SAGE
GEOTECHNICAL

TECHNICAL MEMORANDUM

TO: Mr. Phillip Oppen, Operations Manager, Northwest Interiors & Design, LLC

FROM: Annabel Irwin, PE

DATE: April 3, 2025

RE: Summary of Geotechnical Engineering Services
Ankapura Residence
Mercer Island, Washington
Sage Project No. 074002

INTRODUCTION

Sage Geotechnical, LLC (Sage) provided geotechnical engineering services in support of the Ankapura Residence project, located at 4249 92nd Avenue Southeast in Mercer Island, Washington (site; Figure 1). Services were provided in accordance with the scope outlined in Sage's January 27, 2025, proposal. Findings are summarized herein.

This memorandum has been prepared with information provided by Vector Engineering, Inc. (project civil engineer) and Northwest Interiors & Design, LLC (NWID, project general contractor) and with data collected during Sage's geotechnical field exploration and laboratory testing programs.

PROJECT UNDERSTANDING

The site is developed with a single-family residence. The owners propose to add new landscaping features and retaining walls/rockeries to the exterior of the residence. They will also lower the basement and make improvements to the interior of the residence. Sage understands that the existing building framework will be reused and that the proposed improvements will necessitate additional stormwater management.

SITE CONDITIONS

The site is located in a residential neighborhood and is developed with a single-family residence, a pool, landscaping, and a paved driveway. Site topography is generally flat, and the driveway slopes down to the east at a vertical relief of approximately 3 feet (ft).

The site is located west of a steep slope and several other geologically hazardous areas (Mercer Island, accessed February 18, 2025).

GEOLOGIC SETTING

Geologic information for the site and the surrounding area was obtained from the *Geologic Map of Surficial Deposits in the Seattle 30' x 60' Quadrangle, Washington* (Yount et al. 1993).

Surficial deposits in the vicinity of the site are mapped as Fraser-age glacial till (Qgt), a unit that typically consists of a consolidated, heterogeneous mixture of boulders, cobbles, gravel, sand, and silt. This soil unit typically exhibits very low permeability and high shear strength.

The subsurface conditions observed in Sage's February 2025 explorations were generally consistent with the mapped geology.

SUBSURFACE CONDITIONS

On February 6, 2025, Sage observed NWID excavate two test pits (TP-1 and TP-2) at the approximate locations shown on Figure 2. Test pit TP-1 extended 10.2 ft below ground surface (bgs), and test pit TP-2 extended 10.0 ft bgs.

Sage coordinated and monitored the field explorations, collected representative soil samples, and maintained detailed logs of the subsurface soil and groundwater conditions observed. Subsurface conditions were described using the soil classification system shown on Figure 3, in general accordance with ASTM International (ASTM) standard D2488, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures).* Summary test pit logs are presented on Figures 4 and 5.

Soil samples collected from the explorations were transported to Sage's geotechnical laboratory for further examination and testing. Laboratory test results are presented on Figure 6.

Soil Conditions

The soils observed underlying existing surface conditions (i.e., topsoil) were categorized into two units:

- **Recessional outwash:** Recessional outwash was observed in both test pits and typically consisted of silty sand with variable gravel content. The recessional outwash was in a medium dense, moist condition and extended 2.0 to 2.5 ft bgs.
- **Glacial till:** Glacial till was observed beneath the recessional outwash in both test pits and typically consisted of silty sand with variable gravel and cobble content. The glacial till was in a dense to very dense, moist condition and extended to the maximum depth explored (10.2 ft bgs).

Groundwater Conditions

During Sage's February 2025 field investigation, groundwater seepage was not observed in test pits TP-1 and TP-2. Iron staining, a groundwater indicator, was observed in both test pits, near the contact of the recessional outwash and glacial till units.

The groundwater conditions reported herein are for the specific date and locations indicated and may not be representative of other locations and/or times. Groundwater conditions will vary depending on local subsurface conditions, weather conditions, and other factors. Site groundwater levels are expected to fluctuate seasonally, with maximum levels occurring during late winter and early spring.

