FINAL TECHNICAL REPORT ON EARTH, WATER, TOXIC AND HAZARDOUS MATERIALS LAKEPOINTE MASTER PLAN EIS KING COUNTY, WASHINGTON

Submitted to:

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Submitted by:

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May 1997

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30 May 1997
6-91M-10459-E

Pacific Rim Equities
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Attention: Mr. Mike Gleason

Subject: **Final Technical Report on**
Earth, Water, Toxic and Hazardous Materials
Lakepointe Master Plan EIS
King County, Washington

Dear Mr. Gleason:

As requested by you, AGRA Earth & Environmental, Inc. (AEE) is pleased to submit this final technical report as partial response to the "Scope of Work, Lakepointe Master Plan, (File Nos. A95P0105, A95P0218, A95P0219), Supplemental Environmental Impact Statement," dated 3/5/96, as prepared by King County Department of Development and Environmental Services (DDES). Specifically, we have addressed the assigned portions of the following sections of the EIS:

ELEMENTS OF THE NATURAL ENVIRONMENT
A. EARTH
- Affected Environment
- Significant Impacts
- Mitigation Measures
- Significant Unavoidable Adverse Impacts

C. WATER
- Affected Environment
  2. Groundwater (all subsections)
- Significant Impacts
  1. Surface Water (subsections d., e., f., g., and h.)
  2. Groundwater (all subsections)
- Mitigation Measures
- Significant Unavoidable Adverse Impacts

ELEMENTS OF THE BUILT ENVIRONMENT

B. TOXIC AND HAZARDOUS MATERIALS

Affected Environment
Significant Impacts
Mitigation Measures
Significant Unavoidable Adverse Impacts

We previously prepared a Draft Technical Report dated 8 November 1996. State and county agency comments on the Draft Technical Report were generated between 19 November 1996 and 21 April 1997. This Final Technical Report includes AGRA's responses to those comments and memoranda listed in Callison Architecture's memorandum to Barbara Questad, King County Department of Development and Environmental Services (DDES), State Environmental Policy Act (SEPA) Section, dated 29 April 1997. *Substantive changes, clarifications and edits to the Draft Technical Report will be indicated in this final report with italics. Sections pertaining to erosion and groundwater were substantially reworded, based on the cumulative comments received on the draft technical report.*

Copies of this Final Draft Technical report will be distributed to the following:

Beak Consultants, Inc.	1 copy
Callison Architecture, Inc.	1 copy
Heller, Ehrman, White & McAuliffe	1 copy
King County DDES	15 copies
KPFF	1 copy
Pacific Rim Equities	3 copies
Phillips, McCullough, Wilson, Hill & Fisko	1 copy
Pioneer Towing Company, Inc.	1 copy

We appreciate this opportunity to be of service to you and would be pleased to discuss the contents of this report with you at your convenience.

Respectfully submitted,

AGRA Earth & Environmental, Inc.

DHG

Deborah H. Gardner, R.P.G.
Project Geologist

James S. Dransfield, P.E.
Vice President

DHG/JSD/caj

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FINAL TECHNICAL REPORT ON
EARTH, WATER, TOXIC AND HAZARDOUS MATERIALS
LAKEPOINTE MASTER PLAN EIS
KING COUNTY, WASHINGTON

INTRODUCTION

On 5 March 1996, a final scope of work was issued by King County for the Lakepointe Mixed Use Community (King County File Nos. A95P0105, A95P0218, and A95P0219) Supplemental Environmental Impact Statement. The scope of work identified Earth and Water as Elements of the Natural Environment, and Toxic and Hazardous Materials under Elements of the Built Environment as topics to be addressed in the Supplemental Environmental Impact Statement (EIS). The following report addresses affected environment and significant impacts for earth, groundwater and a portion of surface water issues, and toxic and hazardous materials. Discussions of mitigation measures and significant unavoidable adverse impacts are included at the end of each section where relevant.

1.0 EARTH

A *Preliminary Geotechnical Engineering Evaluation* of the subject site was initiated by AGRA Earth & Environmental, Inc. (AEE) in September 1995 and completed on 8 November 1996. *The preliminary geotechnical report is included as a technical appendix to this Final Technical Report. No changes have been made to the November 1996 report. The purpose of the geotechnical evaluation was to explore subsurface soil and groundwater conditions, determine the physical character of the soil underlying the site, determine whether groundwater seepage zones are likely to influence construction logistics, and provide preliminary recommendations for foundation design, grading and utility installation. Descriptions of these exploration methods and the types of information they provide are presented below in this section.*

Our exploration was accomplished by drilling soil test borings, advancing electric cone penetrometers, and excavating soil test pits to various depths across the site. A total of 27 soil borings and eight cone penetrometer explorations were advanced on the site. Boring depths ranged from 14 to 71.5 feet below the existing ground surface. Eleven of the soil borings were completed as groundwater monitoring wells to characterize subsurface soil and groundwater conditions. Static water levels were generally six to twelve feet below existing grades. In February 1996, 20 test pits were excavated to depths of six to eleven feet below ground surface to explore the wood debris fill and characterize the fill constituents. A copy of the geotechnical report is included as a technical appendix (Appendix A) to this EIS.

Soil borings are drilled using a hollow auger through which core samples are obtained at regular intervals, and are usually terminated when they encounter dense to very dense soil conditions. By visually examining the core samples obtained from each boring, vertical changes in soil and groundwater seepage conditions are documented in each boring. By comparing the soil types encountered at various depths between each boring, horizontal changes may be extrapolated or inferred. This information is summarized and visually presented on geologic cross-sections of the property.

Electric cone penetrometer exploration consists of pressing a rod vertically into the soil and continually recording both the force required to advance the rod and the friction imposed by the surrounding soil types. Abrupt changes in pressure and/or friction signify major changes in soil conditions at known depths. The depths of these abrupt changes are used to refine the periodic record provided by the soil borings. Penetrometer explorations do not allow sampling or direct visual observation of the soil or groundwater conditions encountered, and are not capable of penetrating into very dense or gravelly conditions.

Soil test pits are excavated using a backhoe, and allow continual, direct, visual observation of the soils and groundwater seepage conditions exposed in two-foot wide, ten-foot long and six- to twelve-foot deep excavations, and exposed in the stockpile of materials temporarily removed from each test pit. The use of test pit explorations was especially important for characterizing the subsurface conditions at the Lakepointe site. Test pit explorations allowed direct observation of the character and constituents of the fill material underlying the property, documentation of the small proportion of soil and high proportion of wood and lumber products in the fill, and identification of the relatively consistent composition and geographic expanse of the fill across approximately 35 acres of the 45-acre site.

The main fill layer constitutes the upper ten to fifteen feet of the site that emerged in the 1960s as a peninsula on Lake Washington. Specifically, the peninsula of fill that constitutes three-fifths of the 45-acre site the site is the subject of a negotiated cleanup with the Washington State Department of Ecology (DOE). The geotechnical attributes of the principal fill layer are discussed in the Earth Section of this Final Technical Report, and the environmental attributes are discussed in the Toxics and Hazardous Materials Section. Both sections will include a discussion of the estimated 85,000 cubic yards constituting the main peninsular fill, updated with a discussion of 1996 grading activities that resulted in the surficial regrading of an estimated 9,300 cubic yards of material or debris that accumulated at the site during the 1990s.

The southern three-fifths of the *45-acre* site is underlain by significant thicknesses of very loose fills over soft, compressible peat and organic silt soils. *The northern two-fifths of the site are underlain by fills that directly overlie loose to medium dense, alluvial sands and gravels, without the intermediate layer of compressible organics.* Special foundation systems will be necessary for buildings constructed above these soil conditions. Roadways, sidewalks, and underground utilities will also require special subgrade preparation to tolerate long-term total and differential settlements. In general, *five* layers of material underlie the site:

- *Recent Fills*
- Wood Debris Fill
- Peat and Organic Silt
- Loose Alluvium
- Dense Sand and Gravel

Recent Fills

Existing stockpiles of roofing waste were regraded across a three-acre area of the south-central portion of the site, and existing stockpiles of concrete wash-out material were regraded across a six-acre area in the southwest portion of the site in September or October 1996. The roofing waste consists of a mixture of shredded wood roofing shingles, three-tab asphalt shingles, built-up roofing (a sandwich of roofing tar and tarpaper layers), plastic sheeting, nails and paper products, and was spread in a layer averaging six inches thick across the area between exploration locations A-24, AW-11, TP-13 and TP-14 shown on the Site and Exploration Plan, Figure 2. The roofing waste layer is piled up to six feet deep at one location at the crest of the slope above the Sammamish River shoreline.

The concrete-washout material consists of a silty gravelly sand to sandy gravel mixture created by emptying and rinsing concrete trucks into a wash-out pond and then dredging the solids from the water into stockpiles encircling the pond. Use of the wash-out pond was discontinued in spring 1996 and allowed to dry out over the following summer. In September or October 1996, approximately 6,800 cubic yards of the stockpiled material were regraded to backfill the former pond and level the six acre area. A layer of concrete wash-out ranging from one to five feet high, and averaging three feet high, covers the six acre area bounded by exploration locations AW-3, AW-5, AW-11 and TP-14 shown on the Site and Exploration Plan, Figure 2. The area was regraded to shed runoff towards the north.

The presence or redistribution of these fill materials at the subject site does not have any influence on AEE's preliminary geotechnical evaluation, recommendations, or conclusions. As stated above, AEE recommends special foundation systems or special subgrade preparations for buildings, roadways, sidewalks, and underground utilities constructed above fills or compressible native soils. From a geotechnical standpoint, the materials redistributed across the surface are not classified any differently from other fill layers or from the underlying compressible native soils; foundation loads must be transferred through surficial fills and through compressible native soils to bear on dense, native sands and gravels encountered at depths of 25 to 50 feet below the existing ground surface.

Wood Debris Fill

The wood debris fill is composed predominantly of wood fragments with brick, wire, concrete wash-out products, and a silty sand matrix. The wood debris fill averaged fifteen feet in thickness *over an area of approximately 35 acres, resulting in an estimated volume of 85,000 cubic yards.* The fill on the majority of the site contains an average of 70 percent wood fragments by volume. Concrete and asphalt rubble accounts for approximately 15 percent of the fill by volume, with the balance consisting of soil *that occupies the interstices of the wood and concrete debris*. Between two and 23 feet of fill were encountered on the subject site, with the thinnest layers encountered at the north end of the site, and the deepest fills encountered next to the dredged barge channel. The debris fill is capped with a silty sand or silty gravel layer *ranging from one- to four-feet thick and* averaging two feet thick. The fills encountered towards the north end of the site were associated with existing road embankments, building and utility construction, and contained less wood debris. *The area underlain by wood debris fills closely corresponds to the area underlain by peat soils, shown on the Site and Exploration Plan, Figure 2.*

Peat and Organic Silt

Beneath the fill soils, native peat and organic silt soils were encountered beneath the southern two-thirds of the site. *Areas underlain by peat or organic soils are indicated on the Site and Exploration Plan, Figure 2.* These soft to very soft organic soils were interbedded with silts, clays and sands, and extended to depths of 25 to 44 feet below existing grades beneath the south end of the subject site.

Alluvium Over Dense Sand and Gravel

Beneath the peats and organic silts, the explorations encountered loose alluvium, consisting of interbedded silt, sand and gravel. The loose alluvium grades to dense recessional sands and gravels with hard silt interbeds. These granular soils are interpreted to be post-glacial alluvium and glacial recessional outwash. Medium dense to dense sands and gravels, suitable for supporting foundation loads, were encountered beneath the filled portions of the site at depths of 25 to 50 feet.

1.1 Affected Environment

1.1.1 Topography

A topographic map of the site showing slope categories and areas of flood, erosion, landslide and erosion and seismic hazards as defined by King County Code 21A is provided as Figure 1, Sensitive Areas Ordinance (SAO) Hazard Map.

The majority of the property has been graded flatter than 15 percent, except for roadway and shoreline embankments, which typically exceed 40 percent. No erosion or landslide hazards are indicated for the property or vicinity in the Sensitive Areas Ordinance Folio. However, the majority of the site is mapped as a seismic hazard area, and is mapped within the 100-year floodplain. The boundary of the 100-year floodplain as shown in the SAO Folio corresponds to the approximate 1960 shoreline of the property, prior to placement of fills that raised the property above the lake level. The Federal Emergency Management Agency (FEMA) has prepared flood profiles and a flood map of the Sammamish River. According to the FEMA information, no flood hazards are profiled above lake level west of 68th Avenue N.E. A comparison of existing site elevations to the flood-hazards profiled by FEMA indicates no flood hazards along the river shoreline of the site, and the level of Lake Washington is under control by the U.S. Army Corps of Engineers.

The FEMA flood hazard area closest to the Lakepointe project is mapped adjacent to the east embankment of 68th Avenue N.E. The mapped, adjacent land has not been filled, and is situated at Elevation 17 feet, 4 feet below the lowest elevation on the subject property. The FEMA flood area is included on Figure 1 for comparison to the SAO mapping.

The lowest developed elevation on the property is a wharf at the east end of the inner harbor situated at Elevation 21 feet. The remainder of the upland area is situated above Elevation 24 feet. The 100-year flood hazard profiled at Elevation 21 feet by FEMA occurs approximately 2.6 miles upstream from 68th Avenue N.E. The 500-year flood hazard at Elevation 21 feet occurs approximately 1.6 miles upstream from the site.

1.1.2 Geology

Geologic conditions are shown on the Site and Exploration Plan, Figure 2. Three generalized cross-sections are provided as Figures 3 through 5 to illustrate the general geologic conditions underlying the site. The purpose of the geologic map is to delineate areas underlain by peat soils; however, the surface of the property and surrounding lands consist entirely of artificial fill or modified land. Therefore, the geologic units shown on Figure 2 represent the native soil conditions below the existing fill layer. Four principal geologic units underlie the site:

- Recent Fill and Wood Debris Fill
- Peat and Organic Silt
- Loose Alluvium
- Dense Sand and Gravel

The portion of the site south of N.E. 175th Street is underlain by significant thicknesses of very loose fills over soft, compressible peat, organic silt soils, and/or loose alluvium. Where fills or soft soil conditions occur, dense, bearing conditions are encountered within the underlying sands and gravels at depths of 25 to 45 feet below existing grades. Special foundation systems will be necessary for buildings constructed above these soil conditions. Roadways, sidewalks, and underground utilities will also require special subgrade preparation to tolerate long-term settlements.

The portion of the site north of N.E. 175th Street is underlain by loose to medium dense alluvial sands and gravels. Furthermore, the area between N.E. 175th Street and Bothell Way N.E. includes numerous utility easements and roadfill embankments. Future construction in the vicinity of these rights-of-way will need to be protective of existing right-of-way embankments, utility structures, and utility backfills.

Engineering Characteristics of Wood Debris Fills

The fills are composed predominantly of wood debris with brick, wire, concrete wash-out products, and a silty sand matrix. The fill soils beneath the majority of the site contain an average of 70 percent wood debris by volume and average 15 feet in thickness.

Texture — The texture of the debris is coarse, and includes logs, timber piling stubs, and oversize concrete slabs. The wood fragments were typically less than 8 inches in diameter. The fragments were torn during test pit excavation, and average lengths of the wood fragments are not available. Fragments appeared to be several feet in length, and one log approximately 8 feet long was removed from test pit TP-15. The matrix consists of silty fine sands, and occasionally includes sandy fine gravels of concrete wash-out products.

Relative Density — The relative density of the fill is loose, although timber and concrete obstructions account for *misleadingly high densities.*

Color — The wood mixture is brown, and the soil matrix is generally gray.

Moisture Content — The moisture content is very high, due to the high organic content of the debris, and the proximity to the water table. Moisture contents of the soil matrix above the water table ranged from 12 to 16 percent.

Compressibility — The debris fill is moderately compressible, and the organic components are subject to degradation (and further subsidence) over time. Degradation rates are highest where the material is subject to fluctuating moisture conditions, lowest in either dry or saturated states. *Compressibility of the concrete washout material is low; some settlement will occur in regraded areas if the fill was not deliberately compacted.*

Organic Content — Organic content of the *wood debris* fill *and surficial roofing waste* is high, averaging 70 percent wood debris by volume. *Organic content of the concrete wash-out is zero percent, except where mixed at the boundary with the wood debris.*

Strength Characteristics — The debris fill generally possesses moderate shear strength characteristics in its current, packed condition.

Recent surficial fills were not specifically explored for AEE's Preliminary Geotechnical Engineering Evaluation, and are not addressed in that report. The engineering characteristics of the surficial fills, regraded areas, or existing stockpiles do not differ significantly from the engineering characteristics listed above for wood debris fill. No additional geotechnical investigations of surficial fills, above and beyond the building-specific studies that are already required for design purposes, are warranted.

Engineering Characteristics of Peat and Organic Silt

Native peat soils were encountered beneath the southern two-thirds of the site. These soils extended to depths of 15 to 35 feet below existing grades beneath the southern two-thirds of the subject site.

Texture — The peat soils contain finer organic debris with increasing depth, grading from fibrous to amorphous in texture with depth.

Relative Density — The relative density of the peat and organic soil is very soft.

Color — The color of the peat and organic silt is dark brown.

Moisture Content — The moisture content of peat and organic silt soils typically ranges from 100 to 400 percent, due to the high organic content.

Compressibility — The peat and organic silts soils are highly compressible.

Organic Content — Organic content decreases with depth. The peat soils consist of 90 to 100 percent organic matter by weight, and the organic silt soils are comprised of 50 to 80 percent organic matter by weight.

Strength Characteristics — The peat and organic silts soils demonstrate negligible strength characteristics.

Engineering Characteristics of Loose Alluvium

Soft or loose alluvial soils were encountered beneath the south half of the site. These soils extended to depths of 25 to 45 feet below existing grades beneath the south end of the subject site.

Texture — The texture of these soils coarsens with increasing depth, with silts and clays grading into interbedded fine sands, and sandy fine gravels.

Relative Density — The relative densities range from very soft silts to loose sands and gravels.

Color — The color of inorganic silts, clays, sands and gravels varies between tan, gray, green-gray, and blue-gray.

Moisture Content — Inorganic silts and clays have moisture contents ranging from 25 to 50 percent, and saturated sands and gravels have moisture contents of 5 to 15 percent.

Compressibility — The silt and sand alluvium demonstrate low to moderate compressibility characteristics, and the loose sands and gravel are typically of low compressibility.

Organic Content — Organic content in the alluvial soils decreases with depth. Organic matter occurs in lenses and randomly scattered in the inorganic clays and silts, and occurs rarely in the alluvial sands and gravels.

Strength Characteristics — Soft, inorganic silts and loose sands and gravels are generally low strength soils.

Engineering Characteristics of Dense Sands and Gravels

Beneath loose alluvium, subsurface explorations encountered medium-dense to dense sands and gravels. Interbeds of dense, silty sands and hard silts were occasionally encountered. These granular soils are interpreted to be glacial recessional outwash, but are not easily distinguished from overlying alluvial sands and gravels. The relative density, especially of the finer-textured interbeds, as well as the reduced potential for organic interbeds provide the distinguishing characteristics for the purposes of this discussion. Medium-dense to dense sands and gravels, suitable for supporting foundation loads, were encountered beneath the filled portion of the site at depths of 25 to 50 feet.

Texture — The texture of these soils ranges from medium sands to coarse gravels. Interbeds consisting of silts and silty fine sands account for a small volume of the material.

Relative Density — By definition, these sands and gravels range from medium dense to very dense. Hard silt interbeds are occasionally encountered.

Color — The color ranges from tan to grey.

Moisture Content — The moisture content of the sands and gravels ranges from 5 to 15 percent. Silt interbeds may demonstrate moisture contents of up to 25 percent.

Compressibility — The sands and gravels are of low to very low compressibility.

Organic Content — Organic matter is a rare occurrence in glacial recessional outwash sands and gravels, and was not encountered in sands and gravels at greater depths at this site.

Strength Characteristics — Dense sands and gravels exhibit high frictional shear strength.

Field Investigations

The Site and Exploration Plan shows the locations of all test pits, soil borings and cone penetrometer explorations, and is provided as Figure 2. Logs of AEE's subsurface explorations are incorporated in the *Preliminary Geotechnical Engineering Evaluation*, prepared by AEE and dated 8 November 1996.

Geotech Consultants, Inc. performed a Phase II Environmental Assessment of the subject site in November 1990. Seven shallow groundwater monitoring wells were installed and sampled. A supplemental soil assessment was performed in the vicinity of two underground storage tanks (USTs) located on the lot north of N.E. 175th Street. The results of the assessment were presented in a report entitled *Revised: Phase II Environmental Study—Kenmore Pre-Mix Site*, dated 24 January 1991. The results of further study were presented in a report entitled *Supplemental Sampling and Testing in the Proximity of Monitoring Well B-103*, dated 22 July 1991.

SEACOR resampled four wells remaining on site in December 1991, and presented the results in a *Groundwater Monitoring Report* dated 7 January 1992. Washington Department of Ecology (Ecology) also performed a *Site Hazard Assessment* of the property, dated 19 February 1992.

AEE initiated a *Preliminary Geotechnical Engineering Evaluation* for the subject site in September 1995. This report was finalized on 8 November 1996. A total of 27 soil borings ranging from 14 to 71.5 feet and 8 cone penetrometer explorations ranging from 31 to 47 feet were advanced on the site, and along existing and proposed right-of-ways, between September 1995 and February 1996. Eleven of the soil borings were completed as groundwater monitoring wells to characterize subsurface soil and groundwater conditions. Wells were installed with screen depths ranging from 4 to 14 feet bgs. In March 1996, twenty test pits were excavated to depths of 1 to 11 feet below ground surface to view and explore the wood debris fill and characterize the fill constituents for both geotechnical and environmental purposes.

The results of groundwater sampling and analysis, and wood debris fill characterization are discussed in AEE's *Phase II Environmental Assessment*, dated May 1996, and *Groundwater Analytical Results—August 1996* report dated 8 November 1996, as well as the Toxic and Hazardous Materials section of this report. Activities that have taken place on the site since August 1996 do not change any of our previous conclusions.

The only geotechnical study performed for the site and known to AEE is AEE's Preliminary Geotechnical Engineering Evaluation dated 8 November 1996. Several off-site geotechnical studies were reviewed as part of this scope of work. These included studies performed for the Kenmore Interceptor sewer alignment that passes through the north margin of the subject site, and for the 68th Avenue N.E. Burke Gilman trail underpass. The reports reviewed were:

> *Geotechnical Findings Report, Kenmore Interceptor Land Section and Structures, by CH2M Hill, Kramer, Chin & Mayo, and associated firms, dated May 1986.*

Report, Geotechnical Engineering Services, Missing Link Trail Underpass at 68th Avenue Northeast, by GeoEngineers dated 9 May 1990.

We also reviewed field boring logs and cross sections for construction of the existing 68th Avenue N.E. bridge, performed by Neil Twelker, P.E., date unavailable.

Soils

Currently, the entire site and surrounding land surface consists of modified urban land, with the exception of marsh soils underneath the north abutment of the 68th Avenue N.E. bridge that crosses the Sammamish River. *Because the entire site and surrounding lands are currently mapped as modified urban land, there are currently no significant boundaries between soil types that can be mapped on the site.*

This discussion references the U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS) Soil Survey of King County Area Washington, dated November 1973. A map showing the current distribution of SCS surface soil types is included as Figure 6.

Urban land (Ur) is the only soil category is currently encountered on the surface of the subject site. Urban land is described by the SCS as "soil that has been modified by disturbance of natural layers with additions of fill materials several feet thick to accommodate large industrial and housing installations. The erosion hazard is slight to moderate." This soil unit corresponds to the modified and developed terrain comprising the entire site where placement of fill, regrading, and industrial development is documented. The Urban land soil unit also corresponds to the fill soils that underlie the entire peninsula that forms the majority of the site. *The corresponding geologic classification for this soil category is artificial fill (af). The artificial fill layer is* shown on the geologic cross-sections included with this report *as Figures 3, 4 and 5.*

Geomorphic Processes

The property is located at the mouth of the Sammamish River, at the north end of Lake Washington, within the Puget Lowland basin. The Sammamish River flows west into Lake Washington off the southwest corner of the subject site. The large-scale geomorphic features of the vicinity are the result of Pleistocene Age glaciations, ending with the Vashon glaciation, which receded from the area approximately 13,000 years ago. The native soils underlying the site consist of alluvium deposited during the Holocene Age, following the recession of the Vashon glacier. Significant man-made modifications were performed this century to raise the property elevation above the level of Lake Washington. These modifications occurred both onsite and offsite.

Recessional sands and gravels were deposited by glacial meltwaters and their proceeding river drainages on the upland plateaus, in valleys, and in lakes. A delta of recessional sand and gravel formed at the mouth of the Sammamish River and prograded into the Lake Washington trough. Recessional sands and gravels also blanket the flanks of the trough and river valleys. Once the glacial meltwaters receded, the Sammamish River was fed by precipitation only, resulting in lower depositional energies, and deposition of finer sand and silt alluvium.

Revegetation of the glaciated lowland resulted in a significant source of organic matter that eroded from upstream sources and were deposited downstream. Organic silts and peats were subsequently deposited as the river delta at the mouth continued to prograde into the lake reservoir, building the property up towards the surface elevation of the lake. This depositional process continues today, although at a slower rate due to urbanization. Urbanization replaces the dense vegetation that previously contributed to the organic sediment load of the river, and includes installation of sedimentation and erosion controls to protect surface water quality. No flood controls are implemented along the Sammamish River, and the lake level is controlled further downstream at the U.S. Army Corps of Engineers Hiram Chittenden locks, where freshwater is discharged to Puget Sound. Upstream of the site, urban flooding risks are mitigated by civil engineering design as part of the urbanization process.

Following the lowering of Lake Washington in 1916, the Sammamish River was straightened and channelized in order to facilitate transportation and commercial uses. The south shoreline of the property was formed by the dredged alignment of the straightened river channel. The Kenmore Navigation Channel that angles across the site is also maintained by dredging, and originally served a timber mill located at the head of the channel.

The north end of the site was graded early this century for construction of a railroad, for Bothell Way and for N.E. 175th Street, and for associated industrial developments such as the lumber mill. By 1960, the property was being filled towards the river shoreline and the navigation channel, and the timber mill was replaced with a concrete plant. By 1980, the property had been filled to an elevation approximately ten feet above the surrounding lake level, and bulkheads had been constructed along the navigation channel to protect the industrial-use shorelines.

Modern geomorphic processes continue to be dominated by human activities. Net deposition of alluvial sediments continues in the Sammamish River Navigation Channel, as well as in the Kenmore Navigation Channel. The continued sediment accumulation requires periodic dredging. The sediment depth off the exposed west shoreline of the site, and outside the limits of dredging activities, appears to be controlled by erosive wind and wave action of Lake Washington. According to the hydrographic survey prepared by Reid Middleton for the Shoreline Permit, sediments accumulate to an average depth of approximately three to five feet below the lake level in a triangular zone between the dredged channels. Irregularities in the shallow lakebed topography may be due to disturbance by recreational boat traffic.

Vegetation protects the southern shoreline of the property from the moderate erosive forces of the Sammamish River. The inner end of the Kenmore Navigation Channel is protected from erosion by bulkheads, and there is no evidence that wind forces off Lake Washington have an erosional effect on the vegetated western shoreline of the property. Aside from the erosion processes discussed, natural degradation and settlement of the organic sediments underlying the site will continue at a slow rate over time.

Soil Limitations

The on-site soils accessible for grading are predominantly the existing fill soils. As described previously, the fill soils contain an average of 70 percent wood debris, and 15 percent concrete and asphalt rubble. The remainder consists of silty sand and silty gravel. There is a *thin* soil cap above the wood debris that averages 2 feet thick across the site. The wood debris materials are not suitable as structural fill due to their low strength, moderate compressibility characteristics, and high organic content.

Where soils are encountered in volumes that are worth segregating from debris, the soils should be classified in accordance with the Washington Model Toxics Control Act (MTCA) *and with the Dangerous Waste Regulations (WAC 173-303)* for *allowable recycling or off-site disposal*. Please refer to Section 1.2.1 for the related discussion of soil disposal options. Minor quantities of existing fill associated with the road embankments and building construction at the north end of the site may be suitable for *reuse as* structural fill, if they are essentially free of organic material and debris.

The existing fill soils will not be suitable for supporting structural loads. Building structures will require deep foundations. Light duty driveways, parking or sidewalks could be constructed atop these on-site fills after improvement by some over-excavation and replacement with adequate structural fill. Structural fill may be required for preloading, utility trenches, and grade changes. The Site and Exploration Plan, Figure 2, displays areas underlain by compressible soils, as do the geologic cross-sections, Figures 3, 4, and 5.

1.1.3 Erosion Hazard

According to the King County Sensitive Areas Criteria (KCC 21A) there are no *mapped* erosion hazard areas located within the Lakepointe project site. *The criteria for erosion hazards include steepness of slopes, soil texture, degree of vegetation cover, and presence of stream courses, seasonal or perennial drainage channels. This discussion addresses four geographic categories of erosion hazard on the property: recent fills and surficial stockpiles, perimeter slope areas, bulkheads, and the relatively flat-lying upland portions of the property.*

Recent grading of the former concrete wash-out impoundment in 1996 resulted in leveling six acres of five- to fifteen-foot tall stockpiles that were prone to erosion, but also eliminated the impoundment which had served as a sediment trap. The six acre area of former stockpiles was sloped to shed runoff towards the north and was mulched and hydroseeded as part of *a preliminary grading permit and erosion control submittal to King County in December 1996. The presence of roofing waste fills in the south central portion of the property does not pose additional erosion hazards above and beyond the former stockpiled conditions. Aggregate stockpiles are maintained for commercial sale in the southeast quadrant of the property. The combination of heavy equipment traffic, flat grades and silty materials does result in large puddles of turbid water in the stockyard; commercial stockpiles are not otherwise considered significant erosion hazards. Transportation of aggregate to the site results in a continuous supply of coarse-grained material; however, the heavy equipment traffic and flat-lying grades combine to minimize erosion of coarse materials.*

The types of materials on the surface consist of stockpiled construction materials, woodwaste fill, and other fine-grained materials. Most of the surface materials were observed to contain a significant *proportion* of silt. Considering the surface soils and the low slopes, sediment leaving the site would be of fine-grained texture, such as silt and fine sand. In subsection 1.2.2 of the Significant Impacts section we have estimated the amount of sediment eroding from the site, based on existing conditions. *Subsection 2.1.2 addresses the subject of infiltration.*

The majority of the property can be characterized as *relatively flat-lying,* bare soil without the protection of pavement or vegetation. The existing conditions *of the upland portions of* the site do not include *perennial or seasonal* surface water drainage channels or sloping grades that would be susceptible to erosion*, other than the lake and river that form the site boundaries.*

The steepest slopes on the property are confined to the perimeter shorelines and street embankments, which are predominantly vegetated and comprise a very small percentage of the area of the property. There is no evidence of *major* erosion problems along the river shoreline or street embankments bordering the site. *Localized erosion of the soil cover exists in a two-foot zone confined between the winter and summer shorelines, and is visible during low winter lake levels. The cause of erosion appears to be a combination of winter storm action and summer wave action. Human disturbance of the vegetation cover and exposed soil is also evident along scattered trails that access the shoreline. Otherwise,* the shoreline along Lake Washington and the Sammamish River is protected by vegetation that receives little disturbance; currents and wave action are weak at these locations. The majority of the navigation channel shoreline is protected from surface activities by bulkheads. However, a 400-foot section of unprotected *and unvegetated* shoreline is used as a staging area for a shoreline construction contractor. This unprotected area is periodically disturbed by the staging activities.

Currently, site runoff is collected in a series of catch basins aligned east-west that drain the central portion of the site. These catch basins drain towards the west and discharge through a pipe located at the east end of the inner navigation channel. The discharge outlet is situated *above winter low water levels but is submerged beneath the summer high water level. Evidence of erosion is visible beneath the wharf that projects above the waters of the inner channel; however, the cause of erosion can not be attributed solely to the discharge outlet. Erosion may be a result of bulkhead disrepair, commercial fishing and industrial barge activity, and fresh groundwater seepage. Significant quantities of turbid runoff discharge from the outlet during winter storm events. The outlet likely deposits significant quantities of sediment several feet beyond the discharge point.*

A large-diameter corrugated metal pipe (CMP) outfalls to the southern shoreline of the site. The site is not plumbed to the CMP, and the alignment of the CMP corresponds to a municipal alignment that originates off-site to the north, at or beyond Bothell Way N.E.

1.1.4 Landslide Hazard

According to King County Sensitive Areas (KCC 21A) maps, no landslide hazard areas are mapped within the project site. *However, localized areas along the southern shoreline meet the KCC 21A criteria of: slopes of impermeable soils steeper than fifteen percent and subjected to springs or groundwater seepage; any area that has shown movement in the last 10,000 years; areas incised by stream incision, erosion or undercutting wave action; areas that show risk of avalanche; and, any area located in an area of active sediment accumulation. The western shoreline slope meets the first criteria and the southern shoreline slopes meet the third criteria for landslide hazards.* No evidence of past or potential landsliding or natural sediment deposition on the upland area has been observed on the project site.

The potential for seismic landsliding is considered to be the same along the southern river shoreline as in the interior of the site; adjacent river dredging does not extend deep enough to negatively influence the stability of the southern margin of the exposed land surface. The potential for seismic landsliding is elevated along the inner channel, where deep dredging activity undermines the northwestern shoreline of the site. This elevated potential for seismic landsliding is partially mitigated by existing bulkhead construction. However, during the design phase, slope stability along the shorelines may be more thoroughly investigated.

Shallow-seated slope movements at the site margins are relatively unlikely due to the interlocking character and moderate shear strength of the wood debris fill that extends beneath the low water line. The wood debris fill is unlikely to suffer shallow-seated movements due to the effects of wave erosion or loss of vegetation for the same reasons. The overlying sandy fill at the site boundary is protected from shallow-seated movements by its existing vegetative cover.

1.1.5 Seismic Hazard

The project site is mapped as a seismic hazard area according to the KCC 21A ordinance, due to the loose alluvial soils beneath the site, in conjunction with a shallow groundwater table.

Earthquakes

Large earthquakes reported historically in Washington most frequently occurred deep beneath the Puget Sound region. The most recent and best-documented earthquakes in the Puget Sound area were the 1949 magnitude 7.1 Olympia earthquake and the 1965 magnitude 6.5 Seattle-Tacoma earthquake. Both of these earthquakes occurred within the subducting Juan de Fuca plate at depths of about 34 to 40 miles.

The major cause of damage from an earthquake would be due to shaking from earthquake waves and potential liquefaction-induced settlement. Damage due to actual fault movement beneath the proposed structure would be highly unlikely. The U.S. Geological Survey (1975) proposed that the largest earthquake likely to occur in the Puget Sound region could have a magnitude as large as 7.5. It is believed that such an earthquake event could have a peak hard ground acceleration of about 20 percent of gravity (0.2g) and about 20 to 30 seconds of severe ground shaking. Due to amplification effects within the loose/soft site soils beneath the project site, peak accelerations ranging up to 0.25g to 0.3g could conceivably be experienced at the ground surface during such an event.

Earthquake maps included with the 1988 NEHRP manual entitled Recommended Provisions for the Development of Seismic Regulations for New Buildings indicate that a bedrock site acceleration of approximately 0.3 is appropriate for an earthquake of magnitude 7.5. An earthquake of this size would have a 10 percent probability of exceedance in 50 years, or a return period of 475 years. A moderate earthquake event is generally considered to be associated with a magnitude 6.5 earthquake, which could conceivably have a peak horizontal ground acceleration of up to 0.2g at the project site. This would be considered a higher probability event having a 40 percent probability of exceedance in 50 years (return period of 100 years).

The risk of such earthquake events to impact the project site would be similar to that of the Puget Sound area as a whole. The effects of seismic shaking on the proposed structures would be minimized by the structural design and construction specifications deemed necessary under current building codes.

Liquefaction Potential

Liquefaction potential has been found to be greatest where the groundwater level is shallow and where loose, fine sands occur within a depth of about 50 feet or less. Liquefaction potential decreases with increasing grain size, clay, and gravel contents, but increases as the ground acceleration and duration of shaking increases. As previously stated, groundwater at the site was generally observed at depths of about 5 to 8 feet.

The majority of the soils beneath the site would not be susceptible to liquefaction, *based on the results of our preliminary study*. These soils include the wood debris fill, peat and organic silt, and the dense sand and gravel. The peat and organic silt deposits are distributed in a horizontal layer of relatively uniform thickness, with no significant unbalanced loading across the site. Therefore, the risk of seismically induced lateral spreading within these upper organic layers, should the underlying loose alluvium liquefy, is considered to be low. However, additional analysis and modeling should be performed during design to evaluate the potential for lateral spreading, particularly along the margins of the site.

Beneath the peats and organic silt, some of the explorations encountered loose alluvial sands with interbeds of silt and gravel. Because layers of loose, sandy soils were encountered within the upper 50 feet at the site, liquefaction is considered to be an important design consideration for the proposed development. *Section 1804.5 within the Uniform Building Code (UBC) requires that the potential for liquefaction be evaluated for sites which lie in seismic risk zone 3. According to Figure 16.2 within the 1997 UBC the site lies within seismic zone 3. Table 16-I indicates a seismic zone factor 0.3 for the project site. In the absence of a site-specific peak ground acceleration determination, the seismic zone factor may be assumed to equal the peak ground acceleration. As indicated in the previous Earthquake section, peak accelerations ranging from 0.25 to 0.3 may be experienced at the site.* Structures above the loose alluvial sands may be susceptible to liquefaction-induced settlement. Analysis of the liquefaction potential and induced settlements should be performed during design of specific structures.

1.2 Significant Impacts

1.2.1 Topography/Geology

Additional Geotechnical Requirements

Additional field explorations, laboratory tests, and geotechnical engineering studies would need to be accomplished for design of the buildings and facilities associated with the project development. This additional work is necessary to formulate structure-specific geotechnical criteria for suitable foundation types and capacities, site preparation, and utility construction. For general site development, additional geotechnical study is necessary for specific aspects of the site development such as: design of retaining walls, bulkheads, and utility support; evaluation of settlement due to site filling, and its effect on pavement design; *potential for liquefaction and lateral spreading;* and other aspects.

Additional field explorations and geotechnical engineering, *typical and appropriate for the scale of construction proposed and geologic conditions encountered,* will also be necessary for preliminary site development such as site preparation, overexcavation of unsuitable materials, fill placement, and utility installation. The geotechnical criteria for final design should be based upon specific information such as building types, locations and structural loadings, pavement grades, utility types and grades, and other *design* information which is not yet available.

Based on the results of AEE's Preliminary Geotechnical Engineering Evaluation dated 8 November 1996 and updated on 30 May 1997, piling will be installed to transfer all foundation loads to a suitable layer at depth. A suitable bearing surface is first encountered at depths of 25 to 50 feet below the existing ground surface. Piles will likely be either closed-end steel pipe piles (which would be backfilled with concrete after driving) or precast concrete piles. Installation of piling will be one component of cap construction. Piling may support portions of an engineered cap, but will not penetrate the cap.

Ground surface vibration will be unavoidable during pile driving. Vibrations will be generated at the driving point as it is set into the bearing layer. These vibrations will be attenuated by overlying peat and fill soils, and are unlikely to be transmitted off site beyond the areas underlain by peat soils. These vibrations would be monitored at the nearest structures, and compared to acceptable ground surface accelerations for various structures. Vibration would pose less of a problem for pile-supported structures. For other nearby structures, pre-construction documentation of conditions would be established by photographs, survey and instrumentation of existing cracks. The production pile driving would be preceded by a test pile program, during which the most efficient pile and hammer types would be established, and the need for possible bracing or reinforcement of critical nearby structures could be accomplished as necessary.

One additional, building-specific geotechnical study will be submitted per phase of construction. Seven phases of construction are currently proposed over the next ten years; however, the exact timing of the phased development may be influenced by market conditions.

Topographic Constraints

No topographic constraints exist that would affect the siting of the structures, protection of the sensitive areas (above and beyond the planned setbacks), or scheduling of construction. All of the major structures are to be located in the upland portions of the site. The upland site is relatively flat with elevations ranging from 23 to 32 feet. The shoreline area contains steeper slopes, generally less than ten feet in height. A range of alternatives for shoreline protection, stabilization, or enhancement may be considered. The site topography poses no significant constraint to implementing any of these shoreline alternatives.

The placement of additional fills would surcharge the underlying, compressible peat soils, renewing settlement of the wood debris fill layer. It is assumed that settlements of the existing fill layer have mostly stabilized over the last twenty years; however, the placement of additional fill will result in compression of the underlying peat soils, resulting in new settlements apparent at the surface. Additional fills are unlikely in proposed building areas, where new loads will be supported on piling, but are likely in perimeter landscape areas. Additional field explorations and geotechnical engineering will be performed to address potential settlements once the desired, design criteria have been made available. Potential *settlements may have implications for landscape maintenance, pavement and utility design, as well as remedial design.*

The placement of fill will significantly increase the potential for settlements, while the use of piling will significantly reduce the potential for settlements by supporting the weight of surficial structures. The use of light-weight fills may result in moderate, short-term settlements.

Soil Disposal Options

Ecology performed a Site Hazard Assessment of the property 1992, resulting in the site ranking of 1, the highest priority for remediation. The causes and implications of the ranking are discussed in the Toxic and Hazardous Materials section of this report.

Due to historic site uses, the results of previous investigations, and the site ranking, soil excavated from the site must be characterized in accordance with the requirements of the Model Toxics Control Act (WAC 173-340) and the Dangerous Waste Regulations WAC 173-303-110 prior to export or disposal. *The waste characterization and disposal process will be one element of remedial design required for a negotiated cleanup under MTCA.* The results of characterization will allow classification of the soil that may permit on-site reuse or *on-site or off-site* disposal under MTCA. As discussed in the Affected Environment subsection of the Earth section of this report, soils disposed of on-site may or may not meet the geotechnical requirements for structural fill.

1.2.2 Erosion Hazard

In order to estimate the amount of soil erosion that may occur during construction, we used the Universal Soil Loss Equation (USLE), as described in the King County, Washington, Surface Water Design Manual (SWDM). This equation is the most widely used method of estimating soil loss due to erosion in the United States, and was the method specified in the Lakepointe Master Plan Scope of Work. The equation estimates soil loss due to erosion by taking into account site factors such as rainfall, soil type and the soil's susceptibility to erosion, site topography, ground cover, and erosion control measures utilized during construction. Each factor within this equation is discussed subsequently with the equation as follows:

$$A = R * K * LS * CV * PR$$

Where: A = *annual sediment yield in tons per acre*
R = *rainfall erosion index*
K = *soil erodibility factor*
LS = *length-slope factor*
CV = *cover factor*
PR = *erosion control practice factor*

The rainfall erosion index R, factors into the equation the erosive energy imparted by a design storm event. As directed within the SWDM data for the design storm event was obtained from figure 3.5.1c within the SWDM which provides the 2-year 24-hour total precipitation amounts in inches.

K, the soil erodibility factor, is a quantitative description of the inherent erodibility of a particular soil type. This factor reflects the fact that different soils erode at different rates when all other factors are kept the same. The intrinsic physical properties of each soil type determines the susceptibility of the soil to erode. The K value utilized within the calculations for the project site was derived from published values. The values used were estimated assuming the surface of the project site is bare and the near-surface site soils consist of a heterogeneous mix of fill soils which have a generally moderate to high silt content.

The length-slope factor, LS takes into account the effects of slope length and gradient (topography) of the project site. The site was divided into several groups based upon slope gradient and slope length, with each group assigned an individual length-slope factor. Thus for each group within each phase of the project the amount of erosion was determined using the appropriate length-slope factor with the results summed to give the total amount of anticipated sediment eroded for each phase. However it should be noted that the majority of the site is generally flat with little topographic relief, thus the amount of erosion would be minimal. The remainder of the site is composed of limited areas of slightly to moderately steep slopes which will contribute relatively larger amounts of sediment per unit area, although the percentage of the site consisting of steeper slopes is relatively small, and these steeper slopes are predominantly vegetated.

The cover factor, CV, refers to the type and amount of ground cover present at the site. Ground cover reduces the amount of erosion by acting to hold the soils in place or by dissipating the erosive energy of surface water. In general, the CV value increases with decreasing cover or for cover which has less ability to resist erosion. Thus, the worst case scenario is considered to be bare ground with no cover which would be assigned a CV value of 1. A value of 1 was used within the erosion calculations for this project, as suggested within the SWMD, for determining erosion amounts during the construction phase.

PR, the erosion control practice factor, reflects the condition of the on-site soils during construction and the types of erosion control measures taken. SWDM indicates that a factor of 1.3 should be utilized, which assumes no ground cover and that the all slopes have been compacted and are smooth.

For the purposes of calculating sediment yield from the site, the majority of the site was defined as a homogeneous unit, because the site is relatively level. However, the shoreline slopes and all other slopes were taken into consideration during calculation of soil loss.

Therefore our calculations conservatively approximate existing conditions, assuming the worst-case scenario of no ground cover protection and no sediment traps. The estimated sediment yield quantities for the existing conditions are listed by phase area below. It is estimated that construction will proceed in seven phases over an estimated ten year period.

EXISTING CONDITION SEDIMENT YIELD TABLE

Phase 1 Area	21.8 tons per year
Phase 2 Area	0.6 tons per year
Phase 3 Area	4.4 tons per year
Phase 4 Area	2.2 tons per year
Phase 5 Area	1.8 tons per year
Phase 6 Area	2.4 tons per year
Phase 7 Area	1.2 tons per year
Total Existing	34.4 tons per year

The SWDM version of the USLE estimates the sediment loss during construction by assuming that the surface area for each phase will consist of bare ground throughout construction with no sediment detainment. However, it should be emphasized that during construction appropriate temporary erosion and sedimentation controls (TESC) will be implemented to minimize the potential for off-site migration of sediments generated by construction activities. With each phase of development TESC measures will be undertaken to trap sediment within the construction area and stabilize future undeveloped areas. Thus, sediment discharge would be significantly reduced, provided TESC measures are properly implemented.

During construction of the Phase 1 Area, sediment yield calculations indicate that approximately 34.4 tons of sediment per year could be generated across the entire site, if no erosion control measures were implemented other than those assumed by the USLE. However, upon completion of each phase area, the amount of sediment each area contributed to the overall sediment yield of the site would be reduced to essentially zero since surface water controls such as storm sewers and detention ponds would be operating. Thus, after each phase area was completed the total sediment yield of the site would decrease by the amount it was previously contributing. Our final built-out condition assumes a best-case scenario, that the site has been capped and that all runoff is intercepted except on vegetated shoreline slopes. The following table illustrates the decreasing sediment yield for the site as each phase area is completed. The values provided below take into account all the remaining areas which have not been developed, including the shoreline areas.

CONSTRUCTION SEDIMENT YIELD TABLE	
Phase Completed	Total Site Sediment Yield*
Phase 1	12.6
Phase 2	12.0
Phase 3	7.6
Phase 4	5.4
Phase 5	3.6
Phase 6	1.2
Phase 7	0.0
*After phase completion (tons per year)	

The estimate of 34.4 tons of sediment is roughly equivalent to three dump truck loads per year, which is not surprising considering the expanse of the property (45 acres), the lack of vegetation, and the constant source of fine-grained and coarse-grained sediment that is transported daily across the property. Assuming a wet-weight density of 125 pounds per cubic foot, the 34-ton estimate translates to a thickness of 0.003 inches of soil loss per year distributed across the 45-acre site. The annual soil loss estimate would be significantly higher if the site sloped more steeply, and would be significantly lower if the site were vegetated.

1.2.3 Landslide and Seismic Hazard Areas and Steep Slopes

No landslide hazard areas or significant steep slopes are anticipated to be impacted by the proposal. Existing seismic risks due to the loose/soft soils that exist at depth beneath the site would not be aggravated by surface activities. These *deep, soft soil* conditions could result in liquefaction and strong ground motions during a major earthquake. This will likely require deep foundation support for all structures.

Utilities and on-grade paving will require subgrade improvement and allowance for some long-term settlement. Site development will also involve some improvement in the strength or compressibility characteristics of site soils and stabilization of shoreline areas. This will serve to reduce the likelihood of shallow-seated slope movement.

1.3 Mitigation Measures

Installation of pile foundations will mitigate the risk of ongoing site subsidence. In many areas, the net result of grading will be less loading on the site than currently exists, and therefore the rate of subsidence would be reduced.

Erosion hazards associated with pile driving will be mitigated by the use of pre-cast concrete or steel displacement-type piling to reduce generation of soil cuttings and minimize concrete spills..

Seismic hazards, including seismically-induced landsliding, will be the same for the site as for surrounding geographic Puget Lowland region. Potential impacts from seismic hazards will be mitigated by adherence to applicable building codes and standards during design and construction.

TESC measures will be implemented to control erosion through the construction phases. Soils generated during construction will either remain on site and be capped or may be transported off site and disposed at an appropriate disposal facility in accordance with MTCA requirements.

1.4 Significant Unavoidable Adverse Impacts

Noise during pile driving will be significant, and unavoidable. Pile driving installation may be limited to daytime working hours to minimize the impact of noise.

2.0 WATER

2.1 Affected Environment

2.1.1 Surface Water

By others.

2.1.2 Groundwater

Groundwater levels were measured seasonally between October 1995 and August 1996 in nine monitoring wells on-site (AW-1 through AW-9). Two southern shoreline wells (AW-10 and AW-11) were added in February 1996, and a well installed previously by others (B-102) was included in the April 1996 survey. Static water levels in the wells were observed to vary less than two feet seasonally during the stated time interval, except in well AW-5, where levels varied by almost three feet. Groundwater levels beneath the southern, filled portion of the site closely correspond to adjacent surface water levels *in both* Lake Washington *and the Sammamish River. Groundwater gradients inferred from measurements obtained on 5 August 1996 are presented on Figure 7. Although the groundwater elevations in each well change seasonally, the overall gradient patterns show minimal variation during the course of the year.*

A seasonal low water table develops beneath the filled portion of the site in late winter, contrary to local precipitation patterns, due to the influence of Lake Washington. The lake surface is maintained at *approximately* Elevation *18.4* feet *(relative to King County Aerial Survey Datum) between 1 May and 1 October* to accommodate fisheries and recreational needs, and is *maintained at Elevation 16.5 annually between 1 December and 1 March to increase storage capacity and minimize the potential for shoreline erosion*. A seasonal high water table develops beneath the filled portion of the site between spring and autumn.

One groundwater monitoring well, AW-9, was installed in native, granular soils at the north, upgradient end of the property. Upgradient groundwater levels fluctuate seasonally, consistent with seasonal precipitation patterns.

Groundwater consistently flows south to southwest beneath the north end of the site at a gradient of up to 2 percent, and levels are relatively flat beneath the *southern two-thirds* of the site, where the former lakebed was filled. Minor mounding of groundwater conditions is evident seasonally near the former concrete washout impoundment, *where subsurface conditions are less permeable than in the surrounding wood debris fill*. The impoundment *was backfilled in September or October 1996*.

The shoreline is the most probable discharge location of all groundwater flows. Shoreline discharge appears to be slightly inhibited behind existing bulkheads of the inner navigation channel, based on historic groundwater level measurements. Discharge is concentrated at the northwest corner of the site where groundwater elevations in the native sands and gravels drop rapidly to equilibrate with the adjacent lake level. No other variations in subsurface geology or seasonal groundwater fluctuations were encountered that would suggest that groundwater discharge is concentrated along any particular stretch of the undeveloped lake or river shoreline.

A cleanup action plan negotiated with DOE will address the feasibility, location, and required degree of effectiveness of groundwater barrier(s), as well as appropriate discharge points for contaminated or non-contaminated waters, if intercepted.

Infiltration

The principal sources of groundwater recharge at the site are the adjacent lake and river. Other than the bulkheads along the inner navigation channel, no geologic or hydrologic barriers to surface water or groundwater flow are in evidence along the shoreline of the site. Secondary sources of recharge include runoff, infiltration and evapotranspiration. Runoff flows directly into the inner navigation channel of Lake Washington and to a lesser degree into the Sammamish River, both bodies of surface water that recharge the groundwater table. For the purposes of this discussion, evapotranspiration is considered to be negligible. The mechanism of infiltration at the subject site does occur, and is the focus of the remainder of this subsection.

Groundwater at the property is recharged by precipitation both on-site and off-site. *Some proportion of* off-site precipitation *that lands in upgradient urbanized areas to the north* infiltrates the recessional sand and gravel soils, and migrates south beneath the north end of the site. Because of the granular and relatively pervious nature of site soils, groundwater that migrates onto the north end of the site almost immediately equilibrates with the adjacent lake level *at the northwest corner of the site. Along the east margin of the site, the gradient transition occurs much more slowly, and infiltration from upgradient aquifers off-site appears to play a slight role in groundwater recharge on-site.*

Overall, grades are relatively flat-lying, allowing infiltration to act as a component of surface water dissipation. *Although the majority of the exposed soil surface has been compacted by heavy equipment traffic over the years, the exposed soil layer is relatively thin, inequitably compacted, and demonstrates varying permeabilities through to the underlying wood debris layer. No measurements of surface infiltration rates were performed for this study; however, observations of ponding areas before and after rainfall events support the mechanisms of both runoff and infiltration. Furthermore, the observed mechanism of lateral interflow in the uppermost six inches of the fill material does not preclude the mechanism of vertical infiltration, especially on broad, poorly drained, horizontal surfaces; the existing layer of soil that overlies the wood debris fill does not constitute an impermeable cap, and must not be confused as such.*

The overall contribution of infiltration from the subject site to Lake Washington and the Sammamish River is very small when compared to the contribution from runoff. The contribution to the Sammamish River is considered negligible; the lowermost 2,000 feet of the river west of 68th Avenue N.E. is virtually equilibrated with Lake Washington, and is not distinguished from the lake for the purposes of this discussion. Lake Washington occupies a drainage area of approximately 302,000 acres, and receives 84% of its recharge from the Cedar River and Sammamish River drainage basins; the balancing 16% percent of recharge to Lake Washington originates within the 302,000 acre drainage area. (BEAK, 1996).

The maximum theoretical contribution from combined runoff and infiltration on-site (45 acres) is fifteen-thousandths of one percent (0.00015) of the Lake Washington drainage basin (302,000 acres), or two-ten thousandths of one percent of the recharge volume from the three drainage basins combined. Infiltration alone would constitute some divided proportion of the two-ten thousandths of one percent (0.000024).

Potential Contaminant Sources

This discussion addresses potential sources of groundwater contamination at the Kenmore Industrial Park. For greater details, please reference the Toxic and Hazardous Materials section. Tasks that must be performed prior to construction on site include the following:

1) Negotiation of a cleanup action plan between the Washington State Attorney General, DOE, and the property owner; and
2) Preparation of an Engineering Design Report in accordance with MTCA.

Presently, the principal source of groundwater contamination at the site appears to be the wood debris fill. The fill material extends below the groundwater table. Total petroleum hydrocarbon (TPH) concentrations in the groundwater are attributed to the presence of creosote-treated timber pile butts in the debris, to the history of construction traffic, and to the organic wood leachate of *both* the fill and peat soils. Lead concentrations in the groundwater are attributed to lead paint coatings on wood debris. The source of arsenic concentrations in the groundwater is not known, but may be due to the presence of treated piling in the wood debris; copper arsenate is used as a wood preservative.

Copper concentrations have not been characterized since the time of DOE's Site Hazard Assessment of the subject site in 1992, when concentrations in the surface water impoundment and various sediments were found to be one to two orders of magnitude below MTCA cleanup standards, respectively. No studies of copper concentrations have been performed since 1992.

Other potential sources include tenant storage of 55-gallon drums of petroleum products on the east and south bulkheads of the Kenmore Navigation Channel, and south of the Nelbro Packing, Inc. warehouse. Drums of petroleum product are also stored at Waterfront Construction's area, southwest of the south bulkhead, and at the aggregate stockyard, for maintenance and/or fueling of heavy equipment. *Storage of fuel oil and asphalt products on adjacent properties is not considered potential on-site sources of contamination.*

TPH concentrations measured in the groundwater may be due to the various surface activities listed above; however, concentrations are relatively consistent across the filled portion of the property. Furthermore, the organic wood and peat matrix is suspected to contribute to or interfere with the TPH concentrations. Variations in sample turbidity appear to have the greatest affect on contaminant concentrations. No significant contaminant concentration trends have been observed that distinguish potential surface sources from the general conditions observed beneath the filled portion of the property.

