MBGS
Mud Bay Geotechnical Services, LLC
1001 Cooper Point Rd SW, Suite 140 PMB #108 | Olympia, WA 98502 | 360.481.9784 | CHeathman@MudBayGeotech.com

December 13, 2021 Job: 1761-KIN

Subject: 7805 SE 70th St,
Mercer Island, Washington 98040
Foundation Settlement Geotechnical Report
Parcel #056550-0150

Dear Bob and Eunice Do,

This report presents the results of our geotechnical investigation and contains geotechnical recommendations for the installation of helical pier foundation elements at the address 7805 SE 70th St, Mercer Island, Washington. The analyses, conclusions, and recommendations in this report are based on the information available. These informational resources include: one hand augured boring completed specifically for the subject project, published geologic information for the site, and our experience with similar soil conditions. This exploratory boring is assumed to be representative of the subsurface conditions where the work will occur. If during construction, subsurface conditions differ from those described in the exploration, we should be advised immediately so we may reevaluate our recommendations.

SITE CONDITIONS AND PROJECT DESCRIPTION

The parcel #056550-0150 consists of a total of 0.36 acres in Mercer Island, WA. The parcel location has been given the situs address of 7805 SE 70th St and is identified on the Site Map included as Figure 1 attached to this report. The property is accessed via a concrete driveway off of SE 70th St from the parcel's northeast corner. The parcel is completely developed with landscaped garden beds and vegetation making up the parcels southern, eastern, and northern boundary. The parcel slopes gently south to north, creating minor grade differences across the site. The home foundation is stepped into the property's natural grade, and boasts a daylight basement on the downslope, northern side of the structure.

MBGS
Mud Bay Geotechnical Services, LLC
1001 Cooper Point Rd SW, Suite 140 PMB #108 | Olympia, WA 98502 | 360.481.9784 | CHeathman@MudBayGeotech.com

The purpose of this report is to provide subsurface conditions and geotechnical recommendations for the installation of six (6) helical piers to act as foundation support elements for the deck addition occurring on the north side of the home. The helical piers will be installed on the home's exterior, within the front yard area off of SE 70th St. The area provides adequate space for project equipment staging, and access via foot is feasible from the east via the residential driveway.

SITE GEOLOGY AND SOILS

As part of this project, we reviewed available geologic data and prepared a site-specific geologic map. The project vicinity geologic map is attached as Figure 2, WA DNR Geologic Map. This figure indicates the project vicinity consists of Pleistocene Continental Glacial Till. These deposits generally consist of Pleistocene till and outwash clay, silt, sand, gravel, cobbles, and boulders deposited by or originating from continental glaciers; locally includes peat, nonglacial sediments, modified land, and artificial fill. Conditions observed at the site are generally consistent with the mapped geology at the site.

In addition to the site geology, site-specific soil data made available by the United States Department of Agriculture was consulted. The USDA Soil Map is attached to this report as Figure 3. This figure suggests that the parcel is underlain by *Arents, Alderwood material, 6 to 15 percent slopes*. The USDA describes the Alderwood series as a moderately deep and moderately well-drained soil forming in the parent material of glacial drift and outwash deposits. The conditions observed on-site are generally consistent with the mapped soils for the region. It should be noted that the slope percentages displayed on the map are estimates and do not necessarily reflect true surface topography.

SUBSURFACE EXPLORATION

As part of the geotechnical investigation, one shallow hand augured boring was completed. The boring was completed using a Humboldt Manufacturing model H-4414QC hand auger with a 4-inch diameter bucket tube sampler. In situ testing was performed at selected depths using a Humboldt Manufacturing model H-4202A dynamic cone penetrometer to estimate the density of the soil. The dynamic cone penetrometer uses a 15-lb steel mass falling a height of 20-inches onto an anvil to penetrate a 1.5-inch diameter 45-degree cone tip seated into the bottom of the hole. The number of blows is recorded to achieve a total of ¾ inches of penetration into the soil.

This recorded blow count is correlated to the Standard Penetration Test (SPT) field N-value blow count determined in accordance with ASTM D1586, which is the standard in situ test method for determining relative density of cohesionless soils and the consistency of cohesive soils. Hand auger samples were removed from the bottom of the hole after the dynamic cone penetration testing was performed in order to observe the soil material at the approximate depth the test was performed.

