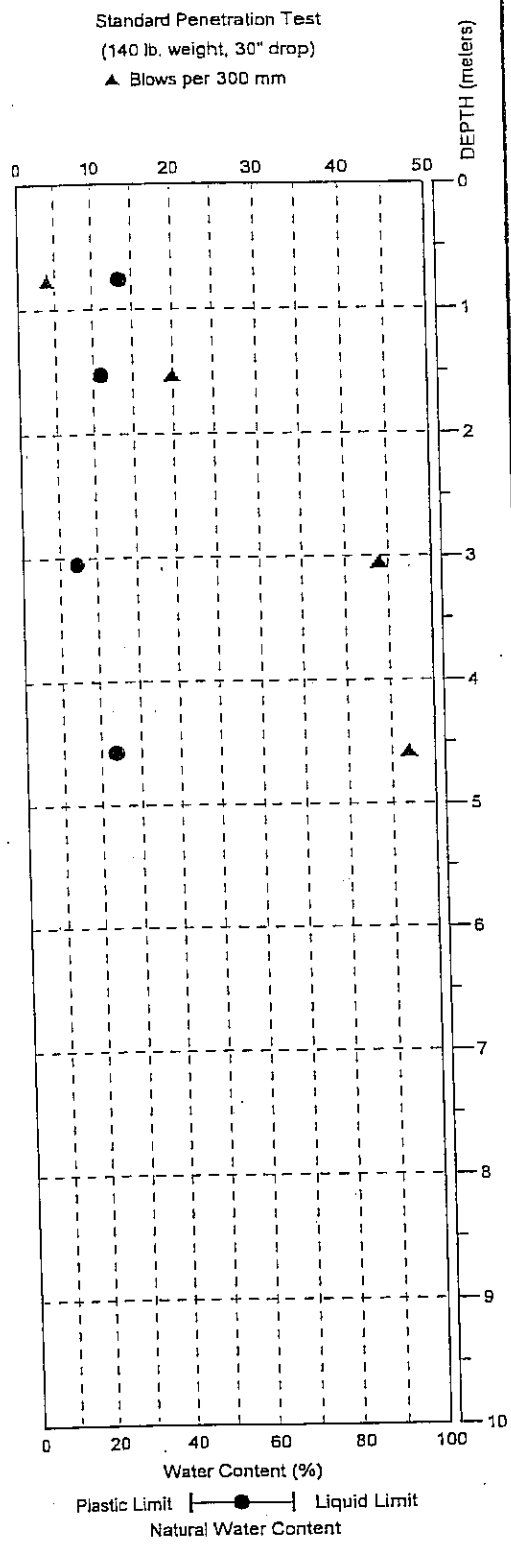
DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 45, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 12 ± meters

LOCATION: See Figure 2D
DATE STARTED: 10/26/99
DATE COMPLETED: 10/26/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		ML	Soft, brown and gray, fine sandy, SILT, moist. Abundant organics/wood fragments. (RECENT ALLUVIUM)	S-1	2-2-2		
1		ML	Stiff, gray, sandy, SILT, moist. Oxidation stains in sample. Fine sand.	S-2	3-7-13		
2		SP SM	Dense, gray, slightly silty, fine to medium SAND, moist. (ADVANCE OUTWASH)	S-3	17-25-19		
3		ML	Hard, dark gray, very sandy, SILT, moist. Fine sand. (GLACIOLACUSTRINE)	S-4	12-20-27	%F	
4							
5							
6							
7							
8							
9							
10							

End of borehole at 5.0 meters.

No groundwater seepage observed due to drilling method.



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

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FIGURE: A-21

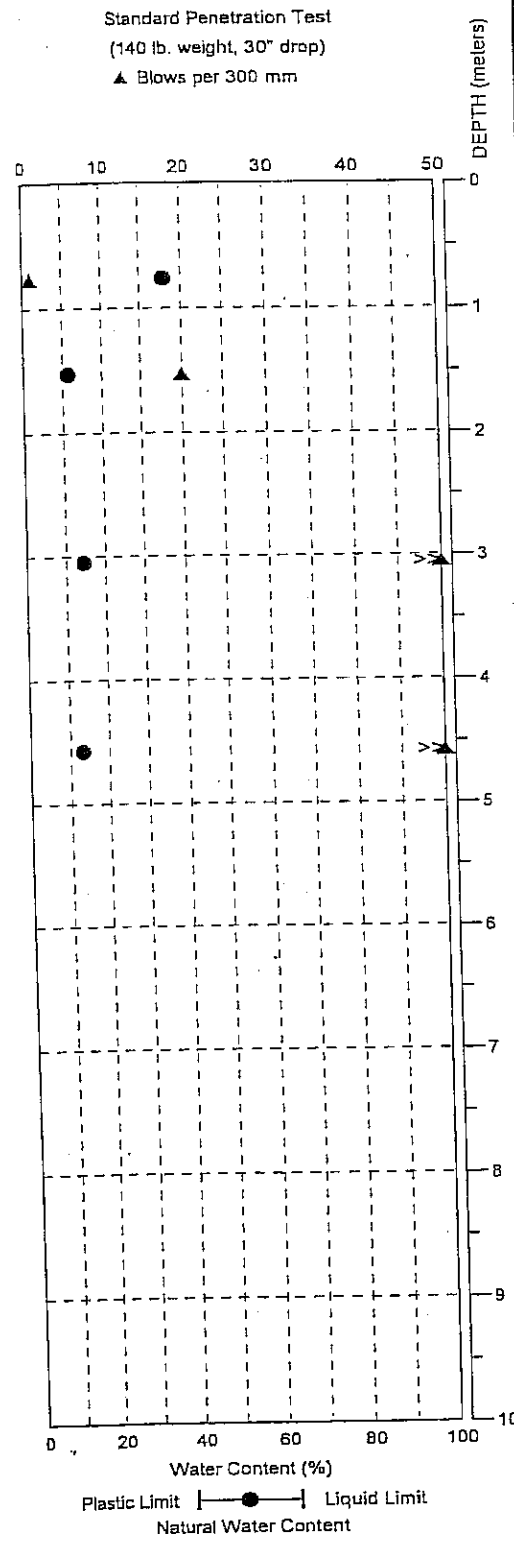
DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 10 ± meters

LOCATION: See Figure 2E
DATE STARTED: 10/20/99
DATE COMPLETED: 10/20/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		ML	Very soft, brown to black, sandy, SILT, wet. Fine to medium sand. Trace organics. (RECENT ALLUVIUM)		S-1	1-1/300mm		
1		SP SM	Medium dense, grayish brown, slightly silty, very gravelly, fine to coarse SAND, wet. Fine to coarse, subround gravel.		S-2	5-7-13		
3		SM	Very dense, grayish brown, slightly gravelly, silty, fine to coarse SAND, moist. Fine, subrounded gravel. (ADVANCE OUTWASH)		S-3	39-50/125mm		
4					S-4	39-50/100mm		
5								

End of borehole at 5.0 meters.

No groundwater observed due to drilling method.



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HWA GEOSCIENCES INC.

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FIGURE: A-22

BORING 98179.GPJ 12/6/99

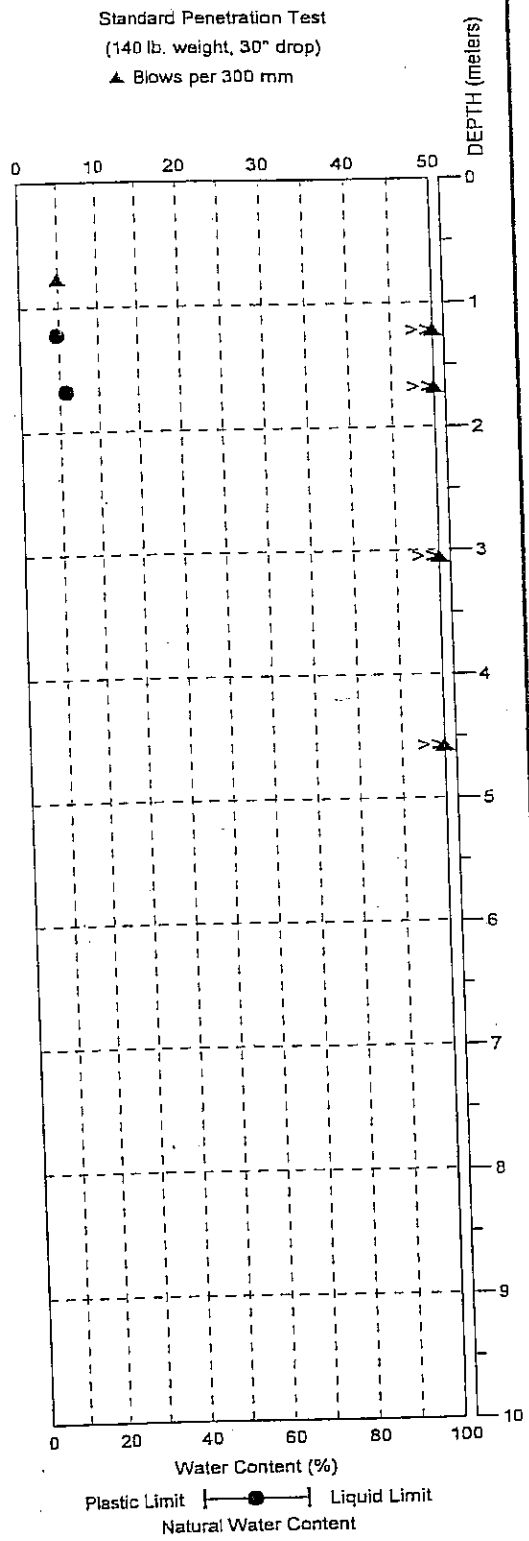
DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 850, HSA
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 9 ± meters

LOCATION: See Figure 2E
DATE STARTED: 10/28/99
DATE COMPLETED: 10/28/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		SM	Loose, dark brown, silty, fine to medium SAND, wet. Abundant organics present. (FILL)		S-1	5-2-3		
1		SP SM	Very dense, grayish brown, slightly silty, gravelly, fine to medium SAND, moist. Fine to coarse, subround gravel. (ADVANCE OUTWASH)		S-2	28-41-40		
		SM	Very dense, brown and gray laminated, silty, gravelly, fine to coarse SAND, moist. Fine, subround gravel.		S-3	7-32-45		▽
2								
3					S-4	20-50/125mm		
4								
5					S-5	50/150mm		
6								
7								
8								
9								
10								

End of borehole at 5.0 meters.

Groundwater measured at a depth of 2 meters, during drilling.



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HWA GEOSCIENCES INC.

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FIGURE: A-23

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 17 ± meters

LOCATION: See Figure 2D
DATE STARTED: 10/12/99
DATE COMPLETED: 10/12/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		GP	60-mm asphalt. Loose, brown, sandy, fine to coarse, subrounded to subangular GRAVEL, moist. Fine to coarse sand. (FILL)					
					S-1	2-3-3		
1		CL	Very soft to soft, gray, sandy, CLAY, moist. Fine to medium sand. Some organics/wood fragments. (RECENT ALLUVIUM)		S-2	1-1-1		
2								
3		SP SM	Dense, olive gray, slightly silty, fine to medium SAND, moist.		S-3	7-9-16		
4					S-4	11-18-23	%F	
5								
6		ML	Stiff, very dark gray, sandy SILT, moist. Fine to medium sand.		S-5	7-4-7	%F	
7		SM	Dense, gray to grayish brown, silty, fine to medium SAND, wet. (ADVANCE OUTWASH)		S-6	12-17-23		
8								
9								
10								

End of borehole at 7.8 meters.

No groundwater seepage observed due to drilling method.

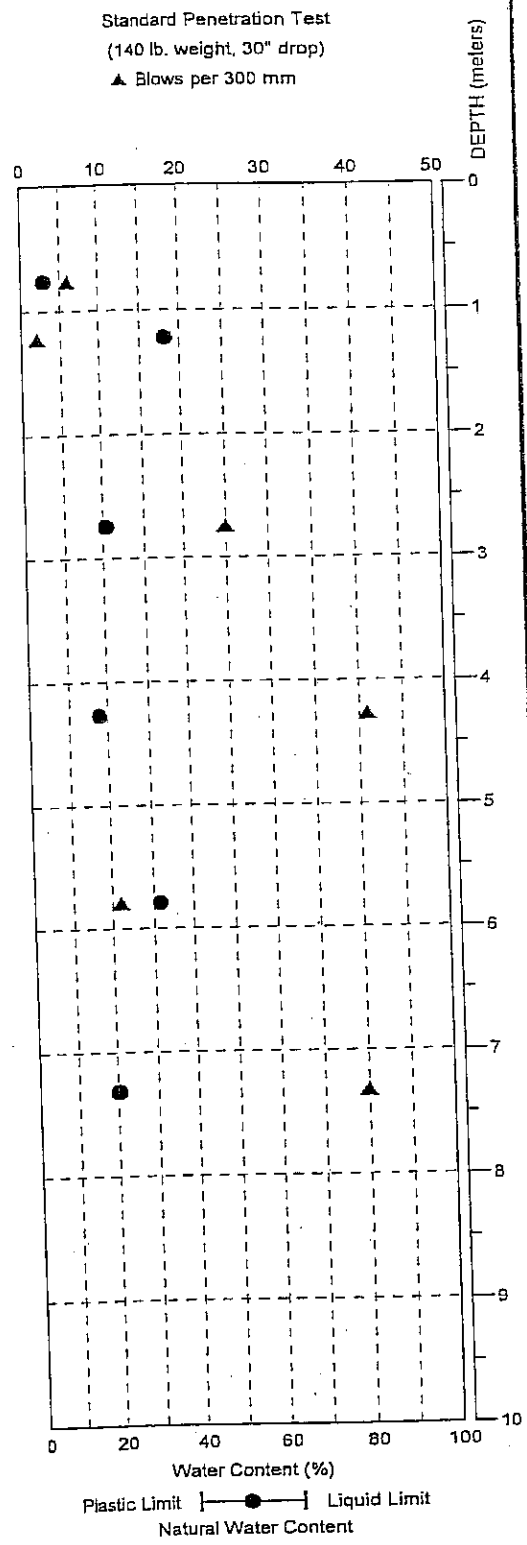

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FIGURE: A-24

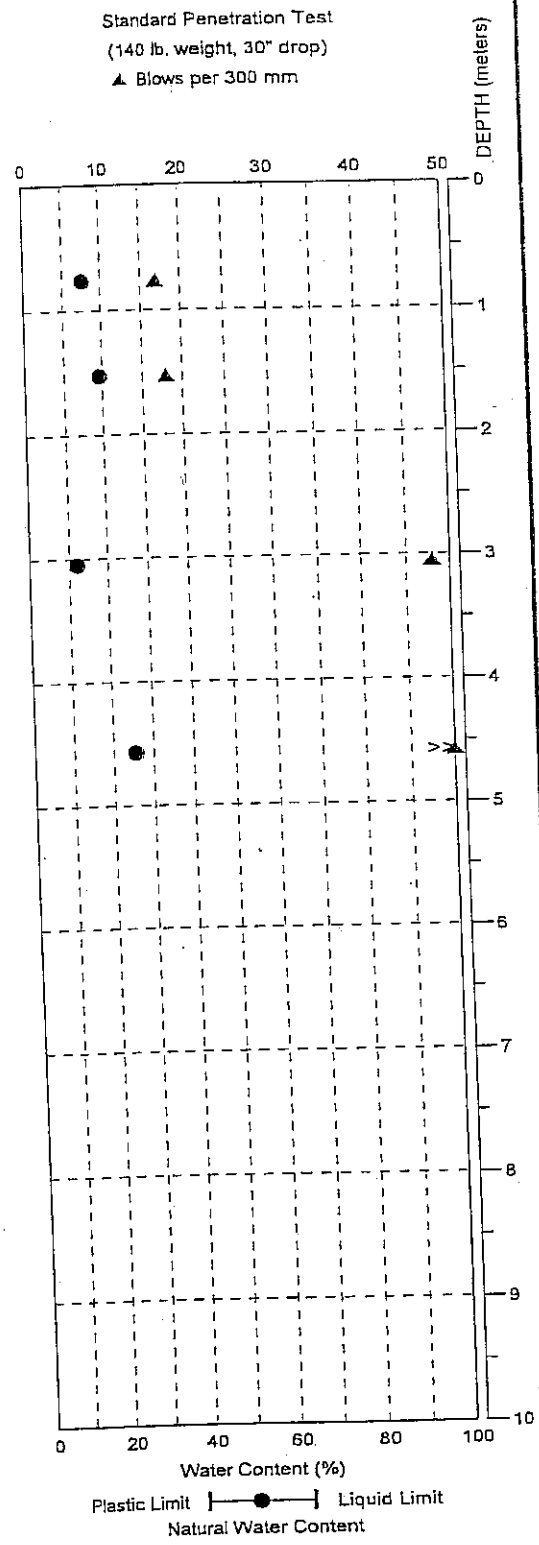
DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 41 ± meters

LOCATION: See Figure 2B
DATE STARTED: 10/13/99
DATE COMPLETED: 10/13/99
LOGGED BY: M. Byers

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0			ASPHALT					
		SM	Medium dense, brown to gray, silty, fine to medium SAND, wet. Trace fine to coarse, subrounded gravel. Grades finer with depth, some oxide stains. (FILL)		S-1	4-5-12		
1		SM	Medium dense, gray, silty, fine to medium SAND, wet. Trace fine to coarse, subrounded gravel. Grades finer with depth, slight oxide stains.		S-2	7-7-11		
2		SP SM	Dense, dark gray, slightly silty, very gravelly, fine to coarse SAND, moist. Fine to coarse subrounded gravel. Large piece of gravel broken in sampler tip. (ADVANCE OUTWASH)		S-3	19-27-21	GS	
3								
4		SM	Very dense, gray, slightly silty, fine SAND, wet.		S-4	29-38-48		
5								
6								
7								
8								
9								
10								

End of borehole at 5.0 meters.

No groundwater observed due to drilling method.



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HWA GEOSCIENCES INC.

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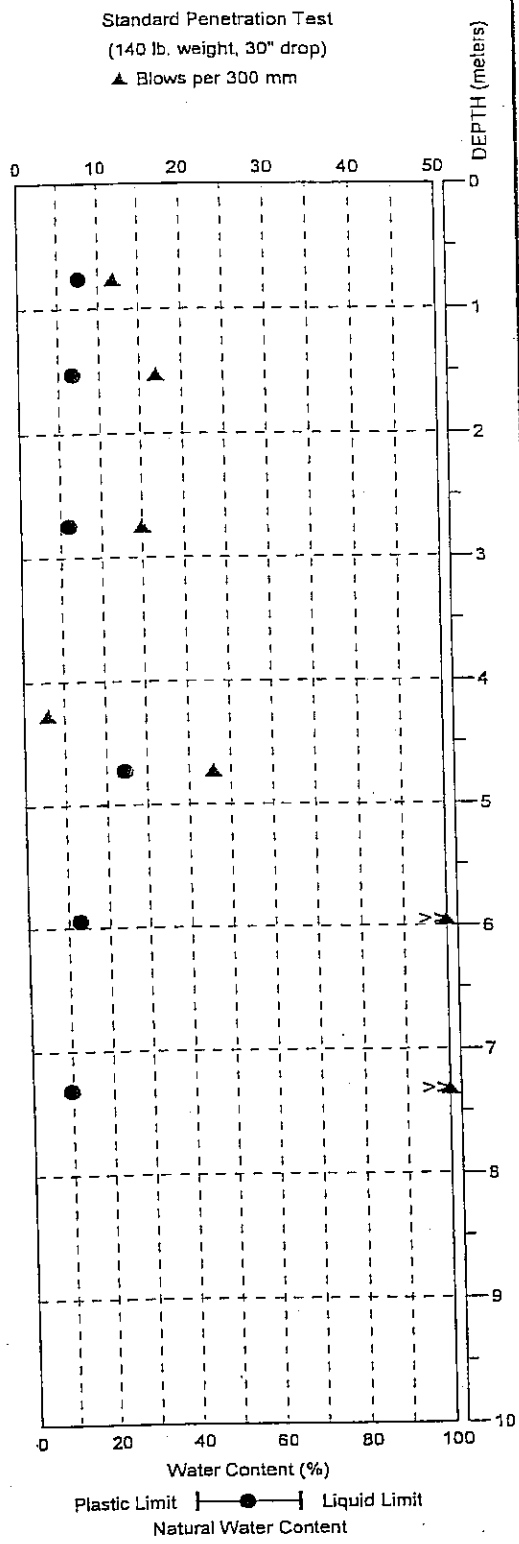
FIGURE: A-25

BORING 98179.GPJ 12/6/99

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 850, HSA
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 37 ± meters

LOCATION: See Figure 2C
DATE STARTED: 11/3/99
DATE COMPLETED: 11/3/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		SP SM	Medium dense, brown, slightly silty, gravelly, fine to medium SAND, moist. Fine to coarse, subrounded gravel. Organics/wood fragments throughout sample. (FILL)	S-1	2-4-8		
1				S-2	8-9-8		
2		SP	Medium dense, brown to dark gray, slightly silty, gravelly, fine to medium SAND, moist. Fine to coarse, subrounded gravel. Some organics/wood fragments.	S-3	3-9-6		
4		SP	Loose to medium dense, brown and gray, silty, gravelly, fine SAND, wet. Fine to coarse, subrounded gravel. [RECENT ALLUVIUM]	S-4A	2-2-1		▽
5				S-4B	1-8-15	%F	
6		GP	Very dense, dark yellowish brown, slightly silty, very sandy, fine to coarse, subrounded to subangular GRAVEL, wet. Fine to coarse sand. (ADVANCE OUTWASH)	S-5	14-63-38	GS	
7		SP	Very dense, brown, gravelly, fine to coarse SAND, wet. Fine to coarse, subrounded gravel.	S-6	8-37 50/100mm		
8			End of borehole at 7.8 meters. Groundwater seepage observed at 4.4 meters at time of drilling.				
9							
10							



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HWA GEOSCIENCES INC.

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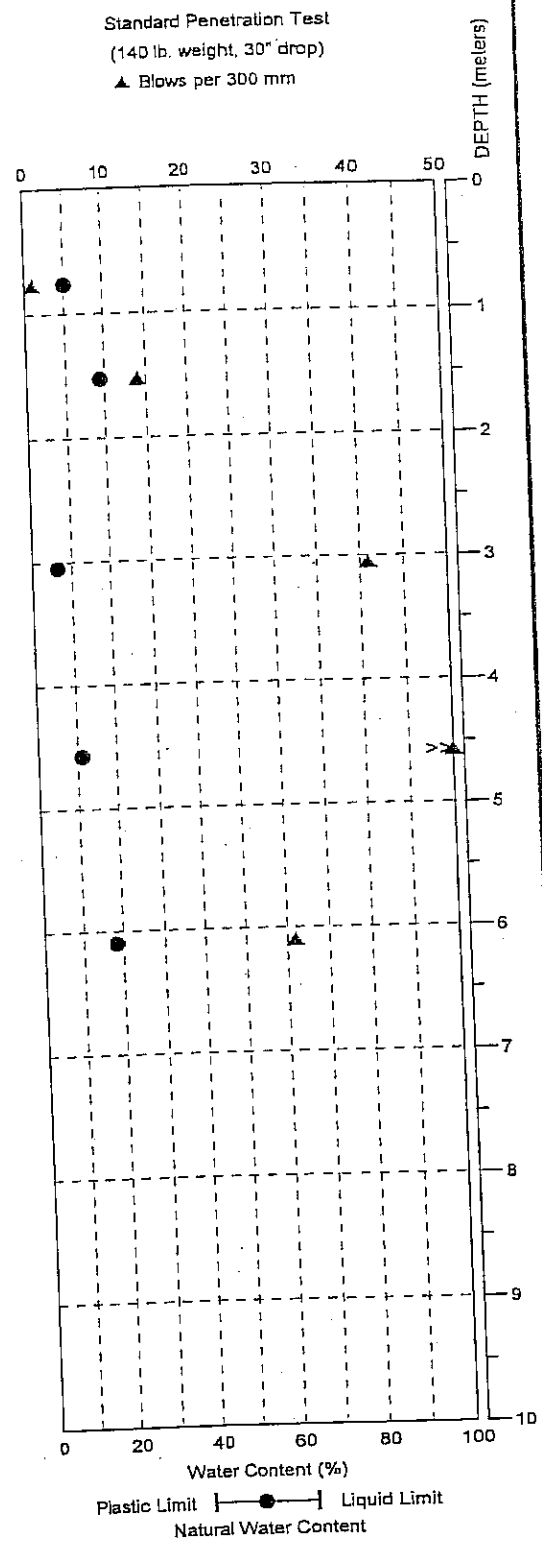
PROJECT NO.: 98179 FIGURE: A-26

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 31 ± meters

LOCATION: See Figure 2C
DATE STARTED: 10/20/99
DATE COMPLETED: 10/20/99
LOGGED BY: M. Byers

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		SM	Very loose, grayish brown, silty, gravelly, fine to medium SAND, wet. Fine to coarse, subrounded gravel. (FILL)	S-1	1-1/300mm		
				S-2	2-1-13		
2.5		GW	Dense, dark gray, very sandy, fine to coarse, subrounded GRAVEL, wet. Fine to coarse sand. (ADVANCE OUTWASH)	S-3	16-21-20	GS	
4		SM	Very dense, dark yellowish to reddish brown (oxide), silty, fine SAND, moist to wet. One 2.5-cm thick gray silty layer.	S-4	16-22-38		
5.5		ML SM	Grades top to bottom from dense, gray, silty, fine to medium SAND, to hard, gray, sandy SILT, wet. Fine sand at bottom of S-5.	S-5	11-13-18		
6.6			End of borehole at 6.6 meters.				

No groundwater seepage observed due to drilling method.



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HWA GEOSCIENCES INC.

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POULSBO, WASHINGTON

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FIGURE: A-27

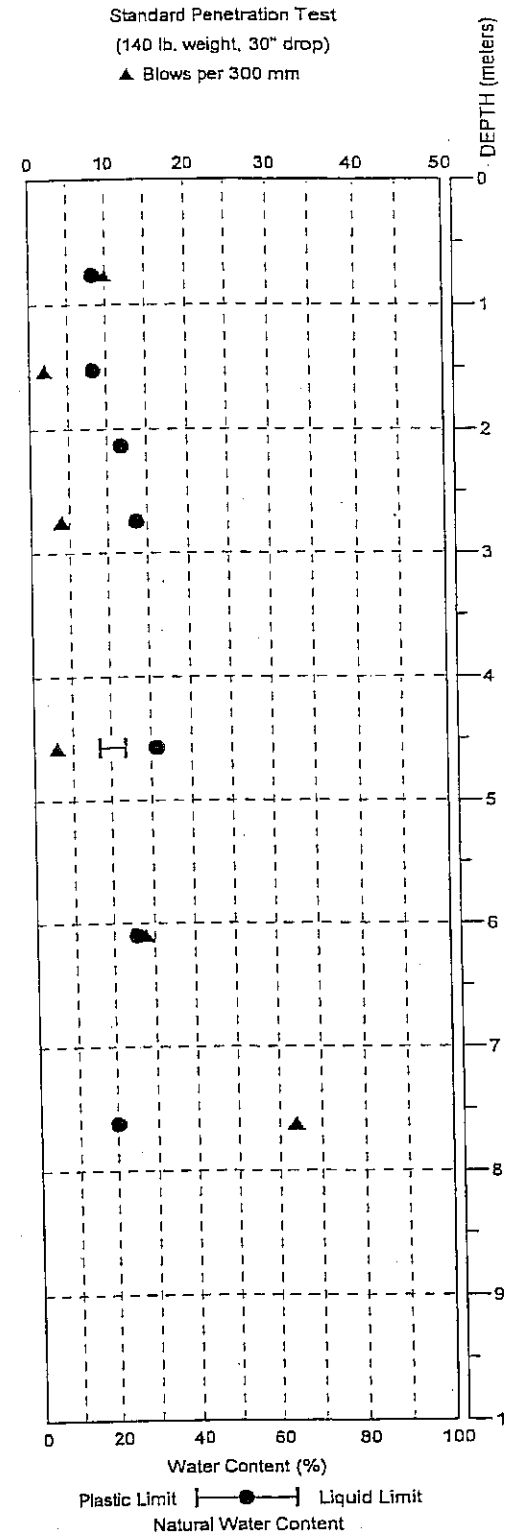
DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 16 ± meters

LOCATION: See Figure 2D
DATE STARTED: 10/19/99
DATE COMPLETED: 10/19/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		SM	Very loose to loose, brown, silty, gravelly, fine to medium SAND, moist. Fine, subrounded gravel. (FILL)	S-1	3-5-5		
1				S-2	1-1-1		
2				S-3			
2.5		CL ML	Soft to medium stiff, dark gray, SILTY CLAY to slightly sandy SILTY CLAY, wet. Fine to medium sand. [RECENT ALLUVIUM]	S-4	2-1-3		
4.5				S-5	3-1-2	AL GS	
6		SP SM	Medium dense, gray, slightly silty, fine to medium SAND, wet.	S-6	7-6-8		
7.5		SP SM	Dense, gray, slightly silty, fine to medium SAND, wet. Grades from silty sand at top to sandy silt at bottom. (ADVANCE OUTWASH)	S-7	11-16-16		

End of borehole at 8.1 meters.

No groundwater seepage observed due to drilling method.



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HWA GEOSCIENCES INC.

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PROJECT NO.: 98179 FIGURE: A-28

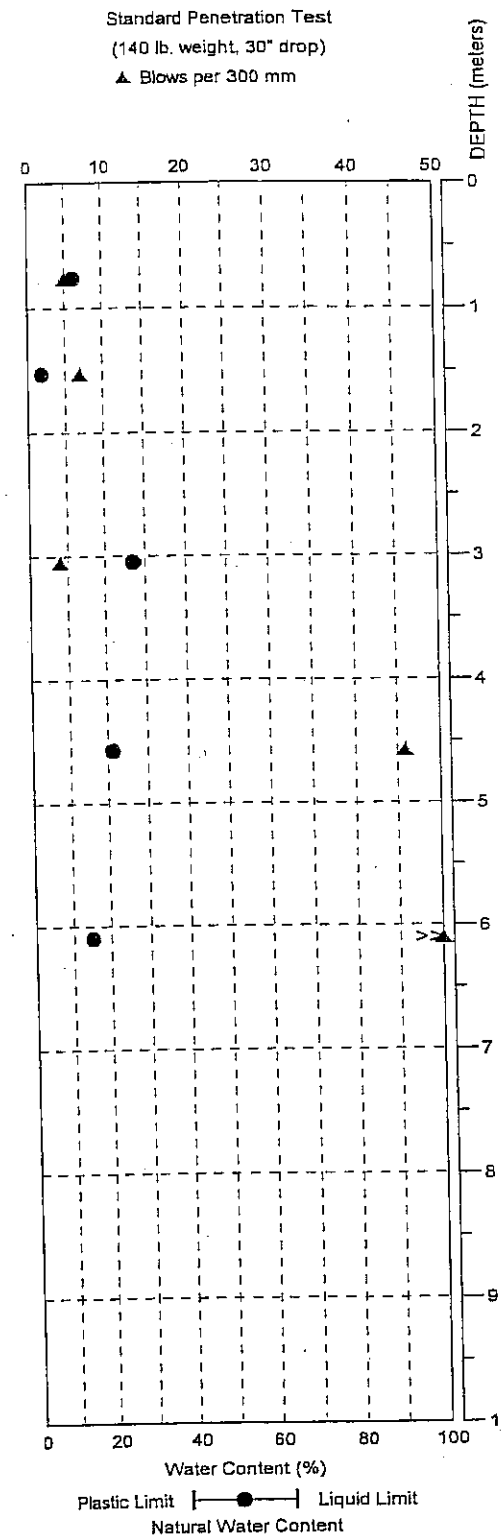
DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 14 ± meters

LOCATION: See Figure 2D
DATE STARTED: 10/20/99
DATE COMPLETED: 10/20/99
LOGGED BY: M. Byers

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0			75 mm asphalt.					
		SM	Loose, dark grayish brown, silty, gravelly, fine to medium SAND, wet. Fine subrounded gravel. Trace organics. (FILL)					
					S-1	3-2-3		
					S-2	2-3-4		
3		CL	Soft, gray, lean CLAY, to loose, gray, silty, fine to medium SAND, wet. (RECENT ALLUVIUM)		S-3	2-2-2		
4		SM	Dense to very dense, dark gray, silty, fine to medium SAND, wet. (ADVANCE OUTWASH)		S-4	14-19-27	%F	
6					S-5	22-31-40		

End of borehole at 6.6 meters.

No groundwater seepage observed due to drilling method.



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HWA GEOSCIENCES INC.

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PROJECT NO.: 98179 FIGURE: A-29

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 45, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 27 ± meters

LOCATION: See Figure 2A
DATE STARTED: 10/19/99
DATE COMPLETED: 10/19/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		SP SM	Very dense, brown, slightly silty, very gravelly, fine to coarse SAND, moist. Fine to coarse, subrounded gravel. (ADVANCE OUTWASH)		S-1	24-36-40		
					S-2	32-50/125mm	%F	
					S-3	32-50/125mm		
4			End of borehole at 3.5 meters.					

No groundwater seepage observed due to drilling method.