2.2 Significant Impacts

2.2.1 Surface Water

Critical Flows for Sediment Transport

Surface water will be collected in a storm drainage system and piped to outfalls at the dredged channel and the Sammamish River. Aside from the wood debris matrix, the soils we encountered at the proposed drainage swale locations were silty SAND, SAND, silty sandy GRAVEL, and sandy GRAVEL. The most critical soil type with respect to erosion would be the silty sand, with an average particle size of approximately 0.5 to 1 millimeter. According to Chow (1959), a permissible unit tractive force of 0.05 pounds per square foot would be recommended for design of a *bioswale*; these soils would be considered easily erodible. A permissible channel velocity in a gently sloping grass-vegetated channel in easily erodible soils would be 5 feet per second or less.

Estimated Increases in Shoreline Erosion

Offshore sediments which may be subject to erosion include silts and fine sands (SAIC, 1996), susceptible to localized erosion at outfall locations. Flow energy will be quickly dissipated as the discharge enters the Sammamish River and Lake Washington. Additional armoring may be required locally at the outfalls so that erosion is not initiated at those locations. *Location-specific outfall analysis will* be addressed in final design.

Existing erosion problems on the waterfront are limited to localized denuded portions of the shoreline bank. *Upland erosion occurs on a broad scale, and the effects are concentrated at one outfall.* The proposed grading and drainage improvements *and implementation of TESC measures during construction* would eliminate these existing erosion problems. *Sediment will continue to reach adjacent surface waters at the existing rate until such time as efficient TESC measures are implemented.*

Pile driving activities will require the use of heavy equipment including crawler-mounted cranes and trucks. The site temporary erosion and sedimentation control plan will address the features required during construction so that the impact of this activity is minimized.

Piles will likely be either closed-end steel pipe piles (which would be backfilled with concrete after driving) or precast concrete piles. Piles would be installed with a hardened steel driving point or H-pile "stinger" attached to the pile tip. The driving point will aid in pile penetration through the variable composition of the upper fill layers. Both of these are displacement-type piles, installed by driving, and generate little or no soil cuttings.

Sediment Accumulation

As part of the site water quality and drainage plan, sediments would be accumulated in catch basins as well as on-site stormwater detention ponds (Callison Architects, Inc., 1996). Other sediment traps would be incorporated into the temporary erosion and sedimentation control plan, to be developed by the project civil engineer. *Infiltration of storm water is not proposed.*

No sediment will reach Lake Sammamish, which is located approximately fifteen miles upstream from the subject site. Sediments may reach Lake Washington or the Sammamish River in the event that the proposed storm system depending on the design of the proposed storm facilities.

2.2.2 Groundwater

The purpose of this discussion is to address potential alterations to groundwater flow as a result of the proposed development. Grading activities occurred between the publication of the Scope of Work in March 1996 and Draft Technical Report in November 1996; alterations due to these activities are briefly and qualitatively addressed in this subsection.

Recent grading activities with roofing waste and concrete washout stockpiles are unlikely to have influenced groundwater quality. Roofing waste stockpiles have been predominantly removed since the most recent groundwater monitoring event. Furthermore, the effects on the groundwater table from the surficial roofing waste would be indistinguishable from the effects of the underlying wood debris fill, which has a very similar composition. In the southwest portion of the site, concrete washout stockpiles existed throughout the environmental and geotechnical investigations that have been performed at the site between 1991 and 1996. The only potential change in groundwater quality would be an improvement due to the termination of the truck washing activities.

Recent regrading activities at the surface have no effect on the groundwater gradient in the vicinity of the roofing waste, but do have a slight effect on groundwater gradient in the vicinity of the former concrete washout pond. The discontinued use of the impoundment for washing concrete trucks eliminated one major point source of recharge to the groundwater beneath the southwestern portion of the site. It should be noted, however, that water rinsed into the impoundment was pumped from the adjacent inner navigation channel, and that no net effect on groundwater quantity resulted from pumping, rinsing, or discontinued use. Groundwater remains mounded beneath the former pond feature to a lesser degree than before the pond was backfilled. The mounding appears principally due to seasonal adjustments in the adjacent lake level, combined with the low permeability of the concrete washout. Infiltration may also play a role at the north end of the former pond, now that the six acre area has been graded to shed runoff towards the north; in addition to ponding, runoff to the lake has also been observed during heavy rainfall.

The most significant alteration to groundwater that would result from the proposal would be the interception and diversion of all surface runoff. *However, the proposed alteration is not anticipated to pose a significant impact on groundwater gradient or quantity.* Runoff would no longer infiltrate vertically through *the upper portion of the* wood debris fill underlying the site*; however, the lower portion of the wood debris fill would continue to exist below the groundwater table.* Intercepted runoff would be treated in accordance with surface water management standards, and discharged to Lake Washington. Lake Washington is the current and proposed receptor of all site runoff. *Furthermore, because the lowermost 2,000 feet of the Sammamish River flow west into Lake Washington, the lake serves as the immediate receptor for all site runoff.*

Interception of runoff and elimination of vertical infiltration will not influence the existing groundwater gradient beneath the site, nor will they influence groundwater temperature. Groundwater quality may be improved by an unknown degree by essentially halving the volume of wood debris fill that is currently exposed to water infiltration.

Potential Impacts to Groundwater

Groundwater contamination issues are discussed in detail in the Toxic and Hazardous Materials section of this report. Potential impacts to groundwater from contaminants on-site will be reduced by the interception and diversion of all runoff. The interception of runoff will eliminate infiltration of runoff through the wood debris fill into the water table.

The surface soils may have been exposed to surface spills of petroleum, and contain arsenic, barium or lead compounds. All three metals are a common Puget Lowland background element. As a suspended solid, the soil contributes to the turbidity and total contaminant concentrations in the groundwater. The groundwater table beneath the filled portion of the site rises and falls with the seasonally-controlled lake level; however, lateral flow rates may not be capable of mobilizing suspended contaminants towards surface waters. Therefore, the potential impacts due to surface construction activities may result in a short-term negative effect on groundwater quality. *Although the proposed development is estimated to take place over a ten year period, the effects of surface construction activities are considered short-term under the condition that proper TESC measures are implemented during construction.* An anticipated impact of project remedial design is the long-term improvement of groundwater quality.

Surface activities such as demolition of existing structures are not expected to impact groundwater at the site. Project construction, however, may disrupt the existing soil cap, *depending on the final elevation of the lower level floor. Removal of the surficial soil layer would expose more permeable wood debris fills that would readily allow infiltration of runoff to the groundwater table. Removal of the surface soils will expose more permeable wood debris, allowing more rapid infiltration of precipitation through the fill.* Surface soils disrupted by construction or removed by planned excavations may filter through the loose matrix of the wood debris fill toward the groundwater table. *Proper TESC measures should be implemented to minimize this effect.*

Installation of piles through the fill and peat layers into underlying sands and gravels is not expected to pose a significant adverse affect on groundwater quality or gradient. Either steel or pre-cast concrete piling may be used at the site. The use of augercast piling, which generates soil cuttings and surface concrete spills is not recommended at this site for geotechnical reasons. Installation of piling will be one component of cap construction. Piling will support portions of an engineered cap.

Temporary construction dewatering and installation of footing drains may be required at the northern margin of the site. Excavation at the north end of the site will encounter native sands and gravels at shallow depths; no groundwater contaminants have been encountered to date in the upgradient well installed at the site. Installation of a footing drain behind and north of the northernmost structure planned at the site will not significantly alter groundwater flow, gradients, or recharge on or off the property. Footing drains will not be required for pile-supported structures.

Bioswales may be constructed within the 100-foot or 200-foot setback from the existing shoreline. These facilities *will* be *underlain by an engineered cap where warranted* to prevent contact between the treated runoff and the underlying fill materials. *Construction of these swales will take place at or below the shoreline and will possibly involve cofferdam construction and dewatering of potentially contaminated groundwater. Both groundwater and surface water will be subjected to turbid runoff during construction of the swales, and will require storage and treatment along with implementation of appropriate TESC measures.*

Aspects of groundwater flow such as potential upwelling through the lake bottom have not been evaluated for this technical report. In the event that upwelling occurs, it is most likely recharged by gravelly aquifers confined at depth below the thick layers of peat. However, significant confined pressures were not encountered in any of the deep geotechnical borings advanced at the site. Upwelling action could be artificially induced, if desired, by installation of groundwater barriers along the shoreline of the site; groundwater flow would be forced outward through the underlying peat during winter and spring, and inward during summer and fall, driven by lake levels that become seasonally imbalanced with groundwater levels. Another potential source of temporary, artificial upwelling would be the placement of significant depths of fill on the upland portions of the site; this action would be temporary and taper over the long term.

The proposed changes in site use will not adversely impact groundwater quantity, and will improve groundwater quality over the long-term. As discussed above, the engineered impervious surface area will benefit groundwater quality by preventing runoff from contacting the upper portions of the wood debris fill. The intercepted runoff will be treated in accordance with surface water management standards and discharged to Lake Washington.

Relative Risk Evaluation

A Substantial and Disproportionate evaluation of remedial alternatives, *including a relative risk evaluation,* and performed in accordance with Ecology's current draft guidelines dated June 1996, will be incorporated into the *cleanup action plan being negotiated* for the site. Refer to the Toxic and Hazardous Materials section of this report for a more detailed discussion of the MTCA process.

2.3 Mitigation Measures

The proposed remedial action of capping the site would reduce but not prevent leaching, as the wood debris fill extends below the groundwater/ lakewater elevation. Therefore, capping would only mitigate leaching of the portion of fill that exists above the summer high water table, and beneath the capped area.

Implementation of proper TESC measures through the construction phases will mitigate potential impacts to groundwater.

2.4 Significant Unavoidable Adverse Impacts

No significant, unavoidable adverse impacts to groundwater quantity or quality are anticipated. No significant unavoidable adverse impacts to surface water quantity are anticipated.

3.0 TOXIC AND HAZARDOUS MATERIALS

3.1 Affected Environment

3.1.1 Site Ranking by Ecology

Ecology prepared a Site Hazard Assessment (SHA) report for the property dated 19 February 1992. As part of the assessment, Ecology identified several geographic management areas of regulatory interest. Ecology's assessment and the subsequent site ranking was based on Ecology's knowledge of site history and site uses, and on the results of previous site characterization studies. The final site scoring of the site using the Washington Ranking Method (WARM), as outlined in Chapter 173-340, resulted in a ranking of 1 (highest rank) on the Site Hazard Assessment List (File TCP ID: N-17-5127-0000). The ranking was based on a quantification of the potential exposure to humans or the environment along specific exposure routes including air, surface water and groundwater. The presence of benzene (a gasoline constituent) in soils temporarily stockpiled for recycling at the Sterling Asphalt facility was the determining factor in Ecology's site scoring calculations, resulting in the ranking of 1. *Other contaminant and pathway combinations resulted in lower rankings.*

Although the stockpile was reportedly covered by tarps, located under partial shelter and bermed, no mechanism existed for the interception of runoff or leachate from the stockpile, constituting improper containment practices. The toxicity and mobility of benzene, along with the improper containment of the soil stockpiles and the proximity of Lake Washington (a fishery resource) were listed as contributing factors to Ecology's priority ranking. Ecology's calculations determined that the soil stockpiles posed the greatest threat to human health and to the environment via surface water, air, and groundwater routes.

The temporary stockpile site was located near the northwest corner of the existing aggregate stockyard, between wells AW-2 and AW-7 shown on Figure 2. Other exposure pathways considered for site scoring were the former landfill (assumed to be situated within the west-central portion of the site) and the concrete truck washout pond. The location of the impoundment corresponds to the assumed location of the former landfill. Subsequent investigation determined that the landfill is not confined to the vicinity of the impoundment, but that the entire site is underlain consistently by wood debris fill. As such, the entire filled portion of the site appears to comprise the landfill.

Overall, contaminant concentrations are slightly elevated above residential cleanup standards. The following types of contaminants were encountered in various media at the Kenmore Industrial Park:

Total Petroleum Hydrocarbons (TPH)
Gasoline-range TPH and associated benzene, toluene, ethylbenzene, and total xylene (BTEX) compounds are encountered in the groundwater at the Kenmore Industrial Park at concentrations well below cleanup standards. Benzene, the BTEX compound for which the site was ranked 1 by Ecology, was encountered in one well (AW-2) at a concentration well below the cleanup standard. No gasoline-range TPH or BTEX compounds were detected in the site soils or wood debris. *The cleanup standard for gasoline is 100 parts per million in soil and 1,000 parts per billion in groundwater.*

Diesel- and oil-range TPH are present in non-turbid groundwater samples at concentrations adding up to 2,420 parts per billion (ppb). Concentrations in turbid groundwater samples range up to 19,000 ppb; it is currently not known whether the high concentrations in the turbid samples are due to contaminated sediment or to organic particles (peat) in the groundwater. Diesel- and oil-range TPH are present in 13 out of 16 soil samples analyzed at concentrations ranging from 15 to 2,530 parts per million (ppm). *The cleanup standard for diesel and oil is 200 parts per million in soil and 1,000 parts per billion in groundwater.*

TPH was either undetected, or detected below the MTCA cleanup standard for soil in a sediment sample collected by Ecology from a stockpile of soils dredged in 1992 from the Kenmore Navigation Channel by a site tenant, Waterfront Construction.

Metals
Arsenic concentrations in non-turbid groundwater samples range from undetected to 150 ppb, and exceed cleanup standards in four wells. Arsenic exists both in the dissolved and suspended solid phase in the groundwater at the site. Arsenic is detected in site soils below cleanup standards. *The cleanup standard for arsenic is 20 parts per million in soil and 5.0 parts per billion in groundwater.*

Barium concentrations in non-turbid groundwater samples are well below cleanup standards. Barium exists both in the dissolved phase and as a suspended solid in groundwater at the site. Barium concentrations exceed cleanup standards at ranges of 292 to 1,510 ppm in three soil or wood samples. Barium is common in Puget

Lowland soils. *The cleanup standard for barium is 200 parts per million in soil and 1,120 parts per billion in groundwater.*

Total lead concentrations in non-turbid groundwater samples range from undetected to 300 ppb, and exceed cleanup standards in four wells. Lead exists predominantly as a suspended solid in groundwater at the site. Lead concentrations exceed cleanup standards at ranges of 292 to 1,510 ppm in three soil or wood samples. *The cleanup standard for lead is 250 parts per million in soil and 2.0 parts per million in groundwater.*

Polychlorinated Biphenyls (PCBs)

PCBs were detected in 1991 in one turbid groundwater sample collected from one well. A subsequent investigation of both soil and groundwater at the site of that well did not detect any PCBs. No PCBs were detected in any subsequent groundwater sampling events at the site. PCBs were detected at concentrations below cleanup standards in two soil samples collected by AEE. PCBs were detected in a wood sample, at a concentration slightly elevated above the cleanup standard for soil. *The cleanup standard for PCBs is 1.0 parts per million in soil and 0.1 parts per billion for groundwater.*

Volatile Organic Compounds (VOCs)

Several chlorinated VOCs were detected in groundwater located in the vicinity of the former impoundment, but at concentrations below cleanup standards. Vinyl chloride was encountered in groundwater in the southwest well, AW-6, at a concentration above the cleanup standard. No VOCs have been detected in the site soils. Acetone was detected at a concentrations well below cleanup standards for groundwater in a water sample collected by Ecology from a former concrete washout impoundment. *The cleanup standard for vinyl chloride is 0.526 parts per million in soil and 0.20 parts per billion in groundwater. The cleanup standard for acetone is 8,000 parts per million in soil and 800 parts per billion in groundwater.*

Proposed Marina

The proposed marina will be located within the Kenmore Navigation Channel. Sediments within the channel are periodically sampled for analysis and dredged. The results of the most recent sampling event are presented in a report prepared by Science Applications International Corporation (SAIC), titled *PSDDA Sediment Characterization for the Kenmore Navigation Channel, Kenmore, Washington*, dated 24 May 1996. Sediments were analyzed in accordance with the Puget Sound Dredged Disposal Analysis (PSDDA) protocols. The analytical results indicated that sediments to be dredged from the inner harbor qualified for open water disposal, although some sediments sampled from the outer channel did not qualify. *The sediments that did not qualify are the subject of negotiations for on-site, upland disposal.*

The sediment sample collected from the area of the proposed marina exceeded the PSDDA screening level for low molecular-weight polycyclic aromatic hydrocarbons (LPAHs); however, a subsequent bioassay determined that the sediments demonstrated no toxic effects and therefore qualify for open water disposal. Sediments in the channel are potentially subject to impact from the same contaminants as the upland areas, due to surface runoff.

3.1.2 Contaminant Maps

Maps showing the exploration locations and contaminant concentrations for both the soil and groundwater media are included as Figures 8 and 9, respectively.

3.1.3 Historic Site Activities

Historic activities that may have contributed to the placement of contaminants on the site and in the Kenmore Navigation Channel occurred in two phases. The first phase consisted of extensive filling and grading activities that raised the elevation of the property above the level of Lake Washington. The second phase consisted of the use of the developed property as an industrial park. The timing of these events is based on information obtained from Ecology's *Site Hazard Assessment* (SHA) report, dated 19 February 1992. This information is supplemented by AEE's review of stereopairs of aerial photographs of the property provided by Walker & Associates of Tukwila, Washington.

Significant filling activities became evident at the north margin of the property by 1956. By 1969, the entire property appeared to have been filled to its current elevation. Based on the subsurface explorations performed by AEE at the site, the fill consists predominantly of wood debris, with lesser amounts of concrete and asphalt rubble, and a minor soil matrix. A larger proportion of soil is encountered within the fill at the north end of the site. Components of the fill that were encountered less frequently included scrap metal, rubber tires, wire cables and stumps, carpeting, and plastic. The origin of the fill was reported to be housing demolition debris related to construction of the Interstate I-5, and the debris encountered is consistent with the reported source. According to the SHA, the property was operated as a private landfill between 1965 and 1984. Records "indicated that stumps, demolition debris and restaurant wastes had been disposed. However, a 1981 letter received by EPA from Bayside Disposal listed 20 landfills in King County (including the Kenmore Landfill) potentially used by the company for the disposal of hazardous materials." Bayside Disposal's letter was written in response to EPA's research on historic disposal sites. AEE's subsurface explorations did not encounter any evidence that the implicated hazardous materials were disposed at the site.

Light industrial activities that may have contributed to the placement of contaminants at the site include painting and paint refurbishment activities at the southwest corner of the site, temporary storage of petroleum-contaminated soils prior to recycling at the asphalt plant, and storage of 55-gallon drums at various locations for containment of petroleum fuel, aviation fuel, motor oil, concrete form-release oil, and lubricating oil. Several tenants fueled and maintained loaders, excavators, cranes and forklifts at the property. Spills and leaks associated with the fueling and maintenance and general traffic of heavy equipment may have contributed to placement of contamination at the site.

Other activities included the concrete and asphalt plant that replaced the former timber mill at the north end of the site. A concrete truck fleet was fueled and maintained in a fenced compound occupying the north central portion of the property. Fuels were stored in above-ground storage tanks (ASTs) inside the fenced compound. An unlined impoundment was maintained in the west central portion of the property to contain washwater rinsed from the concrete trucks. Excess concrete was emptied onto the ground surface surrounding the impoundment, or was recycled into Ecology blocks.

Placement of fill and subsequent light industrial activities potentially have the same effect on the Kenmore Navigation Channel. Storm runoff from the developed upland area results in sedimentation of the channel. Groundwater beneath the filled portion of the site is hydrologically equilibrated with the adjacent surface water, but is also relatively static. Furthermore, bulkheads form a barrier along the majority of the inner channel shoreline, reducing the potential for migration of contaminants between groundwater and surface water.

3.1.4 Administration of the Model Toxics Control Act

The investigation and cleanup of the Lakepointe site is governed by the Washington State Model Toxics Control Act (RCW 70.105D) [MTCA] and overseen by Ecology. The following sections briefly describe how MTCA cleanup regulations (WAC 173-340) and Ecology administer the cleanup process at sites in general, and specifically how the regulations affect the Lakepointe site.

Options for Remedial Actions

Currently, there are six options for Ecology involvement in remedial actions at cleanup sites:

1. Consent Decree (WAC 173-340-520): A consent decree, a formal legal agreement filed in court, may be requested by a potentially liable party or initiated by Ecology. The consent decree spells out the work requirements for the site and the terms under which the work must be completed. The terms of the consent decree require agreement between the applicant, Ecology and the state Attorney General's office, and must undergo a public review and comment period before they can be finalized. Consent decrees can protect the applicant from legal action by other parties that may incur cleanup expenses at the site and facilitate legal claims against other parties that may be responsible for portions of the cleanup costs.

2. Prospective Purchaser Consent Decree: A party which has no liability for the cleanup of a site, but wishes to purchase the site for redevelopment or reuse may pursue this option. The reuse of the site must result in a substantial public benefit and

the applicant must contribute substantial new resources toward the cleanup that might not otherwise be available. The resulting requirements are finalized in a consent decree, allowing the purchaser to estimate the cost of cleanup.

3. *De Minimus* Consent Decree: Applicants, usually landowners, whose contribution to a site is "insignificant in amount and toxicity" may apply for this modified consent decree. Generally, the applicant will pay for a portion of the cleanup costs, without conducting the actual cleanup. Ecology usually only agrees to this type of consent decree if the applicant is affiliated with a different, larger cleanup on which Ecology is also involved.

4. Agreed Orders (WAC 173-340-700): An agreed order is a legally binding, administrative order issued by Ecology and agreed to by the applicant. It is not filed in court and requires no settlement. If the applicant follows the activities laid out in the agreed order for various phases of work, Ecology will not take any enforcement action against the applicant. However, an agreed order does not protect an party from being sued and Ecology can require additional remedial work not included in the original order. Agreed orders are subject to public review.

5. Independent Remedial Action: Property owners who remediate their sites without direct oversight from Ecology may request Ecology's review and approval, following completion of the cleanup actions taken. To address this situation, Ecology has established a voluntary program, the Independent Remedial Action Program. This program requires the applicant to submit a cleanup report for the site to Ecology, along with a fee to cover Ecology's review costs. Based on the review, Ecology may either identify areas where additional work is needed, or issue a "No Further Action" determination. However, Ecology reserves the right to additional review of the site at any future point in time, even if a "No Further Action" letter is issued.

6. Enforcement orders (WAC 173-340-540): MTCA authorizes Ecology to issue administrative orders requiring cleanup activities without an agreement from the landowner or the potentially liable party. These enforcement orders are usually issued in the case of an emergency, or if Ecology believes a cleanup solution will not be reached in a timely manner through negotiation. If landowner fails to comply with the enforcement order, Ecology can initiate the site cleanup themselves and recover the costs from the landowner, at three times the amount spent by Ecology. In addition, the state's Attorney General's Office may issue a fine to the landowner of up to $25,000 per day. These enforcement orders are subject to public notification requirements.

A cleanup action plan will be negotiated between Ecology, the state Attorney General, and the landowner.

Site-Specific Cleanup Levels

Based on MTCA regulations, Ecology defines the approach to the cleanup at any site as a two-step process. First, the potentially liable party must establish cleanup standard(s) for the site. Several factors concerning groundwater and soil should be considered, because these factors can significantly influence the cleanup standard selected. The potentially liable party will then choose a remedial program that attains the selected cleanup standard after completion of remediation. The following paragraphs further define this process.

Establishing a cleanup standard (WAC 173-340-700): Ecology recognizes that eliminating all risks at a cleanup site is not possible. Ecology does require that a site cleanup reduce the risk to what Ecology believes is an acceptable level. This acceptable level must be below a concentration which causes illness in humans, for each cancer-causing (carcinogenic) substance and non-carcinogenic substance. If a site contains more than one of these substances, the combined risk of the substances must considered. These risks have been translated into three options for setting site-specific soil and groundwater cleanup levels.

Method A defines predetermined cleanup levels for 25 of the most common hazardous substances found at sites. Ecology intended these cleanup levels for sites that are not complex, such as small properties, where only a few of the listed substances are present, and where all of the substances are on the Method A list.

Method B establishes cleanup levels using a standard formula which incorporates risk assessment. Ecology has predetermined the level of risk for each substance using information on how hazardous substances can interact with each other, what the health effects may be, and how the migration of these substances on-site and off-site could threaten human health and the environment. The risk level for carcinogenic substances may not exceed 1 in 1,000,000, and the total level of risk at any site may not exceed 1 in 100,000, using Method B cleanup levels. Ecology intended this method to be used for cleanups where the site is large and/or complex, or where one (or more) of the contaminants on the site is not present on the Method A list.

Method C follows the same formula established for Method B. But, MTCA regulations drop the risk for carcinogenic substances to 1 in 100,000 both for individual substances and for total risk caused by all substances. The total risk of the site still cannot exceed 1 in 100,000. This method may be used when (1) cleanups under Methods A or B are technically impossible to achieve, (2) background concentrations are higher that Methods A or B, (3) cleaning up a site to Method A or B levels would actually result in greater harm to the environment, or (4) a commercial or industrial property is qualified, under MTCA regulations, for Method C. Any potentially liable party using Method C carries the burden of proof that the resulting cleanup standard will protect human health and the environment.

The available technology for removal of some contaminants from soil and water is not always effective enough to reduce concentrations to established cleanup standards. In these cases, Ecology may allow a higher standard for these substances, pending improvements in technology. Occasionally, the cleanup standard is below the concentration detectable by laboratory instruments. In this case, the lowest reliable measurement is used as the standard, until lower detection limits become available.

Ecology will not allow the cost of cleaning up a site to set a standard other than those established by these three methods. Ecology believes using cost to permit less stringent standards than those set by the three methods would compromise the protection of human health and the environment and is inconsistent with the intent of the Model Toxics Control Act.

Factors affecting groundwater cleanup standards: The standard selected for remediation of groundwater is based on the highest beneficial use of the water, generally assumed to be drinking water use. In areas where groundwater is a current or future source of drinking water, the cleanup levels must be as stringent as Method A levels, or concentrations listed in federal laws, generally the Safe Drinking Water Act, or levels established by the state board of health. Cleanup standards more stringent than these levels could be established by Ecology if they feel stricter levels are necessary for protection of human health and the environment.

If it can be demonstrated that groundwater does not serve as a potential source of drinking water and has no potential as a future source of drinking water, Ecology uses cleanup levels designed to protect the beneficial use of surface water. To do so, the person undertaking the cleanup action must prove that (1) there are no known or projected points of entry into surface water, (2) the surface water is not a suitable domestic water supply, (3) the flow of groundwater into the surface water will not result in a downstream accumulation of hazardous substances which exceed surface water standards, (4) on-site institutional controls will prevent the use of groundwater between the site and the surface water body, and (5) Ecology determines that it is unlikely that the hazardous substances in groundwater below the site will be transported to an area where groundwater is or could be a drinking water source. Surface water cleanup standards are often stricter than groundwater cleanup standards. Current standards are listed in Ecology Publication #94-145, *Model Toxics Control Act Cleanup Levels and Risk Calculations (CLARC II) Update.*

Factors affecting soil cleanup standards: The zoning of the site and adjacent sites is an important factor to consider when selecting a soil cleanup standard. Typically, governing bodies use three zoning designations for properties: residential, commercial, and industrial. For residential properties, Ecology determined that soil cleanup levels must exceed Method A or B standards unless the property is not currently a residential area, does not have the potential to become a residential area, and appropriate use restrictions are implemented on the property. Ecology has the option to set standards more stringent than Method A or B for residential property, if needed to protect human health and the environment.

For commercially-zoned properties, Ecology presumes that residential soil cleanup levels will be the standards used. However, a property owner can use Method C standards if the zoning for the property, adjacent properties, and properties in the general vicinity is commercial or industrial and the present and/or past uses of these properties are in accordance with that zoning. Ecology expects that only properties located within the interior of a large commercial or industrial corridor will qualify for this exemption. In addition, institutional controls will be required if the standard used is less stringent than Method B. Institutional controls (WAC 173-340-440) include physical measures, such as fences or signs to restrict access to the site, or limits to on-site activities, including zoning restrictions and prohibiting soil excavation or use of groundwater below the site. Any institutional controls must be described in a restrictive covenant and recorded in the deed to the property.

Finally, MTCA regulations include, for some substances, higher Method A or C soil cleanup standards for industrial properties (WAC 173-340-745). No provision exists in the regulations for establishing Method B cleanup standards. The Method A or B cleanup levels are based on the expectation that only adult workers would be exposed to substances on industrial sites. For this reason, the property owner must evaluate the actual land use as well as the zoning designation, because local governments use a variety of zoning categories for industrial land uses. The following characteristics should be intrinsic to the usage of the property: there are no people living on the property; access to the property is not permitted or highly limited; food is not grown on the property; site operations are generally characterized by chemical use and storage, noise, odors, and truck traffic; the land surface is generally covered or paved; support facilities, such as offices or restaurants, may be present but are primarily devoted to the use of employees and do not serve the general public. The proximity of portions of the property to residential areas, schools, and streets may require the use of standard Method A or C cleanup levels in those areas. Ecology also requires institutional controls on these types of sites.

Selecting Cleanup Actions (WAC 173-340-360): Once one (or more) cleanup standard has been established for a site, the potentially liable party must then select the method or methods they will use to clean up the site. Ecology requires employing a permanent solution, whenever practical. MTCA regulations established a hierarchy of preferred cleanup solutions: reuse or recycling; destruction or detoxification; reduction of the amount of waste; on-site containment of waste; on-site or off-site disposal.

Ecology does allow cost considerations to determine points of compliance for an individual site. Points of compliance define where on a site the cleanup levels must be met. Most sites are required to meet the cleanup standard throughout the site. In some cases, Ecology will define conditional points of compliance to allow specific areas within the site to contain higher concentrations than the established standard. Continued monitoring of these specific areas is required to assure no migration of substances has occurred.

Once the cleanup at a site has been completed, conformational monitoring must be conducted to verify that the cleanup action worked and remains effective over time. If Method C was the cleanup standard selected, or if levels which remain at the site exceed Method A or B levels, Ecology will review the site every five years to ensure continued protection of human health and the environment.

Application of MTCA Cleanup Levels to the Lakepointe Site: Lakepointe is a large site, encompassing approximately 45 acres. The site is a former demolition debris landfill that comprises approximately 70 percent of the surface area of the property, and therefore meets the description of a complex site. Therefore, Method B cleanup levels will be selected for the site.

Although the demolition debris found at the Lakepointe site is relatively homogeneous compared to typical municipal landfill debris, potential sources of contamination may exist within the fill. Because it is not practicable to sort through landfill debris, potential sources of contamination at landfills are identified and characterized through sampling and analysis of the landfill leachate. At the site, leachate occurs both from storm water infiltrating vertically through the upper layer of the debris, and from the groundwater table within the debris layer. The groundwater elevation beneath the landfilled portion of the site roughly corresponds to the surface water elevation of the adjacent lake and river slough. As such, soil remediation is not an element of the EPA-accepted, presumptive remedy for landfills, which consists of an engineered cap. However, groundwater monitoring will be performed as an institutional control. As stated above, Method B cleanup levels will be selected as groundwater standards at the site.

MTCA cleanup standards have not been established for sediments. Sediments in the Kenmore Navigation Channel and in the Sammamish River Navigation Channel will be sampled and analyzed for contaminants under separate cleanup negotiations.

Implications of No Further Action Designation

A "No Further Action" (NFA) designation from Ecology may be granted following a satisfactory cleanup performed under the Independent Remedial Action Program (IRAP). The receipt of an NFA removes a property from Toxics Cleanup Program (TCP) listings, such as the Site Register and the Confirmed and Suspected Contaminated Sites (C&SCS) list. The receipt of an NFA provides assurance to lenders that the completed cleanup action meets current, applicable cleanup standards. A cleanup action must be fully completed to Ecology's satisfaction prior to the issuance of an NFA determination, and a lending institution may require an NFA determination prior to lending funds on the property. An NFA is subject to Ecology's review and reevaluation in the event that regulations change, or that new findings of fact are revealed. Therefore, an NFA does not protect the landowner or lender against future liability.

At the subject site, the proposed remedial action will be an engineered cap designed to prevent human contact with the landfilled debris, and to intercept runoff that infiltrates the debris. *An engineered cap consists of an impermeable layer of clay or concrete of sufficient thickness to prevent infiltration of water or contaminations.*

An NFA designation would not protect the owner or lender against future liability. A cleanup action plan negotiated with the state Attorney General and with Ecology establishes a legally binding, minimum scope of work and remedial timeline. The remedial action is then performed under Ecology's oversight. With *a negotiated cleanup such as a Agreed Order or Consent Decree,* a lending institution may fund development of a project prior to completion of a remedial action.

Public Notice Process

MTCA regulations require public involvement and participation in the process of remediating a site (WAC 173-340-600). Ecology's goal is "to provide the public with timely information and meaningful opportunities for participation which are commensurate with each site." The public participation process can take many forms, including public notices, public meetings or hearings, the site register, public participation plans, and the participation of regional citizens' advisory committees. In accordance with the Agreed Order negotiations in progress for the subject site, Ecology shall be responsible for providing public notice in accordance with the requirements of RCW 70.105D.030(2)(a).

Public notice of activities associated with a site cleanup must be made specifically to individuals who make a timely request, i.e., within the public comment period, or who reside with the potentially affected area, and to the general public via publication in the newspaper or other news media Ecology deems to be appropriate. The form of the public notice could include distribution of press releases, fact sheets, personal contact, or signs posted at the facility. Any public notice must indicate the dates of the public comment period, and the duration, generally 30 days. In addition, a public meeting must be held, if requested, within the comment period, by ten or more individuals.

Ecology regularly distributes a site register, which is often used to make a public notice. Some of the activities reported in the site register include determinations of "No Further Action", results of Ecology's site hazard ranking, issuance of enforcement orders, agreed orders or consent decrees, public meetings or hearings, changes in the status of a site, or reports received for sites undergoing independent cleanup actions. The register is published every two weeks and can be received by contacting Ecology's headquarters in Olympia by telephone (360-407-6000), mail (Department of Ecology, Toxics Cleanup Program, P.O. Box 47600, Olympia, WA, 98504-7600), or by e-mail (shan461@ecy.wa.gov).

A public participation plan attempts to provide a coordinated method for effective public interaction, through all the stages of the cleanup process. These plans normally include public notice requirements and how they will be met. This includes information on the timing for public notices, the lengths of comment periods, and an estimate of the potentially affect individuals. The plan must state at least one location where the public can review site information. The plan must specify how to identify the public's concerns and then how to address the concerns once they have been identified. The plans should outline a procedure to amend the plan, if necessary, and provide for coordination with other federal and state laws which may have separate or additional public notification requirements.

Ecology establishes regional citizen's advisory committees to advise Ecology on the concerns of citizens regarding remedial actions taking place, with emphasis on regional rather than site-specific issues. Each of the four regional offices of Ecology must have a regional citizen's advisory group. Individuals who may not serve on these committees include potentially liable parties for sites within each region, individuals closely associated with the potentially liable parties or Ecology employees. The committees meet twice each year and prepare a brief report to Ecology describing the concerns that have been brought to the committee's attention, recommendations for addressing these concerns, and the committees plans for the upcoming year.

3.2 Significant Impacts

3.2.1 Impacts Without Cleanup

The proposed cleanup action will consist of an engineered cap designed to prevent human contact with the fill debris. The cap will intercept all runoff, divert the runoff to storm treatment facilities, where the treated runoff may be returned to the groundwater or surface water resource. Without performing the proposed cleanup, surface runoff and transport of sediments to surrounding surface waters would continue. Infiltration of runoff through the debris fill would continue, resulting in additional formation of leachate beneath the filled portion of the site. Potential sources of contamination would remain on the surface, where they may be mobilized through the infiltration or runoff processes. Please refer to the EARTH section of this report for a discussion of estimated erosion and surface runoff volumes, for both current and proposed conditions.

3.2.2 MTCA Cleanup Standards

Achievement of MTCA Method B cleanup levels in the groundwater would be required by Ecology for residential, commercial, or industrial use of this property. Cleanup of the soil, or debris, would not necessarily be required, due to construction of an engineered cap as the presumptive remedy for a landfill. However, localized remediation of the soil or debris may be the most feasible remedial option for achievement of groundwater cleanup standards. *Localized remediation may consist of exploration for and extraction or immobilization of a suspected or anomalous contaminant, above and beyond those measures deemed sufficient for the remainder of the proposal.*

3.2.3 Site Conditions Which May Warrant Cleanup

Approximately three-fifths of the property is underlain by significant depths of wood debris fill. Rather than remediate the wood debris fill beneath the site, human contact with the wood debris fill will be prevented by the construction of an engineered cap. *The existing surficial soil layer will be disrupted during construction of the engineered cap.* The proposed development will be designed as a cap. The southern extent of the cap towards the river shoreline will be determined in the Engineering Design Report prepared under the negotiated cleanup.

Arsenic and lead concentrations in the groundwater are likely to warrant clean-up to meet MTCA standards for groundwater. The points of compliance and remedial approach will be determined in the Engineering Design Report prepared under the negotiated cleanup.

3.2.4 Discussion of Remedial Alternatives

As part of the project planning process, the following cleanup alternatives were considered, in order of preference as stated in MTCA:

- Reuse or recycling;
- Destruction or detoxification;
- Separation or volume reduction, followed by reuse, recycling, destruction or detoxification of the residual substances;
- Immobilization of hazardous substances;
- Disposal at an engineered facility designed to minimize the future release of hazardous substances and in accordance with applicable state and federal laws;
- Isolation or containment with attendant engineering controls; or,
- Institutional controls and monitoring.

In WAC 173-340-360, MTCA further states that cleanup actions shall meet the following requirements:

- Protect human health and the environment;
- Comply with cleanup standards;

- Comply with applicable state and federal laws;
- Provide for compliance monitoring;
- Use permanent solutions to the extent practicable (based on the criteria of overall protection of human health and the environment, long-term effectiveness, short-term effectiveness, permanent reduction of toxicity, mobility and volume, implementability, cleanup costs, and community concerns);
- Provide for reasonable restoration time frame; and,
- Make provisions for public participation.

Each of the cleanup alternatives was evaluated with respect to the requirements and attendant criteria listed above.

Reuse and Recycling

Implementation of reuse or recycling technology entails extraction of free product or metals from the soil and groundwater. The contaminants must be extracted in sufficient quantity and purity to reuse or recycle as a marketable product. None of the contaminants encountered at the Kenmore Industrial Park exist in sufficient concentration to enable the most-preferred cleanup technology of reuse and recycling.

Destruction or Detoxification

The site consists of a peninsula constructed on approximately 15 feet of fill to raise the elevation of the property above the surrounding surface of Lake Washington. The fill consists predominantly of wood debris. Removal and destruction of the wood debris fill as the medium of contamination would not result in destruction of inorganic contaminants such as lead and arsenic, and may result in the release of interstitial sediments to the surface waters of Lake Washington. Destruction of the wood debris would entail incineration, a cost-prohibitive technology. The closest permanent incineration facility is located in California, and transportation of contaminated material entails short-term risks to the environment. Alternatively, a mobile incinerator could be established on site, pending public approval and a demonstration of cost feasibility. However, replacement of approximately three-quarter million cubic yards of fill would be necessary in order to return site grades to original, and to an elevation above that of Lake Washington. Replacement of the fill would be cost prohibitive, may release sediment to the surface water, and temporarily eliminate the shoreline environment.

Detoxification technologies would entail groundwater treatment in the form of either pump and treatment, or biosparging. Hazardous substances at the site include diesel- and oil-range total petroleum hydrocarbons (TPH), lead and arsenic. Numerous uncertainties are associated with detoxification technologies, none of which would result in a permanent solution, but would require perpetual monitoring, operation and maintenance. For example, chemical treatment by modification of oxidation-reduction potential or pH conditions of the groundwater, in order to transform lead and arsenic to less soluble and less mobile compounds, would need to be compatible with the adjacent surface water environments. Chemical treatment technologies may also result in the dissolution and mobilization of compounds that were previously not of concern.

Biotreatment of the groundwater may remediate heavier petroleum compounds over a significant period of time, but would be ineffective against inorganic contaminants such as lead and arsenic. Furthermore, biotreatment may have adverse effects on the adjacent surface water environments due to nutrient-loading and oxygenation activities. Because of the limited distinction between surface water, groundwater and landfill leachate, physical immobilization technologies such as cutoff trenches would technically constitute immobilization or containment technologies, which are discussed below.

Media transfer technologies were considered as a supplement to the destruction/detoxification process. These technologies include air sparging and/or vapor extraction to remove volatiles from the subsurface media, or thermal desorption to treat petroleum contaminated soils. Volatile contaminants are not encountered in the soil or groundwater at the site in significant quantities, and thermal desorption technology would involve removal and treatment of the debris fill. As stated previously, ex situ technologies involving removal of the fill material at the site pose significant concerns for surface water and shoreline environments.

Media transfer is a feasible application for the collection and venting of landfill gases generated by degradation of the wood debris as well as of the native organic soils underlying the site.

Separation or Volume Reduction

Separation and volume reduction would require sorting through approximately three-quarter million cubic yards of construction/demolition debris. The debris consists of an average of 70 percent wood waste by volume, 15 percent concrete and asphalt rubble, and 15 percent soil. The debris extends below the groundwater table, and may not be suitable for recycling as structural fill due to the high wood content, wet or saturated soil conditions or MTCA classification. Approximately three-quarter million cubic yards of fill material would be required to return the waterfront property to its previous elevation above lake level. Excavation of the debris would potentially release contaminated sediments to the surface waters of Lake Washington and the Sammamish River. As stated above, filling over an open body of water after removal of the debris is expected to generate community concern, temporarily eliminate the shoreline environment, and potentially impact the surface water environments.

These cleanup technologies require removal and sorting of the debris fill. The debris fill extends below the groundwater table, hence, this ex situ technology does not meet the criteria of short-term effectiveness or permanent reduction of toxicity and mobility, due to the potential release of contaminants to the surface waters during construction/remediation and disruption of the shoreline environment.

Immobilization of Hazardous Substances

Immobilization technologies entail vitrification or solidification, both of which are principally applied to contaminated soils. Vitrification relies on the application of high temperatures, in excess of incineration temperatures, to solidify contaminated soil into a rock-like material. Such high temperatures would threaten the surface water environment and fisheries. Furthermore, the majority of the fill at the subject site consists of water-soaked wood debris, which would absorb significant energy during vaporization of water, as well result in significant volume reduction of the debris fill, both due to volatilization and incidental incineration of the wood debris. Incineration of the wood debris would also pose significant fire and air pollution hazards. Furthermore, it is unlikely that vitrification of wood debris would result in immobilization of contaminants. Vitrification technology does not address immobilization of water-borne contaminants in the debris leachate and groundwater. Based on the above, vitrification technology is not considered safe or effective for heterogeneous media with high organic content or shoreline application.

Solidification technology using cement or fly ash is technically possible for solidification of contaminated soils or wood debris at the site. Cement is mixed or injected with the contaminated material. Numerous uncertainties are associated with application of this technology to the subject site. It is not known if the pH of the cement additive would result in solution and mobilization of metals into the groundwater media and adjacent surface waters. It is not known whether the additive would further degrade the wood debris, resulting in volume losses, or whether it would have a preservative effect, or whether the effects would differ above and below the groundwater table.

Sealing the base of the debris fill layer to prevent contaminants from leaching vertically through the underlying native soils was considered. However, the debris layer extends below the groundwater table, and the underlying native soils consist of peats and organic silts, which are extremely porous, but poorly permeable. These native organic soils provide a natural physical barrier to the vertical migration of groundwater, as well as a chemical barrier in terms of their high capacity for adsorption and attenuation of organic and inorganic compounds.

On-site or Off-site Disposal at an Engineered Facility

Based on the analytical results obtained for the site soils, groundwater, and wood debris, the fill material is not classified as hazardous waste, and may be disposed at a RCRA Subtitle D permitted landfill. The closest facility would be the Klickitat County Regional Landfill (KCRLF) in Roosevelt, Washington. There is an intermodal transfer station to the landfill located in Seattle, Washington. Transportation of contaminated media poses short-term risk to the environment.

As with other ex situ technologies listed above, off-site disposal would pose short-term risks to the environment due to the potential release of contaminants to the surface waters surrounding the site. Furthermore, this technology does not meet the criteria for long-term effectiveness; neither toxicity nor volume are reduced by the permanent relocation of the landfill debris to a permitted facility. A significant volume of a permitted landfill would need to be dedicated to the disposal of approximately three-quarter million cubic yards of debris, limiting future capacity of a permitted landfill. Costs associated with disposal at an engineered facility would be prohibitive.

Due to the expanse of the debris fill underlying the waterfront site, on-site disposal at an engineered facility, or engineering the site to serve as a the disposal facility, would technically constitute containment technology, which is discussed in the next paragraph.

Isolation or Containment

Isolation and containment alternatives were considered as part of this proposal. Implementation of this technology would entail a liner, a cutoff wall to isolate groundwater from surface waters and/or an engineered cap to prevent human contact with the landfill debris and prevent surface runoff from infiltrating through the debris. Retrofitting the site with a liner would entail ex situ removal and replacement of the landfill debris. Depending on the positioning, or setback from the river, installation of a cutoff wall may disrupt the vegetation and/or allow reconfiguration of the shoreline environment. Alternatively, a cutoff wall may be setback from the shoreline to prevent disruption of established vegetation and shoreline; however, a setback would not provide the same degree of protection to surface waters.

An appropriately engineered and maintained cap would provide protection to human health and the environment without inordinate cost and is the presumptive remedy for landfills. Approximately 90 percent of the proposed development will consist of impervious building or pavement surfaces, with engineered storm water collection and treatment systems. As such, the additional cost of designing the proposed development to serve as an engineered cap for the existing landfill will be low, making the cap a cost-effective and implementable cleanup technology.

Installation of groundwater barriers may slow the rate of migration onto or through the site, but would not alter existing groundwater levels .

Institutional Controls and Monitoring

Institutional controls such as health and safety plans, fencing, and blood level monitoring are not compatible with the proposed residential and commercial uses of the site. Furthermore, these controls are likely to generate more community concerns than they resolve, do not afford protection to human health or to the environment, and do not provide for permanent reduction of toxicity, volume or mobility of contaminants.

Drinking water use restrictions would not apply at the subject site, as there are no known drinking water wells within a one mile radius of the site.

Long-term groundwater monitoring will be implemented to evaluate the effectiveness of the selected option before, during and after construction of the project.

Preferred Option

Due to the nature of the contaminants of concern, low concentrations and/or low toxicities, and to the apparent lack of significant groundwater contamination, full-scale, ex situ cleanup technologies involving excavation, removal and/or treatment of the wood debris fill do not meet the criteria for practicable, or cost-effective, permanent solutions at this former landfill site. Furthermore, in situ cleanup technologies such as pump and treatment of the groundwater are not practicable due to the low groundwater recharge rates within the landfill debris. These technologies are not practicable to reduce toxicity, mobility or volume of contaminants, under the conditions found at the Lakepointe site.

An appropriately engineered and maintained cap, however, would provide protection to human health and the environment without inordinate cost. An engineered cap is an accepted presumptive remedy for landfills as described in the U.S. Environmental Protection Agency's *Presumptive Remedy for CERCLA Municipal Landfill Sites* (Directive No. 9355.0-49FS, EAP 5440-F-93-035, dated September 1993). Approximately 90 percent of the proposed development will consist of impervious building or pavement surfaces, with engineered storm water collection and treatment systems. As such, the additional cost of designing the proposed development to serve as an engineered cap for the existing landfill will be low making the cap the most cost-effective and implementable cleanup technology available. Therefore, an engineered cap is proposed as the practicable, permanent and final remedial action for the Lakepointe site.

This technology may be implemented in conjunction with localized removal and landfilling of wood debris in areas where contaminants exceed cleanup standards at the point of compliance. Media transfer technologies may be employed to vent landfill gases from the subsurface. Depending on the composition, the vented gases may be treated thermally. Finally, groundwater monitoring will be implemented as an institutional control to document groundwater gradients and contaminant concentrations beneath the site before construction and during the period of phased construction.

The principal objectives of the proposed remedial action are the protection of human health and the environment. These objectives will be satisfactorily accomplished by capping the site:

- Overall protection of human health will be achieved by a cap design that prevents human contact with the debris. Protection of the environment will be served by interception of storm and surface water that would otherwise infiltrate vertically through the debris to the groundwater table beneath the site.

- Areas outside the boundaries of the shoreline property are in compliance with surface water cleanup standards. Sediments are to be addressed in a separate consent decree.

- An engineered cap would comply with applicable state and federal laws and meet the requirements of the presumptive remedy as set forth by the EPA.

- Groundwater would be monitored before, during and after construction for compliance with cleanup standards at the points of compliance, the schedule of which will be addressed in a separate consent decree.

- Provide a practicable, long-term solution that maximizes implementability, minimizes cost, and addresses community concerns regarding the end use of the property and shoreline environment. A permanent reduction in toxicity and mobility would be achieved by the preferred alternative.

- The proposed cleanup alternative would be implemented over a period of approximately ten years during the phased construction of the proposed development.

- The proposal makes provisions for public participation.

The cap design will be coordinated with design of the development and will consist of a combination of buildings, paving, and other cover materials designed to meet the remedial action objectives (RAOs). Short-term effectiveness of the remedial action during phased construction of the project will be addressed in the remedial design, as will compliance monitoring. Long-term effectiveness of the remedial design will be an operation and maintenance issue to be addressed in the consent decree, in accordance with the requirements of WAC 173-340-400 (4)(c). Finally, design of the cleanup action will address community concerns raised during public comment. The precise design of the cap is the principal subject of the design work to be conducted under a negotiated cleanup and scope of work.

3.3 Mitigation Measures

A site cleanup will be negotiated and implemented to minimize exposure of humans and the environment to potential sources of contamination.

3.4 Significant Unavoidable Adverse Impacts

No significant, unavoidable adverse impacts are anticipated.

4.0 LIST OF REFERENCES

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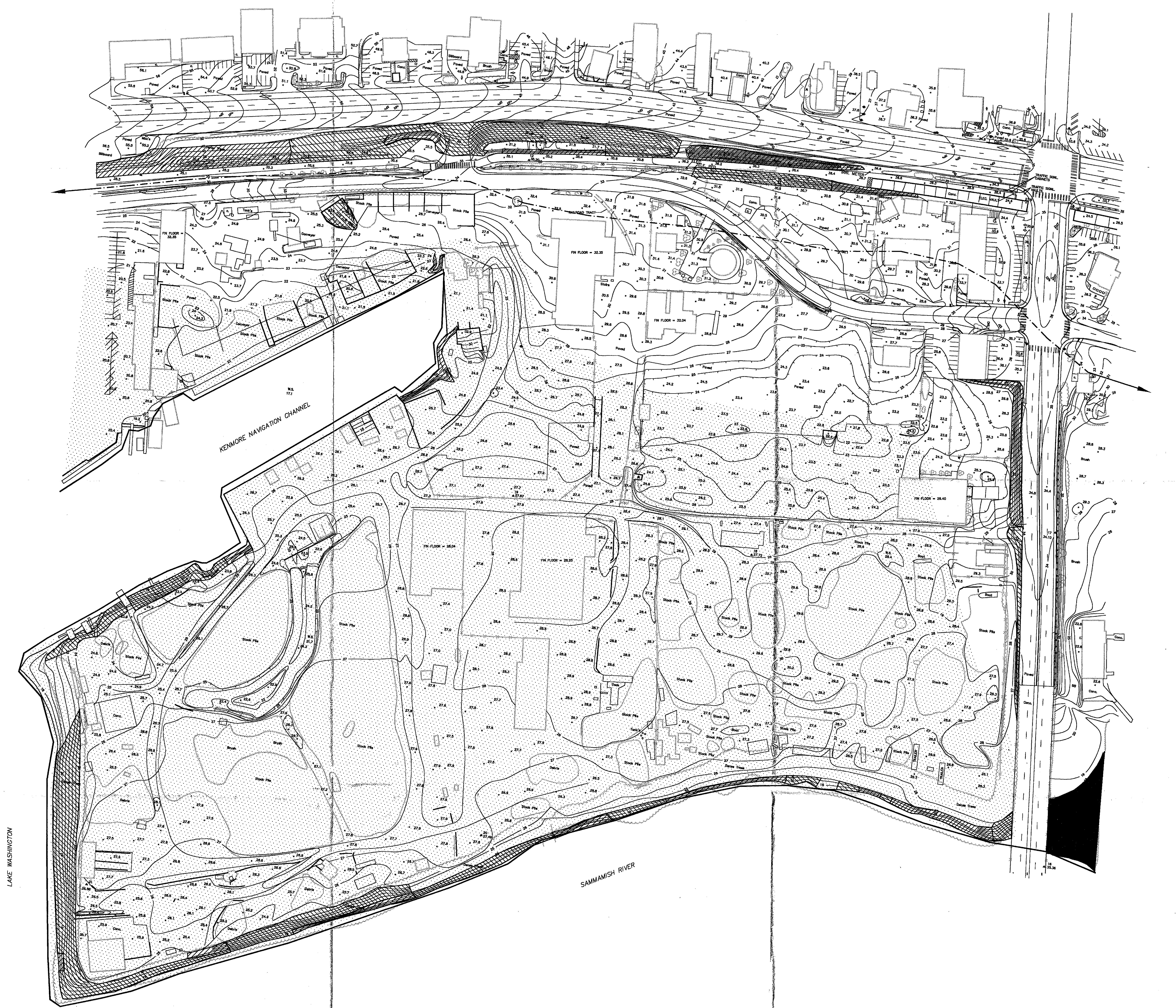


LEGEND

HAZARDS AS DEFINED IN SENSITIVE AREAS ORDINANCE (SAO), KING COUNTY CODE (KCC) 21A

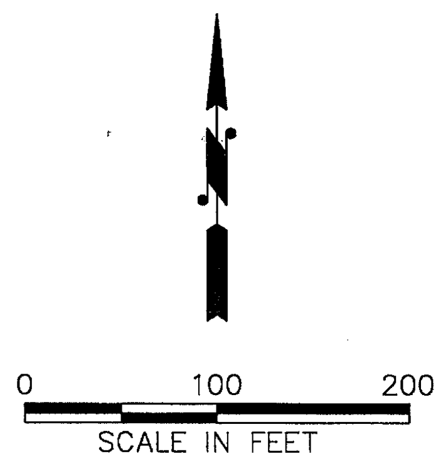
─	CLASS I SHORELINE
░	100 YEAR FLOODPLAIN
‐·‐·‐	NORTHERN BOUNDARY OF SEISMIC HAZARD AREA
▨	SLOPE CATEGORY OF 40% AND ABOVE
▧	SLOPE CATEGORY OF 16–39%

FEMA FLOODPLAIN HAZARD

■	100 YEAR FLOODPLAIN (APPROX. ELEVATION 18')

NOTES: ALL OTHER AREAS OF SITE HAVE A SLOPE CATERGORY OF 0–15%

EROSION HAZARDS AND LANDSLIDE HAZARDS ARE NOT INDICATED ON THE SITE BY KCC 21A.



