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January 12, 2024
Project No. 20150262E002

City of Mercer Island Parks and Recreation
9611 SE 36th Street
Mercer Island, Washington 98040

Attention: Mrs. Sarah Bluvas

Subject: Subsurface Exploration and Limited Geotechnical Engineering Study
Luther Burbank Park Tennis Court Conversion
2424 84th Avenue SE
Mercer Island, Washington

Dear Mrs. Bluvas:

As requested, Associated Earth Sciences, Inc. (AESI) is pleased to provide this letter-report summarizing observed surface and subsurface conditions, and presenting our geotechnical recommendations for conversion of the existing tennis courts to pickleball courts. Our recommendations are based on available topographic and geologic data, completion of three subsurface exploration borings, and our experience working on previously completed similar projects. This letter-report also includes a geotechnical overview of an existing retaining wall at the west side of the tennis courts that abuts a separate parking lot improvement project.

Authorization to proceed with this study was given to AESI by means of an Agreement For Professional Services dated November 6, 2023. Our study was accomplished in general accordance with our proposal, dated October 16, 2023. This letter-report has been prepared for the exclusive use of the City of Mercer Island Parks and Recreation and its agents, for specific application to this project. Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our letter-report was prepared. No other warranty, express or implied, is made.

Site and Project Description

The project site is that of the existing tennis courts in the central portion of Luther Burbank Park. (Figure 1). The proposed project includes converting the existing tennis courts into six pickleball courts, installation of nine light poles, and construction of an accessible ramped walkway on the south side of the courts. The tennis courts appear to have been cut to grade, and a landscaped slope was created to the south, ascending to meet the natural topography. At the time this letter-report was prepared, plans had not been finalized. We recommend that we be allowed to review plans as they near completion to confirm that geotechnical aspects of the project are consistent with the recommendations presented in this letter-report.

Subsurface Exploration

Our field investigation for this study was conducted on December 6, 2023. It included advancing three exploration borings. Two borings were advanced by a subcontracted drilling company with a track-mounted drill rig, and one was completed by AESI using hand methods. The locations of subsurface explorations referenced in this study are presented relative to existing site features on Figure 2 and Figure 3. The various types of sediments, as well as the depths where the characteristics of the sediments changed, are indicated on the exploration logs presented in the attachments. Our explorations were approximately located in the field by measuring from known site features depicted on the aerial photograph used as a basis for Figure 2 and Figure 3.

The conclusions and recommendations presented in this letter-report are based, in part, on the explorations completed for this study. The number, locations, and depths of the explorations were completed within site and budgetary constraints. Because of the nature of exploratory work below ground, extrapolation of subsurface conditions between field explorations is necessary. It should be noted that differing subsurface conditions may be present due to the random nature of deposition and the alteration of topography by past grading and/or filling. The nature and extent of variations between the field explorations may not become fully evident until construction. If variations are observed at that time, it may be necessary to re-evaluate specific recommendations in this letter-report and make appropriate changes.

Exploration Borings

For this study, two hollow-stem auger exploration borings were performed by Boretec 1, Inc., an independent firm working under subcontract to AESI, at the approximate locations shown in Figures 2 and 3. During the drilling process, samples were obtained at generally 2.5- to 5-foot-depth intervals. After completion of drilling, each borehole was backfilled with bentonite chips and capped with retained sod in the landscape areas. Logs of our exploration borings, labeled EB-1 and EB-2, are included with this letter-report in the Appendix.

Disturbed, but representative samples were obtained by using the Standard Penetration Test (SPT) procedure in accordance with *ASTM International* (ASTM) D-1586. This test and sampling method consists of driving a standard 2-inch, outside-diameter, split-barrel sampler a distance of 18 inches into the soil with a 140-pound hammer free-falling a distance of 30 inches. The number of blows for each 6-inch interval is recorded, and the number of blows required to drive the sampler the final 12 inches is known as the Standard Penetration Resistance (“N”) or blow count. If a total of 50 is recorded within one 6-inch interval, the blow count is recorded as the number of blows for the corresponding number of inches of penetration. The resistance, or N-value, provides a measure of the relative density of granular soils or the relative consistency of cohesive soils; these values are plotted on the attached exploration boring logs.

The exploration borings allowed direct observation of in situ subsurface conditions. The borings were continuously observed and logged by a geologist from our firm. Both hollow-stem auger borings were advanced to a depth of 15 feet below the existing ground surface. Once completed, the exploration boreholes were backfilled with bentonite chips. The samples obtained from the split-barrel sampler were classified in the field and representative portions placed in watertight containers. The samples were then transported to our laboratory for further visual classification and laboratory testing. The exploration logs are based on the field observations, N-values, drilling action, and laboratory testing.

Hand-Auger Exploration Boring

The hand-auger boring was advanced with a 4-inch-diameter auger and the subsurface conditions encountered were logged by a geologist from our firm. The samples obtained from the auger barrel were classified in the field, and representative portions were placed in watertight containers. The samples were then transported to our laboratory for further visual classification. Soil descriptions shown on our exploration log are based on the effort required to advance the hand auger, probing resistance within the borehole, and field observations. After completing the hand-auger boring, the borehole was backfilled with the excavated soil. The hand-auger boring (HA-1) was advanced to a depth of 4.5 feet below existing grade where washed rock was encountered and interpreted to represent footing drain rock.

Subsurface Conditions

Regional Geology and Soils Mapping

Review of the regional geologic map, titled *Geologic Map of Mercer Island, Washington,* by GeoMap NW, dated 2006, indicates that the proposed project site is expected to be underlain at shallow depths by Vashon-age lodgement till with pre-Olympia-age glacial deposits mapped nearby. Lodgement till is typically well suited to structural support with proper preparation. Lodgement till typically comprises a very dense, unsorted mixture of silt, sand, gravel, cobbles, and boulders, all deposited and consolidated by the weight of the advancing glacier. The reviewed mapped geology was generally consistent with our subsurface soil observations, although previous sitework and grading appears to have altered the natural stratigraphy present at the project site, likely removing or displacing a substantial portion of the lodgement till in areas where earthwork was more extensive.

Site Stratigraphy

Subsurface conditions at the project site were inferred from the field explorations accomplished for this study, visual reconnaissance of the site, and review of selected applicable geologic literature. As shown on the exploration logs, soils encountered at the subject site were overlain by grass and sod with a root zone typically extending 4 to 6 inches into the subsurface. The underlying soils consisted of previously placed fill soils, Vashon-age lodgement till sediments, and pre-Olympia-age glaciomarine deposits. The following sections present more detailed subsurface information on the sediment types encountered at the site.

Fill

Existing, artificial fill soils (those not naturally placed) were encountered in all of our explorations (EB-1, EB-2, and HA-1), with observed thicknesses of 2.5, 8, and greater than 4 feet below existing ground surface, respectively. The fill generally consisted of loose to dense sand with variable silt and gravel content. Organic materials in the form of fine organics and rootlets were observed in all of the fill samples obtained. Excavated existing fill material is suitable for reuse in structural fill applications if such reuse is specifically allowed by project plans and specifications, if excessively organic and any other deleterious materials are removed, and if moisture content is adjusted to allow compaction to the specified level and to a firm and unyielding condition.

Vashon Lodgement Till

In one of our exploration borings (EB-2), we observed dense, unsorted, silty fine to very fine sand with trace amounts of gravel, interpreted to be representative of lodgement till sediments. The lodgement till was encountered at a depth of 8 feet, situated directly below existing fill soils and extended to a depth of approximately 13 feet below existing ground surface where it was underlain by pre-Olympia-age glaciomarine deposits. The lodgement till was deposited directly from basal, debris-laden glacial ice during the Vashon Stade of the Fraser Glaciation approximately 12,500 to 15,000 years ago. The high relative density of the unweathered till is due to its consolidation by the massive weight of the glacial ice from which it was deposited. Consequently, these materials are dense to very dense, possess high-strength and low-compressibility characteristics, and are relatively impermeable. The lodgement till is suitable for support of new structures with proper preparation. Excavated lodgement till is suitable for use in structural fill applications provided that the moisture content is adjusted to allow compaction to a firm and unyielding condition at the specified level. The lodgement till has a large proportion of fine-grained material making it susceptible to disturbance when wet.

