Geotechnical Engineering Report
Lake Geneva Park Improvements
34429 – 46th Avenue South

King County, Washington

January 11, 2024

Submitted To:
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INTRODUCTION

This *Geotechnical Engineering Report* summarizes our site observations, subsurface explorations, laboratory testing and engineering analyses, and provides geotechnical recommendations and design criteria for the proposed park improvements to be constructed at 34429 – 46th Avenue South in the Auburn area of King County, Washington. The site is currently developed with grass fields, a play area, a paved parking lot and paved walking trails, restrooms, and associated utilities. The general location of the site is shown on the attached Site Location Map, Figure 1.

Our understanding of the project is based on our discussions with you; a review of the *Preliminary Site Plan* provided by you; our November 16, 2023 site visit and subsurface explorations; our understanding of King County development codes; and our experience in the area. Lake Geneva Park occupies two adjacent tax parcels on the northeast shoreline of Lake Geneva. We understand that the proposed development will include the construction of new picnic shelters, sports courts, ADA improvements, and associated site improvements. Based on our review of the *Preliminary Site Plan*, the proposed improvements will be constructed within the northern parcel only. The existing site configuration is illustrated on the attached Site & Exploration Plan, Figure 2.

King County (the County) requires a *Soil Report* to assess the feasibility of on-site soils to support infiltration of stormwater runoff from the proposed new hard surfaces. We have prepared this *Geotechnical Engineering Report* to address the stormwater manual, provide an assessment of potential geologic hazards per King County Code (KCC) Title 21A for critical areas, and to address the geotechnical report requirements of the 2018 International Building Code (IBC).

PURPOSE & SCOPE

The purpose of our scope of services was to evaluate the surface and subsurface conditions across the site as a basis for providing geotechnical recommendations and design criteria for the proposed park improvements. Specifically, the scope of services for this project included the following:

1. Reviewing the available geologic and geotechnical data for the site area;

2. Exploring subsurface conditions at the site by drilling four hollow stem auger borings to depths of 6.5 to 12.75 feet below existing site grades near the proposed improvements;
3. Describing surface and subsurface conditions, including soil type, depth to groundwater, and an estimate high groundwater based on observed subsurface conditions;
4. Providing seismic design parameters, including 2018 IBC site class;
5. Providing recommendations and design criteria for foundation and floor slab support, including conventional spread foundations;
6. Providing recommendations for subgrade walls, including lateral earth pressures and applicable seismic surcharges;
7. Providing our opinion about the feasibility of onsite infiltration in accordance with the *2021 King County Surface Water Design Manual* (2021 KCSWDM), including a preliminary infiltration rate based on grain size test data, as appropriate;
8. Providing geotechnical recommendations for earthwork and grading activities including site preparation, subgrade preparation, fill placement criteria (including hillside grading), suitability of on-site soils for use as structural fill, and temporary and permanent cut and fill slopes;
9. Providing recommendations for erosion and sediment control during wet weather grading and construction; and
10. Preparing this written *Geotechnical Engineering Report* summarizing our site observations and conclusions, and our geotechnical recommendations and design criteria, along with the supporting data.

SITE CONDITIONS

Surface Conditions

The site is located in an area of residential development on the Auburn glacial upland area. According to King County iMap data and the *Limited Boundary and Topographic Survey* (Lanktree Land Surveying, 12/8/23, NAVD88), the site is irregular in shape, measures about 1,410 feet long (east to west) by about 630 feet wide (north to south) and encompasses approximately 502,682 square feet (11.54 acres). The site is currently developed with a play area, parking lot, paved walking trails, and restrooms. The site is bounded by residential development and South 342nd Street to the north, by Military Road South and residential development to the east, South 344th Street to the south, and by residential development and Lake Geneva to the west.

The terrain in the site vicinity generally slopes down towards the Lake Geneva shoreline. The eastern and central portions of the site slope down to the north and northeast at 5 to 10 percent. The western portion of the site slopes down to the west towards Lake Geneva between 10 to 40 percent, becoming steeper immediately above the shoreline. Total topographic relief across the site is on the order of 60 feet.

Vegetation at the site consists of maintained grass fields and scattered stands of deciduous and coniferous trees with a moderately dense understory of shrubs and brush. No evidence of slope instability or soil erosion was observed at the site at the time of our site visit. No evidence of standing water, groundwater seeps, or springs was observed on the site. The site topography is shown on Figure 2, the existing site conditions are shown on Figure 3.

Site Soils

The USDA Natural Resource Conservation Service (NRCS) Web Soil Survey maps the surficial soils at the site as Alderwood gravelly sandy loam (AgB and AgC). An excerpt from the NRCS soils map for the site area is included as Figure 4. These soils are described below.

- Alderwood gravelly sandy loam (AgB): The Alderwood soils are typically derived from glacial till or outwash and are included in hydrologic soil group B.
    - The AgB soils form on slopes of 0 to 8 percent and are listed as a "slight" (off-road, off-trail) erosion hazard when exposed.
    - The AgC soils form on slopes of 8 to 15 percent and are listed as a "slight" (off-road, off-trail) erosion hazard when exposed.

Site Geology

According to the *Lidar-Revised Geologic Map of the Poverty Bay 7.5' Quadrangle, King and Pierce Counties, Washington* (Troost et al, 2014), the underlying geology at the site is mapped as glacial till (Qvt). No areas of landslide deposits or mass wasting are noted on the referenced map within the immediate vicinity of the site. A description of the geologic unit is provided below, and an excerpt of the above reference geologic map is attached as Figure 5.

- *Glacial till (Qvt)*: Vashon glacial till typically consists of a heterogeneous mixture of clay, silt, sand and gravel that was deposited at the base of the continental ice mass during the Vashon Stade of the Fraser Glaciation, some 12,000 to 15,000 years ago. Glacial till was overridden by the ice mass post deposition, and as such is considered overconsolidated and exhibits high strength, low compressibility, low porosity, and low permeability characteristics when undisturbed. Because of the low porosity and permeability typically associated with glacial till, the potential for stormwater infiltration is low.

We reviewed the Washington Geological Survey (WGS) protocol landslide mapping and other compiled landslide mapping groups for the site and surrounding area. The landslide mapping from these sources is shown on the Washington State Department of Natural Resources (WA DNR) Geologic Information Portal. The WGS protocol maps landslide landforms and landslide susceptibility using Lidar based on the criteria provided in the Protocol for Landslide Mapping from Lidar Data in Washington State (Slaughter, et al, 2017) and the Protocol for Shallow-Landslide Susceptibility Mapping (Burns and others, 2012). The other compiled landslide mapping is referenced from published 1:24,000- and 1:100,000-scale geologic maps, landslide hazard zonation studies, watershed analyses, reconnaissance-scale landslide mapping from winter storm landslide events and a lidar-based study of near-shore landforms. Where overlap of sources occurs, the WGS-protocol landslide mapping supersedes the other compiled landslide mapping.

The nearest mapped landslide feature is identified as a low confidence deep-seated translational earthflow of pre-historic age (more than 150 years) that has not been field verified, situated about 0.72 miles northeast of the site on the edge of the glacial upland area. This landslide is not shown on the above referenced geologic map. An excerpt of the WA DNR landslide mapping is included as Figure 6.

Subsurface Explorations

On November 17, 2023, we visited the site and monitored the drilling of four hollow-stem borings to depths of approximately 6.5 to 12.75 feet below the existing ground surface using a track-mounted limited access drill rig. While onsite, we logged the subsurface conditions encountered at each boring location and obtained representative soil samples. Table 1, below, summarizes the approximate functional locations, surface elevations, and termination depths of our borings.

TABLE 1:
APPROXIMATE LOCATIONS, ELEVATIONS, AND DEPTHS OF EXPLORATIONS

Boring Number	Functional Location	Surface Elevation [1] (feet)	Termination Depth (feet)	Termination Elevation[1] (feet)
B-1	West of existing playground	406.0	8.0	398.0
B-2	Northeast of existing playground	416.0	6.5	409.5
B-3	Open field area	419.5	6.5	413.0
B-4	Existing parking lot	420.0	12.7	407.3

Notes:
[1] = Surface elevations estimated from the *Limited Boundary and Topographic Survey* (Lanktree Land Surveying, 12/8/23, NAVD88)

During drilling, soil samples were obtained at 2.5 and 5-foot depth intervals in accordance with the standard penetration test (SPT) method outlined by ASTM D1586. The SPT method consists of driving a standard 2 inch-outer diameter split-spoon sampler 18 inches into the soil with a 140-pound hammer. The number of blows required to drive the sampler through each 6-inch interval is counted, and the total number of blows struck during the final 12 inches is recorded as the Standard Penetration Resistance, or "SPT blow count". If a total of 50 blows are recorded within any 6-inch interval (refusal), the driving is stopped, and the blow counts are recorded as 50 blows for the actual distance the sampler was driven. The resulting Standard Penetration Resistance values indicate the relative density of granular soils and the relative consistency of cohesive soils.

The specific number, locations, and depths of our explorations were selected based on input from you and our understanding of the configuration of the proposed re-development and were adjusted in the field based on consideration for underground utilities, existing site conditions, site access limitations and encountered stratigraphy. Representative soil samples obtained from the borings were placed in sealed containers and taken to our laboratory for further examination and testing as deemed necessary. When complete, the borings were abandoned in accordance with Washington State law, and the surface restored to the extent possible.

The subsurface explorations completed as part of this evaluation indicate the subsurface conditions at specific locations only, as actual subsurface conditions can vary across the site. Furthermore, the nature and extent of such variation would not become evident until additional explorations are performed or until construction activities have begun.

The numbers and approximate locations of our borings are shown on the attached Site & Exploration Plan, Figure 2. The soils encountered were visually classified in accordance with the Unified Soil Classification System (USCS) and ASTM D2488. The USCS is included in Appendix A as Figure A-1, while the descriptive logs of our borings are included as Figures A-2 through A-5.

Subsurface Conditions

Our exploration locations disclosed subsurface conditions that, in our opinion, generally confirmed the mapped stratigraphy. The encountered soil layers and others are described in the following paragraphs.

Topsoil: At the surface at the locations of borings B-1 through B-3, we encountered approximately 0.5 to 0.75 feet of dark brown topsoil.

Gravel Fill: At the surface at the location of boring B-4, we encountered approximately 0.5 feet of gravelly sand with silt in a medium dense, moist condition. This appeared to be placed fill material, with the upper part consisting of material similar to crushed surfacing top course.

Free-draining fill: Underlying the topsoil in boring B-3, we encountered approximately ¾ feet of grey poorly graded sand with silt in a loose, moist condition. We interpret these soils to be free draining fill likely placed as a leveling and drainage course for the turf.

Undocumented fill: Underlying the gravel fill in boring B-4, we encountered approximately 2.75 feet of grey gravelly silty SAND in a medium dense, moist condition. We interpret these soils to be undocumented fill.

Weathered Glacial till: Underlying the topsoil in borings B-1 and B-2 and the free-draining fill in boring B-3, we encountered approximately 1.25 to 2.5 feet of brown, mottled silty sand with some gravel in a medium dense, moist condition. We interpret these soils to be weathered glacial till.

Glacial Till: Underlying the weathered till soils in boring B-1 through B-3 and the undocumented fill in boring B-4, we encountered tan-grey gravelly silt that graded to grey gravelly silty sand in a hard to very dense, moist condition. We interpret these soils to be glacial till. The glacial till was encountered to the full depth explored in all borings. Refusal conditions were encountered in the glacial till soils at all borings locations.

TABLE 2:
APPROXIMATE THICKNESS, DEPTHS, AND ELEVATION OF SOIL TYPES ENCOUNTERED IN EXPLORATIONS

Boring Number	Thickness of (feet, approximate):				Depth to Glacial Till (feet)	Elevation[1] of Glacial Till (feet)
	Topsoil/fill	Weathered Glacial Till	Free-draining Fill	Undocumented fill		
B-1	0.5	2.5	NE	NE	3.0	403.0
B-2	0.7	1.7	NE	NE	2.4	413.6
B-3	0.5	1.3	0.7	NE	2.5	417.0
B-4	0.5	NE	NE	2.9	3.4	416.6

Notes:
[1] = Surface elevations estimated from the *Limited Boundary and Topographic Survey* (Lanktree Land Surveying, 12/8/23, NAVD88)
NE= Not encountered

Laboratory Testing

Geotechnical laboratory tests were performed on select samples retrieved from the borings to estimate index engineering properties of the soils encountered. Samples were visually classified per ASTM D2488 and ASTM D2487. Laboratory testing included moisture content determinations per ASTM D2216 and grain size analyses per ASTM D6913 standard procedures. Test results summarized below in Table 3 and graphical output results are included in Appendix B.

TABLE 3:

LABORATORY TEST RESULTS FOR ON-SITE SOILS

Sample	Soil Type	Lab ID	Gravel Content (percent)	Sand Content (percent)	Silt/Clay Content (percent)	Moisture Content (percent)
B-1, S-1, D: 0.5ft	SM	104523	-	-	-	26.4
B-1, S-4, D: 7.5ft	SM	104524	-	-	-	6.9
B-2, S-2, D: 2.5ft	SM	104525	24.4	31.3	44.3	17.1
B-2, S-3, D: 5ft	SM	104526	-	-	-	8.0
B-3, S-1a, D: 0.5ft	SP-SM	104527	3.5	88.3	8.2	20.2
B-3, S-2, D: 2.5ft	SM	104528	33.3	36.3	30.4	12.5
B-4, S-1, D: 0.25ft	SP-SM	104529	39.7	49.4	10.4	4.9
B-4, S-4, D: 7.5ft	SM	104530	16.0	36.0	48.0	14.1
B-4, S-5,D: 10ft	SM	104531	26.5	38.4	35.1	8.4

Groundwater Conditions

Groundwater or groundwater seepage was not observed in the borings at the time of drilling. However, iron oxidation and mottling was observed in all explorations generally within 1 foot of the top of the undisturbed glacial till. These indicators may be evidence of the seasonal high level of an unconfined aquifer that develops seasonally atop the dense glacial till, often referred to as a perched aquifer. We anticipate fluctuations in the local groundwater levels will occur in response to precipitation patterns, off-site construction activities, and site utilization. Accordingly, observations made during drilling may vary significantly from those encountered during construction.

ENGINEERING CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our data review, site reconnaissance, subsurface explorations, laboratory testing, and our experience in King County; it is our opinion that the proposed park improvements are feasible from a geotechnical engineering standpoint, provided the conclusions and recommendations presented below are appropriately incorporated into the project plans and specifications.

Erosion Hazard Areas KCC Title 21A.06.415

King County defines an erosion hazard area as an area underlain by soils that are subject to severe erosion when disturbed. These soils include, but are not limited to, those classified as having a severe to very severe erosion hazard according to the USDA NRCS. These soils include any of the following when they occur on slopes inclined at 15 percent or more:

A. Alderwood gravelly sandy loam (AgD)
B. Alderwood and Kitsap soils (AkF)
C. Beausite gravely sandy loam (BeD and BeF)
D. Kitsap silt loam (KpD)
E. Ovall gravely loam (OvD and OvF)
F. Ragnar fine sandy loam (RaD)
G. Ragner-Indianola Association (RdE)

Based on our subsurface explorations, we would consider the intact native soils observed to be consistent with Alderwood gravelly sandy loam soils. The USDA NRCS maps the soil types as AgB and AgC Alderwood gravelly sandy loam; however, these soils are distinguished from soil type AgC based on slope. In the portions of the site where the ground surface slopes at more than 15 percent, the soils could accurately be described as type AgC. Therefore, these areas meet the criteria of erosion hazard areas, as illustrated on the attached Figure 2. It is our opinion that if erosion and sediment control Best Management Practices (BMPs) per the 2021 *King County Surface Water Design Manual* are implemented during construction activities, the potential for erosion to impact the project site or adjacent parcels should be minimal. Further discussion on erosion and sediment control is included in the "**Erosion and Sediment Control**" section of this report. We anticipate a temporary erosion and sediment control plan will be required for this project.