NO.	DESCRIPTION	INITIALS/DATE
3		
2		
1		

REVISIONS

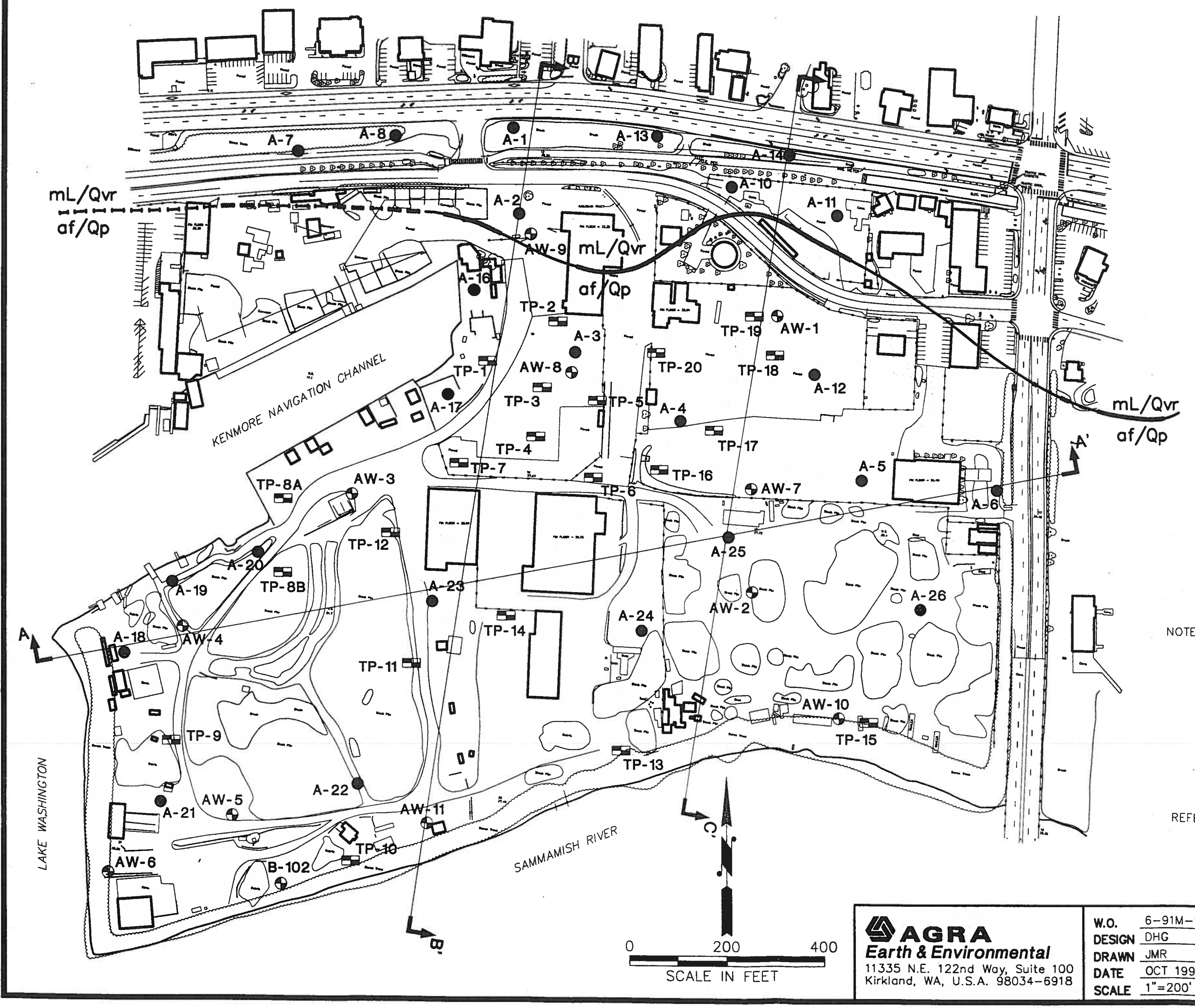
LAKEPOINTE DEVELOPMENT
KING COUNTY, WASHINGTON

AGRA
Earth & Environmental
11335 N.E. 122nd Way, Suite 100
Kirkland, Washington, U.S.A. 98034–6918
Tel (206) 820–4669 Fax (206) 821–3914

SCALE	1"=100'	JOB NO.	6–91M–10459–E
DESIGNED	DHG	DATE	10/21/96
DRAWN	JMR	DATE	10/21/96
CHECKED		SIGNED	
APPROVED		SIGNED	

SAO HAZARD MAP **FIGURE 1**

AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \91\10459–E\TOPO.DWG



LEGEND

AW-11 ⊕	GROUNDWATER MONITORING WELL NUMBER AND LOCATION
A-26 ●	GEOTECHNICAL BORING NUMBER AND LOCATION
TP-20 ▨	TEST PIT NUMBER AND LOCATION
A A'	ALIGNMENT OF GENERALIZED GEOLOGIC CROSS SECTION
mL/Qvr af/Qp	GEOLOGIC CONTACT (DASHED WHERE INFERRED)

mL – MODIFIED LAND

ORIGINAL TOPOGRAPHY DISTURBED BY REMOVAL OF SOME PLEISTOCENE DEPOSITS, GRADING AND ARTIFICIAL FILL OF UNKNOWN QUALITY.

af – ARTIFICIAL FILL

ORIGINAL TOPOGRAPHY MODIFIED BY PLACEMENT OF SIGNIFICANT THICKNESS OF ARTIFICIAL FILL. COMPRISES THE WOOD DEBRIS FILL DESCRIBED IN SUBSURFACE EXPLORATIONS.

af/Qp – PEAT

SIGNIFICANT THICKNESS OF ARTIFICIAL FILL OVER ACCUMULATIONS OF ORGANIC MATERIAL. MAY CONTAIN SMALL AMOUNTS OF SAND, SILT, CLAY AND VOLCANIC ASH DEPOSITED IN SWAMPS AND BAYS.

mL/Qvr – VASHON RECESSIONAL OUTWASH

ORIGINAL TOPOGRAPHY DISTURBED.
LIGHT BROWN, LOOSELY COMPACTED SAND AND GRAVEL, WELL-ROUNDED FROM STREAM TRANSPORTATION. SORTING VARIES; PARTICLE SIZE VARIES FROM MEDIUM SAND TO COBBLES.

NOTES: INFORMATION REGARDING THE EXTENT OF PEAT SOILS WAS SUPPLEMENTED BY PREVIOUS STUDIES PERFORMED FOR RIGHT-OF-WAYS AND FOR METRO SEWER STATION, AND BY REVIEW OF AERIAL PHOTOGRAPHS OF THE SITE AND VICINITY.

THE GEOLOGIC DEPOSITS SHOWN REPRESENT NATIVE SOIL CONDITIONS BELOW ARTIFICIAL FILLS.

MONITORING WELL B-102 WAS INSTALLED BY OTHERS. REFER TO REVISED: PHASE II ENVIRONMENTAL STUDY – KENMORE PRE-MIX SITE, BY GEOTECH CONSULTANTS, INC., DATED 24 JANUARY 1991.

REFERENCE:
U.S. GEOLOGICAL SURVEY (USGS) GEOLOGICAL MAP OM-14, "PRELIMINARY SURFICAL GEOLOGIC MAP OF THE EDMONDS EAST AND EDMONDS WEST QUADRANGLES, SNOHOMISH AND KING COUNTIES, WASHINGTON (1975).

FIGURE 2

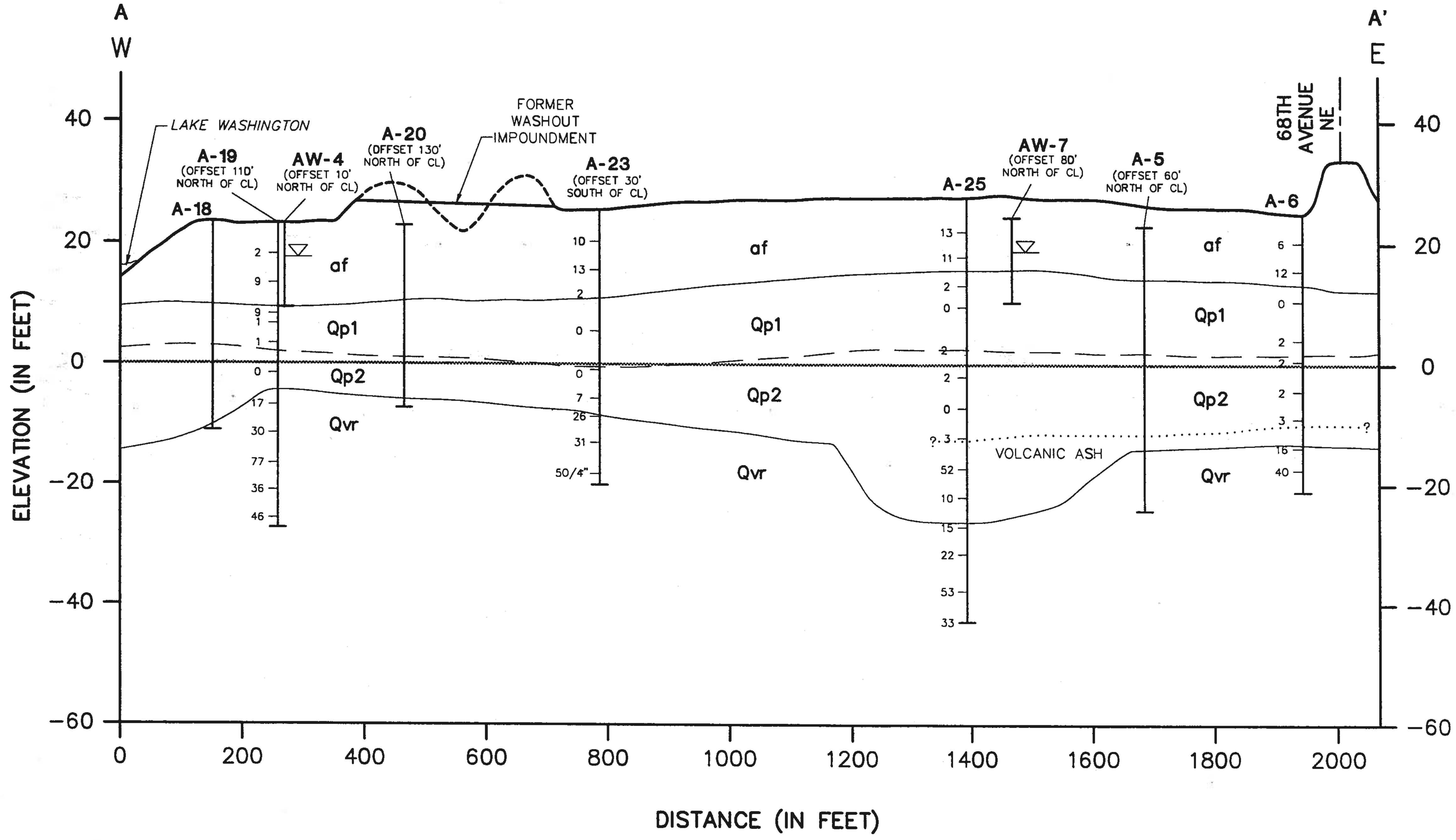
AGRA
Earth & Environmental
11335 N.E. 122nd Way, Suite 100
Kirkland, WA, U.S.A. 98034-6918

W.O. 6-91M-10459-E
DESIGN DHG
DRAWN JMR
DATE OCT 1996
SCALE 1"=200'

LAKEPOINTE DEVELOPMENT
KING COUNTY, WASHINGTON

SITE AND EXPLORATION PLAN

AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \91\10459-E\GEOLOGIC.DWG



mL – MODIFIED LAND

ORIGINAL TOPOGRAPHY DISTURBED BY REMOVAL OF SOME PLEISTOCENE DEPOSITS, GRADING AND ARTIFICIAL FILL OF UNKNOWN QUALITY.

af – ARTIFICIAL FILL

ORIGINAL TOPOGRAPHY MODIFIED BY PLACEMENT OF SIGNIFICANT THICKNESS OF ARTIFICIAL FILL. COMPRISES THE WOOD DEBRIS FILL DESCRIBED IN SUBSURFACE EXPLORATIONS.

Qp – PEAT

ACCUMULATION OF ORGANIC MATERIAL (Qp1)
LOOSE ALLUVIUM.
MAY CONTAIN SMALL AMOUNTS OF SAND, SILT, CLAY AND VOLCANIC ASH DEPOSITED IN SWAMPS AND BOGS (Qp2)

Qvr – VASHON RECESSIONAL OUTWASH

LIGHT BROWN, LOOSELY COMPACTED SAND AND GRAVEL, WELL-ROUNDED FROM STREAM TRANSPORTATION. SORTING VARIES; PARTICLE SIZE VARIES FROM MEDIUM SAND TO COBBLES. NOT DIFFERENTIATED FROM MORE RECENT ALLUVIUM, WHICH MAY CONTAIN SILT, CLAY AND ORGANIC MATTER.

Qvt – VASHON TILL

POORLY SORTED, NONSTRATIFIED LODGMENT TILL DEPOSITED AS GROUND MORAINE. MIXTURE OF CLAY, SILT, SAND, PEBBLES AND COBBLES WITH OCCASIONAL LARGE BOULDERS. STONES ARE SUBANGULAR TO ROUNDED.

LEGEND

A-25 SOIL BORING/MONITORING WELL NUMBER AND LOCATION

▽ OBSERVED GROUNDWATER LEVEL

53 – BLOW COUNT (BLOWS/FOOT)

APPROXIMATE BOUNDARY OF GEOLOGIC UNIT

APPROXIMATE BOUNDARY BETWEEN ORGANIC PEATS (Qp1) AND ALLUVIUM (Qp2)

ELEVATION 0 (KING COUNTY BENCHMARK "KC-B-16")

BOTTOM OF HOLE

0 20 40
VERTICAL SCALE IN FEET

0 200 400
HORIZONTAL SCALE IN FEET

REFERENCE:
U.S. GEOLOGICAL SURVEY (USGS) GEOLOGICAL MAP OM-14, "PRELIMINARY SURFICAL GEOLOGIC MAP OF THE EDMONDS EAST AND EDMONDS WEST QUADRANGLES, SNOHOMISH AND KING COUNTIES, WASHINGTON (1975).

FIGURE 3

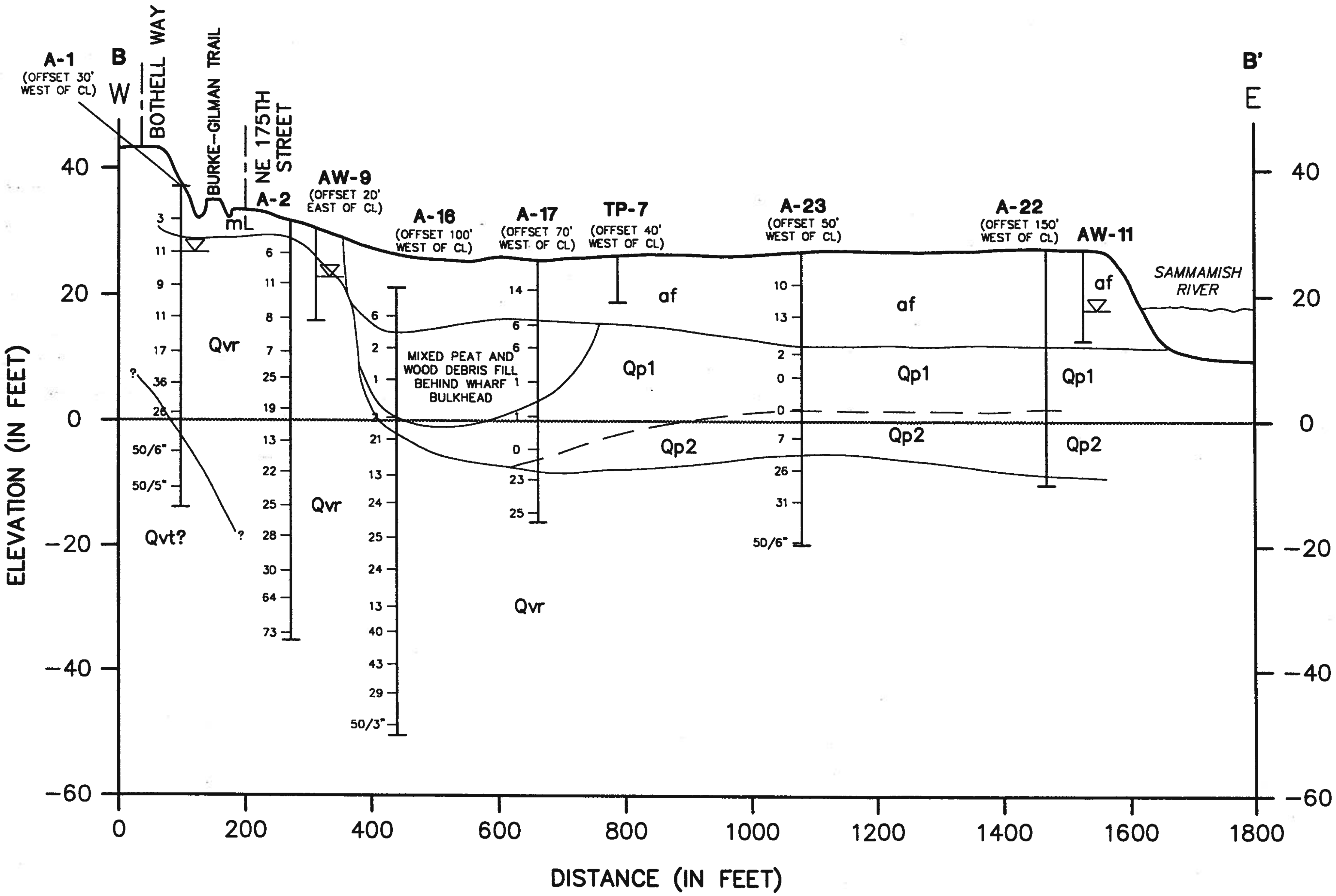
AGRA
Earth & Environmental
11335 N.E. 122nd Way, Suite 100
Kirkland, WA, U.S.A. 98034-6918

W.O. 6-91M-10459-E
DESIGN DHG
DRAWN JMR
DATE OCT 1996
SCALE V:1-20, H:1-200

LAKEPOINTE DEVELOPMENT
KING COUNTY, WASHINGTON

GENERALIZED GEOLOGIC CROSS SECTION
A - A'

AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \91\10459-E\X-S-A.DWG



mL – MODIFIED LAND

ORIGINAL TOPOGRAPHY DISTURBED BY REMOVAL OF SOME PLEISTOCENE DEPOSITS, GRADING AND ARTIFICIAL FILL OF UNKNOWN QUALITY.

af – ARTIFICIAL FILL

ORIGINAL TOPOGRAPHY MODIFIED BY PLACEMENT OF SIGNIFICANT THICKNESS OF ARTIFICIAL FILL. COMPRISES THE WOOD DEBRIS FILL DESCRIBED IN SUBSURFACE EXPLORATIONS.

Qp – PEAT

ACCUMULATION OF ORGANIC MATERIAL (Qp1)
LOOSE ALLUVIUM.
MAY CONTAIN SMALL AMOUNTS OF SAND, SILT, CLAY AND VOLCANIC ASH DEPOSITED IN SWAMPS AND BOGS (Qp2)

Qvr – VASHON RECESSIONAL OUTWASH

LIGHT BROWN, LOOSELY COMPACTED SAND AND GRAVEL, WELL-ROUNDED FROM STREAM TRANSPORTATION. SORTING VARIES; PARTICLE SIZE VARIES FROM MEDIUM SAND TO COBBLES. NOT DIFFERENTIATED FROM MORE RECENT ALLUVIUM, WHICH MAY CONTAIN SILT, CLAY AND ORGANIC MATTER.

Qvt – VASHON TILL

POORLY SORTED, NONSTRATIFIED LODGMENT TILL DEPOSITED AS GROUND MORAINE. MIXTURE OF CLAY, SILT, SAND, PEBBLES AND COBBLES WITH OCCASIONAL LARGE BOULDERS. STONES ARE SUBANGULAR TO ROUNDED.

LEGEND

A-25	SOIL BORING/MONITORING WELL NUMBER AND LOCATION
▽	OBSERVED GROUNDWATER LEVEL
53 –	BLOW COUNT (BLOWS/FOOT)
～	APPROXIMATE BOUNDARY OF GEOLOGIC UNIT
– –	APPROXIMATE BOUNDARY BETWEEN ORGANIC PEATS (Qp1) AND ALLUVIUM (Qp2)
～～	ELEVATION 0 (KING COUNTY BENCHMARK "KC-B-16")
⊥	BOTTOM OF HOLE

0 20 40
VERTICAL SCALE IN FEET

0 200 400
HORIZONTAL SCALE IN FEET

REFERENCE:
U.S. GEOLOGICAL SURVEY (USGS) GEOLOGICAL MAP OM-14, "PRELIMINARY SURFICAL GEOLOGIC MAP OF THE EDMONDS EAST AND EDMONDS WEST QUADRANGLES, SNOHOMISH AND KING COUNTIES, WASHINGTON (1975).

FIGURE 4

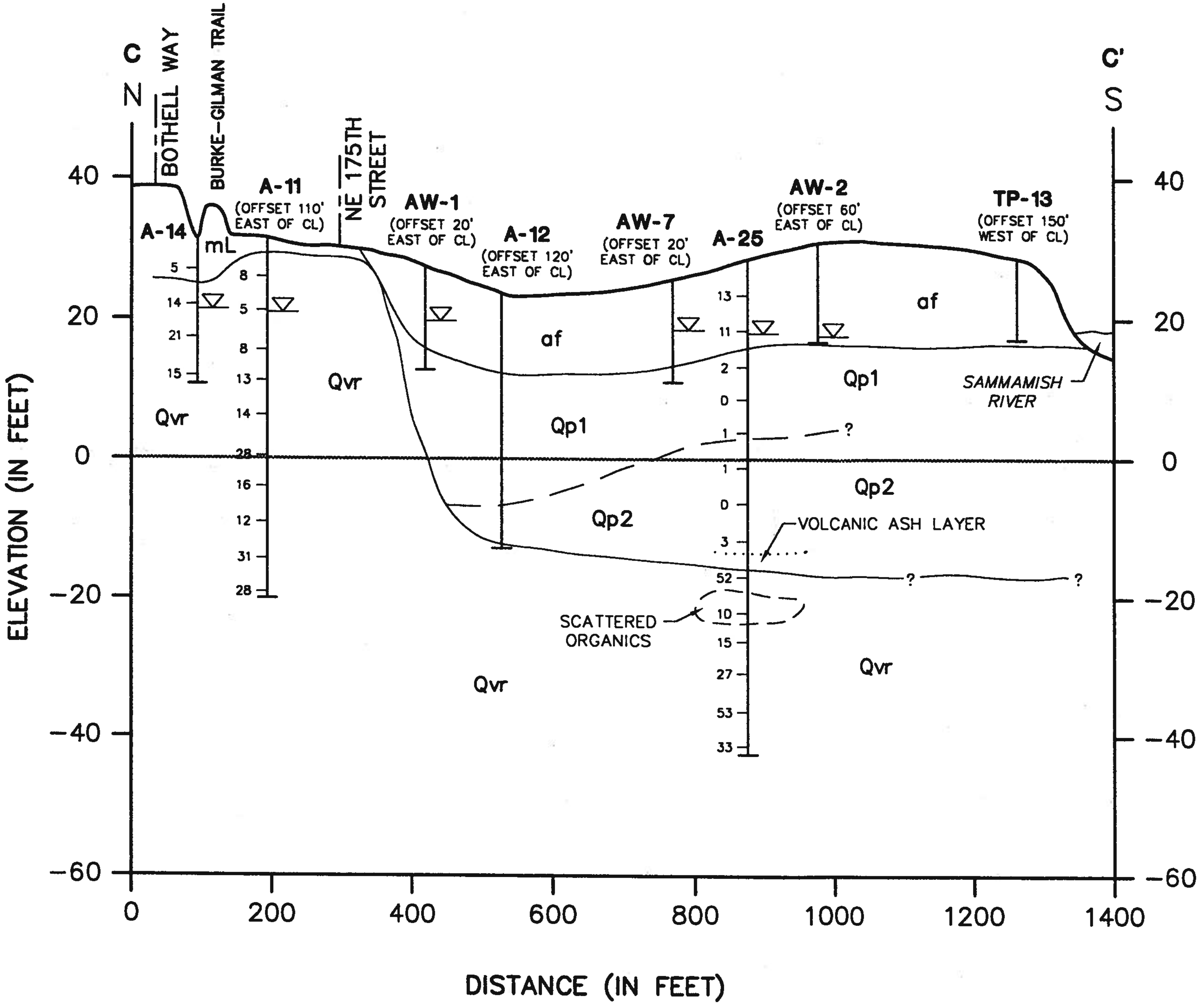
AGRA
Earth & Environmental
11335 N.E. 122nd Way, Suite 100
Kirkland, WA, U.S.A. 98034-6918

W.O. 6-91M-10459-E
DESIGN DHG
DRAWN JMR
DATE OCT 1996
SCALE V:1-20, H:1-200

LAKEPOINTE DEVELOPMENT
KING COUNTY, WASHINGTON

GENERALIZED GEOLOGIC CROSS SECTION B - B'

ACRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \91\10459-E\X-S-B.DWG



mL – MODIFIED LAND

ORIGINAL TOPOGRAPHY DISTURBED BY REMOVAL OF SOME PLEISTOCENE DEPOSITS, GRADING AND ARTIFICIAL FILL OF UNKNOWN QUALITY.

af – ARTIFICIAL FILL

ORIGINAL TOPOGRAPHY MODIFIED BY PLACEMENT OF SIGNIFICANT THICKNESS OF ARTIFICIAL FILL. COMPRISES THE WOOD DEBRIS FILL DESCRIBED IN SUBSURFACE EXPLORATIONS.

Qp – PEAT

ACCUMULATION OF ORGANIC MATERIAL (Qp1)
LOOSE ALLUVIUM.
MAY CONTAIN SMALL AMOUNTS OF SAND, SILT, CLAY AND VOLCANIC ASH DEPOSITED IN SWAMPS AND BOGS (Qp2)

Qvr – VASHON RECESSIONAL OUTWASH

LIGHT BROWN, LOOSELY COMPACTED SAND AND GRAVEL, WELL-ROUNDED FROM STREAM TRANSPORTATION. SORTING VARIES; PARTICLE SIZE VARIES FROM MEDIUM SAND TO COBBLES. NOT DIFFERENTIATED FROM MORE RECENT ALLUVIUM, WHICH MAY CONTAIN SILT, CLAY AND ORGANIC MATTER.

Qvt – VASHON TILL

POORLY SORTED, NONSTRATIFIED LODGMENT TILL DEPOSITED AS GROUND MORAINE. MIXTURE OF CLAY, SILT, SAND, PEBBLES AND COBBLES WITH OCCASIONAL LARGE BOULDERS. STONES ARE SUBANGULAR TO ROUNDED.

LEGEND

A-25	SOIL BORING/MONITORING WELL NUMBER AND LOCATION
▽	OBSERVED GROUNDWATER LEVEL
53 –	BLOW COUNT (BLOWS/FOOT)
∼	APPROXIMATE BOUNDARY OF GEOLOGIC UNIT
– –	APPROXIMATE BOUNDARY BETWEEN ORGANIC PEATS (Qp1) AND ALLUVIUM (Qp2)
⋯	ELEVATION 0 (KING COUNTY BENCHMARK "KC-B-16")
⊥	BOTTOM OF HOLE

0 20 40
VERTICAL SCALE IN FEET

0 200 400
HORIZONTAL SCALE IN FEET

REFERENCE:
U.S. GEOLOGICAL SURVEY (USGS) GEOLOGICAL MAP OM-14, "PRELIMINARY SURFICAL GEOLOGIC MAP OF THE EDMONDS EAST AND EDMONDS WEST QUADRANGLES, SNOHOMISH AND KING COUNTIES, WASHINGTON (1975).

FIGURE 5

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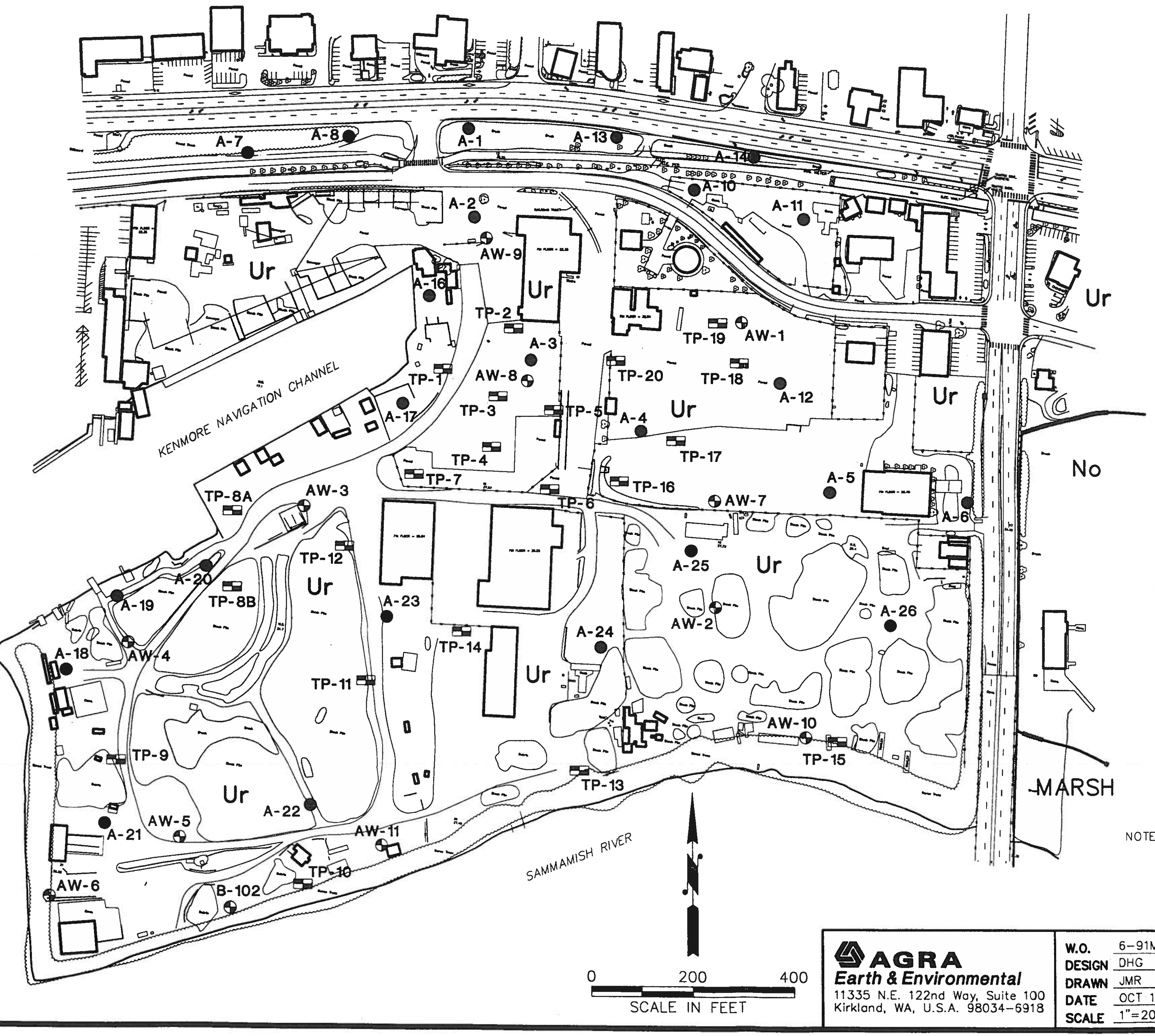
DESIGN DHG
DRAWN JMR
DATE OCT 1996
SCALE V:1-20, H:1-200

LAKEPOINTE DEVELOPMENT
KING COUNTY, WASHINGTON

GENERALIZED GEOLOGIC CROSS SECTION C - C'

AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \91\10459-E\X-S-C.DWG



LEGEND

AW-11 ◓	GROUNDWATER MONITORING WELL NUMBER AND LOCATION
A-26 ●	GEOTECHNICAL BORING NUMBER AND LOCATION
TP-20 ▨	TEST PIT NUMBER AND LOCATION

SCS SOIL TYPES – CURRENT CONDITIONS

Ur – URBAN LAND

SOIL THAT HAS BEEN MODIFIED BY DISTURBANCE OF NATURAL LAYERS WITH ADDITIONS OF FILL MATERIALS SEVERAL FEET THICK TO ACCOMMODATE LARGE INDUSTRIAL AND HOUSING INSTALLATIONS. URBAN LAND DOES NOT CORRESPOND TO A GEOLOGIC UNIT, BUT IS CLASSIFIED AS ARTIFICIAL FILL (AF) OF MODIFIED LAND (ML) IN GEOLOGIC DISCUSSIONS AND ILLUSTRATIONS ACCOMPANYING THIS EIS.

No – NORMA SOILS

POORLY DRAINED SOIL THAT FORMED IN ALLUVIUM, UNDER SEDGES, GRASS, CONIFERS AND HARDWOODS. NORMA SOILS CONSIST OF BLACK, SANDY LOAM TO SILT LOAM. NORMA SOILS CORRESPOND TO QUATERNAY PEAT GEOLOGIC DEPOSITS (QP).

MARSH

AREAS DESIGNATED AS MARSH WERE NOT INCLUDED IN THE SCS SURVEY AND WERE INFERRED TO HAVE BEEN INUNDATED OR INACCESSIBLE. MARSH AREAS CORRESPOND TO QUATERNARY PEAT GEOLOGIC DEPOSITS (QP).

REFERENCE: U.S. DEPARTMENT OF AGRICULTURE (USDA) SOIL CONSERVATION SERVICE (SCS) SOIL SURVEY OF KING COUNTY AREA, WASHINGTON, DATED NOVEMBER 1973.

NOTE: MONITORING WELL B-102 WAS INSTALLED BY OTHERS. REFER TO <u>REVISED: PHASE II ENVIRONMENTAL STUDY – KENMORE PRE-MIX SITE</u>, BY GEOTECH CONSULTANTS, INC., DATED 24 JANUARY 1991.

FIGURE 6

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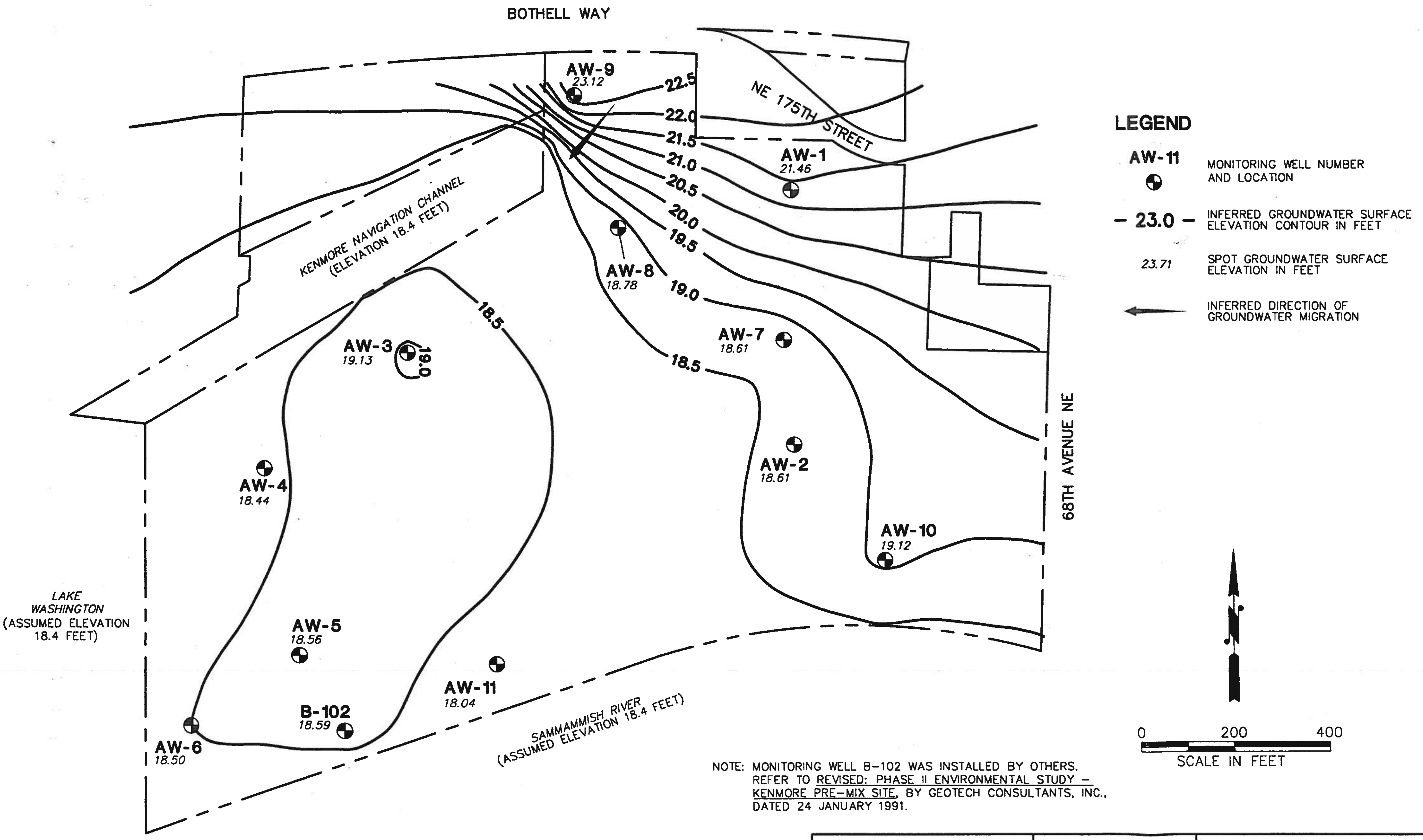
Kirkland, WA, U.S.A. 98034-6918

W.O. 6-91M-10459-E
DESIGN DHG
DRAWN JMR
DATE OCT 1996
SCALE 1"=200'

LAKEPOINTE DEVELOPMENT
KING COUNTY, WASHINGTON

DISTRIBUTION OF SCS SOIL TYPES - 1968

AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \91\10459-E\SCS-SOIL.DWG



NOTE: MONITORING WELL B-102 WAS INSTALLED BY OTHERS. REFER TO REVISED: PHASE II ENVIRONMENTAL STUDY – KENMORE PRE-MIX SITE, BY GEOTECH CONSULTANTS, INC., DATED 24 JANUARY 1991.

FIGURE 7

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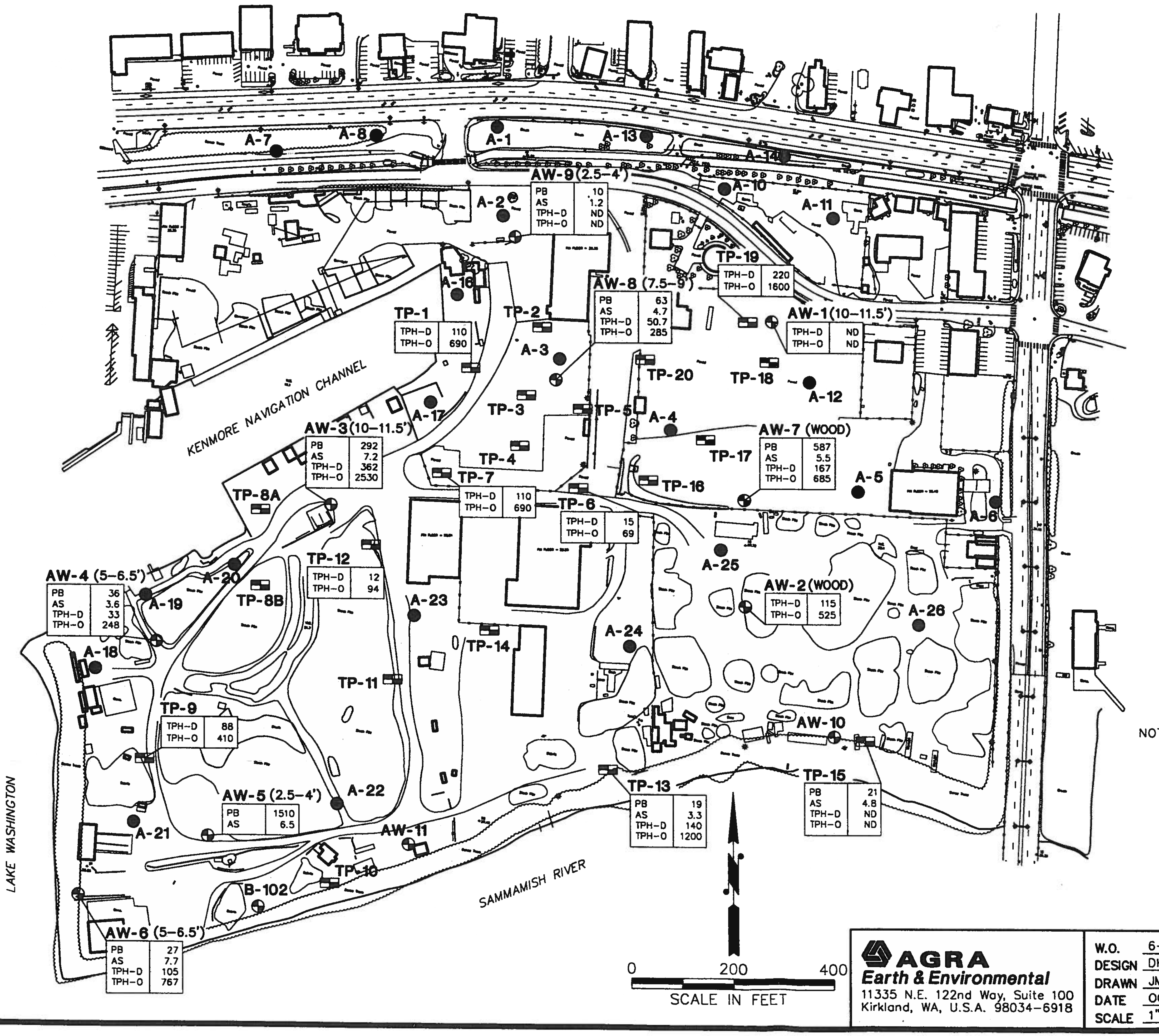
DESIGN DHG
DRAWN JMR
DATE OCT 1996
SCALE 1"=200'

LAKEPOINTE DEVELOPMENT
KING COUNTY, WASHINGTON

GROUNDWATER GRADIENT MAP
FOR 05 AUGUST 1996

AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \91\10459-E\GW0896.DWG



LEGEND

AW-11 ⊕	GROUNDWATER MONITORING WELL NUMBER AND LOCATION
A-26 ●	GEOTECHNICAL BORING NUMBER AND LOCATION
TP-20 ▨	TEST PIT NUMBER AND LOCATION
(2.5-4')	SAMPLE DEPTH COLLECTED (IN FEET)
(WOOD)	NO SOIL SAMPLE OBTAINED DURING EXPLORATION. ANALYSES PERFORMED ON WOOD CUTTINGS.

SOIL TEST RESULTS

ALL CONCENTRATIONS ARE REPORTED IN PARTS PER MILLION (PPM)

ND	NOT DETECTED, BELOW METHOD DETECTION LIMIT
PB	TOTAL LEAD BY EPA METHOD 6010/7000
AS	TOTAL ARSENIC BY EPA METHOD 6010/7000
TPH-D	TOTAL PETROLEUM HYDROCARBONS – DIESEL RANGE BY ECOLOGY METHOD WTPH-D EXT.
TPH-O	TOTAL PETROLEUM HYDROCARBONS – HEAVY OIL RANGE BY ECOLOGY METHOD WTPH-D EXT.

PB	ND
AS	ND
TPH-D	ND
TPH-O	ND

COMPOUNDS

CONCENTRATIONS IN PPM

NOTES: OTHER COMPOUNDS ARE PRESENT. PLEASE REFER TO TOXIC AND HAZARDOUS MATERIALS SECTION OF THIS REPORT, OR TO AEE'S PHASE II ENVIRONMENTAL ASSESSMENT DATED MAY 1996, FOR FURTHER DISCUSSION OF ANALYTICAL RESULTS.

MONITORING WELL B-102 WAS INSTALLED BY OTHERS. REFER TO REVISED: PHASE II ENVIRONMENTAL STUDY – KENMORE PRE-MIX SITE, BY GEOTECH CONSULTANTS, INC., DATED 24 JANUARY 1991.

FIGURE 8

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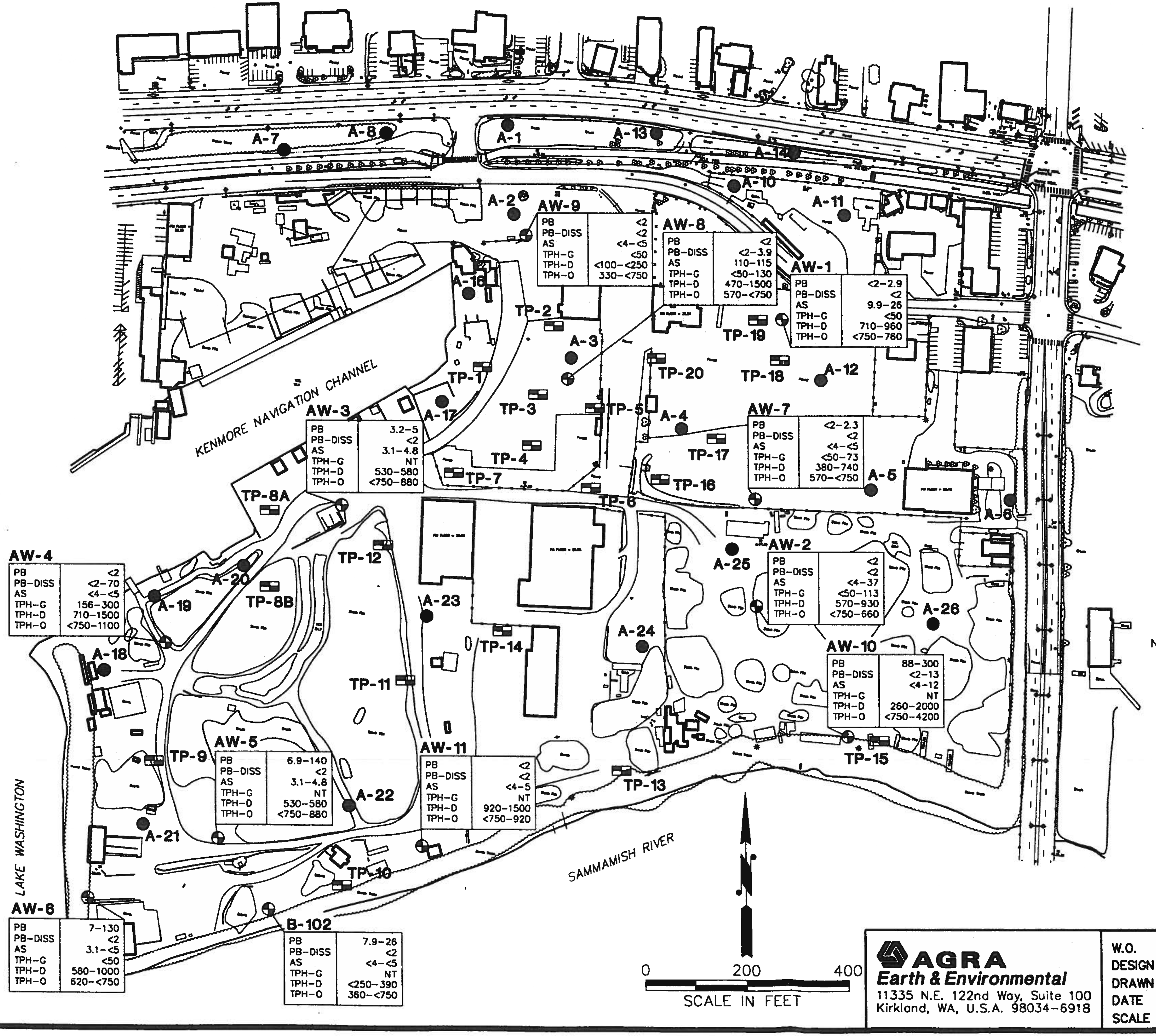
DESIGN DHG
DRAWN JMR
DATE OCT 1996
SCALE 1"=200'

LAKEPOINTE DEVELOPMENT KING COUNTY, WASHINGTON

SOIL CONTAMINANT CONCENTRATIONS

AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \91\10459-E\TPH_SOIL.DWG



LEGEND

AW-11 GROUNDWATER MONITORING WELL NUMBER AND LOCATION

A-26 ● GEOTECHNICAL BORING NUMBER AND LOCATION

TP-20 TEST PIT NUMBER AND LOCATION

GROUNDWATER TEST RESULTS

CONCENTRATIONS IN PARTS PER BILLION (PPB)

ND	NOT DETECTED, BELOW METHOD DETECTION LIMIT
PB	TOTAL LEAD BY EPA METHOD 6010/7000
PB-DISS	DISSOLVED LEAD BY EPA METHOD 6010/7000
AS	TOTAL ARSENIC BY EPA METHOD 6010/7000
TPH-G	TOTAL PETROLEUM HYDROCARBONS – GASOLINE RANGE BY ECOLOGY METHOD WTPH-D EXT.
TPH-D	TOTAL PETROLEUM HYDROCARBONS – DIESEL RANGE BY ECOLOGY METHOD WTPH-D EXT.
TPH-O	TOTAL PETROLEUM HYDROCARBONS – HEAVY OIL RANGE BY ECOLOGY METHOD WTPH-D EXT.

PB	ND
PB-DISS	ND
AS	ND
TPH-G	ND
TPH-D	ND
TPH-O	ND

COMPOUNDS

CONCENTRATIONS IN PPB

NOTES:

1. EXCEPT FOR COLLECTION OF TPH-G SAMPLES, MICROPURGE TECHNIQUES WERE USED TO MINIMIZE TURBIDITY WHILE SAMPLING THE WELLS. CONCENTRATIONS ARE REPORTED AS A RANGE FROM TWO SAMPLING EVENTS.

2. TOTAL ARSENIC IS COMPARABLE TO DISSOLVED ARSENIC CONCENTRATIONS.

3. OTHER COMPOUNDS ARE PRESENT. PLEASE REFER TO TOXIC AND HAZARDOUS MATERIALS SECTION OF THIS REPORT, OR TO AEE'S PHASE II ENVIRONMENTAL ASSESSMENT DATED MAY 1996, FOR FURTHER DISCUSSION OF SAMPLING METHODOLOGY AND ANALYTICAL RESULTS. AUGUST 1996 SAMPLING RESULTS ARE PRESENTED IN AEE'S QUARTERLY GROUNDWATER MONITORING REPORT DATED 08 NOVEMBER 1996.

4. MONITORING WELL B-102 WAS INSTALLED BY OTHERS. REFER TO <u>REVISED: PHASE II ENVIRONMENTAL STUDY – KENMORE PRE-MIX SITE</u>, BY GEOTECH CONSULTANTS, INC., DATED 24 JANUARY 1991.

FIGURE 9

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DESIGN DHG
DRAWN JMR
DATE OCT 1996
SCALE 1"=200'

LAKEPOINTE DEVELOPMENT
KING COUNTY, WASHINGTON

GROUNDWATER
CONTAMINANT CONCENTRATIONS

APPENDIX A

PRELIMINARY GEOTECHNICAL ENGINEERING EVALUATION
PROPOSED KENMORE LAKEPOINTE DEVELOPMENT
KENMORE (KING COUNTY), WASHINGTON

PRELIMINARY GEOTECHNICAL ENGINEERING EVALUATION
PROPOSED KENMORE LAKEPOINTE DEVELOPMENT
N.E. BOTHELL WAY AND 68TH AVENUE N.E.
KING COUNTY, WASHINGTON

Submitted to:

Pacific Rim Equities
11 Crescent Key
Bellevue, Washington 98006

Submitted by:

AGRA Earth & Environmental, Inc.
11335 N.E. 122nd Way, Suite 100
Kirkland, Washington 98034-6918

November 1996

11-10459-00

AGRA
Earth & Environmental

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Earth & Environmental

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8 November 1996
11-10459-00

Pacific Rim Equities
11 Crescent Key
Bellevue, Washington 98006

Attention: Mr. Michael Gleason

Subject: Preliminary Geotechnical Engineering Evaluation
Proposed Kenmore Lakepointe Development
N.E. Bothell Way and 68th Avenue N.E.
King County, Washington

Dear Mr. Gleason:

As requested by you, AGRA Earth & Environmental, Inc. (AEE) is pleased to submit this preliminary report describing our recent geotechnical engineering evaluation for the proposed Lakepointe Development. This report presents the results of our subsurface exploration program and geotechnical engineering evaluation relative to foundation design and construction considerations for the proposed project. This study has been completed in general accordance with our proposals dated 22 August 1995, 12 January 1996 and 8 April 1996, and was initiated after receiving written authorization for our services.

We appreciate this opportunity to be of service to you and would be pleased to discuss the contents of this report or other aspects of the project with you at your convenience.

Respectfully submitted,

AGRA Earth & Environmental, Inc.

James S. Dransfield, P.E.
Vice President

Engineering & Environmental Services

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11-10459-00

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Appendix B — Laboratory Testing Procedures and Results

PRELIMINARY GEOTECHNICAL ENGINEERING EVALUATION
PROPOSED KENMORE LAKEPOINTE DEVELOPMENT
N.E. BOTHELL WAY AND 68TH AVENUE N.E.
KING COUNTY, WASHINGTON

11-10459-00

1.0 SUMMARY

Construction of the proposed project is feasible, from a geotechnical standpoint, with respect to the subsurface conditions encountered at the site. Due to the nature of the near-surface conditions, geotechnical design aspects of the project will be controlled by the low strength, high compressibility, and long-term settlement characteristics of the materials. A brief summary of the project geotechnical considerations is presented below.

- In the central and south portions of the site, our explorations generally encountered significant thicknesses of wood waste fill soils (up to 23 feet) and compressible native peat and organic silt soils (up to 32 feet). This also included areas of the proposed Lakepointe Drive. In the northern portion of the site, in areas of the existing Bothell Way NE and NE 175th Street, sand and gravel fill soils are underlain by loose to medium dense sand and gravel soils. Glacially overconsolidated soils were encountered at depths ranging from 40 to 68 feet.

- In the central and south portions of the site, the proposed Lakepointe Drive construction and development is feasible, although the presence of very loose fill soils, degradable wood waste, and compressible peat soils beneath the site will necessitate special foundation systems and subgrade preparations to provide adequate support for buildings, utilities, and pavement sections.

- In the north portion of the site, subsurface conditions are generally more favorable than in the central and south portions of the site, although the presence of loose sands and gravels may necessitate special foundation systems for heavier structures planned for the area.

- Underground utilities will likely be founded above existing wood waste, soft, undocumented fill soils, and compressive native soils, which will require limited overexcavation and replacement to provide more uniform support. Light weight aggregates may be necessary as bedding and backfill to minimize surcharging of the compressive materials below. In extreme cases, settlement-sensitive utilities may require pile support. Gravity systems should be designed with maximum gradients to compensate for the effects of long-term settlement.

- Pavements and sidewalks will also likely experience settlement over the long term. Geogrid reinforcement beneath the pavement and sidewalk sections would reduce the magnitude of differential settlement between the elements. Long-term total settlement would still occur but would be more uniform with geogrid reinforcement.

- Methane gas was detected in the monitoring wells across the site, which may originate from the wood waste fill and/or the underlying peat. Provisions to manage methane within enclosed building spaces and underground utilities will need to be addressed in final design.

This summary is presented for introductory purposes only and should be used in conjunction with the full text of this report. The project description, site conditions, and detailed geotechnical recommendations are presented in the text of this report. The exploration procedures, and boring, electric cone, monitoring wells, and test pit logs are presented in Appendix A. Laboratory test procedures and results are presented in Appendix B and on the exploration logs, where appropriate.

2.0 SITE AND PROJECT DESCRIPTION

The project site is located southwest of the intersection of N.E. Bothell Way (State Route 522) and Juanita Drive N.E. at the north end of Lake Washington in the Kenmore area of King County, Washington, as presented on the attached Location Map (Figure 1). The 50-acre parcel of land to be developed is rectangular in shape and measures about 1600 feet by 1800 feet. It is bounded by N.E. Bothell Way on the north, a dredged barge channel in Lake Washington on the west, by Juanita Drive N.E. on the east, and by the Sammamish River slough on the south. The northern 200 to 300 feet of the site is separated from the main parcel by the existing east-west trending N.E. 175th Street. The attached Site and Exploration Plan (Figure 2) illustrates the project site and adjacent properties.

Plans for the proposed Kenmore Lakepointe project have not been finalized, but we understand it will include the following features:

- Construction of a new county street, Lakepointe Drive, will include a roughly 1,000-foot long bridge and elevated roadway linking N.E. Bothell Way and Juanita Drive N.E.

- Modification of the existing Burke-Gilman Trail and N.E. 175th Street to accommodate the proposed Lakepointe Drive bridge. The modifications would include approximately 1,400 feet of lowered grades with retaining walls to support cuts.

- The dredging of a portion of existing land along the south side of the barge channel to enlarge boat moorage and shoreline access.

- The construction of new and replacement bulkheads along the south side of the existing barge channel shoreline and new moorage facility.