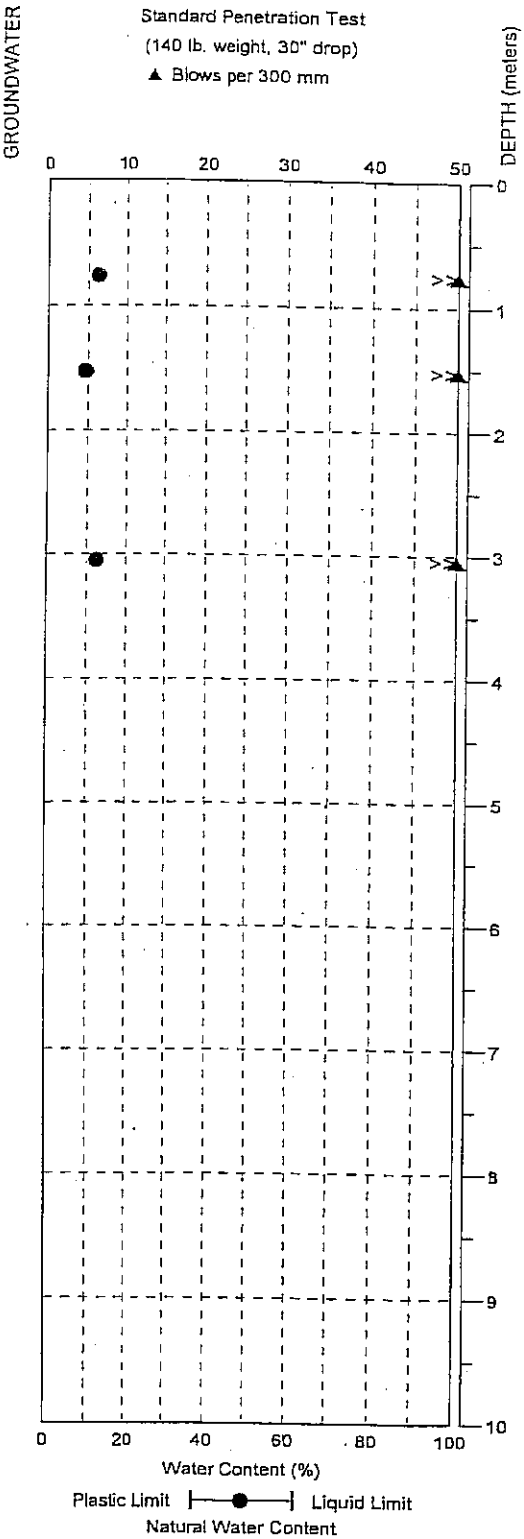

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FIGURE: A-30

BORING 98179.GPJ 12/6/99

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 45, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 31 ± meters

LOCATION: See Figure 2A
DATE STARTED: 10/20/99
DATE COMPLETED: 10/20/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		GP GM	Very dense, brown, slightly silty, very sandy, fine to coarse, subrounded to subangular GRAVEL, moist. Fine to coarse sand. (ADVANCE OUTWASH)		S-1	21-40-54		
1					S-2	54-50/75mm	GS	
2								
3		SM	Very dense, brown, gravelly, silty, fine to coarse SAND, moist. Fine, subround to subangular gravel.		S-3	28-50/100mm	%F	
4								
5					S-4	50/125mm		
6					S-5	50/100mm		
7			End of borehole at 6.6 meters.					
8			No groundwater seepage observed due to drilling method.					
9								
10								

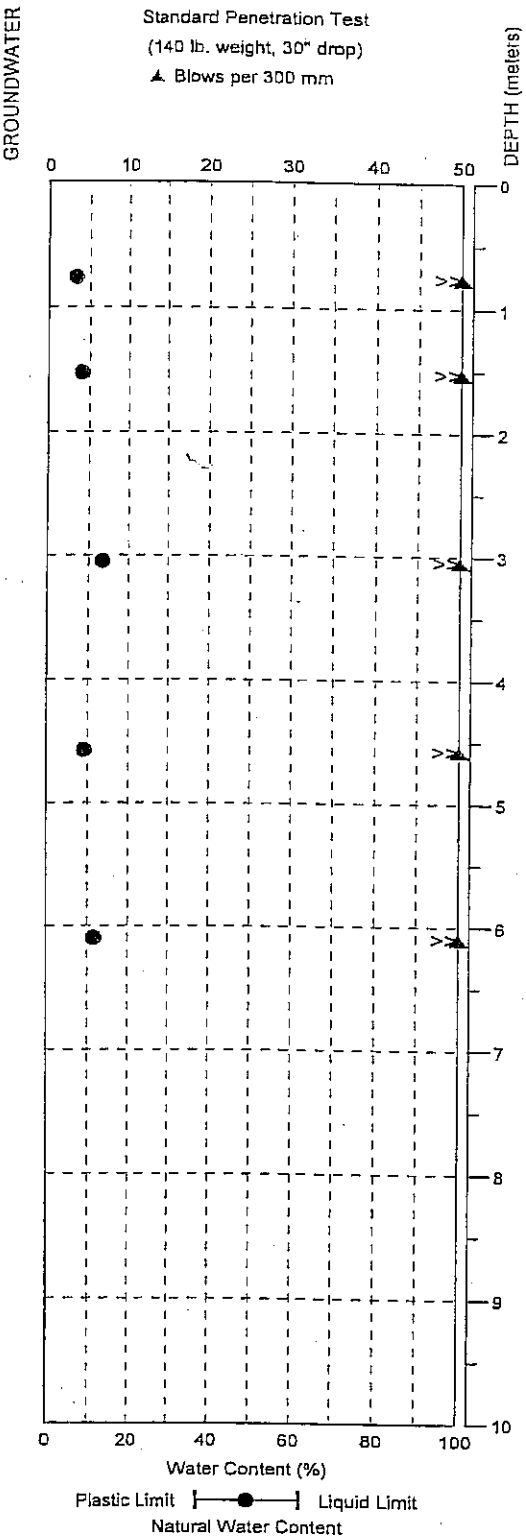

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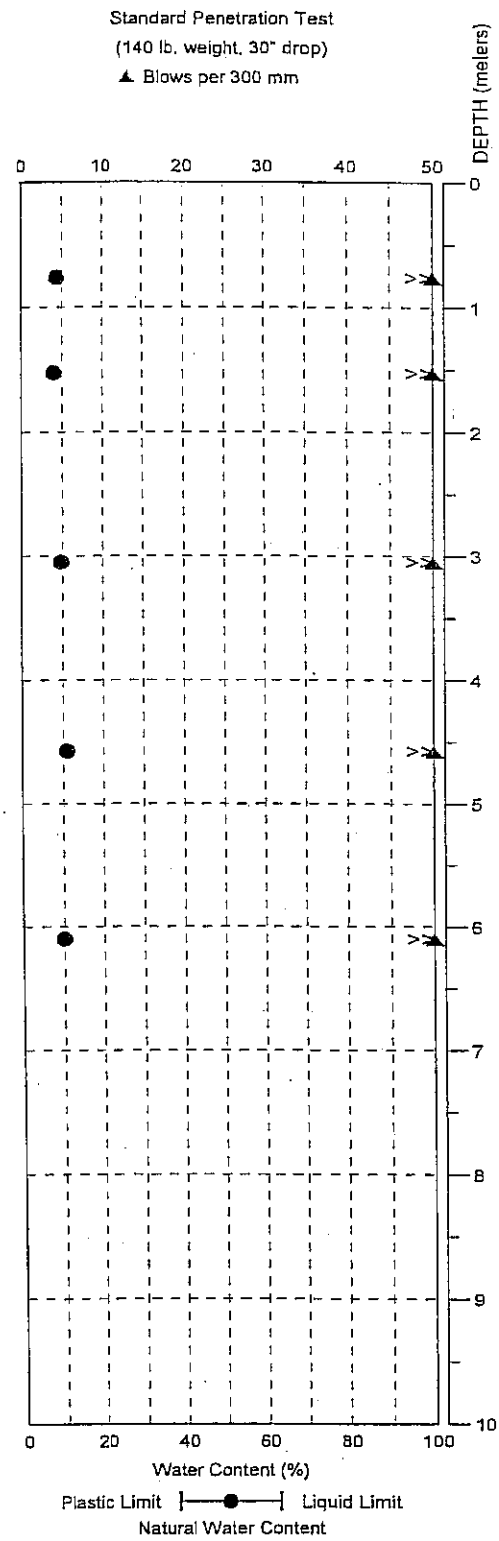
FIGURE: A-31

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 45, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 36 ± meters

LOCATION: See Figure 2B
DATE STARTED: 10/21/99
DATE COMPLETED: 10/21/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		SP SM	Very dense, olive brown, slightly silty, gravelly, fine to coarse SAND, wet. Fine to coarse, subrounded gravel. Driller noted alternating layers of sand and gravel. (ADVANCE OUTWASH)	S-1	15-31-45		
1				S-2	39-50/150mm		
2							
3		GP GM	Very dense, olive brown, slightly silty, very sandy, fine, subrounded GRAVEL, wet. Fine to coarse sand.	S-3	50/150mm	GS	
4							
5		SM	Very dense, dark gray, slightly gravelly, very silty, fine to medium SAND, wet. Fine subrounded gravel.	S-4	34-25-30	GS	
6		GP GM	Very dense, olive brown, slightly silty, sandy, fine, subrounded GRAVEL, wet. Fine to coarse sand.	S-5	100/100mm		
7			End of borehole at 6.6 meters.				
8			No groundwater seepage observed due to drilling method.				
9							
10							



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PROJECT NO.: 98179 FIGURE: A-32

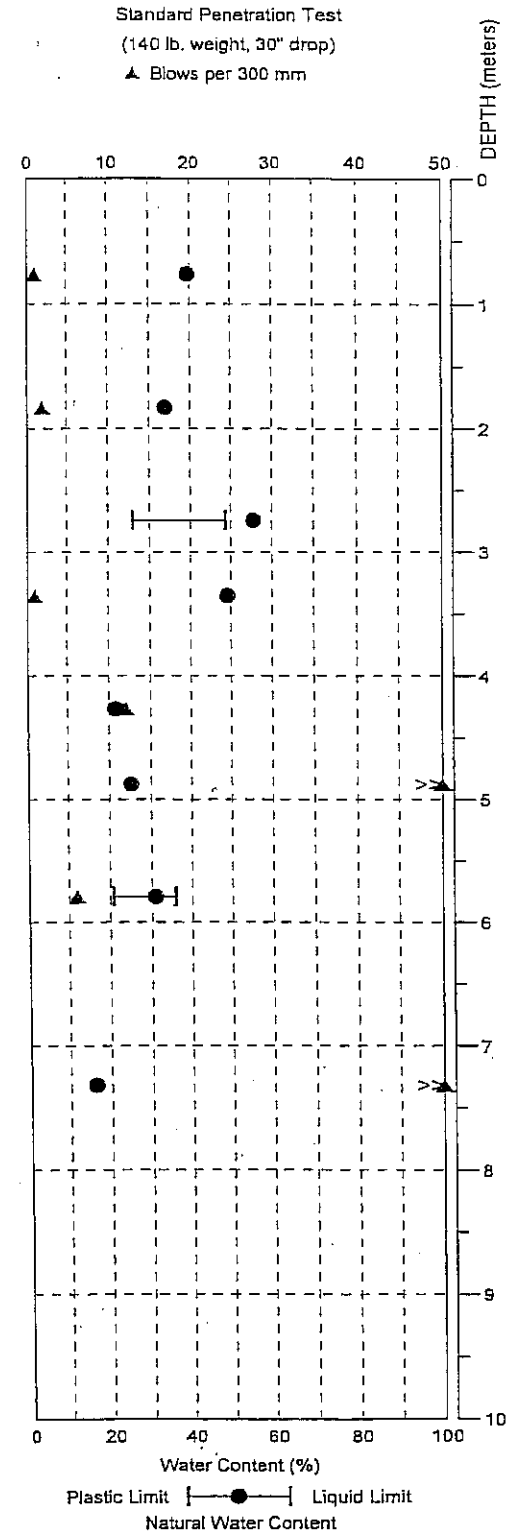
BORING 98179.GPJ 12/6/99

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 45, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 15 ± meters

LOCATION: See Figure 2D
DATE STARTED: 11/3/99
DATE COMPLETED: 11/3/99
LOGGED BY: B. Hawkins

DEPTH (meters)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS
0	CL	Very soft, dark gray and brown, slightly sandy, CLAY, wet. Fine sand. Organics present throughout sample. (RECENT ALLUVIUM)	S-1	1/450mm	
			S-2		
2			S-3	2/450mm	
3			S-4		AL
			S-5	1/450mm	
4	CL	Stiff, dark gray, CLAY, wet. Some laminated sand layers.	S-6	1-3-9	
5	SM	Very dense, dark gray, silty, fine to medium SAND, moist.	S-7	10-24-32	%F
6	CL	Medium stiff, dark gray, slightly sandy, CLAY, wet. Fine sand.	S-8	5-3-3	AL %F
7	SP SM	Very dense, dark gray, slightly silty, gravelly, fine to coarse SAND, moist. Fine, subround gravel. (ADVANCE OUTWASH)	S-9	18-32-39	
8		End of borehole at 7.8 meters.			
		No groundwater seepage observed due to drilling method.			
9					
10					

GROUNDWATER



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HWA GEOSCIENCES INC.

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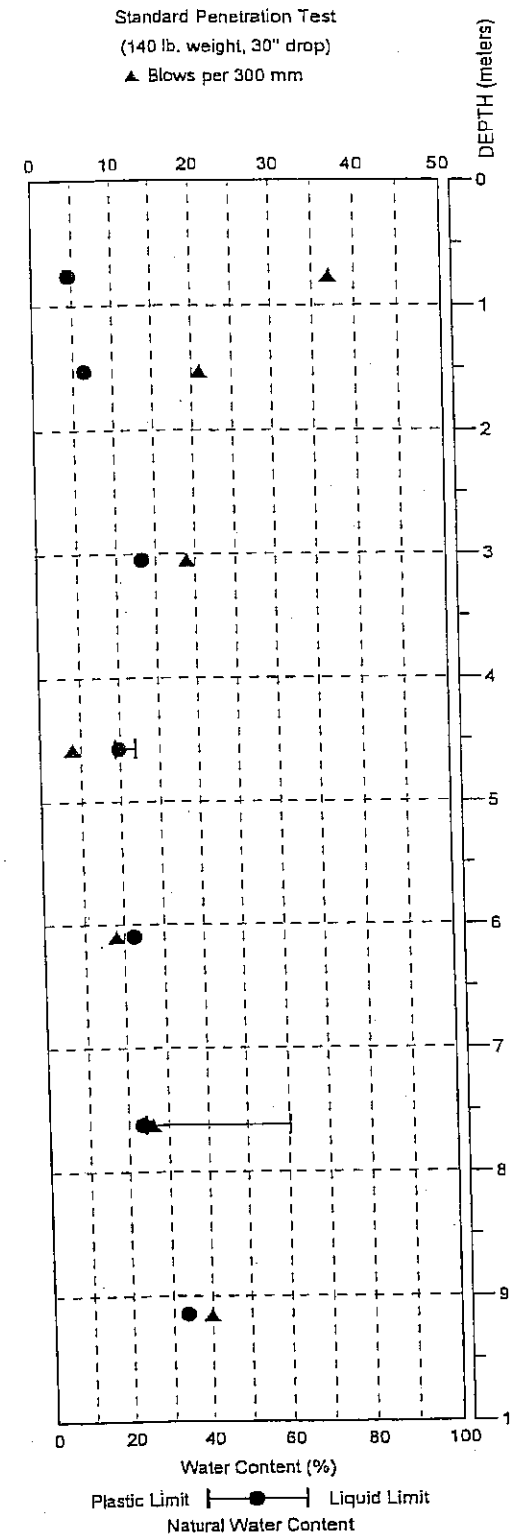
PROJECT NO.: 98179 FIGURE: A-33

BORING 98179.GPJ 12/6/99

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 15 ± meters

LL ION: See Figure 2D
DATE STARTED: 10/19/99
DATE COMPLETED: 10/19/99
LOGGED BY: M. Byers

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		SM	Dense, dark gray, gravelly, silty, fine to medium SAND, moist. Fine, subrounded gravel. Trace roots. (FILL)		S-1	13-16-21		
1		SM	Medium dense, dark gray, gravelly, silty, fine to medium SAND, wet. Fine to coarse, subrounded gravel. Trace roots.		S-2	13-9-12		
2		ML	Very stiff, dark gray, sandy, SILT, wet. Fine sand. (RECENT ALLUVIUM)		S-3	6-8-11	%F	
3		CL ML	Soft, dark gray, SILTY CLAY, wet.		S-4	1-2-2	AL	
4		CH	Medium stiff to stiff, dark gray, fat CLAY, wet.		S-5	8-5-4		
5					S-6	2-5-8	AL	
6					S-7	5-7-13		
7								
8								
9								
10								



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HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

BORING:
BH-33

PAGE: 1 of 2

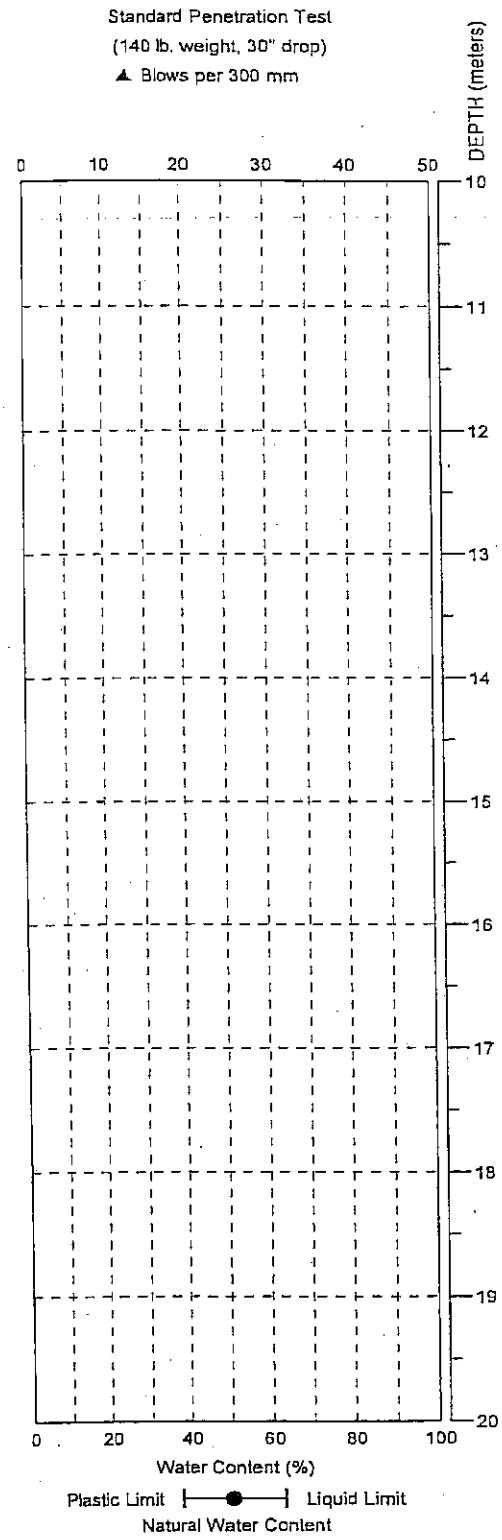
PROJECT NO.: 98179 FIGURE: A-34

BORING 98179.GPJ 12/6/99

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 15 ± meters

LOCATION: See Figure 2D
DATE STARTED: 10/19/99
DATE COMPLETED: 10/19/99
LOGGED BY: M. Byers

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
10			End of borehole at 9.6 meters.					
			No groundwater seepage observed due to drilling method.					
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								



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HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

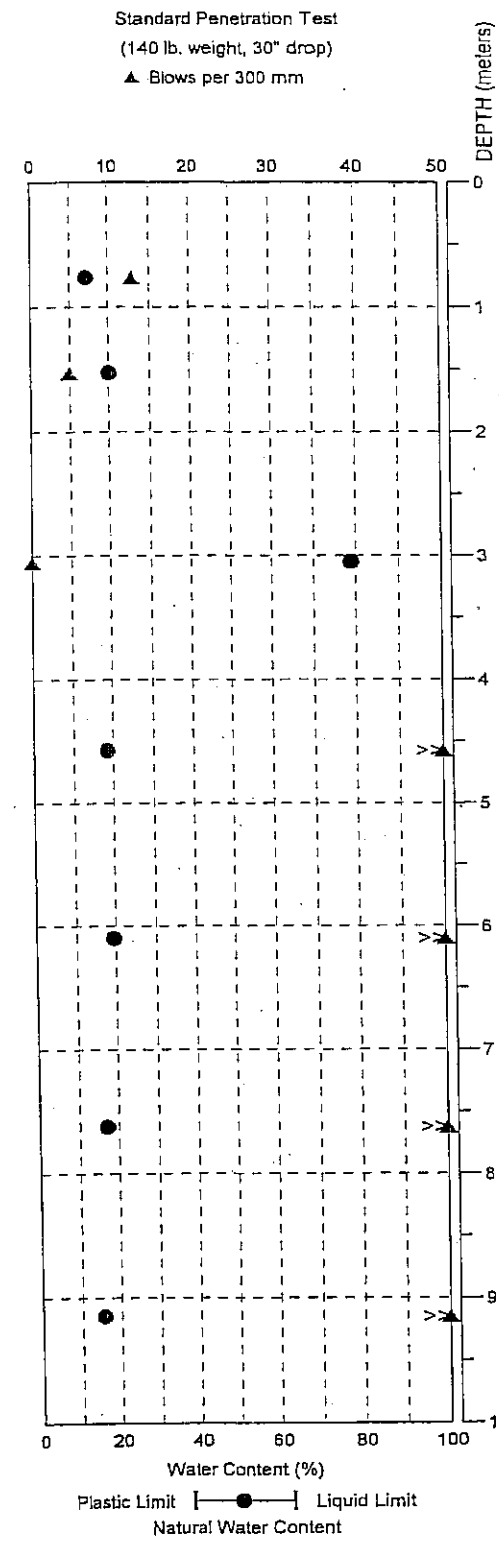
BORING:
BH-33

PROJECT NO.: 98179 FIGURE: A-34

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 45, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 12 ± meters

TION: See Figure 2E
DATE STARTED: 10/28/99
DATE COMPLETED: 10/29/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		SM	Loose to medium dense, brown, slightly gravelly, silty, fine to medium SAND, moist. Fine, subround gravel. (RECENT ALLUVIUM)	S-1	4-6-7		
1				S-2	3-3-2		
2							
3		SM	Very loose, dark reddish brown, silty, fine SAND, wet. Abundant organics.	S-3	0/450mm	AL %F	
4		SM	Very dense, olive gray, slightly silty to silty, fine to medium SAND, wet. (ADVANCE OUTWASH)	S-4	17-25-31	%F	
5							
6				S-5	22-33-44		
7							
8				S-6	24-35-50		
9				S-7	22-32-36		
10							



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HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

BORING:
BH-34

PAGE: 1 of 2

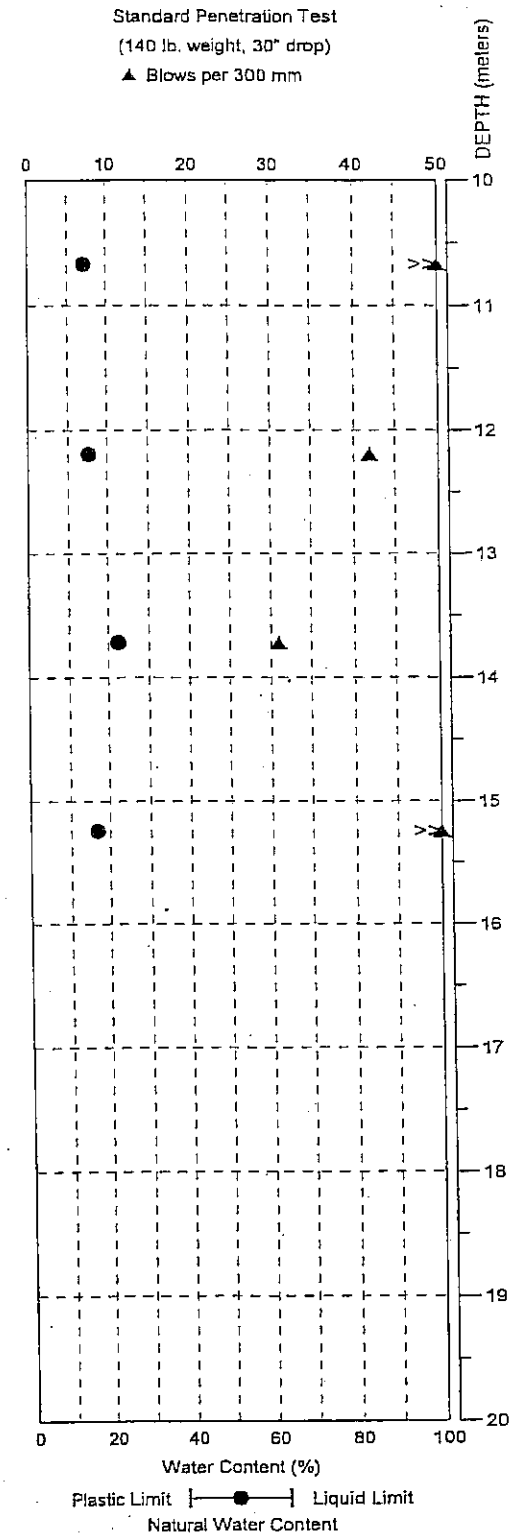
PROJECT NO.: 98179 FIGURE: A-35

BORING 98179.GPJ 12/6/99

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 45, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 12 ± meters

LOCATION: See Figure 2E
DATE STARTED: 10/28/99
DATE COMPLETED: 10/29/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
10		SM	Very dense, olive gray, slightly silty to silty, fine to medium SAND, wet.					
11					S-8	24-39-46		
12					S-9	17-21-21		
		ML	Very stiff, gray, slightly sandy to sandy, SILT, wet. Fine to medium sand. (GLACIOLACUSTRINE)					
13								
14					S-10	8-11-20		
		ML SM	Hard, gray, slightly gravelly, very sandy, SILT, wet. Fine to medium sand, fine subround gravel.					
15					S-11	14-21-30		
16			End of borehole at 15.7 meters.					
			No groundwater seepage observed due to drilling method.					
17								
18								
19								
20								



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HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

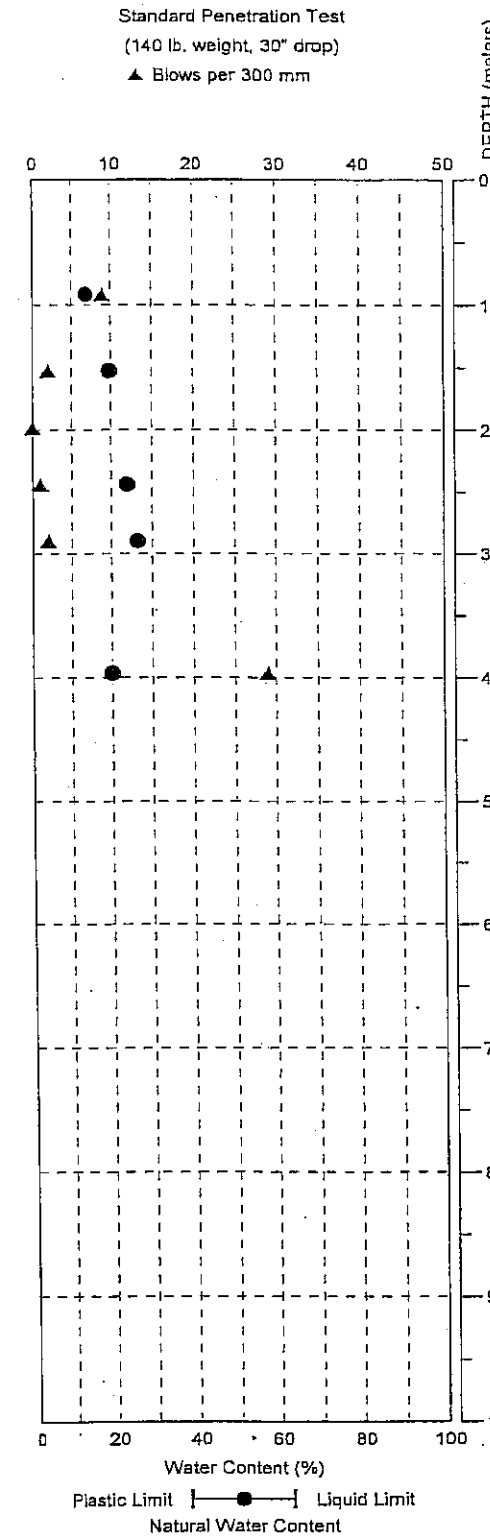
BORING:
BH-34

PROJECT NO.: 98179 FIGURE: A-35

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 45, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 12 ± meters

LOCATION: See Figure 2E
DATE STARTED: 11/1/99
DATE COMPLETED: 11/1/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		SM	Very loose, reddish brown, silty, gravelly, fine to medium SAND, wet. Fine, subround gravel. (RECENT ALLUVIUM)				
1				S-1	5-5-4		
				S-2	2-1-1		
2				S-3	0/450mm		
		ML	Very soft, dark brown, sandy, SILT, wet. Fine sand, abundant organics.	S-4	1/450mm		
3				S-5	2/450mm		
				S-6			
4		SM	Dense, brown and gray, slightly silty to silty, fine SAND, moist. (ADVANCE OUTWASH)	S-7	7-15-14		
5			End of borehole at 4.4 meters. No groundwater seepage observed due to drilling method.				
6							
7							
8							
9							
10							



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HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

BORING:
BH-35

PAGE: 1 of 1

PROJECT NO.: 98179 FIGURE: A-36

BORING 98179.GPJ 12/6/99

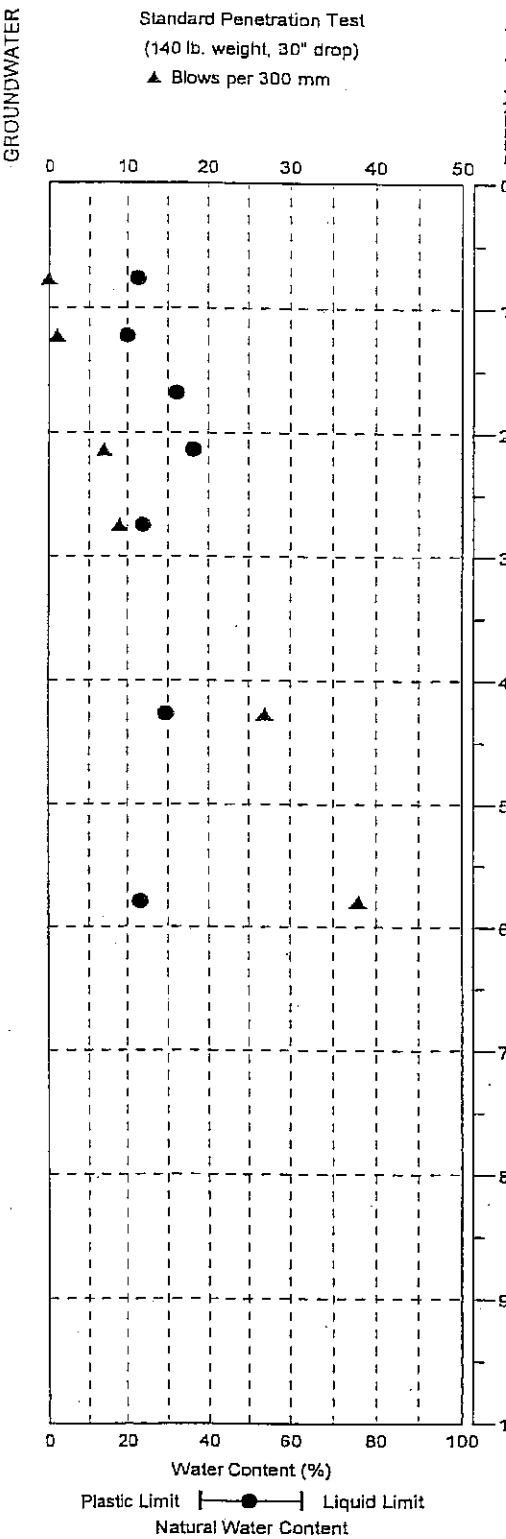
DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 45, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 12 ± meters

LOCATION: See Figure 2E
DATE STARTED: 11/2/99
DATE COMPLETED: 11/2/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
0		SP SM	Very loose, brown, slightly silty, gravelly, fine to coarse SAND, wet. Fine, subround gravel. (RECENT ALLUVIUM)	S-1	0/450mm		
		OL	Very soft, dark brown, very sandy, organic SILT, wet. Abundant organics, wood fragments.	S-2	1/450mm	AL %F	
				S-3		%F	
2		SM	Loose, very dark brown, very silty, fine SAND, wet.	S-4	2-2-5		
3		SP SM	Loose, gray, slightly silty, fine to medium SAND, wet.	S-5	3-4-5		
4		SM	Medium dense to dense, gray, very silty, fine SAND, wet. Interbedded clay, silt lenses. (ADVANCE OUTWASH)	S-6	2-5-22	GS	
6				S-7	15-20-18		

End of borehole at 6.2 meters.

No groundwater seepage observed due to drilling method.