The soil samples were classified visually in the field in general accordance with ASTM D2488, The Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Once transported back to the office, the samples were re-examined, and the field classifications were modified accordingly. A summary log of the boring is included in Appendix A. Note the soil descriptions and interfaces shown on the log are interpretive, and actual changes may be gradual. Upon completion, the hole was backfilled to the original ground surface using excavated material from the spoil piles.

SUBSURFACE SOIL AND GROUNDWATER CONDITIONS

One hand-augured boring was performed within the area that the helical piers are anticipated to be installed, on the north side of the home. This boring was designated BH-1-21, and is expected to reflect the subsurface conditions across the site. The final depth of BH-1-21 was 72 inches below ground surface. The approximate location of this borings is shown on Figure 4, Site Exploration Map, attached to this report.

Based on the conditions encountered in the boring we anticipate the subsurface to consist of an upper unit of *moist, tan, silty sand (SM)* to a depth of approximately 20-inches below ground surface. This unit is underlain by *medium stiff to very stiff, wet, brown, sandy elastic silt (MH)* to a final depth of boring of 72-inches below ground surface.

Static groundwater was not encountered during our subsurface exploration of the site. However, pore seepage was observed from the boring sidewalls starting at a depth of 24-inches below ground surface and continuing throughout the entire boring. We anticipate this to be a result of stormwater infiltration occurring slowly through the moderately drained elastic silt, causing pore seepage to occur during subsurface exploration.

MBGS
Mud Bay Geotechnical Services, LLC
1001 Cooper Point Rd SW, Suite 140 PMB #108 | Olympia, WA 98502 | 360.481.9784 | CHeathman@MudBayGeotech.com

GEOLOGIC HAZARD ASSESSMENT

Due to the moderate sloping topography that creates a somewhat significant grade difference, we performed a cursory review of the available online site information to determine the potential for landslide hazards at the site. The Landslide Map available from the Washington State Department of Natural Resources revealed no mapped landslides in the area immediately surrounding the project vicinity. The nearest landslide deposits mapped by the DNR are positioned over 0.5 miles away from the project site to the southwest and north east. The Landslide Hazard Map is attached to this report as Figure 5, WA DNR Landslide Hazard Map.

The geomorphology (shape of the land) was analyzed during the site evaluation and compared to the Light Detection and Ranging images (LiDAR) from the Washington State LiDAR portal. LiDAR is a remote sensing method where light is pulsed down to the surface of the Earth and back to a sensor. This methodology enables bare earth images of the surface to be analyzed for the presence of geologic landforms. The data reveals no landforms indicating historic landslides in the surrounding vicinity of the parcel. The bare earth imagery also suggests that the natural topography and geology of the region has been heavily altered through large-scale urban grading and construction activities. The absence of mapped landslides within the project vicinity, interpretation of LiDAR imagery of the site location, and an absence of indicators of on-site mass-wasting during site reconnaissance suggests that the geologic hazard at the site is low.

GEOTECHNICAL RECOMMENDATIONS

Temporary Excavations

Temporary excavations will be necessary to construct the foundation repairs. We anticipate that temporary excavation cuts above the groundwater table will be stable at up to 4 feet in height at a vertical inclination, and any remaining height, or any excavation limits below the groundwater table, will be stable at a maximum slope angle of 1H:1V. The ground surface at the top of the temporary cuts should be periodically monitored for vertical movement, cracks, and other signs of instability. If signs of instability are observed, we should be contacted immediately so that we can assist and provide additional geotechnical recommendations. Temporary excavations greater than 4 feet in height and steeper than 1H:1V may require structural shoring to maintain stability. The design of temporary shoring is considered to be beyond the scope of services for this report.

Mud Bay Geotechnical Services, LLC
1001 Cooper Point Rd SW, Suite 140 PMB #108 | Olympia, WA 98502 | 360.481.9784 | CHeathman@MudBayGeotech.com

Foundation Support

Helical piers will be used to support the proposed addition to the existing structure. Helical piers consist of screw like anchors that are drilled into the ground. Typically, these consist of a lead piece with helixes 8 to 10 inches in diameter that are spaced approximately one foot apart. We recommend using helical anchors meeting this basic geometry, installed to a minimum length of 8 feet below the bottom of footing and a minimum torque of 3000 lb-foot., whichever is deeper. Helical anchors meeting this basic geometry criteria should be capable of achieving allowable axial loads of up to 25 kips. Load testing should be performed to 2.0 times the design load on a minimum of 2 helical piers in accordance with ASTM Standard D 1143-81.