Pre-Olympia Glaciomarine Deposits

In both hollow-stem auger exploration borings (EB-1 and EB-2), we observed very stiff, massive silt with variable sand content and trace amounts of gravel. Exploration boring EB-1 encountered these sediments at a depth of approximately 2.5 feet below a cap of existing fill soils while EB-2 encountered these sediments at an approximate depth of 13 feet below a cap of lodgement till. Both hollow-stem auger borings terminated in these sediments without reaching any other underlying sedimentary units. When exposed to hydrochloric acid, samples of these sediments reacted to form gas bubbles, which may indicate the presence of calcium carbonate associated with marine deposition. We interpret these sediments as pre-Olympia glaciomarine deposits, deposited in a glacial marine environment and overridden by glacial ice during subsequent glaciation. These sediments were deposited prior to the Olympia nonglacial interval that occurred from 15,000 to 60,000 years before present and have been consolidated by at least one glaciation.

Hydrology

Moderate groundwater seepage was encountered in exploration boring EB-1, at a depth of approximately 5 feet below ground surface at the time of drilling. It is our opinion that the groundwater observed was perched. Perched water occurs when surface water infiltrates down through relatively permeable soils, such as gravel base courses, existing fill, or coarser-grained lodgement till strata and becomes trapped or "perched" atop a comparatively low-permeability barrier, such as siltier zones within the lodgement till or above the pre-Olympia glaciomarine deposits. When water becomes perched it may travel laterally. The presence and quantity of groundwater will largely depend on the soil grain-size distribution, topography, seasonal precipitation, site use, on- and off-site land usage, and other factors.

Laboratory Testing

Three laboratory grain-size analyses were completed on selected samples recovered from explorations. Laboratory test reports are attached.

Critical Areas - Geologic Hazards

We reviewed the *City of Mercer Island City Code, Section 19.07.160: "Geologically Hazardous Areas[1]"*, which defines geologically hazardous areas as "lands that are susceptible to erosion, landslides, seismic events, or other factors as identified by WAC 365-190-120." We also reviewed geotechnical critical areas-related information available on the *City of Mercer Island GIS Portal*[2]. The project area does not appear to contain areas mapped as geotechnical critical areas, or areas that meet City or State definitions for geotechnical critical areas. Because the project area does not include designated geotechnical critical areas, this letter-report is not intended to serve as a detailed critical areas study and such a study is not warranted, in our opinion. The following sections discuss observed conditions and general project planning recommendations related to geotechnical hazards.

Erosion Hazards

Although no mapped erosion hazards were identified in the current project area, construction documents should include temporary erosion controls in accordance with the City of Mercer

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[1] City of Mercer Island City Code - https://library.municode.com/wa/mercer_island/codes/city_code

[2] City of Mercer Island GIS - https://www.mercerisland.gov/cpd/page/geological-hazards

Island's Best Management Practices (BMPs). Common BMPs include limiting earthwork to seasonally drier periods if possible, use of perimeter silt fences, stabilized construction entrances, and straw mulch in exposed areas. Removal of existing vegetation should be limited to those areas that are required to construct the project, and new landscaping and vegetation with equivalent erosion mitigation potential should be established as soon as practical after grading is complete. During construction, surface water should be collected as close as possible to the source to minimize silt entrainment that could require treatment or detention prior to discharge. Timely implementation of permanent drainage control measures should also be a part of the project plans and will help reduce erosion and generation of silty surface water onsite.

Seismic Hazards

The following discussion is a general assessment of seismic hazards that is intended to be useful to the project design team in terms of understanding seismic issues, and to the structural engineer for design.

All of Western Washington is at risk of strong seismic events resulting from movement of the tectonic plates associated with the Cascadia Subduction Zone (CSZ), where the offshore Juan de Fuca plate subducts beneath the continental North American plate. The site lies within a zone of strong potential shaking from subduction zone earthquakes associated with the CSZ. The CSZ can produce earthquakes up to magnitude 9.0, and the recurrence interval is estimated to be on the order of 500 years. Geologists infer the most recent subduction zone earthquake occurred in 1700 (Goldfinger et al., 2012[3]). Three main types of earthquakes are typically associated with subduction zone environments: crustal, intraplate, and interplate earthquakes. Seismic records in the Puget Sound region document a distinct zone of shallow crustal seismicity (e.g., the Seattle Fault Zone [SFZ]). These shallow fault zones may include surficial expressions of previous seismic events, such as fault scarps, displaced shorelines, and shallow bedrock exposures. The shallow fault zones typically extend from the surface to depths ranging from 16 to 19 miles. A deeper zone of seismicity is associated with the subducting Juan de Fuca plate. Subduction zone seismic events produce intraplate earthquakes at depths ranging from 25 to 45 miles beneath the Puget Lowland including the 1949, 7.2-magnitude event; the 1965, 6.5-magnitude event; and the 2001, 6.8-magnitude event) and interplate earthquakes at shallow depths near the Washington coast including the 1700 earthquake, which had a magnitude of approximately 9.0. The 1949 earthquake appears to have been the largest in this region during recorded history and was centered in the Olympia area. Evaluation of earthquake return rates indicates that an earthquake of the magnitude between 5.5 and 6.0 is likely within a given 20-year period.

Generally, there are four types of potential geologic hazards associated with large seismic events: 1) surficial ground rupture, 2) seismically induced landslides or lateral spreading, 3) liquefaction,

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[3] Goldfinger, C., Nelson, C.H., Morey, A.E., Johnson, J.E., Patton, J.R., Karabanov, E., Gutierrez-Pastor, J., Eriksson, A.T., Gracia, E., Dunhill, G., Enkin, R.J., Dallimore, A., and Vallier, T., 2012, *Turbidite Event History—Methods and Implications for Holocene Paleoseismicity of the Cascadia Subduction Zone*: U.S. Geological Survey Professional Paper 1661–F, 170.

and 4) ground motion. The potential for each of these hazards to adversely impact the proposed project is discussed below.

Surficial Ground Rupture

The site is located within the mapped limits of the SFZ. The SFZ is a broad east-west oriented zone that extends from approximately Issaquah to Alki Beach, and is approximately 2.5 to 4 miles in width from north to south. The SFZ is speculated to contain multiple distinct fault "strands," some of which are well understood and some of which may be poorly understood or unknown. Mapping of individual fault strands is imprecise, as a result of pervasive modification of the land surface by natural erosion and human development, which have obscured possible surficial expression of past seismic events. Studies by the U.S. Geological Survey (USGS) and others have provided evidence of surficial ground rupture along strands of the SFZ (USGS, 2010[4]; Pratt et al., 2015[5]; Haugerud, 2005[6]; Liberty et al., 2008[7]). According to USGS studies the latest movement of this fault was about 1,100 years ago when about 20 feet of surficial displacement took place. This displacement can presently be seen in the form of raised, wave-cut beach terraces along Alki Point in West Seattle and Restoration Point at the south end of Bainbridge Island. Based on our review of the Washington State Department of Natural Resources (WADNR) *Geologic Information Portal*, the nearest mapped inferred fault trace associated with the SFZ is located approximately 500 feet south of the project. Due to the suspected long recurrence interval, the potential for surficial ground rupture along the SFZ is considered to be low during the expected life of the proposed project.

Seismically Induced Landslides

Based on the topographic and subsurface conditions present, it is our opinion that the risk of damage to the proposed project by seismically induced landsliding is low. No quantitative slope stability analysis was completed and none is warranted, in our opinion, for the project as currently proposed.

Liquefaction

Liquefaction is a process through which unconsolidated saturated soil loses strength as a result of vibrations such as those which occur during a seismic event. Our exploration borings did not

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[4] U.S. Geological Survey, 2010, Quaternary Fault and Fold Database for the United States: accessed November 10, 2010, from USGS web site: http://earthquake.usgs.gov/hazards/qfaults/.

[5] Pratt et al., 2015, *Kinematics of Shallow Backthrusts in the Seattle Fault Zone, Washington State*: Geosphere, v. 11, no. 6, p. 1-27).