Erosion Hazard Areas Development Standards KCC Title 21A.24.220

The following development standards apply to development proposals and alterations on sites containing erosion hazard areas and should be incorporated into the project plans and specifications:

A. Clearing in an erosion hazard area is allowed only from April 1 to October 1, except that:
    1. Clearing of up to fifteen-thousand square feet within the erosion hazard area may occur at any time on a lot;
    2. Clearing of noxious weeds may occur at any time; and
    3. Forest practices regulated by the department are allowed at any time in accordance with a clearing and grading permit if the harvest is in conformance with chapter 76.09 RCW and Title 222 WAC;
B. All subdivisions, short subdivisions, binding site plans or urban planned developments on sites with erosion hazard areas shall retain existing vegetation in all erosion hazard areas until building permits are approved for development on individual lots. The department may approve clearing of vegetation on lots if:
    1. The clearing is a necessary part of a large scale grading plan; and
    2. It is not feasible to perform the grading on an individual lot basis;
    C. If the department determines that erosion from a development site poses a significant risk of damage to downstream wetlands or aquatic areas, based either on the size of the project, the proximity to the receiving water or the sensitivity of the receiving water, the applicant shall provide regular monitoring of surface water discharge from the site. If the project does not meet water quality standards established by law or public rules, the county may suspend further development work on the site until such standards are met. (Ord. 15051 § 160, 2004: Ord. 10870 § 469, 1993).

Landslide Hazard Areas KCC Title 21A.06.680

King County defines a landslide hazard area as an area subject to severe risk of landslide, such as:

A. An area with a combination of:
   1. Slopes steeper than fifteen percent of inclination;
   2. Impermeable soils, such as silt and clay, frequently interbedded with granular soils, such as sand and gravel; and,
   3. Springs or groundwater seepage;
B. An area that has shown movement during the Holocene epoch, which is from ten thousand years ago to the present, or that is underlain by mass wastage debris from that epoch;
C. Any area potentially unstable as a result of rapid stream incision, stream bank erosion or undercutting by wave action;
D. An area that shows evidence of or is at risk from snow avalanches; or
E. An area located on an alluvial fan, presently or potentially subject to inundation by debris flows or deposition of stream-transported sediments.

Based on our site observations, it is our opinion that the site does not meet the King County technical definition of a landslide hazard area. In our opinion, no prescriptive buffers or setbacks should be required.

Steep Slope Hazard Areas KCC Title 21A.06.1230

King County defines a steep slope hazard area as an area on a slope of forty percent inclination or more with a vertical elevation change of at least ten feet. For this definition, a slope is delineated by establishing its toe and top and is measured by averaging the inclination over at least ten feet of vertical relief. Also, for the purpose of this definition:

A. The "toe" of a slope means a distinct topographic break in slope that separates slopes inclined at less than forty percent from slopes inclined at forty percent or more. Where no distinct break exists, the "toe" of a slope is the lower most limit of the area where the ground surface drops ten feet or more vertically within a horizontal distance of twenty-five feet; and

B. The "top" of a slope is a distinct topographic break in slope that separates slopes inclined at less than forty percent from slopes inclined at forty percent or more. Where no distinct break exists, the "top" of a slope is the upper-most limit of the area where the ground surface drops ten feet or more vertically within a horizontal distance of twenty-five feet. (Ord. 15051 § 101, 2004: Ord. 10870 § 286, 1993).

There are slopes steeper than 40 percent present on site; however, these slopes are less than 10 vertical feet in height. Based on the above, steep slope hazard areas as defined by King County Code are not present on site, and in our opinion no prescriptive buffer should be required by the County.

Seismic Design

The site is located in the Puget Sound region of western Washington, which is seismically active. Seismicity in this region is attributed primarily to the interaction between the Pacific, Juan de Fuca and North American plates. The Juan de Fuca plate is subducting beneath the North American plate at the Cascadia Subduction Zone (CSZ). This produces both intercrustal (between plates) and intracrustal (within a plate) earthquakes. In the following sections we discuss the design criteria and potential hazards associated with the regional seismicity.

Seismic Site Class

Based on our observations and the subsurface units mapped at the site, we interpret the structural site conditions to correspond to a seismic Site Class "C" in accordance with the 2018 IBC documents and American Society of Civil Engineers (ASCE) standard 7-16 Chapter 20 Table 20.3-1. This is based on the anticipated range of SPT (Standard Penetration Test) blow counts for the soil types in the site area. These conditions were assumed to be representative for the subsurface conditions for the site.

Design parameters

The U.S. Geological Survey (USGS) completed probabilistic seismic hazard analyses (PSHA) for the entire country in November 1996, which were updated and republished in 2002 and 2008. We used the *ATC Hazard by Location* website to estimate seismic design parameters at the site. Table 5, below, summarizes the recommended design parameters.

TABLE 5:
2018 IBC PARAMETERS FOR DESIGN OF SEISMIC STRUCTURES

Spectral Response Acceleration (SRA) and Site Coefficients	Short Period
Risk Category	II
Mapped SRA	S_s = 1.296g
Site Coefficients (Site Class D)	F_a = 1.200
Maximum Considered Earthquake SRA	S_{MS} = 1.555g
Design SRA	S_{DS} = 1.036g

Peak Ground Acceleration

The mapped peak ground acceleration (PGA) for this site is 0.548g. To account for site class, the PGA is multiplied by a site amplification factor (F_{PGA}) of 1.2. The resulting site modified peak ground acceleration (PGA_M) is 0.657g. In general, estimating seismic earth pressures (k_h) by the Mononobe-Okabe method or seismic inputs are taken as approximately 33 to 50 percent of the PGA_M, or approximately 0.219g to 0.329g.

Seismic Hazards

Earthquake-induced geologic hazards may include liquefaction, lateral spreading, slope instability, and ground surface fault rupture. Liquefaction is a phenomenon where there is a reduction or complete loss of soil strength due to an increase in pore water pressure in soils. The increase in pore water pressure is induced by seismic vibrations. Liquefaction primarily affects geologically recent deposits of loose, uniformly graded, fine-grained sands and low-plasticity silts that are below the groundwater table. The site is mapped as having a "very low" liquefaction susceptibility by the *Liquefaction Susceptibility Map of King County, Washington* (2004); an excerpt of this map is included as Figure 7. Based on our review of the WA DNR Liquefaction Susceptibility mapping and the dense nature of the glacial till soils observed within our explorations, it is our opinion that the risk of liquefaction induced settlements during a seismic event is low.

According to the WA DNR Ground Response on the WA Geologic Information Portal, there are no faults mapped in the project vicinity (within 300 feet of site). The site is located about 1.1 miles northeast of the nearest spur of the Tacoma Fault Zone, as shown on the Fault Hazards Map, Figure 8. No evidence of ground fault rupture was observed in our explorations or during our site reconnaissance. Therefore, in our opinion, the proposed park improvements should have no greater risk for ground fault rupture than other structures located in the area.

Foundation Support

Based on the subsurface conditions encountered at our test pit locations and our understanding of the proposed improvements, we recommend that spread footings bear directly on the native weathered or undisturbed glacial soils.

Bearing Surface Preparation

The soil at the base of the foundation excavations should be disturbed as little as possible. All loose, soft, or unsuitable material should be removed. Where materials are over-excavated below a footing bearing surface, the excavated materials should be replaced with structural fill or controlled density fill (CDF). Removal of unsuitable soils, if encountered, below the footings should extend beyond the foundation edges 1 foot horizontally for every 1 foot of vertical excavation. If prepared bearing surfaces remain open for an extended time, we recommend they be protected by placing a rat slab of CDF or a 4-to-6-inch lift of crushed rock. A representative from our firm should observe the foundation excavations to determine if suitable bearing surfaces have been prepared.

Spread Footing Design

For design of new shallow foundation elements, we recommend a minimum width of 24 inches for isolated footings and at least 16 inches for continuous wall footings. All footing elements should be embedded at least 18 inches below grade for frost protection. Lateral loads may be resisted by a combination of base friction and passive pressure against the footings. Spread footing design parameters are provided in Table 6, below.

TABLE 6:
SPREAD FOOTING DESIGN PARAMETERS

Parameter	Value	FS
Allowable Bearing Pressure (psf)	2,500	3.0
Allowable Coefficient of Friction	0.30	1.5
Allowable Passive Pressure (pcf)	250	1.5
Minimum footing Width – Isolated (inches)	24	--
Minimum footing Width – Strip (inches)	16	--
Estimated Total Settlement (inches)	< 1	--
Estimated Differential Settlement Over 50 feet (inches)	< ½	--

Lateral Load Resistance

Lateral loads may be resisted by friction on the base of footings, mats, slabs, and as passive pressure on the sides of footings. We recommend that an allowable coefficient of friction of 0.30 be used to calculate friction between the concrete and the underlying structural fill. Passive pressure may be determined using an allowable equivalent fluid density of 250 pcf (pounds per cubic foot). Factors of safety have been applied to these values.

Settlement

We estimate that settlements of spread footings designed and constructed as recommended will be less than 1 inch, for the anticipated load conditions, with differential settlements between comparably loaded footings of 0.5 inch or less over a span of 50 feet. These estimates are based on assumed column loads of 10 kips.

These estimated settlements should occur essentially as loads are being applied. It should be noted that disturbance of the foundation bearing surface during construction or modifications of the existing groundwater regime at the site could result in larger settlements than estimated herein.

Exterior Slabs-on-grade

We recommend that slab-on-grade construction is supported by firm native soils or structural fill as described below. Areas of old fill material should be evaluated during grading activity for suitability of structural support. Areas of significant organic debris should be removed.

A subgrade modulus of 200 pci (pounds per cubic inch) may be used for floor slab design. We estimate that settlement of the floor slabs designed and constructed as recommended, will be 0.5 inch or less over a span of 50 feet.

Where slabs will be protected from the elements, we recommend they be directly underlain by a capillary break consisting of a minimum 4-inch-thick layer of washed pea gravel (⅜-inch to US No. 8 sieve size) or clean ⅝-inch crushed rock (less than 2 percent passing the US No. 200 sieve) and a vapor retarder, consisting of plastic sheeting or drainage barrier material, be placed beneath floor slabs. If pea gravel is used, a 2-inch layer of clean crushed rock can be placed over it to provide a firmer working surface on which to place the slab reinforcement. The vapor retarder should be placed on top of the capillary break material.

A synthetic vapor retarder is recommended to control moisture migration through the slabs. This is of particular importance where moisture migration through the slab is an issue, such as where adhesives are used to anchor carpet or tile to the slab. The vapor retarder should be required in any heated enclosed spaces and may be required in any enclosed spaces.

Subgrade/Basement Walls

The lateral pressures acting on retaining walls (such as basement or grade separation walls) will depend upon the nature and density of the soil behind the wall as well as the presence or absence of hydrostatic pressure. Below we provide recommended design values and drainage recommendations for retaining walls.

Design Values

For walls backfilled with granular well-drained soil such as gravel backfill for walls or permeable ballast, we provided the appropriate active and at-rest equivalent fluid pressures in Table 7 below. We anticipate the wall will be greater than 6 feet in height and have included a seismic surcharge for the assumed conditions. If walls are constructed with a backslope and will be braced or otherwise restrained against movement, we should be notified so that we can evaluate the anticipated conditions and recommend an appropriate at-rest earth pressure.

TABLE 7:
LATERAL EARTH PRESSURES FOR DESIGN OF RETAINING WALLS

Lateral Earth Pressure Condition, equivalent fluid density (PCF)	Backfill Material	
	Gravel Backfill for Walls (WSDOT 9-03.12(2))	Permeable Ballast (WSDOT 9-03.9(2))
At-rest, level backslope	56	43
Active, level backslope	35	27
Active, 3H:1V backslope	38	29
Active, 2H:1V backslope	45	32
Seismic Surcharge	18H	15H

Lateral loads may be resisted by friction on the base of footings and as passive pressure on the sides of footings and the buried portion of the wall, as described in the "**Foundation Support**" section of this report.

Wall Drainage

Adequate drainage behind retaining structures is imperative. Positive drainage which controls the development of hydrostatic pressure can be accomplished by placing a zone of drainage behind the walls. Granular drainage material should contain less than 2 percent fines and at least 30 percent retained on the US No. 4 sieve.

A minimum 4-inch diameter perforated or slotted PVC pipe should be placed in the drainage zone along the base and behind the wall to provide an outlet for accumulated water and direct accumulated water to an appropriate discharge location. We recommend that a nonwoven geotextile

filter fabric be placed between the soil drainage material and the remaining wall backfill to reduce migration of fines into the drainage zone. The infiltration of fines into the drainage zone can, with time, reduce the permeability of the granular material. The filter fabric should be placed such that it fully separates the drainage material and the backfill and should be extended over the top of the drainage zone. Typical wall drainage and backfilling details are shown on Figure 9.

A soil drainage zone should extend horizontally at least 18 inches from the back of the wall. The drainage zone should also extend from the base of the wall to within 1 foot of the top of the wall. The soil drainage zone should be compacted to approximately 90 percent of the MDD, as determined in accordance with ASTM D1557. Over-compaction should be avoided as this can lead to excessive lateral pressures on the wall. A geocomposite drain mat may also be used instead of free draining soils, provided it is installed in accordance with the manufacturer's instructions.

Temporary Excavations

All job site safety issues and precautions are the responsibility of the contractor providing services/work. The following temporary cut/fill slope guidelines are provided for planning purposes only. Temporary cut slopes will likely be necessary during grading operations or utility installation. Where there is not enough area for sloped excavations, temporary shoring should be provided. If shallow temporary shoring is required, we recommend that it be designed to withstand the lateral earth pressures provided in the basement wall section of this report.

All excavations at the site associated with confined spaces, such as utility trenches and retaining walls, must be completed in accordance with local, state, or federal requirements including the Washington Administrative Code (WAC) and Washington Industrial Safety and Health Administration (WISHA). Excavation, trenching, and shoring is covered under the WAC 296-155 Part N.

Based on the WAC 296-155-66401, it is our opinion that the upper weathered soils and fill soils at the site would be classified as Type C soils, the glacial till soils would be classified as Type A soils. According to WAC 296-155-66403, for temporary excavations of less than 20 feet in depth, the side slopes in Type C soils should be sloped at a maximum inclination of 1½H:1V or flatter from the toe to top of the slope and Type A soils should be laid back at a slope inclination of ¾H:1V or flatter. All exposed slope faces should be covered with a durable reinforced plastic membrane during construction to prevent slope raveling and rutting during periods of precipitation. These guidelines assume that all surface loads are kept at a minimum distance of at least one half the depth of the cut away from the top of the slope and that significant seepage is not present on the slope face. Flatter cut slopes will be necessary where significant raveling or seepage occurs, or if construction materials will be stockpiled along the slope crest.