Wall Backfill

Some of the work performed as part of the project may require new backfill be placed to get the final ground surface back up to the current grade. We recommend all backfill be placed in horizontal layers no more than 6 inches thick with each layer compacted to 95 percent of the maximum dry density. The backfill material should be comprised of Select Borrow material meeting the requirements of Section 9-03.14(2) of the WSDOT Standard Specifications, or an equivalent material.

RECOMMENDED ADDITIONAL SERVICES

Before construction begins, we recommend a copy of the draft plans and specifications prepared for the project are made available for review so that we can ensure that the geotechnical recommendations in this report are included in the Contract. Mud Bay Geotechnical Services, LLC is also available to provide geotechnical engineering and construction monitoring services throughout the remainder of the design and construction of the project. The integrity of the geotechnical elements of a project depend on proper site preparation and construction procedures. In addition, engineering decisions may need to be made in the field if conditions are encountered that differ from those described in this report. During the construction phase of the project, we recommend that Mud Bay Geotechnical Services, LLC be retained to review construction proposals and submittals, observe installation of helical piers, and provide recommendations for any other geotechnical considerations that may arise during construction.

CONSTRUCTION CONSIDERATIONS

Groundwater seepage was observed at shallow depth within the limits of where some of the excavations may be performed to complete the work. The need for some amount of dewatering should be anticipated. The groundwater may also affect the stability of excavations and may require flattening temporary excavation slopes from the recommendations described previously based on observations by the on-site geotechnical special inspector. Excavations below the groundwater at approximately 24 inches below the current ground surface will be susceptible to caving and raveling and temporary casing may be necessary if vertical excavations are used.

INTENDED USE AND LIMITATIONS

This report has been prepared to assist the client and their consultants in the engineering design and construction of the subject project. It should not be used, in part or in whole for other purposes without contacting Mud Bay Geotechnical Services, LLC for a review of the applicability of such reuse. This report should be made available to prospective contractors for their information only and not as a warranty of ground conditions.

The conclusions and recommendations contained in this report are based on Mud Bay Geotechnical Services, LLC understanding of the project at the time that the report was written and on-site conditions that existed at time of the field exploration. If significant changes to the nature, configuration, or scope of the project occur during the design process, we should be consulted to determine the impact of such changes on the recommendations and conclusions presented in this report.

Site exploration and testing describes subsurface conditions only at the sites of subsurface exploration and at the intervals where samples are collected. These data are interpreted by Mud Bay Geotechnical Services, LLC rendering an opinion regarding the general subsurface conditions. Actual subsurface conditions can be discovered only during earthwork and construction operations. The distribution, continuity, thickness, and characteristics of identified (and unidentified) subsurface materials may vary considerably from that indicated by the subsurface data. While nothing can be done to prevent such variability, Mud Bay Geotechnical

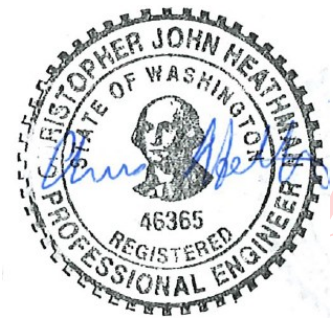
MBGS
Mud Bay Geotechnical Services, LLC
1001 Cooper Point Rd SW, Suite 140 PMB #108 | Olympia, WA 98502 | 360.481.9784 | CHeathman@MudBayGeotech.com

Services, LLC is prepared to work with the project team to reduce the impacts of variability on project design, construction, and performance.

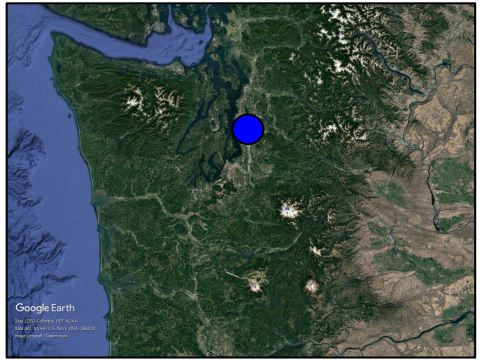
We appreciate the opportunity to serve your geotechnical needs on this project and look forward to working with you in the future. Please contact us at your earliest convenience if you have any questions or would like to discuss any of the contents of this report.