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HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

BORING:
BH-36

PAGE: 1 of 1

PROJECT NO.: 98179 FIGURE: A-37

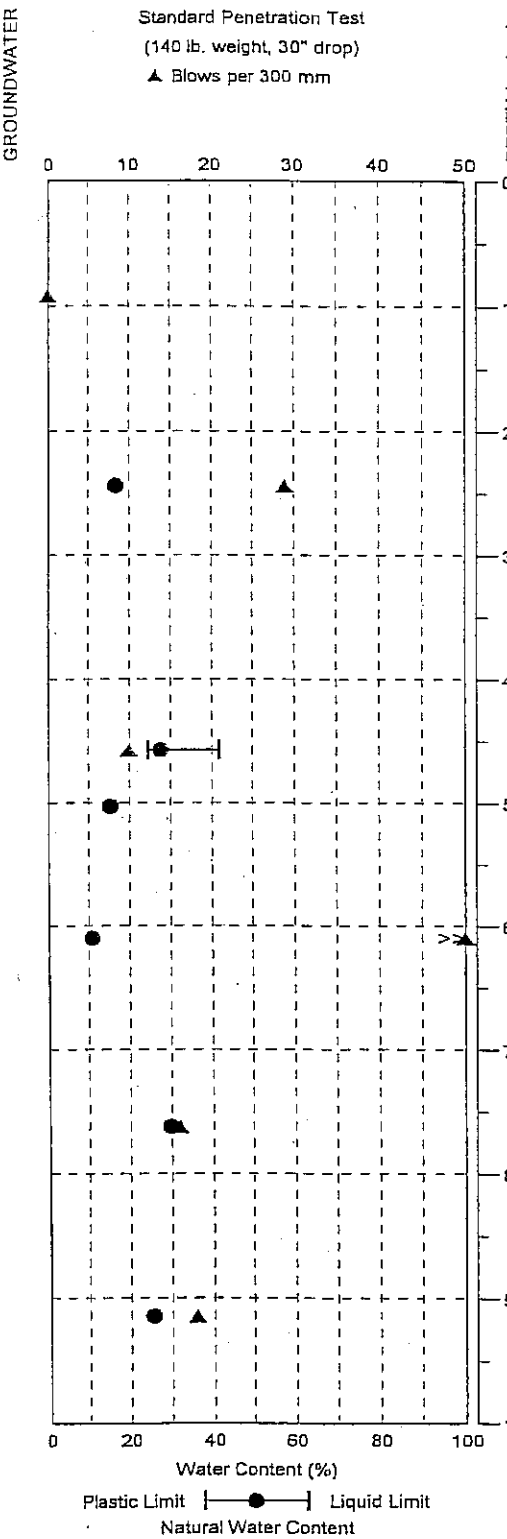
BORING 98179.GPJ 12/6/99

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 45, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 11 ± meters

LOCATION: See Figure 2E
DATE STARTED: 10/27/99
DATE COMPLETED: 10/27/99
LOGGED BY: B. Hawkins

DEPTH (meters)	USCS SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS
0	SM	Very loose, dark brown, silty, gravelly, fine to medium SAND, wet. Abundant organics. (RECENT ALLUVIUM)	S-1A	0/18"	
2	SP SM	Medium dense, gray, slightly silty, fine to medium SAND, moist.	S-1	10-13-16	
4	CL	Stiff, dark gray, CLAY, moist.	S-2	4-4-6	AL
5	ML	Hard, dark gray, slightly gravelly, sandy, SILT, moist. Fine sand, fine subround gravel. (GLACIOLACUSTRINE)	S-3		
6			S-4	16-27-27	
7.5	CL	Very stiff to hard, dark gray, CLAY, moist.	S-5	4-7-9	
9			S-6	4-8-10	

GROUNDWATER



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HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

BORING:
BH-37

PAGE: 1 of 2

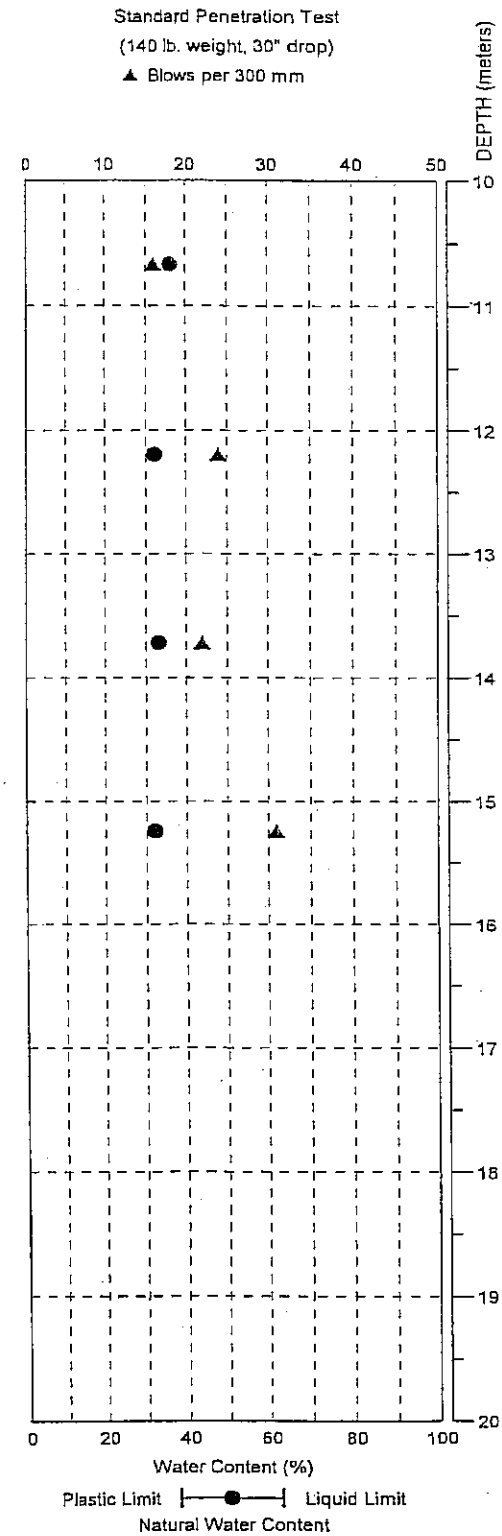
PROJECT NO.: 98179 FIGURE: A-38

BORING 98179.GPJ 12/6/99

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 45, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 11 ± meters

LOCATION: See Figure 2E
DATE STARTED: 10/27/99
DATE COMPLETED: 10/27/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
10		CL	Very stiff to hard, dark gray, CLAY, moist.					
11					S-7	3-6-10		
12					S-8	8-10-14		
13					S-9	8-9-13		
14								
15					S-10	8-12-19		
16			End of borehole at 15.7 meters.					
			No groundwater seepage observed due to drilling method.					
17								
18								
19								
20								



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SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

BORING:
BH-37

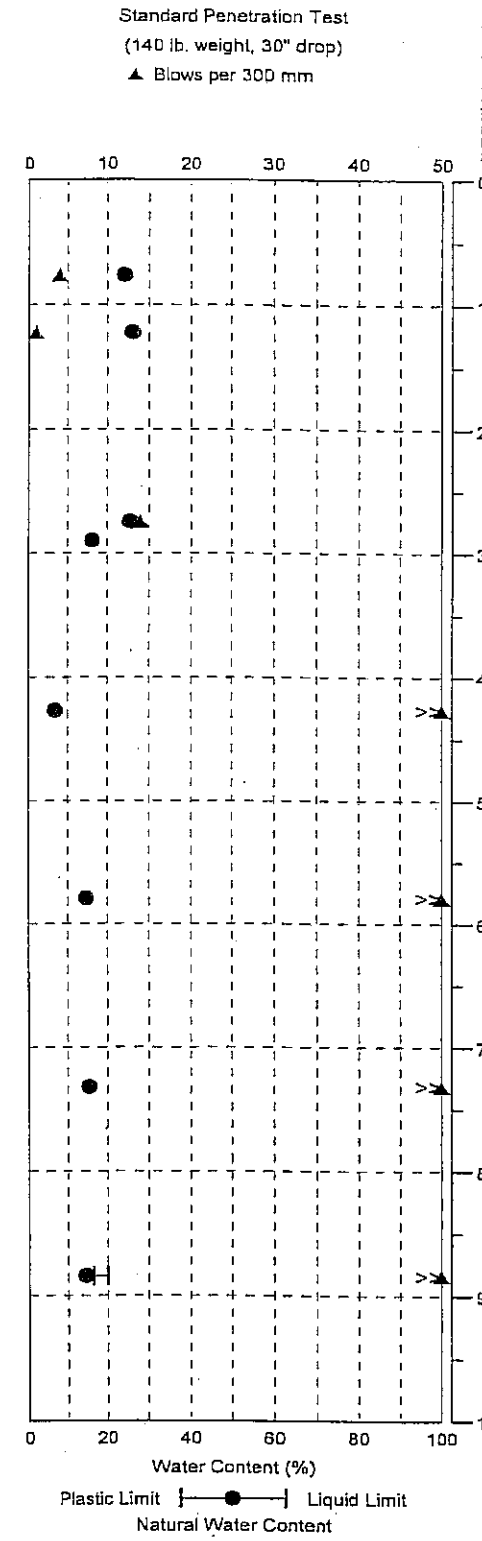
PROJECT NO.: 98179 FIGURE: A-38

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 41 ± meters

LOCATION: See Figure 2B
DATE STARTED: 10/13/99
DATE COMPLETED: 10/14/99
LOGGED BY: B. Hawkins

DEPTH (meters)	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS
0	ML	Very soft to soft, grayish brown, slightly sandy, slightly gravelly, SILT, moist. Fine to medium sand. Fine gravel. (RECENT ALLUVIUM)				
				S-1	3-2-2	
1				S-2	1/300mm-1	AL
2	SM	Medium dense, grayish brown, gravelly, very silty, fine to medium SAND, moist. Fine subrounded gravel.				
3				S-3	4-7-7	
				S-3B		GS
4	GW GM	Very dense, grayish brown, slightly silty, very sandy, fine to coarse, subrounded to subangular GRAVEL, moist. Fine to coarse sand. (ADVANCE OUTWASH)		S-4	30-38-39	GS
5						
6				S-5	50/125mm	
7				S-7	50/150mm	
8	ML	Hard, dark gray, gravelly, sandy, SILT, moist. Fine to coarse, subrounded gravel. Fine sand. (GLACIOLACUSTRINE)				
9				S-8	41-28-50	AL
10						

GROUNDWATER



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HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

BORING:
BH-38

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PROJECT NO.: 98179

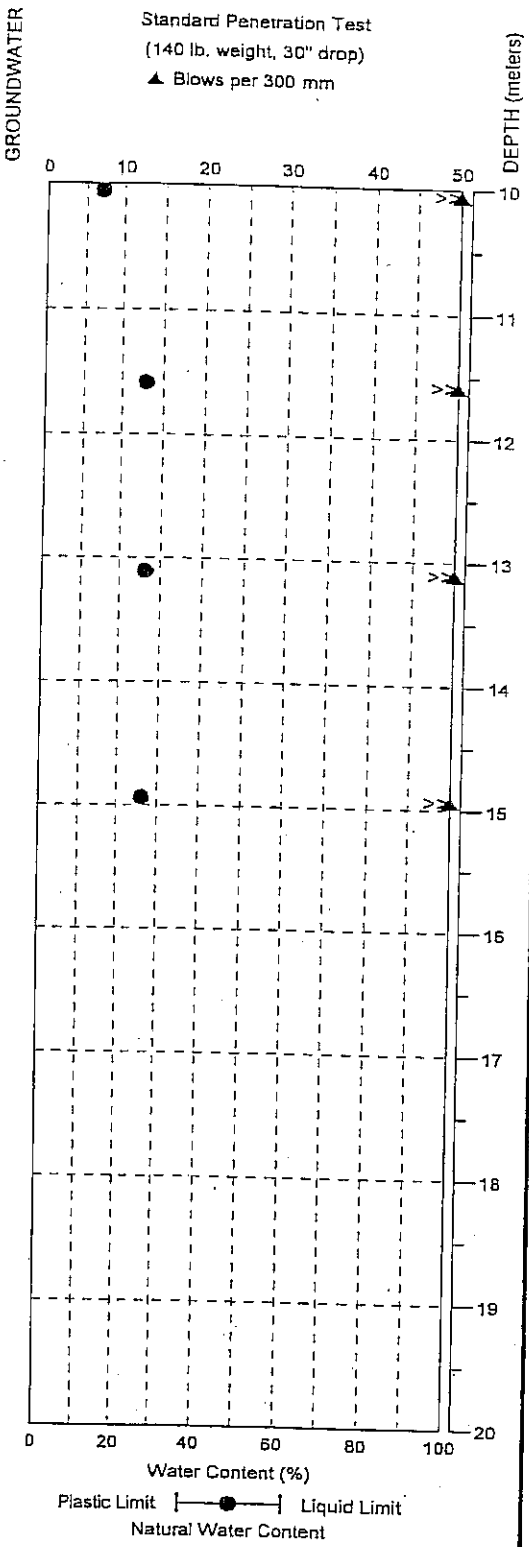
FIGURE: A-39

BORING 98179.GPJ 12/6/99

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 55, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 41 ± meters

LOCATION: See Figure 2B
DATE STARTED: 10/13/99
DATE COMPLETED: 10/14/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
10				S-9	50/125mm		
11		ML	Hard, gray, sandy, SILT, moist. Fine sand.				
12				S-10	20-54 50/75mm		
13				S-11	18 51/150mm		
14							
15				S-12	21-43 50/75mm		
16			End of borehole at 15.4 meters.				
17			No groundwater seepage observed due to drilling method.				
18							
19							
20							



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BORING:
BH-38

PROJECT NO.: 98179

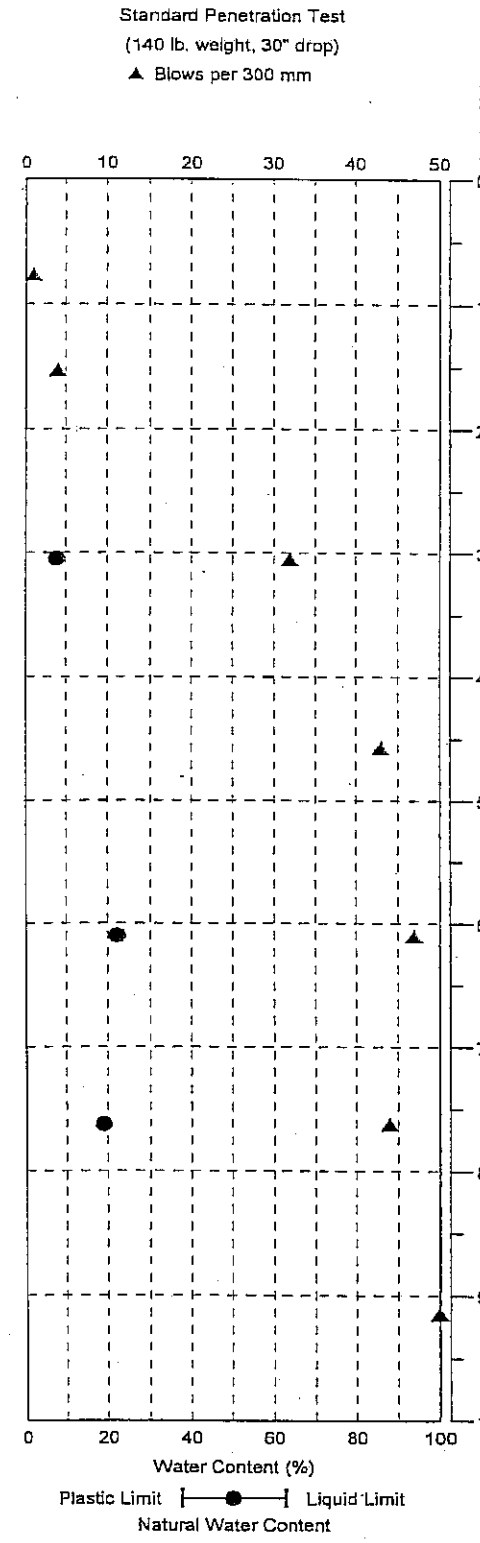
FIGURE: A-39

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 45, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 33 ± meters

LOCATION: See Figure 2C
DATE STARTED: 11/9/99
DATE COMPLETED: 11/9/99
LOGGED BY: B. Hawkins

DEPTH (meters)	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS
0	SM	Very loose, dark brown, silty, gravelly, fine to coarse SAND, wet. Fine to coarse, subround gravel. Abundant organics. (FILL)	S-1	1-1/300mm	
1			S-2	1-2-3	
2					
3	GP GM	Dense, brown, slightly silty, very sandy, fine to coarse, subrounded GRAVEL, wet. Fine to coarse sand. Oxidation stains noted throughout sample. (ADVANCE OUTWASH)	S-3	13-14-18	GS
4			S-4	20-23-20	
5	SP SM	Dense, brown, slightly silty, fine to coarse SAND, moist.			
6	SP SM	Dense, olive gray, slightly silty, fine to coarse SAND, moist.	S-5	18-24-23	GS
7					
8			S-6	20-21-23	GS
9	SM	Dense to very dense, olive gray, silty, fine to coarse SAND, moist. Several silt lenses.	S-7	14-21-29	
10					

GROUNDWATER



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HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

BORING:
BH-39

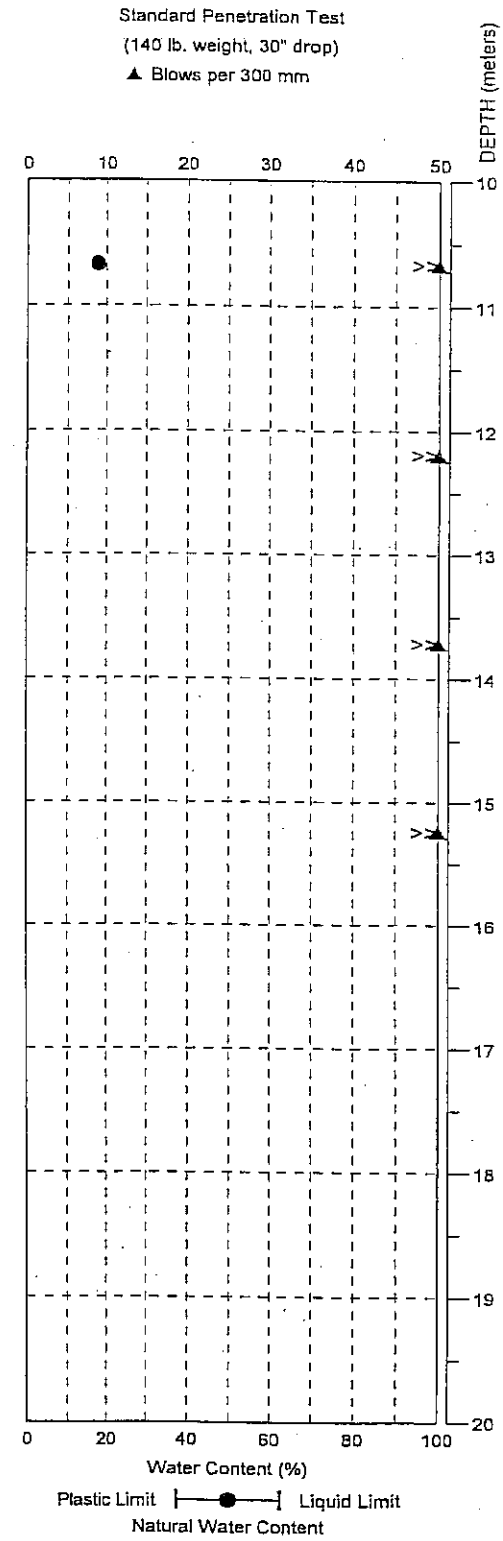
PROJECT NO.: 98179 FIGURE: A-40

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME 45, Mud rotary
SAMPLING METHOD: SPT, AUTOHAMMER
SURFACE ELEVATION: 33 ± meters

LOCATION: See Figure 2C
DATE STARTED: 11/9/99
DATE COMPLETED: 11/9/99
LOGGED BY: B. Hawkins

DEPTH (meters)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER	PEN. RESISTANCE (blows/150 mm)	OTHER TESTS	GROUNDWATER
10–11				S-8	21-28-37	GS	
11–12		ML	Hard, gray, sandy, SILT, moist. Fine sand. Trace fine, subround gravel. (GLACIOLACUSTRINE)				
12				S-9	21-43-50		
13–14				S-10	50/125mm		
15				S-11	20-31 50/75mm		
16			End of borehole at 15.7 meters.				

No groundwater seepage observed due to drilling method.



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BORING: BH-39

PROJECT NO.: 98179 FIGURE: A-40

BORING 98179.GPJ 12/6/99

APPENDIX B

LABORATORY TESTING

APPENDIX B

LABORATORY TESTING

Representative soil samples obtained from the explorations were returned to the HWA laboratory for further examination and testing. Laboratory tests were conducted on selected soil samples to characterize relevant engineering and index properties of the on-site soils. Laboratory tests, as described below, included determination of moisture content, grain size distribution, percent fines, Atterberg Limits, consolidation characteristics, and pH and resistivity.

Moisture Content Testing

All soil samples obtained were tested for moisture content in general accordance with ASTM D 2216. The results of the moisture content determinations are shown on the appropriate exploration logs in Appendix A.

Grain Size Analysis

The grain size distributions for 30 soil samples were determined in general accordance with ASTM D 422. Results of these analyses are plotted on Figures B-1 through B-19.

Percent Fines Analysis

The percent fines (percent passing the US Standard No. 200 sieve) was determined for 25 soil samples in general accordance with ASTM D 1140. Results of these analyses are plotted on Figures B-1 through B-19.

Atterberg Limits Testing

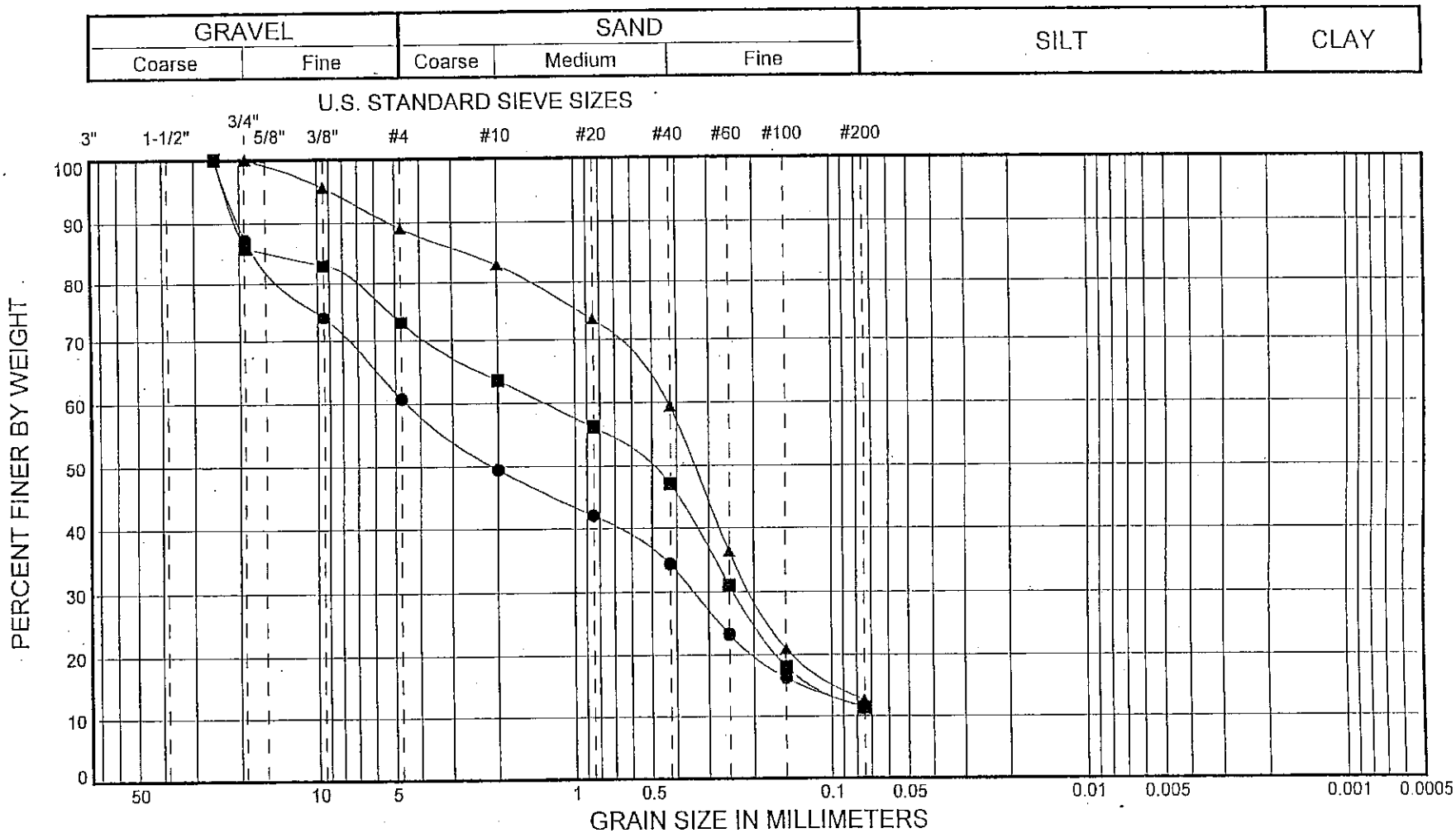
The liquid limit and plastic limit (plasticity characteristics) were determined for 16 soil samples. The tests were conducted in general accordance with test method ASTM D 4318-84; the results are plotted on Figures B-20 through B-22.

Consolidation Testing

Consolidation characteristics were determined for 3 soil samples in general accordance with test method ASTM D 2435; the results are plotted on Figures B-23 through B-25.

Soil pH and Minimum Resistivity

Selected soil samples collected from the borings were tested for determination of soil pH and minimum resistivity, in general accordance with WSDOT Test Method No. 417; the results are plotted on Figure B-26.



SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH- 1	S-1	0.9 - 1.4	(SP-SM) Dark grayish brown, slightly silty, gravelly, fine to coarse SAND	5				39.2	49.3	11.5
■	BH- 2	S-2	2.4 - 2.9	(SP-SM) Dark grayish brown, slightly silty, gravelly, fine to coarse SAND	10				26.9	61.8	11.4
▲	BH- 3	S-1	1.2 - 1.7	(SM) Very dark grayish brown, silty, fine to medium SAND	12				11.0	76.4	12.7

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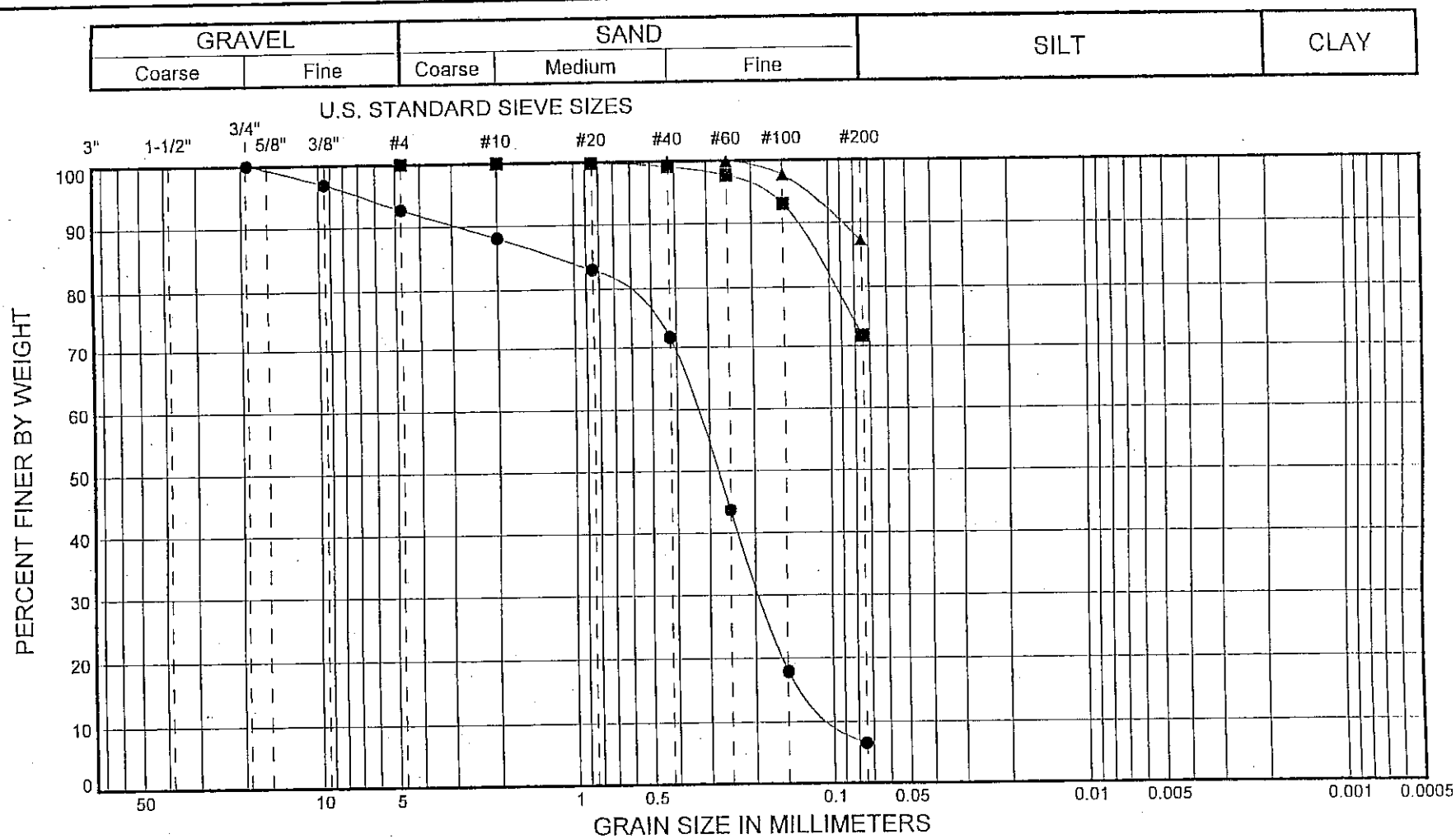
GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179 FIGURE: B-1



SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH- 4	S-3	4.0 - 4.4	(SP-SM) Dark gray, slightly silty, slightly gravelly, fine to medium SAND	18				7.2	86.2	6.6
■	BH- 5	S-2	2.4 - 2.9	(ML) Dark gray, sandy SILT	29					28.1	71.9
▲	BH- 6	S-3	4.0 - 4.4	(CL) Dark gray, lean CLAY	32	32	18	14		12.8	87.2

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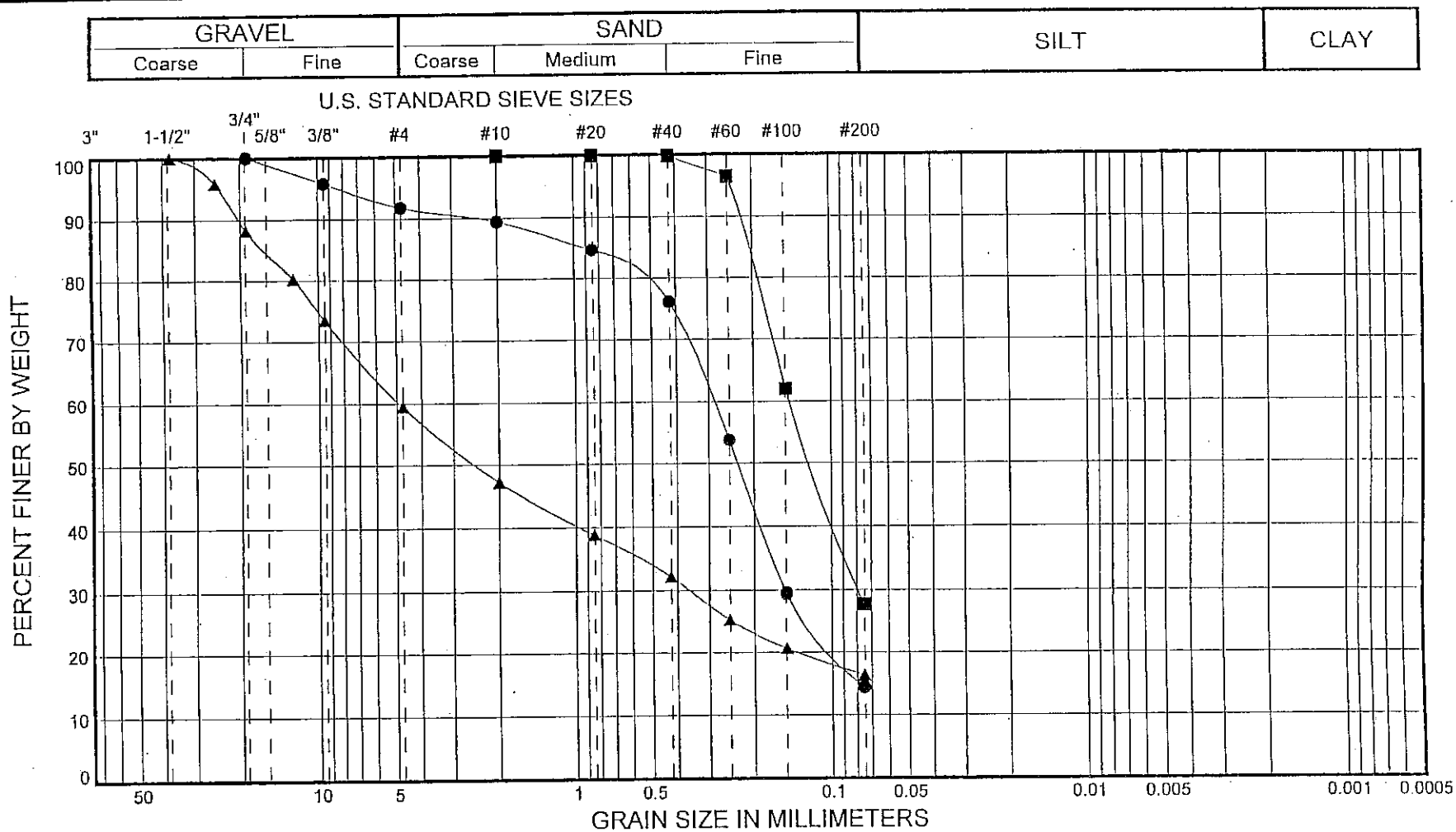
GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179 FIGURE: B-2