- The design and development of commercial, retail, and residential structures, with associated parking facilities, and a marina.

- Widening of N.E. Bothell Way for a limited HOV/bus turnout lane which would include retaining wall construction, roadway widening, and parking.

The purpose of this evaluation was to interpret general surface and subsurface site conditions, from which we could determine the feasibility of the project and formulate preliminary recommendations concerning site preparation, road construction, excavations, foundations, floors, and other construction-related considerations. As described in our proposal letters dated 22 August 1995, 12 January 1996 and 8 April 1996, our scope of services consisted of a subsurface exploration programs, laboratory testing, geotechnical engineering analyses, and preparation of this report.

It should be emphasized that the conclusions and recommendations contained in this report are preliminary, and based on our understanding of the currently proposed utilization of the project site, as derived from verbal information and a conceptual layout plan supplied to us. Consequently, we will need to finalize our conclusions and recommendations once site grades, layout, building types, and foundation loads have been determined. This report has been prepared in accordance with generally accepted geotechnical engineering practice for the exclusive use of Pacific Rim Equities, and their agents, for specific application to this project.

3.0 SITE CONDITIONS

Site conditions for this study were evaluated in September and October 1995, and February and March 1996. The surface and subsurface conditions are described subsequently while the exploration procedures and interpretive logs of the explorations are presented in Appendix A. The laboratory procedures and test results are presented in Appendix B and on the exploration logs where appropriate. The approximate locations of the explorations are shown on the Site and Exploration Plan (Figure 2). Generalized Geologic Cross-Sections A-A', B-B', and C-C' of the site soil conditions are displayed in Figures 3, 4, and 5.

3.1 Surface Conditions

The project site is situated in a region characterized by gently to moderately sloping terrain, sparse native vegetation, and commercial/industrial development. The majority of the subject site has been graded flatter than 15 percent, lying between elevation 25 and 32 feet. Roadway and shoreline embankments often exceed grades of 40 percent, but steep slopes are less than 10 feet. Topographically, the lowest area of the site appears to be in the north-central portion with an elevation of about 22.8 feet. Numerous stockpiles varying from 5 to 20 feet high are situated on the south half of the site. The stockpiles vary from concrete and wood debris to sand and gravel. The south and west side of the site are bounded by the Sammamish River slough and Lake Washington, respectively. According to the U.S. Army Corps of Engineers, the water level in Lake Washington fluctuates seasonally between elevation 19.75 and 22.25, relative to a datum based on Mean Lower Low Water (MLLW), which is calculated as an 18.96 year average. The water level on 19 December 1995 was surveyed to be elevation 16.7 relative to King County Datum NAD 1933, and reported to equal elevation 20.00 on the same date, relative to the U.S. Army Corps of Engineers datum.

The site is currently developed as an industrial park with a few permanent commercial/office buildings, and numerous temporary structures, including storage sheds, a truck scale, mobile trailers, inverted dry docks, and shipping containers. Limited portions of the site are paved with asphalt or concrete surfacing. Existing facilities are serviced by underground sanitary sewer, water, natural gas, power, and telephone utilities. Power is also supplied by underground and overhead lines. Storm runoff is not intercepted across the majority of the subject site except for the north-central portion of the site.

3.2 Subsurface Conditions

The project site is located at the mouth of the Sammamish River, at the north end of Lake Washington, within the Puget Lowland basin. The native soils underlying the site consist of alluvial and fluvial sediments deposited during the Holocene Age, following the recessing of the Vashon glacier. Organic silts and peats were subsequently deposited as the river delta, at the mouth, continued to prograde into the lake reservoir. Following the lowering of Lake Washington in 1916, the Sammamish River was straightened and channelized in order to facilitate transportation and commercial uses. Between 1956 and 1969 approximately 10 to 20 feet of debris fill had been placed across a majority of the site and capped with gravelly sand fill.

The subsurface exploration program for the geotechnical phase consisted of advancing 16 hollow-stem auger borings to a depths of 21 to 71 feet across the site. Additionally, 8 electric cone penetrometer tests were advanced to depths ranging from 31 to 47 feet below the existing ground surface. Eleven additional borings were completed as monitoring wells and were supplemented with twenty test pits for our environmental evaluation; these supplemental explorations are included in this report for additional information. The deeper explorations were completed at the approximate location presented to you prior to beginning the evaluations. However, some minor modifications to the location of our explorations were necessitated by site constraints. Furthermore, locations A-9 and A-15 were not included in the final scope of work. Table 1 below summarizes the functional locations, approximate elevations and depths for our deeper explorations.

In general, our explorations suggest that the soils underlying the site can be segregated into four significant types: 1) wood debris fill; 2) peat and organic silt; 3) loose alluvium; and 4) dense sand and gravel. Specifically, we observed 2 to 23 feet of fill composed predominantly of wood debris with brick, wire, concrete washout products, and silty sand. The fill depth averaged 15 feet deep across the majority of the site, thinning to the north, and locally over 20 feet deep next to the dredged barge channel. The man-placed fill and native peat typically possess low density, low shear strength and high compressibility characteristics. Beneath the fill layer, native, soft to very soft peat and organic silt soils were encountered to depths of 25 to 44 feet deep across the south part of the site. Beneath the peats and silts, our explorations encountered loose to medium dense alluvial sands, gravels, and silty sands. Medium dense, sands and gravels suitable for supporting foundation loads were encountered at depths between 25 and 50 feet. Three boring explorations, Nos. A-1, A-2 and A-6, penetrated glacially overconsolidated soils at depths of 40 feet, 60 feet and 68½ feet, respectively. The very dense bearing stratum present at the north end of the site slopes steeply downward towards the south beneath the subject site. Table 2, below, summarizes the approximate thicknesses, depths, and elevations of these soil layers encountered in our explorations.

TABLE 1
APPROXIMATE LOCATIONS, ELEVATIONS, AND DEPTHS OF EXPLORATIONS

Exploration	Type	Functional Location	Approximate Surface Elevation (feet)	Termination Depth (feet)
A-1	Boring	North bridge abutment, proposed Lakepointe Drive	36	50.0
A-2	Boring	South bridge abutment, proposed Lakepointe Drive	31	66.5
A-3	Boring	Proposed Lakepointe Drive	27	51.5
A-4	Probe	Proposed Lakepointe Drive	24	38.0
A-5	Probe	Proposed Lakepointe Drive	24	46.5
A-6	Boring	Proposed Lakepointe Drive	27	46.5
A-7	Boring	Bothell Way/Burke Gilman Trail	33	21.0
A-8	Boring	Bothell Way/Burke Gilman Trail	36	21.0
A-9*	--	--	--	--
A-10	Boring	Bothell Way/Burke Gilman Trail	31	21.5
A-11	Boring	Bothell Way/Burke Gilman Trail	31	51.5
A-12	Probe	North of Proposed Lakepointe Drive	23	39.0
A-13	Boring	Bothell Way/Burke Gilman Trail	38	21.5
A-14	Boring	Bothell Way/Burke Gilman Trail	36	21.5
A-15*	--	--	--	--
A-16	Boring	Proposed Bulkhead	21	71.0
A-17	Boring	Proposed Bulkhead	25	41.5
A-18	Probe	Channel Dredging Easement	25	39.0
A-19	Boring	Channel Dredging Easement	24	51.5
A-20	Probe	Channel Dredging Easement	26	31.5
A-21	Boring	Southwest Quadrant	27	66.5
A-22	Probe	Southwest Quadrant	27	37.0
A-23	Boring	Southwest Quadrant	27	46.5
A-24	Probe	Southeast Quadrant	28	38.0
A-25	Boring	Southeast Quadrant	29	71.5
A-26	Probe	Southeast Quadrant	29	37.5

Reference: Preliminary Site Topography by GeoDimensions, Inc. dated 7 June 1995

*NOTE: Locations A-9 and A-15 were not drilled.

TABLE 2
APPROXIMATE THICKNESSES, DEPTHS, AND ELEVATIONS OF UPPER SOIL LAYERS OBSERVED IN BORINGS

Exploration	Thickness of Fill (ft)	Thickness of Peat (ft)	Thickness of Silt (ft)	Depth of Medium Dense Sands and Gravels (ft)
A-1	8	0	4½	20
A-2	2	0	4	22
A-3	23	7	0	35
A-4	13	12	10	35
A-5	9	11	17	37
A-6	12½	13	8	39
A-7	8½	0	0	8½
A-8	5	0	3½	12
A-9*	--	--	--	--
A-10	2	0	0	12
A-11	1½	0	0	18
A-12	11	15	7	36
A-13	7	0	0	17
A-14	7½	0	2½	9
A-15*	--	--	--	--
A-16	23	0	3	23
A-17	22	9½	2½	33
A-18	16	9	10	35
A-19	15	8	6	29
A-20	15	10½	6	31
A-21	16	12½	4	36½
A-22	15	10	11	36
A-23	14½	11	7½	34
A-24	14	7	14	35
A-25	12	13	19	51
A-26	13	10	14	37

*NOTE: Locations A-9 and A-15 were not drilled.

3.3 Groundwater Conditions

Groundwater measurements taken on 2 October 1995 from monitoring wells installed in our environmental borings revealed groundwater at depths of 6½ to 12½ feet below the ground surface or between approximately elevations 18 to 23 feet. These groundwater elevations appear to be influenced primarily by the level of Lake Washington. Groundwater appears to flow towards the south to southwest beneath the north end of the site, and appears to be relatively flat beneath the south end of the site, where the former lakebed was backfilled. The boring logs and monitoring well logs enclosed with this report contain groundwater levels noted at specific locations on the site. In all locations, however, groundwater levels should be expected to fluctuate due to changes in season, precipitation patterns, adjacent lake levels, and other on- and off-site factors.

3.4 Seismic Hazard Conditions

Large earthquakes reported historically in Washington have most frequently occurred deep beneath the Puget Sound region. The most recent and best documented earthquakes in the Puget Sound area were the 1949 magnitude 7.1 Olympia earthquake and the 1965 magnitude 6.5 Seattle-Tacoma earthquake. Both of these earthquakes occurred within the subducting Juan de Fuca plate at depths of about 34 to 40 miles. One of the largest earthquakes in the state occurred in the northern Cascade Mountains in December 1872, with an estimated magnitude of 7.3. Most of the earthquakes documented in Washington have occurred in the Puget Sound region between Olympia and the Canadian border, in the Cascade Mountains, and along the Washington-Oregon border.

There are no reported faults in the vicinity of the subject site manifested by surface expression. The major cause of damage from an earthquake would be due to shaking from earthquake waves and potential liquefaction-induced settlement. Damage due to actual fault movement beneath the proposed structure would be highly unlikely. The U.S. Geological Survey (1975) proposed that the largest earthquake likely to occur in the Puget Sound region could have a magnitude as large as 7.5. It is believed that such an earthquake event could have a peak hard ground acceleration of about 20 percent of gravity (0.2g) and about 20 to 30 seconds of severe ground shaking. Due to amplification effects within the loose/soft site soils, peak accelerations ranging up to 0.25g to 0.3g could conceivably be experienced at the ground surface during such an event. It is estimated that an earthquake of magnitude 7.5 would have a 10 percent probability of exceedance in 50 years, or a return period of 475 years. A moderate earthquake event is generally considered to be associated with a magnitude 6.5 earthquake, which could conceivably have a peak horizontal ground acceleration of up to 0.2g at the subject site. This would be considered a higher probability event having a 40 percent probability of exceedance in 50 years (return period of 100 years). The risk of such earthquake events to impact the subject site would be similar to that of the City of Kenmore and the Puget Sound area as a whole. The effects of seismic shaking on the proposed structures would be minimized by the structural design and construction specifications deemed necessary under current building codes.

Based on the soil conditions encountered at the site and an examination of available geologic maps, we recommend that a Site Coefficient Type S_3 having an S Factor of 1.5, as defined in the 1991 Uniform Building Code Table No. 23-J, be utilized in the seismic design of the structure. A site coefficient Type S_3 is required by the UBC for sites with a soil profile 40 feet or more in depth and containing more than 20 feet of soft to medium stiff clay, but not more than 40 feet of soft clay. The 1991 UBC, Chapter 23, Figure No. 23-2, classifies the site as Seismic Zone 3.

Liquefaction potential has been found to be greatest where the groundwater level is shallow and loose fine sands occur within a depth of about 50 feet or less. Liquefaction potential decreases with increasing grain size and clay and gravel content, but increases as the ground acceleration and duration of shaking increases. As previously stated, groundwater at the site was observed at depths of about 6 to 13 feet. Since layers of loose sand soils were encountered within the upper 50 feet at the site, liquefaction was considered to be a potential concern for the proposed development.

Variable thicknesses of potentially liquefiable, loose, sand soils are present beneath the site. Where encountered, the loose sand horizons ranged from about 2 to 6 feet in thickness. These soils tend to be thicker at the southern portion of the site as indicated on the Generalized Geologic Cross-Sections, Figures 4 and 5. Total depth of these loose sand soils range from 9 to 40 feet below ground surface, based on the explorations advanced on site. Groundwater beneath the site ranges from 6 to 13 feet below ground surface. Due to the presence of non-liquefiable cohesive soils and peats separating liquefiable layers, the actual settlement experienced at the ground surface would be variable. Therefore, it is recommended that site-specific liquefaction analyses be performed for each proposed building once its location, size, and bearing capacity has been determined.

4.0 PRELIMINARY GEOTECHNICAL ENGINEERING CONSIDERATIONS

The site evaluation and this preliminary geotechnical engineering report are intended to provide generalized information which can be considered in site planning and feasibility studies for future development. The general opinions and recommendations presented in this report are intended to provide a basis for continued planning of future development.

4.1 Central and South Portions of Site

The central and south portions of the site include those areas south of NE 175th Street and west of Juanita Drive NE.

4.1.1 Site Filling

It appears that fill will be placed in the central and south portions of the site for the eastern portion of embankment of Lakepointe Drive linking Bothell/Lake City Way to Juanita Drive NE, and possibly for future development. Assuming a final ground surface elevation on the order of 20 feet, it appears that existing grades will be cut on the order of 2 to 10 feet in most other areas and, therefore, only minor fills are anticipated across a majority of the site.

Settlement associated with site filling will occur due to consolidation of the wood waste and underlying soft peat and silt, and is anticipated to reach relatively large magnitudes. As a preliminary estimate, the soft peat, silt, and wood waste fill present below the site is expected to compress on the order of 1 to 2 inches for each foot of new surficial fill. Because of the nature of the wood waste material, it is extremely difficult to predict the settlement magnitudes and rates, both short-term and long-term, and such information will probably not be known until the fill is actually placed and settlement monitored. In addition, these settlements would tend to occur over long periods of time, (i.e., years). Significant quantities of "overbuilding" of site fills should therefore be anticipated in order to achieve the long-term desired grade through a preloading process.

4.1.2 General Foundation Considerations

Development in the central and south portions of the site will be complicated by the presence of significant thicknesses of highly compressible soft peat, silt, and wood waste. It appears that pile foundations extending to approximate embedment depths of 10 to 20 feet or deeper within the medium dense to dense sands and gravels would be necessary over much of the property for 40 ton capacity piles and 15 to 20 feet or deeper for 80 to 100 ton capacity piles. The dense bearing stratum was encountered at depths varying from 34 to 44 feet beneath the existing ground surface, which translates into piles on the order of 44 to 64 feet in length. The following report subsections discuss foundation considerations in greater detail.

4.1.3 Pile Foundation Support

Pile foundation support will be necessary for all buildings in the central and south portions of the site. Deep end-bearing piles founded in the dense sand and gravel soils encountered at depth could be used. End bearing piles in the relatively incompressible deep dense sand and gravels are considered appropriate in order to limit settlement of the structures which they would support. Given the required length of the piles anticipated at this site (on the order of 44 to 64 feet below existing grade), it is unlikely that lower capacity piles such as timber piles or augercast piles acting as friction piles supported in the soils above the dense bearing stratum would be suitable for most of the site except for possibly very light structures. In addition, it should be noted that augercast piles would not be appropriate for use where significant thicknesses of wood waste fills or peat are present. Due to the high pressures involved during injection of grout in an augercast pile we anticipate that grout bulbs would develop in the wood waste and soft peat which would increase the downdrag loads on the piling.

A relatively new method of pile installation termed a "driven grout pile," may be considered an appropriate alternative to conventional augercast piling at this site. A driven grout pile involves driving a steel casing in advance of grouting and then removing the casing while still applying grout pressure. This method of pile installation has several advantages in that less grout is typically used, there is less grout spread over the site, and the pile can develop a higher capacity resulting in higher factors of safety. In addition, driving the casing essentially close-ended will compact the loose to medium dense sands encountered in our borings, thus reducing liquefaction potential in these soils.

Appropriate pile types would include driven grout, precast concrete, steel pipe, or steel H-piles. Because of the potential corrosive effects of the wood waste fill and peat, a cast-in-place pile (closed-end steel pipe pile which is backfilled with concrete) may be most appropriate. Table 3 below summarizes typical allowable pile capacities for end-bearing in the medium dense to dense site soils.

TABLE 3
TYPICAL ALLOWABLE VERTICAL COMPRESSIVE
PILE CAPACITY FOR VARIOUS PILE TYPES

Pile Type	Typical Allowable Vertical Pile Capacity in Tons
12" I.D. Concrete Filled Pipe Pile (⅜" wall)	50 - 75
14" O.D. Concrete Filled Pipe Pile (⅜" wall)	70 - 95
12" O.D. Driven grout	75 - 100

It should be noted that these pile capacities assume that sufficient embedment is achieved such that the structural strength of the pile governs the allowable load. Concrete-filled pipe piles should be driven with a closed-bottom plate, to attain sufficient end-bearing capacity at depth. A thinner wall may be feasible, however, with increased risk of driving damage to pipes encountering obstructions. Thinner pile walls would also limit the capacity to the lower end of the ranges listed. These values do not include the possibly limiting effects of combined axial and bending loads.

4.1.4 Uplift Capacity

Uplift pile capacity develops as a result of friction between the pile and adjacent soils. Uplift resistance can be provided by skin friction within the portion of the pile embedded within the dense sand, neglecting the upper site soils. Augercast or grout piles which are subjected to tension loading should be provided with adequate reinforcing steel through the full depth of the drilled pile. We estimate ultimate uplift capacities of 10 tons for a 12-inch diameter steel pipe pile, 15 tons for a 14-inch diameter pile, and 20 tons for 16-inch diameter piles.

4.1.5 Lateral Capacity

Lateral forces imparted as a result of wind and seismic loadings can be resisted by the pile foundation and embedded portion of the pile caps. The piles can be assumed to resist lateral loads by developing passive resistance in the soil surrounding the pile. Assuming a maximum allowable lateral displacement of ½ of an inch, at the pile top, individual piles should be designed for an ultimate lateral capacity of 4, 6 and 8 tons for a 12-, 14- and 16-inch diameter pile, respectively. A reinforcing steel cage should be included in accordance with structural design requirements, sized for appropriate lateral capacity.

It should be noted that pile interaction in a pile group can increase deflections. At the recommended minimum pile spacing of 3-piles diameter center to center, actual pile deflections in the pile group can be double those of an individual pile for the same load per pile. This effect of pile spacing is reduced with increasing pile spacing. Piles subjected to repetitive, cyclic loading may deflect a magnitude of up to twice that of piles subjected to a static load.

Passive pressure would also act against the buried portion of the pile caps and grade beams to resist lateral loads. We recommend an allowable passive equivalent fluid pressure of 150 pounds per cubic foot (pcf) be used for design. This value includes a factor of safety of approximately 1.5. The upper foot of embedment should be neglected. Deflections on the order of 5 percent of the vertical face height are necessary to fully mobilize passive resistance.

4.1.6 Test Pile Program

We recommend a pile load test program prior to production pile installation. Test pile installation data as well as load test data would be reviewed to develop the most cost-effective combination of pile length and capacity. We recommend a combination of compressive, lateral, and tensile load tests at a minimum of one location on the site. Test piles should be installed for the pile type selected for the project. Compressive, lateral and tensile load testing should be completed in accordance with procedures outlined in ASTM specifications D-1143, D-3966, and D-3689, respectively. We recommend that AEE be retained to observe and monitor test pile installation, supervise and perform the load tests, and analyze the data collected. A report would be issued following completion of the testing describing and documenting test pile installation methods and results, load test procedures and results, and other information as appropriate. Table 4 presents our recommended test pile program. Test and reaction piles should be installed in the same manner as the production piles. Provided the test and reaction piles are installed to the recommended depths, uplift capacity tests could be performed on the reaction piles. Driving tests should be completed prior to ordering production piles. Driving tests should be completed for each of the different pile types and capacities planned for the site.

TABLE 4
RECOMMENDED TEST PILE PROGRAM

Compressive:	1 to evaluate bearing capacity (possible reductions in design depths)
Lateral:	1 at any test location
Uplift:	1 at full depth if required by structural engineer
Drive Resistance:	1 test pile for each pile type, wall thickness, and pile capacity planned.

Please note that pile lengths will vary and should be determined by the geotechnical engineer at the time of installation.

4.1.7 Site Utilities

Performance of site utilities will be affected by the placement of large quantities of site fill and trench backfill with resultant settlements. As previously discussed, large magnitudes of settlement, on the order of 1 to 2 inches per foot of new fill, are anticipated where fill is placed over wood waste. Utilities installed in these areas could settle to similar magnitudes. Pile support of site utilities is generally not considered to be a cost effective approach. We recommend that utilities be designed, if possible, to accommodate relatively large settlements which are anticipated. Some abrupt differential settlements may be expected in areas where the utilities will be underlain by the existing wood waste fill and other existing uncontrolled fill. Some overexcavation and replacement of unsuitable fill soil beneath utilities would likely be required for utility placement. The extent of overexcavation would depend largely on the type and size of the utility and the sensitivity to settlement of the utility, but we anticipate that overexcavation depths on the order of 1½ to 2 feet would be necessary for utilities installed in the peat soils which underlie the near-surface fills. Overexcavation depths in the fills will vary considerably depending on the nature of the rubble or debris present at invert elevation. For preliminary planning, a typical 1-foot overexcavation below inverts, for placement of foundation ballast and 6 inches of bedding, can be assumed for utilities in the fill deposits. Gravity sewers should be designed to accommodate the large magnitudes of settlement anticipated. We anticipate that flexible connections would be required especially where the utilities connect to the project structures. Most important would be the need for flexible connections between the site utilities and connection to the essentially stationary pile-supported buildings.

We understand that the initial phases of development call for construction of new Lakepointe Drive connecting N.E. Bothell Way with Juanita Drive N.E. and would include its associated utilities. One alternative might be to completely over excavate all wood waste and other unsuitable fill below this roadway followed by backfilling and placement of the larger more critical and settlement sensitive utilities. Overexcavation and replacement for the successively smaller branch utilities stemming from these main lines could be accomplished until the individual lines become small enough and can be designed flexibly enough that complete overexcavation (or less partial overexcavation) could be accomplished. This alternative would tend to reduce the contribution to settlement provided by the wood waste and other unsuitable fill.

To reduce the amount of increased settlement resulting from replacement of relatively low density on-site soils with higher density backfill we recommend that an imported lightweight material be considered for trench backfill. The selection of trench backfill methods and materials should also be coordinated with environmental soil management planning.

4.1.8 Considerations for Paved Areas

Paved areas will include the new Lakepointe Drive connecting N.E. Bothell Way with Juanita Drive N.E. and other road and parking areas serving the proposed development. As discussed, filled areas could be expected to settle to large magnitude in areas where existing wood waste and peat are present and/or large fill quantities are placed. In our opinion, it is likely that pavements constructed on fill over the wood waste and peat will require maintenance on a regular basis to account for large-scale, uneven settlements. Areas where existing granular fill is present over wood waste are expected to continue to settle (due to the long-term consolidation and decomposition of this organic material). However, settlement would probably not be to the magnitude of those areas receiving new fill. It is likely that a thickness of at least 3 to 4 feet of select fill (or perhaps somewhat lesser fill thickness in conjunction with stabilizing geotextiles) will be necessary over the wood waste to obtain a stable surface for pavement support. Geogrid reinforcement beneath the pavement and sidewalk sections would reduce the magnitude of differential settlement between the elements. Long-term total settlement would still occur but would be more uniform with geogrid reinforcement.

4.1.9 Bulkhead Considerations

Based on our understanding, plans call for the construction of a new bulkhead along the south side of the proposed marina area. Our explorations completed in this area encountered from about 15 feet of undocumented fill including variable amounts of wood waste and about 8 to 10 feet of peat and 6 feet of silt. We anticipate that driven steel sheet piling will be necessary in this construction. Such piling should be driven through the overlying fill material, peat, and silt to a depth sufficient to intercept the medium dense sand and gravel soils which we encountered in our borings at a depth of 23 to 37 feet below present grade. Bulkhead anchoring, if required, would also need to extend to the medium-dense sand and gravel layer.

4.2 North Portion of Site

The north portion of the site includes N.E. 175th Street, N.E. Bothell Way and adjacent areas. In the north part of the site, areas of fill placement would include bridge abutments, a section of elevated roadway linking N.E. Bothell Way and Juanita Drive N.E. and a widened section of the N.E. Bothell Way shoulder as a bus turnout and HOV lane. Fill may also be placed in adjacent areas of possible future development.

Subsurface conditions in the north portion of the site appear generally more favorable than those in the central and south portions of the site. In contrast to conditions to the south, deposits of wood waste, peats and silt were generally not encountered in the explorations. It appears that shallow foundation support for flexible, lightly loaded, single-story structures and pile support for more heavily loaded structures would be appropriate.

The explorations indicate the very dense sand and gravel layer is within about 16 feet of the existing ground surface on the west side of the north portion of the site (refer to boring A-7 for this study), and drops off to the east. Based on existing grades, it appears that new development may take place fairly close to existing grades, hence pile downdrag and large-scale settlements due to site filling do not appear to be a major concern. It therefore appears that for most development, shallow spread footings and slabs-on-grade could be a suitable site development option for lightly loaded structures such as one-story wood frame. Multi-story structures or settlement sensitive structures may require pile foundations. Because the depth to bearing should be relatively shallow and because downdrag and associated reduction in working pile capacity are not anticipated, relatively low to moderate capacity piles such as driven timber or augercast piles would be appropriate alternatives to high capacity piles. Typical compressive capacities for 8-inch tip diameter timber piles are on the order of 25 to 30 tons. Typical compressive capacities for 12 to 16-inch diameter augercast piles are on the order of 40 to 70 tons (depending on diameter). Assuming approximately 10 feet of embedment into the dense to very dense, bearing layer, pile lengths could vary from about 25 to 40 feet or longer.

Site utilities are anticipated to settle to relatively minor extent. Site preparation for pavement is anticipated to consist mainly of compacting the existing fill soils in-place to a firm and non-yielding condition.

4.3 Dewatering

Based on monitoring well readings taken on 2 October 1995, we observed groundwater elevations on the order of 17 to 18.5 feet in the southern and central part of the site and 20.5 to 22 feet in the north part of the site. It should be noted that these groundwater levels were observed during the dry season and groundwater levels will likely rise during the wet season, and will also fluctuate due to precipitation patterns, adjacent lake levels and other factors. Based on planned finished floor elevations of 25 feet for buildings in the central and southern portions of the site, we anticipate that dewatering may be necessary for underground utilities and other underground construction. We recommend that groundwater levels be maintained so that they are no closer than 2 feet below such utilities and planned construction.

It is anticipated that significant amounts of water will be generated to provide the drawdown required for construction to proceed. Due to the large amounts of waste fills on the site, the possibility of contaminants should be considered when disposing of such water.

4.4 Bridge Considerations (Preliminary)

Current improvement plans call for constructing a new Lakepointe Drive connecting N.E. Bothell Way with Juanita Drive N.E. including a flyover bridge 1000 feet or greater in length. In our opinion, pile or drilled pier foundations would likely provide the most economical type of bridge foundation due to the depth of suitable bearing soils. We have considered the following pile types for use at the project site, based primarily on WSDOT 1994 Standard Specifications for Road, Bridge and Municipal Construction:

- Precast concrete piles (WSDOT Standard Specification 6-05.3(3)), which consist of either prestressed or reinforced concrete shafts, with load capacities of 55 or 70 tons;

- Cast-in-place concrete piles (WSDOT Standard Specification 6-05.3(4)), which consist of closed-end steel casing driven to capacity and then filled with concrete, with load capacities of 55, 70, or 100 tons;
- Prestressed hollow concrete piles (WSDOT Standard Specification 6-05.3(5)), with load capacities of 20 to 40 tons;
- Steel H-piles (WSDOT Standard Specification 6-05.3(6)), with load capacities of 70 or 100 tons;
- Drilled shafts (caissons or piers), installed with or without temporary casing and later filled with concrete, with load capacities dependent on the diameter; allowable end-bearing pressures of 20 tsf can usually be achieved for dense or hard soils;
- Augercast piles, with a load capacity of 55 tons.

Cast-in-place concrete piles, precast concrete piles, prestressed hollow concrete piles, drilled shafts, and augercast piles offer a fairly uniform moment of inertia, whereas steel H-piles have significantly different moment resistance in different directions. Cast-in-place concrete piles offer the advantage that the steel shells can be checked for damage prior to filling with concrete. This latter advantage is particularly important when driving into a very dense horizon. In addition, the close proximity of the existing Redi-Mix concrete plant may provide an economic advantage to cast-in-place piles. Precast concrete piles are suitable only where the appropriate tip depth is known in advance with a high degree of certainty, because they cannot readily be spliced or shortened in the field. The low-displacement cross-section of H-piles may be an advantage when driving through rocky embankment fills but may cause the piles to "run" excessively in clean granular soils or moderately stiff cohesive soils. Because drilled shafts and augercast piles create minimal vibrations during installation, they are preferable for locations where significant vibrations cannot be tolerated. However, augercast piles are not capable of resisting high lateral loads; as such, we understand that they are typically not used for bridges. We also understand that drilled shafts are relatively expensive for many sites.

For the pile types listed above, we estimate that properly installed piles may experience total post-construction settlements up to 3/4 inch, with less than ½ inch of differential settlement between adjacent piers. The majority of these settlements will likely occur rapidly as the loads are applied.

We recommend that the effects of pile-driving vibrations in proximity to any existing structures be evaluated prior to construction. Vibrations may potentially cause damage to these structures. In addition, if construction sequencing requires that vibrations be minimized, non-displacement piles such as H-piles, augercast piles, or drilled shafts should be used in lieu of displacement piles.

Soil conditions along the proposed bridge and embankment alignment were evaluated in borings A-2, A-3, and A-6, as well as, cone probes A-4 and A-5. The explorations revealed 2 to 23 feet of loose to medium fill varying in composition and consisting of wood debris, concrete washout products (sand and gravel), silty sand and sandy gravel. These materials overlaid up to 13 feet of peat and up to 8 feet of organic silt. Our explorations encountered medium dense sands and gravels at depths of 22 to 39 feet. These soils became dense at 44 to 56 feet. Groundwater levels measured in monitor wells AW-7, AW-8, and AW-9 on 2 October 1995 revealed static water levels varying from elevation 18 to 22 feet along the alignment.

5.0 ADDITIONAL RECOMMENDATIONS

We recommend that additional field explorations, laboratory tests, and geotechnical engineering studies be accomplished for design of the buildings and facilities associated with eventual project development. This additional work is necessary to formulate structure-specific geotechnical criteria for suitable foundation types, site preparation, lateral and vertical pile capacities, and utility construction. For general site development, additional geotechnical study is necessary for specific aspects of the site development such as retaining walls, bulkheads, utility support, settlement due to site filling, pavement support for parking areas, and other aspects. The geotechnical criteria for final design should be based upon specific information such as building types, locations and structural loadings, pavement grades, utility types and grades, and other information which is not yet available. We recommend that we be retained to provide the design information prior to more detailed site development.

Methane gas has been detected in measurable quantities in the monitoring wells across the site. It will be necessary to address methane gas management in the design of ground level structures and buried utilities. For planning purposes, we recommend the following:

- Where utilities trenches enter the structures, a "plug" of low permeability backfill is recommended. Where driven piles attach to pile caps, we recommend constructing a low permeability seal around the outside of each pile, below the pile cap.

- We recommend the installation of the 10 mil vapor barrier and increased crawl space ventilation beneath the enclosed structures. The HVAC design should include active ventilation of all ground floor rooms (including broom closets, etc.), so that gas accumulation does not occur.

The details of a gas management system can be developed in final design when specific building layout information is available.

For preliminary site development work such as site preparation and overexcavation of unsuitable materials, fill placement, and utility installation, we should be consulted for additional field explorations and geotechnical engineering recommendations for planning and design of this work. If plans and specifications are developed for preliminary site development work it is recommended that AGRA Earth & Environmental, Inc be provided the opportunity for additional studies and general review of their plans and specifications in order that the recommendations of this report may be properly interpreted and implemented.

6.0 CLOSURE

The preliminary conclusions and recommendations presented in this report are based, in part, on the explorations accomplished for this study. The number, locations, and depths of our explorations were completed within the constraints of site access and budget considerations so as to yield the information utilized to formulate our recommendations. The future performance and integrity of the foundations and the success of the earthwork depend largely on proper initial site preparation, drainage, and construction procedures. We are available to provide supplemental geotechnical engineering analyses after site details have been determined, as well as monitoring services during earthwork and foundation construction phases of the project. If variations in the subgrade conditions are observed at that time, we would be able to provide additional geotechnical recommendations to minimize delays as the project develops.

We appreciate the opportunity to be of service on this project. Should you have any questions regarding this report or any aspects of the project, please do not hesitate to call.

Respectfully submitted,

AGRA Earth & Environmental, Inc.

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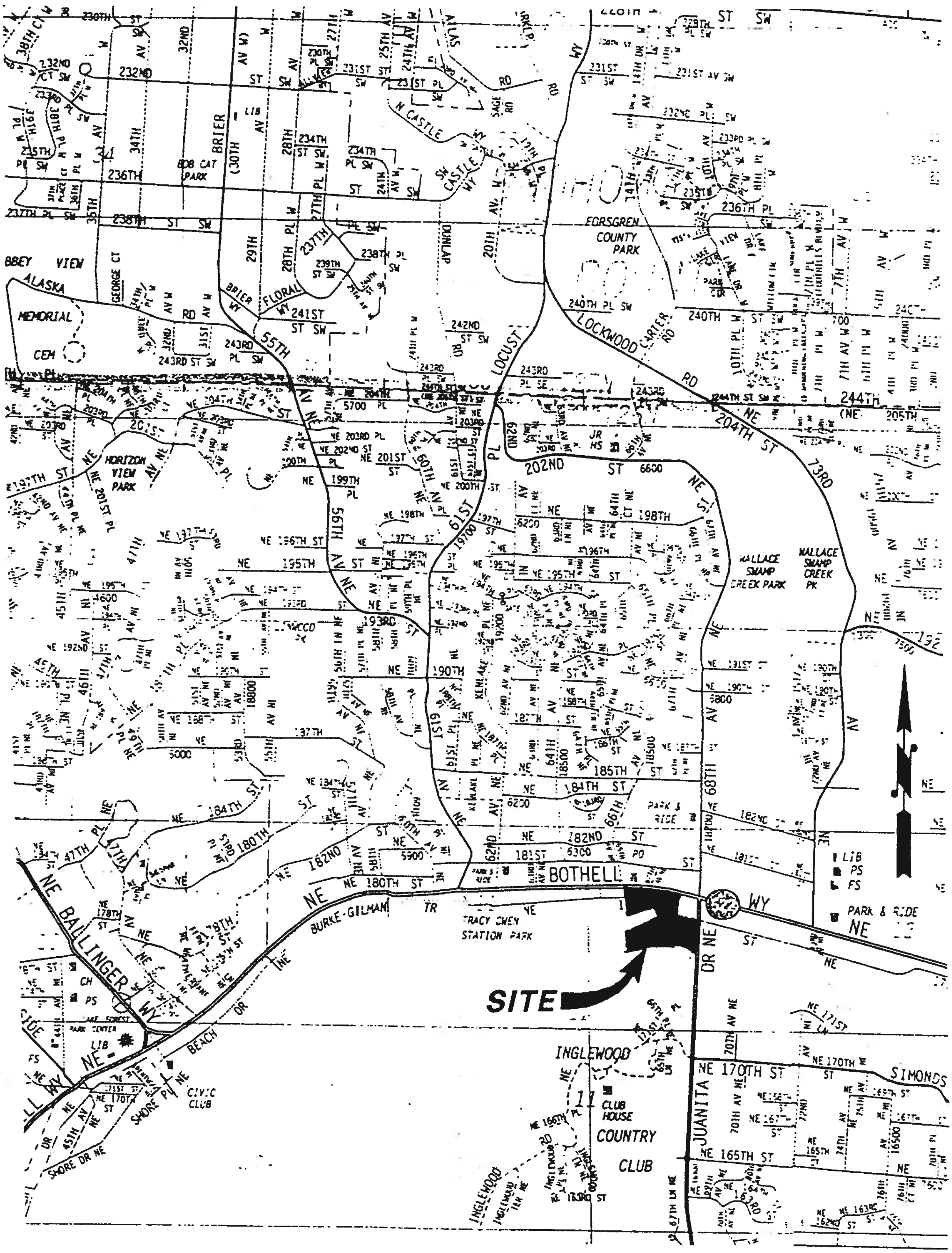


FIGURE 1

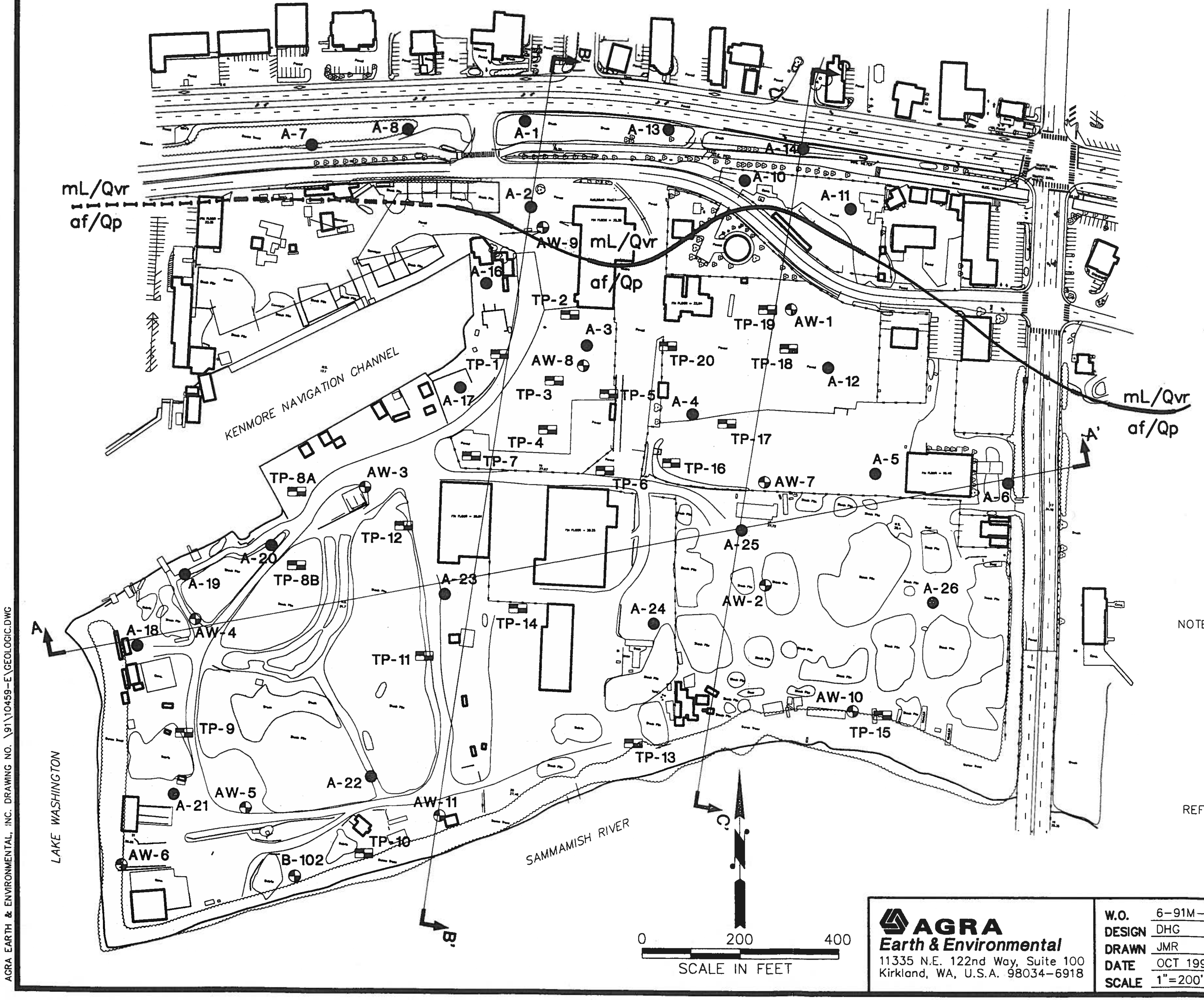
AGRA
Earth & Environmental
11335 N.E. 122nd Way, Suite 100
Kirkland, WA, U.S.A. 98034-6918

W.O.	6-91M-10459-C
DESIGN	DHG
DRAWN	JMR
DATE	NOV 1996
SCALE	N.T.S.

LAKEPOINTE DEVELOPMENT
KING COUNTY, WASHINGTON

LOCATION MAP

AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \91\10459-C\LOCATION.DWG



LEGEND

AW-11 ◒ GROUNDWATER MONITORING WELL NUMBER AND LOCATION

A-26 ● GEOTECHNICAL BORING NUMBER AND LOCATION

TP-20 ▬ TEST PIT NUMBER AND LOCATION

A ┗━ ━┛ A' ALIGNMENT OF GENERALIZED GEOLOGIC CROSS SECTION

$\frac{\text{mL/Qvr}}{\text{af/Qp}}$ GEOLOGIC CONTACT (DASHED WHERE INFERRED)

mL – MODIFIED LAND

ORIGINAL TOPOGRAPHY DISTURBED BY REMOVAL OF SOME PLEISTOCENE DEPOSITS, GRADING AND ARTIFICIAL FILL OF UNKNOWN QUALITY.

af – ARTIFICIAL FILL

ORIGINAL TOPOGRAPHY MODIFIED BY PLACEMENT OF SIGNIFICANT THICKNESS OF ARTIFICIAL FILL. COMPRISES THE WOOD DEBRIS FILL DESCRIBED IN SUBSURFACE EXPLORATIONS.

af/Qp – PEAT

SIGNIFICANT THICKNESS OF ARTIFICIAL FILL OVER ACCUMULATIONS OF ORGANIC MATERIAL. MAY CONTAIN SMALL AMOUNTS OF SAND, SILT, CLAY AND VOLCANIC ASH DEPOSITED IN SWAMPS AND BAYS.

mL/Qvr – VASHON RECESSIONAL OUTWASH

ORIGINAL TOPOGRAPHY DISTURBED. LIGHT BROWN, LOOSELY COMPACTED SAND AND GRAVEL, WELL-ROUNDED FROM STREAM TRANSPORTATION. SORTING VARIES; PARTICLE SIZE VARIES FROM MEDIUM SAND TO COBBLES.

NOTES: INFORMATION REGARDING THE EXTENT OF PEAT SOILS WAS SUPPLEMENTED BY PREVIOUS STUDIES PERFORMED FOR RIGHT-OF-WAYS AND FOR METRO SEWER STATION, AND BY REVIEW OF AERIAL PHOTOGRAPHS OF THE SITE AND VICINITY.

THE GEOLOGIC DEPOSITS SHOWN REPRESENT NATIVE SOIL CONDITIONS BELOW ARTIFICIAL FILLS.

MONITORING WELL B-102 WAS INSTALLED BY OTHERS. REFER TO REVISED: PHASE II ENVIRONMENTAL STUDY – KENMORE PRE-MIX SITE, BY GEOTECH CONSULTANTS, INC., DATED 24 JANUARY 1991.

REFERENCE: U.S. GEOLOGICAL SURVEY (USGS) GEOLOGICAL MAP OM-14, "PRELIMINARY SURFICAL GEOLOGIC MAP OF THE EDMONDS EAST AND EDMONDS WEST QUADRANGLES, SNOHOMISH AND KING COUNTIES, WASHINGTON (1975).

FIGURE 2

AGRA
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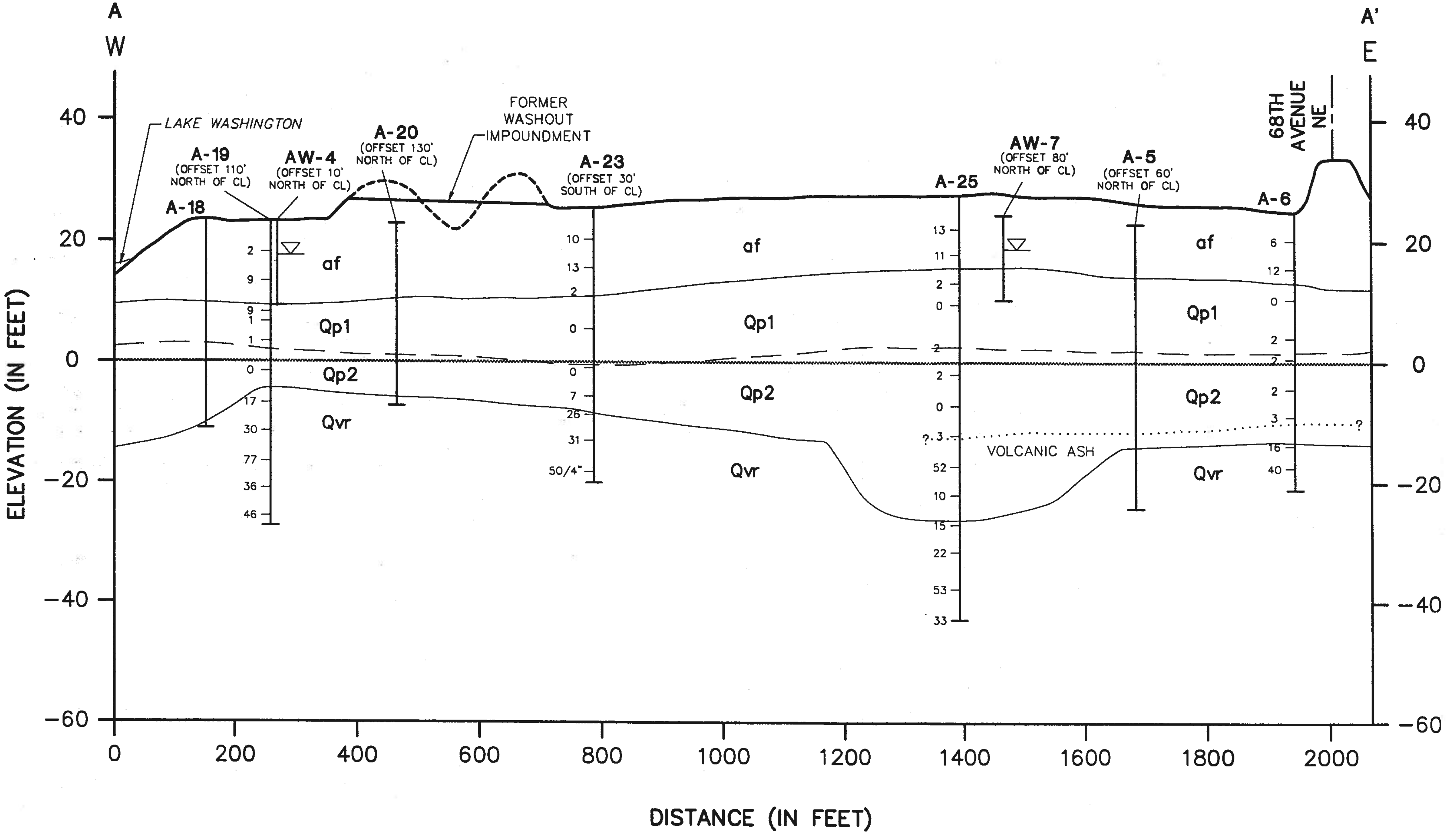
11335 N.E. 122nd Way, Suite 100
Kirkland, WA, U.S.A. 98034-6918

W.O. 6-91M-10459-E
DESIGN DHG
DRAWN JMR
DATE OCT 1996
SCALE 1"=200'

LAKEPOINTE DEVELOPMENT
KING COUNTY, WASHINGTON

SITE AND EXPLORATION PLAN

AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \91\10459-E\GEOLOGIC.DWG



mL – MODIFIED LAND

ORIGINAL TOPOGRAPHY DISTURBED BY REMOVAL OF SOME PLEISTOCENE DEPOSITS, GRADING AND ARTIFICIAL FILL OF UNKNOWN QUALITY.

af – ARTIFICIAL FILL

ORIGINAL TOPOGRAPHY MODIFIED BY PLACEMENT OF SIGNIFICANT THICKNESS OF ARTIFICIAL FILL. COMPRISES THE WOOD DEBRIS FILL DESCRIBED IN SUBSURFACE EXPLORATIONS.

Qp – PEAT

ACCUMULATION OF ORGANIC MATERIAL (Qp1)
LOOSE ALLUVIUM.
MAY CONTAIN SMALL AMOUNTS OF SAND, SILT, CLAY AND VOLCANIC ASH DEPOSITED IN SWAMPS AND BOGS (Qp2)

Qvr – VASHON RECESSIONAL OUTWASH

LIGHT BROWN, LOOSELY COMPACTED SAND AND GRAVEL, WELL-ROUNDED FROM STREAM TRANSPORTATION. SORTING VARIES; PARTICLE SIZE VARIES FROM MEDIUM SAND TO COBBLES. NOT DIFFERENTIATED FROM MORE RECENT ALLUVIUM, WHICH MAY CONTAIN SILT, CLAY AND ORGANIC MATTER.

Qvt – VASHON TILL

POORLY SORTED, NONSTRATIFIED LODGMENT TILL DEPOSITED AS GROUND MORAINE. MIXTURE OF CLAY, SILT, SAND, PEBBLES AND COBBLES WITH OCCASIONAL LARGE BOULDERS. STONES ARE SUBANGULAR TO ROUNDED.

LEGEND

A-25	SOIL BORING/MONITORING WELL NUMBER AND LOCATION
▽	OBSERVED GROUNDWATER LEVEL
53 –	BLOW COUNT (BLOWS/FOOT)
～	APPROXIMATE BOUNDARY OF GEOLOGIC UNIT
– –	APPROXIMATE BOUNDARY BETWEEN ORGANIC PEATS (Qp1) AND ALLUVIUM (Qp2)
～～	ELEVATION 0 (KING COUNTY BENCHMARK "KC-B-16")
⊥	BOTTOM OF HOLE

0 20 40
VERTICAL SCALE IN FEET

0 200 400
HORIZONTAL SCALE IN FEET

REFERENCE:
U.S. GEOLOGICAL SURVEY (USGS) GEOLOGICAL MAP OM-14, "PRELIMINARY SURFICAL GEOLOGIC MAP OF THE EDMONDS EAST AND EDMONDS WEST QUADRANGLES, SNOHOMISH AND KING COUNTIES, WASHINGTON (1975).

FIGURE 3

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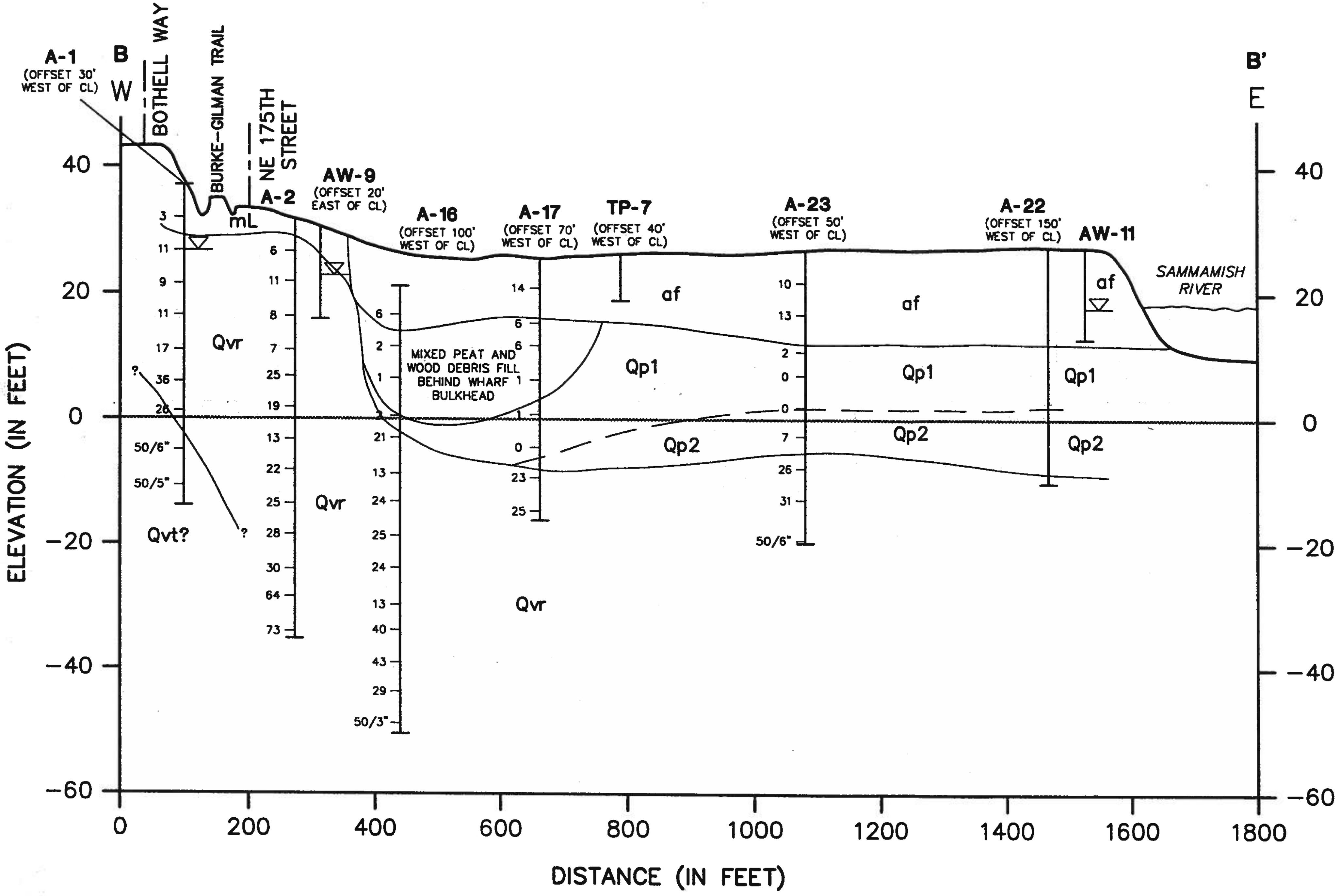
DESIGN DHG
DRAWN JMR
DATE OCT 1996
SCALE V:1-20, H:1-200

LAKEPOINTE DEVELOPMENT
KING COUNTY, WASHINGTON

GENERALIZED GEOLOGIC CROSS SECTION
A - A'

AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \91\10459-E\X-S-A.DWG



mL – MODIFIED LAND

ORIGINAL TOPOGRAPHY DISTURBED BY REMOVAL OF SOME PLEISTOCENE DEPOSITS, GRADING AND ARTIFICIAL FILL OF UNKNOWN QUALITY.

af – ARTIFICIAL FILL

ORIGINAL TOPOGRAPHY MODIFIED BY PLACEMENT OF SIGNIFICANT THICKNESS OF ARTIFICIAL FILL. COMPRISES THE WOOD DEBRIS FILL DESCRIBED IN SUBSURFACE EXPLORATIONS.

Qp – PEAT

ACCUMULATION OF ORGANIC MATERIAL (Qp1)
LOOSE ALLUVIUM.
MAY CONTAIN SMALL AMOUNTS OF SAND, SILT, CLAY AND VOLCANIC ASH DEPOSITED IN SWAMPS AND BOGS (Qp2)

Qvr – VASHON RECESSIONAL OUTWASH

LIGHT BROWN, LOOSELY COMPACTED SAND AND GRAVEL, WELL-ROUNDED FROM STREAM TRANSPORTATION. SORTING VARIES; PARTICLE SIZE VARIES FROM MEDIUM SAND TO COBBLES. NOT DIFFERENTIATED FROM MORE RECENT ALLUVIUM, WHICH MAY CONTAIN SILT, CLAY AND ORGANIC MATTER.