[6] Haugerud, R.A., 2005, *Preliminary Geologic Map of Bainbridge Island, Washington*: U.S. Geological Survey Open-File Report 2005-1387, version 1.0, 1 sheet, scale 1:24,000.

[7] Liberty, Lee M.; Pratt, Thomas L., 2008, *Structure of the Eastern Seattle Fault Zone, Washington State -New Insights from Seismic Reflection Data*: Bulletin of the Seismological Society of America, v. 98, no. 4, p. 1681-1695.

encounter substantial unconsolidated and saturated sediments that warrant a detailed liquefaction analysis, in our opinion.

Recommendations

Site Preparation

New construction is expected to be limited to the new accessible access ramp on the south side of the pickleball court, with associated short retaining walls. We should be allowed to offer situation-specific site preparation recommendations if other new structures are planned.

All topsoil, vegetation, and any other deleterious materials should be removed from below planned construction areas.

After topsoil stripping, the exposed subgrade in the access ramp area is expected to consist of existing fill. Existing fill should be removed from below new retaining wall foundation elements to expose undisturbed dense native soils. The excavation to remove existing fill below footings should extend laterally beyond the limits of the foundation elements by a distance that is half of the depth between the bottom of the new foundation elements and the base of the overexcavation. For example, overexcavation that extends 4 feet deeper than a foundation element should extend laterally 2 feet beyond the plan view limits of the foundation element. The planned footing elevation can then be restored by placement of structural fill.

Below new Portland cement walkways, existing fill should be removed to a depth of at least 2 feet, or until suitable native soils are reached, whichever is less. The resulting subgrade should be compacted and proof-rolled under the observation of AESI. If the resulting surface is free of organic matter and other deleterious materials, and is firm and unyielding, the planned sidewalk subgrade elevation can be restored by placement of structural fill. Any unsuitable or yielding soils should receive additional remedial preparation that is tailored to field conditions at the time of construction.

Structural Fill

Should structural fill be necessary, it should be placed and compacted according to the recommendations presented in this section and requirements included in project specifications. All references to structural fill in this letter-report refer to subgrade preparation, fill type, placement, and compaction of materials, as discussed in this section. If a percentage of compaction is specified under another section of this letter-report, the value given in that section should be used.

After clearing, stripping, and existing fill replacement have been completed in accordance with the “Site Preparation” section of this letter-report, the upper 12 inches of exposed ground should be recompacted to a firm and unyielding condition. If the subgrade contains too much moisture, suitable recompaction may be difficult or impossible to attain and should probably not be attempted. In lieu of recompaction, the area to receive fill should be blanketed with washed rock or quarry spalls to act as a capillary break between the new fill and the wet subgrade. Where the exposed ground remains soft and further overexcavation is impractical, placement of an engineering stabilization fabric may be necessary to prevent contamination of the free-draining layer by silt migration from below. After recompaction of the exposed ground is tested and approved, or a free-draining rock course is laid, structural fill may be placed to attain desired grades.

Structural fill is defined as non-organic soil compliant with project specifications, placed in maximum 8-inch loose lifts, with each lift being compacted to at least 95 percent of the modified Proctor maximum dry density using ASTM D-1557 as the standard. The top of the compacted fill should extend horizontally a minimum distance of 3 feet beyond footings before sloping down at an angle no steeper than 2H:1V (Horizontal:Vertical). Fill slopes should either be overbuilt and trimmed back to final grade or surface-compacted to the specified density. In the case of roadway and utility trench filling, the backfill should be placed and compacted in accordance with City of Mercer Island standards.

Soils in which the amount of fine-grained material (smaller than No. 200 sieve) is greater than approximately 5 percent (measured on the minus No. 4 sieve size) should be considered moisture-sensitive. Use of moisture-sensitive soil in structural fills is not recommended during the winter months or under wet site and weather conditions. Most of the on-site soils are moisture-sensitive and may require moisture-conditioning before use as structural fill. If, at the time of construction, the moisture content of excavated on-site soils are above the optimum level to achieve suitable compaction, soils should be moisture-conditioned prior to use as structural fill. This could be achieved by either adding water if the soil is too dry, or aerating the soil during periods of warm, dry weather if the soil is too wet.

Construction equipment traversing the site when the silty fill and natural sediments are very moist or wet can cause considerable disturbance. If fill is placed during wet weather or if proper compaction of the on-site soil cannot be attained, a select import material consisting of a clean, free-draining gravel and/or sand should be used. Free-draining fill consists of non-organic soil with the amount of fine-grained material limited to 5 percent by weight when measured on the minus No. 4 sieve fraction and at least 30 percent retained on the No. 4 sieve.

The contractor should note that any proposed fill soils must be evaluated by AESI prior to their use in fills. This would involve providing us with a sample of the material at least 3 business days in advance to perform a Proctor test to determine its field compaction standard. A representative from our firm should observe the subgrades and be present during placement of structural fill to observe and document the work and perform a representative number of in-place density tests. In this way, the adequacy of the earthwork may be evaluated as filling progresses and any problem areas may be corrected at that time. Such testing and observation may be required by the governing municipality.

Shallow Foundation Recommendations

We anticipate that short, cast-in-place retaining walls will need to be constructed for support of the planned accessible ramp on the slope at the south end of the pickleball courts. For footings founded upon undisturbed native sediments or structural fill placed over suitable native sediments, we recommend that an allowable bearing pressure of 2,500 pounds per square foot (psf) be used for design purposes. Any disturbed soils generated during construction should be removed from footing subgrades prior to concrete placement. All footing areas should be observed by a representative from our firm prior to concrete placement to verify the condition and suitability of the subgrade.

New Retaining Wall Design Parameters

The recommendations in this section are intended for use designing new retaining walls for the new ramp down to the pickleball court conversion and assume implementation of our recommendations in the “Site Preparation” section of this letter-report.

Horizontally backfilled walls which are free to yield laterally at least 0.1 percent of their height during backfilling may be designed to resist lateral earth pressure represented by an equivalent fluid equal to 35 pounds per cubic foot (pcf). Yielding walls with backfill inclined up to 2H:1V may be designed for an active earth pressure of 50 pcf. The walls may be designed with an allowable base friction coefficient of 0.32. Foundations may be assumed to have passive resistance against lateral translation represented by an allowable passive earth pressure of 250 pcf assuming footings are backfilled with structural fill.

Existing Retaining Wall Geotechnical Recommendations

The following recommendations are applicable to the existing west wall of the tennis courts, and were added to our scope of work to assist the design team for a parking lot improvement project adjacent to the west of the pickleball courts. Other than the recommendations presented in this letter-report section AESI has not participated in design of the parking lot improvement project.

We understand that a separate parking lot improvement project is currently in design, and may include lowering existing grade on the west side of the west pickleball court wall, between the wall and existing parking lot. We anticipate that the parking lot project structural engineer will evaluate the stability of the existing wall with any revisions to site grading, using geotechnical parameters provided here. We are available on request to collaborate further with the design team for the parking lot improvement project. We recommend that the existing retaining wall be evaluated using the following parameters, based on our observations at hand-auger boring HA-1:

Active Lateral Earth Pressure (equivalent fluid)	35 pcf
Slab Surcharge (for existing court slab)	In accordance with Figure 4
Passive Resistance (allowable, equivalent fluid)	150 pcf
Base Friction (allowable)	0.32

pcf = pounds per cubic foot

Pickleball Courts Light Pole Foundation Recommendations

We anticipate that lateral capacities will be the most critical design factor for the planned light pole foundations. We recommend that the allowable end-bearing portion of the axial compressive capacity be assumed to be 1,500 psf for light poles embedded at least 5 feet below the ground surface. For frictional resistance along the shaft of drilled foundation elements, acting both in compression and uplift, an allowable skin friction value of 150 psf is recommended for design. This value is intended for concrete cast "neat" against plumb drill holes free of groundwater. We recommend that frictional resistance be neglected in the uppermost 2 feet below the ground surface. The allowable skin friction value includes a factor of safety of at least 2.0. Lateral loads on the light pole foundations, caused by seismic or transient loading conditions, may be resisted by passive soil pressure against the side of the foundation. An allowable passive earth pressure of 200 pcf, expressed as an equivalent fluid unit weight, may be used and should be attainable if excavations encounter structural fill or glacially consolidated sediments. Because AESI did not complete any explorations below the existing court where the new light poles will be constructed, we recommend that we be allowed to observe light pole excavations to confirm that subsurface conditions are consistent with assumptions made to formulate the recommended geotechnical parameters presented in this section.