Sincerely,

Chris Heathman, P.E.
Mud Bay Geotechnical Services, LLC



Digitally signed by
Chris Heathman, PE
Date: 2021.12.13
17:25:51 -08'00'



Legend

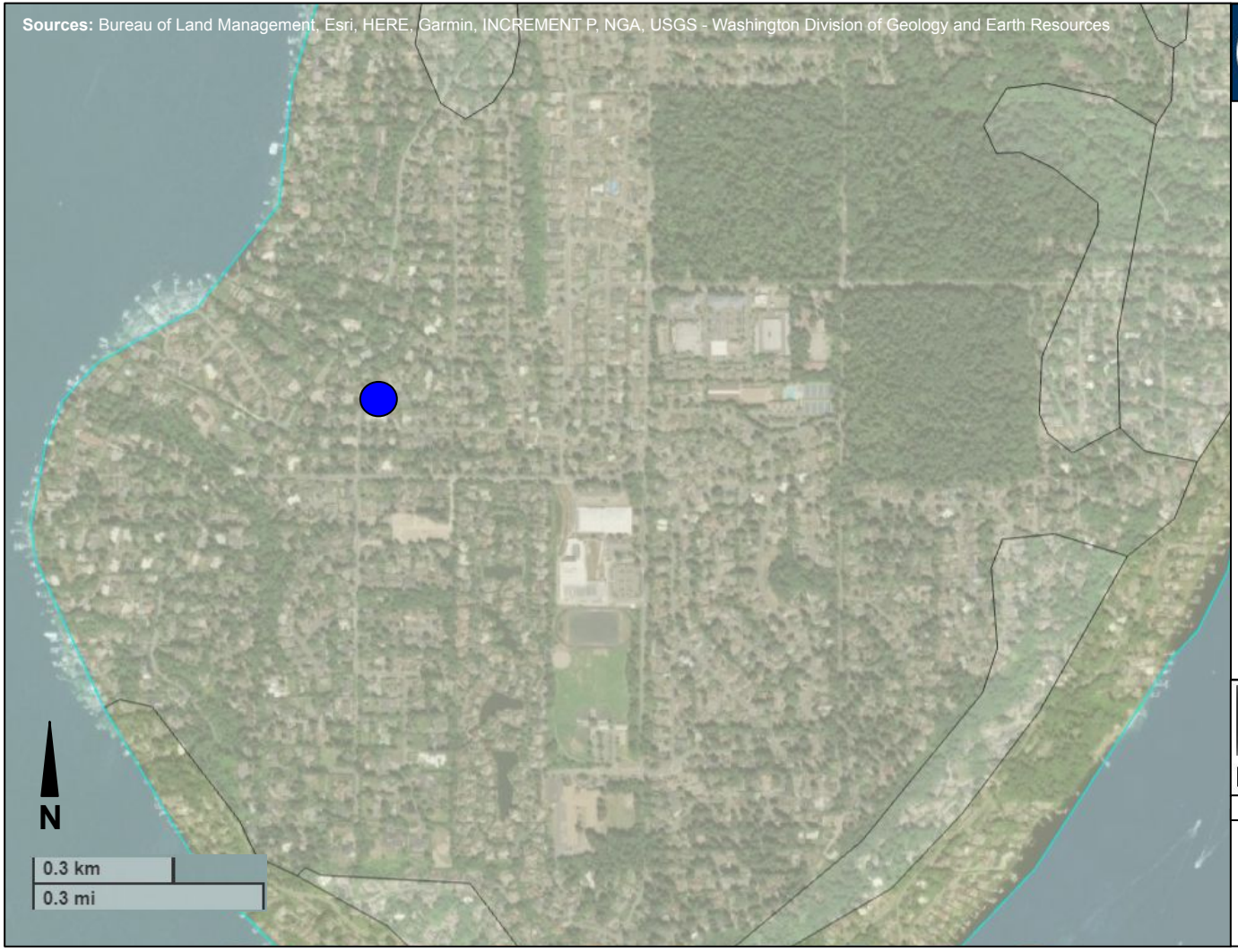
- Site Location
- Approximate Parcel Boundary

