Shaping our community together

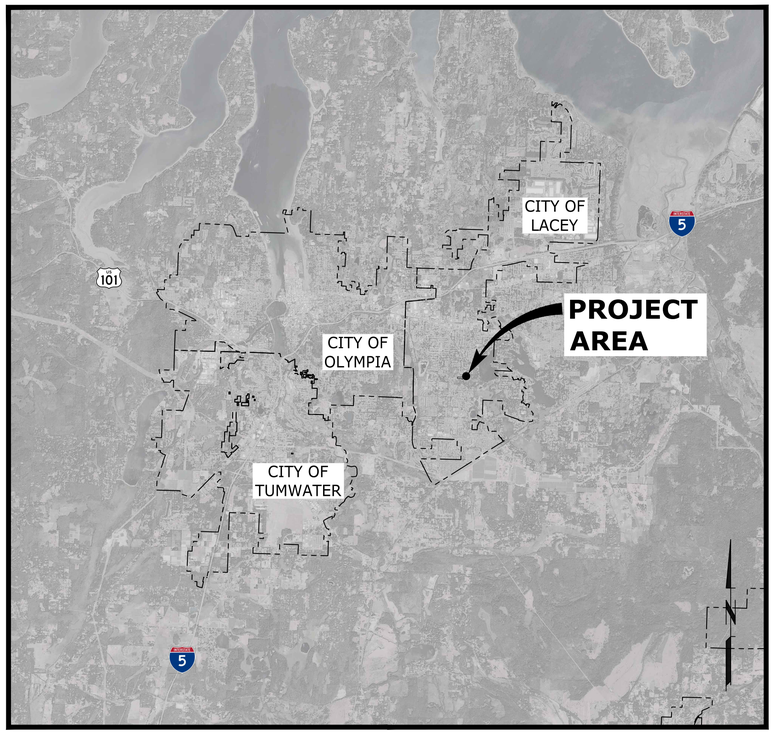
CITY OF LACEY

CITY OF LACEY, WASHINGTON
LIFT STATION 6 REHABILITATION
LACEY CONTRACT

NOVEMBER 2022

60% SUBMITTAL

INDEX OF DRAWINGS



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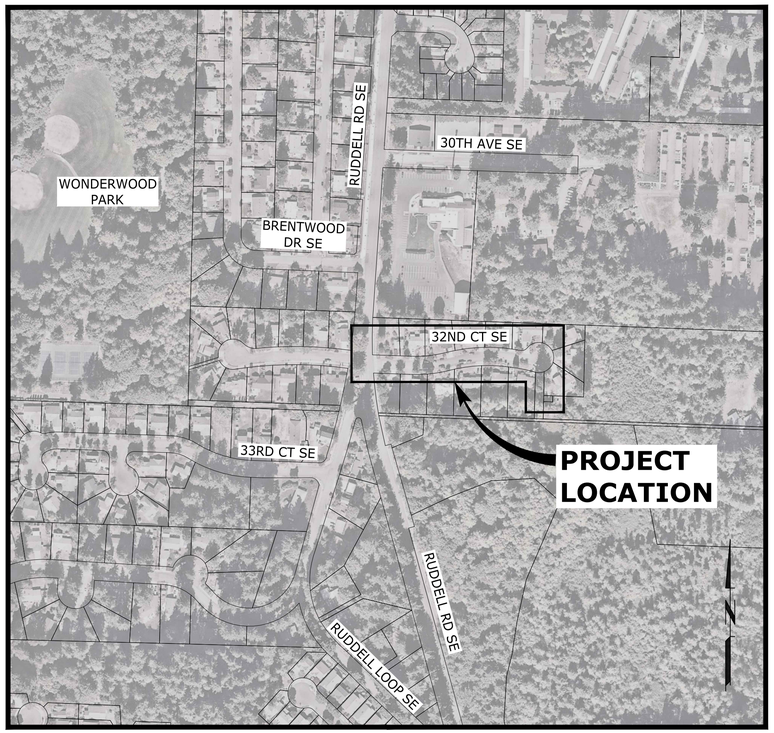

AREA MAP
SCALE: 1"=250'

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MALCOLM MILLER

COUNCIL MEMBERS:
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CITY MANAGER:
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DAVE SCHNEIDER

CITY ENGINEER:
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SCOTT EGGER, P.E.

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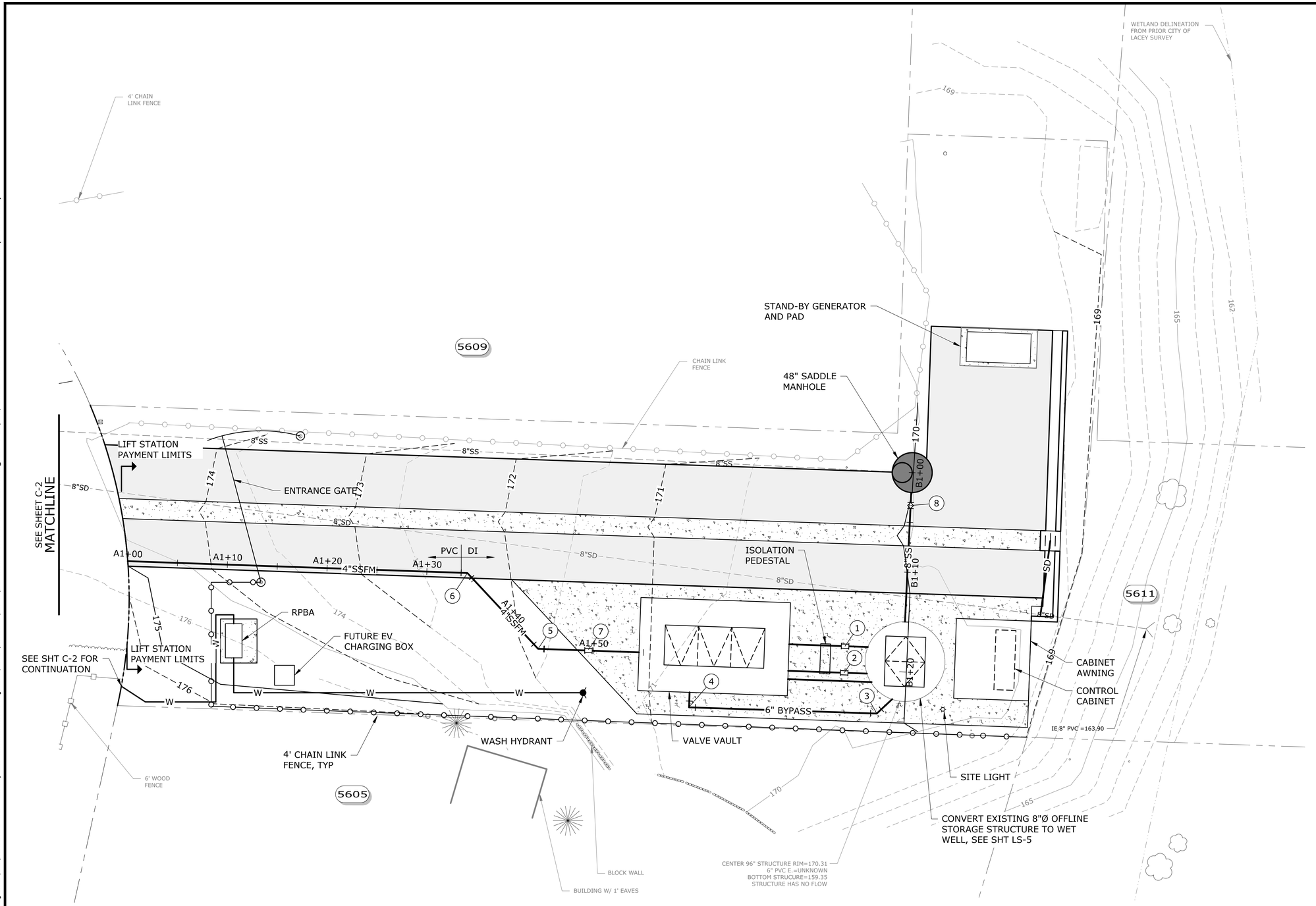

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2. N622854.29, E64883.16
   FURNISH AND INSTALL:
   1-4" LONG BODY SLEEVE, MJ
3. N622852.09, E64877.75
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4. N622869.88, E64878.37
   FURNISH AND INSTALL:
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7. N622879.91, E64855.39
   FURNISH AND INSTALL:
   1-4" LONG BODY SLV, MJ
8. N622847.63, E64899.93
   FURNISH AND INSTALL:
   1-8" PV, MJ

PLAN
SCALE: 1"=5'

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NO.	DATE	BY	REVISION

NOTICE
0 ½ 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

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CITY OF LACEY

CITY OF LACEY
LIFT STATION 6
REHABILITATION

SITE AND PIPING PLAN

PROJECT NO.: 22-3380.04 | SCALE: AS SHOWN | DATE: NOVEMBER 2022

SHEET
LS-4
X of XX

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CITY OF LACEY LIFT STATION 6

Critical Areas Report

Prepared for
City of Lacey and Murraysmith, Inc.

October 2022

Draft

CITY OF LACEY LIFT STATION 6

Critical Areas Report

Prepared for
City of Lacey and Murraysmith, Inc.

October 2022

5309 Shilshole Avenue NW
Suite 200
Seattle, WA 98107
206.789.9658
esassoc.com

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Critical Areas Report

LACEY LIFT STATION – LIFT STATION 6

Critical Areas Report

1.0 Project Authorization and Scope of Work

The City of Lacey (City) proposes to improve an existing wastewater lift station (Lift Station 6; proposed project) located in Lacey, Washington (**Figure 1**). At the request of the City and Murraysmith Inc., Environmental Science Associates (ESA) biologists reviewed the parcel per the scope of work, identified and delineated critical areas (wetlands and priority habitats) (**Figure 2**), and prepared this report to inform project planning and permitting. The study area was limited to within 200 feet of the proposed project area and does not include detailed evaluations or delineations of off-site critical areas.

This report adheres to regulatory requirements described in Lacey Municipal Code (LMC) Chapter 14.33 – Habitat Conservation Areas Protection and Chapter 14.26 – Shoreline Master Plan (SMP). The report provides a brief overview of the proposed project, discusses mapped critical areas and natural resources, presents the results of the field investigation, and documents potential regulatory implications associated with identified critical areas. Other types of critical areas regulated by the City, such as geographically hazardous areas, frequently flooded areas, and critical aquifer recharge areas, are not addressed in this report.

2.0 Proposed Project

The City proposes to improve and upgrade services associated with six lift stations, including Lift Station 6 to meet projected wastewater pumping requirements. The project is part of an ongoing effort to improve the reliability of existing lift stations throughout the city.

The study area consists of parcel 83450100000 and the western portion of parcel 11828110801, located south of 32nd Court Southeast in Lacey, Washington. The nearest address is 5609 32nd Court Southeast. The proposed project area covers approximately 2,500 square feet of the study area and includes the existing lift station. Land use surrounding the study area consists of mostly single-family residential housing, with an undeveloped wetland south and southeast of the study area, and Hicks Lake over 0.25 mile east of the study area. The study area is located within the NW ¼ of Section 28 of Township 18 North, Range 1 West. The parcels are zoned Low-Density Residential and Natural under the jurisdiction of the City.

3.0 Methods

ESA biologists reviewed existing information and conducted a field investigation to identify and assess critical areas. The field investigation was conducted by ESA biologists Maggie Bradshaw and James Watson on August 4, 2022.

3.1 Review of Existing Documentation

Prior to conducting the field assessment, ESA biologists reviewed the following data sources for specific information about the ecological and geographic conditions within the vicinity of the study area:

- U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory;
- USFWS Information for Planning and Consultation species and habitat database;
- Natural Resources Conservation Service Web Soil Survey;
- Washington Department of Fish and Wildlife Priority Habitats and Species mapping;
- Thurston County interactive map;
- City of Lacey Zoning map; and
- Northwest Indian Fisheries Commission (NWIFC) Statewide Integrated Fish Distribution.

The collected information was used as a baseline for the field assessment and delineation.

3.2 Wetland Identification, Delineation, and Classification

ESA biologists delineated wetlands according to local, state, and federal guidelines within the project limits. Wetlands were delineated using the *Routine Determination Method in the U.S. Army Corps of Engineers Wetland Delineation Manual* (Environmental Laboratory 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region – Version 2.0* (Regional Supplement) (USACE 2010) as approved by the Washington State Department of Ecology (Ecology). These methods rely on the presence of three criteria to determine wetland areas, including: (1) the dominance of wetland (i.e., hydrophytic) plant species; (2) the presence of hydric soils; and (3) indicators of wetland hydrology, such as soil saturation within the top 12 inches of the surface or evidence of ponded water. Wetland habitats were assessed using the USFWS habitat classification system (Cowardin et. al. 1979).

Site-specific delineation methods include traversing the study area to observe surface indicators of wetlands (reeds, rushes, willows, etc.; saturated soils or standing water) and establishing at least one set of paired data plots (DP#) to characterize wetland and non-wetland conditions. The methods also included establishing a minimum of one wetland plot in a low spot that overlaps with wetland mapping (DP1).

Data plots (DPs) were marked with orange flagging labeled DP1 (wetland) or DP2 (upland). The flags and data plot locations were recorded using the ArcGIS Fieldmaps application on an Apple

iPad paired with an Arrow 100 GNSS Receiver device. Where the wetland extended beyond the study area, only those portions of the wetland within or adjacent to the study area was flagged and surveyed.

3.3 Wetland Functional Assessment

Functions for the wetland within the study area were classified using the results from the Rating System. The Rating System first classifies a wetland's hydrogeomorphic (HGM) classification and then assigns multiple aspects relating to each function type (i.e., water quality, hydrology, and habitat) a high, medium, or low level of function based on the wetland's attributes. The HGM classification is based on three fundamental factors that influence how wetlands function: (1) position in the landscape (geomorphic setting), (2) water source (hydrology), and (3) the flow and fluctuation of the water once in the wetland (hydrodynamics).

Per LMC 14.28.100, the City has codified use of the Rating System and assigns wetland buffer widths based on wetland category, adjacent land use intensity, habitat score, whether the wetland is listed as having high conservation value, and whether mitigation measures are implemented. Per LMC 14.28.280(C)(2)(a) the City's wetland buffers range from 40 feet to 225 feet.

3.4 Fish and Wildlife Habitat Conservation Areas

The City regulates lakes and streams as fish and wildlife habitat conservation areas under LMC Chapter 14.33. The state water typing system (WAC 222-16-030) classifies streams as S, F, Np, or Ns, depending on their "shoreline of the state" status, presence of fish habitat, annual flow rate (seasonal or perennial), and connections to other waters. The City also assigns buffers to fish and wildlife habitat conservation areas (lakes and streams) to protect habitat functions.

4.0 Results

The following sections describe the results of the review of existing information and the field investigation. ESA identified and delineated one wetland within the study area, Wetland 1 (**Figures 5 and 6**). Only the northern edge of the wetland boundary that occurred on-site was flagged; the remaining boundary was estimated based on topography, plant communities, visual observations in the field, and aerial photography.

ESA biologists photographed the wetland and created figures (**Appendix A**), completed wetland determination datasheets (**Appendix B**), and completed a Washington State Department of Ecology wetland rating form and associated maps (**Appendix C**) for Wetland 1. Wetland characteristics and other relevant information are summarized in **Table 2**.

4.1 Wetlands

Wetland 1 is a category II depressional & flats, palustrine forested (PFO)/palustrine shrub scrub (PSS) wetland feature delineated along the southern slope of the study area. Wetland 1 extends off-site to the east, west, and south. The NWI maps one palustrine, unconsolidated bottom,

permanently flooded, diked/impounded (PUBHh) wetland within the southern segment of the study area and one palustrine, scrub-shrub, seasonally flooded, (PSSC) freshwater forested/shrub wetland southeast the study area, which is hydrologically connected to Hicks Lake located east of the site (**Figure 3**). The NWI mapping is consistent with the field findings. NWI also maps a short segment of stream that is encompassed within the wetland south of the study area, but no streams were mapped within or adjacent to the study area. Thurston County Permit mapper shows a palustrine, open water, shrub/scrub (POW/SS) wetland feature in the southern segment of the study area along with a palustrine shrub scrub east of previous mentioned wetland, corresponding with the NWI mapped wetland.

4.1.1 Landscape Setting, Climate and Precipitation

The study area lies within the Woodland Creek-Frontal Henderson Inlet subwatershed (Hydrologic Unit Code 171100190502) in the Deschutes watershed (Water Resource Inventory Area 13). The land that drains to the study area, and eventually into Henderson Inlet toward the east, is largely developed with mixed-density residential housing, community parks, and commercial land uses.

The field investigation was conducted on August 4, 2022, in the middle of the growing season. In the two months preceding the field investigation, precipitation was higher than normal in June (70 percent increase) and lower than normal in July (89 percent decrease) (NRCS 2022c). There were no rain events in the two weeks prior to the field investigation. Daily precipitation data was generated from the Seattle-Tacoma weather station.

4.1.2 Vegetation

Wetland vegetation within the study area is mostly wooded with a mixed coniferous-deciduous forest primarily dominated by western red cedar (*Thuja plicata*), and bigleaf maple (*Acer macrophyllum*) in the tree canopy. The emergent class was dominated by reed canary grass (*Phalaris arundinacea*) and fringed willowherb (*Epilobium ciliatum*) Non-native or invasive vegetation present includes Himalayan blackberry (*Rubus bifrons*).

Upland vegetation within the study area was dominated by black cottonwood (*Populus trichocarpa*) and bigleaf maple in the tree canopy. The understory was dominated by English ivy (*Hedera helix*) and Himalayan blackberry.

4.1.3 Soils

The Web Soil Survey maps Indianola loamy sand as the single soil type within the study area. Indianola loamy sand is a somewhat excessively drained soil that is common on sandy glacial outwash and considered nonhydric by the Natural Resources Conservation Service (NRCS 2022b). However, 15 percent of the mapped soil can include hydric soils (**Figure 4**).

4.1.4 Hydrology

During the time of field investigation, at least two inches of standing water (A1) was observed two feet away from DP1. At DP1, biologists observed a high water table (A2) and soil saturation (A3) measured to the surface of the soil plot.

4.2 Fish and Wildlife Habitat Conservation Areas

The Washington Department of Fish and Wildlife Priority Habitats and Species map and USFWS Information for Planning and Consultation database list several federally and state-listed species that are potentially affected by anthropogenic activities within the vicinity of the study area. These species are summarized in **Table 1**.

The Olympic and Yelm (Mazama) pocket gophers are listed as an Important Species of Thurston County. The County depicts the soils as "less preferred" potentially due to high saturation in the soils. Burrowing activity was not observed during the field reconnaissance and delineation.

Wood ducks (*Aix sponsa*) were observed in a ponded area in the eastern, delineated end of Wetland 1. The Washington Department of Fish and Wildlife Priority Habitats and Species mapping depicts the study area as a wood duck breeding area. These cavity-nesting ducks nest primarily in late successional forests and riparian areas adjacent to low gradient rivers, sloughs, lakes, and beaver ponds (WDFW 2000). Wood ducks are not federally nor state listed.

None of the species listed in **Table 1** are likely to occur within the vicinity of the study area due to a lack of suitable habitat, and there are no known records of these species occurring in the vicinity of the study area.

TABLE 1
SPECIAL-STATUS SPECIES AND HABITATS POTENTIALLY PRESENT IN THE STUDY AREA

Type	Species Name (*Scientific name*)	Federal Status	State Status	Habitat Requirements	Present in Study Area or Vicinity?
Mammals	Olympia pocket gopher (Thomomys mazama pugentensis); Yelm pocket gopher (Thomomys mazama yelmensis)	LT, CH	LT	Loose sandy loam soils with edible plant cover. Primarily associated with prairies but may be present in grasses/lawns or disturbed areas with suitable soil.	No, the study area is mapped as "less preferred" on Thurston County's geodata center. Soils are too saturated to provide suitable habitat.
	Little brown bat (Myotis lucifugus); Big brown bat (Eptesicus fuscus); Yuma myotis (Myotis yumanensis)	—	PS	Roosts primarily in tree cavities, rock crevices, caves, and mines. Forage primarily over or near water.	Mapped occurrence at the township level, but not likely to occur within the study area.
Birds	Marbled murrelet (Brachyramphus marmoratus)	LT, CH	LE	Nests in old-growth and mature coniferous forests with proximity to marine waters.	No, most likely occurrences are on the Olympic Peninsula and the northern Cascade Range.
	Wood duck (Aix sponsa)	—	PS	Nests in tree cavities primarily in late successional forests and riparian areas adjacent to low gradient rivers, sloughs, lakes, and beaver ponds.	Yes, present in the vicinity; uses cavities in standing dead trees as breeding sites. No trees will require removal for the project and no impacts are anticipated.
	Streaked horned lark (Eremophila alpestris strigata)	LT, CH	LE	Large expanses of bare or sparsely vegetated land, including fields, prairies, upper beaches, airports, and similar areas with sparse grassy vegetation.	No, the forested study area does not provide suitable habitat.
	Yellow-billed cuckoo (Coccyzuz americanus)	LT, CH	LE	Requires large blocks (≥200 acres) of riparian forest; not considered an active breeding species in Washington.	No, extirpated from Washington and Oregon as a breeder; no suitable habitat in study area.
Fish	Bull trout (Salvelinus confluentus)	LT, CH	C	Cold, stable stream channels with clean spawning and rearing gravel.	No, riparian areas or streams are not located within the study area.
Insects	Monarch butterfly (Danaus plexippus)	C	—	Weedy fields and sparsely vegetated habitats, typically near wetlands or riparian areas. Dependent on milkweed.	No, occurrences are concentrated along the Columbia and Snake Rivers.
	Taylor's checkerspot (Euphydryas editha taylori)	LE, CH	LE	Open prairie and grassland, coastal bluffs and dines, and small forest openings (balds).	No, the forested study area does not provide suitable habitat.
Flowering Plants	Golden paintbrush (Castilleja levisecta)	LT	LT	Open grasslands on glacial outwash and alluvial soils, as well and mima mounds.	No, the forested study area does not provide suitable habitat.