Where it is not feasible to slope the site soils back at these inclinations, a retaining structure should be considered. Retaining structures greater than 4-feet in height (bottom of footing to top of structure) or that have slopes of greater than 15 percent above them, should be engineered per Washington Administrative Code (WAC 51-16-080 item 5). This information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that GeoResources assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

Permanent Cut and Fill Slopes

Fill slopes constructed on grades that are steeper than 5H:1V should be constructed in accordance with Appendix J of the 2018 IBC and should utilize proper keying and benching methods. A detail of the Appendix J key and bench requirements are attached as Figure 10. The benches should be 1½ times the width of the equipment used for grading and be a maximum of 3 feet in height. Subsurface drainage may be required in areas where significant seepage is encountered during grading. Collected drainage should be directed to an appropriate discharge point. Surface drainage should be directed away from all slope faces.

Permanent cut or fill slopes in soil should be no steeper than 2H:1V. All permanent slopes should be protected from erosion as soon as feasible after grading is completed. Typical erosion control methods per the adopted 2021 *King County Surface Water Design Manual* should be sufficient for proposed site grading activities. Additionally, permanent slopes should be planted with a hardy vegetative groundcover, mulched, or armored with quarry spalls as soon as feasible after grading is completed.

Site Drainage

All ground surfaces, pavements, and sidewalks at the site should be sloped to direct surface water away from the structures, slopes, and property lines. Surface water runoff from the roof areas, driveways, perimeter footing drains, and wall drains should be collected, tightlined, and conveyed to an appropriate discharge point. We recommend that footing drains are installed for the structures in accordance with IBC 1807.4.2.

Precipitation water from roof downspouts should be collected into tightlines and routed away from the building. Downspout water should not be introduced into the foundation backfill or drains. Surface water should be collected in catch basins and tightlined with the downspout water to an approved discharge point.

Infiltration Recommendations

The surficial site soils were consistent with weathered/undisturbed glacial till with areas of shallow fill soils. The glacial till soils are considered an impermeable layer. Mottling, likely indicative of seasonal high groundwater, was observed throughout the weathered till soils. King County uses the 2021 King County Surface Water Design Manual (2021 KCSWDM) for design of stormwater management systems. Per the 2021 KCSWDM, 3 feet of separation is required from the bottom of an infiltration facility, i.e.; a downspout infiltration trench, and the top of groundwater, glacial till (hard pan), or soils considered impermeable. For Limited Impact Development (LID) infiltration Best Management Practices (BMPs) such as permeable pavement or bio-retention, one foot of separation is required by the 2021 KCSWDM. The separation requirements for infiltration facilities and LID infiltration BMPs cannot be met across the site. We recommend alternative BMPs such as dispersion be used to manage stormwater generated by the new impervious surfaces or the stormwater collected and tightlined to an appropriate discharge point.

Pavement Sections

We understand that improvements to the existing parking and adjacent roadway may be completed as a component of the proposed project. Given the preliminary nature of the project, we have provided recommendations for hot-mix asphalt (HMA) minimum pavement sections based on

King County Road Design and Construction Standards (2016). We were not provided with traffic data prior to preparation of this analysis. There may be an opportunity for value engineering of the recommended minimum pavement sections.

Pavement Subgrades

Pavement subgrade areas should be prepared by excavating into firm native soils to design subgrade elevation or placing and compacting structural fill soils in appropriate lifts to at least 95 percent of maximum dry density as determined in accordance with ASTM D1557. The prepared subgrade should be performance tested by proof-rolling with a fully-loaded dump truck or equivalent point load equipment. Soft, loose, or wet areas that are identified during performance testing should be recompacted or removed, as appropriate. Over-excavated areas should be backfilled with compacted structural fill.

Pavement Sections

We recommend that the minimum HMA pavement section is in accordance with Table 4-1 of the *King County Road Design and Construction Standards* (2016) for residential roads and streets. Table 7, below, summarizes the recommended minimum pavement section thicknesses.

TABLE 7:
MINIMUM SECTION THICKNESS RECOMMENDATIONS (Inches)

½-inch Class HMA	4.0
CSBC or CSTC	8.5
Subgrade[1]	24.0

Notes: CSBC – Crushed Surface Base Course per WSDOT 9-03.9(3)
CSTC – Crushed Surface Top Course per WSDOT 9-03.9(3)
[1] Undisturbed native soils or structural fill compacted to 95 percent MDD, based on ASTM D1557

The above recommended section thicknesses meet the AASHTO 93 design standards based on the assumed traffic loading. Additional loading may contribute to premature failure of the pavement section.

Pavement Frost Conditions

Frost-susceptible soil is generally regarded as having greater than 3 percent finer than 0.02 millimeter (mm). Soil with a fines content not exceeding 7 percent passing the No. 200 sieve, based on the minus ¾-inch fraction, can normally be expected to have 3 percent or less finer than 0.02 mm. Based on the soils observed during our construction monitoring, most of the near-surface soils could be considered frost-susceptible. Based on information provided in the WSDOT Pavement Policy, we recommend assuming the frost depth would be about 18 inches. WSDOT recommends that the total depth of the pavement section be at least 50 percent of the frost depth, or 9 inches.

In our opinion, the recommended pavement sections should provide adequate protection against potential frost heave damage.

Pavement Materials and Construction

In general, the aggregate base course, HMA, and PCC should be constructed in accordance with WSDOT Standard Specifications for Road, Bridge, and Municipal Construction (WSDOT Standard Specifications, 2016). HMA should conform to Section 5-04 in the WSDOT Standard Specifications and the PCC should conform to Section 5-05 of the WSDOT Standard Specifications. We recommend that crushed rock used as CSBC in pavement sections consist of material of approximately the same quality as "crushed surfacing (base course)" (or better) described in Section 9-03.9(3) of the WSDOT Standard Specifications. We further recommend that CSBC material be compacted to at least 95 percent of the MDD based on the modified Proctor procedure (ASTM D1557).

EARTHWORK RECOMMENDATIONS

Site Preparation

All structural areas on the site to be graded should be stripped of vegetation, organic surface soils, and other deleterious materials including existing structures, foundations or abandoned utility lines. Organic topsoil is not suitable for use as structural fill, but may be used for limited depths in non-structural areas. Stripping depths ranging from 6 to 9 inches should be expected to remove topsoil and up to 3½ to remove fill soil based on conditions observed at the exploration locations. Areas of thicker topsoil or organic debris may be encountered in areas of heavy vegetation or depressions.

Where placement of fill material is required, the stripped/exposed subgrade areas should be compacted to a firm and unyielding surface prior to placement of any fill. Excavations for debris removal should be backfilled with structural fill compacted to the densities described in the "**Structural Fill**" section of this report.

We recommend that a member of our staff evaluate the exposed subgrade conditions after removal of vegetation and topsoil stripping is completed and prior to placement of structural fill. The exposed subgrade soil should be proof-rolled with heavy rubber-tired equipment during dry weather or probed with a ½ inch diameter steel rod during wet weather conditions.

Soft, loose, or otherwise unsuitable areas delineated during proofrolling or probing should be recompacted, if practical, or over-excavated and replaced with structural fill. The depth and extent of overexcavation should be evaluated by our field representative at the time of construction. The areas of old fill material should be evaluated during grading operations to determine if they need mitigation; recompaction or removal.

Structural Fill

All material placed as fill for the proposed improvements should be placed as structural fill. Material placed as structural fill should be free of debris, organic matter, trash, and cobbles greater than 4-inches in diameter. The moisture content of the fill material should be adjusted as necessary for proper compaction.

Materials

The suitability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines (material passing US No. 200 sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and adequate compaction becomes more difficult to achieve. During wet weather, we recommend use of well-graded sand and gravel with less

than 5 percent (by weight) passing the US No. 200 sieve based on that fraction passing the ¾-inch sieve, such as *Gravel Backfill for Walls* (WSDOT 9-03.12(2)). If prolonged dry weather prevails during the wall construction, higher fines content (up to 10 to 12 percent) may be acceptable.

Placement and Compaction

The appropriate lift thickness will depend on the structural fill characteristics and compaction equipment used, but it is typically limited to 4 to 6 inches for hand operated equipment; thicker lifts may be appropriate for larger equipment. For larger equipment such as a hoe-pac or drum roller, we recommend a maximum loose-lift thickness of 10 inches. Structural fill should be compacted to at least 95 percent of the MDD as determined by the Modified Proctor (ASTM D1557), except for within 12 inches of the back of any walls, as described in the "**Wall Drainage**" section of this report. Additionally, the moisture content should be maintained within 3 percent of the optimum moisture content in accordance with ASTM D1557.

Suitability of On-Site Materials as Fill

During dry weather construction, non-organic on-site soil may be considered for use as structural fill; provided it meets the criteria described above in the "**Structural Fill"** section and can be compacted as recommended. If the soil material is over-optimum in moisture content when excavated, it will be necessary to aerate or dry the soil prior to placement as structural fill. We generally did not observe the site soils to be excessively moist at the time of our subsurface exploration program.

The previously placed fill encountered at shallow depths at the site may be suitable for reuse, provided that all organic material is removed prior to placement. The deeper glacial till is generally comparable to "common borrow" material and will be suitable for use as structural fill provided the moisture content is maintained within 2 percent of the optimum moisture level.

We recommend that completed graded-areas be restricted from traffic or protected prior to wet weather conditions. The graded areas may be protected by paving, placing asphalt-treated base, a layer of free-draining material such as pit run sand and gravel or clean crushed rock material containing less than 5 percent fines, or some combination of the above.

Erosion and Sediment Control

Weathering, erosion and the resulting surficial sloughing and shallow land sliding are natural processes. These processes are common occurrences on the face of steep slopes. The sediment from any surficial sloughing and shallow land sliding may also cog up existing drainage systems and natural drainage paths. To manage and reduce the potential of these natural processes occurring, we recommend temporary erosion protection and sediment control measures be put in place for the steep slopes at the residence during construction activities. Erosion hazards can be mitigated by applying Best Management Practices (BMP's) outlined in the 2021 *King County Surface Water Design Manual*. To manage and reduce the potential for these natural processes, we recommend the following:

- No drainage of concentrated surface water or significant sheet flow onto slopes greater than 15 percent with more than 10 feet of vertical relief in the eastern portion of the site.
- Any site grading should be limited to surface grades that direct runoff away from the face of slopes to an appropriate discharge location at the toe.

- Existing vegetation should be maintained to the extent feasible during construction activities to reduce the potential for erosion at the site.
- Any areas of exposed soils be covered with mulch, straw, or other approved BMPs for erosion control.

Any erosion and sediment control plan should be in accordance with the 2021 *King County Surface Water Design Manual*.

Wet Weather and Wet Condition Considerations

In the Puget Sound area, wet weather generally begins about mid-October and continues through about May, although rainy periods could occur at any time of year. Therefore, it is strongly encouraged that earthwork be scheduled during the dry weather months of June through September. Most of the soil at the site contains sufficient fines to produce an unstable mixture when wet. Such soil is highly susceptible to changes in water content and tends to become unstable and impossible to compact if the moisture content exceeds the optimum.

In addition, during wet weather months, groundwater levels could increase, resulting in seepage into site excavations. Performing earthwork during dry weather would reduce these problems and costs associated with rainwater, construction traffic, and handling of wet soil. However, should wet weather/wet condition earthwork be unavoidable, the following recommendations are provided:

- The ground surface in and surrounding the construction area should be sloped as much as possible to promote runoff of precipitation away from work areas and to prevent ponding of water.
- Work areas or slopes should be covered with plastic when not being worked. The use of sloping, ditching, sumps, dewatering, and other measures should be employed as necessary to permit proper completion of the work.
- Earthwork should be accomplished in small sections to minimize exposure to wet conditions. That is, each section should be small enough so that the removal of unsuitable soils and placement and compaction of clean structural fill could be accomplished on the same day. The size of construction equipment may have to be limited to prevent soil disturbance. It may be necessary to excavate soils with a backhoe, or equivalent, and locate them so that equipment does not pass over the excavated area. Thus, subgrade disturbance caused by equipment traffic would be minimized.
- Fill material should consist of clean, well-graded, sand and gravel, of which not more than 5 percent fines by dry weight passes the No. 200 mesh sieve, based on wet-sieving the fraction passing the ¾-inch mesh sieve. The gravel content should range from between 20 and 50 percent retained on a No. 4 mesh sieve. The fines should be non-plastic.
- No exposed soil should be left uncompacted and exposed to moisture. A smooth-drum vibratory roller, or equivalent, should roll the surface to seal out as much water as possible.
- In-place soil or fill soil that becomes wet and unstable and/or too wet to suitably compact should be removed and replaced with clean, granular soil (see gradation requirements above).
- Excavation and placement of structural fill material should be observed on a full-time basis by a geotechnical engineer (or representative) experienced in wet weather/wet condition

earthwork to determine that all work is being accomplished in accordance with the project specifications and our recommendations.

- Grading and earthwork should not be accomplished during periods of heavy, continuous rainfall.

We recommend that the above requirements for wet weather/wet condition earthwork be incorporated into the contract specifications.

Plan Review and Construction Monitoring

King County will likely require our review of the project plans and specifications and a letter stating that our recommendations in this report have been included and that the development is appropriate. The County may also require us to perform construction monitoring for the project, specifically for deep foundation elements,

The items listed above are not included in our current scope of work. We typically perform these tasks on a time and materials basis and can provide an estimated budget at your request. The actual costs will depend on the progress of the contractor, the final design details and potentially the weather.

LIMITATIONS

We have prepared this report for use by WJA Design Collaborative, King County, and other members of the design team for use in the design of a portion of this project. The data used in preparing this report and this report should be provided to prospective contractors for their bidding or estimating purposes only. Our report, conclusions and interpretations are based on our subsurface explorations, data from others and limited site reconnaissance, and should not be construed as a warranty of the subsurface conditions.

Variations in subsurface conditions are possible between the explorations and may also occur with time. A contingency for unanticipated conditions should be included in the budget and schedule. Sufficient monitoring, testing and consultation should be provided by our firm during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork and foundation installation activities comply with contract plans and specifications.

The scope of our services does not include services related to environmental remediation and construction safety precautions. Our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design.

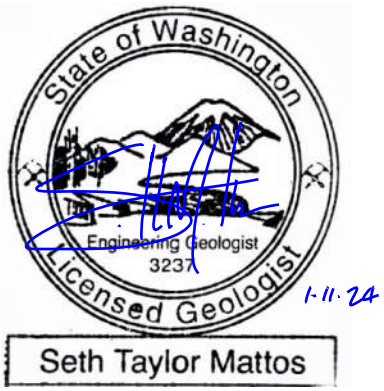
If there are any changes in the loads, grades, locations, configurations or type of facilities to be constructed, the conclusions and recommendations presented in this report may not be fully applicable. If such changes are made, we should be given the opportunity to review our recommendations and provide written modifications or verifications, as appropriate.

◆ ◆ ◆

We have appreciated the opportunity to be of service to you on this project. If you have any questions or comments, please do not hesitate to call at your earliest convenience.