Project Design Coordination and Construction Monitoring

We recommend that AESI perform a geotechnical review of the plans prior to final design completion. In this way, we can confirm that our recommendations have been correctly interpreted and implemented in the design. The City of Mercer Island may require a plan review by the geotechnical engineer as a condition of permitting.

We recommend that AESI be retained to provide geotechnical special inspections during construction, and preparation of a final summary letter when construction is complete. The City of Mercer Island may require such geotechnical special inspections.

We have enjoyed working with you on this study and are confident these recommendations will aid in the successful completion of your project. If you should have any questions or require further assistance, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

Kurt D.
Merriman, P.E.

Digitally signed by
Kurt D. Merriman, P.E.
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KURT D. MERRIMAN
23580

Collin Marshall

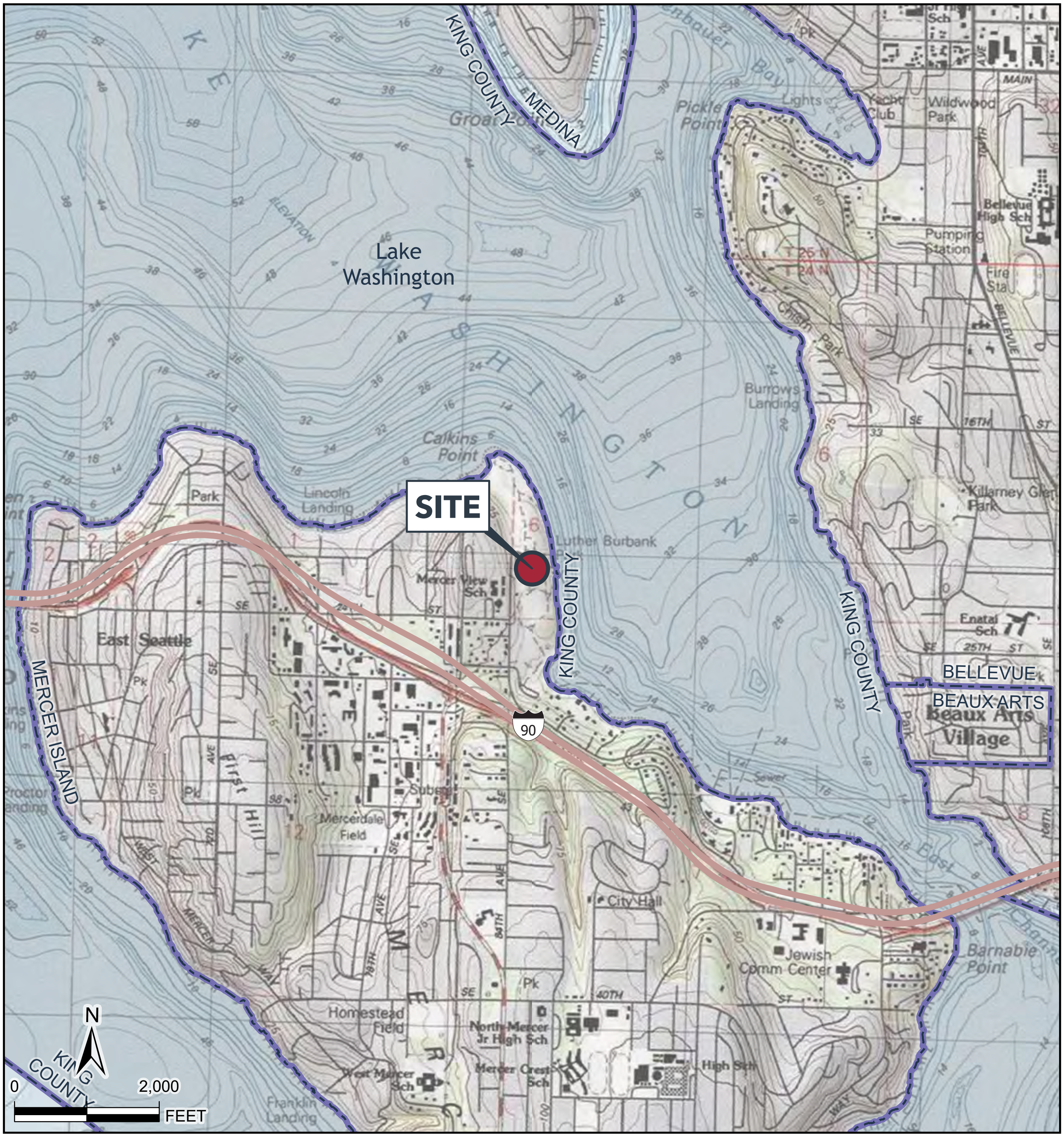
Collin E. Marshall, G.I.T.
Staff Geologist

Bruce Guenzler

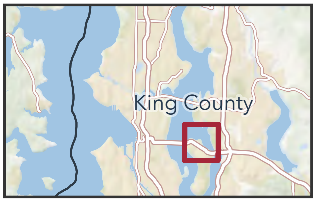
Bruce W. Guenzler, L.E.G.
Principal Engineering Geologist

Kurt D. Merriman, P.E.
Senior Principal Engineer

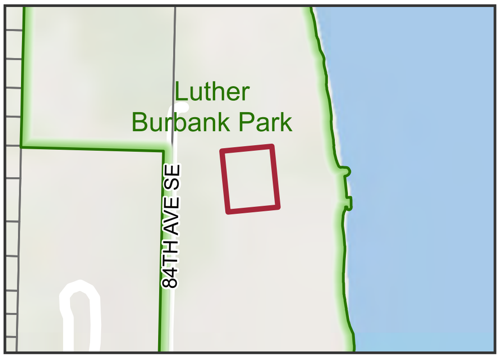
Attachments:
- Figure 1. Vicinity Map
- Figure 2. Site and Exploration Plan - Aerial
- Figure 3. Site and Exploration Plan - Lidar
- Figure 4. Surcharges on Adjacent Walls
- Exploration Logs
- Laboratory Testing Results



COUNTY LOCALE



LOCATION



ESRI, USGS, NATIONAL GEOGRAPHIC, DELORME, NATURALVUE, I-CUBED, GEBCO: ARCGIS ONLINE BASEMAP. WADOT STATE ROUTES 24K (12/20). KING CO: PARCELS (4/23), ROADS (5/23), PARKS (9/22).

NOTE: LOCATION AND DISTANCES SHOWN ARE APPROXIMATE. BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION.