CONCLUSIONS AND RECOMMENDATIONS

The site is underlain by dense to very dense glacial till. In Sage's opinion, the glacial till will provide adequate support for the extended basement and retaining walls/rockeries. Glacial till typically exhibits very low permeability; onsite stormwater infiltration is likely infeasible. The following recommendations should be incorporated into the project design.

Foundation Support

Shallow foundations should be constructed on a prepared subgrade that consists of medium dense to very dense native soil or on compacted structural fill that extends to such soil. At least 6 inches of structural fill should be placed over compacted native soil and directly beneath footings. Pockets of loose or unsuitable material should be overexcavated.

Where overexcavation is required, the overexcavation zone should extend beyond each side of the footing a horizontal distance equal to at least one-half of the overexcavation depth. For example, a 2-ft-wide footing with a 4-ft-deep overexcavation should have a 6-ft-wide overexcavation zone. The foundation design parameters in Table 1 should be used in conjunction with the complete recommendations in this memorandum.

Table 1. Design Parameters for Shallow Foundations

Allowable soil bearing pressure = 3,000 psf
Allowable coefficient of sliding resistance = 0.35
Allowable passive earth pressure = 300 pcf
Minimum foundation width = 18 inches (continuous), 24 inches (isolated)

ft = feet
pcf = pounds per cubic foot
psf = pounds per square foot

Sage used a safety factor of 3 to calculate the allowable soil bearing pressure in Table 1. When developing design parameters, Sage assumed that shallow foundations would be established on at least 6 inches of compacted structural fill placed over a uniformly firm, unyielding subgrade. The geotechnical engineer should evaluate foundation subgrades prior to the placement of formwork, rebar, or structural fill.

The allowable soil bearing pressure in Table 1 applies to dead and live loads, exclusive of the weight of the footing and any overlying backfill. The bearing pressure can be increased by one-third for transient loads, such as those induced by wind and seismic forces.

Sage recommends a minimum width of 18 inches for continuous wall footings and 24 inches for isolated column footings. Perimeter footings should be embedded at least 12 inches below the lowest adjacent grade, where the ground is flat. Interior footings should be embedded at least 6 inches below the nearest adjacent grade. Sage estimates that continuous and isolated foundations will settle less than 0.5 inches if constructed as recommended. Similarly loaded foundation elements will likely experience 0.5 inches or less of differential settlement over 50-ft spans. Settlement is expected to occur as loads are applied during construction.

An allowable coefficient of sliding resistance of 0.35, applied to vertical dead loads only, can be used to compute frictional resistance acting on the base of footings. This coefficient includes a factor of safety of 1.5 on the calculated ultimate value.

The passive resistance of properly compacted structural fill placed against the sides of foundations can be considered equivalent to a fluid with a density of 300 pounds per cubic foot (pcf). This foundation passive earth pressure has been reduced by a factor of 1.5 to limit deflections to less than 2 percent of the embedded depth. The passive earth pressure and friction components can be combined, provided the passive component does not exceed two-thirds of the total. The upper foot of soil should be excluded from the calculation, unless the foundation perimeter will be covered by a slab-on-grade or pavement.

Slabs-On-Grade

Slabs-on-grade should be installed on at least 6 inches of compacted structural fill placed over a uniformly firm, unyielding subgrade. A modulus of vertical subgrade reaction (subgrade modulus) can be used to design slabs-on-grade. The subgrade modulus will vary based on the dimensions of the slab and the magnitude of applied loads on the slab surface; slabs with larger dimensions and loads are influenced by soils to a greater depth. Sage recommends using a subgrade modulus of 250 pounds per cubic inch to design on-grade floor slabs. This subgrade modulus is for a 1-ft-by-1-ft square plate and is not the overall modulus of a larger area.

Interior slabs-on-grade should include a vapor barrier and a capillary break layer, designed and installed in accordance with industry standards.