Respectfully submitted,
GeoResources, LLC

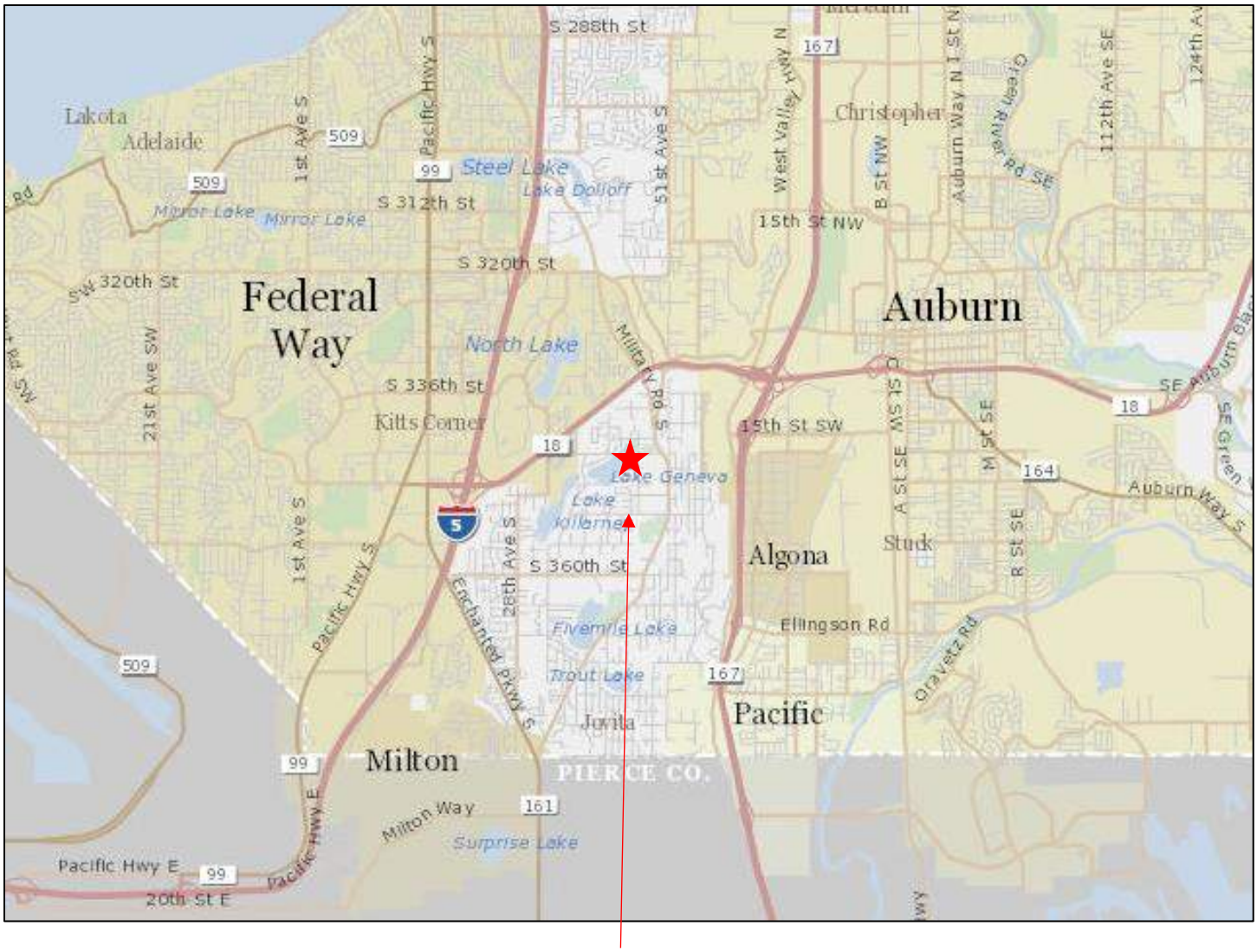
Davis Carlsen, GIT
Senior Staff Geologist



Seth T. Mattos, LEG
Associate

Eric W. Heller, PE, LG
Senior Geotechnical Engineer

MAE:STM:EWH/dc
DocID: WJADC.KC.LakeGenevaPark.RG
Attachments:
Figure 1: Site Location Map
Figure 2: Site & Exploration Plan
Figure 3: Site Vicinity Map
Figure 4: NRCS Soils Map
Figure 5: Geologic Map
Figure 6: WA DNR Landslide Mapping
Figure 7: Liquefaction Susceptibility Map
Figure 8: Fault Hazards Map
Figure 9: Typical Wall Drainage and Backfill
Figure 10: IBC Appendix J Detail
Appendix "A" – Subsurface Explorations
Appendix "B" – Laboratory Test results



Approximate Site Location

Figure created from King County iMap website
(https://gismaps.kingcounty.gov/iMap/)

Not to Scale

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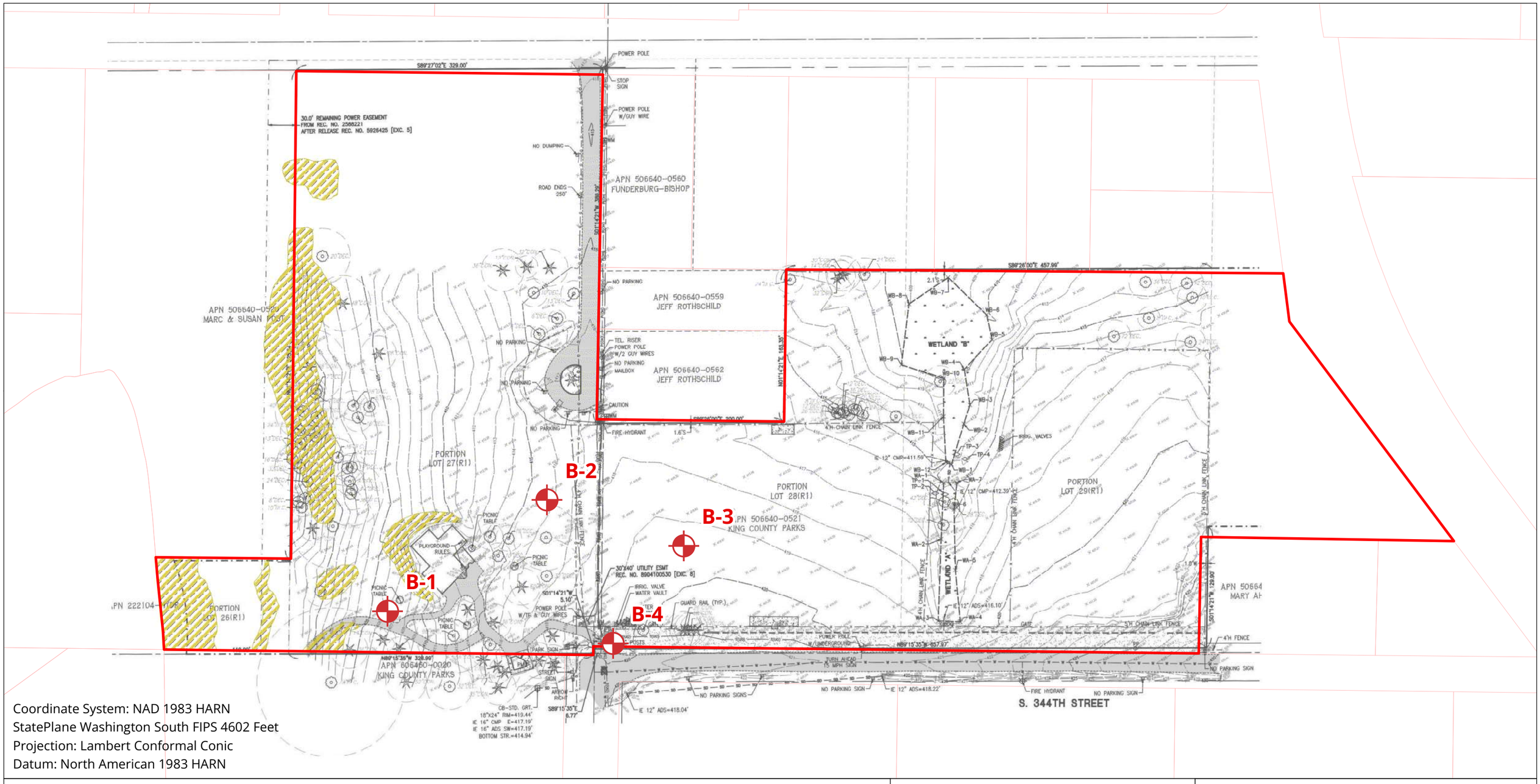
Site Location Map

Proposed Park Upgrades
34429 – 46th Avenue South
Auburn, Washington
PN: 5066400521

Doc ID: WJADC.KC.LakeGenevaPark.F	Jan 2024	Figure 1



Coordinate System: NAD 1983 HARN
StatePlane Washington South FIPS 4602 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983 HARN

King County tax parcels

PN: 0566400521

Number and location of boring

Erosion hazard area

0 50 100 200 300 400 Feet

1 inch = 100 feet

Limited Boundary and Topographic Survey prepared by Lanktree Land Surveying, Inc., dated December 8, 2023

N W E S

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Site & Exploration Plan

Proposed Park Upgrades
34429 - 46th Avenue South
King County, Washington
PN: 5066400521

Doc ID: WJADC.KC.LkGenevaPk.F2	January 2024	Figure 2

Approximate Site Location

Figure created from King County iMap website
(https://gismaps.kingcounty.gov/iMap/)

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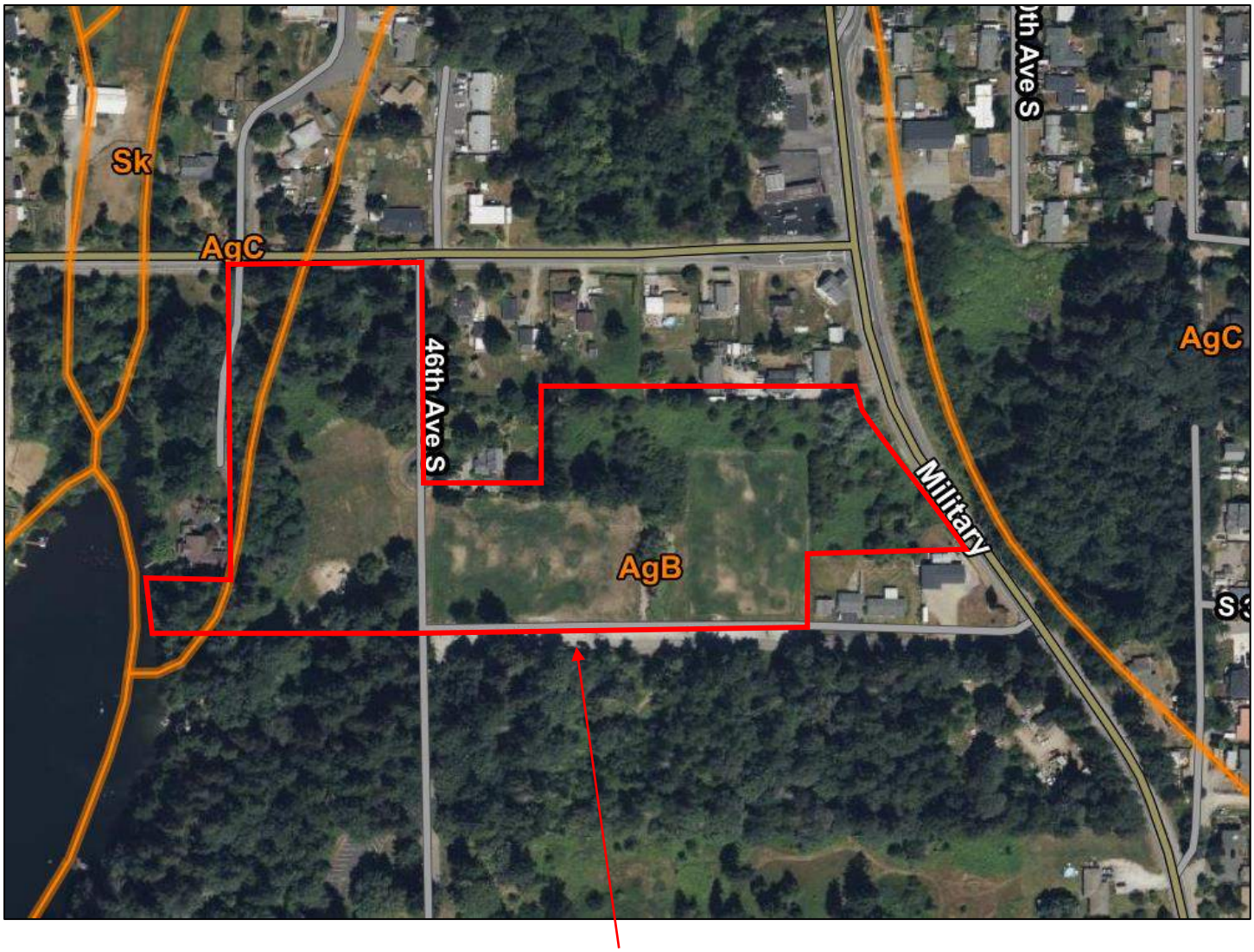
Site Vicinity Map

Proposed Park Upgrades
34429 – 46th Avenue South
Auburn, Washington
PN: 5066400521



Approximate Site Location

Figure created from Web Soil Survey
(http://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx)

Soil Type	Soil Name	Parent Material	Slopes	Erosion Hazard	Hydrologic Soils Group
AgB	Alderwood gravelly sandy loam	Glacial drift and/or glacial outwash over dense glaciomarine deposits	0 to 8	Slight	B
AgC			8 to 15		