NOTES: C = Candidate; CH = Critical Habitat; LE = Listed Endangered; LT = Listed Threatened, PS = Priority Species

SOURCES: USFWS 2022b; WDFW 2022.

5.0 Regulatory Considerations

5.1 City of Lacey

The City regulates wetlands under LMC 14.28 and shorelines under the shoreline code LMC 17.20. Regulated and allowed activities in wetlands are provided under LMC 14.28.100 and 14.28.110. For mitigating wetland and wetland buffer impacts, the City requires restoration, creation, or enhancement of wetlands. Wetlands located within shoreline jurisdiction are also subject to regulation under LMC 16.19.015(C). The proposed project would require review and approval according to these regulations in addition to shoreline approval.

Shoreline

Shorelines of the State are regulated by the City under the Washington State Shoreline Management Act (SMA). Ecology is required to review and approve local programs and certain types of shoreline permits to ensure the project meets the three major policy objectives of the Act (RCW 90.58.020). These policies include: (1) protecting shoreline resources and the natural environment; (2) increasing public access to publicly owned shoreline areas; and (3) encouraging water-dependent uses. If development is proposed within shoreline jurisdiction, the development must result in no net loss of shoreline ecological function. The development will require prioritization of avoidance and minimization of shoreline functions and values, followed by mitigation measures that ensure no net loss of ecological function.

The City of Lacey Shoreline Master Program describes permitted uses, development standards, and modifications for activities within shorelines, including utilities (lift stations). Lift Station 6 is within a Natural shoreline environment designation because of its proximity to a large wetland associated with Hicks Lake (**Figure 10**). Under 17.24.010 (Table 3), utilities as a primary use in a Natural shoreline require Conditional Use permit, however, an early application meeting with the City is recommended to determine if the project would qualify for a Development permit as the lift station is an existing use.

Shoreline Conditional Use Permits provide a system within the master program to have flexibility in the application of use regulations in a manner consistent with the policies of RCW 90.58.020. (Lacey SMP 2015) Additionally, Per SMP 17.30.015(1) and SMP 17.30.015(2) propose the following requirements:

A. That the proposed use is consistent with the policies of RCW 90.58.020 and the master program;

B. That the proposed use will not interfere with the normal public use of public shorelines;

C. That the proposed use of the site and design of the project is compatible with other authorized uses within the area and with uses planned for the area under the Comprehensive Land Use Plan and Shoreline Master Program;

D. That the proposed use will cause no significant adverse effects to the shoreline environment in which it is to be located; and

E. That the public interest suffers no substantial detrimental effect.

Wetland Buffer Requirements

The City generally prohibits filling and grading of wetlands and requires a protective, vegetated buffer around each to limit adverse effects of adjacent expansion. Under LMC 14.28.280(B), wetland buffer widths are based on the wetland category, proposed land use, and the identified wetland functions and values. Category II wetland buffers range from 75 to 225 feet according to LMC 14.28.280(C)(2)(a) (Table 14T-19). The Category II wetland within the study area scored 7 for habitat and has a buffer width of 110 to 150 feet, depending on the implementation of minimization measures. The entire lift station is within 110 feet of the wetland boundary and some form of mitigation or minimization measures may be needed to construct the project.

Potential Project Impacts

The project would redevelop an existing lift station within a graveled wetland buffer and Natural shoreline designation. A maximum of 2,500 square feet of grading and construction disturbance is proposed, but no trees or native vegetation would require removal for the project.

Utility facilities are allowed in buffers under LMC 14.28.120(H) with mitigation as long as best management practices are implemented to protect critical areas. Mitigation may include stormwater retrofits or replacement of non-native/invasive vegetation with native species. Depending on precise project impacts and because upgrades would occur at an existing, developed lift station, it may be possible to demonstrate that the project would have no adverse effect on existing wetlands and therefore no mitigation would be needed (LMC 14.28.510(J)(1). Input from city planning is required to make this determination.

Fish and Wildlife Habitat Conservation Areas

The City regulates FWHCAs under LMC 14.33. As described in Section 4.1, Hicks Lake and the unknown intermittent stream are located more than 200 feet away from the study area and no adverse impacts to streams or lakes would occur due to the project. Wood duck, a cavity nesting duck, was observed in a ponded area within Wetland 1. However, this species would be unaffected by the proposed project as no snags or trees are proposed for removal and no work in wetlands is proposed. Other special-status species listed in **Table 1** above would not be affected by the proposed project due to their absence within the study area and vicinity.

5.2 State and Federal Permits and Approvals

No federal permits are anticipated for this project because it would not involve work below the ordinary high water mark of a stream or lake, or within a wetland. Ecology would review and approve a Shoreline Conditional Use permit, if one was required, but not a Development permit.

6.0 Limitations

Within the limitations of schedule, budget, scope-of-work, and seasonal constraints, we warrant that this investigation was conducted in accordance with generally accepted environmental science practices, including the technical guidelines and criteria in effect at the time this investigation was performed. The results and conclusions of this report represent the authors' best professional judgment, based on information provided by the project proponent in addition to that obtained during this study. No other warranty, expressed or implied, is made.

7.0 References

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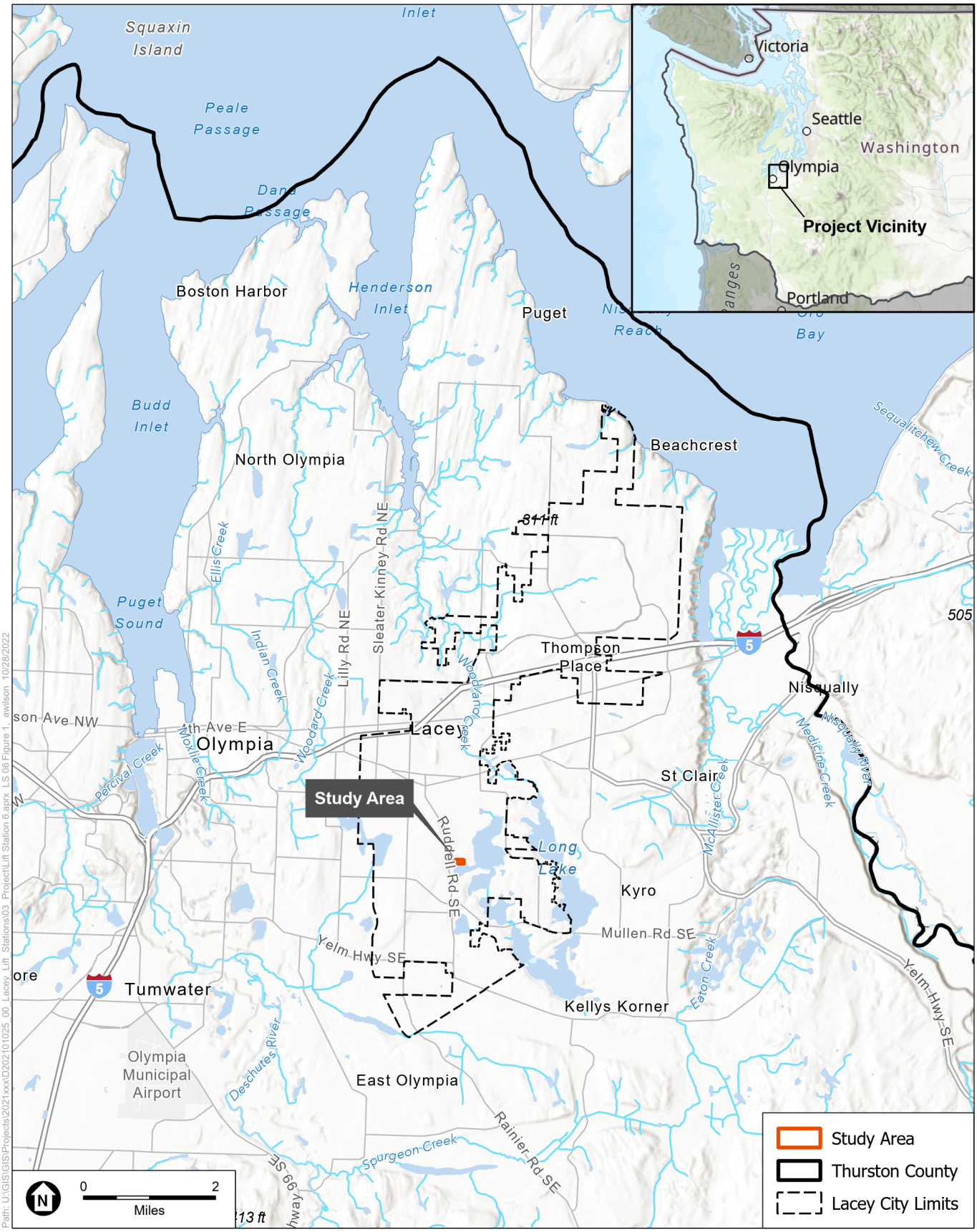
Appendix A
Figures

ESA

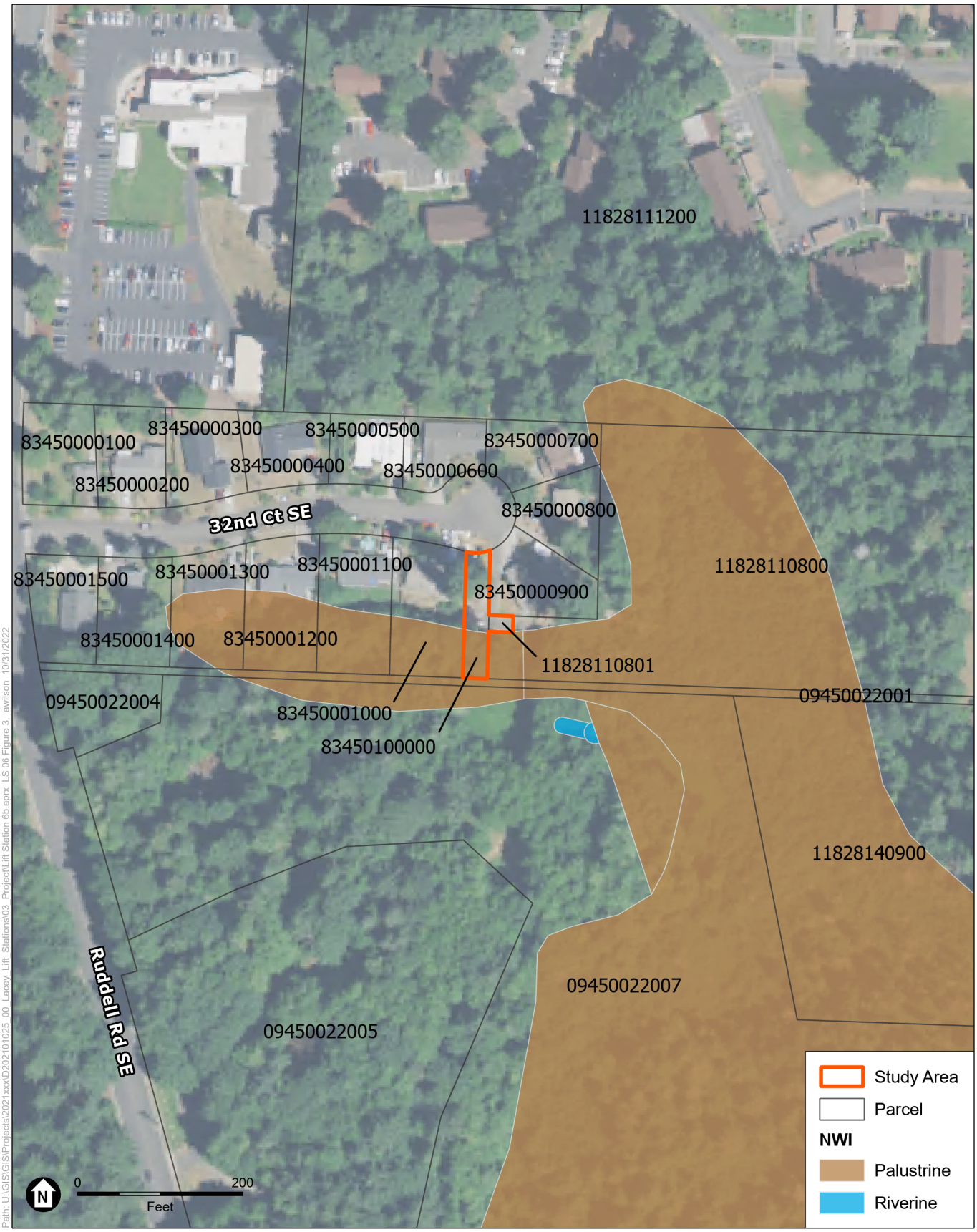


SOURCE: Basemap: Esri, 2022; ; Hydrography: WA DNR, 2021

Lacey Lift Stations

Figure 1
Project Vicinity
Lift Station 06

ESA

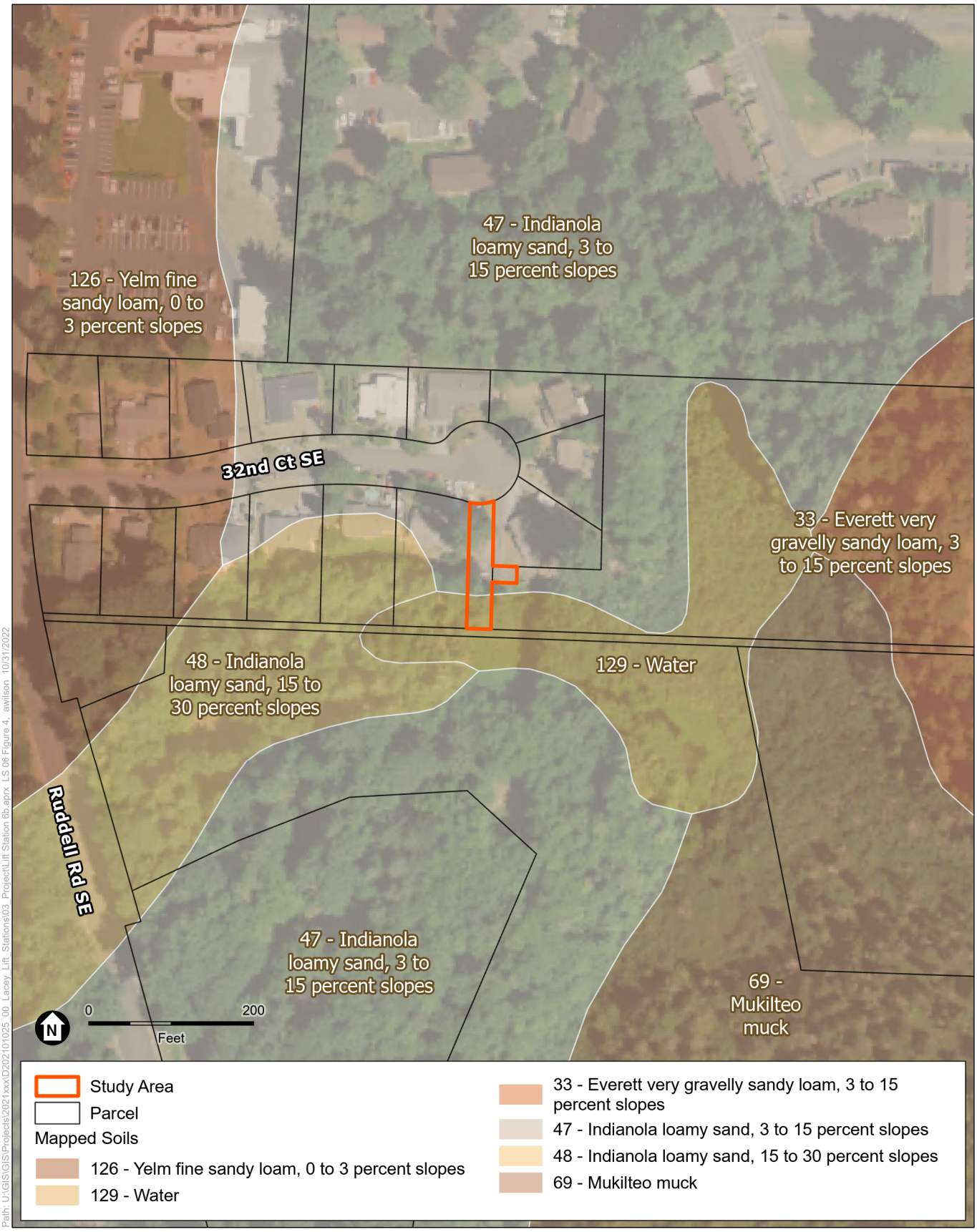


SOURCE: Imagery: USDA NAIP, 2021; Parcels: Thurston County, 2019; Recorded Wetlands: NWI, 2022

Lacey Lift Stations

Figure 2
National Wetland Inventory
Lift Station 6

ESA



SOURCE: Imagery: USDA NAIP, 2021; Parcels: Thurston County, 2019; Soils: USDA SSURGO, 2022

Lacey Lift Station

Figure 3
NRCS Soils
List Station 6

ESA

SOURCE: Imagery: USDA NAIP, 2021; Parcels: Thurston County, 2019; Recorded Wetlands: NWI, 2022; Survey Data: ESA, 2022

Lacey Lift Station

Accuracy statement: Wetland data plots, boundaries and other critical areas were mapped using an Eos Arrow GNSS bluetooth receiver with SBAS real-time corrections and a tablet data collector. All surveyed data recorded horizontal accuracy below 1 meter.

Figure 4
Critical Areas - Wetland Delineation Map
Lift Station 6

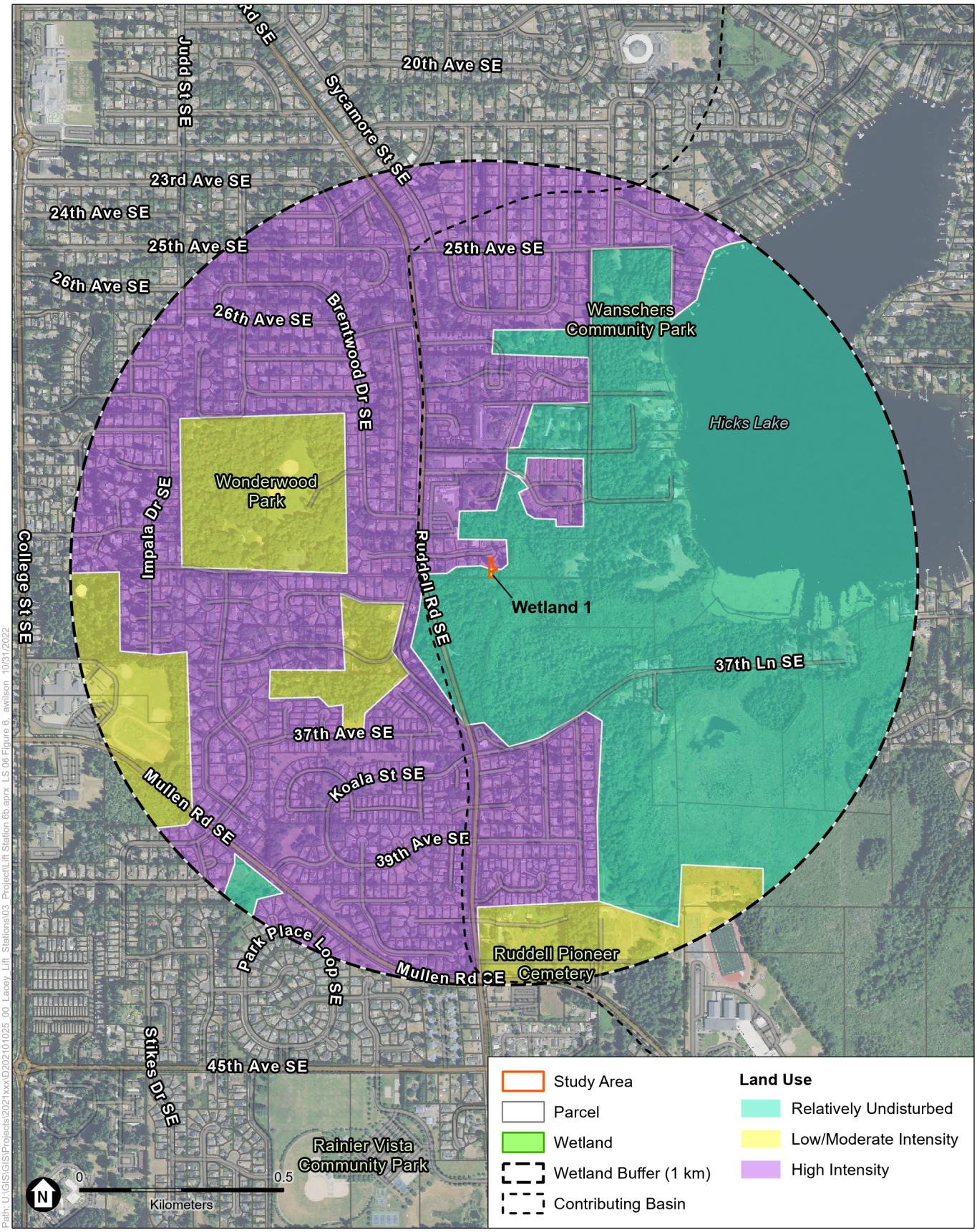
ESA

SOURCE: Imagery: USDA NAIP, 2021; Parcels: Thurston County, 2019; Land Use, Wetland: ESA, 2022