Retaining Wall Design Parameters

Retaining walls should be designed with an equivalent fluid density of 35 pcf for the active condition and 55 pcf for the at-rest condition. A rectangular surcharge of 10H pounds per square foot, where H is the height of the wall, should be used for seismic loading. Sage assumes that the retaining walls will be backfilled with structural fill and wall drainage systems will be installed.

Infiltration Feasibility

The site is underlain by low-permeability glacial till. Low-permeability units, like dense glacial till, rock, and clay, are considered unsuitable for stormwater infiltration (Ecology 2019). As such, Sage does not recommend onsite stormwater infiltration.

Feasibility of Low-Impact Development Best Management Practices

Section 19.06.110 of the *Mercer Island City Code* states that, to the extent feasible, stormwater generated by new and replaced impervious surfaces shall be mitigated with low-impact development best management practices (LID BMPs). With many LID BMPs, such as bioretention facilities, rain gardens, permeable pavement, and dispersion systems, stormwater infiltrates into the underlying soil; however, the site is underlain by dense to very dense glacial till with a low permeability. In Sage's opinion, onsite stormwater infiltration is infeasible, and LID BMPs are likely to fail and result in ponding and flooding.

Geologically Hazardous Areas

The site is located approximately 120 ft to the west of mapped geologically hazardous areas, including a landslide area, a protected slope, a potential slide hazard, a seismic hazard area, and an erosion hazard area (Mercer Island, accessed February 18, 2025). The nearest mapped fault is 0.5 miles north of the site (DNR, accessed February 19, 2025).

Section 19.07.160 of the *Mercer Island City Code* states that the largest buffer shall be applied in instances where more than one geologically hazardous area is mapped. The largest buffer required for the geologically hazardous areas mapped near the site is 75 ft from the top of the slope. The site is not located within a mapped geologically hazardous area or an associated buffer.

CONSTRUCTION CONSIDERATIONS

The following key points should be considered when developing project plans and specifications:

- **Stripping:** Sage observed up to 8 inches of topsoil in its February 2025 explorations. Topsoil should be stripped from areas designated for development. Stripped topsoil is not suitable for reuse as structural fill.
- **Subgrade preparation:** Before structural fill, formwork, or rebar is placed, the subgrade should be scarified; moisture-conditioned; and compacted to a firm, unyielding condition. The prepared subgrade should be proof-rolled in the presence of a qualified geotechnical engineer, who is familiar with the site and can check for soft/disturbed areas. Areas of limited access can be evaluated with a steel T-probe. If soft and/or disturbed subgrade soils are encountered, additional moisture conditioning and compaction should be completed to produce a firm, unyielding subgrade. Alternatively, unsuitable soils can be overexcavated and replaced with compacted structural fill.

- **Site soil:** Because site soils contain significant fines, adequate compaction could be difficult to achieve, particularly during periods of wet weather. Constituents larger than 6 inches in diameter should be removed from soils that will be reused as structural fill.
- **Oversized material:** Cobbles and boulders are often present in glacially derived soils, like recessional outwash and glacial till. Cobbles were observed in Sage's February 2025 explorations. Native soils that will be reused as structural fill should not contain constituents larger than 6 inches in diameter.
- **Import structural fill:** Gravel Borrow is a suitable source of import structural fill. Gravel Borrow should conform to the requirements in Section 9-03.14(1) of the Washington State Department of Transportation's 2025 *Standard Specifications for Road, Bridge, and Municipal Construction* (hereinafter, *2025 WSDOT Standard Specifications*). During periods of wet weather, the fines content should not exceed 5 percent, based on the minus ¾-inch fraction.
- **Fill placement and compaction:** Structural fill should be placed on an approved subgrade that consists of uniformly firm, unyielding native soil or of compacted structural fill that extends to such soil. Structural fill should be placed and compacted in accordance with the requirements in Section 2-03.3(14)C, Method C of the *2025 WSDOT Standard Specifications.* Method A is appropriate for non-structural areas, such as landscaping. Each layer of structural fill should be compacted to at least 95 percent of the maximum dry density, determined in accordance with the compaction control tests in Section 2-03.3(14)D of the *2025 WSDOT Standard Specifications.* Alternatively, the maximum dry density can be determined using ASTM standard test method D1557, *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).*
- **Construction dewatering:** Temporary excavations should be dewatered to allow construction to be completed in the dry. Where shallow groundwater seepage is encountered, the use of conventional sumps and pumps should be sufficient to dewater excavations. The contractor will be responsible for the design, monitoring, and maintenance of dewatering systems.
- **Temporary slopes:** Temporary excavations should be completed in accordance with the requirements in Section 2-09 of the *2025 WSDOT Standard Specifications.* All applicable local, state, and federal safety codes should be followed.