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NRCS Soils Map

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Auburn, Washington
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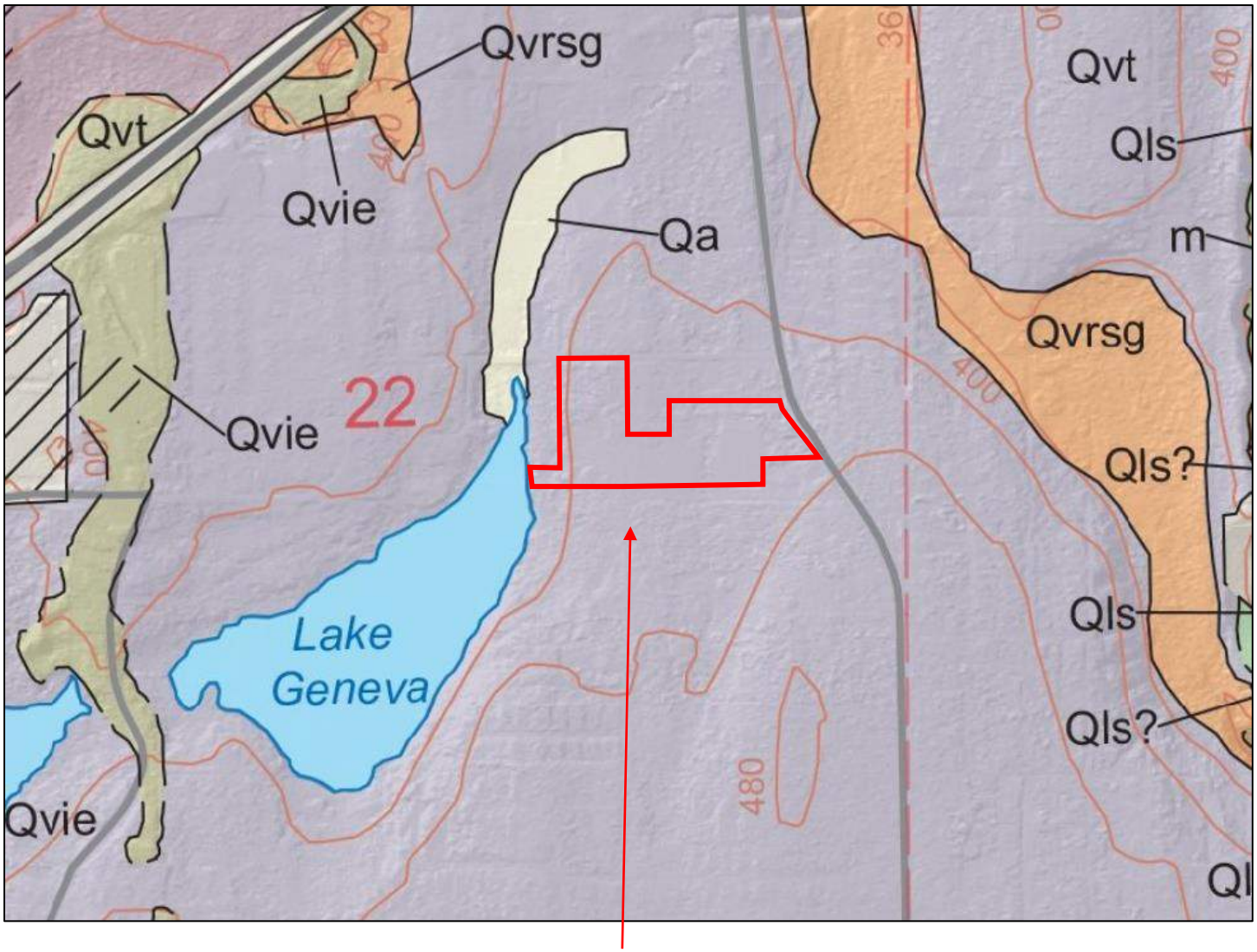
Doc ID: WJADC.KC.LakeGenevaPark.F	Jan 2024	Figure 4



Approximate Site Location

An excerpt from the *Lidar-revised geologic map of the Poverty Bay 7.5' quadrangle, King and Pierce Counties, Washington* by Tabor, R.W., Booth, D.B., and Troost, K.G. (2014)

Symbol	Geologic Unit
Qvt	Till

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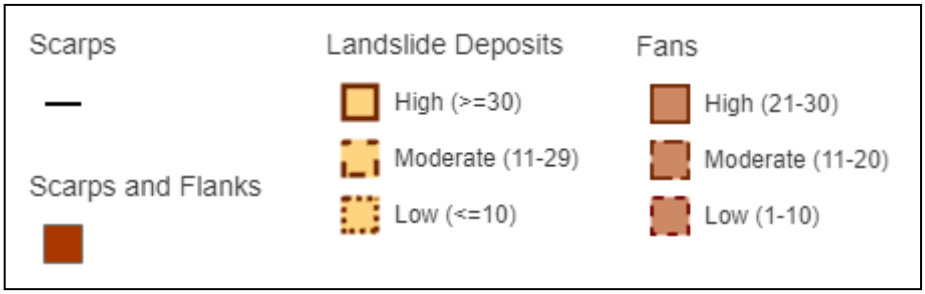
Geologic Map

Proposed Park Upgrades
34429 – 46th Avenue South
Auburn, Washington
PN: 5066400521

Doc ID: WJADC.KC.LakeGenevaPark.F	Jan 2024	Figure 5

Approximate Site Location

An excerpt from the Washington State Department of Natural Resources Geologic Information Portal (https://geologyportal.dnr.wa.gov/)



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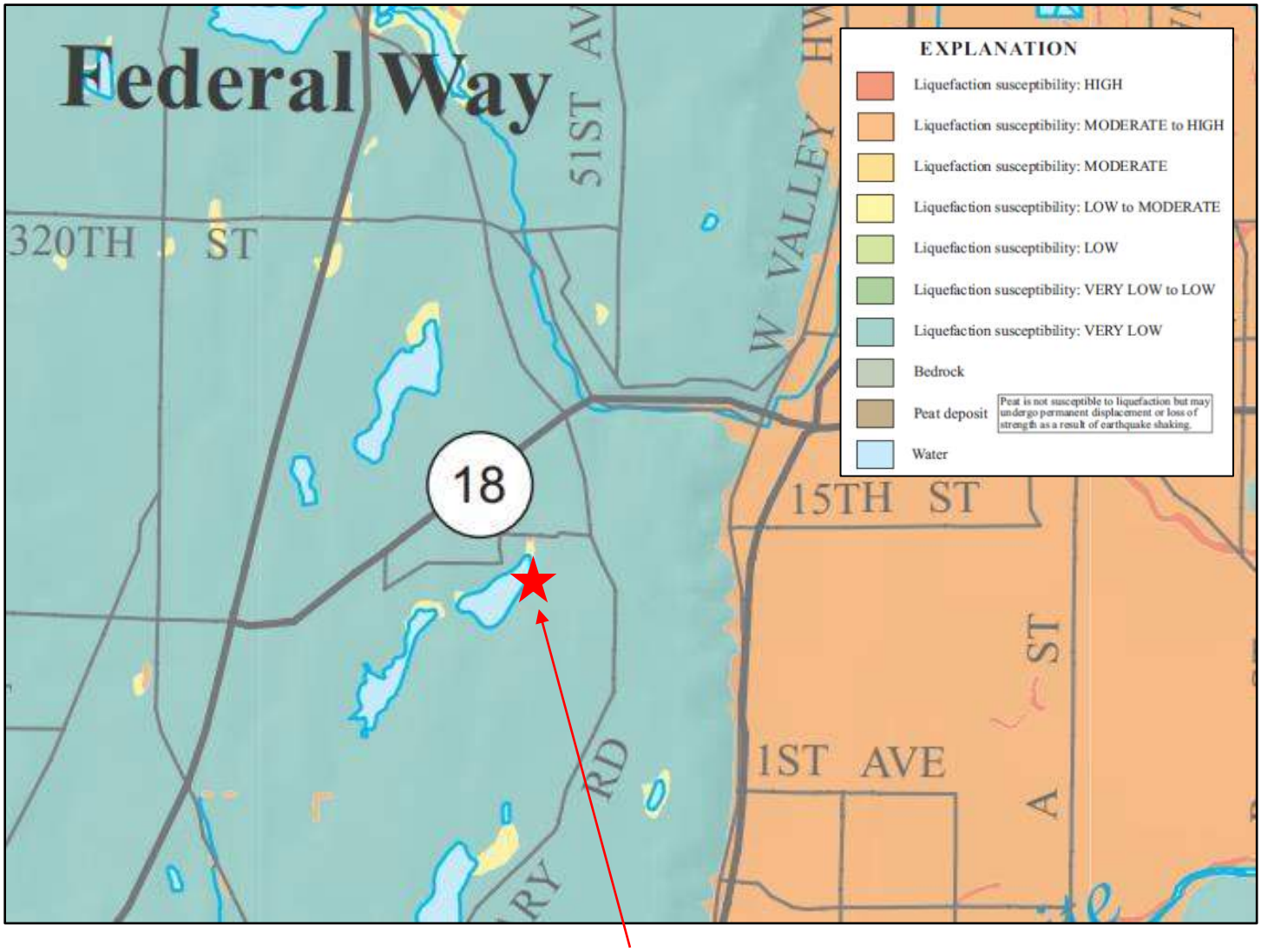
WA DNR Landslide Mapping

Proposed Park Upgrades
34429 – 46th Avenue South
Auburn, Washington
PN: 5066400521

Doc ID: WJADC.KC.LakeGenevaPark.F	Jan 2024	Figure 6



Approximate Site Location

An excerpt from the *Liquification Susceptibility Map of King County, Washington* by Stephen P. Palmer, Sammantha L. Magsino, Eric L. Bilderback, James L. Poelstra, Derek S. Folger, and Rebecca A. Niggemann (2004)

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Liquefaction Susceptibility Map

Proposed Park Upgrades
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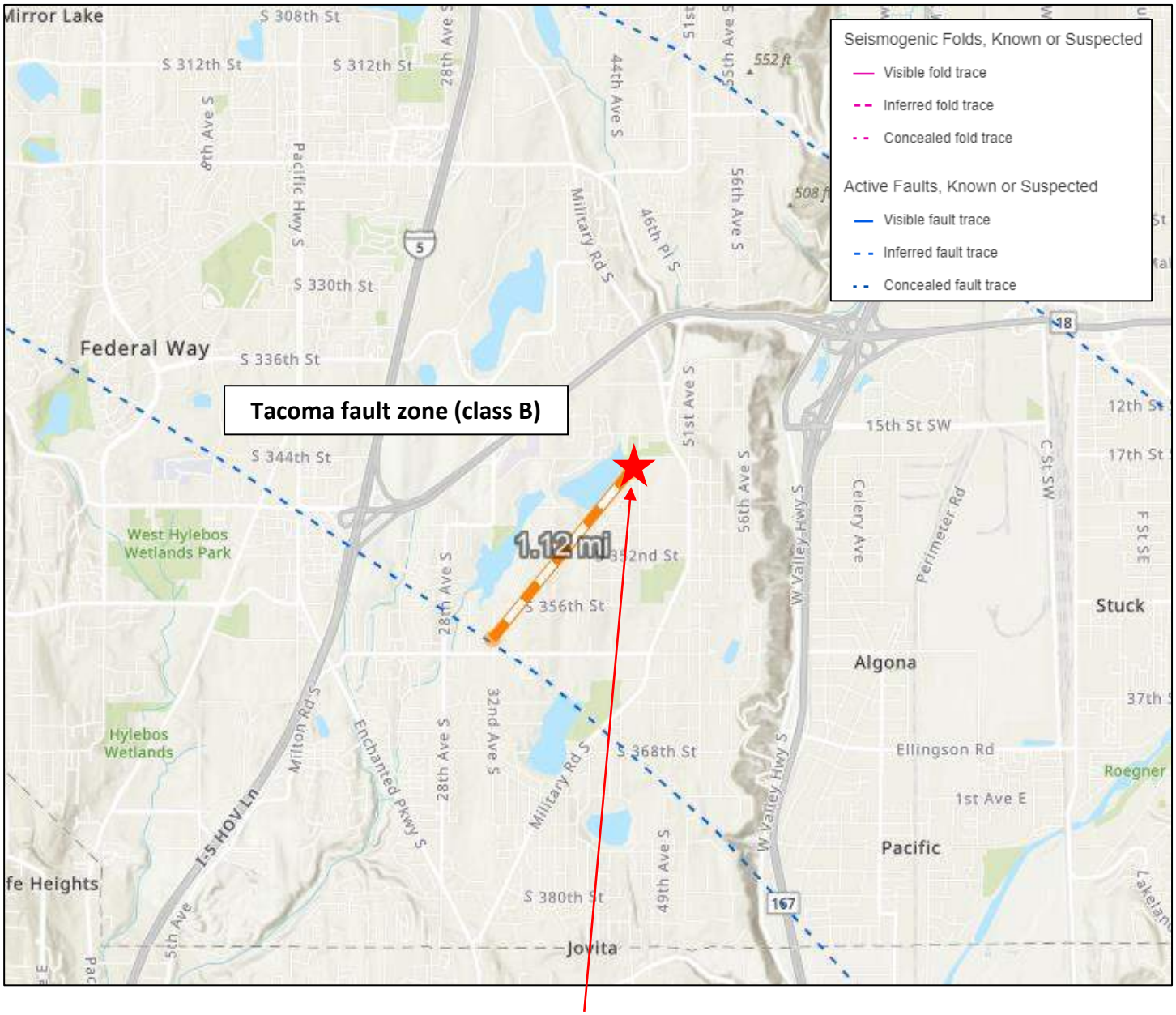
Auburn, Washington
PN: 5066400521

Doc ID: WJADC.KC.LakeGenevaPark.F	Jan 2024	Figure 7



Approximate Site Location

An excerpt from the Washington State Department of Natural Resources Geologic Information Portal (https://geologyportal.dnr.wa.gov/)

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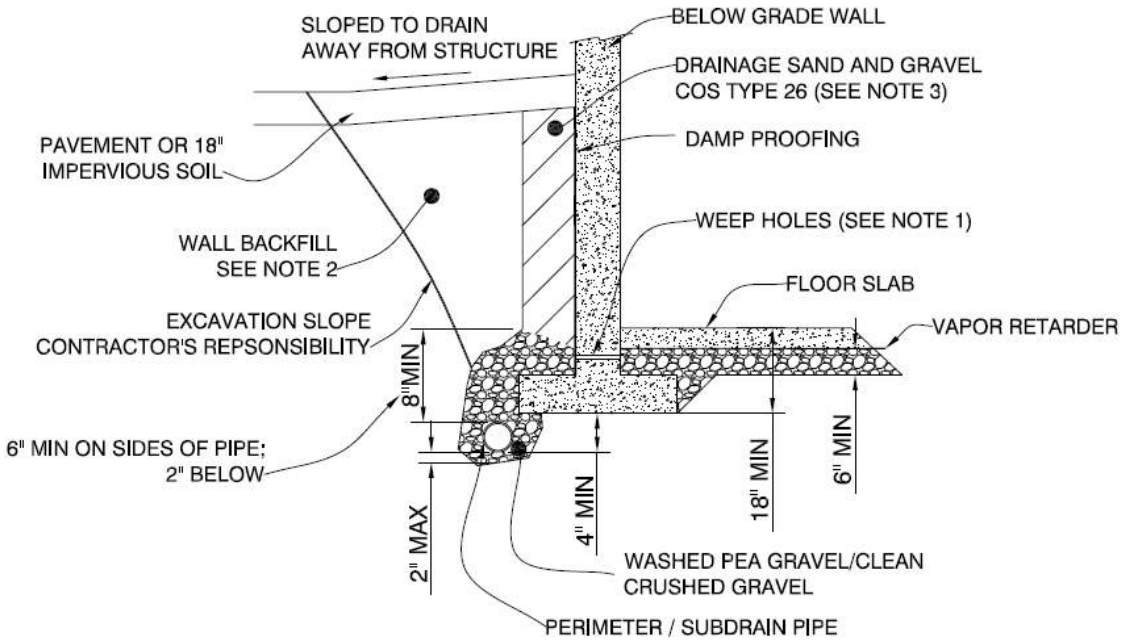
Fault Hazards Map

Proposed Park Upgrades
34429 – 46th Avenue South
Auburn, Washington
PN: 5066400521

Doc ID: WJADC.KC.LakeGenevaPark.F	Jan 2024	Figure 8



Notes:

[redacted]

Materials

Drainage Sand and Gravel

Sieve Size	% Passing by Weight
3/4 "	100
No 4	28-56
No 8	20-50
No 50	3-12
No 100	0-2

3/4" Minus Crushed Gravel

Sieve Size	% Passing by Weight
3/4 "	100
1/2"	75 - 100
1/4"	0 - 25
No 100	0 - 2
(by wet sieving)	(non-plastic)