Lacey Lift Stations

Figure 5
Wetland Rating Figure A
Lift Station 6

ESA



SOURCE: Imagery: USDA NAIP, 2021; Parcels: Thurston County, 2019; Land Use, Wetland: ESA, 2022

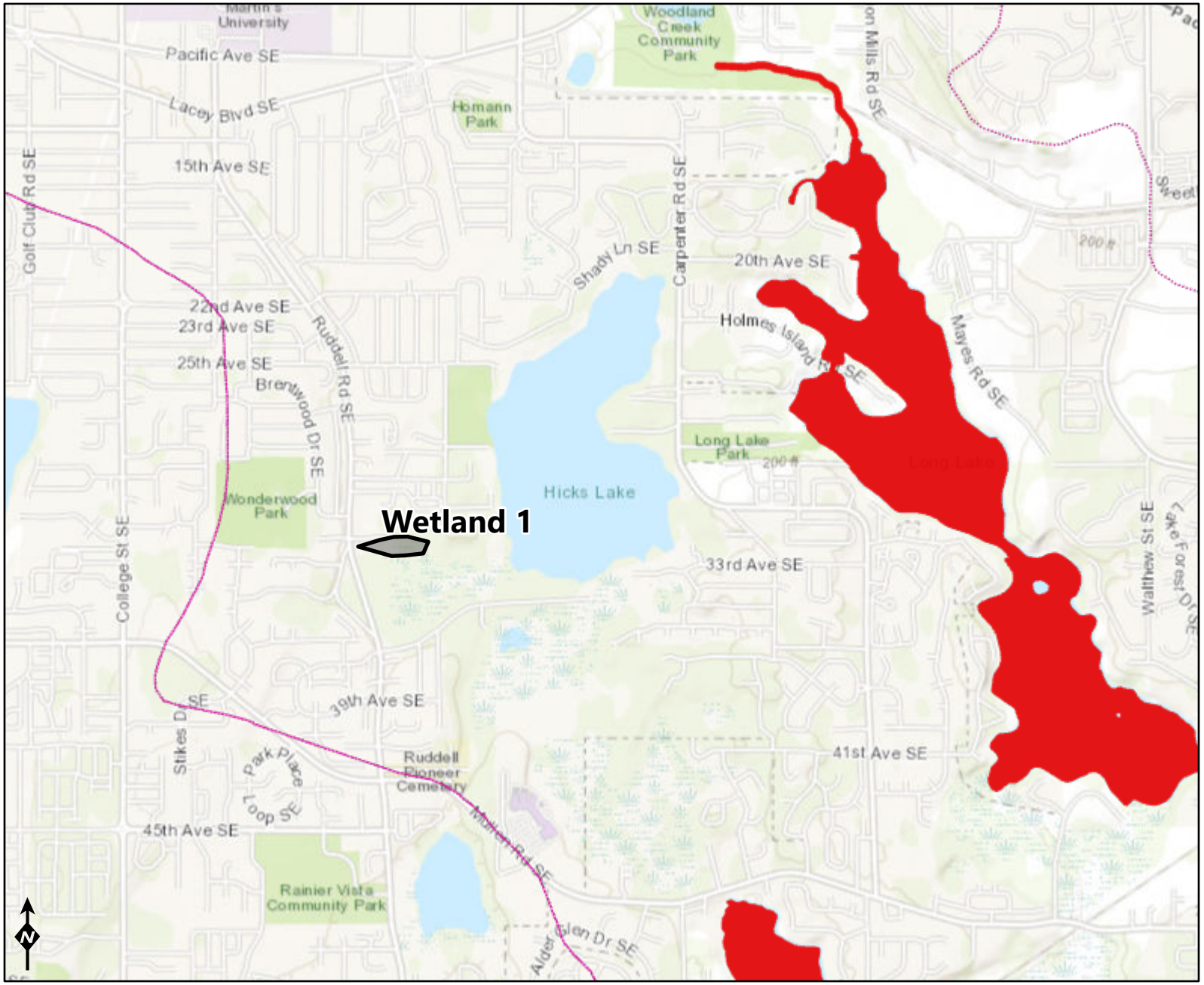
Lacey Lift Stations

Figure 6
Wetland Rating Figure B
Lift Station 6

ESA

September 29, 2022

303(d) - LS06



Assessed Water/Sediment

Water
- Category 5 - 303d
- Category 4C
- Category 4B
- Category 4A
- Category 2
- Category 1

Sediment
- Category 5 - 303d
- Category 4C
- Category 4B
- Category 4A
- Category 2
- Category 1

Subbasins (12 digit HUCs)
- HUC boundary

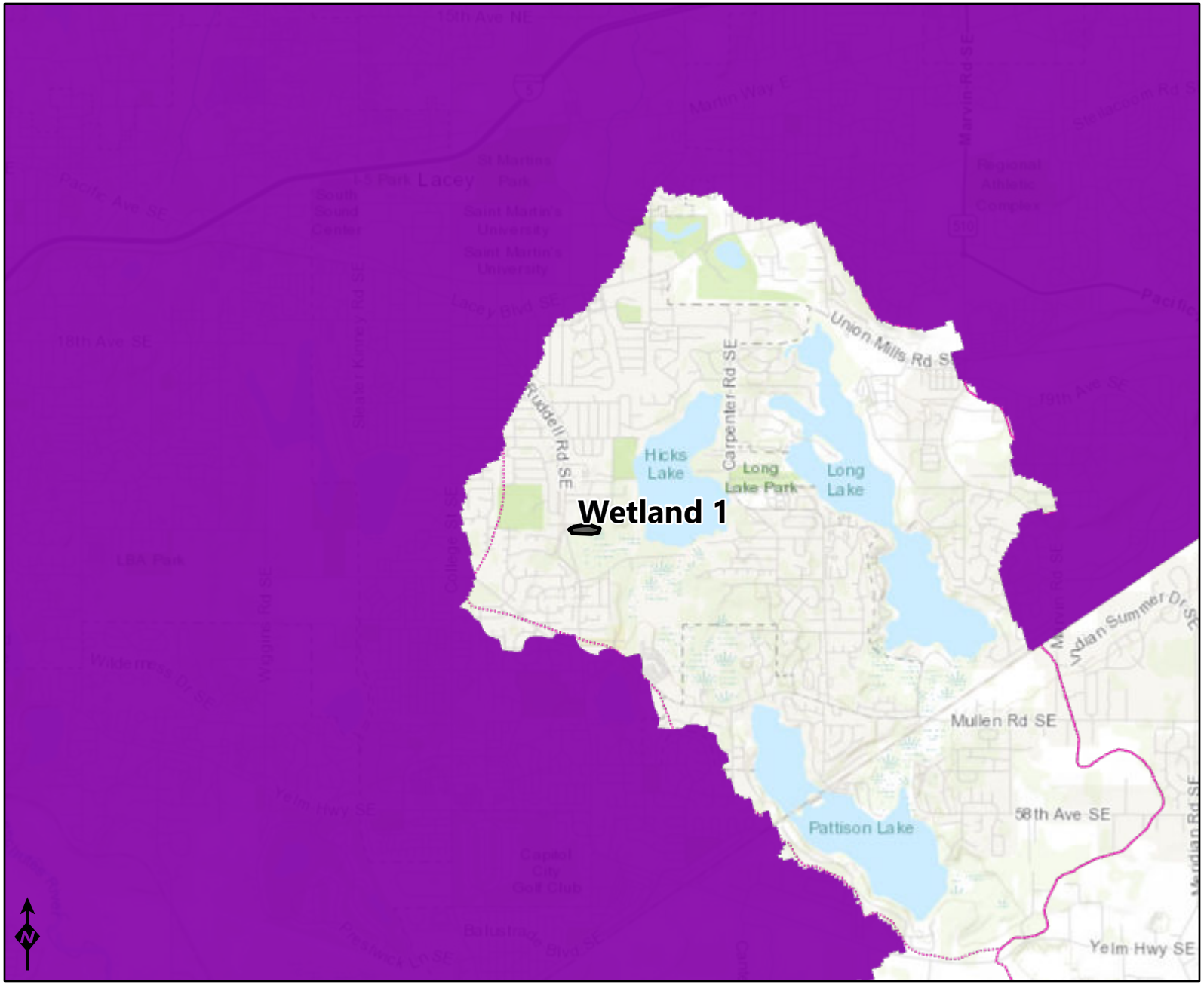
Miles
0 0.23 0.45 0.9

Figure 7
303(d) Listed Waters

DEPARTMENT OF ECOLOGY
State of Washington

September 29, 2022

TMDL - LS06



WQ Improvement Projects
- Approved
- In Development

Subbasins (12 digit HUCs)
- HUC boundary

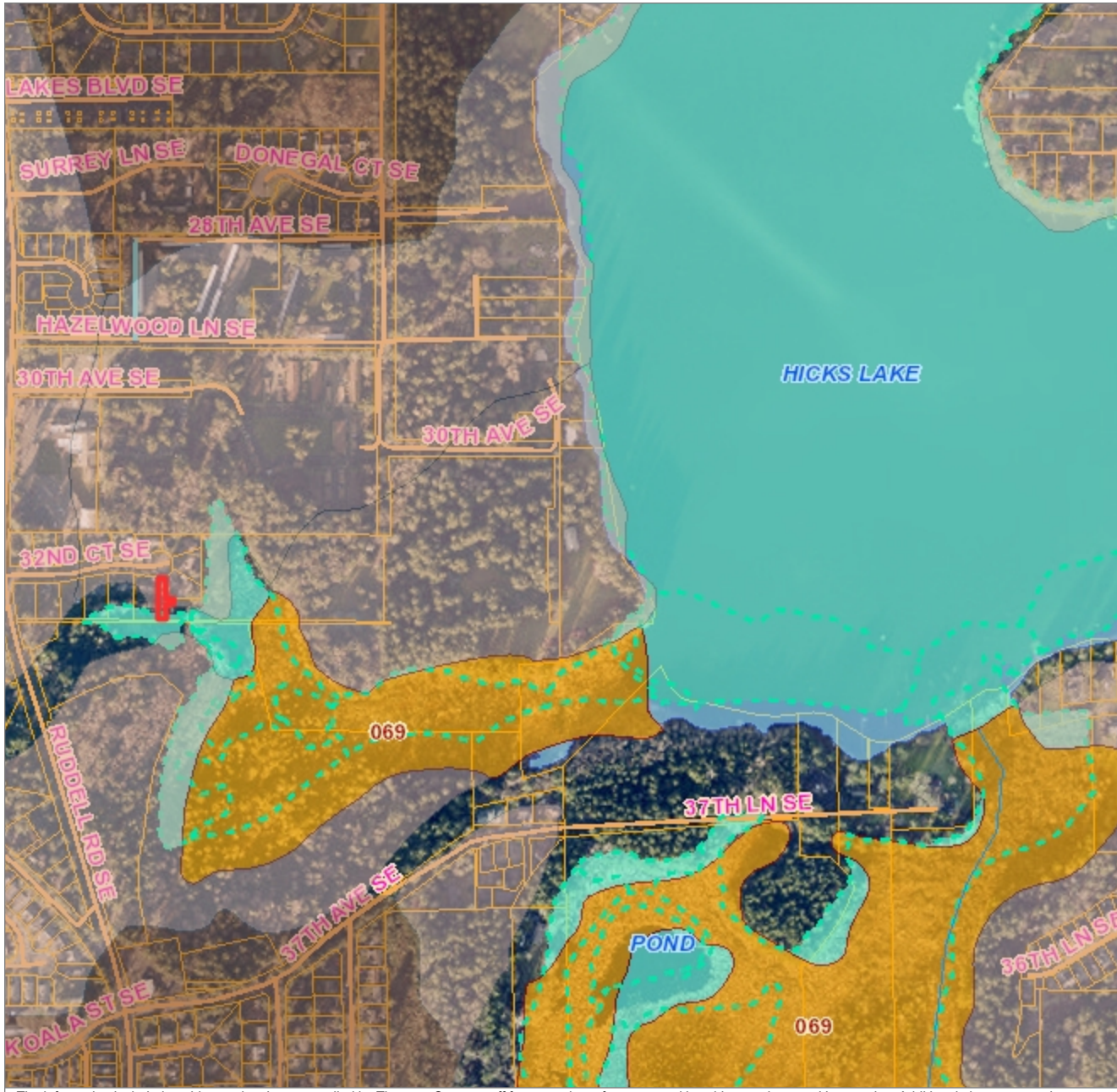
Miles
0 0.5 1 2

Esri, NASA, NGA, USGS, FEMA
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri

Figure 8
TMDL

DEPARTMENT OF ECOLOGY
State of Washington

Thurston County - Lift Station 6



Legend

- Mazama Pocket Gopher Areas
  - Occupied
  - Near
- Oregon Vesper Sparrow Areas
- Taylor's Checkerspot Butterfly Areas
- Oregon Spotted Frog Areas
- Mazama Pocket Gopher Soils
  - Less Preferred
  - More Preferred
- Streams
- Wetland Delineations
  - Verified
  - Delineated
  - Unverified
- Parcel Boundary
- Unknown
- Roads
  - City
  - County
  - Government
  - Private
  - State
- Hydric Soils
- Wetlands
- Waterbodies
- Parcel Boundaries
- Roads - Major
  - Major Roads
  - Ramp

Scale 1: 10,406

0 450 900

Feet

Map Created Using GeoData Public Website

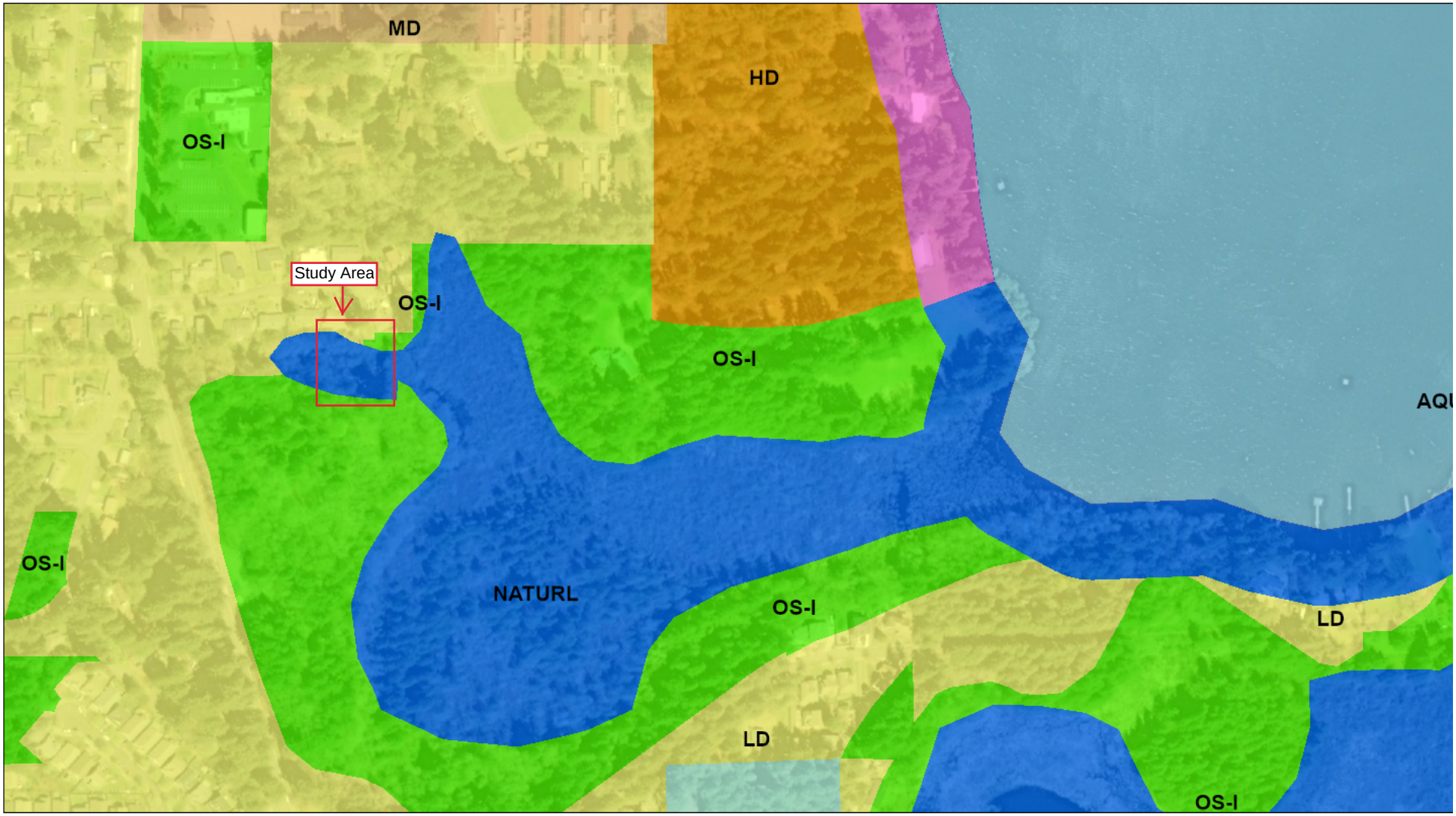
Published: 10/31/2022

Note:

THURSTON COUNTY
WASHINGTON
SINCE 1852

Thurston County GeoData Center

City of Lacey, WA - Zoning Map



October 31, 2022

Lacey City Limits

Lacey Zoning (August 2022)

- LD - Low Density Residential
- MD - Moderate Density Residential
- HD - High Density Residential
- C - Cemetery
- OS-I - Open Space Institutional
- URBCON - Urban Conservancy
- NATURL - Natural
- AQUATC - Lake/Aquatic

1:4,514

0 0.04 0.07

0 0.05 0.1 0.2

Maxar

City

Appendix B
Wetland Photographs

ESA

SOURCE: ESA, 2022

Lacey Lift Station – Lift Station 6

Photo 1

Wetland 1, DP1 facing southwest

Photo 2
Wetland 1, facing south

Appendix C
Wetland Determination Data Forms

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Lacey Lift Stations | City/County: Thurston/Lacey | Sampling Date: 4-Aug-2022
Applicant/Owner: City of Lacey | State: Washington | Sampling Point: DP1
Investigator(s): James Watson, Maggie Bradshaw | Section, Township, Range: S28 T18N R1W
Landform (hillslope, terrace, etc.): Depression | Local relief (concave, convex, none): concave | Slope (%): 1
Subregion (LRR): LRR A | Lat: 47.018605 | Long: -122.808245 | Datum: - WGS84
Soil Map Unit Name: Indianola loamy sand, 5 to 15 percent slopes | NWI classification: Wetland
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✓ No ___ (If no, explain in Remarks.)
Are Vegetation no Soil no or Hydrology no significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ___
Are Vegetation no Soil no or Hydrology no naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ✓ No ___
Hydric Soil Present? Yes ✓ No ___
Wetland Hydrology Present? Yes ✓ No ___
Is the Sampled Area within a Wetland? **Yes X** **No ___**

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30 ft/radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. Acer macrophyllum	20	yes	FACU
2. Thuja plicata	15	yes	FAC
3. Salix scouleriana	2	no	FAC
4.	0		
	37 = Total Cover		
Sapling/Shrub Stratum (Plot size: 30 ft/radius)			
1.	0		
2.	0		
3.	0		
4.	0		
5.	0		
	0 = Total Cover		
Herb Stratum (Plot size: 5 ft/radius)			
1. Epilobium ciliatum	25	yes	FACW
2. Phalaris arundinacea	10	yes	FACW
3.	0		
4.	0		
5.	0		
6.	0		
7.	0		
8.	0		
9.	0		
10.	0		
11.	0		
	35 = Total Cover		
Woody Vine Stratum (Plot size: 30)			
1. Rubus bifrons	20	yes	FAC
2.	0		
	20 = Total Cover		

% Bare Ground in Herb Stratum: 65

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)
Total Number of Dominant Species Across All Strata: 5 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 80 % (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1=	0
FACW species	140	x 2=	280
FAC species	5	x 3=	15
FACU species	10	x 4=	0
UPL species	0	x 5=	
Column Totals:	155 (A)		335 (B)

Prevalence Index = B/A = 2.16

Hydrophytic Vegetation Indicators:
___ 1-Rapid Test For Hydrophytic Vegetation
yes 2-Dominance Test is >50%
___ 3-Prevalence Index is ≤3.0[1]
___ 4-Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ 5-Wetland Non-Vascular Plants[1]
___ 6-Problematic Hydrophytic Vegetation[1](Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes ✓** **No ___**

Remarks:

SOIL

Sampling Point: DP1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0 - 16	7.5YR 2.5/1	100		0			Silt loam	
0 - 0		0		0				
0 - 0		0		0				
0 - 0		0		0				
0 - 0		0		0				
0 - 0		0		0				
0 - 0		0		0				
0 - 0		0		0				
-								

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- X Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type:

Depth (inches): 0

Hydric Soil Present? **Yes** ✓ **No** ___

Remarks:

Soils too saturated to view redox; assume hydric based in presence of water.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- X Surface Water (A1)
- X High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) **(LRR A)**
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) **(LRR A)**
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	yes	Depth (Inches):	2
Water Table Present?	yes	Depth (Inches):	0
Saturation Present? (includes capillary fringe)	yes	Depth (Inches):	0

Wetland Hydrology Present? **Yes** ✓ **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Surface water present 2 feet away.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: Lacey Lift Stations | City/County: Thurston/Lacey | Sampling Date: 4-Aug-2022
Applicant/Owner: City of Lacey | State: Washington | Sampling Point: DP2
Investigator(s): James Watson, Maggie Bradshaw | Section, Township, Range: S28 T18N R1W
Landform (hillslope, terrace, etc.): Flat | Local relief (concave, convex, none): Convex | Slope (%): 4
Subregion (LRR): LRR A | Lat: 45.9830143333 | Long: -122.851366667 | Datum: - WGS84
Soil Map Unit Name: Rafton silt loam, protected | NWI classification: None
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ____ No ✓ (If no, explain in Remarks.)
Are Vegetation no Soil no or Hydrology no significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____
Are Vegetation no Soil no or Hydrology no naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ____ No ✓
Hydric Soil Present? Yes ____ No ✓
Wetland Hydrology Present? Yes ____ No ✓
Is the Sampled Area within a Wetland? **Yes** ____ **No** X

Remarks:
Not all three parameters are met.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30 ft/radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. Populus trichocarpa	40	yes	FACW
2. Acer macrophyllum	25	yes	FACU
3. Alnus rubra	15	no	FAC
4.	0		
	80 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15 ft/radius)			
1.	0		
2.	0		
3.	0		
4.	0		
5.	0		
	0 = Total Cover		
Herb Stratum (Plot size: 5 ft/radius)			
1.	0		
2.	0		
3.	0		
4.	0		
5.	0		
6.	0		
7.	0		
8.	0		
9.	0		
10.	0		
11.	0		
	0 = Total Cover		
Woody Vine Stratum (Plot size: 30)			
1. Hedera helix	80	yes	FACU
2. Rubus bifrons	15	yes	FAC
	95 = Total Cover		

% Bare Ground in Herb Stratum: 100

Dominance Test worksheet:
Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 4 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 50 % (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1=	0
FACW species	40	x 2=	80
FAC species	30	x 3=	90
FACU species	105	x 4=	420
UPL species	0	x 5=	
Column Totals:	175 (A)		590 (B)

Prevalence Index = B/A = 3.37

Hydrophytic Vegetation Indicators:
____ 1-Rapid Test For Hydrophytic Vegetation
____ 2-Dominance Test is >50%
____ 3-Prevalence Index is ≤3.0[1]
____ 4-Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
____ 5-Wetland Non-Vascular Plants[1]
____ 6-Problematic Hydrophytic Vegetation[1](Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** **No** ✓

Remarks:

SOIL

Sampling Point: DP2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0 - 12	5YR 2.5/1	100					Silt loam	
12 - 16	10YR 2/1	100		0			Sandy clay loam	Gravel
0 - 0		0		0				
0 - 0		0		0				
0 - 0		0		0				
0 - 0		0		0				
0 - 0		0		0				
-								

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type:

Depth (inches): 0

Hydric Soil Present? **Yes** **No** ✓

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) **(LRR A)**
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) **(LRR A)**
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present? no Depth (Inches): 0

Water Table Present? no Depth (Inches): 0

Saturation Present? (includes capillary fringe) no Depth (Inches): 0

Wetland Hydrology Present? **Yes** ___ **No** ✓

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Appendix D
Wetland Rating Forms

ESA

TABLE 2
WETLAND 1 SUMMARY INFORMATION

Category	Description
Location	Southern halves of Thurston County; parcel Nos. 83450001000, 83450100000, and 11828110800; approximately 0.09 miles east of Ruddell Road Southeast.
Local Jurisdiction	City of Lacey
WRIA	13
Washington State Department of Ecology/ City of Lacey Rating	Category II
Buffer Width	110 to 150 feet, based on a habitat score of 7. Category II wetlands with a medium habitat score require a 150-foot standard buffer if mitigation measures are not implemented, and a 110-foot standard buffer if mitigation measures are implemented.
Wetland Size	Approx. 0.19 acres
Cowardin Classification	PFO/PSS
Hydrogeomorphic Classification	Depressional & Flats
Wetland Data Sheet(s)	DP1
Upland Data Sheet(s)	DP2
Dominant Vegetation	The forested class was dominated by big-leaf maple and western red cedar with an understory of willows. Emergent vegetation was dominated by reed canary grass and fringed willowherb (Epilobium ciliatum). Much of the area within the wetland consisted of saturated bare ground.
Soils	Soils were a black (7.5YR 2.5/1) silt loam from 0 to 16 inches. The soils were too saturated to observe redoximorphic concentrations within the matrix; therefore, assumed the profile meets the criteria for a redox dark surface (F6) based on the presence of water.
Hydrology	Surface water (A1), high water table (A2), and saturation (A3) were observed during the site visit.
Rationale for Local Rating	Wetland 1 received an overall score of 21 points, which includes 7 points for water quality, 7 points for hydrologic, and 7 points for habitat. Wetland rates as a Category II wetland based on functions.
Functional Assessment	Overall, Wetland 1 provides moderate levels of wetland function due to the combination of high scores for water quality, hydrologic functions, and habitat function. Wetland 1 is a depressional system with high cover by persistent plants and permanent, seasonal, and occasional ponding. The wetland receives pollutants from urban runoff associated with nearby developments and residential housing. These attributes contribute to its moderate water quality score and show the site is valuable to society for its ability to provide this function. Wetland 1 has a stream that intermittently flows, has moderate ability to provide storage during floods, and has moderate ability to provide hydrologic value to society. Wetland 1 provides a high habitat function. Wetland 1 scored high in having five vegetation structures, the interspersion of habitats, and accessible habitat for wildlife. Wetland 1 has a Washington Department of Fish and Wildlife priority habitat feature snags and logs within 330 feet of the wetland unit. Wood ducks (*Aix sponsa*) were observed in a ponded area in Wetland 1. Thus, Wetland 1 earned a point for wood duck breeding area.
Buffer Condition	The buffer has been disturbed by nearby residential development. Dominant buffer vegetation includes bigleaf maple, Himalayan blackberry, and English ivy.

RATING SUMMARY – Western Washington

Name of wetland (or ID #): Wetland 1 - Lift Station 06 Date of site visit: 8/5/2022

Rated by Maggie Bradshaw Trained by Ecology? ☑ Yes ☐ No Date of training Mar-21

HGM Class used for rating Depressional & Flats Wetland has multiple HGM classes? ☐ Yes ☑ No

NOTE: Form is not complete with out the figures requested (*figures can be combined*).
Source of base aerial photo/map ESRI 2022, Google Earth 2021

OVERALL WETLAND CATEGORY II (based on functions ☑ or special characteristics ☐)

1. Category of wetland based on FUNCTIONS

_____ **Category I** - Total score = 23 - 27
X **Category II** - Total score = 20 - 22
_____ **Category III** - Total score = 16 - 19
_____ **Category IV** - Total score = 9 - 15

FUNCTION	Improving Water Quality	Hydrologic	Habitat	
		List appropriate rating (H, M, L)		
Site Potential	M	M	M	
Landscape Potential	M	H	M	
Value	H	M	H	**Total**
Score Based on Ratings	7	7	7	**21**

Score for each function based on three ratings (*order of ratings is not important*)

9 = H, H, H
8 = H, H, M
7 = H, H, L
7 = H, M, M
6 = H, M, L
6 = M, M, M
5 = H, L, L
5 = M, M, L
4 = M, L, L
3 = L, L, L

2. Category based on SPECIAL CHARACTERISTICS of wetland

CHARACTERISTIC	Category
Estuarine	
Wetland of High Conservation Value	
Bog	
Mature Forest	
Old Growth Forest	
Coastal Lagoon	
Interdunal	
None of the above	

Maps and Figures required to answer questions correctly for Western Washington

Depressional Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	D 1.3, H 1.1, H 1.4	
Hydroperiods	D 1.4, H 1.2	
Location of outlet (*can be added to map of hydroperiods*)	D 1.1, D 4.1	
Boundary of area within 150 ft of the wetland (*can be added to another figure*)	D 2.2, D 5.2	
Map of the contributing basin	D 4.3, D 5.3	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	D 3.1, D 3.2	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	D 3.3	

Riverine Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	H 1.1, H 1.4	
Hydroperiods	H 1.2	
Ponded depressions	R 1.1	
Boundary of area within 150 ft of the wetland (*can be added to another figure*)	R 2.4	
Plant cover of trees, shrubs, and herbaceous plants	R 1.2, R 4.2	
Width of unit vs. width of stream (*can be added to another figure*)	R 4.1	
Map of the contributing basin	R 2.2, R 2.3, R 5.2	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	R 3.1	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	R 3.2, R 3.3	

Lake Fringe Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	L 1.1, L 4.1, H 1.1, H 1.4	
Plant cover of trees, shrubs, and herbaceous plants	L 1.2	
Boundary of area within 150 ft of the wetland (*can be added to another figure*)	L 2.2	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	L 3.1, L 3.2	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	L 3.3	

Slope Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	H 1.1, H 1.4	
Hydroperiods	H 1.2	
Plant cover of **dense** trees, shrubs, and herbaceous plants	S 1.3	
Plant cover of **dense, rigid** trees, shrubs, and herbaceous plants (*can be added to another figure*)	S 4.1	
Boundary of area within 150 ft of the wetland (*can be added to another figure*)	S 2.1, S 5.1	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	S 3.1, S 3.2	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	S 3.3	

HGM Classification of Wetland in Western Washington

For questions 1 -7, the criteria described must apply to the entire unit being rated.
If hydrologic criteria listed in each question do not apply to the entire unit being rated, you probably have a unit with multiple HGM classes. In this case, identify which hydrologic criteria in questions 1 - 7 apply, and go to Question 8.

1. Are the water levels in the entire unit usually controlled by tides except during floods?

☑ NO - go to 2 ☐ **YES** - the wetland class is **Tidal Fringe** - go to 1.1

1.1 Is the salinity of the water during periods of annual low flow below 0.5 ppt (parts per thousand)?

☐ **NO - Saltwater Tidal Fringe (Estuarine)** ☐ **YES - Freshwater Tidal Fringe**
*If your wetland can be classified as a Freshwater Tidal Fringe use the forms for **Riverine** wetlands. If it is Saltwater Tidal Fringe it is an **Estuarine** wetland and is not scored. This method **cannot** be used to score functions for estuarine wetlands.*

2. The entire wetland unit is flat and precipitation is the only source (>90%) of water to it. Groundwater and surface water runoff are NOT sources of water to the unit.

☑ NO - go to 3 ☐ **YES** - The wetland class is **Flats**
*If your wetland can be classified as a Flats wetland, use the form for **Depressional** wetlands.*

3. Does the entire wetland unit **meet all** of the following criteria?
- ☐ The vegetated part of the wetland is on the shores of a body of permanent open water (without any plants on the surface at any time of the year) at least 20 ac (8 ha) in size;
- ☐ At least 30% of the open water area is deeper than 6.6 ft (2 m).

☑ NO - go to 4 ☐ **YES** - The wetland class is **Lake Fringe** (Lacustrine Fringe)

4. Does the entire wetland unit **meet all** of the following criteria?
- ☐ The wetland is on a slope (*slope can be very gradual*),
- ☐ The water flows through the wetland in one direction (unidirectional) and usually comes from seeps. It may flow subsurface, as sheetflow, or in a swale without distinct banks.
- ☐ The water leaves the wetland **without being impounded.**

☑ NO - go to 5 ☐ **YES** - The wetland class is **Slope**

NOTE: Surface water does not pond in these type of wetlands except occasionally in very small and shallow depressions or behind hummocks (depressions are usually <3 ft diameter and less than 1 ft deep).

5. Does the entire wetland unit **meet all** of the following criteria?
- ☐ The unit is in a valley, or stream channel, where it gets inundated by overbank flooding from that stream or river,
- ☐ The overbank flooding occurs at least once every 2 years.

☑ NO - go to 6 ☐ **YES** - The wetland class is **Riverine**

NOTE: The Riverine unit can contain depressions that are filled with water when the river is not flooding.

6. Is the entire wetland unit in a topographic depression in which water ponds, or is saturated to the surface, at some time during the year? *This means that any outlet, if present, is higher than the interior of the wetland.*

☐ NO - go to 7 ☑ **YES** - The wetland class is **Depressional**

7. Is the entire wetland unit located in a very flat area with no obvious depression and no overbank flooding? The unit does not pond surface water more than a few inches. The unit seems to be maintained by high groundwater in the area. The wetland may be ditched, but has no obvious natural outlet.

☐ NO - go to 8 ☐ **YES** - The wetland class is **Depressional**

8. Your wetland unit seems to be difficult to classify and probably contains several different HGM classes. For example, seeps at the base of a slope may grade into a riverine floodplain, or a small stream within a Depressional wetland has a zone of flooding along its sides. GO BACK AND IDENTIFY WHICH OF THE HYDROLOGIC REGIMES DESCRIBED IN QUESTIONS 1-7 APPLY TO DIFFERENT AREAS IN THE UNIT (make a rough sketch to help you decide). Use the following table to identify the appropriate class to use for the rating system if you have several HGM classes present within the wetland unit being scored.

NOTE: Use this table only if the class that is recommended in the second column represents 10% or more of the total area of the wetland unit being rated. If the area of the HGM class listed in column 2 is less than 10% of the unit; classify the wetland using the class that represents more than 90% of the total area.

HGM classes within the wetland unit being rated	HGM class to use in rating
Slope + Riverine	Riverine
Slope + Depressional	Depressional
Slope + Lake Fringe	Lake Fringe
Depressional + Riverine along stream within boundary of depression	Depressional
Depressional + Lake Fringe	Depressional
Riverine + Lake Fringe	Riverine
Salt Water Tidal Fringe and any other class of freshwater wetland	Treat as ESTUARINE

If you are still unable to determine which of the above criteria apply to your wetland, or if you have ***more than 2 HGM classes*** *within a wetland boundary, classify the wetland as Depressional for the rating.*

NOTES and FIELD OBSERVATIONS:

DEPRESSIONAL AND FLATS WETLANDS

Water Quality Functions - Indicators that the site functions to improve water quality

D 1.0. Does the site have the potential to improve water quality?	
D 1.1. Characteristics of surface water outflows from the wetland: Wetland is a depression or flat depression (QUESTION 7 on key) with no surface water leaving it (no outlet). points = 3 Wetland has an intermittently flowing stream or ditch, OR highly constricted permanently flowing outlet. points = 2 ☐ Wetland has an unconstricted, or slightly constricted, surface outlet that is permanently flowing points = 1 ☐ Wetland is a flat depression (QUESTION 7 on key), whose outlet is a permanently flowing ditch. points = 1	2
D 1.2. The soil 2 in below the surface (or duff layer) is true clay or true organic (*use NRCS definitions*). Yes = 4 No = 0	0
D 1.3. Characteristics and distribution of persistent plants (Emergent, Scrub-shrub, and/or Forested Cowardin classes): Wetland has persistent, ungrazed, plants > 95% of area points = 5 Wetland has persistent, ungrazed, plants > ½ of area points = 3 Wetland has persistent, ungrazed plants > $^1/_{10}$ of area points = 1 Wetland has persistent, ungrazed plants < $^1/_{10}$ of area points = 0	3
D 1.4. Characteristics of seasonal ponding or inundation: *This is the area that is ponded for at least 2 months. See description in manual.* Area seasonally ponded is > ½ total area of wetland points = 4 Area seasonally ponded is > ¼ total area of wetland points = 2 Area seasonally ponded is < ¼ total area of wetland points = 0	2
Total for D 1 Add the points in the boxes above	**7**

Rating of Site Potential If score is: ☐ **12 - 16 = H** ☑ **6 - 11 = M** ☐ **0 - 5 = L** *Record the rating on the first page*

D 2.0. Does the landscape have the potential to support the water quality function of the site?	
D 2.1. Does the wetland unit receive stormwater discharges? Yes = 1 No = 0	1
D 2.2. Is > 10% of the area within 150 ft of the wetland in land uses that generate pollutants? Yes = 1 No = 0	1
D 2.3. Are there septic systems within 250 ft of the wetland? Yes = 1 No = 0	0
D 2.4. Are there other sources of pollutants coming into the wetland that are not listed in questions D 2.1 - D 2.3? Source Yes = 1 No = 0	0
Total for D 2 Add the points in the boxes above	**2**

Rating of Landscape Potential If score is: ☐ **3 or 4 = H** ☑ **1 or 2 = M** ☐ **0 = L** *Record the rating on the first page*

D 3.0. Is the water quality improvement provided by the site valuable to society?	
D 3.1. Does the wetland discharge directly (i.e., within 1 mi) to a stream, river, lake, or marine water that is on the 303(d) list? Yes = 1 No = 0	0
D 3.2. Is the wetland in a basin or sub-basin where an aquatic resource is on the 303(d) list? Yes = 1 No = 0	0
D 3.3. Has the site been identified in a watershed or local plan as important for maintaining water quality (*answer YES if there is a TMDL for the basin in which the unit is found*)? Yes = 2 No = 0	2
Total for D 3 Add the points in the boxes above	**2**

Rating of Value If score is: ☑ **2 - 4 = H** ☐ **1 = M** ☐ **0 = L** *Record the rating on the first page*

DEPRESSIONAL AND FLATS WETLANDS

Hydrologic Functions - Indicators that the site functions to reduce flooding and stream degradation

D 4.0. Does the site have the potential to reduce flooding and erosion?	
D 4.1. Characteristics of surface water outflows from the wetland: Wetland is a depression or flat depression with no surface water leaving it (no outlet) points = 4 Wetland has an intermittently flowing stream or ditch, OR highly constricted permanently flowing outlet points = 2 Wetland is a flat depression (QUESTION 7 on key), whose outlet is a permanently flowing ditch points = 1 Wetland has an unconstricted, or slightly constricted, surface outlet that is permanently flowing points = 0	2
D 4.2. Depth of storage during wet periods: *Estimate the height of ponding above the bottom of the outlet. For wetlands with no outlet, measure from the surface of permanent water or if dry, the deepest part.* Marks of ponding are 3 ft or more above the surface or bottom of outlet points = 7 Marks of ponding between 2 ft to < 3 ft from surface or bottom of outlet points = 5 ☐ Marks are at least 0.5 ft to < 2 ft from surface or bottom of outlet points = 3 ☐ The wetland is a "headwater" wetland points = 3 Wetland is flat but has small depressions on the surface that trap water points = 1 Marks of ponding less than 0.5 ft (6 in) points = 0	5
D 4.3. Contribution of the wetland to storage in the watershed: *Estimate the ratio of the area of upstream basin contributing surface water to the wetland to the area of the wetland unit itself.* ☐ The area of the basin is less than 10 times the area of the unit points = 5 The area of the basin is 10 to 100 times the area of the unit points = 3 The area of the basin is more than 100 times the area of the unit points = 0 ☐ Entire wetland is in the Flats class points = 5	0
Total for D 4 — Add the points in the boxes above	**7**

Rating of Site Potential If score is: ☐ **12 - 16 = H** ☑ **6 - 11 = M** ☐ **0 - 5 = L** *Record the rating on the first page*

D 5.0. Does the landscape have the potential to support hydrologic function of the site?	
D 5.1. Does the wetland unit receive stormwater discharges? Yes = 1 No = 0	1
D 5.2. Is > 10% of the area within 150 ft of the wetland in land uses that generate excess runoff? Yes = 1 No = 0	1
D 5.3. Is more than 25% of the contributing basin of the wetland covered with intensive human land uses (residential at >1 residence/ac, urban, commercial, agriculture, etc.)? Yes = 1 No = 0	1
Total for D 5 — Add the points in the boxes above	**3**

Rating of Landscape Potential If score is: ☑ **3 = H** ☐ **1 or 2 = M** ☐ **0 = L** *Record the rating on the first page*

D 6.0. Are the hydrologic functions provided by the site valuable to society?	
D 6.1. The unit is in a landscape that has flooding problems. *Choose the description that best matches conditions around the wetland unit being rated. Do not add points. Choose the highest score if more than one condition is met.* The wetland captures surface water that would otherwise flow down-gradient into areas where flooding has damaged human or natural resources (e.g., houses or salmon redds): ● Flooding occurs in a sub-basin that is immediately down-gradient of unit. points = 2 ☑ ● Surface flooding problems are in a sub-basin farther down-gradient. points = 1 ☐ Flooding from groundwater is an issue in the sub-basin. points = 1 ☐ The existing or potential outflow from the wetland is so constrained by human or natural conditions that the water stored by the wetland cannot reach areas that flood. Explain why points = 0 ☐ There are no problems with flooding downstream of the wetland. points = 0	1
D 6.2. Has the site been identified as important for flood storage or flood conveyance in a regional flood control plan? Yes = 2 No = 0	0
Total for D 6 — Add the points in the boxes above	**1**

Rating of Value If score is: ☐ **2 - 4 = H** ☑ **1 = M** ☐ **0 = L** *Record the rating on the first page*

These questions apply to wetlands of all HGM classes.

HABITAT FUNCTIONS - Indicators that site functions to provide important habitat

H 1.0. Does the site have the potential to provide habitat?