  The contractor will be responsible for actual excavation configurations and the maintenance of safe working conditions, including temporary excavation stability. Temporary excavations in excess of 4 ft should be shored or sloped in accordance with the requirements outlined in Safety Standards for Construction Work, Part N (Washington Administrative Code Chapter 296-155). The soil likely to be exposed in the excavations should be considered Type C, with a maximum allowable excavation inclination of 1½ horizontal to 1 vertical (1½H:1V).
- **Permanent slopes:** Permanent cut-and-fill slopes should be no steeper than 2H:1V. This design recommendation does not apply to stormwater pond slopes, which are typically 3H:1V or flatter. Stormwater pond slopes should be designed in accordance with local

stormwater codes. Permanent and temporary slopes should be protected from erosion and seeded or vegetated as soon as practical.

- **Footing drains:** Perimeter foundation footing drains should be included in the design of structures.

USE OF THIS TECHNICAL MEMORANDUM

Sage Geotechnical, LLC has prepared this technical memorandum for the exclusive use of Northwest Interiors & Design, LLC; Vector Engineering, Inc.; and their designated representatives for specific application to the Ankapura Residence project in Mercer Island, Washington. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Sage Geotechnical. Reuse of the information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Sage Geotechnical, shall be at the user's sole risk. Sage Geotechnical warrants that, within the limitations of scope, schedule, and budget, its services have been provided in a manner consistent with that level of skill and care ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions. Sage Geotechnical makes no other warranty, either express or implied.

CLOSING

We trust that this memorandum provides you with the information needed to proceed with the project. If you have questions or comments, or if we can be of further service, please contact Annabel Irwin at annabeli@sagegeotechnical.com.

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Attachments: Figure 1. Vicinity Map
Figure 2. Site and Exploration Plan
Figure 3. Key to Test Pit Logs
Figures 4 and 5. Logs of Test Pits TP-1 and TP-2
Figure 6. Grain Size Analysis Results

REFERENCES

ASTM. 2017. Annual Book of ASTM Standards. In: *Soil and Rock(I).* West Conshohocken, PA: ASTM International.