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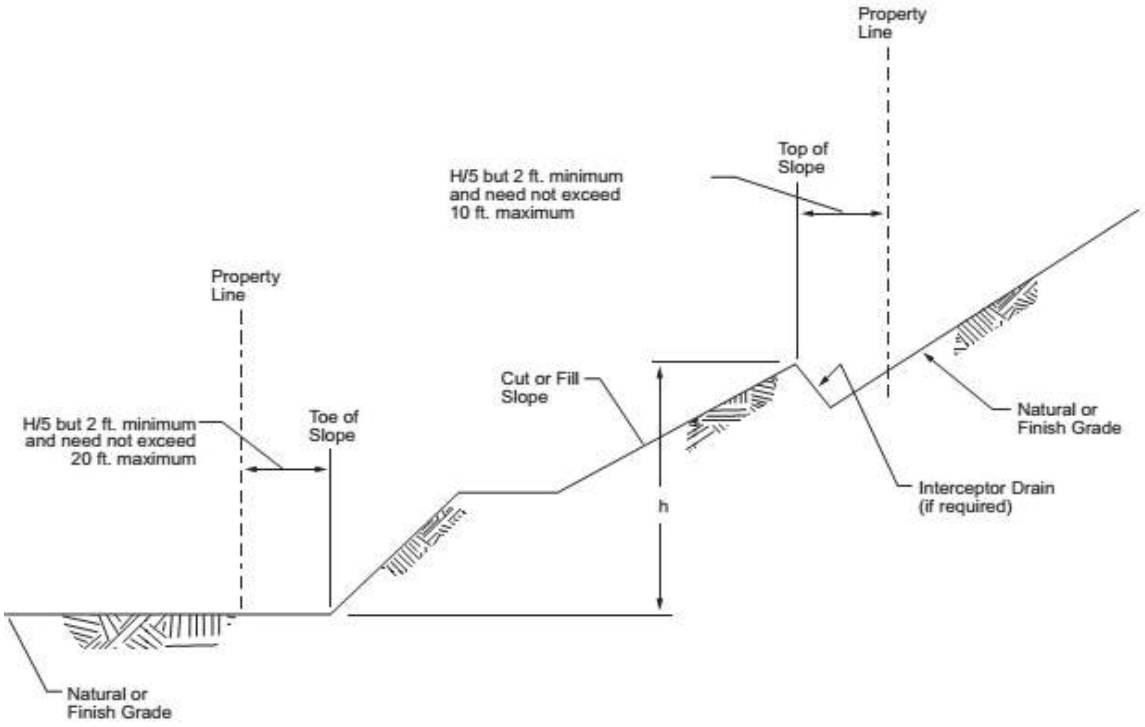
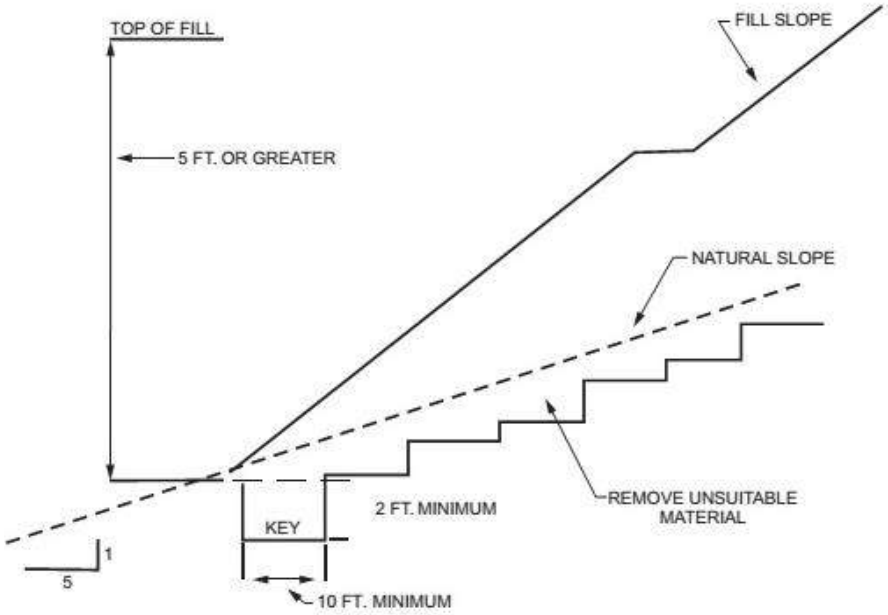
Typical Drainage and Backfill Detail

Proposed Park Upgrades
34429 – 46th Avenue South
Auburn, Washington
PN: 5066400521





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IBC Appendix J Detail

Proposed Park Upgrades
34429 – 46th Avenue South
Auburn, Washington
PN: 5066400521

Appendix A

Subsurface Explorations

SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS More than 50% Retained on No. 200 Sieve	GRAVEL More than 50% Of Coarse Fraction Retained on No. 4 Sieve	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND More than 50% Of Coarse Fraction Passes No. 4 Sieve	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% Passes No. 200 Sieve	SILT AND CLAY Liquid Limit Less than 50	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY Liquid Limit 50 or more	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT

NOTES:

1. Field classification is based on visual examination of soil in general accordance with ASTM D2488-90.
2. Soil classification using laboratory tests is based on ASTM D6913.
3. Description of soil density or consistency are based on interpretation of blow count data, visual appearance of soils, and or test data.

SOIL MOISTURE MODIFIERS:

Dry- Absence of moisture, dry to the touch

Moist- Damp, but no visible water

Wet- Visible free water or saturated, usually soil is obtained from below water table

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Unified Soils Classification System

Proposed Park Upgrades
34429 – 46th Avenue South
Auburn, Washington
PN: 5066400521

TOTAL DEPTH:	8	**EXCAVATION METHOD:**	HSA	**LOGGED BY:**	DC
TOP ELEVATION:	408	**EXCAVATION COMPANY:**	Geologic Drilling Inc	**HAMMER TYPE:**	cathead
LATITUDE:		**EQUIPMENT:**	Bobcat	**HAMMER WEIGHT:**	140 lbs
LONGITUDE:		**NOTES:**	West of existing playground		

Depth	Elevation	SOIL DESCRIPTION	Drilling Notes	Sample	Sampler	Symbol	Blow Count
0	408	Topsoil (6 inches)					
		Brown, mottled, gravelly silty SAND (SM) (loose to medium dense, moist) (weathered glacial till)		1			2 3 4
2	406			2			6 7 15
		Tan-grey, mottled gravelly sandy SILT (ML) (Hard, mosit) (silty glacial till)					
4	404			3			14 20 35
		Grey gravelly silty SAND (SM) (very dense, moist) (glacial till)					
6	402						
				4			100 50/6
8	400	Bottom of Boring CompletedNovember 17, 2023					
10	398						
12	396						

(new title)

TEST RESULTS

Test Results

Plastic Limit ├──┤ Liquid Limit

% Water Content ●

% Fines (<0.075mm) ◇

Penetration - ▲ (blow per foot)

10 20 30 40 50

Ground Water

NOTES

1. Refer to log key for definition of symbols, abbreviations and codes
2. USCS designation is based on visual manual classification and selected lab testing
3. Groundwater level, if indicated, is for the date shown and may vary
4. N.E. = Not Encountered

WJADC.LakeGenevaPark
34429 46th Avenue South
Auburn, Washington

LOG OF BORING B-1

JOB: WJADC.LakeGenevaPark *Sheet 1 of 1*

GeoResources, LLC **FIG. A-2**

TOTAL DEPTH:	6.5	**EXCAVATION METHOD:**	HSA	**LOGGED BY:**	DC
TOP ELEVATION:	416	**EXCAVATION COMPANY:**	Geologic Drilling Inc.	**HAMMER TYPE:**	cathead
LATITUDE:		**EQUIPMENT:**	Bobcat	**HAMMER WEIGHT:**	140 lbs
LONGITUDE:		**NOTES:**	NE of existing playground		

Depth	Elevation	SOIL DESCRIPTION	Drilling Notes	Sample	Sampler	Symbol	Blow Count
0	416	Topsoil (9 inches)					
		Brown, mottled silty SAND with some gravel (SM) (loose to medium dense, moist) (weathered glacial till)		1			2 1 1
2	414	Tan-grey gravelly silty SAND with gravel (SM) (Hard, moist) (silty glacial till)		2			12 16 20
4	412	Grey gravelly silty SAND (SM) (very dense, moist) (glacial till)		3			96 24 36 50/5
6	410						
8	408	Bottom of Boring CompletedNovember 17, 2023					
10	406						
12	404						

(new title)

TEST RESULTS

Test Results

Plastic Limit ├──┤ Liquid Limit

% Water Content ●

% Fines (<0.075mm) ◇

Penetration - ▲ (blow per foot)

10 20 30 40 50

Ground Water

NOTES

1. Refer to log key for definition of symbols, abbreviations and codes
2. USCS designation is based on visual manual classification and selected lab testing
3. Groundwater level, if indicated, is for the date shown and may vary
4. N.E. = Not Encountered

WJADC.LakeGenevaPark
34429 46th Avenue South
Auburn, Washington

LOG OF BORING B-2

JOB: WJADC.LakeGenevaPark *Sheet 1 of 1*

GeoResources, LLC **FIG.**

TOTAL DEPTH:	6.5	**EXCAVATION METHOD:**	HSA	**LOGGED BY:**	DC
TOP ELEVATION:	420	**EXCAVATION COMPANY:**	Geologic Drilling Inc.	**HAMMER TYPE:**	cathead
LATITUDE:		**EQUIPMENT:**	Bobcat	**HAMMER WEIGHT:**	140 lbs
LONGITUDE:		**NOTES:**	Open Field/Proposed Recreation Courts		

Depth	Elevation	SOIL DESCRIPTION	Drilling Notes	Sample	Sampler	Symbol	Blow Count
0	420	Topsoil (6 inches)					
		Grey poorly graded SAND with silt (SP-SM)(loose, moist) (free-draining fill)		1			3 7 5
2	418	Brown, mottled gravelly silty SAND (SM) (medium dense, moist) (weathered glacial till)	no return	2			12 16 20
4	416	Tan-grey gravelly sandy SILT (ML) (hard, moist) (silty glacial till)		3			16 19 26
6	414	Grey gravelly silty SAND (SM) (very dense, moist) (glacial till)					
8	412	Bottom of Boring CompletedNovember 17, 2023					
10	410						
12	408						

(new title)

TEST RESULTS

Test Results

Plastic Limit ⊢——⊣ Liquid Limit

% Water Content ●

% Fines (<0.075mm) ◇

Penetration - ▲ (blow per foot)

10 20 30 40 50

Ground Water

NOTES

1. Refer to log key for definition of symbols, abbreviations and codes
2. USCS designation is based on visual manual classification and selected lab testing
3. Groundwater level, if indicated, is for the date shown and may vary
4. N.E. = Not Encountered

WJADC.LakeGenevaPark
34429 46th Avenue South
Auburn, Washington

LOG OF BORING B-3

JOB: WJADC.LakeGenevaPark *Sheet 1 of 1*

GeoResources, LLC **FIG.**

TOTAL DEPTH:	12.75	**EXCAVATION METHOD:**	HSA	**LOGGED BY:**	DC
TOP ELEVATION:	420	**EXCAVATION COMPANY:**	Geologic Drilling Inc	**HAMMER TYPE:**	cathead
LATITUDE:		**EQUIPMENT:**	Bobcat	**HAMMER WEIGHT:**	140 lbs
LONGITUDE:		**NOTES:**	Existing parking lot		

Depth	Elevation	SOIL DESCRIPTION	Drilling Notes	Sample	Sampler	Symbol	Blow Count	Ground Water
0	420	Gravel Fill (6 inches)		1			18 12 6	
		Grey poorly graded SAND with silt and gravel (SP-SM) (medium dense, mosit) (undocumented fill)						
2	418			2			6 8 16	
		Tan-grey gravelly sandy SILT (ML) (hard, moist)						
4	416			3			8 15 22	
6	414							
		Grey gravelly silty SAND (SM) (very dense, moist) (glacial till)						
		Silty SAND with gravel (SM)		4			150 50/4	
8	412							
10	410	Silty SAND with gravel (SM)		5			100 50/6	
12	408			6			50/2	

(new title)

TEST RESULTS

Test Results

Plastic Limit ├──┤ Liquid Limit

% Water Content ●

% Fines (<0.075mm) ◇

Penetration - ▲ (blow per foot)

10 20 30 40 50

NOTES

1. Refer to log key for definition of symbols, abbreviations and codes
2. USCS designation is based on visual manual classification and selected lab testing
3. Groundwater level, if indicated, is for the date shown and may vary
4. N.E. = Not Encountered

WJADC.LakeGenevaPark
34429 46th Avenue South
Auburn, Washington

LOG OF BORING B-4

JOB: WJADC.LakeGenevaPark *Sheet 1 of 2*

GeoResources, LLC **FIG.**

TOTAL DEPTH:	12.75	**EXCAVATION METHOD:**	HSA	**LOGGED BY:**	DC
TOP ELEVATION:	420	**EXCAVATION COMPANY:**	Geologic Drilling Inc	**HAMMER TYPE:**	cathead
LATITUDE:		**EQUIPMENT:**	Bobcat	**HAMMER WEIGHT:**	140 lbs
LONGITUDE:		**NOTES:**	Existing parking lot		

Depth	Elevation	SOIL DESCRIPTION	Drilling Notes	Sample	Sampler	Symbol	(new title) TEST RESULTS	Blow Count	Ground Water
							Test Results Plastic Limit ├──┤ Liquid Limit % Water Content ● % Fines (<0.075mm) ◇ Penetration - ▲ (blow per foot) 10 20 30 40 50		
		Bottom of Boring CompletedNovember 17, 2023							
14	406								
16	404								
18	402								
20	400								
22	398								
24	396								

NOTES

1. Refer to log key for definition of symbols, abbreviations and codes
2. USCS designation is based on visual manual classification and selected lab testing
3. Groundwater level, if indicated, is for the date shown and may vary
4. N.E. = Not Encountered