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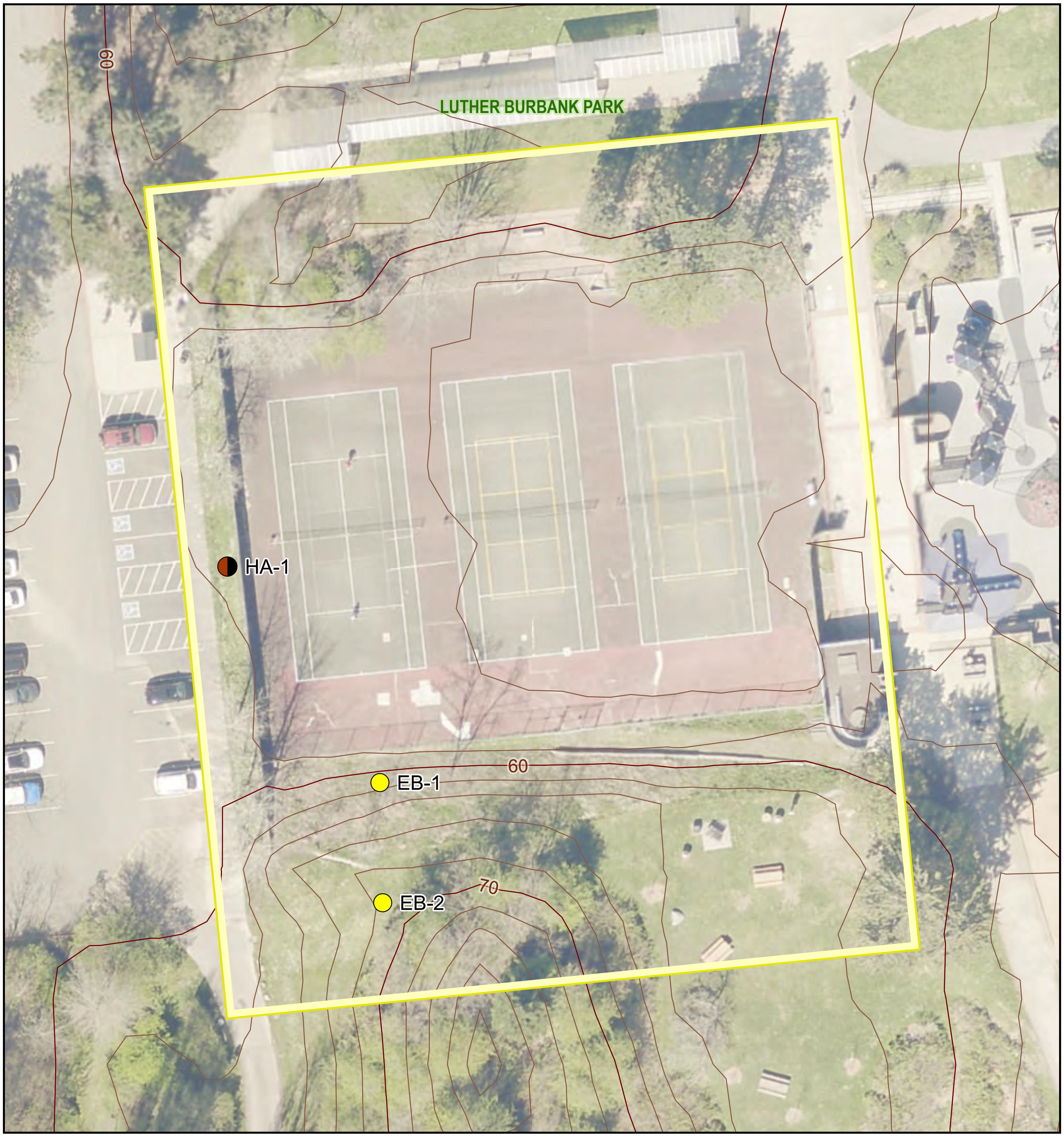
VICINITY MAP

LUTHER BURBANK PARK
MERCER ISLAND, WASHINGTON

PROJECT NO.	DATE	FIGURE
20150262E002	12/23	1

G:\GIS_Projects\aY15post0716\150262 Luther Burbank Park_aprx\20150262E002 F1 VM_Luther Burbank Park.aprx | 20150262E002 F1 VM_Luther Burbank | 2023-12-08 | mtrop



LEGEND

- 🟨 SITE
- ● EXPLORATION BORING
- ◐ HAND BORING
- CONTOUR 10 FT
- CONTOUR 2 FT

DATA SOURCES/REFERENCES:
KING COUNTY: ROADS (5/23), PARKS (9/22).
EAGLEVIEW TECHNOLOGIES, INC.: AERIAL IMAGERY (2021).
WA DNR LIDAR: KING_COUNTY_WEST_2021, ACQUIRED 4/21, 1.5' CELL SIZE. CONTOURS DERIVED FROM LIDAR.

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FEET

LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION.

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EXISTING SITE AND EXPLORATION PLAN

LUTHER BURBANK PARK
MERCER ISLAND, WASHINGTON

PROJECT NO.	DATE	FIGURE
20150262E002	12/23	2

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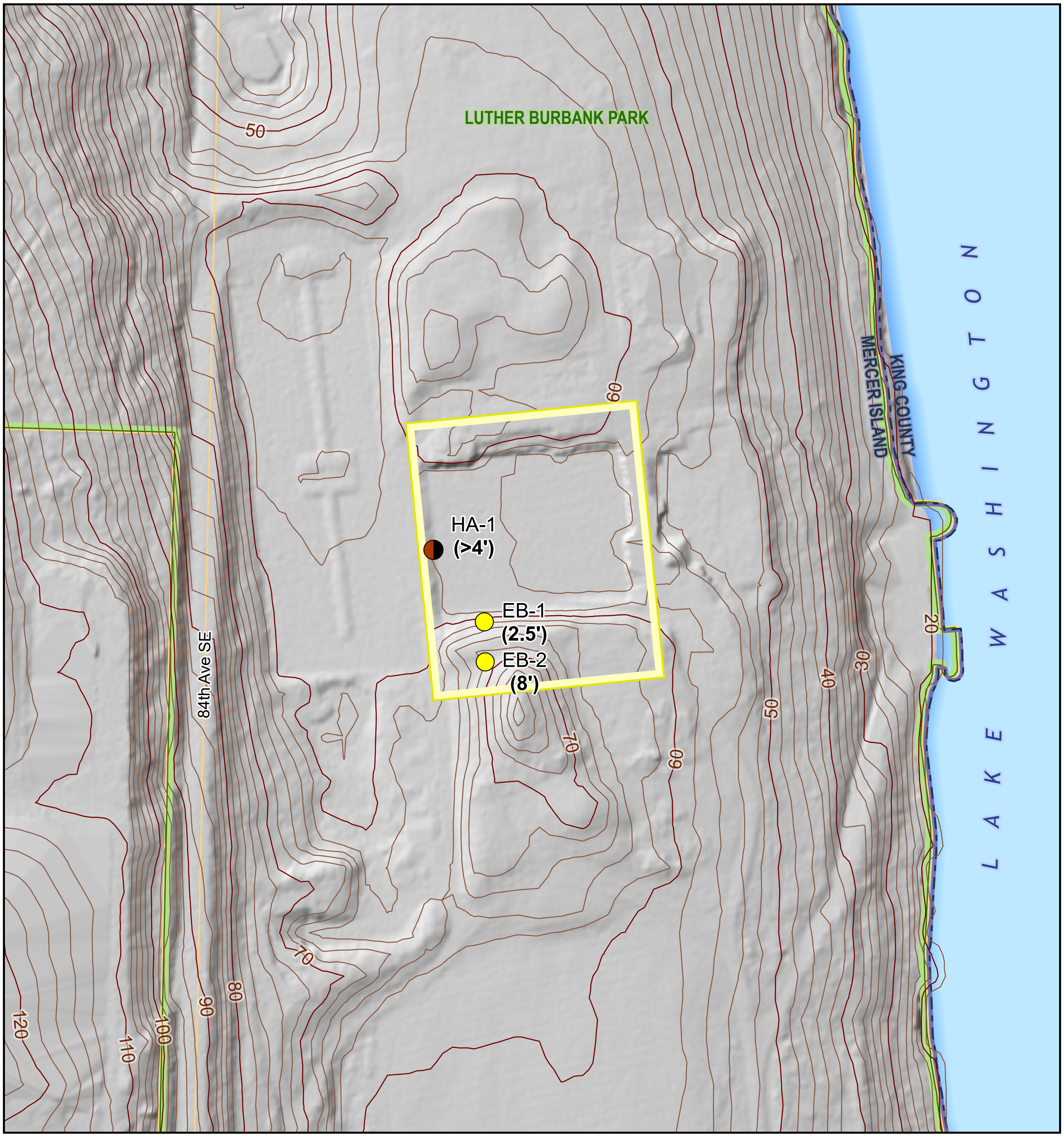

LEGEND

🟨 SITE

EXPLORATION TYPE
(FILL DEPTH - FT)

● EXPLORATION BORING

◐ HAND BORING

∿ CONTOUR 10 FT

∿ CONTOUR 2 FT

🟩 PARK

▭ PARCEL

▭ CITY BOUNDARY

DATA SOURCES/REFERENCES:
KING COUNTY: ROADS (5/23), PARKS (9/22), PARCELS (4/23), CITY BOUNDARIES (5/23), WATERBODIES (9/22).
WA DNR LIDAR: KING_COUNTY_WEST_2021, ACQUIRED 4/21, 1.5' CELL SIZE. CONTOURS DERIVED FROM LIDAR.