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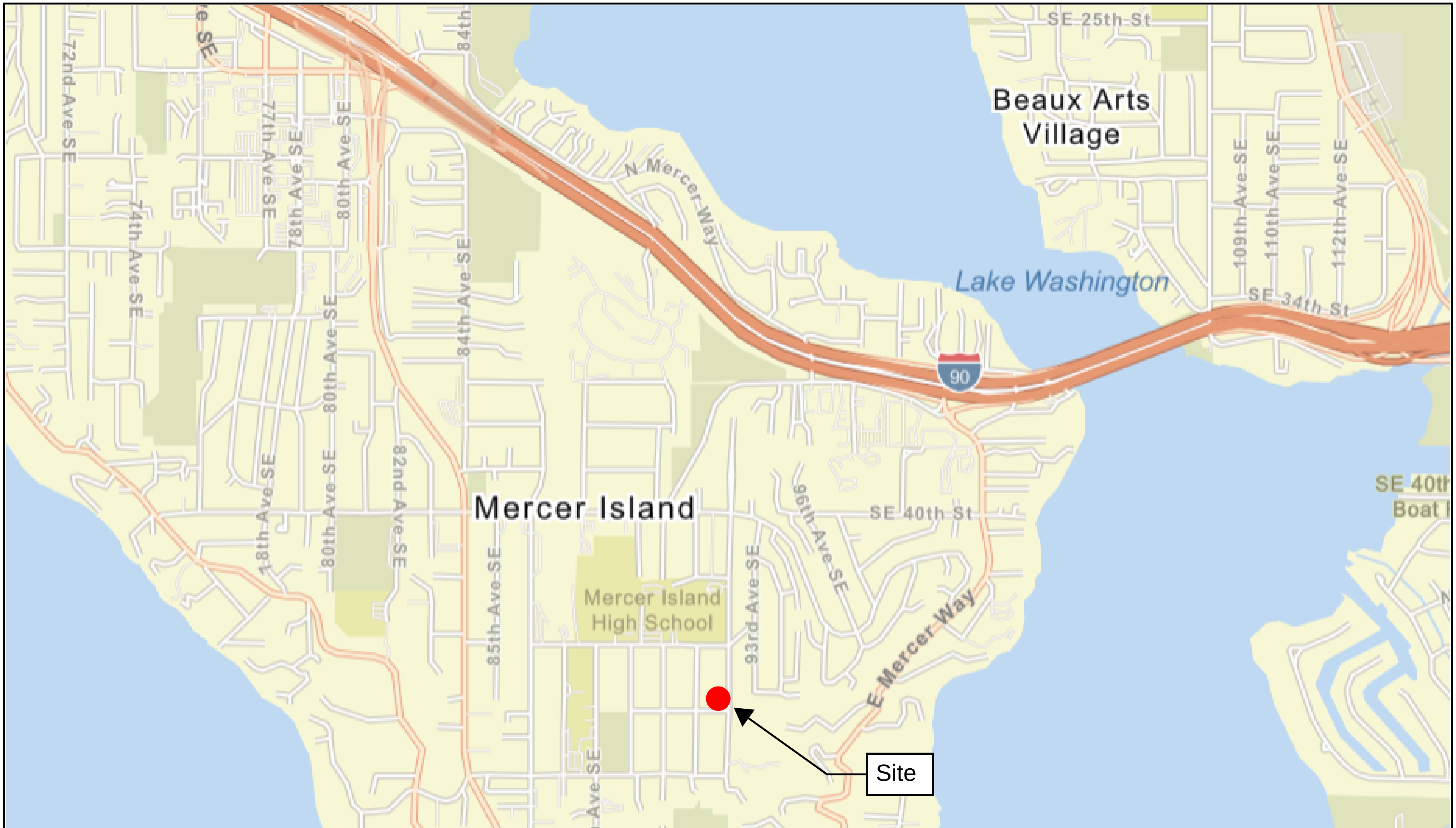
Yount, J.C., J.P. Minard, and G.R. Dembroff. 1993. *Geologic Map of Surficial Deposits in the Seattle 30' x 60' Quadrangle*. Open File Report 93-233. Washington Department of Natural Resources, Washington Division of Geology and Earth Resources.



