PHASE I SITE CHARACTERIZATION REPORT

ST. HELENS INTERGOVERNMENTAL AGREEMENT PHASE I LAGOON REPURPOSING

Prepared for
CITY OF ST. HELENS
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ST. HELENS, OREGON
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The material and data in this report were prepared under the supervision and direction of the undersigned.

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ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
bgs	below ground surface
COC	chain of custody
CRBG	Columbia River Basalt Group
DEQ	Oregon Department of Environmental Quality
DO	dissolved oxygen
Ecology	Washington State Department of Ecology
FSDS	field sampling data sheet
ft/day	foot or feet per day
gpm	gallon(s) per minute
m/s	meter(s) per second
Ma	million years ago
MFA	Maul Foster & Alongi, Inc.
mm	millimeter(s)
OAR	Oregon Administrative Rules
ORP	oxidation-reduction potential
OWRD	Oregon Water Resources Department
project	the proposed lagoon repurposing project
PVC	polyvinyl chloride
RFP	Columbia River Fire & Rescue Department
site	the St. Helens wastewater treatment lagoon property at 451 Plymouth Street, St. Helens, Oregon.
Sonic	Terra Sonic Incorporated
SPT	standard penetration test
SWI	Oregon Statewide Wetlands Inventory

1 INTRODUCTION

On behalf of the City of St. Helens, Maul Foster & Alongi, Inc. (MFA) has prepared this Phase I Site Characterization report describing activities completed to advance the proposed lagoon repurposing project (the project) toward conditional permit approval from the Oregon Department of Environmental Quality (DEQ) under Oregon Administrative Rules (OAR) 340-093-00901. The project would convert the St. Helens wastewater treatment lagoon to a facility designed to receive sediment, soil, and wastewater treatment sludge. The wastewater treatment lagoon is currently owned by the City of St. Helens and is situated on the property located at 451 Plymouth Street, St. Helens, Oregon (the site; see Figure 1-1).

The siting process for the project will follow DEQ guidance for a non-municipal-waste facility. Consistent with DEQ guidance and regulations for non-municipal waste facilities, siting analysis is the process of characterizing a site for suitability as a waste disposal facility. Siting includes gathering public information, completing a Phase I physical site investigation and characterization, and developing a conceptual facility design.

This report presents the results of the Phase I site characterization, the objective of which was to provide sufficient baseline information for developing the facility design, construction program, operations plan, and environmental monitoring program. To demonstrate that this objective has been met, this report presents the following information consistent with OAR 340-093-0130:

- Section 2, Existing conditions—Physical location of the site, including property boundaries and legal description, adjacent landowners, existing land use and zoning, physical setting, wetland and water features, and historic sites.
- Section 3, Climate/meteorology—Historical climate information, including high, low, and average ranges for temperature, precipitation, wind conditions, and other meteorological information.
- Section 4, Hydrology—Surface water drainage characteristics of the site.
- Section 5, Water Balance—Average annual water budget, including precipitation, runoff, run-on, infiltration, and evapotranspiration.
- Section 6, Water Use Inventory—All water supply wells within 5 miles and 1 mile of the site, including public and private water supply wells, surface waters and surface water intakes, and the boundaries of municipal water supply service areas.
- Section 7, Site Investigation—Description of the hydrogeologic field investigation completed to assess subsurface hydrogeologic conditions at the site.
- Section 8, Geology and Hydrogeology Investigation—Results of literature review and field investigation conducted to evaluate the regional geology and hydrogeology.

- Section 9, Geotechnical Investigation—Provides a summary of the geotechnical field investigation completed to assess physical properties of subsurface soils at the site.

2 EXISTING CONDITIONS

2.1 Property Description

The site is located in the south part of St. Helens, Oregon, and immediately west of Multnomah Channel. The site vicinity and the township and range coordinates are shown on Figure 2-1. The site occupies the SW ¼ of section 3 and the NW ¼ of section 10 in township 4 north, range 1 west. From Highway 30, the site is accessed by driving east on Gable Road, then north on Old Portland Road, then east on Plymouth Street to South 6th Street. The St. Helens wastewater treatment lagoon is located immediately south of South 6th Street. The legal description of the site is provided in Appendix A. Stereo pair aerial photographs are provided in Appendix B.

2.2 Adjacent Landowners

A list of adjacent landowners within 0.25 mile of the site boundary is provided in Table 2-1. The list was prepared from information obtained from the Columbia County assessor's office. The tax lots corresponding to the landowner list in Table 2-1 are shown on Figure 2-2.

2.3 Existing Land Use and Zoning

The existing land use and zoning with a 5-mile radius of the site are shown on Figure 2-3. Land use and zoning data were obtained from the Oregon Department of Land Conservation and Development and the Washington State Department of Ecology (Ecology).

2.4 Physical Setting

The regional topographic setting of the site is shown on Figure 1-1. A site-specific topography survey prepared by a registered surveyor is presented in Appendix C. The site topography slopes to the east in a stepwise fashion:

- The western portion of the site lies on a basalt bedrock bluff overlooking the wastewater treatment lagoon to the east. The bluff elevation ranges from about 45 to 80 feet.
- The east edge of the bluff consists of a steep bedrock cliff leading down to the surface of the wastewater treatment lagoon.
- The surface water elevation of the lagoon is about 28 feet. Wastewater treatment lagoon design drawings indicate that the bottom of the lagoon lies at an elevation of about 7 feet.

- The northeast, east, and south margins of the lagoon consist of a constructed dike. The top of the dike lies at an elevation of 31 feet.
- The eastern portion of the site, just east of the dike, lies on a bottomland area between the dike and Multnomah Channel. The bottomland area lies at an elevation of about 15 to 25 feet, except where historical filling has raised the elevation to about 32 feet.

2.5 Seeps, Springs, Streams, Ponds, and Wetlands

Wetland and water features at and adjacent to the site are shown on Figure 2-4. The wetland and water feature locations and boundaries were obtained from the following sources:

- National Wetlands Inventory for the Oregon and Washington States
- Oregon Statewide Wetlands Inventory (SWI). Data included in the SWI cited OTAK Inc. and The Wetlands Conservancy.

MFA did not perform a site-specific wetland delineation to confirm the wetland and water boundaries shown on Figure 2-4. Natural wetland and water features adjacent to the site include the following:

- Multnomah Channel, consisting of permanently flooded, tidally influenced riverine deepwater habitat
- Wetlands along the east bank of Multnomah Channel, consisting of temporarily flooded, freshwater tidal floodplains, banks, and sandbars
- Wetlands on the bottomland between Multnomah Channel and the lagoon, consisting of temporarily flooded tidal depressions and floodplains
- Wetlands in a small, seasonally flowing riverine channel west of the lagoon
- Temporarily flooded scrub-shrub wetlands at the head of the channel west of the lagoon

Artificially created water features associated with the lagoon include the following:

- Open-water habitat comprising most of the lagoon footprint.
- A permanently flooded pond at the base of the northeast margin of the dike. Although this area is mapped as a pond, no pond exists at this location. The area consists of gravel-capped fill.
- An artificially flooded pond comprising the wastewater treatment plant lagoon.
- A semi-permanently flooded pond along the northwest margin of the lagoon.
- A seasonally flooded scrub wetland along the northwest margin of the lagoon.

2.6 Historic Sites

Historic sites within a 5-mile radius of the site are shown on Figure 2-5. Historic site locations were obtained from the Oregon Historical Sites Database (OSP, 2019) and the Washington Information System for Architectural and Archaeological Records Data database (DAHP, 2019). The historic property nearest to the site is the National Guard Armory Complex, located about 0.1 mile north of the site, at 474 South 7th Street. The Oregon and Washington historical sites are listed on Tables 2-2 and 2-3, respectively.

3 CLIMATE AND METEOROLOGY

Climatological normal[1] data for the site were retrieved from the National Center for Environmental Information for the 1981-to-2010 period. Monthly maximum and minimum temperature, precipitation, and evaporation data were collected from the Columbia River Fire & Rescue Department (RFP) meteorological station (Station ID 357466) located in St. Helens, Oregon, approximately 3 miles west of the site. Hourly wind speed and wind direction data were collected from the Scappoose Industrial Airpark monitoring station (Station ID 004201) located in Scappoose, Oregon, approximately 6 miles south-by-southwest of the site. To adequately characterize climatological wind speed and wind direction, five years of hourly data were collected and reviewed for the period from 2013 to 2018.

Table 3-1 summarizes the monthly average high and low temperatures, monthly average total precipitation, days of precipitation, and total evaporation. As shown in Table 3-1, daily average high temperatures range from a minimum of 42 degrees Fahrenheit (°F) in December, to a maximum average of 79.6°F in August. Average daily low temperatures range from a minimum of 32.2°F in December to a maximum of 54.8°F in August. Daily low temperatures below freezing (i.e., less than or equal to 32.0°F) occur from October to May. December through February account for approximately 69 percent of the total days with freezing temperatures.

Precipitation falls primarily from late fall through early spring (October to April), with most of it occurring in November, December, and January. The highest total precipitation occurs in December, with an average of 17.2 days of measurable precipitation (defined as total 24-hour precipitation equal to or greater than 0.01 inch). The lowest total precipitation occurs in July and August, with each month typically experiencing four or fewer days of measurable precipitation. Average annual precipitation measured at the St. Helens RFP meteorological station is 46.6 inches.

Average monthly and annual evaporation data were retrieved from the Western Regional Climate Center for the period from 1963 to 2005. The pan evaporation station nearest to the site and having recent data is the North Willamette Experimental station, located at the North Willamette Research

[1] Climatological normal data represent a 30-year average of a climatic element over a prescribed 30-year interval. Thirty-year climate normals are calculated and maintained by the National Climatic Data Center in Asheville, North Carolina. 1981–2010 represents the most up-to-date 30-year climatological normal interval for St. Helens.

and Extensions Center in Wilsonville, Oregon. As shown on Table 3-1, the highest total evaporation rates occur from May to September.

Wind direction data from the Scappoose Industrial Airpark monitoring station indicate a predominant bimodal pattern between the northwest and southeast, as shown in the wind rose presented in Figure 3-1. The orientation of the bimodal pattern is generally consistent with the orientation of the Columbia River Valley, in which the site is located. Additional data analyses indicate that wind speed and wind direction are heavily influenced by seasonality. Winds are generally lower in speed and originate from the west and south during the winter months, whereas wind speeds are faster and originate from the north during the summer months.

4 HYDROLOGY

4.1 Surface Water Features

Surface water features within 0.25 mile of the site are shown in Figure 2-4 and include the wastewater treatment lagoon present on the site, an unnamed intermittent stream, Multnomah Channel, and the Columbia River. The 100-year floodplain, as determined by the Federal Emergency Management Agency, is shown in Figure 4-1.

4.1.1 Lagoon

The City of St. Helens wastewater treatment lagoon occupies most of the site. The lagoon encompasses approximately 40 acres and is 21 feet deep. The lagoon is identified on Figure 2-4 as an artificially flooded pond (PUBKx) and open-water habitat (L2UBKx). The lagoon receives wastewater from the City of St. Helens sanitary sewer system and discharges treated water to the adjacent Multnomah Channel and Columbia River under National Pollutant Discharge Elimination System waste discharge permit number 101173. Typical discharges from the lagoon are between 6 and 10 million gallons per day (City of St. Helens, 2019).

4.1.2 Unnamed Stream

This stream is west of the site and southeast toward the south end of the lagoon. The stream is identified on Figure 2-4 as a seasonally flowing riverine channel (R4SBC). City of St. Helens wastewater treatment plant staff have confirmed that the stream is intermittent; seasonal discharge from the stream ponds behind an earthen dam just upstream of the lagoon and is subsequently piped around the lagoon and discharged to Multnomah Channel. Engineering staff at the City of St. Helens indicated that storm sewer catch basins along South 11th Street, South 12th Street, and Umatilla Street discharge to this unnamed stream. No flow data are available for this stream.

4.1.3 Multnomah Channel

Multnomah Channel is a distributary of the Willamette River, which adjoins the site to the east. It is identified on Figure 2-4 as permanently flooded, tidally influenced, riverine deepwater habitat (R1UBV). The channel diverges from the main stem of the Willamette River approximately 21.5 miles south of the site, then flows north along the west side of Sauvie Island, and discharges to the Columbia River at the confluence directly north of the site. No stream gauges are present in Multnomah Channel, and no flow data are available. Locally, the wastewater treatment lagoon and the unnamed stream described above both discharge to Multnomah Channel. Multnomah Channel is tidally influenced, and water levels in the channel can change by a few feet over a single tidal cycle.

4.1.4 Columbia River

The Columbia River is the largest river in the Pacific Northwest, and its watershed encompasses much of the region. Locally, the Columbia River receives discharge from Multnomah Channel and, farther downstream, the main stem of the Willamette River. Similar to Multnomah Channel and the Willamette River, the Columbia River is tidally influenced, and water levels can change by a few feet over the course of a single tidal cycle.

The confluence of the Multnomah Channel and the Columbia River is immediately north of the site. The Columbia River then flows northward from the site and discharges to the Pacific Ocean. Monthly and annual flow rates for the Columbia River are presented in Table 4-1. The highest monthly average flow rates occur in June, while the lowest average monthly flow rates occur in September.

5 WATER BALANCE

Water balance calculations were performed, including monthly evaluations for a one-year period of precipitation, runoff, infiltration, and evapotranspiration. The water balance was performed following the method outlined in the U.S. Environmental Protection Agency document *Use of the Water Balance Method for Predicting Leachate Generation for Solid Waste Sites* (USEPA, 1975). Based on the significant differences in site geology and soil characteristics, separate water balance calculations were performed for the basalt bluff and bottomland area east of the lagoon.

5.1 Basalt Bluff

Water balance calculations for the basalt bluff are presented in Table 5-1 and Figure 5-1. Based on this water balance, percolation takes place between approximately October and June, while soil moisture utilization occurs during July and August, and soil moisture recharge occurs during September. The maximum percolation value of 127 millimeters (mm) of water occurs during the month of December.

5.2 Bottomland Area

Water balance calculations for the bottomland area are presented in Table 5-2 and Figure 5-2. Based on this water balance, percolation takes place between approximately October and June, while soil moisture utilization occurs during July and August, and soil moisture recharge occurs during September. The maximum percolation value of 132 mm of water is reached during the month of December. Overall, more infiltration takes place in the bottomland area, while more runoff occurs at the basalt bluff.

6 WATER USE INVENTORY

6.1 Groundwater Well Inventory

Water wells within a 1- to 5-mile radius of the site are shown on Figure 6-1. Well location information was obtained from the Ecology well log database[2] and the Oregon Water Resources Department (OWRD) well log database.[3] A total of 922 wells were identified. The databases plot wells at the midpoint of the section or quarter section in which each well is located; because many of the well symbols on Figure 6-1 represent multiple wells, the figure includes fewer than 922 well symbols.

Water wells within a 1-mile radius of the site were identified by searching the Ecology and OWRD well log databases (see Figure 6-2). The townships, ranges, and sections within a 1-mile radius of the site were used to identify wells. The search of the Ecology database identified four abandoned geotechnical borings. No water wells were identified. The search of the OWRD database identified the following wells:

- A total of 577 wells were identified, of which 306 are geotechnical borings, 215 are monitoring wells, and 56 are water well logs.
- Of the 56 water wells, seven are identified as abandoned.
- Of a total of 49 active wells, 40 are for domestic use, five are for industrial use, and four are for unspecified uses.

The locations of the 49 active wells were mapped using the following hierarchy:

- If a street address for the well was provided in the OWRD database, and the address corresponded to a mappable location, the well location was plotted using the street address. Twenty-two wells were identified with mappable street addresses.

[2] https://fortress.wa.gov/ecy/wellconstruction/map/WCLSWebMap/WellConstructionMapSearch.aspx
[3] https://apps.wrd.state.or.us/apps/gw/well_log/

- If a mappable street address was not provided, the township, range, section, and quarter-quarter information was used to plot the well location.
  - Quarter-quarter section information was provided for 11 wells.
  - For 16 wells, only section information was provided.

Plotting the well locations identified seven wells for which the street address, section, or quarter-quarter location fell within the 1-mile radius of the site. Well information obtained from the OWRD database is provided on Table 6-1, and the well locations are shown on Figure 6-2 as follows:

- Well COLU 55412 is shown based on a mappable well street address and a map of the well location included with the well log.
- Well COLU 3242 is shown based on a mappable owner address. Since the address fell within the same quarter-quarter section of the well, the owner address is assumed to be the well address.
- COLU 3241, COLU 3244, COLU 3245, and COLU 51684 are shown based on quarter-quarter section information.
- COLU 3300 is shown based on section information.

The OWRD well logs for these seven wells are provided in Appendix D.

Based on the location information, the well nearest to the site is well COLU 3242. Assuming that the regional groundwater flow direction is to the east toward Multnomah Channel (see Section 8 for a discussion of the local and regional groundwater flow direction), the seven wells are located either up- or crossgradient of the site. No downgradient water wells were identified between the site and Multnomah Channel.

6.2 Alternative to Field Survey

DEQ guidance requires that a door-to-door field survey be conducted to identify wells not accounted for in OWRD files. MFA is not aware of other wells not accounted for in OWRD files. Nevertheless, in accordance with DEQ guidance for activities that can be conducted in lieu of a door-to-door survey, MFA obtained the following information to identify other water uses in the site vicinity.

6.2.1 Municipal Water Service Area Boundary

The approximate boundary of the City of St. Helens is shown on Figure 6-2. The boundary was developed based on the extent of City of St. Helens water mainlines and laterals, the locations for which were provided by the city.

6.2.2 Location and Description of Surface Water Rights

Surface water rights within a 5-mile radius of the site were identified by searching the Ecology water resources explorer[4] and the OWRD water rights information query.[5] The identified water rights are shown on Figure 6-3. Points of diversion for surface water rights within a 1-mile radius are summarized on Table 6-2. Three points of diversion for surface water rights are present within a 1-mile radius of the site; these represent irrigation and industrial/manufacturing uses. No surface water rights for drinking water are present within 1 mile of the site.

7 2019 SITE INVESTIGATION

In July through September 2019, MFA completed an investigation of the site geology and hydrogeology in general accordance with the site investigation work plan (MFA, 2019). The investigation included completion of exploratory borings and installation of monitoring wells adjacent to the lagoon, water level monitoring, groundwater sampling, and aquifer testing. Specific objectives of the investigation included:

- On the bluff west of the lagoon, characterization of the Sentinel Bluffs basalt, the contact with the Sentinel Bluffs basalt and the Winter Water basalt, and the underlying Winter Water basalt and the hydraulic connection of these basalt units with the lagoon and Multnomah Channel.
- On the dike between the lagoon and Multnomah Channel, characterization of the fill, the alluvium, and the top of the underlying basalt and the hydraulic connection of these units with the lagoon and Multnomah Channel.

7.1 Boring and Monitoring Well Locations

To meet the investigation objectives described above, borings and monitoring wells were installed on July 8 through 12 and 15 through 17, 2019, at the locations described below and shown on Figure-7-1. Boring and monitoring well completion logs are provided in Appendix E. Well completion information is provided in Table 7-1.

7.1.1 Bluff Borings

Two basalt bedrock borings, designated B-1 and B-2, were advanced on the bluff located west of the lagoon. The borings were advanced to a depth of 100 feet below ground surface (bgs), corresponding to an approximate depth of 20 feet below the bottom of the lagoon. The borings were completed as monitoring wells MW-1 and MW-2, each with 20-foot-long screens spanning a 6- to 11-foot-thick interflow zone encountered at the contact between the Sentinel Bluffs member and Winter Water

[4] https://fortress.wa.gov/ecy/waterresources/map/WaterResourcesExplorer.aspx
[5] https://apps.wrd.state.or.us/apps/wr/wrinfo/Default.aspx?t=1

member of the Columbia River Basalt Group (CRBG). The interflow zone consisted of basalt bedrock highly weathered to sandy clay with gravel and gravelly clay with sand that was underlain and overlain by unweathered basalt bedrock.

7.1.2 Dike Borings

Four borings, designated B-3 through B-6, were advanced along the dike located between the lagoon and Multnomah Channel. Boring B-3 was advanced to a depth of 100 feet bgs and borings B-4 through B-6 were advanced to 120 feet bgs. The four borings penetrated dike fill and alluvium. Only B-3 and B-5 encountered basalt bedrock, at depths of 80 feet and 103 feet bgs, respectively. All four borings were completed as monitoring wells MW-3 through MW-6, each with 20-foot-long screens placed in the alluvium.

7.2 Drilling and Well-Installation Procedures

Cascade Drilling provided the drilling and well-installation services, using a Terra Sonic Incorporated 150 CC (Sonic) drill rig equipped with a 4-inch-diameter, 10-foot-long core barrel. Following retrieval and logging of each core, the boring was overdrilled with the Sonic drill rig, using 6-inch-diameter temporary outer casing to facilitate monitoring well installation. Changes in the lithology of the core were recorded on boring logs (provided in Appendix E). Fill and alluvium were described in accordance with the Unified Soil Classification System. Rock core was described in accordance with the Oregon Department of Transportation Soil and Rock Classification Manual (ODOT, 1987) and included rock type, vesicularity, color, degree of weathering, and hardness; as well as joint presence, attitude, spacing, separation, and type of filling, if present.

7.2.1 Standard Penetration Tests

Disturbed split-spoon samples with standard penetration tests (SPTs) and undisturbed Shelby tube samples were obtained from the four dike borings. This work was conducted in the dike fill and at the top of the alluvium immediately below the fill-alluvium contact.

- SPTs consisted of driving the standard split spoon sampler 18 inches into the soil at the borehole bottom, using a 140-pound hammer dropped 30 inches. The number of blows required to drive the sampler every 6 inches was recorded on the boring log.
- Relatively undisturbed samples of dike fill were obtained by using the drill rig to push a 3-inch-diameter Shelby tube a maximum of 24 inches into the undisturbed soil at the bottom of the boring. The soil exposed at the ends of the Shelby tube was examined and classified in the field. After classification, the ends of the tubes were sealed with rubber caps and taped to preserve the natural moisture content of the soils. The tubes were provided to Geotechnical Resources, Inc., for further examination and testing.

7.2.2 Pump Testing

The work plan proposed pump testing at all borings to confirm that subsurface formations could produce sufficient groundwater for placement of a monitoring well and collection of groundwater samples. At the dike borings, loose, wet, alluvial soil prevented the boreholes from staying open, and therefore it was not possible to conduct pump tests of an open section of the boreholes. However, subsequent development of the dike monitoring wells MW-3 through MW-6 confirmed that the wells produce sufficient water for groundwater sample collection.

At basalt bluff boring B-2, a pump test was not conducted because very turbid groundwater was present in the borehole, clogging the pump tubing. However, subsequent development of monitoring well MW-2 confirmed that the well produces sufficient water for groundwater sample collection.

A pump test was successfully conducted at basalt bluff boring B-1 at the depth of the interflow zone. When the interflow zone was encountered, drilling ceased, the core barrel was removed from the borehole, and the outer casing was pulled back to expose a section of the interflow zone and allow groundwater to enter the borehole.

Since water was used during drilling to cool and lubricate the drill bit, a submersible pump was used to remove water from the borehole and lower the water level to the approximate depth of the interflow zone. The pumping rate was reduced as water levels in the borehole began rising, to confirm reentry of groundwater into the borehole. The flow rate was then adjusted to achieve a stable drawdown of the water level, after which the corresponding pumping rate was measured in gallons per minute (gpm), the water level was monitored, and pumping continued for a period of time to confirm that the interflow zone could yield groundwater at a sustained pumping rate.

At the termination of the test, the total drawdown (calculated as the stable drawdown depth minus the prepumping static water level depth) and the corresponding pump rate was recorded in the field notebook. The specific capacity of the borehole was calculated by dividing the pumping rate by the total drawdown. At B-2, a stable drawdown of 26.6 feet was achieved at a pumping rate of 0.32 gpm, corresponding to a specific capacity of 0.01 gpm per foot of drawdown.

7.2.3 Reconnaissance Groundwater Sample Collection

The work plan proposed reconnaissance groundwater sample collection at all borings at the conclusion of the pump testing to characterize the geochemistry of the identified water-bearing zone during drilling. Since pump tests could not be conducted at the dike borings and basalt bluff boring B-2, reconnaissance groundwater samples were not collected from these borings.

Immediately following completion of the B-1 pump test, a reconnaissance groundwater sample was collected by using the submersible pump and the new, disposable tubing used in the pump test to transfer water to the sample containers. A water quality meter was used to periodically measure the following groundwater parameters following the pump test: temperature, pH, specific conductance, dissolved oxygen (DO), oxidation-reduction potential (ORP), and turbidity. The measurements were recorded on the field sampling data sheet (FSDS) provided in Appendix F. Field parameters were collected until all parameters had stabilized according to the criteria identified in the site investigation work plan, at which point a reconnaissance groundwater sample was collected (MFA, 2019).

The reconnaissance groundwater sample was field-filtered, using an in-line 0.45-micrometer filter, and then collected directly into laboratory-supplied containers, placed in an iced cooler, and submitted to the laboratory under standard chain-of-custody (COC) procedures. The groundwater sample was analyzed for major anions and cations, including sodium, calcium, potassium, magnesium, manganese, iron, chloride, sulfate, and bicarbonate.

7.2.4 Monitoring Well Installation

Monitoring wells were installed at each of the six boring locations. At bluff borings B-1 and B-2, the monitoring wells were installed across an interflow zone encountered in each boring. At the dike borings, the work plan called for installation of two monitoring wells in the basalt of the CRBG. However, since the basalt was encountered at much greater depths than expected, all four dike monitoring wells were installed at shallower depths in the alluvium to facilitate assessment of groundwater in the alluvial water-bearing zone closest in elevation to the base of the lagoon.

The monitoring wells were installed with 2-inch-diameter, Schedule 40 polyvinyl chloride (PVC), 0.01-inch machine-slotted prepacked screens surrounded by a 12 x 20 silica sand filter pack. All wells were completed with flush-mounted surface monuments set in concrete. After completion, the six monitoring wells were surveyed by a surveyor licensed in Oregon. Well completion and water level information for the wells is summarized on Table 7-1.

7.3 Monitoring Well Development

The monitoring wells were developed on July 22 through 26 and August 1 and 2, 2019. Surging and purging techniques were used to remove fine-grained material from the filter pack and surrounding formation to improve the hydraulic connection between the wells and the water-bearing zone. The following information was recorded during development and documented on the well development logs provided in Appendix F:

- Depth to water before and after development
- Depth to well bottom before and after development
- Cumulative volume of water removed during development
- Turbidity, pH, conductivity, temperature, DO content, and ORP

7.4 Groundwater Sampling from Monitoring Wells

Groundwater samples were collected from the six monitoring wells on August 6 and 7, 2019. The wells were purged and sampled using low-flow sampling methods with peristaltic and inertia pumps and new, disposable tubing. The groundwater parameters pH, temperature, conductivity, DO, ORP, and turbidity were measured periodically during purging and recorded on the FSDSs provided in Appendix F. Groundwater samples were collected after consecutive readings indicated that the groundwater parameters had stabilized in accordance with the stabilization criteria in Section 3.3.3 of the site investigation work plan.

Groundwater samples were field-filtered using an in-line, 0.45-micrometer filter, and then collected directly into laboratory-supplied containers, placed in iced coolers, and submitted to the laboratory under standard COC procedures. Groundwater samples were analyzed for major anions and cations, including sodium, calcium, potassium, magnesium, manganese, iron, chloride, sulfate, and bicarbonate.

7.5 Groundwater Level Measurements

Water levels from the boreholes and monitoring wells were measured using an electronic water level meter to the nearest 0.01 foot. The depth to water in the monitoring wells was measured from the top of the PVC well casing at the surveyed elevation point. This reference point was marked so that readings would be consistently taken from the same reference point. Water levels were measured and recorded on the water FSDS (Appendix F) during sampling and are summarized on Table 7-1. Water levels were measured again on March 11, 2020 and are included on Table 7-1.

7.6 Aquifer Testing

Following well development, rising head pneumatic slug tests were conducted in two monitoring wells on the bluff (MW-1 and MW-2), and two monitoring wells on the dike (MW-5 and MW-6). The procedure included the following steps:

- Installing and calibrating a data logger (transducer) in the well
- Pressurizing the air column above the standing water, forcing groundwater out of the well screen and into the formation
- Releasing the pressure and recording the rise in head, using the transducer
- Analyzing the rising head data, using AQTESOLV software

Three tests were conducted at each well, at intervals of 12, 24, and 36 inches of water pressure. The pneumatic slug-testing equipment (transducer, laptop, connections, pump, or gas cylinder) was supplied and operated by Steadfast Services Northwest of Vancouver, Washington. MFA used AQTESOLV to analyze the transducer data by the Bouwer and Rice method to determine hydraulic conductivity values for each test. No results are available for the 12-inch test at MW-1, as the data were corrupted because of an equipment malfunction. AQTESOLV outputs are presented in Appendix G, and slug testing results are presented in Table 7-2.

8 GEOLOGY AND HYDROGEOLOGY INVESTIGATION

8.1 Regional Geology

8.1.1 Stratigraphic Units

Based on a geologic literature review, the following alluvial and bedrock geologic units are present at or near the site:

- **Quaternary Alluvium.** Surficial alluvial materials in the study area consist of unconsolidated sands, silts, and gravels associated with active streams. The deposits associated with the Columbia River floodplain are primarily fine sand and silt (Evarts, 2004a). At the site, alluvium is present along the bottomland area between the lagoon and Multnomah Channel.
- **CRBG.** The CRBG comprises a series of Miocene age, laterally extensive flood basalts that are present throughout Oregon, Washington, and Idaho. The CRBG in the vicinity of the site consists of various flows belonging to the Grande Ronde Basalt Formation, which erupted from fissures in the eastern portion of the Columbia Plateau between approximately 16.5 and 15.6 million years ago (Ma). The following are the primary members of the Grande Ronde Basalt in the study area:
  - **Sentinel Bluffs Member.** The Sentinel Bluffs is the uppermost and most widespread of the CRBG units in the vicinity of the site. This member is typically up to 90 meters thick, and was emplaced at 15.6 ±0.2 Ma. (Evarts, 2004a). The upper portion of the unit is generally vesicular and heavily weathered to a reddish-brown, and multiple flows present in the unit are distinguished by vesicular flow tops and reddish-brown weathering horizons. When fresh, it is typically dark gray or black with sparse plagioclase phenocrysts (Ahern, 2017). Chemically, the Sentinel Bluffs member is distinguished by a relatively high magnesium oxide content—up to 4.9 percent by weight (Evarts, 2004a). The bluff adjacent to the wastewater lagoon has been mapped as Sentinel Bluffs (Evarts, 2004a).
  - **Winter Water Member.** The Winter Water is the member underlying the Sentinel Bluffs, and ranges from 20 to 40 meters thick (Evarts, 2004a). In the vicinity of the site, the Winter Water member is typically exposed only in creek beds, is a medium light gray to gray color when fresh, and contains scattered plagioclase phenocrysts 1 to 3 mm across (Ahern, 2017; Evarts, 2004a). The contact between the Sentinel Bluff and Winter Water members is mapped at the base of the basalt bluff on the west side of the lagoon (Evarts, 2004a). The Winter Water member extends east beneath the lagoon and Multnomah Channel.
  - **Ortley Member.** The Winter Water is underlain by the Ortley member, a fine-grained aphanitic unit that varies significantly in thickness based on preexisting topography, but that has been estimated at up to 60 meters thick in some locations (Ahern, 2017). When fresh, the unit is black, and it has been observed to weather to blue or green (Ahern, 2017;

Wagner, 2013). The Ortley member has been mapped at the site underlying the Winter Water member, extending east under the lagoon and Multnomah Channel.

- **Pittsburg Bluff Formation.** The CRBG is unconformably underlain by the Pittsburg Bluff Formation, an Oligocene sedimentary unit deposited in shallow marine to subaerial environments with a maximum known thickness of 200 meters (Ahern, 2017; Evarts, 2004a). The formation comprises massive to thinly bedded layers of fine- to coarse-grained sandstones, shale, and rare conglomerate, with few coal beds (Ahern, 2017; Evarts, 2004a). The Pittsburg Bluff Formation does not outcrop in the St. Helens area, but has been mapped as the basement rock in the vicinity of the site (Evarts, 2004a). If this unit is present at the site, it is likely at substantial depth.

8.1.2 Structural Features

No major structural features are mapped at the site. Regionally, a northwest/southeast-trending fault is mapped approximately 0.6 mile north of the site (Evarts, 2004a). A shallow syncline is present in the region as well, with the fold axis oriented northwest/southeast and located near the town of Warren (Ahern, 2017; Evarts, 2004a). The corresponding anticline axis is mapped approximately 0.7 mile north/northwest of the site (Evarts, 2004b). Additional regional faulting has been mapped northwest and southwest of the site (Ahern, 2017).

Regionally, structural features have been observed to have significant influence on groundwater flow (Ahern, 2017). Wells drilled in the vicinity of the syncline axis typically have higher yields than those elsewhere in the region, and in many areas faulting likely has disrupted the lateral continuity of water-bearing zones in the Columbia River Basalts, resulting in limited capacity and transmissivity over long distances (Ahern, 2017).

8.2 Regional Hydrogeology

8.2.1 Regional Aquifers and Aquitards

Significant regional aquifers and aquitards that have been mapped or observed at the site include the following:

- Shallow Alluvial Deposits. Alluvial deposits at and near the site are discontinuous. Deposits in the Columbia River floodplain are composed largely of silts, while alluvial deposits in more upland areas tend to be coarser-grained, with a higher proportion of sands and gravels (Everts, 2004a). Fine-grained alluvial deposits generally act as aquitards, while more-coarse-grained deposits can be significant aquifers.

- Columbia River Basalts. Groundwater in the CRBG is confined largely to interflow zones associated with structures present at the tops and bottoms of individual basalt flows. These interflow structures include vesicular flow tops, flow-top and flow-bottom breccias, and pillow lava/hyaloclastite complexes, and typically have hydraulic conductivities on the order of 10^{-2} to 10^{-15} meters per second (m/s), which is substantially higher than dense flow interiors, which typically have maximum hydraulic conductivity values on the order of 10^{-9} m/s. The highest values for hydraulic conductivity and porosity are typically observed in brecciated flow tops and bottoms (Tolan, Lindsey, and Porcello, 2009). As a result, the interflow zones of the CRBG are regionally significant aquifers, while the flow interiors act as aquitards between these zones of higher conductivity. In the area surrounding St. Helens, the Sentinel Bluffs member is the most widespread CRBG unit and has the highest average groundwater yield (Ahern, 2017).

8.2.2 Groundwater Flow

Regionally, the groundwater flow direction is generally eastward toward Multnomah Channel and the Columbia River, with a trough in the potentiometric surface located along the syncline axis southwest of the site (Ahern, 2017). In the City of St. Helens, the groundwater flow direction is generally eastward toward Multnomah Channel and the Columbia River (Ahern, 2017).

Shallow alluvial groundwater in the region likely recharges via infiltration of precipitation in areas where alluvial deposits are present at the surface. Recharge to the CRBG interflow zone aquifers is likely to be complex, with recharge areas distributed throughout the region, based on current topography, paleotopography (i.e., at the time of deposition), and subsequent faulting or other structural changes. In some cases, recharge areas may not exist for individual interflow zones. The anticline axis north of the site is a potential recharge, as folding can result in the exposure of interflow zones at the surface, allowing recharge from precipitation in these areas (Tolan, Lindsey, and Porcello, 2009).

The August 2019 groundwater elevation data for the monitoring wells indicates the shallow groundwater in both the alluvium and the CRBG interflow zones likely discharges to Multnomah Channel and the Columbia River, as shown on Figure 8-1. For CRBG interflow zones that do not intersect the river and that are hydraulically isolated by significant flow interiors, water wells are likely to be the most significant discharge areas. Water wells in the area are discussed in Section 6.1 and are shown in Figures 6-1 and 6-2.

8.2.3 Groundwater Chemistry

Analytical data from groundwater samples collected at site monitoring wells are presented in Table 8-1. Basalt groundwater is chemically distinct from groundwater present in the shallow alluvium between the lagoon and Multnomah Channel. The groundwater collected from wells located along the dike generally has higher concentrations of cations and anions than the wells screened in the basalt, and is dominated by sodium, while the groundwater collected downgradient of the wastewater lagoon is generally dominated by calcium (Figure 8-2, Table 8-1).

8.2.4 Site Hydrogeology Evaluation

This section presents a hydrogeologic conceptual site model based on site investigation activities conducted in 2019, as well as on the review of public documents providing information on the geology and hydrogeology of the site vicinity.

The geology of the site vicinity is shown in plan view on Figure 8-3 and in cross section on Figures 8-4 and 8-5. The bluff west of the lagoon has been mapped as the Sentinel Bluffs member of CRBG, which is consistent with the lithology observed during installation of monitoring wells MW-1 and MW-2. Boring logs with detailed descriptions of the lithology are presented in Appendix E. An interflow zone was observed in the basalt at approximately 64 feet bgs at MW-1 and 62 feet bgs at MW-2. The interflow zone includes weathered flow tops, with significant clay and silt, as well as less weathered vesicular basalt. This interflow zone corresponds with the mapped contact between the Sentinel Bluffs and Winter Water members of the CRBG (Evarts, 2004a). Slug testing conducted at wells screened in the interflow indicated that the hydraulic conductivity of the unit is approximately 0.07 to 0.08 foot per day (ft/day) (Table 7-2). The interflow zone is located below the base of the existing lagoon, and does not appear to be hydraulically connected to the lagoon.

East of the lagoon, the basalt is overlain by fill along the dike alignment and by Holocene Columbia River alluvium (Evarts, 2004a). The fill is localized and is not laterally extensive outside the site vicinity. The alluvium contains an upper section that is primarily sand, which underlies the fill in the vicinity of the site, but is not laterally extensive and appears to be present only in the vicinity of the eastern portion of the lagoon and the adjacent dike. Slug tests conducted in the sandy upper alluvium indicate that the hydraulic conductivity of this unit is approximately 18 to 24 ft/day (Table 7-2). The sand is underlain by a thick silt section, with few sandy interbeds. The thickness of the alluvium varies substantially in this area, and the topography of the underlying basalt surface can change significantly over very short lateral distances in this area (see cross section B-B' in Figure 8-5). Immediately downgradient of the berm, the sandy upper alluvium is absent and the alluvium transitions to silt with few sandy silt interbeds, present continuously from the ground surface to the basalt (see Figures 8-4 and 8-5). This silt likely acts as an aquitard between the lagoon and the surface water, and likely inhibits upward migration of groundwater between any deep interflow zones in the basalt and Multnomah Channel above.

Water-level measurements were collected manually at each monitoring well prior to sample collection. Water level elevations at the monitoring wells located along the basalt bluff and screened in the interflow zone were between 29.17 and 26.27 feet National Geodetic Vertical Datum of 1929 (NGVD), while the water level elevations at the monitoring wells along the dike were substantially lower, between 13.82 and 8.51 feet NGVD (Table 7-1). The manual water level measurements suggest that the groundwater flow direction between MW-1 and MW-2 is toward the south, and the groundwater flow direction along the dike is toward the north. Both the measured water levels and the documented stratigraphy at the site suggest that these areas represent separate water-bearing zones. Because of the orientation of the monitoring wells in each water-bearing zone (e.g., in a straight line) a potentiometric surface map was not generated with the existing data.

Each of the geologic materials observed at the site affords a distinct degree of protection from potential groundwater contamination:

- Basalt flow interiors provide a high degree of protection. These units are dense with closed joints and few vesicles, and act as aquitards that prevent groundwater flow.

- Basalt interflow zones provide a low to moderate degree of protection. The interflow zone observed at the site is fractured and vesiculated, but also weathered, with substantial clay and silt content and with hydraulic conductivity values below 0.1 ft/day.
- Alluvial sand provides a low degree of protection. This unit has a higher hydraulic conductivity and appears to be in direct contact with the lagoon. However, the unit also appears to be spatially limited and not connected to surface water.
- Alluvial silt provides a moderate to high degree of protection. The permeability and hydraulic conductivity of silt units are low, and this unit appears to be over 50 feet thick in most locations, and continuous between lagoon and surface water.

9 GEOTECHNICAL INVESTIGATION

This section summarizes the geotechnical investigation conducted to assess the physical properties of subsurface soils at the site. The complete geotechnical investigation report is provided in Appendix H.

Based on the borings completed for this investigation and review of existing subsurface information, the eastern portion of the lagoon near the existing containment levee is underlain by a variable thickness of sand, in turn underlain by a significant thickness of compressible, alluvial silt. The alluvial soils are underlain by basalt, and the depth to basalt varies significantly across the site and ranges from exposed basalt outcrops at the ground surface west of the lagoon to more than 200 feet bgs at one portion of the east side of the site. Our preliminary studies indicate that the loose to medium-dense sand and silt below the groundwater level have the potential to liquefy or strain soften during a code-based seismic event. Without mitigation, the loss of soil strength would result in seismically induced settlement and a risk of lateral spreading displacements. Ground improvement could be used to sufficiently improve the seismic stability of the proposed embankment during a code-based seismic event. The native alluvial silt soils are highly compressible, and the placement of new fill could result in significant total and differential short-term (primary) and long-term (secondary) settlements; these will need to be considered as part of the planning and design process and incorporated into any permanent improvements on the site. Depending on placement and compaction methods for new fills in the lagoon, additional settlement and slope stability of the fill soils could also be a geotechnical design consideration. In a subsequent feasibility study, options identification/optimization, and fill augmentation should be assessed to address both fill settlement and slope stability, as well as the seismic stability noted above.

LIMITATIONS

The services undertaken in completing this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this report.

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TABLES

Table 2-1
Landowners within 0.25 Mile of Site Boundary
City of St. Helens
Wastewater Treatment Lagoon

Map ID	Tax Lot Number	Owner Name	OWNER ADDRESS
0	4N1W 300 100 00100	CITY OF ST HELENS, A MUNICIPAL CORP	PO BOX 278, ST HELENS, OR, 97051
1	4N1W 3BC 1900 01900	HALSTEAD DANIEL D	314 S 4TH ST, ST HELENS, OR, 97051
2	4N1W 3BC 7402 07402	BROWN MERIS DOROTHY & PIERCE KIRK JOSHUA	571 COWLITZ ST, ST HELENS, OR, 97051
3	4N1W 3BD 2200 02200	FOSTER ADAM L & MARY L	355 S 2ND ST, ST HELENS, OR, 97051
4	4N1W 3BC 3400 03400	MILLER LORI & ROBERT DEAN	52612 NORTH RD, SCAPPOOSE, OR, 97056
5	4N1W 3BC 1800 01800	ARMSTRONG MICHAEL J	335 S 3RD ST, ST.HELENS, OR, 97051
6	4N1W 3BD 4800 04800	JAPS JULIE M	344 S 3RD, ST HELENS, OR, 97051
7	4N1W 3BD 800 00800	BROWN ROBERT JAMES III	20238 SW 93RD AVE, TUALATIN, OR, 97062
8	4N1W 3BC 4900 04900	WHITE WILLIAM L & BETH J	325 S 4TH, ST HELENS, OR, 97051
9	4N1W 3BD 1400 01400	REINAN JEFFREY C & KAREN L	1850 8TH ST, COLUMBIA CITY, OR, 97018
10	4N1W 3BC 800 00800	RIDENOUR PATRICK	345 S 3RD ST, ST HELENS, OR, 97051
11	4N1W 3BD 4700 04700	FOSTER ADAM L & MARY L	355 S 2ND ST, ST HELENS, OR, 97051
12	4N1W 3BC 3500 03500	JILLSON KENNETH	35091 HANKEY RD, ST HELENS, OR, 97051
13	4N1W 3BC 1700 01700	HANSET CHARLES A & PATRICIA J	356 S 4TH ST, ST HELENS, OR, 97051
14	4N1W 3BC 4700 04700	POLING BRIAN & ANDREA	337 PARKWAY, ST HELENS, OR, 97051
15	4N1W 3BC 6700 06700	CARLSON FORREST	325 S 5TH ST, ST HELENS, OR, 97051
16	4N1W 3BD 4600 04600	SCHWIEBERT ANDREW LOWELL	365 S 2ND ST, ST HELENS, OR, 97051
17	4N1W 3BC 900 00900	LOHMAN T & B & CATLOW REV LIV & HUDSON B	PO BOX 354, SCAPPOOSE, OR, 97056
18	4N1W 3BC 8200 08200	COWAN TAWNIE	735 ST CLAIR #1801, PORTLAND, OR, 97231
19	4N1W 3BC 7300 07300	SIERRA MENDEZ MARIO &MENDEZ W BRITTANY A	822 NE 115TH CIR, VANCOUVER, WA, 98685
20	4N1W 3BC 9900 09900	PATRICK COLLEEN L	314 S 7TH ST, ST HELENS, OR, 97051
21	4N1W 3BC 3600 03600	MATCHAK MOLLY	315 STRAND ST ##8, ST HELENS, OR, 97051
22	4N1W 3BC 4600 04600	BRODERS JULIE KAY	265 N 4TH ST, ST HELENS, OR, 97051
23	4N1W 3BC 6804 06804	WRIGHT DALE M	365 S 5TH ST, ST HELENS, OR, 97051
24	4N1W 3BD 4503 04503	LUTTRELL JOHN	32791 COAL CREEK RD, SCAPPOOSE, OR, 97056
25	4N1W 3BC12000 12000	COULTAS STEVEN & BARBARA	2110 EUCLID CIRCLE, CAMARILLO, CA, 93010
26	4N1W 3BC 8300 08300	BLACKMORE DANNY FRANK & PATSY LOU	325 S 6TH, ST HELENS, OR, 97051
27	4N1W 3BC 1000 01000	DOWNEY RAYMOND W & MARY D	670 I ST, COLUMBIA CITY, OR, 97018

Table 2-1
Landowners within 0.25 Mile of Site Boundary
City of St. Helens
Wastewater Treatment Lagoon

MAUL FOSTER ALONGI

Map ID	Tax Lot Number	Owner Name	OWNER ADDRESS
28	4N1W 3BC 7200 07200	CHRISTERSSON CHARLOTTE A	334 S 6TH ST, ST HELENS, OR, 97051
29	4N1W 3BD 4501 04501	KROLL WILLIAM W	374 S THIRD, ST HELENS, OR, 97051
30	4N1W 3BC 9800 09800	LOVELL JUDSON E & LISA G	33830 CHURCH RD, WARREN, OR, 97053
31	4N1W 3BC 1600 01600	DUNAGAN DEBORAH J	920 GARA PL, ASTORIA, OR, 97103
32	4N1W 3BD 4500 04500	LUTTRELL JOHN	32791 COAL CREEK RD, SCAPPOOSE, OR, 97056
33	4N1W 3BC 4500 04500	HUGHES JOSHUA ALAN	355 PARKWAY, ST HELENS, OR, 97051
34	4N1W 3BD 1300 01300	WINN CAROL V	170 TUALATIN, ST HELENS, OR, 97051
35	4N1W 3BC10699 10699	CITY OF ST HELENS	PO BOX 278, ST HELENS, OR, 97051
36	4N1W 3BC 8400 08400	BLACKMORE DANNY F	325 S 6TH ST, ST HELENS, OR, 97051
37	4N1W 3BC 6800 06800	CITY OF ST HELENS	PO BOX 278, ST HELENS, OR, 97051
38	4N1W 3BD 4502 04502	PIERCE KIRK & BROWN MERIS	31451 DUTCH CANYON RD, SCAPPOOSE, OR, 97056
39	4N1W 3BC10600 10600	KING BRIAN	335 S 7TH ST, ST HELENS, OR, 97051
40	4N1W 3BC 3700 03700	SADELMYER ANTHONY & WHELAN PAMELA	374 PARK WAY, ST HELENS, OR, 97051
41	4N1W 3BC 9700 09700	ROHLOFF DARLENE L & STANLEY A CO-TRST	334 S 7TH ST, ST HELENS, OR, 97051
42	4N1W 3BC 1500 01500	WADE ANDREW	374 S 4TH ST, ST HELENS, OR, 97051
43	4N1W 4AD 1801 01801	ABBILEY PROPERTIES LLC	PO BOX 582, ST HELENS, OR, 97051
44	4N1W 3BD 2300 02300	CULLEN JULIANNE	390 S 3RD ST, ST HELENS, OR, 97051
45	4N1W 3BC 4400 04400	RAY BRYANT E & MARY A	365 PARKWAY, ST HELENS, OR, 97051
46	4N1W 3BC 1100 01100	BLAKELY TAMARA L & DOGGETT ANTONIA C	PO BOX 1120, ST HELENS, OR, 97051
47	4N1W 3BC 6803 06803	SHWIMER HAL MATTHEW	354 S 6TH ST #2, ST HELENS, OR, 97051
48	4N1W 3BD 4400 04400	CULLEN JULIANNE	390 S 3RD ST, ST HELENS, OR, 97051
49	4N1W 3BC 9600 09600	SAYRE ORVAL & ELEANOR	13907 NW CORNELIUS PASS RD, PORTLAND, OR, 97231
50	4N1W 3BC12200 12200	CITY OF ST HELENS	PO BOX 278, ST HELENS, OR, 97051
51	4N1W 3BC 1402 01402	KALIMAN SHIRLEY J	384 S 4TH ST, ST HELENS, OR, 97051
52	4N1W 3BC 6802 06802	WRIGHT DALE M & VICKI L	365 S 5TH, ST HELENS, OR, 97051
53	4N1W 3BD 2400 02400	BILWOOD PROPERTIES LLC	PO BOX 279, SCAPPOOSE, OR, 97056
54	4N1W 4AD 1800 01800	JOLISSAINT PAUL G & CASEY A	325 S 8TH ST, ST HELENS, OR, 97051
55	4N1W 3BC11900 11900	HAMSHAR REBECCA L & MICHAEL S ROS	344 S 8TH, ST HELENS, OR, 97051

Table 2-1
Landowners within 0.25 Mile of Site Boundary
City of St. Helens
Wastewater Treatment Lagoon

MAUL FOSTER ALONGI

Map ID	Tax Lot Number	Owner Name	OWNER ADDRESS
56	4N1W 3BC 3800 03800	SHROLL SCOTT JEFFREY	PO BOX 274, COLUMBIA CITY, OR, 97018
57	4N1W 3BC 4300 04300	MROWCZYNSKI NOAH LEE	21774 SW FULLER DR, TUALATIN, OR, 97062
58	4N1W 3BC 1200 01200	NOVAK KEVIN F & LEWIS GINGER R	391 S 3RD ST, ST HELENS, OR, 97051
59	4N1W 3BC 8600 08600	SIMPSON JEFF A & JULIE A	PO BOX 265, ST HELENS, OR, 97051
60	4N1W 4AD 2500 02500	DORAN JONATHAN T & ARYANNA L	324 S 9TH ST, ST HELENS, OR, 97051
61	4N1W 3BC 6805 06805	ENGLAND CHANDLER S & SONJA R	364 S 6TH ST, SAINT HELENS, OR, 97051-2516
62	4N1W 3BD 4300 04300	LUEY JAMES R & RHONDA M	270 TUALATIN, ST HELENS, OR, 97051
63	4N1W 3BC10700 10700	LUTTRELL LORI L & TROY D	345 S 7TH ST, ST HELENS, OR, 97051
64	4N1W 3BC 9500 09500	WALKER MISTY T	354 S 7TH ST, ST HELENS, OR, 97051
65	4N1W 3BC 1401 01401	TOWNSEND CAROLYN	2034 COLUMBIA BLVD ##146, ST HELENS, OR, 97051
66	4N1W 3BC 4200 04200	YATES DANNY & MARYANNE	385 PARK WAY, ST. HELENS, OR, 97051
67	4N1W 3BC 1300 01300	BRANDON FRANK B III & BRANDONSCHULTZ SUS	PO BOX 83014, PORTLAND, OR, 97231
68	4N1W 4AD 3403 03403	COOK ERIC	325 S 9TH ST, ST HELENS, OR, 97051
69	4N1W 3BC 8601 08601	ROHLOFF STEVEN D & JANET M	365 S 6TH ST, ST HELENS, OR, 97051
70	4N1W 3BC 6801 06801	WRIGHT DM & VL & WRIGHT JL & EC	365 S 5TH ST, ST HELENS, OR, 97051
71	4N1W 3BD 1100 01100	CITY OF ST HELENS, A MUNICIPAL CORP	PO BOX 278, ST HELENS, OR, 97051
72	4N1W 3BC10800 10800	POWELL SHEILA M	355 S 7TH ST, ST HELENS, OR, 97051
73	4N1W 3BC 3900 03900	ROBINSON KERRY	390 PARKWAY, ST HELENS, OR, 97051
74	4N1W 3BC 9400 09400	MURPHY TREVOR & WOODS TINA ROS	364 S 7TH ST, ST HELENS, OR, 97051
75	4N1W 3BD 1000 01000	PRICE NANCY J	424 S 2ND ST, ST HELENS, OR, 97051
76	4N1W 3BC 1400 01400	ADAY JON A AND TAMELIA J	370 TUALATIN ST, ST HELENS, OR, 97051
77	4N1W 3BD 1200 01200	CITY OF ST HELENS, A MUNICIPAL CORP	PO BOX 278, ST HELENS, OR, 97051
78	4N1W 3BC11800 11800	BURKE JAY J	354 S 8TH ST, ST HELENS, OR, 97051
79	4N1W 3BC 4100 04100	BRODERS JULIE KAY	265 N 4TH ST, ST HELENS, OR, 97051
80	4N1W 4AD 3404 03404	HAMILTON JEFFREY M	335 S 9TH ST, ST HELENS, OR, 97051
81	4N1W 3BC 9301 09301	HARPER JOHN & ZENTNER RUTH	327 W MARINE DR, ASTORIA, OR, 97103
82	4N1W 3BD 2500 02500	HEART ACRES INC	57250 OLD MILL RD, SCAPPOOSE, OR, 97056-2106
83	4N1W 3BC 7100 07100	THOMAS (ROSELUND) CARLEEN M	390 S 6TH ST, ST HELENS, OR, 97051

Table 2-1
Landowners within 0.25 Mile of Site Boundary
City of St. Helens
Wastewater Treatment Lagoon

MAUL FOSTER ALONGI

Map ID	Tax Lot Number	Owner Name	OWNER ADDRESS
84	4N1W 3BD 4200 04200	ARMSTRONG-STEVENSON CHRISTOPHER	PO BOX 3772, PORTLAND, OR, 97231
85	4N1W 3BC11000 11000	VALLADARES ERIN M	345 S 8TH ST, ST HELENS, OR, 97051
86	4N1W 3BC 4000 04000	KEITH TRAVIS LEE	396 PARKWAY, ST HELENS, OR, 97051
87	4N1W 4AD 3409 03409	CAVEN CHRISTOPHER	334 S 10TH ST, ST HELENS, OR, 97051
88	4N1W 3BC 9300 09300	WASHBURN STEPHEN C AND REBECCA J	374 S 7TH ST, ST HELENS, OR, 97051
89	4N1W 3BC11700 11700	MUIR TYLER RON	364 S 8TH ST, ST HELENS, OR, 97051
90	4N1W 4AD 3405 03405	JACOBS JOSEPH ERRIN	345 S 9TH ST, ST HELENS, OR, 97051
91	4N1W 3BC 9302 09302	LUX JOHN W & BECKY A	385 S 6TH ST, ST HELENS, OR, 97051
92	4N1W 3BD 5300 05300	VANDERWALL RAY C & VALERIE ANN	65950 MEISSNER RD, DEER ISLAND, OR, 97054
93	4N1W 3BC 6901 06901	WRIGHT JESSE E	365 S 5TH ST, ST HELENS, OR, 97051
94	4N1W 4AD 2400 02400	CITY OF ST HELENS	PO BOX 278, ST HELENS, OR, 97051
95	4N1W 4AD 3408 03408	TRG INVESTMENTS LLC	16635 NW JOSCELYN ST, BEAVERTON, OR, 97006
96	4N1W 3BC 9200 09200	ZERBY RICHARD C	384 S 7TH ST, ST HELENS, OR, 97051-2519
97	4N1W 3BD 4100 04100	DEAHL ROBERT A	PO BOX 643, ST HELENS, OR, 97051
98	4N1W 4AD 2000 02000	SYKES MICHAEL & GAIL	51230 BANKSTON RD, SCAPPOOSE, OR, 97056
99	4N1W 3BC11600 11600	GRIFFITH MARK S & TERESA C	374 S 8TH ST, ST HELENS, OR, 97051
100	4N1W 3BD 7000 07000	CAVE LINDA L	371 TUALATIN ST, ST HELENS, OR, 97051
101	4N1W 4AD 3501 03501	DOOLEY RYAN B & KAREN	355 S 9TH ST, ST HELENS, OR, 97051
102	4N1W 3BC 8800 08800	HOLT SANDRA K	610 TUALATIN ST, ST HELENS, OR, 97051
103	4N1W 3BD 2600 02600	SMART GLORIA JEAN	409 S 2ND, ST HELENS, OR, 97051
104	4N1W 3BC 7000 07000	ROTH WAYNE D & ANGELA	570 TUALATIN ST, ST HELENS, OR, 97051
105	4N1W 3BD 990 00990	CITY OF ST HELENS	PO BOX 278, ST HELENS, OR, 97051
106	4N1W 3BC 8900 08900	WELLS BRANDON D	630 TUALATIN ST, ST HELENS, OR, 97051
107	4N1W 3BC11100 11100	ETCHISON SHERYL	385 S 7TH ST, ST HELENS, OR, 97051
108	4N1W 3BD 7002 07002	CAVE LINDA L	371 TUALATIN ST, ST HELENS, OR, 97051
109	4N1W 4AD 3500 03500	JAPS JULIE MARIE & BERNARD JAMES	344 S 3RD ST, ST HELENS, OR, 97051
110	4N1W 3BD 900 00900	GULLICKSON LYNN	PO BOX 462, SAINT HELENS, OR, 97051-0462
111	4N1W 3BD 5400 05400	HART OWEN J	415 S 3RD ST, ST HELENS, OR, 97051

Table 2-1
Landowners within 0.25 Mile of Site Boundary
City of St. Helens
Wastewater Treatment Lagoon

MAUL FOSTER ALONGI

Map ID	Tax Lot Number	Owner Name	OWNER ADDRESS
112	4N1W 3BC 9100 09100	RODRIGUES DAVID A & BAMBOO LLC	244 N 8TH ST ##B, ST HELENS, OR, 97051
113	4N1W 3BD 4001 04001	WARWICK JEANEAN L LIVING TRUST	P O BOX 482, ST HELENS, OR, 97051
114	4N1W 3CB 100 00100	REINAN JEFF C	1850 8TH ST, COLUMBIA CITY, OR, 97018
115	4N1W 3BD 2700 02700	WOOD ALAN & MINDY	411 S 2ND ST, ST HELENS, OR, 97051
116	4N1W 3BD 7001 07001	OFFLEY BERNARD D & MACHELL M	414 4TH ST S, ST HELENS, OR, 97051
117	4N1W 3CB 1500 01500	REINAN JEFF C	1850 8TH ST, COLUMBIA CITY, OR, 97018
118	4N1W 3CB 1600 01600	FULLER DANIEL & CRYSTAL	471 TUALATIN ST, ST HELENS, OR, 97051
119	4N1W 4AD 4609 04609	FRYE WILLIAM S & DENA L	365 S 10TH ST, ST HELENS, OR, 97051
120	4N1W 3BC11500 11500	MOSS MATTHEW C & MOSS KRISTINA J	384 S 8TH ST, ST HELENS, OR, 97051
121	4N1W 3BC11200 11200	CALCAGNO CLYDE J AND DEBORAH L	PO BOX 217, SCAPPOOSE, OR, 97056
122	4N1W 3BD 5500 05500	VAUGHAN MARY L	425 S 3RD ST, ST HELENS, OR, 97051
123	4N1W 4DA 8500 08500	LEE CHRISTOPHER D & KIMBERLY D	950 OLD PORTLAND RD, ST HELENS, OR, 97051
124	4N1W 3BD 850 00850	REYNOLDS JILL M	440 S 2ND ST, ST HELENS, OR, 97051
125	4N1W 3BC 9000 09000	LANDRUM NICHOLAS W & JESSICA M	394 S 7TH ST, ST HELENS, OR, 97051
126	4N1W 3BD 2800 02800	MAYO WAYNE P	32452 JP WEST RD, SCAPPOOSE, OR, 97056-2609
127	4N1W 3BD 4000 04000	DUNN RONALD K	PO BOX 354, ST HELENS, OR, 97051
128	4N1W 4AD 2002 02002	LOKKEN MARK E & ALYSSIA K	375 S 8TH ST, ST HELENS, OR, 97051
129	4N1W 4DA 8100 08100	MILLER-WALTERS IRIS M TRUST	2275 GABLE RD, ST HELENS, OR, 97051
130	4N1W 3BD 6900 06900	BROWN ALEXANDER J & VAN HOOSER CHERISE A	424 S 4TH ST, ST HELENS, OR, 97051
131	4N1W 3CB 1700 01700	MCLAIN JOSEPH AUSTIN	PO BOX 365, ST HELENS, OR, 97051
132	4N1W 3CB 1400 01400	REINAN JEFF C	1850 8TH ST, COLUMBIA CITY, OR, 97018
133	4N1W 3CB 1300 01300	CUTSHALL BRET T & NAOMI L	415 S 4TH, ST HELENS, OR, 97051
134	4N1W 3BC11300 11300	GWALCHMAI JAMES H & NANCY M	397 S 7TH ST, ST HELENS, OR, 97051
135	4N1W 3BD 5601 05601	RUBINO PAT A	435 S 3RD ST, ST HELENS, OR, 97051
136	4N1W 4DA 8600 08600	INGRAHAM PAUL E	375 S 10TH ST, ST HELENS, OR, 97051
137	4N1W 3CB 1800 01800	LIFETIME HOME REMODELING LLC	5407 NE 56TH ST, VANCOUVER, WA, 98661
138	4N1W 3BD 3900 03900	BARGER JASON E & BARGER RACHEL L	454 S 3RD ST, ST HELENS, OR, 97051
139	4N1W 4DA 7800 07800	OLSEN PATRICK W & SETO JACQUELIN A	820 TUALATIN ST, ST HELENS, OR, 97051

Table 2-1
Landowners within 0.25 Mile of Site Boundary
City of St. Helens
Wastewater Treatment Lagoon

MAUL FOSTER ALONGI

Map ID	Tax Lot Number	Owner Name	OWNER ADDRESS
140	4N1W 3BC11400 11400	SCHOLL DOROTHY REVOCABLE LIVING TRUST	770 TUALATIN ST, ST HELENS, OR, 97051
141	4N1W 4DA 9400 09400	KAO CHETTRA & CHAM VATSNA	364 S 11TH, ST HELENS, OR, 97051
142	4N1W 3BD 6801 06801	ZIEGLAR TYRONE M	434 S 4TH ST, ST HELENS, OR, 97051
143	4N1W 3CB 1900 01900	WILLARD ROBERT & KIMBERLY	414 S 6TH ST, ST HELENS, OR, 97051
144	4N1W 3CA 100 00100	JOHNSON JANICE A	245 S 18TH ST, ST HELENS, OR, 97051
145	4N1W 4DA 8000 08000	KOSHAREK BRUCE W & WEST RANDY D ROS	390 S 9TH ST, ST HELENS, OR, 97051
146	4N1W 3CB 6100 06100	OREGON MILITARY DEPARTMENT	PO BOX 14350, SALEM, OR, 97309
147	4N1W 3CA 1100 01100	BRUNER BARY L & CATT SANDRA L	204 S SILVER LAKE RD, CASTLE ROCK, WA, 98611
148	4N1W 4DA 8700 08700	GEFRE JACOB R & DIANA V	385 S 10TH ST, ST HELENS, OR, 97051
149	4N1W 3CA 1000 01000	SKINNER LIVING TRUST	9554 N KELLOGG ST, PORTLAND, OR, 97203
150	4N1W 3CB 200 00200	OLIVER JERRY A & YVONNE M	4330 NE MINERAL SPRINGS RD, MCMINNVILLE, OR, 97128
151	4N1W 4DA 9300 09300	RAFFIN LOUIS E & JACQUELINE L CO-	PO BOX 1087, ST HELENS, OR, 97051
152	4N1W 3BD 6800 06800	NAISH BRADLEY B & MERRIE L	PO BOX 514, COLUMBIA CITY, OR, 97018
153	4N1W 3CA 2400 02400	HILL BARBARA	442 S 4TH ST, ST HELENS, OR, 97051
154	4N1W 4DA 8200 08200	CLARK LONNIE R & CRYSTAL M	920 TUALATIN ST, ST HELENS, OR, 97051
155	4N1W 3CB 2000 02000	HAMPTON RYAN E & DANIELLE	424 S 6TH ST, ST HELENS, OR, 97051
156	4N1W 3CA 200 00200	GARTMAN GRANT WILLIAM & GRADY EUGENE	465 S 2ND ST, ST HELENS, OR, 97051
157	4N1W 4DA 7900 07900	CARRIE DAVID IAN & SHEILA F	34386 SLAVENS RD, WARREN, OR, 97053
158	4N1W 4DA 8400 08400	KUKKONEN DANIEL H	394 S 10TH, ST HELENS, OR, 97051
159	4N1W 3CA 1200 01200	SIMONATTI RANDAL A & CHRISTI M	455 S 3RD ST, ST HELENS, OR, 97051
160	4N1W 3CA 2300 02300	WISE KATHLEEN R	446 S 4TH ST, ST HELENS, OR, 97051
161	4N1W 3CA 900 00900	BLUMENTHAL HOWARD DAVID & SKINNER	462 S 3RD ST, ST HELENS, OR, 97051
162	4N1W 4DA 8800 08800	STOKES DOUGLAS A & HENDERSON ANGELA S	395 S 10TH, ST HELENS, OR, 97051
163	4N1W 3CB 3800 03800	KELLER SHIRLEY	405 S 7TH ST, ST HELENS, OR, 97051
164	4N1W 3CB 1201 01201	BUNN KEITH A & BARBARA J	PO BOX 372, ST HELENS, OR, 97051
165	4N1W 4DA 9200 09200	GUSTAFSON RICK W & NANCY M	384 S 11TH, ST HELENS, OR, 97051
166	4N1W 3CA 2200 02200	WARREN WILLIAM F & LAVERNA DEAN	PO BOX 469, COLUMBIA CITY, OR, 97018
167	4N1W 3CB 2001 02001	HICKS RICHARD L & MICHELE S	434 S 6TH ST, ST HELENS, OR, 97051

Table 2-1
Landowners within 0.25 Mile of Site Boundary
City of St. Helens
Wastewater Treatment Lagoon

MAUL FOSTER ALONGI

Map ID	Tax Lot Number	Owner Name	OWNER ADDRESS
168	4N1W 3CA 300 00300	DILLON SEAN M & TERESA M	475 S 2ND ST, ST HELENS, OR, 97051
169	4N1W 3CB 3900 03900	TIMMONS MILTON C & MARY E	PO BOX 913, ST HELENS, OR, 97051
170	4N1W 3CB 1200 01200	BUNN KEITH A & BARBARA J	PO BOX 372, ST HELENS, OR, 97051
171	4N1W 3CA 1300 01300	SHARP BONNIE	PO BOX 1761, ST HELENS, OR, 97051
172	4N1W 3CA 800 00800	CROMWELL KEITH R & MARLENE E	4274 JACKPINE ST NE, SALEM, OR, 97305
173	4N1W 4DA 8300 08300	KUKKONEN DANIEL	394 S 10TH, ST HELENS, OR, 97051
174	4N1W 4DA 9900 09900	BELLS DRAFTING & CONSTRUCTION INC	1300 JOHN ADAMS ST #STE 120, OREGON CITY, OR, 97045
175	4N1W 3CB 3700 03700	LARSON CHRISTOPHER D & CHRISTINA R	415 S 7TH ST, ST HELENS, OR, 97051
176	4N1W 3CB 1100 01100	FOURTH STREET VENTURES LLC	58351 COLUMBIA RIVER HWY, ST HELENS, OR, 97051
177	4N1W 4DA 9100 09100	BRENDEN DAVE H	394 S 11TH ST, ST HELENS, OR, 97051
178	4N1W 3CA 2100 02100	BROWN MARK RODERICK & SHERRY A	464 S 4TH ST, ST HELENS, OR, 97051
179	4N1W 3CB 5100 05100	HEXOM M'LISS ELLETTE REV LIVING TRUST	5212 SE JENNINGS AVE, MILWAUKIE, OR, 97267
180	4N1W 3CB 2100 02100	TARTAN LLC	PO BOX 469, COLUMBIA CITY, OR, 97018
181	4N1W 3CA 400 00400	HIBBS DONALD F JR & DEBRA L	485 S 2ND ST, ST HELENS, OR, 97051
182	4N1W 4DA10100 10100	HARRISON FLOYD W III	394 S 12TH ST, ST HELENS, OR, 97051
183	4N1W 3CB 1101 01101	CITY OF ST HELENS	PO BOX 278, ST HELENS, OR, 97051
184	4N1W 3CA 1400 01400	ROCKDASCHEL ANTHONY D & LISA N	475 S 3RD ST, ST HELENS, OR, 97051
185	4N1W 4DA 8900 08900	LUNGBERG CAROL A	51449 SE WESTLAKE DR, SCAPPOOSE, OR, 97056
186	4N1W 3CB 5200 05200	POWELL PAMELA F	PO BOX A, ST HELENS, OR, 97051
187	4N1W 3CB 1000 01000	READING NATHAN & MEREDITH	465 S 4TH ST, ST HELENS, OR, 97051
188	4N1W 4DA 9000 09000	MINSHULL BERNADETTE M	1070 TUALATIN ST, ST HELENS, OR, 97051
189	4N1W 3CB 3600 03600	ALDRIDGE CLAYTON S	425 S 7TH ST, ST HELENS, OR, 97051
190	4N1W 3CA 2000 02000	SMITH SHASTA L	34337 BERG RD, WARREN, OR, 97053
191	4N1W 3CA 700 00700	PEAHL AMY & JON	18820 NW SHADOW LN, PORTLAND, OR, 97231
192	4N1W 3CB 2200 02200	JORDAN THOMAS JR AND JODEE	32598 PITTSBURG RD, ST HELENS, OR, 97051
193	4N1W 3CA 500 00500	RICKARDS EARL & SUSAN E	5554 NW DEERFIELD WAY, PORTLAND, OR, 97231
193	4N1W 3CA 500 00500	RICKARDS EARL & SUSAN E	5554 NW DEERFIELD WAY, PORTLAND, OR, 97231
195	4N1W 3CB 4000 04000	GALLAGHER ANDREW TYLER	424 S 8TH ST, ST HELENS, OR, 97051

Table 2-1
Landowners within 0.25 Mile of Site Boundary
City of St. Helens
Wastewater Treatment Lagoon

MAUL FOSTER ALONGI

Map ID	Tax Lot Number	Owner Name	OWNER ADDRESS
196	4N1W 4DA 100 00100	SPIELER KAREN L	921 TUALATIN ST, ST HELENS, OR, 97051
197	4N1W 3CA 1500 01500	BLAKE DAVID G	31021 DOWD RD, ST HELENS, OR, 97051
198	4N1W 3CB 5302 05302	ANICKER LEONARD G & SALLY A	29728 PITTSBURG RD, ST HELENS, OR, 97051-9114
199	4N1W 4DA10000 10000	WARNER FAMILY TRUST	59169 TWIN OAKS DR, ST HELENS, OR, 97051
200	4N1W 3CB 3500 03500	HOCHSTETLER VERNON	435 S 7TH ST, ST HELENS, OR, 97051
201	4N1W 3CB 300 00300	FEDERAL NATIONAL MORTGAGE ASSOCIATION	14221 DALLAS PKWY #SUITE 1000, DALLAS, TX, 75254
202	4N1W 4DA 1600 01600	ASCHOFF DORINDA M	201 COWLITZ ST, ST HELENS, OR, 97051
203	4N1W 3CA 1900 01900	FURLONG MICHAEL A	484 S 4TH ST, ST HELENS, OR, 97051
204	4N1W 3CB 5001 05001	HAYTON EARL	2222 SIERRA VISTA CIR, BILLINGS, MT, 59105-8508
205	4N1W 3CB 2300 02300	GUSDAL JOHN & PHARIS A	464 S 6TH ST, ST HELENS, OR, 97051
206	4N1W 3CB 900 00900	RILEY JEFFERY D	58759 SAULSER RD, ST HELENS, OR, 97051-9338
207	4N1W 3CA 1600 01600	WATTERS L R & WATTERS W M TESTAMENT TRT	2035 SE MAIN ST, PORTLAND, OR, 97231
208	4N1W 4DA 200 00200	CHURCHILL WILLIAM R & JENNIFER N	415 S 9TH, ST HELENS, OR, 97051
209	4N1W 3CB 5301 05301	ROMERO TRINA S	424 S 9TH, ST HELENS, OR, 97051
210	4N1W 3CA 600 00600	OAKLEAF MARK JOSEPH	494 S 3RD ST, ST HELENS, OR, 97051
211	4N1W 3CB 3400 03400	GRAYSON JAY	445 S 7TH ST, ST HELENS, OR, 97051
212	4N1W 3CB 400 00400	FENTER DOUGLAS E & FENTER CHRISTINE A	485 S 4TH ST, ST HELENS, OR, 97051
213	4N1W 4DA 3100 03100	BELDEN DAVID A & SHERRY L	31400 HARRIS, DEER ISLAND, OR, 97054
214	4N1W 3CA 1800 01800	BURG JOHN J & GISELA F	492 SOUTH 4TH, ST HELENS, OR, 97051
215	4N1W 3CB 5000 05000	LUTTRELL TERRANCE DALE AND SUSAN MARIE	435 S 8TH ST, ST HELENS, OR, 97051
216	4N1W 3CB 2400 02400	KROLL PATREA R & ROBERT A	474 S 6TH ST, ST HELENS, OR, 97051
217	4N1W 3CB 4100 04100	COCA PAUL W & RHONDA	444 S 8TH ST, ST HELENS, OR, 97051
218	4N1W 4DA 300 00300	DENISON DANIELLE	425 S 9TH ST, ST HELENS, OR, 97051
219	4N1W 3CB 5300 05300	KNUDTSON TODD R & OAKES MELISSA A	434 S 9TH ST, ST HELENS, OR, 97051
220	4N1W 3CB 3300 03300	KELLY CHRISTOPHER M & VICTORIA E	35761 RIDGEWAY LOOP, ST HELENS, OR, 97051
221	4N1W 3CB 800 00800	CARAWAY JARRAD & MISTY NOEL	497 1/2 S 4TH ST, ST HELENS, OR, 97051
222	4N1W 4DA 1700 01700	BELDEN DAVID A & SHERRY L	31400 HARRIS RD, DEER ISLAND, OR, 97054
223	4N1W 4DA 1500 01500	TRACEY ROBERT B & D DARLENE TRUST	724 CEDAROAK ST, ST HELENS, OR, 97051

Table 2-1
Landowners within 0.25 Mile of Site Boundary
City of St. Helens
Wastewater Treatment Lagoon

MAUL FOSTER ALONGI

Map ID	Tax Lot Number	Owner Name	OWNER ADDRESS
224	4N1W 3CA 1700 01700	VANDERWALL RAY C & VALERIE	65950 MEISSNER RD, DEER ISLAND, OR, 97054-9506
225	4N1W 3CB 4900 04900	MOLIDOR BE T	307 SE 39TH AVE, HILLSBORO, OR, 97123
226	4N1W 3CB 2500 02500	ALDEN RAYMOND B & ALDEN LINDA L TRSTS	PO BOX 12, ST HELENS, OR, 97051
227	4N1W 4DA 3200 03200	RENNING TRAVIS & SASHA	1103 TUALATIN ST, ST HELENS, OR, 97051
228	4N1W 4DA 400 00400	KAGELER GORDON S	435 S 9TH ST, ST HELENS, OR, 97051
229	4N1W 4DA 3001 03001	LIEBE MARK	444 S 11TH ST, ST HELENS, OR, 97051
230	4N1W 3CB 5400 05400	MYERS JASON	444 S 9TH ST, ST HELENS, OR, 97051
231	4N1W 4DA 4600 04600	DAVIS SHANNON L	406 S 12TH ST, ST HELENS, OR, 97051
232	4N1W 3CB 3200 03200	TRACEY R B & D D REVOCABLE LIVING TRUST	724 CEDAROAK ST, ST HELENS, OR, 97051
233	4N1W 3CB 500 00500	EDSON CLARK C & EDSON MOLLY M	497 S 4TH ST, ST HELENS, OR, 97051
234	4N1W 4DA 1501 01501	TRACEY ROBERT B & TRACEY D DARLENE	724 CEDAROAK ST, ST HELENS, OR, 97051
235	4N1W 3CB 4800 04800	SMITH SCOTT F & SHELLI L	455 S 8TH, ST HELENS, OR, 97051
236	4N1W 4DA 3300 03300	COPPOCK ALAN ROBERT	405 S 11TH ST, ST HELENS, OR, 97051
237	4N1W 4DA 1799 01799	CITY OF ST HELENS	PO BOX 278, ST HELENS, OR, 97051
238	4N1W 3CB 4202 04202	WYLAND CONNIE J	PO BOX 732, ST HELENS, OR, 97051
239	4N1W 4DA 500 00500	JOHNSON DONALD E	2605 COLUMBIA BLVD, ST HELENS, OR, 97051
240	4N1W 3CB 5401 05401	TOBIASON MARK & CHERYL	35050 PITTSBURG RD, ST HELENS, OR, 97051
241	4N1W 4DA 4500 04500	JPMORGAN CHASE BANK NATIONAL ASSOCIATION	3415 VISION DR, COLUMBUS, OH, 43219
242	4N1W 4DA 2900 02900	PASCHALL PROPERTIES LLC	34850 BURT CT, ST HELENS, OR, 97051
243	4N1W 3CB 4200 04200	STROUP WILLIAM J & JOSEPH R & SHAUNA A	PO BOX 1338, ST HELENS, OR, 97051
244	4N1W 4DA 1800 01800	NELSON CLIFFORD J & KIM L	445 S 10TH ST, SAINT HELENS, OR, 97051
245	4N1W 3CA 2500 02500	CITY OF ST HELENS	PO BOX 278, ST HELENS, OR, 97051
246	4N1W 4DA 1400 01400	TRACEY ROBERT B & D DARLENE REV LV TRTI	724 CEDAROAK ST, ST HELENS, OR, 97051
247	4N1W 3CB 4701 04701	GEORGE JOHN O	36500 NW BURGDORFER RD, NORTH PLAINS, OR, 97133
248	4N1W 4DA 3400 03400	THOMAS SHERYL L	425 S 11TH ST, ST HELENS, OR, 97051
249	4N1W 4DA 600 00600	MIRABILE SARINA	455 S 9TH ST, ST HELENS, OR, 97051
250	4N1W 4DA 4800 04800	MASON LEONARD & JANET REVOC LIV TRT	54376 DAHLGREN RD, SCAPPOOSE, OR, 97056
251	4N1W 3CB 5500 05500	HAWKINS MICHAEL	464 S 9TH ST, ST HELENS, OR, 97051

Table 2-1
Landowners within 0.25 Mile of Site Boundary
City of St. Helens
Wastewater Treatment Lagoon

MAUL FOSTER ALONGI

Map ID	Tax Lot Number	Owner Name	OWNER ADDRESS
252	4N1W 3CB 3100 03100	JACOBS LIVING TRUST	475 S 7TH ST, ST HELENS, OR, 97051
253	4N1W 4DA 1900 01900	NELSON CLIFFORD J & KIM L	445 S 10TH ST, SAINT HELENS, OR, 97051
254	4N1W 4DA 1401 01401	HOOPER MARC W	PO BOX 1074, RAINIER, OR, 97048
255	4N1W 4DA 3500 03500	CARTER JAMES D & CYNTHIA A	435 S 11TH ST, ST HELENS, OR, 97051
256	4N1W 3CA 2600 02600	CITY OF ST HELENS	PO BOX 278, ST HELENS, OR, 97051
257	4N1W 3CB 4301 04301	BARNES JOSHUA J	474 S 8TH ST, ST HELENS, OR, 97051
258	4N1W 4DA 700 00700	MILLER GERAD E	465 S 9TH ST, ST HELENS, OR, 97051
259	4N1W 4DA 4300 04300	JACOBS RAYMOND P	434 S 12TH, ST HELENS, OR, 97051
260	4N1W 4DA 2899 02899	CITY OF ST HELENS	PO BOX 278, ST HELENS, OR, 97051
261	4N1W 3CB 3000 03000	MCHUGH MICHAEL H	495 S 7TH ST, ST HELENS, OR, 97051
262	4N1W 4DA 4900 04900	MUTT AARON M & TRINA L	PO BOX 1730, ST HELENS, OR, 97051
263	4N1W 4DA 1901 01901	ISETT MARCUS & CARLA J	455 S 10TH ST, ST HELENS, OR, 97051
264	4N1W 3CB 5600 05600	CHISUM JAMES L & SOMLUX	484 S 9TH ST, ST HELENS, OR, 97051
265	4N1W 3CB 4700 04700	SKEANS CARSON RANDALL & RONNI LYNN	485 S 8TH ST, ST HELENS, OR, 97051
266	4N1W 4DA 4200 04200	BARNES SUZANN IRENE REVOC LIV TRUST	3214 SE 7TH ST, GRESHAM, OR, 97080
267	4N1W 3CB 4300 04300	BURGER LEGACY TRUST	27010 KINGSLEY RD, SCAPPOOSE, OR, 97056
268	4N1W 4DA 2800 02800	CREEL JAMES L	464 S 11TH ST, ST HELENS, OR, 97051
269	4N1W 4DA 800 00800	BEASTON DELBERT R & LILLIAN L	475 S 9TH, ST HELENS, OR, 97051
270	4N1W 300 200 00200	CITY OF ST HELENS	PO BOX 278, ST HELENS, OR, 97051
270	4N1W 300 200 00200	CITY OF ST HELENS	PO BOX 278, ST HELENS, OR, 97051
271	4N1W 4DA 4201 04201	REINHOLDT DEREK G & KARLA D	444 S 12TH ST, ST HELENS, OR, 97051
272	4N1W 3CB 2900 02900	COLUMBIA COUNTY HABITAT FOR HUMANITY	PO BOX 921, ST HELENS, OR, 97051
273	4N1W 4DA 2000 02000	HALL JEREME CHARLES & HALL MARILA KARIN	465 S 10TH, SAINT HELENS, OR, 97051
274	4N1W 4DA 1200 01200	CITY OF ST HELENS	PO BOX 278, ST HELENS, OR, 97051
275	4N1W 4DA 5901 05901	CARLSON MICHAEL A	334 S 13TH ST, ST HELENS, OR, 97051
276	4N1W 3CB 4703 04703	PHILLIPS RYAN H	495 S 8TH ST, ST HELENS, OR, 97051
277	4N1W 3CB 4400 04400	COLUMBIA COUNTY HABITAT FOR HUMANITY	PO BOX 921, ST HELENS, OR, 97051
278	4N1W 4DA 5000 05000	FIELDING LORIN & BRENDA	PO BOX 307, SCAPPOOSE, OR, 97056
279	4N1W 3CB 5700 05700	SISSON JIMMY D	494 S 9TH ST, ST HELENS, OR, 97051
280	4N1W 4DA 4100 04100	VANZANT ROBERT E	454 S 12TH ST, ST HELENS, OR, 97051
281	4N1W 4DA 2001 02001	PREHEIM JUDITH J	PO BOX 761, ST HELENS, OR, 97051
282	4N1W 4DA 1100 01100	NASSHAHN KURT A & LORI A	PO BOX 1308, SAINT HELENS, OR, 97051-8308
283	4N1W 4DA 5800 05800	RICHARDSON BERNARD J JR	344 S 13TH ST, ST HELENS, OR, 97051
284	4N1W 3CB 4702 04702	LEE CAROL G	497 S 8TH ST, ST HELENS, OR, 97051-2524
285	4N1W 4DA 2700 02700	ALLEN JOSEPH WAYNE & CINDY L	474 S 11TH, ST HELENS, OR, 97051

Table 2-1
Landowners within 0.25 Mile of Site Boundary
City of St. Helens
Wastewater Treatment Lagoon

MAUL FOSTER ALONGI

Map ID	Tax Lot Number	Owner Name	OWNER ADDRESS
286	4N1W 4DA 900 00900	ALBERTSON TERI LYNN & ALBERTSON MICHAEL	148 TERRY FOWLER RD, DERIDDER, LA, 70634
287	4N1W 4DA 5001 05001	FIELDING LORIN & BRENDA	PO BOX 307, SCAPPOOSE, OR, 97056
288	4N1W 4DA 4001 04001	BROWN RODNEY C	464 S 12TH ST, ST HELENS, OR, 97051
289	4N1W 4DA 2100 02100	MCCARTNEY TONY R	485 S 10TH, ST HELENS, OR, 97051
290	4N1W 4DA 1000 01000	MELLOTT BRIAN K	970 PLYMOUTH ST, ST HELENS, OR, 97051
291	4N1W 4DA 5801 05801	BECKER EDMUND L III & SUSAN A	60402 ROBINETTE RD, ST HELENS, OR, 97051
292	4N1W 4DA 2600 02600	SEDERBURG JESSE E	484 S 11TH ST, ST HELENS, OR, 97051
293	4N1W 4DA 5700 05700	NACE CHARLOTTE	365 12TH ST S, ST HELENS, OR, 97051
294	4N1W 4DA 4000 04000	DEHERRERA JOE M & MARGARITA	474 S 12TH, ST HELENS, OR, 97051
295	4N1W 4DA 2200 02200	BECK DANIEL A	495 S 10TH ST, ST HELENS, OR, 97051
296	4N1W 4DA 5701 05701	WOLLITZ MARGARET ANNE	364 S 13TH ST, ST HELENS, OR, 97051
297	4N1W 4DA 2500 02500	GILBERT DANIEL JOHN	494 S 11TH ST, ST HELENS, OR, 97051
298	4N1W 4DA 5100 05100	BRIXEY JOSEPH L & BRAYA L	375 S 12TH ST, ST HELENS, OR, 97051
299	4N1W 3CB 4600 04600	ERVIN KARL F & MYLISA A	836 ADAM LOOP, HOOD RIVER, OR, 97031
300	4N1W 4DA 2300 02300	SEXTON BREIGHLEY KATHLEEN	497 S 10TH ST, ST HELENS, OR, 97051
301	4N1W 4DA 5600 05600	BRENT SHARP RENTALS LLC	PO BOX 977, ST HELENS, OR, 97051
302	4N1W 3CB 5800 05800	SEELIGER MICHAEL H & LINDA M & RYAN T	23570 NW ST HELENS RD, PORTLAND, OR, 97231
303	4N1W 4DA 2400 02400	COY JAMIN WESTLEY & KAYLA D	496 S 11TH ST #A, ST HELENS, OR, 97051
304	4N1W 4DA 2301 02301	EATON LUCAS & OLIVIA D	499 S 10TH ST, ST HELENS, OR, 97051
305	4N1W 4DA 5200 05200	MILLER STEVEN & HILDULA LESLIE	7915 NW SKYLINE BLVD, PORTLAND, OR, 97231
306	4N1W 3CB 4602 04602	515 S 8TH STREET LLC	9465 SW MARTHA ST, TIGARD, OR, 97224
307	4N1W 3CB 6200 06200	DAVEE KIRK J	PO BOX 513, ST HELENS, OR, 97051
308	4N1W 3CB 5900 05900	LEDOUX GREGORY J & JESSICA	4135 NE 71ST AVE, PORTLAND, OR, 97218-3648
309	4N1W 4DA 3700 03700	ASKEW EMILY	497 S 11TH ST, ST HELENS, OR, 97051
310	4N1W 4DA12200 12200	DEMARAY LINDA M	951 PLYMOUTH ST, ST HELENS, OR, 97051
311	4N1W 4DA 3800 03800	BELDEN DAVID A & SHERRY L	31400 HARRIS RD, DEER ISLAND, OR, 97054
312	4N1W 4DA 6700 06700	WARREN WILLIAM F & LAVERNA	14 JULIE DR, ORMAND BEACH, FL, 32176
313	4N1W 3CB 6300 06300	OLIVER CLEVELAND R JR	515 S 9TH ST, ST HELENS, OR, 97051
314	4N1W 4DA 5500 05500	BRENT SHARP RENTALS LLC	PO BOX 977, ST HELENS, OR, 97051
315	4N1W 3CB 5901 05901	SEMLING LIVING TRUST & HAFEMAN GB & MP	P O BOX 1087, SCAPPOOSE, OR, 97056
316	4N1W 4DA12300 12300	BROGLI CARL & COX STEPHANIE K	1855 5TH ST, COLUMBIA CITY, OR, 97018
317	4N1W 4DA12100 12100	ACCARDO MARION K	524 S 10TH ST, ST HELENS, OR, 97051
318	4N1W 3CB 4601 04601	WALLACE ERIN	535 S 8TH ST, ST HELENS, OR, 97051
319	4N1W 4DA13200 13200	WILSON KAILEE	1071 PLYMOUTH ST, ST HELENS, OR, 97051
320	4N1W 4DA 5400 05400	CITY OF ST HELENS	PO BOX 278, ST HELENS, OR, 97051