N

0 120
FEET

LOCATION AND DISTANCES SHOWN ARE APPROXIMATE.

BLACK AND WHITE REPRODUCTION OF THIS COLOR ORIGINAL MAY REDUCE ITS EFFECTIVENESS AND LEAD TO INCORRECT INTERPRETATION.

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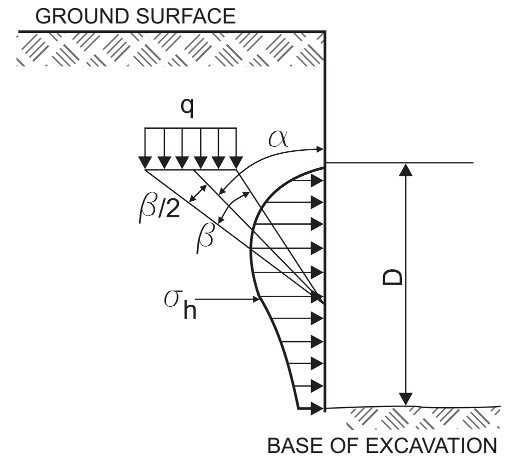
EXISTING SITE AND EXPLORATION PLAN

LUTHER BURBANK PARK
MERCER ISLAND, WASHINGTON

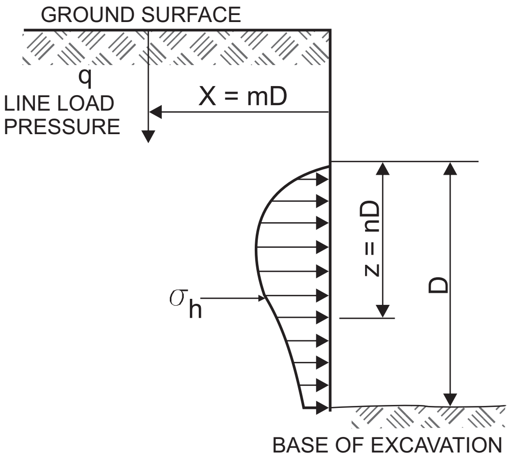
PROJECT NO.	DATE	FIGURE
20150262E002	1/24	2

G:\GIS_Projects\aY15post0716\150262 Luther Burbank Park_aprx\20150262E002 F3 Lidar_Luther Burbank Park.aprx | 20150262E002 F3 Lidar_Luther Burbank | 2024-01-04 | mtrop



ISOLATED FOOTING

$$\sigma_h = 0.64q\,(\beta - \mathrm{SIN}\,\beta\,\mathrm{COS}2\alpha)$$



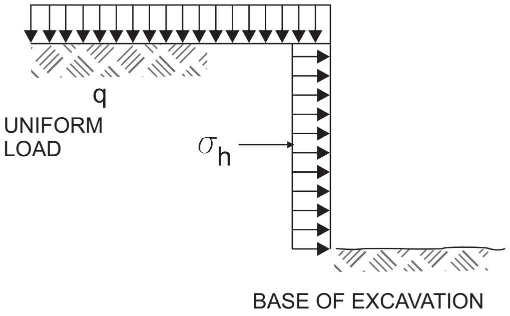
CONTINUOUS FOOTING PARALLEL TO EXCAVATION

(FOR m>0.4)

$$\sigma_h = \frac{1.28q}{D} \quad \frac{m^2\,n}{(m^2 + n^2)^2}$$

(FOR m≤0.4)

$$\sigma_h = \frac{q}{D} \quad \frac{0.2\,n}{(0.16 + n^2)^2}$$



UNIFORM LOAD DISTRIBUTION

σ_h = 0.4q

q = VERTICAL PRESSURE IN PSF

LEGEND:

D	EXCAVATION DEPTH BELOW FOOTING IN FEET
σ_h	LATERAL SOIL PRESSURE IN PSF
q	UNIT LOADING PRESSURE IN PSF
β	RADIANS

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SURCHARGES ON
ADJACENT WALLS
LUTHER BURBANK PARK
MERCER ISLAND, WASHINGTON

PROJ NO. 20150262E002
DATE: 1/24
FIGURE: 4

150494 E Lk Sammamish \ 150494 F4 Pressure 12-16.cdr

Coarse-Grained Soils - More than 50%(1) Retained on No. 200 Sieve	Gravels - More than 50%(1) of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines(2)	▨	**GW**	Well-graded gravel and gravel with sand, little to no fines
			▨	**GP**	Poorly-graded gravel and gravel with sand, little to no fines
		≥12% Fines(2)	▨	**GM**	Silty gravel and silty gravel with sand
			▨	**GC**	Clayey gravel and clayey gravel with sand
	Sands - 50%(1) or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines(2)	▨	**SW**	Well-graded sand and sand with gravel, little to no fines
			▨	**SP**	Poorly-graded sand and sand with gravel, little to no fines
		≥12% Fines(2)	▨	**SM**	Silty sand and silty sand with gravel
			▨	**SC**	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50%(1) or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50		▨	**ML**	Silt, sandy silt, gravelly silt, silt with sand or gravel
			▨	**CL**	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			▨	**OL**	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		▨	**MH**	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			▨	**CH**	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			▨	**OH**	Organic clay or silt of medium to high plasticity
Highly Organic Soils			▨	**PT**	Peat, muck and other highly organic soils

Terms Describing Relative Density and Consistency

	Density	SPT(3) blows/foot
Coarse-Grained Soils	Very Loose	0 to 4
	Loose	4 to 10
	Medium Dense	10 to 30
	Dense	30 to 50
	Very Dense	>50

	Consistency	SPT(3) blows/foot
Fine-Grained Soils	Very Soft	0 to 2
	Soft	2 to 4
	Medium Stiff	4 to 8
	Stiff	8 to 15
	Very Stiff	15 to 30
	Hard	>30

Test Symbols

G = Grain Size
M = Moisture Content
A = Atterberg Limits
C = Chemical
DD = Dry Density
K = Permeability

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

(4) Estimated Percentage

Component	Percentage by Weight
Trace	<5
Some	5 to <12
Modifier (silty, sandy, gravelly)	12 to <30
Very *modifier* (silty, sandy, gravelly)	30 to <50

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch
Slightly Moist - Perceptible moisture
Moist - Damp but no visible water
Very Moist - Water visible but not free draining
Wet - Visible free water, usually from below water table

Symbols

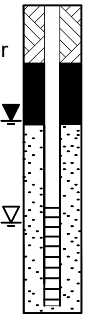
Sampler Type and Description

Blows/6" or portion of 6"
Split-Spoon Sampler (SPT)
California Sampler
Ring Sampler
Continuous Sampling
Grab Sample
Portion not recovered

Groundwater depth

ATD ▼ At time of drilling

Static water level (date) ∇



Cement grout surface seal
Bentonite seal
Filter pack with blank casing section
Screened casing or Hydrotip with filter pack
End cap

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

(1) Percentage by dry weight
(2) Combined USCS symbols used for fines between 5% and 12%
(3) (SPT) Standard Penetration Test (ASTM D-1586)
(4) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)

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EXPLORATION LOG KEY

FIGURE: A1

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Exploration Boring EB-1

Luther Burbank Park
Sheet: 1 of 1

Mercer Island, WA	Start Date: 12/6/23	Logged By: CEM
20150262E002	Ending Date: 12/6/23	Approved By: JHS

Driller/Equipment: BoreTec 1 / HSA Mini Tracked RC Rig
Hammer Weight/Drop: 140#/30"
Hole Diameter (in): 8
▼Groundwater Depth ATD (ft):

Total Depth (ft): 16.5
Ground Surface Elevation (ft): 51
Datum: Project Datum
▽ Groundwater Depth Post Drilling (ft) (Date): ()