Source: Esri 2025

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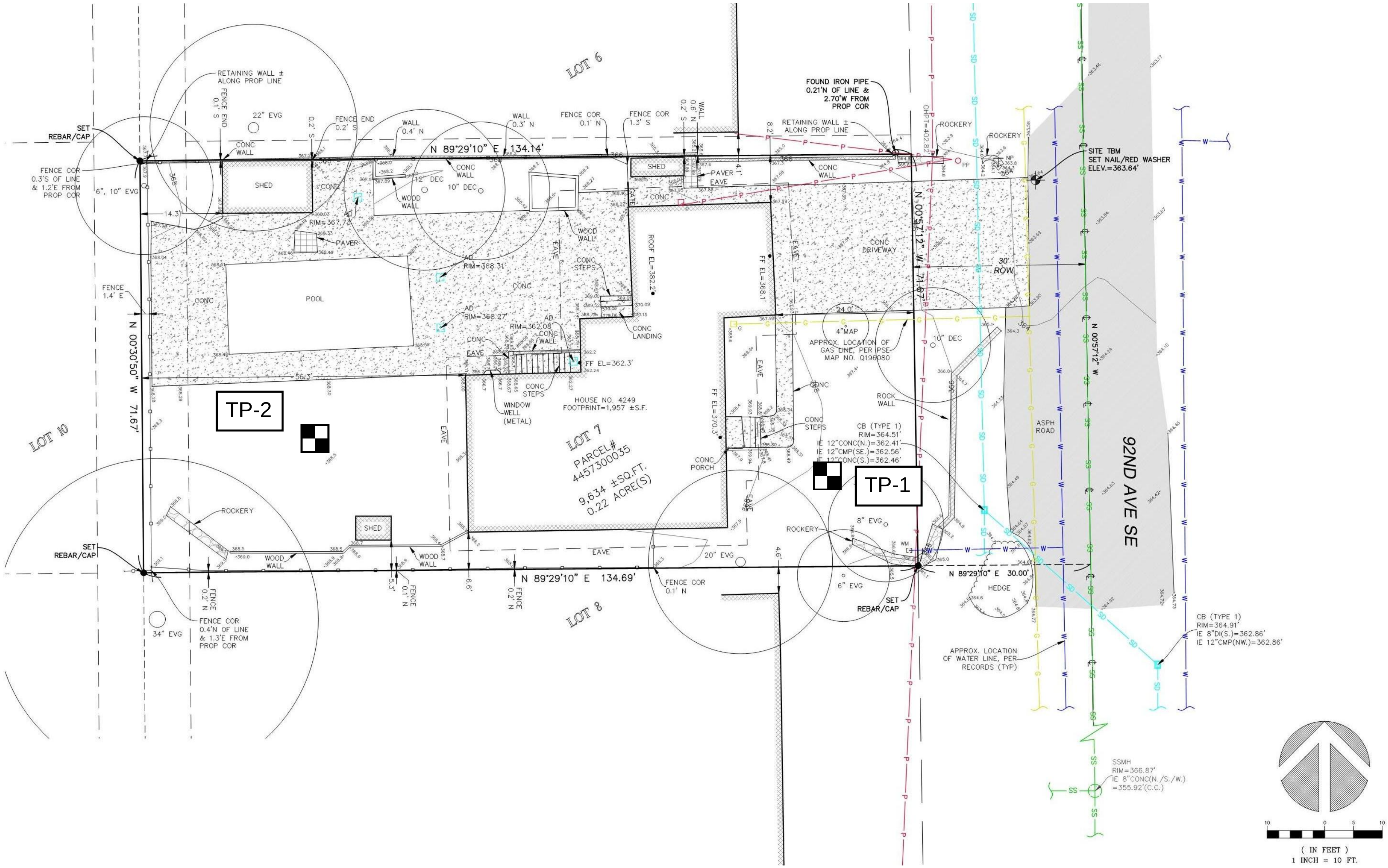
Vicinity Map	
Ankapura Residence	
Mercer Island, Washington	Figure 1



Approximate Test Pit Location and Designation

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Source: Terrane 2021

Site and Exploration Plan

Ankapura Residence

Mercer Island, Washington

Figure 2

Project: **Ankapura Residence** Project Location: **Mercer Island, Washington** Project Number: **074002**	Key to Test Pit Logs **Sheet 1 of 1**

Depth (feet)	Sample Type	Sample Number	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
1	2	3	4	5	6	7