Table 2-1
Landowners within 0.25 Mile of Site Boundary
City of St. Helens
Wastewater Treatment Lagoon

MAUL FOSTER ALONGI

Map ID	Tax Lot Number	Owner Name	OWNER ADDRESS
321	4N1W 3CB 6400 06400	THORPE WILLIAM C & KRISTINE M	58309 RIDGON RD, WARREN, OR, 97053
322	4N1W 3CB 5902 05902	LIZAMA JOSE FELIX	534 S 9TH ST, ST HELENS, OR, 97051
323	4N1W 4DA12400 12400	LAGRAND TOWNHOMES LLC	2035 SE EVERGREEN ST, MILWAUKIE, OR, 97222
324	4N1W 4DA13600 13600	MATZEN RONALD I & CYNTHIA L FAM TRUST	PO BOX 290, ST HELENS, OR, 97051
325	4N1W 4DA13100 13100	JILLSON KENNETH DEAN	35091 HANKEY RD, ST HELENS, OR, 97051
326	4N1W 4DA12000 12000	SHEEHAN CHEYENNE F	534 S 10TH ST, ST HELENS, OR, 97051
327	4N1W 3CB 6500 06500	MINNICK TONI L	535 S 9TH ST, ST HELENS, OR, 97051
328	4N1W 3CB 6001 06001	SCHNEIDER CODY D & CARISA K	544 S 9TH ST, ST HELENS, OR, 97051
329	4N1W 4DA12500 12500	HUTCHESON HAROLD H	525 S 10TH ST, ST HELENS, OR, 97051
330	4N1W 4DA13300 13300	PAULSON AARON	P O BOX 1418, ST HELENS, OR, 97051
331	4N1W 4DA13000 13000	GORTLER KURT T & JENNY R	524 S 11TH ST, ST HELENS, OR, 97051
332	4N1W 3CB 6600 06600	LLOYD GEORGE M IV	545 S 9TH ST, ST HELENS, OR, 97051
333	4N1W 4DA13700 13700	LEWALLEN ROSEANN LOUISE	405 S 12TH, ST HELENS, OR, 97051
334	4N1W 4DA11900 11900	MCCOY STEVE & MARIA VIVAS	544 S 10TH ST, ST HELENS, OR, 97051
335	4N1W 4DA12600 12600	KAPELOS ROBERT J & VICKIE D	535 S 10TH ST, ST HELENS, OR, 97051
336	4N1W 4DA13900 13900	THOMPSON FAMILY TIMBER LLC	PO BOX 538, CLATSKANIE, OR, 97016
337	4N1W 4DA13400 13400	GULLECKSON LANA M	525 S 11TH ST, ST HELENS, OR, 97051
338	4N1W 4DA12900 12900	BRUNER JUSTIN N	534 S 11TH ST, ST HELENS, OR, 97051
339	4N1W 3CB 6700 06700	WALDRON MICHAEL	555 S 9TH, ST HELENS, OR, 97051
340	4N1W 4DA13800 13800	MORRICE CODY G & DANIELLE R	415 S 12TH ST, ST HELENS, OR, 97051
341	4N1W 4DA13500 13500	KEIM TRENTON M	524 S 12TH ST #UNIT A & B, ST.HELENS, OR, 97051
342	4N1W 4DA11800 11800	MCMULLEN JUSTIN	554 S 10TH ST, ST HELENS, OR, 97051
343	4N1W 4DD 6600 06600	ROBINSON DIANA L	1321 PLYMOUTH ST, ST HELENS, OR, 97051
344	4N1W 4DA12700 12700	BELL PEGGY J	545 S 10TH ST, ST HELENS, OR, 97051
345	4N1W 4DD 3600 03600	WATTENBARGER JAMES G	P O BOX 733, ST HELENS, OR, 97051
346	4N1W 4DA12800 12800	DEAVILLE PEGGY J	545 S 10TH ST, ST HELENS, OR, 97051
347	4N1W 300 600 00600	OREGON DEPARTMENT OF FISH & WILDLIFE	4034 FAIRVIEW INDUSTRIAL DR SE, SALEM, OR, 97302
348	4N1W 4DD 201 00201	WEGNER LLOYD	195 FRANTZ ST, ST HELENS, OR, 97051
349	4N1W 4DD 6502 06502	THOMPSON FAMILY TIMBER LLC	PO BOX 538, CLATSKANIE, OR, 97016
350	4N1W 4DD 4304 04304	THE DUNNINGTON GROUP LLC	7133 SE LANGWOOD ST, HILLSBORO, OR, 97123
351	4N1W 4DD 6700 06700	MEYER JEFFERY & LAURA	415 S 13TH ST, ST HELENS, OR, 97051
352	4N1W 4DD 1600 01600	SHERECK TAMMY & CINKOSKY BRENT ROS	555 S 10TH, ST HELENS, OR, 97051
353	4N1W 4DD 700 00700	MULLINS JEANANN M	564 S 10TH ST, ST HELENS, OR, 97051
354	4N1W 4DD 6400 06400	FOULK RICHARD & KATHLEEN	424 S 13TH ST, ST HELENS, OR, 97051
355	4N1W 4DD 8800 08800	BELLISLE JOHN & ROSANNE ET AL	115 MADRONA CT, ST HELENS, OR, 97051

Table 2-1
Landowners within 0.25 Mile of Site Boundary
City of St. Helens
Wastewater Treatment Lagoon

MAUL FOSTER ALONGI

Map ID	Tax Lot Number	Owner Name	OWNER ADDRESS
356	4N1W 300 500 00500	CITY OF ST HELENS OREGON	PO BOX 278, ST HELENS, OR, 97051
357	4N1W 4DD 3000 03000	JAMES GLORIA M	554 S 11TH ST, ST HELENS, OR, 97051
358	4N1W 4DD 4500 04500	NAGLE SHIRLEY A	435 S 12TH ST, ST HELENS, OR, 97051
359	4N1W 4DD 4303 04303	BELL RAYMOND	6400 SE LAKE RD #200, PORTLAND, OR, 97231
360	4N1W 4DD 6800 06800	LAPPING ADAM R	425 S 13TH ST, ST HELENS, OR, 97051
361	4N1W 4DD 1700 01700	MILLER SARAH	565 S 10TH ST, ST HELENS, OR, 97051
362	4N1W 4DD 600 00600	MASTERSON BONNIE L	67094 NICOLAI RD, RAINIER, OR, 97048
363	4N1W 4DD 6300 06300	SCHOLL RAYMOND E & MELVENA M	444 S 13TH ST, ST HELENS, OR, 97051
364	4N1W 4DD 2900 02900	RONALD AND MYRA TRUST	564 S 11TH, ST HELENS, OR, 97051
365	4N1W 4DD 4600 04600	HOLZ LINDA M	445 S 12TH ST, ST HELENS, OR, 97051
366	4N1W 4DD 8701 08701	BM HOMES LLC	800 NE TENNEY RD #110, VANCOUVER, WA, 98685
367	4N1W 4DD 4305 04305	CITY OF ST HELENS	PO BOX 278, ST HELENS, OR, 97051
368	4N1W 4DD 6900 06900	KUMPULA PATRICK W	435 S 13TH ST, ST HELENS, OR, 97051
369	4N1W 4DD 1800 01800	HALL JEFFERY	575 S 10TH ST, ST HELENS, OR, 97051
370	4N1W 4DD 500 00500	GSMPS MORTGAGE LOAN TRUST 2006-RP1	1 FOUNTAIN PL, BUFFALO, NY, 14203
371	4N1W 4DD 6200 06200	SCHOLL RAYMOND E & MELVENA M	444 S 13TH ST, ST HELENS, OR, 97051
372	4N1W 4DD 3701 03701	CASAS ROBERTO & AMALIA	565 S 11TH ST, ST HELENS, OR, 97051-2410
373	4N1W 4DD 8600 08600	STANSBURY PAUL L	434 S 14TH ST, ST HELENS, OR, 97051
374	4N1W 4DD 200 00200	WALLACE BRIAN W	595 S 9TH ST, ST HELENS, OR, 97051
375	4N1W 4DD 4700 04700	HOWARD CONNIE LYNN	PO BOX 63, RAINIER, OR, 97048
376	4N1W 4DD 4202 04202	HAMPSTEAD INVESTMENTS LLC	31386 RAYMOND CREEK RD, SCAPPOOSE, OR, 97056
377	4N1W 4DD 2700 02700	COX ROBERT L & PATRICIA A	584 SOUTH 11TH ST, ST HELENS, OR, 97051
378	4N1W 4DD 7000 07000	STORK SURVIVORS TRT & STORK FAMILY TRT	2567 2ND AVE ##408, SAN DIEGO, CA, 92103
379	4N1W 4DD 6100 06100	MARPE ROCHELLE D	PO BOX 752, ST HELENS, OR, 97051
380	4N1W 4DD 3700 03700	AUSTIN SCOTT J	575 S 11TH ST, ST HELENS, OR, 97051
381	4N1W 4DD 8500 08500	WILLIAMS ROBERT HANK & SHERYL ANN	444 S 14TH ST, ST HELENS, OR, 97051
382	4N1W 4DD 1900 01900	STANSBURY SUSAN M	595 S 10TH ST, ST HELENS, OR, 97051
383	4N1W 4DD 202 00202	HEAD BRENDA LEE	597 S 9TH ST, ST HELENS, OR, 97051-2513
384	4N1W 4DD 4800 04800	HARMAN JOHN D LIVING TRUST	882 NORTH POINTE DR NW, ALBANY, OR, 97321
385	4N1W 4DD 4204 04204	NOLLETTE CYNTHIA L	PO BOX 851, ST HELENS, OR, 97051-0851
386	4N1W 4DD 7100 07100	KING LYLE R A & JUDY A	34965 ACHILLES RD, WARREN, OR, 97053
387	4N1W 4DD 400 00400	MORGAN JEFF M & DELONG ELICIA ROS	970 UMATILLA ST, ST HELENS, OR, 97051
388	4N1W 4DD 6000 06000	BURKE CHRISTOPHER R	464 S 13TH ST, ST HELENS, OR, 97051
389	4N1W 4DD 2701 02701	CONNALL ERNEST D & CAROLYN C	1070 UMATILLA ST, ST HELENS, OR, 97051
390	4N1W 4DD 3800 03800	CITY OF ST HELENS	PO BOX 278, ST HELENS, OR, 97051

Table 2-1
Landowners within 0.25 Mile of Site Boundary
City of St. Helens
Wastewater Treatment Lagoon

Map ID	Tax Lot Number	Owner Name	OWNER ADDRESS
391	4N1W 4DD 8400 08400	JESTER ROBERT A & DANA J	454 S 14TH ST, ST HELENS, OR, 97051
392	4N1W 4DD 1901 01901	STANSBURY SUSAN M	595 S 10TH ST, ST HELENS, OR, 97051
393	4N1W 4DD 5900 05900	MERWIN KENNETH J & HOLLY D	475 S 12TH, ST HELENS, OR, 97051
394	4N1W 4DD 4203 04203	SINES VERNON LEE & JUNE E	584 S 12TH ST, ST HELENS, OR, 97051
395	4N1W 4DD 2500 02500	CONNALL ERNEST & CAROLYN	1070 UMATILLA ST, ST HELENS, OR, 97051
396	4N1W 4DD 7200 07200	RIGGS EDWARD	465 S 13TH ST, ST HELENS, OR, 97051
397	4N1W 4DD 2000 02000	SMITH ASHLEE & WALLACE RAINA & AARON	597 S 10TH ST, ST HELENS, OR, 97051
398	4N1W 4DD 5901 05901	SEASTONE CURLEY C & ROBERTA A	474 S 13TH, ST HELENS, OR, 97051
399	4N1W 4DD 8300 08300	SNYDER MARK E	464 S 14TH ST, ST HELENS, OR, 97051
400	4N1W 4DD 4900 04900	KUBECK TRINA	485 S 12TH, ST HELENS, OR, 97051
401	4N1W 4DD 4200 04200	GRUNDY JOSEPH LELAND II & GINGER MICHELL	594 S 12TH ST, ST HELENS, OR, 97051
402	4N1W 4DD 7300 07300	COOPER KYLE L & TAMMY A	P.O. BOX 453, ST HELENS, OR, 97051
403	4N1W 4DD 300 00300	WINKLER JEROME A	605 S 9TH ST, ST HELENS, OR, 97051
404	4N1W 4DD 304 00304	BRIONES PROPERTIES LLC	20310 SE TICKLE CREEK RD, BORING, OR, 97009
405	4N1W 4DD 5800 05800	WOMELSDORFF JAMES	490 S 13TH, ST HELENS, OR, 97051
406	4N1W 4DD 5000 05000	HILLS TYLER R	PO BOX 1327, ST HELENS, OR, 97051
407	4N1W 4DD 4205 04205	STREATER DANIKA M & HERB KRISTINA M	596 S 12TH ST, ST HELENS, OR, 97051
408	4N1W 4DD 7400 07400	DOMINGUEZ KITTRIDGE A & BRITTANY	485 S 13TH ST, ST HELENS, OR, 97051
409	4N1W 4DD 303 00303	SCHULTE GARRETT	615 S 9TH ST, ST HELENS, OR, 97051
410	4N1W 4DD 2100 02100	JOHNSON SCOTT T & STEPHENS KELLY M	1045 UMATILLA ST, ST HELENS, OR, 97051
411	4N1W 4DD 8200 08200	THOMPSON MILDRED TRUST	PO BOX 1241, ST HELENS, OR, 97051
412	4N1W 4DD 305 00305	COLEY ROBERT S & NICOLE F	614 S 10TH ST, ST HELENS, OR, 97051
413	4N1W 4DD 4206 04206	MAFFIOLI MATTHEW N	598 S 12TH ST, ST HELENS, OR, 97051
414	4N1W 4DD 2200 02200	DAVIS JOHN DOUGLAS & CECELIA I	1065 UMATILLA ST, ST HELENS, OR, 97051
415	4N1W 4DD 5100 05100	MULLER PETE N & DEBORA A	1270 UMATILLA ST, ST HELENS, OR, 97051
416	4N1W 4DD 2400 02400	FISCHER VERNON M & REIKO	PO BOX 1076, ST HELENS, OR, 97051
417	4N1W 4DD 7500 07500	HUDSON GARY JESSE & BARBARA MARIE	1700 8TH ST, COLUMBIA CITY, OR, 97018
418	4N1W 4DD 302 00302	GAGE MISTY MARIE	625 S 9TH ST, ST HELENS, OR, 97051
419	4N1W 4DD 5700 05700	SCOTT ERIC E & PATRICIA A	496 S 13TH ST, ST HELENS, OR, 97051-2312
420	4N1W 4DD 8101 08101	CARVER CHRISTOPHER A & HEATHER L	494 S 14TH, ST HELENS, OR, 97051
421	4N1W 4DD 301 00301	BERRY CHARLES R & ELIZABETH A	624 S 10TH ST, ST HELENS, OR, 97051
422	4N1W 4DD 3901 03901	DECIOUS JULIE R AND STEVEN R	PO BOX 139, ST HELENS, OR, 97051
423	4N1W 4DD 2401 02401	BIELINDA STEVEN J	604 S 11TH, ST HELENS, OR, 97051
424	4N1W 4DD 4100 04100	DECIOUS JULIE R AND STEVEN R	PO BOX 139, ST HELENS, OR, 97051
425	4N1W 4DD 2201 02201	TAUSCHER JANICE M & GERALD L	635 S 10TH ST, ST HELENS, OR, 97051

Table 2-1
Landowners within 0.25 Mile of Site Boundary
City of St. Helens
Wastewater Treatment Lagoon

MAUL FOSTER ALONGI

Map ID	Tax Lot Number	Owner Name	OWNER ADDRESS
426	4N1W 4DD 8100 08100	MCCARTER CHRISTOPHER R & ASHLEY N	498 S 14TH ST, ST HELENS, OR, 97051
427	4N1W 300 400 00400	COLUMBIA RIVER FIRE AND RESCUE	270 COLUMBIA BLVD, ST HELENS, OR, 97051
428	4N1W 4DD 3900 03900	FOGARTY ASONIA M	PO BOX 243, ST HELENS, OR, 97051
429	4N1W 4DD 2300 02300	FORD GEORGE C ET AL	614 S 11TH ST, ST HELENS, OR, 97051
430	4N1W 4DD 5200 05200	LIGGETT JAMES M	1215 UMATILLA ST, ST HELENS, OR, 97051
431	4N1W 4DD 4000 04000	BUNN KEITH A & BARBARA J	PO BOX 372, ST HELENS, OR, 97051
432	4N1W 4DD 5600 05600	CALLISTER TED M	504 S 13TH ST, ST HELENS, OR, 97051
433	4N1W 4DD 5300 05300	FOGLE GREGORY W & SUSAN L	515 S 12TH ST, ST HELENS, OR, 97051
434	4N1W 4DD 4001 04001	FOGARTY ASONIA M	PO BOX 243, ST HELENS, OR, 97051
435	4N1W 4DD 7600 07600	ALDAZ JOSE LUIS & ADRIANA	505 S 13TH ST, ST HELENS, OR, 97051
436	4N1W 4DD 5500 05500	BENHAM HEIDE D	514 S 13TH ST, ST HELENS, OR, 97051
437	4N1W 4DD11300 11300	CITY OF ST HELENS OREGON	PO BOX 278, ST HELENS, OR, 97051
438	4N1W 4DD 8000 08000	BRINKERHOFF KEITH J & LORRAINE S	504 S 14TH ST, ST HELENS, OR, 97051
439	4N1W 4DD 5301 05301	SWAIM GLORIA J	525 S 12TH ST, ST HELENS, OR, 97051
440	4N1W 4DD 7700 07700	EIB KENNETH W & KAREN L	310 N VERNONIA RD, ST HELENS, OR, 97051
441	4N1W 4DD 5400 05400	CASTILE SUSAN & CLARKE JAMES	524 S 13TH ST, ST HELENS, OR, 97051
442	4N1W 4DD 7900 07900	BOYD JOHN WALTER & KAZUMI	514 S 14TH ST, ST HELENS, OR, 97051
443	4N1W 4DD 7800 07800	EIB KENNETH W & KAREN L	310 N VERNONIA RD, ST HELENS, OR, 97051
444	4N1W 4DD 7901 07901	SPIELER JR CARL W CONTINUING TRUST	921 TUALATIN ST, ST HELENS, OR, 97051
445	4N1W 4DD10800 10800	CITY OF ST HELENS OREGON	PO BOX 278, ST HELENS, OR, 97051
445	4N1W 4DD10800 10800	CITY OF ST HELENS OREGON	PO BOX 278, ST HELENS, OR, 97051
446	4N1W1000 300 00300	CITY OF ST HELENS	PO BOX 278, ST HELENS, OR, 97051
447	4N1W1000 100 00100	OREGON DEPARTMENT OF FISH & WILDLIFE	4034 FAIRVIEW INDUSTRIAL DR SE, SALEM, OR, 97302
447	4N1W1000 100 00100	OREGON DEPARTMENT OF FISH & WILDLIFE	4034 FAIRVIEW INDUSTRIAL DR SE, SALEM, OR, 97302
447	4N1W1000 100 00100	OREGON DEPARTMENT OF FISH & WILDLIFE	4034 FAIRVIEW INDUSTRIAL DR SE, SALEM, OR, 97302
447	4N1W1000 100 00100	OREGON DEPARTMENT OF FISH & WILDLIFE	4034 FAIRVIEW INDUSTRIAL DR SE, SALEM, OR, 97302
447	4N1W1000 100 00100	OREGON DEPARTMENT OF FISH & WILDLIFE	4034 FAIRVIEW INDUSTRIAL DR SE, SALEM, OR, 97302
448	4N1W 900 101 00101	CITY OF ST HELENS OREGON	PO BOX 278, ST HELENS, OR, 97051
449	4N1W 9AA 2300 02300	CITY OF ST HELENS OREGON	PO BOX 278, ST HELENS, OR, 97051
450	4N1W 9AA 1200 01200	LOCAL #1 AOWP&PW	PO BOX 657, ST HELENS, OR, 97051
451	4N1W 900 100 00100	CITY OF ST HELENS OREGON	PO BOX 278, ST HELENS, OR, 97051
451	4N1W 900 100 00100	CITY OF ST HELENS OREGON	PO BOX 278, ST HELENS, OR, 97051
452	4N1W 3CB 4201 04201	WYLAND CONNIE J	PO BOX 732, ST HELENS, OR, 97051
453	4N1W 4AD 2004 02004	BELL RAYMOND	6400 SE LAKE RD #STE 200, MILWAUKIE, OR, 97222
454	4N1W 4AD 2003 02003	BELLS DRAFTING & CONSTRUCTION INC	1300 JOHN ADAMS ST #STE 120, OREGON CITY, OR, 97045-1691

Table 2-1
Landowners within 0.25 Mile of Site Boundary
City of St. Helens
Wastewater Treatment Lagoon

MAUL FOSTER ALONGI

Map ID	Tax Lot Number	Owner Name	OWNER ADDRESS
455	4N1W 4DD 203 00203	CONNALL ERNEST & CAROLYN	1070 UMATILLA ST, ST HELENS, OR, 97051
456	4N1W 4DD 204 00204	WEGNER LLOYD	195 FRANTZ ST, ST HELENS, OR, 97051
457	4N1W 3BC 6900 06900	WRIGHT DALE M & VICKI L	365 S 5TH ST, ST HELENS, OR, 97051
458	4N1W 4AD 1900 01900	GALAHER ELIZA C	820 OLD PORTLAND RD, ST HELENS, OR, 97051
459	4N1W 4AD 2501 02501	FORD JAMES & TAMMIE	344 S 9TH ST, ST HELENS, OR, 97051
460	4N1W 4AD 2001 02001	WATERS LINDA K	345 S 8TH, ST HELENS, OR, 97051
461	4N1W 4DA 6800 06800	MORENO JUAN CARLOS & FLORES LAURA	13820 SW ELECTRIC ST #202, BEAVERTON, OR, 97005-4868
462	4N1W 4DA 3600 03600	VANCE TAYLOR REECE	3822 NE BROGDEN ST, HILLSBORO, OR, 97124
463	4N1W 4DA 3900 03900	DURAN MICHAEL LEE & MARGARET ANN	491 S 11TH ST, ST HELENS, OR, 97051-2441
464	4N1W 4DA 6801 06801	WING LARRY A	1324 OLD PORTLAND RD, ST HELENS, OR, 97051
465	4N1W 3BC 7401 07401	MINISZEWSKI TASHA	305 S 5TH ST, ST HELENS, OR, 97051
467	4N1W 3BC 7400 07400	NYBERG JENNIFER	314 S 6TH ST, ST HELENS, OR, 97051
468	4N1W 3CB 4704 04704	GEORGE JOHN O	36500 NW BURGDORFER RD, NORTH PLAINS, OR, 97133

Table 2-2
Historic Sites in St. Helens
City of St. Helens
Wastewater Treatment Lagoon

Property Name	Object ID	Resource ID	Address	Year Built	Original Use	Eligibility
Cox-Williams House	8465	34213	280 S 1st St	1890	Single dwelling	Eligible/significant
St Helens Downtown Historic District	8645	34403	--	1851	Other	Eligible/significant
--	123807	34361	114 S 3rd St	1912	Single dwelling	Eligible/contributing
Hattan House	123808	34362	252 S 3rd St	1908	Single dwelling	Eligible/contributing
--	123809	34363	275 S 2nd St	1910	Single dwelling	Eligible/contributing
Masten-Peel House	123810	34364	285 S 2nd St	1900	Single dwelling	Eligible/contributing
Rutherford, Laud, House	123811	34365	295 S 2nd St	1911	Single dwelling	Eligible/contributing
--	123812	34366	270 Cowlitz St	1920	Single dwelling	Eligible/contributing
--	123813	34367	274 Cowlitz St	1940	Single dwelling	Not eligible/out of period
--	123814	34368	301 S 2nd St	c. 1920	Single dwelling	Eligible/contributing
--	123815	34369	315 S 2nd St	c. 1920	Single dwelling	Eligible/contributing
--	123816	34370	325 S 2nd St	1922	Single dwelling	Eligible/contributing
Morton House	123817	34371	355 S 2nd St	1910	Single dwelling	Eligible/contributing
Hamlin-McCormic House	123818	34372	365 S 2nd St	1910	Single dwelling	Eligible/contributing
--	123819	34373	344 S 3rd St	1924	Residential auxiliary	Not eligible/non-contributing
--	123820	34386	176 S 4th St	1916	Single dwelling	Eligible/contributing
--	123821	34388	164 S 4th St	1920	Single dwelling	Eligible/contributing
--	123822	34389	154 S 4th St	1905	Single dwelling	Eligible/contributing
--	123823	34390	144 S 4th St	1926	Single dwelling	Eligible/contributing
--	123824	34391	134 S 4th St	1924	Single dwelling	Eligible/contributing
--	123825	34392	224 S 4th St	1926	Single dwelling	Eligible/contributing
--	123826	34393	234 S 4th St	1926	Single dwelling	Eligible/contributing
Knighton, Henry, House	123827	34394	155 S 4th St	1851	Single dwelling	Eligible/contributing
McMichael House	123828	34395	165 S 4th St	1967	Single dwelling	Not eligible/out of period
--	123829	34396	185 S 4th St	c. 1925	Single dwelling	Eligible/contributing
--	123830	34397	430 St Helens St	c. 1890	Single dwelling	Eligible/contributing
--	123831	34398	480 St Helens St	c. 1910	Single dwelling	Eligible/contributing
5-plex	123835	649979	2544-2584 Sykes Rd	c. 1951	Multiple dwelling	Not eligible/non-contributing
Yankton Baptist Church	123836	648234	33579 Pittsburg Rd	1903	Religious facility	Not eligible/non-contributing
National Guard Armory complex	123840	64029	474 S 7th St	1955	Military facility	Eligible/contributing
Cliff-Ross House	123842	34220	145 S 1st St	1905	Single dwelling	Eligible/contributing
Muckle Building	123843	34221	31-41 Cowlitz St	1909	Business	Eligible/contributing
Thompson, Frank, House	123844	34222	154 N 2nd St	1924	Single dwelling	Eligible/contributing
Gumm, John, School	123845	34223	251 St Helens St	1919	School	Eligible/contributing
McCormick Building	123846	34224	289-299 S 1st St	1921	Commercial: general	Eligible/contributing
Gray House	123847	34225	105 S 1st St	1905	Single dwelling	Eligible/contributing
Warrior Rock Lighthouse	123874	34275	18330 NW Sauvie Island Rd	1937	Transportation: general	Eligible/contributing
Ross, Dr Edwin, House	123877	34282	90 Columbia Blvd	1895	Single dwelling	Eligible/contributing
Burcham House	123878	34283	100 S 1st St	c. 1922	Single dwelling	Eligible/contributing
--	123879	34284	110 S 1st St	1939	Single dwelling	Not eligible/out of period
Shinn House	123880	34285	120 S 1st St	1914	Single dwelling	Eligible/contributing
--	123881	34286	130 S 1st St	1928	Single dwelling	Not eligible/non-contributing
Arthur George House	123882	34287	180 S 1st St	1912	Single dwelling	Eligible/contributing
--	123883	34289	50 Plaza	c. 1928	Commercial: general	Eligible/contributing
--	123884	34290	236-240 S 1st St	1938	Business	Not eligible/out of period
St Helens First National Bank	123885	34291	230 S 1st St	1926	Financial institute	Eligible/contributing
Columbia Theater	123886	34293	210-212 S 1st St	1928	Theater	Eligible/contributing
US National Bank	123887	34294	200 S 1st St	1948	Financial institute	Not eligible/out of period
Orcadia Hotel	123888	34301	30 Cowlitz St	1908	Hotel	Eligible/contributing
Lope House	123889	34307	330 S 1st St	1910	Single dwelling	Eligible/contributing
St Helens Hotel	123890	34308	71 Cowlitz St	1910	Hotel	Eligible/contributing
--	123891	34309	164 N 2nd St	1924	Single dwelling	Eligible/contributing
--	123892	34310	144 N 2nd St	1908	Single dwelling	Eligible/contributing

Table 2-2
Historic Sites in St. Helens
City of St. Helens
Wastewater Treatment Lagoon

Property Name	Object ID	Resource ID	Address	Year Built	Original Use	Eligibility
--	123893	34311	134 N 2nd St	1910	Single dwelling	Eligible/contributing
Dillard, William Walden, House	123894	34313	124 N 2nd St	1922	Single dwelling	Eligible/contributing
--	123895	34314	170 Columbia Blvd	1908	Single dwelling	Eligible/contributing
Plymouth Congressional Church Parsonage	123896	34315	130 Columbia Blvd	1912	Church-related residence	Eligible/contributing
Shepard, Orin, House	123897	34317	115 S 1st St	1926	Single dwelling	Eligible/contributing
Dillard House	123898	34318	135 S 1st St	1895	Single dwelling	Eligible/contributing
George, Frank, House	123899	34319	155 S 1st St	1915	Single dwelling	Eligible/contributing
Dart House	123900	34320	167 S 1st St	1910	Single dwelling	Eligible/contributing
Miles, Samuel, House	123901	34321	175 S 1st St	1886	Multiple dwelling	Eligible/contributing
--	123902	34323	100 St Helens St	1971	Business	Not eligible/out of period
--	123903	34325	190 S 2nd St	1910	Single dwelling	Eligible/contributing
--	123904	34326	184 S 2nd St	1910	Single dwelling	Eligible/contributing
--	123905	34328	172 S 2nd St	1927	Single dwelling	Not eligible/non-contributing
--	123906	34329	144 S 2nd St	1920	Single dwelling	Eligible/contributing
--	123907	34330	114 S 2nd St	1920	Single dwelling	Eligible/contributing
Sothard House	123908	34331	171 Columbia Blvd	1905	Single dwelling	Not eligible/non-contributing
--	123909	34333	203-205 S 1st St	--	Commercial: general	Not eligible/non-contributing
--	123910	34337	261-263 S 1st St	1921	Commercial: general	Eligible/contributing
McCormick Apartments	123911	34339	170 Cowlitz St	1929	Multiple dwelling	Eligible/contributing
--	123912	34340	260 S 2nd St	1885	Single dwelling	Eligible/contributing
--	123913	34341	171 St Helens St	c. 1905	Single dwelling	Not eligible/non-contributing
--	123914	34342	161 St Helens St	1940	Business	Not eligible/out of period
Muckle-George House	123915	34343	105 Cowlitz St	1910	Single dwelling	Eligible/contributing
--	123916	34344	325 S 1st St	1909	Single dwelling	Eligible/contributing
Isbister House	123917	34345	333 S 1st St	c. 1900	Single dwelling	Eligible/contributing
--	123918	34346	155 N 2nd St	1910	Single dwelling	Eligible/contributing
--	123919	34347	145 N 2nd St	1906	Single dwelling	Not eligible/non-contributing
--	123920	34348	125 N 2nd St	1918	Single dwelling	Eligible/contributing
--	123921	34349	115 N 2nd St	1918	Single dwelling	Eligible/contributing
--	123922	34352	260 St Helens St	1885	Single dwelling	Not eligible/non-contributing
--	123923	34353	280 St Helens St	1908	Single dwelling	Eligible/contributing
--	123924	34354	184 S 3rd St	1910	Single dwelling	Eligible/contributing
--	123925	34355	174 S 3rd St	1921	Single dwelling	Eligible/contributing
--	123926	34356	164 S 3rd St	1918	Single dwelling	Eligible/contributing
Wellington, John H, House	123927	34357	154 S 3rd St	1895	Single dwelling	Eligible/contributing
--	123928	34359	134 S 3rd St	1920	Single dwelling	Eligible/contributing
--	123929	34375	324 S 3rd St	c. 1920	Single dwelling	Eligible/contributing
--	123930	34376	314 S 3rd St	1919	Single dwelling	Eligible/contributing
--	123931	34377	271 Cowlitz St	1913	Single dwelling	Eligible/contributing
--	123932	34378	201 Cowlitz St	c. 1920	Single dwelling	Eligible/contributing
--	123933	34379	125 S 3rd St	1914	Single dwelling	Eligible/contributing
--	123934	34380	135 S 3rd St	1914	Single dwelling	Eligible/contributing
--	123935	34381	155 S 3rd St	1920	Single dwelling	Eligible/contributing
--	123936	34382	163-165 S 3rd St	1910	Single dwelling	Eligible/contributing
--	123937	34383	175 S 3rd St	1910	Single dwelling	Eligible/contributing
--	123938	34384	197 S 3rd St	1910	Single dwelling	Eligible/contributing
St. Helens Sentinel-Mist Building	123939	34385	360 St Helens St	1940	Commercial: general	Not eligible/out of period
--	123940	34399	205 S 4th St	1910	Single dwelling	Eligible/contributing
--	123941	34400	225 S 4th St	1931	Single dwelling	Not eligible/non-contributing
--	123942	34401	235 S 4th St	1926	Single dwelling	Eligible/contributing
House	124077	650001	488 S 17th St	c. 1915	Single dwelling	Not eligible/non-contributing
House	124079	650004	33107 Pittsburg Rd	c. 1938	Single dwelling	Not eligible/non-contributing

Table 2-2
Historic Sites in St. Helens
City of St. Helens
Wastewater Treatment Lagoon

Property Name	Object ID	Resource ID	Address	Year Built	Original Use	Eligibility
House	124097	652040	155 Michael Ave	c. 1945	Single dwelling	Not eligible/non-contributing
--	124103	654097	455 N 12th St	--	Single dwelling	Undetermined
--	124104	654098	314 S 15th St	--	Single dwelling	Undetermined
Gilby Motor Company Building	124114	34338	271-285 S 1st St	1923	Business	Eligible/contributing
--	124118	34387	172 S 4th St	c. 1890	Single dwelling	Eligible/contributing
Gray Building	124128	34292	220-224 S 1st St	1925	Professional	Eligible/contributing
Hewitt Building	124129	34302	298 S 1st St	1919	Business	Eligible/contributing
JC Penney's Building	124130	34303	274 S 1st St	1921	Department store	Eligible/contributing
Christ Episcopal Church	124131	34304	260 S 1st St	1897	Religious facility	Eligible/contributing
Vacant Lot	124132	34316	110 Columbia Blvd	--	Vacant/not in use	Not eligible/non-contributing
St Helens Ice & Beverage Co.	124133	34322	187 S 1st St	c. 1930	Warehouse	Eligible/contributing
Morton, S C, Building	124134	34324	189 S 1st St	1920	Commercial: general	Not eligible/non-contributing
--	124135	34327	176 S 2nd St	1910	Single dwelling	Eligible/contributing
Adams, H W H, Grocery	124136	34332	201 S 1st St	1927	Department store	Eligible/contributing
Knights of Pythias Lodge	124137	34334	215 S 1st St	1927	Meeting hall	Eligible/contributing
St Helens Masonic Lodge	124138	34335	235 S 1st St	1913	Meeting hall	Eligible/contributing
Rutherford Building	124139	34336	245-257 S 1st St	1919	Commercial: general	Eligible/contributing
--	124140	34350	165 S 2nd St	1914	Single dwelling	Eligible/contributing
Watkins House	124141	34351	185 N 2nd St	1960	Single dwelling	Not eligible/out of period
--	124142	34358	144 S 3rd St	--	Single dwelling	Not eligible/non-contributing
--	124143	34360	122 S 3rd St	--	Single dwelling	Not eligible/non-contributing
--	124144	34374	334 S 3rd St	1918	Single dwelling	Not eligible/non-contributing
--	124145	34433	170 S 2nd St	1910	Single dwelling	Not eligible/non-contributing
Vacant Lot	124172	658844	221-225 S 1st St	--	Vacant/not in use	Not eligible/non-contributing
Vacant Lot	124173	658845	240 S 2nd St	--	Vacant/not in use	Not eligible/non-contributing
Vacant Lot	124174	658846	212-214 S 2nd St	--	Vacant/not in use	Not eligible/non-contributing
Vacant Lot	124175	658847	191 S 3rd St	--	Vacant/not in use	Not eligible/non-contributing
Vacant Lot	124176	658848	115 S 4th St	--	Vacant/not in use	Not eligible/non-contributing
Columbia County Courthouse	135549	34280	Strand St	1906	Courthouse	Eligible/contributing
Longshoremen's Hall, Restrooms, Creamery	135550	34281	Strand St	c. 1915	Water related	Not eligible/non-contributing
Plaza	135551	34295	Plaza & 1st St	1907	Park/plaza	Eligible/contributing
Columbia County Bank	135552	34296	263 Strand St	1908	Financial institute	Eligible/contributing
Bennett Building	135553	34297	273-277 Strand St	1929	Business	Eligible/contributing
Vacant Lot	135554	34298	283 Strand St	--	Vacant/not in use	Not eligible/non-contributing
Vacant Lot	135555	34299	293 Strand St	--	Vacant/not in use	Not eligible/non-contributing
Tavern	135556	34300	295 Strand St	1953	Commercial: general	Not eligible/out of period
Morgus Building	135557	34305	313-317 Strand St	1912	Commercial: general	Eligible/contributing
--	135558	34306	325-327 Strand St	1908	Warehouse	Eligible/contributing
Milton Way Bridge	135577	654283	Milton Way	c. 1914	Transportation: general	Eligible/contributing

NOTES:

-- = Information not available.

Table 2-3
Historic Sites in Washington
City of St. Helens
Wastewater Treatment Lagoon

MAUL FOSTER ALONGI

Property Name	ID	Address	Year Built	Eligibility
Number 6 Barn	676473	291XX NW 67th Ave, Ridgefield, WA	c. 1930	Determined eligible
Weber Pioneer Historic Property	709196, 709197, 709198, 7091952, 709193, 709194	3807 Pioneer St, Ridgefield, WA	c. 1940	Determined eligible
Ridgefield Hardware	554610	104 N Main, Ridgefield, WA	1910	Determined eligible
Hilltop Farm	700688	6600 NW 287th Street, Ridgefield, WA	c. 1900	Determined eligible
The Red Barn	700750	1605 Caples Road, Woodland, WA	1940	Determined eligible
--	677093	234 Love Ave, Woodland, WA	1925	Determined eligible
--	677175	123 Truth St, Woodland, WA	1910	Determined eligible
Pushmeir, Augustus, Barn	700643	1342 Dike Road, Woodland, WA	1920	Determined eligible
Bozorth, Squire Sr. & Millie, House	4269	345 N Pekin Rd, Woodland, WA	c. 1855	Determined eligible

Table 3-1
Regional Climatology
City of St. Helens
Wastewater Treatment Lagoon

Climate Metric	Units	Month												Annual
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
High Temperature [1]	(°F)	43.6	48.2	54.2	59.5	66.3	71.8	78.3	79.6	73.9	61.2	49.2	42.0	**60.7**
Low Temperature [1]	(°F)	32.5	33.4	36.9	40.1	45.1	50.2	54.6	54.8	50.5	43.6	37.1	32.2	**42.6**
Daily Low Temperatures below Freezing [1]	(day)	14.4	11.1	7.30	2.90	0.80	--	--	--	--	0.70	6.50	14.4	**58.1**
Total Precipitation [1]	(in)	6.96	4.98	4.87	3.56	2.92	1.98	0.72	0.92	1.79	3.65	7.07	7.22	**46.6**
Days with Precipitation [2]	(day)	16.9	13.4	15.8	14.0	10.7	8.33	4.03	3.69	5.41	11.2	16.7	17.2	**137.3**
Total Evaporation [3]	(in)	0.63	1.18	2.29	3.31	5.15	6.01	7.40	6.78	4.68	2.39	1.05	0.57	**41.4**

NOTES:

-- = not applicable

°F = degrees Fahrenheit.

GHCN-D = Global Historical Climate Network—Daily.

in = inch(es).

NCDC = National Climatic Data Center.

NWREC = North Willamette Research and Extensions Center.

REFERENCES:

[1] Climatic Normals obtained from the NCDC in Asheville, NC. Station ID: USW00004201 (St. Helens RFP) Normals represent period from 1981 through 2010.

[2] Data derived from daily summary data obtained from the GHCN-D dataset from the NCDC. Represents period from 1981 through 2010,

[3] Data retrieved from the Western Regional Climate Center. Represents the North Willamette Experimental Station located at the NWREC operated by Oregon State University. NWREC is the closest station to the project site that measures evaporation. Averages represent period from 1963 through 2005.

Table 4-1
Columbia River Flow Rates
City of St. Helens
Wastewater Treatment Lagoon

MAUL FOSTER ALONGI

Month	Average Discharge (cubic feet per second)		
	Minimum	Maximum	Mean
January	115,700	198,500	161,000
February	120,800	255,700	179,000
March	119,400	372,100	191,000
April	141,800	388,000	226,000
May	205,700	409,200	307,000
June	205,700	601,800	413,000
July	166,900	380,600	276,000
August	128,700	182,600	156,000
September	127,700	95,950	115,000
October	97,550	133,200	117,000
November	101,800	167,300	125,000
December	105,300	195,400	146,000
Annual	179,900	237,800	206,614

NOTE:

Data obtained from the U.S. Geological Survey National Water Information System, for Gauge 14144700, Columbia River at Vancouver, Washington.

Table 5-1
Basalt Bluff Water Balance Calculations
City of St Helens
Wastewater Treatment Lagoon

Parameter	Description	January	February	March	April	May	June	July	August	September	October	November	December	Source Notes
T_a	Average monthly temperature (C)	3.33	4.89	7.50	9.89	13.17	16.11	19.17	19.56	16.78	11.33	6.17	2.83	(1)
I	Heat index	42.78												$I = \Sigma(T_a/5)^{1.5}$
a	PET calculation parameter	1.17												a = 0.49+0.0179*I -0.0000771*I^2 +0.000000675*I^3
PET	Potential evapotranspiration	20.49	22.26	25.29	28.10	32.02	35.61	39.38	39.87	36.43	29.82	23.74	19.93	$PET = 1.6*(10T_a/I)^a$
P	Average monthly precipitation (mm)	176.78	126.49	123.70	90.42	74.17	50.29	18.29	23.37	45.47	92.71	179.58	183.39	(1)
C(r/o)	Runoff coefficient	0.20	0.20	0.20	0.20	0.20	0.15	0.15	0.15	0.15	0.20	0.20	0.20	(2)
R/O	Runoff (mm)	35.36	25.30	24.74	18.08	14.83	7.54	2.74	3.51	6.82	18.54	35.92	36.68	P * C(r/o)
I	Infiltration (mm)	141.43	101.19	98.96	72.34	59.33	42.75	15.54	19.86	38.65	74.17	143.66	146.71	P - (R/O)
I-PET		120.94	78.93	73.67	44.24	27.31	7.14	-23.84	-20.01	2.22	44.35	119.93	126.79	I - PET
ΣNEG (I-PET)		--	--	--	--	--	0.00	-23.84	-43.84	--	--	--	--	Summed negative values of I-PET
RZ	Root zone depth (m)	0.46												(3)
AW	Available water (mm)	150												(4)
ST	Soil moisture storage (mm/m)	68.58	68.58	68.58	68.58	68.58	68.58	53.00	40.00	42.22	68.58	68.58	68.58	(5)
ΔST	Change in soil moisture storage (mm/m)	0.00	0.00	0.00	0.00	0.00	0.00	-15.58	-13.00	2.22	26.36	0.00	0.00	Change in ST from month to month
AET	Actual evapotranspiration (mm)	20.49	22.26	25.29	28.10	32.02	35.61	31.12	32.86	36.43	29.82	23.74	19.93	Where (I-PET) is positive, AET = PET. Where (I-PET) is negative, AET = PET + [(I-PET) + ΔST]
PERC	Percolation (mm)	120.94	78.93	73.67	44.24	27.31	7.14	0.00	0.00	0.00	17.99	119.93	126.79	I - AET - ΔST

NOTES:

-- =not applicable.

C = degrees Celsius.

m = meters.

mm = millimeters.

NCDC = National Climatic Data Center.

NRCS = Natural Resources Conservation Service.

USEPA = U.S. Environmental Protection Agency.

References:

(1) Average monthly temperature and precipitation values are mean Climatic Normals obtained from the NCDC in Asheville, NC. Station ID: USW00004201 (St. Helens RFP). Normals represent period from 1981 through 2010.

(2) Runoff coefficient obtained from USEPA, 1975, Table 3. Values for sandy soil and steep slopes were selected based on field observations.

(3) Root zone depth value selected based on field observations and NRCS description of mapped xerumbrepts at the site.

(4) Available water value based on USEPA, 1975, Table 2. Values for sandy loam were selected based on field observations and NRCS mapped soil description.

(5) Prior to the first negative value of (I-PET), ST = AW/RZ, representing soil moisture storage value at field capacity. Values during the dry season (I-PET is negative) are obtained from tables in Thornthwaite and Mather, 1957 (Thornthwaite, C.W. and Mather, J.R., 1957, Instructions and tables for computing potential evapotranspiration and the water balance: Centerton, N.J., Laboratory of Climatology, Publications in Climatology, v. 8, no. 3, p. 185-311). Following the end of the dry season, values are calculated by adding (I-PET) to the previous month's ST value, until the maximum soil moisture storage value is reached.

MAUL FOSTER ALONGI

Table 5-2
Bottomland Area Water Balance Calculations
City of St Helens
Wastewater Treatment Lagoon

Parameter	Description	January	February	March	April	May	June	July	August	September	October	November	December	Source Notes
T_a	Average monthly temperature (C)	3.33	4.89	7.50	9.89	13.17	16.11	19.17	19.56	16.78	11.33	6.17	2.83	[1]
I	Heat index	42.78												$I = \Sigma(T_a/5)^{1.5}$
a	PET calculation parameter	1.17												a = 0.49+0.0179*I -0.0000771*I^2 +0.000000675*I^3
PET	Potential evapotranspiration	20.49	22.26	25.29	28.10	32.02	35.61	39.38	39.87	36.43	29.82	23.74	19.93	$PET = 1.6*(10T_a/I)^a$
P	Average monthly precipitation (mm)	176.78	126.49	123.70	90.42	74.17	50.29	18.29	23.37	45.47	92.71	179.58	183.39	[1]
C(r/o)	Runoff coefficient	0.17	0.17	0.17	0.17	0.17	0.13	0.13	0.13	0.13	0.17	0.17	0.17	[2]
R/O	Runoff (mm)	30.05	21.50	21.03	15.37	12.61	6.54	2.38	3.04	5.91	15.76	30.53	31.18	P * C(r/o)
I	Infiltration (mm)	146.73	104.99	102.67	75.05	61.56	43.75	15.91	20.33	39.56	76.95	149.05	152.21	P - (R/O)
I-PET		126.24	82.72	77.38	46.95	29.54	8.15	-23.47	-19.54	3.13	47.13	125.31	132.29	I - PET
ΣNEG (I-PET)		--	--	--	--	--	0.00	-23.47	-43.01	--	--	--	--	Summed negative values of I-PET
RZ	Root zone depth (m)	1.52												[3]
AW	Available water (mm)	250												[4]
ST	Soil moisture storage (mm/m)	380	380	380	380	380	380	377	362	365	380	380	380	[5]
ΔST	Change in soil moisture storage (mm/m)	0.00	0.00	0.00	0.00	0.00	0.00	-3.00	-15.00	3.13	14.87	0.00	0.00	Change in ST from month to month
AET	Actual evapotranspiration (mm)	20.49	22.26	25.29	28.10	32.02	35.61	18.91	35.33	36.43	29.82	23.74	19.93	Where (I-PET) is positive, AET = PET. Where (I-PET) is negative, AET = PET + [(I-PET) + ΔST]
PERC	Percolation (mm)	126.24	82.72	77.38	46.95	29.54	8.15	0.00	0.00	0.00	32.26	125.31	132.29	I - AET - ΔST

NOTES:

-- = not applicable.

C = degrees Celsius.

m = meters.

mm = millimeters.

NCDC = National Climatic Data Center.

NRCS = Natural Resources Conservation Service.

USEPA = U.S. Environmental Protection Agency.

References:

[1] = Average monthly temperature and precipitation values are mean Climatic Normals obtained from the NCDC in Asheville, NC. Station ID: USW00004201 (St. Helens RFP). Normals represent period from 1981 through 2010.

[2] = Runoff coefficient obtained from USEPA, 1975, Table 3. Values for heavy soil and flat slopes were selected based on field observations.

[3] = Root zone depth value selected based on field observations and NRCS description of mapped soils at the site.

[4] = Available water value based on USEPA, 1975, Table 2. Values for clay loam were selected based on field observations and NRCS mapped soil descriptions.

[5] = Prior to the first negative value of (I-PET), ST = AW/RZ, representing soil moisture storage value at field capacity. Values during the dry season (I-PET is negative) are obtained from tables in Thornthwaite and Mather, 1957 (Thornthwaite, C.W. and Mather, J.R., 1957, Instructions and tables for computing potential evapotranspiration and the water balance: Centerton, N.J., Laboratory of Climatology, Publications in Climatology, v. 8, no. 3, p. 185-311). Following the end of the dry season, values are calculated by adding (I-PET) to the previous months ST value, until the maximum soil moisture storage value is reached.

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Table 6-1
Information for Water Wells within 1 Mile of SIte
City of St. Helens
Wastewater Treatment Lagoon

Well ID	Owner Name	Owner Address	Driller Name	Driller Company	Driller Address	Driller Bonded License Number	Date of Drilling	Township	Range	Section	Quarter Section (40 ac.)	Quarter Section (160 ac.)
COLU 3241	Jay Potter	NA	F J McKnight	NA	NA	420	05/12/1966	4 N	1 W	3	Southwest	Northwest
COLU 3242	John Knutson	405 E. 4th St., St. Helens, OR	F J McKnight	NA	NA	420	12/07/1965	4 N	1 W	3	Northeast	Southwest
COLU 3244	Walter Erickson	NA	Ao Olsen	NA	NA	282	12/31/1938	4 N	1 W	4	Northwest	Southwest
COLU 3245	Walter Erickson	NA	Walter B Erickson	NA	NA	NA	03/01/1939	4 N	1 W	4	Northwest	Southwest
COLU 3300	Ed Price	NA	NA	NA	NA	NA	12/31/1956	4 N	1 W	9	NA	NA
COLU 51684	Bill Daekme	164 S. 15th, St. Helens, OR, 97051	Arthur McMullen	McMullen Drilling Corp.	NA	1480	03/01/2001	4 N	1 W	9	Northwest	Northwest
COLU 55412	Gary Kervin	PO Box 780, Scappoose, OR 97056	Arthur McMullen	McMullen Drilling Corp.	NA	1480	12/28/2018	4 N	1 W	9	Northwest	Northeast

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Table 6-1
Information for Water Wells within 1 Mile of SIte
City of St. Helens
Wastewater Treatment Lagoon

Well ID	Tax Lot	Street Address of Well	Aquifer Screened	Approximate Land Elevation (feet)	Depth of Well (feet)	Construction	Yield (gpm)	Water Use	Static Water Level (feet bgs)
COLU 3241	NA	NA	Blue coarse rock	79	105	6-inch-diameter steel casing to 45 feet bgs; open borehole to 125 feet bgs; bentonite seal from 0 to 20 feet bgs	8	Domestic	18
COLU 3242	NA	NA	Clay and sand	62	170	6-inch steel casing to 90 feet bgs; open borehole to 170 feet bgs; bentonite seal from 0 to 60 feet bgs	15	Domestic	50
COLU 3244	NA	Columbia River Hwy.	NA	102	320	12-inch casing to 300 feet bgs; open borehole to 320 feet bgs	120	Industrial	200
COLU 3245	NA	NA	NA	102	320	12-inch casing to 300 feet bgs; open borehole to 320 feet bgs	120	Industrial	200
COLU 3300	NA	NA	NA	39	40	6-inch casing to 40 feet bgs; open borehole to 106 feet bgs	NA	Domestic	80
COLU 51684	1200	Old Portland Rd.	Basalt	75	80	6-inch steel casing to 19 feet bgs; plastic casing to 80 feet bgs with perforations from 69 to 80 feet bgs; cement seal from 0 to 19 feet bgs	9	Domestic	25
COLU 55412	1000	Near 1875 Old Portland Rd., St. Helens, OR 97051	Basalt	69	200	6-inch steel casing to 20 feet bgs; plastic casing to 200 feet bgs with perforations from 160 to 200 feet bgs; bentonite seal from 0 to 20 feet bgs	40	Domestic	54

NOTES:
ac. = acre.
bgs = below ground surface.
gpm = gallons per minute.
NA = not available.

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Table 6-2
Surface Water Rights Points of Diversion
City of St. Helens
Wastewater Treatment Lagoon

State	Certificate Number	Name	Source	Priority Date	Rate (cfs)	Use	Full Record
Oregon	9498	MCCORMICK	MILTON CREEK	04/18/1928	0.2	IRRIGATION	http://apps.wrd.state.or.us/apps/wr/wrinfo/wr_details.aspx?snp_id=61881
Oregon	84493	BOISE CASCADE CORP.	COLUMBIA RIVER	12/30/1993	0.035	INDUSTRIAL/MANUFACTURING USES	http://apps.wrd.state.or.us/apps/wr/wrinfo/wr_details.aspx?snp_id=161921
Oregon	85053	BOISE WHITE PAPER LLC	MULTNOMAH CHANNEL	12/30/1993	65	INDUSTRIAL/MANUFACTURING USES	http://apps.wrd.state.or.us/apps/wr/wrinfo/wr_details.aspx?snp_id=164021

NOTES:

Data retrieved from Oregon Water Resources Department Water Right Information Search at https://www.oregon.gov/OWRD/programs/WaterRights/WRIS/Pages/default.aspx, on December 11, 2019.

cfs = cubic feet per second.

Table 7-1
Monitoring Well Completion Summary
City of St. Helens
Wastewater Treatment Lagoon

Location	Well Depth (feet bgs)	Casing Diameter (inches)	Screen Interval (feet bgs)	Measuring Point Elevation (feet NGVD)	Water Level Measurement Date	Depth to Water (feet below TOC)	Water Level Elevation (feet NGVD)
MW-1	80	2	60-80	56.07	08/06/2019	29.80	26.27
					03/11/2020	29.51	26.56
MW-2	70	2	50-70	68.94	08/07/2019	39.77	29.17
					03/11/2020	40.17	28.77
MW-3	45	2	25-45	31.18	08/06/2019	17.36	13.82
					03/11/2020	15.53	15.65
MW-4	50	2	30-50	31.14	08/07/2019	22.63	8.51
					03/11/2020	20.15	10.99
MW-5	50	2	30-50	30.89	08/06/2019	20.42	10.47
					03/11/2020	18.90	11.99
MW-6	50.5	2	30.5-50.5	30.86	08/07/2019	22.29	8.57
					03/11/2020	19.90	10.96

NOTES:
bgs = below ground surface.
NAVD = North American vertical datum.
TOC = top of casing.

Table 7-2
Slug Test Results
City of St. Helens
Wastewater Treatment Lagoon

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Location	Test Date	K (ft/day)			
		12-Inch Displacement	24-Inch Displacement	36-Inch Displacement	Geometric Mean
MW-1	09/19/2019	--	0.077	0.069	0.073
MW-2	09/18/2019	0.078	0.101	0.068	0.081
MW-5	09/20/2019	21.1	18.3	17.3	18.8
MW-6	09/20/2019	24.610	25.830	21.970	24.1

NOTES:

-- = not applicable.

ft/day = feet per day.

K = hydraulic conductivity.

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Table 8-1
Groundwater Analytical Results
City of St. Helens
Wastewater Treatment Lagoon

Location	RBC, Groundwater, Ingestion and Inhalation from Tapwater		RBC, Groundwater in Excavation, Construction Worker and Excavation Worker	RBC, GW, Vapor Intrusion into Buildings		RBC, GW, Volatilization to Outdoor Air			B1	MW-1	MW-2	MW-3
Sample Name									B1-20190711-RGW-68.0	MW-1-20190806-GW-70	MW-2-20190807-GW-60	MW-3-20190806-GW-35
Collection Date	Residential	Urban Residential		Residential	Occupational	Residential	Urban Residential	Occupational	07/11/2019	08/06/2019	08/07/2019	08/06/2019
Collection Depth (ft bgs)									68	70	60	35
Dissolved Metals (ug/L)												
Calcium	NV	NV	NV	NV	NV	NV	NV	NV	65,100	54,300	10,300	60,400
Iron	NV	NV	NV	NV	NV	NV	NV	NV	2,410	397	11,400	21,600
Magnesium	NV	NV	NV	NV	NV	NV	NV	NV	13,100	10,900	2,310	13,300
Manganese	480	1,800	3,200,000	NV	NV	NV	NV	NV	249	321	119	1,590
Potassium	NV	NV	NV	NV	NV	NV	NV	NV	12,800	10,800	8,330	4,610
Sodium	NV	NV	NV	NV	NV	NV	NV	NV	59,100	68,800	116,000	55,100
Anions (mg/L)												
Chloride	NV	NV	NV	NV	NV	NV	NV	NV	111	109	37.6	13.7
Sulfate	NV	NV	NV	NV	NV	NV	NV	NV	8.4	10.8	25.3	1.2 U
Dissolved Alkalinity (mg/L)												
Alkalinity, bicarbonate (as $CaCO_3$)	NV	NV	NV	NV	NV	NV	NV	NV	169	165	154	308

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Table 8-1
Groundwater Analytical Results
City of St. Helens
Wastewater Treatment Lagoon

Location	RBC, Groundwater, Ingestion and Inhalation from Tapwater		RBC, Groundwater in Excavation, Construction Worker and Excavation Worker	RBC, GW, Vapor Intrusion into Buildings		RBC, GW, Volatilization to Outdoor Air			MW-4	MW-5		MW-6
Sample Name									MW-4-20190807-GW-40	MW-5-20190806-GW-40	MW-5-20190806-GW-40-FD	MW-6-20190807-GW-40.5
Collection Date	Residential	Urban Residential		Residential	Occupational	Residential	Urban Residential	Occupational	08/07/2019	08/06/2019	08/06/2019	08/07/2019
Collection Depth (ft bgs)									40	40	40	41
Dissolved Metals (ug/L)												
Calcium	NV	NV	NV	NV	NV	NV	NV	NV	182,000	187,000	177,000	123,000
Iron	NV	NV	NV	NV	NV	NV	NV	NV	69,800	88,300	83,000	85,300
Magnesium	NV	NV	NV	NV	NV	NV	NV	NV	40,700	47,700	44,800	30,900
Manganese	480	1,800	3,200,000	NV	NV	NV	NV	NV	4,600	7,920	7,450	3,430
Potassium	NV	NV	NV	NV	NV	NV	NV	NV	14,900	10,300	9,500	11,400
Sodium	NV	NV	NV	NV	NV	NV	NV	NV	163,000	148,000	139,000	210,000
Anions (mg/L)												
Chloride	NV	NV	NV	NV	NV	NV	NV	NV	90.5	90.1	90.5	161
Sulfate	NV	NV	NV	NV	NV	NV	NV	NV	1.2 U	1.2 U	1.2	1.2 U
Dissolved Alkalinity (mg/L)												
Alkalinity, bicarbonate (as $CaCO_3$)	NV	NV	NV	NV	NV	NV	NV	NV	967	840	846	716

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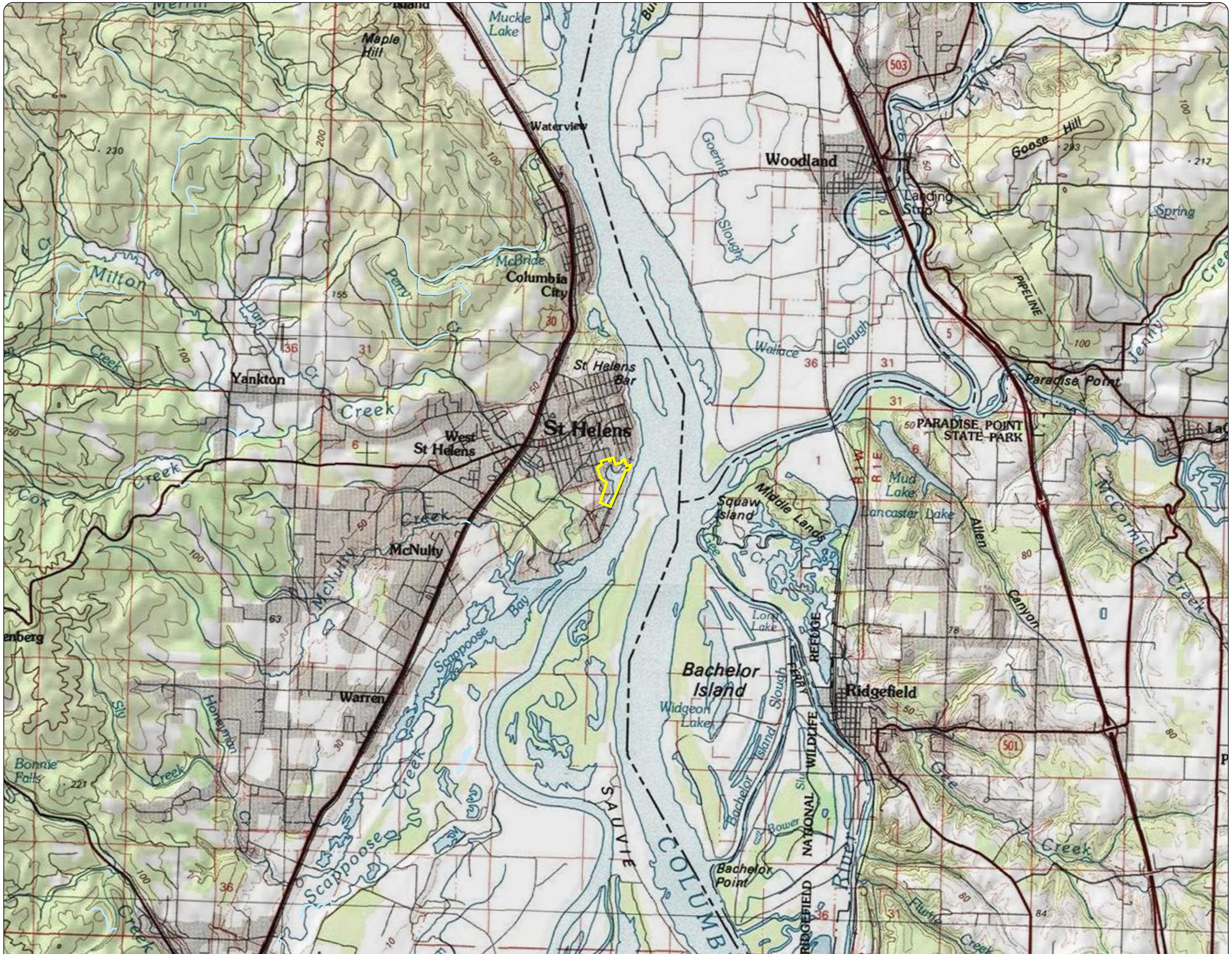
Table 8-1
Groundwater Analytical Results
City of St. Helens
Wastewater Treatment Lagoon

NOTES:
Shading (color key below) indicates values that exceed screening criteria.
DEQ residential ingestion and inhalation from topwater generic RBC.
DEQ urban residential ingestion and inhalation from topwater generic RBC.
$CaCO_3$ = calcium carbonate.
DEQ = Oregon Department of Environmental Quality.
ft bgs = feet below ground surface.
GW = groundwater.
mg/L = milligrams per liter.
NV = no value.
RBC = risk-based concentrations.
U = not detected.
ug/L = micrograms per liter.

FIGURES

Figure 1-1
Site Location

City of St. Helens
Wastewater Treatment Lagoon
St. Helens, Oregon



Legend

Property Boundary

0 1
Miles

Source: U.S .Geological Survey (1990) 7.5-minute topographic quadrangle: Saint Helens Section 3, Township 4 North, Range 1 West

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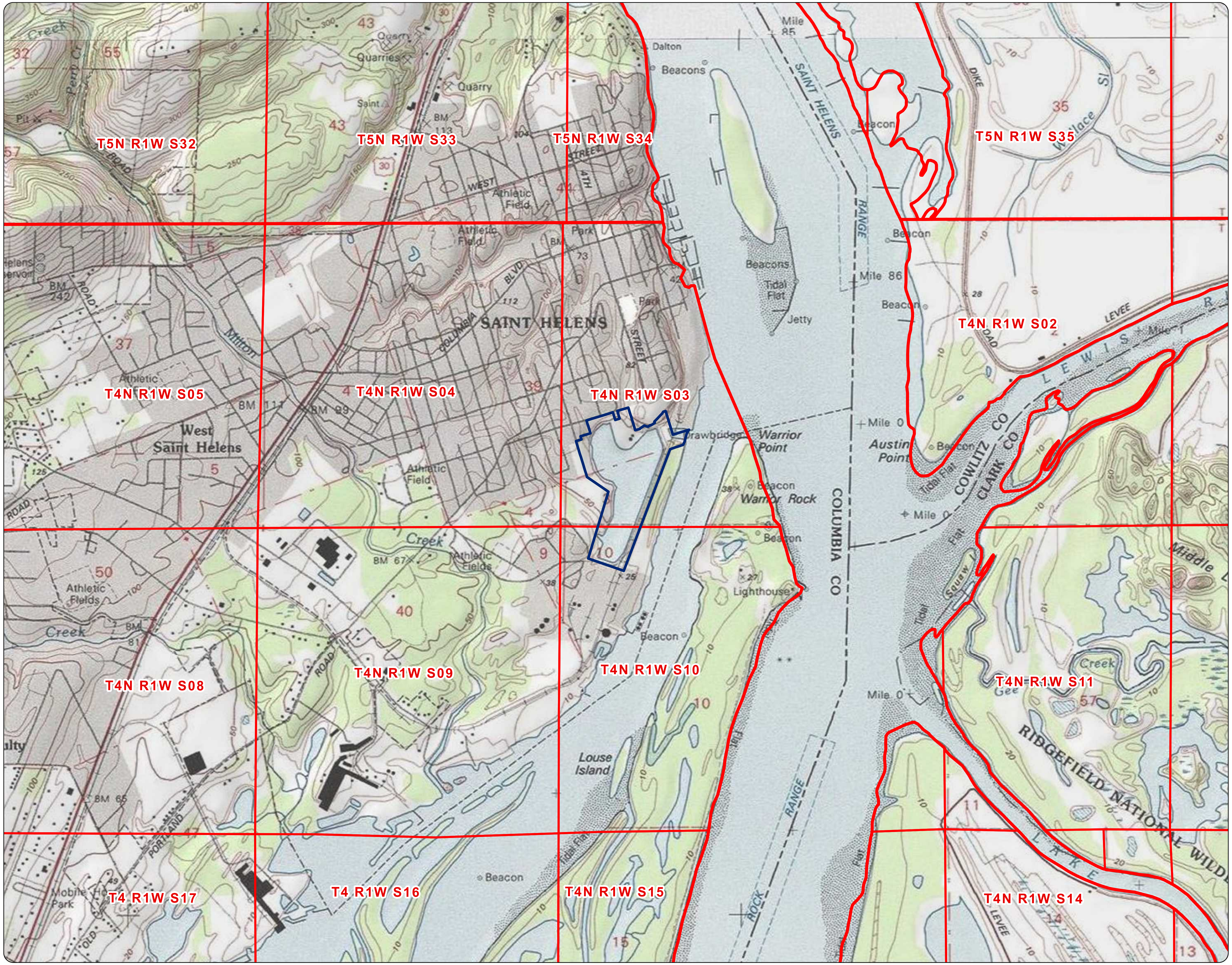
Figure 2-1
Site Vicinity Map
City of St. Helens
Wastewater Treatment Lagoon
St. Helens, Oregon



Legend
Property Boundary
PLSS Divisions

1 inch = 1,667 feet

0 1,000
Feet

Source: U.S. Geological Survey (1990) 7.5-minute topographic quadrangle: Saint Helens
Section 3, Township 4 North, Range 1 West
NOTE:
PLSS = Public Land Survey System

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Figure 2-2
Adjacent Landowners
City of St. Helens
Wastewater Treatment Lagoon
St. Helens, Oregon

Legend

- Tax Lots with corresponding Map ID
- Property Boundary
- Quarter-Mile Buffer

0 — 0.1
Miles

Source: Aerial imagery obtained form ESRI ArcGIS Online.

NOTES:

1. See Table 2-1 for property owner information associated with the Map ID.
2. Tax lot and ownership data obtained from the Columbia County Assessor's Office.

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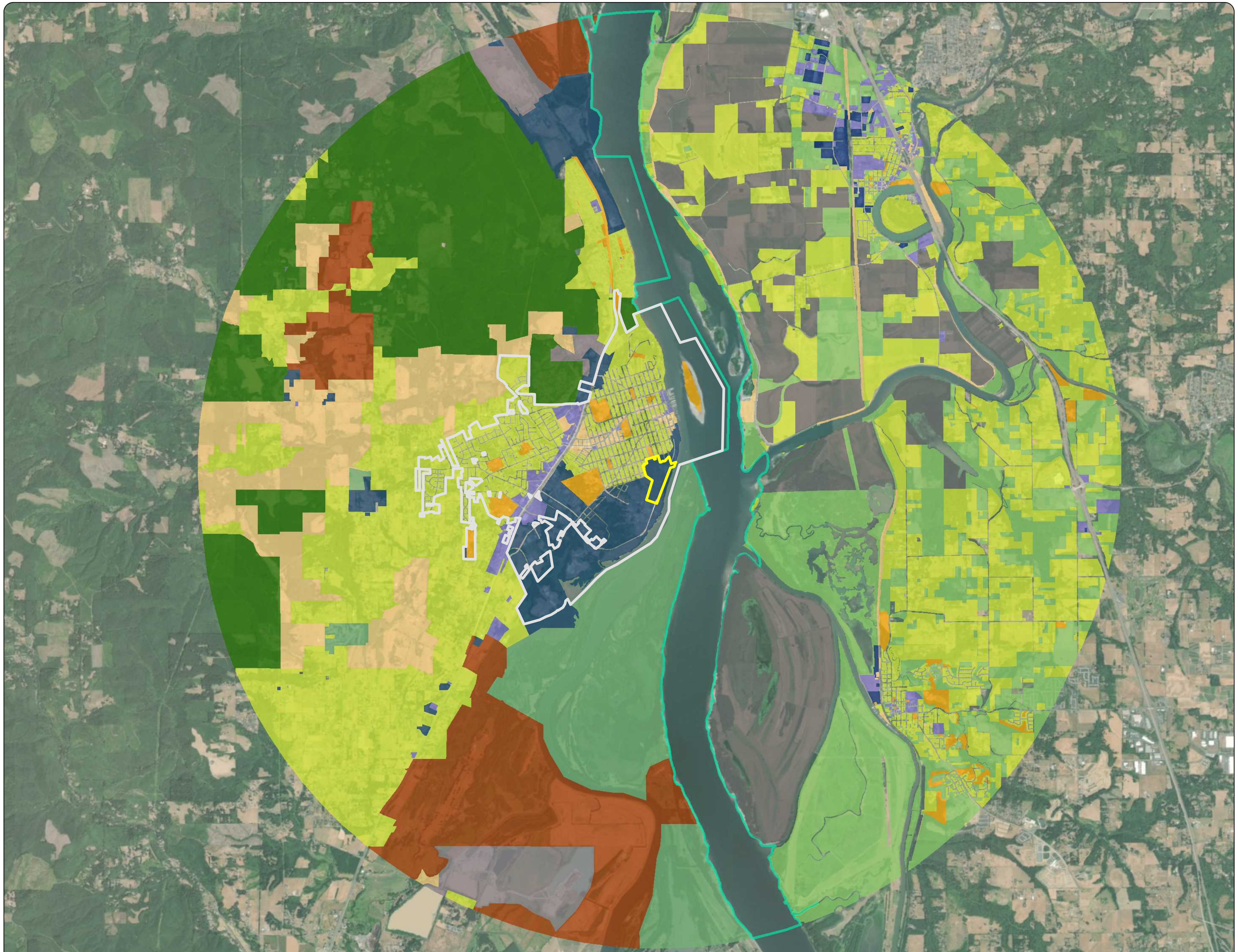

Figure 2-3
Existing Land Use and Zoning

City of St. Helens
Wastewater Treatment Lagoon
St. Helens, Oregon

Legend

- Property Boundary
- St. Helen's City Limits

Zoning Description for Washington

- Services/Trade
- Manufacturing
- Resource production and extraction
- Transportation, communication, and utilities
- Undeveloped land and water areas
- Cultural, entertainment and recreational
- Residential

Zoning Description for Oregon

- Coastal Shorelands
- Commercial
- Exclusive Farm Use
- Industrial
- Mineral and Aggregate
- Mixed Use
- Open Space/Conservation
- Forest
- Public and Semi-Public Uses
- Residential

0 0.5 1
Miles

Source:
Aerial photograph obtained from Esri ArcGIS Online.
Land use and zoning data obtained from the Oregon Department of Land Conservation and Development and the Washington Department of Ecology.

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Produced By: aguse
Project:

Figure 2-4
Wetland and Water Features

City of St. Helens
Wastewater Treatment Lagoon
St. Helens, Oregon

Legend

- Property Boundary
- Oregon & Washington NWI
- OTAK Inc. 1999
- The Wetlands Conservancy 2009

Wetland Class Level Definitions

PSS1Cx - Seasonally flooded scrub
PABFx - Semi-permanently flooded ponds
PUBKx - Artificially flooded pond
L2UBKx - Open water habitat
R1UBV - Permanently flooded, tidally influenced riverine deepwater habitat
R1USQ - Temporarily flooded, freshwater tidal floodplains, banks, and sandbars
R4SBC - Seasonally flowing riverine channels
PSS - Temporarily flooded scrub-shrub wetland
PFO/EM - Temporarily flooded tidal depressions and floodplains
PUBHh - Permanently flooded ponds

1 inch = 333 feet

0 250
Feet

Source: Aerial imagery obtained from ESRI ArcGIS Online. Wetland and water feature boundaries obtained from the NWI for the Oregon and Washington states, and the Oregon SWI. Data included in the SWI cited OTAK Inc. and The Wetlands Conservancy.
NOTES:
NWI = U.S. Fish and Wildlife Service's National Wetlands Inventory.
SWI = Statewide Wetlands Inventory.

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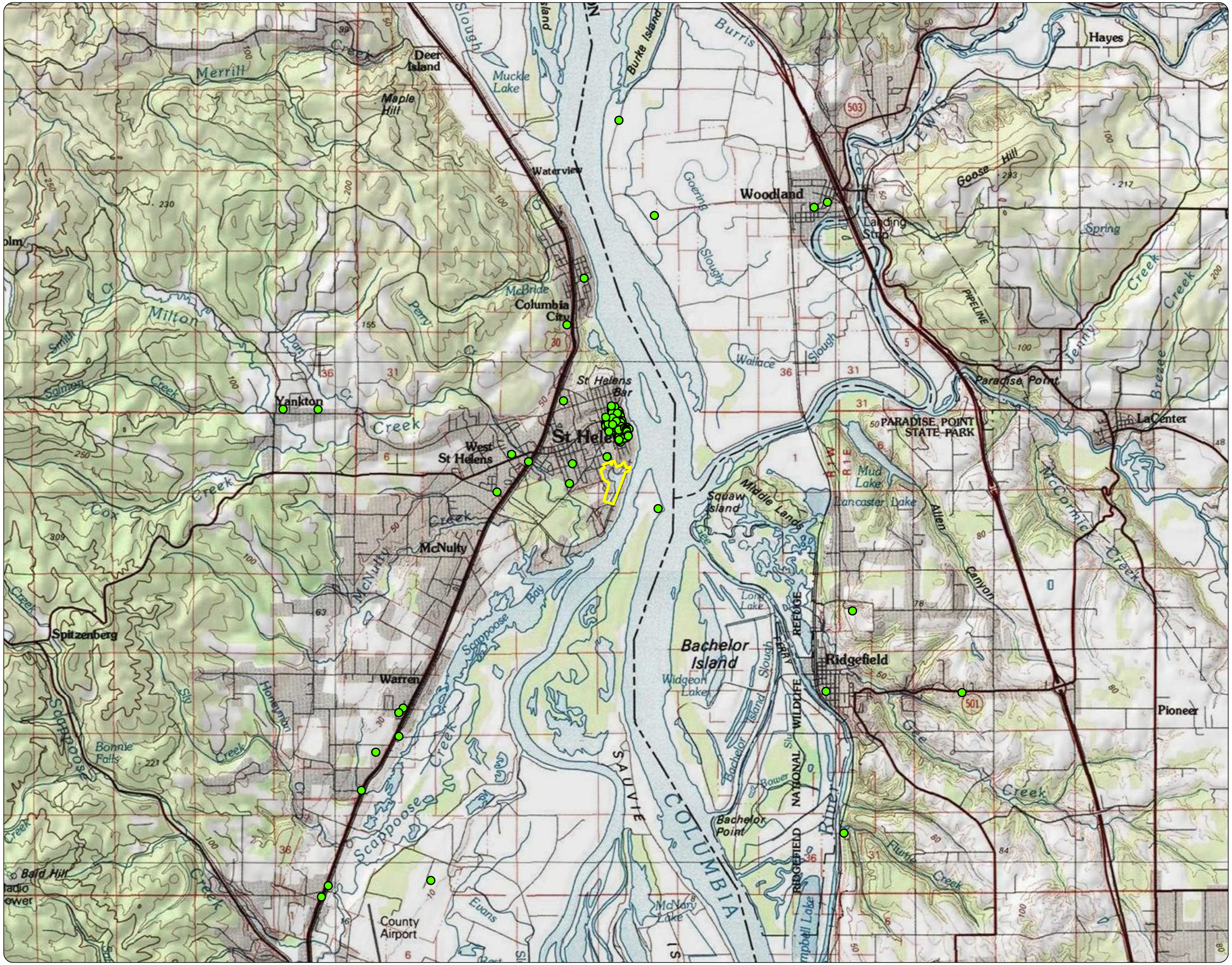
Figure 2-5
Historic Sites

City of St. Helens
Wastewater Treatment Lagoon
St. Helens, Oregon



Legend

- Historical Site Location
- Property Boundary

0 1
Miles

Source: US Geological Survey (1990) 7.5-minute topographic quadrangle: Saint Helens

NOTES:
Historic site data obtained from the Oregon Historical Sites Database (http://heritagedata.prd.state.or.us/historic/), and the Washington Information System for Architectural & Archaeological Records Data database (https://fortress.wa.gov/dahp/wisaardp3/).

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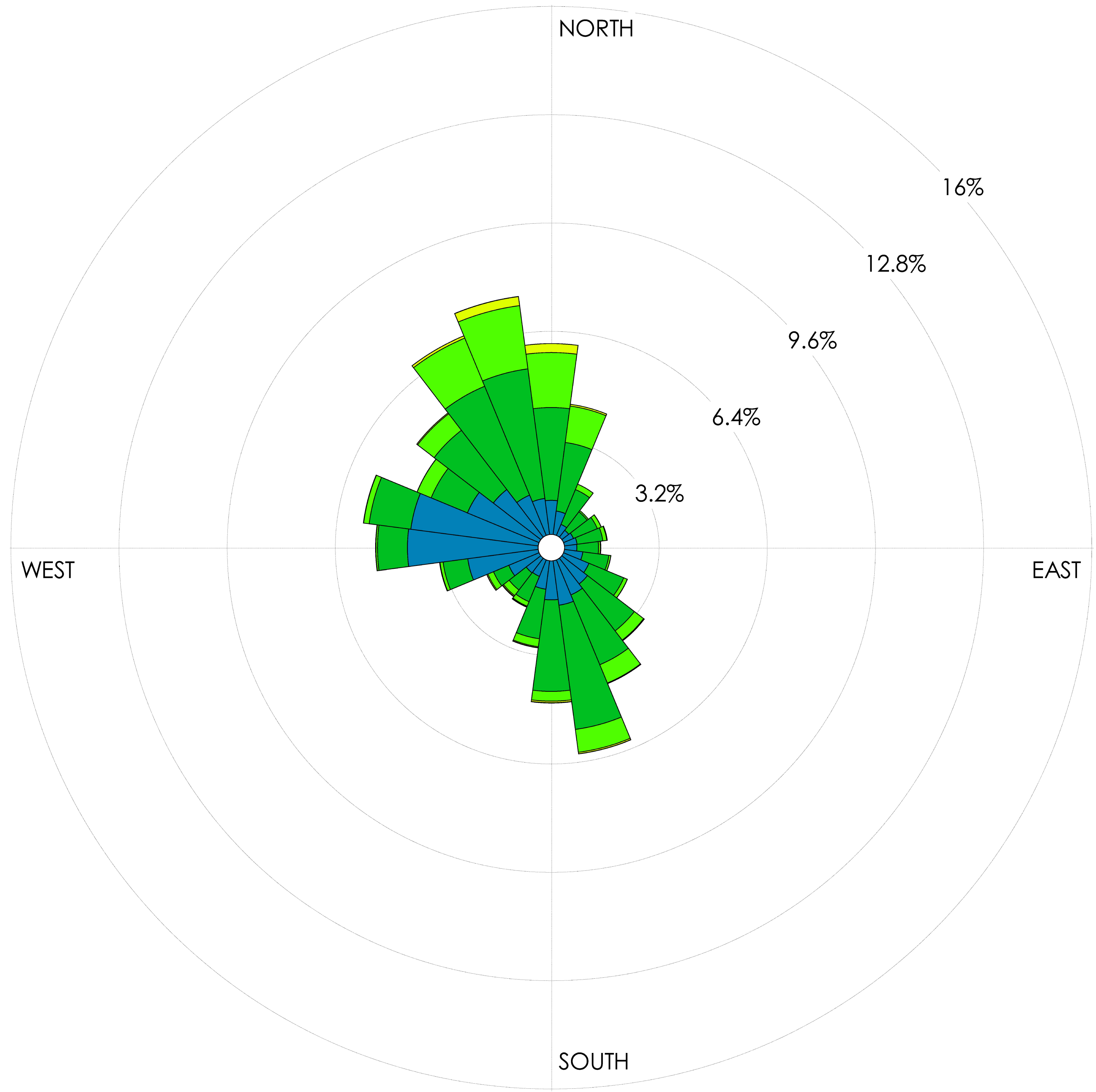
Figure 3-1
Wind Rose Plot for Scappoose Industrial Park

City of St. Helens
Wastewater Treatment Lagoon
St. Helens, Oregon



Legend

WIND SPEED (m/s)

- >= 10.00
- 8.00 - 10.00
- 6.00 - 8.00
- 4.00 - 6.00
- 2.00 - 4.00
- 0.27 - 2.00

NOTES:
Wind rose displays the wind speed direction (blowing from).
Data period start date: 1/1/2013, 00:00
Data period end date: 12/31/2018, 23:59
Total data count: 52,211 hours
Calm winds: 11.55 percent
Average wind speed: 2.24 meters/second

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Print Date: 12/11/2019

Approved By:

Produced By: aguse

Project: 0830.03

Figure 4-1
Flood Hazard Zones

City of St. Helens
Wastewater Treatment Lagoon
St. Helens, Oregon

Legend

Property Boundary

Flood Hazard Zones

Zone Type

- 1% Annual Chance Flood Hazard
- Regulatory Floodway
- 0.2% Annual Chance Flood Hazard
- Area with Reduced Risk Due to Levee

0 0.15 0.3
Miles

Source: Flood zone boundaries obtained from The Federal Emergency Management Agency.