Depth (ft)	Sample Type	Sample	% Recovery	Graphic Symbol	Description	Water Level	Blows/6"	Blows/Foot (10 20 30 40 50+)	Other Tests
0					**Grass/Sod - 6 inches**				
					Artificial Fill Cuttings cobbly; some drill chatter.				
2.5		1			**Pre-Olympia Glaciomarine Deposits** Slightly moist, light gray to light brown oxidized, SILT, some very fine sand, trace rounded gravel present as dropstones; some oxidation; massive; rare organics (rootlets); faint hydrochloric acid reaction; free water observed on sample rod likely from perched zone within fill above 2.5 feet (ML). Driller notes cobbles to 4 feet.		9 9 11	20	
5		2			Slightly moist, gray, SILT; some light brown oxidation bands; chaotic texture; faint hydrochloric acid reaction (ML).		7 10 14	24	
7.5		3			Slightly moist, gray, SILT; chaotic texture; moderate hydrochloric acid reaction (ML).		8 13 14	27	
10		4			As above; faint hydrochloric reaction.		4 8 11	19	
12.5									
15		5			As above; faint hydrochloric reaction.		5 9 10	19	
					No groundwater encountered.				
17.5									

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Exploration Boring EB-2

Luther Burbank Park | Sheet: 1 of 1

Mercer Island, WA	Start Date: 12/6/23	Logged By: CEM
20150262E002	Ending Date: 12/6/12	Approved By: JHS

Driller/Equipment: BoreTec 1 / HSA Mini Tracked RC Rig
Hammer Weight/Drop: 140#/30"
Hole Diameter (in): 8
▼ Groundwater Depth ATD (ft): Not encountered

Total Depth (ft): 16.5
Ground Surface Elevation (ft): 62
Datum: Project Datum
▽ Groundwater Depth Post Drilling (ft) (Date): ()

Depth (ft)	Sample Type	Sample	% Recovery	Graphic Symbol	Description	Water Level	Blows/6"	Blows/Foot (10 20 30 40 50+)	Other Tests
0					**Grass/Sod - 6 inches**				
					Artificial Fill Increased drill action Cobbly from 1 to 2 feet.				
2.5		1			Moist, light brown to dark brown, very silty, fine to very fine SAND, trace gravel; chaotic texture; oxidized; abundant fine organics and rootlets (SM). Driller states cobbly at 3.5 feet.		2 13 15	28	
5		2			Top 4 inches: Moist, dark brown to black, very silty, SAND, trace gravel; abundant organics (SM). Bottom 8 inches: Slightly moist, orange turning to light brown, SILT, some very fine sand (ML).		4 5 7	12	
7.5		3			Top 6 inches: Moist, light turning to dark brown oxidized, sandy, SILT, trace gravel; abundant fine organics (ML). **Vashon Lodgement Till** Bottom 12 inches: Slightly moist, light brown to tan, silty, very fine SAND, trace gravel; unstratified; no hydrochloric acid reaction (SM).		13 14 20	34	
10		4			Slightly moist, light brown, silty, very fine SAND, trace gravel; some oxidation; unstratified; vertical fractures present; no hydrochloric acid reaction (SM).		10 14 21	35	
12.5									
					Pre-Olympia Glaciomarine Deposits				
15		5			Slightly moist, gray, SILT, some fine sand; massive; faint hydrochloric acid reaction (ML).		7 11 15	26	
					No groundwater encountered.				
17.5									

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Exploration Boring HA-1

Luther Burbank Park
Sheet: 1 of 1

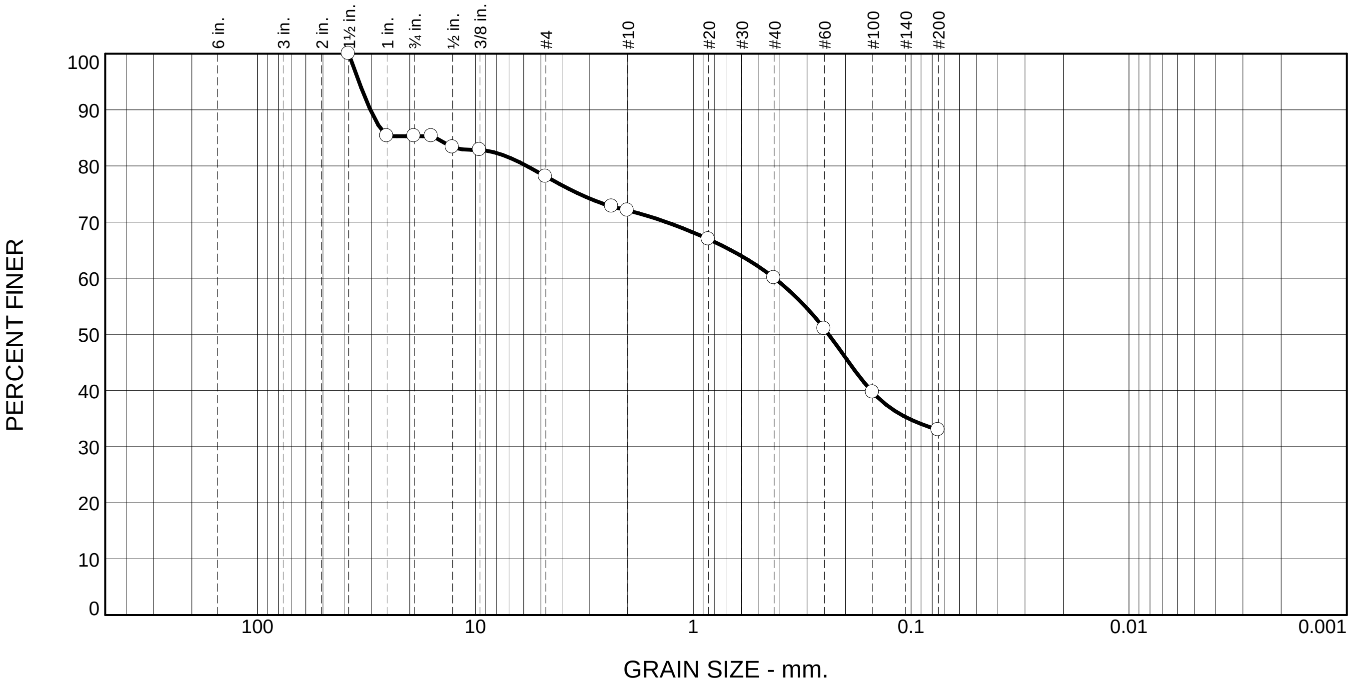
Mercer Island, WA	Start Date: 12/6/23	Logged By: CEM
20150262E002	Ending Date: 12/6/23	Approved By: JHS

Driller/Equipment: Hand Auger
Hammer Weight/Drop: N/A
Hole Diameter (in): 4
▼ Groundwater Depth ATD (ft): Not encountered

Total Depth (ft): 4.5
Ground Surface Elevation (ft): 56
Datum: Project Datum
▽ Groundwater Depth Post Drilling (ft) (Date): ()

Depth (ft)	Sample Type	Sample	% Recovery	Graphic Symbol	Description	Water Level	Blows/6"	Blows/Foot 10 20 30 40 50+	Other Tests
0					**Grass/Sod - 4 inches**				
					Artificial Fill				
		1			Concrete chunk at 0.5 feet. Loose, slightly moist, medium brown, very silty, very fine SAND to very sandy, SILT, some gravel; abundant rootlets (SM).				
		2			As above; some clasts of gray, silty, fine to medium sand (SM).				
2.5									
		3			As above; abundant organics (rootlets) (SM). Looser, gravelly auguring.				
		4			Moist, light brown, silty, GRAVEL, some fine to coarse sand and fine rounded gravel; mixed lithology; well sorted; appears to be pea gravel (GM).				
5					No groundwater encountered.				
7.5									
10									
12.5									
15									
17.5									

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	14.7	7.2	6.0	12.1	27.0	33.0	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5"	100.0		
1"	85.3		
3/4"	85.3		
5/8"	85.3		
1/2"	83.4		
3/8"	82.9		
#4	78.1		
#8	72.8		
#10	72.1		
#20	66.9		
#40	60.0		
#60	51.0		
#100	39.7		
#200	33.0		

* (no specification provided)

Material Description

very silty gravelly SAND

Atterberg Limits (ASTM D 4318)

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

Classification

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

Coefficients

D_{90}= 30.3218 D_{85}= 15.1861 D_{60}= 0.4234
D_{50}= 0.2391 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 12-11-2023 **Date Tested:** 12-13-2023
Tested By: FEW
Checked By: CM/BG
Title:

Location: Onsite
Sample Number: EB-2 **Depth:** 2.5'
Date Sampled: 12-6-2023

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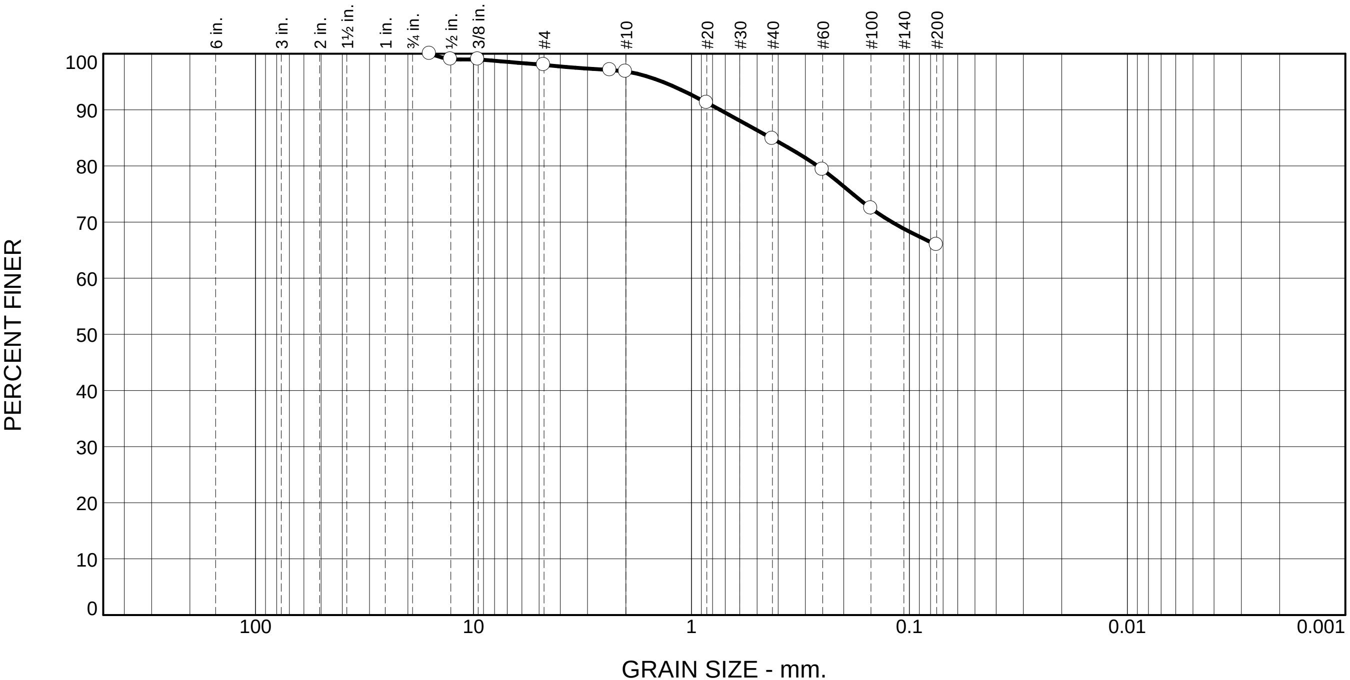
Client: City of Mercer Island Parks & Rec.
Project: Luther Burbank Park
Project No: 20150262 E002 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.0	1.2	11.9	18.9	66.0	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
5/8"	100.0		
1/2"	99.0		
3/8"	99.0		
#4	98.0		
#8	97.1		
#10	96.8		
#20	91.2		
#40	84.9		
#60	79.3		
#100	72.5		
#200	66.0		

* (no specification provided)

Material Description

very sandy SILT trace gravel

Atterberg Limits (ASTM D 4318)

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

Classification

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

Coefficients

D_{90}= 0.7397	D_{85}= 0.4318	D_{60}=
D_{50}=	D_{30}=	D_{15}=
D_{10}=	C_u=	C_c=

Remarks

Date Received: 12-11-2023 **Date Tested:** 12-13-2023

Tested By: FEW

Checked By: CM/BG

Title:

Location: Onsite

Sample Number: EB-2 **Depth:** 10'

Date Sampled: 12-6-2023

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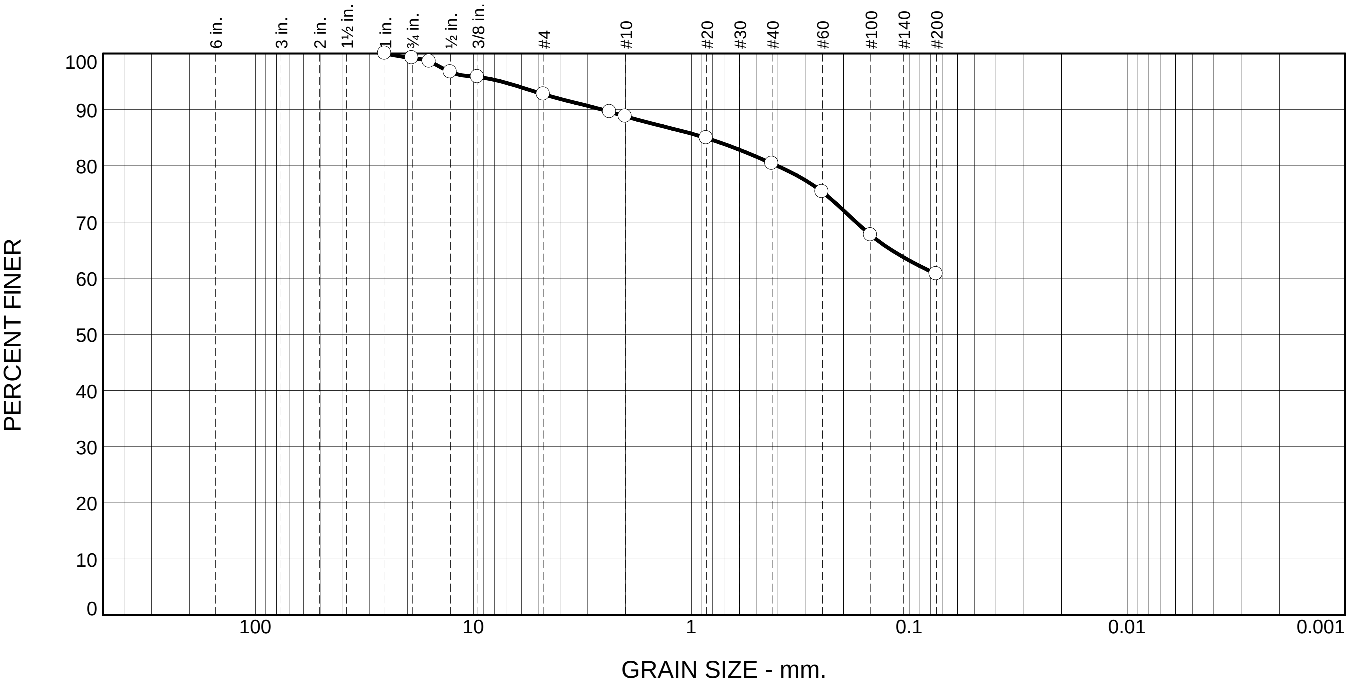
Client: City of Mercer Island Parks & Rec.

Project: Luther Burbank Park

Project No: 20150262 E002 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.8	6.5	3.9	8.4	19.7	60.7	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1"	100.0		
3/4"	99.2		
5/8"	98.6		
1/2"	96.7		
3/8"	95.8		
#4	92.7		
#8	89.6		
#10	88.8		
#20	84.9		
#40	80.4		
#60	75.3		
#100	67.7		
#200	60.7		

* (no specification provided)

Material Description

very sandy SILT some gravel

Atterberg Limits (ASTM D 4318)

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

Classification

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

Coefficients

D_{90}= 2.5564 D_{85}= 0.8600 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 12-11-2023 **Date Tested:** 12-13-2023
Tested By: FEW
Checked By: CM/BG
Title:

Location: Onsite
Sample Number: HA-1 **Depth:** 3'
Date Sampled: 12-6-2023

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Client: City of Mercer Island Parks & Rec.
Project: Luther Burbank Park

Project No: 20150262 E002 **Figure**