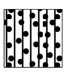
COLUMN DESCRIPTIONS

1 Depth (feet): Depth in feet below the ground surface.
2 Sample Type: Type of soil sample collected at the depth interval shown.
3 Sample Number: Sample identification number.
4 Material Type: Type of material encountered.
5 Graphic Log: Graphic depiction of the subsurface material encountered.
6 MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
7 REMARKS AND OTHER TESTS: Comments and observations regarding drilling or sampling made by driller or field personnel.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
GS: Grain size analysis
w: Gravimetric water content
-200: Wash sieve (No. 200 Sieve)

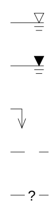
MATERIAL GRAPHIC SYMBOLS


Silty SAND (SM)

TYPICAL SAMPLER GRAPHIC SYMBOLS


Grab Sample

OTHER GRAPHIC SYMBOLS


Water level (at time of Excavation, ATD)
Water level (after waiting, AW)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific exploration locations and at the time the explorations were completed. They are not warranted to be representative of subsurface conditions at other locations or times.

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Project: **Ankapura Residence**	Log of Test Pit TP-1
Project Location: **Mercer Island, Washington**	**Sheet 1 of 1**
Project Number: **074002**	

Date(s) Explored **2-6-25**	Logged By **AMI**	Checked By **LGL**
Excavation Method **Excavator**	Bucket Size/Type **24" Toothed**	Total Depth of Test Pit **10.2 ft**
Excavator Type **Deere 50G**	Excavation Contractor **Northwest Interiors & Design, LLC**	Approximate Surface Elevation **Not measured**
Groundwater Level and Date Measured **Not measured**	Sampling Method(s) **Grab**	Hammer Data **N/A**
Test Pit Backfill **Spoils**	Approximate Location **47.569434, -122.216387**	

Depth (feet)	Sample Type	Sample Number	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
0			SM		4 inches of grass/sod over dark brown, silty, fine to coarse SAND with gravel and roots (loose, moist) **(TOPSOIL)**	
	Grab	S-1	SM		Brown, silty, fine to coarse SAND with gravel (medium dense, moist) **(RECESSIONAL OUTWASH)**	
	Grab	S-2			-Iron staining	
			SM		Gray-brown-mottled, silty, fine to coarse SAND with gravel (dense, moist) **(GLACIAL TILL)**	
5	Grab	S-3			-Gravelly, with cobbles, gray	
					-Very dense	
10	Grab	S-4				
					Total Depth: 10.2 ft	
15						

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Figure 4

Project: **Ankapura Residence**	# Log of Test Pit TP-2
Project Location: **Mercer Island, Washington**	**Sheet 1 of 1**
Project Number: **074002**	

Date(s) Explored **2-6-25**	Logged By **AMI**	Checked By **LGL**
Excavation Method **Excavator**	Bucket Size/Type **24" Toothed**	Total Depth of Test Pit **10.0 ft**
Excavator Type **Deere 50G**	Excavation Contractor **Northwest Interiors & Design, LLC**	Approximate Surface Elevation **Not measured**
Groundwater Level and Date Measured **Not measured**	Sampling Method(s) **Grab**	Hammer Data **N/A**
Test Pit Backfill **Spoils**	Approximate Location **47.569452, -122.216758**	

Depth (feet)	Sample Type	Sample Number	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
0			SM		4 inches of grass/sod over dark brown, silty, fine to coarse SAND with roots (loose, moist) **(TOPSOIL)**	
		S-1	SM		Red-brown, silty, fine to coarse SAND with trace roots (medium dense, moist) **(RECESSIONAL OUTWASH)**	
		S-2	SM		Gray-brown-mottled, iron-stained, silty, fine to coarse SAND with gravel (dense, moist) **(GLACIAL TILL)**	w = 16.9% GS
5					-Gray	
		S-3				
					-Very dense	
10		S-4			Total Depth: 10.0 ft	
15						