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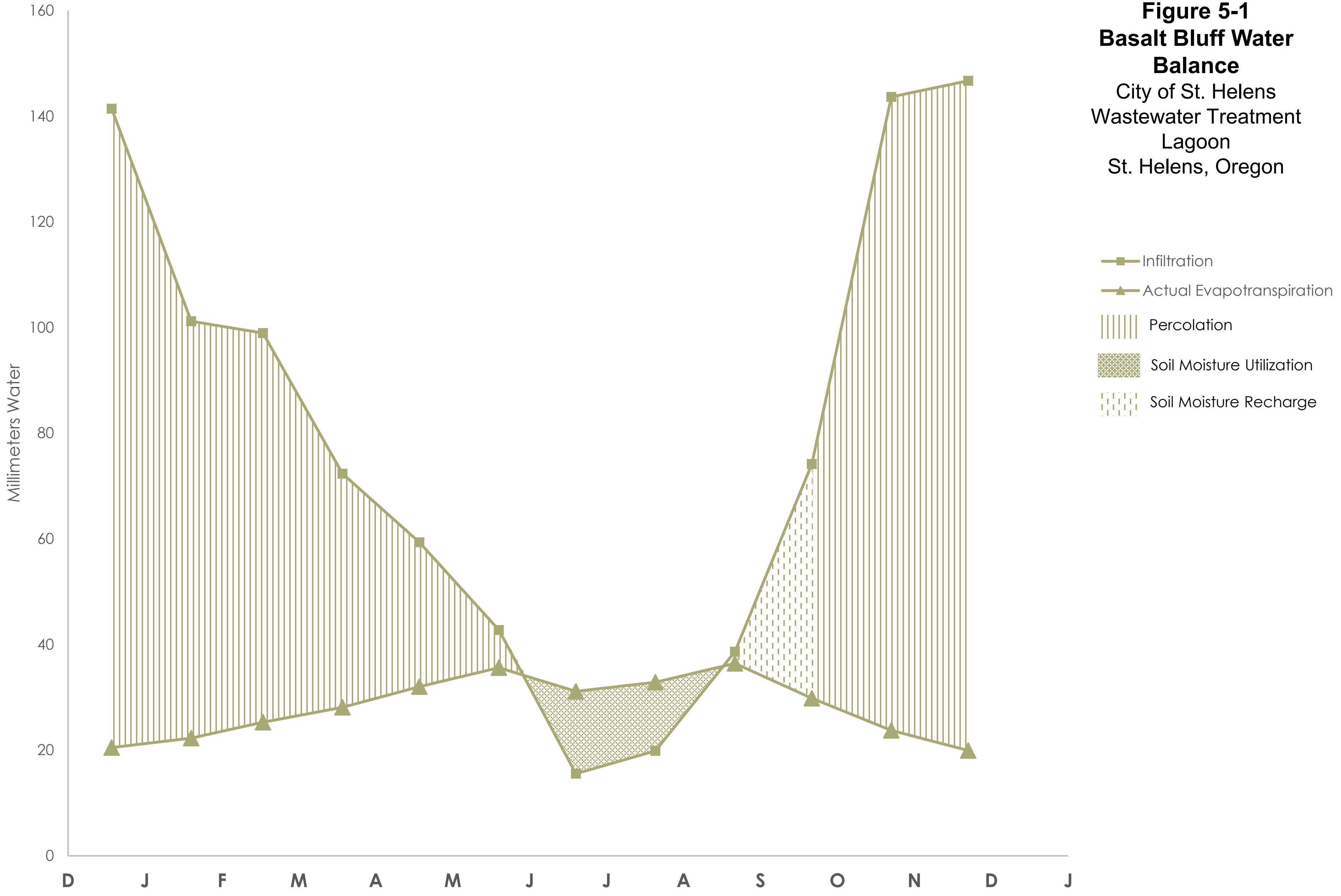
Figure 5-1
Basalt Bluff Water Balance

City of St. Helens
Wastewater Treatment
Lagoon
St. Helens, Oregon



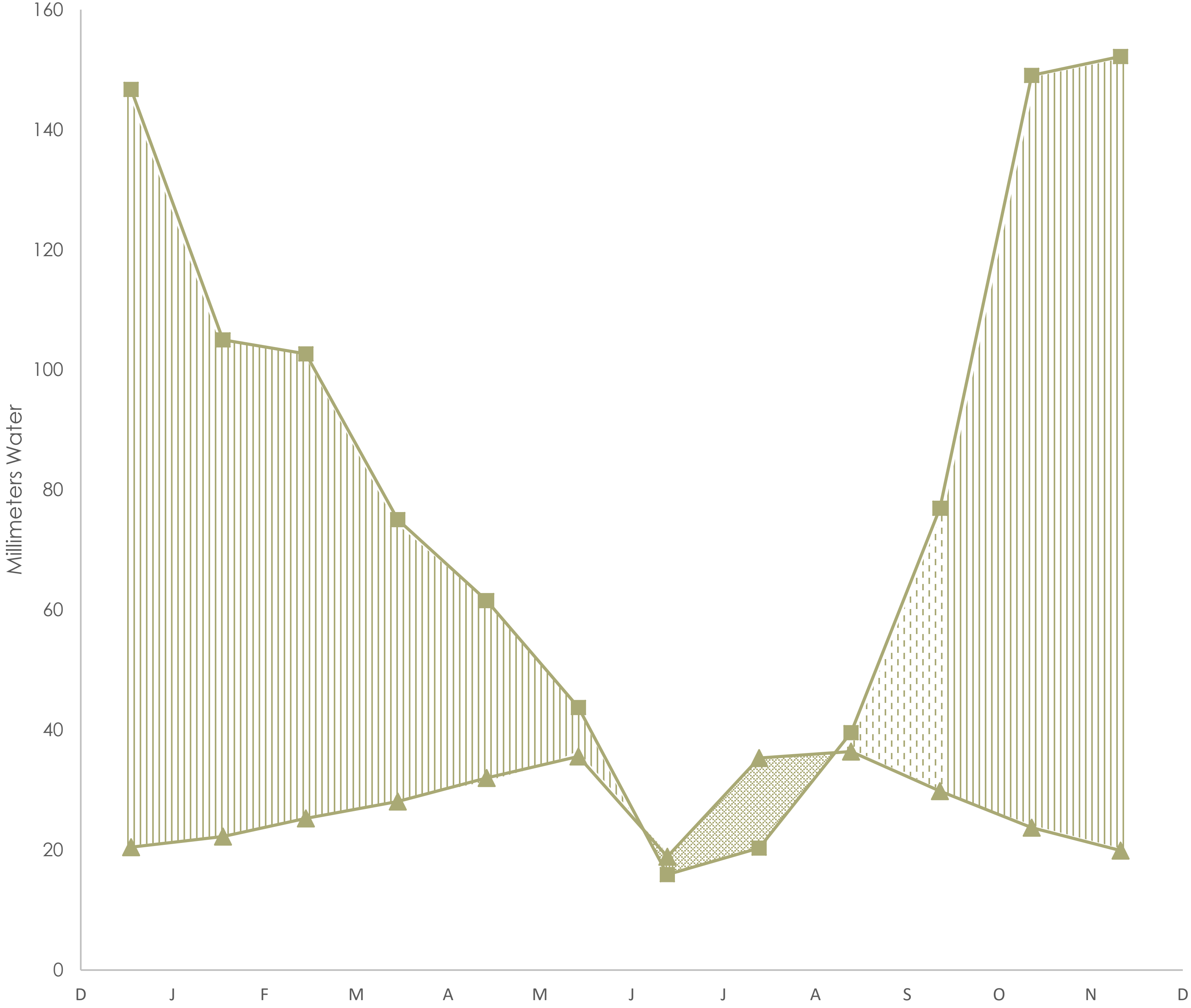


Figure 5-2
Bottomland Area
Water Balance
City of St. Helens
Wastewater Treatment
Lagoon
St. Helens, Oregon

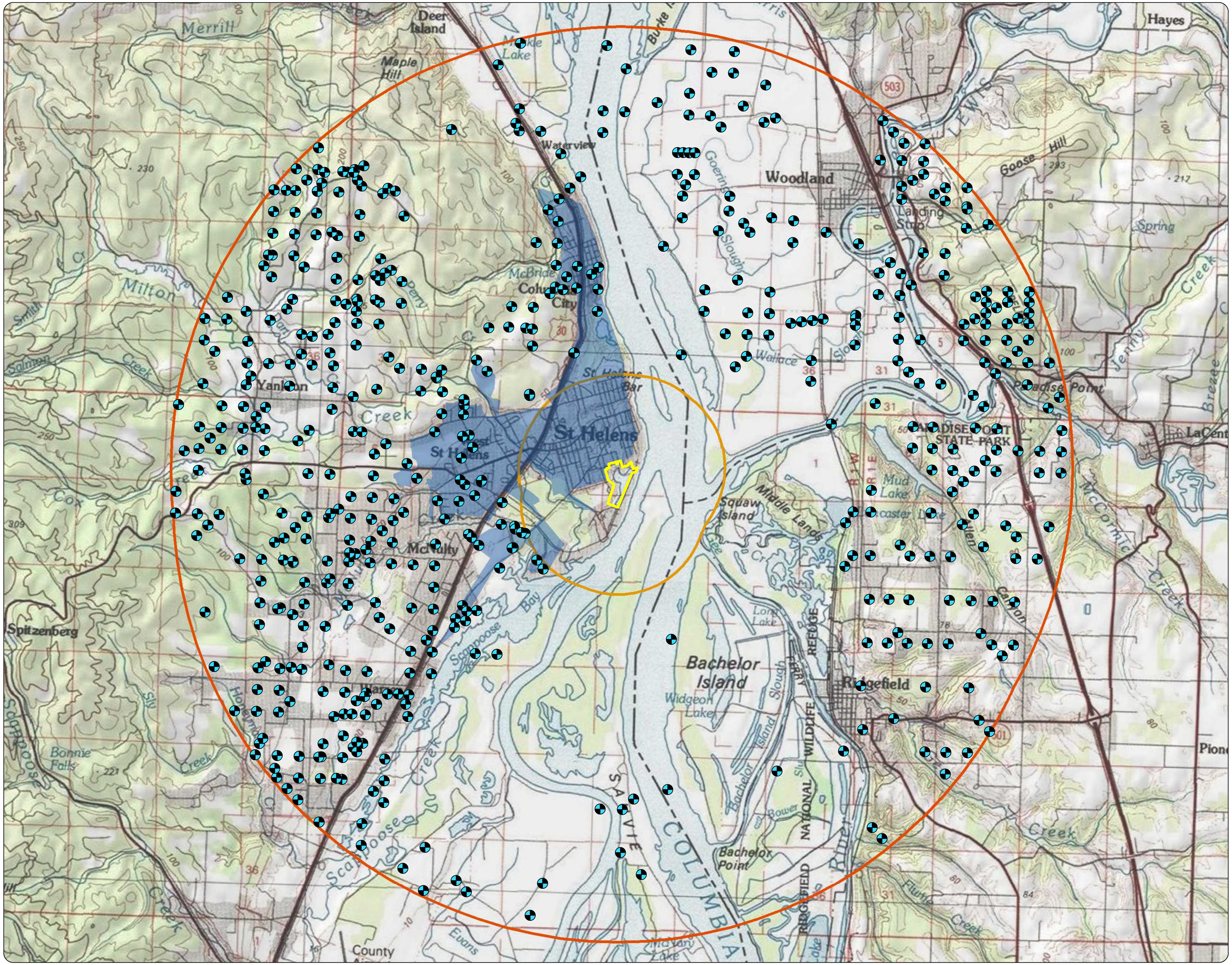


Figure 6-1
Water Wells Within a 1- to 5-Mile Radius of the Site

City of St. Helens
Wastewater Treatment Lagoon
St. Helens, Oregon

Legend

- Water Wells
- Property Boundary
- Approximate Service Area Boundary
- 1-Mile Radius
- 5-Mile Radius

0 1
Miles

Source: Well location information obtained from OWRD and Ecology. Shown are 922 wells in total.

NOTES:
1. Ecology = Washington Department of Ecology.
2. OWRD = Oregon Water Resources Department
3. See Figure 6-2 for well locations within a 1-mile radius of the site.
4. Service Area Boundary is an approximation of the extent of the City of St. Helens water mainlines and laterals. Locations of water mainlines and laterals were obtained from the City of St. Helens.

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Project: 0830.03

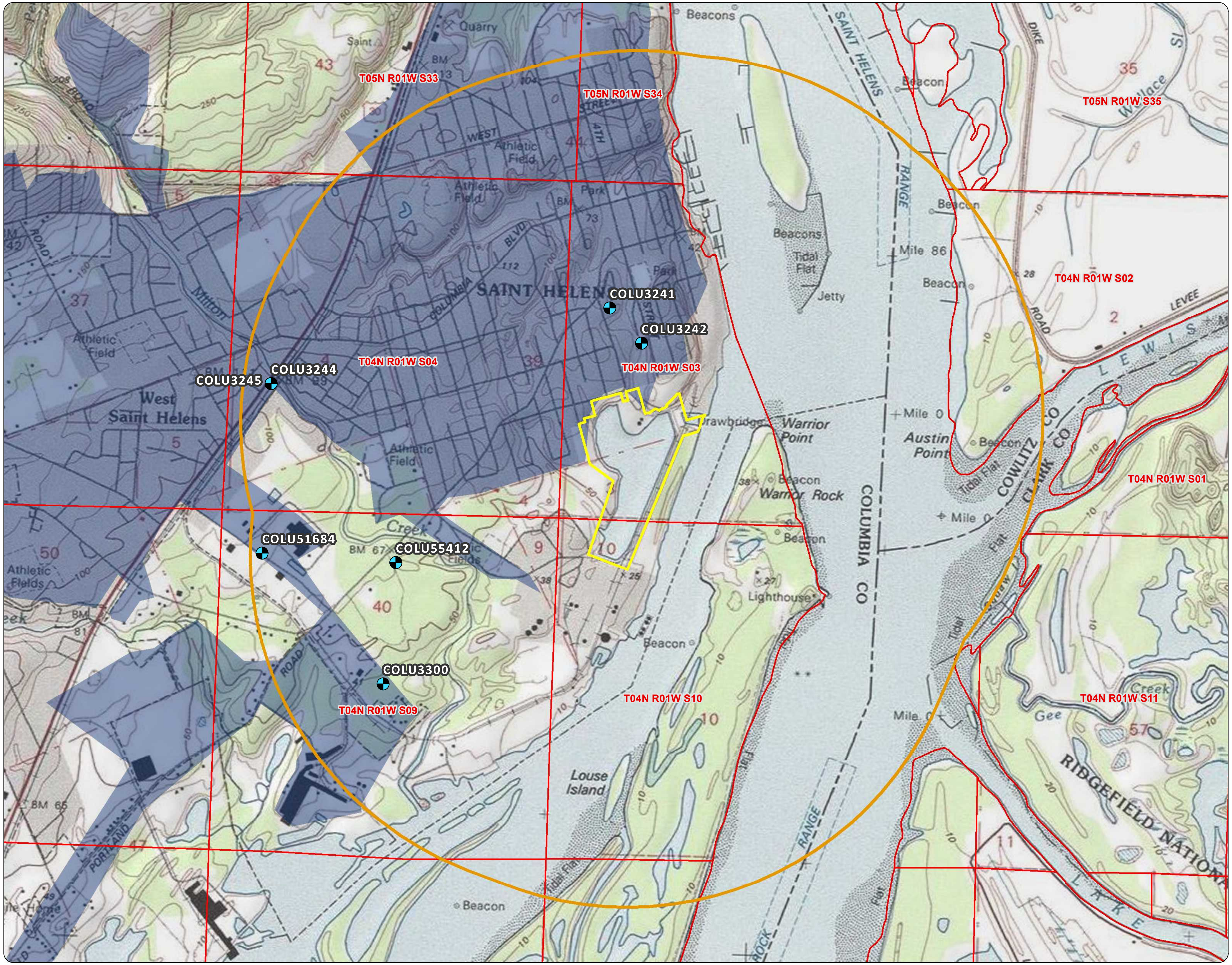

Figure 6-2
Water Wells Within a 1-Mile Radius of the Site

City of St. Helens
Wastewater Treatment Lagoon
St. Helens, Oregon

Legend

- Water Wells
- Property Boundary
- Approximate Service Area Boundary
- 1-Mile Radius
- PLSS Divisions

0 0.25
Miles

Source: Well location information obtained from the Oregon Water Resources Department.
NOTES:
1. PLSS = Public Land Survey System.
2. Service Area Boundary is an approximation of the extent of the City of St. Helens water mainlines and laterals. Locations of water mainlines and laterals were obtained from the City of St. Helens.

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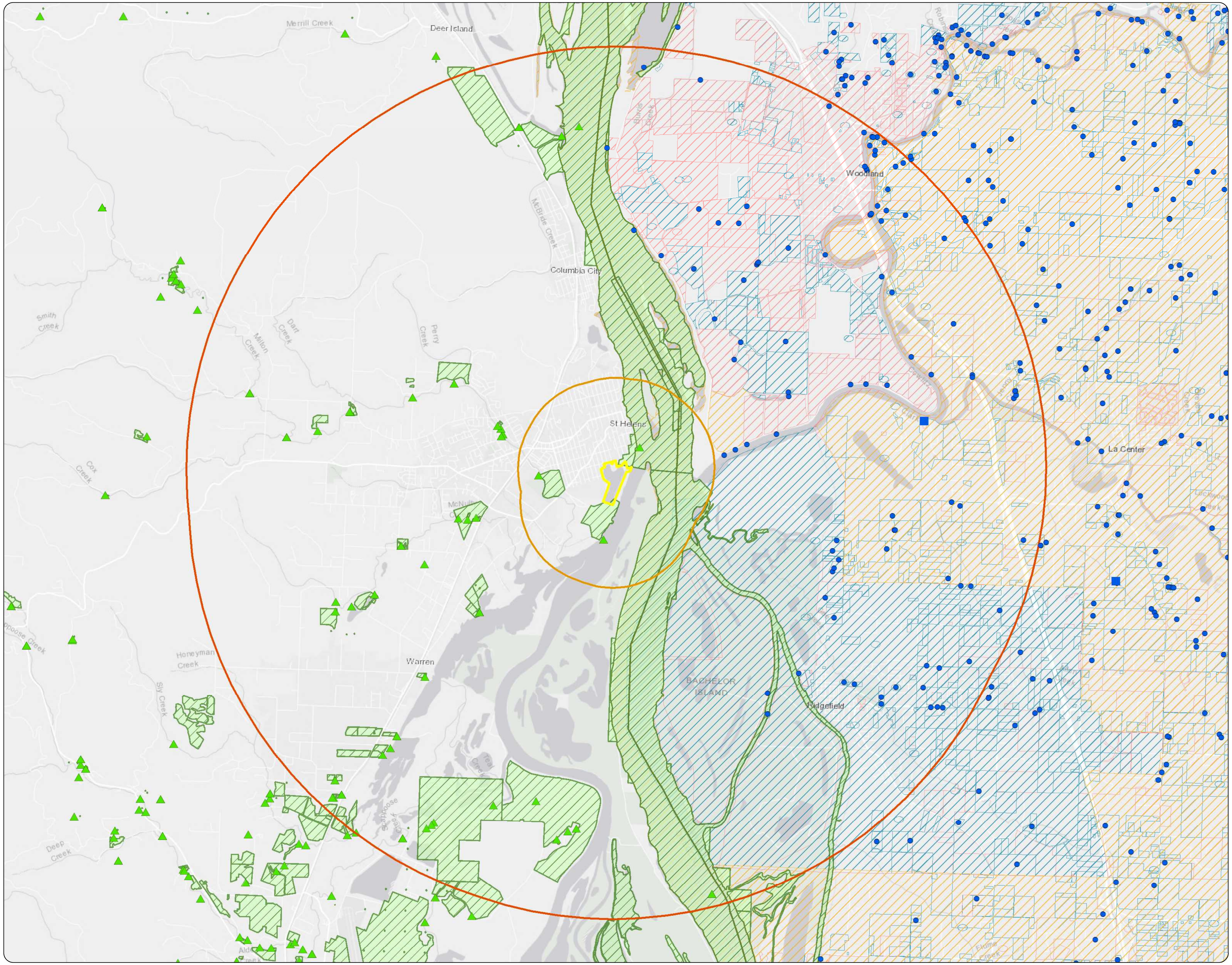
Approved By:
Produced By: aguse
Project: 0830.03

Figure 6-3
Surface Water Rights within a 5-Mile Radius of the Site

City of St. Helens
Wastewater Treatment Lagoon
St. Helens, Oregon



Legend

- Property Boundary
- 1-Mile Radius
- 5-Mile Radius

Oregon Points of Diversion

- Surface Water Points of Diversion
- Surface Water Places of Use

Washington Water Device Types

- Headworks
- Irrigation Dam
- Surface Water Pump
- Reservoir Dam

Washington Places of Use

- Certificate
- Claim
- Permit

0 1
Miles

Source: Oregon water rights data obtained from the Oregon State Water Resources Dapartment. Washington water rights data obtained from the Washington State Department of Ecology.

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Print Date: 12/18/2019
Approved By:
Produced By: aguse
Project: 0830.03

Figure 7-1
Boring and Monitoring Well Locations

City of St. Helens
Wastewater Treatment Lagoon
St. Helens, Oregon

Legend

Boring and Monitoring Well Location

Property Boundary

0 250 500
Feet

Source: Aerial photograph obtained from Mapbox.

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Print Date: 12/11/2019

Approved By:

Produced By: aguse

Project: 0830.03

Figure 8-1
August 2019
Groundwater Elevations

City of St. Helens
Wastewater Treatment Lagoon
St. Helens, Oregon

Legend

- Boring and Monitoring Well Location
- Property Boundary
- Water Level Elevation Contour (2-feet)

0 250 500
Feet

Source: Aerial photograph obtained from Mapbox.
Note:
Vertical datum is National Geodetic Vertical Datum of 1929.

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Print Date: 3/6/2020
Approved By:
Produced By: aguse
Project: 0830.03

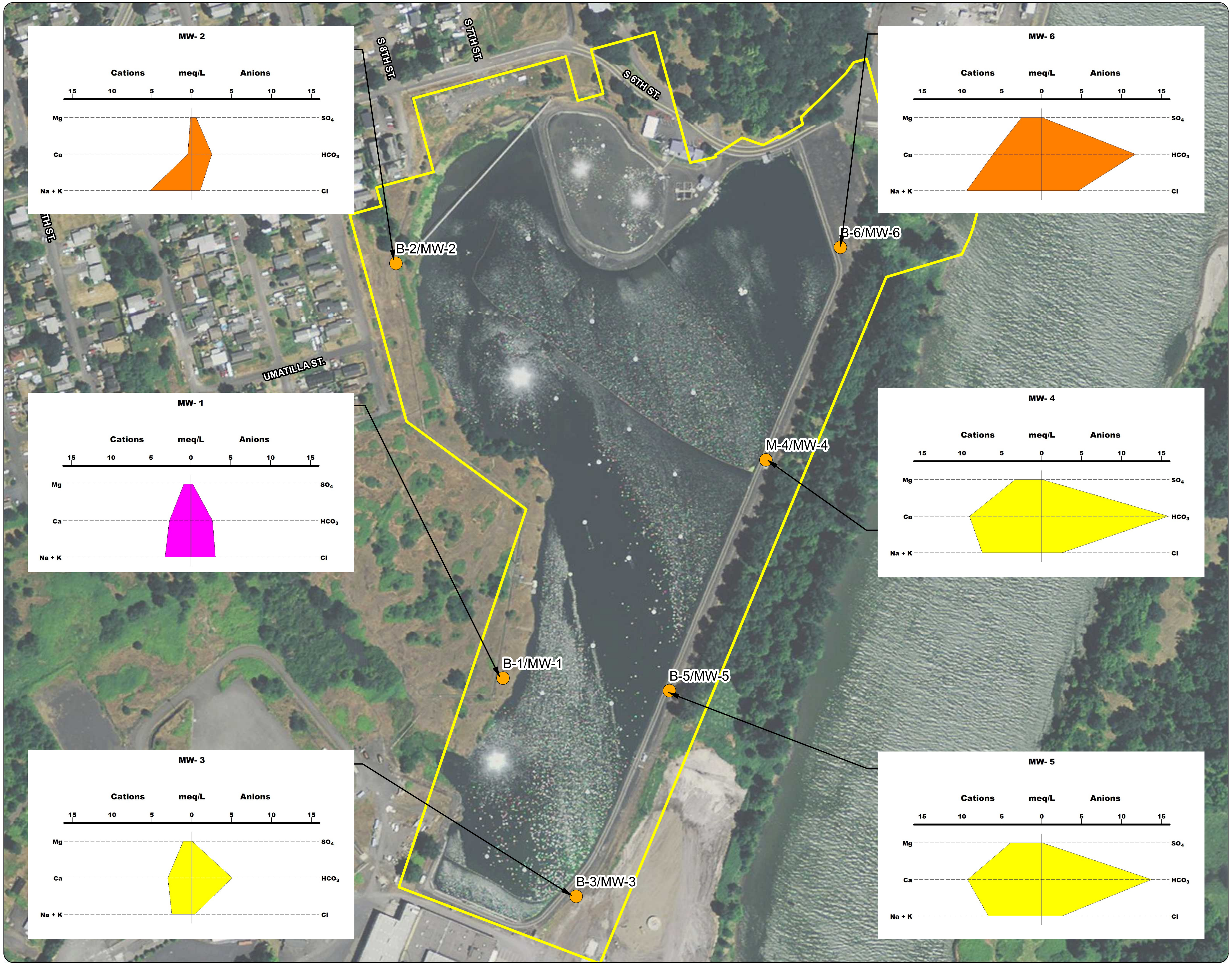

Figure 8-2
Monitoring Well Stiff Diagrams

City of St. Helens
Wastewater Treatment Lagoon
St. Helens, Oregon

Legend

Proposed boring and monitoring well locations

Property Boundary (approximate)

STIFF VALUES COLOR KEY
Yellow = Ca-HCO_3 dominant waters.
Orange = Na-HCO_3 dominant waters.
Pink = Na-Cl dominant waters.

0 250 500
Feet

Source: Aerial photograph obtained from Mapbox.
NOTES:
1. Ca = Calcium
2. Cl = Chlorine
2. HCO_3 = bicarbonate
3. K = Potassium
4. meq/L = Milliequivalents Per Litre
5. Mg = Magnesium
6. Na = Sodium
7. SO_4 = Sulfate

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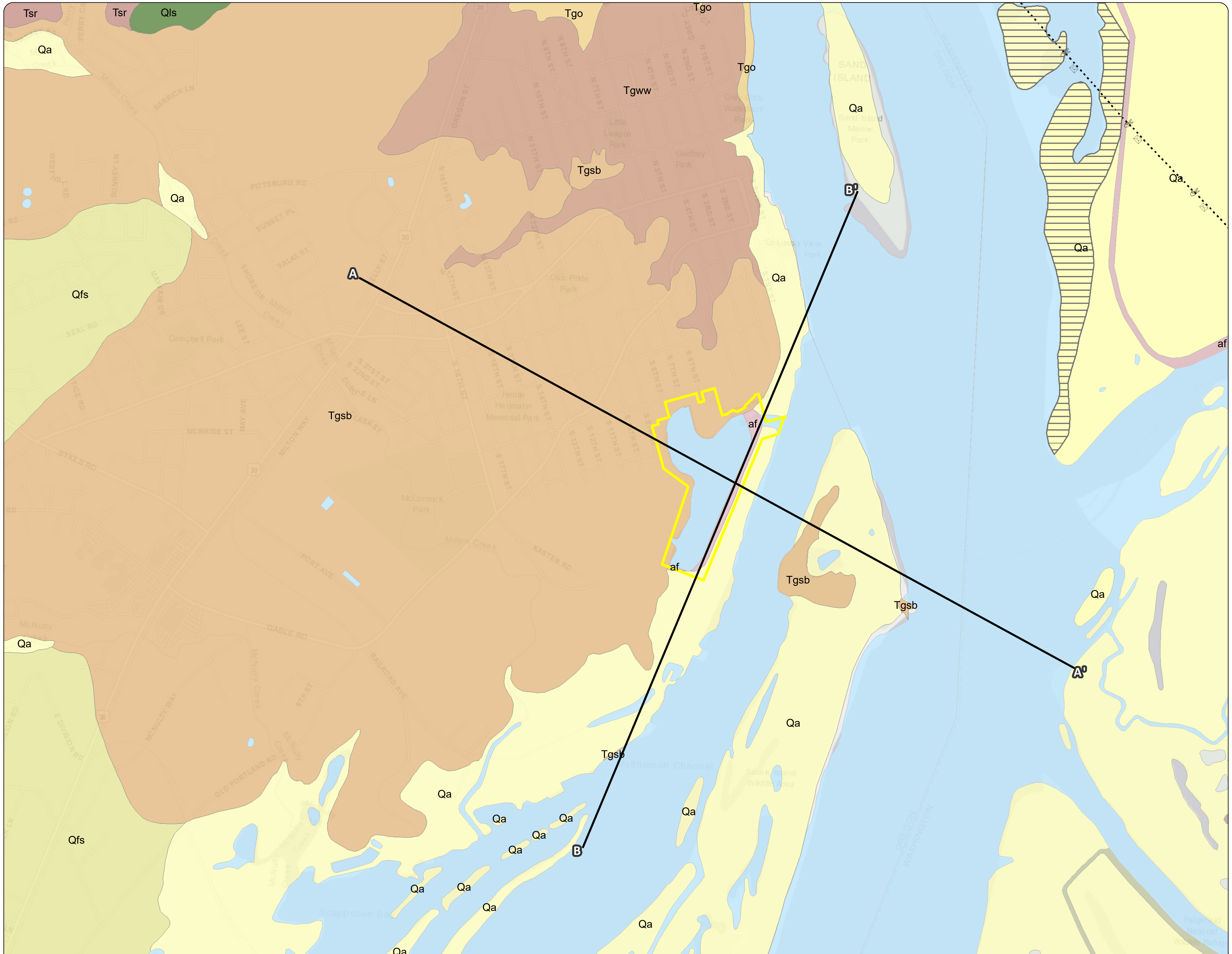
Figure 8-3
Site Geology

City of St. Helens
Wastewater Treatment Lagoon
St. Helens, Oregon



Legend

Cross Section

Property Boundary

Map Unit, Group Member

- Qa (Alluvium), Columbia River alluvium
- Qfs (Cataclysmic flood deposits, fine-grained facies)
- Qls (Landslide deposits)
- Tgo, Member of Ortley
- Tgsb, Member of Sentinel Bluffs
- Tgww, Member of Winter Water
- Tsr, Sandy River Mudstone
- af, Artificial fill
- Water

Description

Alluvium and minor dredge spoils deposited since 1880

Faults

Oblique-Slip Movement

(Eb) Oblique reverse right-lateral, certain concealed [62]

0 0.15 0.3
Miles

Source: Geologic data obtained from the Oregon Department of Geology and Mineral Industries and the Washington Department of Natural Resources.

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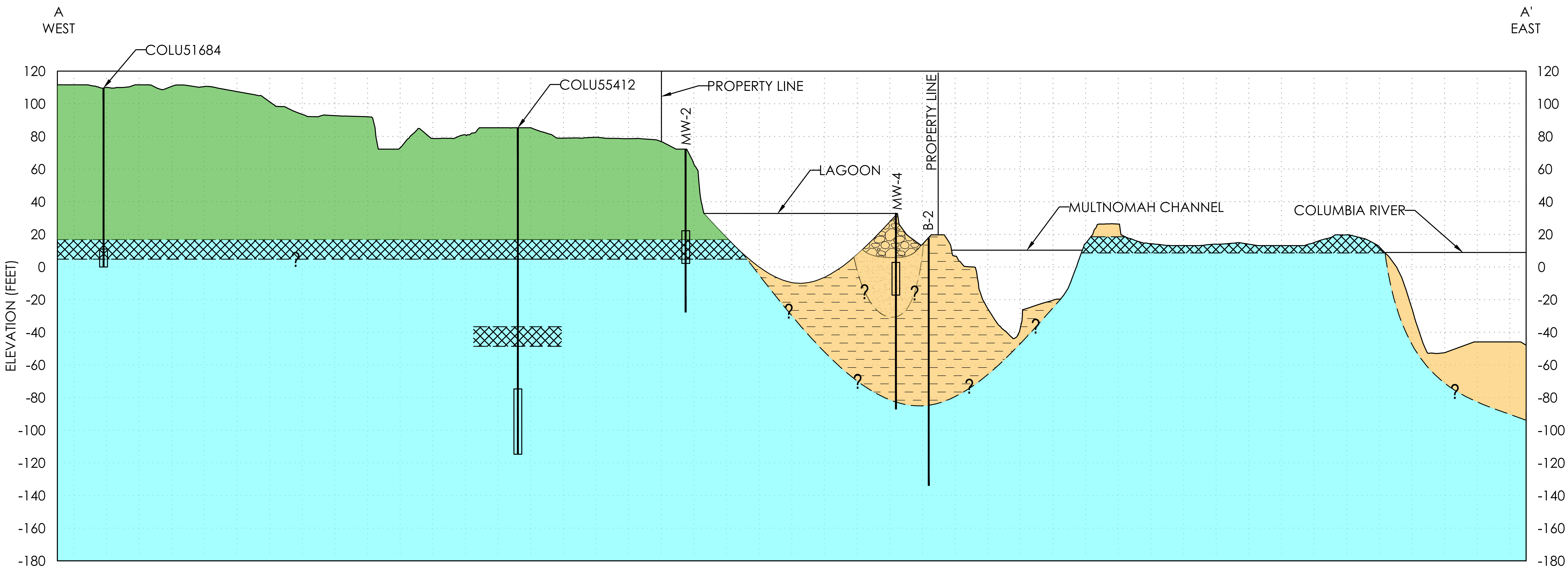
Project: 0830.03 Produced By: aguse Approved By: Print Date: 12/18/2019 Path: C:\Users\aguse\Desktop\St. Helens 0830 03\04 IGA Phase II\Projects\Fig8-2 Site Geology.mxd



LEGEND

ALLUVIUM
SAND
SANDY GRAVEL
SILT
SENTINEL BLUFFS BASALT
WINTER WATER BASALT
INTERFLOW ZONE
LITHOLOGIC CONTACT
INFERRED LITHOLOGIC CONTACT

HORIZONTAL SCALE: 1' = 600'
VERTICAL SCALE: 1' = 60'
VERTICAL EXAGGERATION: 10

NOTE:
CONTACTS SHOWN OUTSIDE OF AREAS PENETRATED BY A BORING OR WELL ARE BASED ON SURFICIAL MAPPING AND CROSS-SECTIONS PRESENTED IN EVARTS, R. C. 2004. GEOLOGIC MAP OF THE SAINT HELENS QUADRANGLE, COLUMBIA COUNTY, OREGON, AND COWLITZ AND CLARK COUNTIES, WASHINGTON, U.S. GEOLOGICAL SURVEY INVESTIGATIONS MAP 2834.

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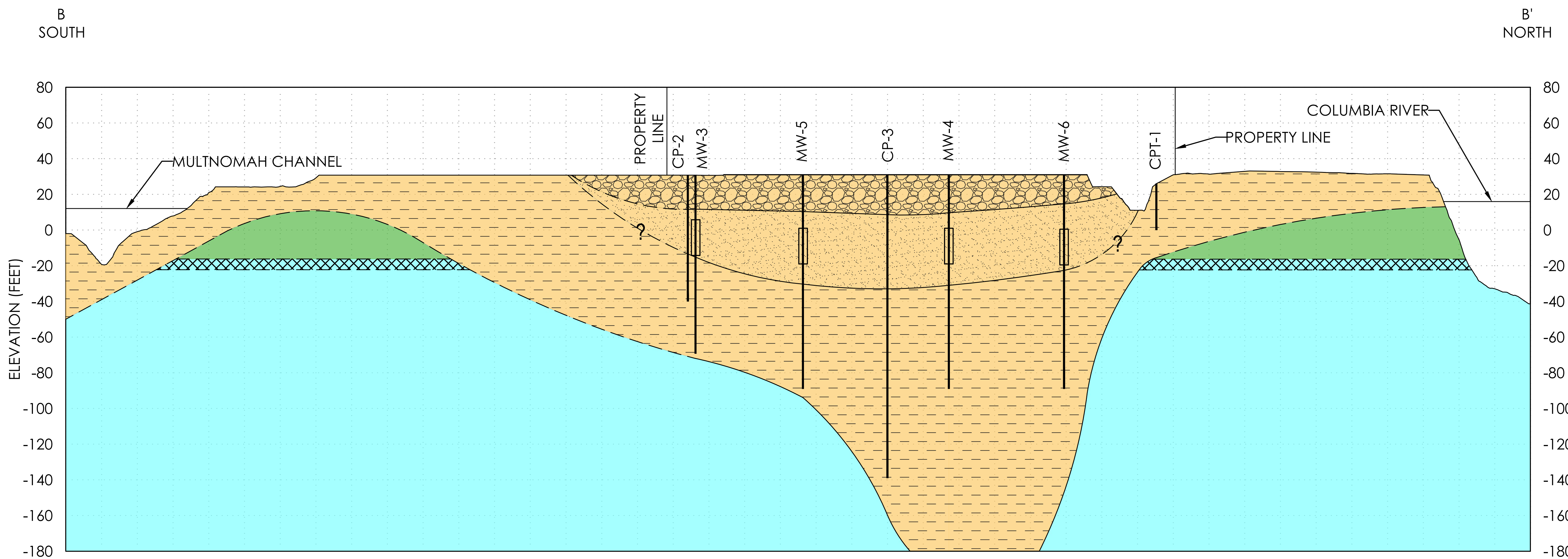
SCALE AS NOTED

NOTE: BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALE ACCORDINGLY.

Figure 8-4
Generalized Geologic Cross Section A-A'
Phase 1 Lagoon Repurposing
St. Helens, Oregon



LEGEND

ALLUVIUM

SAND

SANDY GRAVEL

SILT

SENTINEL BLUFFS BASALT

WINTER WATER BASALT

INTERFLOW ZONE

LITHOLOGIC CONTACT

INFERRED LITHOLOGIC CONTACT

HORIZONTAL SCALE: 1' = 600'
VERTICAL SCALE: 1' = 60'
VERTICAL EXAGGERATION: 10

NOTE:
CONTACTS SHOWN OUTSIDE OF AREAS PENETRATED BY A BORING OR WELL ARE BASED ON SURFICIAL MAPPING AND CROSS-SECTIONS PRESENTED IN EVARTS, R. C. 2004. GEOLOGIC MAP OF THE SAINT HELENS QUADRANGLE, COLUMBIA COUNTY, OREGON, AND COWLITZ AND CLARK COUNTIES, WASHINGTON, U.S. GEOLOGICAL SURVEY INVESTIGATIONS MAP 2834.

PLOTTED BY: Tessa Shobram FILENAME: G:\00_MFA Civil 3D\00_PROJECTS\0830.03 - City of St. Helens\EXHIBIT\FIG-GEO SECTION-V1.dwg

PLOTTED ON: 2020-05-01 8:52 AM

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SCALE AS NOTED

NOTE: BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALE ACCORDINGLY.

Figure 8-5
Generalized Geologic Cross Section B-B'

Phase 1 Lagoon Repurposing
St. Helens, Oregon

APPENDIX A
LEGAL DESCRIPTION

TICOR TITLE

7381501283D

TICOR TITLE

After recording return to:

Robert M. Meek, Esq.
Legal Department, Real Estate
Boise White Paper, L.L.C.
1111 W. Jefferson St., Suite 100
Boise, ID 83702

Until a change is requested, all tax statements shall be sent to Grantee at the following address:
City of St. Helens, Oregon
P.O. Box 278
St. Helens, OR 97051

GRANTOR: Boise White Paper, L.L.C.
GRANTEE: City of St. Helens, OR

COLUMBIA COUNTY, OREGON 2015-008180
DEED-D
Cnt=1 Pgs=10 HUSERB 09/24/2015 03:56:19 PM
$50.00 $11.00 $20.00 $5.00 $10.00 = $96.00

00206207201500081800100109

I, Elizabeth E. Huser, County Clerk for Columbia County, Oregon certify that the instrument identified herein was recorded in the Clerk records.
Elizabeth E. Huser - County Clerk

STATUTORY SPECIAL WARRANTY DEED

(1300 Kaster Road)

(St. Helens, Columbia County, Oregon)

BOISE WHITE PAPER, L.L.C., a Delaware limited liability company, having and address of 1111 West Jefferson Street, Boise, Idaho 83702 ("Grantor"), conveys and specially warrants to City of St. Helens, Oregon, P.O. Box 278, St. Helens, Oregon 97051 ("Grantee") the real property in Columbia County Oregon, more particularly described on Exhibit A attached hereto and by this reference incorporated herein (the "Real Property"), free of encumbrances except as specifically set forth herein.

TOGETHER with all the right, title and interest, if any, of Grantor in and to any streets and roads abutting the Real Property to the center lines thereof, and all access rights of Grantor in and to the Property (collectively, the "Access Rights"); and

TOGETHER with the hereditaments and appurtenances and all the estate and rights of Grantor in and to the Real Property, including, without limitation, timber rights, mineral rights and water rights (collectively the "Property Rights", and together with the Real Property and Access Rights, the "Property");

SUBJECT only to taxes, assessments and other governmental charges not yet delinquent, and the following exceptions, none of which, individually or in the aggregate, materially impair the current use (or materially detract from the value as currently used) of the Property: (i) mechanic's, workmen's repairmen's, warehousemen's, carriers, or other like liens arising or incurred in the ordinary course of business for amounts which are not yet delinquent; (ii) easements, quasi-easements, licenses, covenants, rights-of-way and other similar restrictions, including any other agreements, conditions, restrictions or other matters which would be shown by a current title report or other similar report or listing; (iii) any conditions that may be shown by a current survey, title report or physical inspection; (iv) current leases assigned to Grantee as landlord; (v) zoning, building and other similar restrictions (collectively, the "Permitted Exceptions").

GRANTEE AGREES, on behalf of itself and all successors, assigns and future owners of the Real Property, that no groundwater shall be used, consumed or otherwise put to beneficial use. This covenant shall run with the land.

THIS INSTRUMENT WILL NOT ALLOW USE OF THE PROPERTY DESCRIBED IN THIS INSTRUMENT IN VIOLATION OF APPLICABLE LAND USE LAWAS AND REGULATIONS. BEFORE SIGNING OR ACCEPTING THIS INSTRUMENT, THE PERSON ACQUIRING FEE TITLE TO THE PROPERTY SHOULD CHECK WITH THE APPROPRIATE CITY OR COUNTY PLANNING DEPARTMENT TO VERIFY APPROVED USES AND TO DETERMINE ANY LIMITS ON LAWSUITS AGAINST FARMING OR FOREST PRACTICES AS DEFINED IN ORS 30.930.

The true and actual consideration for this transfer is $3,000.000.00.

DATED: September 22, 2015

BOISE WHITE PAPER, L.L.C., a
Delaware limited liability company

By: Bernadette Madarieta
Name: Bernadette Madarieta 9/22/15

Its: Vice President

STATE OF OREGON
COUNTY OF COLUMBIA
THIS INSTRUMENT WAS ACKNOWLEDGED BEFORE ME ON 9-24-2015
BY RANDY PETERSON AS MAYOR OF THE CITY OF ST HELENS
Rosanne Bellisle
NOTARY PUBLIC OF OREGON

OFFICIAL STAMP
ROSANNE M BELLISLE
NOTARY PUBLIC-OREGON
COMMISSION NO. 941699
MY COMMISSION EXPIRES AUGUST 06, 2019

City of St. Helens a municipality of the State of Oregon hereby approves the above conveyance in fee of real property.

Dated this 24th September, 2015

City of St. Helens

By Randall R Peterson

Randall R. Peterson, Mayor

STATE OF IDAHO)
) ss.
COUNTY OF ADA)

On this 22nd day of September, 2015 before me, the undersigned, a notary public in and for said state, personally appeared Bernadette Madarieta, known to me to be the Vice President of Boise White Paper, L.L.C., a Delaware limited liability company, that executed the above instrument on behalf of said company and acknowledged to me the that said company executed same.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal the day and year in this certificate first above written.

MEREDITH R. SCHREINER
NOTARY
PUBLIC
STATE OF IDAHO

NOTARY PUBLIC FOR IDAHO
Residing at: Boise, Idaho
My Commission Expires: 11-8-2018

{PCA Legal/176284/0011/01606290.DOCX: }

EXHIBIT "A"

PARCEL 1:
A parcel of land in the Thomas H. Smith Donation Land Claim No. 40 in Sections 9 and 10, Lot 7 of said Section 9 and Lots 1 and 2 of said Section 10, all in Township 4 North, Range 1 West of the Willamette Meridian, Columbia County, Oregon, more particularly described as follows:

Beginning at a point in said Lot 7 which is 1425.31 feet distant South 19°17'25" West from the Southwesterly corner of Block 70 in the City of St. Helens, Columbia County, Oregon; thence South 68°51' East for a distance of 174.09 feet to the most Southeasterly corner of Terrace Street in Hawley Addition to St. Helens, Oregon; thence North 29°00' East along the most Easterly line of Terrace Street for a distance of 356.14 feet to the most Easterly corner of said Terrace Street; thence North 61°00' West, along the Northeasterly line of said Terrace Street, for a distance of 420.0 feet to its intersection with the Northeasterly prolongation of the Northwesterly line of Lot 9 of Block 12, said Hawley Addition, said point of intersection being marked with an iron pipe; thence South 68°51' East for a distance of 1,193.31 feet to a point marked by an iron pipe on the Northwesterly line of the right of way of the Spokane, Portland and Seattle Railway Company; thence South 21°09' West, along said Northwesterly right of way line, for a distance of 310.10 feet to a point which is 50 feet distant North 68°51' West from a point on the center line of Spokane, Portland and Seattle Railway Company's railroad, which is located by beginning at the point of the intersection of the center line of Columbia Street with the Southerly line of Cowlitz Street in said City of St. Helens and running thence South 16°57' East for a distance of 670 feet to the point of beginning of a 1,910.08 foot radius curve to the right, Southerly along said curve through a central angle of 38°06' for a distance of 1,270 feet to the end of said curve, and South 21°09' West tangent to said curve for a distance of 2,827.8 feet; thence South 68°51' East for a distance of 25 feet to a point 25 feet distant Northwesterly from, when measured at right angles to, said railroad center line; thence South 21°09' West, parallel to said center line, for a distance of 1,671.5 feet to a point; thence South 68°51' East a distance of 25 feet to the center line of the Spokane, Portland and Seattle Railway Company right of way; thence Southwesterly along the center line of the right of way of Spokane, Portland and Seattle Railway Company to its intersection with a line bearing South 68°51' East from a point which is 2,191.00 feet distant South 21°09' West from the point of beginning; thence North 68°51' West to said point, which is 2191.00 feet distant South 21°09' West from the point of beginning; thence continuing North 68°51' West for a distance of 1,093.3 feet to a point in the center of Milton Creek; thence Northerly along the center of said Milton Creek as follows: North 42°15' East for a distance of 122.4 feet; North 61°50' East for a distance of 292.6 feet; North 42°47' East for a distance of 213.6 feet; North 17°57' West for a distance of 587.0 feet; North 37°22' East for a distance of 210.0 feet; North 04°22' East for a distance of 225.0 feet and North 60°37' West for a distance of 119.1 feet to the point of intersection with the Southwesterly prolongation of the center line of Fir Street in said Hawley Addition; thence North 29°00' East along said Southwesterly prolongation for a distance of 23.5 feet to a point on the South line of Brook Street in said Hawley Addition; thence Southeasterly along said South line of Brook Street as follows: South 61°00' East a distance of 490.0 feet; South 29°00' West for a distance of 50.0 feet, and South 61°00' East for a distance of 799.92 feet to a point which is 969.16 feet distant South 21°09' West from the point of beginning; thence North 21°09' East along the Southeasterly line of said Hawley Addition for a distance of 969.16 feet to the point of beginning. EXCEPT that portion lying within the bounds of the Spokane, Portland and Seattle Railway Company right of way. ALSO EXCEPT that tract of land as conveyed to City of St. Helens by deed recorded April 24, 1970 under Deed Book 177, page 23, Records of Columbia County, Oregon.

PARCEL 2:
A parcel of land in the Thomas H. Smith Donation Land Claim No. 40 in Sections 9 and 10 and Lots 1 and 2 of said Section 10, all in Township 4 North, Range 1 West of the Willamette Meridian, Columbia County, Oregon, more particularly described as follows:

Beginning at a point in said Lot 1 which is 2,108.59 feet distant South and 413.1 feet distant East from the Southwesterly corner of Block 70 of the City of St. Helens, Columbia County, Oregon; thence North 68°51' West for a distance of 25 feet to the true point of beginning of this description, said true point of beginning being also a point 25 feet distant South 68°51' East from the center line of the railroad of Spokane, Portland and Seattle Railway Company at a point which is located by beginning at the point of intersection of the center line of Columbia Street with the Southerly line of Cowlitz Street in said City of St. Helens and running thence South 16°57' East for a distance of 670 feet to the point of beginning of a 1,910.08 foot radius curve to the right; thence Southerly along said curve through a central angle of 38°06' for a distance of 1270 feet to the end of said curve, the end of said curve being hereinafter referred to as "Point A", and thence South 21°09'

EXHIBIT "A"
(Continued)

West tangent to said curve for a distance of 3,317.7 feet; thence from the true point of beginning South 21°09' West parallel with said railroad center line for a distance of 1,171.5 feet to a point; thence North 68°51' West a distance of 25 feet to the center line of the Spokane, Portland and Seattle Railway Company right of way; thence Southwesterly along the center line of the right of way of Spokane, Portland and Seattle Railway Company to its intersection with a line bearing South 68°51' East from a point, hereinafter referred to a "Point B", which is 2,191.0 feet distant South 21°09' West from a point which is 1425.31 feet distant South 19°17'25" West from the Southwesterly corner of said Block 70 of the City of St. Helens; thence South 68°51' East to a point on the low water line of the West bank of the Willamette Slough which is 1208.20 feet distant from Point B; thence Northerly along said low water line as follows: North 29°53' East for a distance of 505.87 feet; thence North 30°21' East for a distance of 700 feet; and thence North 27°31' East for a distance of 603.73 feet to a point 389 feet distant South 68°51' East from the true point of beginning; thence South 68°51' East for a distance of 206 feet to a point; thence North 05°42' East for a distance of 450.3 feet to a point on the low water line of said West bank; thence North 17°20' East along said low water line for a distance of 366.8 feet; thence North 68°51' West for a distance of 425.6 feet to a point marked by an iron pipe on the Southeasterly line of the right of way of Spokane, Portland and Seattle Railway Company which is 50 feet distant South 68°51' East from the center line of the railroad of Spokane, Portland and Seattle Railway Company at a point which is 2,517.7 feet distant South 21°09' West from Point A; thence South 21°09' West along said Southeasterly right of way line for a distance of 100.0 feet; thence North 68°51' West for a distance of 25 feet; thence South 21°09' West parallel with center line of said railroad for a distance of 700 feet to the true point of beginning. EXCEPT that portion lying within the bounds of the Spokane, Portland and Seattle Railway Company right of way.

PARCEL 3:
Blocks 4, 10, 11, 12 and 13, HAWLEY ADDITION TO ST. HELENS, in the City of St. Helens, Columbia County, Oregon. Together with that portion of vacated streets that attaches by operation of law pursuant to City of St. Helens Ordinance No. 2448 as recorded November 21, 1983 in Deed Book 249 at page 872, Deed Records of Columbia County, Oregon.

PARCEL 4:
Lots 1, 2, 3, 4, 5, 6, 7 and 8, Block 7, HAWLEY ADDITION TO ST. HELENS, in the City of St. Helens, Columbia County, Oregon. Together with that portion of vacated streets that attaches by operation of law pursuant to City of St. Helens Ordinance No. 2448 as recorded November 21, 1983 in Deed Book 249 at page 872, Deed Records of Columbia County, Oregon.

PARCEL 5:
Parcel 5A: Block 26, HAWLEY ADDITION TO ST. HELENS, in the City of St. Helens, Columbia County, Oregon. Together with that portion of vacated California Street, Brook Street and Fir Street of HAWLEY ADDITION TO ST. HELENS, in the City of St. Helens, Columbia County, Oregon, described as follows:
Beginning at the most Easterly corner of Lot 4, Block 26, HAWLEY ADDITION TO ST. HELENS; thence along the Southerly line of Kaster Road 30 feet to the center line of Fir Street; thence along the centerline of Fir Street and an extension thereof, South 29° West to the South line of Brook Street; thence Northwesterly along the Southerly line of Brook Street to an intersection with an extension of the centerline of California Street extended; thence North 29° East along the extension of California Street to an intersection with the South line of Kaster Road; thence South 61° East along Kaster Road 30 feet to the most Northerly corner of Block 26, HAWLEY ADDITION TO ST. HELENS; thence South 29° West along the Westerly line of Block 26, a distance of 299.98 feet to the most Westerly corner of said Block; thence along the Southerly line of Block 26, South 75°02' East 206.16 feet to the most Southerly corner of Block 26; North 29° East along the Easterly line of Block 26, a distance of 249.99 feet to the point of beginning. ALSO together with that portion of the Thomas H. Smith Donation Land Claim in Section 9, Township 4 North, Range 1 West, Willamette Meridian, Columbia County, Oregon, bounded on the Northeast by Brook Street, bounded on the Northwest by the extension of the centerline of California Street, bounded on the Southwest by the centerline of Milton Creek and bounded on the Southeast by extension of the centerline of Fir Street.

Parcel 5B: Block 25, HAWLEY ADDITION TO ST. HELENS, in the City of St. Helens, Columbia County, Oregon. Together with that portion of vacated California Street and Brook Street of HAWLEY ADDITION TO ST. HELENS, in the City of St. Helens, Columbia County, Oregon, described as follows:
Beginning at the most Easterly corner of Lot 4, Block 25, HAWLEY ADDITION TO ST. HELENS; thence along the South side of Kaster Road, South 61° East 30 feet to the centerline of California Street; thence along the

EXHIBIT "A"
(Continued)

centerline of California Street and an extension thereof, South 29° West to the South line of Brook Street; thence along the South line of Brook Street in a Northwesterly direction to the intersection of the Easterly line of Seventh Street; thence along the Easterly line of Seventh Street North 44°20' East 60.22 feet to the most Westerly corner of Lot 8, Block 25, HAWLEY ADDITION TO ST. HELENS; thence along the Northerly line of Brook Street South 40°46' East 290.25 feet to the most Southerly corner of Lot 7, Block 25; thence along the Westerly line of California Street North 29° East 300.58 feet to the point of beginning. ALSO together with that portion of the Thomas H. Smith Donation Land Claim in Section 9, Township 4 North, Range 1 West, Willamette Meridian, Columbia County, Oregon, bounded on the Northeast by Brook Street, bounded on the Northwest by the extension of the Southeasterly margin of Seventh Street, bounded on the Southwest by the centerline of Milton Creek, and bounded on the Southeast by the extension of the centerline of California Street.

Parcel 5C: That portion of vacated 7th Street that attaches by operation of law pursuant to City of St. Helens Ordinance No. 2448, as recorded November 21, 1983 in Deed Book 249 at page 872, Deed Records of Columbia County, Oregon, being a portion of 7th Street in South St. Helens as per plat on file and of record in the Clerk's Office, Columbia County, Oregon, in Section 9, Township 4 North, Range 1 West, Willamette Meridian, Columbia County, Oregon, more particularly described as follows:
Beginning at the most Easterly corner of Lot 16, Block 32 of said SOUTH ST. HELENS; thence South 45°40' East a distance of 60.00 feet to the Southeasterly right of way line of 7th Street; thence South 44°20' West, along said Southeasterly right of way line a distance of 133.91 feet, more or less, to the point of intersection of the center line of vacated Brook Street and said Southeasterly right of way line of 7th Street; thence Northwesterly on a line drawn between the said point of intersection of the center line of vacated Brook Street and the Southeasterly right of way line of 7th Street and the point of intersection of the center line of vacated North Milton Way and the Northwesterly right of way line of 7th Street; thence North 44°20' East, along the Northwesterly right of way line of 7th Street a distance of 120.85 feet, more or less, to the point of beginning.

Parcel 5D: That portion of vacated 7th Street that attaches by operation of law pursuant to City of St. Helens Ordinance No. 2519, as recorded April 16, 1987 in Deed Book 268, page 745, Deed Records of Columbia County, Oregon, being a portion of 7th Street in SOUTH ST. HELENS, as per plat on file and of record in the Clerk's Office, Columbia County, Oregon, in Section 9, Township 4 North, Range 1 West, Willamette Meridian, Columbia County, Oregon, more particularly described as follows:
Beginning at the most Easterly corner of Lot 16, Block 32 of said SOUTH ST. HELENS; thence South 45°40' East a distance of 60.00 feet to the Southeasterly right of way line of said 7th Street; thence North 44°20' East, along said Southeasterly right of way line of said 7th Street, a distance of 103.70 feet, more or less, to the Northwesterly corner of Lot 1, Block 25 of HAWLEY ADDITION TO ST. HELENS, which is on the Southwesterly right of way line of Kaster Road; thence Northwesterly along the Southwesterly right of way line of said Kaster Road to the Southeasterly corner of Lot 12, Block 32 of SOUTH ST. HELENS; thence South 44°20' West along the Northwesterly right of way line of said 7th Street to the most Easterly corner of Lot 16, Block 32, SOUTH ST. HELENS and the point of beginning.

Parcel 5E: Lots 1, 2, 3, 4, 13, 14, 15 and 16, Block 32, SOUTH ST. HELENS, in the City of St. Helens, Columbia County, Oregon. Together with that portion of vacated North Milton Way which attaches by operation Law pursuant to City of St. Helens Ordinance No. 2254, as recorded June 12, 1978 under Deed Book 218, page 450, Deed Records of Columbia County, Oregon.

Parcel 5F: Part of Block C, SOUTH ST. HELENS, Columbia County, Oregon, and part of vacated North Milton Way in said SOUTH ST. HELENS, described as follows:
Beginning at the Southwest corner of Block 32, SOUTH ST. HELENS, Columbia County, Oregon; thence Easterly along the Southerly line of said Block 32 and the Northerly right of way line of North Milton Way to a point on said line that is the intersection of said line with the Southeasterly prolongation of the Southwesterly line of Lot 2 in said Block 32; thence South 42°26' West to the center of Milton Creek; thence Westerly along the center of said Milton Creek to the Southeasterly right of way line of Old Portland Road; thence North 42°26' East along said right of way line to the point of beginning.

Parcel 5G: A tract of land situate in the Northeast quarter of Section 9, Township 4 North, Range 1 West, Willamette Meridian, Columbia County, Oregon, more particularly described as follows:
Beginning at the Southwest corner of Block 32, SOUTH ST. HELENS, Columbia County, Oregon; thence Easterly along the Southerly line of said Block 32, and the Northerly right of way line of North Milton Way to a

EXHIBIT "A"
(Continued)

point on said line that is the intersection of said line with the Southeasterly prolongation of the Southwesterly line of said Lot 2 in said Block 32; thence South 42°26' West to the centerline of vacated North Milton Way and the true point of beginning of the following described tract; thence continuing South 42°26' West to the center of Milton Creek; thence Easterly along the center of said Milton Creek to the Westerly right of way line of Seventh Street; thence Northeasterly along the Westerly right of way line of said Seventh Street to the centerline of vacated North Milton Way; thence Westerly along the said centerline of vacated North Milton Way to the true point of beginning.

Parcel 5H: That portion of Lots 5 and 12, Block 32, SOUTH ST. HELENS, in the City of St. Helens, Columbia County, Oregon, lying Southwesterly of Kaster Road. EXCEPTING therefrom that portion dedicated to the City of St. Helens as recorded May 4, 1987 in Book 268, page 914, Records of Columbia County, Oregon.

PARCEL 6:
Blocks 8 and 9, HAWLEY ADDITION TO ST. HELENS, in the City of St. Helens, Columbia County, Oregon.

PARCEL 7:
Lots 2 through 20, inclusive, Block 2, HAWLEY ADDITION TO ST. HELENS, in the City of St. Helens, Columbia County, Oregon. Together with a portion of vacated California Street that attaches by operation of law pursuant to City of St. Helens order recorded December 24, 1973 in Deed Book 194, page 291, Deed Records of Columbia County, Oregon, being that half of vacated California Street which abuts Lots 13, 14, 15, 16, 17, 18, 19 and 20 of said Block 2.

PARCEL 8:
Lot 1, Block 2, HAWLEY ADDITION TO ST. HELENS, in the City of St. Helens, Columbia County, Oregon. Together with a portion of vacated California Street that attaches by operation of law pursuant to City of St. Helens order recorded December 24, 1973 in Deed Book 194, page 291, Deed Records of Columbia County, Oregon, being that half of vacated California Street which abuts said Lot 1, Block 2.

PARCEL 9:
Parcel 9A: Blocks 3 and 6 and Lots 5 through 14, inclusive, Block 5, HAWLEY ADDITION TO ST. HELENS, in the City of St. Helens, Columbia County, Oregon. Together with that portion of vacated Church Street, Park Street, Pine Street, Franklin Street and Center Street that attaches by operation of law pursuant to City of St. Helens Ordinance No. 2448 as recorded November 21, 1983 in Book 249, page 872, Deed Records of Columbia County, Oregon.

Parcel 9B: Blocks 27, 28, 29, 30 and 31, HAWLEY ADDITION TO ST. HELENS, in the City of St. Helens, Columbia County, Oregon. Together with that portion of vacated Church Street, Pine Street, Franklin Street, Center Street and Brook Street that attaches by operation of law pursuant to City of St. Helens Ordinance No. 2448 as recorded November 21, 1983 in Book 249, page 872, Deed Records of Columbia County, Oregon. ALSO Together with that portion of vacated Fir Street that attaches by operation of law pursuant to City of St. Helens Order of Vacation as recorded November 29, 1947 in Deed Book 97, page 164, Deed Records of Columbia County, Oregon.

PARCEL 10:
Lots 1, 2 and 15, Block 5, HAWLEY ADDITION TO ST. HELENS, in the City of St. Helens, Columbia County, Oregon. Together with that portion of vacated Pine Street that attaches by operation of law pursuant to City of St. Helens Ordinance No. 2448 as recorded November 21, 1983 in Book 249, page 872, Deed Records of Columbia County, Oregon.

PARCEL 11:
Block 1, HAWLEY ADDITION TO ST. HELENS, in the City of St. Helens, Columbia County, Oregon. Together with that portion of vacated California Street that attaches by operation of law pursuant to City of St. Helens Order recorded December 24, 1973 in Deed Book 194, page 291, Deed Records of Columbia County, Oregon. EXCEPTING THEREFROM that portion dedicated to the City of St. Helens as recorded May 4, 1987 in Deed Book 268, page 914, Deed Records of Columbia County, Oregon.

PARCEL 12:
A tract of land situated in Section 4, Township 4 North, Range 1 West, Willamette Meridian, Columbia County,

EXHIBIT "A"
(Continued)

Oregon, more particularly described as follows:

Beginning at a point on the Southerly line of the H.M. Knighton Donation Land Claim in Columbia County, Oregon, at the intersection with the East line of Kaster road, said point being North 71°30' East 32.59 feet from the Southwest corner of said claim; thence from this point of beginning, North 71°30' East along the South line of said claim, 513.01 feet to the Westerly line of 16th Street extended; thence North 16°57'23" West along said 16th Street extended, 37.67 feet to the South line of East Street as shown on the plat of St.Helens, Columbia County, Oregon; thence along the Southerly line of said East Street, South 73°02'37" West 280 feet to the West line of 17th Street extended; thence North 16°57'23" West along 17th Street, 126.7 feet to the South line of Old Portland Road; thence South 41°49' West along Old Portland Road 276.00 feet to the East line of Kaster Road; thence along Kaster Road, South 20°14' East 31.27 feet; thence South 41°31' East to the point of beginning. EXCEPTING THEREFROM that portion dedicated to the City of St. Helens as recorded May 4, 1987 in Deed Book 268, page 914, Deed Records of Columbia County, Oregon.

PARCEL 13:
A tract of land being a portion of Lots 9 and 10, Block 32, SOUTH ST. HELENS, Columbia County, Oregon, more particularly described as follows:

Beginning at a point which is North 71°30' East 32.59 feet from the Southwest corner of the H.M. Knighton Donation Land Claim, Columbia County, Oregon, said point being the intersection of the South line of said Knighton Donation Land Claim and the Easterly right of way line of Kaster Road; thence North 71°30' East along said Claim line, a distance of 170.06 feet to the most Westerly corner of Lot 8 of Block 32, SOUTH ST. HELENS Addition , Columbia County, Oregon; thence South 45°40' East, a distance of 16.77 feet to the most Northerly corner of that tract as described in Book 59, page 125, Columbia County Deed Records; thence along the Northwesterly side of tract as described in Book 59, page 125, South 44°20' West a distance of 158.4 feet to the said Easterly right of way line of Kaster Road; thence North 41°31' West a distance of 94.86 feet to the point of beginning. EXCEPTING THEREFROM that portion dedicated to the City of St. Helens as recorded May 4, 1987 in Deed Book 268, page 914, Deed Records of Columbia County, Oregon.

PARCEL 14:
Lots 6, 7, 8, 9, 10 and 11, Block 32, SOUTH ST. HELENS, Columbia County, Oregon. EXCEPTING THEREFROM the following described parcel: A tract of land being a portion of Lots 9 and 10, Block 32, SOUTH ST. HELENS, Columbia County, Oregon, more particularly described as follows:

Beginning at a point which is North 71°30' East 32.59 feet from the Southwest corner of the H.M. Knighton Donation Land Claim, Columbia County, Oregon, said point being the intersection of the South line of said Knighton Donation Land Claim and the Easterly right of way line of Kaster Road; thence North 71°30' East along said Claim line, a distance of 170.06 feet to the most Westerly corner of Lot 8 of Block 32, SOUTH ST. HELENS Addition , Columbia County, Oregon; thence South 45°40' East, a distance of 16.77 feet to the most Northerly corner of that tract as described in Book 59, page 125, Columbia County Deed Records; thence along the Northwesterly side of tract as described in Book 59, page 125, South 44°20' West a distance of 158.4 feet to the said Easterly right of way line of Kaster Road; thence North 41°31' West a distance of 94.86 feet to the point of beginning. ALSO EXCEPTING THEREFROM that portion dedicated to the City of St. Helens as recorded May 4, 1987 in Deed Book 268, page 914, Deed Records of Columbia County, Oregon.

PARCEL 15:
A tract of land in Sections 9 and 10, Township 4 North, Range 1 West, Willamette Meridian, Columbia County, Oregon, more particularly described as follows:

Beginning at a point in the Thomas H. Smith Donation Land Claim No. 40 in Section 9, Township 4 North, Range 1 West, Willamette Meridian, Columbia County, Oregon, that is South 3,389.14 feet and West 1,261.43 feet from the Southwest corner of Block 70, City of St. Helens; thence South 68°51' East to the Northerly right of way line of the Burlington-Northern Railroad Spur, (formerly Spokane, Portland and Seattle Railroad and also formerly the St. Helens Dock and Terminal Railroad); thence in a general Westerly direction along said Northerly line of the Burlington-Northern Railroad Spur right of way to the East bank of Milton Creek; thence Northeasterly and Northwesterly along the East bank of Milton Creek to a point that is North 68°51' West of the point of beginning; thence South 68°51' East to the point of beginning.

EXHIBIT "A"
(Continued)

PARCEL 16:
A tract of land situated in Sections 3, 4, 9 and 10, Township 4 North, Range 1 West, Willamette Meridian, Columbia County, Oregon, more particularly described as follows:

Beginning at the point of intersection with the Northwesterly right of way line of the Spokane, Portland and Seattle Railroad and the Northwesterly line of Government Lot 4 in Section 3, Township 4 North, Range 1 West, Willamette Meridian, Columbia County, Oregon; thence Southwesterly along the Northwesterly line of said Government Lot 4 and of Government Lot 6 in said Section 3 and Northwesterly line of Government Lot 6 in Section 4, said Township and Range to its intersection with the Northeasterly line of HAWLEY ADDITION TO ST. HELENS, Columbia County, Oregon; thence South 61°00' East along Northeasterly line of said HAWLEY ADDITION TO ST. HELENS to its intersection with the Northeasterly extension of center line of Block 12 of said HAWLEY ADDITION TO ST. HELENS; thence South 68°51' East 1,193.31 feet to the Northwesterly right of way line of the said Spokane, Portland and Seattle Railroad right of way; thence North 21°09' East along the Northwesterly right of way line of the said Spokane, Portland and Seattle Railroad right of way, to the point of beginning. EXCEPTING THEREFROM that portion conveyed to City of St. Helens, Oregon, by deed recorded April 24, 1970 in Book 177, page 23, Deed Records of Columbia County, Oregon, and that portion conveyed to St. Helens Rural Fire Protection District by deed recorded May 24, 1989 as Instrument No. 89-2674, Records of Columbia County, Oregon.

PARCEL 17:
A tract of land situated in Sections 3 and 10, Township 4 North, Range 1 West, Willamette Meridian, Columbia County, Oregon, more particularly described as follows:

Beginning at the intersection of the Southeasterly right of way line of the Spokane, Portland and Seattle Railroad and the Northwesterly line of Government Lot 4 in Section 3, Township 4 North, Range 1 West, Willamette Meridian, Columbia County, Oregon; thence Northeasterly along the Northwesterly line of said Government Lot 4 to the low water line of the Willamette Slough, also known as Multnomah Channel; thence Southwesterly along the low water line of said Willamette Slough to its intersection of the Northeasterly line of Tract 9-1 conveyed to St. Helens Paper Corporation, a Delaware Corporation by deed recorded May 7, 1964 in Book 154, page 896, Deed Records of Columbia County, Oregon; thence North 68°51' West a distance of 425.6 feet to the Southeasterly right of way line of said Spokane, Portland and Seattle Railroad; thence Northeasterly along the Southeasterly right of way line of said Spokane, Portland and Seattle Railroad to the point of beginning. EXCEPTING therefrom that portion conveyed to Spokane, Portland and Seattle Railway Company by deed recorded June 16, 1970 in Book 177, page 557, Deed Records of Columbia County, Oregon.

PARCEL 18:
All of Government Lot 4 of Section 9, Township 4 North, Range 1 West, Willamette Meridian, Columbia County, Oregon and all of Governments Lots 2, 3, 4 and 5 of Section 16, Township 4 North, Range 1 West, Willamette Meridian, Columbia County, Oregon.

WARRANTY DEED

BOISE CASCADE CORPORATION, a Delaware corporation, grantor, conveys to CITY OF ST. HELENS, OREGON, a municipal corporation, grantee, the following described real property and all appurtenances thereto:

A. Beginning at a point which is East 1222.9 feet from the Southwest corner of Section 3, Township 4 North, Range 1 West, Willamette Meridian, Columbia County, Oregon, said point being on the South line of said Section 3 and the Westerly Right of Way line of the SP&S Railway; thence North 21°09' East along said Right of Way a distance of 1360.06 feet to the South line of the H. M. Knighton Donation Land Claim; thence North 71°30' East along said Donation Land Claim a distance of 45.46 feet to a point which is 15 feet from (when measured at right angles to) to the centerline of said Railway; thence South 21°09' West running parallel to and 15 feet distant from said centerline a distance of 1826.71 feet; thence South 26°52' West a distance of 100.5 feet; thence South 39°30' West a distance of 83.82 feet to said right of way; thence North 21°09' East along said right of way a distance of 617.64 feet to the point of beginning.

B. Beginning at a point on the Easterly line of Block 36, City of St. Helens' as per plat on file and of record in the clerk's office of Columbia County, Oregon which is South 16°55' East 578.65 feet from the Northeast corner of said Block 36, said point being the Westerly Right of Way line of the SP&S Railway; thence South 21°09' West along said Right of Way a distance of 401.53 feet to the South line of the H. M. Knighton Donation Land Claim; thence North 71°30' East along said Donation Land Claim a distance of 45.46 feet; thence North 21°09' East running parallel to and 15.0 feet distant from centerline of said railroad a distance of 327.83 feet to the East line of said Block 36; thence North 16°55' West a distance of 56.76 feet to the point of beginning.

Subject to:

Recorded By
Pioneer National
Title Insurance Company

Right, title and interest of the State of Oregon in and to that portion of the above premises lying between ordinary high and low water.

The rights of fishing, navigation and commerce in the State of Oregon, the Federal Government, the public in and to that portion thereof lying below the ordinary high water mark of the Columbia River.

This conveyance is given in consideration of other performance promised.

This conveyance is given on the express condition that if Grantee shall at any time cease to use the property principally for the purpose of primary, secondary or other municipal or industrial waste treatment or disposal, then Grantor shall have the right to declare this conveyance null and void and to retake possession of the property.

Grantor covenants with Grantee that it owns the above property free of all encumbrances except those stated above and, subject to those exceptions, warrants and will forever defend the property from the lawful claims of all persons.

DATED , 1970.

~~BOISE~~ CASCADE CORPORATION

CS

John Maurice

By John E. Clute

STATE OF IDAHO)
) ss.
County of Ada)

On this 24th day of July, 1970, personally appeared J. E. Clute, who, being duly sworn, did say that he is Vice President of BOISE CASCADE CORPORATION, and that this deed was voluntarily signed in behalf of the corporation by authority of its board of directors.

Before me:

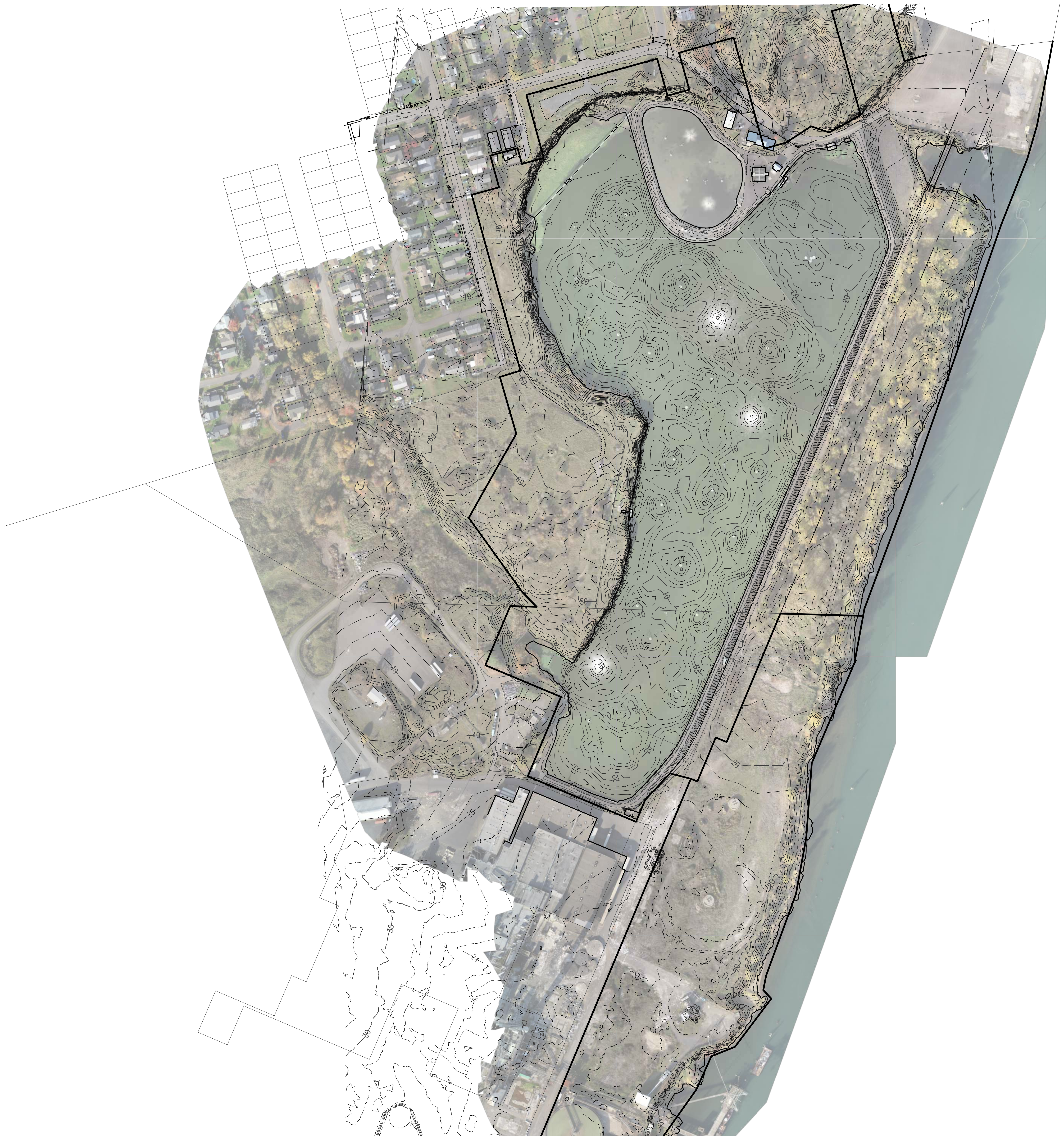
[signature]
Notary Public for Idaho
My commission expires: 8-12-73

JUL 30 4 23 PM '70

APPENDIX B
STEREO PAIR PHOTOGRAPHS

APPENDIX C

SITE SURVEY



NOTES:

1. UTILITIES SHOWN ARE BASED ON UNDERGROUND UTILITY LOCATE MARKINGS AS PROVIDED BY OTHERS, PROVIDED PER UTILITY LOCATE TICKET NUMBER 19311213. THE SURVEYOR MAKES NO GUARANTEE THAT THE UNDERGROUND LOCATES REPRESENT THE ONLY UTILITIES IN THE AREA. CONTRACTORS ARE RESPONSIBLE FOR VERIFYING ALL EXISTING CONDITIONS PRIOR TO BEGINNING CONSTRUCTION.

2. FIELD WORK WAS CONDUCTED NOVEMBER 2019.

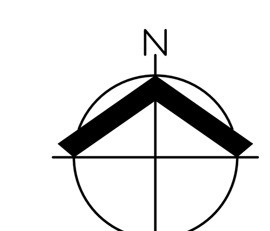
3. VERTICAL DATUM: ELEVATIONS ARE NGVD 29.
ELEVATIONS ARE BASED ON A VERTCON SHIFT OF −3.15 FEET APPLIED TO NGS BENCHMARK NO. RD4218 LOCATED AT THE NW CORNER OF THE LAGOON.
BENCHMARK NO. RD4218 ELEVATION = 78.30 FEET (NAVD 88)
75.15 FEET (NGVD 29)

4. THIS IS NOT A BOUNDARY SURVEY TO BE RECORDED WITH THE COUNTY. BOUNDARIES ARE PRELIMINARY AND SHOULD BE CONFIRMED WITH THE STAMPING SURVEYOR PRIOR TO RELYING ON FOR DETAILED DESIGN OR CONSTRUCTION. THE BOUNDARY SHOWN HEREON IS PARTIALLY BASED ON GIS DATA FROM THE CITY OF ST. HELENS WEBSITE AND SHOULD BE USED FOR VISUAL PURPOSES ONLY.

5. CONTOUR INTERVAL IS 1 FOOT.

6. BATHYMETRIC INFORMATION WAS PROVIDED BY MAUL FOSTER & ALONGI, INC. AND COMBINED WITH LIDAR DATA FROM THE STATE OF OREGON DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES WEBSITE.

4. HORIZONTAL DATUM: A LOCAL DATUM PLANE DERIVED FROM STATE PLANE OREGON NORTH 3601 NAD83(2011)EPOCH:2010.0000 BY MULTIPLYING BY A PROJECT MEAN GROUND COMBINED SCALE FACTOR OF 1.0000328962 AT A CENTRAL PROJECT POINT WITH INTERNATIONAL FOOT STATE PLANE GRID COORDINATES N805128.443 E7614876.336 AND A MERIDIAN CONVERGENCE ANGLE OF −1°38'04" STATE PLANE COORDINATES WERE DERIVED FROM GPS OBSERVATIONS USING THE ORGN NETWORK. DISTANCES SHOWN ARE INTERNATIONAL FOOT GROUND VALUES.



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ST HELENS LAGOON

CITY OF ST HELENS OREGON
TAX LOT 200 TAX MAP 4N1W300

EXISTING CONDITIONS PLAN - COVER SHEET

DESIGNED BY:
DRAWN BY: HDS
MANAGED BY: NSW
CHECKED BY: TJA
DATE: 12/09/2019

REGISTERED PROFESSIONAL LAND SURVEYOR
OREGON
JANUARY 9, 2007
NICK WHITE
70652LS
RENEWS: 6/30/20

REVISIONS

JOB NUMBER
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CONTINUED ON SHEET 4

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CITY OF ST HELENS — OREGON

TAX LOT 200 — TAX MAP 4N1W300

EXISTING CONDITIONS AERIAL PLAN

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MANAGED BY:	NSW
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3 OF 11

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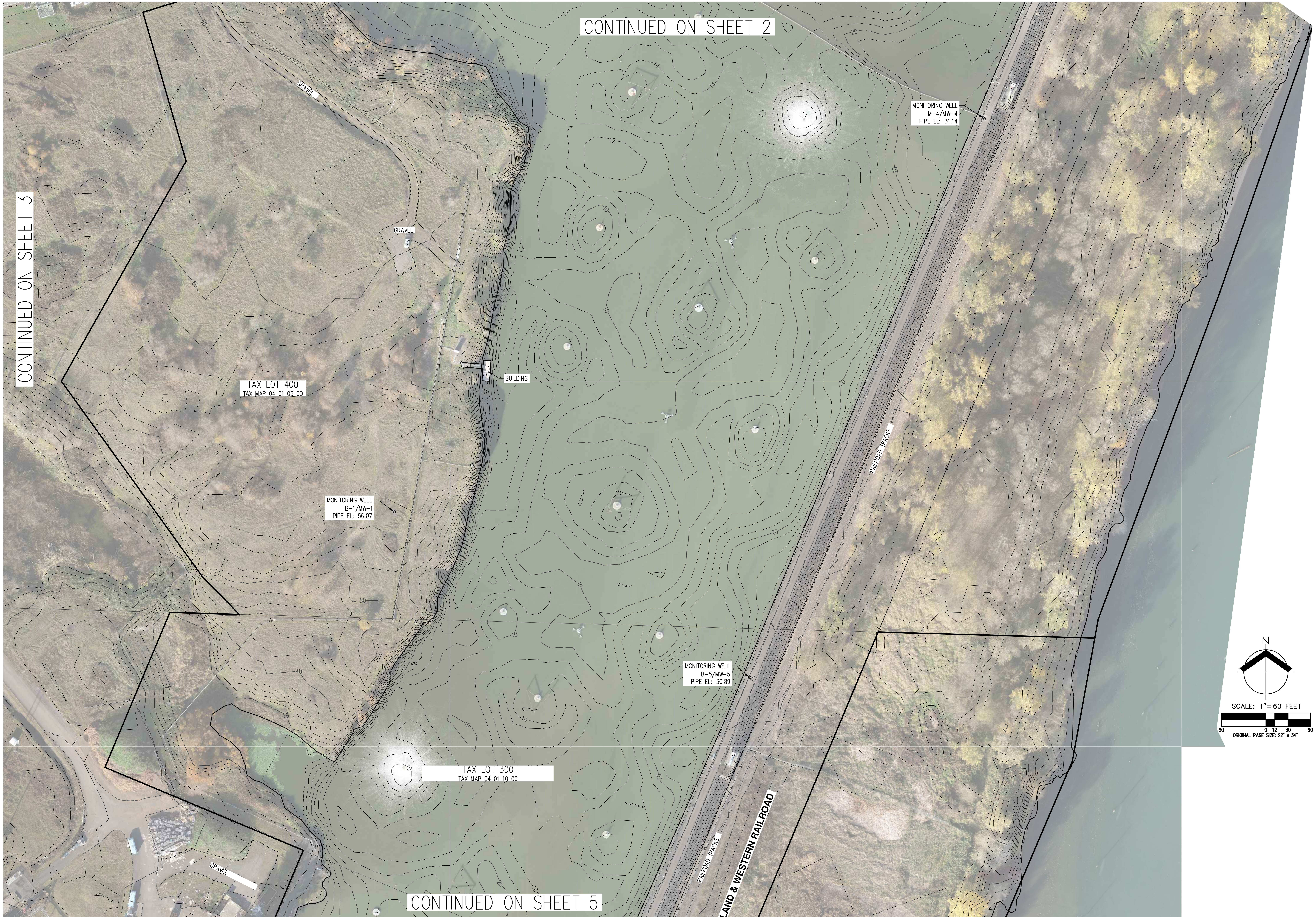

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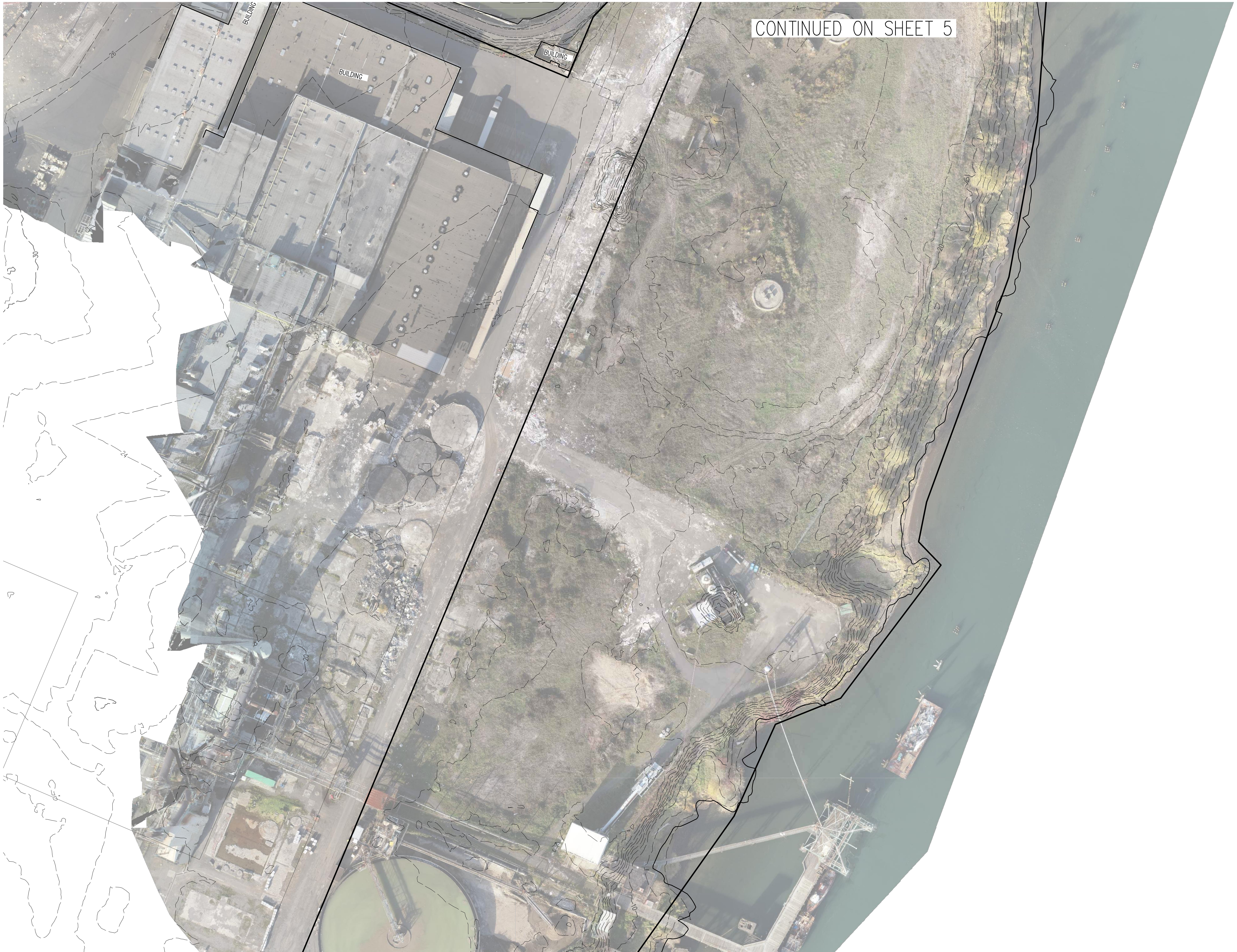

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6 OF 11

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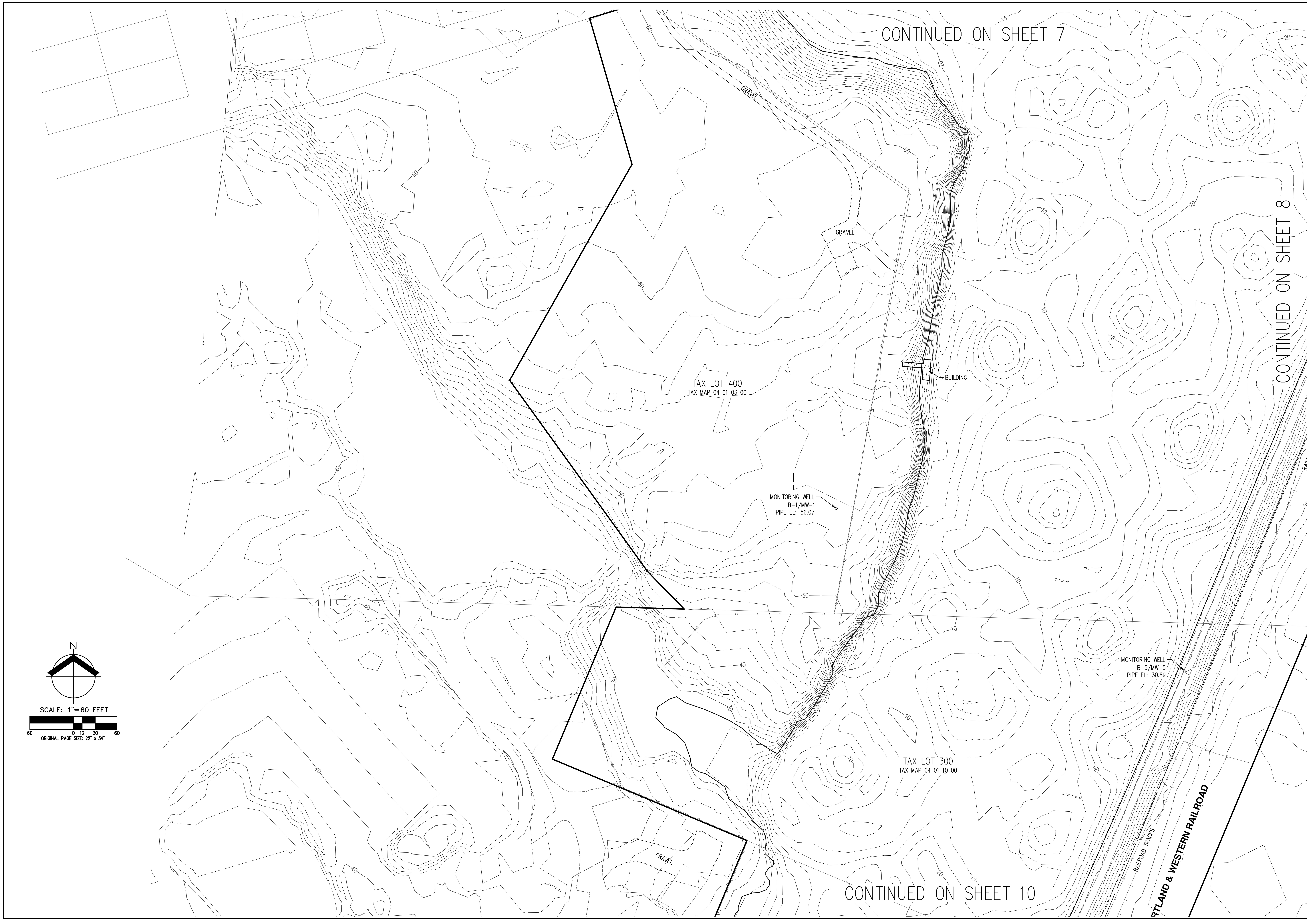

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8 OF 11

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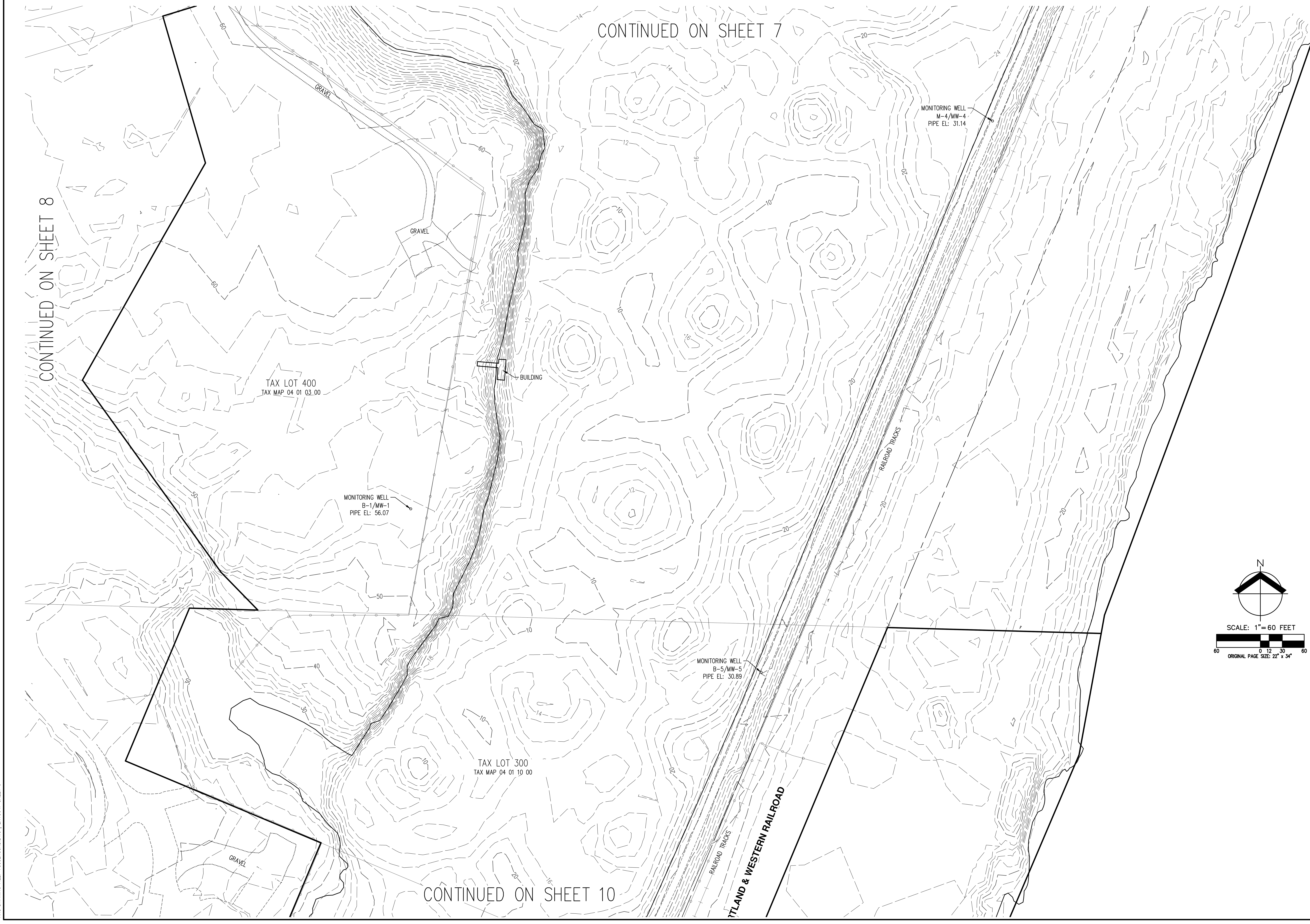

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TAX LOT 200 — TAX MAP 4N1W300

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503.563.6151
WWW.AKS-ENG.COM
ENGINEERING · SURVEYING · NATURAL RESOURCES
FORESTRY · PLANNING · LANDSCAPE ARCHITECTURE

ST HELENS LAGOON

CITY OF ST HELENS OREGON
TAX LOT 200 TAX MAP 4N1W300

EXISTING CONDITIONS PLAN

DESIGNED BY:
DRAWN BY: HDS
MANAGED BY: NSW
CHECKED BY: TJA
DATE: 12/09/2019

REGISTERED PROFESSIONAL LAND SURVEYOR
OREGON
JANUARY 9, 2007
NICK WHITE
70652LS
RENEWS: 6/30/20

REVISIONS

JOB NUMBER
7835

SHEET
11 OF 11

AKS DRAWING FILE: 7835EXCOND.DWG | LAYOUT: SHEET 11

APPENDIX D

OREGON WATER RESOURCES DEPARTMENT WELL LOGS

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

COLU 3241

WATER WELL REPORT
STATE OF OREGON
(Please type or print)

State Well No. 4N/1W-3E

State Permit No.