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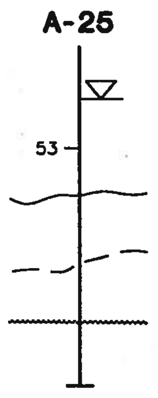
LEGEND



SOIL BORING/MONITORING WELL NUMBER AND LOCATION
OBSERVED GROUNDWATER LEVEL
BLOW COUNT (BLOWS/FOOT)
APPROXIMATE BOUNDARY OF GEOLOGIC UNIT
APPROXIMATE BOUNDARY BETWEEN ORGANIC PEATS (Qp1) AND ALLUVIUM (Qp2)
ELEVATION 0 (KING COUNTY BENCHMARK "KC-B-16")
BOTTOM OF HOLE

0 20 40
VERTICAL SCALE IN FEET

0 200 400
HORIZONTAL SCALE IN FEET

REFERENCE:
U.S. GEOLOGICAL SURVEY (USGS) GEOLOGICAL MAP OM-14, "PRELIMINARY SURFICAL GEOLOGIC MAP OF THE EDMONDS EAST AND EDMONDS WEST QUADRANGLES, SNOHOMISH AND KING COUNTIES, WASHINGTON (1975).

FIGURE 4

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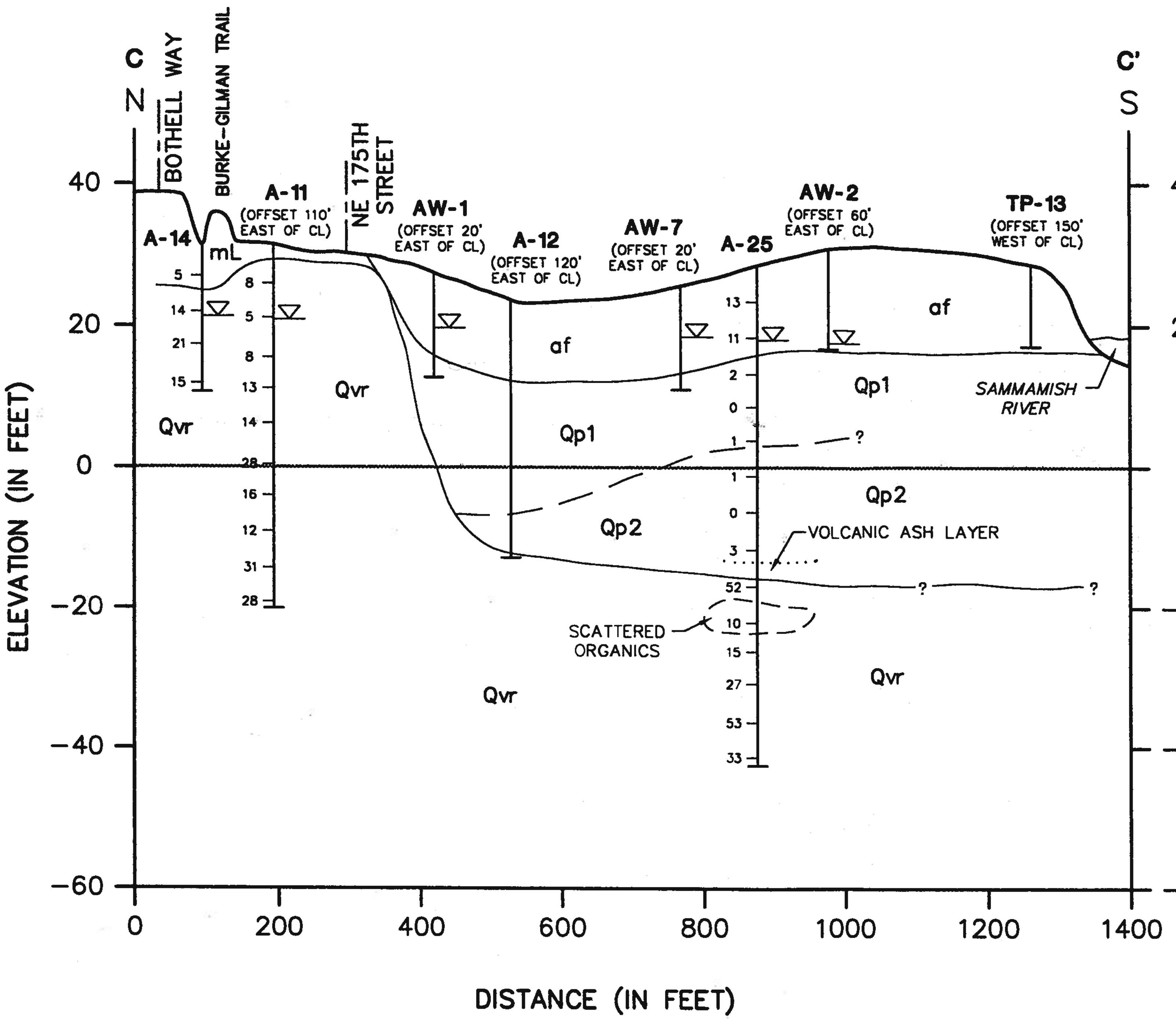
DRAWN JMR
DATE OCT 1996
SCALE V:1-20, H:1-200

LAKEPOINTE DEVELOPMENT
KING COUNTY, WASHINGTON

GENERALIZED GEOLOGIC CROSS SECTION
B - B'

AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \91\10459-E\X-S-B.DWG



mL – MODIFIED LAND

ORIGINAL TOPOGRAPHY DISTURBED BY REMOVAL OF SOME PLEISTOCENE DEPOSITS, GRADING AND ARTIFICIAL FILL OF UNKNOWN QUALITY.

af – ARTIFICIAL FILL

ORIGINAL TOPOGRAPHY MODIFIED BY PLACEMENT OF SIGNIFICANT THICKNESS OF ARTIFICIAL FILL. COMPRISES THE WOOD DEBRIS FILL DESCRIBED IN SUBSURFACE EXPLORATIONS.

Qp – PEAT

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LOOSE ALLUVIUM.
MAY CONTAIN SMALL AMOUNTS OF SAND, SILT, CLAY AND VOLCANIC ASH DEPOSITED IN SWAMPS AND BOGS (Qp2)

Qvr – VASHON RECESSIONAL OUTWASH

LIGHT BROWN, LOOSELY COMPACTED SAND AND GRAVEL, WELL-ROUNDED FROM STREAM TRANSPORTATION. SORTING VARIES; PARTICLE SIZE VARIES FROM MEDIUM SAND TO COBBLES. NOT DIFFERENTIATED FROM MORE RECENT ALLUVIUM, WHICH MAY CONTAIN SILT, CLAY AND ORGANIC MATTER.

Qvt – VASHON TILL

POORLY SORTED, NONSTRATIFIED LODGMENT TILL DEPOSITED AS GROUND MORAINE. MIXTURE OF CLAY, SILT, SAND, PEBBLES AND COBBLES WITH OCCASIONAL LARGE BOULDERS. STONES ARE SUBANGULAR TO ROUNDED.

LEGEND

A-25 SOIL BORING/MONITORING WELL NUMBER AND LOCATION
OBSERVED GROUNDWATER LEVEL
53 BLOW COUNT (BLOWS/FOOT)
APPROXIMATE BOUNDARY OF GEOLOGIC UNIT
APPROXIMATE BOUNDARY BETWEEN ORGANIC PEATS (Qp1) AND ALLUVIUM (Qp2)
ELEVATION 0 (KING COUNTY BENCHMARK "KC-B-16")
BOTTOM OF HOLE

0 20 40
VERTICAL SCALE IN FEET

0 200 400
HORIZONTAL SCALE IN FEET

REFERENCE:
U.S. GEOLOGICAL SURVEY (USGS) GEOLOGICAL MAP OM-14, "PRELIMINARY SURFICAL GEOLOGIC MAP OF THE EDMONDS EAST AND EDMONDS WEST QUADRANGLES, SNOHOMISH AND KING COUNTIES, WASHINGTON (1975).

FIGURE 5

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Kirkland, WA, U.S.A. 98034-6918

W.O. 6-91M-10459-E
DESIGN DHG
DRAWN JMR
DATE OCT 1996
SCALE V:1-20, H:1-200

LAKEPOINTE DEVELOPMENT
KING COUNTY, WASHINGTON

GENERALIZED GEOLOGIC CROSS SECTION
C - C'

AGRA EARTH & ENVIRONMENTAL, INC. DRAWING NO. \91\10459-E\X-S-C.DWG

APPENDIX A
SUBSURFACE EXPLORATION PROCEDURES AND LOGS
11-10459-00

APPENDIX A
SUBSURFACE EXPLORATION PROCEDURES AND LOGS
11-10459-00

FIELD EXPLORATION

The field exploration program conducted for this study was accomplished in generally two phases. The primary program consisted of advancing 16 test borings and 8 electric cone penetrometer tests to evaluate the subsurface soil conditions. This program was supplemented with the installation of 11 monitoring wells for environmental screening purposes. The second phase of the program consisted of excavating 20 test pit explorations on the west half of the site to explore the wood debris fill and characterize the fill constituents. The approximate locations of the explorations are indicated on the Site and Exploration Plan (Figure 2). The locations were obtained in the field by taping from site features shown on the plan provided by the client. The locations of the explorations should be considered accurate only to the degree implied by the method used. Elevations of the explorations are based upon a site topographic map by GeoDimensions dated 7 June 1995.

It should also be emphasized that our explorations reveal subsurface conditions only at discrete locations across the project site and that actual conditions could vary between these exploration locations. Furthermore, the nature and extent of any such variations would not become evident until additional explorations are performed or construction activities have begun. If significant variations are observed at that time, we may need to modify our conclusions and recommendations to reflect actual conditions.

The attached boring logs describe the various types of soils and materials encountered in each borehole, based primarily on interpretations made in the field and supported by our subsequent laboratory testing of selected samples. Our logs also indicate the approximate depth of the contacts between different soil types, although these contacts may be gradational or undulating. Where a change in soil type occurred between sampling intervals, we inferred the depth of contact. In addition, our logs indicate the depth of any groundwater observed in the boreholes, the Standard Penetration Resistance at each sample location, the test pit explorations, and any laboratory tests performed on the soil samples.

Hollow Stem Auger Borings

Sixteen borings were drilled in September and October 1995 by two local exploration drilling companies under subcontract to our firm. A summary of their depths and locations is given in Table 1 of the report text. Thirteen of the borings were drilled by Gregory Drilling advancing a 4¼-inch inside diameter hollow-stem auger with a truck-mounted CME 85 drill rig utilizing a bentonite slurry to prevent heaving conditions within the boring which would prevent obtaining undisturbed samples. The three remaining borings were drilled by Davies Drilling by advancing a 3¼-inch inside diameter hollow-stem auger with a track-mounted Mobil B-53 drill rig. During the drilling process, samples were generally obtained at 2½ or 5 foot depth intervals. The borings were continuously observed and logged by an engineering geologist from our firm.

Undisturbed samples were obtained by pushing a 3-inch outside diameter, seamless steel Shelby tube into the soil using the hydraulic system on the drill rig in accordance with ASTM:D-1587. Since the thin wall tube is pushed rather than driven, the sample obtained is considered relatively undisturbed. The samples were classified in the field by examining each end prior to sealing with plastic caps. The samples were then transported to our laboratory where they were extruded for further classification and laboratory testing.

Disturbed samples were obtained by using the Standard Penetration Test procedure as described in ASTM:D-1586. This test and sampling method consists of driving a standard 2-inch outside diameter, split barrel sampler a distance of 18-inches into the soil with a 140 pound hammer free falling a distance of 30 inches. The number of blows for each 6-inch interval is recorded. The number of blows required to drive the sampler the final 12 inches is considered the Standard Penetration Resistance ("N") or blow count. The blow count is presented graphically on the boring logs in this appendix. If a total of 50 blows is recorded within one 6-inch interval, the blow count is recorded as 50 blows for the number of inches of penetration. The resistance, or "N" value, provides a measure of the relative density of granular soils or the relative consistency of cohesive soils.

The soil samples obtained from the split-barrel sampler were classified in the field and representative portions were placed in plastic containers. The samples were then transported to our laboratory for further visual classification and laboratory testing. Samples are generally saved for a period of 30 days unless special arrangements are made. The boring logs are presented in this appendix and the soil descriptions are based on the inspection of samples secured, field logs and laboratory tests.

Groundwater conditions observed while advancing the test borings are indicated on the boring logs in this appendix by a triangular symbol and the designation "ATD" (At Time of Drilling). These subsurface water conditions were evaluated by observing the moisture condition of the samples or the wetted level on the drilling rods. That depth, shown on the boring logs, is generally indicative of the open water level in the borings at the time the borings were advanced, but do not necessarily represent the true regional groundwater table.

Cone Penetrometer Tests

The eight Cone Penetrometer Tests (CPTs) were performed to depths of approximately 31 to 47 feet below grade. The testing was performed for us by Northwest Cone Exploration during the period of 6 through 8 September 1995. A summary of the CPT probe numbers and locations is provided in Table 1 of the text and Figure 2.

The CPT consists of pushing a cone-tipped probe in a soil deposit and recording the resistance of the soil to that penetration. The test was conducted in general accordance with ASTM Test Designation D-3441. The test equipment consists of a cone assembly equipped with a piezometer at the tip, a series of hollow sounding rods, a hydraulic frame to push the cone and rods into the soil, and an electronic data processing unit. A drill truck was used to provide the needed thrust capacity.

The cone penetrometer consists of a conical tip with a 60 degree apex angle and a cylindrical friction sleeve. The interior of the device is instrumented with strain gauges allowing simultaneous measurements of cone and sleeve resistance during penetration. The pressure due to the head of groundwater above the tip of the cone and any excess pore water pressures generated due to penetration of the cone into the soils are measured by an electronic piezometer installed at the tip of the cone. Electric signals from the strain gauges and the piezometer are transmitted by cable to the data processing unit. The cone assembly used on this project has a cross-sectional area of 10 square centimeters, and a sleeve surface area of 150 square centimeters.

Output quantities for the cone tip penetration resistance and sleeve friction are simultaneously recorded in units of tons per square foot (tsf) versus depth in units of meters (m). The recording apparatus is also designed to calculate and record the ratio of friction resistance to tip resistance (known as the friction ratio). The cone tip resistance and friction ratio were evaluated using published literature in order to classify the subsurface soils. Plots of the tip resistance, sleeve resistance, and friction ratio, as well as the interpreted results of the tests are presented in this appendix.

Monitoring Well Installations

Groundwater monitoring wells were installed in nine test boring locations, Nos. AW-1 through AW-9, were drilled during the period of 14 through 22 September 1995. Two additional monitoring wells, Nos. AW-10 and AW-11, were installed within 75 feet of the shoreline 29 February 1996. All eleven wells were installed by Gregory Drilling under subcontract to our firm using a truck-mounted CME 85 drill rig with hollow-stem auger. They consisted of installing 10 feet of 2-inch inside diameter PVC, 0.020-inch slotted well screen in the bottom of each boring. A blank PVC pipe riser extended from the lower slotted section of pipe to the ground surface. A Colorado No. 10-20 sand pack was utilized to backfill around the slotted section to provide a good hydraulic communication between the well screen and formation. A bentonite seal was placed within 2 feet of the ground surface. A flush-mounted or stick-up steel monument (depending on location) was cemented in-place to protect the top of the monitoring well. The groundwater levels recorded after drilling were measured by lowering an electronic water probe into the monitoring wells. The groundwater level measured within each monitoring well is indicated by a triangle symbol on the appropriate boring log along with the date of the measurement. The monitoring well logs are presented in this appendix, and site soil descriptions are based on samples secured, field logs, and laboratory tests.

Groundwater measurements taken on 2 October 1995 from nine of the monitoring wells installed on site indicated static groundwater levels between approximately Elevation 18 and 23, roughly corresponding to the lake level. The groundwater gradient appears to flow towards the south beneath the north end of the site, and appears to be relatively flat beneath the south end of the site, where the former lakebed was filled in. These water levels represent depths of 6.5 to 12.5 feet below existing grades, within the surficial fill soils. The underlying peat soils are also saturated, but are less permeable than the surficial fill soils, based on our observations and previous experience.

Following the completion of a professional site survey performed by Summit Surveying of Kirkland, Washington, groundwater elevations measured on 2 October 1995, 26 February 1996 and 16 April 1996 were calculated and displayed in Table 1 to this appendix. One additional well, B-102, installed by Geotech Consultants in December 1990, was included in this study due to its location within 50 feet of the southern shoreline of the site. Groundwater levels measured in this monitoring well are also displayed in Table A-1 to this appendix.

Test Pits

The second phase of the program consisted of 20 test pit explorations (Nos. TP-1 through TP-20), excavated by a rubber-tired backhoe owned and operated by Fed-Ex Construction under subcontract to our firm on 29 February and 1 March 1996. These test pit excavations permitted a detailed evaluation of the subsurface conditions in areas of lower level basement cuts proposed at the time for the western half of the project site. Also, they are more representative indicators of true near-surface site character than soil exploration drilling since they allow continuous visual observation of the composition of the wood debris fills over a widespread area across the site.

Each test pit was continuously logged and observed by an experienced engineering geologist from our firm. In situ strength and quality attributes of materials encountered were estimated by our field observer based on experience with similar soils and the difficulty incurred during excavation. Representative samples of the soils in the test pits were retrieved, classified in the field, and transported to our laboratory for a detailed evaluation and classification. The test pit logs are presented in this appendix and the soil descriptions are based on the inspection of the samples secured, field logs, and laboratory tests.

Table A-1: Summary of Fluid Level Measurements
Kenmore Lakepointe Development
King County, Washington
AGRA Earth & Environmental, Inc., Project No. 11-10459-00

Well Number/ Top of Casing Elevation (feet)	Date Measured	Depth to Water (feet)	Groundwater Elevation (feet)
AW-1/ 26.76	2-Oct-95	6.22	20.54
	29-Feb-96	6.57	20.19
	16-Apr-96	6.90	19.86
AW-2/ 31.32	2-Oct-95	13.48	17.84
	29-Feb-96	13.86	17.46
	16-Apr-96	12.80	18.52
AW-3/ 28.23	2-Oct-95	9.42	18.81
	29-Feb-96	9.76	18.47
	16-Apr-96	9.30	18.93
AW-4/ 27.61	2-Oct-95	9.84	17.77
	29-Feb-96	10.26	17.35
	16-Apr-96	9.30	18.31
AW-5/ 29.71	2-Oct-95	9.40	20.31
	29-Feb-96	12.27	17.44
	16-Apr-96	10.30	19.41
AW-6/ 28.46	2-Oct-95	10.70	17.76
	29-Feb-96	11.08	17.38
	16-Apr-96	10.10	18.36
AW-7/ 25.18	2-Oct-95	7.32	17.86
	29-Feb-96	7.66	17.52
	16-Apr-96	6.80	18.38
AW-8/ 26.16	2-Oct-95	8.06	18.10
	29-Feb-96	8.42	17.74
	16-Apr-96	7.50	18.66
AW-9/ 30.22	2-Oct-95	8.18	22.04
	29-Feb-96	6.51	23.71
	16-Apr-96	7.00	23.22
AW-10/ 30.12	2-Oct-95	Not Applicable	Not Applicable
	29-Feb-96	12.48	17.64
	16-Apr-96	11.90	18.22
AW-11/ 29.59	2 October 1995	Not Applicable	Not Applicable
	29-Feb-96	12.11	17.48
	16-Apr-96	11.10	18.49
B-102/ 25.51	2-Oct-95	Not Applicable	Not Applicable
	29-Feb-96	Not Applicable	Not Applicable
	16 April 1996	7.10	18.41

PROJECT: *Kenmore Lakepointe Development*

W.O. *11-10459-00* BORING NO. *A-1*

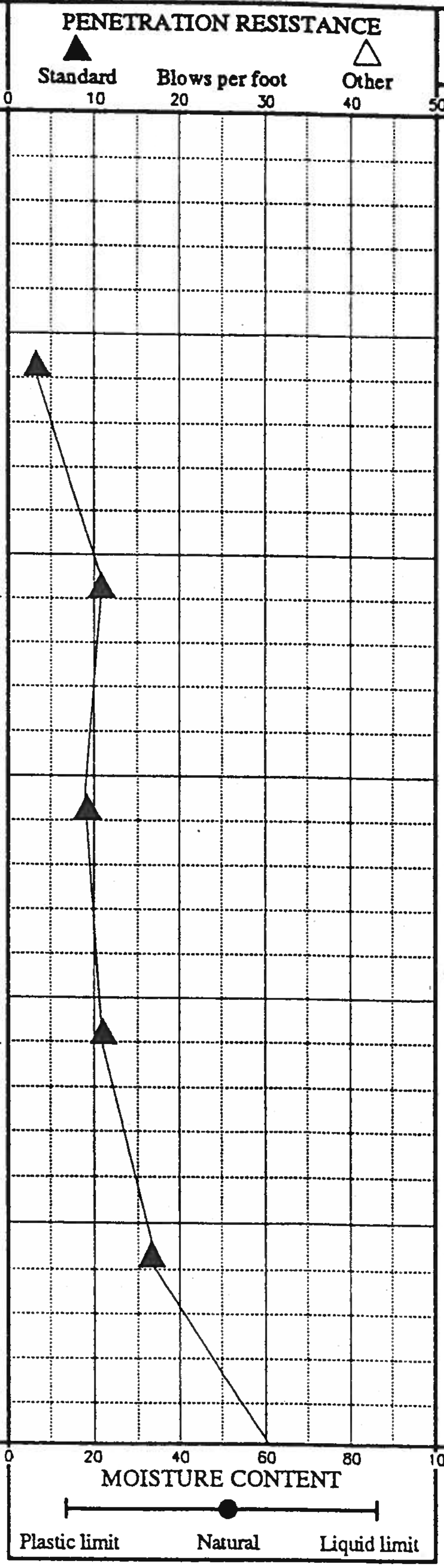
Page 1 of 2

SOIL DESCRIPTION

Location: *On Bench North of Detention Pond*

Approximate ground surface elevation: *36.5 feet*

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
0	*Sod over loose, damp to moist, dark tan, silty, fine SAND with some gravel and medium sand (Fill)*			
5	*Grading into moist, mixed brown-tan, gravelly, silty SAND with scattered cobbles (Fill)*	I	*S-1*	
	Loose to medium dense, damp to moist, mottled orange in tan, silty, fine SAND			
10	*Becoming wet to saturated*	I	*S-2*	P/ ATD
	Medium stiff, moist to wet, orangish tan, fine sandy SILT interbedded with loose, wet, tan, silty, fine to medium SAND			
15		I	*S-3*	
	Fractured lenses of stiff, moist to wet, orangish yellow, SILT with some clay, 1/4-inch fracture filled with silty, fine SAND 16.5 to 17 feet			
20	*Medium dense, wet to saturated, tan, silty, fine to medium SAND*	I	*S-4*	▼ ATD
	Grades to gravelly at 23 feet			
25		I	*S-5*	
	Lens of stiff, moist to wet, yellowish tan, very fine sandy SILT at 26.5 feet			
30	*(continued)*			



TESTING

LEGEND

- I 2.00-inch OD split-spoon sample
- ▼ ATD Groundwater level at time of drilling
- II 3.00-inch OD Shelby tube sample
- ✕ Sample not recovered
- P/ ATD Perched groundwater level at time of drilling

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling method: *HSA* Hammer type: *Cathead* Date drilled: *11, 12 September 1995* Logged by: *HWB*

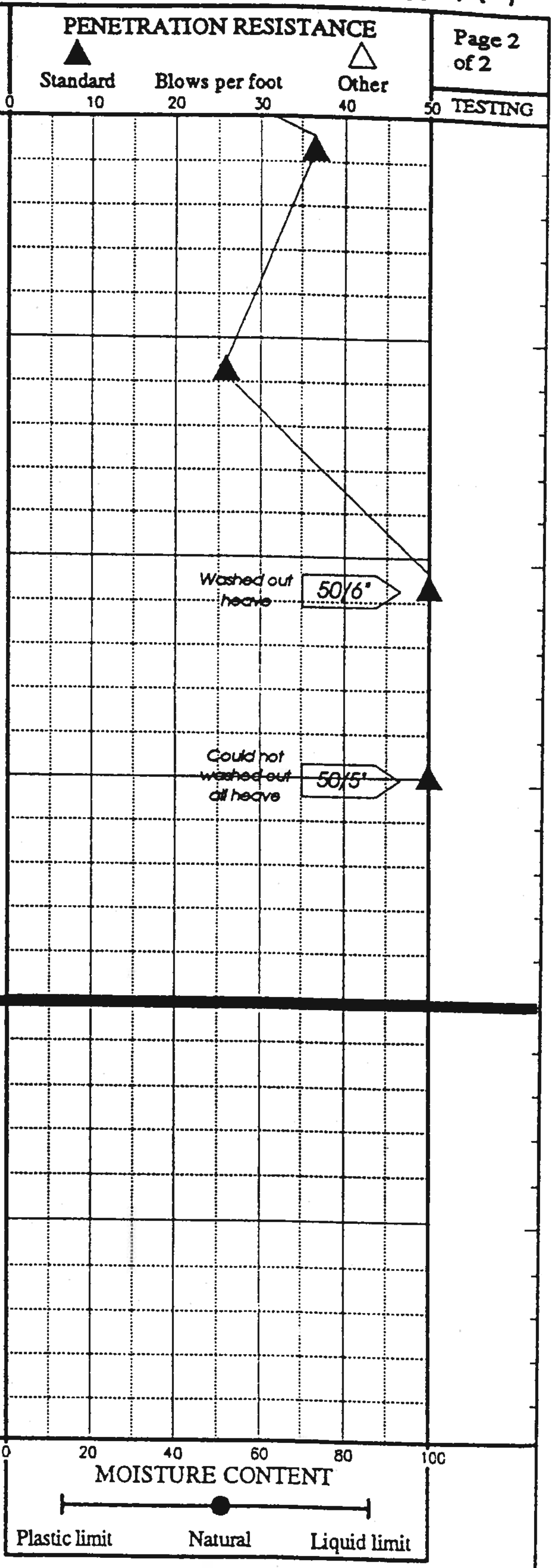
PROJECT: Kenmore Lakepointe Development **W.O.** 11-10459-00 **BORING NO.** A-1

Page 2 of 2

Location: On Bench North of Detention Pond

Approximate ground surface elevation: 36.5 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
30	Dense, saturated tan, silty, gravelly SAND	╳	S-6	
	Medium dense, saturated, gray, silty, gravelly SAND/sandy GRAVEL			
35		I	S-7	
	Very dense, wet, gray, gravelly, silty SAND			
40		I	S-8	
	Grades into a silty, gravelly SAND			
45		I	S-9	
50	Boring terminated at approximately 50 feet. No sample taken at 50 feet as the hole colapsed.			
55				
60				



LEGEND

- I 2.00-inch OD split-spoon sample
- ╳ Sample not recovered
- ▼ ATD Groundwater level at time of drilling
- P/ATD Perched groundwater level at time of drilling
- II 3.00-inch OD Shelby tube sample

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling method: HSA Hammer type: Cathead Date drilled: 11, 12 October 1995 Logged by: HWB

PROJECT: Kenmore Lakepointe Development W.O. 11-10459-00 BORING NO. A-2

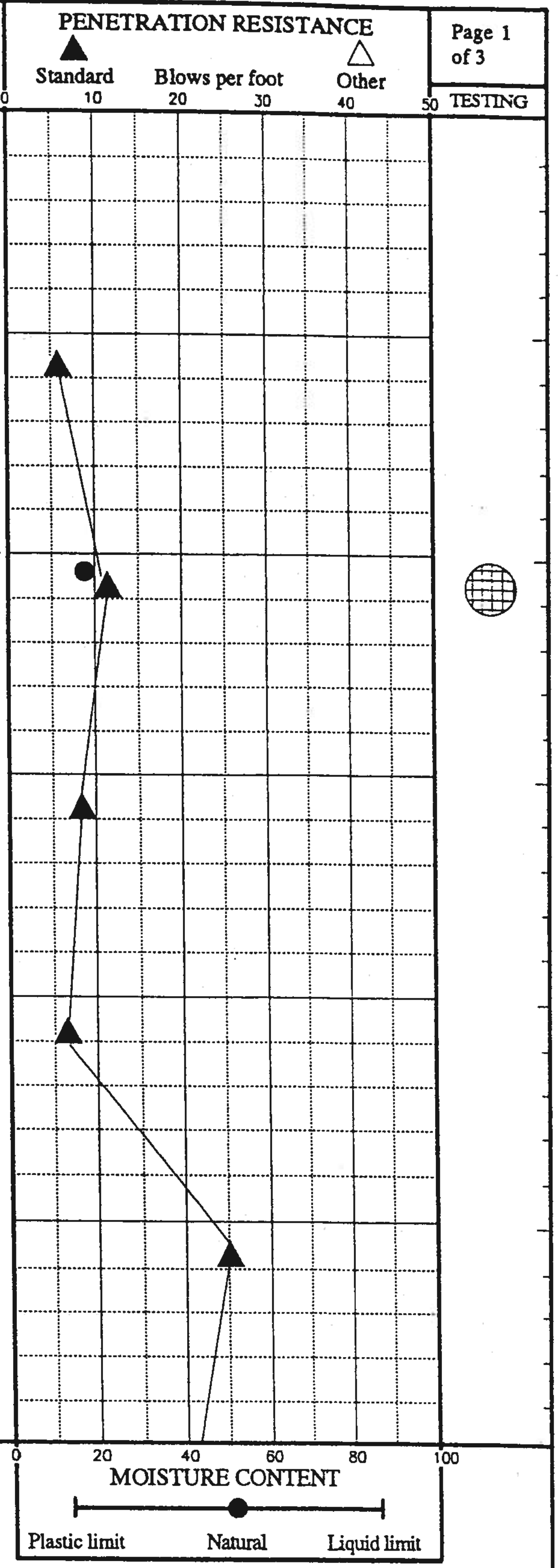
Page 1 of 3

SOIL DESCRIPTION

Location: 10' South & 10' West from SW corner of Entry Planter

Approximate ground surface elevation: 31.5 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
0	2" Asphalt over 2" of 1-1/2 inch angular Base Course over medium dense, damp, medium to dark brown, silty, sandy GRAVEL (Fill)			
	Loose to medium dense, damp, orangish-tan, fine SAND with some silt and trace gravel			
	Medium stiff, moist to wet, mottled yellow-tan-buff, very fine sandy SILT			
5	Loose, damp, yellowish tan, silty, fine SAND	I	S-1	
	Becoming moist, tan, fine to medium SAND with some silt			
10	Medium dense, wet to saturated, tan SAND with trace to some gravel and silt	I	S-2	ATD
	Loose, wet to saturated, yellowish tan, silty, fine SAND			
15		I	S-3	
	Medium stiff, wet, yellowish tan, very fine sandy SILT			
	Loose, saturated, gray, fine to medium SAND with some silt			
20		I	S-4	
	Stiff, moist to wet, yellowish tan, SILT with some clay			
	Medium dense, saturated, yellowish tan, silty, fine SAND to fine SAND with some silt and interbeds of stiff, wet, yellowish tan, very fine sandy SILT			
25		I	S-5	
30	(continued)			



LEGEND

I	2.00-inch OD split-spoon sample	X	Sample not recovered
▼ ATD	Groundwater level at time of drilling	⊕	Grain size analysis
II	3.00-inch OD Shelby tube sample		

AGRA
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11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling method: HSA/Mud Rotary Hammer type: Mechanical Date drilled: 12 September 1995 Logged by: HWB

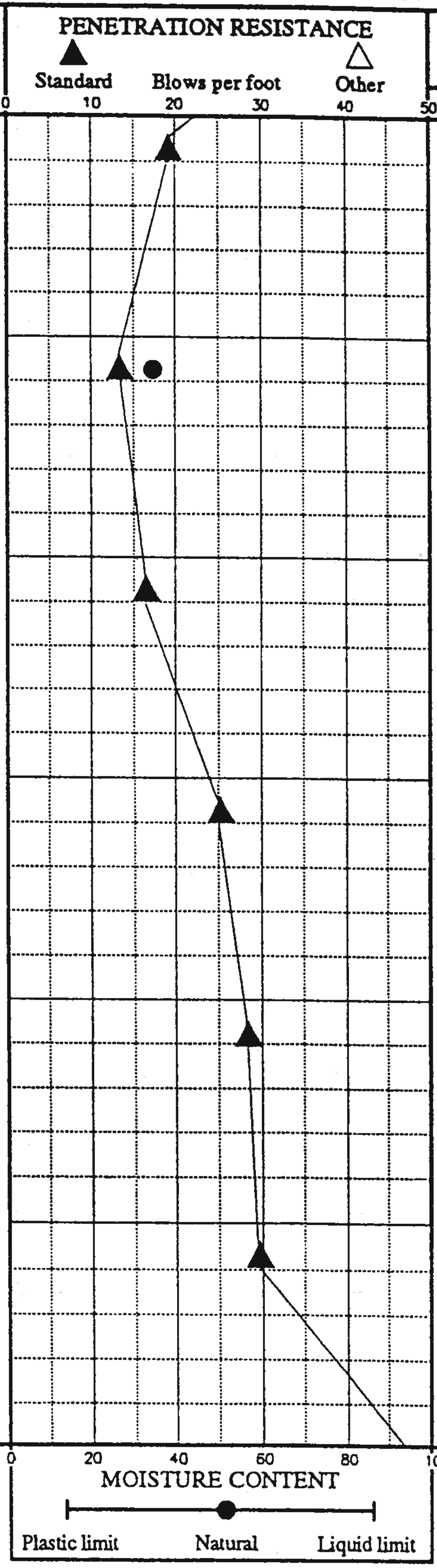
PROJECT: Kenmore Lakepointe Development W.O. 11-10459-00 BORING NO. A-2

Page 2 of 3

Location: 10' South & 10' West from SW corner of Entry Planter

Approximate ground surface elevation: 31.5 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER	TESTING
30	*Medium dense, saturated, yellowish tan, silty, fine SAND to fine SAND with some silt and interbeds of stiff, wet, yellowish tan, very fine sandy SILT (As Above)*		S-6		
35			S-7		▦
40			S-8		
45	*Interbed of SILT with some clay*		S-9		
	Medium dense, saturated, tannish gray, gravelly SAND/sandy GRAVEL with some silt				
50			S-10		
55			S-11		
60	*(continued)*				



LEGEND

I 2.00-inch OD split-spoon sample

✕ Sample not recovered

▼ ATD Groundwater level at time of drilling

▦ Grain size analysis

II 3.00-inch OD Shelby tube sample

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AGRA Earth and Environmental, Inc.

Drilling method: HSA/Mud Rotary Hammer type: Mechanical Date drilled: 12 September 1995 Logged by: HWB

PROJECT: Kenmore Lakepointe Development W.O. 11-10459-00 BORING NO. A-2

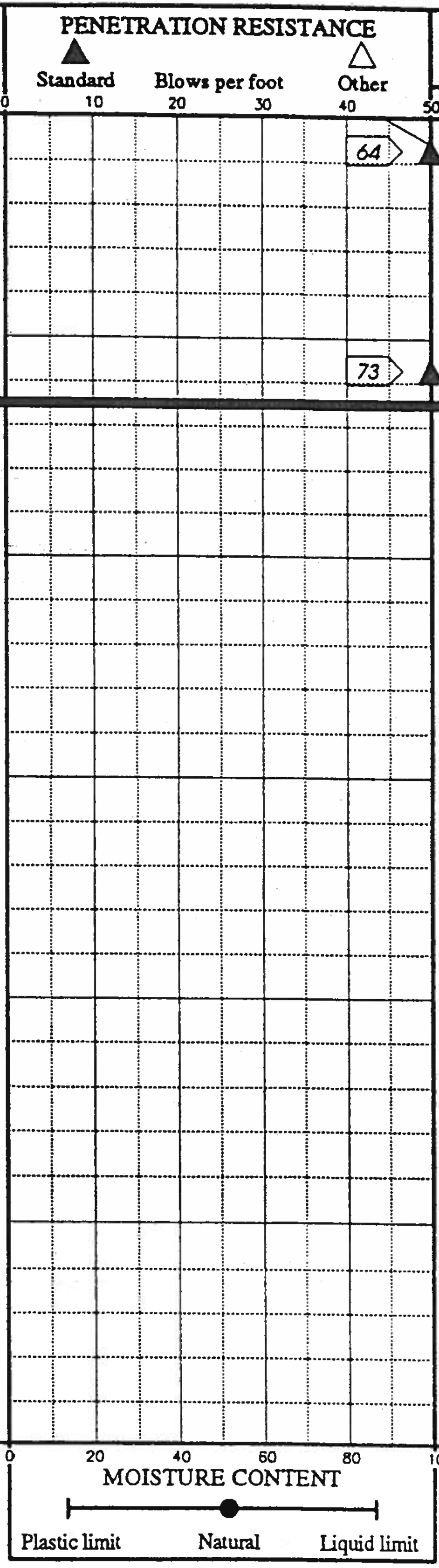
Page 3 of 3

SOIL DESCRIPTION

Location: 10' South & 10' West from SW corner of Entry Planter

Approximate ground surface elevation: 31.5 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE NUMBER
60	Very dense, saturated, yellowish tan, gravelly SAND with some silt	S-12
65	Lens of hard, wet, yellowish tan, SILT with some fine sand	S-13
	Boring terminated at approximately 66.5 feet. Switched to mud rotary at 30 feet.	
70		
75		
80		
85		
90	(continued)	



TESTING

LEGEND

I	2.00-inch OD split-spoon sample
ATD	Groundwater level at time of drilling
II	3.00-inch OD Shelby tube sample
X	Sample not recovered
⊕	Grain size analysis

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Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

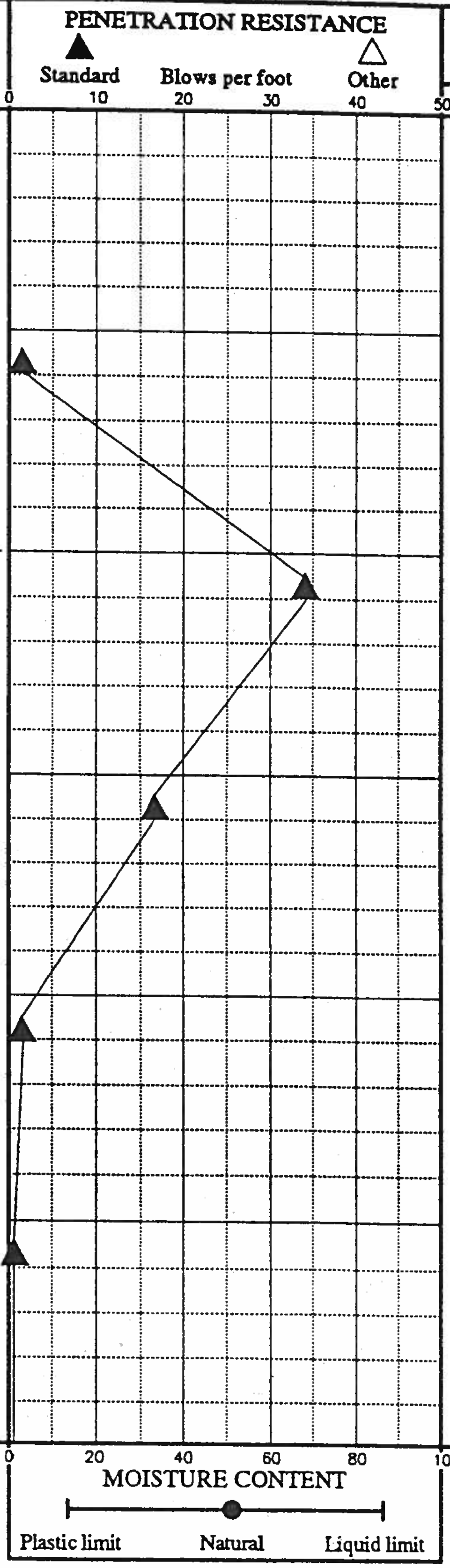
Drilling method: HSA/Mud Rotary Hammer type: Mechanical Date drilled: 12 September 1995 Logged by: HWB

Kenmore Lakepointe
PROJECT: Development
W.O. 11-10459-00 BORING NO. A-3

Page 1
of 2

Location: 90' South & 20' East from SW corner of Building
Approximate ground surface elevation: 27 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
0	2" Asphalt over 2" to 4" of Base Course over medium dense, moist to wet, tan, gravelly, silty SAND with some organics (Fill)			
	Very loose to loose, wet, blackish gray to tannish gray, silty SAND with some gravel, organics and debris (treated wood, brick, concrete, etc.) (creosote-like odor - 1ppm on OVM) (Wood Debris Fill)			
5		I	S-1	
	Interbeds of medium dense to dense, moist, gray, silty, gravelly SAND to silty, sandy GRAVEL (Concrete Washout)			
10		I	S-2	▼ ATD
15	Very loose to loose, saturated, blackish gray to tannish gray, silty SAND with some gravel and wood debris (Fill)	I	S-3	
20		I	S-4	
	Very loose, wet to saturated, dark brown, fibrous to amorphous PEAT with interbeds of brown, organic silts	X	S-5	
25		I	S-6	
30	(continued)			



TESTING

LEGEND

- I 2.00-inch OD split-spoon sample
- X Sample not recovered
- ▼ ATD Groundwater level at time of drilling
- II 3.00-inch OD Shelby tube sample

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

Drilling method: HSA/Mud Rotary Hammer type: Mechanical Date drilled: 11 September 1995 Logged by: HWB

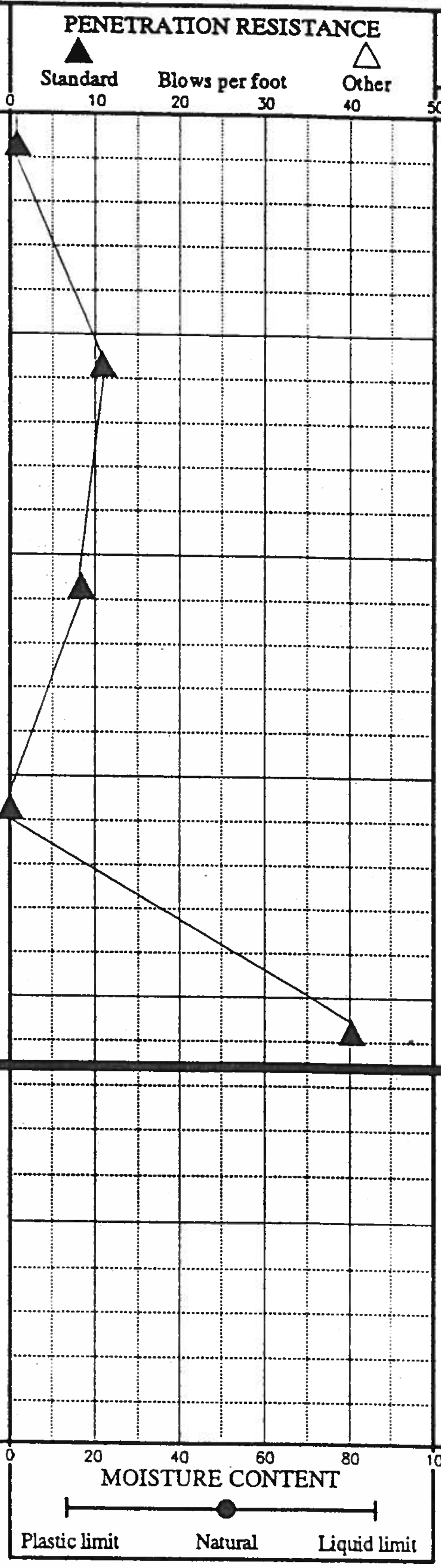
AGRA Earth and Environmental, Inc.

PROJECT: *Kenmore Lakepointe Development* W.O. *11-10459-00* BORING NO. *A-3*

Page 2 of 2

SOIL DESCRIPTION
Location: *90' South & 20' East from SW corner of Building*
Approximate ground surface elevation: *27 feet*

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
30	*Very loose, saturated, blackish-browish gray, gravelly, silty SAND with organics and PEAT interbeds*	I	*S-7*	
	Medium dense, saturated, gray, silty fine SAND with trace organics			
35		I	*S-8*	
40		I	*S-9*	
	Becoming very loose			
45		I	*S-10*	
	Very soft, clayey SILT lens at 46.2 feet			
	Dense, saturated, yellowish tan, fine to medium SAND with some silt			
50		I	*S-11*	
	Boring terminated at approximately 51.5 feet. Switched to mud rotary at 45 feet.			
55				
60				



LEGEND

I 2.00-inch OD split-spoon sample

X Sample not recovered

▼ ATD Groundwater level at time of drilling

II 3.00-inch OD Shelby tube sample

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11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

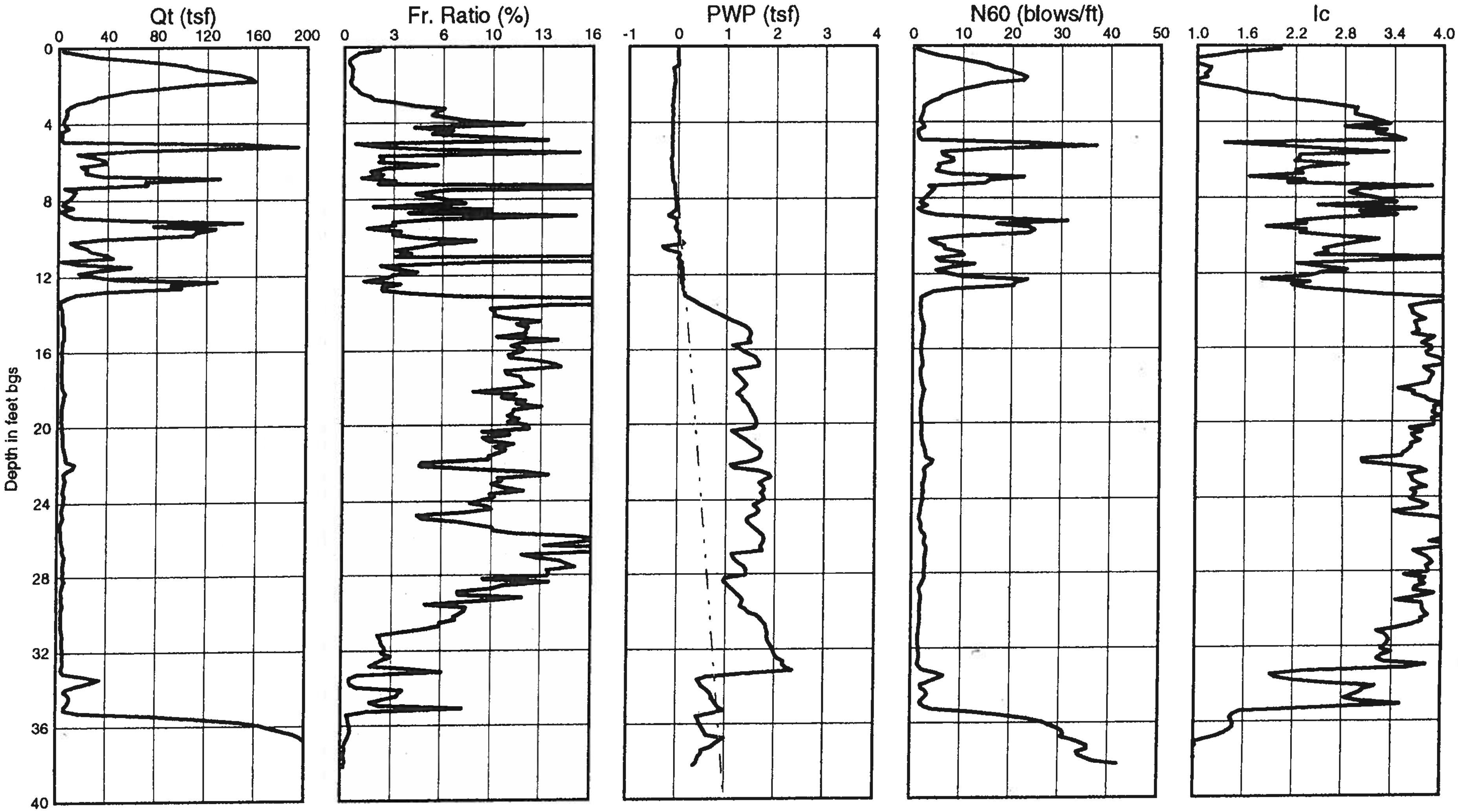
Drilling method: *HSA/Mud Rotary* Hammer type: *Mechanical* Date drilled: *11 September 1995* Logged by: *HWB*

Cone Penetration Test - A4

Test Date : Sep 07, 1995
Location : Kenmore LakePointe Development

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 24.50
Water Table Depth : 8.00



Qt normalized for
unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 120 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 11-10459-01 DATE: Sept. 8, 1995 DRAWN BY: Keith Brown

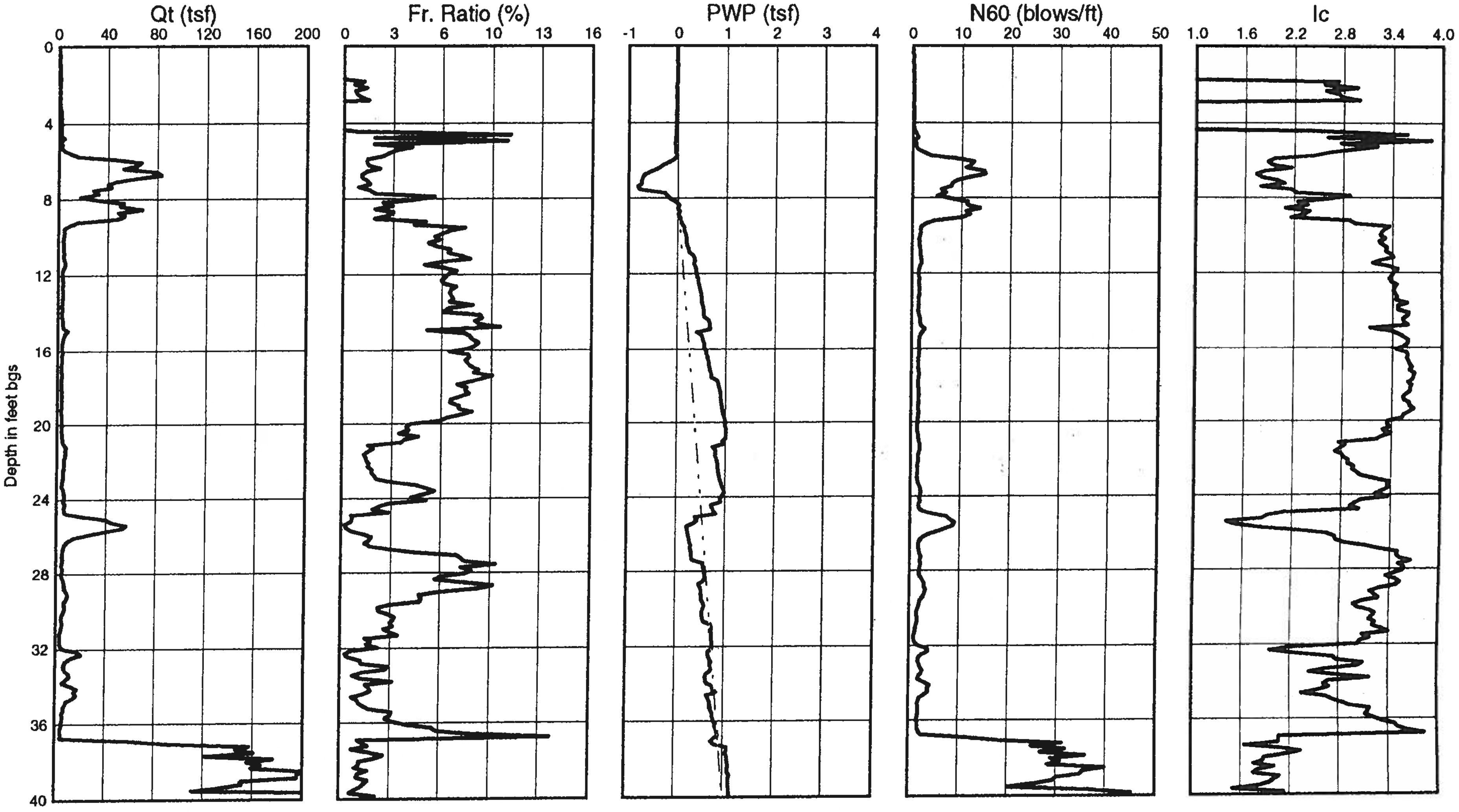
AGRA E & E, Inc.

Cone Penetration Test - A5

Test Date : Sept 07, 1995
Location : Kenmore LakePointe Development

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 24.50
Water Table Depth : 8.00



Qt normalized for
unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 120 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 11-10459-01 DATE: Sept. 8, 1995 DRAWN BY: Keith Brown

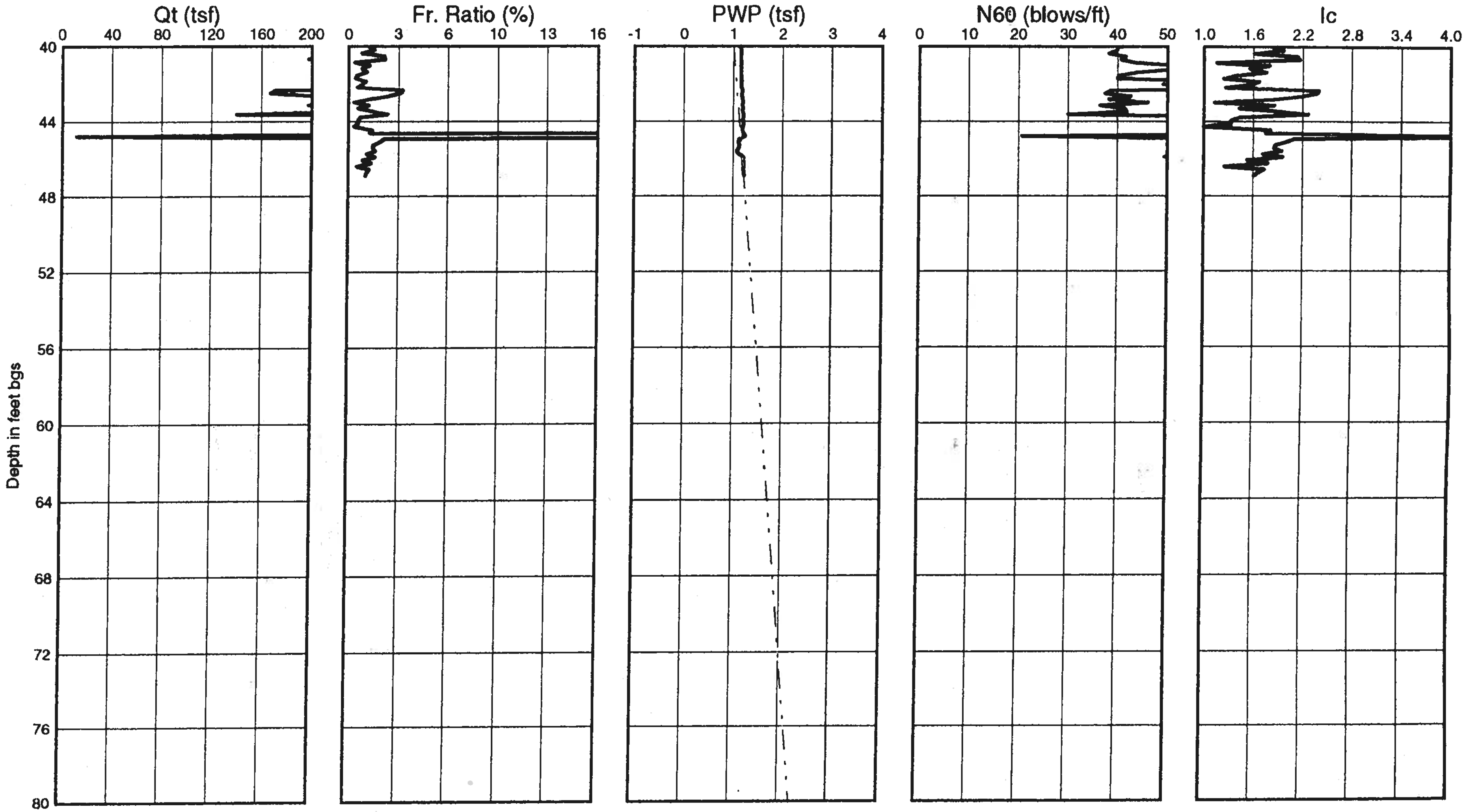
AGRA E & E, Inc.