H 1.1. Structure of plant community: *Indicators are Cowardin classes and strata within the Forested class.* Check the Cowardin plant classes in the wetland. *Up to 10 patches may be combined for each class to meet the threshold of ¼ ac or more than 10% of the unit if it is smaller than 2.5 ac. Add the number of structures checked.*

☑ Aquatic bed	4 structures or more: points = 4	4
☑ Emergent	3 structures: points = 2	
☑ Scrub-shrub (areas where shrubs have > 30% cover)	2 structures: points - 1	
☑ Forested (areas where trees have > 30% cover)	1 structure: points = 0	

If the unit has a Forested class, check if:

☑ The Forested class has 3 out of 5 strata (canopy, sub-canopy, shrubs, herbaceous, moss/ground-cover) that each cover 20% within the Forested polygon

H 1.2. Hydroperiods

Check the types of water regimes (hydroperiods) present within the wetland. The water regime has to cover more than 10% of the wetland or ¼ ac to count (*see text for descriptions of hydroperiods*).

☑ Permanently flooded or inundated	4 or more types present: points = 3	2
☑ Seasonally flooded or inundated	3 types present: points = 2	
☑ Occasionally flooded or inundated	2 types present: points = 1	
☐ Saturated only	1 types present: points = 0	
☐ Permanently flowing stream or river in, or adjacent to, the wetland		
☐ Seasonally flowing stream in, or adjacent to, the wetland		
☐ **Lake Fringe wetland**	**2 points**	
☐ **Freshwater tidal wetland**	**2 points**	

H 1.3. Richness of plant species

Count the number of plant species in the wetland that cover at least 10 ft^2.
Different patches of the same species can be combined to meet the size threshold and you do not have to name the species. ***Do not include Eurasian milfoil, reed canarygrass, purple loosestrife, Canadian thistle***

1

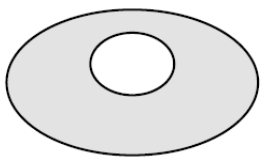
If you counted:	> 19 species	points = 2
	5 - 19 species	points = 1
	< 5 species	points = 0

H 1.4. Interspersion of habitats

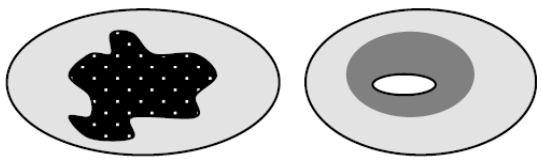
Decide from the diagrams below whether interspersion among Cowardin plants classes (described in H 1.1), or the classes and unvegetated areas (can include open water or mudflats) is high, moderate, low, or none. *If you have four or more plant classes or three classes and open water, the rating is always high.*

3

None = 0 points

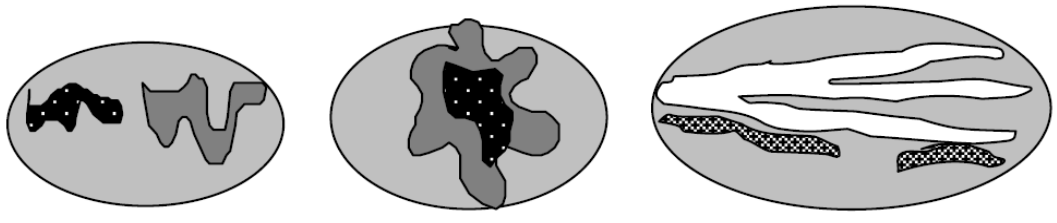


Low = 1 point



Moderate = 2 points

All three diagrams in this row are **HIGH** = 3 points



H 1.5. Special habitat features: Check the habitat features that are present in the wetland. *The number of checks is the number of points.* ☑ Large, downed, woody debris within the wetland (> 4 in diameter and 6 ft long) ☑ Standing snags (dbh > 4 in) within the wetland ☐ Undercut banks are present for at least 6.6 ft (2 m) **and/or** overhanging plants extends at least 3.3 ft (1 m) over a stream (or ditch) in, or contiguous with the wetland, for at least 33 ft (10 m) ☐ Stable steep banks of fine material that might be used by beaver or muskrat for denning (> 30 degree slope) OR signs of recent beaver activity are present (*cut shrubs or trees that have not yet weathered where wood is exposed*) ☑ At least ¼ ac of thin-stemmed persistent plants or woody branches are present in areas that are permanently or seasonally inundated (*structures for egg-laying by amphibians*) ☑ Invasive plants cover less than 25% of the wetland area in every stratum of plants (*see H 1.1 for list of strata*)	4
Total for H 1 Add the points in the boxes above	**14**

Rating of Site Potential If Score is: ☐ **15 - 18 = H** ☑ **7 - 14 = M** ☐ **0 - 6 = L** *Record the rating on the first page*

H 2.0. Does the landscape have the potential to support the habitat function of the site?	
H 2.1 Accessible habitat (include *only habitat that directly abuts wetland unit*). *Calculate:* 18 % undisturbed habitat + (5 % moderate & low intensity land uses / 2) = 20.5% If total accessible habitat is: > 1/3 (33.3%) of 1 km Polygon points = 3 20 - 33% of 1 km Polygon points = 2 10 - 19% of 1 km Polygon points = 1 < 10 % of 1 km Polygon points = 0	2
H 2.2. Undisturbed habitat in 1 km Polygon around the wetland. *Calculate:* 23 % undisturbed habitat + (7 % moderate & low intensity land uses / 2) = 26.5% Undisturbed habitat > 50% of Polygon points = 3 Undisturbed habitat 10 - 50% and in 1-3 patches points = 2 Undisturbed habitat 10 - 50% and > 3 patches points = 1 Undisturbed habitat < 10% of 1 km Polygon points = 0	2
H 2.3 Land use intensity in 1 km Polygon: If > 50% of 1 km Polygon is high intensity land use points = (-2) ≤ 50% of 1km Polygon is high intensity points = 0	-2
Total for H 2 Add the points in the boxes above	**2**

Rating of Landscape Potential If Score is: ☐ **4 - 6 = H** ☑ **1 - 3 = M** ☐ **< 1 = L** *Record the rating on the first page*

H 3.0. Is the habitat provided by the site valuable to society?	
H 3.1. Does the site provide habitat for species valued in laws, regulations, or policies? *Choose only the highest score that applies to the wetland being rated* . Site meets ANY of the following criteria: points = 2 ☐ It has 3 or more priority habitats within 100 m (see next page) ☐ It provides habitat for Threatened or Endangered species (any plant or animal on the state or federal lists) ☑ It is mapped as a location for an individual WDFW priority species ☐ It is a Wetland of High Conservation Value as determined by the Department of Natural Resources ☐ It has been categorized as an important habitat site in a local or regional comprehensive plan, in a Shoreline Master Plan, or in a watershed plan Site has 1 or 2 priority habitats (listed on next page) with in 100m points = 1 Site does not meet any of the criteria above points = 0	2

Rating of Value If Score is: ☑ **2 = H** ☐ **1 = M** ☐ **0 = L** *Record the rating on the first page*

WDFW Priority Habitats

Priority habitats listed by WDFW (see complete descriptions of WDFW priority habitats, and the counties in which they can be found, in: Washington Department of Fish and Wildlife. 2008. Priority Habitat and Species List. Olympia, Washington. 177 pp.
http://wdfw.wa.gov/publications/00165/wdfw00165.pdf or access the list from here:
http://wdfw.wa.gov/conservation/phs/list/

Count how many of the following priority habitats are within 330 ft (100 m) of the wetland unit: ***NOTE**: This question is independent of the land use between the wetland unit and the priority habitat.*

- ☐ **Aspen Stands**: Pure or mixed stands of aspen greater than 1 ac (0.4 ha).
- ☐ **Biodiversity Areas and Corridors**: Areas of habitat that are relatively important to various species of native fish and wildlife (*full descriptions in WDFW PHS report*).
- ☐ **Herbaceous Balds**: Variable size patches of grass and forbs on shallow soils over bedrock.
- ☐ **Old-growth/Mature forests**: Old-growth west of Cascade crest – Stands of at least 2 tree species, forming a multi-layered canopy with occasional small openings; with at least 8 trees/ac (20 trees/ha) > 32 in (81 cm) dbh or > 200 years of age. Mature forests – Stands with average diameters exceeding 21 in (53 cm) dbh; crown cover may be less than 100%; decay, decadence, numbers of snags, and quantity of large downed material is generally less than that found in old-growth; 80-200 years old west of the Cascade crest.
- ☐ **Oregon White Oak**: Woodland stands of pure oak or oak/conifer associations where canopy coverage of the oak component is important (*full descriptions in WDFW PHS report p. 158 – see web link above*).
- ☐ **Riparian**: The area adjacent to aquatic systems with flowing water that contains elements of both aquatic and terrestrial ecosystems which mutually influence each other.
- ☐ **Westside Prairies**: Herbaceous, non-forested plant communities that can either take the form of a dry prairie or a wet prairie (*full descriptions in WDFW PHS report p. 161 – see web link above*).
- ☐ **Instream**: The combination of physical, biological, and chemical processes and conditions that interact to provide functional life history requirements for instream fish and wildlife resources.
- ☐ **Nearshore**: Relatively undisturbed nearshore habitats. These include Coastal Nearshore, Open Coast Nearshore, and Puget Sound Nearshore. (*full descriptions of habitats and the definition of relatively undisturbed are in WDFW report – see web link on previous page*).
- ☐ **Caves**: A naturally occurring cavity, recess, void, or system of interconnected passages under the earth in soils, rock, ice, or other geological formations and is large enough to contain a human.
- ☐ **Cliffs**: Greater than 25 ft (7.6 m) high and occurring below 5000 ft elevation.
- ☐ **Talus**: Homogenous areas of rock rubble ranging in average size 0.5 - 6.5 ft (0.15 - 2.0 m), composed of basalt, andesite, and/or sedimentary rock, including riprap slides and mine tailings. May be associated with cliffs.
- ☑ **Snags and Logs**: Trees are considered snags if they are dead or dying and exhibit sufficient decay characteristics to enable cavity excavation/use by wildlife. Priority snags have a diameter at breast height of > 20 in (51 cm) in western Washington and are > 6.5 ft (2 m) in height. Priority logs are > 12 in (30 cm) in diameter at the largest end, and > 20 ft (6 m) long.

Note: All vegetated wetlands are by definition a priority habitat but are not included in this list because they are addressed elsewhere.

CATEGORIZATION BASED ON SPECIAL CHARACTERISTICS

Wetland Type *Check off any criteria that apply to the wetland. List the category when the appropriate criteria are met.*	**Category**
SC 1.0. Estuarine Wetlands Does the wetland meet the following criteria for Estuarine wetlands? ☐ The dominant water regime is tidal, ☐ Vegetated, and ☐ With a salinity greater than 0.5 ppt ☐ Yes - Go to **SC 1.1** ☑ No = **Not an estuarine wetland**	
SC 1.1. Is the wetland within a National Wildlife Refuge, National Park, National Estuary Reserve, Natural Area Preserve, State Park or Educational, Environmental, or Scientific Reserve designated under WAC 332-30-151? ☐ Yes = **Category I** ☐ No - Go to **SC 1.2**	
SC 1.2. Is the wetland unit at least 1 ac in size and meets at least two of the following three conditions? ☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing, and has less than 10% cover of non-native plant species. (If non-native species are *Spartina* , see page 25) ☐ At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed grassland. ☐ The wetland has at least two of the following features: tidal channels, depressions with open water, or contiguous freshwater wetlands. ☐ Yes = **Category I** ☐ No = **Category II**	
SC 2.0. Wetlands of High Conservation Value (WHCV) SC 2.1. Has the WA Department of Natural Resources updated their website to include the list of Wetlands of High Conservation Value? ☑ Yes - Go to **SC 2.2** ☐ No - Go to **SC 2.3** SC 2.2. Is the wetland listed on the WDNR database as a Wetland of High Conservation Value? ☐ Yes = **Category I** ☑ No = **Not WHCV** SC 2.3. Is the wetland in a Section/Township/Range that contains a Natural Heritage wetland? http://www1.dnr.wa.gov/nhp/refdesk/datasearch/wnhpwetlands.pdf ☐ Yes - **Contact WNHP/WDNR and to SC 2.4** ☐ No = **Not WHCV** SC 2.4. Has WDNR identified the wetland within the S/T/R as a Wetland of High Conservation Value and listed it on their website? ☐ Yes = **Category I** ☐ No = **Not WHCV**	
SC 3.0. Bogs Does the wetland (or any part of the unit) meet both the criteria for soils and vegetation in bogs? *Use the key below.* ***If you answer YES you will still need to rate the wetland based on its functions*** . SC 3.1. Does an area within the wetland unit have organic soil horizons, either peats or mucks, that compose 16 in or more of the first 32 in of the soil profile? ☐ Yes - Go to **SC 3.3** ☑ No - Go to **SC 3.2** SC 3.2. Does an area within the wetland unit have organic soils, either peats or mucks, that are less than 16 in deep over bedrock, or an impermeable hardpan such as clay or volcanic ash, or that are floating on top of a lake or pond? ☐ Yes - Go to **SC 3.3** ☑ No = **Is not a bog** SC 3.3. Does an area with peats or mucks have more than 70% cover of mosses at ground level, AND at least a 30% cover of plant species listed in Table 4? ☐ Yes = **Is a Category I bog** ☐ No - Go to **SC 3.4** **NOTE**: If you are uncertain about the extent of mosses in the understory, you may substitute that criterion by measuring the pH of the water that seeps into a hole dug at least 16 in deep. If the pH is less than 5.0 and the plant species in Table 4 are present, the wetland is a bog. SC 3.4. Is an area with peats or mucks forested (> 30% cover) with Sitka spruce, subalpine fir, western red cedar, western hemlock, lodgepole pine, quaking aspen, Engelmann spruce, or western white pine, AND any of the species (or combination of species) listed in Table 4 provide more than 30% of the cover under the canopy? ☐ Yes = **Is a Category I bog** ☐ No = **Is not a bog**	

SC 4.0. Forested Wetlands

Does the wetland have at least 1 contiguous acre of forest that meets one of these criteria for the WA Department of Fish and Wildlife's forests as priority habitats? ***If you answer YES you will still need to rate the wetland based on its functions.***

☐ **Old-growth forests** (west of Cascade crest): Stands of at least two tree species, forming a multi-layered canopy with occasional small openings; with at least 8 trees/ac (20 trees/ha) that are at least 200 years of age OR have a diameter at breast height (dbh) of 32 in (81 cm) or more.

☐ **Mature forests** (west of the Cascade Crest): Stands where the largest trees are 80-200 years old OR the species that make up the canopy have an average diameter (dbh) exceeding 21 in (53 cm).

☐ Yes = **Category I** ☑ No = **Not a forested wetland for this section**

SC 5.0. Wetlands in Coastal Lagoons

Does the wetland meet all of the following criteria of a wetland in a coastal lagoon?

☐ The wetland lies in a depression adjacent to marine waters that is wholly or partially separated from marine waters by sandbanks, gravel banks, shingle, or, less frequently, rocks

☐ The lagoon in which the wetland is located contains ponded water that is saline or brackish (> 0.5 ppt) during most of the year in at least a portion of the lagoon (*needs to be measured near the bottom*)

☐ Yes - Go to **SC 5.1** ☑ No = **Not a wetland in a coastal lagoon**

SC 5.1. Does the wetland meet all of the following three conditions?

☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing), and has less than 20% cover of aggressive, opportunistic plant species (see list of species on p. 100).

☐ At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed grassland.

☐ The wetland is larger than $^{1}/_{10}$ ac (4350 ft^2)

☐ Yes = **Category I** ☐ No = **Category II**

SC 6.0. Interdunal Wetlands

Is the wetland west of the 1889 line (also called the Western Boundary of Upland Ownership or WBUO)? ***If you answer yes you will still need to rate the wetland based on its habitat functions.***

In practical terms that means the following geographic areas:

☐ Long Beach Peninsula: Lands west of SR 103

☐ Grayland-Westport: Lands west of SR 105

☐ Ocean Shores-Copalis: Lands west of SR 115 and SR 109

☐ Yes - Go to **SC 6.1** ☑ No = **Not an interdunal wetland for rating**

SC 6.1. Is the wetland 1 ac or larger and scores an 8 or 9 for the habitat functions on the form (rates H,H,H or H,H,M for the three aspects of function)?

☐ Yes = **Category I** ☐ No - Go to **SC 6.2**

SC 6.2. Is the wetland 1 ac or larger, or is it in a mosaic of wetlands that is 1 ac or larger?

☐ Yes = **Category II** ☐ No - Go to **SC 6.3**

SC 6.3. Is the unit between 0.1 and 1 ac, or is it in a mosaic of wetlands that is between 0.1 and 1 ac?

☐ Yes = **Category III** ☐ No = **Category IV**

Category of wetland based on Special Characteristics

If you answered No for all types, enter "Not Applicable" on Summary Form

Geotechnical Engineering Services
Draft Report

Lift Station 6 Replacement
Lacey, Washington

for
Murraysmith, Inc.

June 14, 2022

GeoEngineers

1101 South Fawcett Avenue, Suite 200
Tacoma, Washington 98402
253.383.4940

Geotechnical Engineering Services Draft Report

Lift Station 6 Replacement
Lacey, Washington

File No. 0353-022-00

June 14, 2022

Prepared for:

Murraysmith, Inc.
600 Union Street, Suite 300
Seattle, Washington 98101

Attention: Brian Casey, PE

Prepared by:

GeoEngineers, Inc.
1101 South Fawcett Avenue, Suite 200
Tacoma, Washington 98402
253.383.4940

Brett E. Larabee, PE
Senior Geotechnical Engineer

David S. Phelps, PE
Principal Geotechnical Engineer

BEL:DSP:tlm

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APPENDICES

1.0 INTRODUCTION AND PROJECT UNDERSTANDING

This report presents the results of GeoEngineers, Inc. (GeoEngineers) geotechnical engineering services for the City of Lacey Lift Station 6 (LS6) Replacement project. The LS6 project site is located near 5611 32nd Court SE in Lacey, Washington. A vicinity map is provided as Figure 1, Vicinity Map. A site plan is included as Figure 2, Site Plan. Our understanding of the project is based on our review of the project Request for Qualifications dated September 8, 2022, our communications with, and materials provided by Murraysmith, Inc. (Murraysmith) and our experience on similar lift station projects in Lacey.

LS6 was constructed in 1974 and includes a two-pump wet pit/dry pit pump station. We understand that the existing infrastructure at LS6 is aging and will be repaired, replaced or repurposed. No new wet wells are planned at the site; however, we understand that the existing 8-foot-diameter offline storage structure at the site will be converted into a wet well. Deep excavations are not envisioned as part of the project; however, new manholes are planned with base of structure elevations on the order of 5 feet below grade. A new sewer force main and 600 feet of water main on 32nd Court SE is also planned for the project.

The site is bordered to the south by a hillside which leads down to a wetland area. We understand that slope movement has resulted in tilting or undermining of existing LS6 improvements. Measures to address the reported slope movement are being considered as part of this project, if warranted.

2.0 PURPOSE AND SCOPE OF SERVICES

The purpose of our services is to characterize soil and groundwater conditions at the site as a basis for providing geotechnical engineering design recommendations and construction considerations related to the LS6 Replacement project. Our specific scope of services is included in our Task Order Agreement with Murraysmith dated March 10, 2022 which was executed on March 21, 2022. Our authorized scope of services includes hydrogeological services to support dewatering design for deep excavations. However, because deep excavations that extend below the water table are no longer envisioned as part of this project, significant dewatering measures are not expected to be necessary, and our proposed hydrogeological services were no longer requested by Murraysmith.

3.0 SITE CONDITIONS

3.1. Literature Review

3.1.1. Geologic Setting

We reviewed the *Geologic Map of the Lacey 7.5-minute Quadrangle, Thurston County, Washington* (Logan, Walsh, Schasse, and Polenz 2003). The map indicates that the soils near the project consist of Latest Vashon recessional sand and minor silt (Qgos). Peat deposits (Qp) are mapped in lower elevations areas at the base of the slope on the southern site boundary. Vashon till (Qgt), which regionally underlies the Qgos unit, is mapped at the surface west of the project site.

Recessional sand deposits are described in the literature (for example, Drost et al. 1999) as moderately well sorted, fine- to medium-grained sand and minor silt. These deposits are not glacially consolidated and are typically in a loose to medium dense condition. In this report, we refer to Latest Vashon recessional

sand and minor silt deposit as “recessional outwash”. Groundwater in this unit is mostly unconfined and perched, and the soils have moderate to high permeability. Drost et al (1999) indicates the Qgos unit is between 25 and 50 feet thick in this area.

Peat soils typically consist of organic rich mineral sediments often present in closed depressions near wetlands and other bodies of water. Peat soils are highly compressible and can decompose and deteriorate over time.

Vashon till is a highly compact mixture of clay, silt, sand and gravel that was deposited below, and subsequently overridden by, glacial ice. The upper few feet of till deposits can be weathered and in a loose to dense condition. Underlying relatively undisturbed till is typically very dense with low permeability. Drost et al (1999) indicates the till unit is between 25 and 50 feet thick in this area.

3.1.2. Critical Areas Review

Based on our review of Chapter 14.37 (Geological Sensitive Areas Protection) of the City of Lacey Municipal Code, the slope to the south of the site likely meets the criteria of a landslide hazard and erosion hazard area. Development near and around these hazard areas is still permissible; however, special considerations need to be taken to avoid destabilizing the landslide area or increasing the erosion hazard.