(1) OWNER:
Name Jay C Potter
Address 469 C West st.
Rainer Ore

(2) LOCATION OF WELL:
County Columbia Driller's well number
SW ¼ NW ¼ Section 3 T. 4N R. 1W W.M.
Bearing and distance from section or subdivision corner

(3) TYPE OF WORK (check):
New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 12.

(4) PROPOSED USE (check):
Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

(6) CASING INSTALLED:
Threaded ☐ Welded ☒
6" Diam. from 0 ft. to 45 ft. Gage .250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(7) PERFORATIONS:
Perforated? ☐ Yes ☒ No
Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

(8) SCREENS:
Well screen installed? ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(9) CONSTRUCTION:
Well seal—Material used in seal Betonite
Depth of seal 20 ft. Was a packer used? no
Diameter of well bore to bottom of seal 10 in.
Were any loose strata cemented off? ☐ Yes ☒ No Depth
Was a drive shoe used? ☒ Yes ☐ No
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off

(10) WATER LEVELS:
Static level 14 ft. below land surface Date 5/15/66
Artesian pressure lbs. per square inch Date

(11) WELL TESTS:
Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "
Bailer test 8 gal./min. with 40 ft. drawdown after 1 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? ☐ Yes ☒ No

(12) WELL LOG:
Diameter of well below casing 6
Depth drilled 105 ft. Depth of completed well 105 ft.
Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Red Clay Coarse	0	40
Blue Rock Coarse	40	125

Work started 5/5 1966 Completed 5/12 1966
Date well drilling machine moved off of well 5/14 1966

(13) PUMP:
Manufacturer's Name Berkeley
Type: Submersible H.P. ½

Water Well Contractor's Certification:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME F. E. McKnight
(Person, firm or corporation) (Type or print)
Address 840 West Street St. Helens
Drilling Machine Operator's License No. 323
[Signed] F. E. McKnight
(Water Well Contractor)
Contractor's License No. 420 Date 5/22/, 1966

(USE ADDITIONAL SHEETS IF NECESSARY)

COOLU
3242

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the
STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

RECEIVED DEC 24 1965 STATE ENGINEER SALEM, OREGON
RECEIVED JAN 6 1966 STATE ENGINEER SALEM, OREGON

WATER WELL REPORT
STATE OF OREGON
(Please type or print)

State Well No. 4N/1W-3L
State Permit No.

(1) OWNER:
Name John A Knutson
Address 405 East 4th
St. Helens Ore

(2) LOCATION OF WELL:
County Columbia Driller's well number
NE ¼ SW ¼ Section 3 T. 4N R. 1W W.M.
Bearing and distance from section or subdivision corner

(3) TYPE OF WORK (check):
Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
andonment, describe material and procedure in Item 12.

(4) PROPOSED USE (check):
Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) TYPE OF WELL:
Rotary ☐ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

(6) CASING INSTALLED: Threaded ☐ Welded ☒
6" Diam. from 0 ft. to 90 ft. Gage 250
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

(7) PERFORATIONS: Perforated? ☐ Yes ☒ No
Type of perforator used
Size of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

(8) SCREENS: Well screen installed? ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(9) CONSTRUCTION:
Well seal—Material used in seal Betonite
Depth of seal 60 ft. Was a packer used? No
Diameter of well bore to bottom of seal 9 in.
Were any loose strata cemented off? ☐ Yes ☒ No Depth
Was a drive shoe used? ☒ Yes ☐ No
Was well gravel packed? ☐ Yes ☒ No Size of gravel:
Gravel placed from ft. to ft.
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? depth of strata
Method of sealing strata off

(10) WATER LEVELS:
Static level 50 Ft. ft. below land surface Date 12/7/65
Artesian pressure lbs. per square inch Date

(11) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
" " " "
" " " "
Bailer test 15 gal./min. with 60 ft. drawdown after 1 hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? ☐ Yes ☒ No

(12) WELL LOG: Diameter of well below casing 6 in
Depth drilled 170 ft. Depth of completed well 170 ft.
Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Clay, Red, Fine	0	30
Clay, Red, Med	30	50
Clay, Light Red, med	50	65
Clay, Orange, med (gravel)	65	75
Clay, Blue, med	75	90
Clay, Orange, Med	90	100
Clay & sand, Light Orange, Med	100	130
Sand & Clay, Light Orange, med	130	155
Sand & clay, Blue, med	155	170

Work started 10/27 1965 Completed 12/7 1965
Date well drilling machine moved off of well 12/7 1965

(13) PUMP:
Manufacturer's Name
Type: H.P.

Water Well Contractor's Certification:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
NAME F.E. McKnight
(Person, firm or corporation) (Type or print)
Address 840 West St. St. Helens Ore
Drilling Machine Operator's License No. 232
[Signed] F.E. McKnight
(Water Well Contractor)
Contractor's License No. 420 Date 12/7/, 1965

(USE ADDITIONAL SHEETS IF NECESSARY)

STATE ENGINEER
Salem, Oregon

COLU

3244

Well Record

STATE WELL NO. 4N/1W-4M
COUNTY COLUMBIA
~~APPLICATION NO.~~ GR-512

OWNER: Walter S. Erickson of Jewel Ice Cream Co.
MAILING ADDRESS: St. Helens, Oregon

LOCATION OF WELL: Owner's ~~No.~~ #1
CITY AND STATE:

NW ¼ SW ¼ Sec. 4 T. 4 N. S., R. 1 E. W., W.M.

Bearing and distance from section or subdivision corner ½ mile south of SPS depot on Columbia River Highway

Altitude at well

Section

TYPE OF WELL: drilled Date Constructed 1938

Depth drilled 320 Depth cased 300

CASING RECORD:

12-inch

FINISH:

AQUIFERS:

WATER LEVEL:

200-feet

PUMPING EQUIPMENT: Type Berkeley Pumping Co. H.P. 10
Capacity 100 G.P.M.

WELL TESTS:
Drawdown ft. after hours Pumping 120 G.P.M.
Drawdown ft. after hours G.P.M.

USE OF WATER industrial & manu. Temp. °F. , 19
SOURCE OF INFORMATION GR-2676
DRILLER or DIGGER Olsen, Boring, Oregon
ADDITIONAL DATA:
Log Water Level Measurements Chemical Analysis Aquifer Test

REMARKS:

State Printing 89316

STATE ENGINEER
Salem, Oregon

COLU 3245

Well Record

STATE WELL NO. 4N/1W-4M
COUNTY Columbia
APPLICATION NO. GR-512

OWNER: Walter S. Erickson of Jewel Ice Cream Co.
MAILING ADDRESS:
CITY AND STATE: St. Helens, Oregon

LOCATION OF WELL: Owner's No. #1

NW ¼ SW ¼ Sec. 4 T. 4 N., R. 1 W., W.M.

Bearing and distance from section or subdivision corner Black 3 Highway Additon to St. Helens

Altitude at well

X			

Section 4

TYPE OF WELL: drilled Date Constructed 3/1/39

Depth drilled 320 Depth cased

CASING RECORD: 12 inch casing 0 to 300 ft.

FINISH:

AQUIFERS:

WATER LEVEL: 200 ft.

PUMPING EQUIPMENT: Type H.P.
Capacity G.P.M.

WELL TESTS:
Drawdown None ft. after hours 120 G.P.M.
Drawdown ft. after hours G.P.M.

USE OF WATER Induatrial Temp. °F. , 19

SOURCE OF INFORMATION

DRILLER or DIGGER Walter B. Erickson

ADDITIONAL DATA:
Log No Water Level Measurements Chemical Analysis Aquifer Test

REMARKS:

STATE ENGINEER
Salem, Oregon

COLU Well Record

3300

STATE WELL NO. 4N/1W-9
COUNTY Columbia
APPLICATION NO.

OWNER: Beryl Ed Price

MAILING ADDRESS: Box 1025 Station A

LOCATION OF WELL: Owner's No.

CITY AND STATE: St. Helens, Oregon

¼ ¼ Sec. 9 T. 4 N., R. 1 W., W.M.

Bearing and distance from section or subdivision corner

Altitude at well 70 ft.

TYPE OF WELL: Drilled Date Constructed 1956

Depth drilled 106 ft. Depth cased 40 ft.

Section 9

CASING RECORD:
6 inch

FINISH:

AQUIFERS:

WATER LEVEL:
80 ft.

PUMPING EQUIPMENT: Type Fairbanks Morse Jet H.P. 2
Capacity G.P.M.

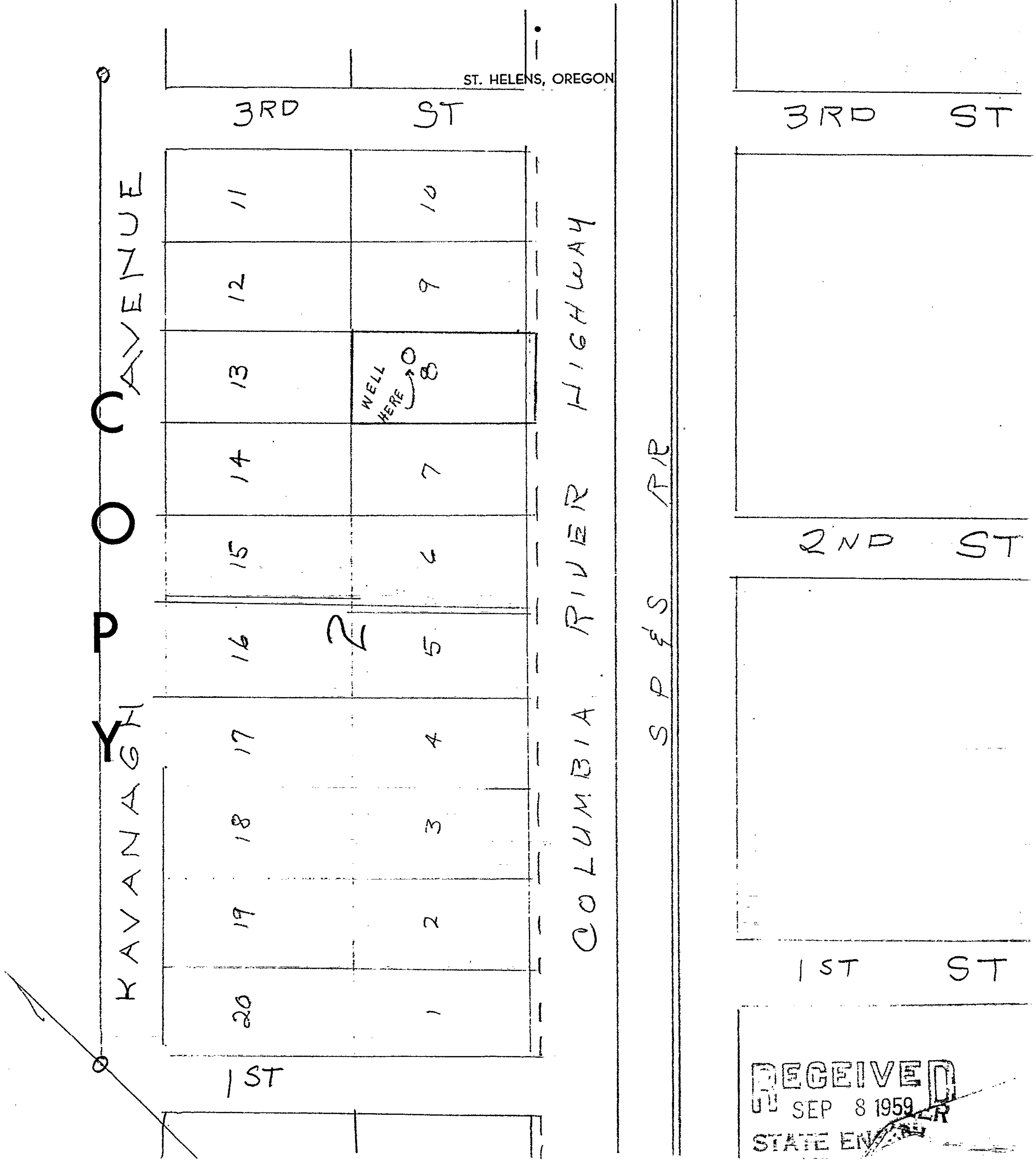
WELL TESTS:
Drawdown ft. after hours G.P.M.
Drawdown ft. after hours G.P.M.

USE OF WATER Domestic Temp. °F. , 19
SOURCE OF INFORMATION Belated registration statement
DRILLER or DIGGER Guy Lutrell
ADDITIONAL DATA:
Log Water Level Measurements Chemical Analysis Aquifer Test

REMARKS:

LOCATION
NW 1/4 SE 1/4 SEC 8 T4 R1W

County of Columbia
Office of Assessor
ST. HELENS, OREGON



COLU 51684

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)
Instructions for completing this report are on the last page of this form.

WELL I.D. # L 44717
START CARD # 126452

(1) OWNER: Well Number 1
Name Bill Daemke
Address 164 S. 15th
City St. Helens State OR Zip 97051

(2) TYPE OF WORK
[X] New Well [ ] Deepening [ ] Alteration (repair/recondition) [ ] Abandonment

(3) DRILL METHOD:
[X] Rotary Air [ ] Rotary Mud [ ] Cable [ ] Auger
[ ] Other

(4) PROPOSED USE:
[X] Domestic [ ] Community [ ] Industrial [ ] Irrigation
[ ] Thermal [ ] Injection [ ] Livestock [ ] Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval [ ] Yes [X] No Depth of Completed Well 80 ft.
Explosives used [ ] Yes [ ] No Type ____ Amount ____

HOLE Diameter	From	To	SEAL Material	From	To	Sacks or pounds
10"	0	19	Cement	0	19	6 Sacks
6"	19	80				

How was seal placed: Method [ ] A [ ] B [X] C [ ] D [ ] E
[ ] Other
Backfill placed from ____ ft. to ____ ft. Material ____
Gravel placed from ____ ft. to ____ ft. Size of gravel ____

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6"	+1	19	250	[X]	[ ]	[X]	[ ]
Liner:	4.5"	-3	80		[ ]	[X]	[X]	[ ]

Final location of shoe(s) 19

(7) PERFORATIONS/SCREENS:
[X] Perforations Method Drill Hole
[ ] Screens Type ____ Material ____

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
69	80	1/2	2 ft			[ ]	[X]

(8) WELL TESTS: Minimum testing time is 1 hour
[ ] Pump [ ] Bailer [X] Air [ ] Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
9		80	1 hr.

Temperature of water 52° Depth Artesian Flow Found ____
Was a water analysis done? [ ] Yes By whom ____
Did any strata contain water not suitable for intended use? [ ] Too little
[ ] Salty [ ] Muddy [ ] Odor [ ] Colored [ ] Other ____
Depth of strata: ____

(9) LOCATION OF WELL by legal description:
County Columbia Latitude ____ Longitude ____
Township 4N N or S Range 1W E or W. WM.
Section 09 NW 1/4 NW 1/4
Tax Lot 1200 Lot ____ Block ____ Subdivision ____
Street Address of Well (or nearest address) Old Portland Rd St. Helens, OR 97051

(10) STATIC WATER LEVEL:
25 ft. below land surface. Date 3/1/01
Artesian pressure ____ lb. per square inch. Date ____

(11) WATER BEARING ZONES:
Depth at which water was first found 55

From	To	Estimated Flow Rate	SWL
55	75	9 [redacted] GPM	25

(12) WELL LOG:
Ground Elevation ____

Material	From	To	SWL
CLAY : ROCK	0	12	
BASALT	12	80	25

RECEIVED
MAR 2 0 2001
WATER RESOURCES DEPT.
SALEM, OREGON

Date started 2/28/01 Completed 3/1/01

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.
WWC Number ____
Signed ____ Date ____

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.
WWC Number 1480
Signed A McNall Date 3/2/01

ORIGINAL – WATER RESOURCES DEPARTMENT FIRST COPY – CONSTRUCTOR SECOND COPY – CUSTOMER

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

COLU 55412
1/22/2019

WELL I.D. LABEL# L 132783
START CARD # 1041592
ORIGINAL LOG #

(1) LAND OWNER

Owner Well I.D.
First Name GARY Last Name KERVIN
Company
Address PO BOX 780
City SCAPPOOSE State OR Zip 97056

(2) TYPE OF WORK

[X] New Well [ ] Deepening [ ] Conversion
[ ] Alteration (complete 2a & 10) [ ] Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:									

	Material	From	To	Amt	sacks/lbs
Seal:					

(3) DRILL METHOD

[X] Rotary Air [ ] Rotary Mud [ ] Cable [ ] Auger [ ] Cable Mud
[ ] Reverse Rotary [ ] Other

(4) PROPOSED USE

[X] Domestic [ ] Irrigation [ ] Community
[ ] Industrial/ Commericial [ ] Livestock [ ] Dewatering
[ ] Thermal [ ] Injection [ ] Other

(5) BORE HOLE CONSTRUCTION

Special Standard [ ] (Attach copy)
Depth of Completed Well 200.00 ft.

BORE HOLE

Dia	From	To
10	0	20
6	20	200

SEAL

Material	From	To	Amt	sacks/lbs
Bentonite Chips	0	20	7	S
		Calculated	6	
		Calculated		

How was seal placed: Method [ ] A [ ] B [ ] C [ ] D [ ] E
[X] Other POUR
Backfill placed from ft. to ft. Material
Filter pack from ft. to ft. Material Size
Explosives used: [ ] Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
(●)	( )	6	[X]	1.5	20	250	(●)	( )	[X]	[ ]
( )	(●)	4	[ ]	3	200	40	( )	(●)	[ ]	[X]
( )	( )		[ ]				( )	( )	[ ]	[ ]
( )	( )		[ ]				( )	( )	[ ]	[ ]
( )	( )		[ ]				( )	( )	[ ]	[ ]

Shoe [ ] Inside [X] Outside [ ] Other Location of shoe(s) 20
Temp casing [ ] Yes Dia From + [ ] To

(7) PERFORATIONS/SCREENS

Perforations Method saw cut
Screens Type Material

Perf/ Screen	Casing/ Screen Liner	Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Perf	Liner	4	160	200	.25	6	60	

(8) WELL TESTS: Minimum testing time is 1 hour

( ) Pump ( ) Bailer (●) Air ( ) Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
40		200	1

Temperature 41 °F Lab analysis [ ] Yes By
Water quality concerns? [ ] Yes (describe below) TDS amount 192 ppm

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County COLUMBIA Twp 4.00 N N/S Range 1.00 W E/W WM
Sec 9 NW 1/4 of the NE 1/4 Tax Lot 1000
Tax Map Number Lot
Lat ° ' " or 45.84953100 DMS or DD
Long ° ' " or -122.81478500 DMS or DD
( ) Street address of well (●) Nearest address
NEAR 1875 OLD PORTLAND ROAD\NST. HELENS, OREGON 97051

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration			[ ]	
Completed Well	12/26/2018		[ ]	54

Flowing Artesian? [ ] Dry Hole? [ ]

WATER BEARING ZONES Depth water was first found 170.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
12/28/2018	170	180	40		[ ]	54
					[ ]	
					[ ]	
					[ ]	
					[ ]	

(11) WELL LOG

Ground Elevation

Material	From	To
basalt weatherd	0	5
tan claystone	5	14
gray basait	14	98
gray brn sandstone	98	110
gray basait	110	170
pours gray basalt	170	180
gray basalt	180	200

Date Started 12/26/2018 Completed 12/28/2018

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

License Number 1975 Date 1/22/2019

Signed AARON MORLEY (E-filed)

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.

License Number 1480 Date 1/22/2019

Signed ARTHUR MCMULLEN (E-filed)

Contact Info (optional) 503 397 2356

WATER SUPPLY WELL REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

COLU 55412

1/22/2019

Map of Hole

STATE OF OREGON
WELL LOCATION MAP

This map is supplemental to the WATER SUPPLY WELL REPORT

Oregon Water Resources Department
725 Summer St NE, Salem OR 97301
(503)986-0900

LOCATION OF WELL

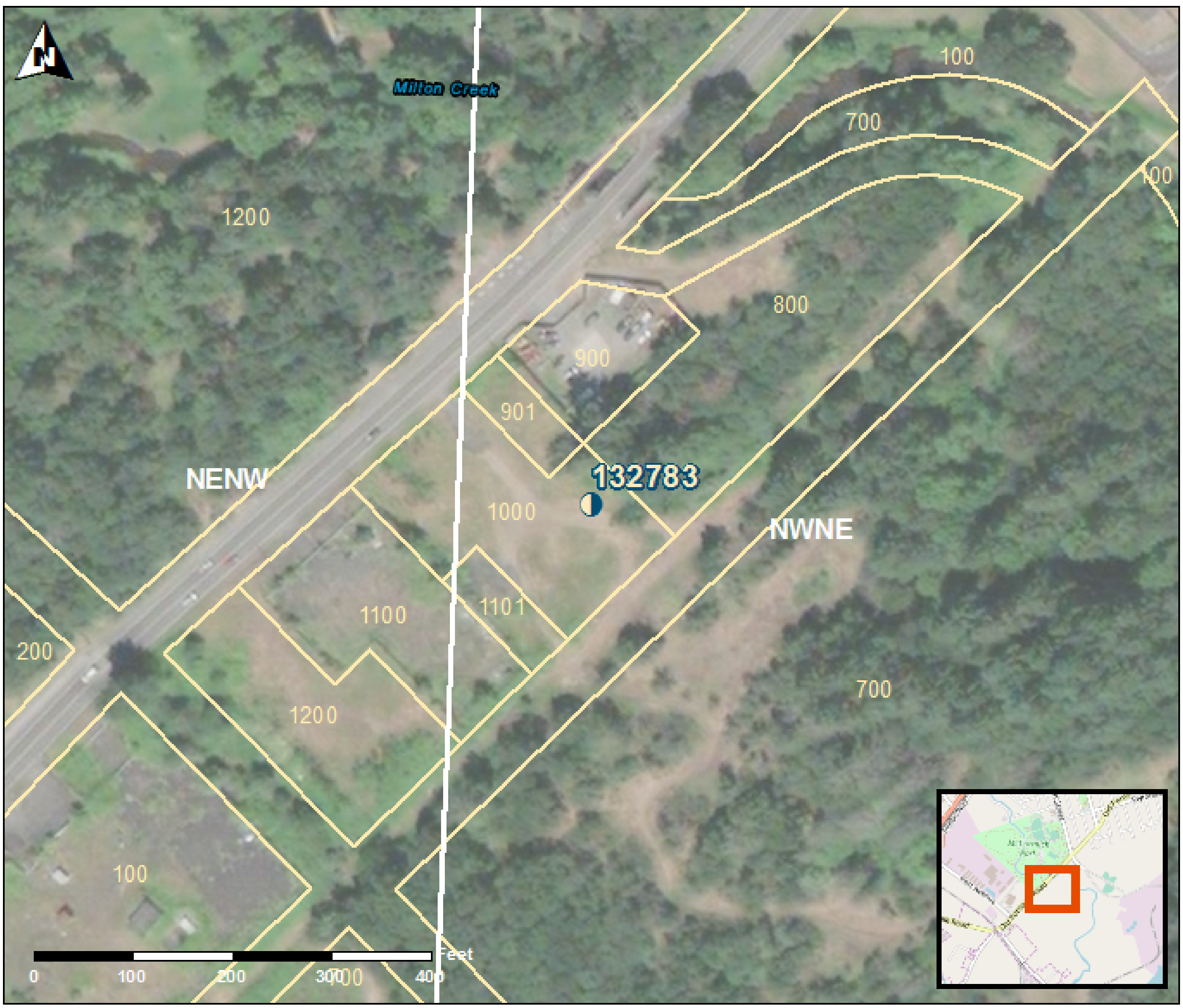
Latitude: 45.849531 Datum: WGS84
Longitude: -122.814785
Township/Range/Section/Quarter-Quarter Section:
WM 4N 1W 9 NWNE
Address of Well:
NEAR 1875 OLD PORTLAND ROAD
ST. HELENS, OREGON 97051

Well Label: 132783

Printed: January 22, 2019

DISCLAIMER: This map is intended to represent the approximate location the well. It is not intended to be construed as survey accurate in any manner.

Provided by well constructor



APPENDIX E

BORING AND MONITORING WELL COMPLETION LOGS

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number	Well Number	Sheet
	0830.03.04-02	MW-1	1 of 5

Project Name	St. Helens Lagoon	TOC Elevation (feet)	
Project Location	St. Helens	Surface Elevation (feet)	
Start/End Date	7/10/19 to 7/11/19	Northing	
Driller/Equipment	Dan Rider/Terra Sonic Incorporated 150 CC	Easting	
Geologist/Engineer	C. Schweitzer	Hole Depth	100.0-feet
Sample Method	Core Barrel: Ten-foot intervals.	Outer Hole Diam	6" to 4"-inch

Depth (feet, BGS)	Well Details	Sample Data: Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
0			100	CB					0.0 to 44.0 feet: Basalt with trace vesicles <5%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (low to high angle), joints are closed.
1									
2									
3									
4									
5									
6									
7									
8									
9									
10			100	CB					
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number 0830.03.04-02	Well Number MW-1	Sheet 2 of 5

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
			100	CB					
21									
22									
23									
24									
25									
26									
27									
28									
29									
30			100	CB					
31									
32									
33									
34									
35									
36									
37									
38									
39									
40			100	CB					
41									
42									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0830.03.04-02	MW-1	3 of 5

Depth (feet, BGS)	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Soil Description
44							44.0 to 45.5 feet: SANDY CLAY WITH GRAVEL (CL); gray; 70% fines, medium plasticity; 20% sand, coarse to very coarse; 10% gravel, very fine to coarse; soft; trace weathered bedrock; some fresh, angular bedrock.
45.5							45.5 to 50.0 feet: Basalt with trace vesicles <5%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (low to high angle), joints are closed.
50		0	CB				50.0 to 60.0 feet: No recovery.
60		100	CB				60.0 to 64.0 feet: Basalt with trace vesicles <5%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (low to high angle), joints are closed.
64							64.0 to 71.0 feet: SANDY CLAY WITH GRAVEL (CL); gray with brown mottling; 70% fines, medium plasticity; 20% sand, medium to very coarse, angular; 10% gravel, very fine to coarse, angular; soft; highly weathered in situ basalt bedrock in a fine matrix of weathered material with weathering rinds, slight porosity, slight

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0830.03.04-02	**MW-1**	**4 of 5**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
66									intact bedrock.
70			**100**	**CB**					
71									71.0 to 75.0 feet: GRAVELLY CLAY WITH SAND (CL); dark gray when wet; 60% fines; 10% sand, very fine to coarse; 30% gravel, fine to very coarse, angular; soft; trace weathered bedrock; wet.
75									75.0 to 80.0 feet: Highly vesicular basalt >20%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (low to high angle), joints are open and filled with firm dark gray clay material that encapsulates the bedrock.
80			**100**	**CB**					80.0 to 100.0 feet: Highly vesicular basalt <20%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (high to low angle), joints are closed.

Depth scale: 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
89									
90			100	CB					@ 90.0 feet: Becomes less vesicular <10%.
91									
92									
93									
94									
95									@ 95.0 feet: Becomes less vesicular <5%, and increase in jointing.
96									
97									
98									
99									
100									

Total Depth = 100.0 feet bgs.

Borehole Details:
0.0 to 80.0 feet bgs: 6-inch borehole.
80.0 to 100.0 feet bgs: 4-inch borehole.

Borehole Completion Details:
0.0 to 5.0 feet bgs: Concrete.
5.0 to 58.0 feet bgs: Bentonite chips hydrated with potable water.
58.0 to 81.5 feet bgs: 12/20 Silica Sand.
81.5 to 100.0 feet bgs: Bentonite chips hydrated with potable water.

Monitoring Well Completion
Well Tag Number: L133559
Flushmount monitoring well.
0.0 to 60.0 feet bgs: 2-inch-diameter, schedule 40, PVC blank riser pipe.
60.0 to 80.0 feet bgs: 2-inch-diameter, schedule 40, 0.010-inch machine slot, pre-pack well screen.
80.0 to 80.5 feet bgs: 2-inch-diameter end cap.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number	Well Number	Sheet
	0830.03.04-02	MW-2	1 of 5

Project Name	**St. Helens Lagoon**	TOC Elevation (feet)	
Project Location	**St. Helens**	Surface Elevation (feet)	
Start/End Date	**7/8/19 to 7/10/19**	Northing	
Driller/Equipment	**Dan Rider/Terra Sonic Incorporated 150 CC**	Easting	
Geologist/Engineer	**C. Schweitzer**	Hole Depth	**100.0-feet**
Sample Method	**Core Barrel: Ten-foot intervals.**	Outer Hole Diam	**6" to 4"-inch**

Depth (feet, BGS)	Well Details	Sample Data: Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
0			100	CB					0.0 to 62.0 feet: Basalt with trace vesicles <5%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (low to high angle), joints are closed.
1									
2									
3									
4									
5									
6									
7									
8									
9									
10			100	CB					
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
21			100	CB					
22									
23									
24									
25									
26									
27									
28									
29									
30			100	CB					
31									
32									
33									
34									
35									
36									
37									
38									
39									
40			100	CB					
41									
42									

NOTES: *1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.*

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0830.03.04-02	**MW-2**	**3 of 5**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
44									
45									
46									
47									
48									
49									
50			**100**	**CB**					
51									
52									
53									
54									
55									
56									
57									
58									
59									
60			**100**	**CB**					
61									
62									62.0 to 68.0 feet: SANDY CLAY WITH GRAVEL (CL); gray with brown mottling; 70% fines; 20% sand, medium to very coarse; 10% gravel, very fine to medium, angular; soft; highly weathered in situ bedrock in a fine matrix, with slight porosity; some intact bedrock with weathering rinds.
63									
64									
65									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0830.03.04-02	**MW-2**	**4 of 5**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
66									@ 66.0 feet: Becomes gray with more intact rock only moderately weathered.
68									68.0 to 100.0 feet: Highly vesicular basalt <20%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (high to low angle), fewer joints, joints are closed.
70			**100**	**CB**					
80			**100**	**CB**					@ 80.0 feet: Becomes less vesicular, <10%.
85									@ 85.0 feet: Becomes less vesicular, <5%, with an increase in joints.

Depth scale: 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number 0830.03.04-02	Well Number MW-2	Sheet 5 of 5

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
89									
90			100	CB					
91									
92									
93									
94									
95									
96									
97									
98									
99									
100									

Total Depth = 100.0 feet bgs.

Borehole Details:
0.0 to 70.0 feet bgs: 6-inch borehole.
70.0 to 100.0 feet bgs: 4-inch borehole.

Borehole Completion Details:
0.0 to 2.0 feet bgs: Concrete.
2.0 to 48.0 feet bgs: Bentonite chips hydrated with potable water.
48.0 to 71.0 feet bgs: 12/20 Silica Sand.
71.0 to 100.0 feet bgs: Bentonite chips hydrated with potable water.

Monitoring Well Completion
Well Tag Number: L133560
Flushmount monitoring well.
0.0 to 50.0 feet bgs: 2-inch-diameter, schedule 40, PVC blank riser pipe.
50.0 to 70.0 feet bgs: 2-inch-diameter, schedule 40, 0.010-inch machine slot, pre-pack well screen.
70.0 to 70.5 feet bgs: 2-inch-diameter end cap.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0830.03.04-02	**MW-3**	**1 of 5**

Project Name	**St. Helens Lagoon**	TOC Elevation (feet)	
Project Location	**St. Helens**	Surface Elevation (feet)	
Start/End Date	**7/17/19 to 7/17/19**	Northing	
Driller/Equipment	**Dan Rider/Terra Sonic Incorporated 150 CC**	Easting	
Geologist/Engineer	**C. Schweitzer**	Hole Depth	**100.0-feet**
Sample Method	**Core Barrel: Ten-foot intervals.**	Outer Hole Diam	**6" to 4"-inch**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
0			100	CB					0.0 to 1.0 feet: SANDY GRAVEL (GW); gray; 0% fines; 20% sand; 80% gravel, fine to coarse, angular; loose; no odor; no sheen; moist.
1									1.0 to 2.0 feet: GRAVELLY CLAY (CL); brown; 80% fines, medium plasticity; 0% sand; 20% gravel, very fine to medium, angular; stiff; no odor; no sheen; moist.
2									2.0 to 5.0 feet: SAND WITH GRAVEL (SW); gray; 0% fines; 90% sand, very fine to coarse; 10% gravel, fine to very coarse, angular; loose; trace cobbles; no odor; no sheen; moist.
5			100	CB					5.0 to 5.5 feet: GRAVELLY CLAY (CL); brown; 80% fines, medium plasticity; 0% sand; 20% gravel, very fine to medium, angular; stiff; no odor; no sheen; moist.
5.5									5.5 to 8.0 feet: SANDY CLAYEY GRAVEL (GW); gray; 20% fines, medium plasticity; 30% sand, medium to coarse; 50% gravel, fine to coarse, angular; loose; trace cobbles; no odor; no sheen; moist.
8									8.0 to 10.0 feet: GRAVELLY SAND (SW); brown; 0% fines; 80% sand, fine to coarse; 20% gravel, fine to very coarse, angular; loose; trace silt clasts; no odor; no sheen; moist.
10									10.0 to 15.0 feet: No recovery.
15			100	CB SPT			21, 11, 15		15.0 to 22.0 feet: SAND WITH GRAVEL (SW); gray; 0% fines; 90% sand, fine to medium; 10% gravel, fine to very coarse, angular; loose; trace silt clasts; no odor; no sheen; moist.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number 0830.03.04-02	Well Number MW-3	Sheet 2 of 5

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
21									
22									22.0 to 48.0 feet: SAND (SP); dark gray; 0% fines; 100% sand, very fine to medium; 0% gravel; very loose; no odor; no sheen; wet.
23									
24									
25			0	CB					
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									
40			100	CB					
41									
42									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number 0830.03.04-02	Well Number MW-3	Sheet 3 of 5

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
44									
45									
46									
47									
48									48.0 to 75.0 feet; SILT (ML); gray; 100% fines, low plasticity; 0% sand; 0% gravel; soft; trace organics, plant matter, and rootlets; no odor; no sheen; moist to wet.
49									
50			100	CB					
51									
52									
53									
54									
55									
56									
57									
58									
59									
60			100	CB					
61									
62									
63									
64									
65									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0830.03.04-02	MW-3	4 of 5

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
66									
67									
68									
69									
70			100	CB					
71									
72									
73									
74									
75									75.0 to 80.0 feet: SILTY SAND (SM); gray; 20% fines, low plasticity; 80% sand, very fine to fine; 0% gravel; loose; trace organics and wood fragments; no odor; no sheen; wet.
76									
77									
78									
79									
80			100	CB					80.0 to 100.0 feet: Basalt with trace vesicles <5%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (low to high angle), joints are closed.
81									
82									
83									
84									
85									
86									
87									
88									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
89									
90			100	CB					
91									
92									
93									
94									
95									
96									
97									
98									
99									
100									

Total Depth = 100.0 feet bgs.

Borehole Details:
0.0 to 90.0 feet bgs: 6-inch borehole.
90.0 to 100.0 feet bgs: 4-inch borehole.

Borehole Completion Details:
0.0 to 3.0 feet bgs: Concrete.
3.0 to 5.0 feet bgs: 12/20 Silica Sand.
5.0 to 23.0 feet bgs: Bentonite chips hydrated with potable water.
23.0 to 46.5 feet bgs: 12/20 Silica Sand.
46.5.0 to 70.0 feet bgs: Bentonite chips hydrated with potable water.
70.0 to 100.0 feet bgs: Native soil heave/slough.

Monitoring Well Completion
Well Tag Number: L133572
Flushmount monitoring well.
0.0 to 25.0 feet bgs: 2-inch-diameter, schedule 40, PVC blank riser pipe.
25.0 to 45.0 feet bgs: 2-inch-diameter, schedule 40, 0.010-inch machine slot, pre-pack well screen.
45.0 to 45.5 feet bgs: 2-inch-diameter end cap.

NOTES: *1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.*

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0830.03.04-02	**MW-4**	**1 of 6**

Project Name	**St. Helens Lagoon**	TOC Elevation (feet)	
Project Location	**St. Helens**	Surface Elevation (feet)	
Start/End Date	**7/15/19 to 7/15/19**	Northing	
Driller/Equipment	**Dan Rider/Terra Sonic Incorporated 150 CC**	Easting	
Geologist/Engineer	**C. Schweitzer**	Hole Depth	**120.0-feet**
Sample Method	**Core Barrel: Ten-foot intervals.**	Outer Hole Diam	**6" to 4"-inch**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
0–2			100	CB					0.0 to 2.0 feet: SANDY GRAVEL (GW); gray; 0% fines; 20% sand; 80% gravel, fine to very coarse, angular; loose; no odor; no sheen; moist. @ 1.5 feet: Becomes brown.
2–4									2.0 to 4.0 feet: GRAVELLY CLAY (CL); brown; 80% fines, medium plasticity; 0% sand; 20% gravel, very fine to medium, angular; stiff; no odor; no sheen; moist.
4–8.5									4.0 to 8.5 feet: SAND WITH GRAVEL (SW); gray; 0% fines; 90% sand, very fine to coarse; 10% gravel, fine to very coarse, angular; loose; trace cobbles; no odor; no sheen; moist. @ 4.1 feet: Piece of black plastic.
5			100	CB SH		Shelby tube at 5.0'			
8.5–11									8.5 to 11.0 feet: GRAVELLY SAND (SW); gray; 0% fines; 70% sand, very fine to coarse; 30% gravel, fine to very coarse, angular; loose; trace cobbles; no odor; no sheen; moist.
11–12									11.0 to 12.0 feet: SANDY CLAYEY GRAVEL (GW); brown; 20% fines, medium plasticity; 30% sand, medium to coarse; 50% gravel, very fine to coarse, angular; loose; trace slightly weathered vesicular basalt cobbles; no odor; no sheen; moist.
12–13									12.0 to 13.0 feet: SANDY GRAVELLY CLAY (CL); brown fines with gray sand; 50% fines, medium plasticity; 30% sand, very fine to medium; 20% gravel, very fine to medium, angular; very soft; no odor; no sheen; wet.
13–16									13.0 to 16.0 feet: GRAVELLY SAND (SW); gray; 0% fines; 80% sand, fine to coarse; 20% gravel, fine to very coarse, angular; loose; trace cobbles; no odor; no sheen; wet.
15			100	CB SPT			25, 21, 16		
16–20									16.0 to 20.0 feet: SANDY GRAVEL WITH CLAY (GW); brown; 10% fines; 40% sand, fine to very coarse; 50% gravel, fine to very coarse, angular; loose; some cobbles; no odor; no sheen; wet.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
21									20.0 to 23.0 feet: SAND WITH GRAVEL (SW); brown; 0% fines; 90% sand, fine to very coarse; 10% gravel, fine to very coarse, angular; loose; no odor; no sheen; wet.
22									
23									23.0 to 65.0 feet: SAND (SP); dark gray; 0% fines; 100% sand, very fine to medium; 0% gravel; very loose; no odor; no sheen; wet.
24									
25			0	CB					
26									
27									
28									
29									
30									
31									
32									
33									
34									
35			0	CB					
36									
37									
38									
39									
40									
41									
42									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number **0830.03.04-02**	Well Number **MW-4**	Sheet **3 of 6**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
44									
45									
46									
47									
48									
49									
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60			100	CB					
61									
62									
63									
64									
65									65.0 to 95.0 feet; SILT (ML); gray; 100% fines, low plasticity; 0% sand; 0% gravel; soft; trace organics, plant matter, and rootlets; no odor;

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0830.03.04-02	MW-4	4 of 6

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
66									no sheen; moist to wet.
67									
68									
69									
70			100	CB					
71									
72									
73									
74									
75									
76									
77									
78									
79									
80			100	CB					
81									
82									
83									
84									
85									
86									
87									
88									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0830.03.04-02	MW-4	5 of 6

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
89									
90			100	CB					
91									
92									
93									
94									
95									95.0 to 105.0 feet: SILTY SAND (SM); gray; 20% fines, low plasticity; 80% sand, very fine to fine; 0% gravel; loose; trace organics and rootlets; no odor; no sheen; wet.
96									
97									
98									
99									
100			100	CB					
101									
102									
103									
104									
105									105.0 to 113.0 feet; SILT (ML); gray; 100% fines, low plasticity; 0% sand; 0% gravel; soft; trace organics and rootlets; no odor; no sheen; moist.
106									
107									
108									
109									
110			100	CB					
111									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
112									
113									113.0 to 120.0 feet: SILTY SAND (SM); gray; 20% fines, low plasticity; 80% sand, very fine to fine; 0% gravel; loose; trace organics and rootlets; no odor; no sheen; moist.
114									
115									
116									@ 116.0 feet: Becomes only 10% fines.
117									@ 117.0 feet: wood fragment.
118									
119									
120									

Total Depth = 120.0 feet bgs.

Borehole Details:
0.0 to 90.0 feet bgs: 6-inch borehole.
90.0 to 120.0 feet bgs: 4-inch borehole.

Borehole Completion Details:
0.0 to 2.0 feet bgs: Concrete.
2.0 to 27.0 feet bgs: Bentonite chips hydrated with potable water.
27.0 to 51.0 feet bgs: 12/20 Silica Sand.
51.0.0 to 75.0 feet bgs: Bentonite chips hydrated with potable water.
75.0 to 120.0 feet bgs: Native soil heave/slough.

Monitoring Well Completion
Well Tag Number: L133571
Flushmount monitoring well.
0.0 to 30.0 feet bgs: 2-inch-diameter, schedule 40, PVC blank riser pipe.
30.0 to 50.0 feet bgs: 2-inch-diameter, schedule 40, 0.010-inch machine slot, pre-pack well screen.
50.0 to 50.5 feet bgs: 2-inch-diameter end cap.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0830.03.04-02	**MW-5**	**1 of 6**

Project Name	**St. Helens Lagoon**	TOC Elevation (feet)	
Project Location	**St. Helens**	Surface Elevation (feet)	
Start/End Date	**7/16/19 to 7/16/19**	Northing	
Driller/Equipment	**Dan Rider/Terra Sonic Incorporated 150 CC**	Easting	
Geologist/Engineer	**C. Schweitzer**	Hole Depth	**120.0-feet**
Sample Method	**Core Barrel: Ten-foot intervals.**	Outer Hole Diam	**6" to 4"-inch**

Depth (feet, BGS)	Well Details	Sample Data: Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
0			100	CB					0.0 to 2.0 feet: SANDY GRAVEL (GW); gray; 0% fines; 20% sand; 80% gravel, fine to coarse, angular; loose; no odor; no sheen; moist.
2									2.0 to 3.0 feet: GRAVELLY CLAY (CL); brown; 80% fines, medium plasticity; 0% sand; 20% gravel, very fine to medium, angular; stiff; no odor; no sheen; moist.
3									3.0 to 6.0 feet: SAND WITH GRAVEL (SW); gray; 0% fines; 90% sand, very fine to coarse; 10% gravel, fine to very coarse, angular; loose; trace cobbles; no odor; no sheen; moist.
5			100	CB SPT			10, 11, 15		@ 5.0 feet: Thin brown silt bed.
6									6.0 to 9.0 feet: SANDY CLAYEY GRAVEL (GW); gray; 20% fines, medium plasticity; 30% sand, medium to coarse; 50% gravel, very fine to coarse, angular; loose; no odor; no sheen; moist.
9									9.0 to 15.0 feet: GRAVELLY SAND (SW); gray; 0% fines; 80% sand, fine to coarse; 20% gravel, fine to very coarse, angular; loose; trace cobbles; no odor; no sheen; moist.
15			100	CB					15.0 to 16.0 feet: SANDY GRAVELLY CLAY (CL); brown fines with gray sand and gravel; 50% fines, medium plasticity; 30% sand, very fine to medium; 20% gravel, fine to medium, angular; very soft; no odor; no sheen; wet.
16									16.0 to 23.0 feet: SAND WITH GRAVEL (SW); gray; 0% fines; 90% sand, fine to medium; 10% gravel, fine to very coarse, angular; loose; no odor; no sheen; wet.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number **0830.03.04-02**	Well Number **MW-5**	Sheet **2 of 6**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
21									
22									
23									23.0 to 63.0 feet: SAND (SP); dark gray; 0% fines; 100% sand, very fine to medium; 0% gravel; very loose; no odor; no sheen; wet.
24									
25			100	CB SPT			2, 3, 6		
26									
27									
28									
29									
30									
31									
32									
33									
34									
35			0	CB					
36									
37									
38									
39									
40									
41									
42									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number 0830.03.04-02	Well Number MW-5	Sheet 3 of 6

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
44									
45									
46									
47									
48									
49									
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60			100	CB					
61									
62									
63									63.0 to 103.0 feet; SILT (ML); gray; 100% fines, low plasticity; 0% sand; 0% gravel; soft; trace organics, plant matter, and rootlets; no odor; no sheen; moist to wet.
64									
65									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number 0830.03.04-02	Well Number MW-5	Sheet 4 of 6

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
66									
67									
68									
69									
70			100	CB					
71									
72									
73									
74									
75									
76									
77									
78									
79									
80			100	CB					
81									
82									
83									
84									
85									
86									
87									
88									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0830.03.04-02	MW-5	5 of 6

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
89									
90			100	CB					
91									
92									
93									
94									
95									
96									
97									
98									
99									
100			100	CB					
101									
102									
103									103.0 to 120.0 feet: Basalt with some vesicles <25%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (low to high angle), joints are closed.
104									
105									
106									
107									
108									
109									
110			100	CB					@ 110.0 feet: Becomes less vesicular, <10%.
111									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
112									
113									
114									
115									@ 115.0 feet: Becomes less vesicular, <5%.
116									
117									
118									
119									
120									

Total Depth = 120.0 feet bgs.

Borehole Details:
0.0 to 90.0 feet bgs: 6-inch borehole.
90.0 to 120.0 feet bgs: 4-inch borehole.

Borehole Completion Details:
0.0 to 5.0 feet bgs: Concrete.
5.0 to 27.0 feet bgs: Bentonite chips hydrated with potable water.
27.0 to 51.0 feet bgs: 12/20 Silica Sand.
51.0.0 to 54.0 feet bgs: Bentonite chips hydrated with potable water.
54.0 to 120.0 feet bgs: Native soil heave/slough.

Monitoring Well Completion
Well Tag Number: L133553
Flushmount monitoring well.
0.0 to 30.0 feet bgs: 2-inch-diameter, schedule 40, PVC blank riser pipe.
30.0 to 50.0 feet bgs: 2-inch-diameter, schedule 40, 0.010-inch machine slot, pre-pack well screen.
50.0 to 50.5 feet bgs: 2-inch-diameter end cap.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0830.03.04-02	**MW-6**	**1 of 6**

Project Name	**St. Helens Lagoon**	TOC Elevation (feet)	
Project Location	**St. Helens**	Surface Elevation (feet)	
Start/End Date	**7/11/19 to 7/12/19**	Northing	
Driller/Equipment	**Dan Rider/Terra Sonic Incorporated 150 CC**	Easting	
Geologist/Engineer	**C. Schweitzer**	Hole Depth	**120.0-feet**
Sample Method	**Core Barrel: Ten-foot intervals.**	Outer Hole Diam	**6" to 4"-inch**

Depth (feet, BGS)	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Soil Description
0.0	100	CB				0.0 to 4.0 feet: SANDY GRAVEL (GW); gray; 0% fines; 20% sand; 80% gravel, fine to very coarse, angular; loose; no odor; no sheen; moist.
2.5						@ 2.5 feet: Becomes brown.
4.0						4.0 to 5.0 feet: GRAVELLY CLAY (CL); brown; 60% fines, medium plasticity; 0% sand; 40% gravel, very fine to medium, angular; stiff; no odor; no sheen; moist.
5.0	100	CB SPT			6, 4, 5	5.0 to 6.0 feet: SANDY CLAYEY GRAVEL (GW); brown with dark gray sand and gravel; 20% fines, medium plasticity; 30% sand, medium to coarse; 50% gravel, very fine to coarse, angular; loose; fines in clumps; no odor; no sheen; moist.
6.0						6.0 to 10.0 feet: SAND WITH GRAVEL (SW); brown; 0% fines; 90% sand, very fine to coarse; 10% gravel, fine to very coarse, angular; loose; trace cobbles up to 2 inch; no odor; no sheen; moist.
10.0						10.0 to 11.0 feet: SILTY GRAVELLY SAND (SM); dark gray; 30% fines, low plasticity; 50% sand, very fine to medium; 20% gravel, fine to medium, angular; loose; trace cobbles up to 3 inch; no odor; no sheen; moist.
11.0						11.0 to 20.0 feet: GRAVELLY SAND (SW); gray; 0% fines; 80% sand, fine to very coarse; 20% gravel, fine to very coarse, angular; loose; trace cobbles up to 2 inch; no odor; no sheen; moist.
13.0						@ 13.0 feet: Becomes brown, with a thin silt bed.
15.0	100	CB SH		Shelby Tube at 15.0'		
16.0						@ 16.0 feet: Becomes gray, with a thin silt bed.
18.0						@ 18.0 feet: Becomes brown.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number 0830.03.04-02	Well Number MW-6	Sheet 2 of 6

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
21									20.0 to 55.0 feet: SAND (SP); dark gray; 0% fines; 100% sand, very fine to medium; 0% gravel; very loose; no odor; no sheen; wet.
22									
23									
24									
25			0	CB SPT			1, 2, 5		
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number 0830.03.04-02	Well Number MW-6	Sheet 3 of 6

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
44									
45									
46									
47									
48									
49									
50			100	CB					
51									
52									
53									
54									
55									55.0 to 120.0 feet; SILT (ML); gray; 100% fines, low plasticity; 0% sand; 0% gravel; soft; trace organics, plant matter, and rootlets; trace light interbedded zones of light gray sand; no odor; no sheen; moist to wet.
56									
57									
58									
59									
60			100	CB					
61									
62									
63									
64									
65									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
66									
67									
68									
69									
70			100	CB					
71									
72									
73									
74									
75									
76									
77									
78									
79									
80			100	CB					
81									
82									
83									
84									
85									
86									
87									
88									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number	Well Number	Sheet
	0830.03.04-02	**MW-6**	**5 of 6**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
89									
90			100	CB					
91									
92									
93									
94									
95									
96									
97									
98									
99									
100			100	CB					
101									
102									
103									
104									
105									
106									
107									
108									
109									
110			100	CB					
111									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
112									
113									
114									
115									
116									
117									
118									
119									
120									

Total Depth = 120.0 feet bgs.

Borehole Details:
0.0 to 120.0 feet bgs: 6-inch borehole.

Borehole Completion Details:
0.0 to 3.5 feet bgs: Concrete.
3.5 to 28.0 feet bgs: Bentonite chips hydrated with potable water.
28.0 to 51.0 feet bgs: 12/20 Silica Sand.
51.0 to 120.0 feet bgs: Native soil heave/slough.

Monitoring Well Completion
Well Tag Number: L133558
Flushmount monitoring well.
0.0 to 30.5 feet bgs: 2-inch-diameter, schedule 40, PVC blank riser pipe.
30.5 to 50.5 feet bgs: 2-inch-diameter, schedule 40, 0.010-inch machine slot, pre-pack well screen.
50.5 to 51.0 feet bgs: 2-inch-diameter end cap.

NOTES: *1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.*

APPENDIX F
FIELD DOCUMENTATION

60-80

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Well Development Form

Project No. 0830.03.04	Date 8/2/19
Site Location: St. Helens, OR	Well: MW-1
Name: Phase I Lagoon Repurposing	Initial DTB: 81.48 Final DTB 81.02
Development Method: surge block, waterra pump	Initial DTW: 28.83 Final DTW 51.5
Total Water Removed 41.5 gal	Pore Volume: 52.6 ft x 0.163 = 8.57
Water Contained	Casing Diameter: 2" (6" borehole)
Estimated Specific Capacity	Meter No. vane YSI 1, waterra, PDX turb 1

Time	Cum. Vol Removed	Turbidity NTU	pH	Conductivity (uS/cm)	Temp °C	DO (mg/L)	Eh	Comments
1105	2	OR	5.97	521.3	17	3.47	134.6	surge @ 79' began surge @ 1045
1122	3	OR	6.96	474.1	17.5	2.53	98.9	surge @ 78 began @ 1108
1138	4	OR	7.39	543.7	17.2	3.06	80.7	surge @ 77 began @ 1125
1155	5	OR	7.58	306.2	18.0	3.54	67.6	surge @ 76 began @ 1141
1216	6.5	OR	7.76	581	18.5	3.39	56.8	surge @ 75 began @ 1201
1235	8.5	OR	7.83	583	18.4	2.52	49.3	surge @ 74 began @ 1218
1250	9.5	OR	7.87	570.5	18.0	1.16	35.2	surge @ 73 began @ 1237
1308	10.5	OR	7.82	573	19.6	0.91	15.7	surge @ 72 began @ 1255
1322	12	OR	7.81	607	20.3	0.89	0.3	surge @ 71 began @ 1310
1334	14	OR	7.81	563	19.5	0.60	-15.5	surge @ 70 began @ 1324
1349	15.5	OR	7.86	523.2	19.9	0.85	-26.5	surge @ 69 began @ 1336
1405	17.5	OR	7.92	536.4	19.6	0.82	-34.2	surge @ 68 began @ 1352
1419	19	OR	8.01	544.5	20.4	0.77	-40.0	surge @ 67 began @ 1407
1431	21	OR	8.10	539.3	20.1	0.64	-47.9	surge @ 66 began @ 1421
1445	22	OR	8.16	537.1	20.2	0.65	-52.8	surge @ 65 began @ 1433
1459	24	OR	8.13	557	20.8	0.68	-55.0	surge @ 64 began @ 1447
1513	25	OR	8.06	576	22.2	0.66	-57.1	surge @ 63 began @ 1501
1527	26	OR	8.03	595	23.3	0.92	-58.3	surge @ 62 began @ 1515
1540	27.5	OR	8.02	619	21.0	0.83	-52.5	surge @ 61 began @ 1529
1551	29	OR	7.96	618	22.3	8.96	-50.0	surge @ 60 began @ 1542

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OR = overrange

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Well Development Form

Project No. 0830.03.04	Date 8/12/19
Site Location: St. Helens, OR	Well: MW-1
Name: Phase I Lagoon Repurposing	Initial DTB: 81.48 Final DTB 81.02'
Development Method: surge block, waterra pump	Initial DTW: 28.88 Final DTW 51.5'
Total Water Removed 41.5	Pore Volume: 52.6 ft x 0.163 = 8.57
Water Contained	Casing Diameter: 2" (6" borehole)
Estimated Specific Capacity	Meter No. vanc YSI 1, waterra, PDX turb 1

Time	Cum. Vol Removed	Turbidity NTU	pH	Conductivity (uS/cm)	Temp °C	DO (mg/L)	Eh	Comments
1611	30	—	—	—	—	—	—	surge block removed began purge @ 1601
1621	31.5	1403	8.07	662	17.8	3.45	-53.1	purge @ 70' began @ 1616
1626	32.5	639	8.02	601	17.3	3.58	-36.0	purge @ 70'
1631	33.5	30	7.88	613	17.2	3.51	-22.0	purge @ 70'
1636	34.5	745	7.81	644	17.5	3.26	-13.3	purge @ 70'
1641	35.5	777	7.82	652	17.5	3.37	-8.0	purge @ 70'
1646	36.5	766	7.86	655	17.6	3.47	-6.6	purge @ 70'
1651	37.5	730	7.87	656	17.5	3.55	-5.5	purge @ 70'
1656	38.5	681	7.87	657	17.5	3.45	-4.4	purge @ 70'
1701	39.5	650	7.86	658	17.6	3.48	-2.5	purge @ 70'
1706	40.5	634	7.87	659	17.5	3.38	-1.8	purge @ 70'
1711	41.5	-12	7.88	660	17.4	3.45	-0.5	purge @ 70'

uld not get ORP to stabalize w/in 10% and needed to return uipment.

rrs offsite 1800.

50'-70'

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Well Development Form

Project No. 0830.03.04	Date 8/1/2019
Site Location: St. Helens, OR	Well: MW-2
Name: Phase 1 Lagoon Repurposing	Initial DTB: 72.14' — Final DTB —
Development Method: Surge block waterra pump	Initial DTW: 41.20' — Final DTW —
Total Water Removed 45 gal	Pore Volume: 30.94ft × 0.163 = 5.04
Water Contained	Casing Diameter: 2" (6" borehole)
Estimated Specific Capacity	Meter No. Vanc YSI 1, waterra, PDX turb 1

Time	Cum. Vol Removed	Turbidity NTU	pH	Conductivity (uS/cm)	Temp °C	DO (mg/L)	Eh	Comments
0922	3	OR	9.37	434.5	17.5	1.89	49.4	surge @ 69' began surge @ 0858
0948	5	OR	9.05	379.2	16.8	1.19	14.7	surge @ 68' began surge @ 0930
1007	7	OR	9.04	391.7	17.2	1.60	13.0	surge @ 67' began surge @ 0950
1028	9	OR	9.02	402.1	17.9	1.69	7.5	surge @ 66' began surge @ 1011
1059	11	OR	9.05	418.5	18.3	1.64	-3.9	surge @ 65' began surge @ 1030
1122	13	OR	9.01	427.3	18.3	1.99	-3.8	surge @ 64 began surge @ 1104
1138	15	OR	9.03	417.3	18.2	1.68	-6.2	surge @ 63 began surge @ 1124
1157	16	OR	9.11	413.5	18.8	1.96	-8.1	surge @ 62 began surge @ 1142
1217	17	OR	9.14	409.9	20.2	1.51	-10.4	surge @ 61 began surge @ 1200
1237	19	OR	9.17	411.9	20.7	1.06	-14.5	surge @ 60 began surge @ 1220
1302	20	OR	9.18	415.0	21.9	0.84	-20.9	surge @ 59 began surge @ 1245
1321	21	OR	9.24	414.6	21.6	0.64	-25.6	surge @ 58 began surge @ 1305
1339	23	OR	9.25	415.1	23.3	0.69	-30.3	surge @ 57 began surge @ 1323
1358	24	OR	9.25	416.9	24.3	0.85	-33.2	surge @ 56 began surge @ 1342
1417	25.	OR	9.27	419.9	24.3	0.68	-33.6	surge @ 55 began surge @ 1401
1437	26	OR	9.27	430.0	25.2	1.14	-35.6	surge @ 54 began surge @ 1420
1457	27	OR	9.21	437.5	25.2	1.35	-35.3	surge @ 53 began surge @ 1442
1517	28	OR	9.14	445.5	24.5	2.93	-24.2	surge @ 52 began surge @ 1500
1536	29	OR	9.04	442.7	29.8	2.37	-19.5	surge @ 51 began surge @ 1520
1553	30	OR	9.13	446.2	30.1	2.30	-19.2	surge @ 50 began surge @ 1539

𝍸 IIII   OR = overrange   Page 1 of

8/1 0800 E. Curtis Onsite
1035 Had to reposition and strap down waterra + slow flow rate
1650 water wasn't flowing very well — difficult to take readings. WL @ ~56'
1800 E. Curtis offsite

8/2 0800 E. Curtis onsite DTW was ~ 41.91'

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0923 Having trouble getting water to flow. Talked to M. D'Andrea and decided to move to the next well and come back to this one later to do more surging.

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Well Development Form

Project No. 0830.03.04	Date 8/1/2019
Site Location: St Helens OR	Well: MW-2
Name: Phase 1 Lagoon Repurposing	Initial DTB: 72.14' Final DTB —
Development Method: Surge block waterra pump	Initial DTW: 41.20' Final DTW —
Total Water Removed 45 gal	Pore Volume: 30.94 ft X 0.163 = 5.04
Water Contained	Casing Diameter: 2" (6" borehole)
Estimated Specific Capacity	Meter No. Van C YSI 1, waterra, PDX turb 1

Time	Cum. Vol Removed	Turbidity NTU	pH	Conductivity (uS/cm)	Temp °C	DO (mg/L)	Eh	Comments
1613	32	—	—	—	—	—	—	surge block removed purge @ bottom @ 1603
1630	35	3923	9.25	424.5	16.6	0.80	-6.5	purge @ 60' purge began @ 1615
1635	37	3110	9.26	437.8	17.4	1.02	-5.5	purge @ 60'
1640	40	OR	8.99	448.0	17.3	1.01	2.5	purge @ 60'
1645	43	2356	9.11	437.1	16.4	1.21	3.5	purge @ 60'
1650	45	—	9.20	436.8	17.0	2.72	10.5	purge @ 60'
1655	~~47~~	—	—	—	—	—	—	~~purge @ 60'~~ purge @ 60' began purge @ 0857

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MAUL FOSTER ALONGI

Well Development Form

Project No. 0830.03.04	Date 7/22/19 + 7/23/19
Site Location: St. Helens, OR	Well: B-6/MW-6
Name: Phase I Lagoon Repurposing	Initial DTB: 50.0' Final DTB 49.95'
Development Method: Surgeblock, waterra pump	Initial DTW: 22.2' Final DTW 22.96'
Total Water Removed 103.5 gal	Pore Volume: 27.8 ft x 0.163 ≈ 4.53 gal
Water Contained	Casing Diameter: 2" (6" borehole)
Estimated Specific Capacity	Meter No. PDX waterra 1, YSI 1, turbidity meter 1

Time	Cum. Vol Removed	Turbidity NTU	pH	Conductivity (uS/cm)	Temp °C	DO (mg/L)	Eh	Comments
7/22 1017	5	OR	6.56	1105	17.6	0.30	-83.9	surge @ 49' began surge @ 09:40
1027	10	OR	6.59	1716	17.4	0.17	-57.3	increased flow rate
1045	15	OR	6.57	1813	17.5	0.18	-76.2	decreased flow rate
1106	22.5	OR	6.60	1749	17.9	0.60	73.5	surge @ 48' began surge @ 10:50
1121	25	OR	6.57	1779	17.9	0.44	-54.5	48'
1146	27.5	OR	6.54	1777	18.1	0.96	-40.2	surge @ 47' began surge @ 11:27
1158	30	OR	6.54	1562	18.5	0.23	-57.2	47'
1217	32	OR	6.61	1771	18.6	0.71	-34.8	surge @ 46' began surge @ 12:04
1232	35	OR	6.54	1792	18.5	0.28	-18.9	46'
12:49	40	OR	6.50	1857	17.2	0.13	-11.5	surge @ 45' began surge @ 12:36 — increased flow rate
1310	45	OR	6.52	1897	17.4	0.18	-15.8	45'
1333	50	OR	6.46	1882	18.8	0.22	-2.5	surge @ 44' began surge @ 13:16
1347	52	OR	6.49	1899	18.5	0.24	-14.0	44'
1407	55	OR	6.21	1909	18.7	0.18	-0.7	surge @ 43' began surge @ 13:52 — 1415 generator quit
1435	57	OR	6.32	1918	20.2	0.25	-42.3	43'
1506	60	OR	6.40	1907	19.5	0.41	-48.2	surge at 42' began surge @ 14:43
7/23 0845	62.5	OR	6.29	1826	16.7	0.38	311.3	surge @ 42' began surge @ 18:18 — water began flowing 08:30
0905	65	OR	6.44	1875	16.7	0.36	188.9	surge @ 41' began surge @ 08:57
0925	67.5	OR	6.50	1901	16.7	0.43	143.3	surge @ 40' began surge @ 09:09
0948	70	OR	6.58	1918	16.7	0.41	120.2	surge @ 39' began surge @ 09:28

OR = over range

Page 1 of 2

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7/22/19 08:30 E. Curtis + C. Schweitzer onsite. 10:05. C. Schweitzer off site

15:10 out of gas + generator died. Packed up equipment to get gas and other supplies.

16:30 E. Curtis off site

7/23/19 0730 E. Curtis onsite

Well Development Form

MAUL
FOSTER
ALONGI

Project No. 0830.03.04	Date 7/22/19 + 7/23/19
Site Location: St. Helens, OR	Well: B-6/MW-6
Name: Phase I Lagoon Repurposing	Initial DTB: 50.0' Final DTB ~~[illegible]~~ 49.85'
Development Method: surge block, waterra pump	Initial DTW: 22.2' Final DTW 22.96'
Total Water Removed 103.5 gal	Pore Volume: 27.8 ft × 0.163 = 4.53 gal
Water Contained	Casing Diameter: 2" (6" borehole)
Estimated Specific Capacity	Meter No. PDX waterra 1, YSI 1, turbidity meter 1

Time	Cum. Vol Removed	Turbidity NTU	pH	Conductivity (uS/cm)	Temp °C	DO (mg/L)	Eh	Comments
1017	73	OR	6.56	1925	16.7	0.48	93.3	surge at 38' began surge @ 09:30
1036	80	OR	6.56	1942	17.8	0.44	100.5	surge @ 37' began surge @ 1020
1101	82.5	OR	6.56	1957	17.5	0.65	104.1	surge @ 36' began surge @ 1045
1122	85	OR	6.57	1952	17.5	0.72	107.4	surge @ 35' began surge @ 1105
1144	87.5	OR	6.55	1946	17.5	0.51	109.9	surge @ 34' began surge @ 1125
1202	90	OR	6.58	1800	18.5	0.34	110.2	surge @ 33' began surge @ 1146
1225	91.5	OR	6.64	1717	19.9	0.57	93.7	surge @ 32' began surge @ 1207
1236	92	OR	6.56	1739	20.1	0.57	119.2	surge @ 30.5' began surge @ 1228
1241	92.5	OR	6.55	1779	20.2	0.58	130.2	30.5'
1246	93	OR	6.55	1788	20.1	0.57	141.4	30.5'
1310	98	—	—	—	—	—	—	surgeblock removed purge @ bottom start @ 1300
1319	99.5	35.0	6.37	1907	17.3	1.57	152.8	purge @ 40.5' began purge @ 13:14
1324	100.5	8.0	6.39	1921	17.6	1.32	161.4	purge @ 40.5'
1329	101.5	69.4	6.46	1935	17.4	1.19	166.7	purge @ 40.5'
1334	102.5	59.0	6.53	1908	17.3	1.22	166.9	purge @ 40.5'
1339	103.5	55.2	6.52	1936	17.4	1.19	177.7	purge @ 40.5'
~~1344~~	~~104.5~~							~~purge @ 40.5'~~

MAUL FOSTER ALONGI

Well Development Form

Project No. 0830.03.04	Date 7/23/19 – 7/24/19
Site Location: St. Helens, OR	Well: MW-4
Name: Phasel Lagoon Repurposing	Initial DTB: 51.28' Final DTB 50.74'
Development Method: Surge block, waterra pump	Initial DTW: 22.34' Final DTW 22.33'
Total Water Removed 66 gal	Pore Volume: 28.94' x 0.163 = 4.72
Water Contained	Casing Diameter: 2" (6" borehole)
Estimated Specific Capacity	Meter No. PDX waterra, YSI 1, turb 1

	Time	Cum. Vol Removed	Turbidity NTU	pH	Conductivity (uS/cm)	Temp °C	DO (mg/L)	Eh	Comments
7/23	1527	3	OR	6.03	830	19.1	1.14	389.8	surge @ 50' began surge @ 1509
	1547	5	OR	6.50	1355	18.5	0.33	150.6	surge @ 49' began surge @ 1532
	1608	10	OR	6.66	1675	18.6	0.16	155.7	surge @ 48' began surge @ 1549
	1629	13	OR	6.69	1749	18.7	0.28	173.9	surge @ 47' began surge @ 1612
	1647	15	OR	6.68	1754	19.0	0.15	190.2	surge @ 46' began surge @ 1631
	1707	20	OR	6.72	1736	18.9	0.16	194.3	surge @ 45' began surge @ 1649
7/24	0857	22.5	OR	6.23	1713	18.0	0.30	942.1	surge @ 44' began surge @ 0832
	0911	25	OR	6.49	1880	18.5	0.40	901.1	surge @ 43' began surge @ 0855
	0933	27.5	OR	6.69	1899	18.2	0.52	873.3	surge @ 42' began surge @ 0917
	0957	31	OR	6.63	1853	18.3	0.10	863.9	surge @ 41' began surge @ 0936
	1012	33	OR	6.70	1805	18.4	0.07	849.4	surge @ 40' began surge @ 0954
	1033	35	OR	6.72	1886	19.3	0.20	852.7	surge @ 39' began surge @ 1017
	1052	37.5	OR	6.68	1973	19.4	0.09	844.8	surge @ 38' began surge @ 1036
	1114	40	OR	6.74	1907	20.1	0.13	896.7	surge @ 37' began surge @ 1058
	1132	42	OR	6.72	1943	21.3	0.09	893.0	surge @ 36' began surge @ 1117
	1152	45	OR	6.79	1925	20.9	0.12	864.9	surge @ 35' began surge @ 1136
	1213	46	OR	6.69	1916	21.8	0.12	886.3	surge @ 34' began surge @ 1156
	1232	47.5	OR	6.75	1957	20.8	0.24	894.8	surge @ 33' began surge @ 1216
	1252	50	OR	6.73	1918	22.4	0.15	893.9	surge @ 32' began surge @ 1235
	1317	65	OR	6.67	1956	19.9	0.20	889.7	surge @ 31' began surge @ 1258

OR = over range

||||| ||||| |||

7/23 18:00 E. Curtis off site

7/24 0745 E. Curtis onsite

MAUL FOSTER ALONGI

Well Development Form

Project No. 0830.03.04	Date 7/23/19 & 7/24/19
Site Location: St. Helens, OR	Well: MW-4
Name: Phase I Lagoon Repurposing	Initial DTB: 51.28' Final DTB 50.74'
Development Method: Surge block, waterra pump	Initial DTW: 22.34' Final DTW 22.33'
Total Water Removed 66 gal	Pore Volume: 28.94 x 0.163 = 4.72
Water Contained	Casing Diameter: 2" (6" borehole)
Estimated Specific Capacity	Meter No. PDX waterra 1, YSI 1, turbidity meter 1

Time	Cum. Vol Removed	Turbidity NTU	pH	Conductivity (uS/cm)	Temp °C	DO (mg/L)	Eh	Comments
1336	57.5	OR	6.79	1947	21.4	0.26	902.1	surge @ 30' began surge @ 1320
1354	62	—	—	—	—	—	—	surge block removed purge @ bottom start @ 1344
1400	63	2741	6.56	1988	18.7	0.62	927.1	purge @ 40' began purge @ 1355
1405	64	1578	6.55	1995	18.6	0.43	937.6	purge @ 40'
1410	65	841	6.60	2002	18.7	0.42	943.4	purge @ 40'
1415	66	29	6.68	1999	18.8	0.45	938.4	purge @ 40'

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MAUL FOSTER ALONGI

Well Development Form

Project No. 0830.03.04	Date 7/24/19 + 7/24/19
Site Location: St. Helens, OR	Well: MW-5
Name: Phase 1 Lagoon Repurposing	Initial DTB: 51.59' Final DTB 51.30'
Development Method: Surge block, waterra pump	Initial DTW: 20.4' Final DTW 20.44'
Total Water Removed 65 gal	Pore Volume: 31.19 × 0.163 = 5.08
Water Contained	Casing Diameter: 2" (6" borehole)
Estimated Specific Capacity	Meter No. PDX waterra 1, YSI 1, turbidity meter 1

Time	Cum. Vol Removed	Turbidity NTU	pH	Conductivity (uS/cm)	Temp °C	DO (mg/L)	Eh	Comments
7/24 1547	2	OR	5.92	928	20.4	1.02	970.7	surge @ 49' began surge @1530
1606	5	OR	6.66	645	19.0	1.10	972.0	surge @ 48' began surge @ 1551
1624	7.5	OR	6.61	677	19.1	1.05	992.4	surge @ 47' began surge @ 1610
1642	10	OR	6.76	922	19.1	1.06	997.7	surge @ 46' began surge @ 1627
1658	12.5	OR	6.75	1077	19.0	0.66	998.2	surge @45' began surge @1643
1715	15	OR	6.68	1135	19.5	0.47	1007.9	surge @44' began surge @1700
1732	17.5	OR	6.75	1189	20.5	0.11	1007.4	surge @ 43' began surge @1718
1748	20	OR	6.74	1192	20.9	0.14	997.1	surge @42' began surge @1734
1802	22	OR	6.72	1328	20.0	0.12	999.0	surge @ 41' began surge @1750
7/25 0840	25	OR	6.04	1322	18.7	1.80	1062.9	surge @40' began surge @ 0824
0904	27.5	OR	6.49	1514	18.4	0.30	1034.5	surge @ 39' began surge @ 0846
0926	30	OR	6.62	1648	18.4	0.36	1044.3	surge @ 38' began surge @0911
0946	32.5	OR	6.73	1751	18.7	0.18	1028.1	surge @ 37' began surge @0929
1013	35	OR	6.69	1804	19.2	0.11	1030.5	surge @ 36' began surge @0951
1034	37.5	OR	6.78	1849	19.3	0.21	1032.0	surge @ 35' began surge @1015
1052	40	OR	6.69	1886	19.6	0.10	1045.3	surge @ 34' began surge @1036
1107	42.5	OR	6.70	1914	19.6	0.10	1046.0	surge @ 33' began surge @1054
1126	45	OR	6.87	1885	20.0	0.13	1047.1	surge @ 32' began surge @1110
1142	47.5	OR	6.82	1782	21.5	0.24	1053.1	surge @ 31' began surge @1129
1204	50	OR	6.94	1780	23.2	0.19	1036.3	surge @ 30' began surge @1144

HHT HHT I OR= over range

7/24 1845 E. Curtis offsite
7/25 0745 E. Curtis onsite

MAUL FOSTER ALONGI

Well Development Form

Project No. 0830.03.04	Date 7/24/19 + 7/25/19
Site Location: St. Helens, OR	Well: MW-5
Name: Phase 1 Lagoon Repurposing	Initial DTB: 51.8 ft · Final DTB 51.30'
Development Method: surge block, waterra pump	Initial DTW: 20.4' · Final DTW 20.44'
Total Water Removed 65 gal	Pore Volume: 31.19x0.163= 5.08
Water Contained	Casing Diameter: 2" (6" borehole)
Estimated Specific Capacity	Meter No. PDX waterra 1, YSI 1, turbidity meter 1

Time	Cum. Vol Removed	Turbidity NTU	pH	Conductivity (uS/cm)	Temp °C	DO (mg/L)	Eh	Comments
1221	55	–	–	–	–	–	–	surgeblock removed purge @ bottom @ 1221
1230	57	1019	6.62	1916	18.3	0.15	1058.9	purge @ 40' began purge @ 1225
1235	59	6	6.66	1898	18.2	0.14	1030.4	purge @ 40'
1240	61	55.2	6.61	1943	18.2	0.11	1042.2	purge @ 40'
1245	63	36.0	6.74	1969	18.1	0.11	1023.6	purge @ 40'
1250	65	30.1	6.67	1980	18.1	0.12	1034.7	purge @ 40'

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25-45

MAUL FOSTER ALONGI

Well Development Form

Project No. 0830.03.04	Date 7/25/19 + 7/26/19
Site Location: St. Helens, OR	Well: MW-3
Name: Phase 1 Lagoon Repurposing	Initial DTB: 45.65 / Final DTB 45.63'
Development Method: Surge block, waterra pump	Initial DTW: 10.11' / Final DTW 17.46'
Total Water Removed 49 gal	Pore Volume: 35.54 × 0.163 = 5.79
Water Contained	Casing Diameter: 2" (6" borehole)
Estimated Specific Capacity	Meter No. PDX waterra 1, YSI 1, turbidity meter 1

	Time	Cum. Vol Removed	Turbidity NTU	pH	Conductivity (uS/cm)	Temp °C	DO (mg/L)	Eh	Comments
7/25	1435	1.5	OR	6.11	731	23.0	0.12	1059.9	surge @ 44' began surge @ 1415
	1453	3	OR	6.74	688	21.8	0.06	1045.6	surge @ 43' began surge @ 1437
	1516	5	OR	6.72	675	21.4	0.11	1050.0	surge @ 42' began surge @ 1457
	1536	7.5	OR	6.84	678	22.3	0.11	1049.0	surge @ 41' began surge @ 1520
	1558	10	OR	6.87	670	22.7	0.07	1052.7	surge @ 40' began surge @ 1540
	1615	12	OR	6.69	645	23.0	0.06	1052.1	surge @ 39' began surge @ 1602
	1633	14	OR	6.86	645	23.9	0.05	1048.4	surge @ 38' began surge @ 1617
	1650	15	OR	6.74	649	23.6	0.06	1054.1	surge @ 37' began surge @ 1634
	1709	17	OR	6.71	649	23.9	0.05	1054.9	surge @ 36' began surge @ 1652
7/26	0901	18.5	OR	5.98	678	19.7	0.99	1090.0	surge @ 35' began surge @ 0840
	0923	22	OR	6.69	568.2	18.4	0.86	1072.3	surge @ 34' began surge @ 0905
	0950	25	OR	6.76	588	18.4	0.82	1083.0	surge @ 33' began surge @ 0930
	1006	27	OR	6.93	600	19.3	0.38	1072.6	surge @ 32' begans surge @ 0957
	1024	29	OR	7.07	561	19.1	0.36	1076.6	surge @ 31' began surge @ 1010
	1043	32	OR	6.94	582	19.6	0.25	1076.3	surge @ 30' began surge @ 1026
	1104	34.5	OR	6.93	613	20.4	0.20	1075.1	surge @ 29' began surge @ 1046
	1119	36.5	OR	6.87	625	22.0	0.15	1075.8	surge @ 28' began surge @ 1105
	1137	39	OR	6.88	648	24.2	0.12	1067.7	surge @ 27' began surge @ 1122
	1157	40	OR	6.92	633	25.9	0.21	1062.4	surge @ 26' began surge @ 1140
	1210	41.5	OR	7.05	617	26.8	0.15	1057.3	surge @ 25' began surge @ 1200

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7/25 1745 E. Curtis offsite

7/26 0800 E. Curtis onsite

MAUL FOSTER ALONGI

Well Development Form

Project No. 0830.03.04	Date 7/25/19 + 7/26/19
Site Location: St. Helens, OR	Well: MW-3
Name: Phase 1 Lagoon Repurposing	Initial DTB: 45.65' — Final DTB 45.63'
Development Method: surge block, waterra pump	Initial DTW: 10.11' — Final DTW 17.46'
Total Water Removed 49 gal	Pore Volume:
Water Contained	Casing Diameter: 2" (6" borehole)
Estimated Specific Capacity	Meter No. PDX waterra 1, YSI 1, turbidity meter 1

Time	Cum. Vol Removed	Turbidity NTU	pH	Conductivity (uS/cm)	Temp °C	DO (mg/L)	Eh	Comments
1235	45	—	—	—	—	—	—	surge block removed purge @ bottom @ 1225
1245	46	1275	7.09	595	19.6	0.84	1083.1	purge @ 35' began purge @ 1240
1250	46.5	1547	6.91	589	19.8	0.84	1087.4	purge @ 35'
1255	47	1444	6.94	600	19.9	0.81	1093.0	purge @ 35'
1300	47.5	1374	7.15	605	19.9	0.86	1083.8	purge @ 35'
1305	48	1359	6.90	603	19.7	0.77	1091.7	purge @ 35'
1310	48.5	1346	6.93	601	19.8	0.76	1087.8	purge @ 35'
1315	49	1274	6.93	599	19.8	0.77	1089.7	purge @ 35'

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Maul Foster & Alongi, Inc.

109 East 13th Street, Vancouver, WA 98660 (360) 694-2691 Fax. (360) 906-1

Water Field Sampling Data Sheet

Client Name	City of St. Helens	**Sample Location**	MW-1
Project #	0830.03.04-02	**Sampler**	EMC & JRM
Project Name	St. Helens Lagoon	**Sampling Date**	8/6/2019
Sampling Event		**Sample Name**	MW-1-20190806-GW-70
Sub Area		**Sample Depth**	70
FSDS QA:		**Easting**	
		Northing	
		TOC	

Hydrology/Level Measurements

Date	Time	DT-Bottom	DT-Product	DT-Water	(Product Thickness) DTP-DTW	(Water Column) DTB-DTW	(Gallons/ft x Water Column) Pore Volume
				29.8			

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Water Quality Data

Purge Method	Time	Purge Vol (gal)	Flowrate l/min	pH	Temp (C)	E Cond (uS/cm)	DO (mg/L)	ORP	Turbidity
(5) Inertia Pump	11:03:00 AM	1	0.29	6.96	68	646	9.62	135.1	120.64
	11:08:00 AM	1	0.29	7.42	63.7	636	9.1	91.9	140.18
	11:13:00 AM	1	0.29	7.55	63.5	626	8.66	75.1	178.91
	11:18:00 AM	1.5	0.29	7.61	63.1	618	8.41	68.3	242.4
	11:23:00 AM	1.9	0.29	7.64	63.6	616	8.43	62.6	279.6
	11:28:00 AM	2.3	0.29	7.66	63.5	620	7.86	51.6	
Final Field Parameters									

Methods: (1) Submersible Pump (2) Peristaltic Pump (3) Disposable Bailer (4) Vacuum Pump (5) Dedicated Bailer (6) Inertia Pump (7) Other (specify)

Water Quality Observations:

Sample Information

Sampling Method	Sample Type	Sampling Time	Container Code/Preservative	#	Filtered
(5) Inertia Pump	Groundwater	12:16:00 PM	VOA-Glass		
			Amber Glass		
			White Poly	1	Yes
			Yellow Poly		
			Green Poly		
			Red Total Poly	1	Yes
			Red Dissolved Poly		
			Total Bottles	2	

General Sampling Comments

Page: 1/3

Final DTW: 39.25'

Maul Foster & Alongi, Inc.

109 East 13th Street, Vancouver, WA 98660 (360) 694-2691 Fax. (360) 906-1

Water Field Sampling Data Sheet

Client Name	City of St. Helens	**Sample Location**	MW-1
Project #	0830.03.04-02	**Sampler**	EMC & JRM
Project Name	St. Helens Lagoon	**Sampling Date**	8/6/2019
Sampling Event		**Sample Name**	MW-1-20190806-GW-70
Sub Area		**Sample Depth**	70
FSDS QA:		**Easting**	
		Northing	
		TOC	

Hydrology/Level Measurements

Date	Time	DT-Bottom	DT-Product	DT-Water	(Product Thickness) DTP-DTW	(Water Column) DTB-DTW	(Gallons/ft x Water Column) Pore Volume
				29.8			

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Water Quality Data

Purge Method	Time	Purge Vol (gal)	Flowrate l/min	pH	Temp (C)	E Cond (uS/cm)	DO (mg/L)	ORP	Turbidity
(5) Inertia Pump	11:33:00 AM	2.5	0.29	7.64	64.1	630	7.38	30	95.23
	11:38:00 AM	2.5	0.29	7.61	64.1	636	6.78	11.7	97.17
	11:41:00 AM	2.7	0.29	7.6	64	639	6.39	2.7	104.33
	11:44:00 AM	2.8	0.29	7.6	64	642	6.1	-2.9	108.71
	11:47:00 AM	3	0.29	7.59	65	644	5.84	-8.7	119.6
	11:52:00 AM	3.5	0.29	7.58	64.7	648	5.42	-17.8	124.44
Final Field Parameters									

Methods: (1) Submersible Pump (2) Peristaltic Pump (3) Disposable Bailer (4) Vacuum Pump (5) Dedicated Bailer (6) Inertia Pump (7) Other (specify)

Water Quality Observations:

Sample Information

Sampling Method	Sample Type	Sampling Time	Container Code/Preservative	#	Filtered
(5) Inertia Pump	Groundwater	12:16:00 PM	VOA-Glass		
			Amber Glass		
			White Poly	1	Yes
			Yellow Poly		
			Green Poly		
			Red Total Poly	1	Yes
			Red Dissolved Poly		
			Total Bottles	2	

General Sampling Comments

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Final DTW: 39.25'

Maul Foster & Alongi, Inc.