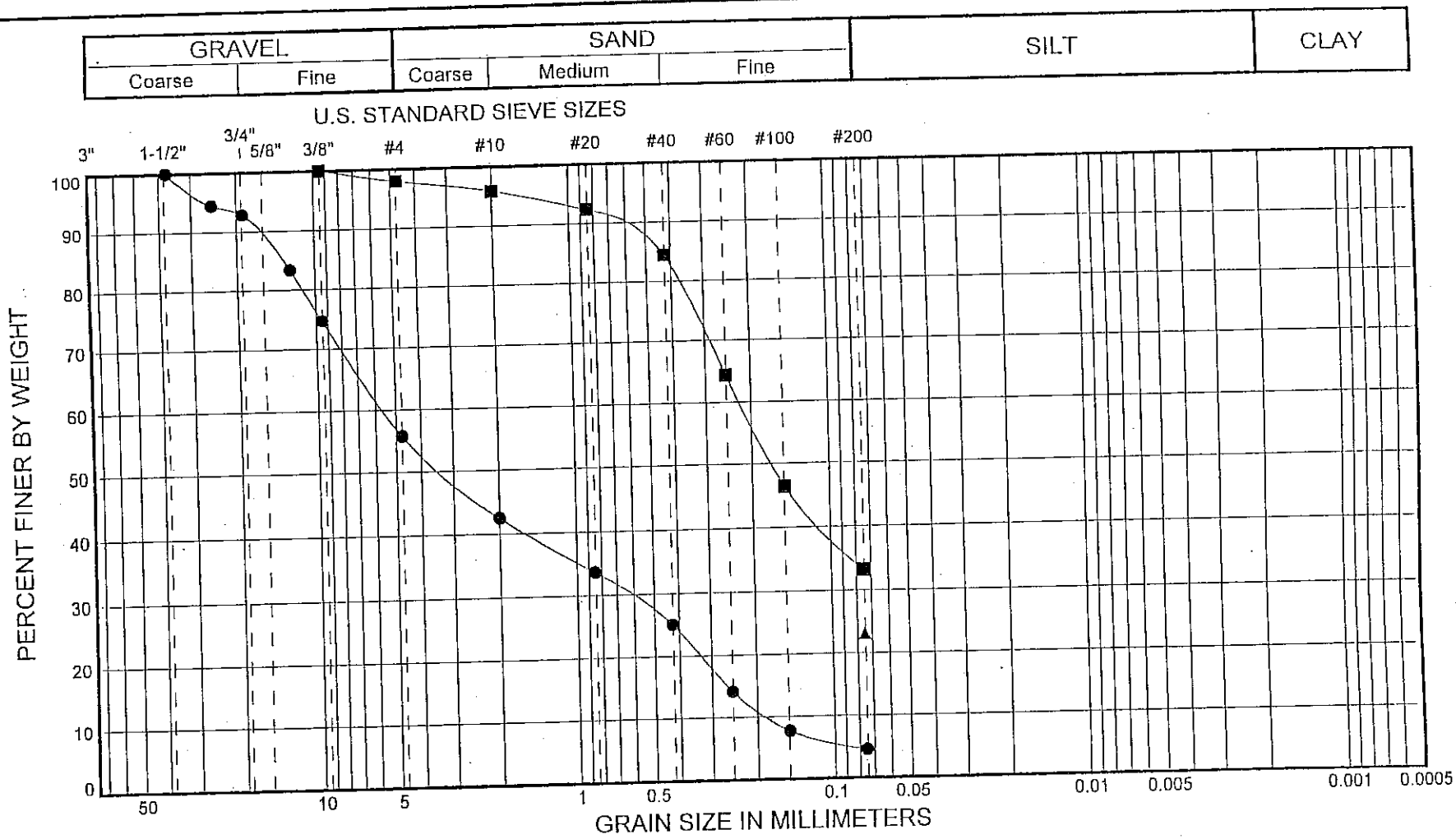
SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH- 7	S-1	0.9 - 1.4	(SM) Grayish brown, slightly gravelly, silty SAND	12				8.2	77.4	14.4
■	BH- 8	S-5	7.0 - 7.5	(SM) Grayish brown, silty, fine SAND	18					72.2	27.8
▲	BH- 9	S-5	5.3 - 5.8	(SM) Olive brown, silty, very gravelly fine to coarse SAND	8				40.5	43.2	16.3

HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179 FIGURE: B-3



SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH-10	S-4	4.3 - 4.7	(SP) Brown, very gravelly, fine to coarse SAND	5				44.2	51.2	4.6
■	BH-11	S-3	3.0 - 3.5	(SM) Olive gray, very silty, fine to medium SAND	12				2.0	64.7	33.2
▲	BH-11	S-5	6.1 - 6.6	(SM) Dark gray, silty, fine SAND	11						23.0

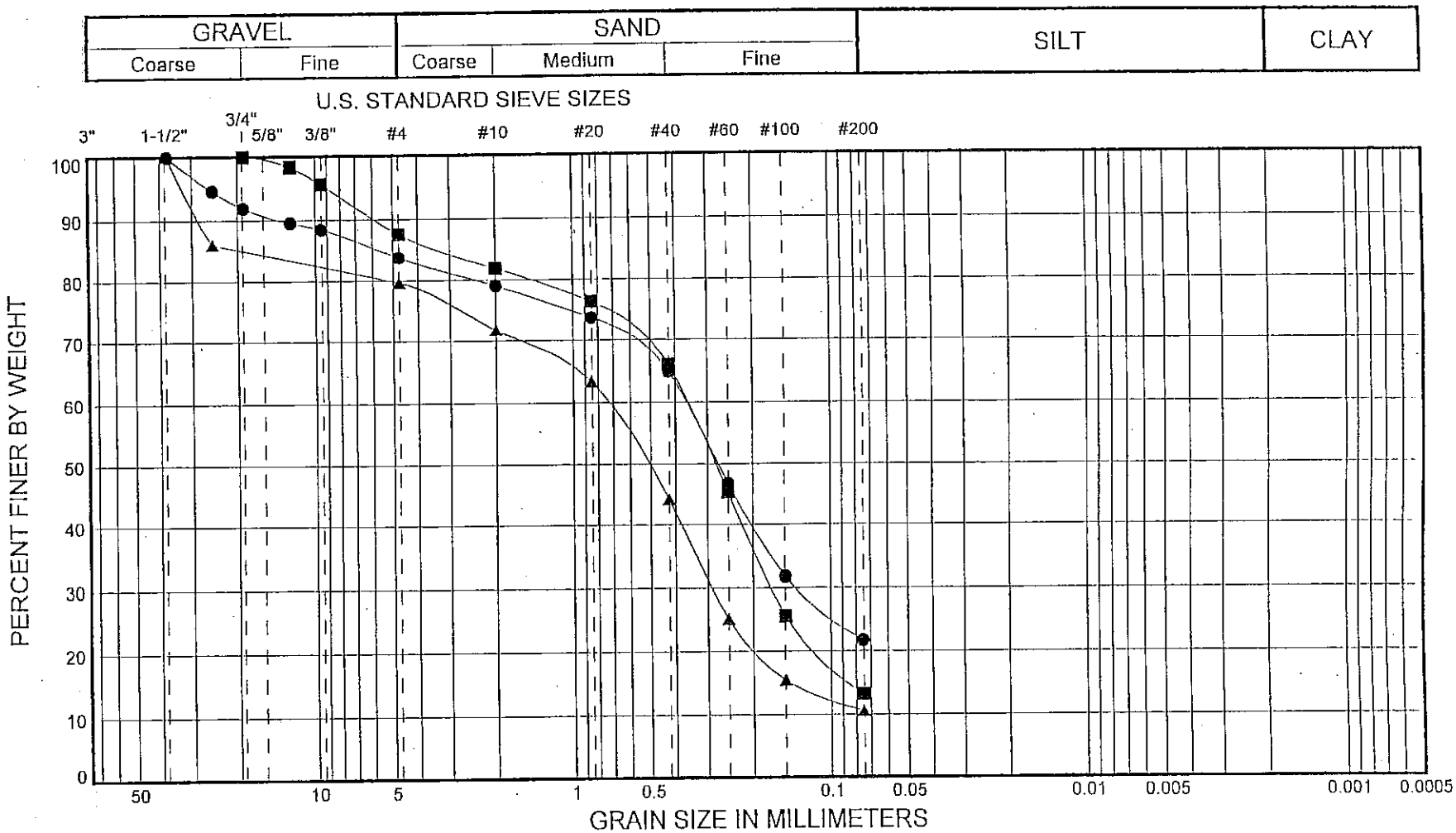
HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179

FIGURE: B-4



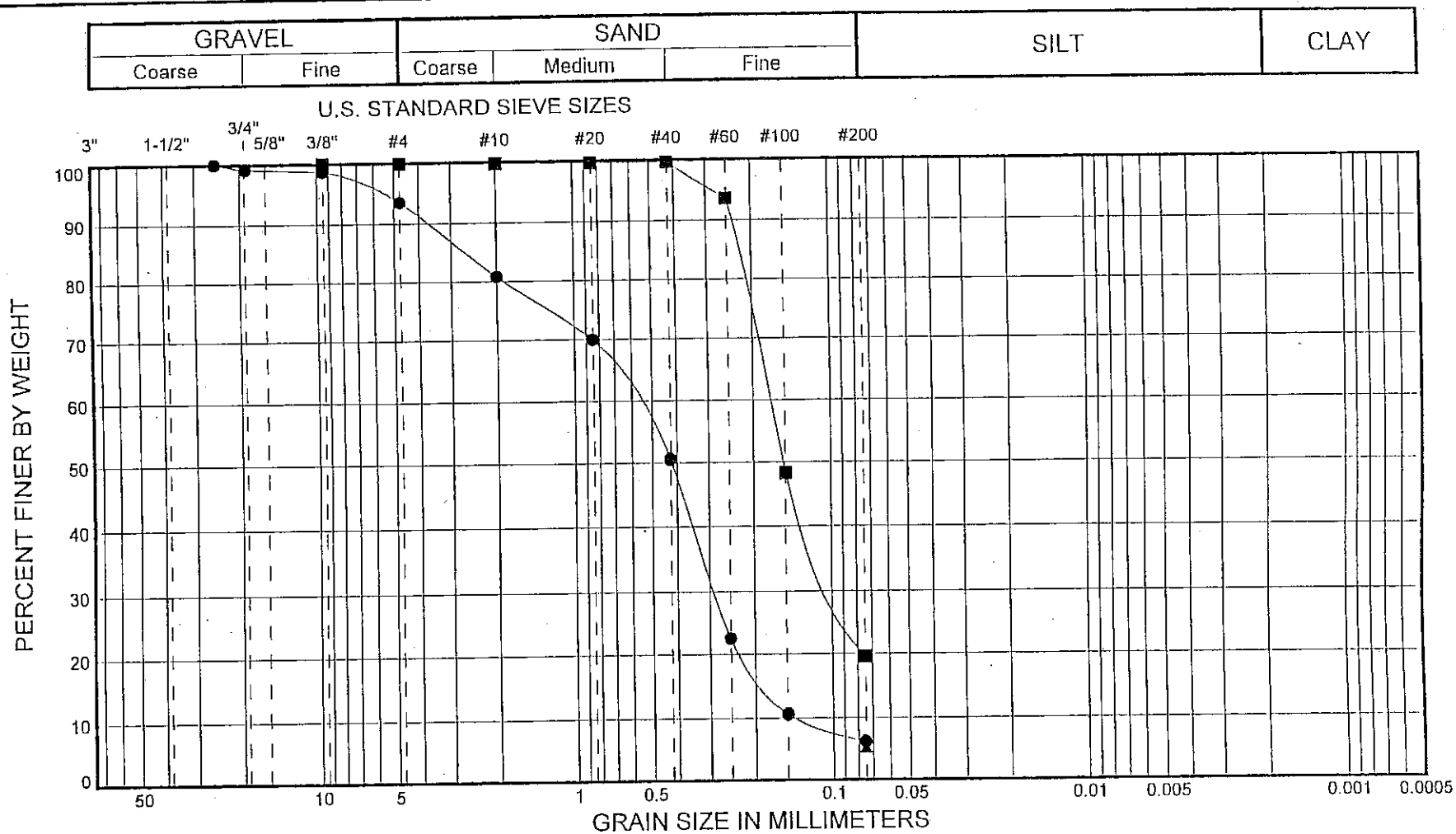
SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH-12	S-2	1.5 - 2.0	(SM) Olive brown, gravelly, silty, fine to medium SAND	11				16.3	62.0	21.7
■	BH-12	S-5	6.1 - 6.6	(SM) Olive gray, gravelly, silty, fine to medium SAND	15				12.4	74.3	13.3
▲	BH-13	S-3	2.7 - 3.2	(SW-SM) Brown, slightly silty, gravelly, fine to medium SAND	12				20.4	69.0	10.6

HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179 FIGURE: B-5



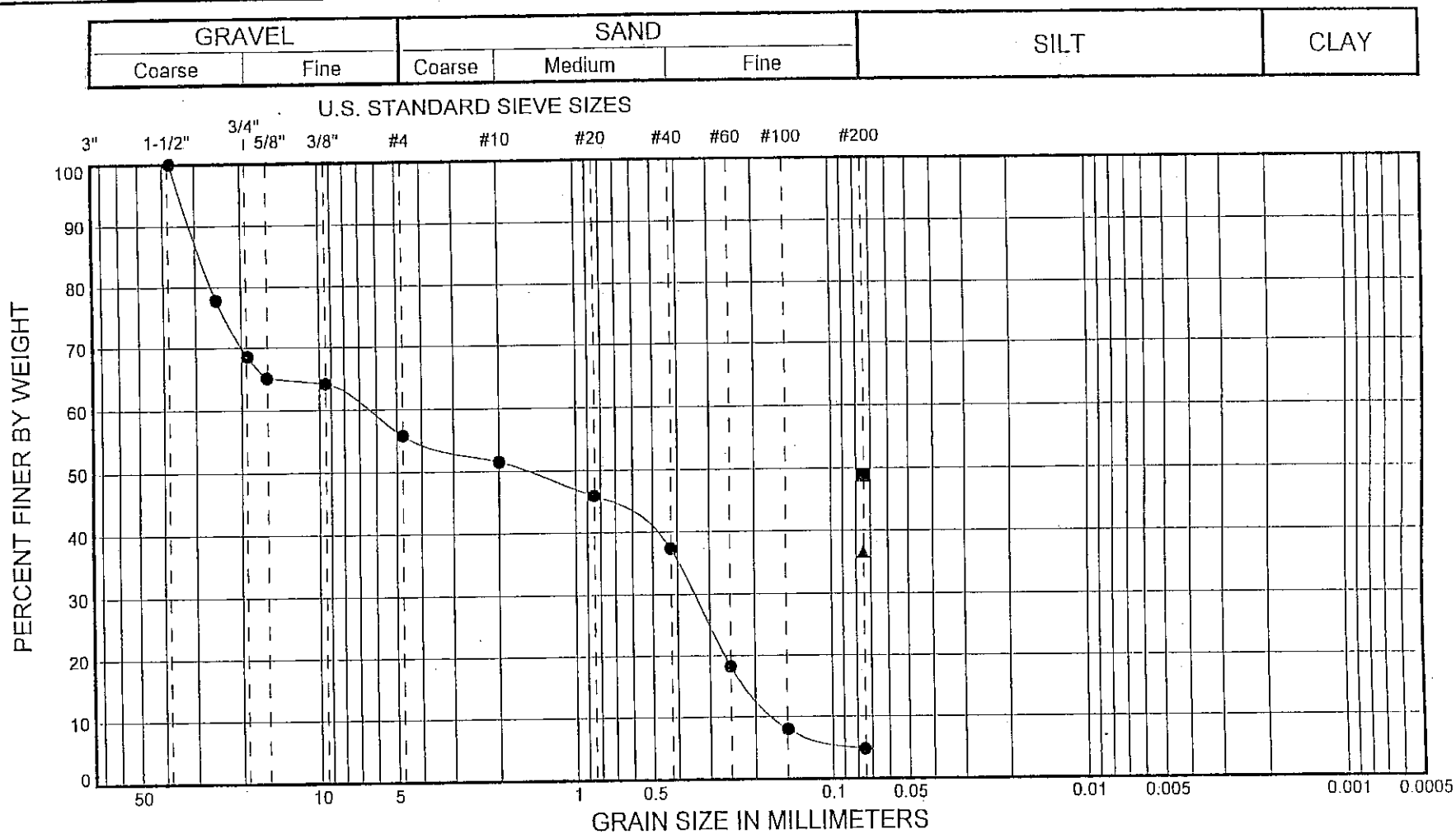
SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH-13	S-4	4.3 - 4.7	(SP-SM) Olive gray, slightly silty, slightly gravelly, fine to coarse SAND	15				6.5	87.3	6.2
■	BH-14	S-3	3.0 - 3.5	(SM) Grayish brown, silty fine SAND	24				0.1	80.4	19.6
▲	BH-15	S-3	3.0 - 3.5	(SP-SM) Brown, slightly silty, fine to medium SAND	24						5.3

HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179 FIGURE: B-6



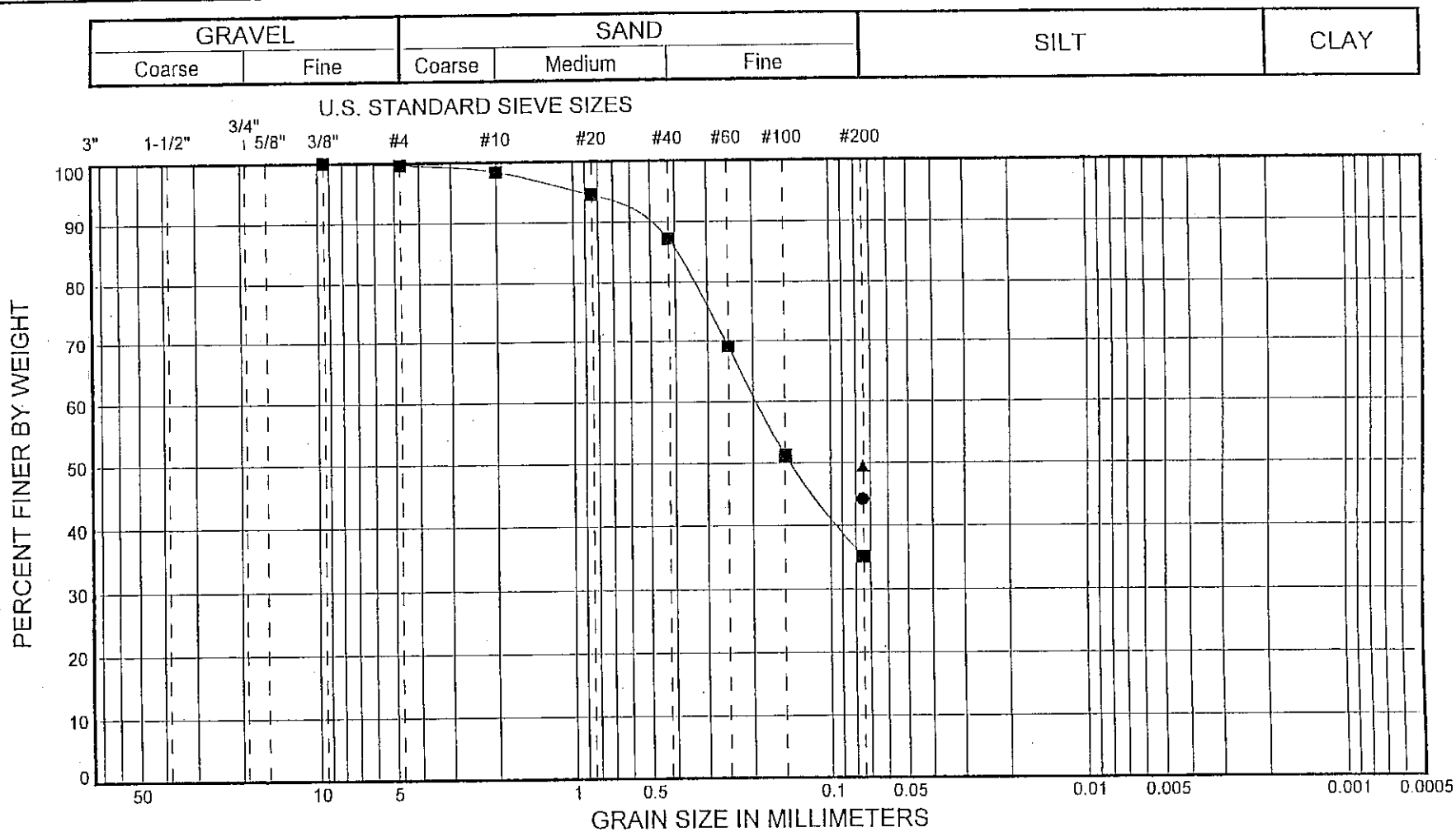
SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH-15	S-4	4.6 - 5.0	(SP) Olive brown, Very gravelly, fine to coarse SAND	14				44.2	51.0	4.8
■	BH-16	S-3	3.0 - 3.5	(SM) Gray, very silty SAND	26						48.9
▲	BH-17	S-2	2.3 - 2.7	(SM) Dark brown, very silty SAND	52						36.6

HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179 FIGURE: B-7



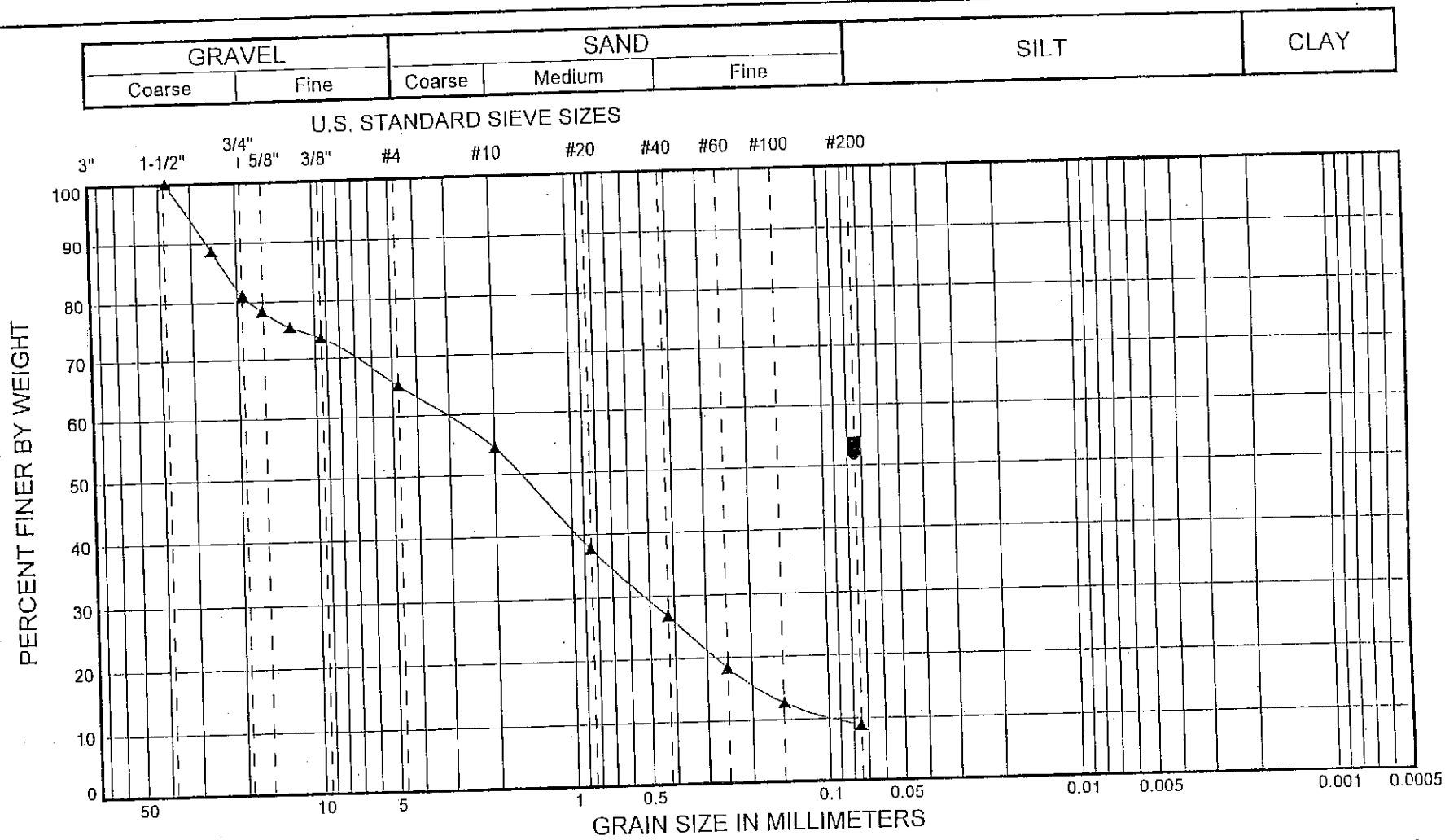
SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH-17	S-3	3.8 - 4.3	(SM) Gray, very silty, fine SAND	23						44.2
■	BH-18	S-2	1.5 - 2.0	(SM) Dark gray, very silty, fine to medium SAND	23				0.4	64.4	35.2
▲	BH-18	S-4	4.6 - 5.0	(SM) Grayish brown, very silty, fine to medium SAND	22						49.5

HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179 FIGURE: B-8



SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH-19	S-2	1.5 - 2.0	(ML) Dark gray, very sandy, SILT	27						51.9
■	BH-20	S-4	4.6 - 5.0	(ML) Dark gray, very sandy, SILT	24						53.6
▲	BH-21	S-2	1.5 - 2.0	(SP-SM) Grayish brown, slightly silty, very gravelly, fine to coarse SAND	11				34.8	56.3	8.9

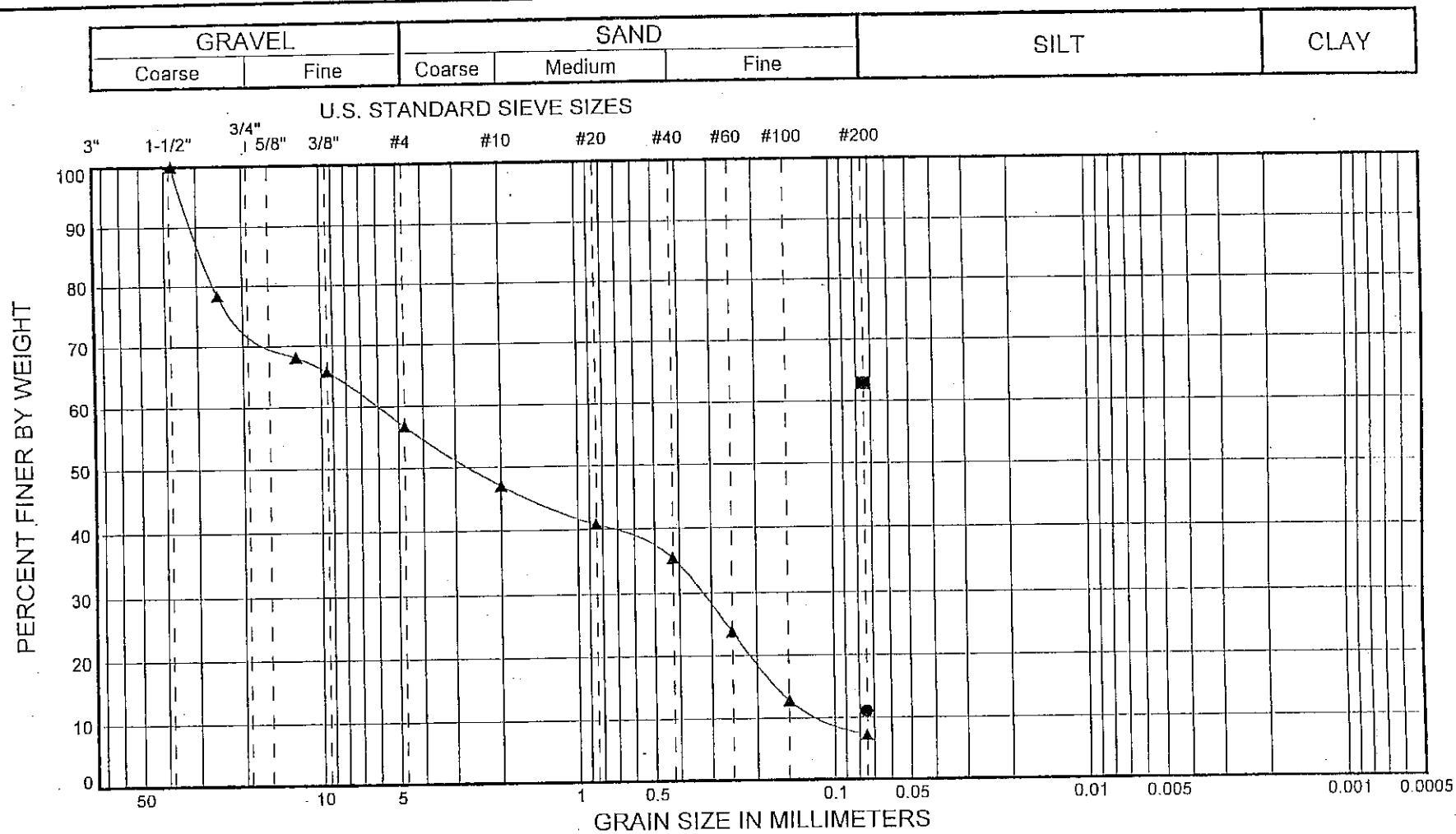
HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179

FIGURE: B-9



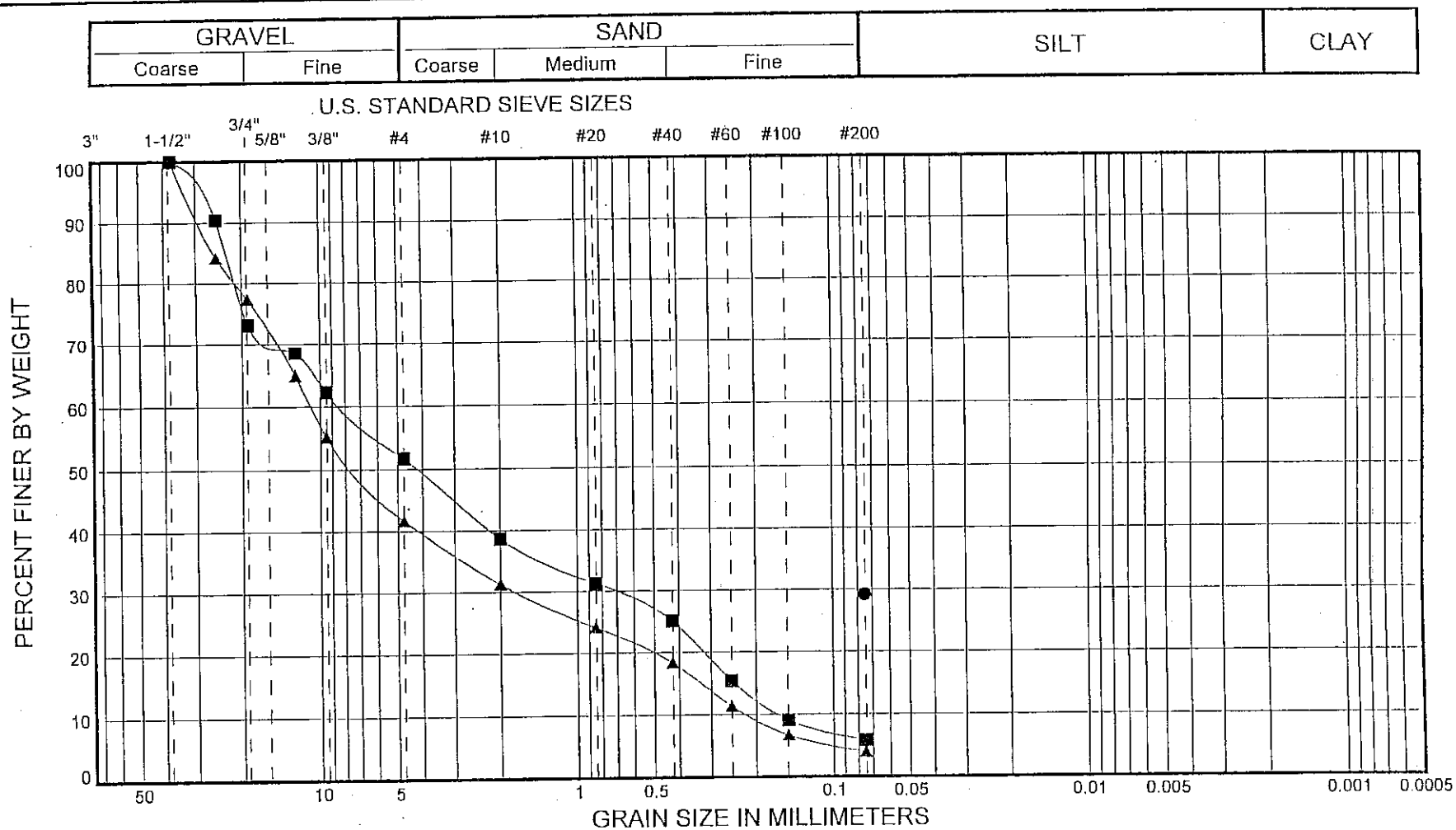
SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH-23	S-4	4.3 - 4.7	(SP-SM) Olive gray, slightly silty, fine to medium SAND	18						11.1
■	BH-23	S-5	5.8 - 6.2	(ML) Very dark gray, sandy SILT	32						62.9
▲	BH-24	S-3	3.0 - 3.5	(SP-SM) Dark gray, slightly silty, very gravelly, fine to coarse SAND	12				43.3	49.6	7.2

HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179 FIGURE: B-10



SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH-25	S-4B	4.7 - 5.2	(SM) Olive gray, silty, gravelly, fine SAND	25						29.2
■	BH-25	S-5	5.9 - 6.4	(GP-GM) Dark yellowish brown, slightly silty, very sandy, fine to coarse GRAVEL	8				48.3	45.9	5.8
▲	BH-26	S-3	3.0 - 3.5	(GW) Dark gray, very sandy, fine to coarse GRAVEL	6				58.3	37.8	3.9