MBGS

Mud Bay Geotechnical Services, LLC

JOB #: 1761-KIN	Date: Dec., 2021

Figure 1: Site Map
7805 SE 70th St,
Mercer Island WA 98040
Geotechnical Report



WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND EARTH RESOURCES

Legend

Site Location

Geologic Units 100K

- Pleistocene continental glacial drift
- Pleistocene continental glacial till
- Pleistocene glacial and nonglacial deposits

MBGS

Mud Bay Geotechnical Services, LLC

JOB #: 1761-KIN	Date: Dec., 2021

Figure 2: WA DNR Geologic Map
7805 SE 70th St,
Mercer Island WA 98040
Geotechnical Report

USDA **Natural Resources Conservation Service**

Legend

Approximate Parcel Boundary

Map Unit Symbol	Map Unit Name
AmC	Arents, Alderwood material, 6 to 15 percent slopes
KpB	Kitsap silt loam, 2 to 8 percent slopes
KpD	Kitsap silt loam, 15 to 30 percent slopes

MBGS

Mud Bay Geotechnical Services, LLC

JOB #: 1761-KIN | Date: Dec., 2021

Figure 3: USDA Soil Map

7805 SE 70th St,
Mercer Island WA 98040
Geotechnical Report

Legend

- Approximate Parcel Boundary
- Boring Location

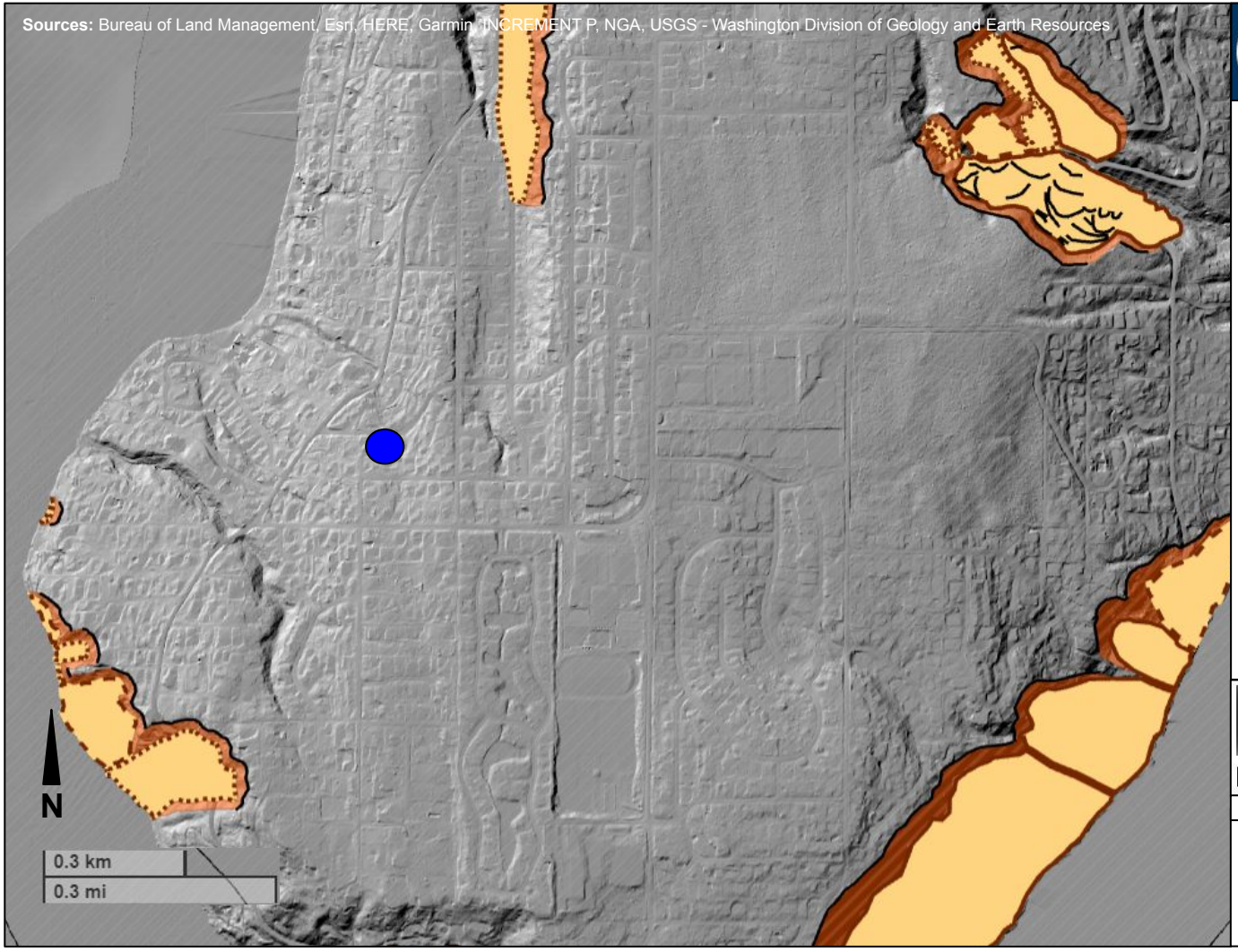
MBGS

Mud Bay Geotechnical Services, LLC

JOB #: 1761-KIN	Date: Dec., 2021

Figure 4: Site Exploration Map

7805 SE 70th St,
Mercer Island WA 98040
Geotechnical Report



WASHINGTON STATE DEPARTMENT OF
NATURAL RESOURCES
DIVISION OF GEOLOGY AND EARTH RESOURCES

Legend

- Site Location
- Scarps and Flanks
- Landslide Deposits
  - High (30-40)
  - Moderate (11-29)
  - Low (1-10)

MBGS

Mud Bay Geotechnical Services, LLC

JOB #: 1761-KIN	Date: Dec., 2021

Figure 5: WA DNR Landslide Map
7805 SE 70th St,
Mercer Island WA 98040
Geotechnical Report

APPENDIX A – FINAL BORING LOGS