109 East 13th Street, Vancouver, WA 98660 (360) 694-2691 Fax. (360) 906-1

Water Field Sampling Data Sheet

Client Name	City of St. Helens	**Sample Location**	MW-1
Project #	0830.03.04-02	**Sampler**	EMC & JRM
Project Name	St. Helens Lagoon	**Sampling Date**	8/6/2019
Sampling Event		**Sample Name**	MW-1-20190806-GW-70
Sub Area		**Sample Depth**	70
FSDS QA:			

Easting		**Northing**		**TOC**	

Hydrology/Level Measurements

Date	Time	DT-Bottom	DT-Product	DT-Water	(Product Thickness) DTP-DTW	(Water Column) DTB-DTW	(Gallons/ft x Water Column) Pore Volume
				29.8			

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Water Quality Data

Purge Method	Time	Purge Vol (gal)	Flowrate l/min	pH	Temp (C)	E Cond (uS/cm)	DO (mg/L)	ORP	Turbidity
(5) Inertia Pump	11:57:00 AM	3.7	0.29	7.57	64.9	652	4.91	-27.6	133.59
	12:02:00 PM	4	0.29	7.56	64.7	658	4.43	-34.3	122.69
	12:07:00 PM	4	0.29	7.55	64.9	662	4.16	-38.4	127.09
	12:10:00 PM	4	0.29	7.54	65.1	665	3.94	-45.1	121.53
	12:13:00 PM	4.3	0.29	7.54	65.3	667	3.79	-48	122.81
Final Field Parameters	12:16:00 PM	4.5	0.29	7.54	65.4	669	3.63	-51.6	125.75

Methods: (1) Submersible Pump (2) Peristaltic Pump (3) Disposable Bailer (4) Vacuum Pump (5) Dedicated Bailer (6) Inertia Pump (7) Other (specify)

Water Quality Observations:

Sample Information

Sampling Method	Sample Type	Sampling Time	Container Code/Preservative	#	Filtered
(5) Inertia Pump	Groundwater	12:16:00 PM	VOA-Glass		
			Amber Glass		
			White Poly	1	Yes
			Yellow Poly		
			Green Poly		
			Red Total Poly	1	Yes
			Red Dissolved Poly		
			Total Bottles	2	

General Sampling Comments

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Final DTW: 39.25'

Maul Foster & Alongi, Inc.

109 East 13th Street, Vancouver, WA 98660 (360) 694-2691 Fax. (360) 906-1

Water Field Sampling Data Sheet

Client Name	City of St. Helens	**Sample Location**	MW-2
Project #	0830.03.04-02	**Sampler**	EMC & JRM
Project Name	St. Helens Lagoon	**Sampling Date**	8/7/2019
Sampling Event		**Sample Name**	MW-2-20190807-GW-60
Sub Area		**Sample Depth**	60
FSDS QA:		**Easting** / **Northing** / **TOC**	

Hydrology/Level Measurements

Date	Time	DT-Bottom	DT-Product	DT-Water	(Product Thickness) DTP-DTW	(Water Column) DTB-DTW	(Gallons/ft x Water Column) Pore Volume
8/7/2019	13:15			39.77			

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Water Quality Data

Purge Method	Time	Purge Vol (gal)	Flowrate l/min	pH	Temp (C)	E Cond (uS/cm)	DO (mg/L)	ORP	Turbidity
(5) Inertia Pump	1:42:00 PM	0.4	0.4	8.71	64.4	496	7.13	36.7	164.82
	1:47:00 PM	0.4	0.2	9.03	62.9	490	4.61	21.3	209.98
	1:52:00 PM	0.8	0.2	9.05	62.6	491.4	4.44	17.3	224.41
	1:57:00 PM	1	0.2	9.05	62.4	490.4	4.19	16.3	222.94
	2:02:00 PM	2	0.2	9.05	62	488.7	3.35	15	211.52
	2:07:00 PM	2.3	0.2	9.04	62.3	488.2	3.71	12.9	194.52
Final Field Parameters									

Methods: (1) Submersible Pump (2) Peristaltic Pump (3) Disposable Bailer (4) Vacuum Pump (5) Dedicated Bailer (6) Inertia Pump (7) Other (specify)

Water Quality Observations:

Sample Information

Sampling Method	Sample Type	Sampling Time	Container Code/Preservative	#	Filtered
(5) Inertia Pump	Groundwater	2:20:00 PM	VOA-Glass		
			Amber Glass		
			White Poly	1	Yes
			Yellow Poly		
			Green Poly		
			Red Total Poly	1	Yes
			Red Dissolved Poly		
			Total Bottles	2	

General Sampling Comments

Page: 1/2

Maul Foster & Alongi, Inc.

109 East 13th Street, Vancouver, WA 98660 (360) 694-2691 Fax. (360) 906-1

Water Field Sampling Data Sheet

Client Name	City of St. Helens	**Sample Location**	MW-2
Project #	0830.03.04-02	**Sampler**	EMC & JRM
Project Name	St. Helens Lagoon	**Sampling Date**	8/7/2019
Sampling Event		**Sample Name**	MW-2-20190807-GW-60
Sub Area		**Sample Depth**	60
FSDS QA:		**Easting** / **Northing** / **TOC**	

Hydrology/Level Measurements

Date	Time	DT-Bottom	DT-Product	DT-Water	(Product Thickness) DTP-DTW	(Water Column) DTB-DTW	(Gallons/ft x Water Column) Pore Volume
8/7/2019	13:15			39.77			

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Water Quality Data

Purge Method	Time	Purge Vol (gal)	Flowrate l/min	pH	Temp (C)	E Cond (uS/cm)	DO (mg/L)	ORP	Turbidity
(5) Inertia Pump	2:12:00 PM	2.5	0.2	9.03	62.6	487.9	3.65	11.1	183.48
	2:17:00 PM	2.8	0.2	9.03	62.6	487.3	3.46	9.9	175.48
Final Field Parameters	2:20:00 PM	3	0.2	9.03	62.6	487.9	3.42	9.03	167.01

Methods: (1) Submersible Pump (2) Peristaltic Pump (3) Disposable Bailer (4) Vacuum Pump (5) Dedicated Bailer (6) Inertia Pump (7) Other (specify)

Water Quality Observations:

Sample Information

Sampling Method	Sample Type	Sampling Time	Container Code/Preservative	#	Filtered
(5) Inertia Pump	Groundwater	2:20:00 PM	VOA-Glass		
			Amber Glass		
			White Poly	1	Yes
			Yellow Poly		
			Green Poly		
			Red Total Poly	1	Yes
			Red Dissolved Poly		
			Total Bottles	2	

General Sampling Comments

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Maul Foster & Alongi, Inc.

109 East 13th Street, Vancouver, WA 98660 (360) 694-2691 Fax. (360) 906-1

Water Field Sampling Data Sheet

Client Name	City of St. Helens	**Sample Location**	MW-3
Project #	0830.03.04-02	**Sampler**	EMC & JRM
Project Name	St. Helens Lagoon	**Sampling Date**	8/6/2019
Sampling Event		**Sample Name**	MW-3-20190806-GW-35
Sub Area		**Sample Depth**	35
FSDS QA:		**Easting** / **Northing** / **TOC**	

Hydrology/Level Measurements

Date	Time	DT-Bottom	DT-Product	DT-Water	DTP-DTW (Product Thickness)	DTB-DTW (Water Column)	Pore Volume (Gallons/ft x Water Column)
				17.36			

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Water Quality Data

Purge Method	Time	Purge Vol (gal)	Flowrate l/min	pH	Temp (C)	E Cond (uS/cm)	DO (mg/L)	ORP	Turbidity
(5) Inertia Pump	1:20:00 PM	0.1	0.45	6.63	66	840	16	-102.1	1412
	1:25:00 PM	0.3	0.19	6.59	65	840	2.5	-110.9	149.5
	1:30:00 PM	0.5	0.19	6.61	68.9	837	0.21	-116.7	126.3
	1:35:00 PM	0.6	0.15	6.62	69.2	834	0.15	-117.3	151.2
	1:40:00 PM	1	0.15	6.66	67.4	801	0.08	-120.4	324.6
	1:45:00 PM	1.3	0.15	6.74	66.6	753	0.06	-125.7	1111.6
Final Field Parameters									

Methods: (1) Submersible Pump (2) Peristaltic Pump (3) Disposable Bailer (4) Vacuum Pump (5) Dedicated Bailer (6) Inertia Pump (7) Other (specify)

Water Quality Observations:

Turbidity would not settle and continued to jump around. Eventually did settle and quite jumping.

Sample Information

Sampling Method	Sample Type	Sampling Time	Container Code/Preservative	#	Filtered
(5) Inertia Pump	Groundwater	2:25:00 PM	VOA-Glass		
			Amber Glass		
			White Poly	1	Yes
			Yellow Poly		
			Green Poly		
			Red Total Poly	1	Yes
			Red Dissolved Poly		
			Total Bottles	2	

General Sampling Comments

Page: 1/3

Final DTW: 17.50' bgs

Maul Foster & Alongi, Inc.
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Water Field Sampling Data Sheet

Client Name	City of St. Helens	**Sample Location**	MW-3
Project #	0830.03.04-02	**Sampler**	EMC & JRM
Project Name	St. Helens Lagoon	**Sampling Date**	8/6/2019
Sampling Event		**Sample Name**	MW-3-20190806-GW-35
Sub Area		**Sample Depth**	35
FSDS QA:		**Easting** / **Northing** / **TOC**	

Hydrology/Level Measurements

Date	Time	DT-Bottom	DT-Product	DT-Water	DTP-DTW (Product Thickness)	DTB-DTW (Water Column)	Pore Volume (Gallons/ft x Water Column)
				17.36			

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Water Quality Data

Purge Method	Time	Purge Vol (gal)	Flowrate l/min	pH	Temp (C)	E Cond (uS/cm)	DO (mg/L)	ORP	Turbidity
(5) Inertia Pump	1:50:00 PM	1.5	0.15	6.83	67.2	714	0.05	-132.9	287.9
	1:55:00 PM	2	0.15	6.89	66.9	691	0.04	-136.9	38.41
	2:00:00 PM	2.2	0.15	6.92	66.5	684	0.03	-139.7	70.76
	2:05:00 PM	2.2	0.15	6.93	66.8	677	0.02	-140.9	15.6
	2:10:00 PM	2.4	0.15	6.94	67.1	673	0.02	-142.1	15.24
	2:13:00 PM	2.4	0.15	6.95	66.8	670	0.01	-142.5	15.12
Final Field Parameters									

Methods: (1) Submersible Pump (2) Peristaltic Pump (3) Disposable Bailer (4) Vacuum Pump (5) Dedicated Bailer (6) Inertia Pump (7) Other (specify)

Water Quality Observations: Turbidity would not settle and continued to jump around. Eventually did settle and quite jumping.

Sample Information

Sampling Method	Sample Type	Sampling Time	Container Code/Preservative	#	Filtered
(5) Inertia Pump	Groundwater	2:25:00 PM	VOA-Glass		
			Amber Glass		
			White Poly	1	Yes
			Yellow Poly		
			Green Poly		
			Red Total Poly	1	Yes
			Red Dissolved Poly		
			Total Bottles	2	

General Sampling Comments

Page: 2/3

Final DTW: 17.50' bgs

Maul Foster & Alongi, Inc.

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Water Field Sampling Data Sheet

Client Name	City of St. Helens	**Sample Location**	MW-3
Project #	0830.03.04-02	**Sampler**	EMC & JRM
Project Name	St. Helens Lagoon	**Sampling Date**	8/6/2019
Sampling Event		**Sample Name**	MW-3-20190806-GW-35
Sub Area		**Sample Depth**	35
FSDS QA:		**Easting** / **Northing** / **TOC**	

Hydrology/Level Measurements

Date	Time	DT-Bottom	DT-Product	DT-Water	DTP-DTW (Product Thickness)	DTB-DTW (Water Column)	Pore Volume (Gallons/ft x Water Column)
				17.36			

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Water Quality Data

Purge Method	Time	Purge Vol (gal)	Flowrate l/min	pH	Temp (C)	E Cond (uS/cm)	DO (mg/L)	ORP	Turbidity
(5) Inertia Pump	2:16:00 PM	2.5	0.15	6.96	66.8	667	0.01	-143	15.31
	2:19:00 PM	2.5	0.15	6.96	66.9	666	0.01	-143	19.43
	2:22:00 PM	3	0.15	6.96	66.9	667	0	-143	11.64
Final Field Parameters	2:25:00 PM	3	0.15	6.97	66.9	666	0	-143.4	19.96

Methods: (1) Submersible Pump (2) Peristaltic Pump (3) Disposable Bailer (4) Vacuum Pump (5) Dedicated Bailer (6) Inertia Pump (7) Other (specify)

Water Quality Observations:

Turbidity would not settle and continued to jump around. Eventually did settle and quite jumping.

Sample Information

Sampling Method	Sample Type	Sampling Time	Container Code/Preservative	#	Filtered
(5) Inertia Pump	Groundwater	2:25:00 PM	VOA-Glass		
			Amber Glass		
			White Poly	1	Yes
			Yellow Poly		
			Green Poly		
			Red Total Poly	1	Yes
			Red Dissolved Poly		
			Total Bottles	2	

General Sampling Comments

Page: 3/3

Final DTW: 17.50' bgs

Maul Foster & Alongi, Inc.

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Water Field Sampling Data Sheet

Client Name	City of St. Helens	**Sample Location**	MW-4
Project #	0830.03.04-02	**Sampler**	EMC & JRM
Project Name	St. Helens Lagoon	**Sampling Date**	8/7/2019
Sampling Event		**Sample Name**	MW-4-20190807-GW-40
Sub Area		**Sample Depth**	40
FSDS QA:			

Easting		**Northing**		**TOC**	

Hydrology/Level Measurements

Date	Time	DT-Bottom	DT-Product	DT-Water	DTP-DTW (Product Thickness)	DTB-DTW (Water Column)	Pore Volume (Gallons/ft x Water Column)
8/7/2019	10:00			22.63			

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Water Quality Data

Purge Method	Time	Purge Vol (gal)	Flowrate l/min	pH	Temp (C)	E Cond (uS/cm)	DO (mg/L)	ORP	Turbidity
(2) Peristaltic Pump	10:18:00 AM	0.1	0.15	6.59	66.8	2073	0.87	-85.4	685.36
	10:23:00 AM	0.2	0.15	6.66	65.6	2087	0.23	-116.7	141.09
	10:28:00 AM	0.3	0.15	6.69	66.7	2091	0.16	-126.5	55.49
	10:33:00 AM	0.4	0.15	6.69	66.4	2096	0.11	-130.5	55.1
	10:38:00 AM	0.5	0.15	6.7	65.7	2099	0.5	-135	22.23
	10:44:00 AM	1	0.15	6.7	65.7	2102	0.03	-138.4	126.02
Final Field Parameters									

Methods: (1) Submersible Pump (2) Peristaltic Pump (3) Disposable Bailer (4) Vacuum Pump (5) Dedicated Bailer (6) Inertia Pump (7) Other (specify)

Water Quality Observations:

Sample Information

Sampling Method	Sample Type	Sampling Time	Container Code/Preservative	#	Filtered
(5) Inertia Pump	Groundwater	11:06:00 AM	VOA-Glass		
			Amber Glass		
			White Poly	1	Yes
			Yellow Poly		
			Green Poly		
			Red Total Poly	1	Yes
			Red Dissolved Poly		
			Total Bottles	2	

General Sampling Comments

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Final DTW: 23.61

Maul Foster & Alongi, Inc.

109 East 13th Street, Vancouver, WA 98660 (360) 694-2691 Fax. (360) 906-1

Water Field Sampling Data Sheet

Client Name	City of St. Helens	**Sample Location**	MW-4
Project #	0830.03.04-02	**Sampler**	EMC & JRM
Project Name	St. Helens Lagoon	**Sampling Date**	8/7/2019
Sampling Event		**Sample Name**	MW-4-20190807-GW-40
Sub Area		**Sample Depth**	40
FSDS QA:			

Easting		**Northing**		**TOC**	

Hydrology/Level Measurements

Date	Time	DT-Bottom	DT-Product	DT-Water	(Product Thickness) DTP-DTW	(Water Column) DTB-DTW	(Gallons/ft x Water Column) Pore Volume
8/7/2019	10:00			22.63			

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Water Quality Data

Purge Method	Time	Purge Vol (gal)	Flowrate l/min	pH	Temp (C)	E Cond (uS/cm)	DO (mg/L)	ORP	Turbidity
(2) Peristaltic Pump	10:49:00 AM	1.1	0.15	6.7	65.9	2102	0.02	-140.2	57.94
	10:54:00 AM	1.4	0.15	6.7	66.2	2107	0.01	-141.9	61.89
	10:57:00 AM	1.5	0.15	6.7	66.3	2104	0.01	-142.5	86.21
	11:00:00 AM	1.6	0.15	6.7	66.7	2106	0.01	-142.9	17.03
	11:03:00 AM	1.8	0.15	6.7	66.7	2107	0	-144	15.89
Final Field Parameters	11:06:00 AM	1.9	0.15	6.7	66.7	2107	0	-144.2	29.6

Methods: (1) Submersible Pump (2) Peristaltic Pump (3) Disposable Bailer (4) Vacuum Pump (5) Dedicated Bailer (6) Inertia Pump (7) Other (specify)

Water Quality Observations:

Sample Information

Sampling Method	Sample Type	Sampling Time	Container Code/Preservative	#	Filtered
(5) Inertia Pump	Groundwater	11:06:00 AM	VOA-Glass		
			Amber Glass		
			White Poly	1	Yes
			Yellow Poly		
			Green Poly		
			Red Total Poly	1	Yes
			Red Dissolved Poly		
			Total Bottles	2	

General Sampling Comments

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Final DTW: 23.61

Maul Foster & Alongi, Inc.

109 East 13th Street, Vancouver, WA 98660 (360) 694-2691 Fax. (360) 906-1

Water Field Sampling Data Sheet

Client Name	City of St. Helens	**Sample Location**	MW-5
Project #	0830.03.04-02	**Sampler**	EMC & JRM
Project Name	St. Helens Lagoon	**Sampling Date**	8/6/2019
Sampling Event		**Sample Name**	MW-5-20190806-GW-40
Sub Area		**Sample Depth**	40
FSDS QA:			

Easting		**Northing**		**TOC**	

Hydrology/Level Measurements

Date	Time	DT-Bottom	DT-Product	DT-Water	(Product Thickness) DTP-DTW	(Water Column) DTB-DTW	(Gallons/ft x Water Column) Pore Volume
				20.42			

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Water Quality Data

Purge Method	Time	Purge Vol (gal)	Flowrate l/min	pH	Temp (C)	E Cond (uS/cm)	DO (mg/L)	ORP	Turbidity
(2) Peristaltic Pump	3:05:00 PM	0.4	0.25	6.68	67.7	1776	0.77	-102.8	510.9
	3:10:00 PM	0.5	0.25	6.65	67.7	1787	0.14	-124.2	159.6
	3:15:00 PM	0.5	0.15	6.67	71.7	1781	0.11	-129.1	32.6
	3:20:00 PM	0.6	0.2	6.66	67.8	1806	0.07	-130.4	248.9
	3:25:00 PM	0.8	0.2	6.66	68.3	1826	0.02	-133.6	837.2
	3:30:00 PM	1.2	0.2	6.67	68.2	1839	0.01	-135.5	334.7
Final Field Parameters									

Methods: (1) Submersible Pump (2) Peristaltic Pump (3) Disposable Bailer (4) Vacuum Pump (5) Dedicated Bailer (6) Inertia Pump (7) Other (specify)

Water Quality Observations:

Sample Information

Sampling Method	Sample Type	Sampling Time	Container Code/Preservative	#	Filtered
(5) Inertia Pump	Groundwater	3:55:00 PM	VOA-Glass		
			Amber Glass		
			White Poly	1	Yes
			Yellow Poly		
			Green Poly		
			Red Total Poly	1	Yes
			Red Dissolved Poly		
			Total Bottles	2	

General Sampling Comments

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Final DTW: 21.55

Maul Foster & Alongi, Inc.

109 East 13th Street, Vancouver, WA 98660 (360) 694-2691 Fax. (360) 906-1

Water Field Sampling Data Sheet

Client Name	City of St. Helens	**Sample Location**	MW-5
Project #	0830.03.04-02	**Sampler**	EMC & JRM
Project Name	St. Helens Lagoon	**Sampling Date**	8/6/2019
Sampling Event		**Sample Name**	MW-5-20190806-GW-40
Sub Area		**Sample Depth**	40
FSDS QA:		**Easting**	
		Northing	
		TOC	

Hydrology/Level Measurements

Date	Time	DT-Bottom	DT-Product	DT-Water	(Product Thickness) DTP-DTW	(Water Column) DTB-DTW	(Gallons/ft x Water Column) Pore Volume
				20.42			

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Water Quality Data

Purge Method	Time	Purge Vol (gal)	Flowrate l/min	pH	Temp (C)	E Cond (uS/cm)	DO (mg/L)	ORP	Turbidity
(2) Peristaltic Pump	3:05:00 PM	1.5	0.2	6.67	69.2	1872	0.01	-137.3	381.9
	3:40:00 PM	1.8	0.2	6.66	69.2	1876	0	-138	427.5
	3:45:00 PM	2	0.2	6.66	69.2	1893	-0.01	-139.3	82.5
	3:50:00 PM	2.1	0.2	6.66	69.3	1903	-0.01	-140.1	155.4
Final Field Parameters	3:55:00 PM	2.4	0.2	6.66	69.3	1908	-0.01	-140.5	75.86

Methods: (1) Submersible Pump (2) Peristaltic Pump (3) Disposable Bailer (4) Vacuum Pump (5) Dedicated Bailer (6) Inertia Pump (7) Other (specify)

Water Quality Observations:

Sample Information

Sampling Method	Sample Type	Sampling Time	Container Code/Preservative	#	Filtered
(5) Inertia Pump	Groundwater	3:55:00 PM	VOA-Glass		
			Amber Glass		
			White Poly	1	Yes
			Yellow Poly		
			Green Poly		
			Red Total Poly	1	Yes
			Red Dissolved Poly		
			Total Bottles	2	

General Sampling Comments

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Final DTW: 21.55

Maul Foster & Alongi, Inc.

109 East 13th Street, Vancouver, WA 98660 (360) 694-2691 Fax. (360) 906-1

Water Field Sampling Data Sheet

Client Name	City of St. Helens	**Sample Location**	MW-6
Project #	0830.03.04-02	**Sampler**	EMC & JRM
Project Name	St. Helens Lagoon	**Sampling Date**	8/7/2019
Sampling Event		**Sample Name**	MW-6-20190808-GW-40.5
Sub Area		**Sample Depth**	40.5
FSDS QA:			

Easting		**Northing**		**TOC**	

Hydrology/Level Measurements

Date	Time	DT-Bottom	DT-Product	DT-Water	DTP-DTW (Product Thickness)	DTB-DTW (Water Column)	Pore Volume (Gallons/ft x Water Column)
				22.29			

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Water Quality Data

Purge Method	Time	Purge Vol (gal)	Flowrate l/min	pH	Temp (C)	E Cond (uS/cm)	DO (mg/L)	ORP	Turbidity
(2) Peristaltic Pump	11:37:00 AM	0.3	0.29	6.8	63.8	1952	1.39	-53.1	33.07
	11:42:00 AM	0.4	0.29	6.74	61.6	1946	0.14	-111.5	36.28
	11:47:00 AM	0.7	0.29	6.73	62.1	1947	0.06	-125.7	48.92
	11:52:00 AM	1	0.14	6.74	63	1948	0.04	-131.9	64.28
	11:57:00 AM	1.2	0.26	6.74	62.5	1945	0.01	-136.2	55.79
	12:00:00 PM	1.5	0.2	6.74	62.3	1944	0	-137.9	49.03
Final Field Parameters									

Methods: (1) Submersible Pump (2) Peristaltic Pump (3) Disposable Bailer (4) Vacuum Pump (5) Dedicated Bailer (6) Inertia Pump (7) Other (specify)

Water Quality Observations:

Sample Information

Sampling Method	Sample Type	Sampling Time	Container Code/Preservative	#	Filtered
(5) Inertia Pump	Groundwater		VOA-Glass		
			Amber Glass		
			White Poly	1	Yes
			Yellow Poly		
			Green Poly		
			Red Total Poly	1	Yes
			Red Dissolved Poly		
			Total Bottles	2	

General Sampling Comments

Page: 1/2

Final DTW: 22.29 bgs

Maul Foster & Alongi, Inc.

109 East 13th Street, Vancouver, WA 98660 (360) 694-2691 Fax. (360) 906-1

Water Field Sampling Data Sheet

Client Name	City of St. Helens	**Sample Location**	MW-6
Project #	0830.03.04-02	**Sampler**	EMC & JRM
Project Name	St. Helens Lagoon	**Sampling Date**	8/7/2019
Sampling Event		**Sample Name**	MW-6-20190808-GW-40.5
Sub Area		**Sample Depth**	40.5
FSDS QA:		**Easting** / **Northing** / **TOC**	

Hydrology/Level Measurements

Date	Time	DT-Bottom	DT-Product	DT-Water	DTP-DTW (Product Thickness)	DTB-DTW (Water Column)	Pore Volume (Gallons/ft x Water Column)
				22.29			

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Water Quality Data

Purge Method	Time	Purge Vol (gal)	Flowrate l/min	pH	Temp (C)	E Cond (uS/cm)	DO (mg/L)	ORP	Turbidity
(2) Peristaltic Pump	12:03:00 PM	1.7	0.2	6.74	62.2	1941	-0.01	-139.5	138.26
Final Field Parameters	12:06:00 PM	2	0.2	6.74	62.1	1936	-0.01	-140.9	116.52

Methods: (1) Submersible Pump (2) Peristaltic Pump (3) Disposable Bailer (4) Vacuum Pump (5) Dedicated Bailer (6) Inertia Pump (7) Other (specify)

Water Quality Observations:

Sample Information

Sampling Method	Sample Type	Sampling Time	Container Code/Preservative	#	Filtered
(5) Inertia Pump	Groundwater		VOA-Glass		
			Amber Glass		
			White Poly	1	Yes
			Yellow Poly		
			Green Poly		
			Red Total Poly	1	Yes
			Red Dissolved Poly		
			Total Bottles	2	

General Sampling Comments

Page: 2/2

Final DTW: 22.29' bgs

Maul Foster & Alongi, Inc.

109 East 13th Street, Vancouver, WA 98660 (360) 694-2691 Fax. (360) 906-1

Water Field Sampling Data Sheet

Client Name	City of St. Helens	**Sample Location**	B -1
Project #	0830.03.04-02	**Sampler**	CS
Project Name	St. Helens Lagoon	**Sampling Date**	7/11/2019
Sampling Event	Recon GW	**Sample Name**	B1-20190711-RGW-68.0
Sub Area		**Sample Depth**	
FSDS QA:		**Easting** / **Northing** / **TOC**	

Hydrology/Level Measurements

Date	Time	DT-Bottom	DT-Product	DT-Water	(Product Thickness) DTP-DTW	(Water Column) DTB-DTW	(Gallons/ft x Water Column) Pore Volume

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Water Quality Data

Purge Method	Time	Purge Vol (gal)	Flowrate l/min	pH	Temp (C)	E Cond (uS/cm)	DO (mg/L)	ORP	Turbidity
(1) Submersible Pump	9:50:00 PM		1	7.08	18.5	648	0.12	-619.2	1289
	9:54:00 AM		1	7.16	19	665	0.11	-625.5	1212
	9:58:00 AM		1	7.22	18.7	678	0.11	-627.2	1127
	10:02:00 AM		1	7.24	18.6	677	0.11	-625	897
Final Field Parameters	10:06:00 AM		1	7.24	18.7	678	0.12	-621	719

Methods: (1) Submersible Pump (2) Peristaltic Pump (3) Disposable Bailer (4) Vacuum Pump (5) Dedicated Bailer (6) Inertia Pump (7) Other (specify)

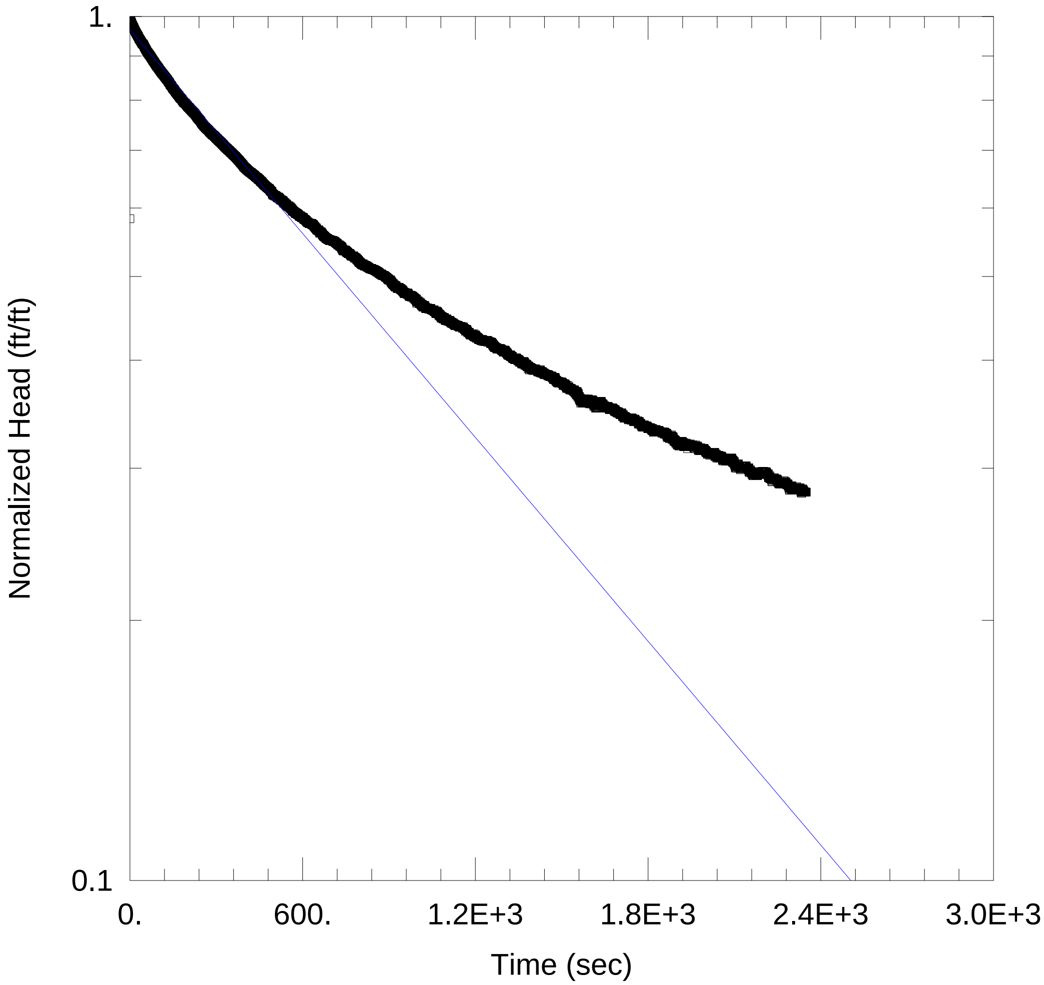
Water Quality Observations: Turbid, brown, cloudy

Sample Information

Sampling Method	Sample Type	Sampling Time	Container Code/Preservative	#	Filtered
(1) Submersible Pump	Groundwater	10:06:00 AM	VOA-Glass		
			Amber Glass		
			White Poly	1	Yes
			Yellow Poly		
			Green Poly		
			Red Total Poly		
			Red Dissolved Poly	1	Yes
			Total Bottles	2	

General Sampling Comments Page: 1/1

APPENDIX G
AQTESOLV OUTPUTS



WELL TEST ANALYSIS

Data Set: L:\...\MW1_24.aqt
Date: 12/05/19 Time: 10:01:36

PROJECT INFORMATION

Company: MFA
Client: St Helens
Project: 0830.03.03
Test Well: MW-1
Test Date: 9/19/2019

AQUIFER DATA

Saturated Thickness: 11. ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-1_24)

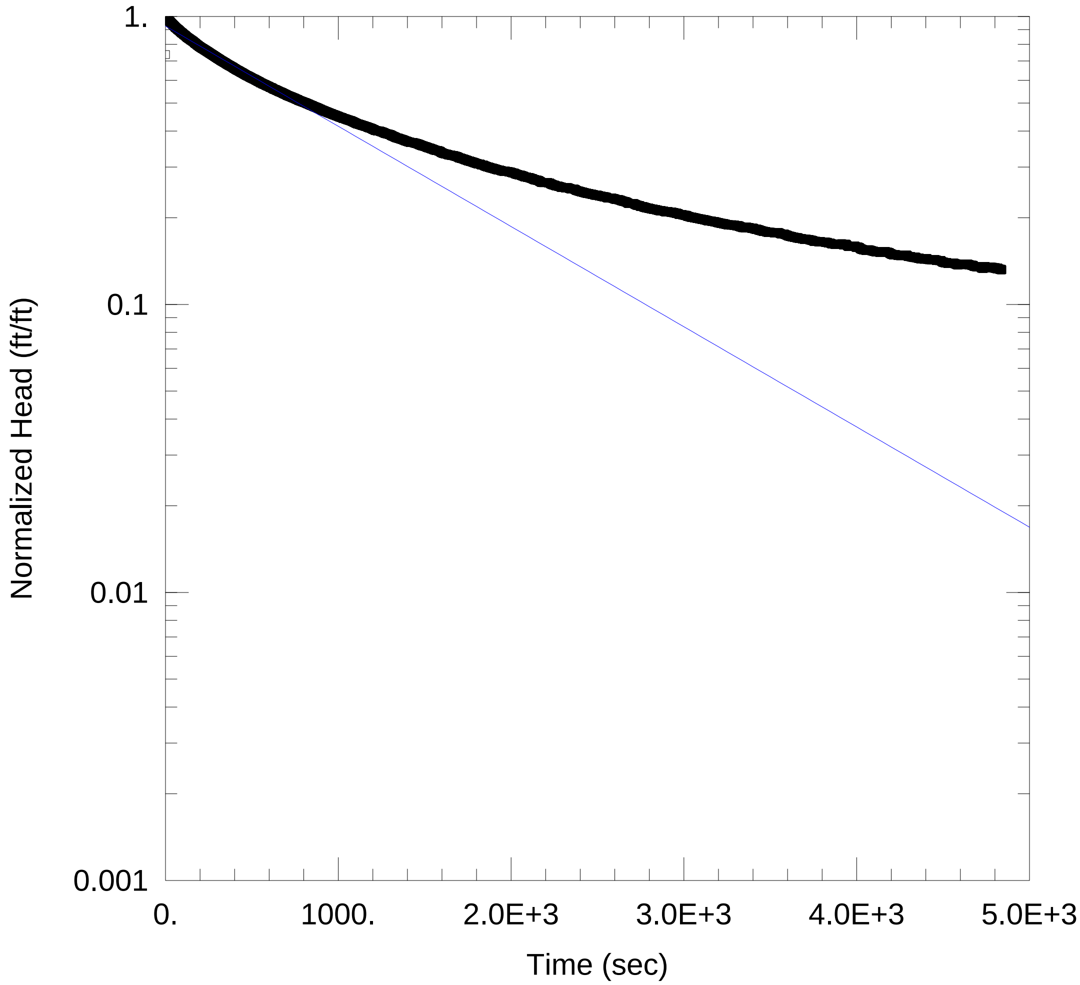
Initial Displacement: -1.097 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.0833 ft

Static Water Column Height: 50.3 ft
Screen Length: 20. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.07747 ft/day y0 = -1.059 ft



WELL TEST ANALYSIS

Data Set: L:\...\MW1_36.aqt
Date: 12/05/19 Time: 10:02:43

PROJECT INFORMATION

Company: MFA
Client: St Helens
Project: 0830.03.03
Test Well: MW-1
Test Date: 9/19/2019

AQUIFER DATA

Saturated Thickness: 11. ft
Anisotropy Ratio (Kz/Kr): 0.1

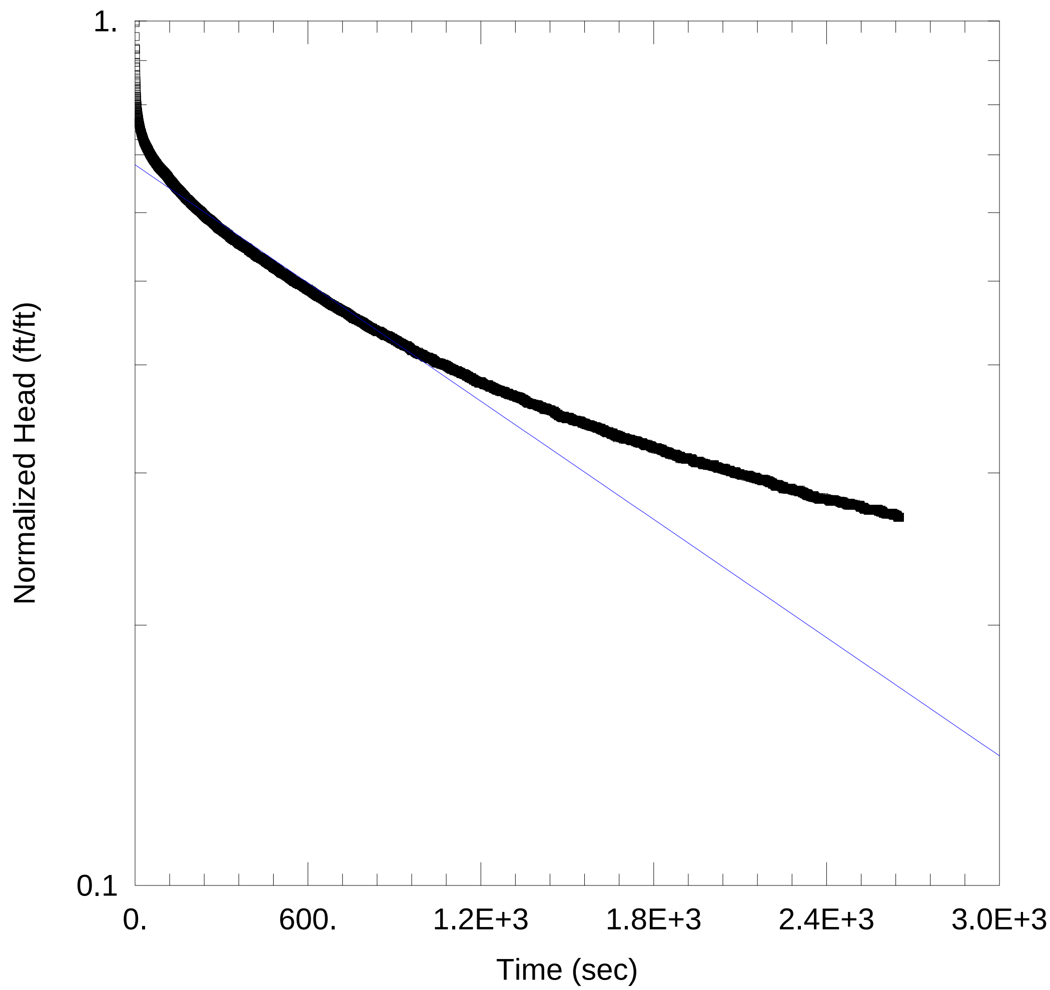
WELL DATA (MW-1_36)

Initial Displacement: -2.596 ft
Static Water Column Height: 50.3 ft
Total Well Penetration Depth: 20. ft
Screen Length: 20. ft
Casing Radius: 0.0833 ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.06856 ft/day
y0 = -2.403 ft



WELL TEST ANALYSIS

Data Set: L:\...\MW2_12.aqt
Date: 12/05/19 Time: 10:03:24

PROJECT INFORMATION

Company: MFA
Client: St Helens
Project: 0830.03.03
Test Well: MW-2
Test Date: 9/18/2019

AQUIFER DATA

Saturated Thickness: 6. ft Anisotropy Ratio (Kz/Kr): 0.1

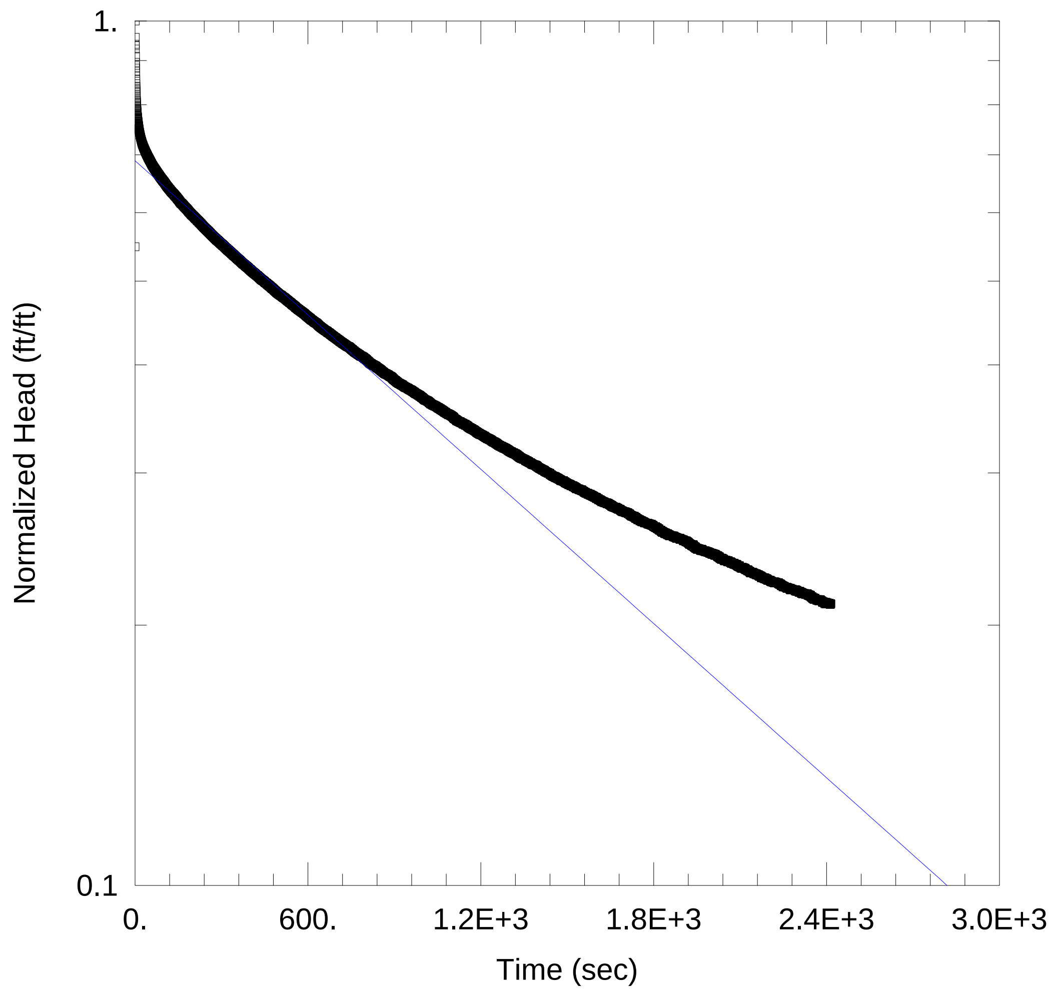
WELL DATA (MW-2_12)

Initial Displacement: -1.207 ft Static Water Column Height: 29.42 ft
Total Well Penetration Depth: 20. ft Screen Length: 20. ft
Casing Radius: 0.0833 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.07752 ft/day y0 = -0.8228 ft



WELL TEST ANALYSIS

Data Set: L:\...\MW2_24.aqt
Date: 12/05/19 Time: 10:07:25

PROJECT INFORMATION

Company: MFA
Client: St Helens
Project: 0830.03.03
Test Well: MW-2
Test Date: 9/18/2019

AQUIFER DATA

Saturated Thickness: 6. ft Anisotropy Ratio (Kz/Kr): 0.1

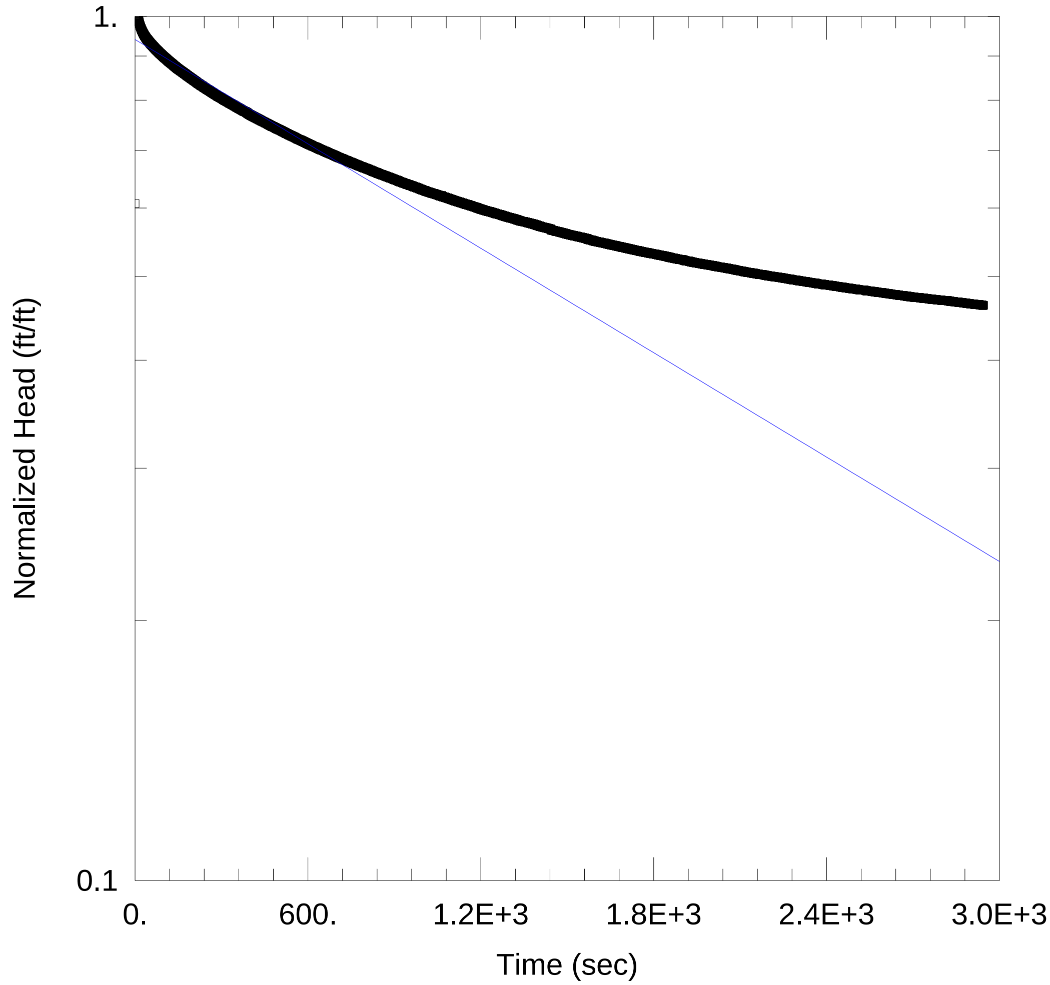
WELL DATA (MW-2_24)

Initial Displacement: -2.139 ft Static Water Column Height: 29.42 ft
Total Well Penetration Depth: 20. ft Screen Length: 20. ft
Casing Radius: 0.0833 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.1012 ft/day y0 = -1.474 ft



WELL TEST ANALYSIS

Data Set: L:\...\MW2_36.aqt
Date: 12/05/19 Time: 10:08:06

PROJECT INFORMATION

Company: MFA
Client: St Helens
Project: 0830.03.03
Test Well: MW-2
Test Date: 9/18/2019

AQUIFER DATA

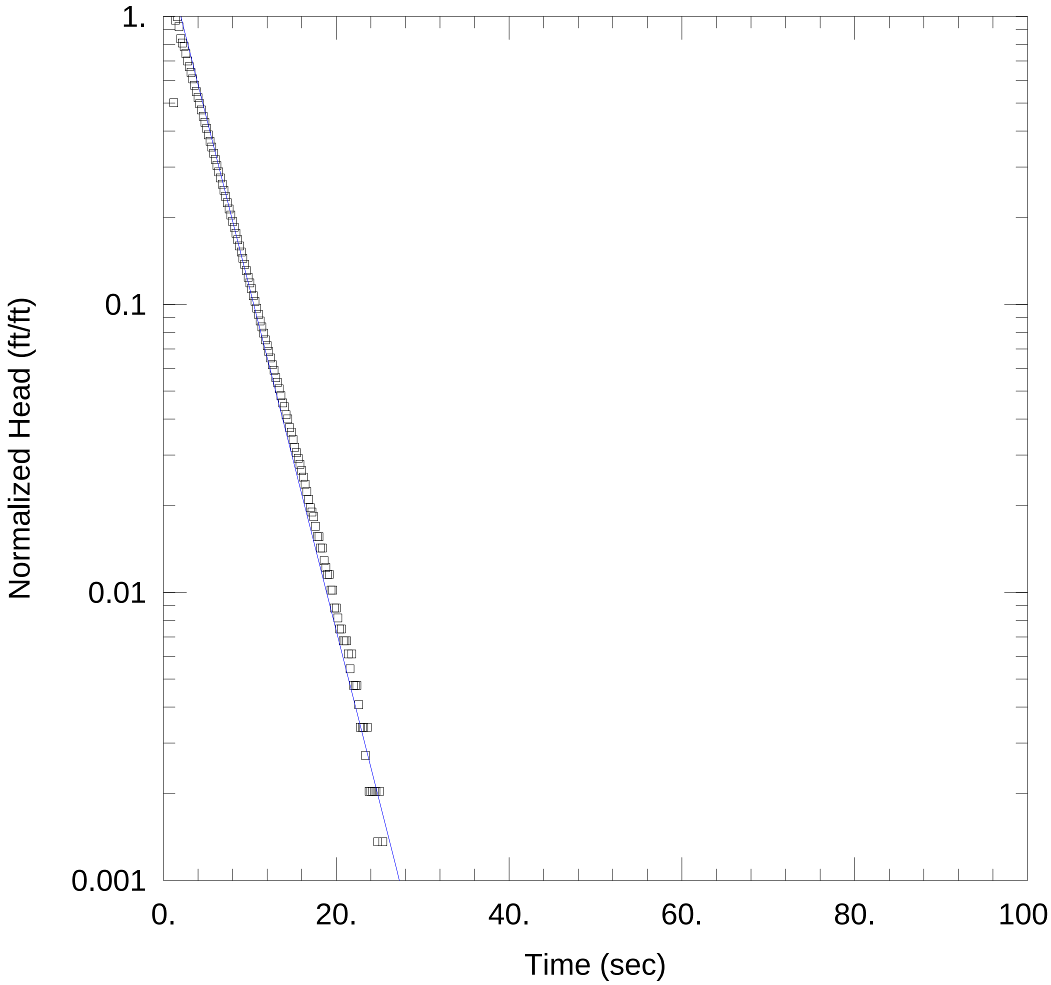
Saturated Thickness: 6. ft
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-2_36)

Initial Displacement: -3.614 ft
Static Water Column Height: 29.42 ft
Total Well Penetration Depth: 20. ft
Screen Length: 20. ft
Casing Radius: 0.0833 ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.06849 ft/day
y0 = -3.398 ft



WELL TEST ANALYSIS

Data Set: L:\...\MW5_12.aqt
Date: 12/05/19 Time: 10:08:55

PROJECT INFORMATION

Company: MFA
Client: St Helens
Project: 0830.03.04
Test Well: MW-5
Test Date: 9/20/2019

AQUIFER DATA

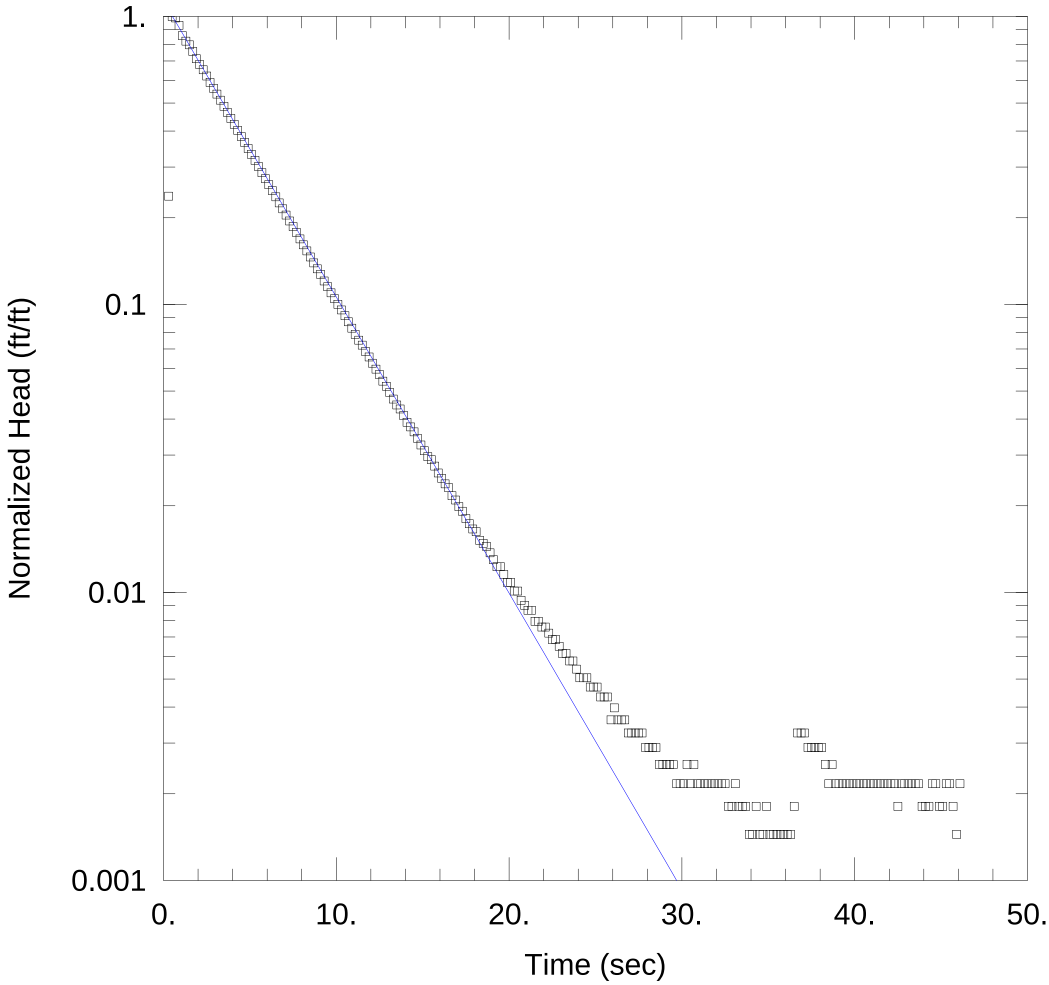
Saturated Thickness: 42.25 ft Anisotropy Ratio (Kz/Kr): 0.01

WELL DATA (MW-5_12)

Initial Displacement: -1.271 ft Static Water Column Height: 29.75 ft
Total Well Penetration Depth: 29.25 ft Screen Length: 20. ft
Casing Radius: 0.0833 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice
K = 21.09 ft/day y0 = -2.196 ft



WELL TEST ANALYSIS

Data Set: L:\...\MW5_24.aqt
Date: 12/05/19 Time: 10:09:22

PROJECT INFORMATION

Company: MFA
Client: St Helens
Project: 0830.03.04
Test Well: MW-5
Test Date: 9/20/2019

AQUIFER DATA

Saturated Thickness: 42.25 ft Anisotropy Ratio (Kz/Kr): 0.01

WELL DATA (MW-5_24)

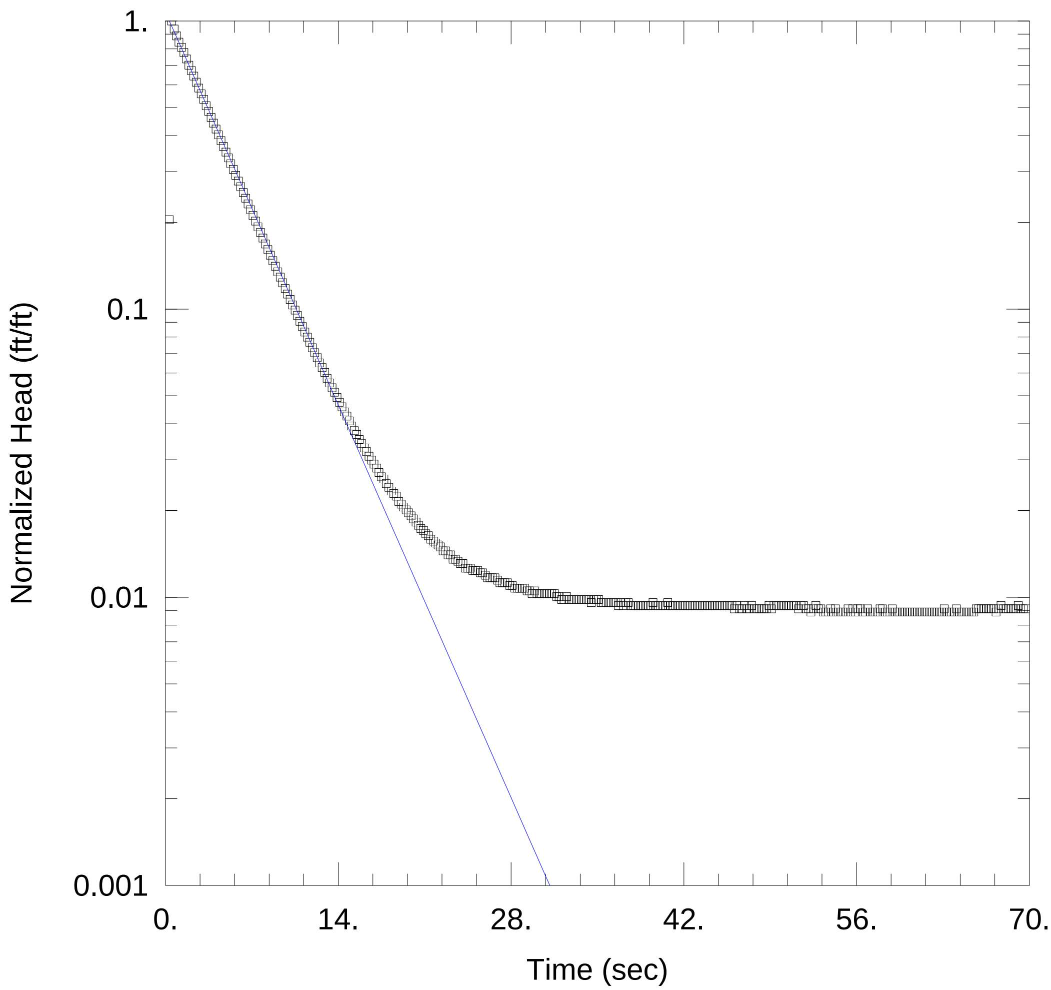
Initial Displacement: -2.39 ft
Total Well Penetration Depth: 29.25 ft
Casing Radius: 0.0833 ft

Static Water Column Height: 29.75 ft
Screen Length: 20. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 18.3 ft/day y0 = -2.706 ft



WELL TEST ANALYSIS

Data Set: L:\...\MW5_36.aqt
Date: 12/05/19 Time: 10:09:50

PROJECT INFORMATION

Company: MFA
Client: St Helens
Project: 0830.03.04
Test Well: MW-5
Test Date: 9/20/2019

AQUIFER DATA

Saturated Thickness: 42.25 ft Anisotropy Ratio (Kz/Kr): 0.01

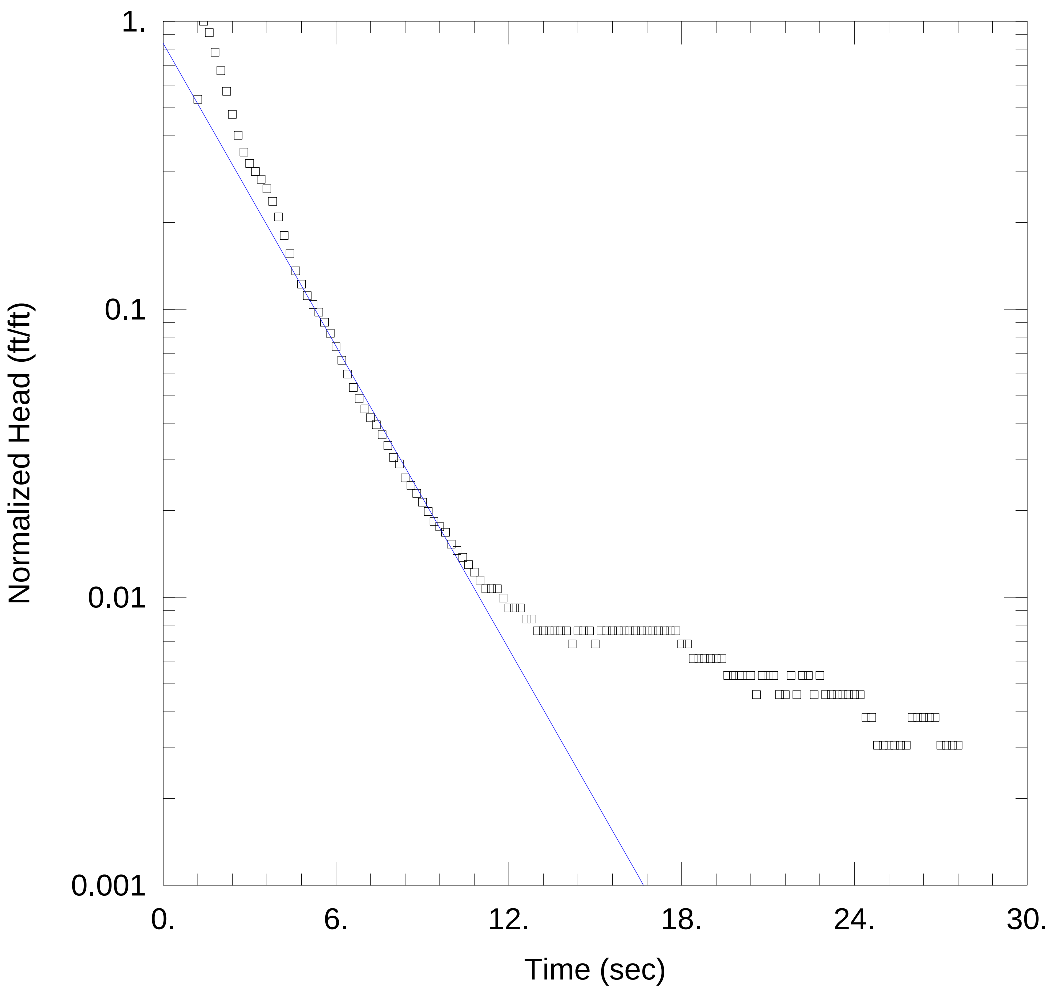
WELL DATA (MW-5_36)

Initial Displacement: -3.691 ft Static Water Column Height: 29.75 ft
Total Well Penetration Depth: 29.25 ft Screen Length: 20. ft
Casing Radius: 0.0833 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 17.32 ft/day y0 = -3.967 ft



WELL TEST ANALYSIS

Data Set: L:\...\MW6_12.aqt
Date: 12/05/19 Time: 10:10:16

PROJECT INFORMATION

Company: MFA
Client: St Helens
Project: 0830.03.04
Test Well: MW-6
Test Date: 9/20/2019

AQUIFER DATA

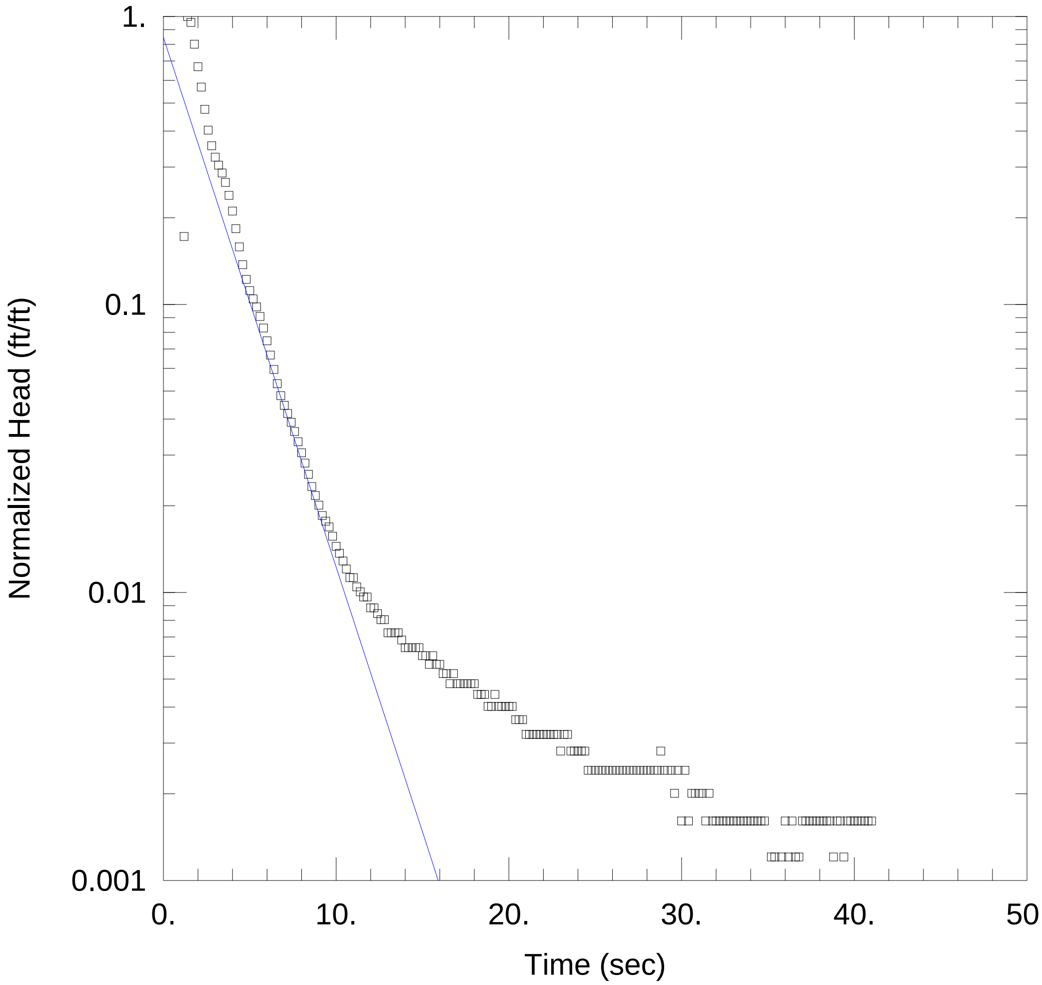
Saturated Thickness: 31.9 ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-6_12)

Initial Displacement: -1.13 ft Static Water Column Height: 27.4 ft
Total Well Penetration Depth: 27.4 ft Screen Length: 20. ft
Casing Radius: 0.0833 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice
K = 24.61 ft/day y0 = -0.9458 ft



WELL TEST ANALYSIS

Data Set: L:\...\MW6_24.aqt
Date: 12/05/19 Time: 10:10:58

PROJECT INFORMATION

Company: MFA
Client: St Helens
Project: 0830.03.04
Test Well: MW-6
Test Date: 9/20/2019

AQUIFER DATA

Saturated Thickness: 31.9 ft Anisotropy Ratio (Kz/Kr): 0.1

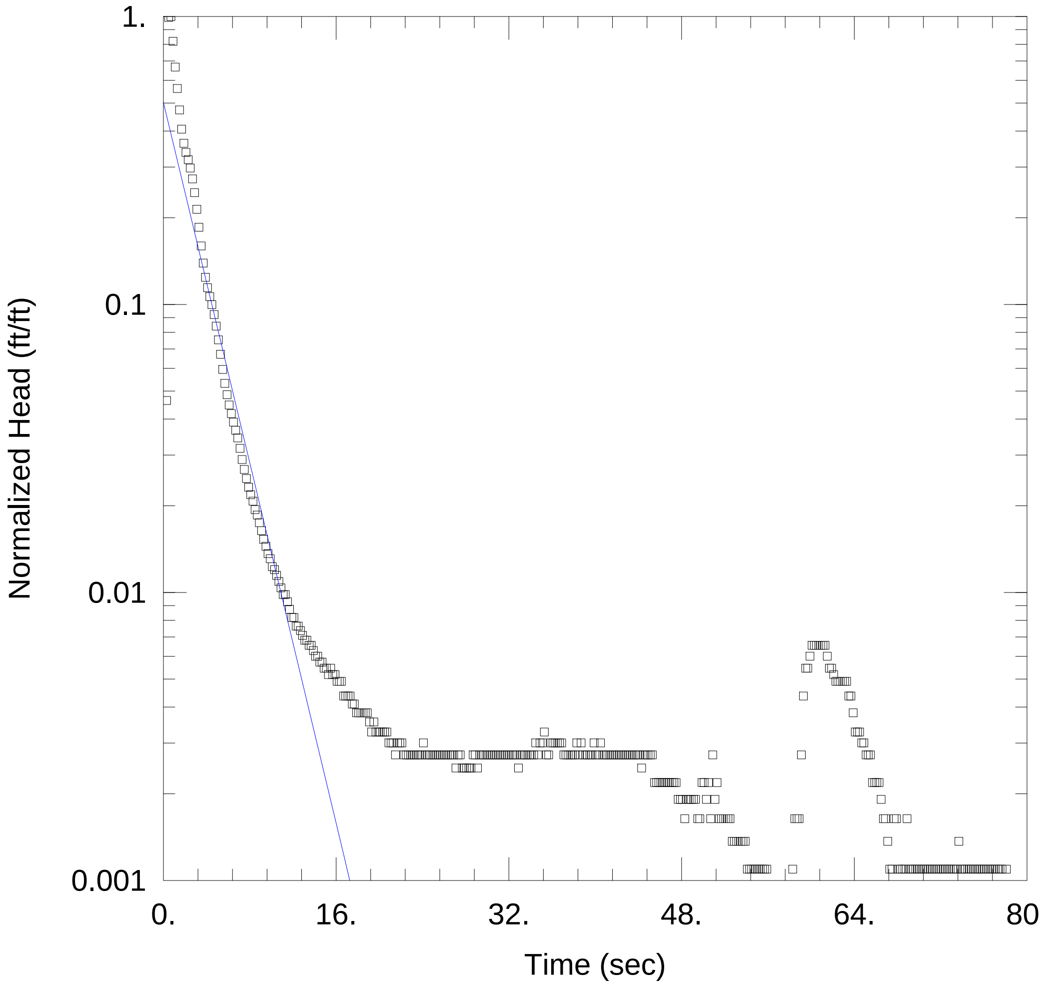
WELL DATA (MW-6_24)

Initial Displacement: -2.146 ft Static Water Column Height: 27.4 ft
Total Well Penetration Depth: 27.4 ft Screen Length: 20. ft
Casing Radius: 0.0833 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 25.83 ft/day y0 = -1.814 ft



WELL TEST ANALYSIS

Data Set: L:\...\MW6_36.aqt
Date: 12/05/19 Time: 10:11:20

PROJECT INFORMATION

Company: MFA
Client: St Helens
Project: 0830.03.04
Test Well: MW-6
Test Date: 9/20/2019

AQUIFER DATA

Saturated Thickness: 31.9 ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-6_36)

Initial Displacement: -3.162 ft Static Water Column Height: 27.4 ft
Total Well Penetration Depth: 27.4 ft Screen Length: 20. ft
Casing Radius: 0.0833 ft Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 21.97 ft/day y0 = -1.59 ft

APPENDIX H

PRELIMINARY PHASE I GEOTECHNICAL INVESTIGATION REPORT

GRI
9750 SW Nimbus Avenue
Beaverton, OR 97008-7172
p | 503-641-3478 f | 503-644-8034

December 19, 2019

6266 PRELIMINARY PHASE I GEOTECHNICAL RPT

DRAFT

Maul Foster & Alongi, Inc.
2001 NW 19th Avenue, Suite 200
Portland, OR 97209

Attention: Jacob M. Faust, PE

SUBJECT: Preliminary Phase I Geotechnical Investigation
Wastewater Lagoon Repurposing
City of St. Helens, Oregon

At your request, GRI completed a preliminary Phase I geotechnical investigation as part of the Oregon Department of Environmental Quality (DEQ) Phase I Site Characterization for the proposed Wastewater Lagoon Repurposing in St. Helens, Oregon. The Vicinity Map, Figure 1, shows the general location of the site. The purpose of our investigation was to evaluate subsurface conditions at the site and develop preliminary geotechnical conclusions and recommendations for site improvements associated with filling in the existing wastewater treatment plant (WWTP) lagoon as part of the Phase I Site Characterization, along with recommendations for additional geotechnical explorations and analysis for Phase II Site Characterization. The investigation included a review of available geologic and geotechnical information for the area, subsurface explorations, laboratory testing, and engineering analyses. This report describes the work accomplished and provides our preliminary conclusions and recommendations regarding foundation support, lateral earth pressures, slope stability, seismic design considerations, and ground improvement.

In addition, GRI reviewed recent boring logs completed by Maul Foster & Alongi, Inc. (MFA), as part of their work for the Phase I Site Characterization and older boring and test-pit logs completed prior to construction of the Aeration Lagoon.

PROJECT DESCRIPTION

The proposed project includes repurposing the existing 39-acre WWTP as a sediment disposal facility for the City of St. Helens (City). The existing lagoon will be drained and solids from it will be collected and stored in cells within the facility. The lagoon will be partially to fully filled, with dredged spoils collected during river dredging. The spoils will be delivered to the site by barges that dock at either the existing Boise Cascade dock structure south of the lagoon or a new dock structure near the existing Boise Cascade dock. It is our understanding that the lagoon will be filled with spoils to at least the top of the existing containment levee along the eastern side of the lagoon at about elevation 31 ft. In addition, as currently planned, approximately two-thirds of the lagoon will be filled with an additional 40 ft or more of fill with 5H:1V (Horizontal to Vertical) side slopes to the top of the vertical rock face along the western side of the lagoon at about elevation 55 to 70 ft. Following filling, the facility will be repurposed by the City as a park. Park improvements may include an amphitheater, ball fields, paved access roads and parking lots, and ancillary buildings.

SITE DESCRIPTION

General

The WWTP is bordered by S 6th Street to the north, residential developments and grassy fields to the west, the Cascade Tissue Group mill (formerly Boise Cascade) to the south, and the Multnomah Channel to the east. The majority of the site is occupied by the large WWTP lagoon. The WWTP is located adjacent to the northern edge of the lagoon. Based on review of existing as-built drawings, the bottom of the WWTP lagoon is at about elevation 7 ft (vertical datum unknown). An impoundment levee is located along the eastern edge of the lagoon with a top-of-levee elevation of about 31 ft. The levee is about 10 ft wide at the top, surfaced with asphalt concrete (AC) pavement, and is used as an access road for vehicular traffic for plant operations. The levee side slopes are surfaced with large, angular basalt fragments with side slopes of about 2H:1V on the eastern (Multnomah Channel) side of the levee. On the western (lagoon) side, slopes of the levee range from about 3H:1V above elevation 20 ft and about 5.5H:1V below elevation 20 ft. The bottom of the lagoon partially lined with a PVC liner. An existing conditions survey of the project site completed by AKS Engineering & Forestry, LLC is provided in Appendix A.

Geologic Setting

The project site is located on the western bank of the Multnomah Channel near the confluence with the Columbia River, just downstream of the entrance to Scappoose Bay. Warrior Point, the northernmost tip of Sauvie Island, is located beyond the mouth of Multnomah Channel to the east. The Cascadia Subduction Zone and associated Cascadia fold and fault belt are approximately 120 miles to the west. Published geologic mapping indicates the western portion of the project site is underlain by the Sentinel Bluffs member of the Grand Ronde Basalt, which is part of the Columbia River Basalt Group (Evarts, 2004). The Sentinel Bluffs member is in turn underlain by the Winter Water Basalt Group, shown in cross section to underlie the eastern portion of the project site (beyond the extent of mapped Sentinel Bluffs), which is mantled by Quaternary-age alluvium at the surface. A narrow strip of artificial fill is mapped along the eastern boundary of the WWTP lagoon (west of the alluvium), coincident with the location of the retention berm/levee. A northwest-southeast-trending fault is shown on the geologic map (Evarts, 2004) approximately 1.5 miles northeast of the site; this fault is not included in the USGS Quaternary Fold and Fault Database (USGS, 2006). The closest identified Quaternary-age fault is the Portland Hills Fault located approximately 13.5 km southwest of the site (USGS, 2006). No mapped or historic landslides were identified at the project site or in the immediate vicinity on the Oregon Department of Geology and Mineral Industries (DOGAMI) statewide landslide hazard database (SLIDO). DOGAMI is the state agency responsible for geologic hazard mapping in Oregon. Landslide hazard ratings at the site range from low (landsliding unlikely) to high (landsliding likely), with areas of greater hazard generally corresponding to areas of steeper relief such as the western portion of the project site (Burns and Watzig, 2014).

Geologic Reconnaissance

An Oregon-registered geologist from GRI conducted a walking geologic reconnaissance of the project site on September 23, 2019. GRI conducted the reconnaissance to evaluate surface conditions at the site for obvious indications of potential slope instability and other geologic hazards relative to the site.

An impoundment levee starts at the northern portion of the site and extends approximately 0.5 mile to the southwest, then extends approximately 0.1 mile to the west along the southern end of the site. An inlet approximately 100 to 250 ft wide from the Multnomah Channel is located near the northeastern corner of the lagoon within about 100 ft of the bottom of the levee. The ground surface east of the levee is relatively flat to gently undulating and is about 230 to 250 ft wide, with ground surface elevation ranging from about elevation 15 to 25 ft to the crest of the Multnomah Channel. Dense vegetation, including grasses, shrubs, and young to mature trees, covers the ground surface. An abandoned rail track runs along the base of the levee in a generally northeast-southwest direction.

A steeply sloping to near vertical rock cliff is located along the western edge of the lagoon; the western portion of the project site is shown on the geologic map as Sentinel Bluffs basalt. Elevations along the top of the cliff range from about elevation 80 ft near the northern end of the lagoon to about elevation 30 ft near the southern end of the lagoon. The ground surface above the rock cliff is vegetated with grass and mature trees with visible basalt outcrops. Portions of the near-vertical cliff face in the northern portion of the site exhibited evidence of past rockfall events (accumulated talus material at the base of the cliff and possible source areas visible on the cliff face). A historical topographic map reviewed by GRI identified the project site as a quarry, and past quarrying at the site may influence the appearance of the cliff face. Obvious evidence of large-scale, active deep-seated slope instability was not observed at the site. GRI observed areas of ponded water and hummocky topography above the cliffs, possibly a result of near-surface bedrock. A drainage channel enters the lagoon near the southwestern corner of the site with water levels in the channel apparently controlled by a weir system.

SUBSURFACE CONDITIONS

General

Subsurface materials and conditions at the site were investigated between July 29 and August 2, 2019, with two mud-rotary borings, designated B-1 and B-2, and three cone penetration test (CPT) probes, designated CPT-1 through CPT-3. The borings were advanced to depths ranging from about 156.5 to 201.5 ft, and the CPT probes to depths ranging from about 22 to 158 ft. Approximate locations of the explorations performed for this investigation and previous explorations by others are provided on Figure 2. Logs of the borings and CPT probes are provided on Figures 1B through 6B. The field and laboratory programs conducted to evaluate the physical engineering properties of the materials encountered in the explorations are described in Appendix B. The terms and symbols used to describe the soils and rock encountered in the explorations are defined in Tables 1B through 4B and on the attached legend.

In addition, GRI reviewed available geotechnical data from MFA for their recent work on site for the Phase I Site Characterization and Shannon and Wilson's logs provided in the January 26, 1972, construction plans for the WWTP lagoon. Figure 2 shows the locations of the nearby borings, and logs of the borings are provided in Appendices C and D, respectively. The subsurface conditions encountered in the previous borings are in general agreement with the subsurface information obtained during our recent investigation.

GRI also reviewed the U.S. Department of Agriculture (USDA) Web Soil Survey Map covering the project area and the surrounding vicinity, which includes soil survey areas within Clark County, Washington (Version 17, September 16, 2019), Cowlitz County, Washington (Version 20, September 16, 2019), and Columbia County, Oregon (Version 16, September 10, 2019). The USDA map provided in Appendix E indicates the project site east of the lagoon and impoundment berm is mantled by *Sauvie silt loam*, while the area west of the lagoon is described as *Rock outcrop – Xerumbrepts complex, undulating surface*. The mapped USDA soil units generally agree with GRI's observations and review of surface and subsurface conditions at the project site.

Soils

For the purpose of discussion, the materials disclosed by the investigation have been grouped into the following major units based on their physical characteristics and engineering properties:

1. **FILL**
2. **SAND**
3. **SILT**
4. **BASALT**

The following paragraphs provide a detailed description of the soil units and a discussion of the groundwater conditions at the site.

1. FILL. Boring B-1 was drilled next to existing railroad tracks and encountered about 10 in. of crushed rock at the ground surface. Probes CPT-2 and CPT-3 were drilled through crushed-rock surfacing and CPT-1 was drilled through an existing AC-surfaced parking lot. The thickness of fill in the CPT probes was not measured.

2. SAND. Sand was encountered below the crushed-rock surfacing or pavement in explorations B-1 and CPT-1 through CPT-3 and extends to depths ranging from about 13.8 to 25 ft. The sand is gray to brown, fine to medium grained, and contains a variable silt content ranging from trace to some silt. Wood debris was encountered within the sand in boring B-1 below a depth of about 17.5 ft. Based on SPT N-values and CPT tip-resistance values, the relative density of the sand typically ranges from loose to medium dense.

3. SILT. Silt was encountered at the ground surface in boring B-2 and beneath the sand in explorations B-1 and CPT-1 through CPT-3 and extends to depths ranging from about 21.5 to 201.5 ft. Boring B-1 was terminated in the silt at a depth of about 201.5 ft. The silt is brown to gray and contains variable percentages of clay and sand, ranging from a trace of clay to clayey and a trace of fine-grained sand to sandy. The silt generally contains wood debris. A 12-ft-thick layer of silty sand was encountered at a depth of about 138 ft in boring B-1, 5- to 7-ft-thick layers of silty sand were encountered in boring B-2 at depths of about 70 and 145 ft, and interbedded layers of sand were encountered within the silt below depths of about 65 ft in probe CPT-3. Based on SPT N-values, Torvane shear-strength values, and CPT tip-resistance values, the relative consistency of the silt ranges from very soft to very stiff and is generally soft to medium stiff. Atterberg-limits testing completed on samples of silt are summarized on Figures 12B through 15B and indicate the silt has a low to high plasticity.

Consolidation tests were conducted on samples of silt and indicate the soil is normally to slightly overconsolidated and has a moderate to high compressibility in the normally consolidated range of stresses and a low compressibility in the preconsolidated range of stresses, see Figures 17B through 21B. Secondary compression testing completed on samples of silt from boring B-1 indicate a low to moderate rate of secondary compression in both the preconsolidated and normally consolidated range of stresses. The results of the secondary compression tests are shown on Figure 22B.

Two multistage, triaxial shear-strength tests indicate this soil unit exhibits an effective angle of internal friction, ϕ', of about 34°, as indicated on Figures 23B and 24B. In addition, strain-controlled cyclic direct simple shear (DSS) testing was completed on samples of silt from a depth of approximately 39 ft in boring B-1 and approximately 64 ft in boring B-2. The boring B-1 samples were tested at shear strains of 0.5%, 0.8%, and

1.6%, and the B-2 samples were tested at shear strains of 0.8% and 1.6%. The tabulated results are provided in Appendix B.

4. BASALT. Basalt was encountered beneath the silt in explorations B-2 and CPT-1 through CPT-3. These explorations were terminated in the basalt at depths ranging from about 22 to 158 ft. The basalt encountered in boring B-2 is dark gray and predominantly decomposed with slightly weathered inclusions. The basalt is very soft to soft (R1 to R2).

Groundwater

The borings were completed using mud-rotary drilling techniques, which do not allow an accurate measurement of the groundwater level during drilling. Pore-pressure dissipation testing completed in probes CPT-1 through CPT-3 indicates groundwater at depths ranging from about 1.7 to 10.4 ft below the ground surface, see Figures 7B through 11B. We anticipate groundwater closely reflects water levels in the nearby Columbia River. However, shallow perched groundwater conditions may develop in the fill during periods of prolonged precipitation. It is our understanding that water levels within the existing, PVC-lined wastewater lagoon are generally maintained at about elevation 28 ft.

CONCLUSIONS AND RECOMMENDATIONS

General

Based on the borings completed for this investigation and review of existing subsurface information, the eastern portion of the lagoon near the existing containment levee is underlain by a variable thickness of sand underlain by a significant thickness of highly compressible, alluvial silt. Interbedded layers of sand were encountered within the silt between depths of about 65 and 152 ft. The silt is underlain by basalt. The depth to basalt from the toe of the levee varies significantly across the length of the site and ranges from a depth of about 23 and 63 ft near the northern and southern ends of the levee, respectively, to over 200 ft deep about 500 ft south of the northern edge of the lagoon. The western edge of the lagoon consists of a vertical basalt cliff. The depth of basalt slopes downward from west to east across the lagoon.

Our preliminary studies indicate the existing, loose to medium-dense, unimproved sand and silt below the groundwater level have the potential to liquefy or strain soften during a code-based seismic event. Liquefaction and soil strain softening of these unimproved soils would result in reduced soil strength and potentially significant settlement. Without the use of ground improvement to improve the existing soil conditions, this reduction in soil strength would result in seismic instability of the proposed embankment slope during a code-based seismic event. Our studies indicate ground-improvement methods can be used to improve the seismic stability of the proposed embankment during a code-based seismic event. In addition, the existing, unimproved alluvial soils are highly compressible, and the placement of new fill could result in significant total and differential short-term (primary) and long-term (secondary) settlements. Depending on placement and compaction methods for new fills in the lagoon, additional settlement and slope stability of the fill soils could also be a geotechnical design consideration. The following sections of this report provide our preliminary conclusions and recommendations for conceptual-level design of the facility.

Seismic Considerations

Based on anticipated code-based seismic demands at the site due to the presence of loose to medium-dense sand and low-plasticity silt layers below the groundwater level identified in our recent explorations, it is our opinion there is a risk of liquefaction and lateral spreading at the site during a code-based seismic event.

Liquefaction is a process by which saturated granular materials, such as sand, and non-plastic and low-plasticity silts, temporarily lose strength during and immediately after a code-based seismic event. Lateral spreading involves the horizontal displacement of large volumes of soil as a result of seismically induced liquefaction and inertial loading. Associated differential vertical movements or ground surface subsidence from lateral spreading may range up to about half of the total horizontal movement. In addition, our recent cyclic DSS testing identified a potential reduction in shear strength (softening) of the soils below the groundwater level during a code-based seismic event. This reduction in shear strength is significantly less than would be anticipated for low-plasticity silts based on conventional methods for predicting strength loss where the silts would be considered sand like, but additional cyclic DSS testing will need to be completed as part of the Phase II geotechnical investigation for confirmation.

Our preliminary modeling of the east embankment slope identified a risk of seismic slope instability for the existing, unimproved soil conditions during a code-based seismic event. Ground-improvement methods are commonly used for similar site conditions to improve the existing soils and thereby reduce estimated seismic slope movements to tolerable levels. Our preliminary evaluations indicate a gridded pattern of deep soil mixing (DSM) columns or similar ground-improvement techniques could be used to mitigate the liquefaction hazards at the site.