WJADC.LakeGenevaPark
34429 46th Avenue South
Auburn, Washington

LOG OF BORING B-4

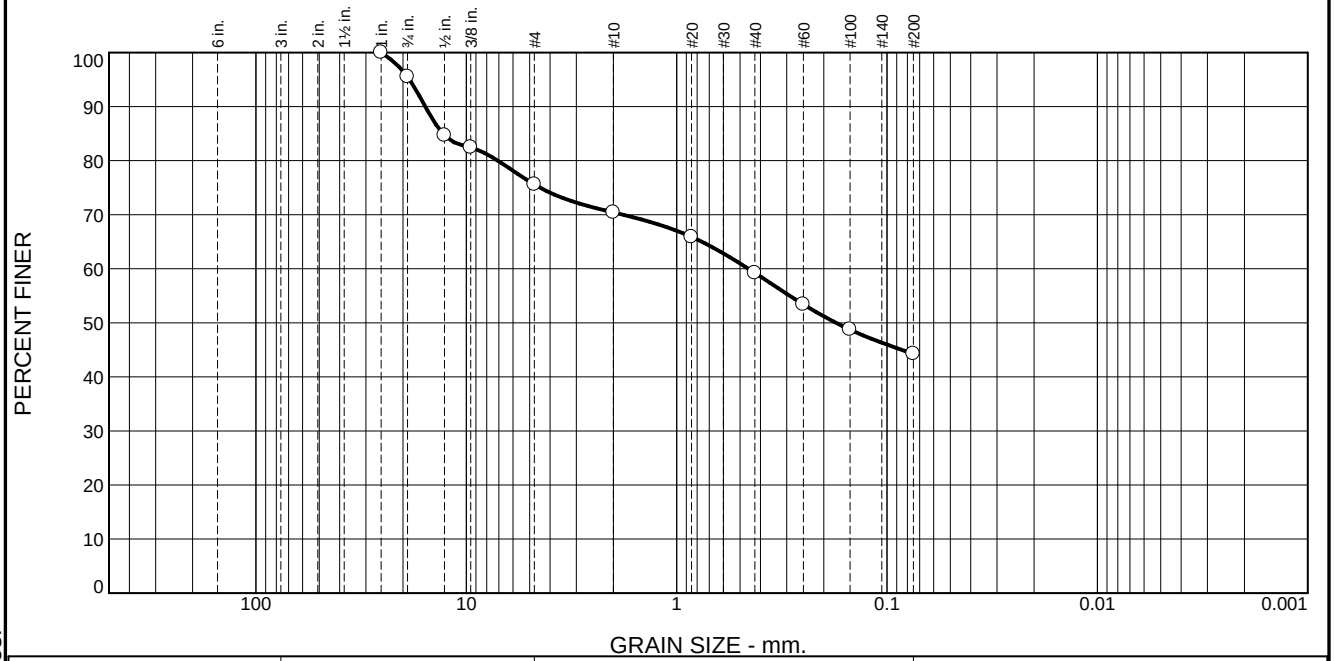
JOB: WJADC.LakeGenevaPark *Sheet 2 of 2*

GeoResources, LLC **FIG.**

Appendix B

Laboratory Test Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.5	19.9	5.2	11.2	14.9	44.3	

Test Results (ASTM D 6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1	100.0		
.75	95.5		
.5	84.7		
0.375	82.4		
#4	75.6		
#10	70.4		
#20	65.9		
#40	59.2		
#60	53.4		
#100	48.7		
#200	44.3		

* (no specification provided)

Material Description

Tan-grey gravelly silty SAND with gravel (SM) (Hard, moist) (silty glacial till)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 15.6666 D_{85}= 12.9324 D_{60}= 0.4560
D_{50}= 0.1748 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Natural Moisture: 17.1%

Date Received: 11/17/23 **Date Tested:** 11/22/23

Tested By: MAW

Checked By: STM

Title: PM

Source of Sample: B-2 **Depth:** 2.5
Sample Number: 2

Date Sampled: 11/17/23

GeoResources, LLC

Fife, WA

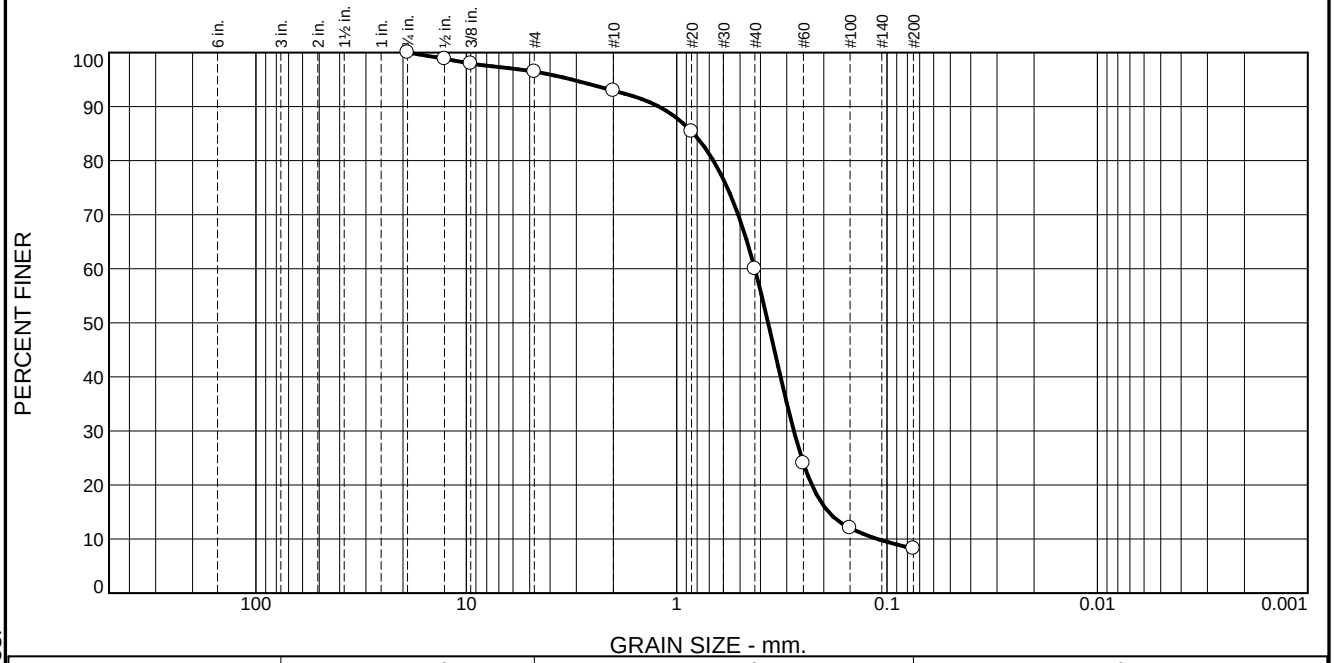
Client: WJA Design Collaborative
Project: WJADC.LakeGenevaPark

Project No: WJADC.LakeGenevaPark **Figure** B-1

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: _____ **Checked By:** _____

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.5	3.5	33.0	51.8	8.2	

Test Results (ASTM D 6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.75	100.0		
.5	98.8		
0.375	98.0		
#4	96.5		
#10	93.0		
#20	85.4		
#40	60.0		
#60	24.0		
#100	12.1		
#200	8.2		

* (no specification provided)

Material Description

Grey poorly graded SAND with silt (SP-SM)(loose, moist) (free-draining fill)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 1.2140 D_{85}= 0.8315 D_{60}= 0.4250
D_{50}= 0.3676 D_{30}= 0.2775 D_{15}= 0.1898
D_{10}= 0.1109 C_u= 3.83 C_c= 1.63

Remarks

Natural Moisture: 20.2%

Date Received: 11/17/23 **Date Tested:** 11/22/23

Tested By: MAW

Checked By: STM

Title: PM

Source of Sample: B-3 **Depth:** 0.5
Sample Number: 1

Date Sampled: 11/17/23

GeoResources, LLC

Fife, WA

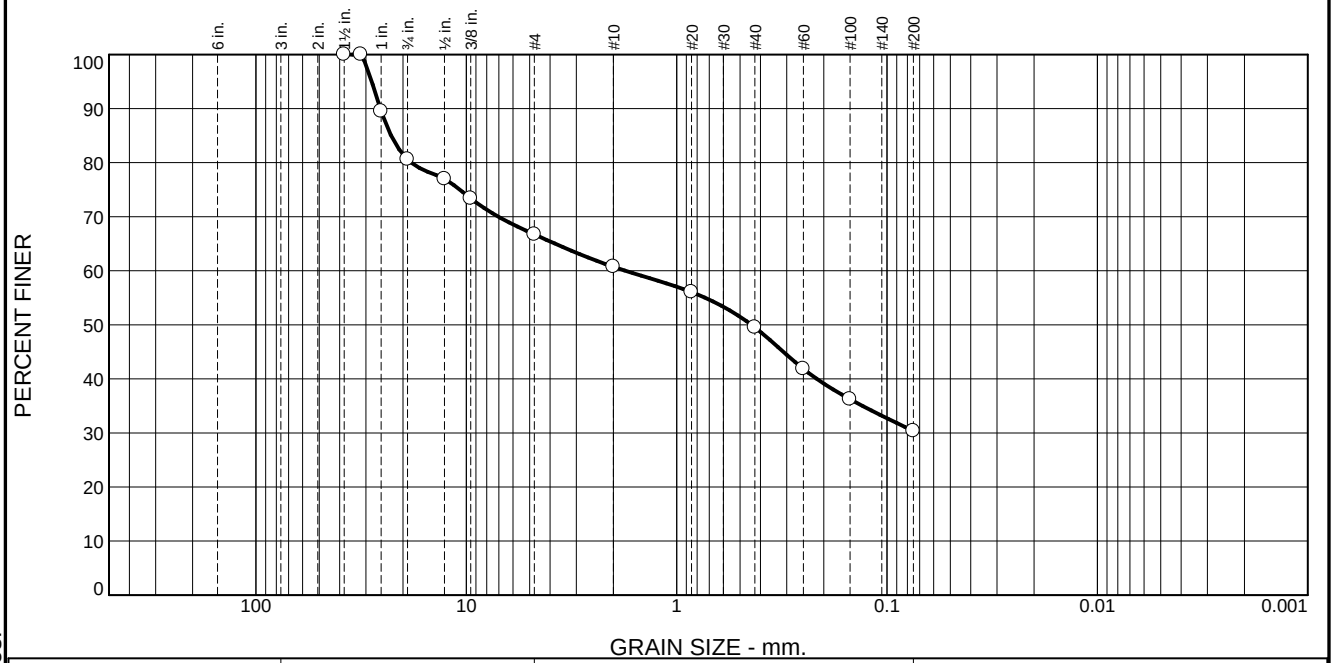
Client: WJA Design Collaborative
Project: WJADC.LakeGenevaPark

Project No: WJADC.LakeGenevaPark **Figure** B-2

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: _____ **Checked By:** _____

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	19.4	13.9	6.0	11.2	19.1	30.4	

Test Results (ASTM D 6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100.0		
1.25	100.0		
1	89.5		
.75	80.6		
.5	77.0		
0.375	73.4		
#4	66.7		
#10	60.7		
#20	56.0		
#40	49.5		
#60	41.9		
#100	36.2		
#200	30.4		

* (no specification provided)

Material Description

Silty SAND with gravel (SM)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 25.6491 D_{85}= 22.8004 D_{60}= 1.7527
D_{50}= 0.4410 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Natural Moisture: 12.5%

Date Received: 11/17/23 **Date Tested:** 11/22/23

Tested By: MAW

Checked By: STM

Title: PM

Source of Sample: B-3 **Depth:** 2.5
Sample Number: 2

Date Sampled: 11/17/23

GeoResources, LLC

Fife, WA

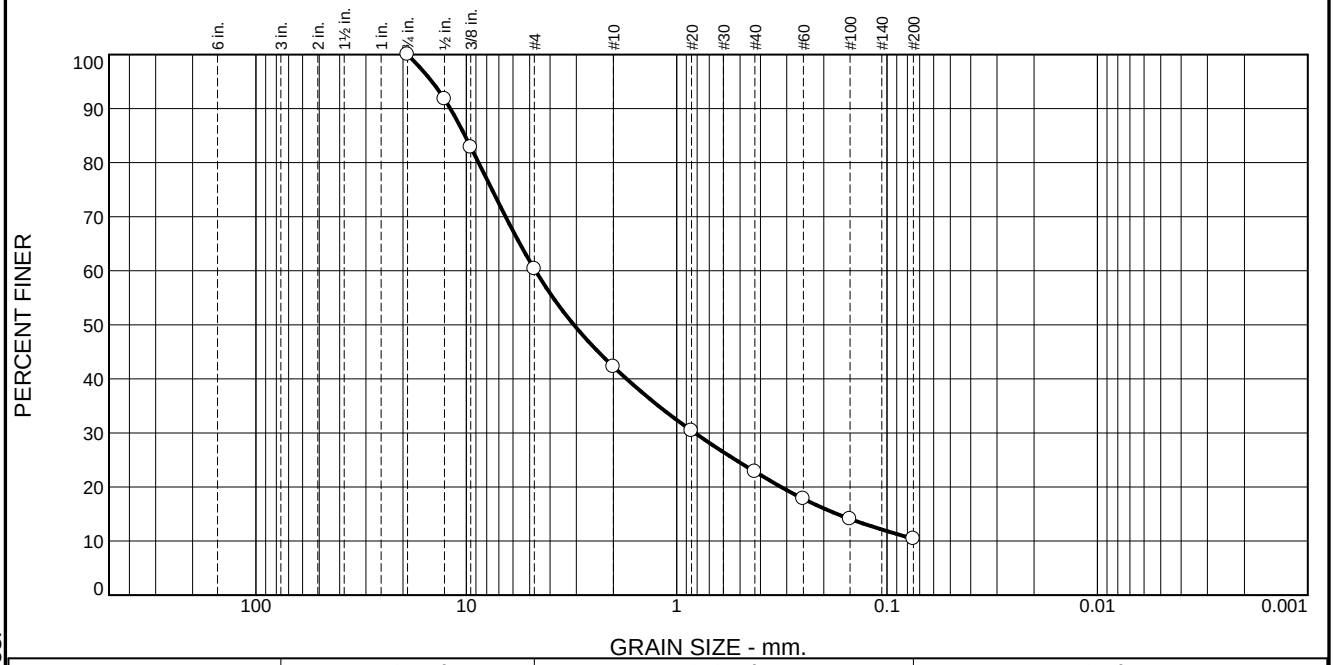
Client: WJA Design Collaborative
Project: WJADC.LakeGenevaPark

Project No: WJADC.LakeGenevaPark **Figure** B-3

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: _____ **Checked By:** _____

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	39.7	18.1	19.4	12.4	10.4	

Test Results (ASTM D 6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.75	100.0		
.5	91.8		
0.375	82.9		
#4	60.3		
#10	42.2		
#20	30.4		
#40	22.8		
#60	17.8		
#100	14.1		
#200	10.4		

* (no specification provided)

Material Description

Poorly graded SAND with silt and gravel (SP-SM)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-1-a