Cone Penetration Test - A5

Test Date : Sept 07, 1995
Location : Kenmore LakePointe Development

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 24.50
Water Table Depth : 8.00



Qt normalized for
unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 120 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

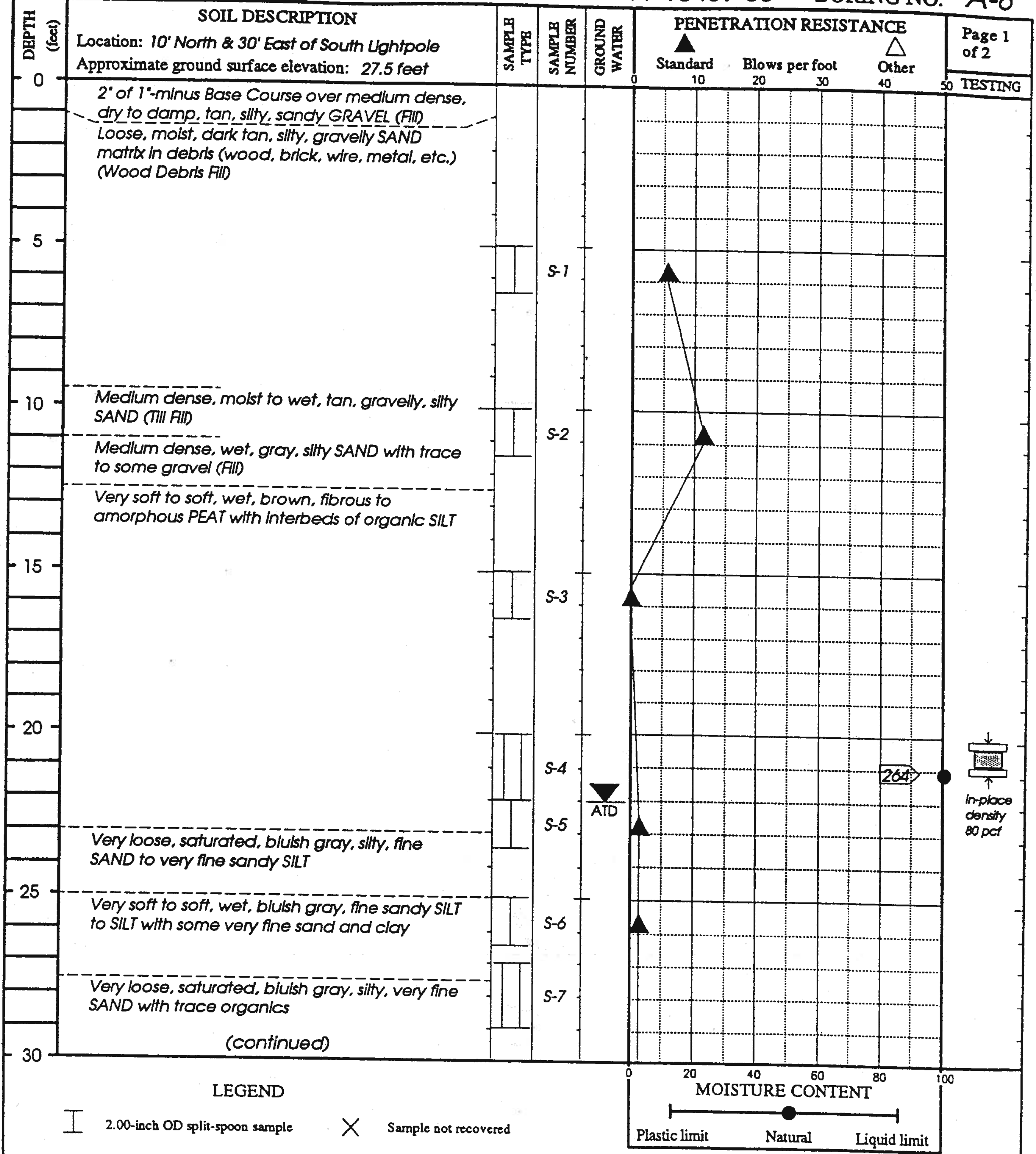
PROJECT NO. 11-10459-01 DATE: Sept. 8, 1995 DRAWN BY: Keith Brown

AGRA E & E, Inc.

Kenmore Lakepointe
PROJECT: Development
W.O. 11-10459-00
BORING NO. A-6

Page 1 of 2

SOIL DESCRIPTION
Location: 10' North & 30' East of South Lightpole
Approximate ground surface elevation: 27.5 feet



2" of 1"-minus Base Course over medium dense, dry to damp, tan, silty, sandy GRAVEL (Fill)

Loose, moist, dark tan, silty, gravelly SAND matrix in debris (wood, brick, wire, metal, etc.) (Wood Debris Fill)

Medium dense, moist to wet, tan, gravelly, silty SAND (Till Fill)

Medium dense, wet, gray, silty SAND with trace to some gravel (Fill)

Very soft to soft, wet, brown, fibrous to amorphous PEAT with interbeds of organic SILT

Very loose, saturated, bluish gray, silty, fine SAND to very fine sandy SILT

Very soft to soft, wet, bluish gray, fine sandy SILT to SILT with some very fine sand and clay

Very loose, saturated, bluish gray, silty, very fine SAND with trace organics

(continued)

LEGEND

I 2.00-inch OD split-spoon sample

▼ ATD Groundwater level at time of drilling

Ⅱ 3.00-inch OD Shelby tube sample

× Sample not recovered

Consolidation test

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

Drilling method: HSA/Mud Rotary
Hammer type: Mechanical
Date drilled: 13 September 1995
Logged by: HWB

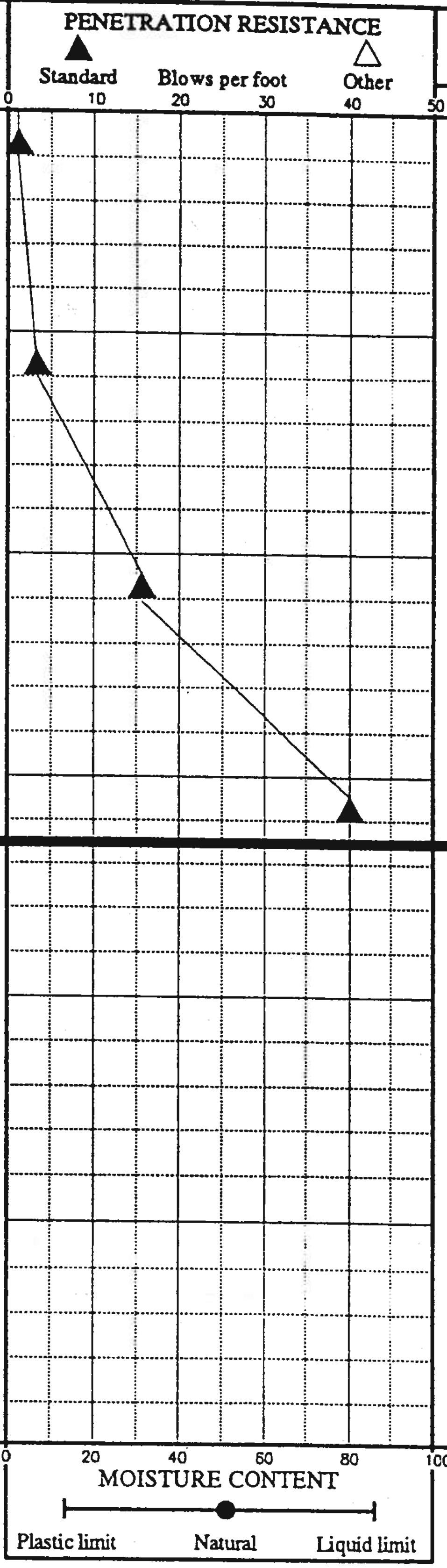
AGRA Earth and Environmental, Inc.

Kenmore Lakepointe
PROJECT: Development W.O. 11-10459-00 BORING NO. A-6

Page 2 of 2

SOIL DESCRIPTION
Location: 10' North & 30' East of South Lightpole
Approximate ground surface elevation: 27.5 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
30	Interbedded very soft ot soft, wet to saturated, dark brown to brown, fibrous PEAT and organic SILT with some clay	I	S-8	
35	Volcanic ash layer at 35.8 feet	I	S-8	
	Very loose, saturated, bluish gray, silty, very fine SAND/very fine sandy SILT			
40	Medium dense, saturated, gray, sandy GRAVEL/ gravelly SAND with trace to some silt	I	S-10	
	Dense, saturated, gray, fine GRAVEL with trace sand and silt			
45		I	S-11	
	Boring terminated at approximately 46.5 feet. Switched to mud rotary at 40 feet.			
50				
55				
60				



LEGEND

I	2.00-inch OD split-spoon sample
▼ ATD	Groundwater level at time of drilling
II	3.00-inch OD Shelby tube sample
X	Sample not recovered
⌶	Consolidation test

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling method: HSA/Mud Rotary Hammer type: Mechanical Date drilled: 11 September 1995 Logged by: HWB

PROJECT: Kenmore Lakepointe Development **W.O.** 11-10459-00 **BORING NO.** A-7

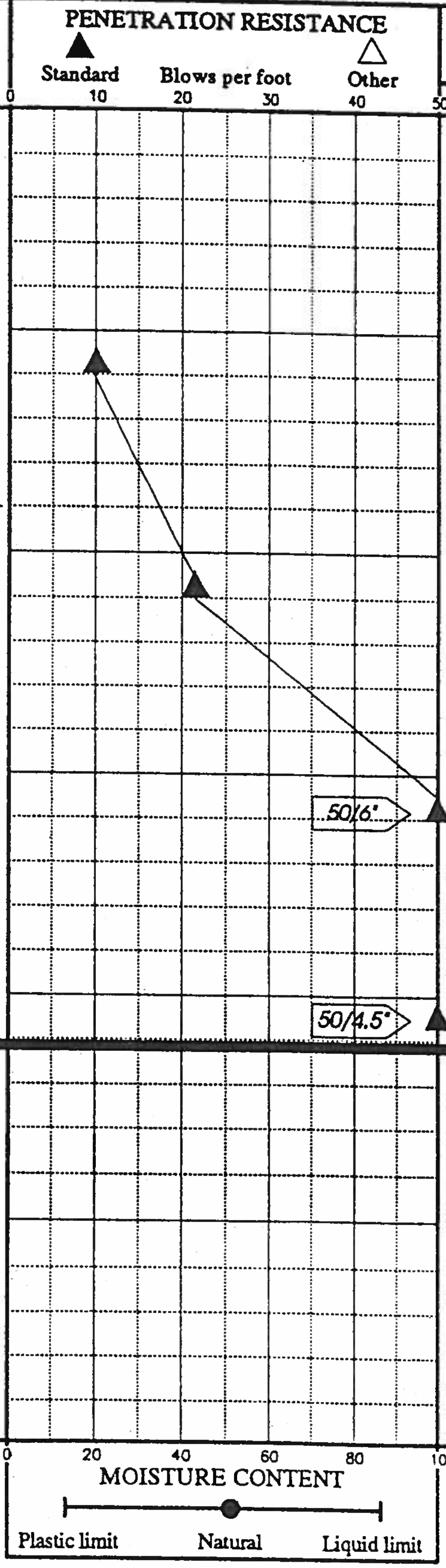
Page 1 of 1

SOIL DESCRIPTION

Location: 90' W & 9' N of Manhole

Approximate ground surface elevation: 33.5 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE NUMBER	GROUND WATER
0	Sod over loose, moist, brown, gravelly, silty SAND (Topsoil)		
	Loose to medium dense, moist, tan, gravelly SAND with some silt (Fill)		
5		S-1	
	Medium dense, wet to saturated, tan, gravelly, silty SAND		ATD
10		S-2	
	Grading to a silty, gravelly SAND		
15	Very dense, saturated, tan, silty, gravelly SAND/ silty, sandy GRAVEL	S-3	
20	Very dense, moist to wet, tan, silty, gravelly SAND	S-4	
	Boring terminated at approximately 21 feet		
25			
30			



TESTING

LEGEND

I 2.00-inch OD split-spoon sample

X Sample not recovered

▼ ATD Groundwater level at time of drilling

II 3.00-inch OD Shelby tube sample

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling method: HSA Hammer type: Mechanical Date drilled: 09 October 1995 Logged by: HWB

PROJECT: *Kenmore Lakepointe Development* W.O. *11-10459-00* BORING NO. *A-8*

Page 1 of 1

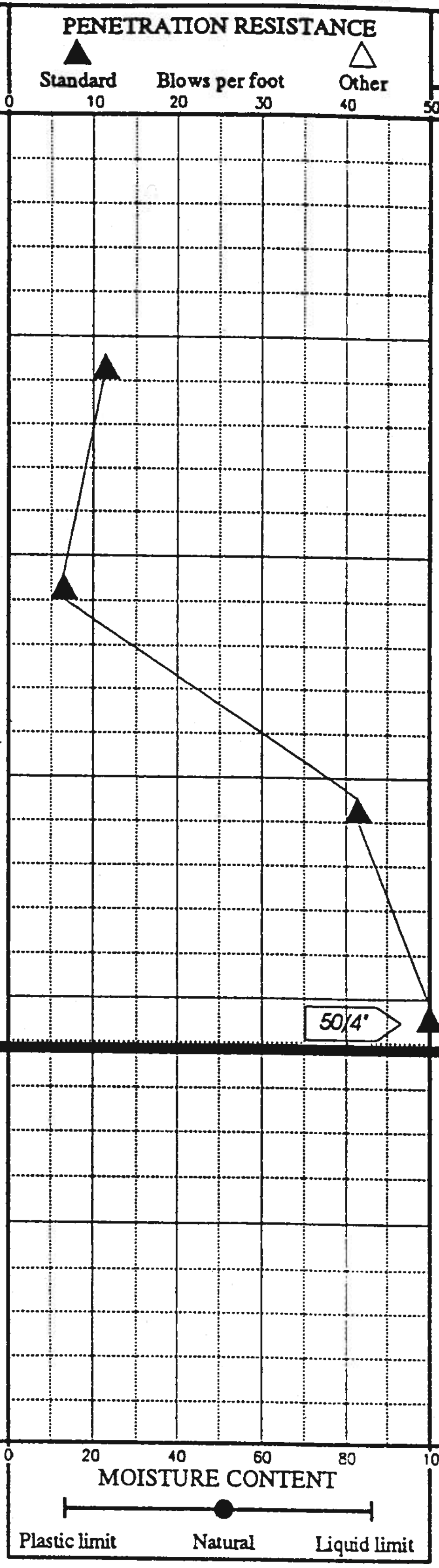
SOIL DESCRIPTION

Location: *120' E of Manhole & 20' N of Path*

Approximate ground surface elevation: *36 feet*

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
0	*Grass over loose, moist, brown, silty, gravelly SAND (Fill)*			
	Medium dense, moist, dark brown, gravelly, silty SAND (Fill)			
5	*Medium dense, damp to moist, tan, silty, fine SAND*	I	S-1	
10	*Becomes wet to saturated*			P ATD
	Medium stiff, moist, yellowish tan, laminated SILT with trace organics	I	S-2	
	Dense, wet to saturated, tan, gravelly SAND with some silt			▼ ATD
15		I	S-3	
	Very dense, moist to wet, gravelly, silty SAND			
20		I	S-4	
	Boring terminated at approximately 21 feet			
25				
30				

TESTING



LEGEND

I 2.00-inch OD split-spoon sample

X Sample not recovered

▼ ATD Groundwater level at time of drilling

P ATD Perched groundwater level at time of drilling

II 3.00-inch OD Shelby tube sample

AGRA Earth and Environmental, Inc.

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

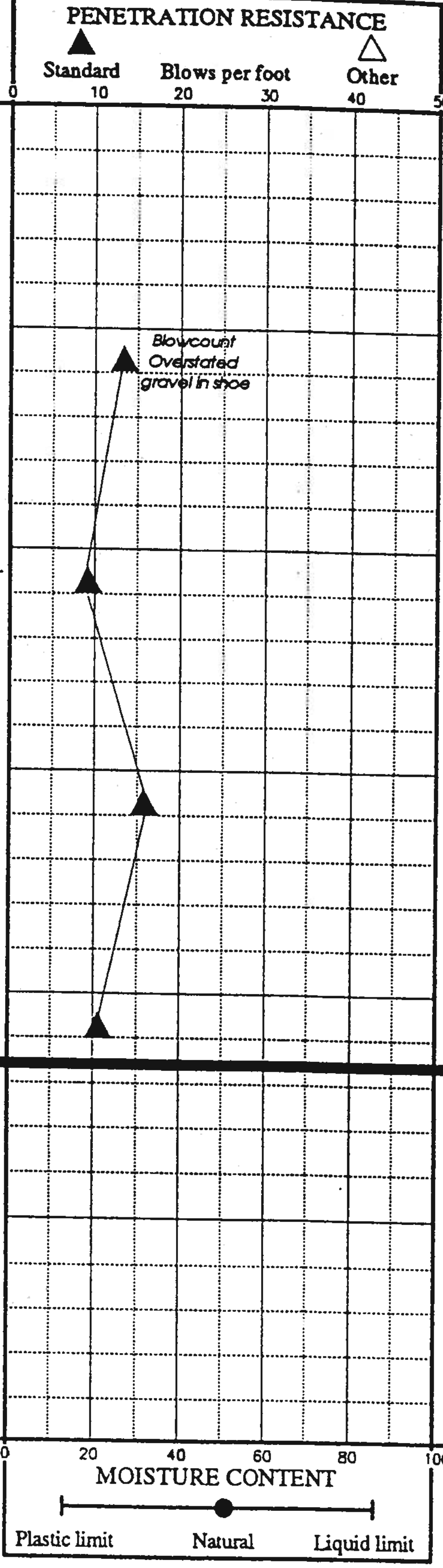
Drilling method: *HSA* Hammer type: *Mechanical* Date drilled: *09 October 1995* Logged by: *HWB*

Kenmore Lakepointe
PROJECT: Development
W.O. 11-10459-00 BORING NO. A-10

Page 1 of 1

Location: 9' N of Corner Fence Post
Approximate ground surface elevation: 31.5 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER	TESTING
0	2" of 1 1/2-inch minus Crushed Rock over 4" of Asphalt over medium dense, moist, tan, sandy GRAVEL with some silt (Fill)				
	Loose, damp to moist, orangish tan, gravelly SAND/sandy GRAVEL with some silt (Recessional)				
5		X	S-1		
	Loose to medium dense, moist to wet, tan, SAND with some silt and trace gravel (by drilling action)				
	Medium dense, saturated, tan, silty, fine SAND				
10		I	S-2	▼ ATD	
15		I	S-3		
	Grading to silty, fine to medium SAND with trace gravel				
20		I	S-4		
	Boring terminated at approximately 21.5 feet				
25					
30					



LEGEND

I	2.00-inch OD split-spoon sample
X	Sample not recovered
▼ ATD	Groundwater level at time of drilling
II	3.00-inch OD Shelby tube sample

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Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling method: HSA
Hammer type: Mechanical
Date drilled: 09 October 1995
Logged by: HWB

PROJECT: Kenmore Lakepointe Development   W.O. 11-10459-00   BORING NO. A-11

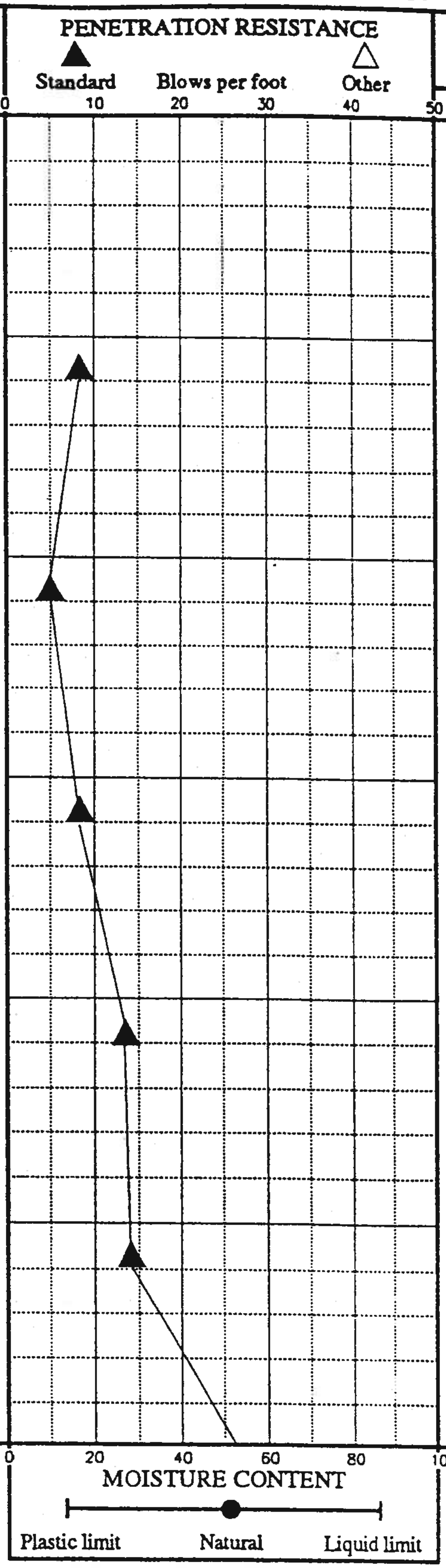
Page 1 of 2

SOIL DESCRIPTION

Location: 20' South & 55' West from Catch Basin in Boat Yard

Approximate ground surface elevation: 31 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
0	4" of 5/8 inch minus Gravel Fill over 1" Concrete over medium dense, damp, tan, sandy GRAVEL with some silt (Fill)			
	Loose, damp, orangish tan, sandy GRAVEL with some silt (Recessional)			
5		I	S-1	
	Becoming cobbly at 8.5 feet			
10	Loose, saturated, yellowish tan, silty, fine to medium SAND	I	S-2	▼ ATD
	Loose, saturated, yellowish tan, silty, fine SAND			
15		I	S-3	
	Becoming mottled orange-tan-gray			
	Stiff, wet, yellowish tan, SILT with some clay and interbeds of silty, very fine SAND			
20		I	S-4	
	Medium dense, saturated, gray, silty, fine SAND			
	Interbedded medium stiff/medium dense, wet to saturated, tan, very fine sandy SILT with some clay to silty, very fine SAND			
25		I	S-5	
	Medium dense, saturated, gray, gravelly SAND with some silt			
30	(continued)			



LEGEND

- I 2.00-inch OD split-spoon sample
- × Sample not recovered
- ▼ ATD Groundwater level at time of drilling
- II 3.00-inch OD Shelby tube sample

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Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

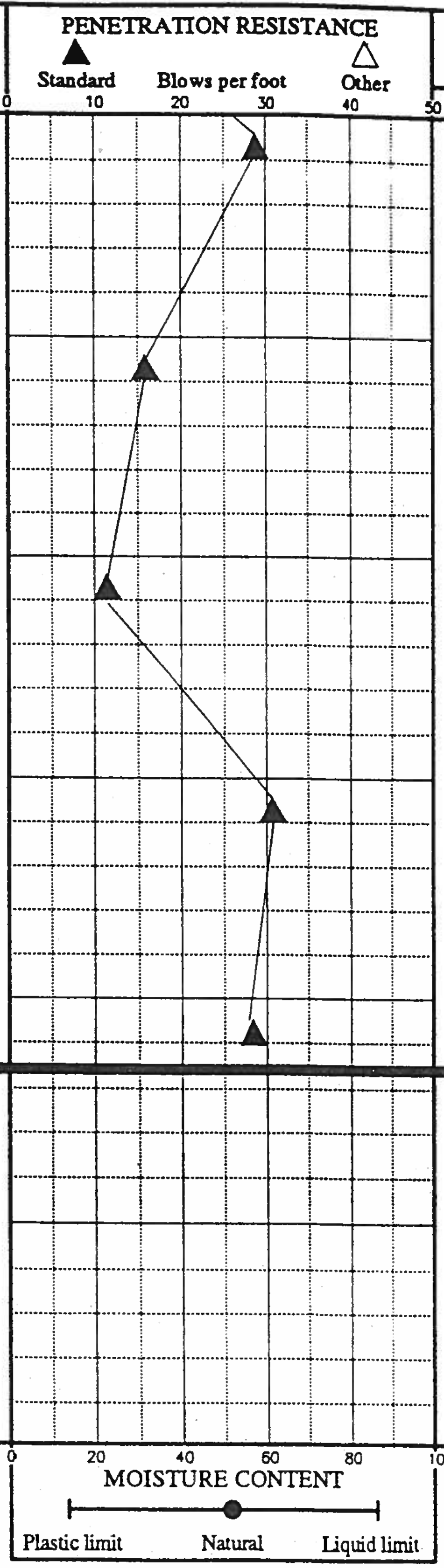
AGRA Earth and Environmental, Inc.

Drilling method: HSA/Mud Rotary   Hammer type: Mechanical   Date drilled: 11 September 1995   Logged by: HWB

PROJECT: *Kenmore Lakepointe Development*　W.O. *11-10459-00*　BORING NO. *A-11*

Page 2 of 2

DEPTH (feet)	SOIL DESCRIPTION Location: *20' South & 55' West from Catch Basin in Boat Yard* Approximate ground surface elevation: *31 feet*	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
30	*Medium dense, saturated, gray, silty, fine SAND with some medium sand*	I	*S-6*	
	Becoming gravelly at 32 to 33 feet			
	Medium dense, saturated, gray, silty, fine SAND with trace gravel			
35		I	*S-7*	
40		I	*S-8*	
	Becoming dense			
45		I	*S-9*	
50	*Becoming medium dense*	I	*S-10*	
	Boring terminated at approximately 51.5 feet. Switched to mud rotary at 30 feet.			
55				
60				



TESTING

LEGEND

I 2.00-inch OD split-spoon sample

X Sample not recovered

▼ ATD Groundwater level at time of drilling

II 3.00-inch OD Shelby tube sample

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

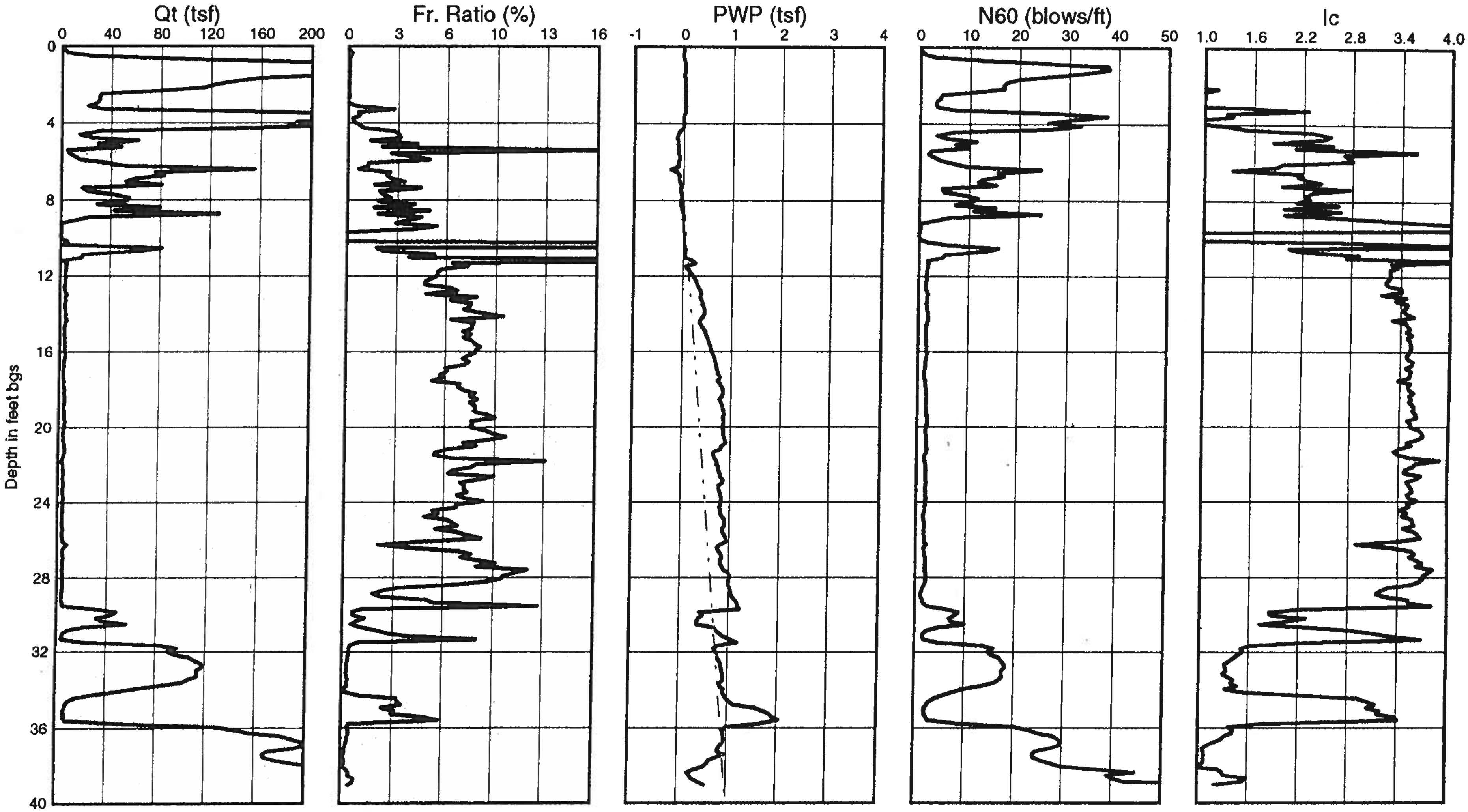
Drilling method: *HSA/Mud Rotary*　Hammer type: *Mechanical*　Date drilled: *11 September 1995*　Logged by: *HWB*

Cone Penetration Test - A12

Test Date : Sept 07, 1995
Location : Kenmore LakePointe Development

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 23.30
Water Table Depth : 8.00



Qt normalized for
unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 120 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 11-10459-01 DATE: Sept. 8, 1995 DRAWN BY: Keith Brown

AGRA E & E, Inc.

PROJECT: *Kenmore Lakepointe Development* W.O. *11-10459-00* BORING NO. *A-13*

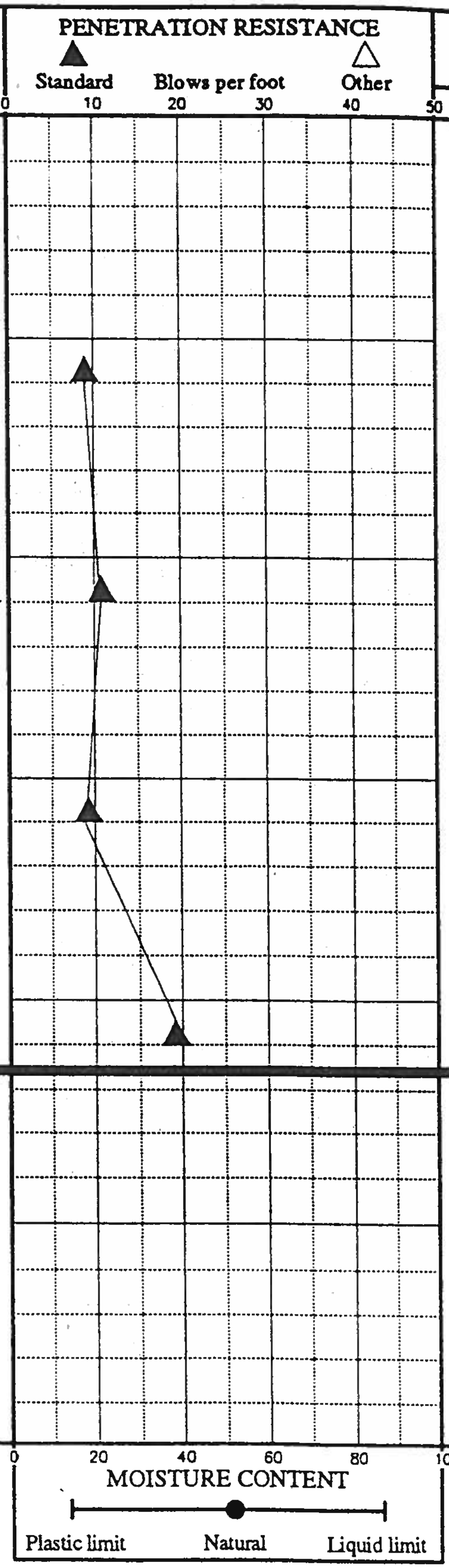
Page 1 of 1

SOIL DESCRIPTION

Location: *55' West of Pole & 18' South of Curb*

Approximate ground surface elevation: *38 feet*

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
0	*Sod over loose, moist, dark tan, silty, gravelly SAND to gravelly SAND with some silt and trace organics (Fill)*			
5	*Becoming mixed tan-brown, silty, gravelly SAND with scattered cobbles (Fill)*	I	S-1	
	Medium dense, moist to wet, slight orange mottling in orangish tan, fine to medium SAND with some silt and trace gravel			
10		I	S-2	▼ ATD
	Loose, saturated, slight orange mottling in orangish tan, silty, fine SAND			
15		I	S-3	
20	*Interbedded stiff, wet, some orange mottling in tan, fine sandy SILT/SILT with some silty, fine SAND and medium dense, saturated, tan, silty, fine SAND*	I	S-4	
	Boring terminated at approximately 21.5 feet			
25				
30				



LEGEND

I 2.00-inch OD split-spoon sample

X Sample not recovered

▼ ATD Groundwater level at time of drilling

II 3.00-inch OD Shelby tube sample

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling method: *HSA* Hammer type: *Cathead* Date drilled: *18 October 1995* Logged by: *HWB*

PROJECT: Kenmore Lakepointe Development

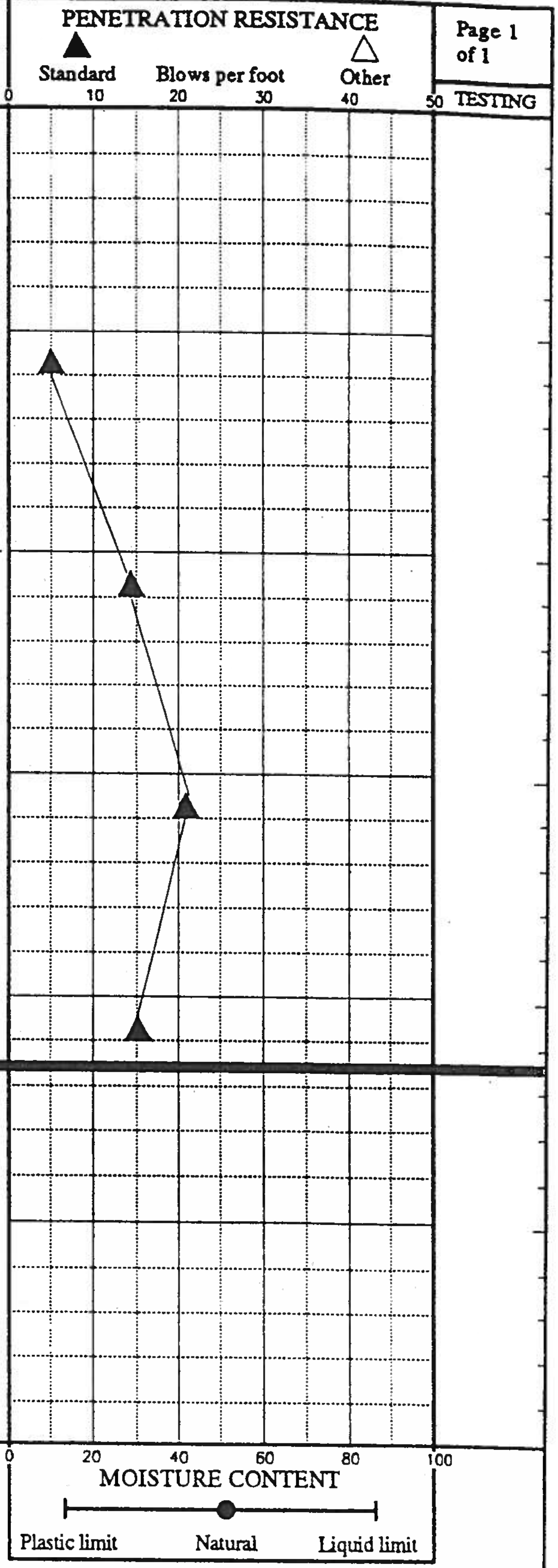
W.O. 11-10459-00 BORING NO. A-14

Page 1 of 1

Location: 45' East of Sanitary Sewer In Bottom of Ditch

Approximate ground surface elevation: 32 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
0	Sod over loose, damp to moist, gray, PEA GRAVEL with trace sand and silt (Fill)			
	Loose, moist, tan, gravelly, fine to medium SAND with some silt and scattered cobbles and orgaincs (Fill)			
5		I	S-1	
	Medium dense, moist to wet, tan, silty, fine SAND with trace to some gravel and medium sand			
10	Becoming wet to saturated	I	S-2	▼ ATD
15	Slight orange mottling	I	S-3	
	Stiff, wet, gray, SILT with interbeds of sandy SILT and medium dense, wet to saturated, silty, fine SAND			
20		I	S-4	
	Boring terminated at approximately 21.5 feet			
25				
30				



LEGEND

I 2.00-inch OD split-spoon sample

X Sample not recovered

▼ ATD Groundwater level at time of drilling

II 3.00-inch OD Shelby tube sample

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

Drilling method: HSA Hammer type: Cathead Date drilled: 18 October 1995 Logged by: HWB

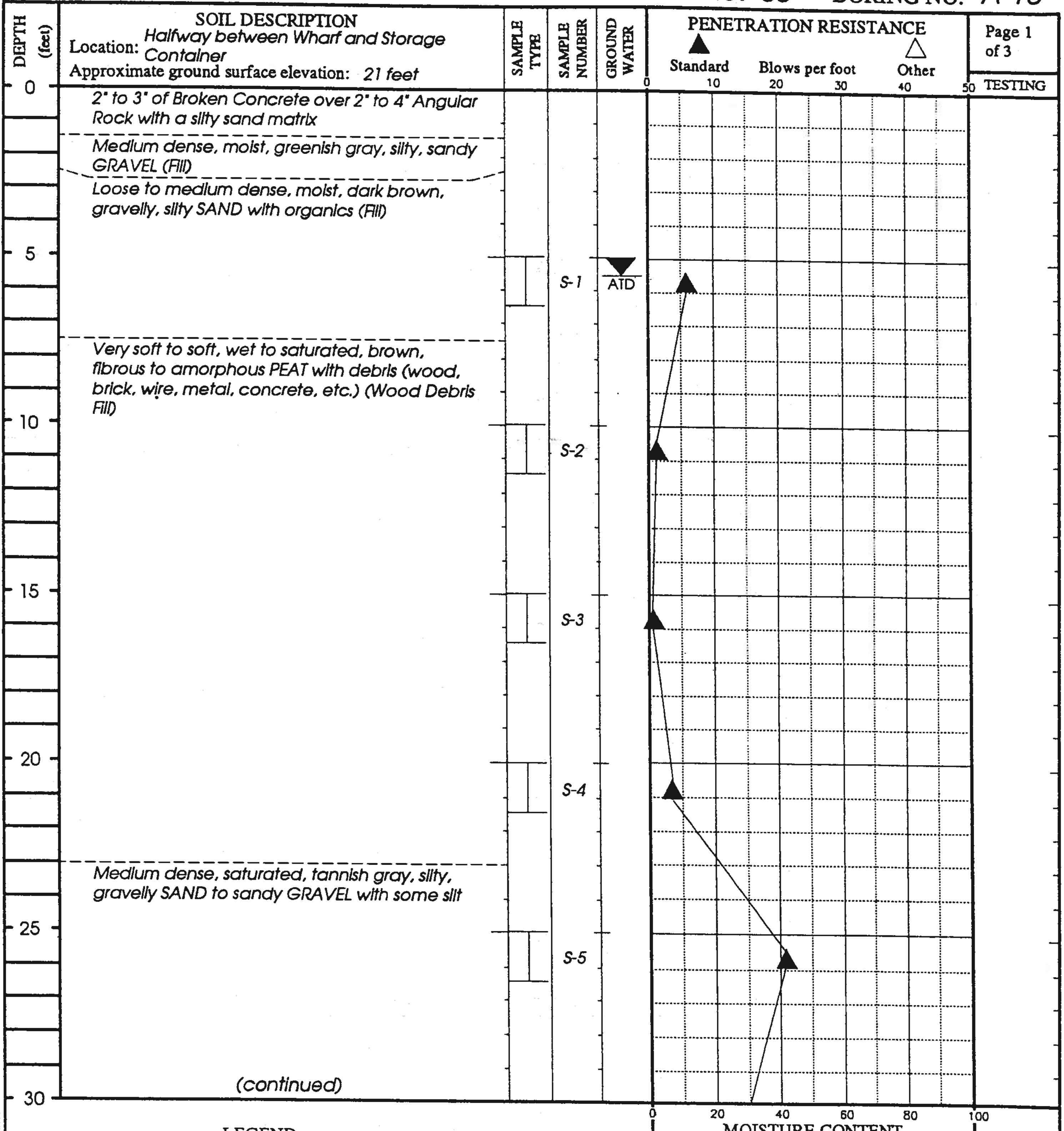
PROJECT: Kenmore Lakepointe Development W.O. 11-10459-00 BORING NO. A-16

Page 1 of 3

SOIL DESCRIPTION

Location: Halfway between Wharf and Storage Container

Approximate ground surface elevation: 21 feet



2" to 3" of Broken Concrete over 2" to 4" Angular Rock with a silty sand matrix

Medium dense, moist, greenish gray, silty, sandy GRAVEL (Fill)

Loose to medium dense, moist, dark brown, gravelly, silty SAND with organics (Fill)

Very soft to soft, wet to saturated, brown, fibrous to amorphous PEAT with debris (wood, brick, wire, metal, concrete, etc.) (Wood Debris Fill)

Medium dense, saturated, tannish gray, silty, gravelly SAND to sandy GRAVEL with some silt

(continued)

MOISTURE CONTENT

Plastic limit — Natural — Liquid limit

LEGEND

I	2.00-inch OD split-spoon sample
X	Sample not recovered
▼ ATD	Groundwater level at time of drilling
II	3.00-inch OD Shelby tube sample

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

Drilling method: HSA/Mud Rotary Hammer type: Mechanical Date drilled: 13 September 1995 Logged by: HWB

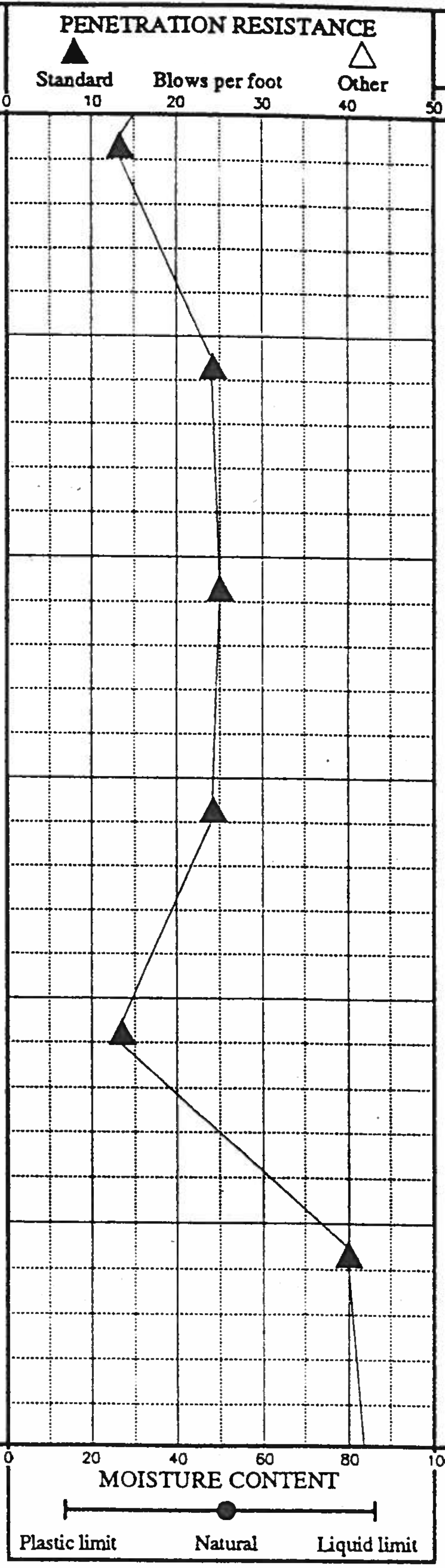
AGRA Earth and Environmental, Inc.

Kenmore Lakepointe
PROJECT: Development **W.O.** 11-10459-00 **BORING NO.** A-16

Page 2 of 3

SOIL DESCRIPTION
Location: Halfway between Wharf and Storage Container
Approximate ground surface elevation: 24 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER	TESTING
30	Stiff, wet, mottled yellowish tan, SILT with trace to some very fine sands	I	S-6		
	Medium dense, wet to saturated, bluish gray, silty, very fine SAND				
35	Grading to very fine sandy SILT	I	S-7		
	Grading to silty, very fine SAND				
40		I	S-8		
45		I	S-9		
50	Interbedded stiff/medium dense, wet to saturated, mottled orange-tan, very fine sandy SILT/silty, very fine SAND	I	S-10		
	Medium dense, saturated, tannish gray, gravelly SAND with some silt				
55		I	S-11		
	Dense, saturated, gray, medium SAND with trace to some gravel and silt				
60	(continued)				



LEGEND

I 2.00-inch OD split-spoon sample
X Sample not recovered
▼ ATD Groundwater level at time of drilling
II 3.00-inch OD Shelby tube sample

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

Drilling method: HSA/Mud Rotary Hammer type: Mechanical Date drilled: 13 September 1995 Logged by: HWB

PROJECT: Kenmore Lakepointe Development

W.O. 11-10459-00 BORING NO. A-16

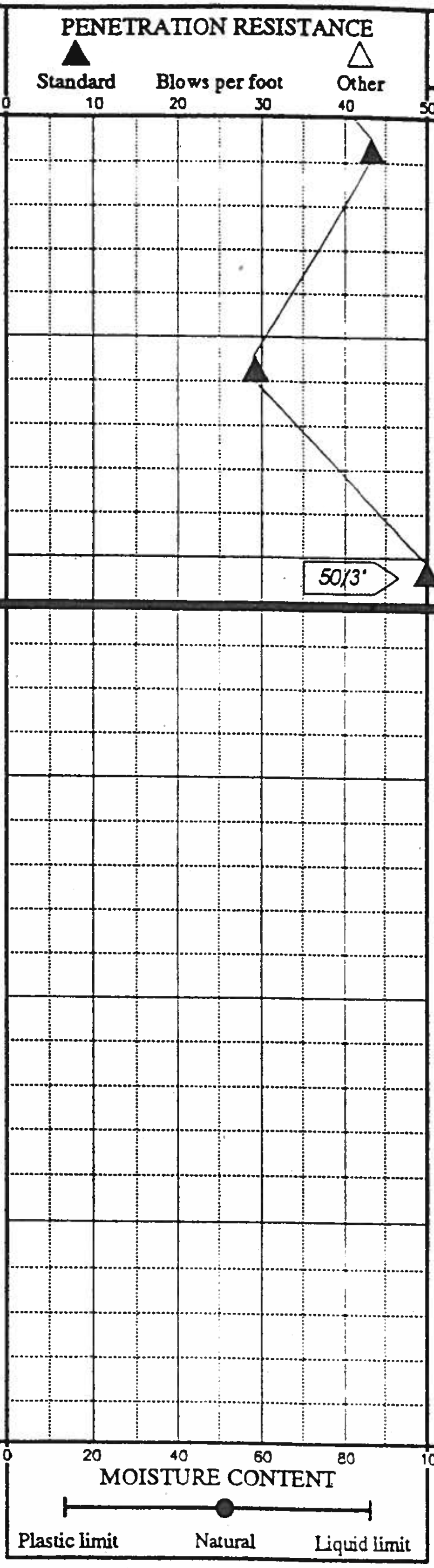
Page 3 of 3

SOIL DESCRIPTION

Location: Halfway between Wharf and Storage Container

Approximate ground surface elevation: 24 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER	TESTING
60	Dense, saturated, bluish gray, silty SAND with trace gravel	I	S-12		
	Medium dense, saturated, gray, GRAVEL with some sand and trace silt to sandy GRAVEL with trace silt				
65		I	S-13		
	Very dense, saturated, gray, sandy GRAVEL with some silt				
70		I	S-14		
	Boring terminated at approximately 71 feet. Switched to mud rotary at 55 feet.				
75					
80					
85					
90					



LEGEND

I 2.00-inch OD split-spoon sample

X Sample not recovered

▼ ATD Groundwater level at time of drilling

II 3.00-inch OD Shelby tube sample

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling method: HSA/Mud Rotary Hammer type: Mechanical Date drilled: 13 September 1995 Logged by: HWB

PROJECT: Kenmore Lakepointe Development **W.O.** 11-10459-00 **BORING NO.** A-17

Page 1 of 2

SOIL DESCRIPTION

Location: 30' NE from Ecology Block Wall

Approximate ground surface elevation: 25.5 feet

DEPTH (feet): 0, 5, 10, 15, 20, 25, 30

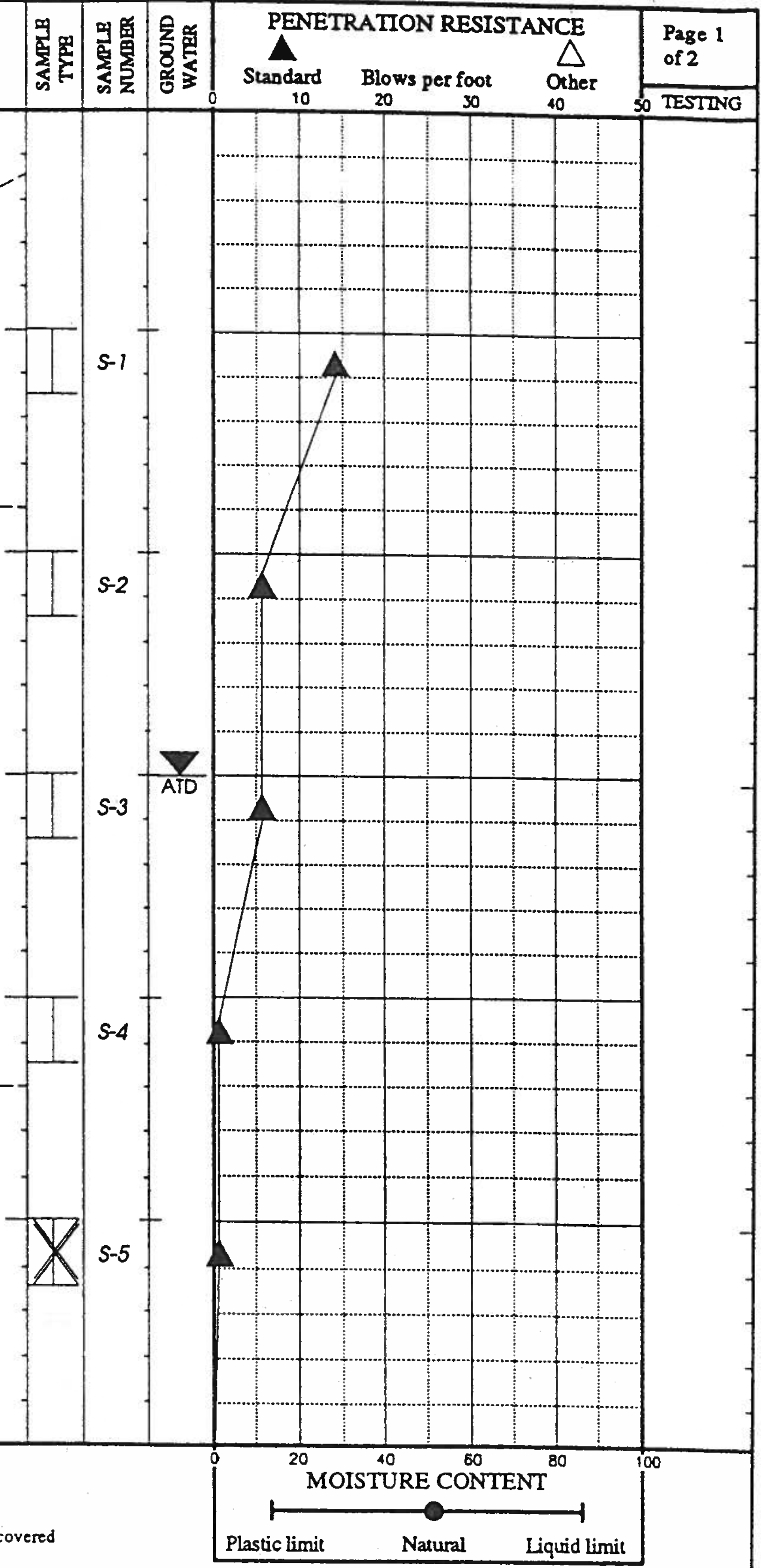
4" Broken Concrete over medium dense, moist, silty, gravelly SAND with 2" to 4" Angular Rock and trace organics (Fill)

Loose to medium dense, wet, blackish gray, silty SAND with some gravel matrix and wood debris (brick, wire, concrete, etc.) (Wood Debris Fill)

Soft to medium stiff, wet, blackish brown -dark brown, fibrous to amorphous PEAT with wood debris (Fill)

Very soft, wet to saturated, blackish brown-brown, fibrous to amorphous PEAT

(continued)



LEGEND

- 2.00-inch OD split-spoon sample
- Sample not recovered
- Groundwater level at time of drilling (ATD)
- 3.00-inch OD Shelby tube sample

AGRA Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling method: HSA/Mud Rotary Hammer type: Mechanical Date drilled: 08 September 1995 Logged by: HWB

PROJECT: Kenmore Lakepointe Development W.O. 11-10459-00 BORING NO. A-17

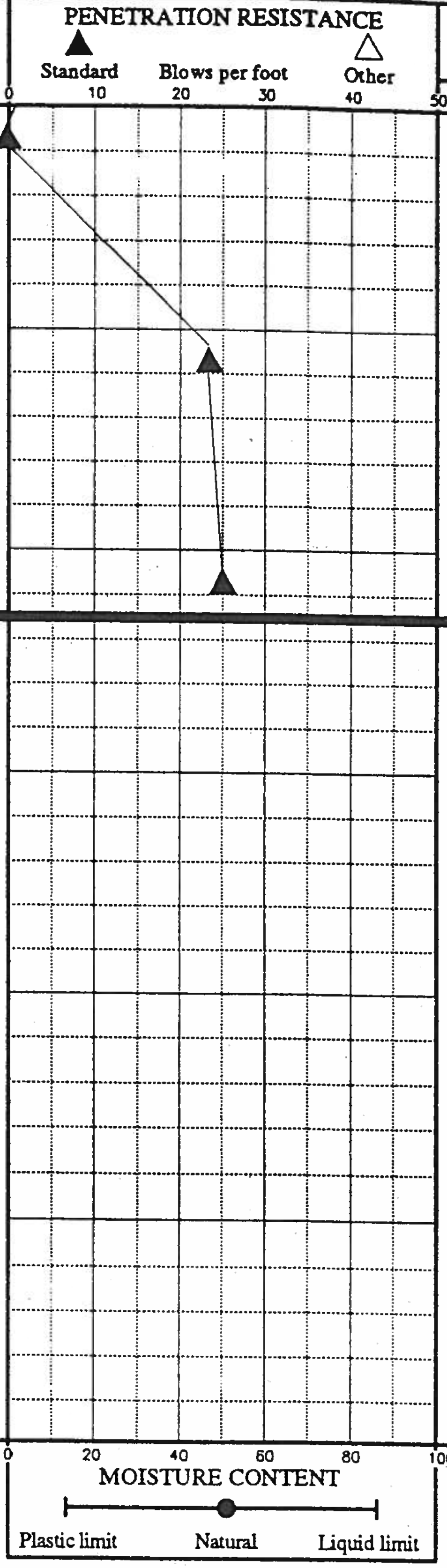
Page 2 of 2

SOIL DESCRIPTION

Location: 30' NE from Ecology Block Wall

Approximate ground surface elevation: 25.5 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER	TESTING
30	Very soft, wet to saturated, blackish brown-brown, fibrous to amorphous PEAT (As Above)	I	S-6		
	Soft, wet, dark gray, sandy SILT with organics				
	Medium dense, saturated, greenish gray, silty, sandy GRAVEL to sandy GRAVEL with some silt				
35		I	S-7		
40	Very stiff, wet, greenish gray, SILT with some clay and silty sand lens at 41.1 to 41.3 feet	I	S-8		
	Boring terminated at approximately 41.5 feet				
45					
50					
55					
60					



LEGEND

- I 2.00-inch OD split-spoon sample
- X Sample not recovered
- ▼ ATD Groundwater level at time of drilling
- II 3.00-inch OD Shelby tube sample

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

Drilling method: HSA/Mud Rotary Hammer type: Mechanical Date drilled: 08 September 1995 Logged by: HWB

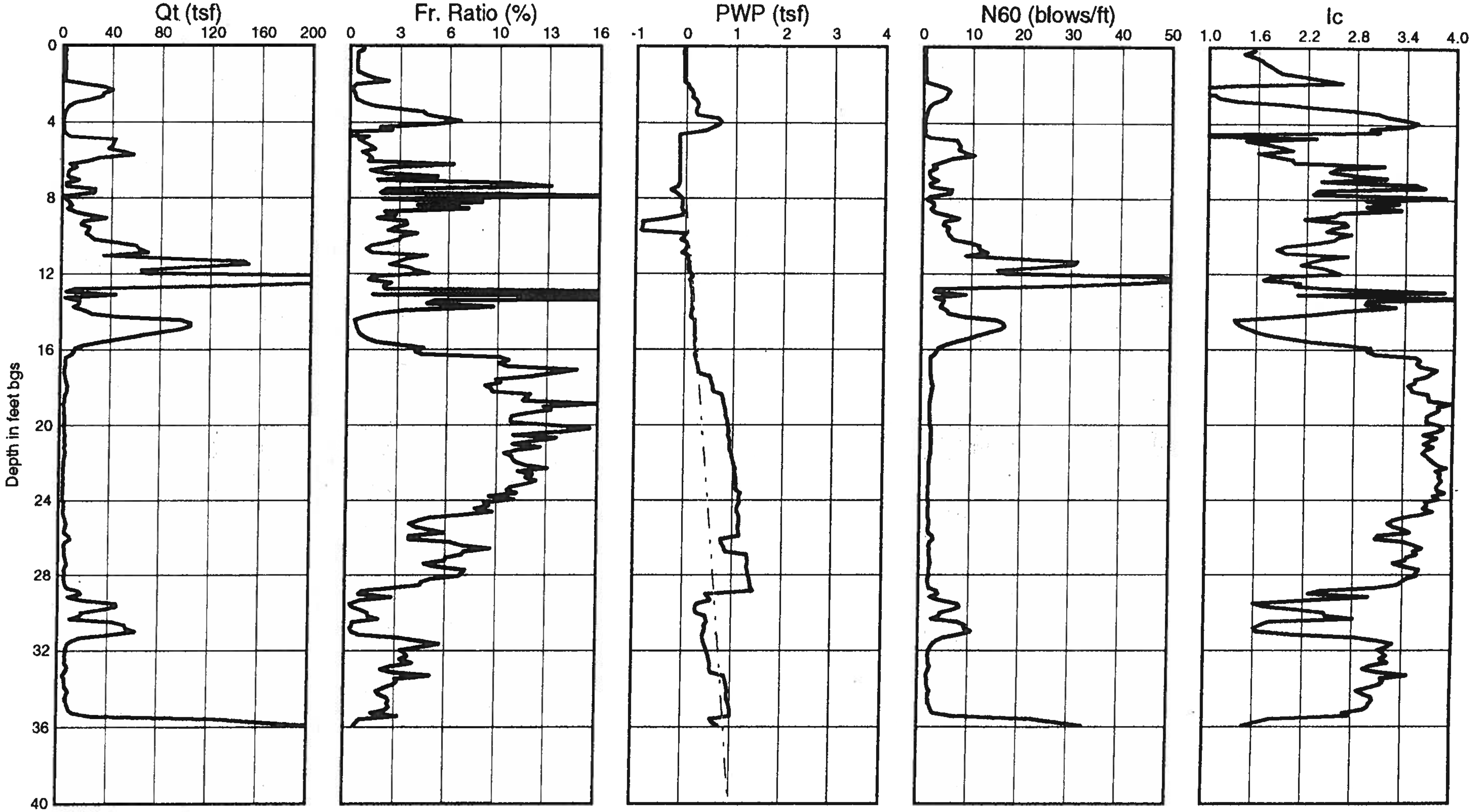
AGRA Earth and Environmental, Inc.