Settlements

We anticipate up to 65 ft of fill may be required to achieve final grades. These fills will induce both primary and secondary settlements in the compressible silt soils encountered at the site. In addition, it is anticipated that the dredged spoils used to fill the lagoon will be saturated and highly variable. Depending on pretreatment prior to placement, compacting these dredged soils as structural fill may be impractical. Due to the significant variation to bedrock across the site and the anticipated variability in fill materials, mitigating differential settlements for future site improvements will be a significant design consideration. As part of the Phase II geotechnical investigation, the process for fill placement, compaction, and settlement monitoring will need to be further evaluated. A surcharge program is also one option to consider to reduce differential settlements to tolerable levels.

Foundation Support

As previously discussed, the site is underlain by a significant thickness of compressible silt soils. In addition, up to 65 ft of potentially uncontrolled fill is planned to be placed on the site. Our experience indicates foundations supported on uncontrolled fill can experience excessive total and differential settlement that can lead to structural distress to the buildings. Additional geotechnical explorations should be completed to assist in evaluating settlement implications for new buildings that may be part of a future site condition. For preliminary design, we anticipate new buildings will be supported on a deep-foundation system such as steel-pipe piles driven to the basalt or ground improvement consisting of deep soil mixing.

Recommendations for Additional Work

We recommend an additional geotechnical field-exploration program and engineering analyses be completed to support advancement of the Phase II geotechnical investigation and to inform the appropriate level of seismic mitigation needed for design of the wastewater lagoon repurposing facility. Supplemental subsurface explorations consisting of CPTs and borings are recommended to further characterize the soil properties and subsurface profile. Specifically, we recommend CPT explorations be completed to further delineate the thickness and engineering properties of the silt soils and depth to basalt. In addition to CPT explorations, borings should be completed to obtain relatively undisturbed samples of silt for additional laboratory analysis. A limited suite of cyclic testing of the silty soils was completed for this phase of work. Additional cyclic testing will be an important consideration in estimating the seismic performance of the site.

For preliminary planning purposes, we recommend completion of about 10 additional subsurface explorations as part of the Phase II geotechnical investigation. The explorations should consist of a combination of mud-rotary borings and CPT probes extending to the underlying basalt. Four of the explorations should be completed within the eastern portion of the lagoon, four of the explorations should be completed near the toe of the eastern side of the levee near the railroad tracks, and the remaining two explorations should be completed about halfway between the existing railroad tracks and Multnomah Channel. Shear-wave velocity testing should be completed in one of the CPT probes where basalt is anticipated to be encountered at significant depth. In the mud-rotary borings, samples should be collected using a standard split-spoon sampler and/or undisturbed Shelby tube sampler at 5-ft intervals of depth to 100 ft and 10-ft intervals of depth below 100 ft. The borings and CPT probes should be well spaced to provide information on the depth to basalt and subsurface conditions above the basalt.

In addition, to supplement the information collected from the borings and probes or if drill rig access is restricted, geophysical profile lines should be completed. We recommend completion of three east-west geophysical profiles that extend from near the vertical basalt cliff near the western end of the lagoon to the Multnomah Channel. Additional north-south profile lines can be completed, which may allow a reduction in the number of recommended additional explorations.

Additional bathymetry of the small channel near the northeastern edge of the lagoon should also be gathered to facilitate slope-stability modeling.

LIMITATIONS

This report presents the results of a preliminary Phase I geotechnical investigation of the proposed St. Helens Wastewater Lagoon Repurposing. The information presented herein is preliminary and provides our general conclusions regarding the feasibility of the project with respect to the observed site conditions. This information is intended for planning and preliminary estimating purposes. A more-detailed geotechnical investigation, including subsurface explorations, geophysical explorations, laboratory testing, and engineering analyses, should be completed as part of the Phase II geotechnical investigation in order to determine the appropriate level of seismic mitigation needed to accommodate the lagoon repurposing design.

Please contact the undersigned if you have any questions about our preliminary design recommendations.

Submitted for GRI,

Scott M. Schlechter, PE, GE Principal	George A. Freitag, CEG Principal	Brian J. Bayne, PE Senior Engineer

This document has been submitted electronically.

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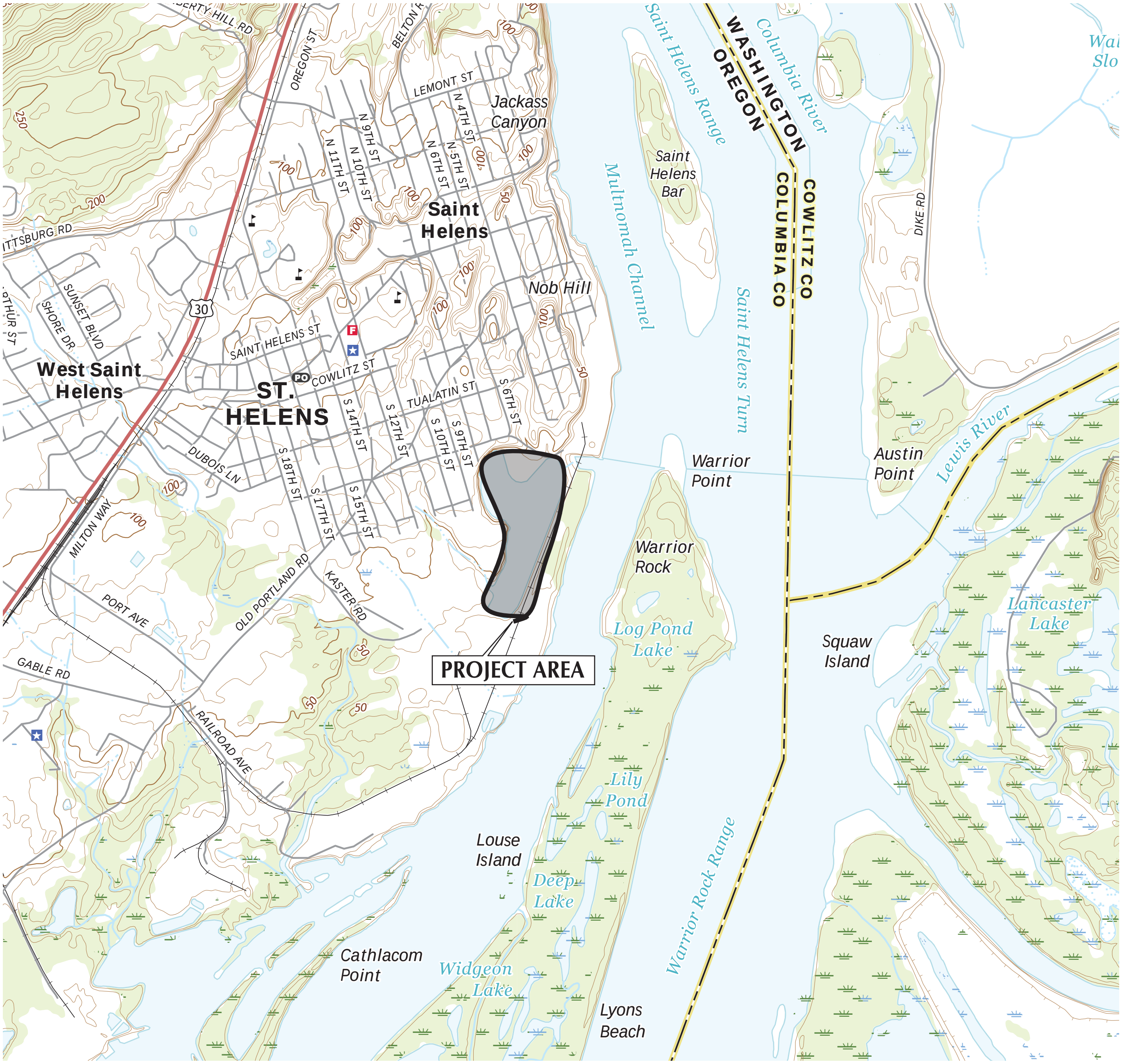
Burns, W. J., and Watzig, R. J., 2014, Statewide landslide information database for Oregon, release 3.4 (SLIDO-3.4): Oregon Department of Geology and Mineral Industries.

Evarts, R. C., 2004, Geologic Map of the St Helens Quadrangle, Columbia County, Oregon and Cowlitz and Clark Counties, Washington. USGS Scientific Investigations Map 2834, scale: 1:24,000.

U.S. Geological Survey, 2006, Quaternary fault and fold database for the United States, accessed 9/30/2019, from USGS web site: http//earthquake.usgs.gov/hazards/qfaults/



USGS TOPOGRAPHIC MAP
SAINT HELENS, OREG. (2017)

North

0 1/2 1 MILE

GRI

MAUL, FOSTER, AND ALONGI
LAGOON REPURPOSING

VICINITY MAP

DEC. 2019 JOB NO. 6266 FIG. 1

BORING COMPLETED BY GRI (JULY 29 - AUGUST 2, 2019)

CONE PENETRATION TEST COMPLETED BY GRI (JULY 30 - 31, 2019)

BORING COMPLETED BY MAUL FOSTER ALONGI (2019)

EXPLORATION COMPLETD BY SHANNON & WILSON (1968-1969)

SITE PLAN FROM GOOGLE EARTH (IMAGE DATE JULY 2018)

North

0 400 800 FT

GRI

MAUL, FOSTER, AND ALONGI
LAGOON REPURPOSING

SITE PLAN

DEC. 2019 JOB NO. 6266 FIG. 2

APPENDIX A

Existing Conditions Survey (AKS Engineering and Forestry, 2019)

NOTES:

1. UTILITIES SHOWN ARE BASED ON UNDERGROUND UTILITY LOCATE MARKINGS AS PROVIDED BY OTHERS, PROVIDED PER UTILITY LOCATE TICKET NUMBER 19311213. THE SURVEYOR MAKES NO GUARANTEE THAT THE UNDERGROUND LOCATES REPRESENT THE ONLY UTILITIES IN THE AREA. CONTRACTORS ARE RESPONSIBLE FOR VERIFYING ALL EXISTING CONDITIONS PRIOR TO BEGINNING CONSTRUCTION.

2. FIELD WORK WAS CONDUCTED NOVEMBER 2019.

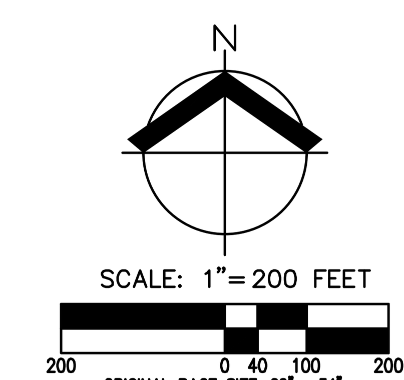
3. VERTICAL DATUM: ELEVATIONS ARE NGVD 29.
ELEVATIONS ARE BASED ON A VERTCON SHIFT OF −3.15 FEET APPLIED TO NGS BENCHMARK NO. RD4218 LOCATED AT THE NW CORNER OF THE LAGOON.
BENCHMARK NO. RD4218 ELEVATION = 78.30 FEET (NAVD 88)
75.15 FEET (NGVD 29)

4. THIS IS NOT A BOUNDARY SURVEY TO BE RECORDED WITH THE COUNTY. BOUNDARIES ARE PRELIMINARY AND SHOULD BE CONFIRMED WITH THE STAMPING SURVEYOR PRIOR TO RELYING ON FOR DETAILED DESIGN OR CONSTRUCTION. THE BOUNDARY SHOWN HEREON IS PARTIALLY BASED ON GIS DATA FROM THE CITY OF ST. HELENS WEBSITE AND SHOULD BE USED FOR VISUAL PURPOSES ONLY.

5. CONTOUR INTERVAL IS 1 FOOT.

6. BATHYMETRIC INFORMATION WAS PROVIDED BY MAUL FOSTER & ALONGI, INC. AND COMBINED WITH LIDAR DATA FROM THE STATE OF OREGON DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES WEBSITE.

4. HORIZONTAL DATUM: A LOCAL DATUM PLANE DERIVED FROM STATE PLANE OREGON NORTH 3601 NAD83(2011)EPOCH: 2010.0000 BY MULTIPLYING BY A PROJECT MEAN GROUND COMBINED SCALE FACTOR OF 1.0000328962 AT A CENTRAL PROJECT POINT WITH INTERNATIONAL FOOT STATE PLANE GRID COORDINATES N805128.443 E7614876.336 AND A MERIDIAN CONVERGENCE ANGLE OF −1°38'04" STATE PLANE COORDINATES WERE DERIVED FROM GPS OBSERVATIONS USING THE ORGN NETWORK. DISTANCES SHOWN ARE INTERNATIONAL FOOT GROUND VALUES.



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ST HELENS LAGOON

CITY OF ST HELENS OREGON
TAX LOT 200 TAX MAP 4N1W300

EXISTING CONDITIONS PLAN - COVER SHEET

DESIGNED BY:
DRAWN BY: HDS
MANAGED BY: NSW
CHECKED BY: TJA
DATE: 12/09/2019

REGISTERED PROFESSIONAL LAND SURVEYOR
OREGON
JANUARY 9, 2007
NICK WHITE
70652LS
RENEWS: 6/30/20

REVISIONS

JOB NUMBER
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SHEET
1 OF 11

AKS DRAWING FILE: 7835EXCOND.DWG | LAYOUT: SHEET 1

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OREGON
TAX MAP 4N1W300

EXISTING CONDITIONS AERIAL PLAN

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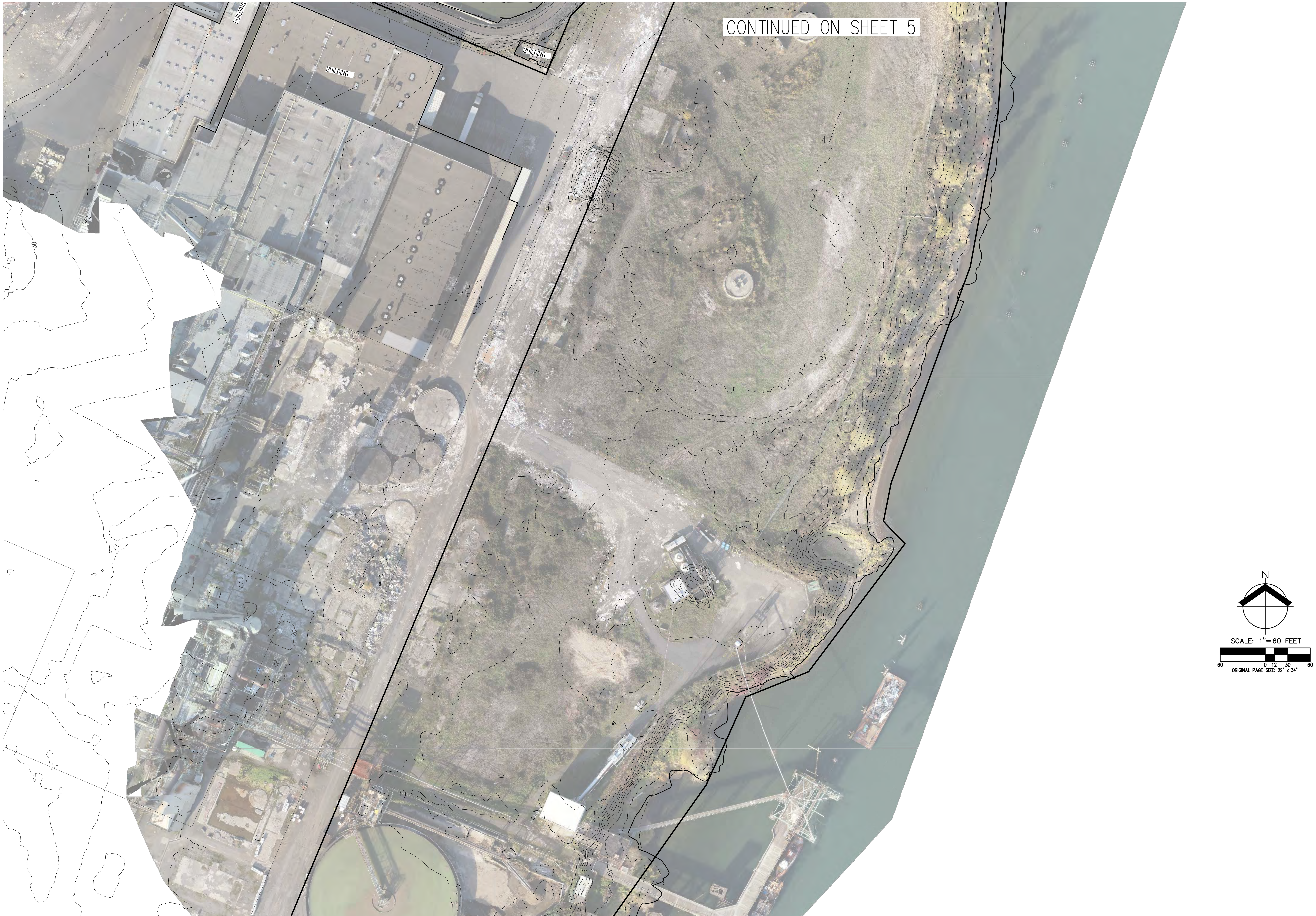

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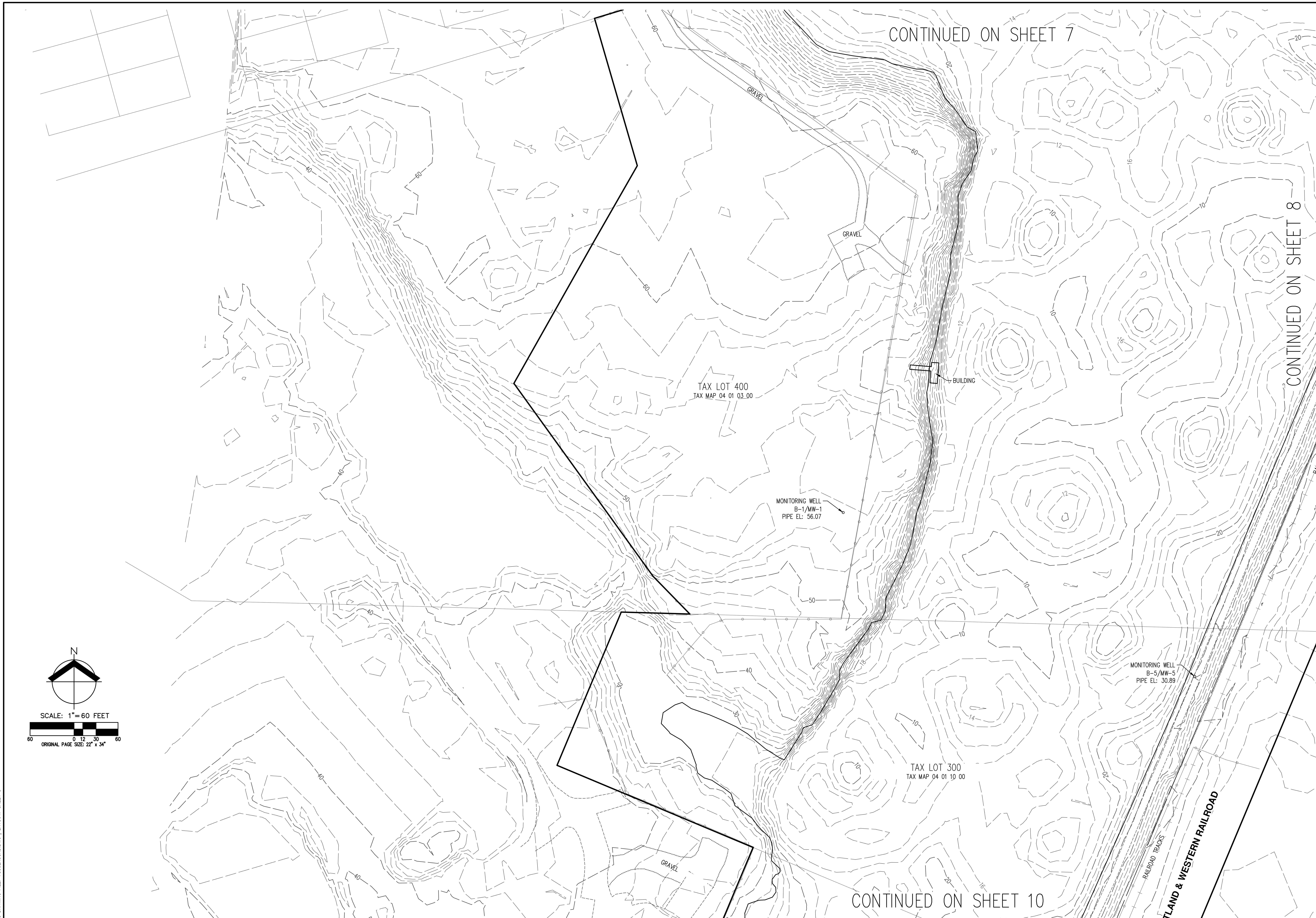

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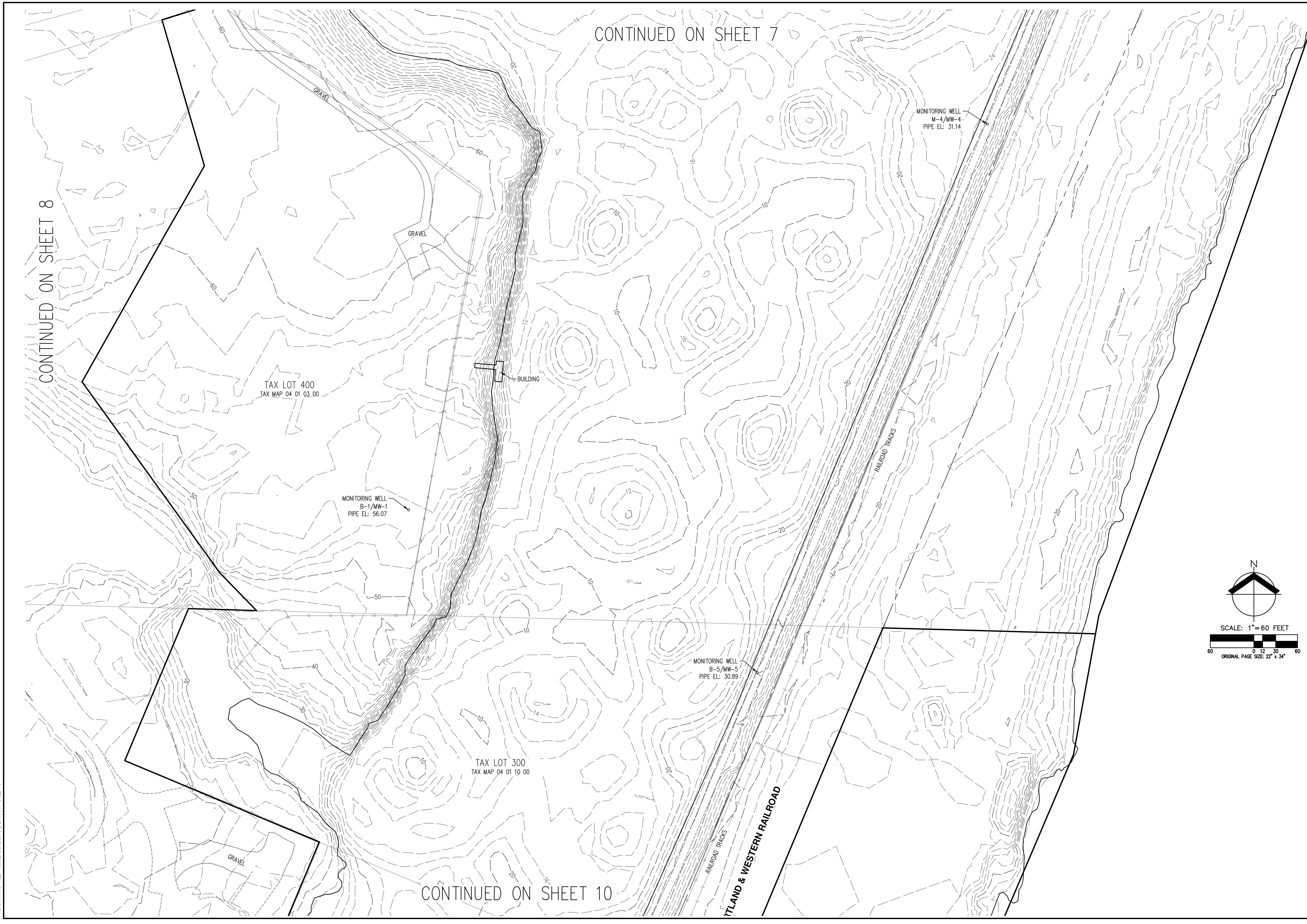

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11 OF 11

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APPENDIX B

Field Explorations and Laboratory Testing

APPENDIX B

FIELD EXPLORATIONS AND LABORATORY TESTING

FIELD EXPLORATIONS

General

Subsurface materials and conditions at the site were investigated by GRI between July 29 and August 2, 2019, with two mud-rotary borings, designated B-1 and B-2, and three cone penetration test (CPT) probes, designed CPT-1 through CPT-3. The locations of the borings and probes are shown on Figure 2. The above fieldwork is discussed in more detail below.

Mud-Rotary Borings

Borings B-1 and B-2 were advanced to depths of about 156.5 to 201.5 ft using mud-rotary drilling techniques using a CME 55 HT track-mounted drill rig provided and operated by Western States Soil Conservation, Inc., of Hubbard, Oregon. Disturbed samples were obtained from the borings at about 2.5-ft intervals of depth to a depth of about 15 ft, 5-ft intervals from 15 to 80 ft of depth, and 5- to 10-ft intervals below 80 ft of depth. Disturbed samples were obtained using a 2-in.-outside-diameter (O.D.) standard split-spoon sampler. Standard Penetration Tests (SPT) were conducted by driving the sampler into the soil a distance of 18 in. using a 140-lb hammer dropped 30 in. The number of blows required to drive the standard split-spoon sampler the last 12 in. is known as the Standard Penetration Resistance, or SPT N-value. The SPT N- values provide a measure of the relative density of granular soils and the relative consistency of cohesive soils. Samples obtained from the borings were placed in airtight jars and returned to our laboratory for further classification and testing. In addition, relatively undisturbed samples were collected by pushing a 3-in.-O.D. Shelby tube into the undisturbed soil a maximum distance of 24 in. using the hydraulic ram of the drill rig. The soil exposed in the ends of the Shelby tubes was examined and classified in the field. After classification, the tubes were sealed with rubber caps and returned to our laboratory for further examination and testing. All samples were returned to our laboratory for further examination and testing.

Logs of the mud-rotary borings are provided on Figures 1B and 2B. Each log presents a descriptive summary of the various types of materials encountered in the boring and notes the depth where the materials and/or characteristics of the materials change. To the right of the descriptive summary, the numbers and types of samples taken during the drilling operation are indicated. Farther to the right, SPT N-values are shown graphically along with the natural moisture contents, Torvane shear-strength values, fines contents, Atterberg-limits determinations, and dry densities of soil samples. The terms and symbols used to describe the soil and rock encountered in the borings are defined in Tables 1B and 2B and the attached legend.

Cone Penetrometer Test Probes

Probes CPT-1 through CPT-3 were advanced to depths of about 21.2 to 158 ft, where refusal installation conditions were encountered, using a truck-mounted electrical cone provided and operated by Oregon Geotechnical Explorations, Inc., of Keizer, Oregon. During a CPT, a steel cone is forced vertically into the soil at a constant rate of penetration. The force required to cause penetration at a constant rate can be related to the bearing capacity of the soil immediately surrounding the point of the penetrometer cone. This force is measured and recorded every 4 in. In addition to the cone measurements, measurements are obtained of the magnitude of force required to force a friction sleeve attached above the cone through the soil. The force required to move the friction sleeve can be related to the undrained shear strength of fine-grained soils. The dimensionless ratio of sleeve friction to point-bearing capacity indicates the type of soil penetrated. The cone penetration resistance can be used to evaluate the relative consistency or density of cohesionless and cohesive soils, respectively. In addition, a piezometer fitted between the cone and the sleeve measures changes in water pressures as the probe is advanced and can also be used to measure the depth of the top of the groundwater surface. CPT-1 included shear-wave velocity testing. For this test, an accelerometer is placed in the cone equipment, which allows measurement of the arrival times of shear waves at the cone base from impulses generated at the ground surface that can then be used to calculate shear-wave velocities in the soil profile. The logs of CPTs are provided on Figures 3B through 6B. The shear-wave velocity measurements for CPT-2 are provided on Figure 5B. Graphical data from pore-pressure dissipation tests are provided on Figures 7B through 11B. Interpretations of the soil types encountered by the probe are shown graphically on the logs. Guidelines for the classification of soils in the CPT probe are provided in Table 3B.

LABORATORY TESTING

General

All samples obtained from the field were returned to our laboratory, where the physical characteristics of the samples were noted and the field classifications modified where necessary. At the time of classification, the natural moisture content of each soil sample was determined. Additional testing included Torvane shear strength, dry unit weight, washed-sieve analysis (percent passing the U.S. No. 200 sieve), Atterberg limits, one-dimensional consolidation, unconfined compression strength, triaxial compression testing, and cyclic direct simple shear (DSS) testing. The following paragraphs describe the testing program in more detail.

Natural Moisture Content

Natural moisture content determinations were made in conformance with ASTM International (ASTM) D2216. The results are shown on Figures 1B and 2B and summarized in Table 4B.

Torvane Shear Strength

The approximate undrained shear strengths of relatively undisturbed, fine-grained soil samples were determined using a Torvane shear device. The Torvane is a hand-held apparatus with vanes that are inserted into the soil. The torque required to fail the soil in shear around the vanes is measured using a calibrated spring. The results of the Torvane shear-strength test are summarized on Figures 1B and 2B.

Dry Unit Weight

The dry unit weight of undisturbed soil samples was determined in the laboratory in accordance with ASTM D2937 by cutting a cylindrical specimen of soil from a Shelby tube sample. The dimensions of the specimen were carefully measured, the volume calculated, and the specimen weighed. After oven-drying, the specimen was reweighed and the water content was calculated. The dry unit weight was then computed. The dry unit weight is shown on Figures 1B and 2B and summarized in Table 4B.

Washed-Sieve Analysis

Washed-sieve analyses were performed on selected samples of the soil to assist in their classification. The test is performed by taking a sample of known dry weight and washing it over a No. 200 sieve. The material retained on the sieve is oven-dried and weighed. The percentage of material passing that passes the No. 200 sieve is then calculated. The results are summarized on Figures 1B and 2B and in Table 4B.

Atterberg Limits

Atterberg limits tests were performed on 11 samples of the fine-grained soil in substantial conformance with ASTM D4318. The test data are shown on Figures 1B and 2B and summarized in Table 4B. The results are also shown graphically on Figures 12B through 16B.

One-Dimensional Consolidation

One-dimensional consolidation testing was performed in accordance with ASTM D2435 to obtain data on the compressibility characteristics of three relatively undisturbed sample of fine-grained soil. Test results are summarized on Figures 17B through 21B in the form of a curve showing effective stress versus percent strain. The initial moisture content and unit weight of the sample are also provided on the figure.

In addition, secondary compression was recorded on two samples in substantial conformance with ASTM D2435 Test Method B during the one-dimensional consolidation tests. The results are provided on Figure 22B in the form of curves showing deflection versus the log of time.

Unconfined Compression

An unconfined compression test was performed on a selected sample of silt. The test was conducted in accordance with ASTM D2166. The test results are summarized below.

Boring	Sample	Depth, ft	Unconfined Compressive Strength, psf	Undrained Shear Strength, psf
B-1	S-10	28.3	1,270	635

Triaxial Compression Test

Two isotropically consolidated, undrained (CIU) triaxial compression tests with pore-pressure measurements were performed on selected samples of soil from borings B-1 and B-2. Samples for these tests were collected with a relatively undisturbed 2.85-in.-inside-diameter (I.D.) Shelby tube. The specimens were extruded from the tubes, the ends of the sample were trimmed square, and the samples were encapsulated in a protective rubber membrane and mounted into a triaxial cell. Vertical filter paper drains were placed on the sides of each sample to enhance drainage and reduce the equalization time of strain-induced pore pressures.

Upon completion of sample preparation, the samples were saturated under an effective confining pressure of approximately 1 to 2 psi, with a back pressure of at least 40 psi to achieve timely saturation. Subsequently, the effective confining stress was increased and the sample was allowed to consolidate with the drainage line open. Following consolidation, the drainage line was closed and the sample was sheared undrained at a constant rate of strain while measurements were made of axial load, axial strain, and shear-induced pore pressure. The peak deviator stress ($\sigma_1 - \sigma_3$) was selected as the point of failure for each stage on the Mohr-Coulomb envelope.

The test results are summarized on Figures 23B and 24B. A graphical summary of deviator stress, effective stress ratio, and change in pore pressure versus axial strain is shown on the left side of the figure. Farther to the right, on the top half of the figure is the modified Mohr-Coulomb envelope based on maximum effective shear stress and the corresponding effective normal stress at failure. A summary of the test data, including sample identification and initial and final moisture content of the samples, is tabulated below the modified Mohr-Coulomb plot.

Cyclic Direct Simple Shear

Strain-controlled, cyclic DSS tests were performed in conformance with standard of practice and ASTM D6528 on relatively undisturbed soil samples extruded from a Shelby tube. The test provides data on the cyclic resistance, degradation potential, and post-cyclic behavior of the underlying fine-grained soils, necessary for seismic and slope-stability studies. The cyclic tests were completed at a frequency of 0.1 Hz, and the post-cyclic shear-strength tests were completed at a shear-strain rate of 5%/hour. The results of the cyclic DSS tests are tabulated below.

STRAIN-CONTROLLED CYCLIC DSS TEST RESULTS

Boring	Depth, ft	Confining Pressure(1), psf	Overconsolidation Ratio (OCR)	Shear Strain, %	Ru at 60 Cycles	Max Ru at 200 Cycles	Static Shear Strength, psf	Post-Cyclic Shear Strength, psf
B-1	39.0	2,500	1.5(2)	Static	N/A	N/A	930	N/A
B-1	39.2	2,500	1.5(3)	0.5	0.35	0.42	N/A	1,040
B-1	39.8	2,500	1.5(3)	0.8	0.59	0.64	N/A	1,000
B-1	39.6	2,500	1.5(3)	1.6	0.84	0.88	N/A	965
B-1	39.4	7,500	1.0(4)	0.8	0.32	0.39	N/A	2,023
B-2	64.3	3,500	1.5(2)	Static	N/A	N/A	1,240	N/A
B-2	64.0	3,500	1.5(2)	0.8	0.42	0.45	N/A	1,200
B-2	63.8	3,500	1.5(2)	1.6	0.78	0.85	N/A	1,110
B-2	63.6	3,500	3.1(5)	1.6	0.26	0.39	N/A	2,330

Notes:

1) Confinement pressure was equivalent to existing overburden pressure with the exception of B-1 at 39.4 ft, which was consolidated to a confinement pressure of approximately 3 times the overburden pressure.
2) Interpolated from consolidation testing.
3) Specimen consolidated to existing overburden pressure and then tested.
4) Specimen consolidated to confining pressure and then tested at confining pressure
5) Specimen consolidated to 11,000 psf and then tested at confining pressure.

Table 1B: GUIDELINES FOR CLASSIFICATION OF SOIL

Description of Relative Density for Granular Soil

Relative Density	Standard Penetration Resistance (N-values) blows per ft
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	over 50

Description of Consistency for Fine-Grained (Cohesive) Soils

Consistency	Standard Penetration Resistance (N-values) blows per ft	Torvane or Undrained Shear Strength, tsf
Very Soft	0 - 2	less than 0.125
Soft	2 - 4	0.125 - 0.25
Medium Stiff	4 - 8	0.25 - 0.50
Stiff	8 - 15	0.50 - 1.0
Very Stiff	15 - 30	1.0 - 2.0
Hard	over 30	over 2.0

Grain-Size Classification

Boulders:
- >12 in.

Cobbles:
- 3 - 12 in.

Gravel:
- 1/4 - 3/4 in. (fine)
- 3/4 - 3 in. (coarse)

Sand:
- No. 200 - No. 40 sieve (fine)
- No. 40 - No. 10 sieve (medium)
- No. 10 - No. 4 sieve (coarse)

Silt/Clay:
- pass No. 200 sieve

Modifier for Subclassification

	Primary Constituent SAND or GRAVEL	Primary Constituent SILT or CLAY
Adjective	**Percentage of Other Material (by weight)**	
trace:	5 - 15 (sand, gravel)	5 - 15 (sand, gravel)
some:	15 - 30 (sand, gravel)	15 - 30 (sand, gravel)
sandy, gravelly:	30 - 50 (sand, gravel)	30 - 50 (sand, gravel)
trace:	< 5 (silt, clay)	*Relationship of clay and silt determined by plasticity index test*
some:	5 - 12 (silt, clay)	
silty, clayey:	12 - 50 (silt, clay)	

Table 2B: GUIDELINES FOR CLASSIFICATION OF ROCK

Relative Rock Weathering Scale

Term	*Field Identification*
Fresh	Crystals are bright. Discontinuities may show some minor surface staining. No discoloration in rock fabric.
Slightly Weathered	Rock mass is generally fresh. Discontinuities are stained and may contain clay. Some discoloration in rock fabric. Decomposition extends up to 1 in. into rock.
Moderately Weathered	Rock mass is decomposed 50% or less. Significant portions of rock show discoloration and weathering effects. Crystals are dull and show visible chemical alteration. Discontinuities are stained and may contain secondary mineral deposits.
Predominantly Decomposed	Rock mass is more than 50% decomposed. Rock can be excavated with geologist's pick. All discontinuities exhibit secondary mineralization. Complete discoloration of rock fabric. Surface of core is friable and usually pitted due to washing out of highly altered minerals by drilling water.
Decomposed	Rock mass is completely decomposed. Original rock "fabric" may be evident. May be reduced to soil with hand pressure.

Relative Rock Hardness Scale

Term	Hardness Designation	Field Identification	Approximate Unconfined Compressive Strength
Extremely Soft	R0	Can be indented with difficulty by thumbnail. May be moldable or friable with finger pressure.	$<$ 100 psi
Very Soft	R1	Crumbles under firm blows with point of a geology pick. Can be peeled by a pocket knife and scratched with fingernail.	100 - 1,000 psi
Soft	R2	Can be peeled by a pocket knife with difficulty. Cannot be scratched with fingernail. Shallow indentation made by firm blow of geology pick.	1,000 - 4,000 psi
Medium Hard	R3	Can be scratched by knife or pick. Specimen can be fractured with a single firm blow of hammer/geology pick.	4,000 - 8,000 psi
Hard	R4	Can be scratched with knife or pick only with difficulty. Several hard hammer blows required to fracture specimen.	8,000 - 16,000 psi
Very Hard	R5	Cannot be scratched by knife or sharp pick. Specimen requires many blows of hammer to fracture or chip. Hammer rebounds after impact.	$>$ 16,000 psi

RQD and Rock Quality

Relation of RQD and Rock Quality

RQD (Rock Quality Designation), %	Description of Rock Quality
0 - 25	Very Poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

Terminology for Planar Surface

Bedding	Joints and Fractures	Spacing
Laminated	Very Close	$<$ 2 in.
Thin	Close	2 in. – 12 in.
Medium	Moderately Close	12 in. – 36 in.
Thick	Wide	36 in. – 10 ft
Massive	Very Wide	$>$ 10 ft

Table 3B: CONE PENETRATION TEST (CPT) CORRELATIONS

Cohesive Soils

Cone Tip Resistance, tsf	Consistency
<5	Very Soft
5 to 15	Soft to Medium Stiff
15 to 30	Stiff
30 to 60	Very Stiff
>60	Hard

Cohesionless Soils

Cone Tip Resistance, tsf	Relative Density
<20	Very Loose
20 to 40	Loose
40 to 120	Medium
120 to 200	Dense
>200	Very Dense

Reference

Kulhawy, F. H., and Mayne, P. W., 1990, Manual on estimating soil properties for foundation design, Electric Power Research Institute, EL-6800.

Table 4B

SUMMARY OF LABORATORY RESULTS

Sample Information						Atterberg Limits			
Location	Sample	Depth, ft	Elevation, ft	Moisture Content, %	Dry Unit Weight, pcf	Liquid Limit, %	Plasticity Index, %	Fines Content, %	Soil Type
B-1	S-2	5.0	–	22	–	–	–	–	SAND
	S-3	7.5	–	19	–	–	–	6	SAND
	S-4	10.0	–	27	–	–	–	–	SAND
	S-5	12.5	–	30	–	–	–	4	SAND
	S-6	15.0	–	29	–	–	–	–	SAND
	S-7	17.5	–	28	–	–	–	7	SAND
	S-8	20.0	–	29	–	–	–	7	SAND
	S-9	25.0	–	57	–	–	–	–	SILT
	S-10	28.3	–	55	68	–	–	–	SILT
	S-10	29.5	–	52	–	–	–	96	SILT
	S-11	30.0	–	52	–	56	16	94	SILT
	S-12	35.0	–	50	–	–	–	–	SILT
	S-13	38.5	–	46	75	–	–	–	SILT
	S-13	39.5	–	46	–	46	3	81	SILT
	S-14	40.0	–	51	–	51	9	–	SILT
	S-15	45.0	–	50	–	–	–	82	SILT
	S-16	49.5	–	49	–	–	–	81	SILT
	S-17	50.0	–	47	–	51	9	–	SILT
	S-18	55.0	–	51	–	–	–	–	SILT
	S-19	60.0	–	49	–	44	11	72	SILT
	S-20	65.0	–	51	–	–	–	–	SILT
	S-21	70.0	–	42	–	–	–	–	SILT
	S-22	75.0	–	54	–	44	11	62	Sandy SILT
	S-23	80.0	–	37	–	48	7	–	SILT
	S-24	90.0	–	45	–	–	–	–	SILT
	S-25	100.0	–	52	–	53	20	96	SILT
	S-27	120.0	–	48	–	–	–	–	SILT
	S-28	130.0	–	68	–	68	15	97	SILT
	S-29	140.0	–	33	–	–	–	27	Silty SAND
	S-30	150.0	–	39	–	–	–	–	SILT
	S-31	160.0	–	38	–	35	1	82	SILT
	S-33	180.0	–	42	–	41	5	96	SILT
	S-35	200.0	–	42	–	–	–	–	SILT
B-2	S-1	3.5	–	76	–	–	–	–	Clayey SILT
	S-3	7.0	–	48	–	–	–	92	Clayey SILT
	S-4	10.0	–	44	–	47	18	–	Clayey SILT
	S-5	14.5	–	50	–	–	–	–	Clayey SILT
	S-6	15.0	–	50	–	–	–	–	Clayey SILT
	S-7	20.0	–	52	–	–	–	86	Clayey SILT
	S-8	24.3	–	53	70	–	–	97	Clayey SILT

Table 4B

SUMMARY OF LABORATORY RESULTS

Sample Information						Atterberg Limits			
Location	Sample	Depth, ft	Elevation, ft	Moisture Content, %	Dry Unit Weight, pcf	Liquid Limit, %	Plasticity Index, %	Fines Content, %	Soil Type
B-2	S-9	25.0	--	55	--	57	18	--	Clayey SILT
	S-10	30.0	--	53	--	--	--	--	Clayey SILT
	S-12	35.0	--	48	--	--	--	--	SILT
	S-13	40.0	--	50	--	--	--	--	SILT
	S-15	45.0	--	68	--	--	--	--	SILT
	S-16	50.0	--	68	--	87	47	97	SILT
	S-18	55.0	--	82	--	--	--	--	SILT
	S-19	60.0	--	52	--	--	--	--	SILT
	S-20	63.4	--	47	78	--	--	84	SILT
	S-20	64.0	--	48	--	50	16	78	SILT
	S-21	65.0	--	46	--	55	11	--	SILT
	S-22	70.0	--	37	--	--	--	29	Silty SAND
	S-23	75.0	--	41	--	43	4	--	SILT
	S-24	80.0	--	41	--	--	--	--	SILT
	S-25	85.0	--	46	--	--	--	61	SILT
	S-26	90.0	--	48	--	54	7	--	SILT
	S-27	95.0	--	45	--	--	--	--	SILT
	S-28	100.0	--	56	--	56	9	--	SILT
	S-29	105.0	--	51	--	--	--	--	SILT
	S-30	115.0	--	40	--	42	5	--	SILT
	S-31	125.0	--	37	--	--	--	64	SILT
	S-32	135.0	--	37	--	--	--	--	SILT
	S-33	145.0	--	37	--	--	--	--	Silty SAND

BORING AND TEST PIT LOG LEGEND

SOIL SYMBOLS

Symbol	Typical Description
	LANDSCAPE MATERIALS
	FILL
	GRAVEL; clean to some silt, clay, and sand
	Sandy GRAVEL; clean to some silt and clay
	Silty GRAVEL; up to some clay and sand
	Clayey GRAVEL; up to some silt and sand
	SAND; clean to some silt, clay, and gravel
	Gravelly SAND; clean to some silt and clay
	Silty SAND; up to some clay and gravel
	Clayey SAND; up to some silt and gravel
	SILT; up to some clay, sand, and gravel
	Gravelly SILT; up to some clay and sand
	Sandy SILT; up to some clay and gravel
	Clayey SILT; up to some sand and gravel
	CLAY; up to some silt, sand, and gravel
	Gravelly CLAY; up to some silt and sand
	Sandy CLAY; up to some silt and gravel
	Silty CLAY; up to some sand and gravel
	PEAT

BEDROCK SYMBOLS

Symbol	Typical Description
	BASALT
	MUDSTONE
	SILTSTONE
	SANDSTONE

SURFACE MATERIAL SYMBOLS

Symbol	Typical Description
	Asphalt concrete PAVEMENT
	Portland cement concrete PAVEMENT
	Crushed rock BASE COURSE

SAMPLER SYMBOLS

Symbol	Sampler Description
	2.0-in. O.D. split-spoon sampler and Standard Penetration Test with recovery (ASTM D1586)
	Shelby tube sampler with recovery (ASTM D1587)
	3.0-in. O.D. split-spoon sampler with recovery (ASTM D3550)
	Grab Sample
	Rock core sample interval
	Sonic core sample interval
	Geoprobe sample interval

INSTALLATION SYMBOLS

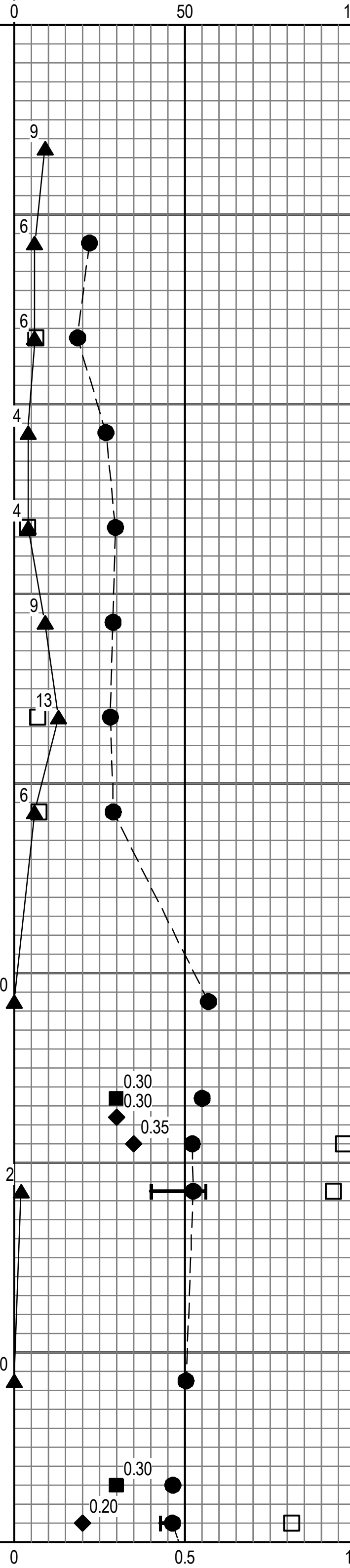
Symbol	Symbol Description
	Flush-mount monument set in concrete
	Concrete, well casing shown where applicable
	Bentonite seal, well casing shown where applicable
	Filter pack, machine-slotted well casing shown where applicable
	Grout, vibrating-wire transducer cable shown where applicable
P	Vibrating-wire pressure transducer
	1-in.-diameter solid PVC
	1-in.-diameter hand-slotted PVC
	Grout, inclinometer casing shown where applicable

FIELD MEASUREMENTS

Symbol	Typical Description
	Groundwater level during drilling and date measured
	Groundwater level after drilling and date measured
	Rock core recovery (%)
	Rock quality designation (RQD, %)

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	DEPTH, FT	INSTALLATION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT	COMMENTS AND ADDITIONAL TESTS
		Surface Elevation: Not Available						
		Crushed rock SURFACING (4-in.-minus Fill)	0.8					
		SAND, trace to some silt, gray-brown, loose, fine to medium grained						
					S-1		4 5 4	
5					S-2		2 3 3	Possible chemical odor below 5 ft
					S-3		2 3 3	
10		---fine to coarse grained below 10 ft			S-4		2 2 2	
					S-5		1 2 2	
15					S-6		3 4 5	
		---dark gray, contains wood fragments below 17.5 ft			S-7		5 6 7	S-7 includes large wood fragment in sampler. Blow counts may not be representative.
20					S-8		4 4 2	
25		SILT, some clay to clayey, up to trace fine-grained sand, brown to dark brown, very soft	25.0		S-9		0 0 0	Possible chemical odor below 25 ft
		---gray, medium stiff below 28 ft			S-10			Dry Density = 68 pcf
30		---very soft to soft, contains wood debris below 30 ft			S-11		0 0 2	
35		---dark brown to gray below 35 ft			S-12		0 0 0	
		---trace to some sand, trace clay below 38 ft			S-13			Dry Density = 75 pcf
40								

▲ BLOWS PER FOOT
● MOISTURE CONTENT, %
□ FINES CONTENT, %
LIQUID LIMIT, %
PLASTIC LIMIT, %



◆ TORVANE SHEAR STRENGTH, TSF
■ UNDRAINED SHEAR STRENGTH, TSF

(CONTINUED NEXT PAGE)

Logged By: G. Martin	**Drilled by:** Western States Soil Conservation, Inc.	
Date Started: 7/31/19	**GPS Coordinates:** 45.8552° N -122.7976° W (WGS 84)	
Drilling Method: Mud Rotary **Equipment:** CME 55 HT Track-Mounted Drill Rig **Hole Diameter:** 5 in.	**Hammer Type:** Auto Hammer **Weight:** 140 lb **Drop:** 30 in. **Energy Ratio:** 0.76	
Note: See Legend for Explanation of Symbols		

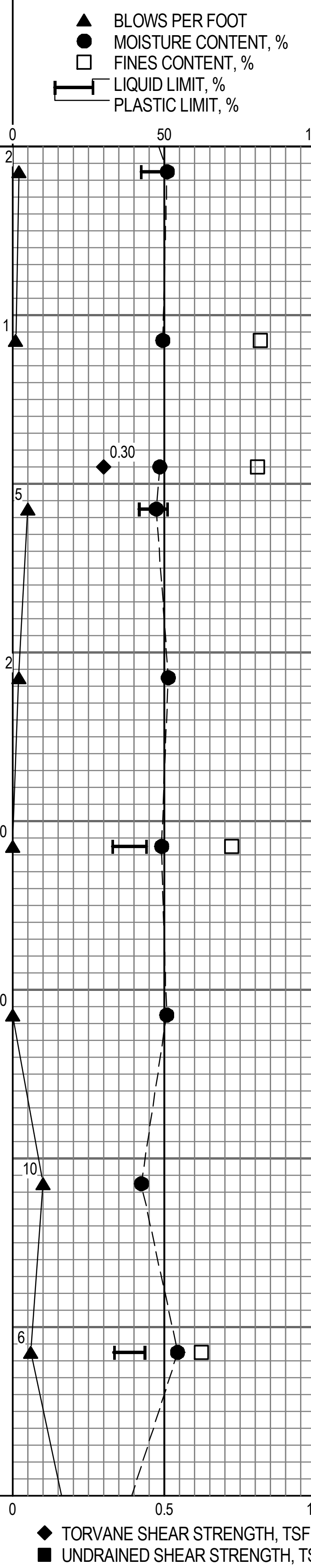
GRI

BORING B-1

DEC. 2019 JOB NO. 6266 FIG. 1B

GRI BORING LOG (GPS) - NO ELEV GRI DATA TEMPLATE.GDT 12/10/19

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	DEPTH, FT	INSTALLATION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT	COMMENTS AND ADDITIONAL TESTS
		Surface Elevation: Not Available						
		SILT, some clay, trace to some fine- to medium-grained sand, dark gray to brown-gray, very soft to soft, contains wood debris			S-14		0 1 1	
45					S-15		0 0 1	
		---medium stiff below 48 ft			S-16			
50					S-17		0 2 3	
55		---trace fine-grained sand, very soft to soft below 55 ft			S-18		0 0 2	
60		---some sand below 60 ft			S-19		0 0 0	
65					S-20		0 0 0	
70		---stiff below 70 ft			S-21		2 2 8	
75		---sandy, some clay to clayey, medium stiff below 75 ft			S-22		1 1 5	Chemical odor in sample S-22
80								



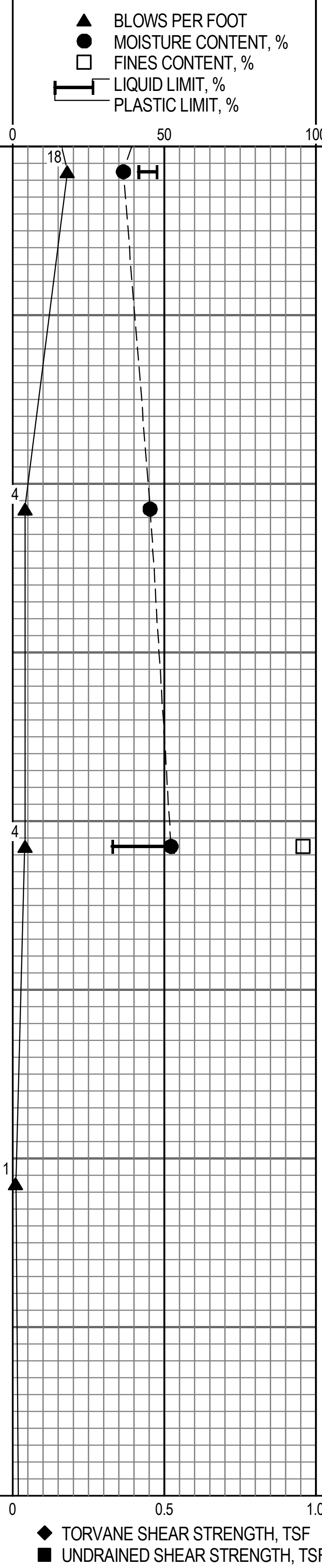
(CONTINUED NEXT PAGE)

GRI

BORING B-1

DEC. 2019 JOB NO. 6266 FIG. 1B

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL Surface Elevation: Not Available	DEPTH, FT	INSTALLATION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT	COMMENTS AND ADDITIONAL TESTS
		SILT, some fine-grained sand to sandy, trace to some clay, dark brown-gray, very stiff, contains shell fragments and wood debris			S-23		1 8 10	
85								
90		---some clay to clayey, up to trace sand, gray, soft to medium stiff, shell fragments absent below 90 ft			S-24		0 1 3	
95								
100					S-25		0 0 4	
105								
110		---very soft below 110 ft			S-26		2 1 0	
115								
120								



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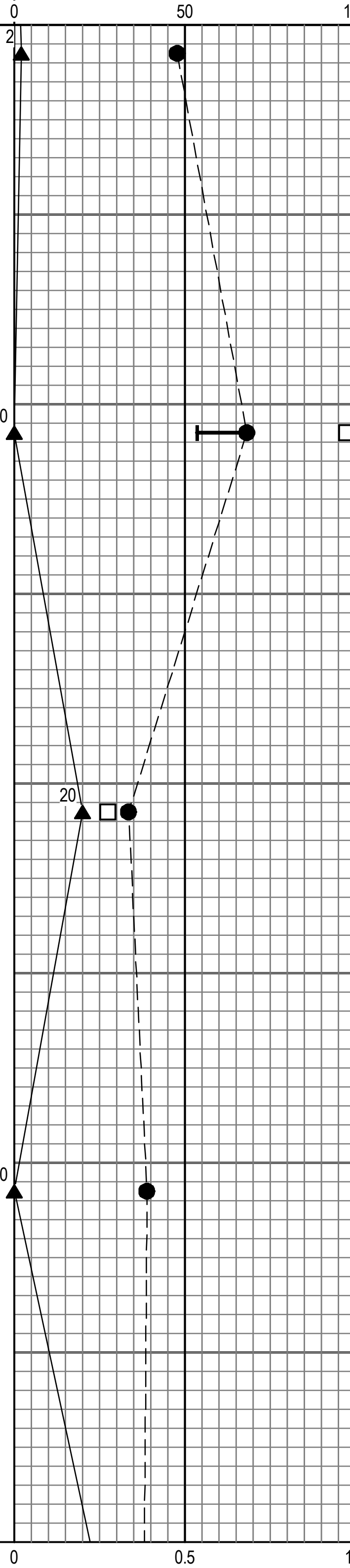
GRI

BORING B-1

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL **Surface Elevation:** Not Available	DEPTH, FT	INSTALLATION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT	▲ BLOWS PER FOOT ● MOISTURE CONTENT, % □ FINES CONTENT, % LIQUID LIMIT, % PLASTIC LIMIT, %	COMMENTS AND ADDITIONAL TESTS
		SILT, some clay to clayey, up to trace fine-grained sand, very soft to soft, contains wood debris			S-27		0 0 2	2	
125									
130					S-28		0 0 0	0	
135									
		Silty SAND, gray, medium dense, contains wood debris	138.0						Driller notes material change at 138 ft
140					S-29		9 8 12	20	
145									
150		SILT, trace to some clay, trace fine-grained sand, gray, very soft, contains wood debris	150.0		S-30		1 0 0	0	
155									
160									



(CONTINUED NEXT PAGE)

◆ TORVANE SHEAR STRENGTH, TSF
■ UNDRAINED SHEAR STRENGTH, TSF

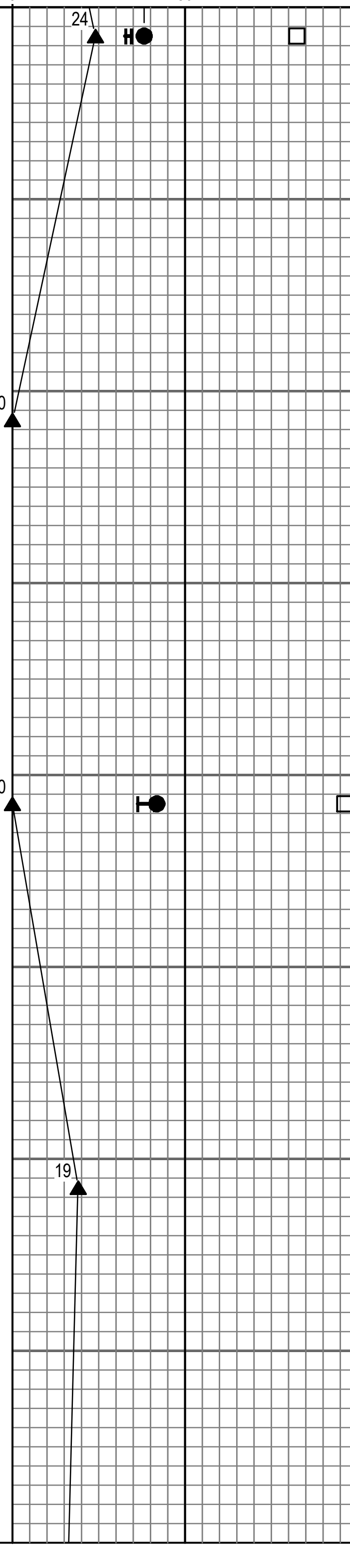
GRI BORING LOG (GPS) - NO ELEV GRI DATA TEMPLATE.GDT 12/10/19

GRI

BORING B-1

DEC. 2019 JOB NO. 6266 FIG. 1B

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL Surface Elevation: Not Available	DEPTH, FT	INSTALLATION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT	▲ BLOWS PER FOOT ● MOISTURE CONTENT, % □ FINES CONTENT, % LIQUID LIMIT, % / PLASTIC LIMIT, % 0 50 100	COMMENTS AND ADDITIONAL TESTS
		SILT, trace to some fine-grained sand, trace clay, gray, very stiff, contains wood debris			S-31		3 9 15	24	Driller indicates possible necking of borehole prior to S-31. Blow counts may not be representative
165									
170		---very soft below 170 ft			S-32		0 0 0	0	
175									
180		---trace to some clay, up to trace sand below 180 ft			S-33		0 0 0	0	
185									
190		---very stiff below 190 ft			S-34		5 7 12	19	
195									
200									



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0 0.5 1.0

◆ TORVANE SHEAR STRENGTH, TSF
■ UNDRAINED SHEAR STRENGTH, TSF

GRI

BORING B-1

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL **Surface Elevation:** Not Available	DEPTH, FT	INSTALLATION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT	▲ BLOWS PER FOOT ● MOISTURE CONTENT, % □ FINES CONTENT, % LIQUID LIMIT, % PLASTIC LIMIT, % (0 50 100)	COMMENTS AND ADDITIONAL TESTS
		SILT, trace to some clay, trace fine-grained sand, gray, stiff, contains scattered organics	201.5		S-35		0 6 10	16	
		(8/2/2019)							

Depth scale: 205, 210, 215, 220, 225, 230, 235, 240

0 0.5 1.0

◆ TORVANE SHEAR STRENGTH, TSF
■ UNDRAINED SHEAR STRENGTH, TSF

GRI

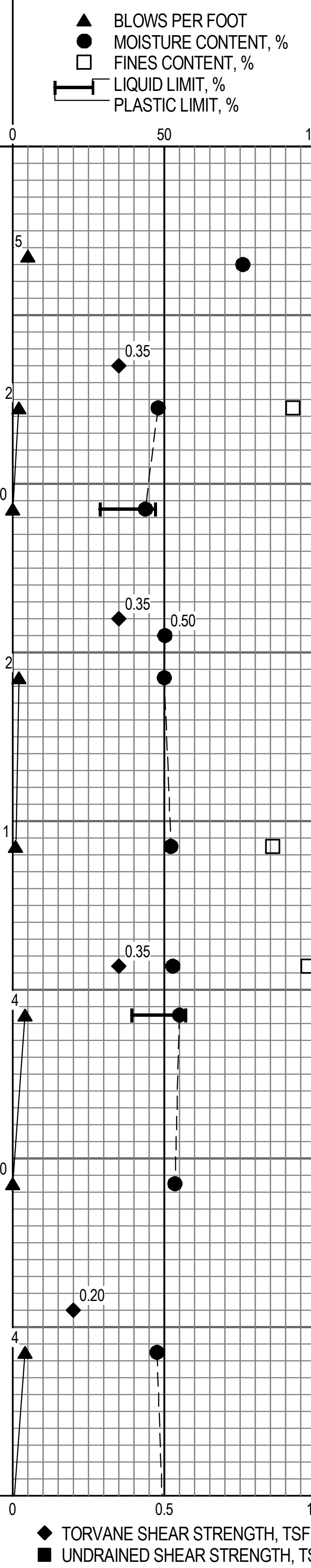
BORING B-1

DEC. 2019 JOB NO. 6266 FIG. 1B

BORING B-2

DEPTH, FT	CLASSIFICATION OF MATERIAL	SAMPLE NO.	BLOW COUNT	COMMENTS AND ADDITIONAL TESTS
0	**Surface Elevation:** Not Available			
0	Clayey SILT, up to trace fine-grained sand, gray to dark gray, medium stiff, contains wood debris, 3-in.-thick heavily rooted zone at ground surface			
		S-1	1 3 2	
5		S-2		
7	---dark gray-brown, very soft to soft below 7 ft	S-3	0 1 1	
10		S-4	0 0 0	
		S-5		
15	---wood debris absent below 15 ft			
16	---2-in.-thick sand lens at approximately 16 ft	S-6	0 1 1	
20	---dark gray below 20 ft	S-7	0 0 1	
		S-8		Dry Density = 70 pcf
25	---soft to medium stiff at 25 ft	S-9	0 1 3	
30	---contains wood debris below 30 ft	S-10	0 0 0	
		S-11		
35	---some clay to clayey, soft to medium stiff below 35 ft	S-12	0 2 2	
40				

Column headings: DEPTH, FT; GRAPHIC LOG; CLASSIFICATION OF MATERIAL; DEPTH, FT; INSTALLATION; SAMPLE NO.; SAMPLE TYPE; BLOW COUNT



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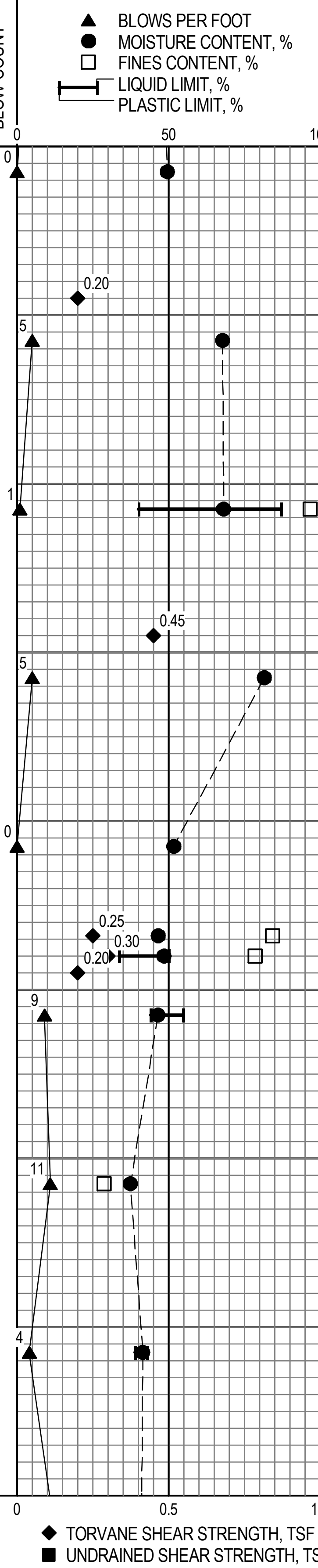
Logged By: G. Martin	**Drilled by:** Western States Soil Conservation, Inc.
Date Started: 7/29/19	**GPS Coordinates:** 45.8504° N -122.7997° W (WGS 84)
Drilling Method: Mud Rotary **Equipment:** CME 55 HT Track-Mounted Drill Rig **Hole Diameter:** 5 in.	**Hammer Type:** Auto Hammer **Weight:** 140 lb **Drop:** 30 in. **Energy Ratio:** 0.76
Note: See Legend for Explanation of Symbols	

GRI

BORING B-2

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL Surface Elevation: Not Available	DEPTH, FT	INSTALLATION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT	COMMENTS AND ADDITIONAL TESTS
		SILT, some clay to clayey, up to trace fine-grained sand, gray to dark gray, very soft to soft, contains wood debris			S-13		0 0 0	
					S-14			
45		---medium stiff at 45 ft			S-15		1 2 3	
50		---dark gray to dark brown below 50 ft			S-16		0 0 1	
		---medium stiff below 53 ft			S-17			
55					S-18		0 2 3	
60		---very soft below 60 ft			S-19		0 0 0	
		---some clay, trace to some sand, gray, soft to medium stiff, interbedded with sand lenses up to 1/8 in. thick below 63 ft			S-20			Dry Density = 78 pcf Organics = 8%
65		---trace to some clay, dark gray, stiff below 65 ft			S-21		0 4 5	
70		Silty SAND, gray to dark gray, medium dense, medium to coarse grained, contains wood debris	70.0		S-22		4 5 6	
75		SILT, trace to some clay and fine-grained sand, dark gray, medium stiff	75.0		S-23		1 2 2	
80								



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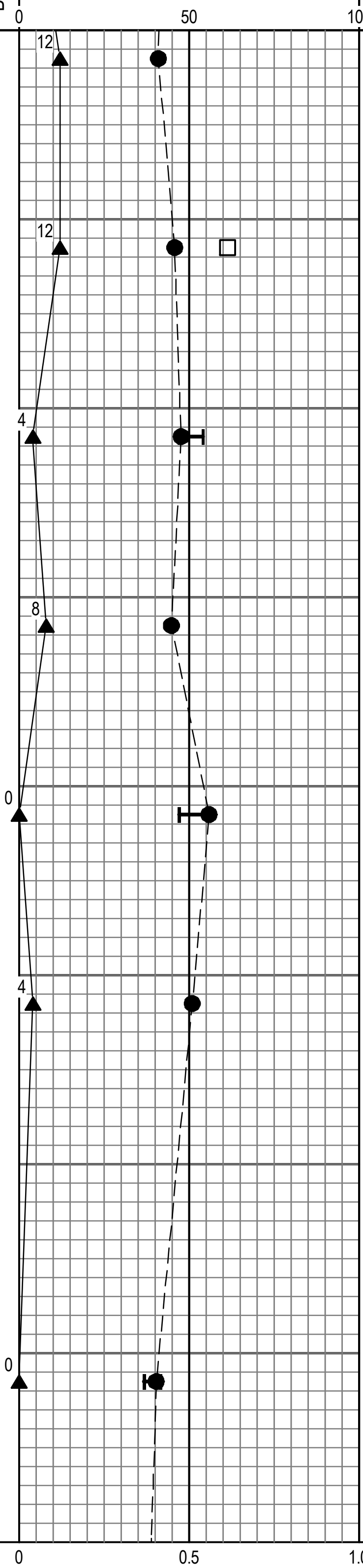
GRI

BORING B-2

DEC. 2019 JOB NO. 6266 FIG. 2B

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	DEPTH, FT	INSTALLATION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT	COMMENTS AND ADDITIONAL TESTS
		Surface Elevation: Not Available						
		SILT, some fine- to medium-grained sand to sandy, trace to some clay, dark gray, stiff, contains wood debris			S-24		2 6 6	
85					S-25		1 5 7	
90		---trace to some fine-grained sand, dark gray-brown, soft to medium stiff below 90 ft			S-26		0 1 3	
95		---medium stiff to stiff below 95 ft			S-27		1 4 4	
100		---up to trace sand, very soft below 100 ft			S-28		0 0 0	
105		---soft to medium stiff below 105 ft			S-29		0 1 3	
110								
115		---trace to some sand, dark gray, very soft below 115 ft			S-30		0 0 0	
120								

▲ BLOWS PER FOOT
● MOISTURE CONTENT, %
□ FINES CONTENT, %
LIQUID LIMIT, %
PLASTIC LIMIT, %



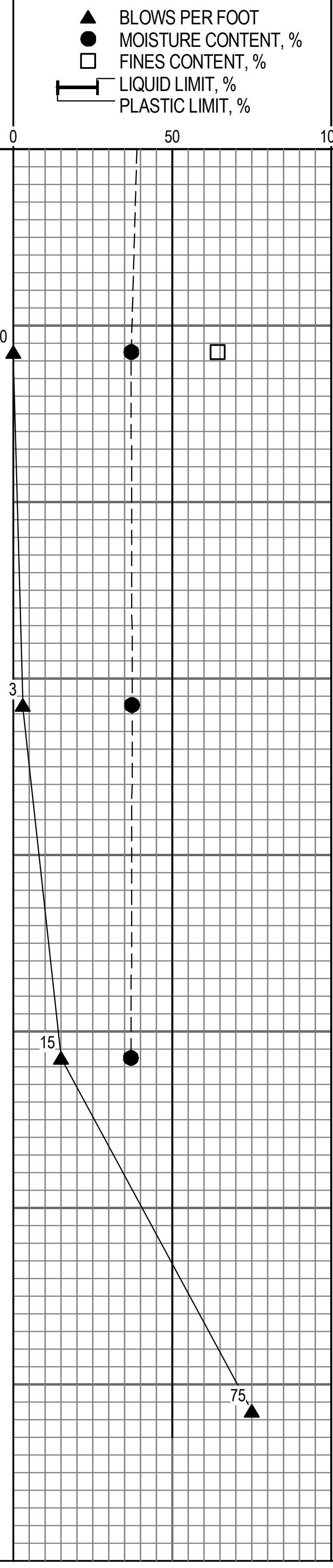
◆ TORVANE SHEAR STRENGTH, TSF
■ UNDRAINED SHEAR STRENGTH, TSF

(CONTINUED NEXT PAGE)

GRI

BORING B-2

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL **Surface Elevation:** Not Available	DEPTH, FT	INSTALLATION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT	COMMENTS AND ADDITIONAL TESTS
120		SILT, trace to some clay and fine-grained sand, gray, very soft	120.0					
125		---some clay to clayey, up to trace sand below 125 ft			S-31		0 0 0	
130								
135		---trace to some clay and sand, contains wood debris below 135 ft			S-32		6 3 0	
140								
145		Silty SAND, gray, medium dense, fine grained	145.0		S-33		10 5 10	
150								
		BASALT, non-vesicular, dark gray, predominantly decomposed with slightly weathered inclusions, very soft to soft (R1 to R2)	152.0					Drill rig chatter, loss of full tub of drilling fluid below 152 ft
155					S-34		19 46 29	
		(7/30/2019)	156.5					
160								

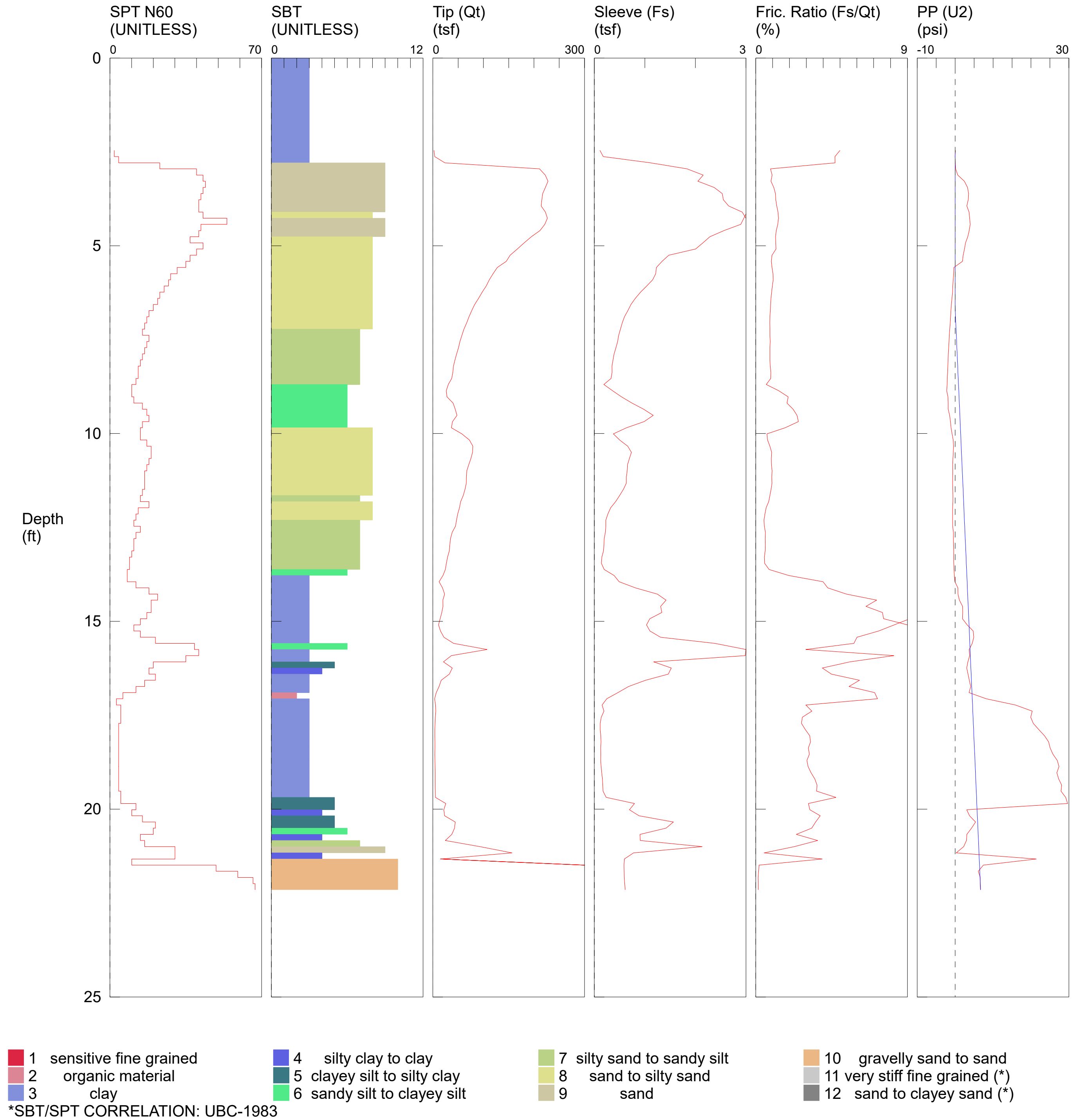


◆ TORVANE SHEAR STRENGTH, TSF
■ UNDRAINED SHEAR STRENGTH, TSF

GRI

BORING B-2

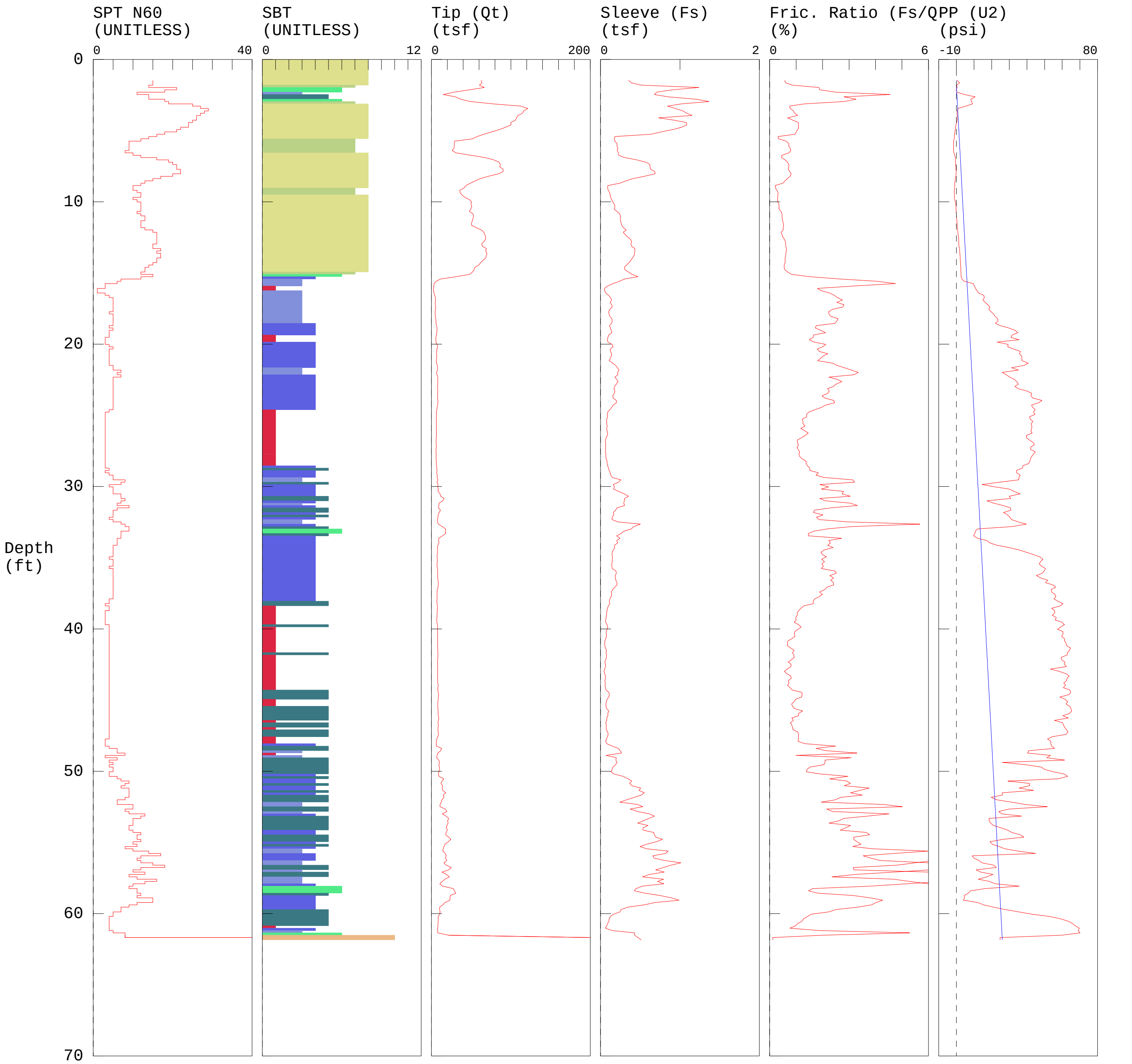
DEC. 2019 JOB NO. 6266 FIG. 2B



GRI

Observed By: G. Martin	Advanced By: Oregon Geotechnical Explorations, Inc.
Date Started: 07/30/19	Ground Surface Elevation: Not Available
Coordinates: Not Available	

CONE PENETRATION TEST CPT-1



1	sensitive fine grained	4	silty clay to clay	7	silty sand to sandy sil	10	gravelly sand to sand
2	organic material	5	clayey silt to silty cl	8	sand to silty sand	11	very stiff fine grained (*)
3	clay	6	sandy silt to clayey si	9	sand	12	sand to clayey sand (*)

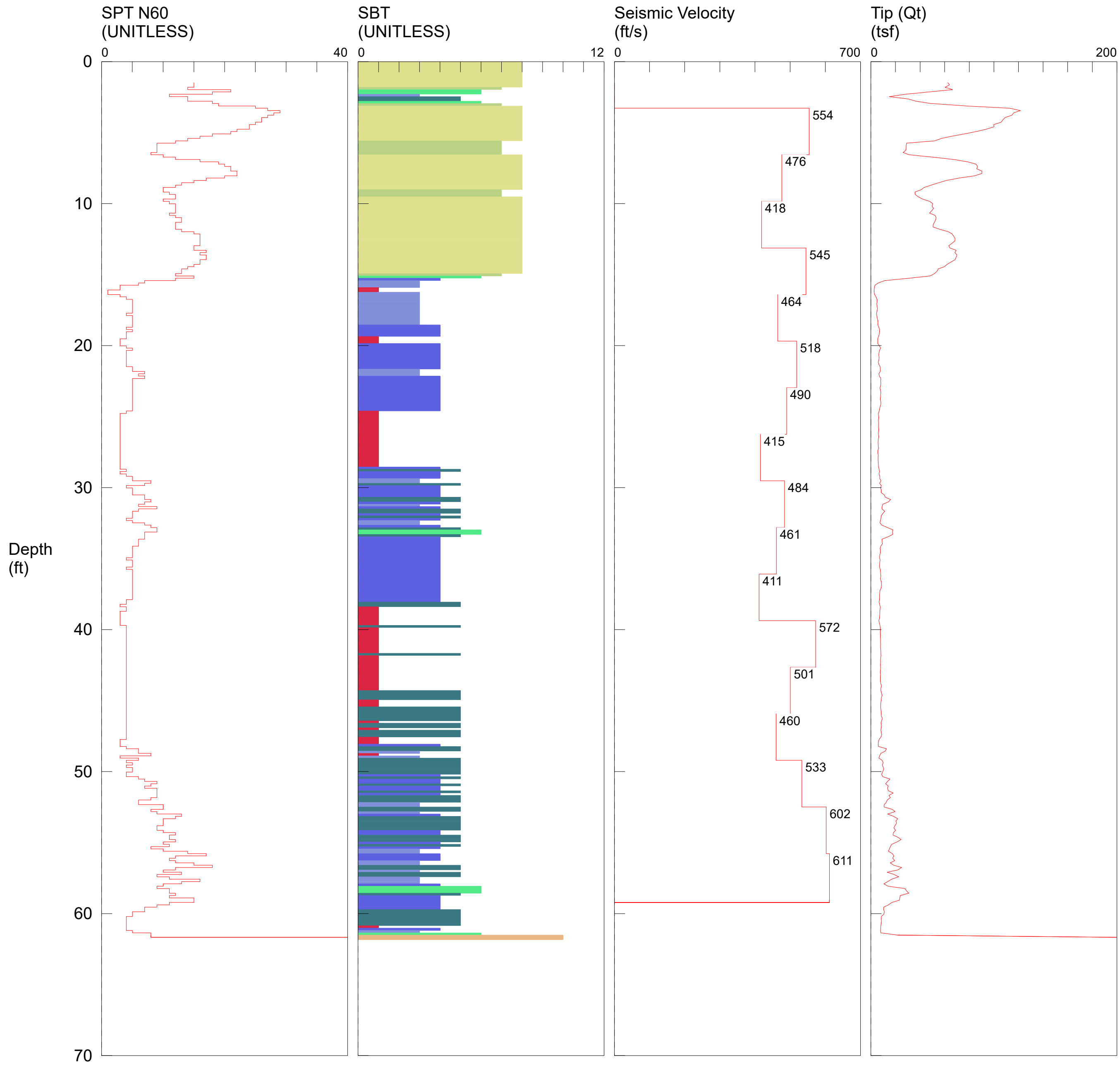
*SBT/SPT CORRELATION: UBC-1983

GRI

Observed By: G. Martin	Advanced By: Oregon Geotechnical Explorations, Inc.
Date Started: 07/30/19	Ground Surface Elevation: Not Available
Coordinates: Not Available	

CONE PENETRATION TEST CPT-2

DEC. 2019 JOB NO. 6266 FIG. 4B



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

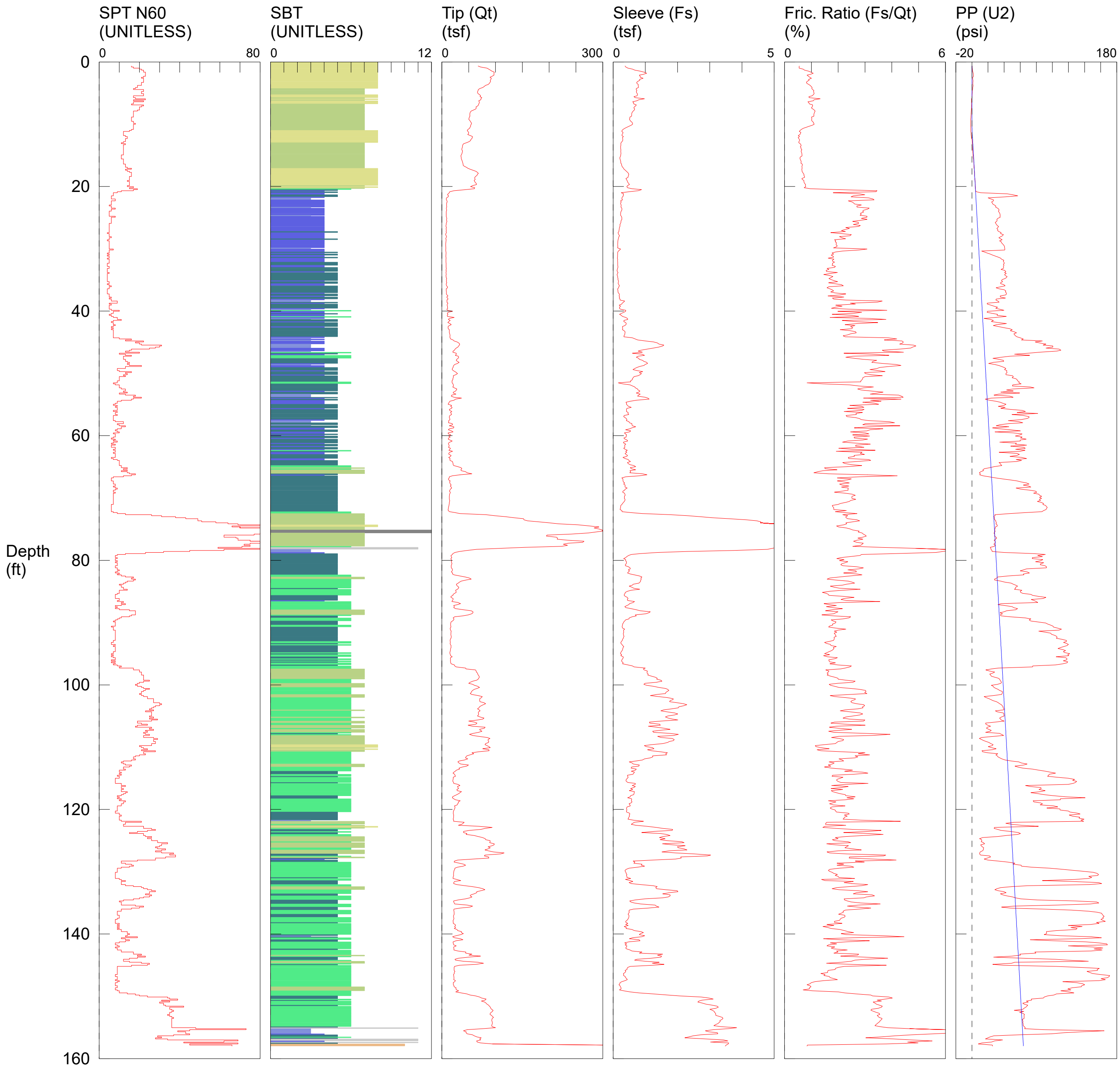
Observed By: G. Martin	Advanced By: Oregon Geotechnical Explorations, Inc.
Date Started: 07/30/19	Ground Surface Elevation: Not Available
Coordinates: Not Available	