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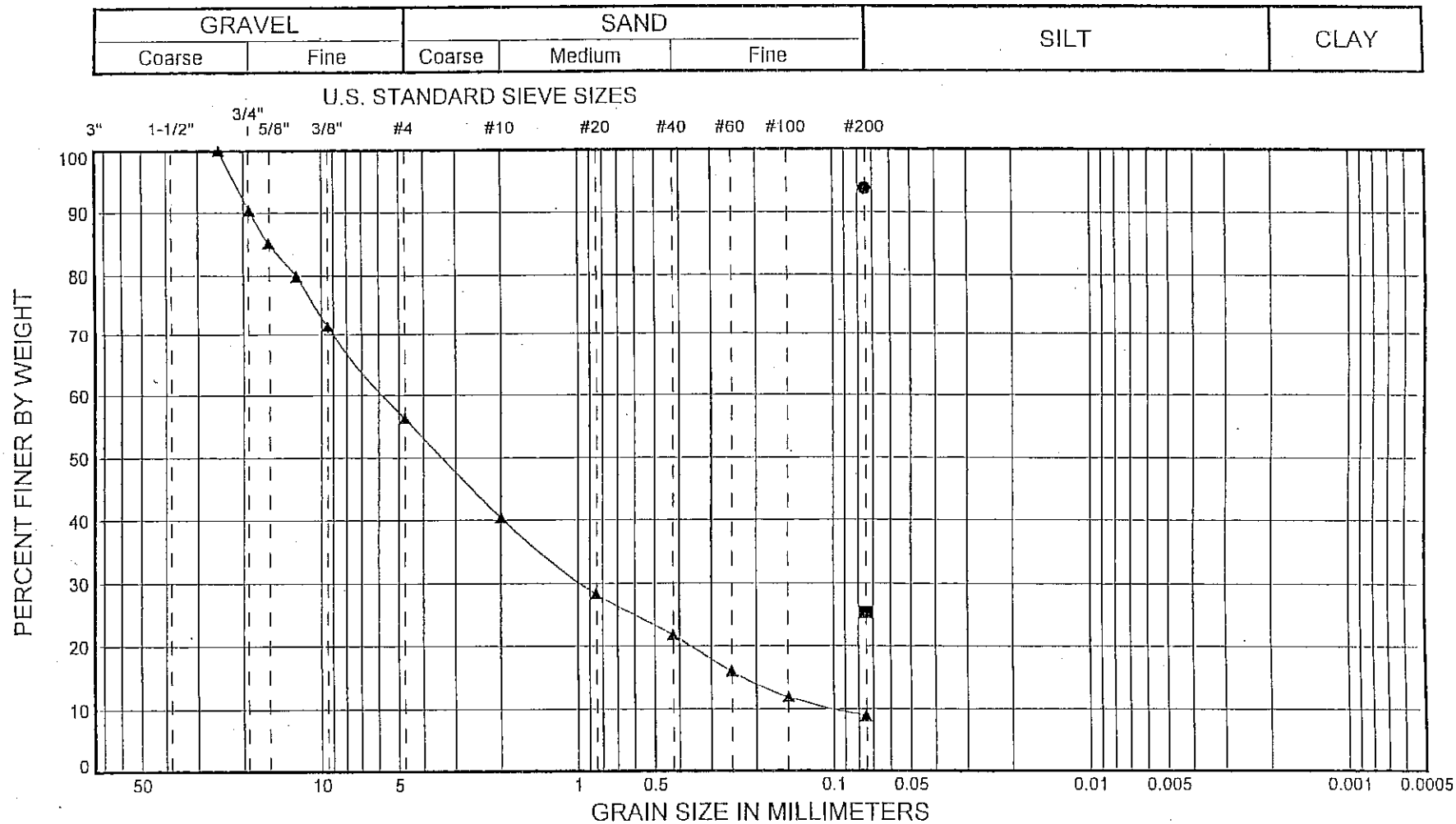
SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179 FIGURE: B-11



SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH-27	S-5	4.6 - 5.0	(CL-ML) Dark gray, slightly sandy, SILTY CLAY	31	24	17	7			93.7
■	BH-28	S-4	4.6 - 5.0	(SM) Dark gray, silty, fine to medium SAND	21						25.3
▲	BH-29	S-2	1.5 - 2.0	(SW-SM) Brown, slightly silty, very gravelly, fine to coarse SAND	9				43.7	47.4	8.9

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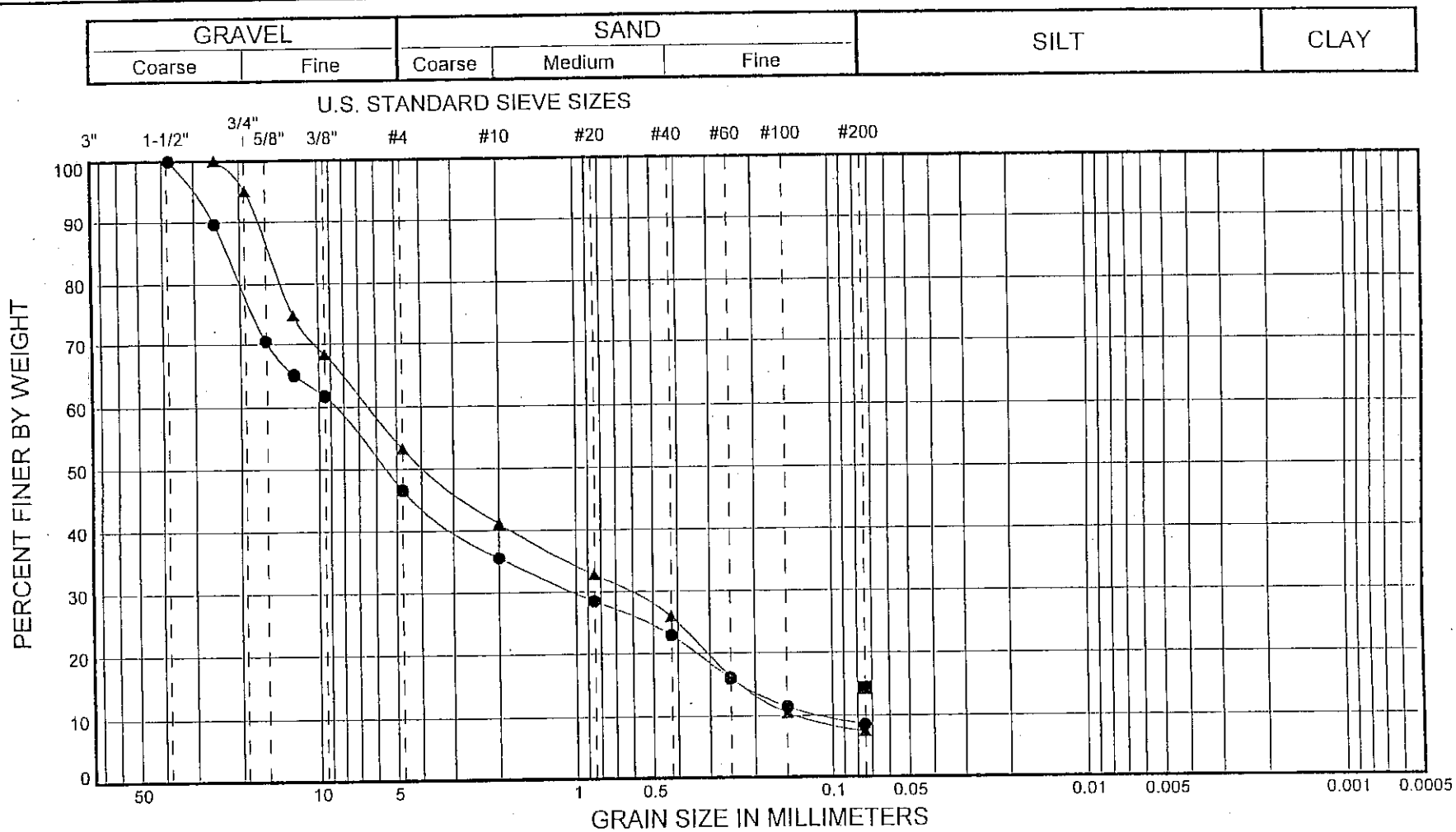
SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179 FIGURE: B-12



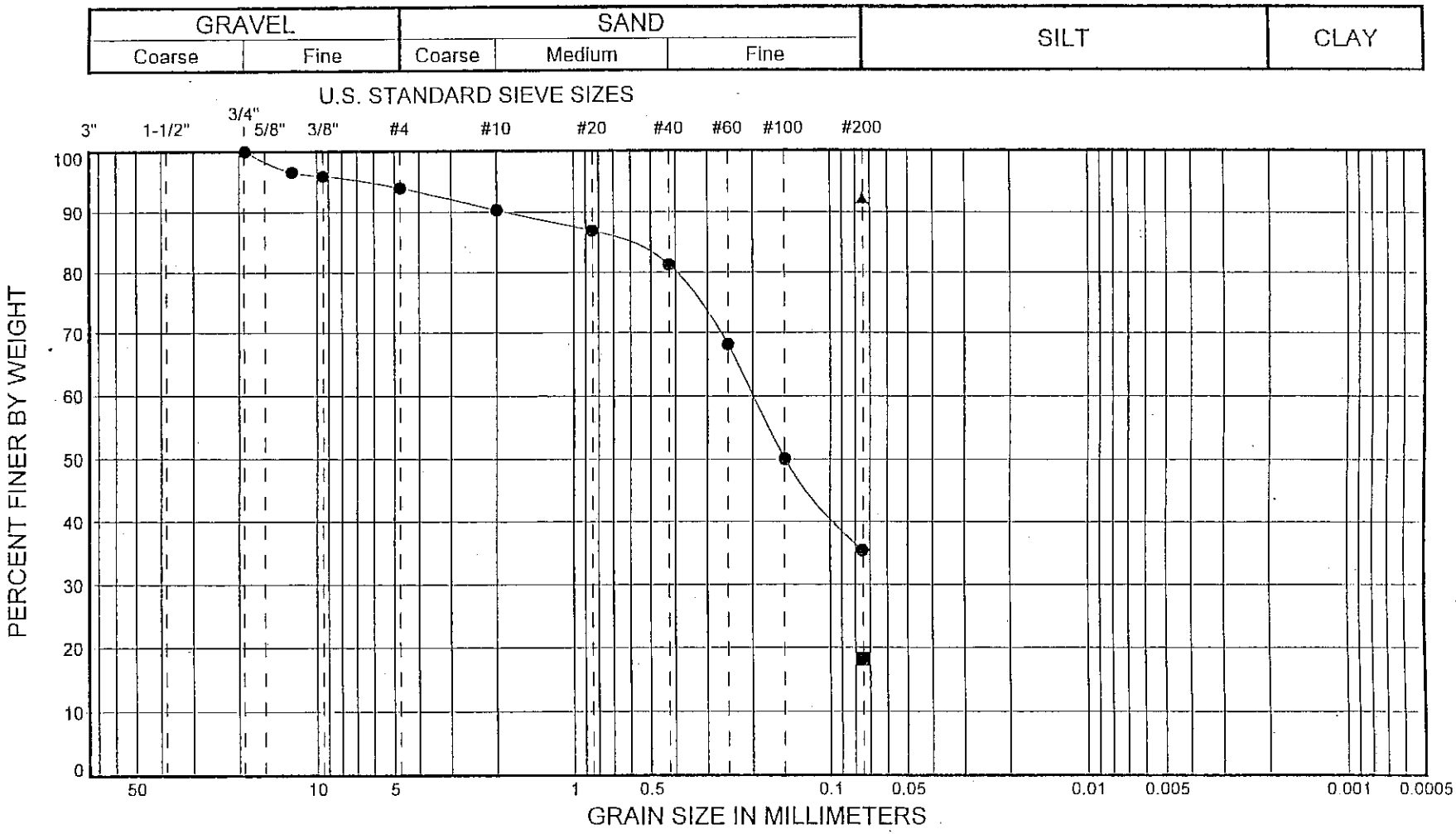
SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH-30	S-2	1.5 - 2.0	(GW-GM) Brown, slightly silty, very sandy, fine to coarse GRAVEL	8				53.4	38.1	8.5
■	BH-30	S-3	3.0 - 3.5	(SM) Brown, silty, fine to coarse SAND	14						14.4
▲	BH-31	S-3	3.0 - 3.5	(GP-GM) Dark olive brown, slightly silty, very sandy, fine GRAVEL	10				46.7	45.8	7.4

HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179 FIGURE: B-13



SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH-31	S-4	4.6 - 5.0	(SM) Dark gray, slightly gravelly, very silty, fine to medium SAND	11				6.0	58.5	35.4
■	BH-32	S-7	4.9 - 5.3	(SM) Dark gray, silty SAND	25						18.2
▲	BH-32	S-8	5.8 - 6.2	(CL) Dark gray, slightly sandy, lean CLAY	31	36	21	15			92.2

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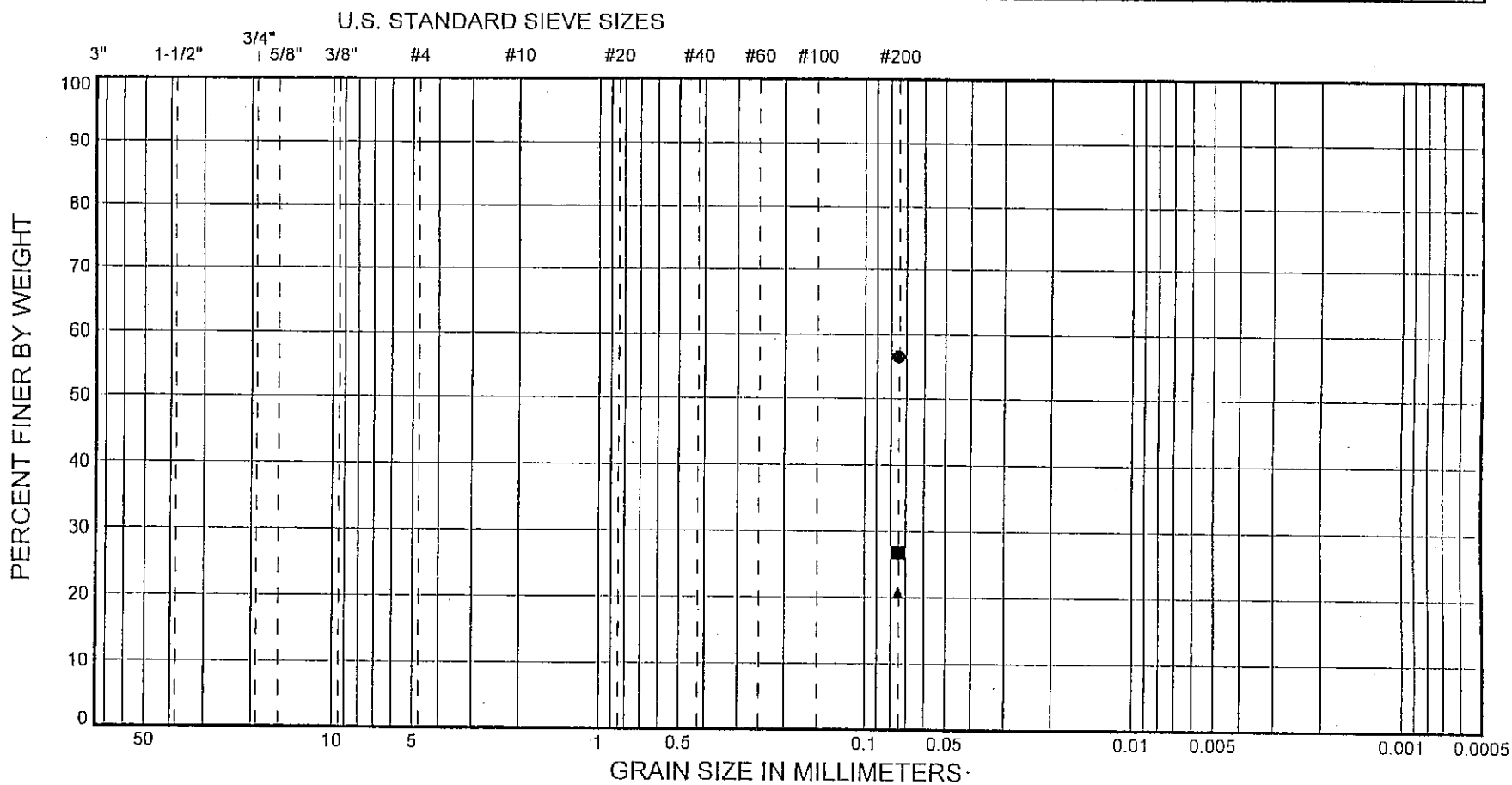
SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179 FIGURE: B-14



SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH-33	S-3	3.0 - 3.5	(ML) Dark gray, sandy SILT	27						56.6
■	BH-34	S-3	3.0 - 3.5	(SM) Very dark reddish brown, silty, fine SAND	79	NP	NP	NP			26.8
▲	BH-34	S-4	4.6 - 5.0	(SM) Olive gray, silty fine to medium SAND	19						20.7

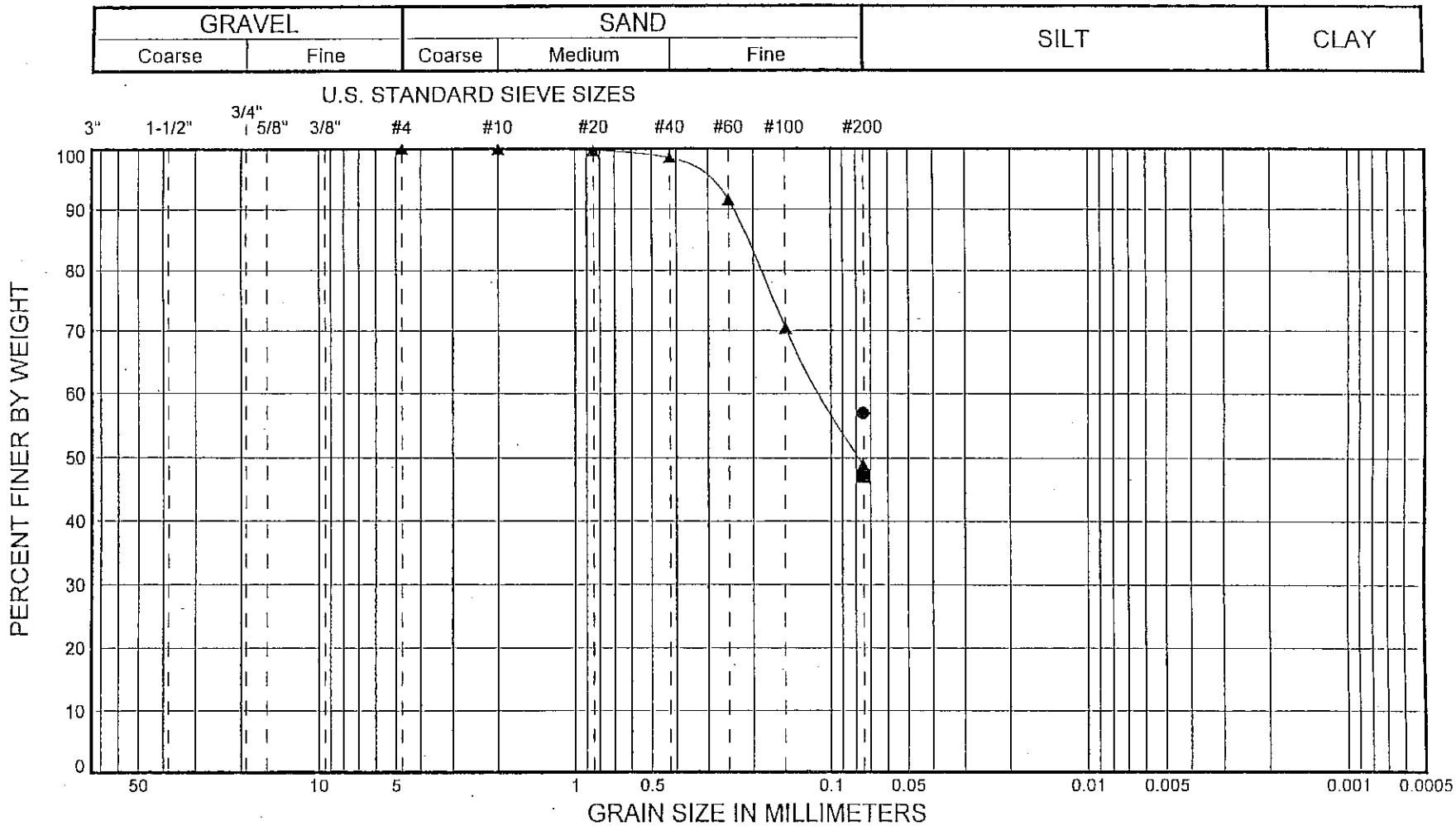
HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179

FIGURE: B-15



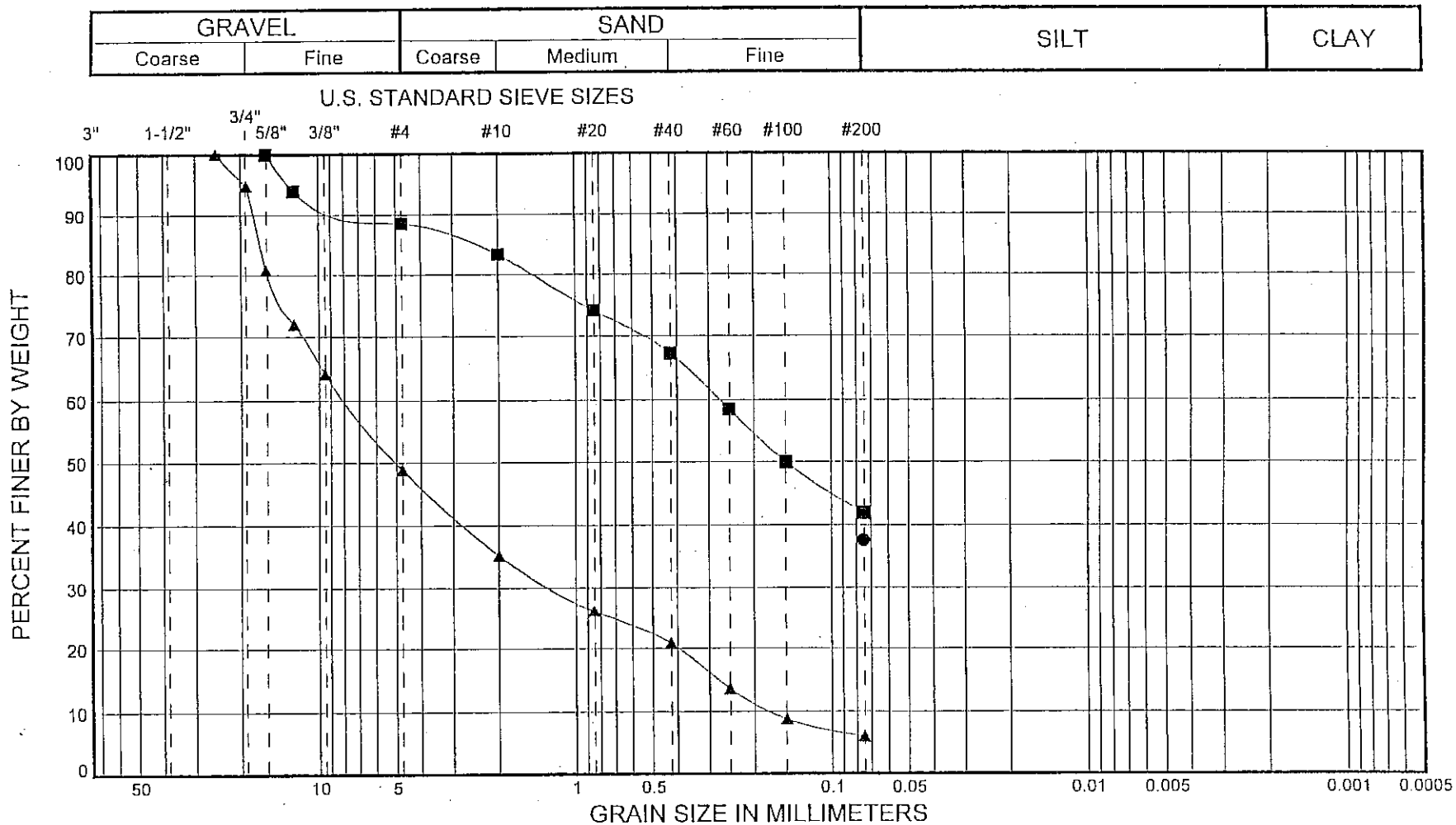
SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH-36	S-2	1.2 - 1.7	(OL) Very dark brown, very sandy, organic SILT	20	NP	NP	NP			57.0
■	BH-36	S-3	1.7 - 2.3	(SM) Very dark brown, silty SAND	32						47.2
▲	BH-36	S-6	4.3 - 4.7	(SM) Gray, very silty, fine SAND	30					51.0	49.0

HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179 FIGURE: B-16



SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH-36	S-7	5.8 - 6.2	(SM) Dark gray, silty SAND	23						37.6
■	BH-38	S-3B	2.9 - 3.2	(SM) Grayish brown, gravelly, very silty, fine to medium SAND	16				11.5	46.5	42.0
▲	BH-38	S-4	4.3 - 4.7	(GW-GM) Grayish brown, slightly silty, very sandy, fine to coarse GRAVEL	7				51.1	42.8	6.1

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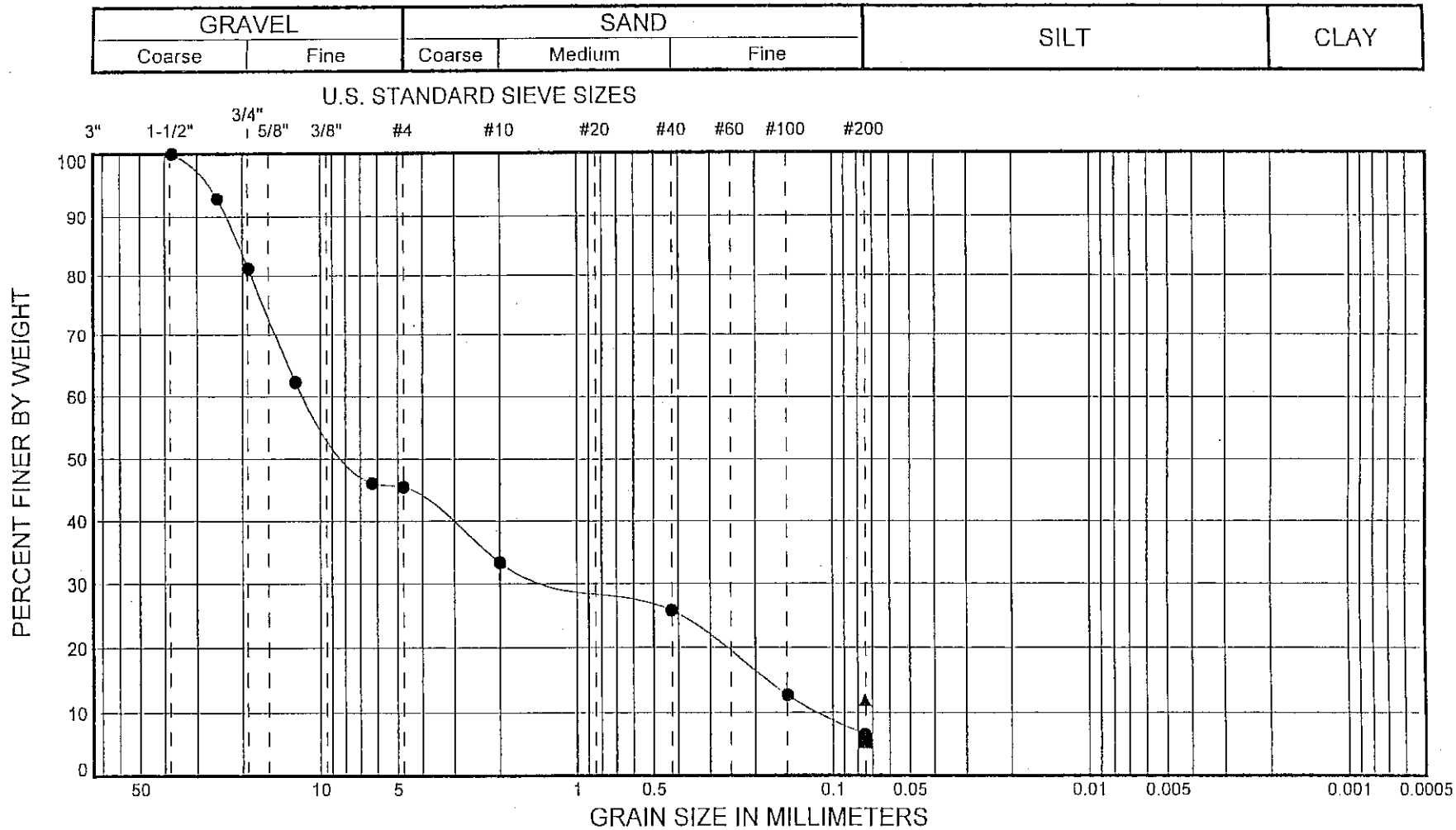
SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179 FIGURE: B-17

HWAGRS7 98179.GPJ 12/5/98



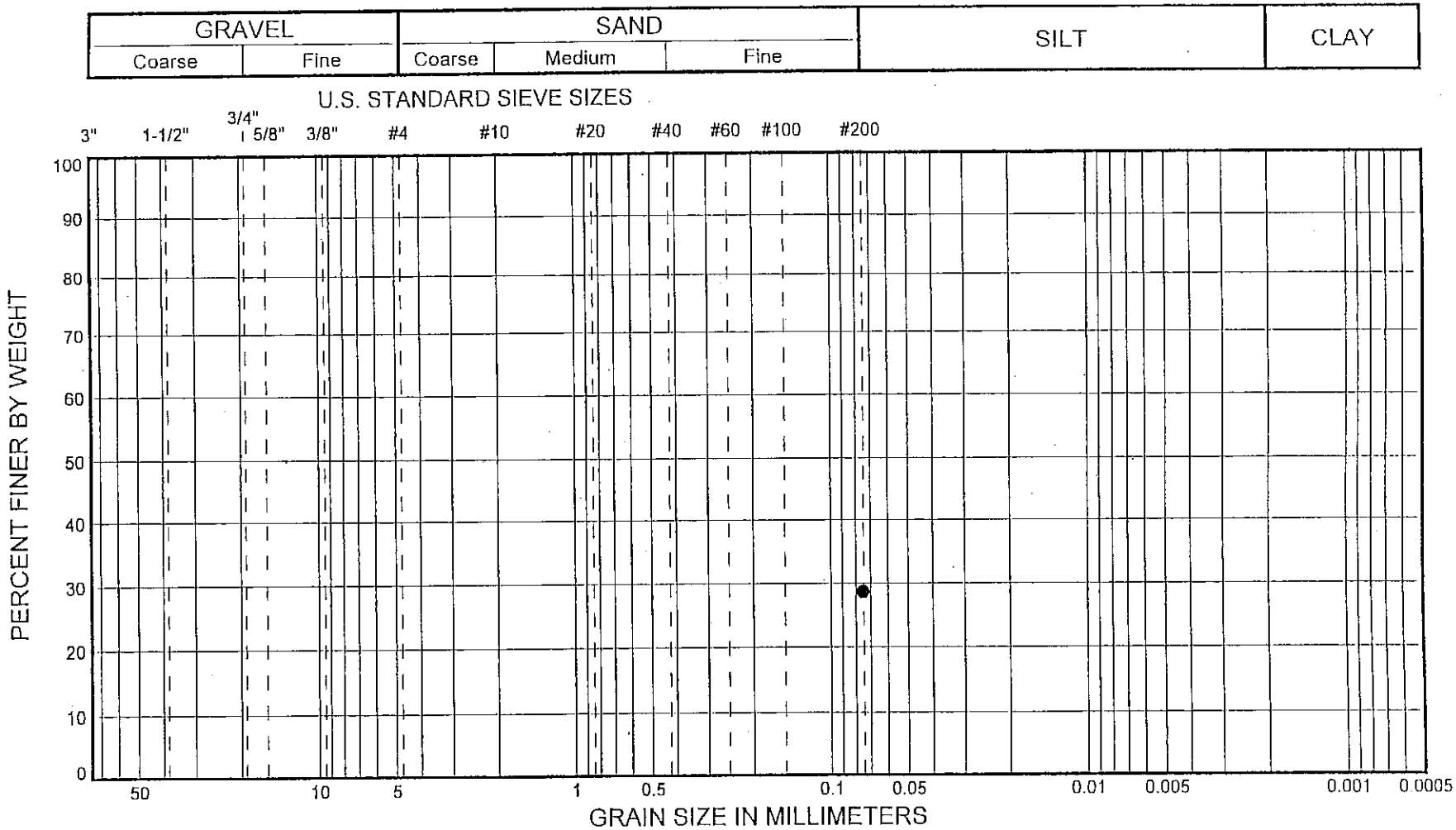
SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH-39	S-3	3.0 - 3.5	(GP-GM) Brown, slightly silty, very sandy, fine to coarse GRAVEL	8				54.5	38.9	6.6
■	BH-39	S-5	6.1 - 6.6	(SP-SM) Olive gray, slightly silty, fine to coarse SAND	22						5.3
▲	BH-39	S-6	7.6 - 8.1	(SP-SM) Olive gray, slightly silty, fine to coarse SAND	19						11.9

HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179 FIGURE: B-18



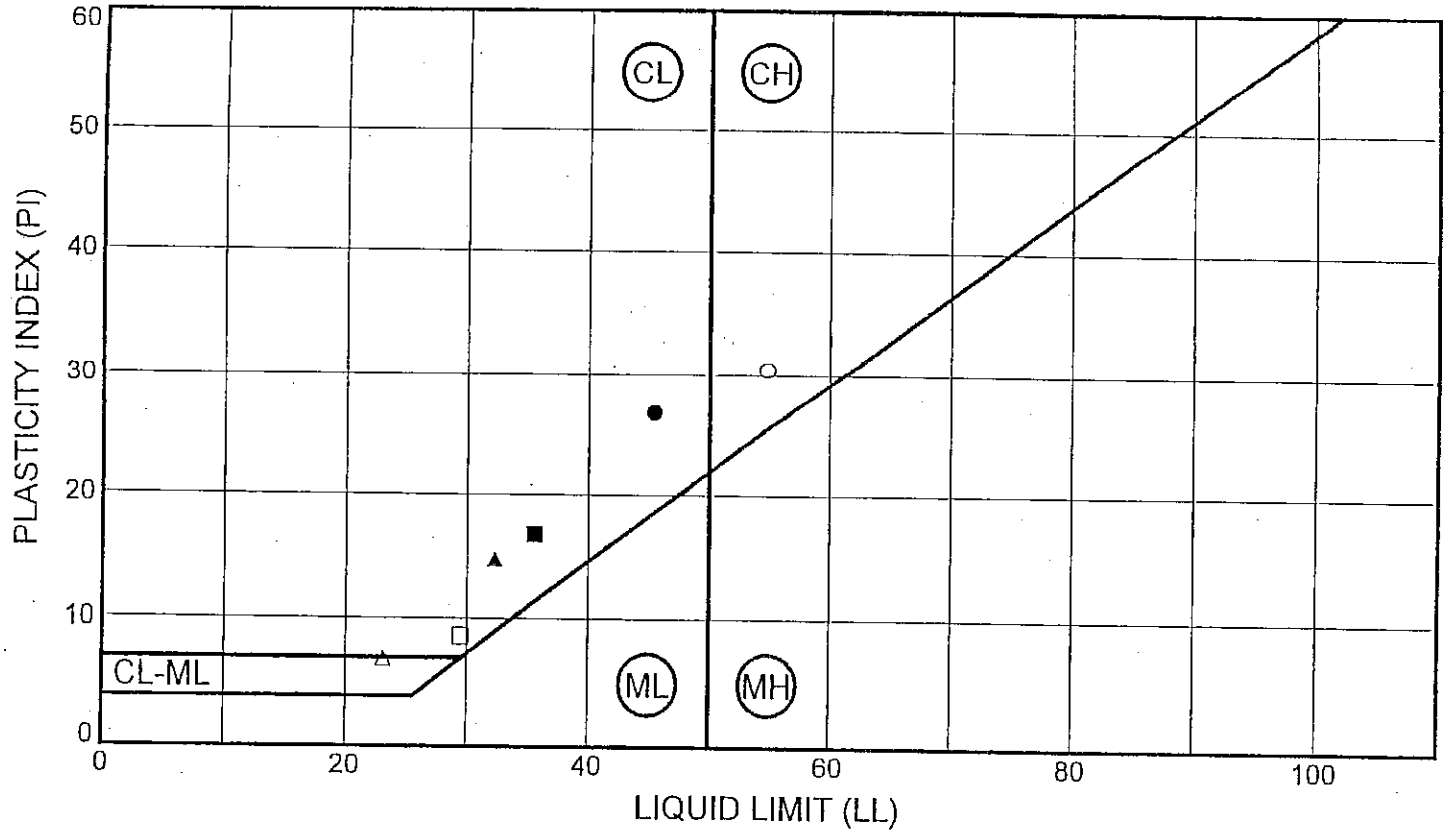
SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Gravel	% Sand	% Fines
●	BH-39	S-8	10.7 - 11.1	(SM) Olive gray, silty, fine to coarse SAND	18						28.7

HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

GRAIN SIZE DISTRIBUTION TEST RESULTS

PROJECT NO.: 98179 FIGURE: B-19

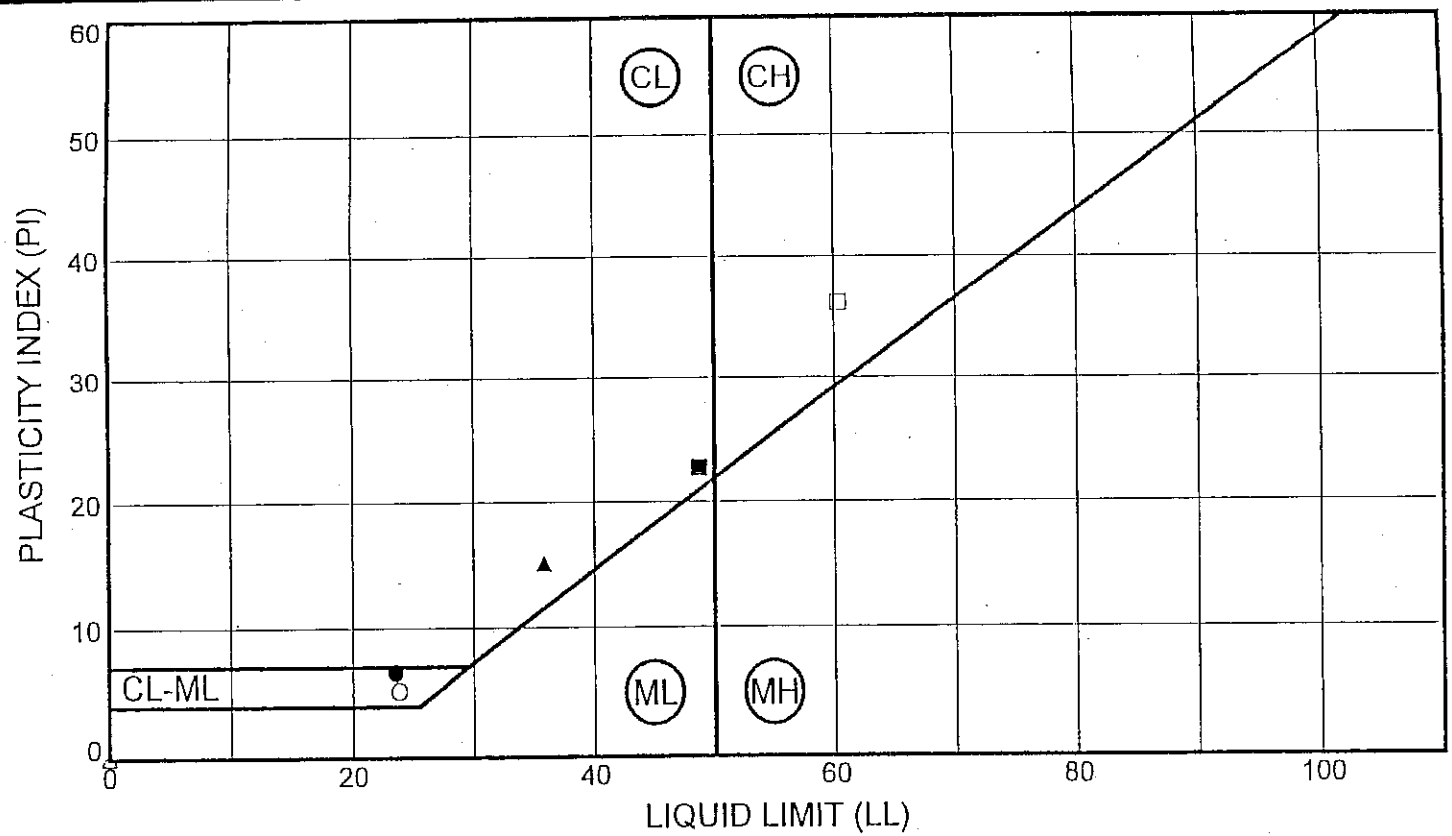


SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Fines
●	BH- 4	S-5	7.0 - 7.6	(CL) Dark gray, lean CLAY	38	45	19	26	
■	BH- 5	S-4	5.5 - 5.9	(CL) Dark gray, lean CLAY	48	36	19	17	
▲	BH- 6	S-3	4.0 - 4.4	(CL) Dark gray, lean CLAY	32	32	18	14	87.2
○	BH- 7	S-2	2.4 - 2.9	(CH) Mottled dark gray and grayish brown, fat CLAY	36	55	24	31	
□	BH-17	S-5	6.1 - 6.7	(CL) Dark gray, sandy, lean CLAY	36	30	21	9	
△	BH-19	S-3	3.0 - 3.5	(CL-ML) Dark gray, sandy SILTY CLAY	25	23	16	7	

HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

PLASTICITY CHART



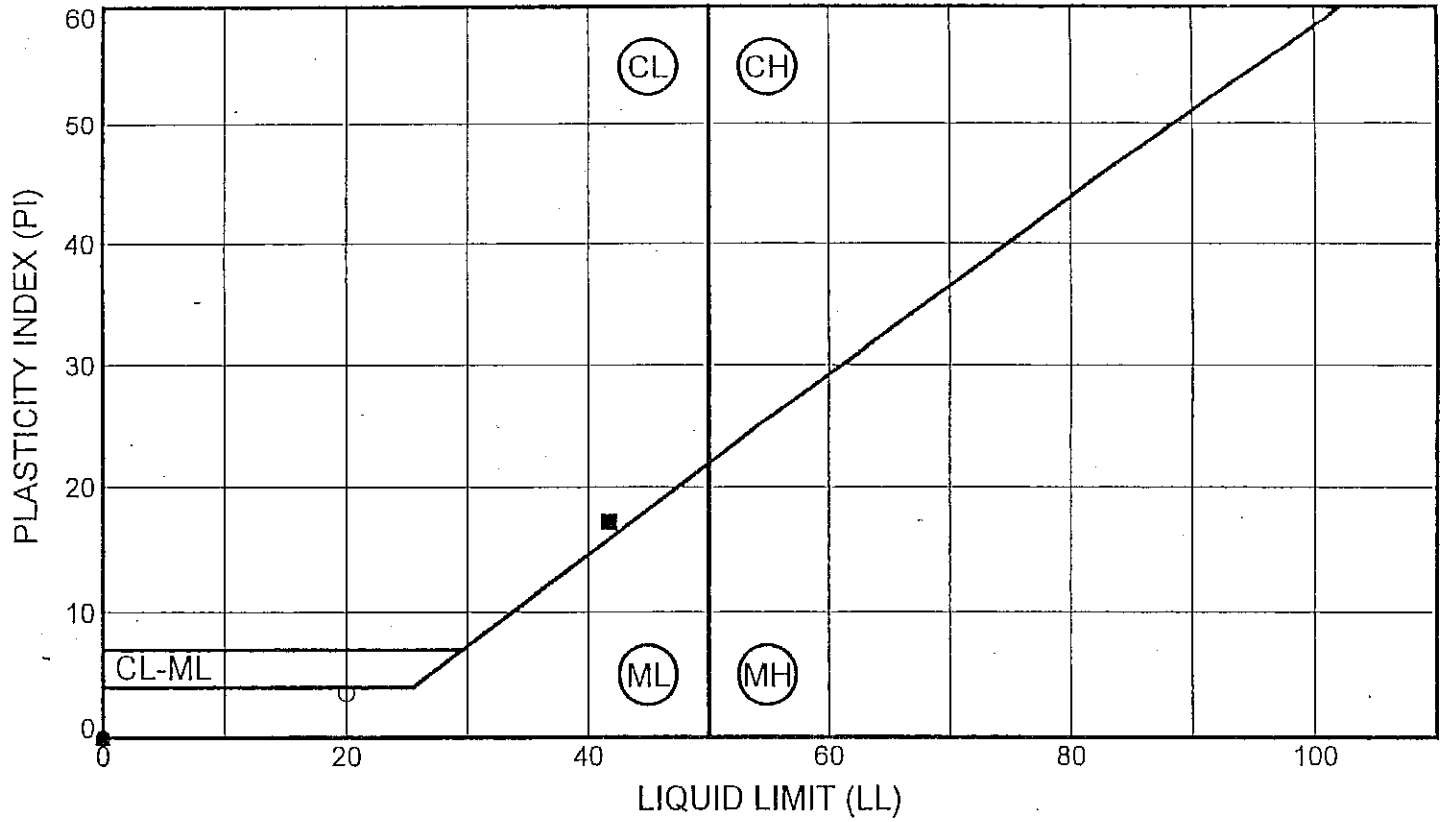
SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Fines
●	BH-27	S-5	4.6 - 5.0	(CL-ML) Dark gray, slightly sandy, SILTY CLAY	31	24	17	7	93.7
■	BH-32	S-4	2.7 - 3.4	(CL) Dark gray, lean CLAY	56	49	26	23	
▲	BH-32	S-8	5.8 - 6.2	(CL) Dark gray, slightly sandy, lean CLAY	31	36	21	15	92.2
○	BH-33	S-4	4.6 - 5.0	(CL-ML) Dark gray, SILTY CLAY	20	24	19	5	
□	BH-33	S-6	7.6 - 8.1	(CH) Dark gray, fat CLAY	24	60	24	36	
△	BH-34	S-3	3.0 - 3.5	(SM) Very dark reddish brown, silty, fine SAND	79	NP	NP	NP	26.8

HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

PLASTICITY CHART

PROJECT NO.: 98179 FIGURE: B-21



SYMBOL	SAMPLE		DEPTH (m)	CLASSIFICATION	% MC	LL	PL	PI	% Fines
●	BH-36	S-2	1.2 - 1.7	(OL) Very dark brown, very sandy, organic SILT	20	NP	NP	NP	57.0
■	BH-37	S-2	4.6 - 5.0	(CL) Dark gray, lean CLAY	28	42	24	18	
▲	BH-38	S-2	1.2 - 1.7	(ML) Grayish brown, slightly sandy, slightly gravelly, SILT	26	NP	NP	NP	
○	BH-38	S-8	8.8 - 9.3	(ML) Dark gray, sandy, SILT	14	20	16	4	

HWA GEOSCIENCES INC.

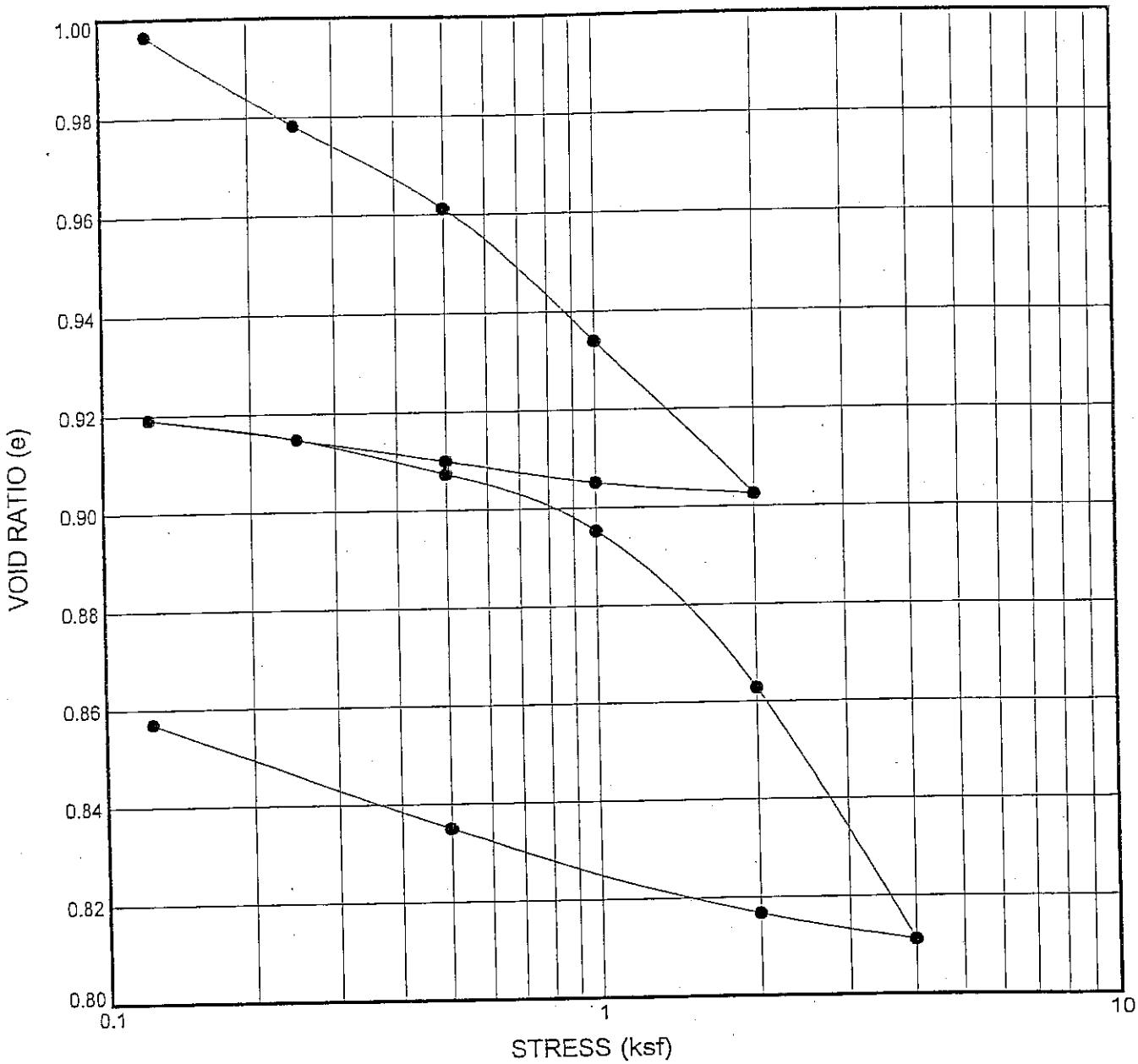
SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

PLASTICITY CHART

PROJECT NO.: 98179

FIGURE: B-22

SAMPLE		DEPTH (m)	CLASSIFICATION
BH-17	S-5	6.1 - 6.7	(CL) Dark gray, sandy, lean CLAY



	INITIAL	FINAL		
WATER CONTENT (%)	36.2	31.6	LIQUID LIMIT, LL (%)	30
DRY DENSITY (pcf)	85.7	92.5	PLASTIC LIMIT, PL (%)	21
DEGREE OF SATURATION (%)	99.3	101.3	PLASTICITY INDEX, PI (%)	9
			ASSUMED SPECIFIC GRAVITY	2.75

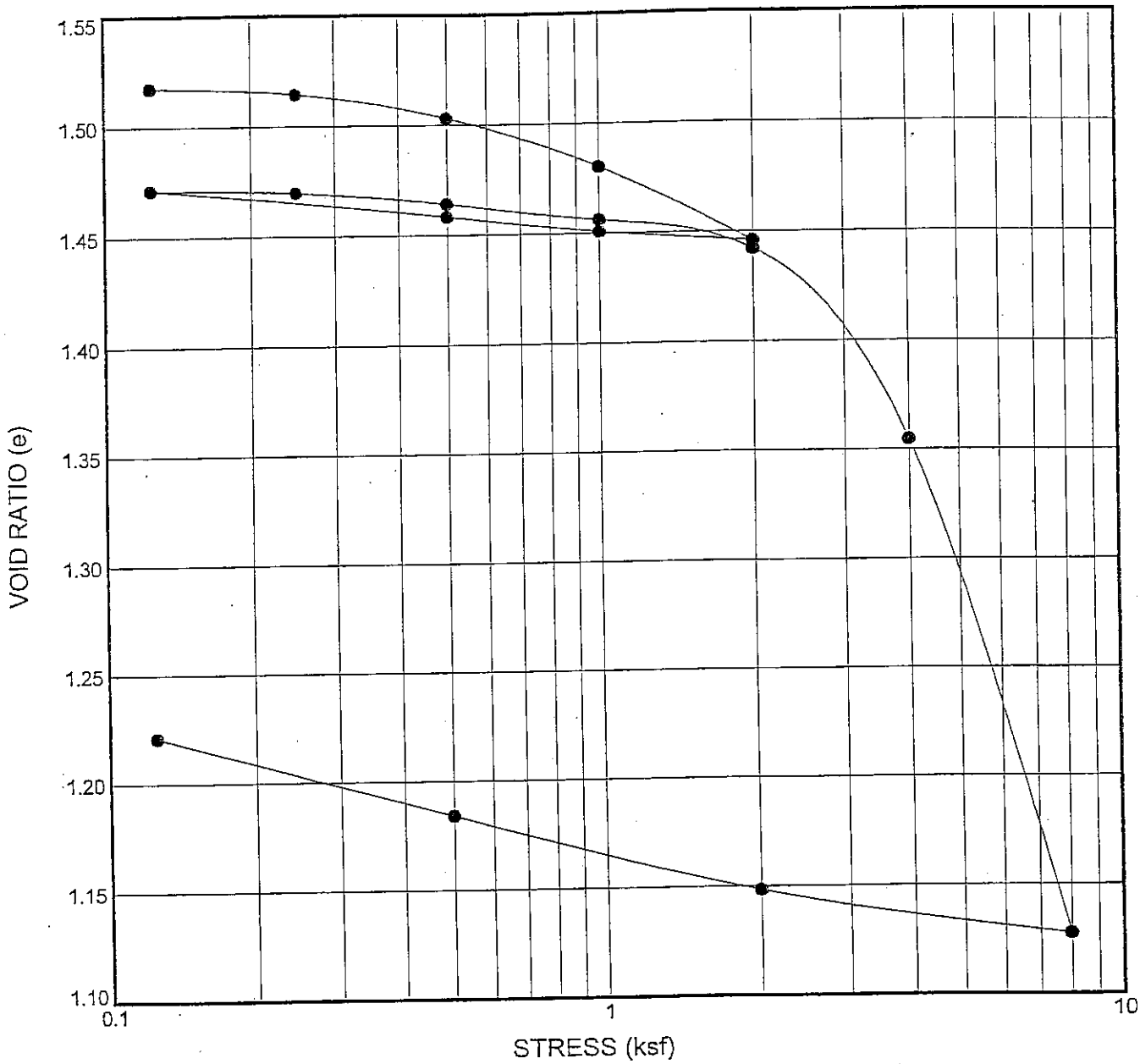
HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

CONSOLIDATION TEST RESULT

PROJECT NO.: 98179 FIGURE: B-23

SAMPLE		DEPTH (m)	CLASSIFICATION
BH-32	S-4	2.7 - 3.4	(CL) Dark gray, lean CLAY



	INITIAL	FINAL		
WATER CONTENT (%)	54.9	44.4	LIQUID LIMIT, LL (%)	49
DRY DENSITY (pcf)	68.2	77.3	PLASTIC LIMIT, PL (%)	26
DEGREE OF SATURATION (%)	99.6	100	PLASTICITY INDEX, PI (%)	23
			ASSUMED SPECIFIC GRAVITY	2.75

HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

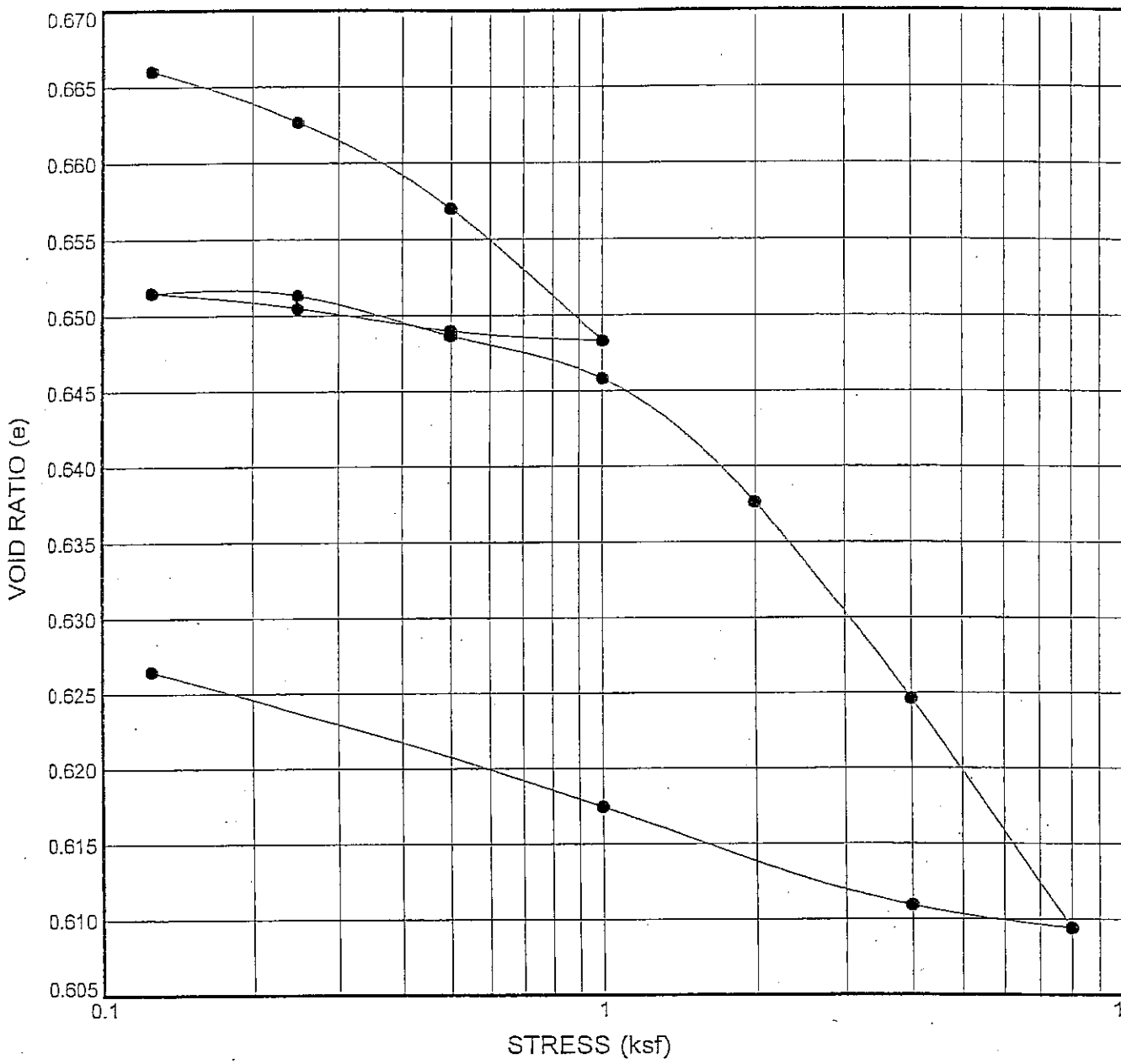
CONSOLIDATION TEST RESULT

PROJECT NO.: 98179 FIGURE: B-25

HWACONV 98179.GPJ 12/5/99

Borehole	Sample	Depth (meters)	pH	Minimum Resistivity (ohms/cm)
BH-1	S-2	2.4 – 2.6	6.7	18,000
BH-2	S-2	2.4 – 2.9	6.8	N/A
BH-2	S-3	4.0 – 4.4	N/A	32,000
BH-3	S-1	1.2 – 1.7	6.0	N/A
BH-3	S-2	2.7 – 3.2	6.6	44,000
BH-4	S-2	2.4 – 2.9	7.6	5,600
BH-5	S-1B	1.1 – 1.4	5.9	7,400
BH-6	S-1	0.9 – 1.4	5.2	4,800
BH-7	S-1	0.9 – 1.4	6.7	31,000
BH-8	S-2	2.4 – 2.9	7.4	46,000
BH-25	S-3	2.7 -3.2	7.1	5,700
BH-26	S-4	4.7 -5.2	6.3	17,000
BH-26	S-3	3.0 -3.5	5.8	36,000
BH-27	S-4	2.7 -3.2	6.3	5,200
BH-28	S-3	3.0 -3.5	6.7	5,100

SAMPLE		DEPTH (m)	CLASSIFICATION
BH-27	S-3	2.1 - 2.7	(CL-ML) Gray, SILTY CLAY



	INITIAL	FINAL		
WATER CONTENT (%)	23.7	23.1	LIQUID LIMIT, LL (%)	
DRY DENSITY (pcf)	102.9	106.4	PLASTICITY INDEX, PI (%)	
DEGREE OF SATURATION (%)	95.4	103.2	ASSUMED SPECIFIC GRAVITY	2.75

HWA GEOSCIENCES INC.

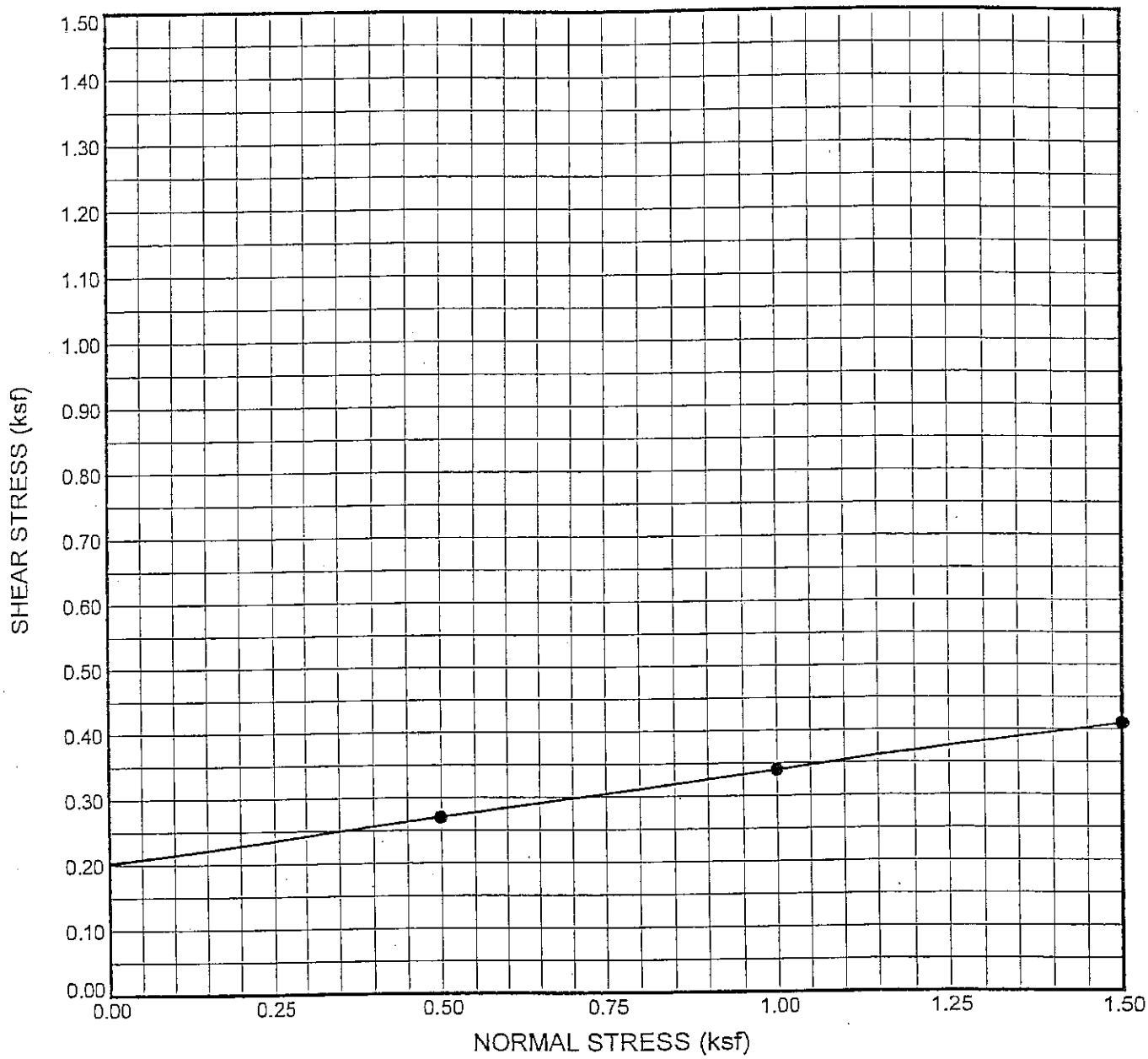
SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

CONSOLIDATION TEST RESULT

PROJECT NO.: 98179 FIGURE: B-24

HWACONV 98179.GPJ 12/6/99

SAMPLE		DEPTH (m)	CLASSIFICATION
BH-32	S-4	2.7 - 3.4	(CL) Dark gray, lean CLAY
TEST CONDITIONS:		Test performed on relatively undisturbed specimens, displacement rate=0.045 in/min	



FRICTION ANGLE (degrees)	8
APPARENT COHESION (psf)	200
AVERAGE DRY DENSITY (pcf)	71.1
AVERAGE WATER CONTENT (%)	53.0

HWA GEOSCIENCES INC.

SR 305 IMPROVEMENTS PROJECT
POULSBO, WASHINGTON

DIRECT SHEAR
TEST RESULT

PROJECT NO.: 98179 FIGURE: B-27

HWADIRS 98179.GPJ 12/28/99

APPENDIX C

GLOBAL STABILITY ANALYSES

Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	9.6	0	1	0
Advance Outwash	20.4	0	38	1	0

Hong West & Assoc. - Lynnwood WA

98179

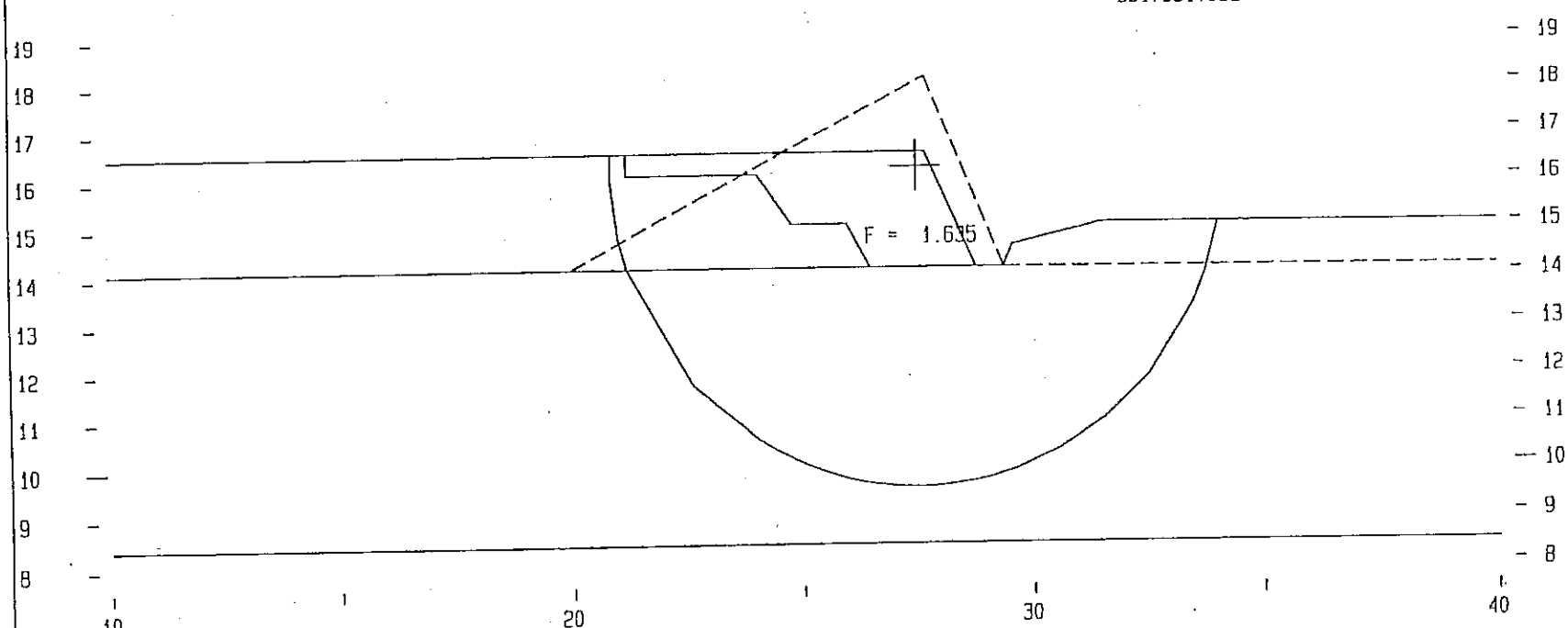
SR 305 Improvements

7 Dec. 1999

Emb. Stability - Sta.19+320

Right Slope-End of Constr.