Cone Penetration Test - A18

Test Date : Sept 08, 1995
Location : Kenmore LakePointe Development

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 25.00
Water Table Depth : 8.00



Qt normalized for
unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 120 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 11-10459-01
DATE: Sept. 8, 1995
DRAWN BY: Keith Brown

AGRA E & E, Inc.

Kenmore Lakepointe
PROJECT: Development

W.O. 11-10459-00 BORING NO. A-19

Page 1 of 2

DEPTH (feet)

SOIL DESCRIPTION
Location: 5' N & 15' NE from Corner of Ecology Block Wall
Approximate ground surface elevation: 24 feet

SAMPLE TYPE | SAMPLE NUMBER | GROUND WATER | TESTING

0

Loose, damp to moist, brown, silty SAND with some gravels, quarry spalls and organics (Fill)

Very loose to loose, moist to wet, blackish gray to blackish brown, silty SAND with some gravels and debris (wood, plastic, concrete, wire, etc.) (Wood Debris Fill)

5

S-1

ATD

Becoming wet to saturated

10

S-2

Wood log 14 to 15 feet

15

Very soft, wet to saturtaed, brown, fibrous to amorphous PEAT

S-3

S-4

20

S-5

Very soft, wet, brown, organic SILT with some clay and interbeds of PEAT

25

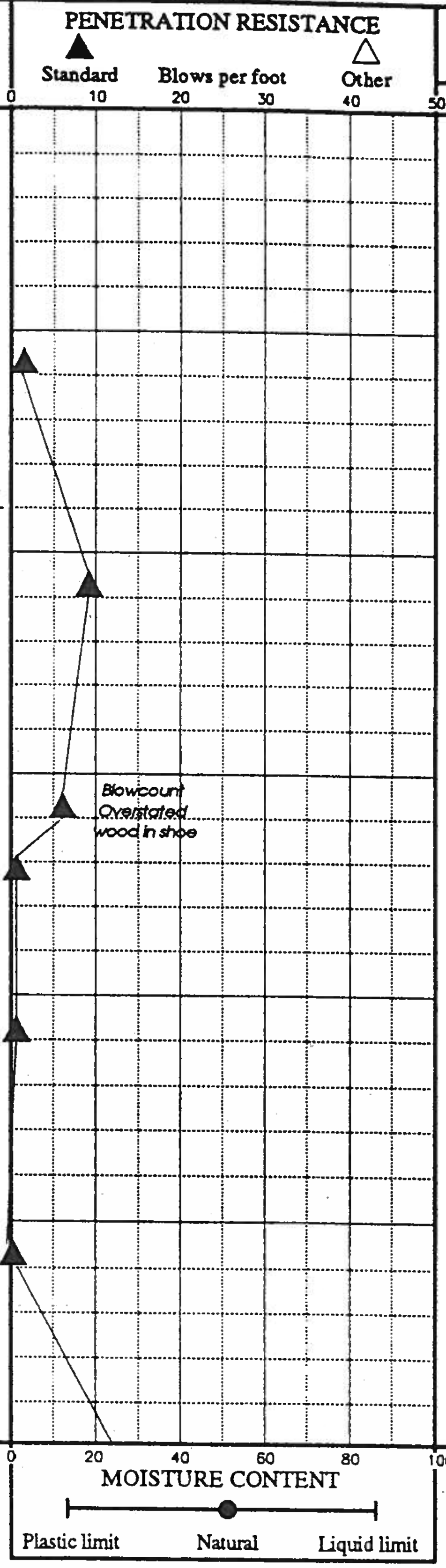
S-6

Very soft, wet to saturated, brown, fibrous to amorphous PEAT

Medium dense, saturated, tannish gray, sandy GRAVEL with some silt

(continued)

30



Blowcount Overstated wood in shoe

LEGEND

2.00-inch OD split-spoon sample

Sample not recovered

Groundwater level at time of drilling

3.00-inch OD Shelby tube sample

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

Drilling method: HSA/Mud Rotary Hammer type: Mechanical Date drilled: 07 September 1995 Logged by: HWB

AGRA Earth and Environmental, Inc.

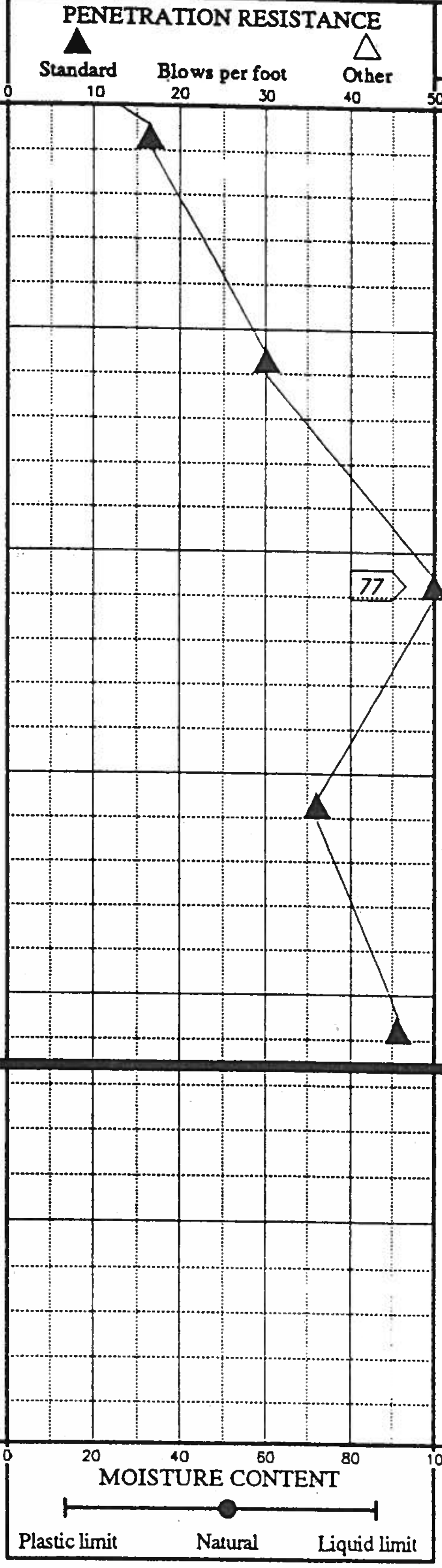
PROJECT: Kenmore Lakepointe Development W.O. 11-10459-00 BORING NO. A-19

Page 2 of 2

Location: 5' N &15" NE from Corner of Ecology Block Wall

Approximate ground surface elevation: 24 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
30	Medium dense, saturated, tannish gray, sandy GRAVEL with some silt (As Above)	I	S-7	
35	Medium dense to dense, saturated, light gray, fine to medium SAND with some silt to silty, fine to medium SAND	I	S-8	
40	Very dense, saturated, greenish gray, silty, sandy GRAVEL	I	S-9	
45 50	Dense, saturated, tannish gray to gray, sandy GRAVEL to gravelly SAND with trace to some silt	I I	S-10 S-11	
55 60	Boring terminated at approximately 51.5 feet. Switched to mud rotary at 20 feet.			



TESTING

LEGEND

- I 2.00-inch OD split-spoon sample
- ATD Groundwater level at time of drilling
- II 3.00-inch OD Shelby tube sample
- X Sample not recovered

AGRA Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

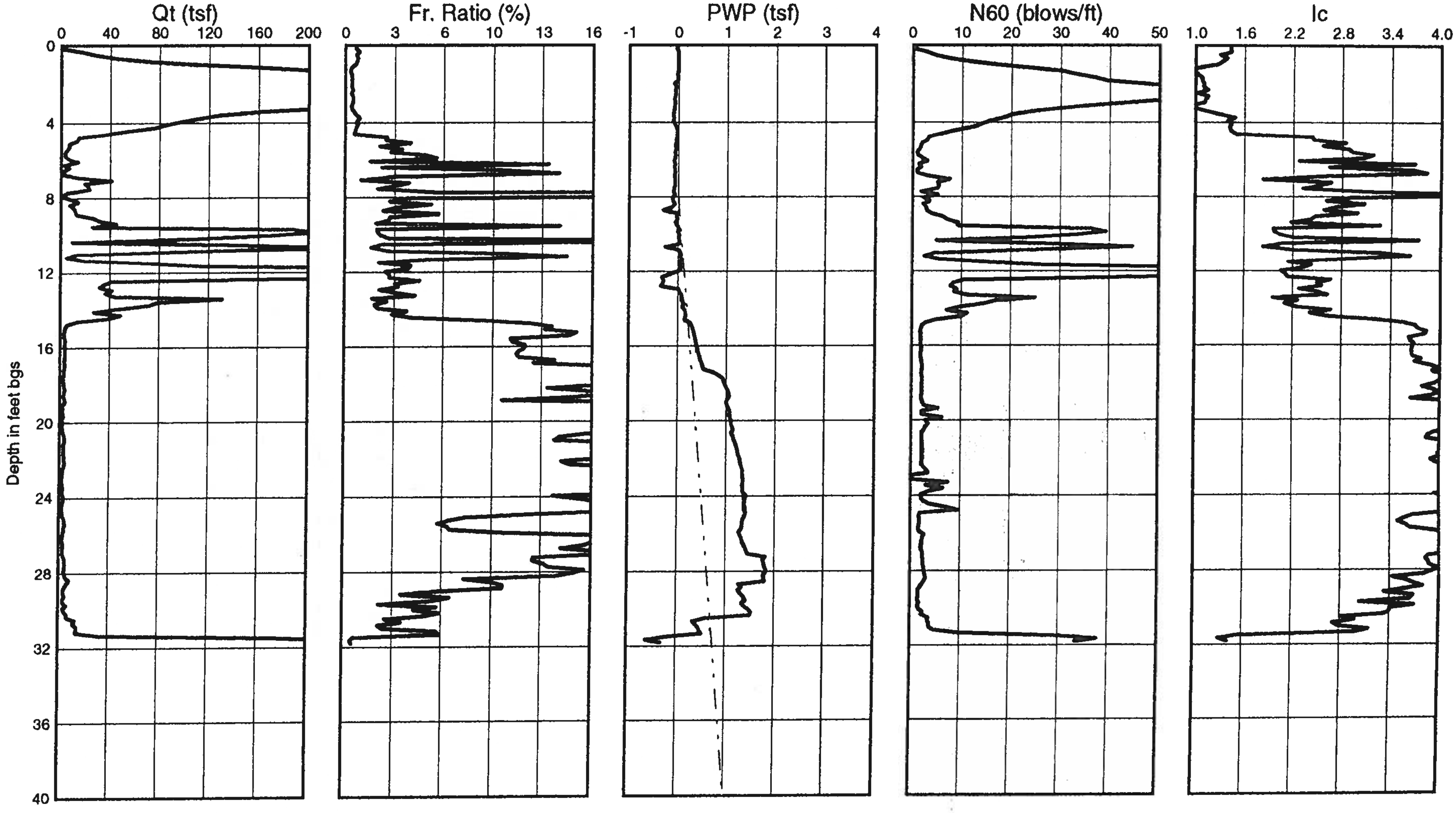
Drilling method: HSA/Mud Rotary Hammer type: Mechanical Date drilled: 07 September 1995 Logged by: HWB

Cone Penetration Test - A20

Test Date : Sept 07, 1995
Location : Kenmore LakePointe Development

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 23.80
Water Table Depth : 8.00



Qt normalized for
unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 120 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

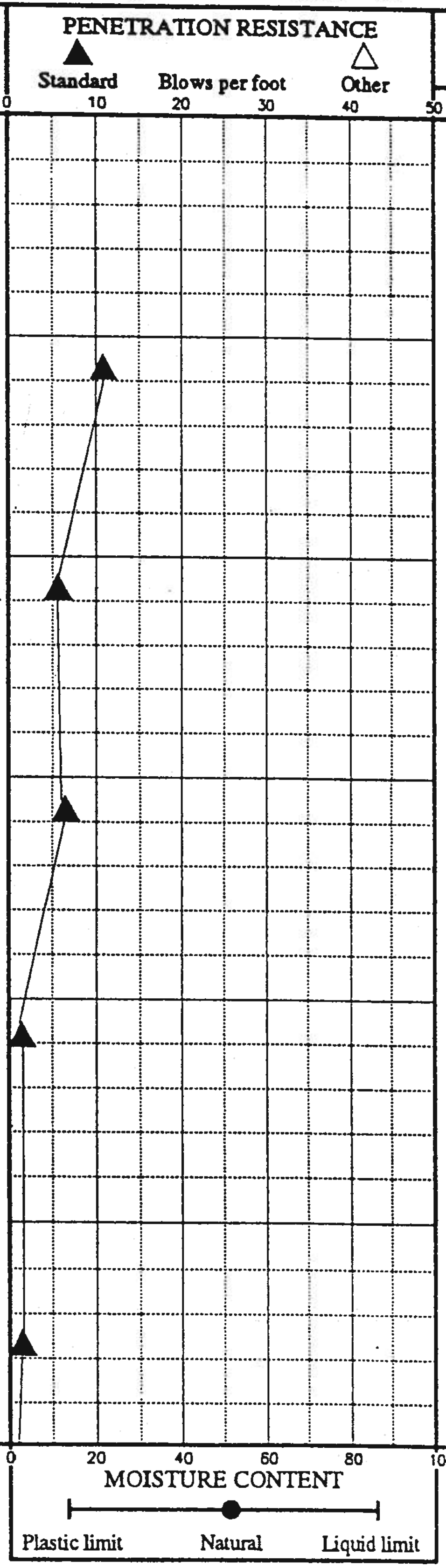
PROJECT NO. 11-10459-01 DATE: Sept. 8, 1995 DRAWN BY: Keith Brown

AGRA E & E, Inc.

PROJECT: Kenmore Lakepointe Development
W.O. 11-10459-00
BORING NO. A-21
Page 1 of 3

SOIL DESCRIPTION
Location: 75' SW of SW Corner of Asphalt Pad
Approximate ground surface elevation: 26.5 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
0	Medium dense to dense, damp, tan, silty SAND matrix around 2" to 4" Angular Rock (Fill)			
	Loose to medium dense, moist to wet, blackish brown-brown-tan, silty, sandy matrix with some gravel in debris fill (wood, brick, metal, wire, concrete, etc.) (Wood Debris Fill)			
5		I	S-1	
10	Becoming wet to saturated	I	S-2	▼ ATD
15		I	S-3	
	Very soft to soft, wet to saturated, brown, fibrous to amorphous PEAT			
20		I	S-4	
25		II	S-5	
	Very loose, saturated, gray, silty, very fine SAND			
	Soft, wet, gray, clayey SILT	I	S-6	
30	(continued)			



LEGEND

I	2.00-inch OD split-spoon sample
X	Sample not recovered
▼ ATD	Groundwater level at time of drilling
II	3.00-inch OD Shelby tube sample

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling method: HSA/Mud Rotary Hammer type: Mechanical Date drilled: 08 September 1995 Logged by: HWB

PROJECT: Kenmore Lakepointe Development

W.O. 11-10459-00

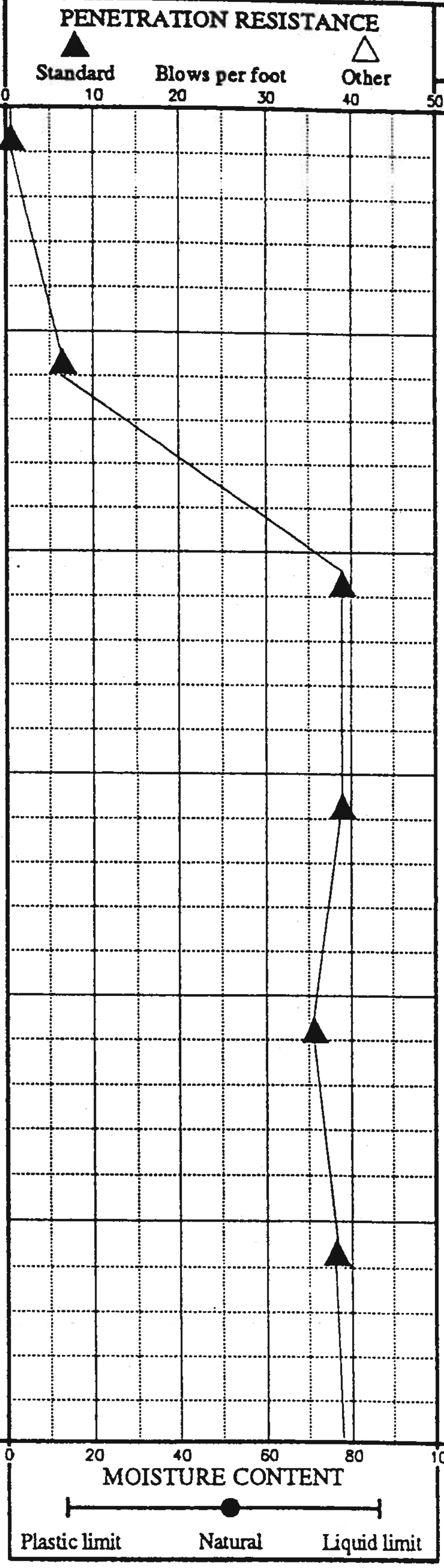
BORING NO. A-21

Page 2 of 3

Location: 75' SW of SW Corner of Asphalt Pad

Approximate ground surface elevation: 26.5 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
30	*Very loose, saturated, gray, silty, fine to medium SAND*	I	*S-7*	
	Interbedded soft, wet, brown PEAT with soft to medium stiff, wet, clayey SILT, loose, saturated, gray, coarse SAND with trace silt and loose, saturated, blackish gray, silty, fine SAND with some medium and coarse sand and organics (Heave?)			
35		I	*S-8*	
	Dense, saturated, greenish gray, silty, sandy GRAVEL			
40		I	*S-9*	
	Grading to a gray, medium SAND with some gravel and silt			
45		I	*S-10*	
	Dense, saturated, gray, medium SAND with trace to some silt and trace gravel			
50		I	*S-11*	
55		I	*S-12*	
60	*(continued)*			



TESTING

LEGEND

I 2.00-inch OD split-spoon sample

X Sample not recovered

▼ ATD Groundwater level at time of drilling

II 3.00-inch OD Shelby tube sample

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

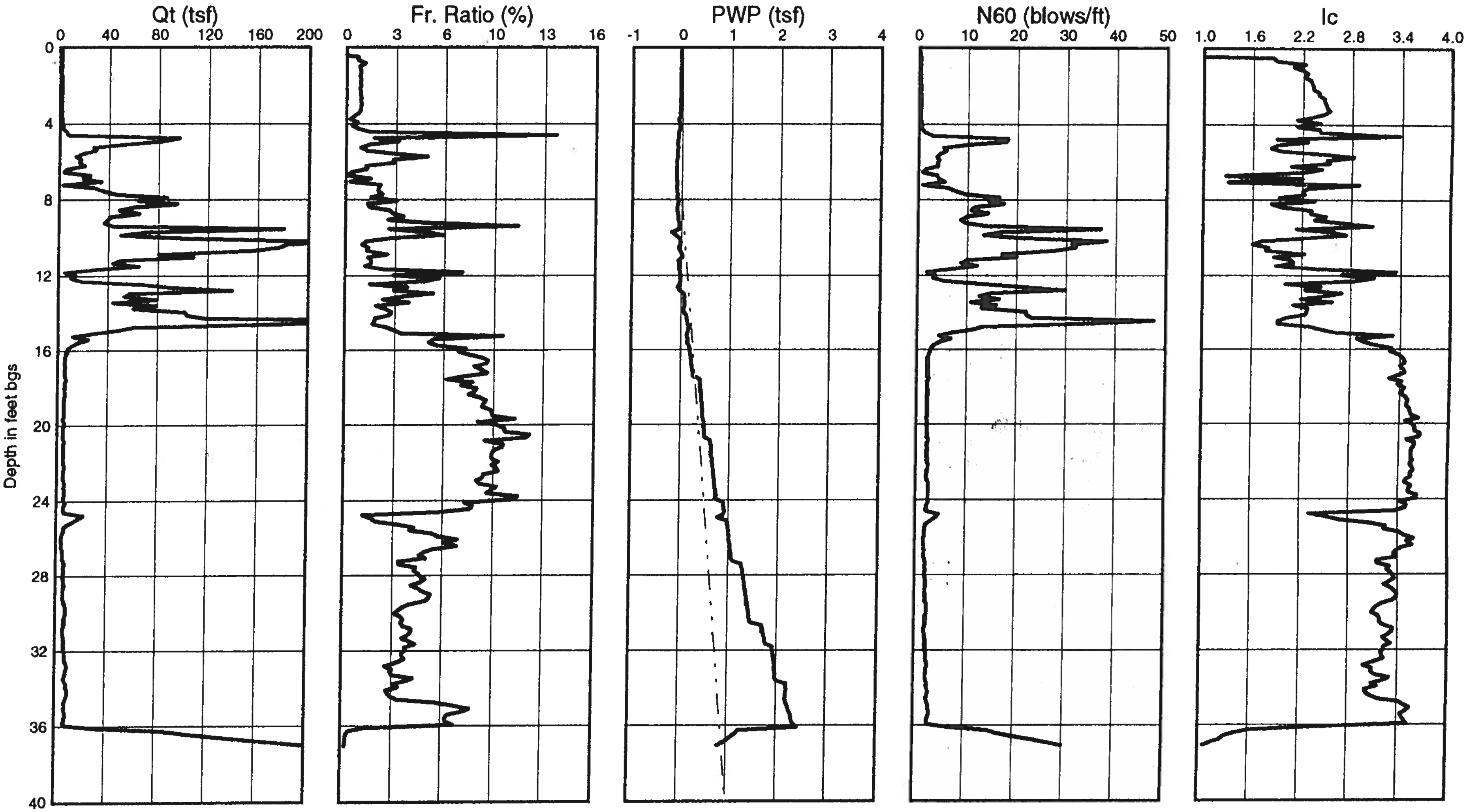
Drilling method: *HSA/Mud Rotary* Hammer type: *Mechanical* Date drilled: *08 September 1995* Logged by: *HWB*

Cone Penetration Test - A22

Test Date : Sept 08, 1995
Location : Kenmore LakePointe Development

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 27.30
Water Table Depth : 8.00



Qt normalized for
unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 120 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 11-10459-01 DATE: Sept. 8, 1995 DRAWN BY: Keith Brown

AGRA E & E, Inc.

Kenmore Lakepointe
PROJECT: Development

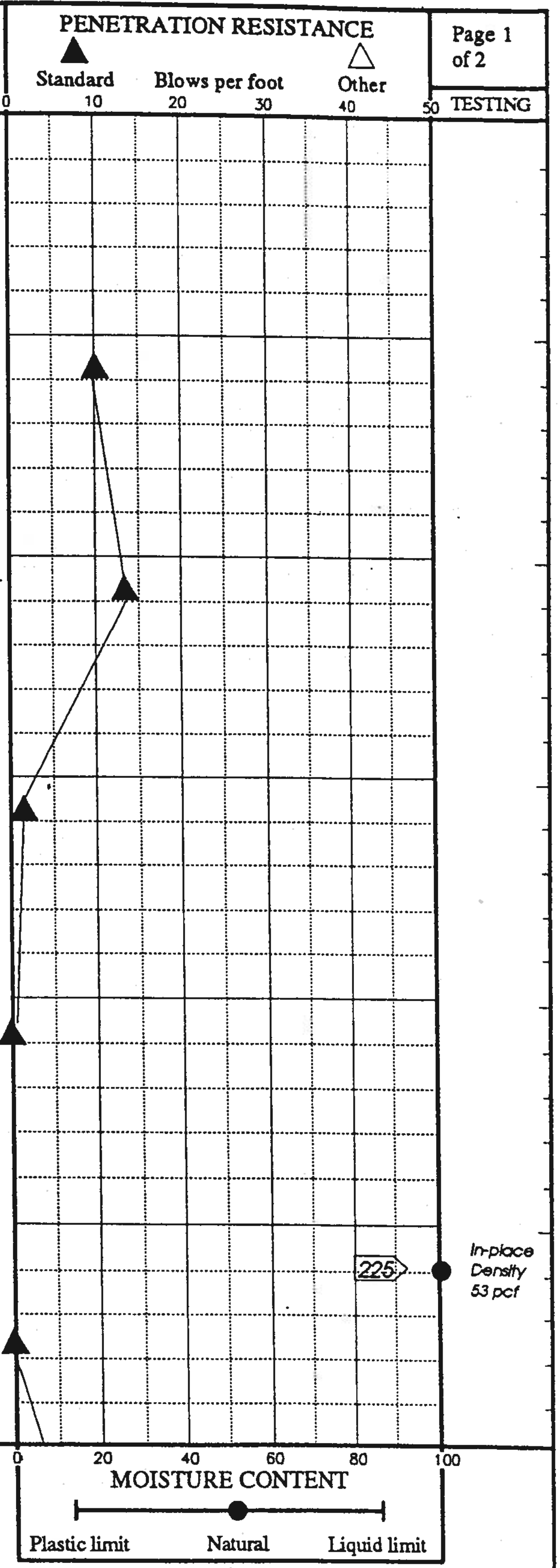
W.O. 11-10459-00

BORING NO. A-23

Page 1 of 2

SOIL DESCRIPTION
Location: 7' N & 36' W from Fence Corner
Approximate ground surface elevation: 27 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
0	Medium dense, damp, tan, GRAVEL and ROCK with silty sand matrix			
	Loose to medium dense, moist to wet, blackish tan, brown, silty sand matrix with some gravel in debris fill (concrete, wood, brick, metal, wire, etc.) (Wood Debris Fill)			
5		I	S-1	
10	Becoming wet to saturated	I	S-2	ATD
15	Very soft, wet to saturated, brown with some blackish brown, fibrous to amorphous PEAT with some organic silt	I	S-3	
20		I	S-4	
25	Very soft, wet, gray, clayey SILT/SILT with some clay and trace organics	II	S-5	
		I	S-6	
30	(continued)			



LEGEND

I 2.00-inch OD split-spoon sample

X Sample not recovered

▼ ATD Groundwater level at time of drilling

II 3.00-inch OD Shelby tube sample

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling method: HSA/Mud Rotary Hammer type: Mechanical Date drilled: 12 September 1995 Logged by: HWB

Kenmore Lakepointe
PROJECT: Development

W.O. 11-10459-00 **BORING NO.** A-23

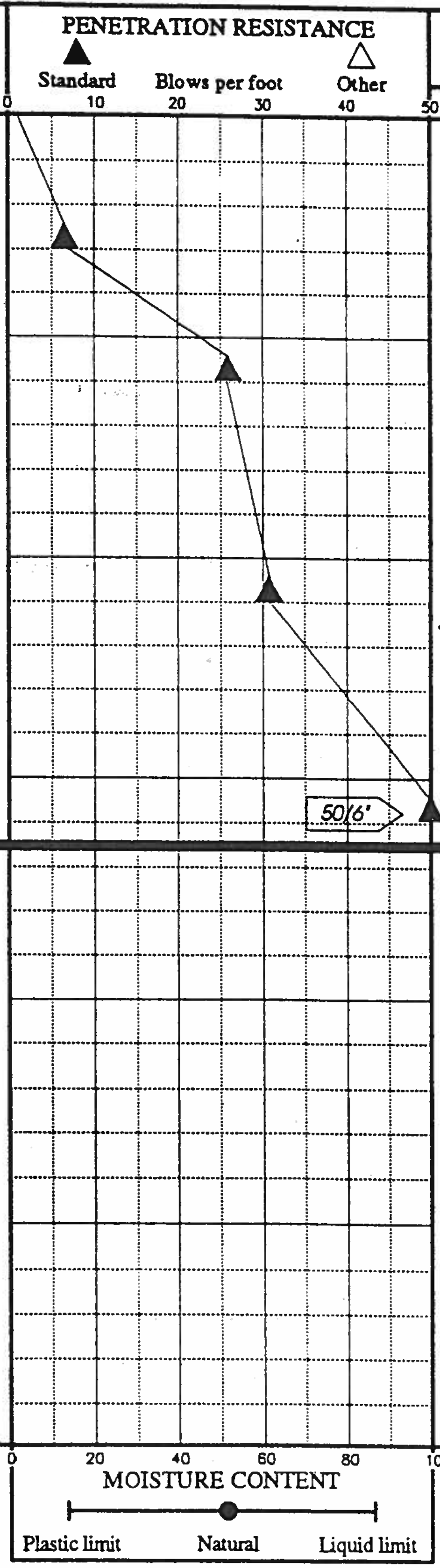
Page 2 of 2

SOIL DESCRIPTION

Location: 7' N & 36' W from Fence Corner

Approximate ground surface elevation: 27 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE NUMBER
30	*Soft to medium stiff, wet, gray, clayey SILT to SILT with some clay*	S-7
	Interbedded loose, saturated, gray, fine to medium SAND with some silt and medium stiff, wet, gray, SILT with some fine sand with a silty, fine sand lens	S-8
35	*Medium dense, saturated, gray, gravelly SAND with trace to some silt*	S-9
40	*Dense, saturated, greenish gray, sandy GRAVEL with some silt to silty, sandy GRAVEL*	S-10
45	*Very dense, saturated, greenish gray, cobbly GRAVELS with silty sand matrix*	S-11
	Boring terminated at approximately 46.5 feet. Switch to mud rotary at 40 feet.	
50		
55		
60		



TESTING

LEGEND

- 2.00-inch OD split-spoon sample
- Sample not recovered
- ATD Groundwater level at time of drilling
- 3.00-inch OD Shelby tube sample

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

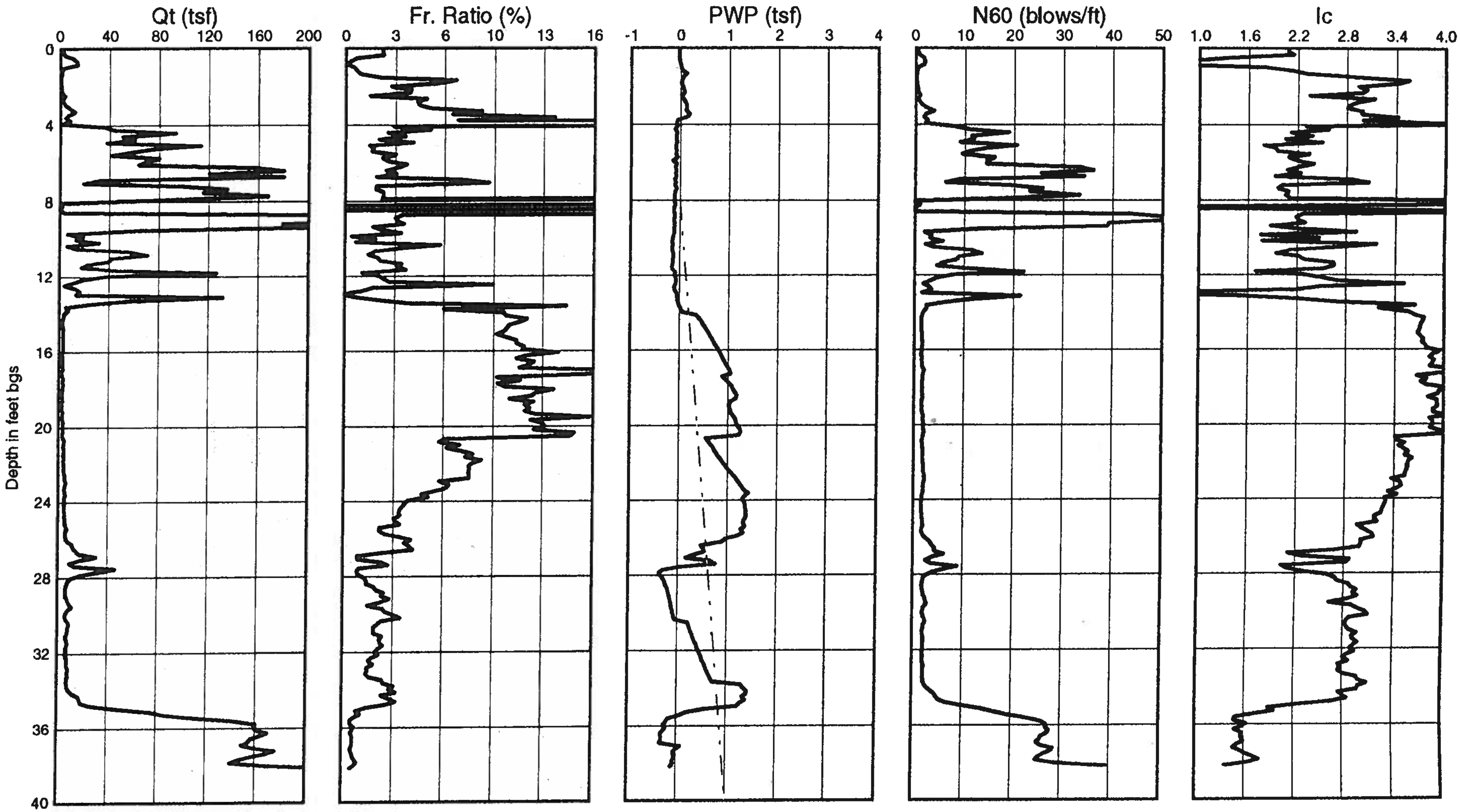
Drilling method: HSA/Mud Rotary **Hammer type:** Mechanical **Date drilled:** 12 September 1995 **Logged by:** HWB

Cone Penetration Test - A24

Test Date : Sep 06, 1995
Location : Kenmore LakePointe Development

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 28.90
Water Table Depth : 8.00



Qt normalized for
unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 120 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 11-10459-01 DATE: Sept. 8, 1995 DRAWN BY: Keith Brown

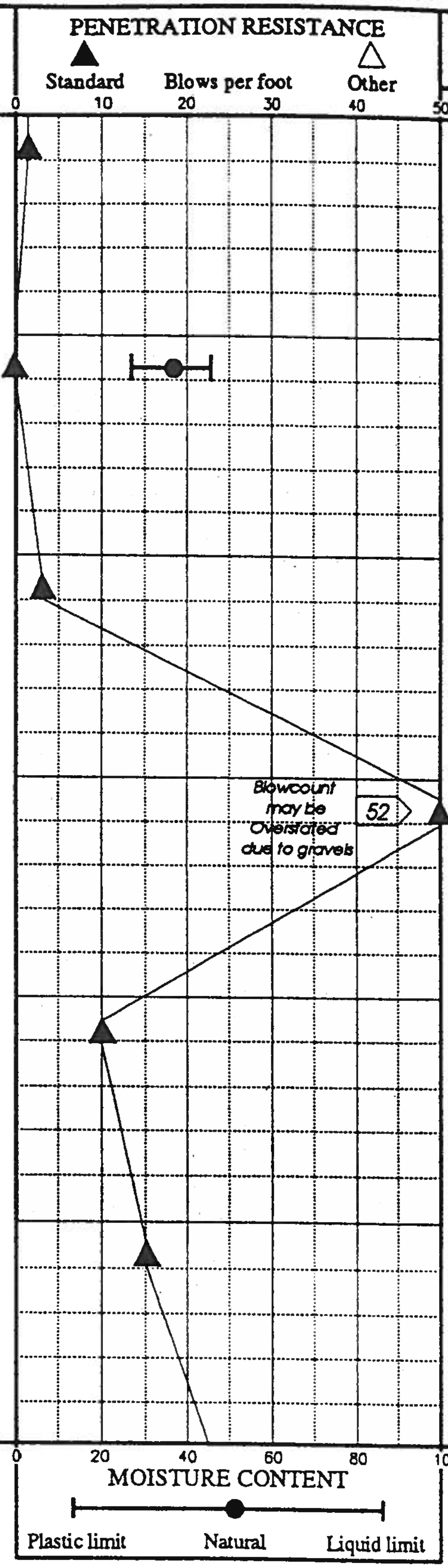
AGRA E & E, Inc.

PROJECT: Kenmore Lakepointe Development W.O. 11-10459-00 BORING NO. A-25

Page 2 of 3

Location: 35' S & 15' W of SW Corner of Structure
Approximate ground surface elevation: 29.5 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
30	Very soft to soft, wet to saturated, blackish brown, amorphous PEAT to fibrous PEAT	I	S-7	
	Interbeds of very loose, saturated, gray, silty, fine SAND at 31.5 feet			
	Very soft to soft, wet, bluish gray, clayey SILT/silty CLAY with trace very fine sand and organics			
35		I	S-8	
	Soft, wet, bluish gray, very fine sandy SILT with trace organics			
40	Volcanic ash layer at 40.5 feet	I	S-9	
	Dense to very dense, saturated, gray, sandy GRAVEL with trace to some silt			
45		I	S-10	
	Loose/stiff, wet to saturated, bluish gray, silty, fine SAND/very fine sandy SILT with scattered organics			
50		I	S-11	
	Grading into medium dense, saturated, gray, silty, fine SAND			
55		I	S-12	
	Medium dense, saturated, light gray, fine to medium SAND with some silt and trace gravel			
60	(continued)			



TESTING

LEGEND

I 2.00-inch OD split-spoon sample

X Sample not recovered

▼ ATD Groundwater level at time of drilling

II 3.00-inch OD Shelby tube sample

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

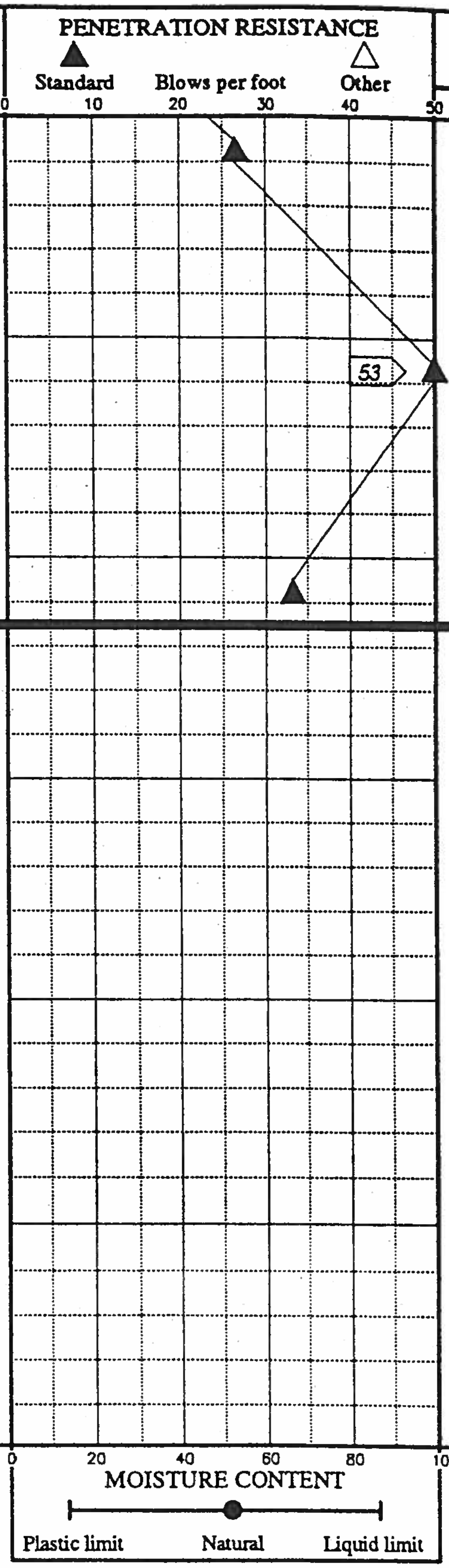
Drilling method: HSA/Mud Rotary Hammer type: Mechanical Date drilled: 06 September 1995 Logged by: HWB

Kenmore Lakepointe
PROJECT: Development W.O. 11-10459-00 BORING NO. A-25

Page 3 of 3

SOIL DESCRIPTION
Location: 35' S & 15' W of SW Corner of Structure
Approximate ground surface elevation: 29.5 feet

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER
60	Medium dense to dense, saturated, light gray, fine to medium SAND with some silt and trace gravel (As Above)	I	S-13	
	Hard, moist to wet, bluish gray, clayey SILT to SILT with some clay			
65		I	S-14	
	Very dense, wet to saturated, tan, gravelly SAND/sandy GRAVEL with some silt			
70	Grades to dense, sandy GRAVEL	I	S-15	
	Boring terminated at approximately 71.5 feet. Switched to mud rotary at 65 feet.			
75				
80				
85				
90				



TESTING

LEGEND

I 2.00-inch OD split-spoon sample

X Sample not recovered

▼ ATD Groundwater level at time of drilling

II 3.00-inch OD Shelby tube sample

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

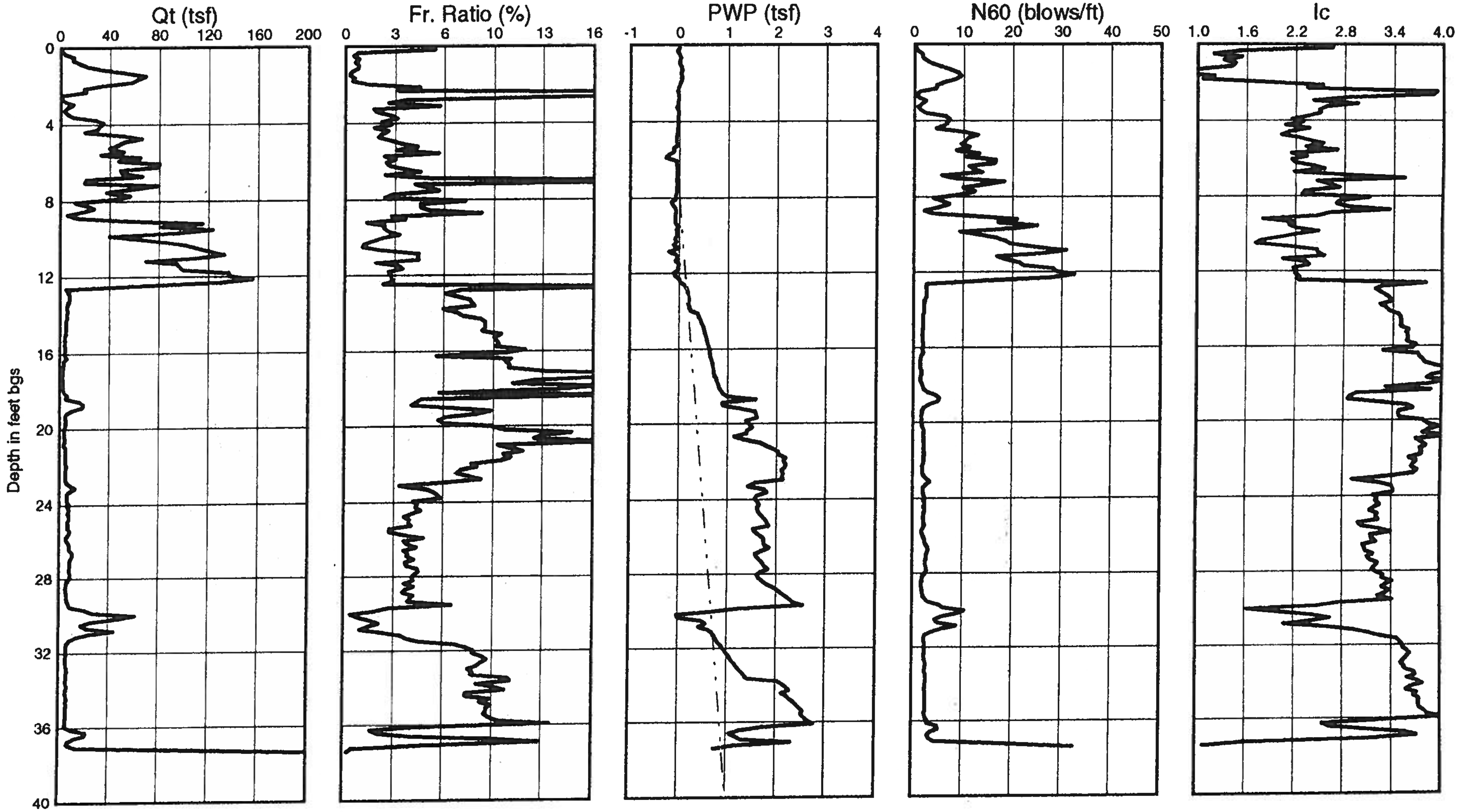
Drilling method: HSA/Mud Rotary Hammer type: Mechanical Date drilled: 06 September 1995 Logged by: HWB

Cone Penetration Test - A26

Test Date : Sep 06, 1995
Location : Kenmore LakePointe Development

Operator : Northwest Cone Exploration

Ground Surf. Elev. : 28.00
Water Table Depth : 8.00



Qt normalized for
unequal end area effects

Fr Ratio = 100*F/(Qt-Sigmav)
Gamma = 120 pcf

After Jefferies and Davies (1993)

After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 <Ic < 1.90 - Clean to silty sand
1.90 <Ic < 2.54 - Silty sand to sandy silt
2.54 <Ic < 2.82 - Clayey silt to silt clay
2.82 <Ic < 3.22 - Clays

PROJECT NO. 11-10459-01 DATE: Sept. 8, 1995 DRAWN BY: Keith Brown

AGRA E & E, Inc.

PROJECT: Kenmore Lakepointe Development

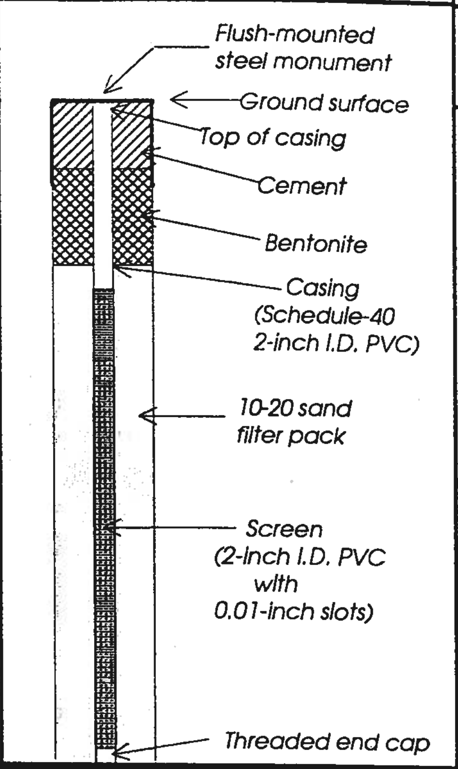
W.O. 11-10459-00 WELL NO. AW-1

Elevation reference: King County Datum NAD 1983
Ground surface elevation: 27 feet
Well completed: 22 September 1995
Casing elevation: 26.76 feet

AS-BUILT DESIGN

Page 1 of 1

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER	TESTING
0	2" Asphalt over 2" Angular Base Course						
	Loose, moist, dark brown, wood debris with 0-25% silty SAND (Wood Debris Fill)						
			S-1	5	0		
5	Soft to very soft, wet, dark gray, fine sandy, organic SILT with plant matter (no odor)		S-2	3	0	▽ 10/2/95	
			S-3	0	0		
10	Very stiff, wet, dark brown, peaty SILT with sand (no odor)		S-4	22	0		
	Very loose, moist, dark brown, peaty, fine SAND (no odor)		S-5	0	0		
15	Bottom of boring at 14 feet.						
20							
25							
30							



Unique Ecology Well No. ABN 249.

LEGEND

- 2-inch O.D. split-spoon sample
- ▽ Observed groundwater level 0/00/00 = date observed

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling started: 22 September 1995 Drilling completed: 22 September 1995 Logged by: DHG

PROJECT: *Kenmore Lakepointe Development*

W.O. *11-10459-00* WELL NO. *AW-2*

Elevation reference: *King County Datum NAD 1983*

Ground surface elevation: *29 feet*

Well completed: *20 September 1995*

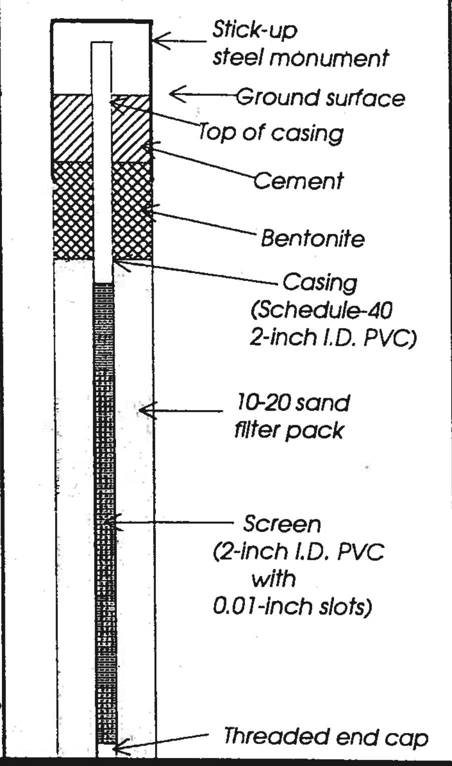
Casing elevation: *31.32 feet*

AS-BUILT DESIGN

Page 1 of 1

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER
0	*Very dense, damp to moist, gray, silty, sandy, angular GRAVEL (no odor) (Fill)*		S-1	50/ 5"	0	
5	*Dense to very loose, wet to saturated, wood debris with 0-25% black, sandy, organic SILT (Wood Debris Fill)*		S-2	9	0	
	With brick fragments		S-3	32	0	
10			S-4	46	0	
	With angular gravel		S-5	4	0	▽ 10/2/95
15	*Bottom of boring at 14 feet.*					
20						
25						
30						

TESTING



Unique Ecology Well No. ABN 247.

LEGEND

I 2-inch O.D. split-spoon sample

▽ Observed groundwater level 0/00/00 = date observed

AGRA

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Kirkland, Washington 98034-6918

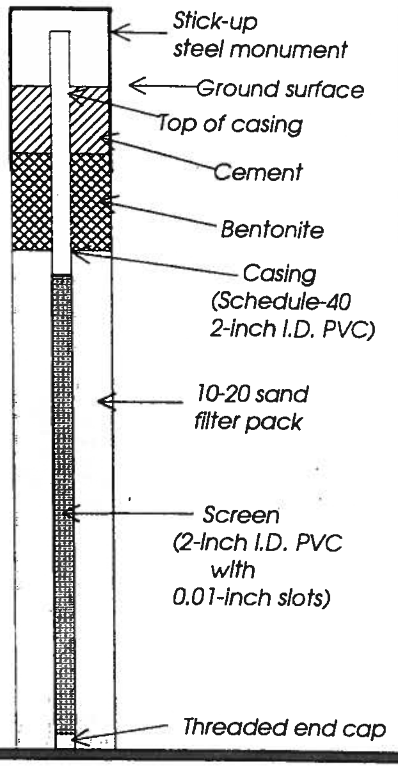
AGRA Earth and Environmental, Inc.

Drilling started: *20 September 1995* Drilling completed: *20 September 1995* Logged by: *DHG*

PROJECT: Kenmore Lakepointe Development W.O. 11-10459-00 WELL NO. AW-3

Elevation reference: King County Datum NAD 1983	Well completed: 19 September 1995	AS-BUILT DESIGN	Page 1 of 1
Ground surface elevation: 25.5 feet	Casing elevation: 28.23 feet		

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER
0	*Medium dense, wet, white to gray, silty SAND with gravel, concrete wash (Fill)*					
	Medium dense to very loose, wet to water-bearing, brown, wood debris with 0-50% gray, silty SAND with gravel (no odor) (Wood Debris Fill)	I	S-1	12	0	
5		I	S-2	3	0	
		I	S-3	1	0	
						▽ 10/2/95
10		I	S-4	10	0	
	Soft, wet, dark brown, amorphous PEAT (no odor)					
		I	S-5	2	0	
15	*Bottom of boring at 14 feet.*					
20						
25						
30						



Unique Ecology Well No. ABN 244.