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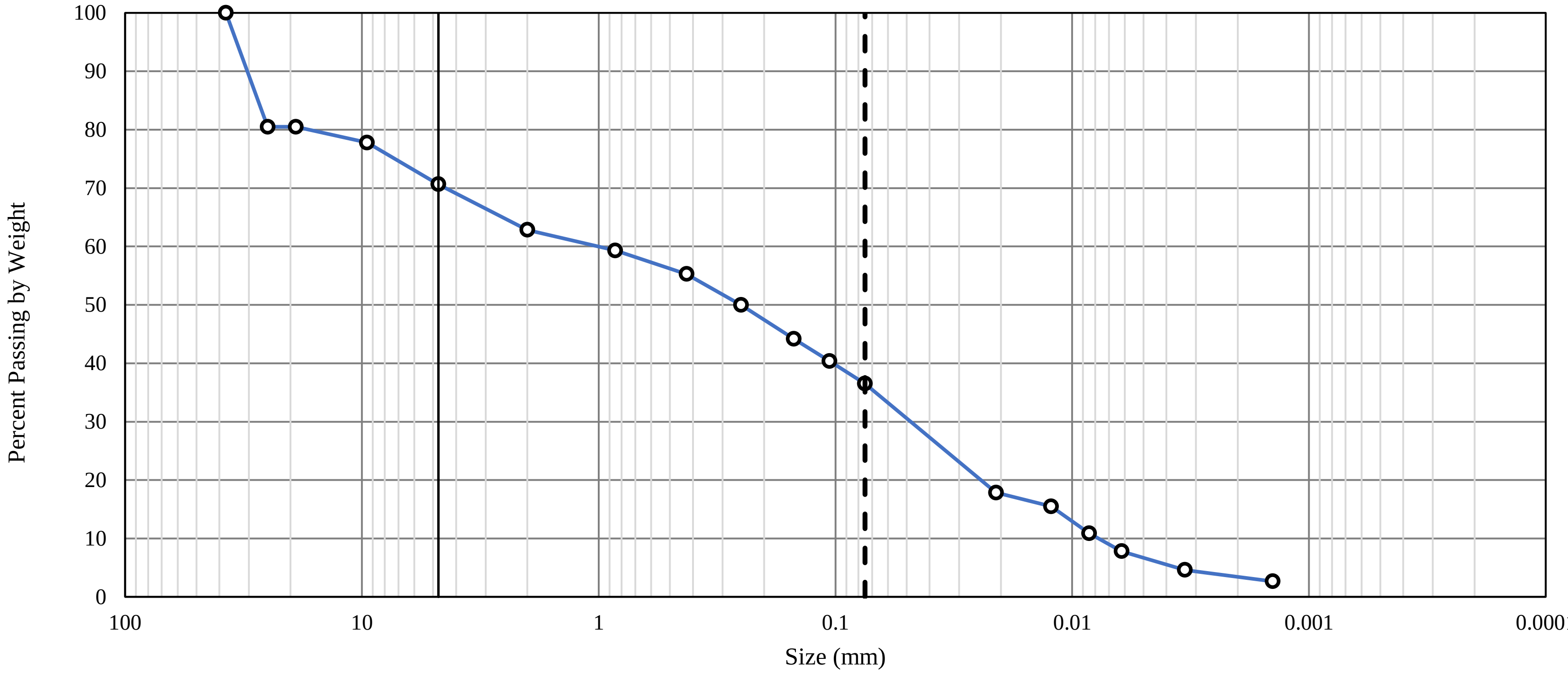
Figure 5



	Depth	w	D90	D60	D30	D10	Cu	Cc	% G	% S	% F	USCS
	(ft)	(%)	(mm)	(mm)	(mm)	(mm)	-	-	(%)	(%)	(%)	-
TP2 S-2	3.0	16.9%	30.46	1.01	0.05	0.01	129.9	0.3	29.4	34.1	36.5	SM

w = as-received moisture content
% G = percent gravel and larger
% S = percent sand
% F = percent fines
USCS = Unified Soil Classification System group symbol
To be well-graded: 1 < Cc < 3, Cu > 4 for GW, Cu > 6 for SW

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Grain Size Analysis Results
ASTM D422

Ankapura Residence

Mercer Island, Washington | Figure 6