9B179B1.GSL



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	0	28	1	0
Advance Outwash	20.4	0	38	1	0

Hong West & Assoc. - Lynnwood WA

98179

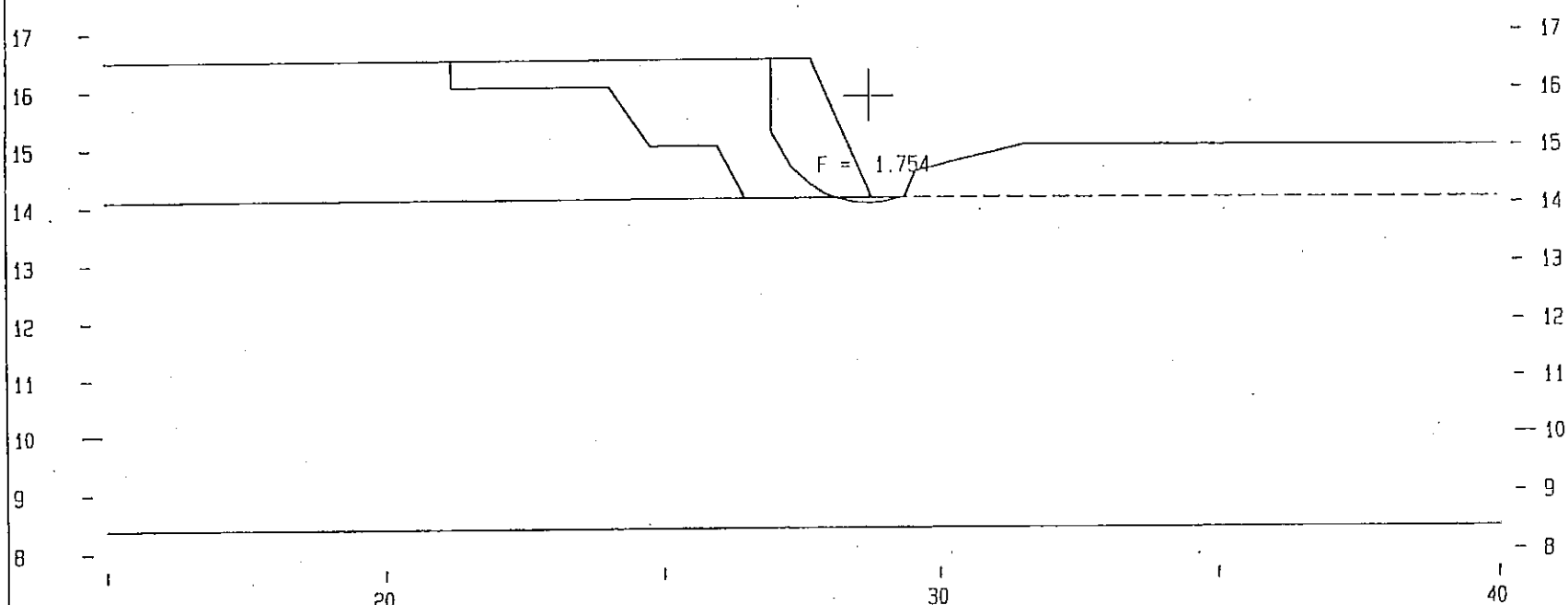
SR 305 Improvements

7 Dec. 1999

Emb. Stability - Sta.19+320

Right Slope-Long Term

9817982.GSL



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	0	28	1	0
Advance Outwash	20.4	0	38	1	0

Seismic coefficient = .16

Hong West & Assoc. - Lynnwood WA

98179

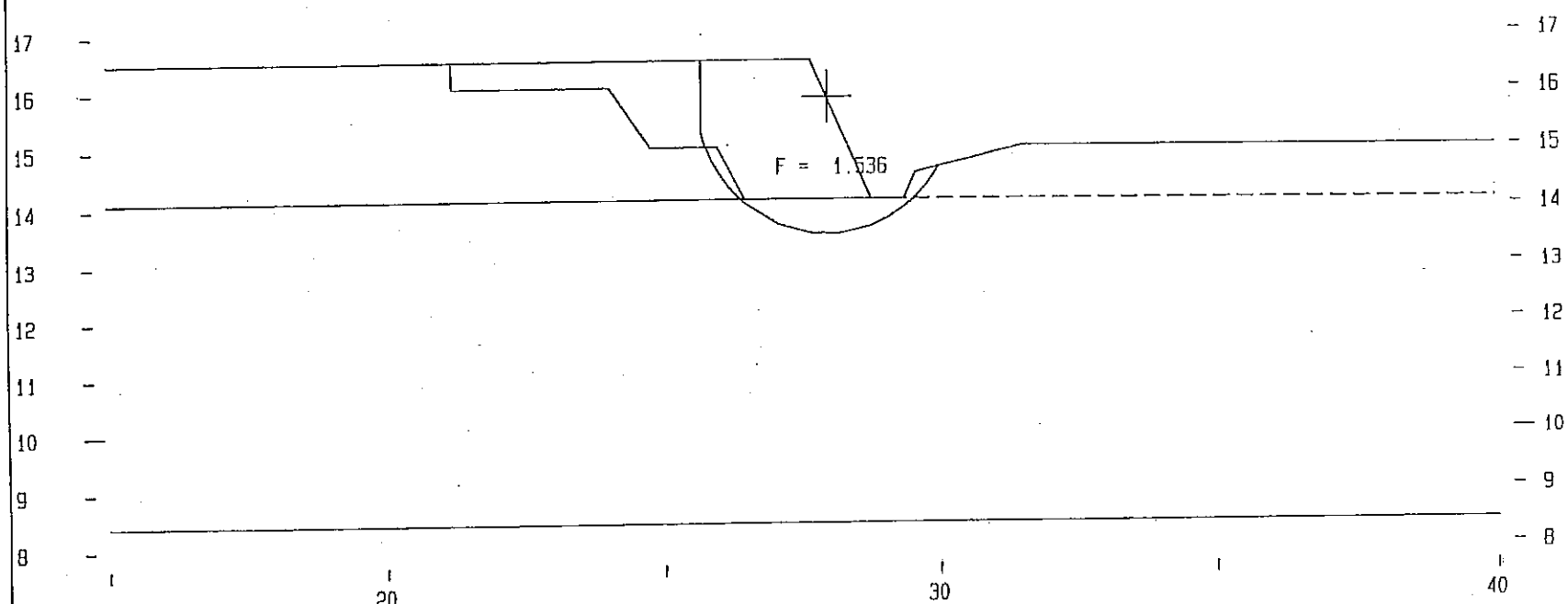
SR 305 Improvements

7 Dec. 1999

Emb. Stability - Sta.19+320

Right Slope-Dynamic

98179B3.GSL



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	9.6	0	1	0
Advance Outwash	20.4	0	38	1	0

Hong West & Assoc. - Lynnwood WA

98179

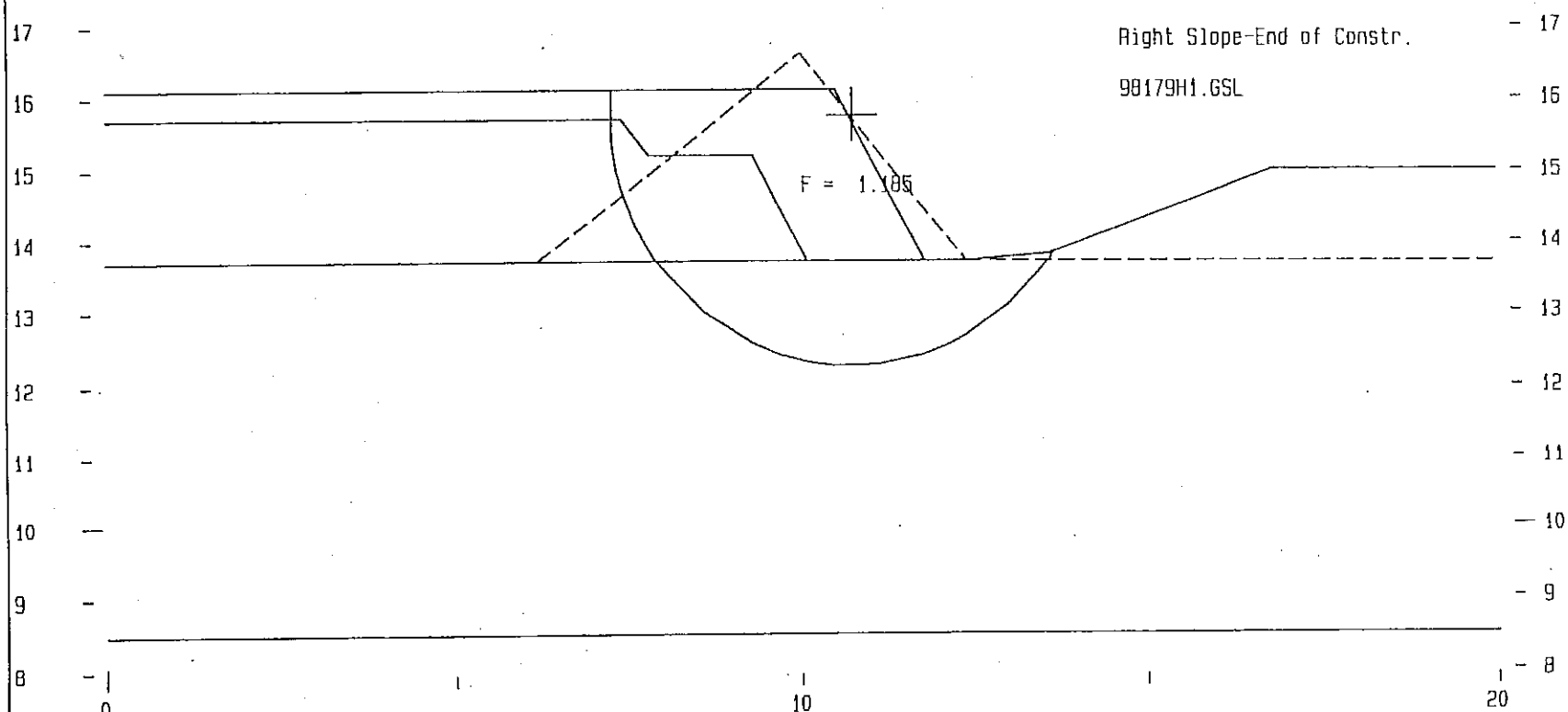
SR 305 Improvements

7 Dec. 1999

Emb. Stability - Sta.19+400

Right Slope-End of Constr.

98179H1.GSL



Material	Unit Wt	C	Phi	Piezo	Ru
	kN/m3	kPa	deg	Surf.	
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	0	28	1	0
Advance Outwash	20.4	0	38	1	0

Hong West & Assoc. - Lynnwood WA

98179

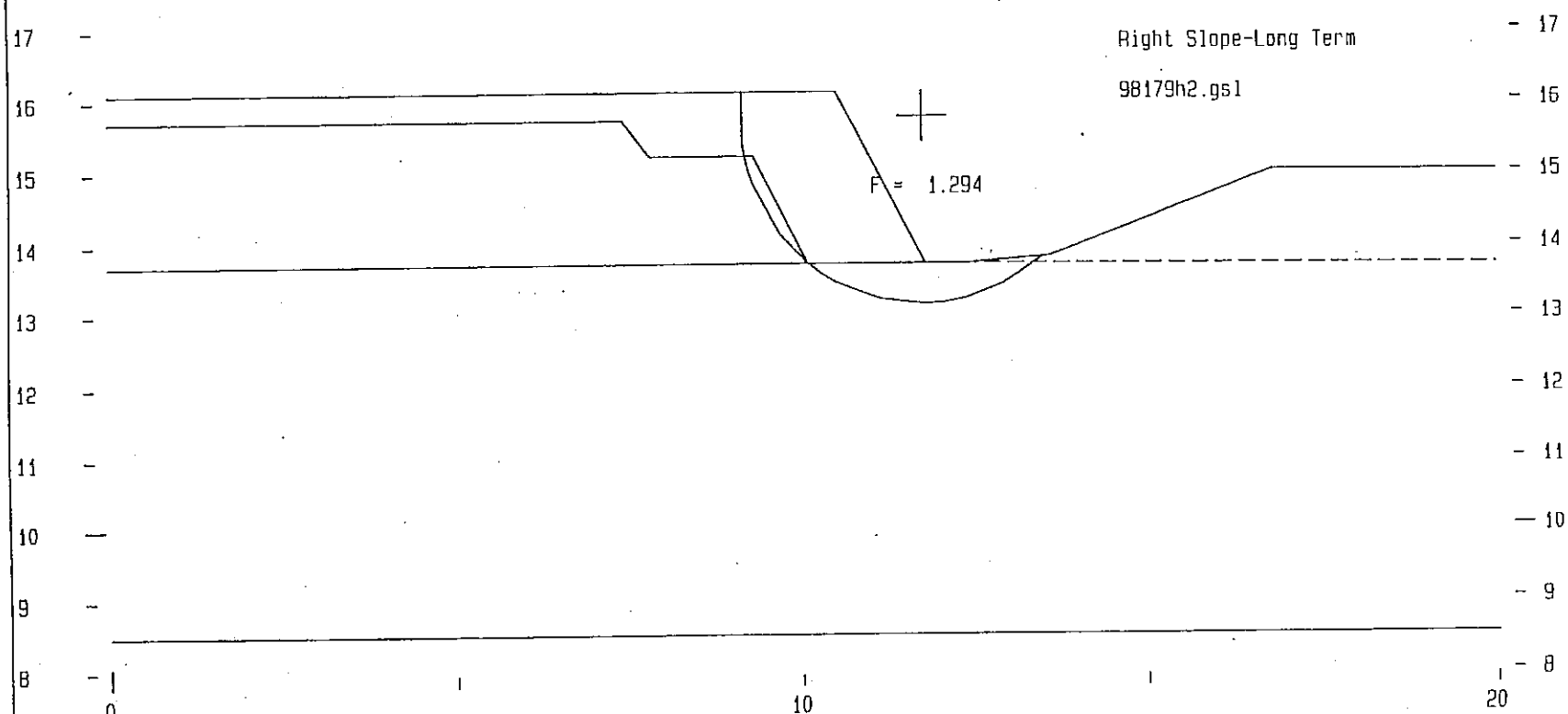
SR 305 Improvements

7 Dec. 1999

Emb. Stability - Sta.19+400

Right Slope-Long Term

98179h2.gsl



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	0	28	1	0
Advance Outwash	20.4	0	38	1	0

Hong West & Assoc. - Lynnwood WA

98179

SR 305 Improvements

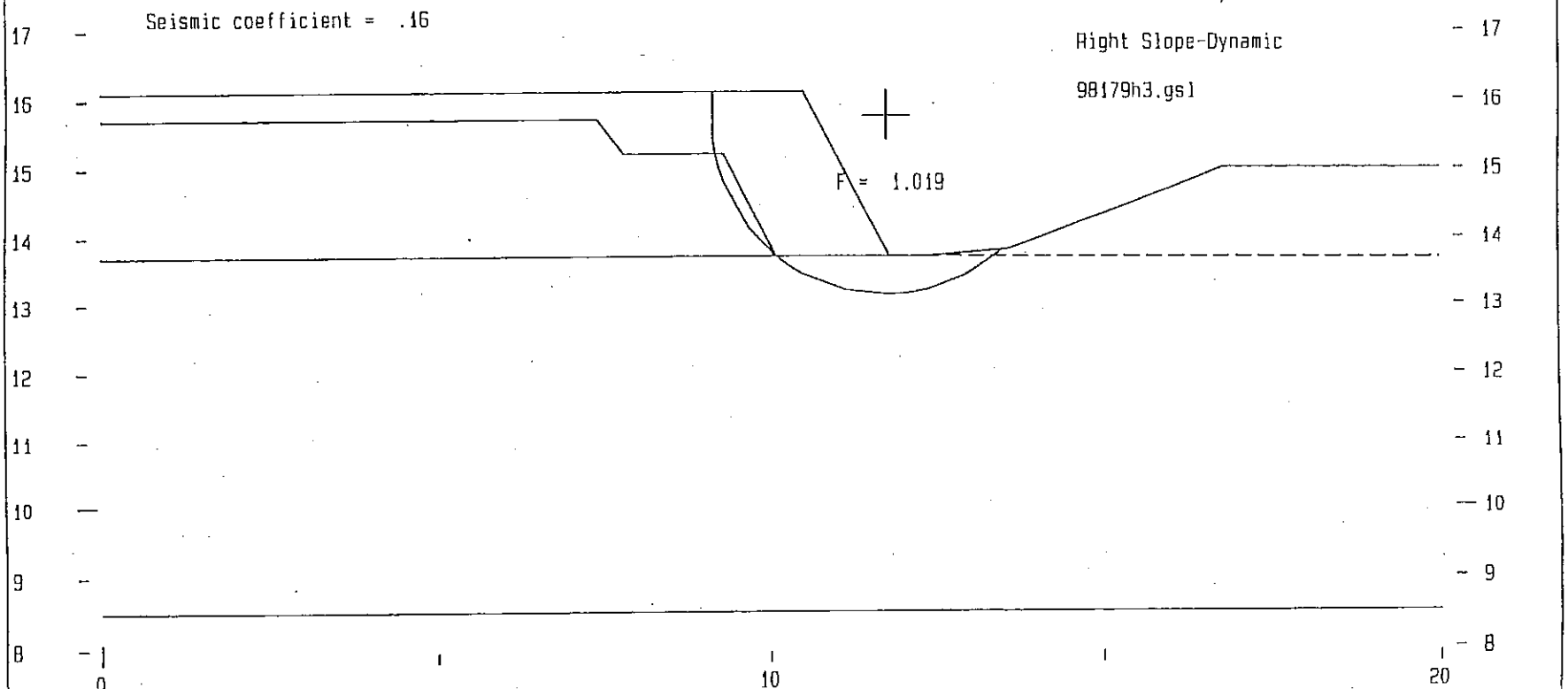
7 Dec. 1999

Emb. Stability - Sta.19+400

Right Slope-Dynamic

98179h3.gsl

Seismic coefficient = .16



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
19 Structural Fill	19.6	1	38	0	0
Exist. Embank.	18.9	0	36	0	0
18 Recent Alluvium	18.1	9.6	0	1	0
Advance Outwash	20.4	0	38	1	0

Hong West & Assoc. - Lynnwood WA

98179

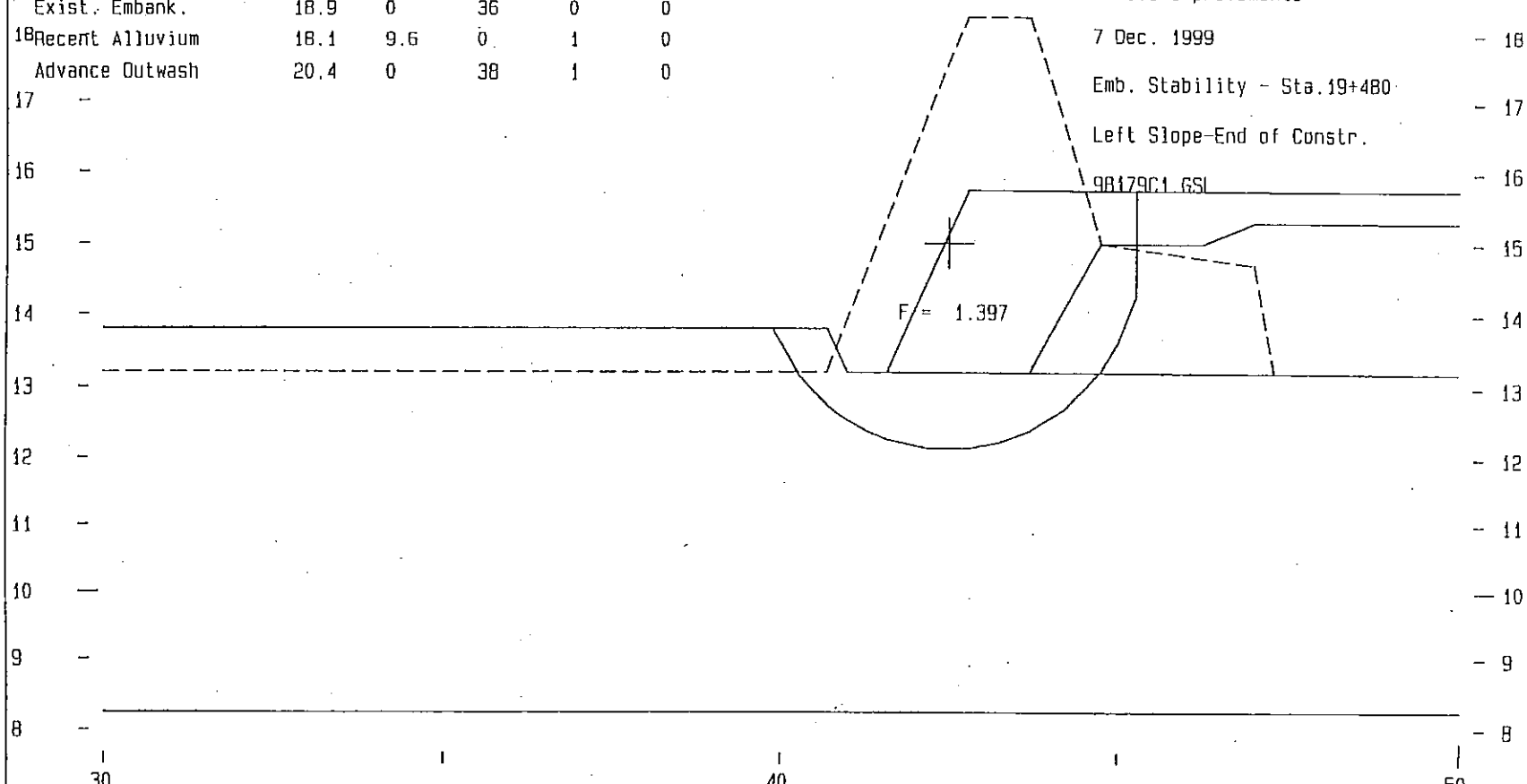
SR 305 Improvements

7 Dec. 1999

Emb. Stability - Sta.19+480

Left Slope-End of Constr.

98179C1.GSL



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent AlluviumA	18.1	3	28	0	0
Recent Alluvium	18.1	0	28	1	0
Advance Outwash	20.4	0	38	1	0

Hong West & Assoc. - Lynnwood WA

98179

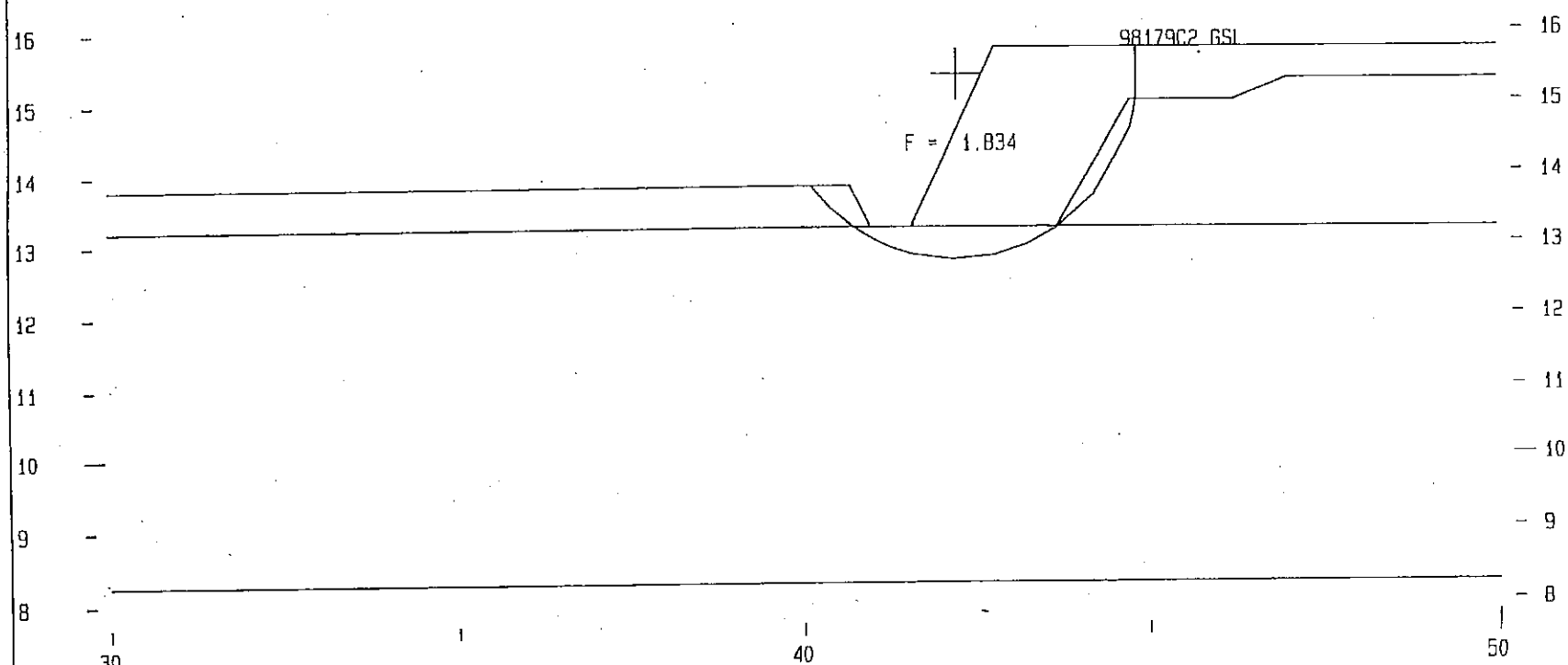
SR 305 Improvements

7 Dec. 1999

Emb. Stability - Sta.19+480

Left Slope-Long Term

98179C2.GSL



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent AlluviumA	18.1	3	28	0	0
Recent Alluvium	18.1	0	28	1	0
Advance Outwash	20.4	0	38	1	0

Seismic coefficient = .16

Hong West & Assoc. - Lynnwood WA

98179

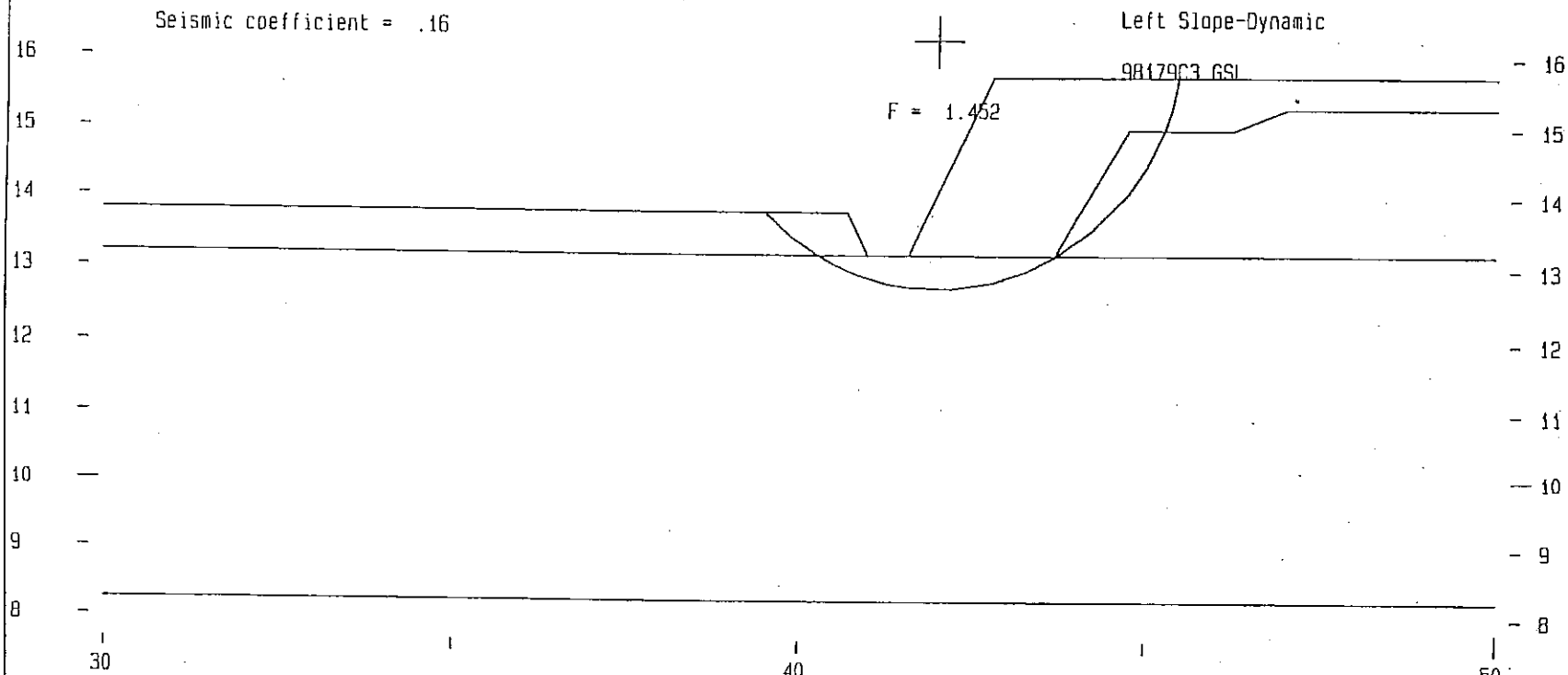
SR 305 Improvements

7 Dec. 1999

Emb. Stability - Sta.19+480

Left Slope-Dynamic

98179C3.GSI



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	9.6	0	1	0
Advance Outwash	20.4	0	38	1	0

Hong West & Assoc. - Lynnwood WA

98179

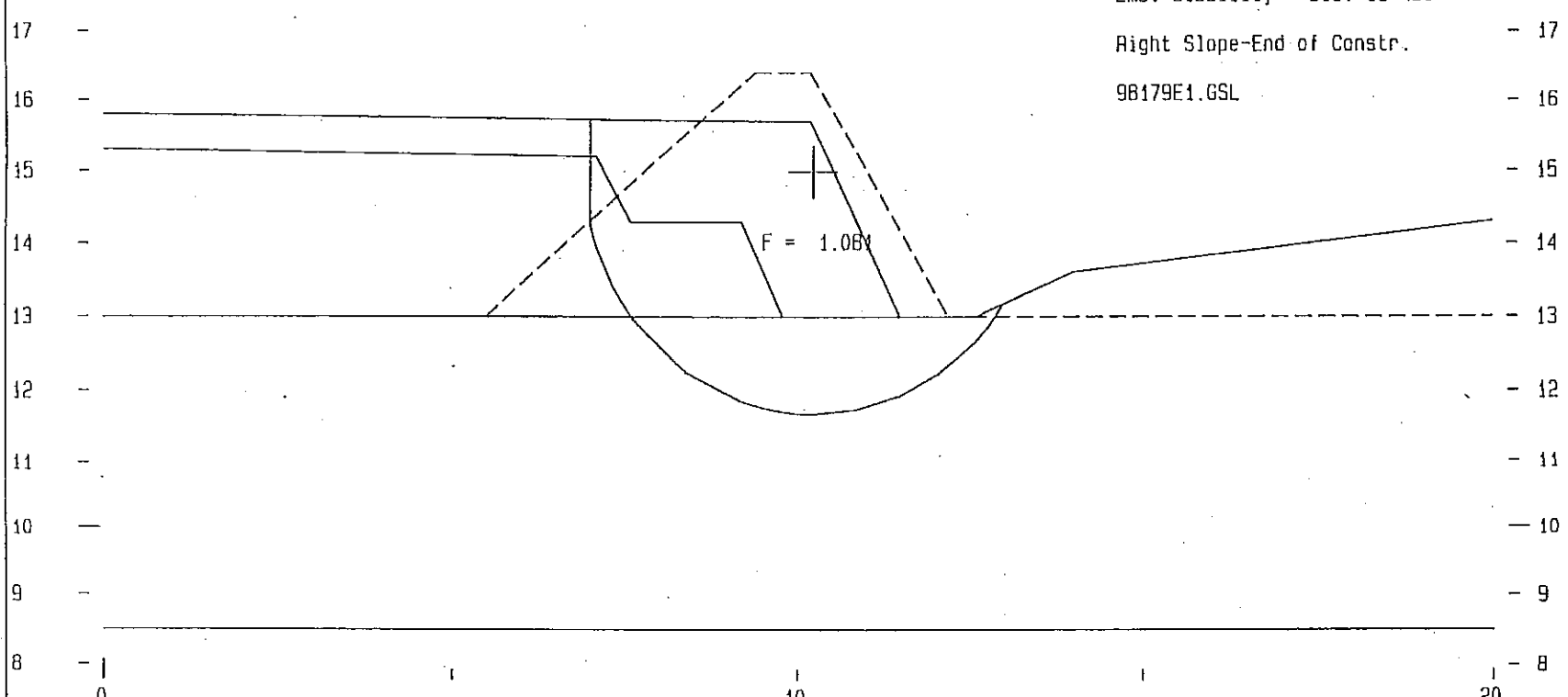
SR 305 Improvements

27 dec. 1999

Emb. Stability - Sta. 19+480

Right Slope-End of Constr.