Coefficients

D_{90}= 11.9154 D_{85}= 10.1550 D_{60}= 4.6914
D_{50}= 3.0812 D_{30}= 0.8198 D_{15}= 0.1726
D_{10}= C_u= C_c=

Remarks

Natural Moisture: 4.9%

Date Received: 11/17/23 **Date Tested:** 11/22/23

Tested By: MAW

Checked By: STM

Title: PM

Source of Sample: B-4 **Depth:** 0.25
Sample Number: 1

Date Sampled: 11/17/22

GeoResources, LLC

Fife, WA

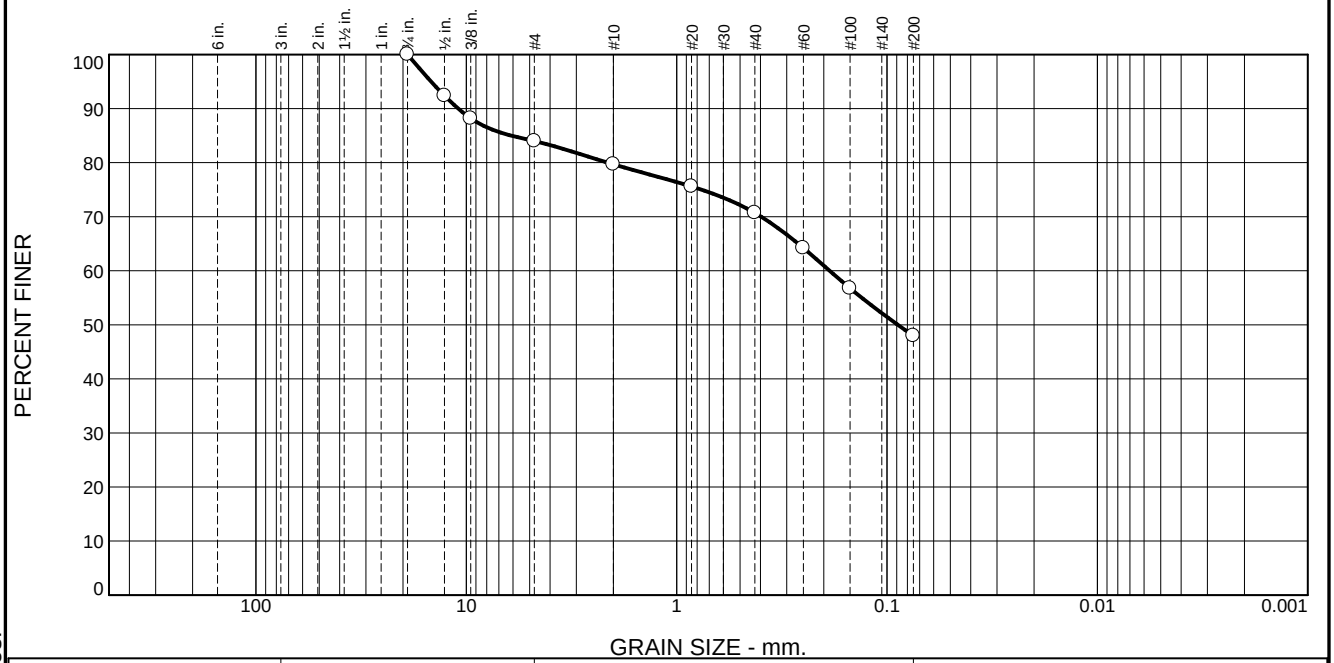
Client: WJA Design Collaborative
Project: WJADC.LakeGenevaPark

Project No: WJADC.LakeGenevaPark **Figure** B-4

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: _____ **Checked By:** _____

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	16.0	4.3	9.0	22.7	48.0	

Test Results (ASTM D 6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.75	100.0		
.5	92.4		
0.375	88.2		
#4	84.0		
#10	79.7		
#20	75.6		
#40	70.7		
#60	64.2		
#100	56.8		
#200	48.0		

* (no specification provided)

Material Description

Silty SAND with gravel (SM)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 10.9373 D_{85}= 6.1130 D_{60}= 0.1874
D_{50}= 0.0889 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Natural Moisture: 14.1%

Date Received: 11/17/23 **Date Tested:** 11/22/23

Tested By: MAW

Checked By: STM

Title: PM

Source of Sample: B-4 **Depth:** 7.5
Sample Number: 4

Date Sampled: 11/17/23

GeoResources, LLC

Fife, WA

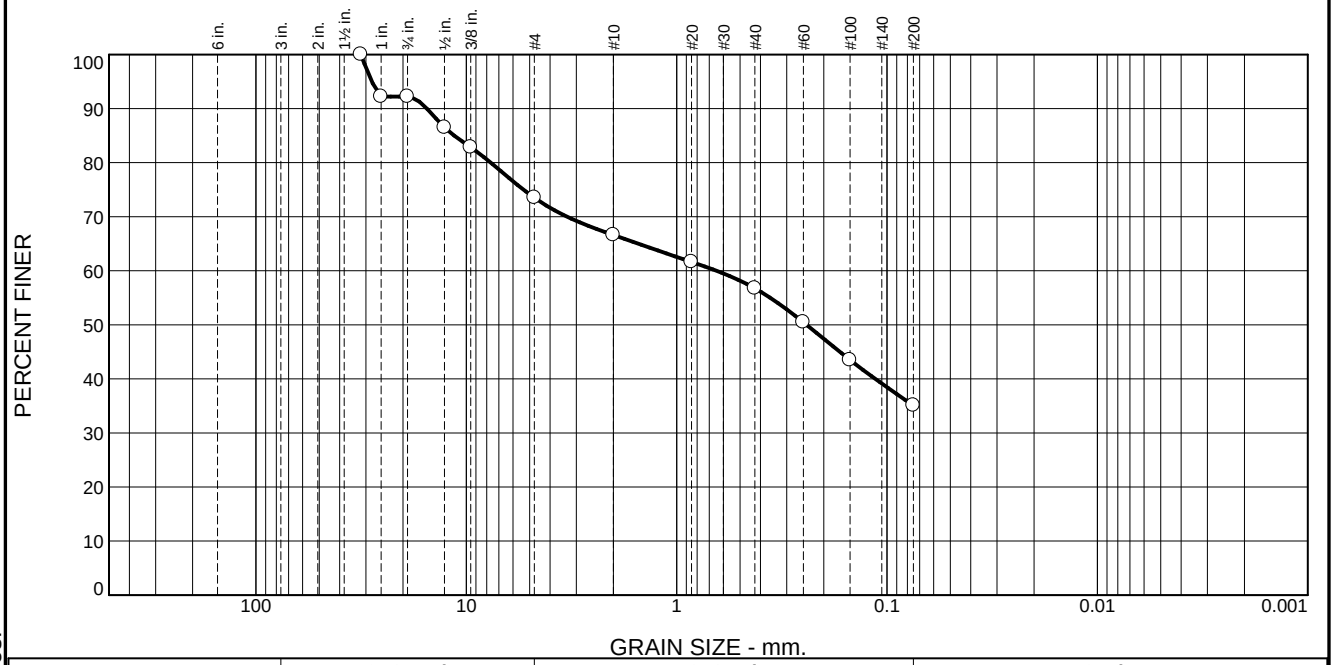
Client: WJA Design Collaborative
Project: WJADC.LakeGenevaPark

Project No: WJADC.LakeGenevaPark **Figure** B-5

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: _____ **Checked By:** _____

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	7.8	18.7	6.9	9.8	21.7	35.1	

Test Results (ASTM D 6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.25	100.0		
1	92.2		
.75	92.2		
.5	86.5		
0.375	82.8		
#4	73.5		
#10	66.6		
#20	61.6		
#40	56.8		
#60	50.5		
#100	43.5		
#200	35.1		

* (no specification provided)

Material Description

Silty SAND with gravel (SM)

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 15.3888 D_{85}= 11.4376 D_{60}= 0.6470
D_{50}= 0.2413 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Natural Moisture: 8.4%

Date Received: 11/17/23 **Date Tested:** 11/22/23

Tested By: MAW

Checked By: STM

Title: PM

Source of Sample: B-4 **Depth:** 10
Sample Number: 5

Date Sampled: 11/17/23

GeoResources, LLC

Fife, WA

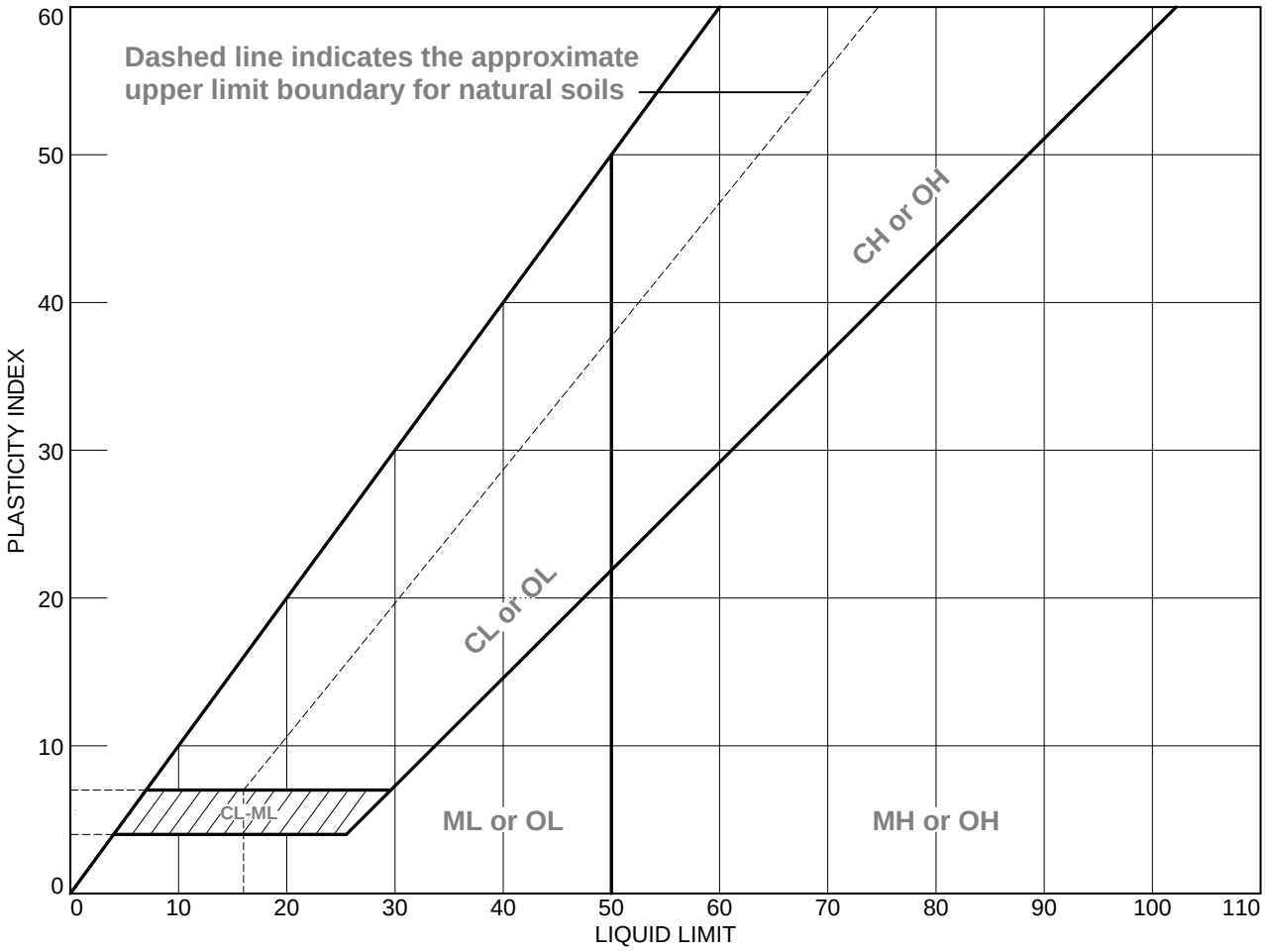
Client: WJA Design Collaborative
Project: WJADC.LakeGenevaPark

Project No: WJADC.LakeGenevaPark **Figure** B-6

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

Tested By: _____ **Checked By:** _____

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B-1	1	0.5	26.4	NP	NV	NP	SM
■	B-1	4	7.5	6.9	NP	NV	NP	SM

GeoResources, LLC

Fife, WA

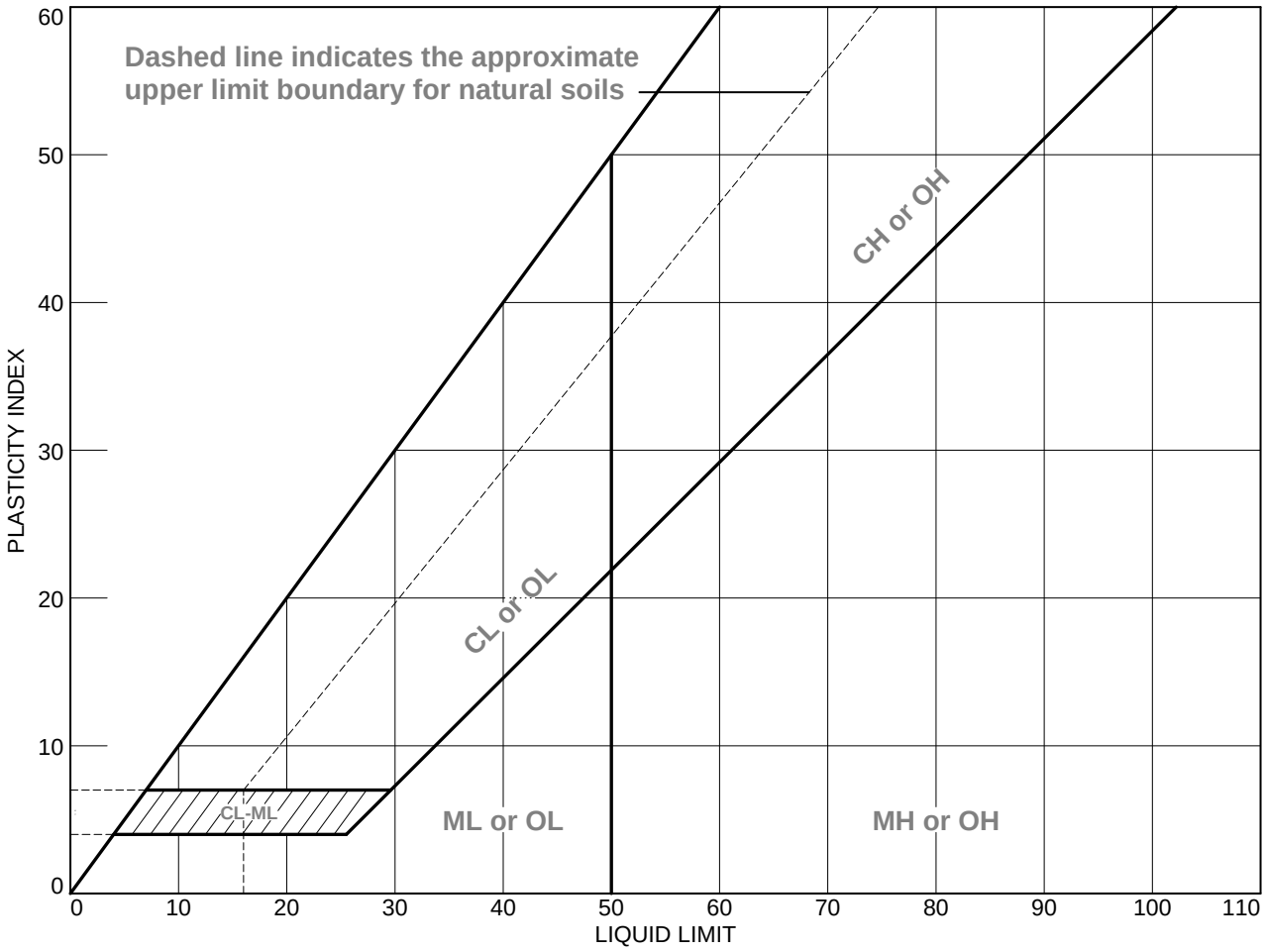
Client: WJA Design Collaborative
Project: WJADC.LakeGenevaPark

Project No.: WJADC.LakeGenevaPark **Figure**

Tested By: _____ **Checked By:** _____

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B-2	3	5	8.0	NP	NV	NP	SM

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicitive of apparently identical samples.

GeoResources, LLC

Fife, WA

Client: WJA Design Collaborative
Project: WJADC.LakeGenevaPark

Project No.: WJADC.LakeGenevaPark **Figure**

Tested By: _____ **Checked By:** _____