TESTING

LEGEND

I 2-inch O.D. split-spoon sample

▽ 0/00/00 Observed groundwater level 0/00/00 = date observed

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Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling started: 19 September 1995 Drilling completed: 19 September 1995 Logged by: DHG

Kenmore Lakepointe
PROJECT: Development

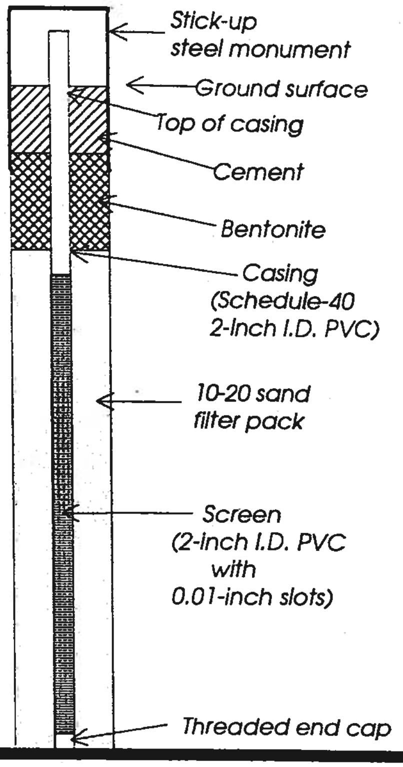
W.O. 11-10459-00 WELL NO. AW-4

Elevation reference: King County Datum NAD 1983
Ground surface elevation: 25 feet
Well completed: 19 September 1995
Casing elevation: 27.61 feet

AS-BUILT DESIGN

Page 1 of 1

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER	TESTING
0							
	Medium dense, wet to damp, brown and gray mixed, silty, fine to medium SAND and fine GRAVEL with sand and silt (no odor) (Fill)	I	S-1	24	0		
5		I	S-2	10	0		
	Very loose to very dense, saturated, brown, wood debris with 0-25% silty SAND (no odor) (Wood Debris Fill)	I	S-3	1	0		
10		I	S-4	50/ 3"	0	▽ 10/2/95	
		I	S-5	50/ 2"	0		
15	Bottom of boring at 14 feet.						
20							
25							
30							



Unique Ecology Well No. ABN 243.

LEGEND

I 2-inch O.D. split-spoon sample

▽ 0/00/00 Observed groundwater level 0/00/00 = date observed

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AGRA Earth and Environmental, Inc.

Drilling started: 19 September 1995
Drilling completed: 19 September 1995
Logged by: DHG

PROJECT: Kenmore Lakepointe Development

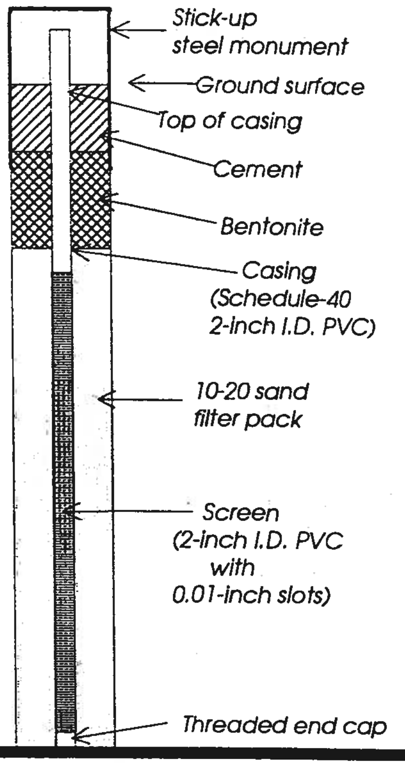
W.O. 11-10459-00 WELL NO. AW-5

Elevation reference: King County Datum NAD 1983
Ground surface elevation: 27 feet
Well completed: 19 September 1995
Casing elevation: 29.71 feet

AS-BUILT DESIGN

Page 1 of 1

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER	TESTING
0	Very dense, moist, brown, silty, medium SAND with gravel and 50% wood debris (no odor) (Fill)		S-1	50/ 4"	0		
5	Loose to medium dense, wet to saturated, brown, wood debris with 0-25% silty SAND, brick and concrete fragments (creosote like odor) (Wood Debris Fill)		S-2	6	0		
			S-3	6	0		
10			S-4	16	0		
			S-5	6	0		
15	Bottom of boring at 14 feet.						
20							
25							
30							



Unique Ecology Well No. ABN 242.

LEGEND

2-inch O.D. split-spoon sample

▽ Observed groundwater level
0/00/00 = date observed

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Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling started: 19 September 1995 Drilling completed: 19 September 1995 Logged by: DHG

PROJECT: Kenmore Lakepointe Development

W.O. 11-10459-00 WELL NO. AW-6

Elevation reference: King County Datum NAD 1983

Ground surface elevation: 26.5 feet

Well completed: 19 September 1995

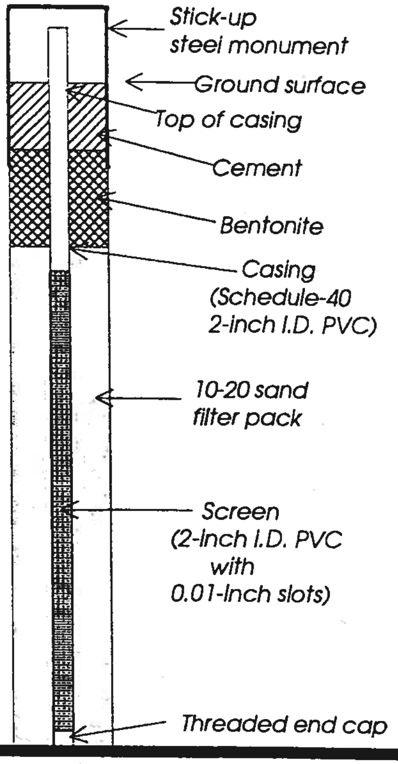
Casing elevation: 28.46 feet

AS-BUILT DESIGN

Page 1 of 1

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER
0	Loose, moist, tan, silty, gravelly SAND (Fill)					
	Loose, wet, brown, silty SAND with 50% wood debris (no odor) (Fill)		S-1	5	0	
5			S-2	3	0	
	Loose to very loose, saturated, brown, wood debris with 0-25% sandy SILT (no odor) (Wood Debris Fill)		S-3	0	0	
10			S-4	22	0	▽ 10/2/95
			S-5	0	0	
15	Bottom of boring at 14 feet.					
20						
25						
30						

TESTING



Unique Ecology Well No. ABN 241.

LEGEND

I 2-inch O.D. split-spoon sample

▽ 0/00/00 Observed groundwater level 0/00/00 = date observed

AGRA Earth & Environmental
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Kirkland, Washington 98034-6918

Drilling started: 19 September 1995 Drilling completed: 19 September 1995 Logged by: DHG

PROJECT: Kenmore Lakepointe Development

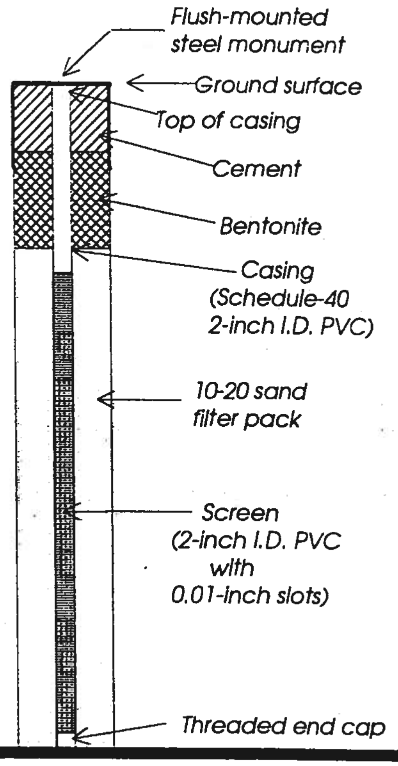
W.O. 11-10459-00 WELL NO. AW-7

Elevation reference: King County Datum NAD 1983
Ground surface elevation: 25.5 feet
Well completed: 20 September 1995
Casing elevation: 25.18 feet

AS-BUILT DESIGN

Page 1 of 1

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER
0	*Medium dense, moist, tan, silty SAND with gravel (Fill)*					
	Loose to very loose, wet to saturated, brown to black, wood debris with 0-25% black, silty SAND (no odor) (Wood Debris Fill)	I	S-1	8	0	
5		I	S-2	4	0	
						▽ 10/2/95
		I	S-3	6	0	
10		I	S-4	3	0	
	Very soft, wet, brown, amorphous PEAT (no odor)	I	S-5	0	0	
15	*Bottom of boring at 14 feet.*					
20						
25						
30						



Unique Ecology Well No. ABN 248.

TESTING

LEGEND

I 2-inch O.D. split-spoon sample

▽ 0/00/00 Observed groundwater level 0/00/00 = date observed

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Earth & Environmental
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Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling started: 20 September 1995
Drilling completed: 20 September 1995
Logged by: DHG

Kenmore Lakepointe
PROJECT: Development

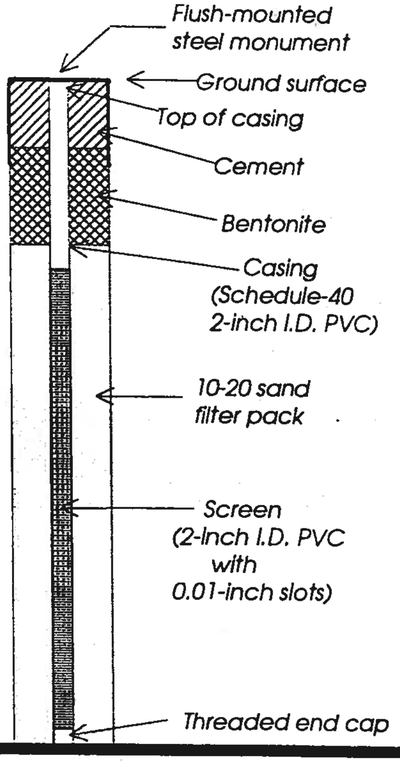
W.O. 11-10459-00 WELL NO. AW-8

Elevation reference: King County Datum NAD 1983
Ground surface elevation: 26 feet
Well completed: 20 September 1995
Casing elevation: 26.16 feet

AS-BUILT DESIGN

Page 1 of 1

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER	TESTING
0	2" Asphalt over 2" Angular Base Course						
	Loose, moist, brown and gray, silty SAND with 50% wood debris (creosote like odor) (Fill)	I	S-1	7	0		
5	Loose to medium dense, wet to saturated, brown and black, wood debris with 25-50% silty GRAVEL and sandy, organic SILT (creosote like odor) (Wood Debris Fill)	I	S-2	10	0		
		I	S-3	12	0	▽ 10/2/95	
10	With concrete washout	I	S-4	18	0		
		I	S-5	50/ 3"	0		
15	Bottom of boring at 14 feet.						
20							
25							
30							



Unique Ecology Well No. ABN 245.

LEGEND

I 2-inch O.D. split-spoon sample

▽ Observed groundwater level
0/00/00 0/00/00 = date observed

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling started: 20 September 1995
Drilling completed: 20 September 1995
Logged by: DHG

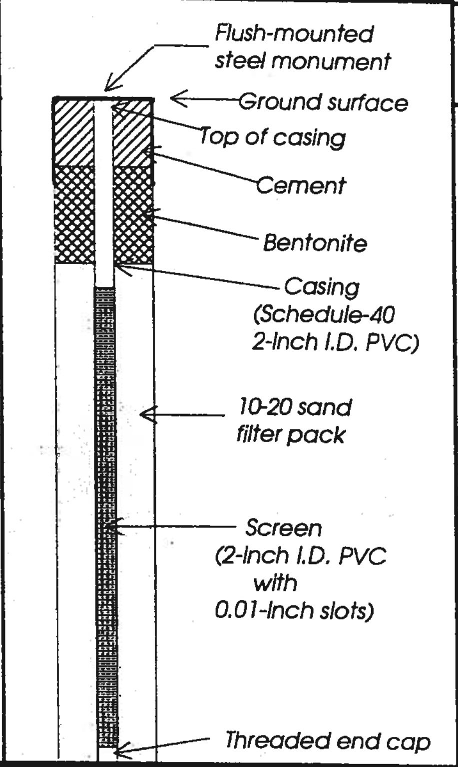
PROJECT: *Kenmore Lakepointe Development* W.O. *11-10459-00* WELL NO. *AW-9*

Elevation reference: *King County Datum NAD 1983*
Ground surface elevation: *30 feet*
Well completed: *20 September 1995*
Casing elevation: *30.22 feet*

AS-BUILT DESIGN

Page 1 of 1

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER	TESTING
0	*3" Asphalt over 2" Angular Base Course*						
	Medium dense, damp, light brown, silty, medium SAND (no odor) (Fill)		*S-1*	*15*	*0*		
5	*Loose to medium dense, wet to saturated, gravelly, fine to coarse SAND with some silt (no odor)*		*S-2*	*10*	*0*		
			S-3	*12*	*0*	▽ 10/2/95	
10			*S-4*	*6*	*0*		
	Very loose, saturated, red-tan, silty, fine SAND (no odor)		*S-5*	*3*	*0*		
15	*Bottom of boring at 14 feet.*						
20							
25							
30							



Unique Ecology Well No. ABN 246.

LEGEND

I 2-inch O.D. split-spoon sample

▽ 0/00/00 Observed groundwater level 0/00/00 = date observed

AGRA Earth and Environmental, Inc.

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

Drilling started: *20 September 1995* Drilling completed: *20 September 1995* Logged by: *DHG*

PROJECT: *Kenmore Lakepointe Development*　　W.O. *11-10459-00* WELL NO. *AW-10*

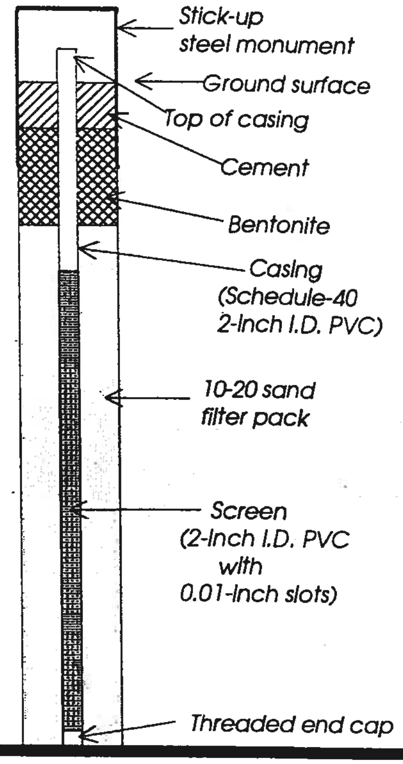
Elevation reference: *King County Datum NAD 1983*　　Well completed: *27 February 1996*

Ground surface elevation: *27 feet*　　Casing elevation: *31.12 feet*

Page 1 of 1

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER
0	*Very loose, wet, brown, silty, fine SAND with wood fragments (Fill)*					
		I	S-1	1	0	
5	*Loose to very loose, wet, brown to black, wood debris, 0-25% silty SAND with gravel (creosote-like odor) (Wood Debris Fill)*	I	S-2	9	0	
		I	S-3	22	0	
10		I	S-4	7	0	
						▽ 2/29/96
		I	S-5	1	0	
15	*Bottom of boring at 14 feet.*					
20						
25						
30						

AS-BUILT DESIGN



Unique Ecology Well No. ABN 297.

TESTING

LEGEND

I 2-inch O.D. split-spoon sample

▽ 0/00/00 Observed groundwater level 0/00/00 = date observed

AGRA
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling started: *27 February 1996*　　Drilling completed: *27 February 1996*　　Logged by: *DHG*

Kenmore Lakepointe
PROJECT: Development

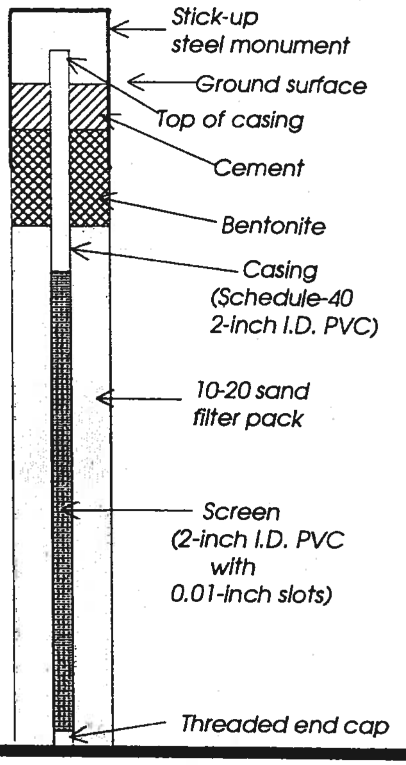
W.O. 11-10459-00 WELL NO. AW-11

Elevation reference: King County Datum NAD 1983
Ground surface elevation: 27 feet
Well completed: 27 February 1996
Casing elevation: 29.59 feet

AS-BUILT DESIGN

Page 1 of 1

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING	GROUND WATER	TESTING
0	Loose to very loose, wet, brown, silty SAND to sandy SILT with wood fragments (decomposition odor) (Fill)						
		I	S-1	4	0		
	Loose to very loose, wet to saturated, brown to black, wood debris, 0-25% silty SAND with some brick and copper wire (no odor) (Wood Debris Fill)						
5		I	S-2	4	0		
		I	S-3	2	0		
10		I	S-4	2	0		
						▽ 2/29/96	
	(creosote-like odor)	I	S-5	7	0		
15	Bottom of boring at 14 feet.						
20							
25							
30							



Unique Ecology Well No. ABN 269.

LEGEND

I 2-inch O.D. split-spoon sample

▽ 0/00/00 Observed groundwater level 0/00/00 = date observed

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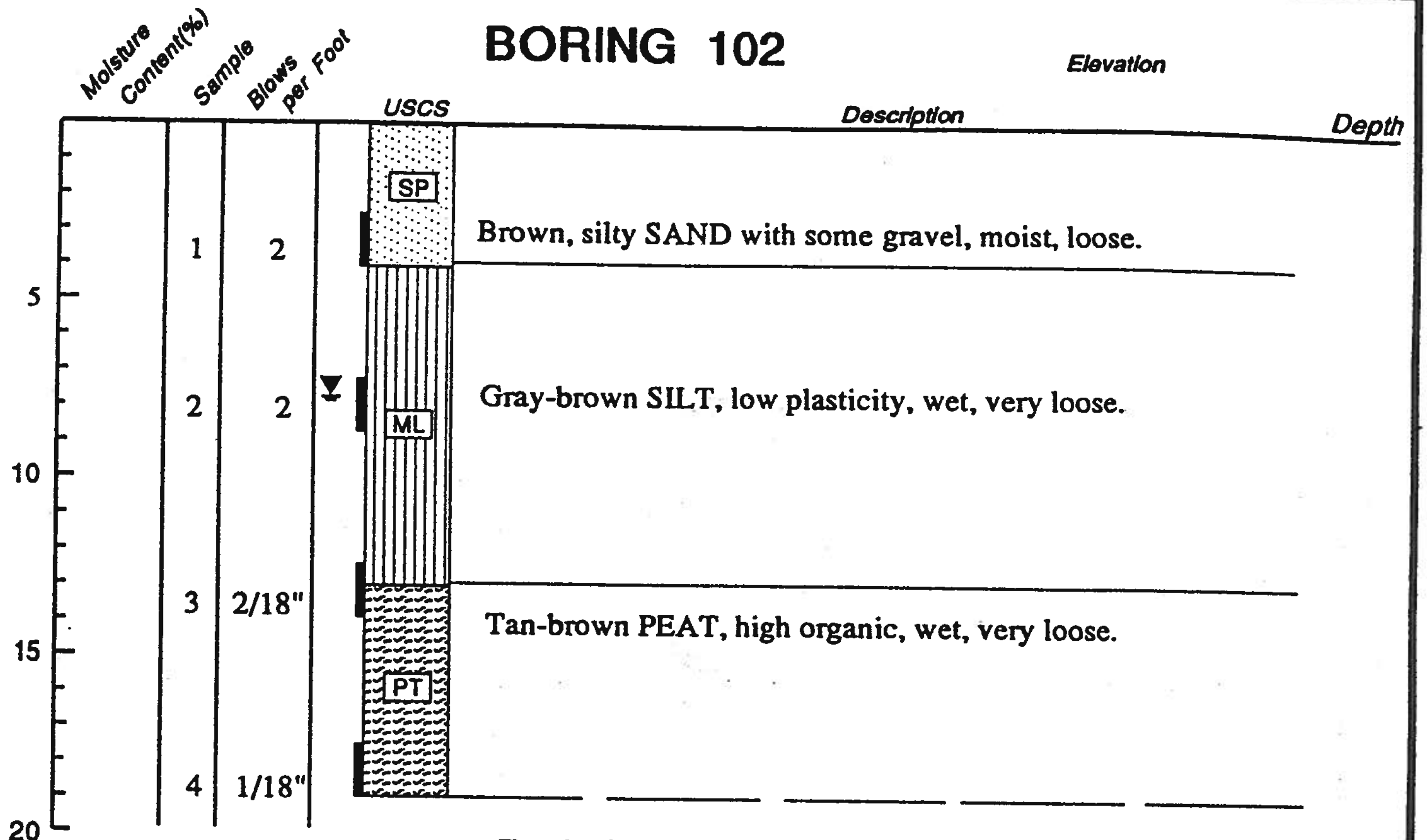
Earth & Environmental
11335 NE 122nd Way, Suite 100
Kirkland, Washington 98034-6918

AGRA Earth and Environmental, Inc.

Drilling started: 27 February 1996
Drilling completed: 27 February 1996
Logged by: DHG

BORING 102



Brown, silty SAND with some gravel, moist, loose.

Gray-brown SILT, low plasticity, wet, very loose.

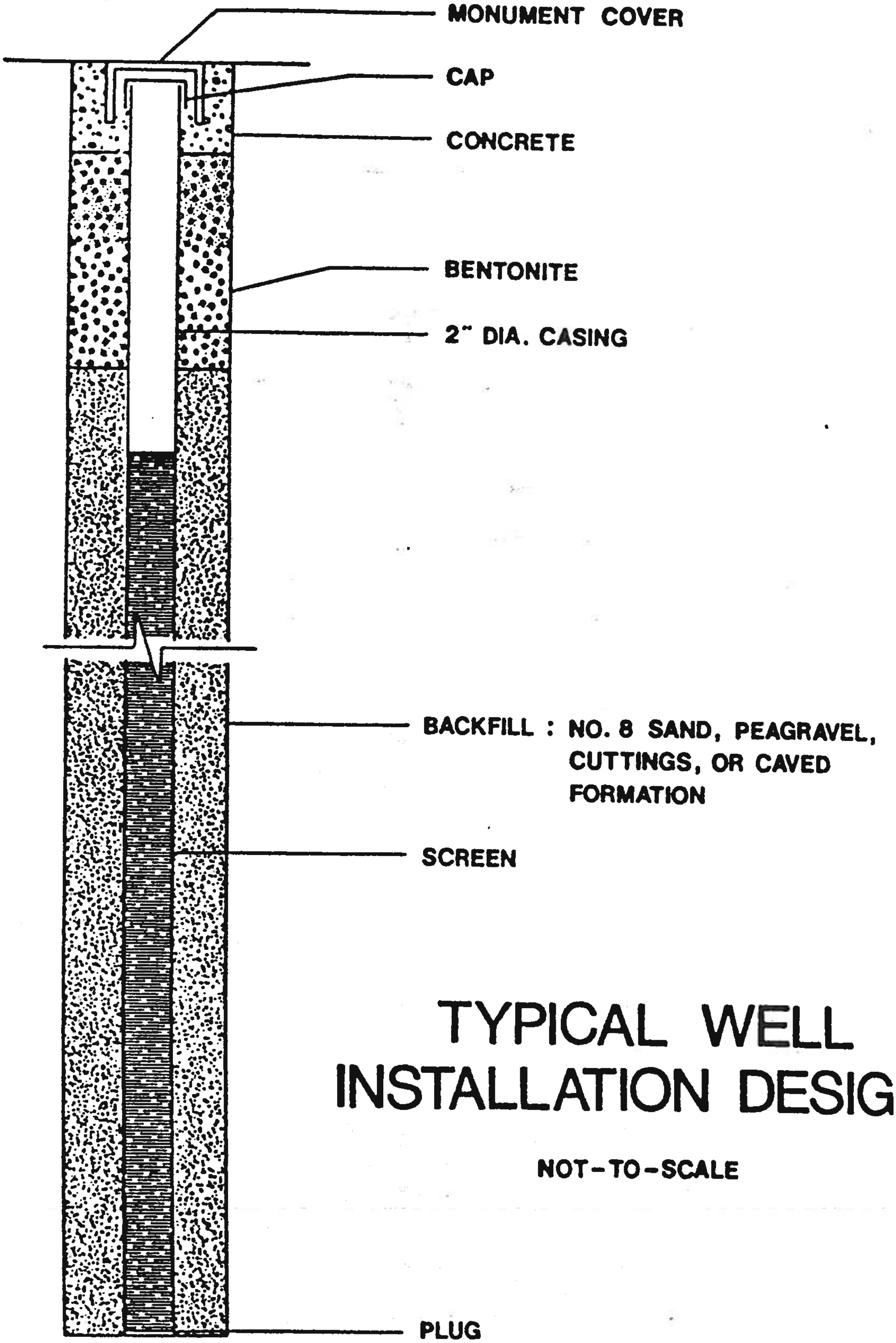
Tan-brown PEAT, high organic, wet, very loose.

Test boring completed at 19 feet during drilling on 12/14/90.
Groundwater encountered at 7.52 feet.

GEOTECH
CONSULTANTS,INC.

TEST BORING LOG
38 ACRES
KENMORE, WASHINGTON

Job No:	Date:	Logged by:	Plate:
0260-3	DEC 1990	AMC	9



TYPICAL WELL INSTALLATION DESIGN

NOT-TO-SCALE

GEOTECH CONSULTANTS

38 ACRES
KENMORE, WASHINGTON

Job No.:	Date:		Plate:
0260-3	JAN 1991	N.T.S	11

TEST PIT LOGS/ 29 February and 1 March 1996
Kenmore Lakepointe Development
King County, Washington

11-10459-00

Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-1	Elev. 25	0-1.5	Medium dense, moist, brown, silty, sandy angular GRAVEL. No odor. (Fill)
		1.5-1.8	**Asphalt Paving**
		1.8-2.5	Dense to very dense, moist, brown, silty, fine to medium SAND with gravel. No odor. (Fill)
		2.5-6	Dense, moist, brown, angular GRAVEL and boulders (1-12" quarry spalls) with concrete slabs, dimensioned wood, and matrix of silty fine sand. No odor. (Fill)

Test Pit TP-1 terminated at 6 feet due to boulder obstructions. No groundwater seepage encountered. Minor caving of sidewalls below 3 feet.
Collected sample TP-1/4' (Gravel Fill Matrix)

Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-2	Elev. 28	0-1.7	Very dense, moist, brown and grey mixed, silty, sandy angular GRAVEL with asphalt chunks. Many wood fragments below depth of 1 foot. No odor. (Fill)
		1.7-6	**Wood Debris Fill** - Dense to loose, moist to wet, dark brown • 95% wood shards and dimensioned lumber with steel pipe, metal casting. Oily coating on debris, petroleum odor. • 5% silty SAND and pea gravel. Wet below 5.5'.
		6-6.2	Concrete wash-out layer.

Test Pit TP-2 terminated at 6.2 feet due to concrete obstruction. No groundwater seepage encountered. Moderate caving of sidewalls below 4 feet.

TEST PIT LOGS/ 29 February and 1 March 1996
Kenmore Lakepointe Development
King County, Washington

11-10459-00

Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-3	Elev. 25	0-0.2	**Asphalt Pavement**
		0.2-1.3	Medium dense to dense, wet, grey, silty, sandy angular GRAVEL. No odor. (Fill)
		1.3-7.6	**Wood Debris Fill** - Dense to loose, moist to wet, dark brown • 90% wood shards and dimensioned lumber with steel pipe, metal casting. Oily coating on debris, petroleum odor. • 5% asphalt roof shingles • 5% silty SAND and pea gravel. Wet below 5.5′. Increasing debris below 7 feet - plastic, glass, styrofoam, brick
		7.6-7.8	**Concrete wash-out layer.**
			Test Pit TP-3 terminated at 7.8 feet due to concrete obstruction. Light groundwater seepage encountered in gravel base beneath pavement. No caving of sidewalls while test pit remained open. **Collected sample TP-3/5′ (Wood Debris Fill Matrix Soil)**

Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-4	Elev. 26.5	0-0.2	**Asphalt Pavement**
		0.2-2.8	Dense, moist to wet, dark grey, silty, sandy angular GRAVEL, to silty, gravelly SAND. No odor. (Fill)
		1.3-7.6	**Wood Debris Fill** - Dense to loose, moist to wet, dark brown • 90% wood shards and dimensioned lumber with steel pipe, metal casting. Oily coating on debris, petroleum odor. • 5% asphalt roof shingles • 5% silty SAND and pea gravel. Wet below 5.5′. Increasing debris below 7 feet - plastic, glass, styrofoam, brick
		7.6-7.8	**Concrete wash-out layer.**
			Test Pit TP-4 terminated at 7.8 feet due to concrete obstruction. Light groundwater seepage encountered in gravel base beneath pavement. No caving of sidewalls while test pit remained open. **Collected sample TP-4/2′ (Gravel Fill Matrix)**

TEST PIT LOGS/ 29 February and 1 March 1996
Kenmore Lakepointe Development
King County, Washington

11-10459-00

Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-5	Elev. 25	0-0.2	**Asphalt Pavement**
		0.2-1.4	Dense, moist to wet, grey and brown mixed, silty, fine to medium SAND with gravel. No odor. (Fill)
		1.4-3.3	Very dense, damp, grey, angular GRAVEL with silt and sand over dense, moist to wet, brown, silty SAND with gravel, some asphalt fragments. No odor. (Fill)
		3.3-7.5	**Wood Debris Fill** - Dense, moist to wet, dark brown • 80% wood shards and dimensioned lumber • 15% silty SAND, loose, wet • 5% brick, gravel, concrete rubble, trace drywall and fiberglass
			Test Pit TP-5 terminated at 7.5 feet. Static groundwater level encountered at 7.3 feet. No caving of sidewalls while test pit remained open. Collected sample **TP-5/2.5' (Fill Soil)**

Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-6	Elev. 27	0-0.3	**Asphalt Pavement**
		0.3-1.5	Medium dense to loose, wet, red-brown, silty SAND with gravel, rock spalls, brick and asphalt fragments over pea gravel layer. No odor. (Fill)
		1.5-7	Very dense, wet, black, silty, sandy, angular GRAVEL with concrete rubble (30%) and wood fragments (20%). Wood content increases to 40-50% below 3 feet. No odor. (Fill)
		7-7.4	**Wood Debris Fill** - Very dense, moist to wet, dark brown • 90% wood shards and dimensioned lumber • 10% silty SAND, loose, wet
			Test Pit TP-6 terminated at 7.4 feet due to bulk lumber. Light groundwater seepage encountered from 2.5 to 3 feet. No caving of sidewalls while test pit remained open. Collected sample **TP-6/6' (Gravel Fill Matrix)**

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Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-7	Elev. 27	0-0.3	Asphalt Pavement
		0.3-2.3	Medium dense to very dense, moist to wet, brown, silty SAND with angular gravel, and some pea gravel. No odor. (Fill)
		2.3-7	Wood Debris Fill - Dense, moist to wet, dark brown • 90% wood shards, dimensioned lumber and beams, logs • 10% silty SAND, loose, wet, trace copper wiring, metal pipe, wire cables.
			Test Pit TP-7 terminated at 7 feet due to bulk lumber. No groundwater seepage encountered. No caving of sidewalls while test pit remained open. **Collected sample TP-7/2' (Fill Soil)**

Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-8A	Elev. 27	0-0.8	Very dense, wet, grey, silty, sandy, angular GRAVEL. No odor. (Fill)
		0.8-1.0	Asphalt Pavement
			Test Pit TP-8A terminated at 1 foot due refusal on asphalt. No groundwater seepage encountered.

Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-8B	Elev. 26	0-1.0	Concrete wash-out layer
		1.0-1.2	Asphalt Pavement
			Test Pit TP-8B terminated at 1.2 foot due refusal on asphalt. No groundwater seepage encountered.

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Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-9	Elev. 27	0-1.2	Dense to very dense, wet, grey, silty, sandy, angular GRAVEL. No odor. (Fill)
		1.2-5	Wood Debris Fill - Dense, moist to wet, dark brown • 90% wood shards, dimensioned lumber • 10% silty SAND
		5-9.8	Wood Debris Fill - Dense, moist to wet, dark brown • 70% wood shards, dimensioned lumber • 20% auto body panels, steel I-beams, wire cables, tires, brick • 10% silty SAND with gravel
			Test Pit TP-9 terminated at 9.8 feet due to metal obstructions. No groundwater seepage encountered. No caving of sidewalls while test pit remained open. Collected sample **TP-9/6' (Wood Debris Fill Matrix Soil)**

Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-10	Elev. 26	0-1.1	Dense, wet, brown, silty, sandy, angular GRAVEL. No odor. (Fill)
		1.1-9.5	Wood Debris Fill - Loose to medium dense, moist to wet, dark brown • 50% wood shards, dimensioned lumber • 50% silty SAND
			Test Pit TP-10 terminated at 9.5 feet. Static groundwater level encountered at 8.8 feet. Moderate caving of sidewalls. Collected sample **TP-10/5' (Wood Debris Fill Matrix)**

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Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-11	Elev. 27	0-1	Very loose, wet, grey, silty SAND. No odor. (Concrete wash-out)
		1-3.5	Dense, moist, brown, silty, sandy, rounded GRAVEL. No odor. (Fill)
		3.5-4	Dense, moist, brown, silty, gravelly SAND with hay and clumps of roots.
		4.5-5	Concrete Obstruction
		5-6	Wood Debris Fill - Dense, moist to wet, dark brown • 80% wood shards, dimensioned lumber • 20% silty SAND
			Test Pit TP-11 terminated at 6 feet on wire cable obstruction. No groundwater seepage encountered. Moderate caving of upper 2 feet of sidewalls.

Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-12	Elev. 25	0-1	Very loose, wet, grey, silty fine to medium SAND with rounded gravel. No odor. (Concrete wash-out)
		1-3.5	Wood Debris Fill - Medium dense, wet, brown • 90% wood shards • 5% silty SAND • 5% brick, gravel, concrete and asphalt rubble
		3.5-5.5	Asphalt
		5.5-6.5	Wood Debris Fill - Medium dense, wet, brown • 90% wood shards, dimensioned lumber, logs • 5% silty SAND with gravel • 5% concrete and asphalt rubble
		6.5-9.5	Loose, wet to waterbearing, grey, fine to coarse sandy, rounded GRAVEL with silt.
			Test Pit TP-12 terminated at 9.5 feet. Static groundwater level encountered at 9 feet. Moderate caving of sidewalls below 6 feet. Collected sample TP-12/7' (Gravel Fill Matrix)

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Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-13	Elev. 26	0-2.3	Dense, moist, grey, sandy, rounded GRAVEL with silt, grading to wet, brown, silty, sandy, angular GRAVEL with rock spalls, wood shards (10%) . No odor. (Fill)
		2.3-5.5	Wood Debris Fill - Loose, wet, brown, decomposing • 50% shredded wood • 30% silty SAND with gravel • 15% concrete and brick rubble, some concrete slabs • 5% plastic hangers and sheeting
		5.5-8	Medium dense, wet, grey, silty, fine to medium SAND with gravel, concrete rubble (20%), wood fragments (10%).
		8-10.5	Wood Debris Fill - Loose, wet, brown • 70% wood shards • 30% silty SAND
			Test Pit TP-13 terminated at 10.5 feet. Static groundwater level encountered at 9.9 feet. Minor caving of sidewalls. Collected sample TP-13/6.5' (Fill Soil)

Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-14	Elev. 28	0-0.5	Asphalt Shingles
		0.5-3.7	GP-GM-Very dense, moist, brown, sandy, angular GRAVEL with silt, with rock spalls, concrete rubble, wood fragments below 2 feet. No odor. (Fill)
		3.7-10.8	Wood Debris Fill - Loose, wet, brown • 60% wood shards • 20% silty SAND with gravel • 15% concrete rubble and slabs, brick • 5% sheet metal, auto body parts
			Test Pit TP-14 terminated at 10.8 feet. Light groundwater seepage from 0-1 and 7-8 feet. Minor caving of sidewalls. Collected sample TP-14/8' (Wood Debris Fill Matrix)

Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-15	Elev. 27	0-0.3	Dense, wet, grey, clean, fine to medium SAND with gravel. No odor. (Fill)
		0.3-2.7	Medium dense, wet, brown, fine to medium SAND with gravel, with wood fragments, concrete rubble. No odor. (Fill)
		2.7-9	**Wood Debris Fill** - Loose, wet, brown • 80% wood shards • 15% silty SAND with gravel • 5% concrete rubble, brick, wire cables

Test Pit TP-15 terminated at 9 feet. Moderate groundwater seepage below 4 feet. Static groundwater level encountered at 8.5 feet. Moderate caving of sidewalls in upper 3 feet. Sheen visible on water table. Collected sample **TP-15/7' (Wood Debris Fill Matrix)**

Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-16	Elev. 25	0-4.6	Dense, moist, grey, clean, fine to medium SAND with gravel, grading to silty, gravelly SAND. No odor. (Fill)
		4.6-9.5	**Wood Debris Fill** - Loose, wet, brown • 50% wood shards • 40% silty SAND with gravel • 10% carpeting and foampadding, glass, plastic

Test Pit TP-16 terminated at 9.5 feet. Static groundwater level encountered at 8.5 feet. No caving of sidewalls while test pit remained open. Sheen visible on water table.
Collected sample **TP-16/6' (Wood Debris Fill Matrix)**

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Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-17	Elev. 23.5	0-3.0	Very dense, moist, grey, silty, sandy, angular GRAVEL, with concrete rubble (10%), trace wood fragments. No odor. (Fill)
		3.0-8.0	Debris Fill - Dense, wet, brown • 30% wood shards • 40% silty SAND with gravel • 20% tire retreads, rubber scraps • 5% concrete rubble, brick, steel rebar

Test Pit TP-17 terminated at 8.0 feet. Static groundwater level encountered at 7.2 feet. No caving of sidewalls while test pit remained open. Sheen visible on water table.

Collected sample **TP-17/3' (Gravel Fill Matrix)**

Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-18	Elev. 24	0-1.5	Very dense, moist to wet, dark brown, silty, sandy, angular GRAVEL, with asphalt rubble. No odor. (Fill)
		1.5-3.0	Rock Mat-Quarry spalls (2-4") over rockery boulders
		3.0-4.5	Very dense, moist, grey mottled, silty, fine to medium SAND with gravel. No odor. (Fill)
		4.5-7.1	Wood **Debris Fill** - Loose, wet, black • 50% tree roots, dimensioned lumber • 40% silty SAND • 10% tires, wire hangers

Test Pit TP-18 terminated at 7.1 feet. Static groundwater level encountered at 6.7 feet. Moderate caving of sidewalls below 4.5 feet. Sheen visible on water table.

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Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-19	Elev. 28	0-0.5	Asphalt Pavement
		0.5-1.3	Dense, moist, brown, silty, sandy, angular grading to rounded GRAVEL. No odor. (Fill)
		1.3-1.8	Concrete Slab
		1.8-4.3	Wood Debris Fill - Loose, wet, black • 90% dimensioned timbers • 10% silty SAND
		4.3-10.4	Medium dense, wet, grey, silty, fine SAND with gravel and trace organics, grading to medium stiff, clayey SILT with sand and gravel, scattered plant matter.

Test Pit TP-19 terminated at 10.4 feet. No groundwater seepage encountered while test pit remained open. No caving of sidewalls while test pit remained open.
Collected sample TP-19/2' (Wood Debris Fill Matrix)

Test Pit No.	Approx. Elev.	Depth (ft)	Soil Description
TP-20	Elev. 28	0-0.3	**Asphalt Paving**
		0.3-1.4	Dense, moist to wet, brown, silty, sandy, angular GRAVEL, with rock spalls. No odor. (Fill)
		1.4-2.9	Dense, moist to wet, grey, fine to medium SAND with silt. No odor (Fill)
		2.9-6	**Wood Debris Fill** - Loose, wet, black • 60% dimensioned timbers • 30% silty SAND with gravel • 10% wire, pipe, scrap metal
		6-8.9	**Wood Debris Fill** - Loose, wet, black • 90% dimensioned timbers • 10% silty SAND with gravel

Test Pit TP-20 terminated at 8.9 feet. No groundwater seepage encountered while test pit remained open. No caving of sidewalls while test pit remained open. Collected sample **TP-20/8' (Wood Debris Fill Matrix)**

APPENDIX B
LABORATORY TESTING PROCEDURES AND RESULTS
11-10459-00

APPENDIX B
LABORATORY TESTING PROCEDURES AND RESULTS
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LABORATORY TESTING PROCEDURES

A series of laboratory tests were performed during the course of this study to evaluate the index and geotechnical engineering properties of the subsurface soils. Descriptions of the types of tests performed are given below.

Visual Classification

Samples recovered from the exploration locations were visually classified in the field during the exploration program. Representative portions of the samples were carefully packaged in watertight containers and transported to our laboratory where the field classifications were verified or modified as required. Visual classification was generally done in accordance with the Unified Soil Classification system. Visual soil classification includes evaluation of color, relative moisture content, soil type based on grain size, and accessory soil types included in the sample. Soil classifications are presented on the exploration logs in Appendix A.

Moisture Content Determinations

Moisture content determinations were performed on representative samples obtained from the explorations in order to aid in identification and correlation of soil types. The determinations were made in general accordance with the test procedures described in ASTM:D-2216. The results of the tests are shown on the exploration logs in Appendix A.

Atterberg Limits

Atterberg limits are used primarily for classification and indexing of cohesive soils. The liquid and plastic limits are two of the five Atterberg limits and are defined as the moisture content of a cohesive soil at arbitrarily established limits for liquid and plastic behavior, respectively. Liquid and plastic limits were established for selected samples in general accordance with ASTM:D-423 and ASTM:D-424, respectively. The results of the Atterberg limits are presented on a plasticity chart in this appendix where the plastic index (liquid limit minus plastic limit) is related to the liquid limit. The plastic limits and liquid limits are also presented adjacent to the appropriate samples on the exploration logs in Appendix A.

Grain Size Analysis

A grain size analysis indicates the range in diameter of soil particles included in a particular sample. Grain size analyses were performed on representative samples in general accordance with ASTM:D-422. The results of the grain size determinations for the samples were used in classification of the soils, and are presented in this appendix.

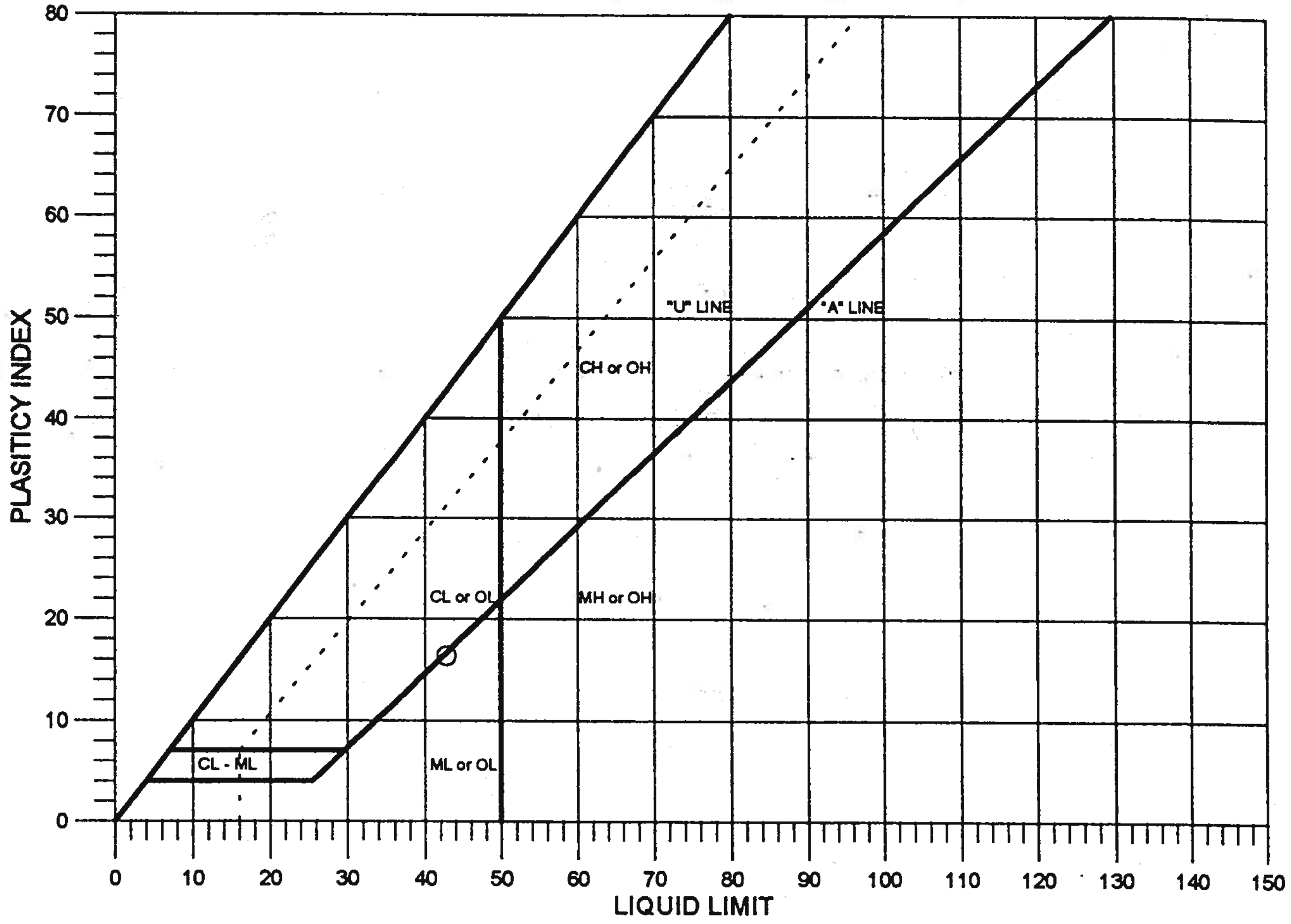
Consolidation Test

A one-dimensional consolidation test was performed in general accordance with ASTM:D-2435 on a selected sample of the site soils to provide data for developing settlement estimates. The undisturbed soil sample was carefully trimmed and fit into a rigid ring. Porous stones were placed on both the top and bottom of the sample to allow drainage. Vertical loads were then applied to the sample incrementally in such a way that the sample was allowed to consolidate under each load increment. The rebound of the sample during unloading was also measured. The results of the consolidation test are presented in this appendix as a plot of percent consolidation (strain) versus applied load (stress).

In-Place Density

In-place density of some site soils was determined by computing the volume of a portion of the undisturbed samples obtained from the boring explorations then weighting the sample. The density computed for the sample is presented on the boring logs in Appendix A.

PLASTICITY CHART ASTM: D4318

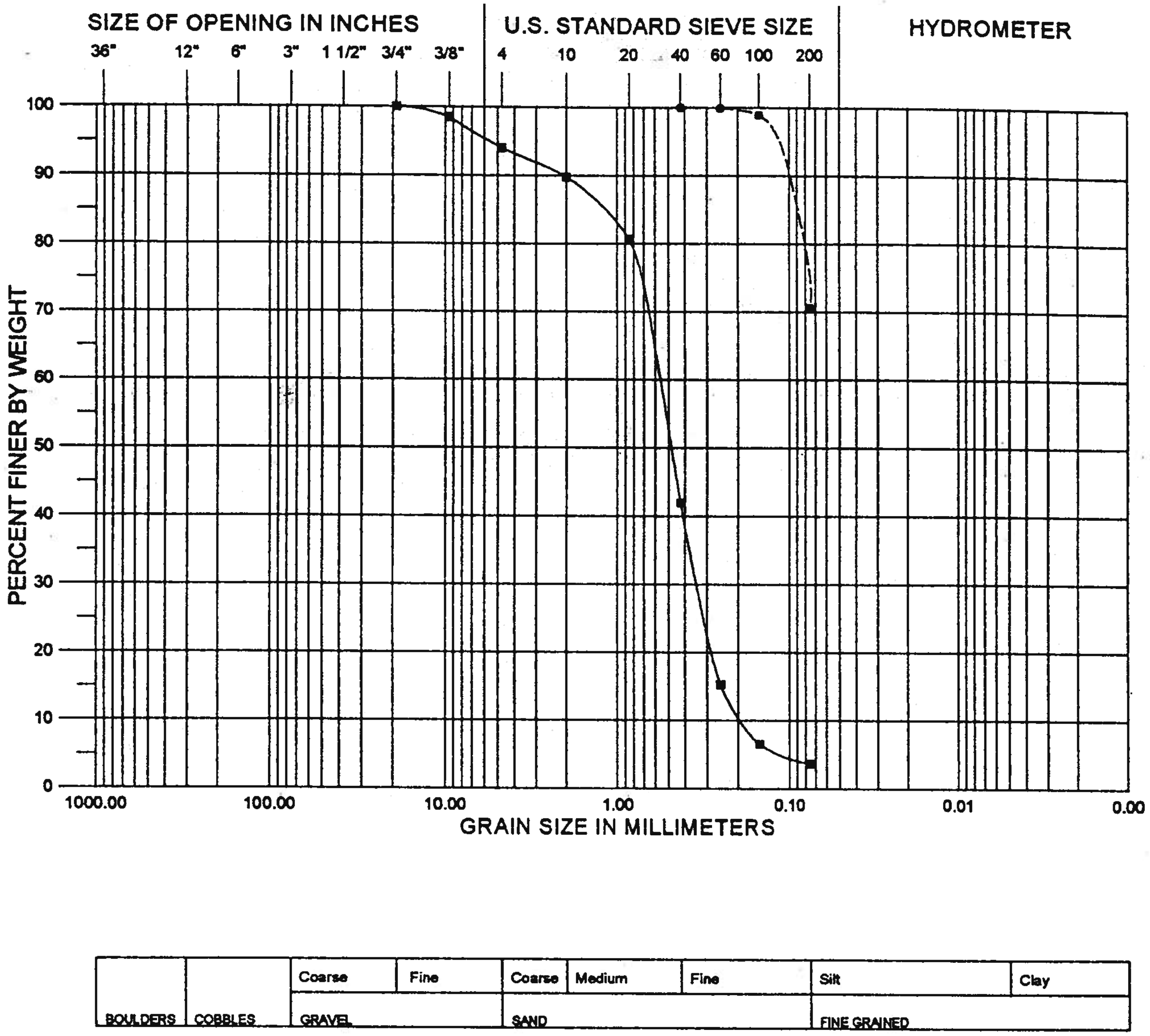


Symbol	Sample Type	Sample	Depth	Moisture	Liquid Limit	Plastic Limit	Plastic Index	Description
○	A-25	S-8	35.0-36.5'	37%	44	28	16	ML
□								
△								
◊								
✤								
☆								
⊕								
▲								

Project:	Kenmore Lakepointe Development
Work Order:	11-10459-01
Date:	9-29-95

AGRA
Earth & Environmental, Inc.
11335 NE 122nd Way
Suite 100
Kirkland, Washington 98034-6918

GRAIN SIZE DISTRIBUTION



	Exploration	Sample	Depth	Moisture	Fines	Soil Description
■-■-■-■-■	A-2	S-2	10.0-11.5'	19%	4%	Coarse to Fine SAND, trace gravel and silt
●-●-●-●-●	A-2	S-7	35.0-36.5'	34%	71%	Fine Sandy SILT
✱-✱-✱-✱-✱						

Project: Kenmore Lakepointe Development
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Date: 9-29-95

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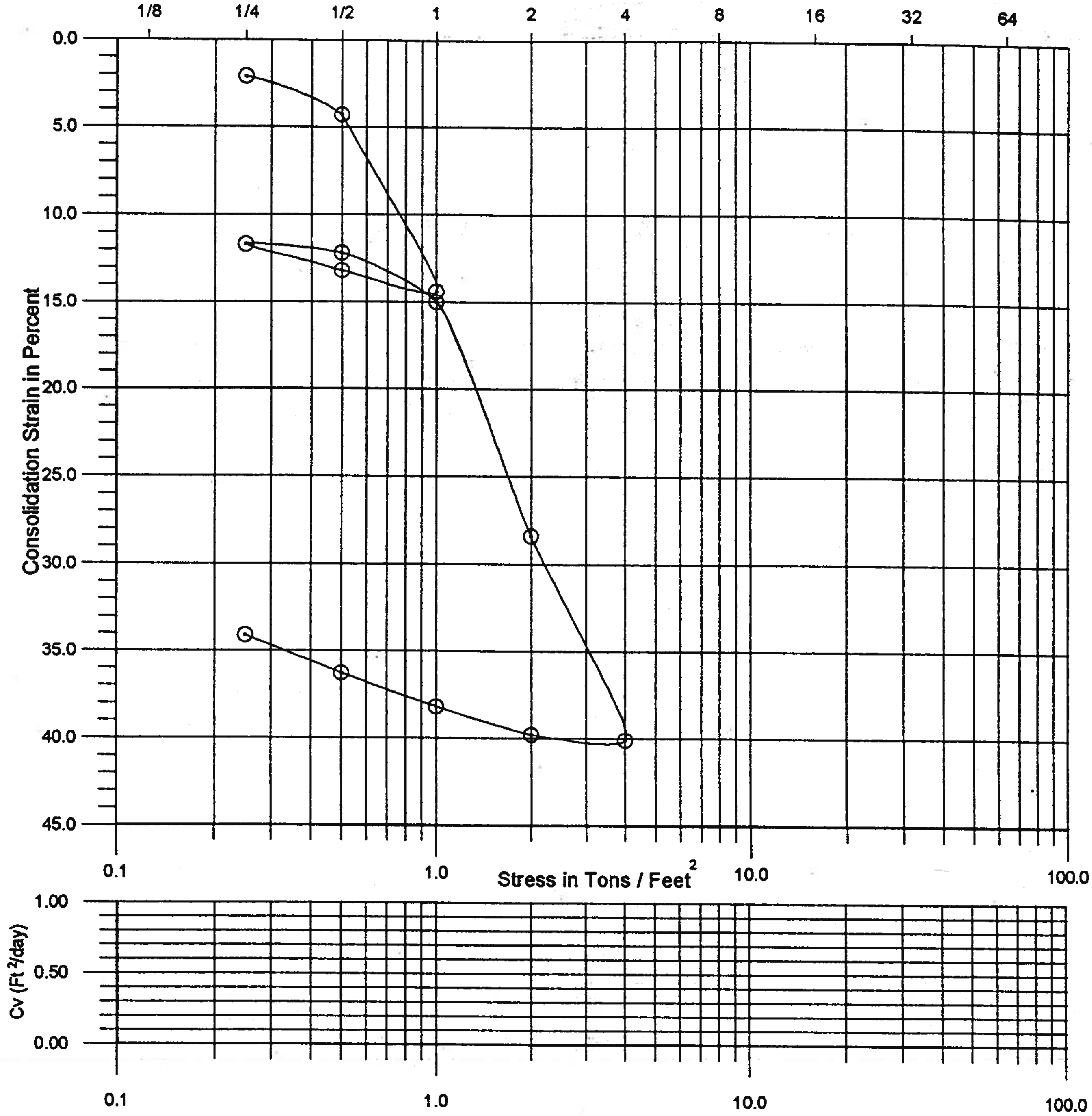
11335 NE 122nd Way
Suite 100
Kirkland, Washington 98034-6918

CONSOLIDATION ASTM: D2435



Project:	Kenmore Lakepointe Development		
Work Order:	11-10459-01		
Date:	10-5-95	Depth	21.0'
Exploration:	A-6	Sample:	S-4
Moisture:	264%	Density:	22 pcf
USCS:			

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