GRI

CONE PENETRATION TEST CPT-2

(SEISMIC VELOCITY PROFILE)

DEC. 2019 JOB NO. 6266 FIG. 5B



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

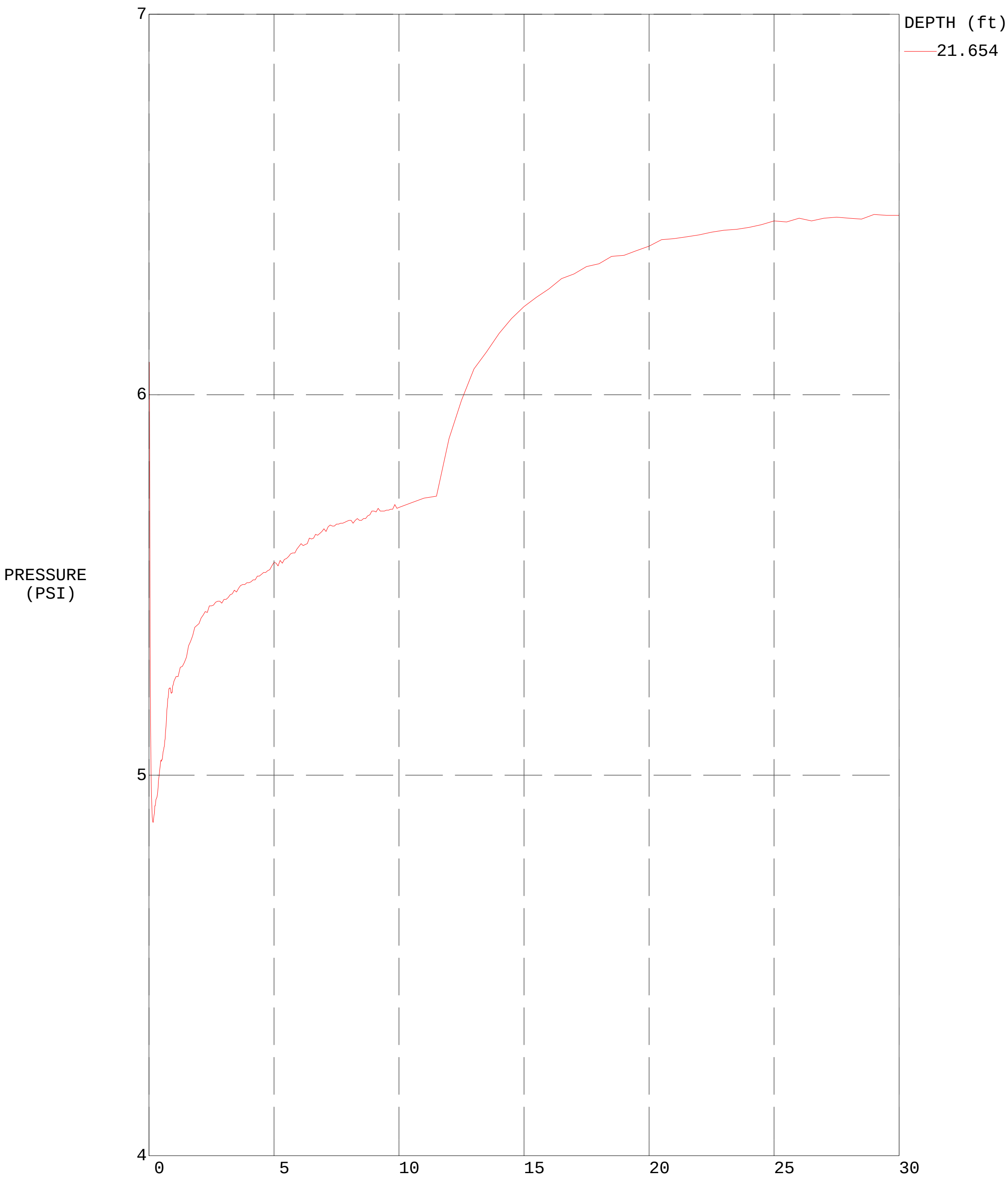
*SBT/SPT CORRELATION: UBC-1983

GRI

Observed By: G. Martin	Advanced By: Oregon Geotechnical Explorations, Inc.
Date Started: 07/31/19	Ground Surface Elevation: Not Available
Coordinates: Not Available	

CONE PENETRATION TEST CPT-3

DEC. 2019 JOB NO. 6266 FIG. 6B



MAXIMUM PRESSURE = 6.474 (PSI)IME: (MINUTES)
HYDROSTATIC PRESSURE = 6.507 (PSI), WATER TABLE: 6.64 ft
OPERATOR: OGE BAK

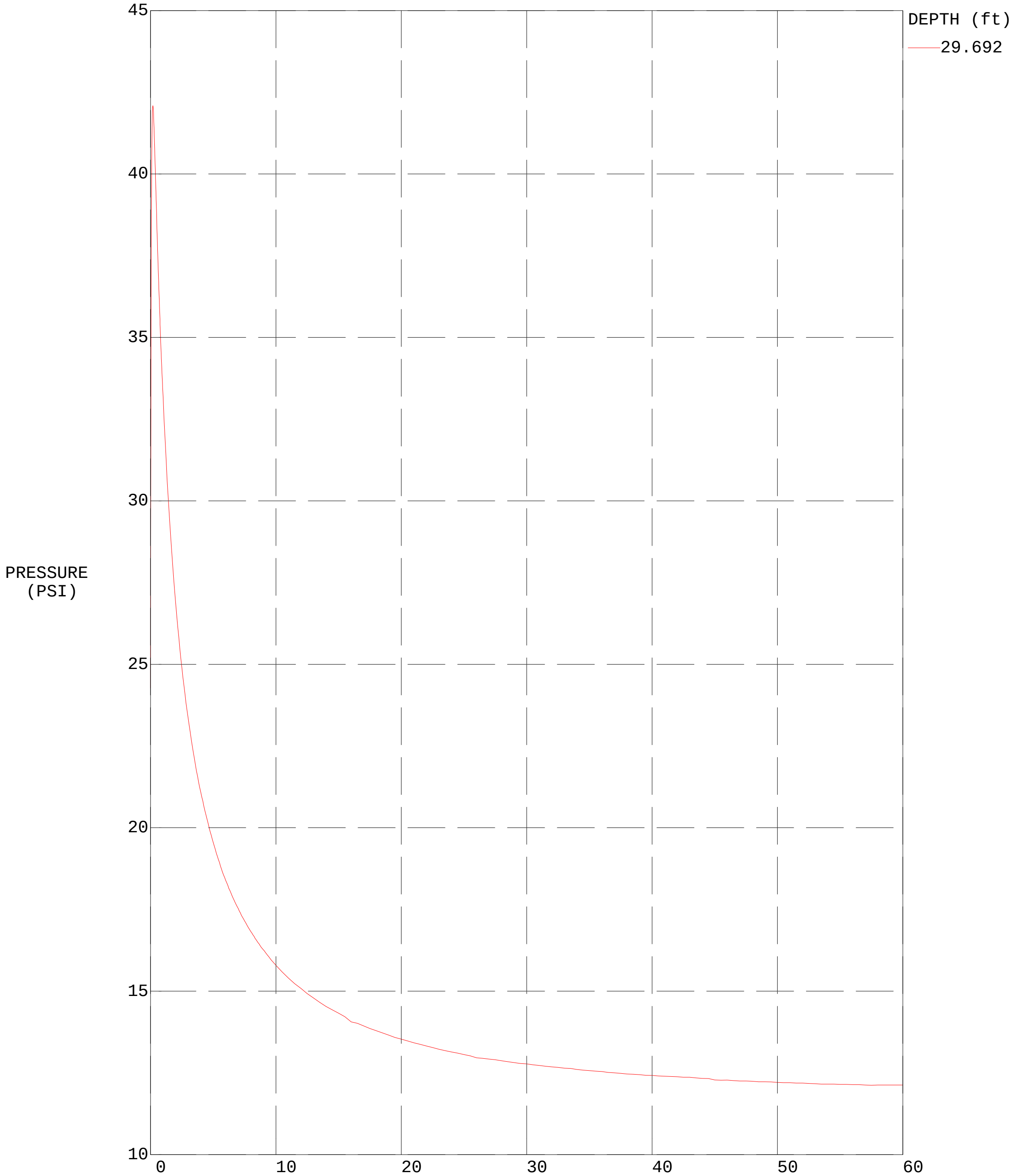
Observed By: G. Martin	Advanced By: Oregon Geotechnical Explorations, Inc.
Date Started: 07/30/19	Ground Surface Elevation: Not Available
Coordinates: Not Available	

GRI

CONE PENETRATION TEST CPT-1

(PORE PRESSURE DISSIPATION)

DEC. 2019 JOB NO. 6266 FIG. 7B



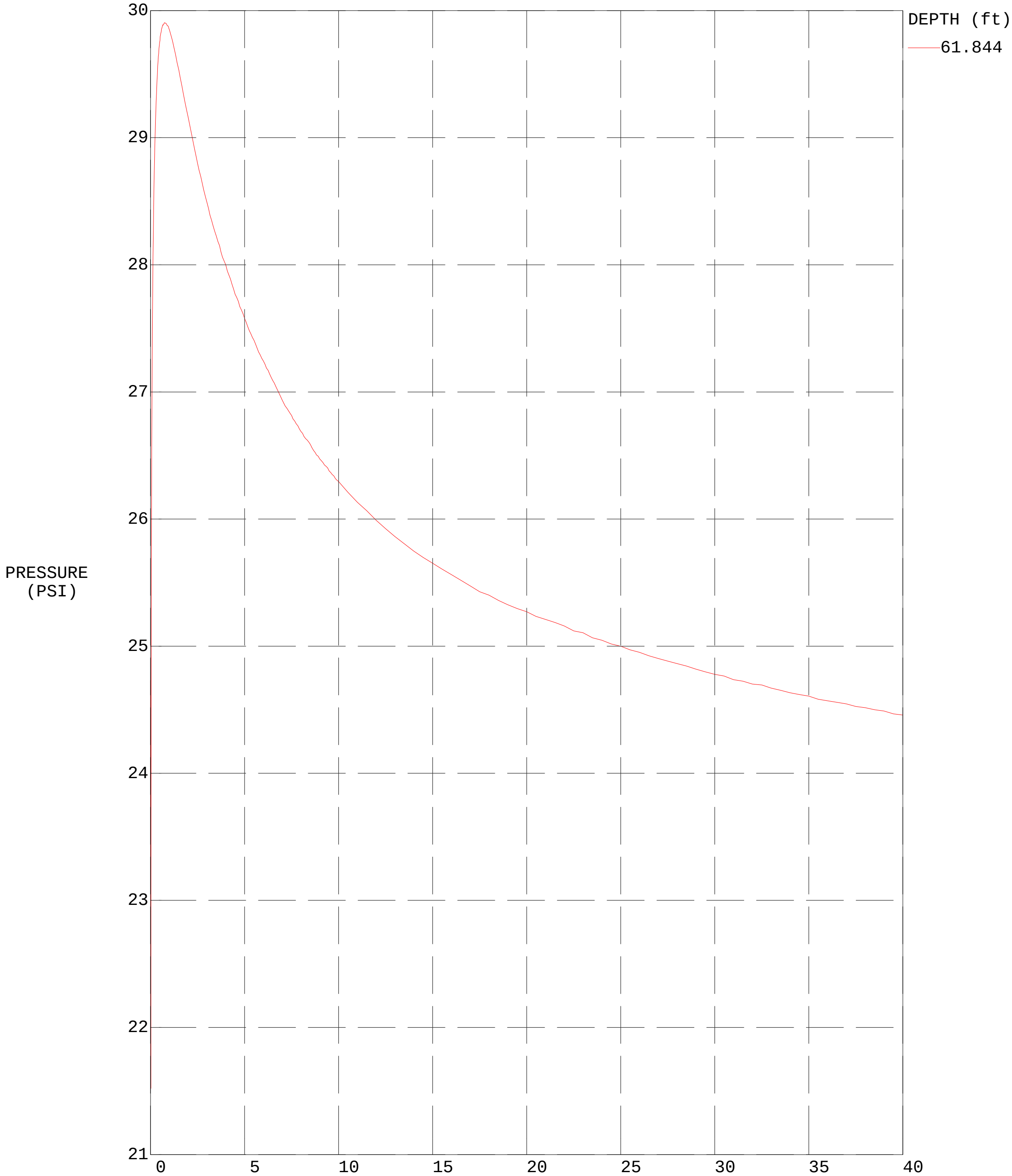
MAXIMUM PRESSURE = 42.094 (PSI)ME: (MINUTES)
HYDROSTATIC PRESSURE = 12.113 (PSI), WATER TABLE: 1.74 ft
OPERATOR: OGE BAK

Observed By: G. Martin	Advanced By: Oregon Geotechnical Explorations, Inc.
Date Started: 07/30/19	Ground Surface Elevation: Not Available
Coordinates: Not Available	

GRI

CONE PENETRATION TEST CPT-2

(PORE PRESSURE DISSIPATION)



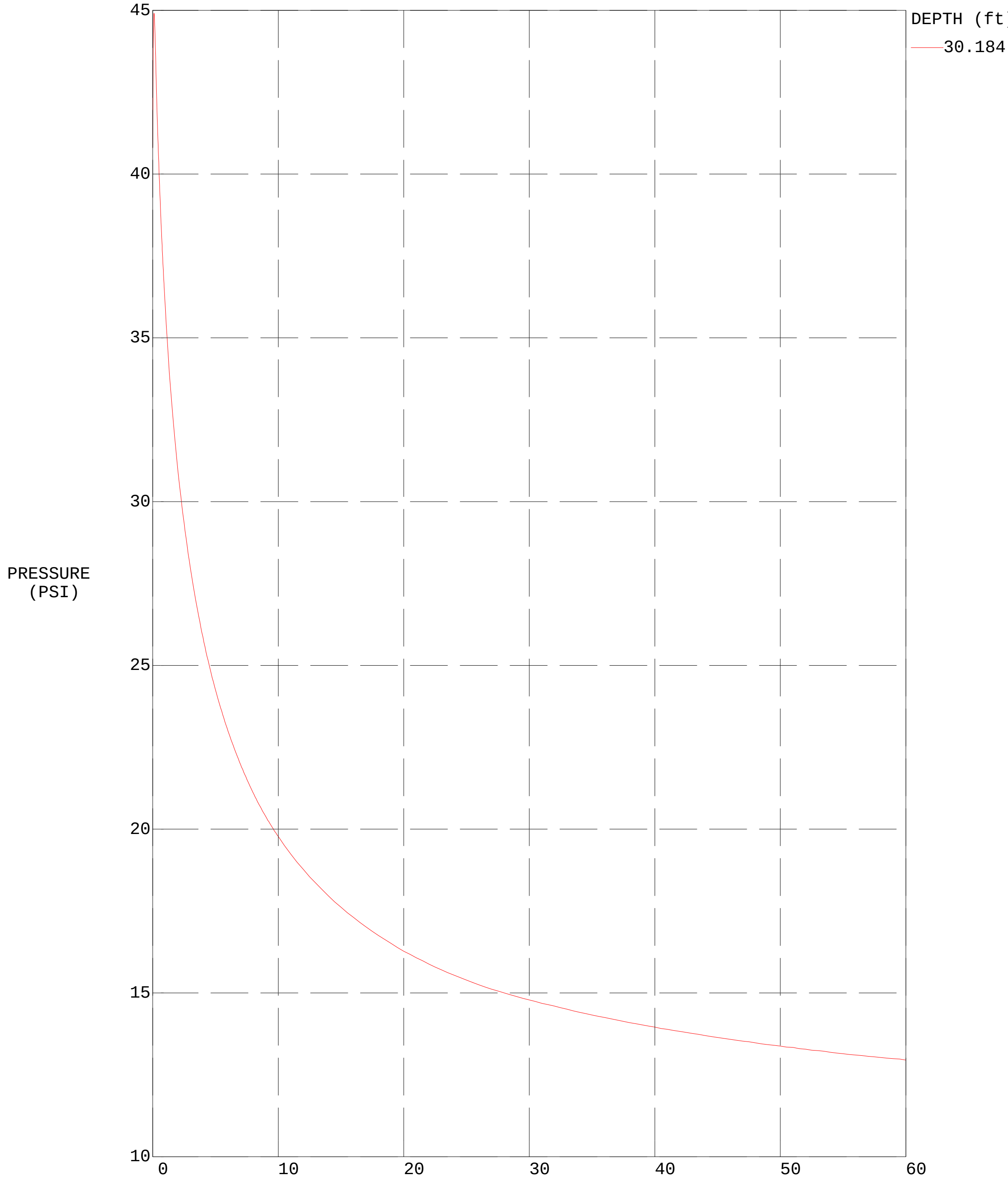
MAXIMUM PRESSURE = 29.905 (PSI)ME: (MINUTES)
HYDROSTATIC PRESSURE = 26.048 (PSI), WATER TABLE: 1.74 ft
OPERATOR: OGE BAK

Observed By: G. Martin	Advanced By: Oregon Geotechnical Explorations, Inc.
Date Started: 07/30/19	Ground Surface Elevation: Not Available
Coordinates: Not Available	

GRI

CONE PENETRATION TEST CPT-2

(PORE PRESSURE DISSIPATION)



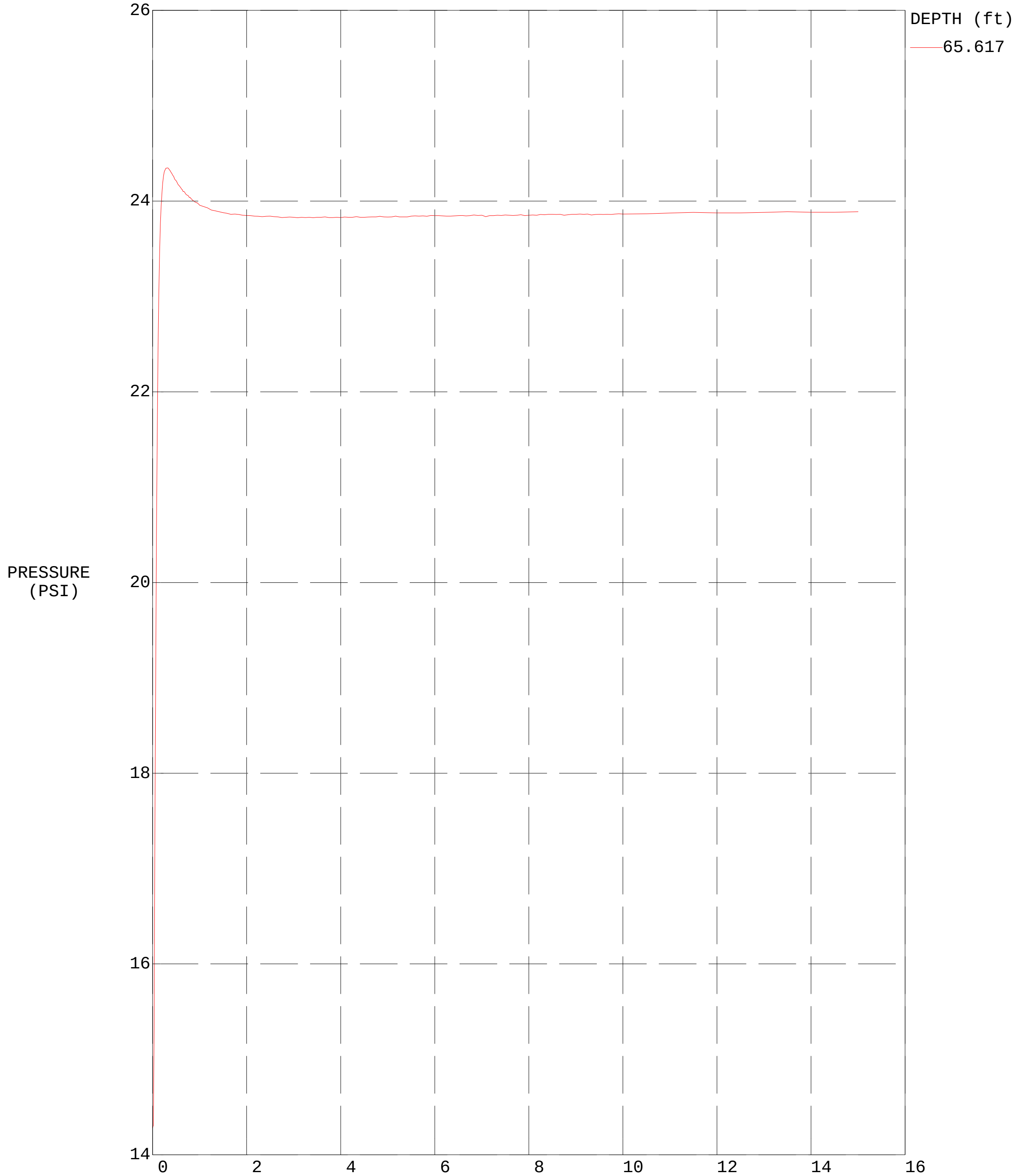
MAXIMUM PRESSURE = 44.91 (PSI)IME: (MINUTES)
HYDROSTATIC PRESSURE = 8.57 (PSI), WATER TABLE: 10.41 ft
OPERATOR: OGE BAK

Observed By: G. Martin	Advanced By: Oregon Geotechnical Explorations, Inc.
Date Started: 07/31/19	Ground Surface Elevation: Not Available
Coordinates: Not Available	

GRI

CONE PENETRATION TEST CPT-3
(PORE PRESSURE DISSIPATION)

DEC. 2019 JOB NO. 6266 FIG. 10B



MAXIMUM PRESSURE = 24.348 (PSI)ME: (MINUTES)
HYDROSTATIC PRESSURE = 23.926 (PSI), WATER TABLE: 10.41 ft
OPERATOR: OGE BAK

GRI

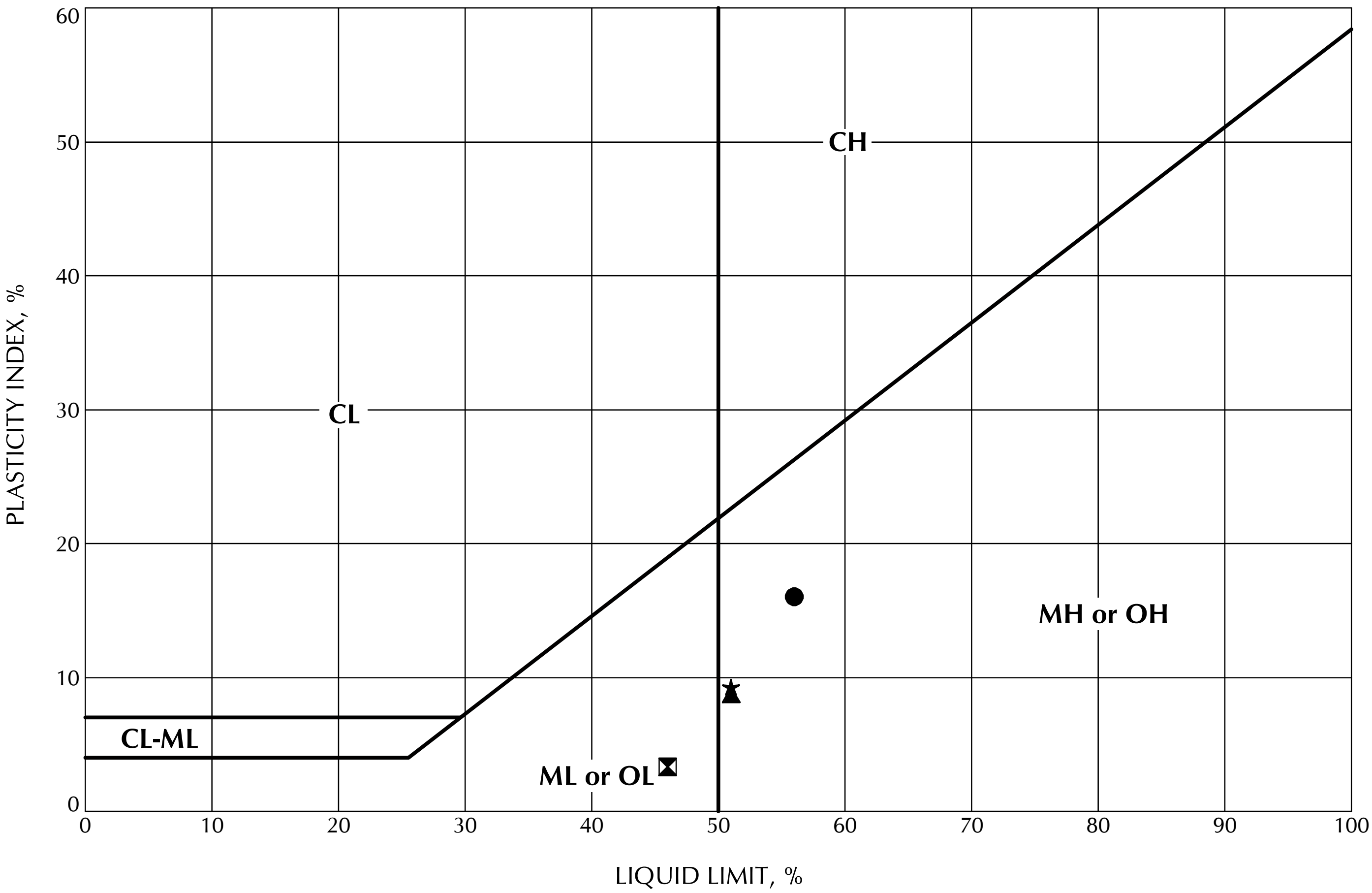
Observed By: G. Martin	Advanced By: Oregon Geotechnical Explorations, Inc.
Date Started: 07/31/19	Ground Surface Elevation: Not Available
Coordinates: Not Available	

CONE PENETRATION TEST CPT-3
(PORE PRESSURE DISSIPATION)

DEC. 2019 JOB NO. 6266 FIG. 11B

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
ML	INORGANIC CLAYEY SILTS TO VERY FINE SANDS OF SLIGHT PLASTICITY
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
MH	INORGANIC SILTS AND CLAYEY SILT
CH	INORGANIC CLAYS OF HIGH PLASTICITY



	Location	Sample	Depth, ft	Classification	LL	PL	PI	MC, %
●	B-1	S-11	30.0	SILT, some clay to clayey, up to a trace of fine-grained sand, brown to dark-brown	56	40	16	52
⧗	B-1	S-13	39.5	SILT, some fine-grained sand, trace clay, gray	46	43	3	46
▲	B-1	S-14	40.0	SILT, some clay, trace to some fine- to medium-grained sand, dark gray to brown-gray	51	42	9	51
★	B-1	S-17	50.0	SILT, some clay, trace to some fine- to medium-grained sand, dark gray to brown-gray	51	42	9	47

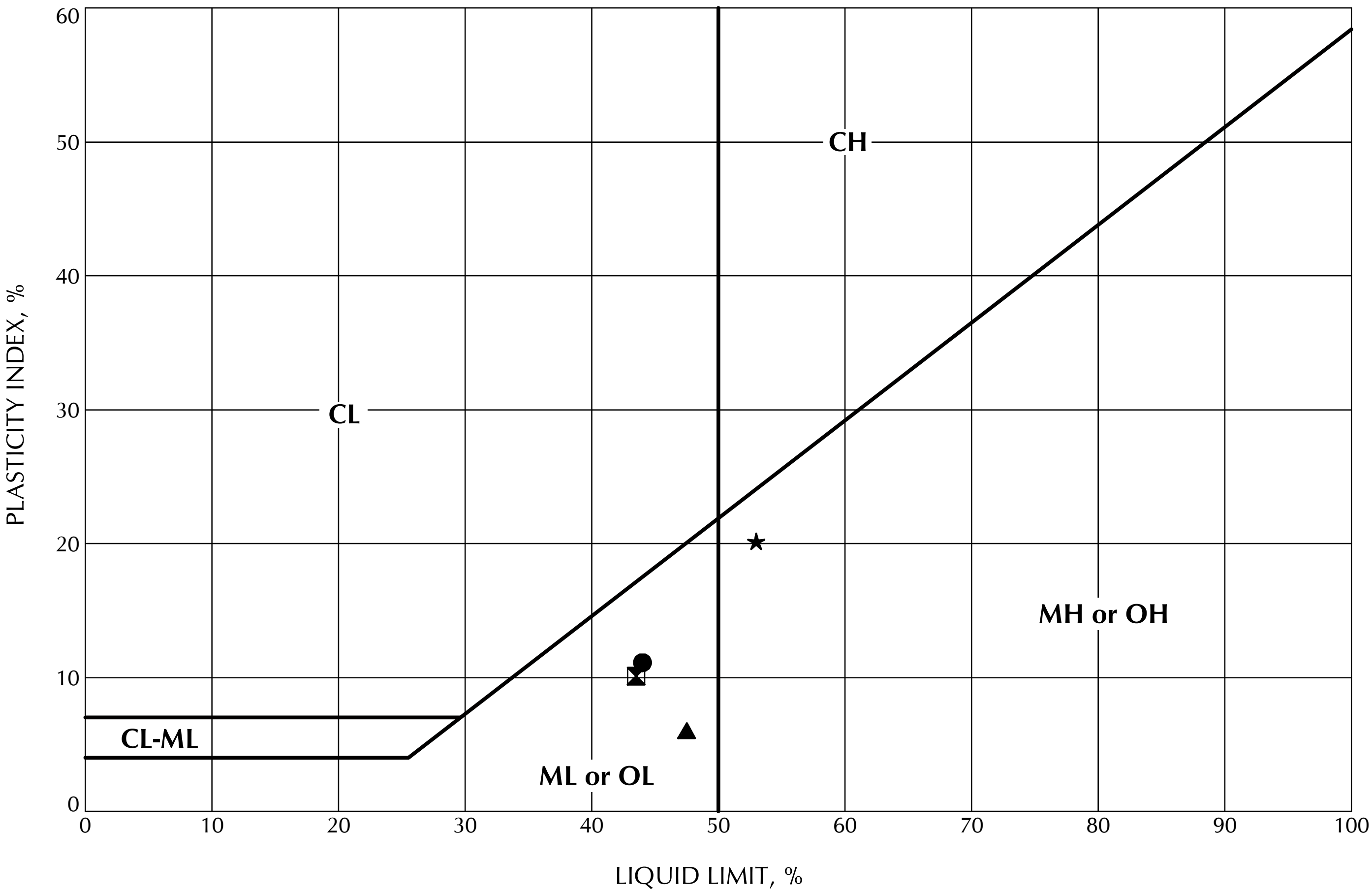
ATTERBERG-PLASTICITY 4 PER PAGE GRI DATA TEMPLATE.GDT 12/10/19

GRI

PLASTICITY CHART

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
ML	INORGANIC CLAYEY SILTS TO VERY FINE SANDS OF SLIGHT PLASTICITY
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
MH	INORGANIC SILTS AND CLAYEY SILT
CH	INORGANIC CLAYS OF HIGH PLASTICITY



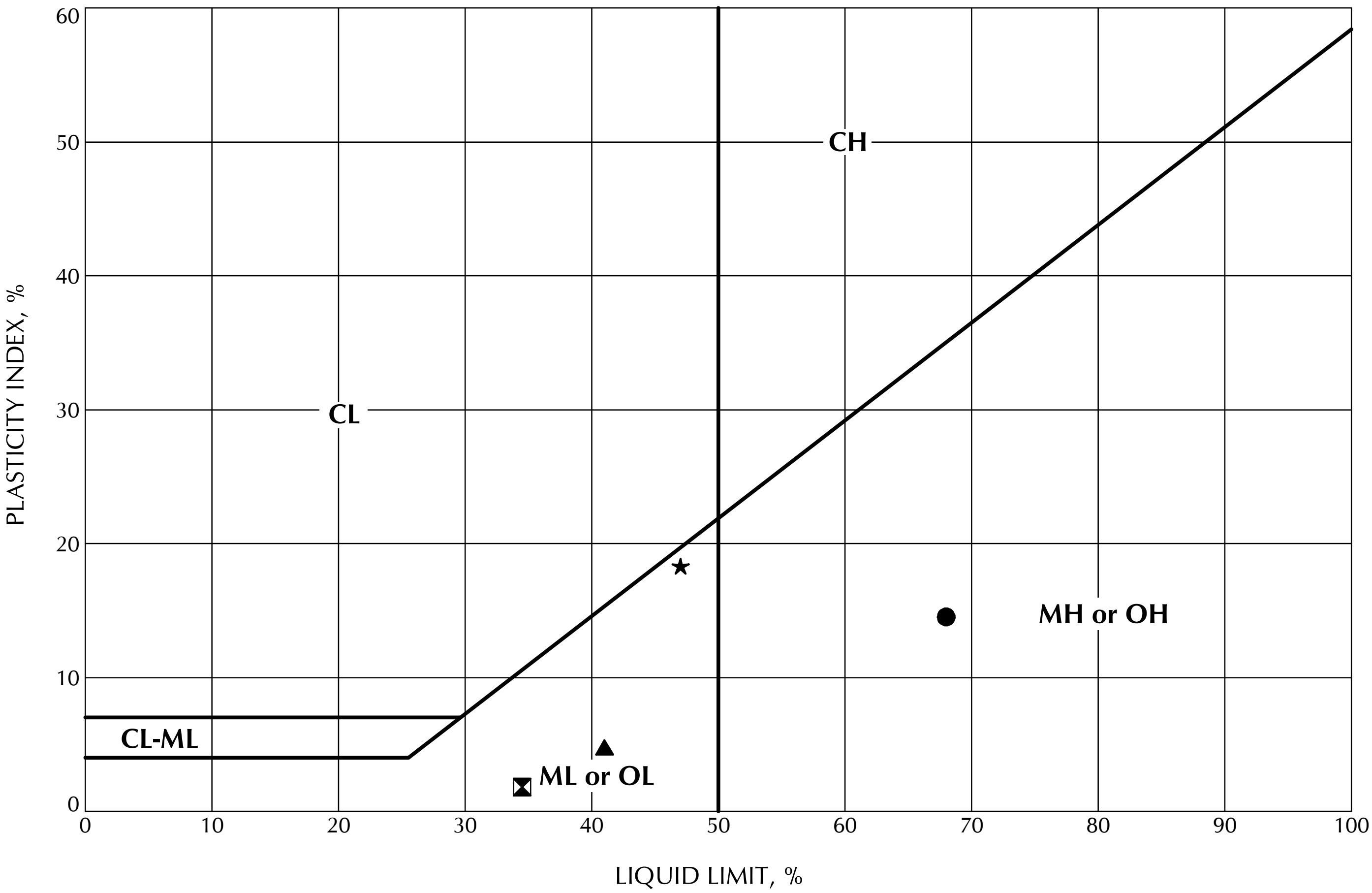
	Location	Sample	Depth, ft	Classification	LL	PL	PI	MC, %
●	B-1	S-19	60.0	SILT, some clay and fine-grained sand, dark gray	44	33	11	49
⧗	B-1	S-22	75.0	Sandy SILT, some clay to clayey, dark gray, fine-grained sand	44	33	11	54
▲	B-1	S-23	80.0	SILT, some fine-grained sand to sandy, trace to some clay, dark brown-gray	48	41	7	37
★	B-1	S-25	100.0	SILT, some clay to clayey, up to trace fine-grained sand, gray	53	33	20	52

GRI

PLASTICITY CHART

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
ML	INORGANIC CLAYEY SILTS TO VERY FINE SANDS OF SLIGHT PLASTICITY
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
MH	INORGANIC SILTS AND CLAYEY SILT
CH	INORGANIC CLAYS OF HIGH PLASTICITY



	Location	Sample	Depth, ft	Classification	LL	PL	PI	MC, %
●	B-1	S-28	130.0	SILT, some clay to clayey, up to trace fine-grained sand	68	53	15	68
⧗	B-1	S-31	160.0	SILT, trace to some fine-grained sand, trace clay, gray	35	33	1	38
▲	B-1	S-33	180.0	SILT, trace to some clay, up to trace fine-grained sand, gray	41	36	5	42
★	B-2	S-4	10.0	Clayey SILT, up to trace fine-grained sand, dark gray-brown	47	29	18	44

GRI

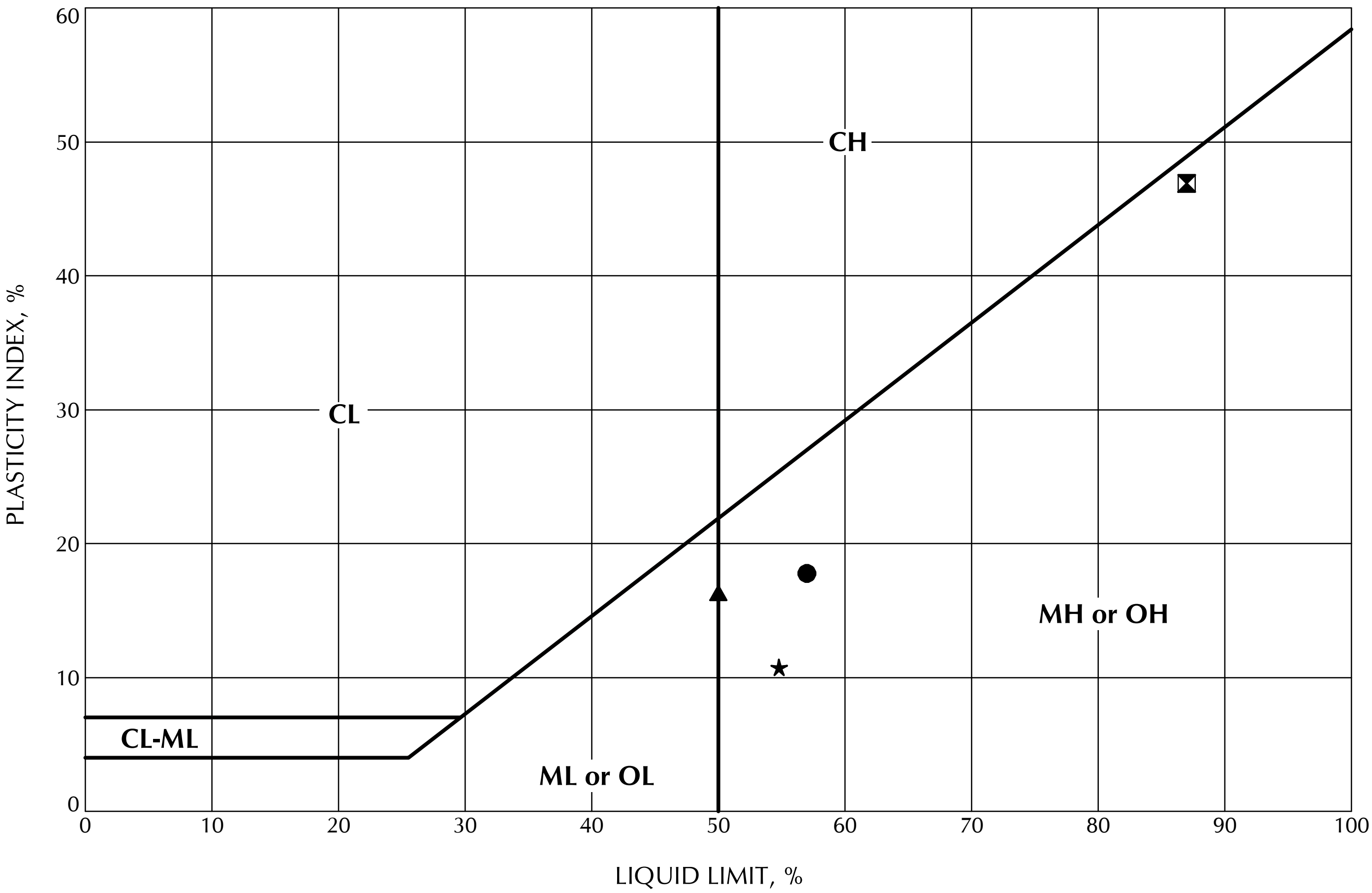
PLASTICITY CHART

DEC. 2019 JOB NO. 6266 FIG. 14B

ATTERBERG-PLASTICITY 4 PER PAGE GRI DATA TEMPLATE.GDT 12/10/19

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
ML	INORGANIC CLAYEY SILTS TO VERY FINE SANDS OF SLIGHT PLASTICITY
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
MH	INORGANIC SILTS AND CLAYEY SILT
CH	INORGANIC CLAYS OF HIGH PLASTICITY



	Location	Sample	Depth, ft	Classification	LL	PL	PI	MC, %
●	B-2	S-9	25.0	Clayey SILT, up to trace fine-grained sand, dark gray	57	39	18	55
⧗	B-2	S-16	50.0	Clayey SILT, up to trace fine-grained sand, dark gray to dark brown	87	40	47	68
▲	B-2	S-20	64.0	SILT, some clay, trace to some fine-grained sand, gray	50	34	16	48
★	B-2	S-21	65.0	SILT, trace to some clay and fine-grained sand, dark gray	55	44	11	46

GRI

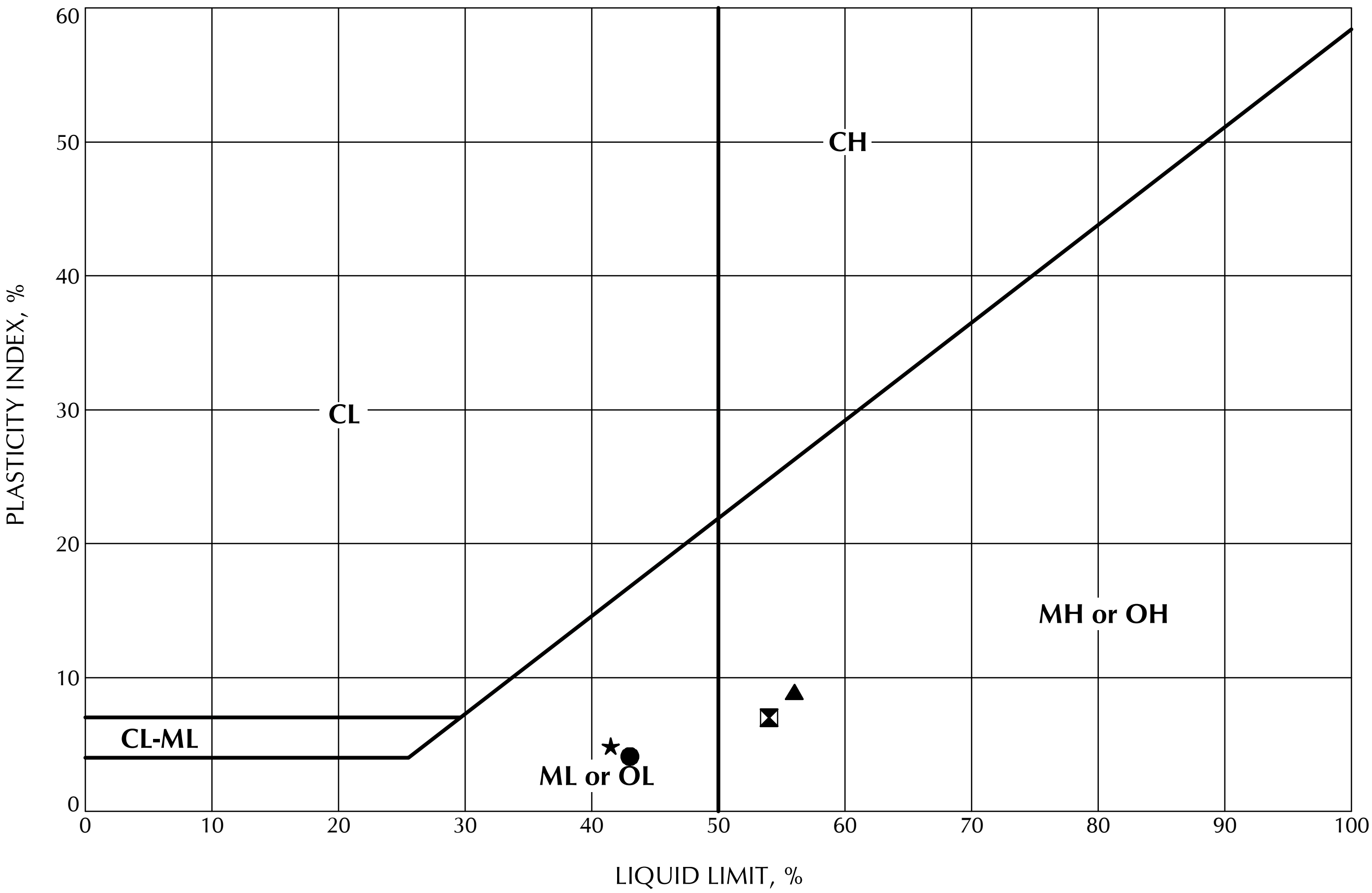
PLASTICITY CHART

DEC. 2019 JOB NO. 6266 FIG. 15B

ATTERBERG-PLASTICITY 4 PER PAGE GRI DATA TEMPLATE.GDT 12/10/19

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
ML	INORGANIC CLAYEY SILTS TO VERY FINE SANDS OF SLIGHT PLASTICITY
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY

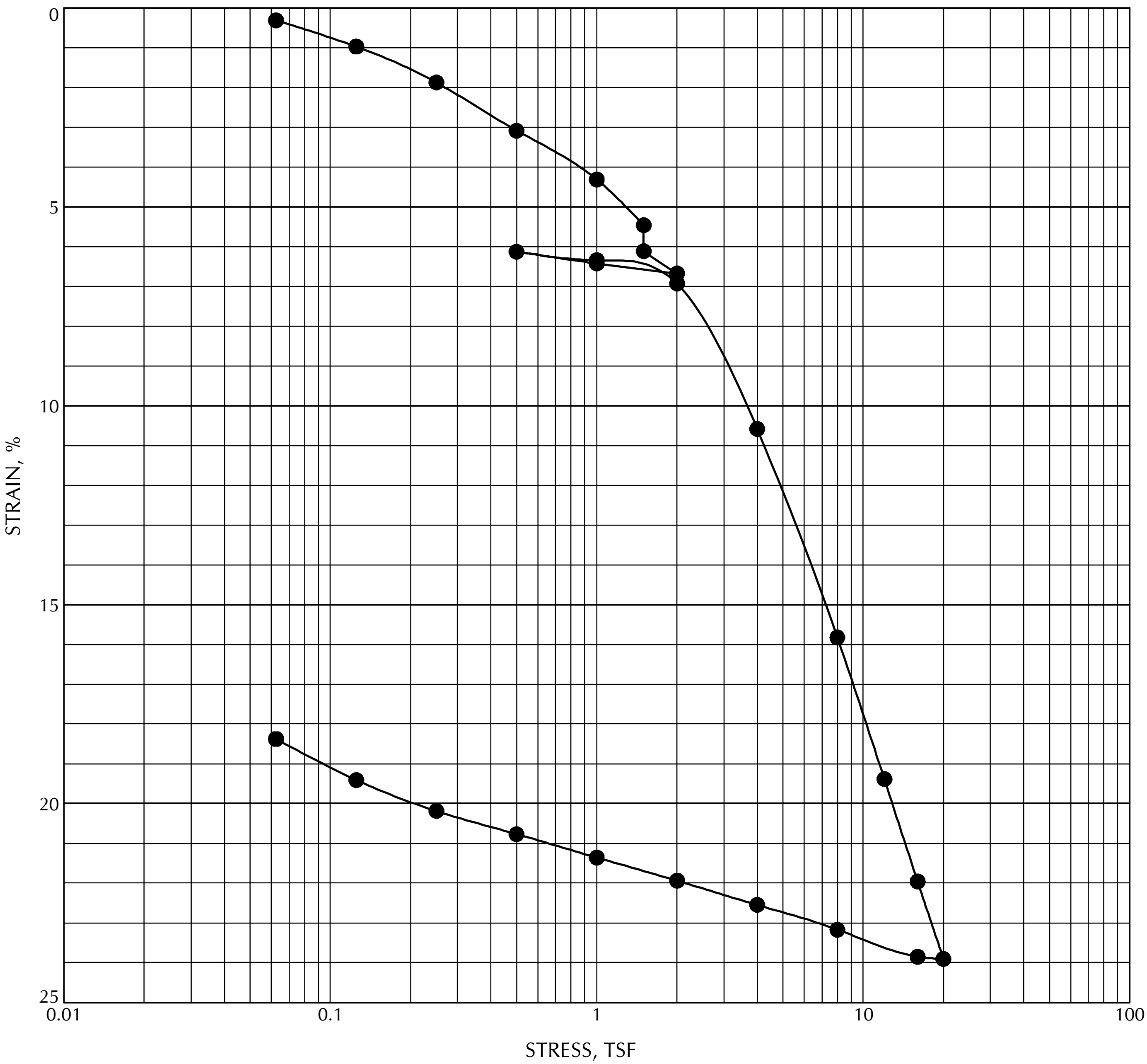
GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
MH	INORGANIC SILTS AND CLAYEY SILT
CH	INORGANIC CLAYS OF HIGH PLASTICITY



	Location	Sample	Depth, ft	Classification	LL	PL	PI	MC, %
●	B-2	S-23	75.0	SILT, trace to some clay and fine-grained sand, dark gray	43	39	4	41
⧗	B-2	S-26	90.0	SILT, trace to some clay and fine-grained sand, dark gray-brown	54	47	7	48
▲	B-2	S-28	100.0	SILT, trace to some clay, up to trace fine-grained sand, dark gray-brown	56	47	9	56
★	B-2	S-30	115.0	SILT, trace to some clay and fine-grained sand, dark gray	42	37	5	40

ATTERBERG-PLASTICITY 4 PER PAGE GRI DATA TEMPLATE.GDT 12/10/19

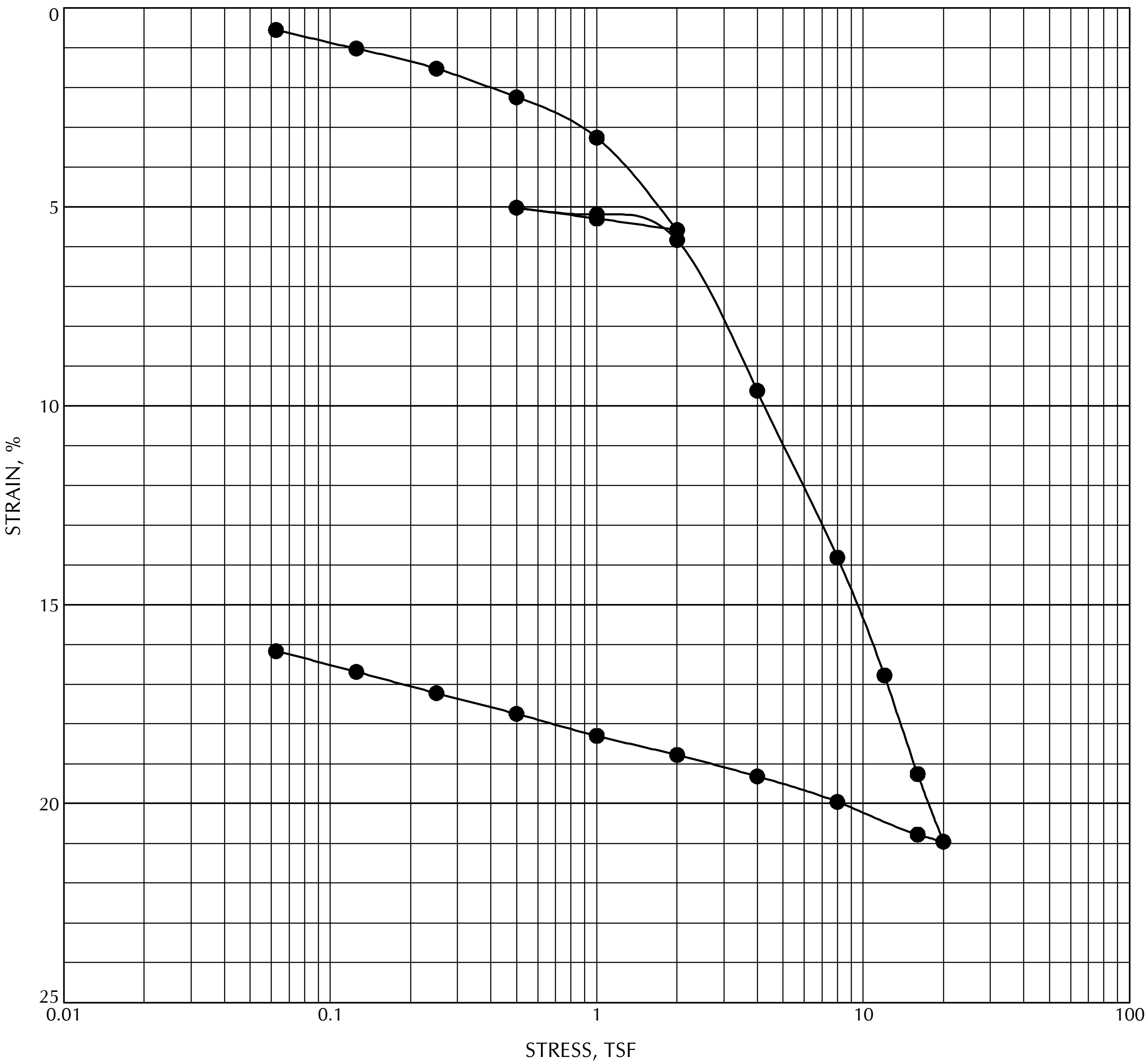
PLASTICITY CHART



	Location	Sample	Depth, ft	Classification	Initial γ_d, pcf	Initial MC, %
●	B-1	S-10	29.8	SILT, some clay to clayey, up to trace fine-grained sand, gray, medium stiff	68	53

GRI

CONSOLIDATION TEST

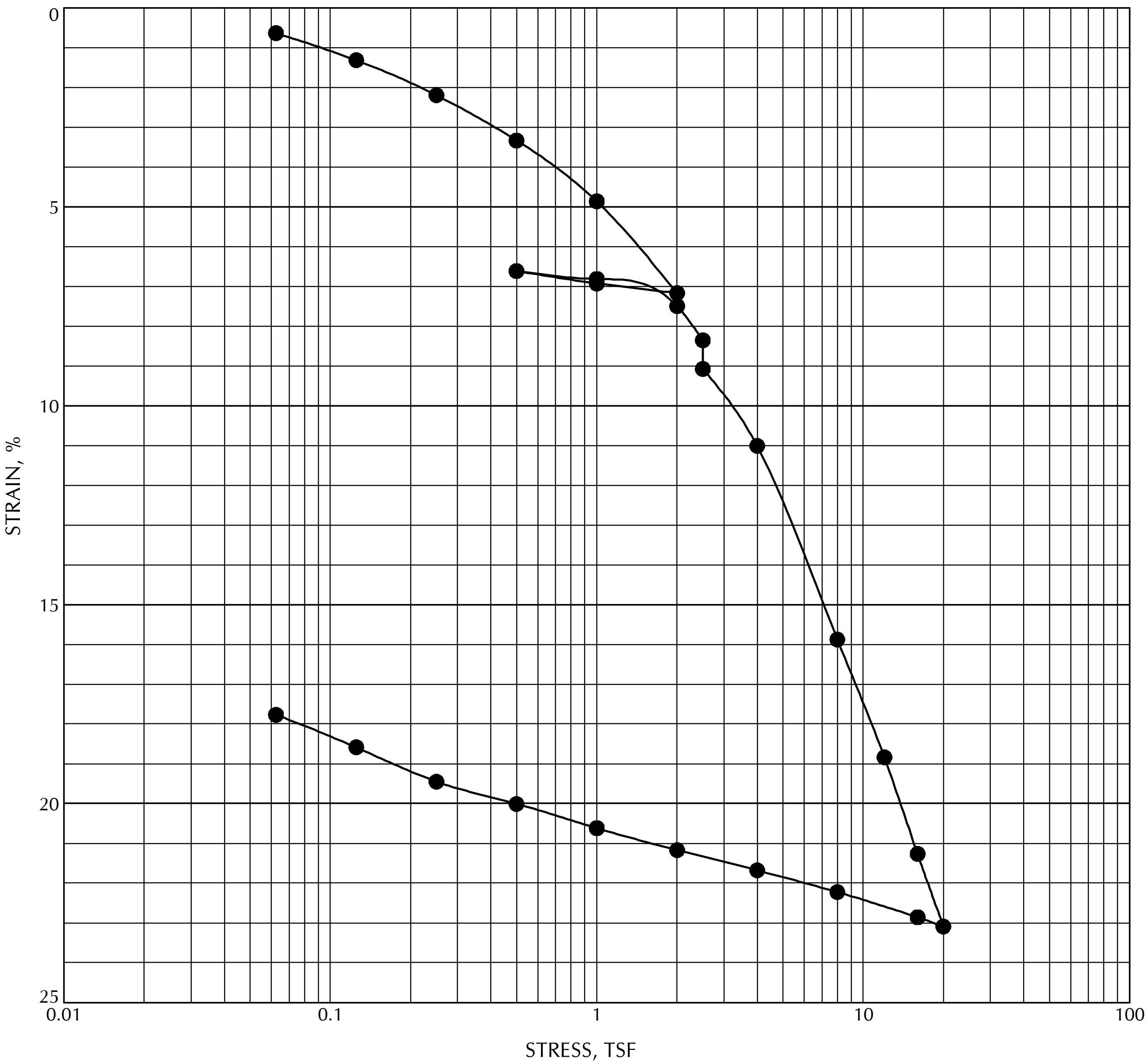


	Location	Sample	Depth, ft	Classification	Initial γ_d, pcf	Initial MC, %
●	B-1	S-13	38.8	SILT, some fine-grained sand, trace clay, gray, soft to medium stiff	75	46

GRI

CONSOLIDATION TEST

DEC. 2019 JOB NO. 6266 FIG. 18B



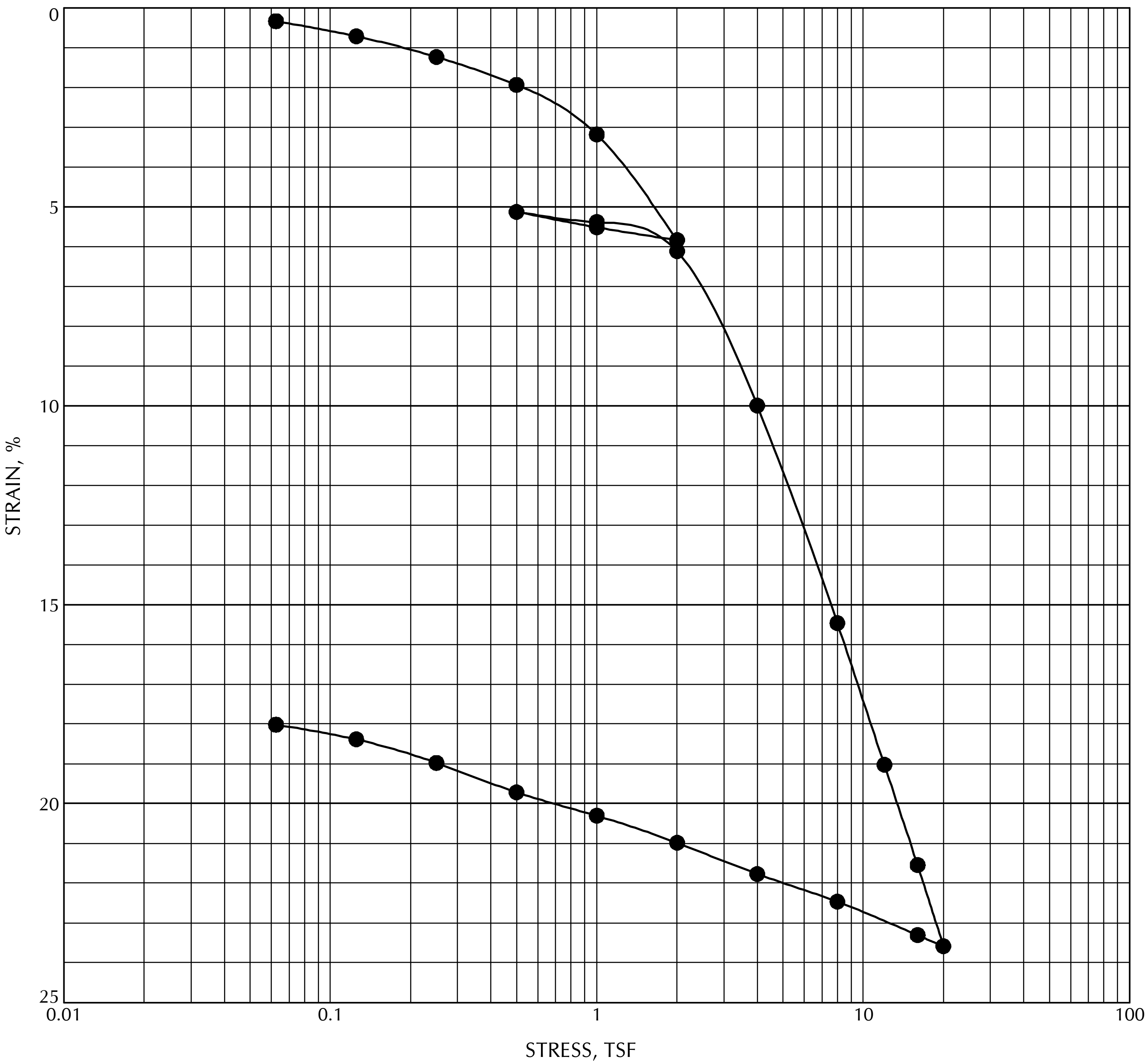
	Location	Sample	Depth, ft	Classification	Initial γ_d, pcf	Initial MC, %
●	B-1	S-16	49.8	SILT, some clay, trace to some fine- to medium-grained sand, dark gray to brown-gray, medium stiff	70	50

CONSOL STRAIN GRI-0 TO 25-1 PER PAGE GRI DATA TEMPLATE.GDT 12/10/19

GRI

CONSOLIDATION TEST

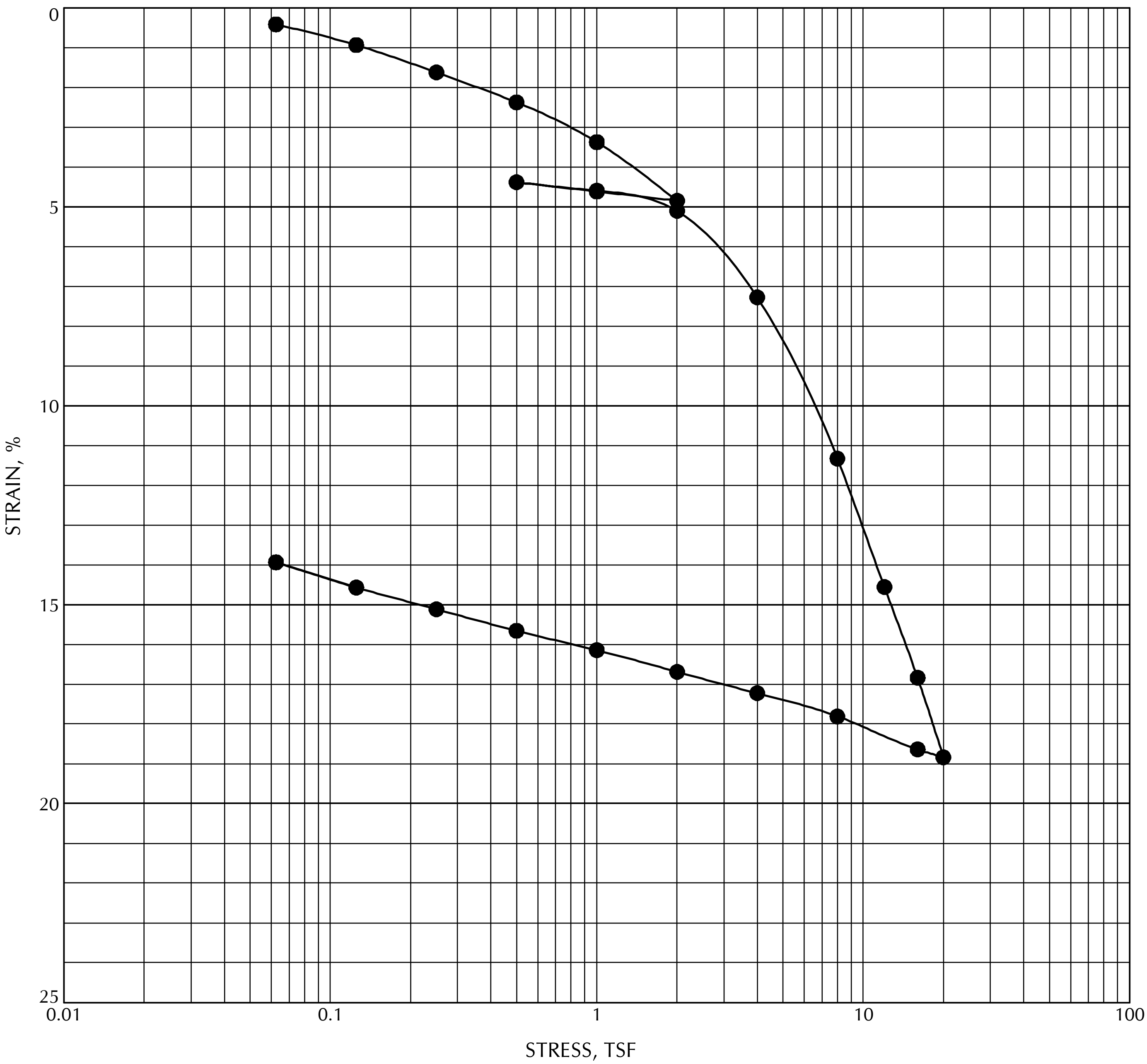
DEC. 2019 JOB NO. 6266 FIG. 19B



	Location	Sample	Depth, ft	Classification	Initial γ_d, pcf	Initial MC, %
●	B-2	S-5	14.8	Clayey SILT, up to trace fine-grained sand, gray, medium stiff	74	50

GRI

CONSOLIDATION TEST



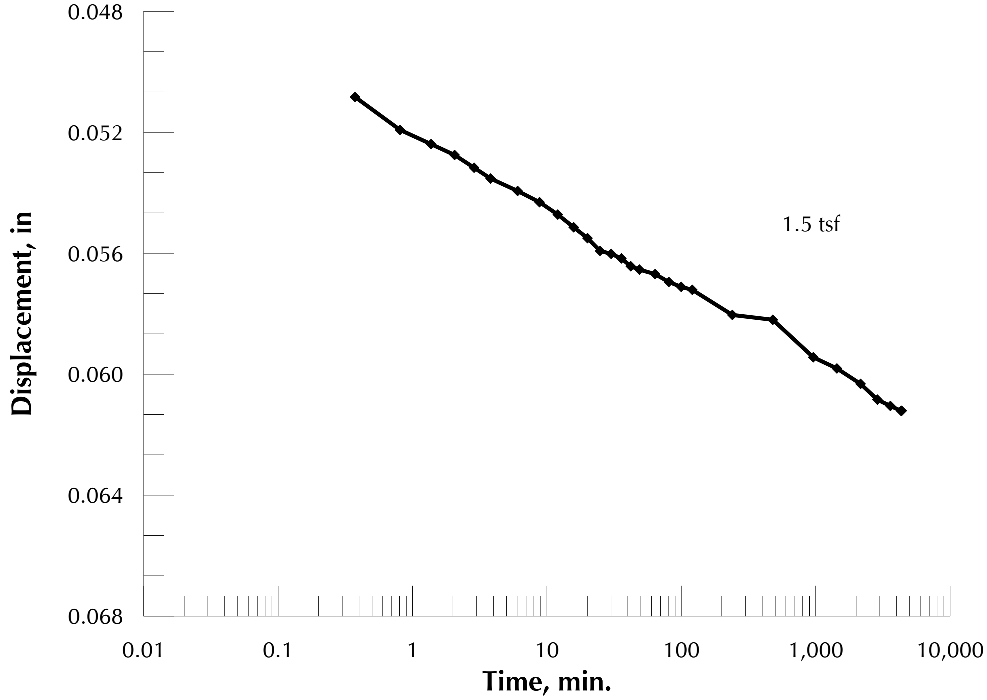
	Location	Sample	Depth, ft	Classification	Initial γ_d, pcf	Initial MC, %
●	B-2	S-20	63.5	SILT, some clay, trace to some fine-grained sand, gray, soft to medium stiff	78	47

CONSOL STRAIN GRI-0 TO 25-1 PER PAGE GRI DATA TEMPLATE.GDT 12/10/19

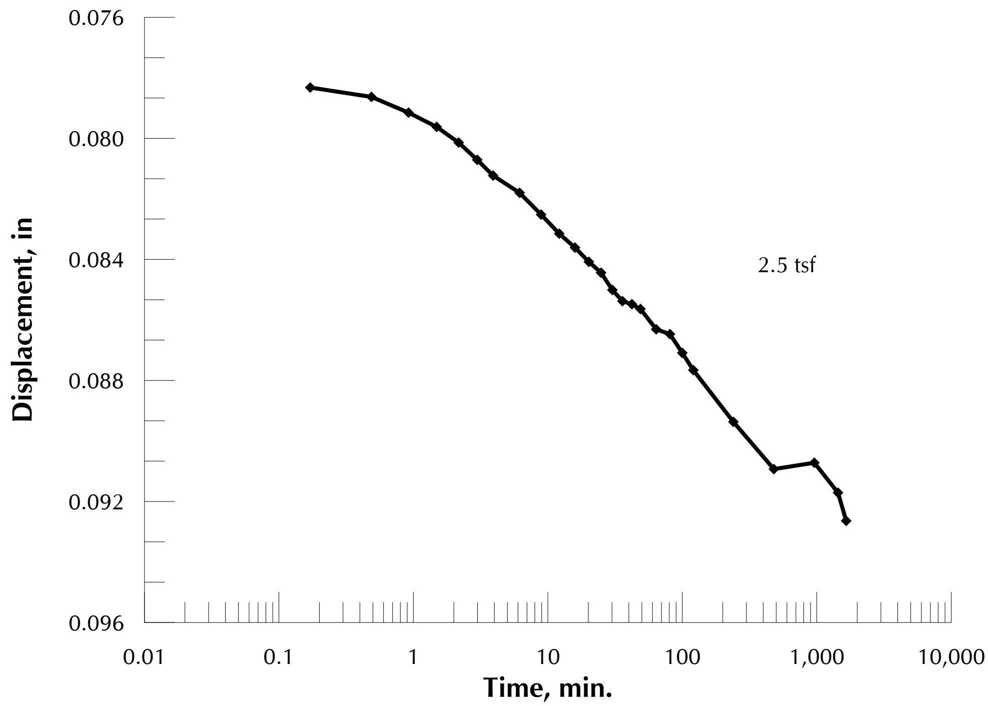
GRI

CONSOLIDATION TEST

B-1, S-10 (29.8 ft)

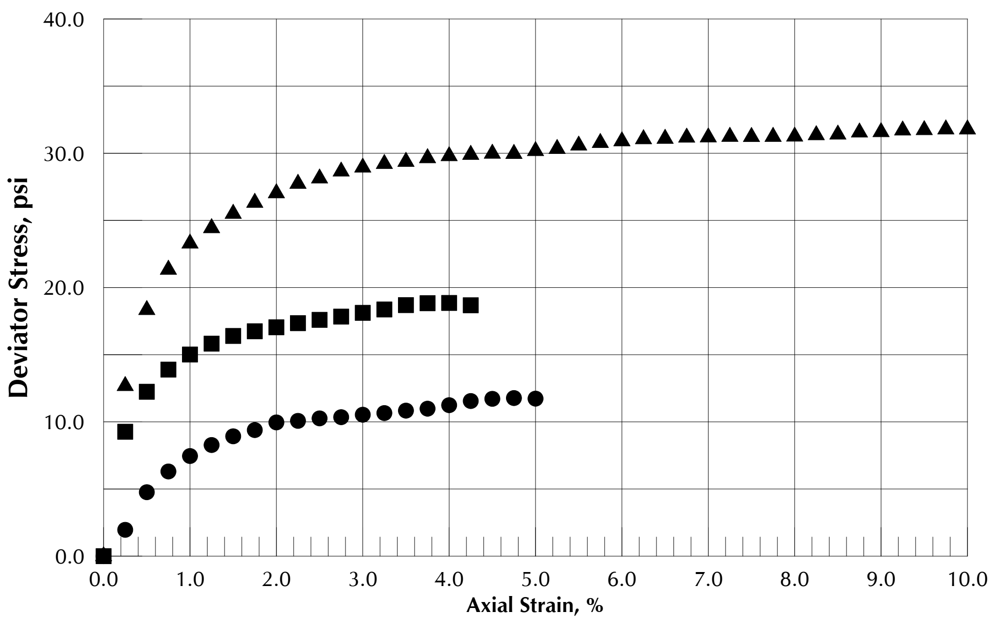


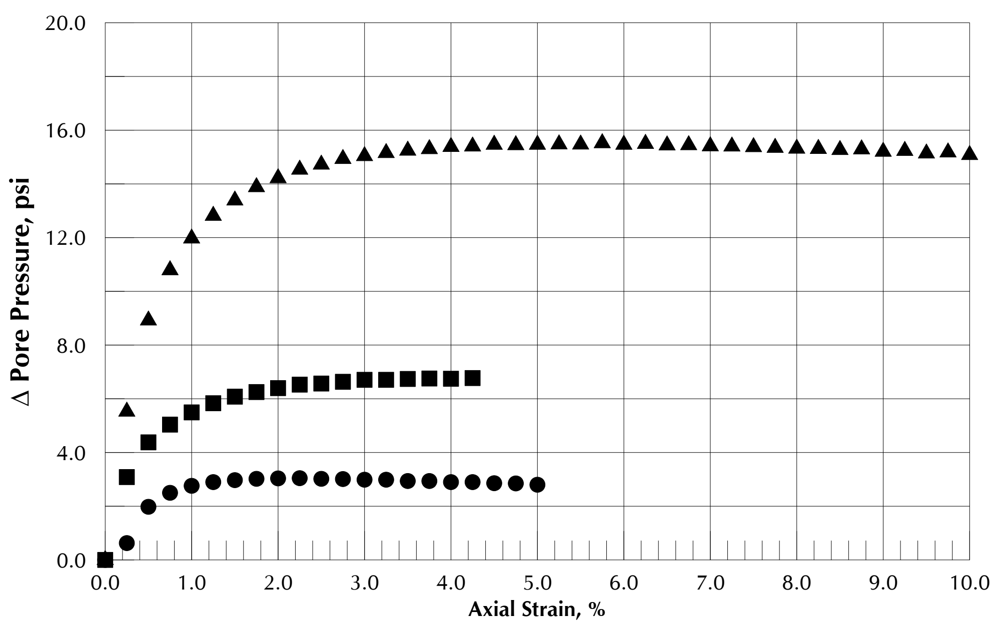
B-1, S-16 (49.8 ft)

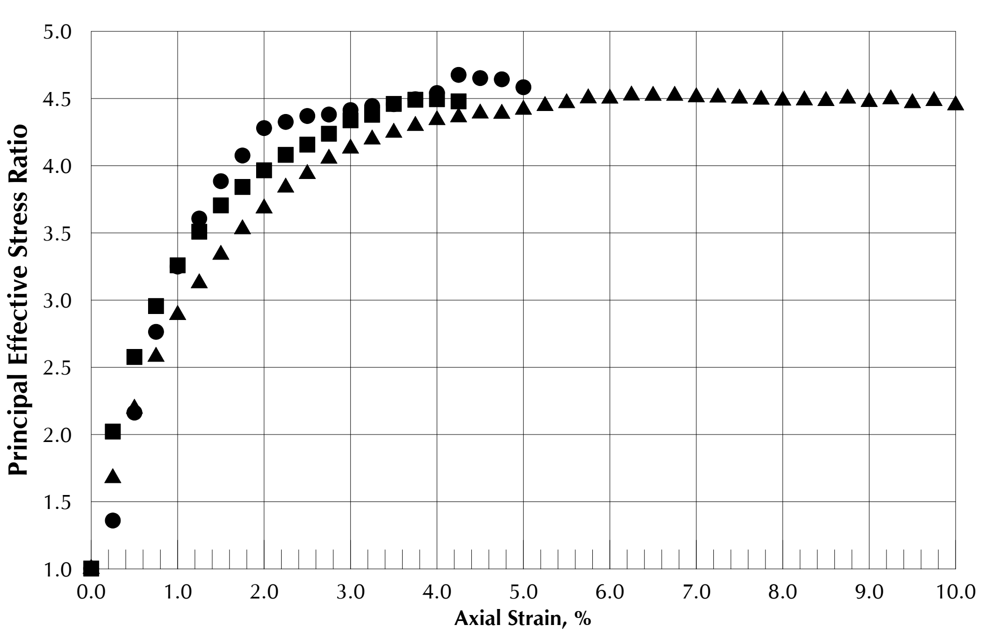


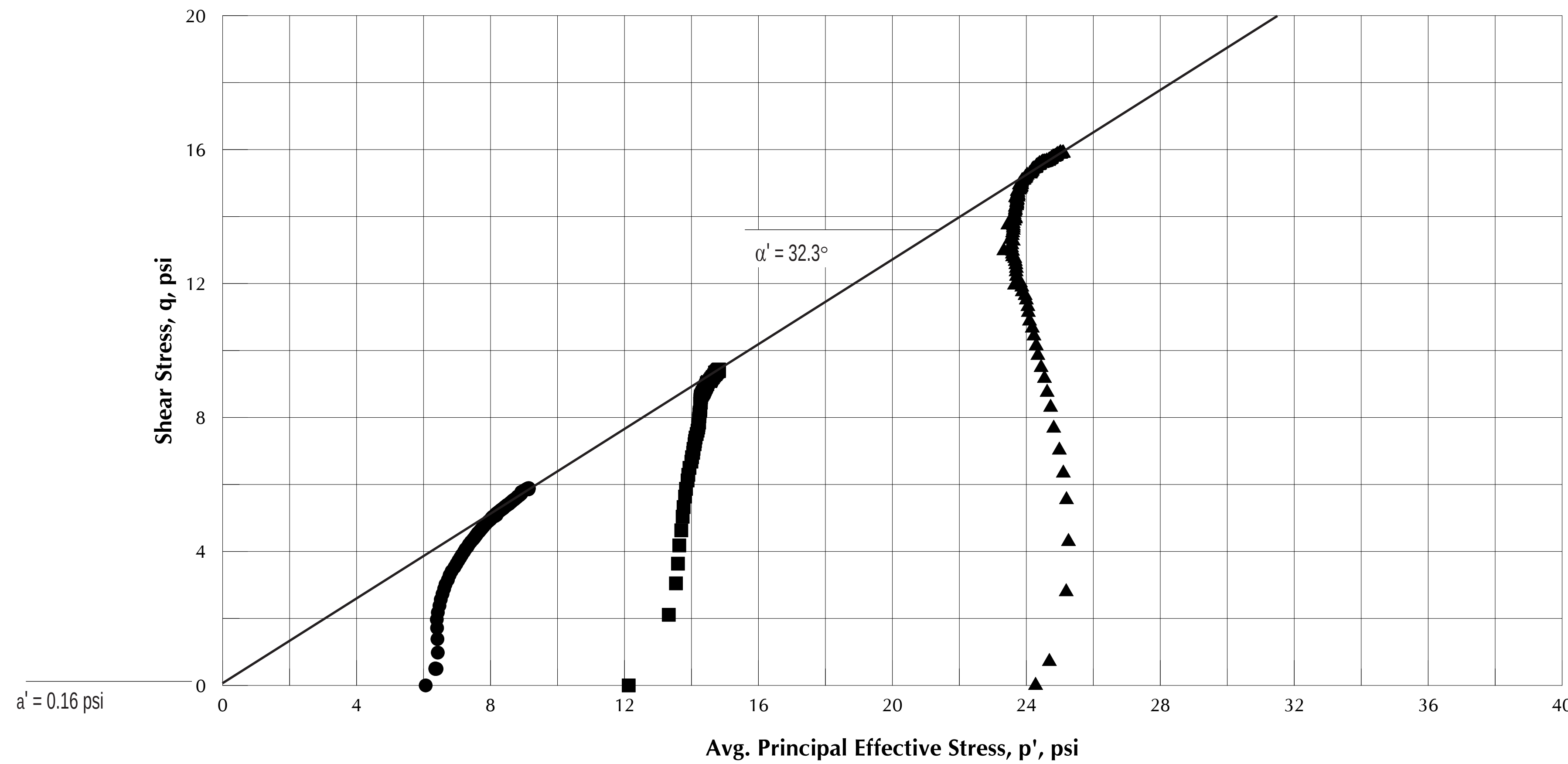
GRI

SECONDARY COMPRESSION









	Stage 1	Stage 2	Stage 3
Test Symbol	●	■	▲
Boring No.	B-1	B-1	B-1
Sample No.	S-10	S-10	S-10
Depth, ft	29	29	29
Vertical Effective Consolidation Stress, psf	875	1,750	3,500
Sample Height, in.	6.0	5.7	5.5
Initial Sample Diameter, in.	2.85	--	--
Dry Unit Wt, pcf	68.3	--	--
W.C.% before test	55	--	--
W.C.% after test	--	--	41
Strain Rate, %/hr	1	1	1

Soil Classification: **SILT, some clay, gray, medium stiff**

TYPE OF TEST:

■ CU ☐ CD ☐ UU ■ UNDISTURBED ☐ REMOLDED

■ PRESATURATED ■ BACK PRESSURE

FAILURE CRITERIA: MAXIMUM DEVIATOR STRESS

REMARKS: TAN α' = SIN ϕ'

a' = c' COS ϕ' (psi)

α' = 32.3°

ϕ' = 34.3°

c' = 0.20 psi

a' = 0.16 psi

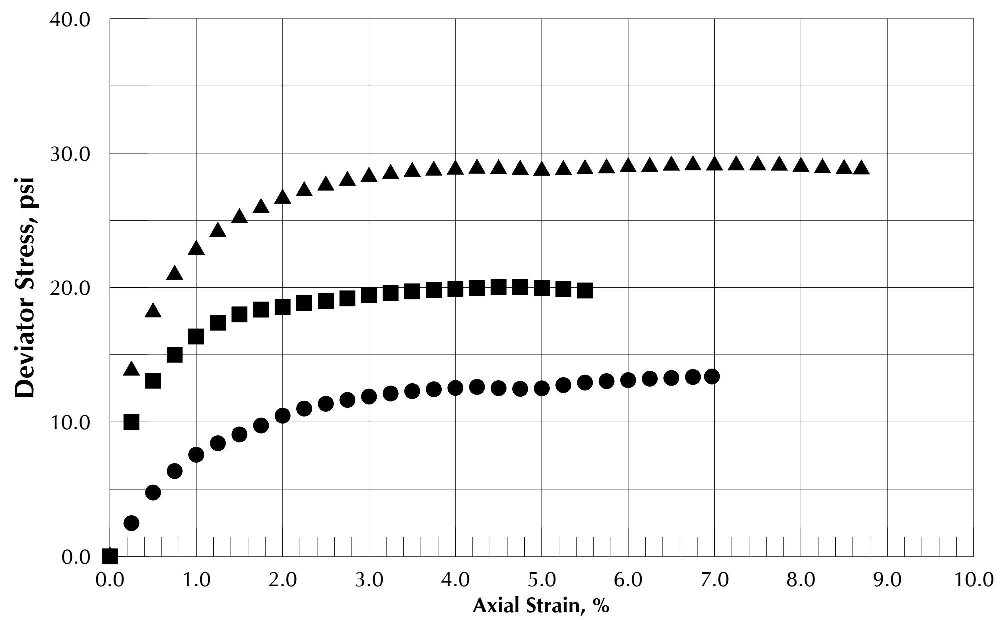
GRI

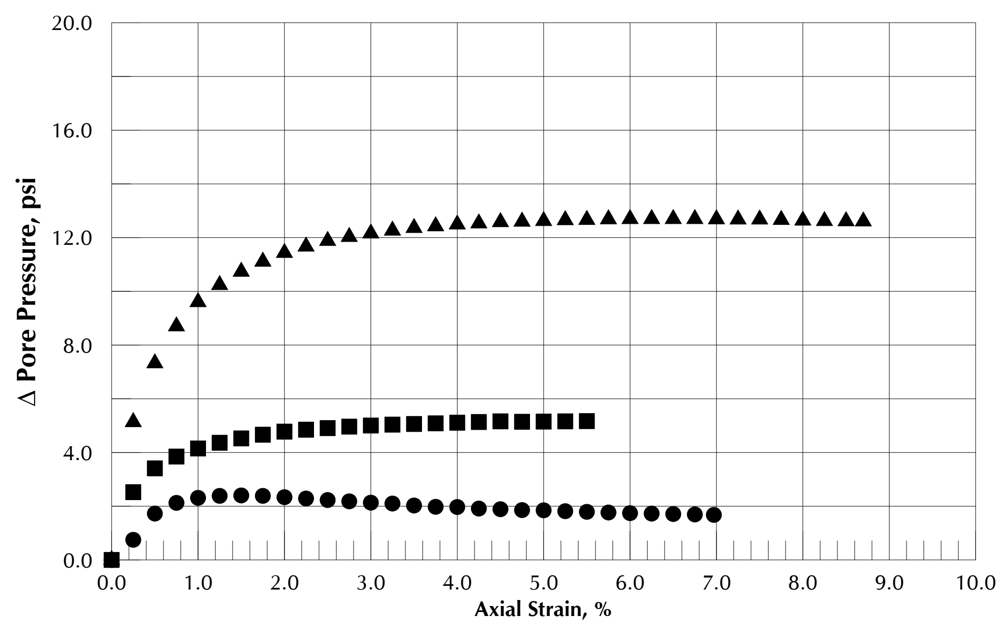
(CU MULTI-STAGE TEST)

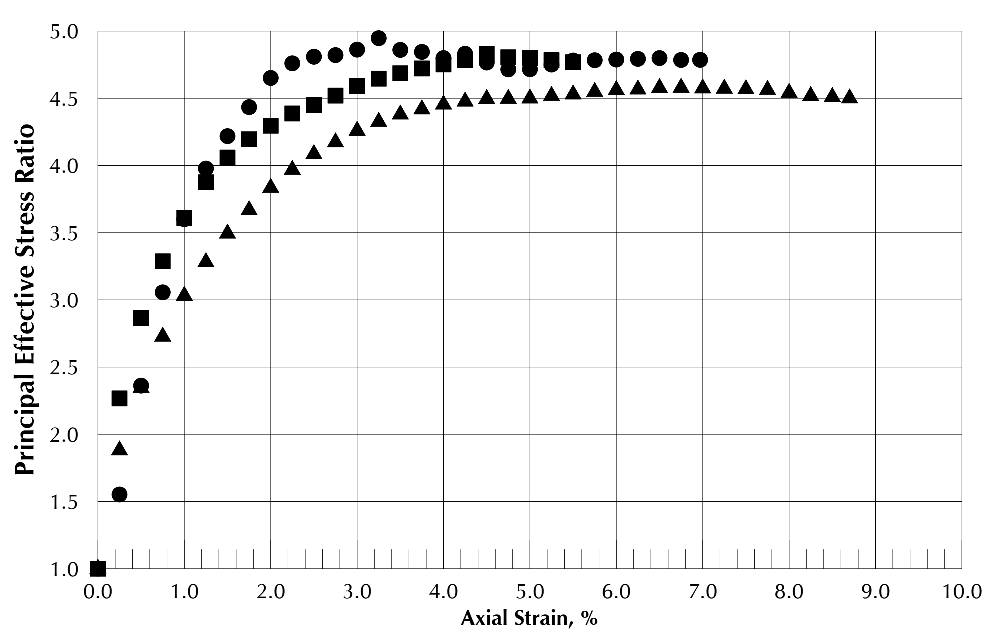
TRIAXIAL SHEAR STRENGTH TEST

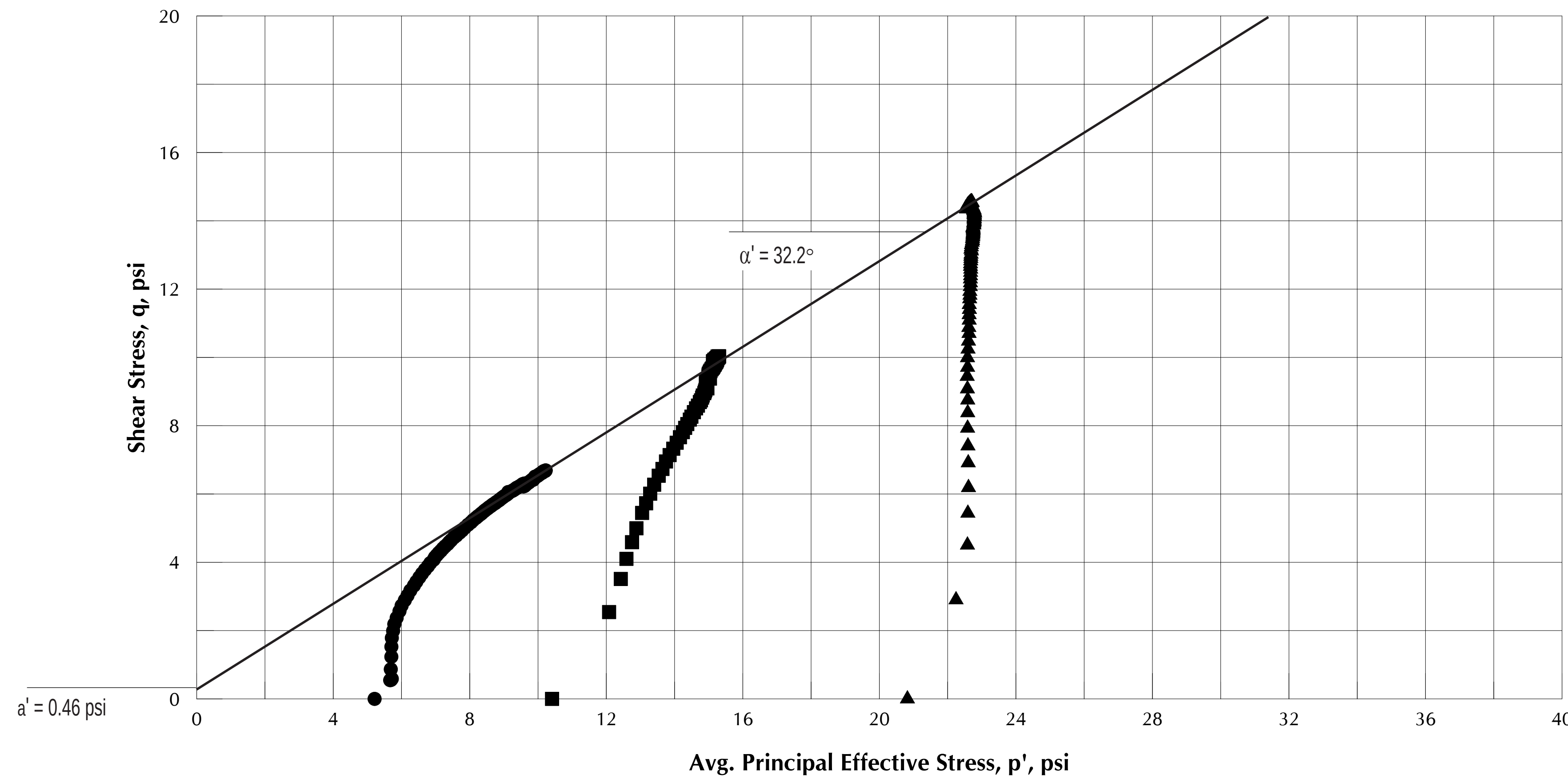
(BORING B-1, SAMPLE S-10)

DEC. 2019 JOB NO. 6266 FIG. 23B









	Stage 1	Stage 2	Stage 3
Test Symbol	●	■	▲
Boring No.	B-2	B-2	B-2
Sample No.	S-8	S-8	S-8
Depth, ft	24.5	24.5	24.5
Vertical Effective Consolidation Stress, psf	750	1,500	3,000
Sample Height, in.	6.0	5.6	5.4
Initial Sample Diameter, in.	2.85	--	--
Dry Unit Wt, pcf	70.0	--	--
W.C.% before test	53	--	--
W.C.% after test	--	--	46
Strain Rate, %/hr	1	1	1

TYPE OF TEST:

■ CU ☐ CD ☐ UU ■ UNDISTURBED ☐ REMOLDED

■ PRESATURATED ■ BACK PRESSURE

FAILURE CRITERIA: MAXIMUM DEVIATOR STRESS

REMARKS: TAN α' = SIN ϕ'

a' = c' COS ϕ' (psi)

α' = 32.2°

ϕ' = 34.2°

c' = 0.60 psi

a' = 0.46 psi

Soil Classification: SILT, trace to some clay, gray, medium stiff

GRI

(CU MULTI-STAGE TEST)

TRIAXIAL SHEAR STRENGTH TEST

(BORING B-2, SAMPLE S-8)

APPENDIX C

Maul Foster & Alongi Boring Logs (2019)

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0830.03.04-02	**MW-1**	**1 of 5**

Project Name	**St. Helens Lagoon**	TOC Elevation (feet)	
Project Location	**St. Helens**	Surface Elevation (feet)	
Start/End Date	**7/10/19 to 7/11/19**	Northing	
Driller/Equipment	**Dan Rider/Terra Sonic Incorporated 150 CC**	Easting	
Geologist/Engineer	**C. Schweitzer**	Hole Depth	**100.0-feet**
Sample Method	**Core Barrel: Ten-foot intervals.**	Outer Hole Diam	**6" to 4"-inch**

Depth (feet, BGS)	Well Details	Sample Data: Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
			100	**CB**					0.0 to 44.0 feet: Basalt with trace vesicles <5%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (low to high angle), joints are closed.
1									
2									
3									
4									
5									
6									
7									
8									
9									
10			**100**	**CB**					
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number	Well Number	Sheet
	0830.03.04-02	MW-1	2 of 5

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
20–30			100	CB					
30–40			100	CB					
40–			100	CB					

Depth scale: 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Depth (feet, BGS)	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Soil Description
44.0–45.5							44.0 to 45.5 feet: SANDY CLAY WITH GRAVEL (CL); gray; 70% fines, medium plasticity; 20% sand, coarse to very coarse; 10% gravel, very fine to coarse; soft; trace weathered bedrock; some fresh, angular bedrock.
45.5–50.0							45.5 to 50.0 feet: Basalt with trace vesicles <5%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (low to high angle), joints are closed.
50.0–60.0		0	CB				50.0 to 60.0 feet: No recovery.
60.0–64.0		100	CB				60.0 to 64.0 feet: Basalt with trace vesicles <5%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (low to high angle), joints are closed.
64.0–71.0							64.0 to 71.0 feet: SANDY CLAY WITH GRAVEL (CL); gray with brown mottling; 70% fines, medium plasticity; 20% sand, medium to very coarse, angular; 10% gravel, very fine to coarse, angular; soft; highly weathered in situ basalt bedrock in a fine matrix of weathered material with weathering rinds, slight porosity, slight

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
66									intact bedrock.
70			**100**	**CB**					
71									71.0 to 75.0 feet: GRAVELLY CLAY WITH SAND (CL); dark gray when wet; 60% fines; 10% sand, very fine to coarse; 30% gravel, fine to very coarse, angular; soft; trace weathered bedrock; wet.
75									75.0 to 80.0 feet: Highly vesicular basalt >20%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (low to high angle), joints are open and filled with firm dark gray clay material that encapsulates the bedrock.
80			**100**	**CB**					80.0 to 100.0 feet: Highly vesicular basalt <20%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (high to low angle), joints are closed.