3.2. Surface Conditions

LS6 is located in a residential neighborhood and is boarded to the east and west by single-family homes. LS6 is accessed by an asphalt paved driveway extending from the 32nd Court SE cul-de-sac. The driveway is oriented north-south, is about 8 feet wide, and grades downward from the cul-de-sac to the lift station. The change in elevation between the cul-de-sac and the lift station is on the order of 7 feet. The asphalt driveway was observed to be cracked and patched.

The lift station infrastructure is located at the south end of the driveway in an area that is relatively flat. The majority of the lift station is located below grade with the exception of manhole covers and a generator and lift station electrical control box. The generator and electrical control box are located near the crest of the existing slope described below. We understand that they are supported on slab-on-grade type foundations. Undermining of the foundation slab supporting the electrical control box has occurred. During our site visit we observed an approximately 1- to 2-inch void below the electrical control box foundation primarily under the southeast corner.

The southern boundary of the lift station property is formed by a slope that grades downward to a wetland area. The slope is on the order of 10 feet tall and is inclined approximately 35 degrees (about 1.4 horizontal to 1 vertical [H:V]). The slope is densely vegetated with ivy, blackberries, ferns and deciduous and coniferous tress on the order of 12 to 24 inches in diameter. Some of the trees are tilting downslope. We observed tree trunk growth patterns shaped similar to a “J” at the base of some of the trees. Tilting and “J” shaped tree bases can be an indication of surficial slope creep. We did not observe indications of groundwater seepage on the face of the slope or any obvious signs of recent large scale slope movement or erosion including hummocky terrain, cracks or colluvium.

3.3. Subsurface Conditions

3.3.1. Subsurface Explorations and Laboratory Testing

We explored on-site subsurface conditions by advancing two borings (B-1 and B-2) at the approximate locations shown on Figure 2. The borings were advanced to depths between 26.5 and 31.5 feet below ground surface (bgs) using track-mounted drilling equipment operated by drillers subcontracted to GeoEngineers. A monitoring well was installed in B-2 after drilling was complete. Details of the exploration program and summary logs of the explorations are included in Appendix A, Field Explorations. Ground surface elevations provided on the logs were determined using materials provided by Murraysmith and are referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

Soil samples obtained from the borings were taken to our geotechnical laboratory for further evaluation. Testing included moisture content determinations, percent fines determination and gradation analyses. A description of the laboratory test procedures and test results are presented in Appendix B, Laboratory Testing and/or on the boring logs.

3.3.2. Soil Conditions

In boring B-1, we observed what we interpret to be fill extending to approximately 5 feet bgs. Fill consisted of medium dense gravel with silt, sand and occasional cobbles. Underlying the fill in boring B-1, we observed recessional outwash extending to the full depth explored, about 26.5 feet bgs. The recessional outwash consisted primarily of loose to medium dense silty sand and sand with variable silt content.

In boring B-2, we observed fill extending to approximately 8 feet bgs. Fill consisted of medium dense silty sand with gravel and occasional debris (asphalt pieces). Between the base of the fill layer and the underlying outwash soils we observed an approximately 1.5-foot-thick transitional layer of medium stiff sandy silt which we expect may be the former ground surface horizon prior to fill placement. Underlying outwash soils consisted of loose to medium dense silty sand and sand with silt.

We observed heaving conditions within the outwash soils below the groundwater table (see boring log B-2 and the groundwater discussion below). Heaving of up to 12 inches was observed inside the hollow-stem auger during drilling.

3.3.3. Groundwater Conditions

Our interpretation of groundwater conditions at the site is based on groundwater observations made during drilling and subsequent groundwater measurements taken in the B-2 monitoring well.

Boring B-2 was completed as 2-inch-diameter monitoring well. Groundwater was measured at around 14 feet bgs at the time of drilling (March 30, 2022) and around 7 feet bgs on June 6, 2022.

We anticipate that groundwater levels at the site will fluctuate throughout the year but are unlikely to rise above about 5 feet bgs. Groundwater levels at the site will also likely fluctuate based on season and rainfall events.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1. Summary

A summary of our primary geotechnical considerations is provided below. The summary is presented for introductory purposes and should be used in conjunction with the complete recommendations presented in this report.

- Based on the groundwater information collected to date and the planned depth of the proposed improvements (less than about 5 feet below existing grades), significant groundwater seepage is not expected in shallow excavations at the site. If project plans change, and deeper excavations are planned, we should be notified to provided appropriate groundwater handling recommendations.
- Lightly loaded lift station infrastructure can be adequately supported on shallow foundations established within a few feet of existing site grades.
- The slope to the south of the site appears to be in a stable condition with regards to global slope stability and, in our opinion, the proposed improvements can be constructed without destabilizing the slope. However, surficial movement of this slope has been observed and ongoing surficial movement is likely to continue and should be anticipated.
- Site soils below groundwater are potentially liquefiable. Seismic and foundation design must consider this condition.

4.2. Seismic Design Considerations

4.2.1. Seismic Design Parameters

We evaluated seismic site response using map-based methods described in the *2018 International Building Code* (IBC). The 2018 IBC references the 2016 version of *Minimum Design Loads for Buildings and Other Structures* (American Society of Civil Engineers [ASCE] 7-16) to determine earthquake ground motions.

Based on our understanding of soil and groundwater conditions at the site and our experience in the area, we recommend that seismic design parameters be developed assuming Site Class D. Using the seismic design parameters provided in the table below are contingent on the following:

- The fundamental period of vibration of proposed improvement structures will be less than 0.5 seconds
- The parameter S_{M1} as determined by equation 11.4-2 in ASCE 7-16 is increased by 50 percent for all applications of S_{M1}

These requirements are related to exceptions provided in ASCE 7-16 for sites underlain by liquifiable soils (first requirement per Section 20.3 of ASCE 7-16) and Site Class D sites where the mapped spectral response acceleration at 1-second periods (S_1) is greater than or equal to 0.2 g (second requirement per ASCE 7-16, Supplement 3). If either of these requirements are not met, additional seismic design including completing a site-specific response analysis or a ground motion hazard analysis could be required.

TABLE 1. SEISMIC DESIGN CRITERIA

2018 IBC Parameters[1]	Value
Site Class	D
Mapped MCE_R Spectral Response Acceleration at Short Period, S_s (g)	1.38
Mapped MCE_R Spectral Response Acceleration at 1-second period, S_1 (g)	0.50
Site Modified Peak Ground Acceleration, PGA_M	0.65
Short Period Site Coefficient, F_a	1.0
Long Period Site Coefficient, F_v	1.80
Design Spectral Acceleration at 0.2-second period, S_{DS} (g)	0.92
Design Spectral Acceleration at 1.0-second period, S_{D1} (g)	0.60
T_S (S_{D1} / S_{DS}) (seconds)	0.66

Notes:

[1] Parameters developed based on latitude 47.0184572 and longitude -122.8080729 using the Applied Technology Council (ATC) Hazards online tool (https://hazards.atcouncil.org/).

4.2.2. Liquefaction

Liquefaction refers to the condition by which vibration or shaking of the ground, usually from earthquake forces, results in the development of excess pore pressures in saturated soils with subsequent loss of strength in the deposit of soil so affected. In general, soils that are susceptible to liquefaction include very loose to medium dense clean to silty sands and some silts that are below groundwater.

We evaluated the liquefaction potential of site soils for the IBC design level earthquake (PGA=0.65, M=7.66) using simplified methods (Youd and Idriss 2001), which are based on comparing the cyclic resistance ratio (CRR) of a soil layer (the cyclic shear stress required to cause liquefaction) to the cyclic stress ratio (CSR) induced by an earthquake. The factor of safety (FS) against liquefaction is determined by dividing the CRR by the CSR.

Based on our analysis, there is a risk of liquefaction occurring within the recessional outwash deposits below the groundwater table during the design earthquake event. Our calculations indicate that liquefaction-related settlement on the order of 2 to 4 inches are possible following the design earthquake. We expect that differential liquefaction settlement over a distance of 100 feet could be on the order of 1 to 2 inches.

4.2.3. Lateral Spreading

Lateral spreading involves lateral displacement of large, surficial blocks of soil as the underlying soil layer liquefies. Due to the presence of liquifiable soils and the slope to the south of the site, it in our opinion there is a risk of lateral spreading occurring at this site. Completing a detailed lateral spreading evaluation was not included in our scope of work; however, we expect that lateral slope movements as the result of lateral spreading could exceed 6 to 12 inches if liquefaction in triggered during the design seismic event. We anticipate that mitigating lateral spreading at this site is beyond the scope of the lift station replacement project; however, lateral spreading will be considered in design, we should be notified and additional analyses and design considerations will be required.

4.2.4. Surface Fault Rupture

According to the Washington State Department of Natural Resources (DNR) Interactive Natural Hazards Map (accessed December 1, 2021 https://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/geologic-hazard-maps), traces of the Olympia Fault are mapped in the project vicinity. The location of the Olympia Fault is not well understood, and the actual location could be different than that shown on the interactive map. The mapped fault does not appear to have any surface manifestations at the site and bedrock in the area is covered by a thick section of glacially consolidated sediments. Based on the lack of surface evidence of the fault, the uncertainty in the location of the fault, and that the fault is overlain by glacially consolidated soils, in our opinion there is a low risk of fault rupture occurring at the site.

4.3. Slope Stability

4.3.1. Slope Stability Analysis and Results

We evaluated stability of the existing slope on the south side of the lift station using the software program SLOPE/W (GEO-SLOPE International, Ltd. 2020). SLOPE/W evaluates the stability of numerous trial shear surfaces using a vertical slice limit-equilibrium method. This method compares the ratio of forces and moments driving slope movement versus forces and moments resisting slope movement for each trial shear surface and presents the result as the factor of safety (FS). The program then sorts the trial shear surfaces and identifies the surface with the lowest factor of safety, or the "critical" shear surface. We assumed a circular arc slip surface and used the Spencer method to calculate the forces.

Soil properties used in our analysis are based on our interpretation of soil conditions observed in our borings and our experience. The slope stability cross section we considered is based on field measurements and provided survey data and is intended to represent a "typical" cross section of the slope. We did not consider pseudo static (seismic) slope stability in our analysis.

Figure 3, Slope Stability Results Global Failure and Figures 4 and 5, Slope Stability Results Shallow Failure - Unsaturated show slope stability results for the existing slope condition. The analysis shown on Figure 3 considers a larger and deeper "global" slope failure. The calculated factor of safety for this failure is around 1.5, which is typically considered acceptable. For example, the Washington State Department of Transportation (WSDOT) *Geotechnical Design Manual* (GDM) recommends that the FS of slopes adjacent to, but not directly supporting structures, be at least 1.3.

The analyses shown in Figures 4 and 5 consider relatively shallow failures associated with slope creep or surficial sloughing. The analysis shown on Figure 4 considered unsaturated conditions on the slope face. The analysis shown on Figure 5 assumes the surficial soils have become saturated which could occur during a period of prolonged wet weather. Considering shallow surficial type failures, our stability results indicate that the slope is marginally stable (FS =1.1) considering unsaturated conditions and has a FS of less than 1.0 considering saturated conditions suggesting that movement could occur.

4.3.2. Slope Stability Discussion

In our opinion there is a low risk of a deep-seated global slope stability type failure occurring at the site. Observations at the site and our slope stability analyses suggest that the surficial soils on the slope are prone to movement and ongoing slope creep. Surficial sloughing is expected to continue in the future. The risk of surficial slope movement occurring is expected to be highest during prolonged periods of wet

weather. Based on our stability analyses, we expect surficial slope movement will be confined to the upper few feet of the soil profile.

4.3.3. Recommendations Considering Slope Stability

Ongoing surficial slope movement could further undermine and potentially destabilize the electrical control box foundation and could impact other existing at-grade lift station infrastructure. Unless measures are taken to mitigate slope movement, we recommend that existing at-grade equipment foundations be relocated and setback at least 5 feet from the crest of the slope. The setback should also be established for new at-grade improvements supported on shallow foundations. The crest of the slope should be defined as the south edge of the existing asphalt driveway. Possible slope stabilization measures are discussed in the sections below.

4.3.4. Slope Stabilization Alternatives

4.3.4.1. General

The sections below discuss slope stabilization alternatives. The recommendations provided below are preliminary. Additional analyses and design will be required to complete final design of the selected slope stabilization alternative. Slope stabilization alternatives must consider maintaining or removing existing vegetation.

4.3.4.2. Surface and Subsurface Drainage

Surface grading could be completed to collect and direct surface water away from the slope which can improve surficial slope stability. Installation of a shallow drainage channel near the crest of the slope to collect and divert surface water should be considered.

A subsurface drain could be installed at the crest of the slope to improve slope stability during wet conditions. Water collected in a drainage channel or subsurface drain will need to be routed to an appropriate discharge point, such as a tightline to a lower portion of the slope or storm drain.

4.3.4.3. Vegetation and Erosion Control

While the slope is densely vegetated, planting new vegetation with deep root systems, installing erosion control products, and replanting areas of bare ground near the crest of the slope could help reduce surficial slope movement potential.

4.3.4.4. Retaining Wall

Retaining walls could be considered at the crest of the slope to help prevent surficial soil movement from impacting lift station infrastructure. In order for retaining walls to be effective, they would have to (1) extend deep enough to be resistant to slope movement and loss of soil on the downslope side of the wall; and (2) be established below the slip surface of the surficial movement to avoid loading the slope. To meet this criteria, we expect that retaining walls would need to be designed for exposed heights of about 5 feet.

We expect that gravity retaining walls (such as gabion baskets or block walls) or vertically installed walls (such as sheet pile or soldier piles and lagging walls) are feasible alternatives at this site. Construction of gravity retaining walls would require excavating temporary slopes to expose the bearing surface for the wall. The location and height of the wall will likely depend on the geometry of the cut slope that can be achieved given the site constraints, especially in the areas where existing lift station infrastructure is near the crest of the slope. We anticipate that excavation depths on the order of 6 feet could be required to establish the bearing surface and construct gravity type retaining walls.

Vertically installed walls such as sheet pile walls of solider pile and lagging walls could be advantageous as they can be installed along the crest of the slope without impacting existing lift station infrastructure. These walls would need to be designed for surcharges, stickup conditions, and limited passive resistance assuming erosion or surficial slope movement occurs in front (down-slope of the wall). Because these walls would be installed on the top of the slope and would not impact the existing slope face, disturbance to trees and vegetation of the slope face could be minimized or eliminated. We anticipate that the toe of sheet piles or solider piles would need to extend about 15 feet below existing site grades (about 2 times the exposed wall height) to establish fixity.

4.3.4.5. Slope Reinforcement

Opposed to constructing a retaining wall to stabilize the slope crest, reinforcement elements could be installed on the slope to prevent ongoing surficial slope movement. The "SRT Slope Reinforcement System" developed by GeoPier is an example of this type of slope reinforcement (https://www.geopier.com/solutions/slope-reinforcement-system/srt-system).

The "SRT Slope Reinforcement System" consists of discrete plate piles driven into the slope on a regular spacing. The upper portion of the pile is equipped with a plate that provides reinforcement to the soil mass and the lower portion of the pile is embedded through the unstable soils developing fixity in the underlying soils. An advantage of this alternative is that little or no excavation would be required on the slope. The SRT system is described as effective on slopes up to 45 degrees and for unstable soils up to 15 feet thick. Because the SRT system is proprietary, if this alternative is selected the design and construction would be completed by GeoPier. The SRT elements would be installed across the entire width of the slope and extend to near the base of the slope. SRT plate piles are typically installed using a pneumatic hammer attached to a long reach excavator.

4.4. Retaining Walls and Below Grade Structures

4.4.1. Design Parameters

We recommend that the lateral earth pressures provided below be considered for design below-grade structures and for preliminary evaluation of retaining walls. If retaining walls as previously discussed in this report are considered at the site, we should be notified to confirm that the provided earth pressures are appropriate for the selected wall type.

If drained design parameters are used, drainage systems must be included in the design in accordance with the recommendations presented in Section 4.5.2 Foundation Bearing Surface Preparation below.

- Active soil pressure may be estimated using an equivalent fluid density of:
  - 37 pounds per cubic foot (pcf) for the drained and level backfill condition
  - 80 pcf for the undrained and level backfill condition; this value includes hydrostatic pressures
  - 57 pcf for the drained condition with sloping backfill behind the structure up to 2H:1V
  - 90 pcf for the undrained condition with sloping backfill behind the structure up to 2H:1V; this value includes hydrostatic pressures
- At-rest soil pressure may be estimated using an equivalent fluid density of:
  - 57 pcf for the drained and level backfill condition
  - 90 pcf for the undrained and level backfill condition; this value includes hydrostatic pressures

- 77 pcf for the drained condition with sloping backfill behind the structure up to 2H:1V
- 100 pcf for the undrained condition with sloping backfill behind the structure up to 2H:1V; this value includes hydrostatic pressures

- For seismic considerations, a uniform lateral pressure of 10H pounds per square foot (psf) (where H is the height of the retaining structure or the depth of a structure below ground surface) should be added to the lateral earth pressure.
- An additional 2 feet of fill representing a typical traffic surcharge of 250 psf should be included if vehicles are allowed to operate within ½ the height of the top of retaining walls or below grade structures. Other surcharge loads should be considered on a case-by-case basis. We can provide additional surcharge loads for specific loading conditions once known.

The active soil pressure condition assumes the wall is free to move laterally 0.001 H, where H is the wall height). The at-rest condition is applicable where walls are restrained from movement. The above-recommended lateral soil pressures do not include other surcharge loads than described. We should be consulted if other surcharge loads are anticipated.

Overcompaction of fill placed directly behind retaining walls or below-grade structures must be avoided. We recommend use of hand-operated compaction equipment and maximum 6-inch loose lift thickness when compacting fill within about 5 feet of retaining walls and below-grade structures.

Bearing surfaces for retaining walls and below grade structures should be prepared following Section 4.5 Foundation Support of this report. If base of below grade structures are located deeper than 4 feet below site grades, the recommended structural fill pad below the foundation can be eliminated provided the bearing surface can be compacted to a uniformly firm and unyielding condition. Provided bearing surfaces are prepared as recommended retaining wall and below grade structure foundations may be designed using the allowable soil bearing values and lateral resistance values presented in Section 4.5.

4.4.2. Retaining Wall Drainage System

If retaining walls or below-grade structures are designed using drained parameters, a drainage system behind the structure must be constructed to collect water and prevent the buildup of hydrostatic pressure against the structure. We recommend the drainage system include a zone of free-draining backfill a minimum of 18 inches in width against the back of the wall. The drainage material should consist of coarse sand and gravel containing less that 5 percent fines based on the fraction of material passing the ¾-inch sieve. Material similar to "Gravel Backfill for Drains" per *WSDOT Standard Specifications* Section 9-03.12(4) is also suitable. Waffle board-type drainage mats may be considered instead of gravel provided they are protected from accumulating silt and discharge appropriately.

A perforated, rigid, smooth-walled drainpipe with a minimum diameter of 4 inches should be placed along the base of the structure within the free-draining backfill and extend for the entire wall length. The drainpipe should be metal or rigid polyvinyl chloride (PVC) pipe and be sloped to drain by gravity. Discharge should be routed to appropriate discharge areas and designed to reduce erosion potential. Cleanouts should be provided to allow routine maintenance. We recommend roof downspouts or other types of drainage systems not be connected to retaining wall drain systems

4.5. Foundation Support

4.5.1. General

The foundation support recommendations provided in this report are suitable for design and construction of lightly loaded (up to 2,000 psf allowable bearing resistance) footings. If heavy equipment, settlement sensitive improvements, occupied structures or foundations with bottom elevations greater than about 5 feet below existing site grades are planned, we should be consulted further and can provide supplemental recommendations, if needed.

We recommend that foundations bear on 6 inches of compacted structural fill underlain by proof-compacted firm and unyielding existing site soils. Footings should be established at least 18 inches below the lowest adjacent grade and have a minimum width of 24 inches.

4.5.2. Foundation Bearing Surface Preparation

Footings should bear on 6-inch pad of compacted structural fill. Structural fill should also extend 6 inches laterally beyond the edges of the footings.

Prior to placement of structural fill, the base of all footing excavations should be proof-compacted to a uniformly firm and unyielding condition as evaluated by a representative from our firm prior to placement of structural fill. Loose or disturbed materials present at the base of footing excavations should be removed or compacted. If soft or otherwise unsuitable areas are observed at the base of the excavation that cannot be compacted to a stable and uniformly firm condition the following options may be considered: (1) the exposed soils be moisture conditioned and recompacted; or (2) the unsuitable soils be overexcavated and replaced with compacted structural fill.

Prepared bearing surfaces should be evaluated by GeoEngineers during construction (prior to placement of formwork and reinforcement) to confirm bearing surfaces have been prepared in accordance with our recommendations.

4.5.3. Allowable Soil Bearing Resistance and Settlement

Shallow foundations bearing on surfaces prepared as recommended above can be designed using an allowable bearing resistance of up to 2,000 psf. This bearing pressure applies to the total of dead and long-term live loads and may be increased by 1/3 when considering total loads, including earthquake or wind loads. This is a net bearing pressure. The weight of the footing and overlying backfill can be ignored in calculating footing sizes.

We estimate that settlement of footings designed and established on surfaces prepared as recommended will be less than about 1 inch, with differential settlements of less than ½ inch between comparably loaded isolated column footings or along 50 feet of continuous footing. Static settlement estimates are in addition to the estimated liquefaction induced settlement values discussed in Section 4.2.2. Liquefication. Settlement is expected to occur rapidly as loads are applied. Settlements could be greater than estimated if loose or disturbed soil is present beneath footings. As design progresses, we should be provided the actual structure loads and footing sizes in order to confirm the settlement estimates above are appropriate.