MBGS Mud Bay Geotechnical Services, LLC			Project: Helical Piers	Client: Bob Do	Bore No. 1 of 1: BH-1-21
			Project Number: 1761-KIN	Contractor: N/A	Equipment: Humboldt H-4414QC Auger
Address: 7805 SE 70th St, Mercer Island, WA 98040		Started: 11/30/2021		Bit Type: Bucket Tube Auger	Diameter: 4 inches
	Date	Completed: 11/30/2021		Hammer Type: Humboldt H-4202A	Fluid: n/a
Logged By: Logan Krehbiel		Backfilled: 11/30/2021		Hammer Weight: 15 lbs	Hammer Drop: 20 inches
Helper: Noelle Ng			Groundwater Depth: n/a	Elevation: Existing Surface	Total Depth of Boring: 72 inches
GPS Method: n/a			GPS Coordinates: (± __ ft.)		GPS Elevation: (± __ ft.)

Depth (in.)	Sample Type	Sample Number	Blow Counts (blows/3/4")	Graphic Log	Lithology **Soil Group Name:** modifier, color, moisture, density/consistency, grain size, other descriptors **Rock Description:** modifier, color, hardness/degree of concentration, bedding and joint characteristics, solutions, void conditions.	Dry Density (pcf)	Moisture Content (%)	Additional Test
					Moist, tan, silty sand (SM). ▽			
24"	☒	S-1	9		Stiff, wet, brown, sandy elastic silt (MH).			
36"	☒	S-2	10					
48"	☒	S-3	7		Medium stiff, wet, brown, sandy elastic silt (MH).			
72"	☒	S-3	16		Very stiff, wet, brown, sandy elastic silt (MH).			

Test Pit and Boring Log Symbols

- Standard Penetration Slit Spoon Sampler (SPT)
- California Sampler
- Shelby Tube
- CPP Sampler
- Stabllized Ground water
- Groundwater At time of Drilling
- Bulk/ Bag Sample

Soil Density Modifiers

Gravel, Sand, Non-Plastic Silt		Elastic Silts and Clays	
Blows/3/4"	Density	Blows/3/4"	Consistency
0-4	Very Loose	0-1	Very Soft
5-10	Loose	2-4	Soft
11-24	Medium Dense	5-8	Medium Stiff
25-50	Dense	9-15	Stiff
REF	Very Dense	16-30	Very Stiff
		31-60	Hard
		>60	Very Hard