Depth scale: 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number: **0830.03.04-02**	Well Number: **MW-1**	Sheet: **5 of 5**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
89									
90			100	CB					@ 90.0 feet: Becomes less vesicular <10%.
91									
92									
93									
94									
95									@ 95.0 feet: Becomes less vesicular <5%, and increase in jointing.
96									
97									
98									
99									
100									

Total Depth = 100.0 feet bgs.

Borehole Details:
0.0 to 80.0 feet bgs: 6-inch borehole.
80.0 to 100.0 feet bgs: 4-inch borehole.

Borehole Completion Details:
0.0 to 5.0 feet bgs: Concrete.
5.0 to 58.0 feet bgs: Bentonite chips hydrated with potable water.
58.0 to 81.5 feet bgs: 12/20 Silica Sand.
81.5 to 100.0 feet bgs: Bentonite chips hydrated with potable water.

Monitoring Well Completion
Well Tag Number: L133559
Flushmount monitoring well.
0.0 to 60.0 feet bgs: 2-inch-diameter, schedule 40, PVC blank riser pipe.
60.0 to 80.0 feet bgs: 2-inch-diameter, schedule 40, 0.010-inch machine slot, pre-pack well screen.
80.0 to 80.5 feet bgs: 2-inch-diameter end cap.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Maul Foster & Alongi, Inc.	**Geologic Borehole Log/Well Construction**		
	Project Number	Well Number	Sheet
	0830.03.04-02	**MW-2**	**1 of 5**

Project Name	**St. Helens Lagoon**	TOC Elevation (feet)	
Project Location	**St. Helens**	Surface Elevation (feet)	
Start/End Date	**7/8/19 to 7/10/19**	Northing	
Driller/Equipment	**Dan Rider/Terra Sonic Incorporated 150 CC**	Easting	
Geologist/Engineer	**C. Schweitzer**	Hole Depth	**100.0-feet**
Sample Method	**Core Barrel: Ten-foot intervals.**	Outer Hole Diam	**6" to 4"-inch**

Depth (feet, BGS)	Well Details	Sample Data: Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
0			**100**	**CB**					0.0 to 62.0 feet: Basalt with trace vesicles <5%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (low to high angle), joints are closed.
1									
2									
3									
4									
5									
6									
7									
8									
9									
10			**100**	**CB**					
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Maul Foster & Alongi, Inc.	**Geologic Borehole Log/Well Construction**		
	Project Number **0830.03.04-02**	*Well Number* **MW-2**	*Sheet* **2 of 5**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
			100	CB					
21									
22									
23									
24									
25									
26									
27									
28									
29									
30			100	CB					
31									
32									
33									
34									
35									
36									
37									
38									
39									
40			100	CB					
41									
42									

NOTES: *1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.*

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number 0830.03.04-02	Well Number MW-2	Sheet 3 of 5

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
44									
45									
46									
47									
48									
49									
50			100	CB					
51									
52									
53									
54									
55									
56									
57									
58									
59									
60			100	CB					
61									
62									62.0 to 68.0 feet: SANDY CLAY WITH GRAVEL (CL); gray with brown mottling; 70% fines; 20% sand, medium to very coarse; 10% gravel, very fine to medium, angular; soft; highly weathered in situ bedrock in a fine matrix, with slight porosity; some intact bedrock with weathering rinds.
63									
64									
65									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
66									@ 66.0 feet: Becomes gray with more intact rock only moderately weathered.
67									
68									68.0 to 100.0 feet: Highly vesicular basalt <20%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (high to low angle), fewer joints, joints are closed.
69									
70			100	CB					
71									
72									
73									
74									
75									
76									
77									
78									
79									
80			100	CB					@ 80.0 feet: Becomes less vesicular, <10%.
81									
82									
83									
84									
85									@ 85.0 feet: Becomes less vesicular, <5%, with an increase in joints.
86									
87									
88									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number 0830.03.04-02	Well Number MW-2	Sheet 5 of 5

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
89									
90			100	CB					
91									
92									
93									
94									
95									
96									
97									
98									
99									
100									

Total Depth = 100.0 feet bgs.

Borehole Details:
0.0 to 70.0 feet bgs: 6-inch borehole.
70.0 to 100.0 feet bgs: 4-inch borehole.

Borehole Completion Details:
0.0 to 2.0 feet bgs: Concrete.
2.0 to 48.0 feet bgs: Bentonite chips hydrated with potable water.
48.0 to 71.0 feet bgs: 12/20 Silica Sand.
71.0 to 100.0 feet bgs: Bentonite chips hydrated with potable water.

Monitoring Well Completion
Well Tag Number: L133560
Flushmount monitoring well.
0.0 to 50.0 feet bgs: 2-inch-diameter, schedule 40, PVC blank riser pipe.
50.0 to 70.0 feet bgs: 2-inch-diameter, schedule 40, 0.010-inch machine slot, pre-pack well screen.
70.0 to 70.5 feet bgs: 2-inch-diameter end cap.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel.

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0830.03.04-02	**MW-3**	**1 of 5**

Project Name	**St. Helens Lagoon**	TOC Elevation (feet)	
Project Location	**St. Helens**	Surface Elevation (feet)	
Start/End Date	**7/17/19 to 7/17/19**	Northing	
Driller/Equipment	**Dan Rider/Terra Sonic Incorporated 150 CC**	Easting	
Geologist/Engineer	**C. Schweitzer**	Hole Depth	**100.0-feet**
Sample Method	**Core Barrel: Ten-foot intervals.**	Outer Hole Diam	**6" to 4"-inch**

Depth (feet, BGS)	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Soil Description
0	**100**	**CB**				0.0 to 1.0 feet: SANDY GRAVEL (GW); gray; 0% fines; 20% sand; 80% gravel, fine to coarse, angular; loose; no odor; no sheen; moist.
1						1.0 to 2.0 feet: GRAVELLY CLAY (CL); brown; 80% fines, medium plasticity; 0% sand; 20% gravel, very fine to medium, angular; stiff; no odor; no sheen; moist.
2						2.0 to 5.0 feet: SAND WITH GRAVEL (SW); gray; 0% fines; 90% sand, very fine to coarse; 10% gravel, fine to very coarse, angular; loose; trace cobbles; no odor; no sheen; moist.
5	**100**	**CB**				5.0 to 5.5 feet: GRAVELLY CLAY (CL); brown; 80% fines, medium plasticity; 0% sand; 20% gravel, very fine to medium, angular; stiff; no odor; no sheen; moist.
5.5						5.5 to 8.0 feet: SANDY CLAYEY GRAVEL (GW); gray; 20% fines, medium plasticity; 30% sand, medium to coarse; 50% gravel, fine to coarse, angular; loose; trace cobbles; no odor; no sheen; moist.
8						8.0 to 10.0 feet: GRAVELLY SAND (SW); brown; 0% fines; 80% sand, fine to coarse; 20% gravel, fine to very coarse, angular; loose; trace silt clasts; no odor; no sheen; moist.
10						10.0 to 15.0 feet: No recovery.
15	**100**	**CB SPT**			**21, 11, 15**	15.0 to 22.0 feet: SAND WITH GRAVEL (SW); gray; 0% fines; 90% sand, fine to medium; 10% gravel, fine to very coarse, angular; loose; trace silt clasts; no odor; no sheen; moist.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number **0830.03.04-02**	Well Number **MW-3**	Sheet **2 of 5**

Depth (feet, BGS)	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Soil Description
21							
22							22.0 to 48.0 feet: SAND (SP); dark gray; 0% fines; 100% sand, very fine to medium; 0% gravel; very loose; no odor; no sheen; wet.
23							
24							
25		0	CB				
26							
27							
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40		100	CB				
41							
42							

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number 0830.03.04-02	Well Number MW-3	Sheet 3 of 5

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
44									
45									
46									
47									
48									48.0 to 75.0 feet; SILT (ML); gray; 100% fines, low plasticity; 0% sand; 0% gravel; soft; trace organics, plant matter, and rootlets; no odor; no sheen; moist to wet.
49									
50			100	CB					
51									
52									
53									
54									
55									
56									
57									
58									
59									
60			100	CB					
61									
62									
63									
64									
65									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
66									
67									
68									
69									
70			100	CB					
71									
72									
73									
74									
75									75.0 to 80.0 feet: SILTY SAND (SM); gray; 20% fines, low plasticity; 80% sand, very fine to fine; 0% gravel; loose; trace organics and wood fragments; no odor; no sheen; wet.
76									
77									
78									
79									
80			100	CB					80.0 to 100.0 feet: Basalt with trace vesicles <5%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (low to high angle), joints are closed.
81									
82									
83									
84									
85									
86									
87									
88									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number **0830.03.04-02**	Well Number **MW-3**	Sheet **5 of 5**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
89									
90			100	CB					
91									
92									
93									
94									
95									
96									
97									
98									
99									
100									

Total Depth = 100.0 feet bgs.

Borehole Details:
0.0 to 90.0 feet bgs: 6-inch borehole.
90.0 to 100.0 feet bgs: 4-inch borehole.

Borehole Completion Details:
0.0 to 3.0 feet bgs: Concrete.
3.0 to 5.0 feet bgs: 12/20 Silica Sand.
5.0 to 23.0 feet bgs: Bentonite chips hydrated with potable water.
23.0 to 46.5 feet bgs: 12/20 Silica Sand.
46.5.0 to 70.0 feet bgs: Bentonite chips hydrated with potable water.
70.0 to 100.0 feet bgs: Native soil heave/slough.

Monitoring Well Completion
Well Tag Number: L133572
Flushmount monitoring well.
0.0 to 25.0 feet bgs: 2-inch-diameter, schedule 40, PVC blank riser pipe.
25.0 to 45.0 feet bgs: 2-inch-diameter, schedule 40, 0.010-inch machine slot, pre-pack well screen.
45.0 to 45.5 feet bgs: 2-inch-diameter end cap.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0830.03.04-02	**MW-4**	**1 of 6**

Project Name	**St. Helens Lagoon**	TOC Elevation (feet)	
Project Location	**St. Helens**	Surface Elevation (feet)	
Start/End Date	**7/15/19 to 7/15/19**	Northing	
Driller/Equipment	**Dan Rider/Terra Sonic Incorporated 150 CC**	Easting	
Geologist/Engineer	**C. Schweitzer**	Hole Depth	**120.0-feet**
Sample Method	**Core Barrel: Ten-foot intervals.**	Outer Hole Diam	**6" to 4"-inch**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
0–2			**100**	**CB**					0.0 to 2.0 feet: SANDY GRAVEL (GW); gray; 0% fines; 20% sand; 80% gravel, fine to very coarse, angular; loose; no odor; no sheen; moist. @ 1.5 feet: Becomes brown.
2–4									2.0 to 4.0 feet: GRAVELLY CLAY (CL); brown; 80% fines, medium plasticity; 0% sand; 20% gravel, very fine to medium, angular; stiff; no odor; no sheen; moist.
4–8.5			**100**	**CB SH**		**Shelby tube at 5.0'**			4.0 to 8.5 feet: SAND WITH GRAVEL (SW); gray; 0% fines; 90% sand, very fine to coarse; 10% gravel, fine to very coarse, angular; loose; trace cobbles; no odor; no sheen; moist. @ 4.1 feet: Piece of black plastic.
8.5–11									8.5 to 11.0 feet: GRAVELLY SAND (SW); gray; 0% fines; 70% sand, very fine to coarse; 30% gravel, fine to very coarse, angular; loose; trace cobbles; no odor; no sheen; moist.
11–12									11.0 to 12.0 feet: SANDY CLAYEY GRAVEL (GW); brown; 20% fines, medium plasticity; 30% sand, medium to coarse; 50% gravel, very fine to coarse, angular; loose; trace slightly weathered vesicular basalt cobbles; no odor; no sheen; moist.
12–13									12.0 to 13.0 feet: SANDY GRAVELLY CLAY (CL); brown fines with gray sand; 50% fines, medium plasticity; 30% sand, very fine to medium; 20% gravel, very fine to medium, angular; very soft; no odor; no sheen; wet.
13–16			**100**	**CB SPT**			**25, 21, 16**		13.0 to 16.0 feet: GRAVELLY SAND (SW); gray; 0% fines; 80% sand, fine to coarse; 20% gravel, fine to very coarse, angular; loose; trace cobbles; no odor; no sheen; wet.
16–20									16.0 to 20.0 feet: SANDY GRAVEL WITH CLAY (GW); brown; 10% fines; 40% sand, fine to very coarse; 50% gravel, fine to very coarse, angular; loose; some cobbles; no odor; no sheen; wet.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number **0830.03.04-02**	Well Number **MW-4**	Sheet **2 of 6**

Depth (feet, BGS)	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Soil Description
20–23							20.0 to 23.0 feet: SAND WITH GRAVEL (SW); brown; 0% fines; 90% sand, fine to very coarse; 10% gravel, fine to very coarse, angular; loose; no odor; no sheen; wet.
23							23.0 to 65.0 feet: SAND (SP); dark gray; 0% fines; 100% sand, very fine to medium; 0% gravel; very loose; no odor; no sheen; wet.
25		0	CB				
35		0	CB				

Depth scale: 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
44									
45									
46									
47									
48									
49									
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60			100	CB					
61									
62									
63									
64									
65									65.0 to 95.0 feet; SILT (ML); gray; 100% fines, low plasticity; 0% sand; 0% gravel; soft; trace organics, plant matter, and rootlets; no odor;

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
66									no sheen; moist to wet.
67									
68									
69									
70			100	CB					
71									
72									
73									
74									
75									
76									
77									
78									
79									
80			100	CB					
81									
82									
83									
84									
85									
86									
87									
88									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
89									
90			100	CB					
91									
92									
93									
94									
95									95.0 to 105.0 feet: SILTY SAND (SM); gray; 20% fines, low plasticity; 80% sand, very fine to fine; 0% gravel; loose; trace organics and rootlets; no odor; no sheen; wet.
96									
97									
98									
99									
100			100	CB					
101									
102									
103									
104									
105									105.0 to 113.0 feet; SILT (ML); gray; 100% fines, low plasticity; 0% sand; 0% gravel; soft; trace organics and rootlets; no odor; no sheen; moist.
106									
107									
108									
109									
110			100	CB					
111									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	**Geologic Borehole Log/Well Construction**		
	Project Number **0830.03.04-02**	Well Number **MW-4**	Sheet **6 of 6**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
112									
113									113.0 to 120.0 feet: SILTY SAND (SM); gray; 20% fines, low plasticity; 80% sand, very fine to fine; 0% gravel; loose; trace organics and rootlets; no odor; no sheen; moist.
114									
115									
116									@ 116.0 feet: Becomes only 10% fines.
117									@ 117.0 feet: wood fragment.
118									
119									
120									

Total Depth = 120.0 feet bgs.

<u>Borehole Details:</u>
0.0 to 90.0 feet bgs: 6-inch borehole.
90.0 to 120.0 feet bgs: 4-inch borehole.

<u>Borehole Completion Details:</u>
0.0 to 2.0 feet bgs: Concrete.
2.0 to 27.0 feet bgs: Bentonite chips hydrated with potable water.
27.0 to 51.0 feet bgs: 12/20 Silica Sand.
51.0.0 to 75.0 feet bgs: Bentonite chips hydrated with potable water.
75.0 to 120.0 feet bgs: Native soil heave/slough.

<u>Monitoring Well Completion</u>
Well Tag Number: L133571
Flushmount monitoring well.
0.0 to 30.0 feet bgs: 2-inch-diameter, schedule 40, PVC blank riser pipe.
30.0 to 50.0 feet bgs: 2-inch-diameter, schedule 40, 0.010-inch machine slot, pre-pack well screen.
50.0 to 50.5 feet bgs: 2-inch-diameter end cap.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number **0830.03.04-02**	Well Number **MW-5**	Sheet **1 of 6**

Project Name	**St. Helens Lagoon**	TOC Elevation (feet)	
Project Location	**St. Helens**	Surface Elevation (feet)	
Start/End Date	**7/16/19 to 7/16/19**	Northing	
Driller/Equipment	**Dan Rider/Terra Sonic Incorporated 150 CC**	Easting	
Geologist/Engineer	**C. Schweitzer**	Hole Depth	**120.0-feet**
Sample Method	**Core Barrel: Ten-foot intervals.**	Outer Hole Diam	**6" to 4"-inch**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
0			100	CB					0.0 to 2.0 feet: SANDY GRAVEL (GW); gray; 0% fines; 20% sand; 80% gravel, fine to coarse, angular; loose; no odor; no sheen; moist.
2									2.0 to 3.0 feet: GRAVELLY CLAY (CL); brown; 80% fines, medium plasticity; 0% sand; 20% gravel, very fine to medium, angular; stiff; no odor; no sheen; moist.
3									3.0 to 6.0 feet: SAND WITH GRAVEL (SW); gray; 0% fines; 90% sand, very fine to coarse; 10% gravel, fine to very coarse, angular; loose; trace cobbles; no odor; no sheen; moist.
5			100	CB SPT			10, 11, 15		@ 5.0 feet: Thin brown silt bed.
6									6.0 to 9.0 feet: SANDY CLAYEY GRAVEL (GW); gray; 20% fines, medium plasticity; 30% sand, medium to coarse; 50% gravel, very fine to coarse, angular; loose; no odor; no sheen; moist.
9									9.0 to 15.0 feet: GRAVELLY SAND (SW); gray; 0% fines; 80% sand, fine to coarse; 20% gravel, fine to very coarse, angular; loose; trace cobbles; no odor; no sheen; moist.
15			100	CB					15.0 to 16.0 feet: SANDY GRAVELLY CLAY (CL); brown fines with gray sand and gravel; 50% fines, medium plasticity; 30% sand, very fine to medium; 20% gravel, fine to medium, angular; very soft; no odor; no sheen; wet.
16									16.0 to 23.0 feet: SAND WITH GRAVEL (SW); gray; 0% fines; 90% sand, fine to medium; 10% gravel, fine to very coarse, angular; loose; no odor; no sheen; wet.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

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Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number 0830.03.04-02	Well Number MW-5	Sheet 2 of 6

Depth (feet, BGS)	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Soil Description
21							
22							
23							23.0 to 63.0 feet: SAND (SP); dark gray; 0% fines; 100% sand, very fine to medium; 0% gravel; very loose; no odor; no sheen; wet.
24							
25		100	CB SPT			2, 3, 6	
26							
27							
28							
29							
30							
31							
32							
33							
34							
35		0	CB				
36							
37							
38							
39							
40							
41							
42							

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0830.03.04-02	MW-5	3 of 6

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
44									
45									
46									
47									
48									
49									
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60			100	CB					
61									
62									
63									63.0 to 103.0 feet; SILT (ML); gray; 100% fines, low plasticity; 0% sand; 0% gravel; soft; trace organics, plant matter, and rootlets; no odor; no sheen; moist to wet.
64									
65									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
66									
67									
68									
69									
70			100	CB					
71									
72									
73									
74									
75									
76									
77									
78									
79									
80			100	CB					
81									
82									
83									
84									
85									
86									
87									
88									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0830.03.04-02	**MW-5**	**5 of 6**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
89									
90			**100**	**CB**					
91									
92									
93									
94									
95									
96									
97									
98									
99									
100			**100**	**CB**					
101									
102									
103									*103.0 to 120.0 feet: Basalt with some vesicles <25%, dark gray when wet, fresh, hard, close non-systematically jointed, randomly oriented (low to high angle), joints are closed.*
104									
105									
106									
107									
108									
109									
110			**100**	**CB**					*@ 110.0 feet: Becomes less vesicular, <10%.*
111									

NOTES: *1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.*

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number	Well Number	Sheet
	0830.03.04-02	MW-5	6 of 6

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
112									
113									
114									
115									@ 115.0 feet: Becomes less vesicular, <5%.
116									
117									
118									
119									
120									

Total Depth = 120.0 feet bgs.

Borehole Details:
0.0 to 90.0 feet bgs: 6-inch borehole.
90.0 to 120.0 feet bgs: 4-inch borehole.

Borehole Completion Details:
0.0 to 5.0 feet bgs: Concrete.
5.0 to 27.0 feet bgs: Bentonite chips hydrated with potable water.
27.0 to 51.0 feet bgs: 12/20 Silica Sand.
51.0.0 to 54.0 feet bgs: Bentonite chips hydrated with potable water.
54.0 to 120.0 feet bgs: Native soil heave/slough.

Monitoring Well Completion
Well Tag Number: L133553
Flushmount monitoring well.
0.0 to 30.0 feet bgs: 2-inch-diameter, schedule 40, PVC blank riser pipe.
30.0 to 50.0 feet bgs: 2-inch-diameter, schedule 40, 0.010-inch machine slot, pre-pack well screen.
50.0 to 50.5 feet bgs: 2-inch-diameter end cap.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number **0830.03.04-02**	Well Number **MW-6**	Sheet **1 of 6**

Project Name	**St. Helens Lagoon**	TOC Elevation (feet)	
Project Location	**St. Helens**	Surface Elevation (feet)	
Start/End Date	**7/11/19 to 7/12/19**	Northing	
Driller/Equipment	**Dan Rider/Terra Sonic Incorporated 150 CC**	Easting	
Geologist/Engineer	**C. Schweitzer**	Hole Depth	**120.0-feet**
Sample Method	**Core Barrel: Ten-foot intervals.**	Outer Hole Diam	**6" to 4"-inch**

Depth (feet, BGS)	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Soil Description
0	100	CB				0.0 to 4.0 feet: SANDY GRAVEL (GW); gray; 0% fines; 20% sand; 80% gravel, fine to very coarse, angular; loose; no odor; no sheen; moist.
2.5						@ 2.5 feet: Becomes brown.
4						4.0 to 5.0 feet: GRAVELLY CLAY (CL); brown; 60% fines, medium plasticity; 0% sand; 40% gravel, very fine to medium, angular; stiff; no odor; no sheen; moist.
5	100	CB SPT			6, 4, 5	5.0 to 6.0 feet: SANDY CLAYEY GRAVEL (GW); brown with dark gray sand and gravel; 20% fines, medium plasticity; 30% sand, medium to coarse; 50% gravel, very fine to coarse, angular; loose; fines in clumps; no odor; no sheen; moist.
6						6.0 to 10.0 feet: SAND WITH GRAVEL (SW); brown; 0% fines; 90% sand, very fine to coarse; 10% gravel, fine to very coarse, angular; loose; trace cobbles up to 2 inch; no odor; no sheen; moist.
10						10.0 to 11.0 feet: SILTY GRAVELLY SAND (SM); dark gray; 30% fines, low plasticity; 50% sand, very fine to medium; 20% gravel, fine to medium, angular; loose; trace cobbles up to 3 inch; no odor; no sheen; moist.
11						11.0 to 20.0 feet: GRAVELLY SAND (SW); gray; 0% fines; 80% sand, fine to very coarse; 20% gravel, fine to very coarse, angular; loose; trace cobbles up to 2 inch; no odor; no sheen; moist.
13						@ 13.0 feet: Becomes brown, with a thin silt bed.
15	100	CB SH		Shelby Tube at 15.0'		
16						@ 16.0 feet: Becomes gray, with a thin silt bed.
18						@ 18.0 feet: Becomes brown.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number	Well Number	Sheet
	0830.03.04-02	**MW-6**	**2 of 6**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
21									20.0 to 55.0 feet: SAND (SP); dark gray; 0% fines; 100% sand, very fine to medium; 0% gravel; very loose; no odor; no sheen; wet.
25			0	CB SPT			1, 2, 5		

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
44									
45									
46									
47									
48									
49									
50			100	CB					
51									
52									
53									
54									
55									55.0 to 120.0 feet; SILT (ML); gray; 100% fines, low plasticity; 0% sand; 0% gravel; soft; trace organics, plant matter, and rootlets; trace light interbedded zones of light gray sand; no odor; no sheen; moist to wet.
56									
57									
58									
59									
60			100	CB					
61									
62									
63									
64									
65									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number	Well Number	Sheet
	0830.03.04-02	MW-6	4 of 6

Depth (feet, BGS)	Well Details	Sample Data: Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
66									
67									
68									
69									
70			100	CB					
71									
72									
73									
74									
75									
76									
77									
78									
79									
80			100	CB					
81									
82									
83									
84									
85									
86									
87									
88									

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number	Well Number	Sheet
	0830.03.04-02	**MW-6**	**5 of 6**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
89									
90			100	CB					
91									
92									
93									
94									
95									
96									
97									
98									
99									
100			100	CB					
101									
102									
103									
104									
105									
106									
107									
108									
109									
110			100	CB					
111									

NOTES: *1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.*

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
112									
113									
114									
115									
116									
117									
118									
119									
120									

Total Depth = 120.0 feet bgs.

Borehole Details:
0.0 to 120.0 feet bgs: 6-inch borehole.

Borehole Completion Details:
0.0 to 3.5 feet bgs: Concrete.
3.5 to 28.0 feet bgs: Bentonite chips hydrated with potable water.
28.0 to 51.0 feet bgs: 12/20 Silica Sand.
51.0 to 120.0 feet bgs: Native soil heave/slough.

Monitoring Well Completion
Well Tag Number: L133558
Flushmount monitoring well.
0.0 to 30.5 feet bgs: 2-inch-diameter, schedule 40, PVC blank riser pipe.
30.5 to 50.5 feet bgs: 2-inch-diameter, schedule 40, 0.010-inch machine slot, pre-pack well screen.
50.5 to 51.0 feet bgs: 2-inch-diameter end cap.

NOTES: 1. bgs = below ground surface. 2. PVC = polyvinyl chloride. 3. CB = Core Barrel. 4. SH = Shelby Tube. 5. SPT = Standard Penetration Test.

APPENDIX D

Shannon and Wilson Exploration Logs (1968 and 1969)

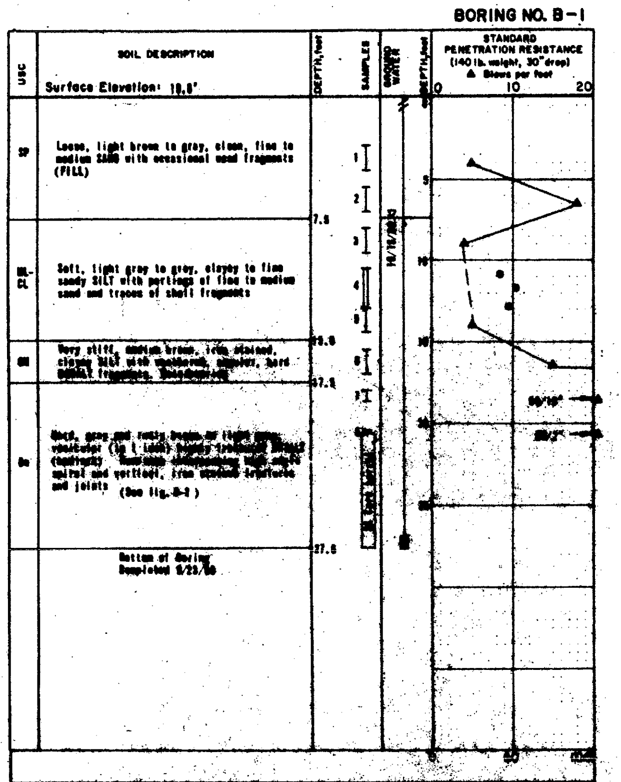


FIG. B-1

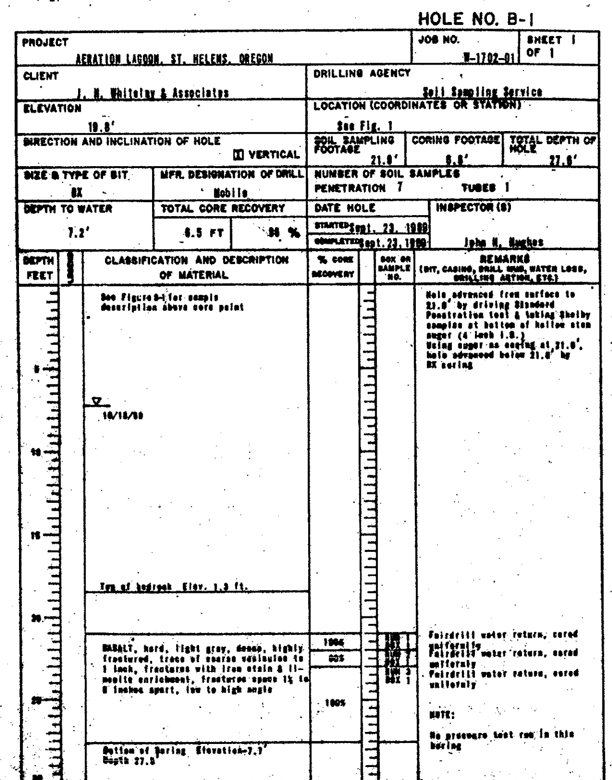


FIG. B-2

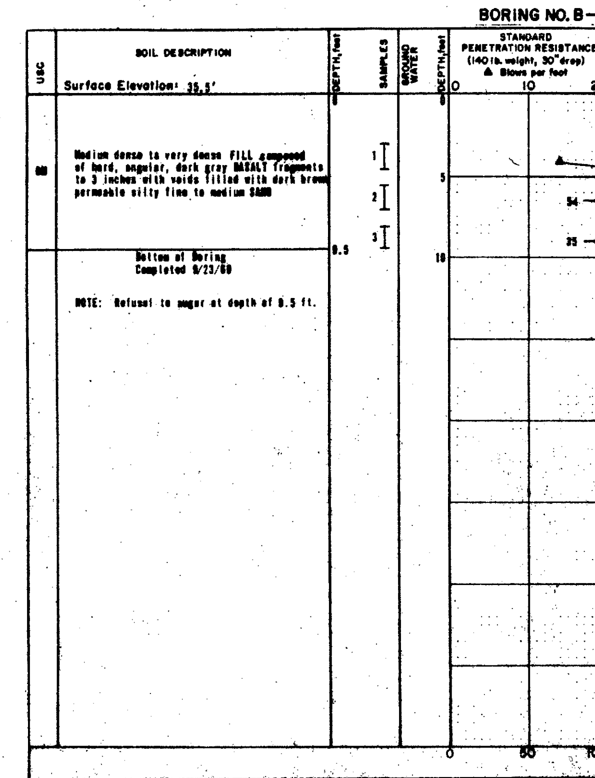


FIG. B-3

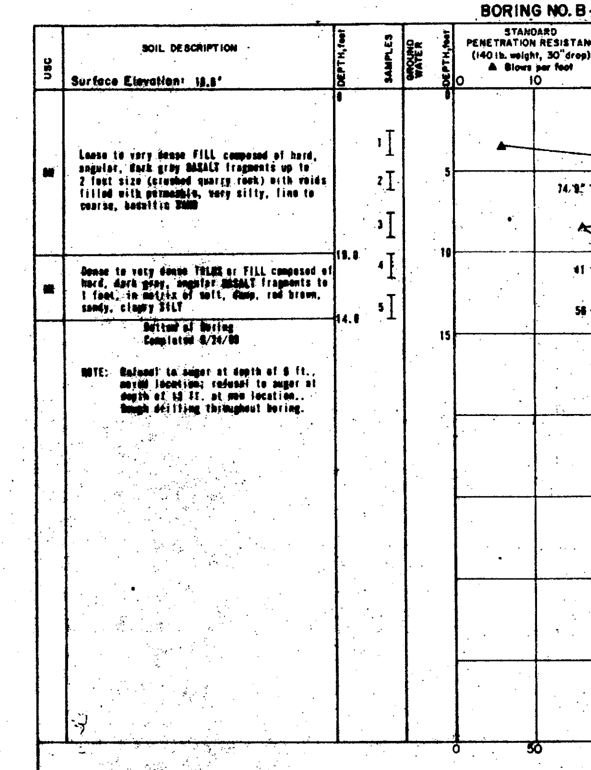


FIG. B-4

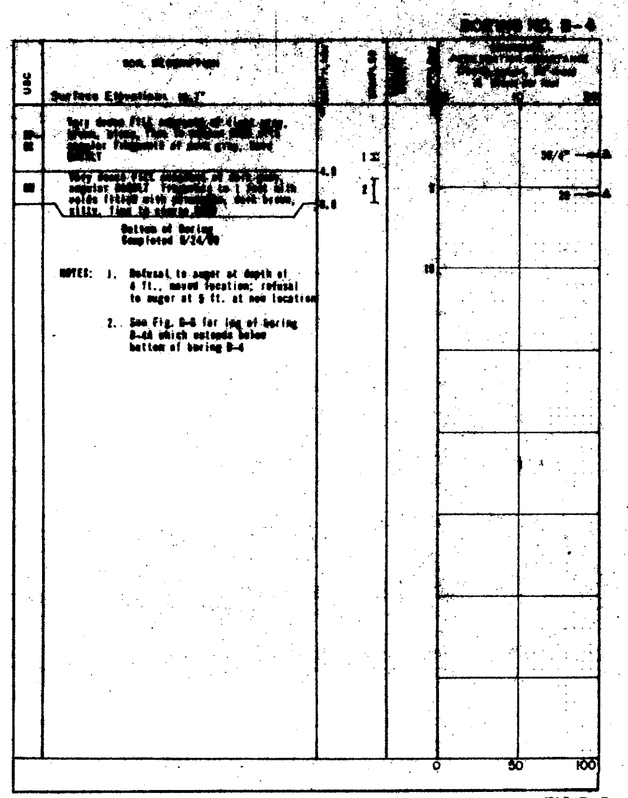


FIG. B-5

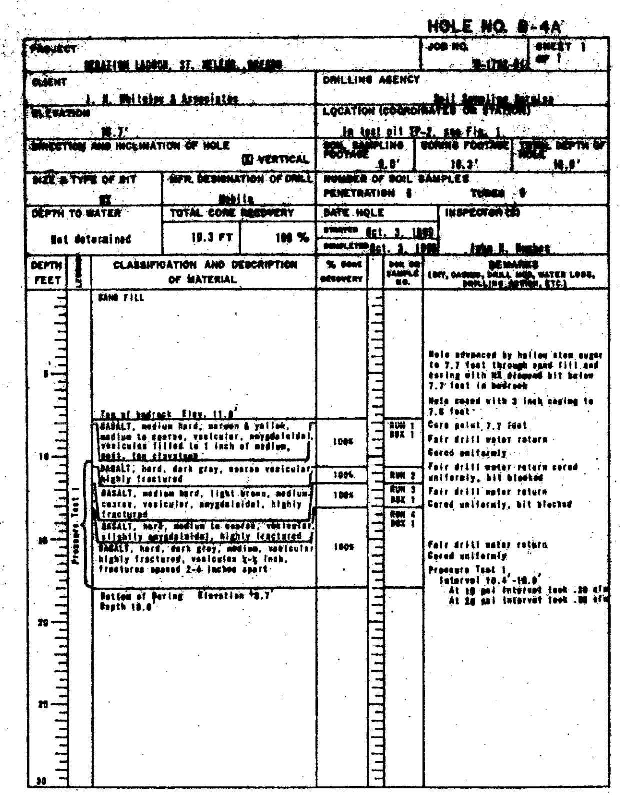
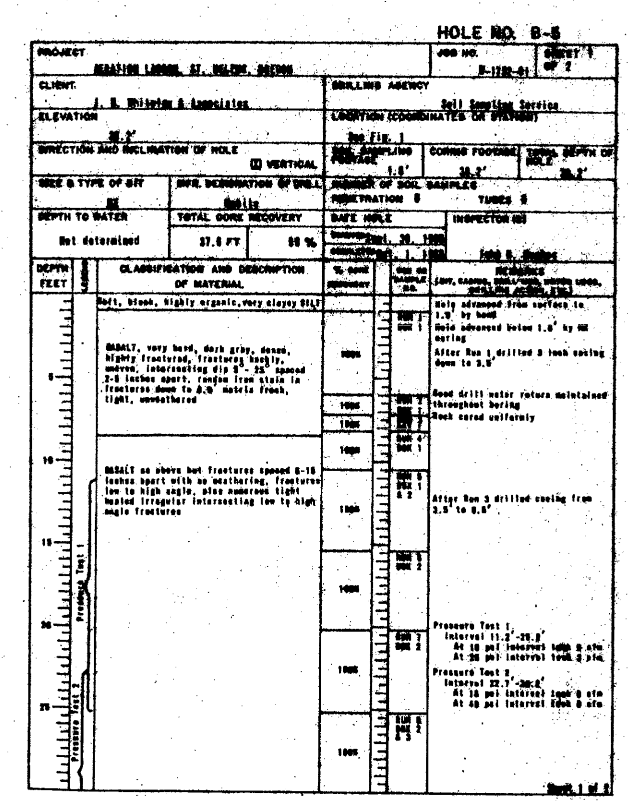


FIG. B-6



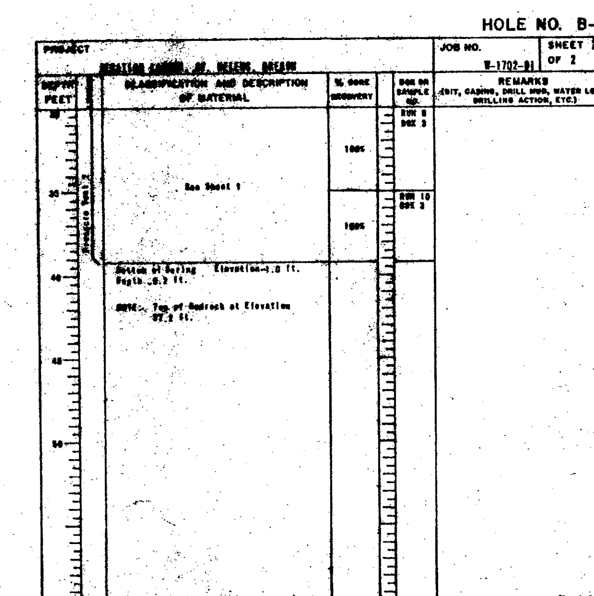


FIG. B-7

NOTE: SOILS INVESTIGATION CONDUCTED BY SHANNON & WILSON

LEGEND

2.0" O.D. split spoon sample	Impervious seal
3.0" O.D. thin-wall sample	Water level
Sample not recovered	Piezometer tip
Atterberg limits: Liquid limit, Natural water content, Plastic limit	P Sampler pushed
	USC Unified Soil Classification
	% Water content

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	APPROVED: J.H.W.	DATE: 9-26-70	C-5

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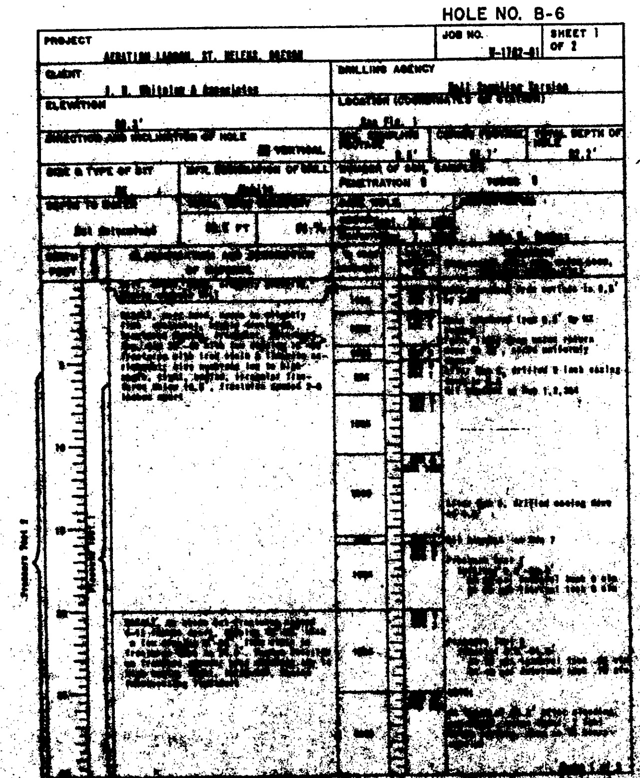
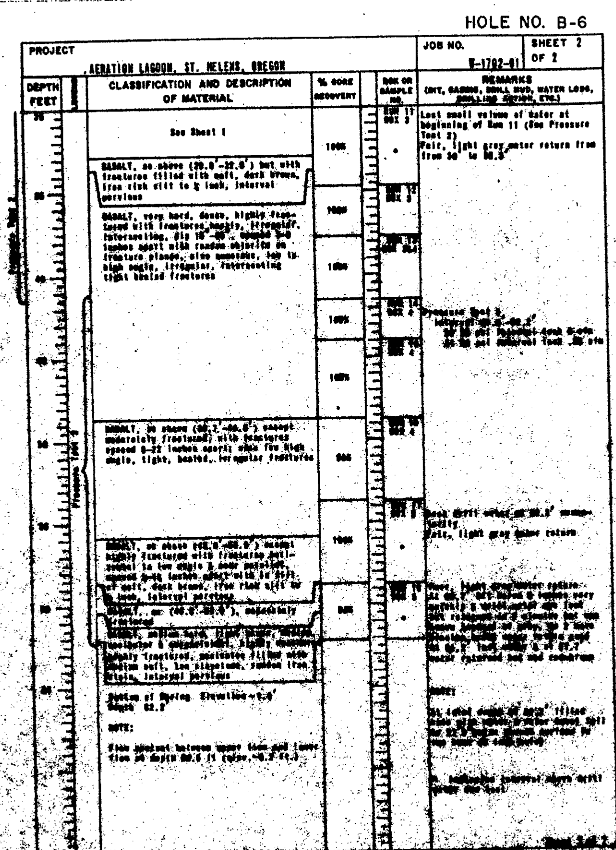
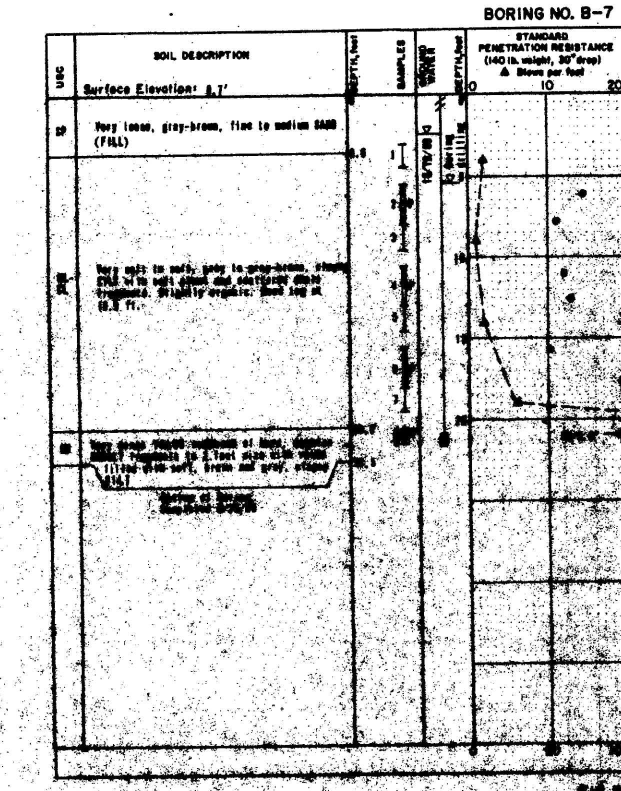
Jack H. Whiteley







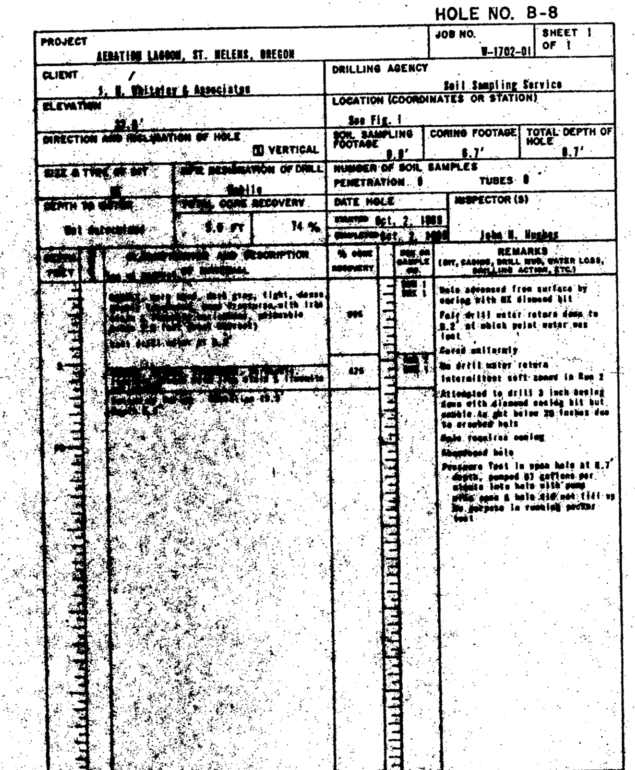


FIG.B-10

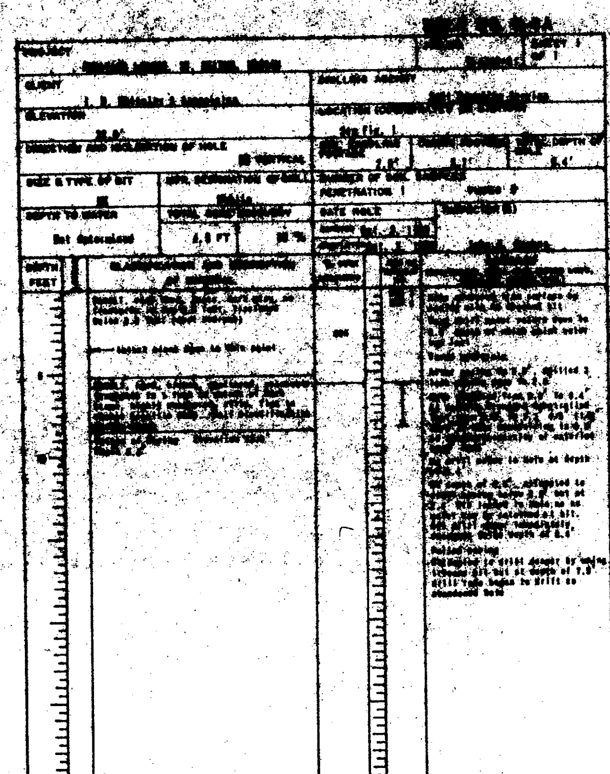


FIG B-11

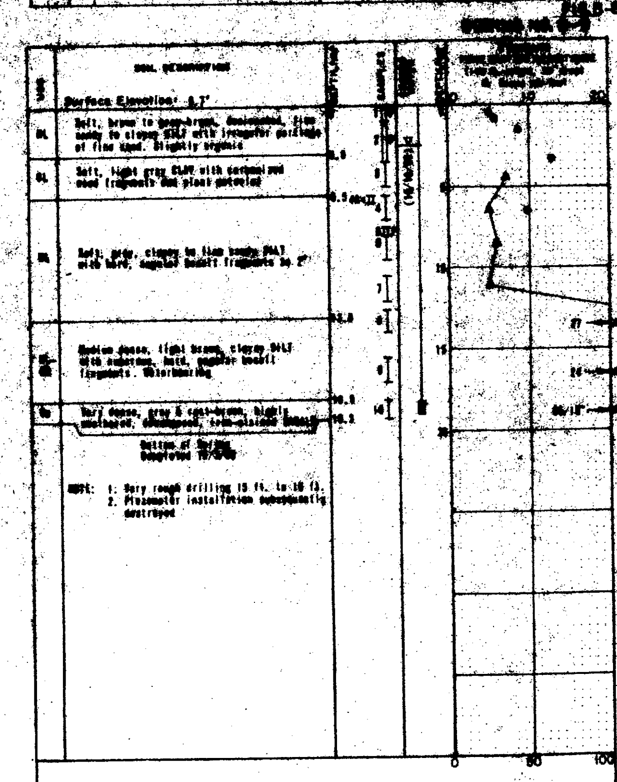
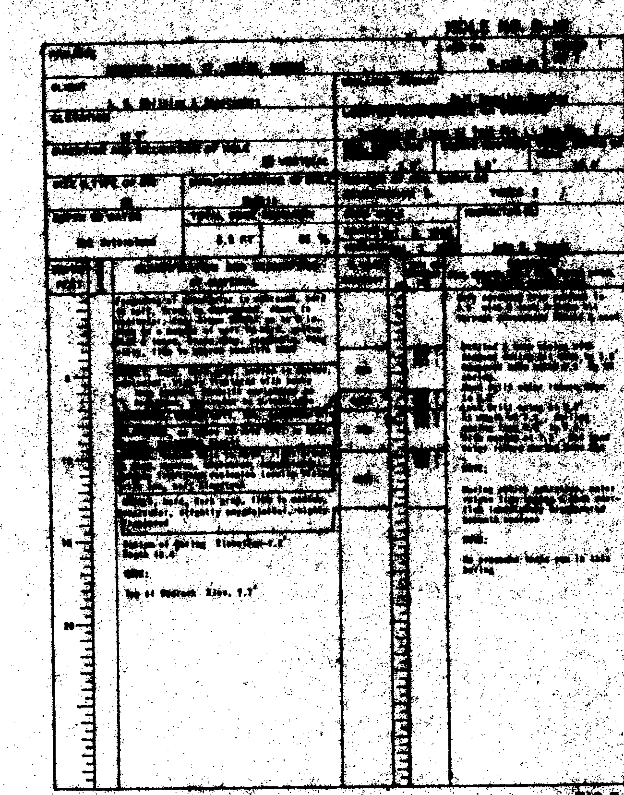


FIG.B-12



LEGEND

NOTE: SOILS INVESTIGATION CONDUCTED BY SHANNON & WILSON

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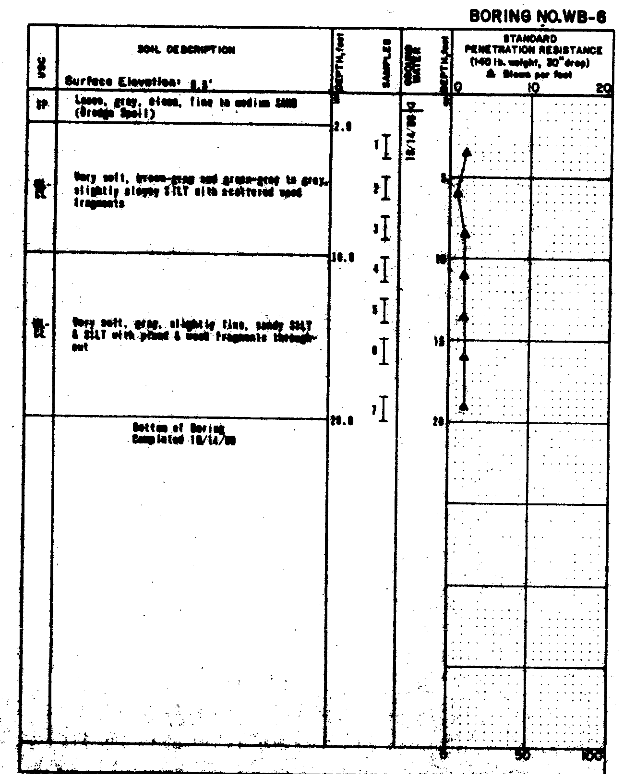

FIG. B-22

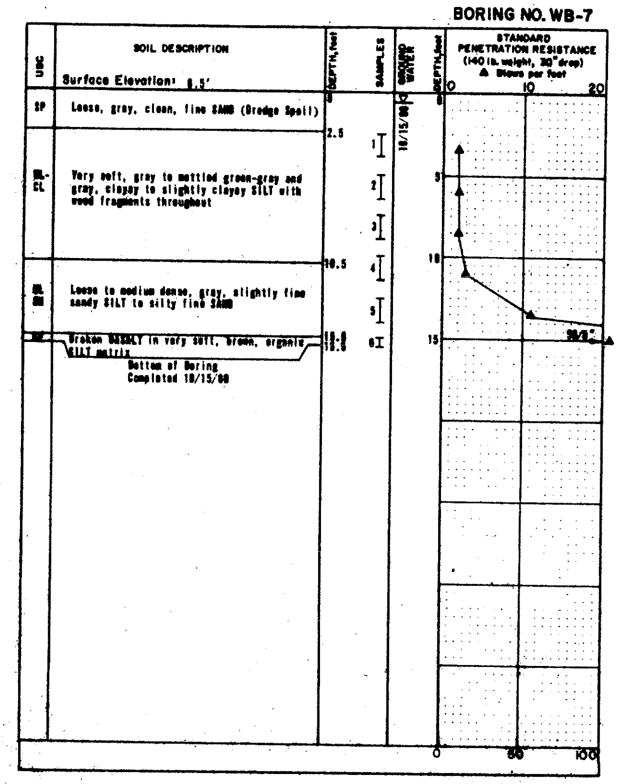

FIG. B-23

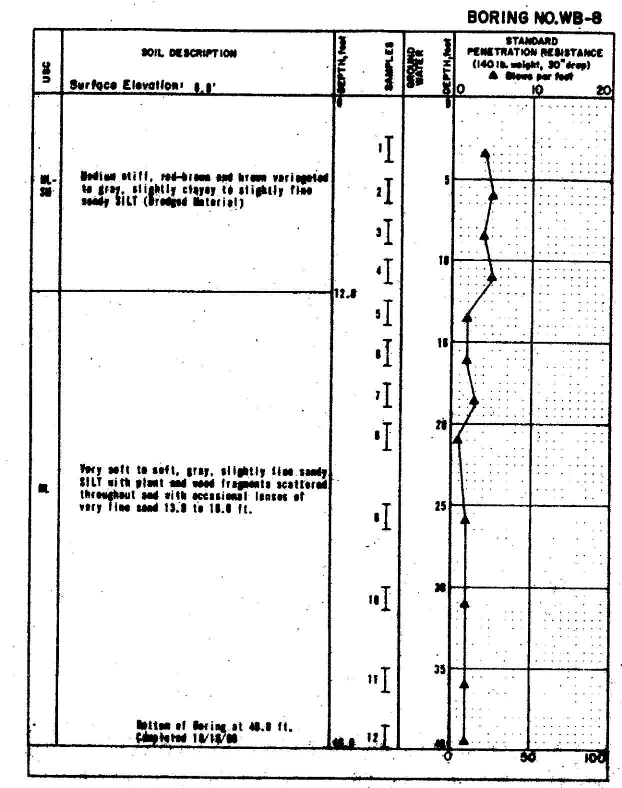

FIG. B-24

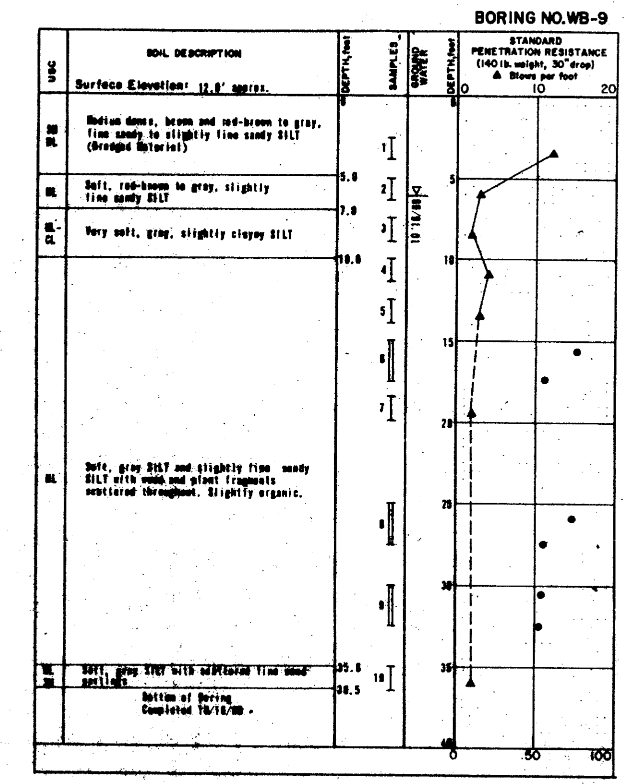

FIG. B-25

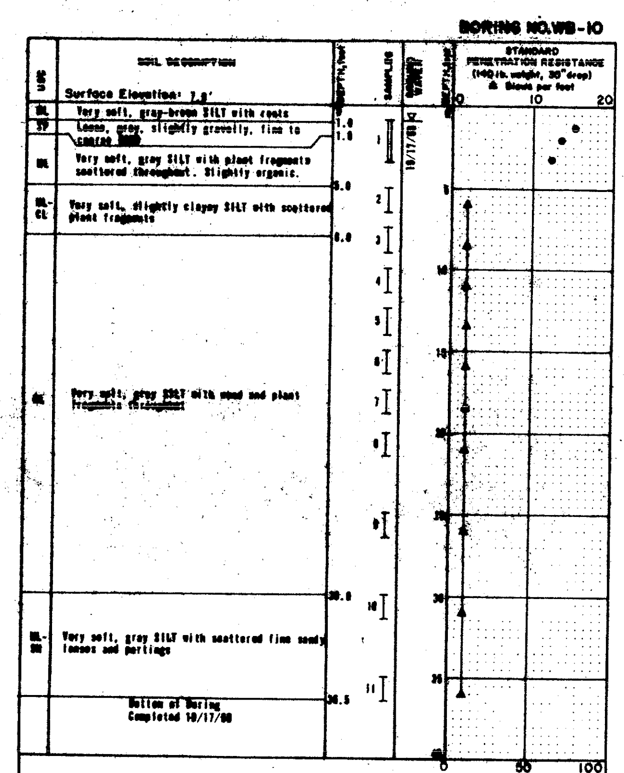

FIG. B-26

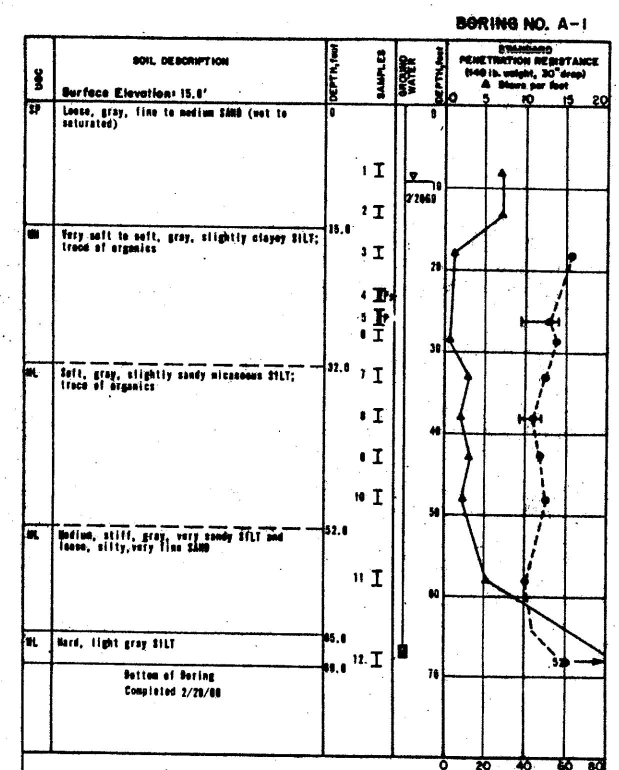

FIG. B-27

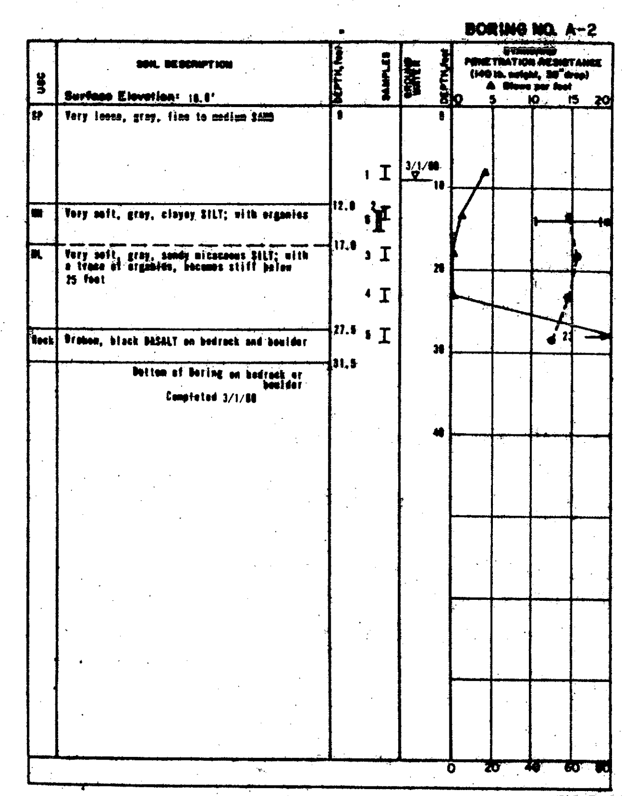

FIG. B-28

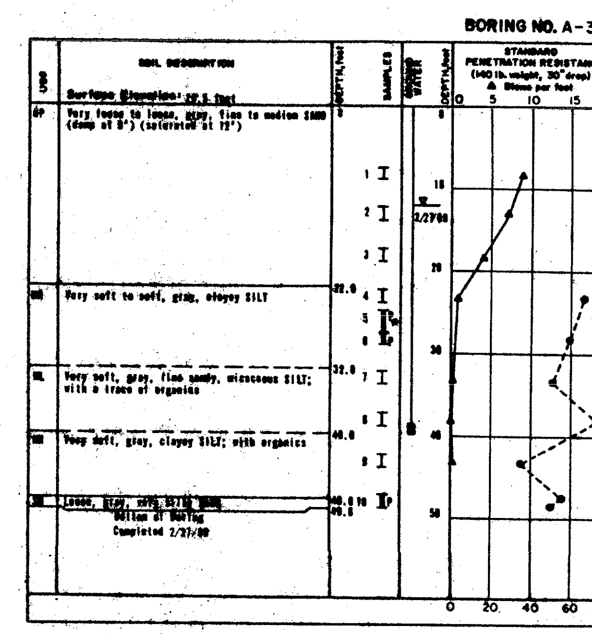

FIG. B-29

NOTE: SOILS INVESTIGATION CONDUCTED BY SHANNON & WILSON

LEGEND

- 2.0" O.D. split spoon sample
- 3.0" O.D. thin-wall sample
- Sample not recovered
- Impervious seal
- Water level
- Piezometer tip
- Sampler pushed
- Atterberg limits: Liquid limit, Natural water content, Plastic limit
- P Sampler pushed
- USC Unified Soil Classification
- % Water content

CITY OF ST. HELENS, OREGON

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APPROVED: J.H.W.	DATE: 3-26-70	

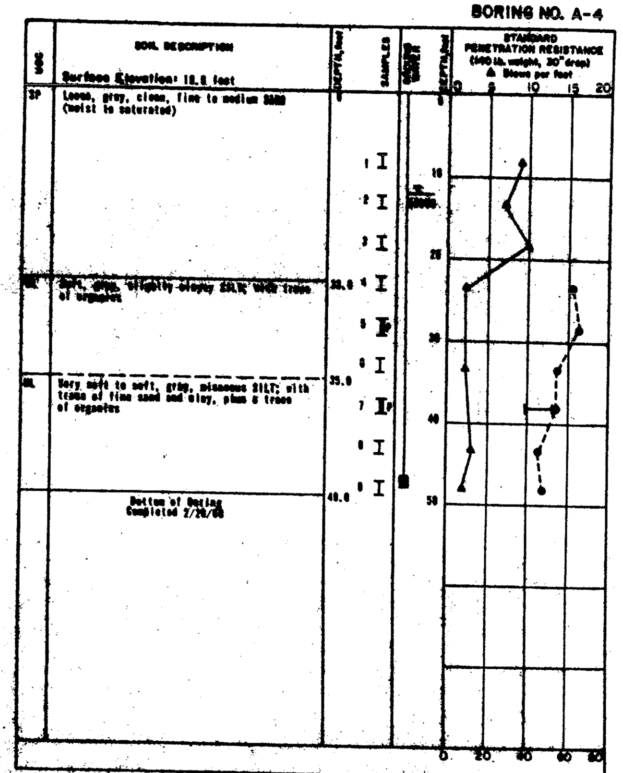


FIG. B-30

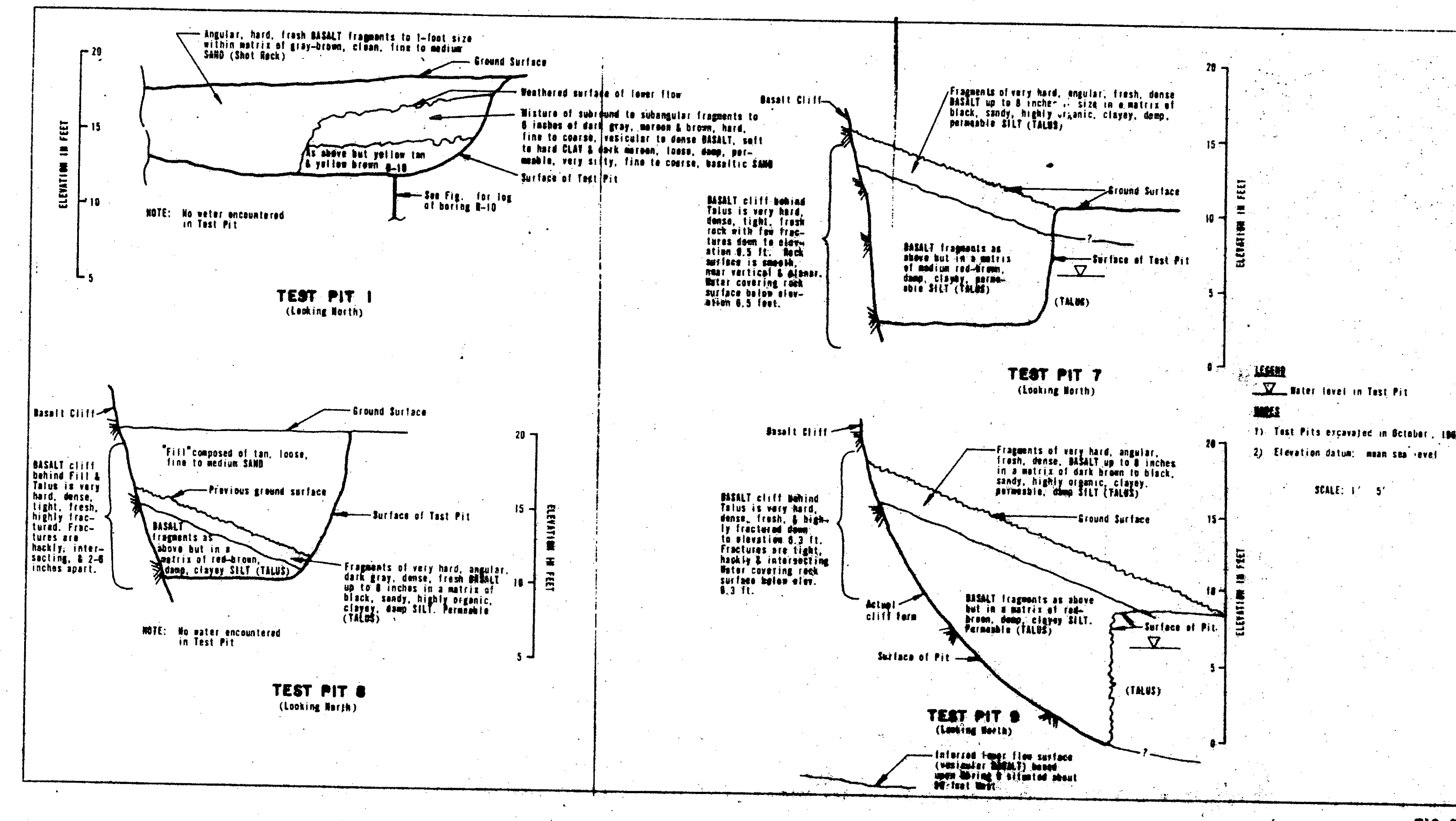


FIG. B-31

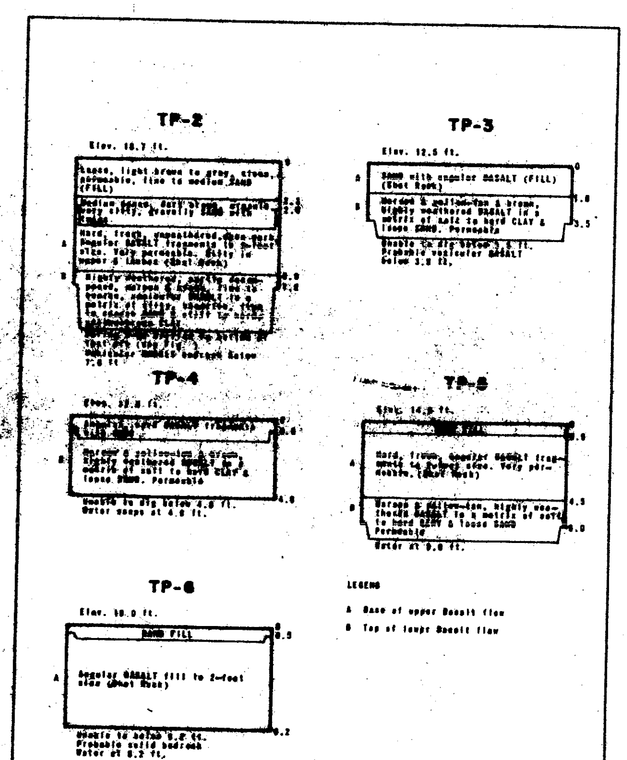
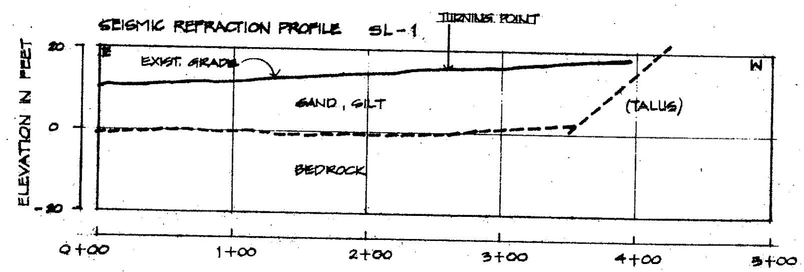
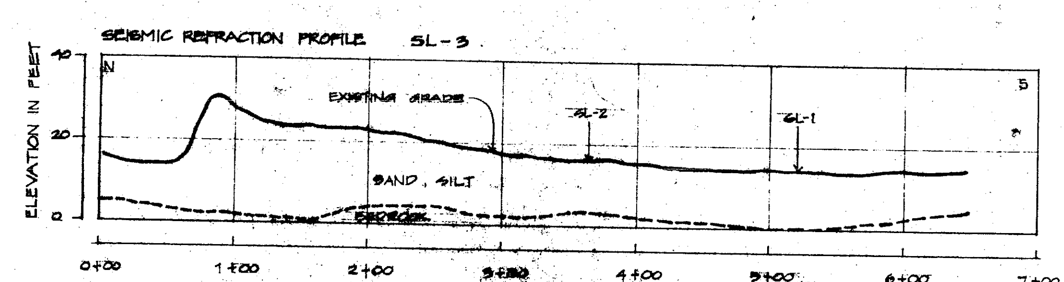
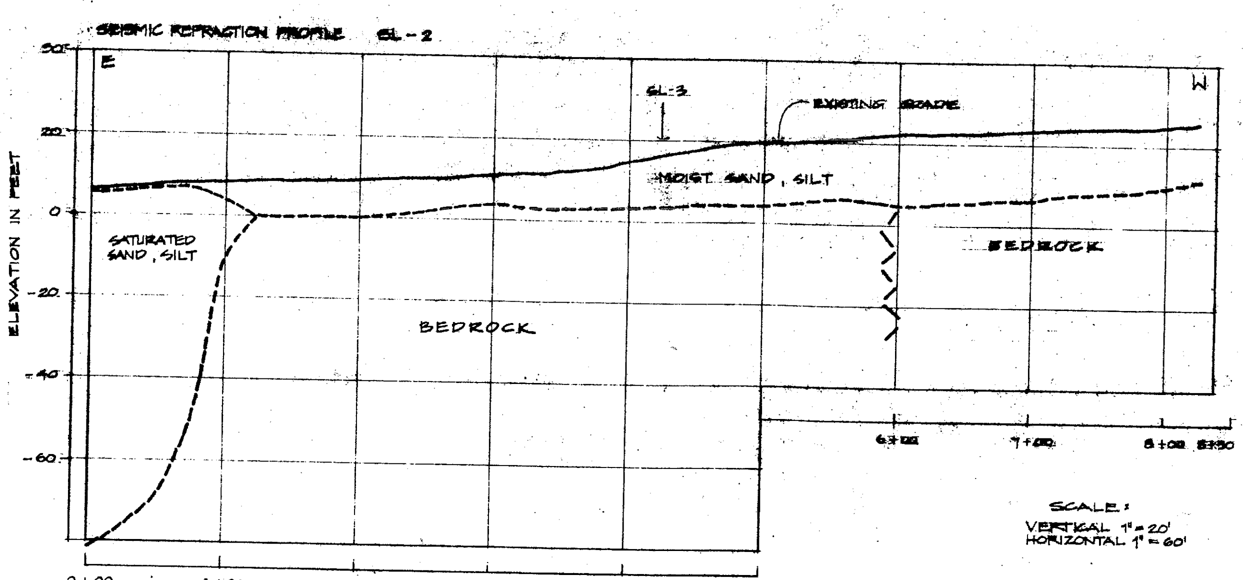
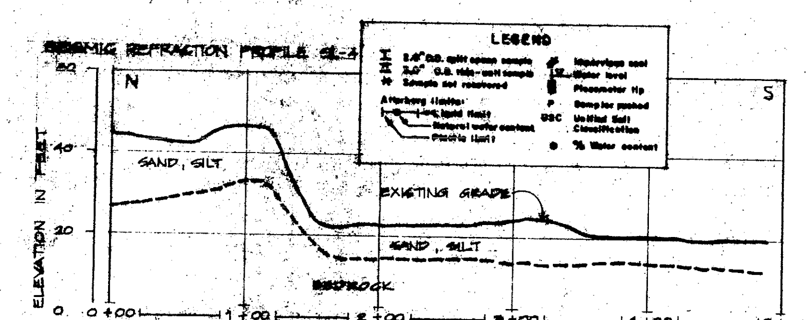


FIG. B-32









SCALE:
VERTICAL 1" = 20'
HORIZONTAL 1" = 60'

NOTE: SOILS INVESTIGATION CONDUCTED BY SHANNON & WILSON

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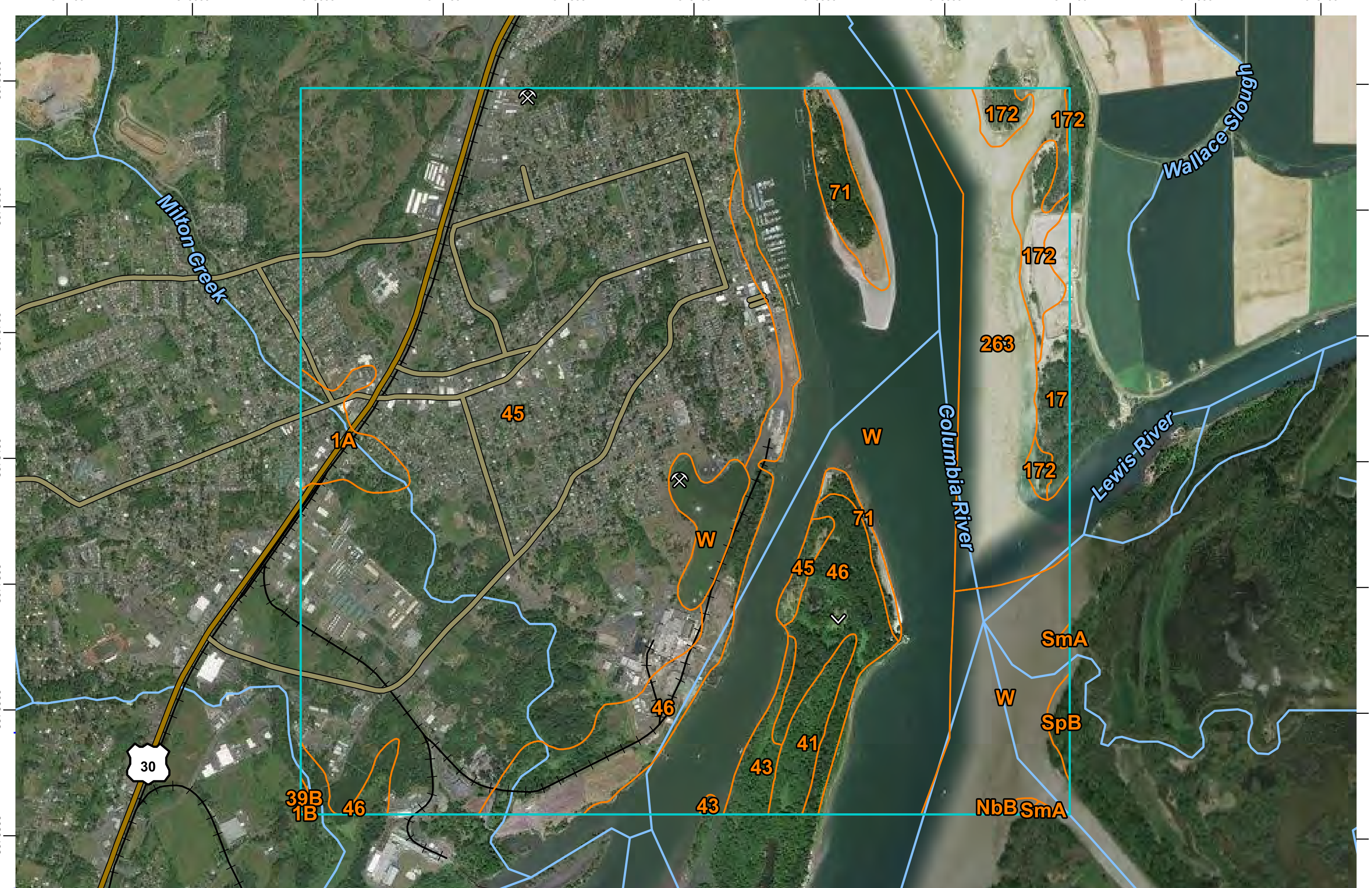
APPENDIX E

U.S. Department of Agriculture Soil Map



Map Scale: 1:29,300 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 400, 800, 1600, 2400

Feet: 0, 1000, 2000, 4000, 6000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:20,000 to 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Clark County, Washington
Survey Area Data: Version 17, Sep 16, 2019

Soil Survey Area: Columbia County, Oregon
Survey Area Data: Version 16, Sep 10, 2019

Soil Survey Area: Cowlitz County, Washington
Survey Area Data: Version 20, Sep 16, 2019

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 29, 2015—Jun 11, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
NbB	Newberg silt loam, 3 to 8 percent slopes	2.4	0.1%
SmA	Sauvie silt loam, 0 to 3 percent slopes	2.3	0.1%
SpB	Sauvie silty clay loam, 0 to 8 percent slopes	8.3	0.3%
W	Water	151.5	4.8%
Subtotals for Soil Survey Area		**164.6**	**5.2%**
Totals for Area of Interest		**3,165.1**	**100.0%**

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1A	Aloha silt loam, 0 to 3 percent slopes	45.5	1.4%
1B	Aloha silt loam, 3 to 8 percent slopes	0.1	0.0%
39B	Quafeno loam, 3 to 8 percent slopes	1.3	0.0%
41	Rafton silt loam	32.3	1.0%
43	Rafton-Sauvie-Moag complex	24.9	0.8%
45	Rock outcrop-Xerumbrepts complex, undulating	1,573.0	49.7%
46	Sauvie silt loam	247.9	7.8%
71	Xeropsamments, nearly level	50.3	1.6%
W	Water	702.2	22.2%
Subtotals for Soil Survey Area		**2,677.4**	**84.6%**
Totals for Area of Interest		**3,165.1**	**100.0%**

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
17	Caples silty clay loam, 0 to 3 percent slopes	37.8	1.2%
172	Riverwash	55.1	1.7%
263	Water	230.2	7.3%
Subtotals for Soil Survey Area		**323.1**	**10.2%**
Totals for Area of Interest		**3,165.1**	**100.0%**