4.5.4. Lateral Resistance

The ability of soil to resist lateral loads is a function of frictional resistance, which can develop on the base of footings and slabs and passive resistance, which can develop on the face of below-grade elements of the structure as these elements tend to move into the soil. We expect that the allowable frictional resistance on the base of footings may be computed using a coefficient of friction of 0.4 applied to the vertical dead-load forces.

The allowable passive resistance on the face of footings or other embedded foundation elements may be computed using an equivalent fluid density of 300 pcf for undisturbed site soils or structural fill extending out from the face of the foundation element a distance at least equal to 2½ times the depth of the element. These values include a factor of safety of about 1.5.

The passive earth pressure and friction components may be combined, provided that the passive component does not exceed $^2/_3$ of the total. The passive earth pressure value is based on the assumptions that the adjacent grade is level, and that groundwater remains below the base of the footing throughout the year. The top foot of soil should be neglected when calculating passive lateral earth pressure unless the area adjacent to the foundation is covered with pavement or a slab-on-grade.

4.6. Site Development and Earthwork

4.6.1. General

We anticipate that site development and earthwork will include clearing and stripping, excavating for utilities and other below grade improvements, establishing subgrades for foundations and placing and compacting fill and backfill materials. We expect that site grading and earthwork can be accomplished with conventional earthmoving equipment. The following sections provide specific recommendations for site development and earthwork.

4.6.2. Clearing, Stripping and Demolition

We recommend that existing pavements and hardscaping be completely removed from areas that will be developed. During removal and/or demolition, excessive disturbance of surficial soils may occur, especially if left exposed to wet conditions. Disturbed and demolition areas may require additional remediation during construction and grading.

Within vegetated areas, stripping depths on the order of 2 to 3 inches should be expected. The primary root system of trees and shrubs should be removed during stripping activities. Stripped material should not be used as fill and backfill materials and likely will need to be exported offsite for disposal.

4.6.3. Erosion and Sedimentation Control

Erosion and sedimentation rates and quantities can be influenced by construction methods, slope length and gradient, amount of soil exposed and/or disturbed, soil type, construction sequencing and weather. Implementing an erosion and sedimentation control plan will reduce the project impact on erosion-prone areas. The plan should be designed in accordance with applicable city, county and/or state standards. The plan should incorporate basic planning principles, including:

- Scheduling grading and construction to reduce soil exposure.

- Re-vegetating or mulching denuded areas.
- Directing runoff away from exposed soils.
- Reducing the length and steepness of slopes with exposed soils.
- Decreasing runoff velocities.
- Preparing drainage ways and outlets to handle concentrated or increased runoff.
- Confining sediment to the project site.
- Inspecting and maintaining control measures frequently.

Some sloughing and raveling of exposed or disturbed soil on slopes should be expected. We recommend that disturbed soil be restored promptly so that surface runoff does not become channeled.

Temporary erosion protection should be used and maintained in areas with exposed or disturbed soils to help reduce erosion and reduce transport of sediment to adjacent areas and receiving waters. Permanent erosion protection should be provided by paving, structure construction or landscape planting.

Until the permanent erosion protection is established, and the site is stabilized, site monitoring may be required by qualified personnel to evaluate the effectiveness of the erosion control measures and to repair and/or modify them as appropriate. Provisions for modifications to the erosion control system based on monitoring observations should be included in the erosion and sedimentation control plan.

4.6.4. Temporary Excavations and Dewatering

Excavations deeper than 4 feet must be shored or laid back at a stable slope if workers are required to enter. Shoring and temporary slope inclinations must conform to the provisions of Title 296 Washington Administrative Code (WAC), Part N, "Excavation, Trenching and Shoring." Regardless of the soil type encountered in the excavation, shoring, trench boxes or sloped sidewalls will be required under Washington Industrial Safety and Health Act (WISHA).

In general, temporary cut slopes at this site should be inclined no steeper than about 1½H:1V. This guideline assumes that all surface loads are kept at a minimum distance of at least ½ the depth of the cut away from the top of the slope and that seepage is not present on the slope face.

The static groundwater level at the site is expected to remain below about 5 feet bgs (about Elevation 164 feet) throughout the year. Excavation below the static groundwater table will likely require the use of dewatering systems such as wells or well points. Perched groundwater could be encountered in shallow excavations above the static groundwater level. We anticipate that shallow perched groundwater can be handled adequately with sumps, pumps and/or diversion ditches, as necessary. If planned excavation depths will exceed about 5 feet below existing site grades, we should be notified and can provide more detailed dewatering design recommendations.

Excavation, shoring and dewatering are interrelated; the design and implementation of these elements must be coordinated and must consider the over-all construction staging to ensure a consistent and compatible approach. We recommend that the contractor performing the work be made responsible for designing and installing construction shoring and for controlling and collecting groundwater encountered. The contract documents must specify that the contractor is responsible for selecting excavation and dewatering methods, monitoring the excavations for safety and providing shoring, as required, to protect personnel and structures.

4.6.5. Surface Drainage

Surface water from roofs, driveways and landscape areas should be collected and controlled. Curbs or other appropriate measures such as sloping pavements, sidewalks and landscape areas should be used to direct surface flow away from permanent improvements, erosion sensitive areas and from behind retaining structures.

4.6.6. Subgrade Preparation

Subgrades that will support structures and roadways should be thoroughly compacted to a uniformly firm and unyielding condition on completion of stripping and before placing structural fill. We recommend that subgrades for structures and roadways be evaluated, as appropriate, to identify areas of yielding or soft soil. Probing with a steel probe rod or proof-rolling with a heavy piece of wheeled construction equipment are appropriate methods of evaluation.

If soft or otherwise unsuitable subgrade areas are revealed during evaluation that cannot be compacted to a stable and uniformly firm condition, we recommend that: (1) the unsuitable soils be scarified (e.g., with a ripper or farmer's disc), aerated and recompacted, if practical; or (2) the unsuitable soils be removed and replaced with compacted structural fill, as needed.

4.6.7. Subgrade Protection and Wet Weather Considerations

Most of the soils encountered in our exploration contain a significant quantity of fines and will be susceptible to disturbance during periods of wet weather. Soil with high fines content is very sensitive to small changes in moisture and is susceptible to disturbance from construction traffic when wet or if earthwork is performed during wet weather. The wet weather season generally begins in October and continues through May in western Washington; however, periods of wet weather can occur during any month of the year. In our opinion, earthwork at the site should take place during the summer months or during periods of extended dry weather. If wet weather earthwork is unavoidable, we offer the following recommendations:

- The ground surface in and around the work area should be sloped so that surface water is directed away from the work area. The ground surface should be graded so that areas of ponded water do not develop. Measures should be taken by the contractor to prevent surface water from collecting in excavations and trenches. Measures should be implemented to remove surface water from the work area.
- Earthwork activities should not take place during periods of heavy precipitation.
- Slopes with exposed soils should be covered with plastic sheeting.
- The contractor should take necessary measures to prevent on-site soils and other soils to be used as fill from becoming wet or unstable. These measures may include the use of plastic sheeting, sumps with pumps and grading. The site soils should not be left uncompacted and exposed to moisture. Sealing exposed soils by rolling with a smooth-drum roller prior to periods of precipitation will help reduce the extent to which these soils become wet or unstable.
- Construction traffic should be restricted to specific areas of the site, preferably areas that are surfaced with working pad materials not susceptible to wet weather disturbance.

- Construction activities should be scheduled so that the length of time that soils are left exposed to moisture is reduced to the extent practical.
- Protective surfacing such as placing asphalt-treated base (ATB) or haul roads made of quarry spalls or a layer of free-draining material such as well-graded pit-run sand and gravel may be necessary to limit disturbance to completed areas.

4.7. Fill Materials

4.7.1. Structural Fill

The workability of material for use as structural fill will depend on the gradation and moisture content of the soil. We recommend that washed crushed rock or select granular fill, as described below, be used for structural fill during the rainy season. If prolonged dry weather prevails during the earthwork phase of construction, materials with a somewhat higher fines content may be acceptable. Weather and site conditions should be considered when determining the type of import fill materials purchased and brought to the site for use as structural fill.

Material used for structural fill should be free of debris, organic contaminants and rock fragments larger than 6 inches. For most applications, we recommend that structural fill material consist of material similar to "Select Borrow" or "Gravel Borrow" as described in Section 9-03.14 of the *WSDOT Standard Specifications*.

4.7.2. Select Granular Fill

Select granular fill should consist of well-graded sand and gravel or crushed rock with a maximum particle size of 6 inches and less than 5 percent fines by weight based on the minus ¾-inch fraction. Organic matter, debris or other deleterious material should not be present. In our opinion, material with gradation characteristics similar to WSDOT Specification 9-03.9 (Aggregates for Ballast and Crushed Surfacing), or 9-03.14 (Borrow) is suitable for use as select granular fill, provided that the fines content is less than 5 percent (based on the minus ¾-inch fraction) and the maximum particle size is 6 inches.

4.7.3. Pipe Bedding

Trench backfill for the bedding and pipe zone should consist of well-graded granular material similar to "gravel backfill for pipe zone bedding" described in Section 9-03.12(3) of the *WSDOT Standard Specifications*. The material must be free of roots, debris, organic matter and other deleterious material. Other materials may be appropriate depending on manufacturer specifications and/or local jurisdiction requirements.

4.7.4. Trench Backfill

Trench backfill must be free of debris, organic matter and rock fragments larger than 6 inches. We recommend that trench backfill material consist of material similar to "Select Borrow" or "Gravel Borrow" as described in Section 9-03.14 of the *WSDOT Standard Specifications*. Where excavations occur in the wet, alternative materials such as select granular fill should be considered.

4.7.5. On-Site Soil

In our opinion, the existing fill and recessional outwash soils can be used as structural fill, provided that they can be adequately moisture conditioned, placed and compacted as recommended and do not contain

organic or other deleterious material. Based on our experience the sand with silt and silty sand outwash soils present at the site can be moisture sensitive and will be difficult to properly compact when wet. If earthwork occurs during a typical wet season, or if the soils are persistently wet and cannot be dried back due to prevailing wet weather conditions, we recommend the use of imported structural fill or select granular fill, as described above.

We expect that soils generated from below the static groundwater level will be generated at a moisture content above what is optimum for compaction. In order to reuse these soils, it will likely be necessary to dry the soils out before they can be re-used. This typically requires a large area where the soils can be spread and tilled and prolonged dry weather conditions. If it is not feasible to moisture condition existing soils, or if earthwork is planned to take place during the wet weather months, we recommend that the project budget include a contingency for using imported material as fill and structural fill.

4.8. Fill Placement and Compaction

4.8.1. General

To obtain proper compaction, fill soil should be compacted near optimum moisture content and in uniform horizontal lifts. Lift thickness and compaction procedures will depend on the moisture content and gradation characteristics of the soil and the type of equipment used. The maximum allowable moisture content varies with the soil gradation and should be evaluated during construction. Generally, 8- to 12-inch loose lifts are appropriate for steel-drum vibratory roller compaction equipment. Compaction should be achieved by mechanical means. During fill and backfill placement, sufficient testing of in-place density should be conducted to check that adequate compaction is being achieved.

4.8.2. Area Fills and Pavement Bases

Fill placed to raise site grades and materials under pavements and structural areas should be placed on subgrades prepared as previously recommended. Fill material placed below structures and footings should be compacted to at least 95 percent of the theoretical maximum dry density (MDD) per ASTM International (ASTM) D 1557. Fill material placed less than 2 feet below pavement sections should be compacted to at least 95 percent of the MDD. Fill placed deeper than 2 feet below pavement sections should be compacted to at least 90 percent of the MDD. Fill material placed in landscaping areas should be compacted to a firm condition that will support construction equipment, as necessary, typically around 85 to 90 percent of the MDD.

4.8.3. Backfill Behind Below-Grade Structures

Backfill behind retaining walls or below-grade structures should be compacted to between 90 and 92 percent of the MDD. Overcompaction of fill placed directly behind below-grade structures should be avoided to limit pressures on the wall. We recommend use of hand-operated compaction equipment and maximum 6-inch loose lift thickness when compacting fill within about 5 feet behind below-grade structures.

4.8.4. Trench Backfill

For utility excavations, we recommend that the initial lift of fill over the pipe be thick enough to reduce the potential for damage during compaction but generally should not be greater than about 18 inches. In addition, rock fragments greater than about 1 inch in maximum dimension should be excluded from this lift.

Trench backfill material placed below structures and footings should be compacted to at least 95 percent of the MDD. In paved areas, trench backfill should be uniformly compacted in horizontal lifts to at least 95 percent of the MDD in the upper 2 feet below subgrade. Fill placed below a depth of 2 feet from subgrade in paved areas must be compacted to at least 90 percent of the MDD. In non-structural areas, trench backfill should be compacted to a firm condition that will support construction equipment as necessary.

4.9. Pavement Design

Existing pavements should be protected during construction. If existing pavements are damaged or removed (i.e., for utilities), we recommend the pavement be sawcut to establish clean edges prior to asphalt replacement. The thickness of the existing pavement section at the site is currently unknown; however, based on our observations the existing pavements appeared to be in fair condition and appeared to be providing adequate support for current site usage. We recommend that the existing pavement section be matched in thickness when restoring pavements in saw-cut areas. In areas where new pavements are planned, we recommend considering the following minimum pavement section. This pavement section is based on our experience and is suitable for support of conventional maintenance vehicles and occasional support of heavier construction traffic.

4.9.1. Recommended Pavement Section

- 3 inches of hot mix asphalt, class ½ inch, PG 58-22
- 4 inches of compacted crushed surfacing base course (CSBC)
- Subgrade prepared as recommended in Section 4.6.6. Subgrade Preparation of this report

CSBC should be moisture conditioned to near optimum moisture content and compacted to at least 95 percent of the theoretical MDD per ASTM D 1557. CSBC should conform to applicable sections of 4-04 and 9-03.9(3) of the *WSDOT Standard Specifications*. The contractor can elect to substitute crushed surfacing top course (CSTC) for CSBC in the top 2 inches of the crushed surfacing base section as a leveling layer and to allow for more precise grading.

5.0 LIMITATIONS

We have prepared this report for the exclusive use of Murraysmith, Inc. and their authorized agents for the Lift Station 6 Replacement Project in Lacey, Washington.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

Please refer to Appendix C titled “Report Limitations and Guidelines for Use” for additional information pertaining to use of this report.

6.0 REFERENCES

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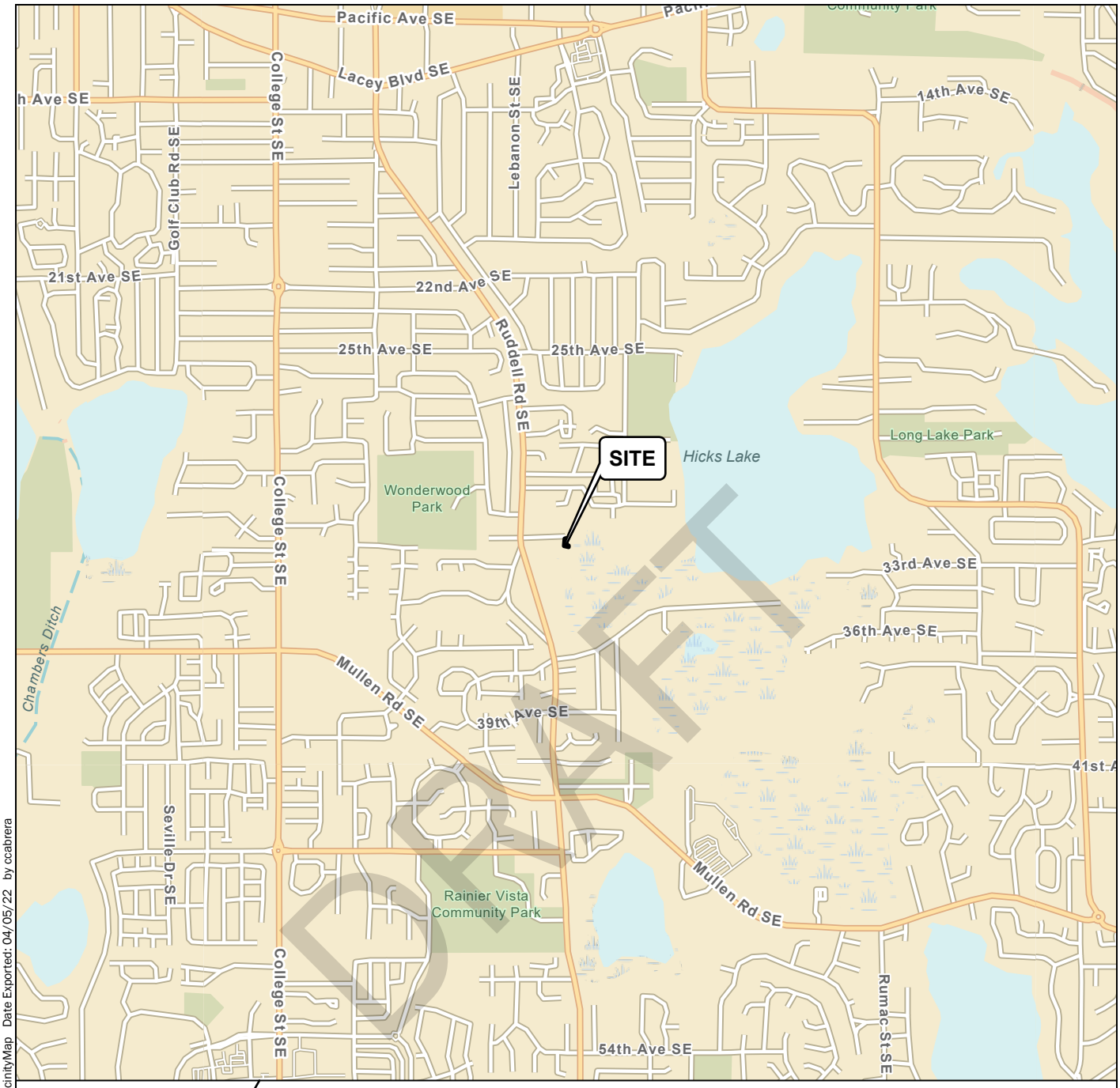

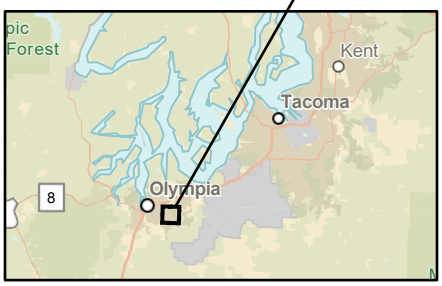

N
W E
S

2,000 0 2,000

Feet

Vicinity Map

Lacey Lift Station 6
Lacey, Washington

GeoEngineers

Figure 1

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: ESRI

Projection: NAD 1983 UTM Zone 10N

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Legend

Site Boundary

B-1 Boring by GeoEngineers, Inc., 2022

B-2 Monitoring Well by GeoEngineers, Inc., 2022

40 0 40
Feet

N
W E
S

Site Plan

Lacey Lift Station 6
Lacey, Washington, Thurston County

GeoEngineers

Figure 2

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Aerial from Google Earth Pro dated 6/26/2021.