98179E1.GSL



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	0	28	1	0
Advance Outwash	20.4	0	38	1	0

Hong West & Assoc. - Lynnwood WA

98179

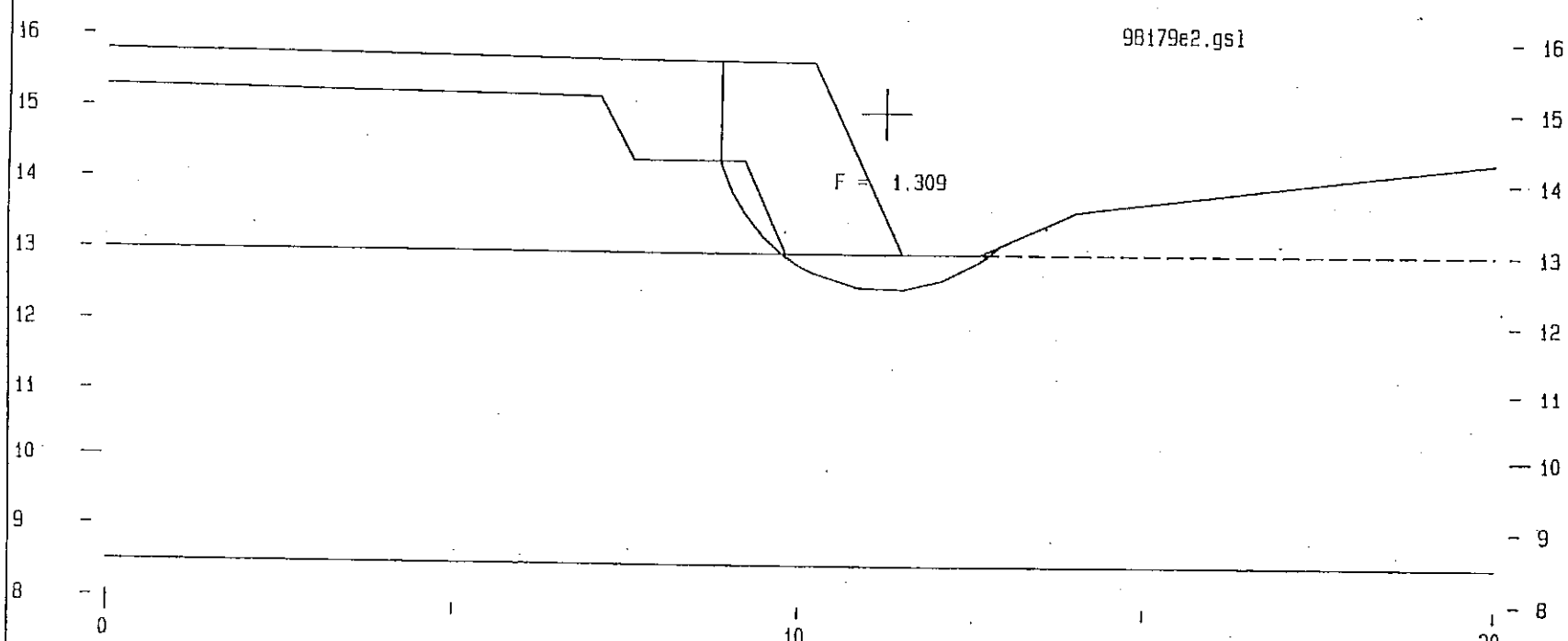
SR 305 Improvements

27 dec. 1999

Emb. Stability - Sta. 19+480

Right Slope-Long Term

98179e2.gsl



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	0	28	1	0
Advance Outwash	20.4	0	38	1	0

Seismic coefficient = .16

Hong West & Assoc. - Lynnwood WA

98179

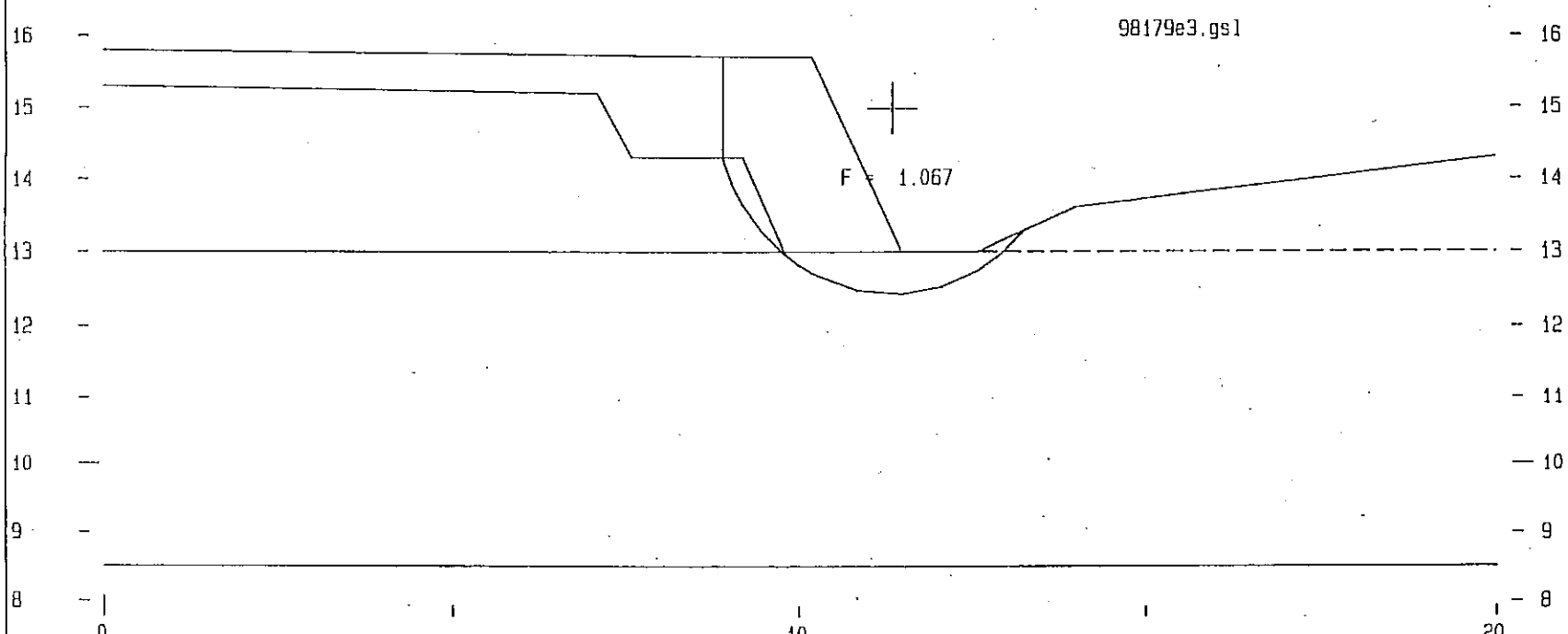
SR 305 Improvements

27 dec. 1999

Emb. Stability - Sta. 19+480

Right Slope-Dynamic

98179e3.gsl



Material	Unit Wt	C	Phi	Piezo	Ru
	kN/m3	kPa	deg	Surf.	
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	9.6	0	1	0
Advance Outwash	20.4	0	38	1	0

Hong West & Assoc. - Lynnwood WA

98179

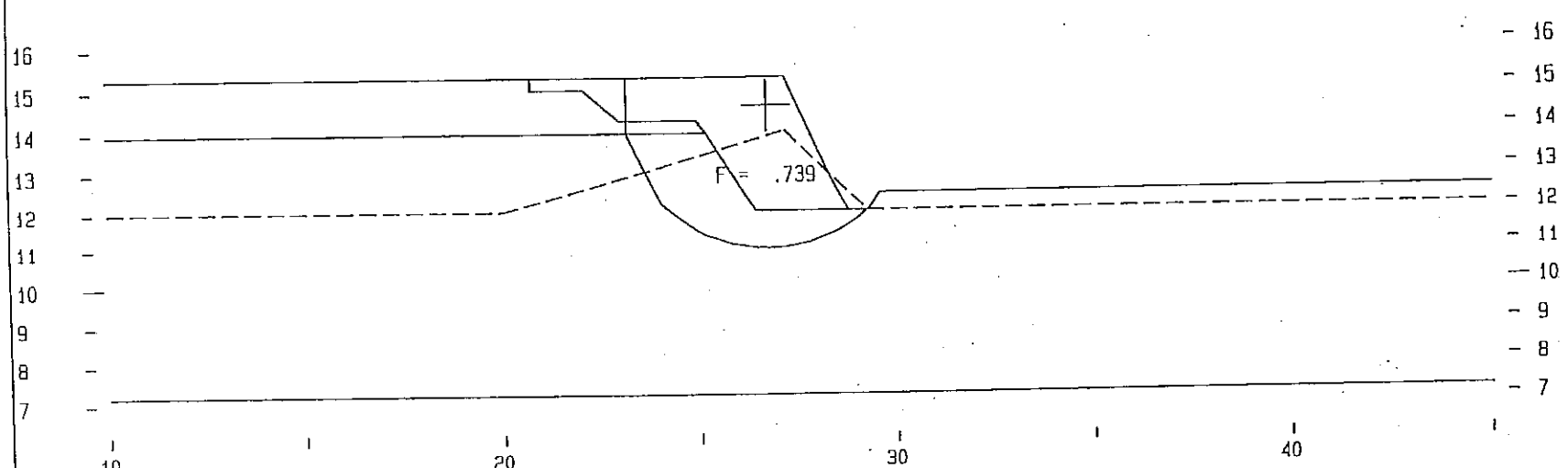
SR 305 Improvements

7 Dec. 1999

Emb. Stability - Sta.19+566

Right Slope-End of Constr.

9817901.GSL



Material	Unit Wt	C	Phi	Piezo	Ru
	kN/m3	kPa	deg	Surf.	
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	0	28	1	0
Advance Outwash	20.4	0	38	1	0

Hong West & Assoc. - Lynnwood WA

98179

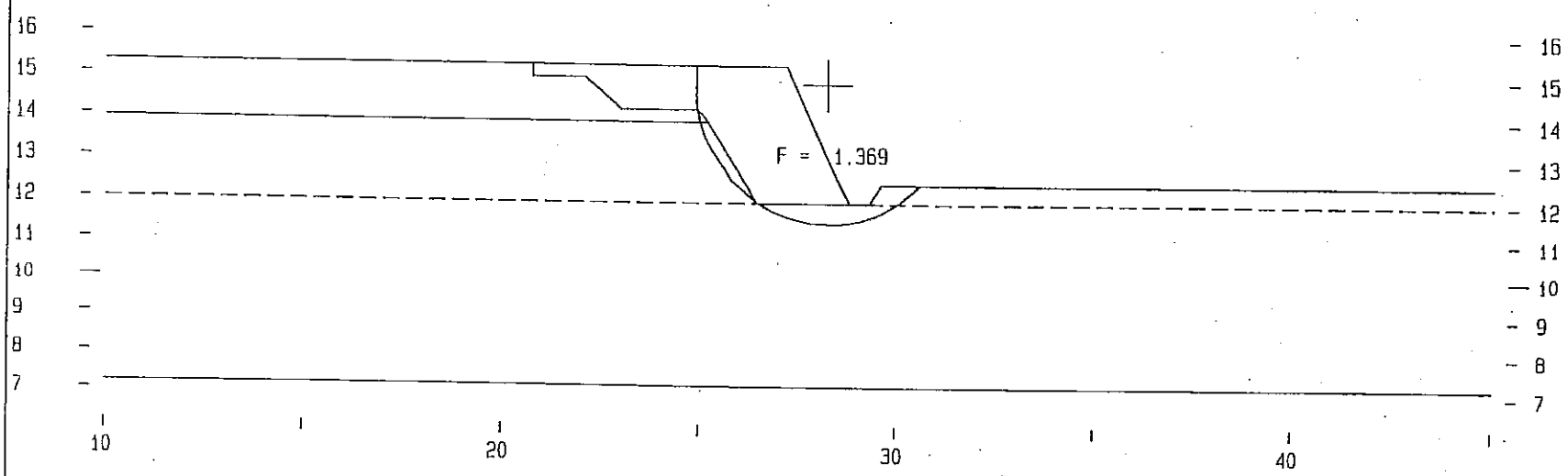
SR 305 Improvements

7 Dec. 1999

Emb. Stability - Sta.19+566

Right Slope-Long Term

9817902.GSL



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	0	28	1	0
Advance Outwash	20.4	0	38	1	0

Seismic coefficient = .16

Hong West & Assoc. - Lynnwood WA

98179

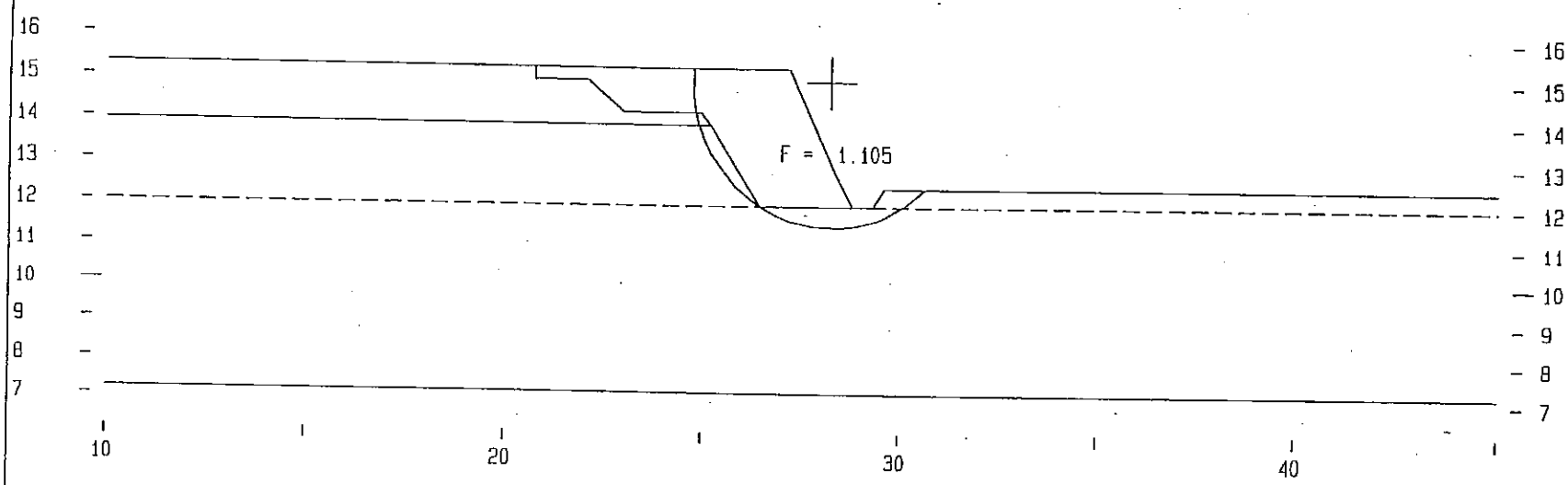
SR 305 Improvements

7 Dec. 1999

Emb. Stability - Sta.19+566

Right Slope-Dynamic

9817903.GSL



Material	Unit Wt	C	Phi	Piezo	Ru
	kN/m3	kPa	deg	Surf.	
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	9.6	0	1	0
Advance Outwash	20.4	0	38	1	0

Hong West & Assoc. - Lynnwood WA

98179

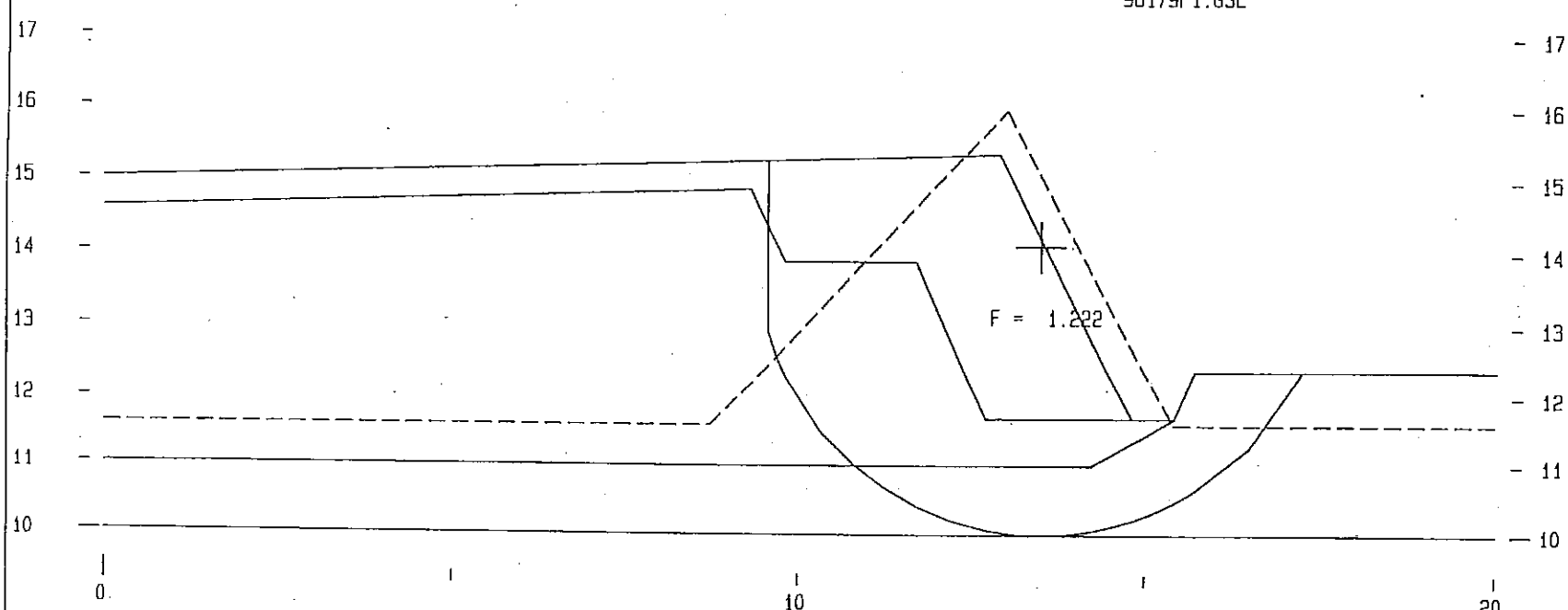
SR 305 Improvements

27 dec. 1999

Emb. Stability - Sta. 19+720

Right Slope-End of Constr.

98179F1.GSL



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	0	28	1	0
Advance Outwash	20.4	0	38	1	0

Hong West & Assoc. - Lynnwood WA

98179

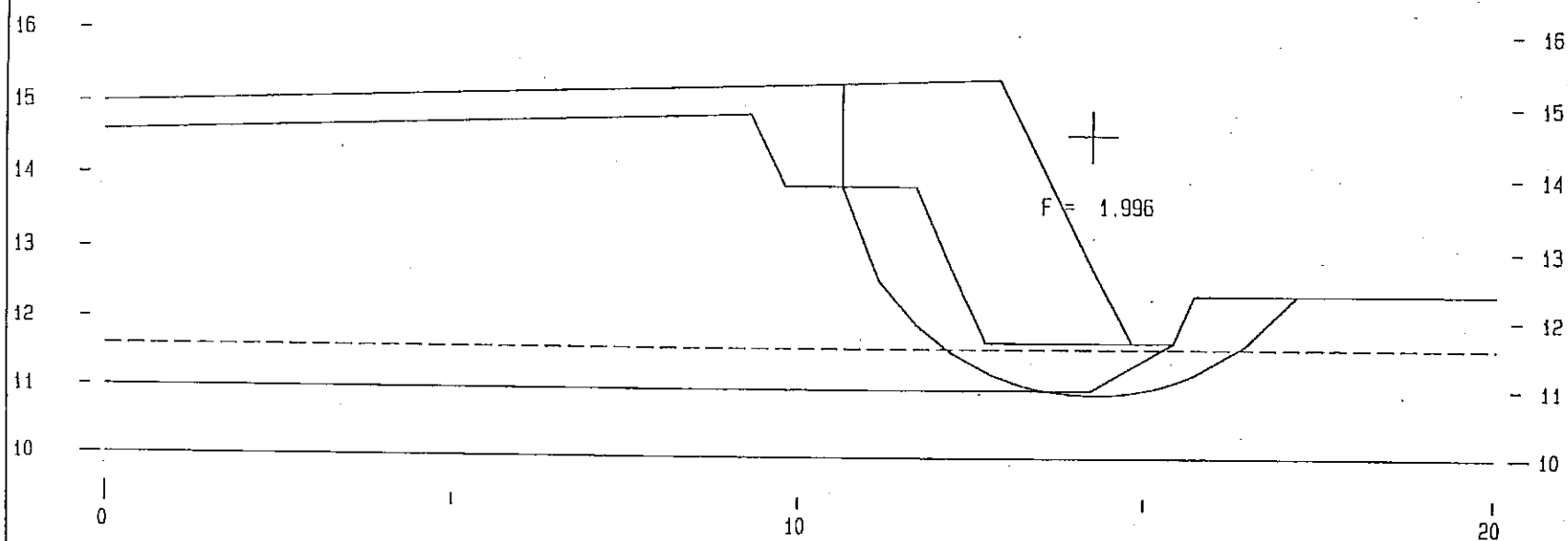
SR 305 Improvements

27 dec. 1999

Emb. Stability - Sta. 19+720

Right Slope-Long Term

98179f2.gsl



Material	Unit Wt	C	Phi	Piezo	Ru
	kN/m3	kPa	deg	Surf.	
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	0	28	1	0
Advance Outwash	20.4	0	38	1	0

Seismic coefficient = .16

Hong West & Assoc. - Lynnwood WA

98179

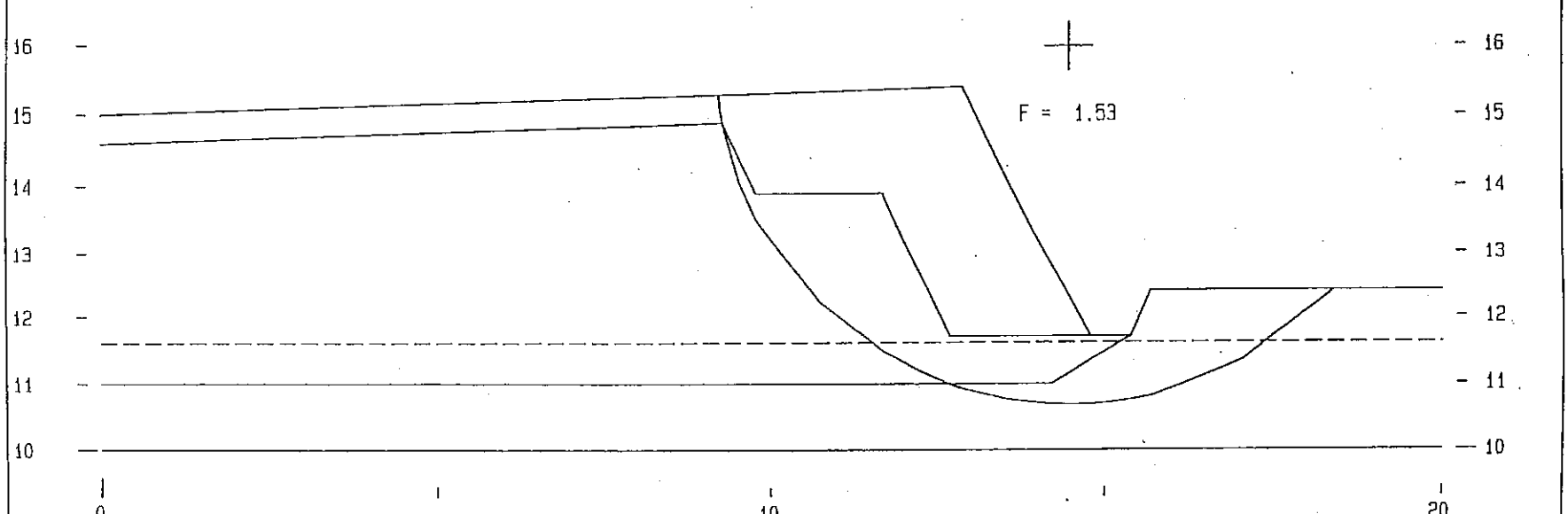
SR 305 Improvements

27 dec. 1999

Emb. Stability - Sta. 19+720

Right Slope-Dynamic

98179f3.gsl



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	14.4	0	1	0
Advance Outwash	20.4	0	38	1	0

Hong West & Assoc. - Lynnwood WA

98179

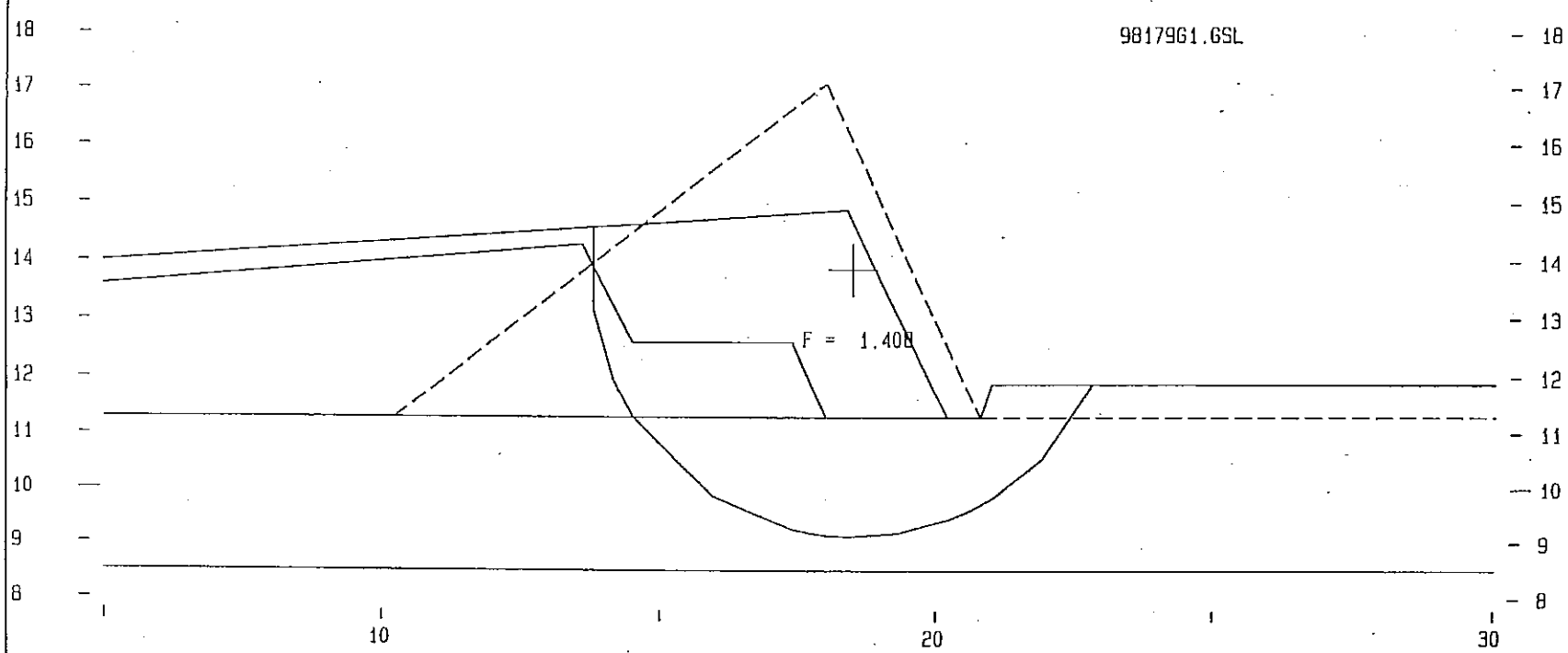
SR 305 Improvements

7 Dec. 1999

Emb. Stability - Sta.19+867

Right Slope-End of Constr.

98179G1.GSL



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	0	28	1	0
Advance Outwash	20.4	0	38	1	0

Hong West & Assoc. - Lynnwood WA

98179

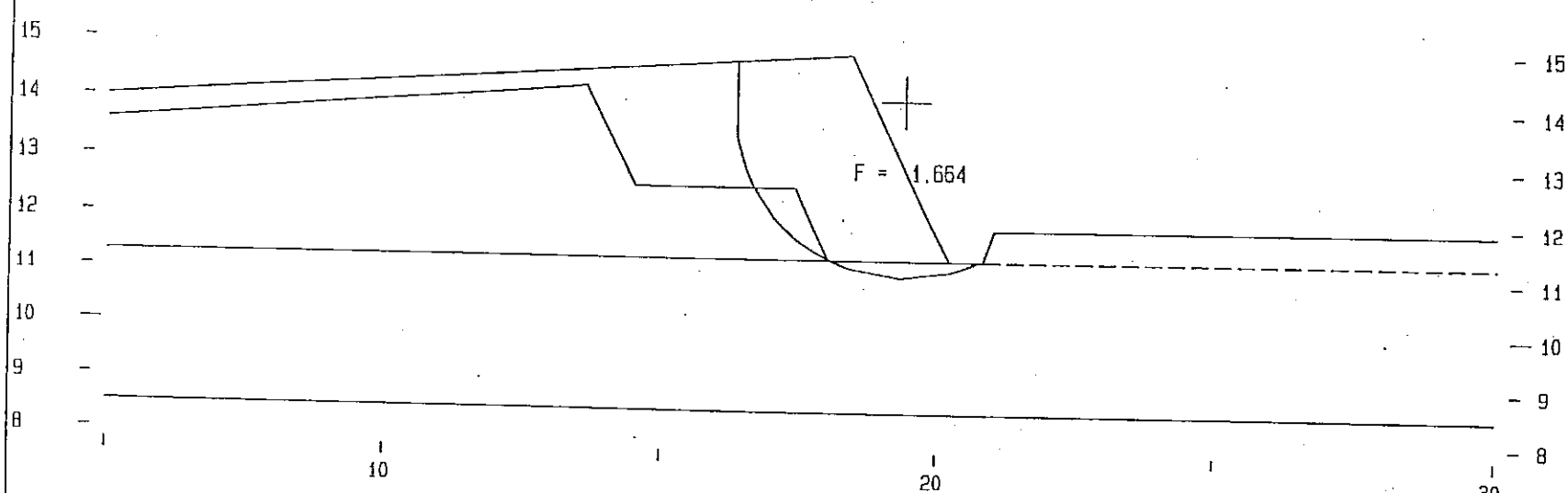
SR 305 Improvements

7 Dec. 1999

Emb. Stability - Sta.19+867

Right Slope-Long Term

98179g2.gsl



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Structural Fill	19.6	10	38	0	0
Exist. Embank.	18.9	0	36	0	0
Recent Alluvium	18.1	0	28	1	0
Advance Outwash	20.4	0	38	1	0

Seismic coefficient = .16

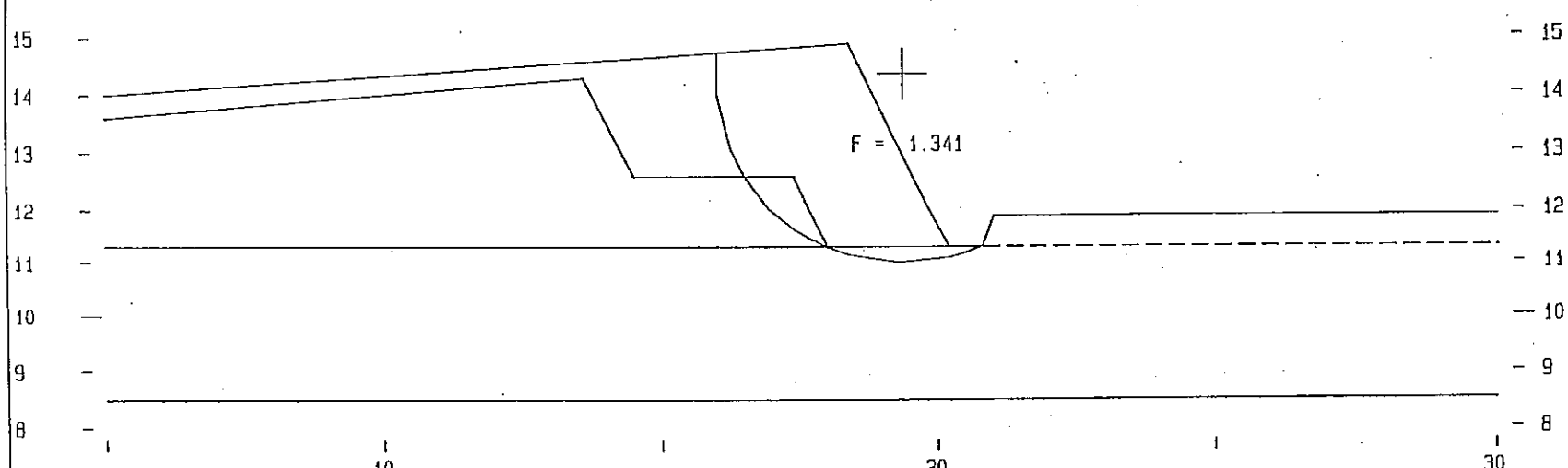
Hong West & Assoc. - Lynnwood WA

98179

SR 305 Improvements

7 Dec. 1999

Emb. Stability - Sta.19+867

Right Slope-Dynamic

98179g3.gsl