Projection: WA State Plane, South Zone, NAD83, US Foot

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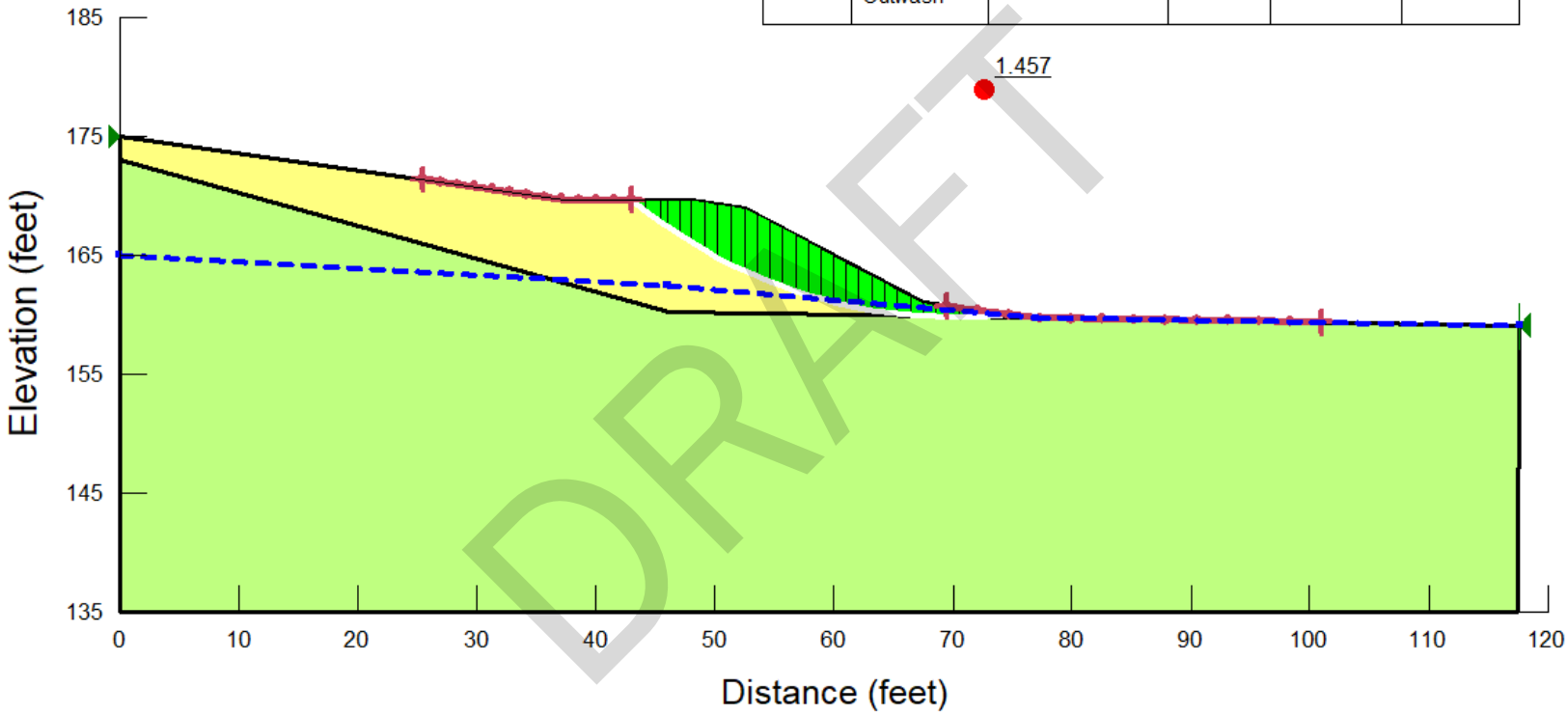
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Fill	Mohr-Coulomb	120	0	28
	Recessional Outwash	Mohr-Coulomb	120	0	32



Not to Scale

Notes:
1. The locations of all features shown are approximate.
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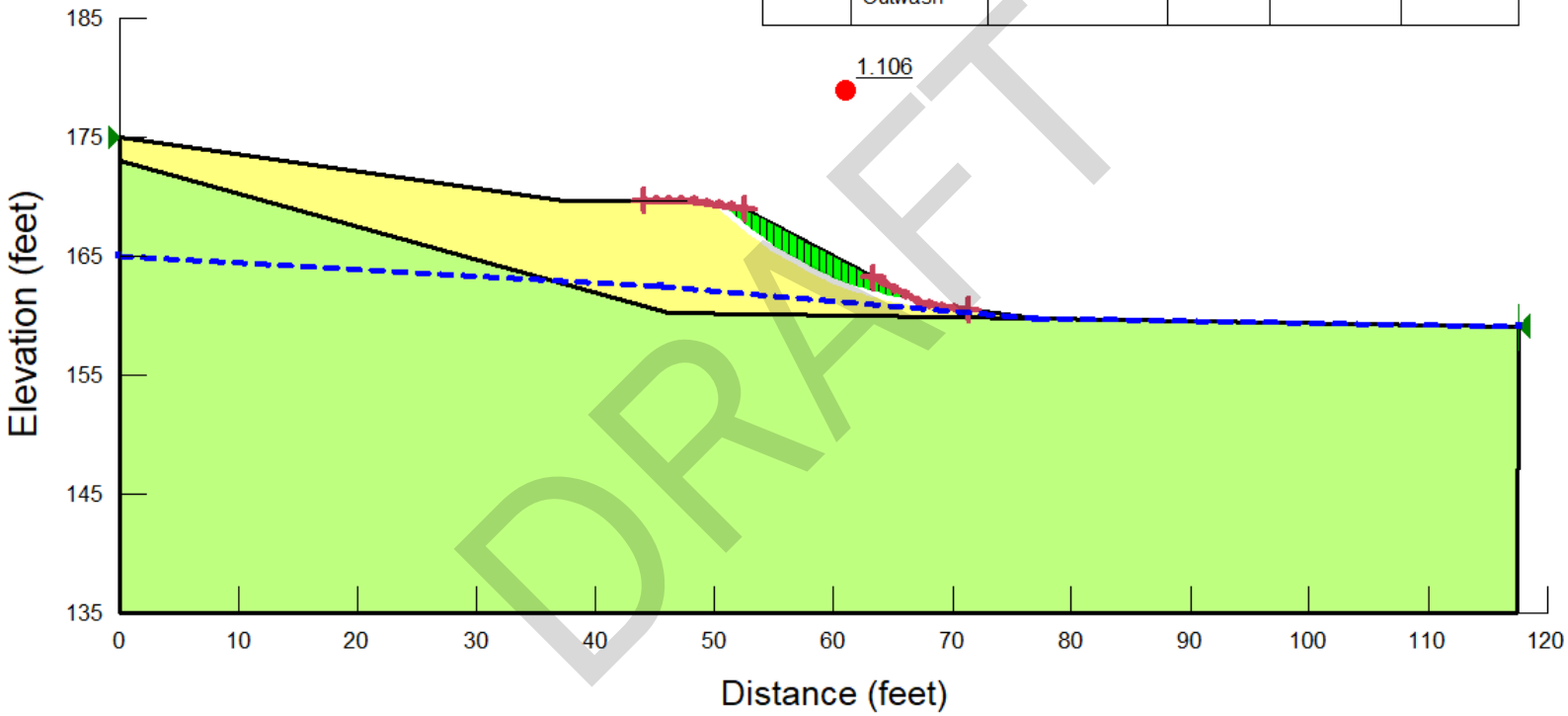
Slope Stability Results
Global Failure

Lacey Lift Station 6
Lacey, Washington

GeoEngineers

Figure 3

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Fill	Mohr-Coulomb	120	0	28
	Recessional Outwash	Mohr-Coulomb	120	0	32



Not to Scale

Notes:
1. The locations of all features shown are approximate.
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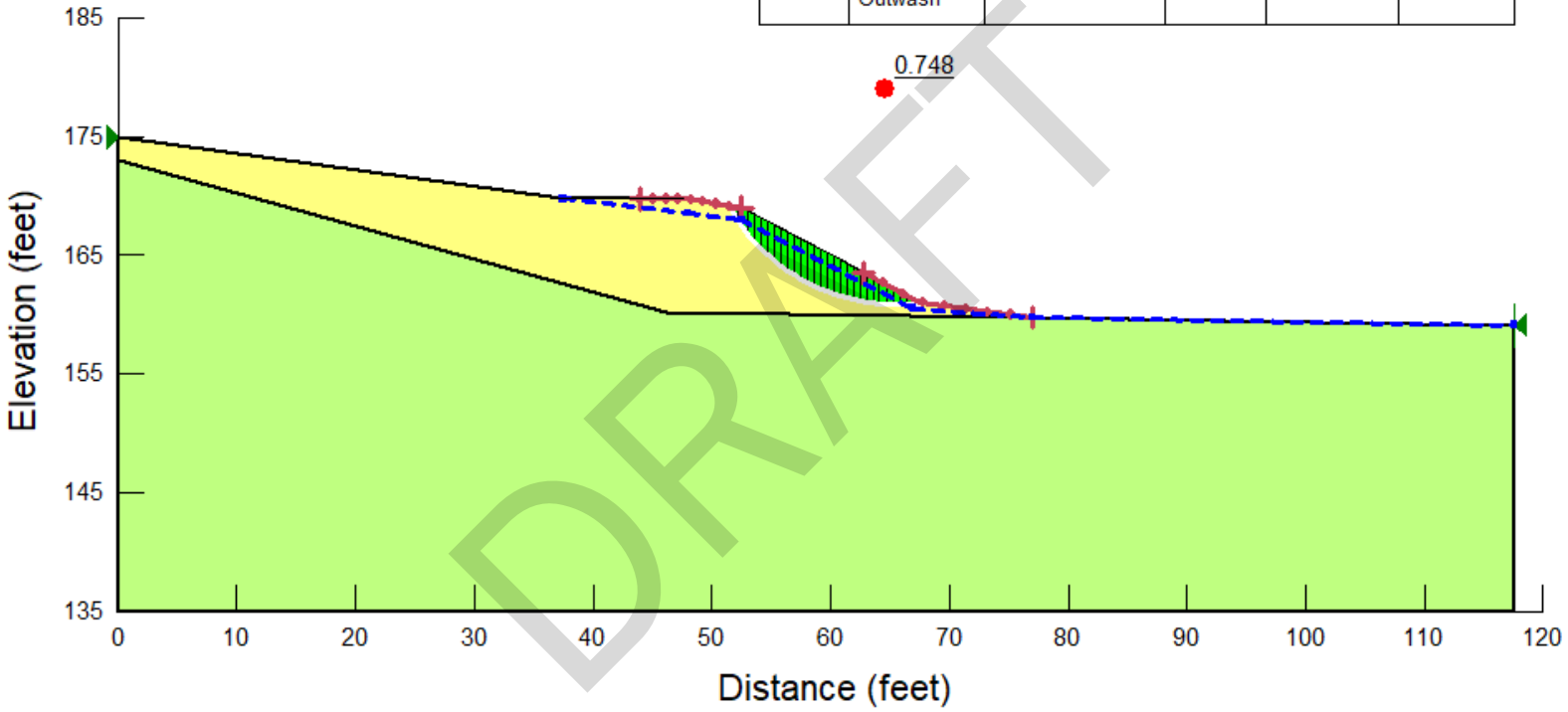
Slope Stability Results
Shallow Failure - Unsaturated

Lacey Lift Station 6
Lacey, Washington

GeoEngineers

Figure 4

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	Fill	Mohr-Coulomb	120	0	28
	Recessional Outwash	Mohr-Coulomb	120	0	32



Not to Scale

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Slope Stability Results
Shallow Failure - Unsaturated

Lacey Lift Station 6
Lacey, Washington

GeoEngineers

Figure 5

APPENDIX A
Subsurface Explorations

APPENDIX A
SUBSURFACE EXPLORATIONS

Soil conditions at the project site were explored by advancing two borings on March 30, 2022. The approximate locations of our explorations are shown on Figure 2, Site Plan. Although the explorations were located in the field using a global positioning system (GPS) device, the locations shown on Figure 2 should be considered approximate. The elevations shown on the boring logs were determined using survey data provided by Murraysmith, Inc. and are referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

The borings were completed using track-mounted drilling equipment provided and operated by Holocene Drilling, Inc. under subcontract to GeoEngineers. Borings were advanced using hollow-stem auger drilling methods to depths between 26.5 and 31.5 feet below ground surface (bgs). The explorations were continuously monitored by a representative from our firm who examined and classified the soil encountered, obtained representative soil samples and maintained a detailed log of the explorations. Soil encountered in the borings was classified in general accordance with ASTM International (ASTM) D 2488 and the classification chart listed in Figure A-1, Key to Exploration Logs. Logs of the borings are presented in Figures A-2 and A-3, Logs of Borings. The logs are based on interpretation in the field and indicate the depth at which we interpret subsurface materials or their characteristics to change, although these changes might actually be gradual.

Soil samples were obtained from the borings at approximate 2.5- to 5-foot-depth intervals using a 2-inch, outside-diameter, standard split-spoon sampler (Standard Penetration Test [SPT]) in general accordance with ASTM D 1586. The sampler was driven into the soil using a 140-pound automatic hammer, free-falling 30 inches. The number of blows required to drive the sampler each of three, 6-inch increments of penetration (total of 18 inches) were recorded in the field. The sum of the blow counts for the final 12 inches of penetration, unless otherwise noted, is reported on the boring logs.

The soil borings were backfilled by our drilling subcontractor following Washington Department of Ecology Guidelines. Soil cuttings generated during drilling were collected in drums and taken offsite by the driller for disposal. Boring B-2 was finished as monitoring wells after drilling was completed. A flush surface mount monument was constructed around the well in accordance with Washington Department of Ecology Guidelines.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% RETAINED ON NO. 200 SIEVE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	SOD	Sod/Forest Duff
	TS	Topsoil

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel / Dames & Moore (D&M)

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DD	Dry density
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
Mohs	Mohs hardness scale
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PL	Point lead test
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
UU	Unconsolidated undrained triaxial compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

Key to Exploration Logs

GeoEngineers

Figure A-1

Drilled: Start 3/30/2022 End 3/30/2022	Total Depth (ft) 26.5	Logged By LSP Checked By BEL	Driller Holocene Drilling	Drilling Method Hollow-stem Auger	
Surface Elevation (ft) 178 Vertical Datum NAVD88	Hammer Data Autohammer 140 (lbs) / 30 (in) Drop	Drilling Equipment Diedrich D-50			
Easting (X) 1064815 Northing (Y) 622843	System Datum WA State Plane South NAD83 (feet)	See "Remarks" section for groundwater observed			

Notes: Vac truck used to advance boring to 3 feet

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0							GP-GM	Grayish brown fine to coarse gravel with silt and occasional cobbles (medium dense, moist) (fill)			Vac truck used to advance boring to 5 feet
175			6			1 SA				4	6	
	5		14	7		2		SM	Brown silty fine to medium sand (loose, moist) (recessional outwash)			
170			15	11		3			Becomes medium dense			
	10		15	11		4 SA		SP-SM	Brown fine to medium sand with silt (medium dense, moist)	4	8	
165								ML	Oxidized brown sandy silt (medium stiff, wet)			Groundwater observed at approximately 13½ feet during drilling
	15		15	15		5A						
						5B		SP	Dark brown fine to medium sand with trace silt (medium dense, wet)			
160												
	20		10	6		6 SA			Becomes loose	24	5	
155												
	25		18	32		7			Becomes dense			

Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Aerial Imagery.

Log of Boring B-1

GeoEngineers

Project: Lacey Lift Station 6
Project Location: Lacey, Washington
Project Number: 0353-022-00

Figure A-2
Sheet 1 of 1

Drilled	Start	End	Total Depth (ft)	Logged By	Checked By	Driller	Drilling Method
	3/30/2022	3/30/2022	31.5	LSP	BEL	Holocene Drilling	Hollow-stem Auger

Hammer Data	Autohammer 140 (lbs) / 30 (in) Drop	Drilling Equipment	Diedrich D-50
Surface Elevation (ft) Vertical Datum	174 NAVD88	Top of Casing Elevation (ft)	
Easting (X) Northing (Y)	1064826 622797	Horizontal Datum	WA State Plane South NAD83 (feet)

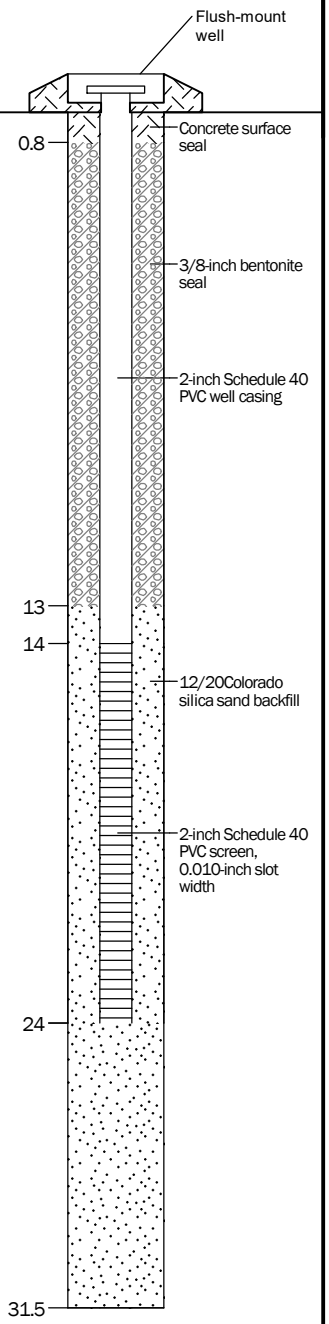
DOE Well I.D.: BNZ 365
A 2-in well was installed on 3/30/2022 to a depth of 24 ft.

Groundwater Date Measured	Depth to Water (ft)	Elevation (ft)
6/6/2022	7.00	167.00

Notes: Vac truck used to advance boring to 3 feet

Depth (feet)	Elevation (feet)	Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)
0	170	6			1			SM	Brown silty fine to medium sand with gravel, occasional cobbles and debris (asphalt) (medium dense, moist) (fill)		
5		6	10		2						
	165	17	5		3A 3B %F			ML	Black silty sand with organics (medium stiff, moist) (former ground surface horizon)	48	30
10		17	9		4			SM	Grayish brown silty fine to medium sand (loose, moist) (recessional outwash)		
	160										
15		16	8		5 SA				Becomes gray, wet	26	19
	155							SP-SM	Gray fine to medium silty sand (loose, moist)		
20		18	7		6 SA				(1 foot of heave)	23	21
	150										
25		0	22		7				(1 foot of heave)		
	145										
30		14	15		8				(1 foot of heave)		

WELL LOG



Note: See Figure A-1 for explanation of symbols.
Coordinates Data Source: Horizontal approximated based on Aerial Imagery. Vertical approximated based on Aerial Imagery.

Log of Boring with Monitoring Well B-2

GeoEngineers

Project: Lacey Lift Station 6
Project Location: Lacey, Washington
Project Number: 0353-022-00

Figure A-3
Sheet 1 of 1

APPENDIX B
Laboratory Testing

APPENDIX B
LABORATORY TESTING

Soil samples obtained from the explorations were transported to our laboratory and examined to confirm or modify field classifications, as well as to evaluate engineering properties of the soil. Representative samples were selected for laboratory testing. The following paragraphs provide a description of the tests performed at our laboratory.

Grain-Size Analysis

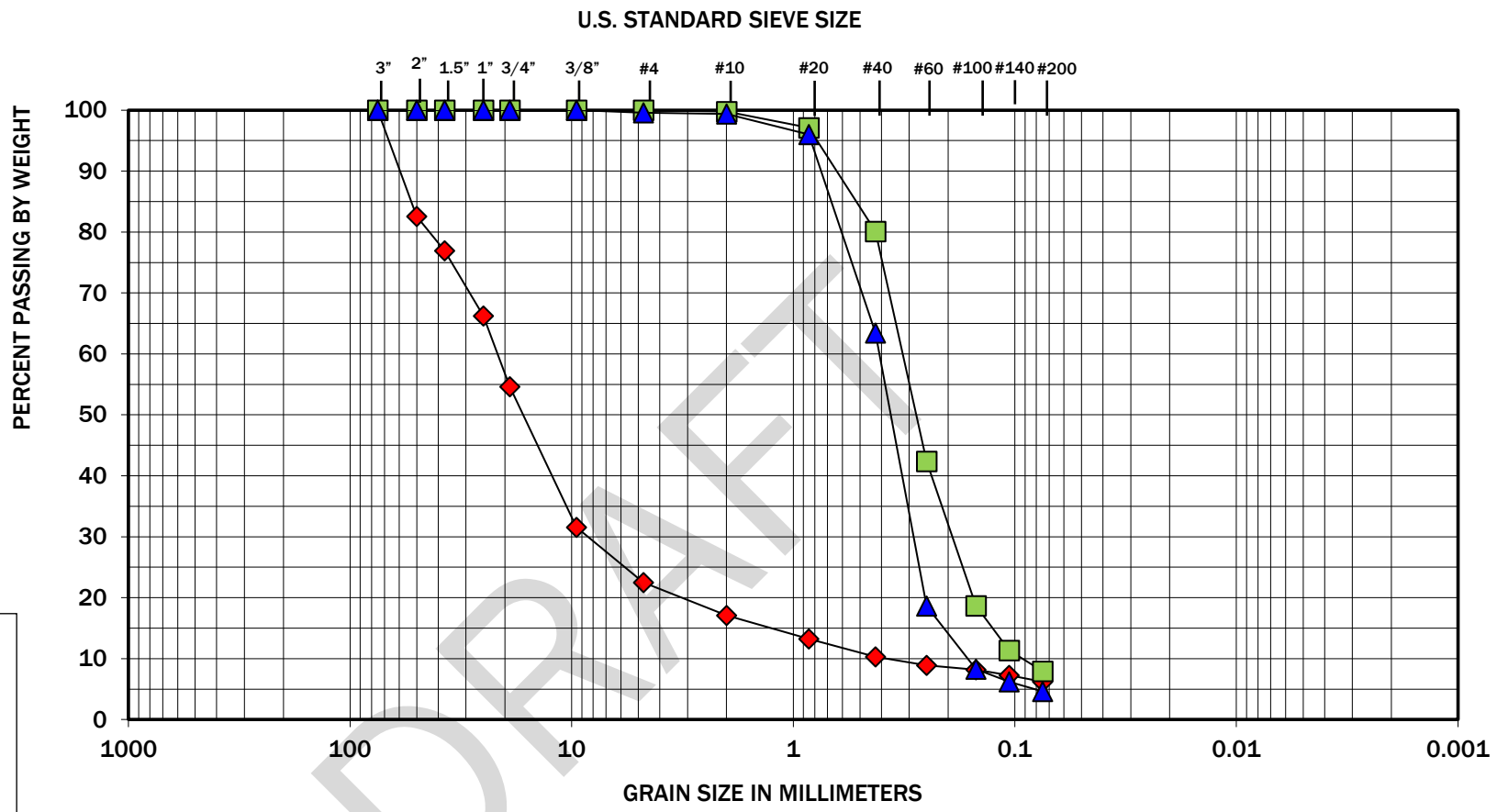
Grain-size analyses were performed on selected soil samples in general accordance with ASTM International (ASTM) Test Method D 6913. This test provides a quantitative determination of the distribution of particle sizes in soils. Figures B-1 and B-2, Sieve Analysis Results present the results of the grain-size analyses.

Percent Passing U.S. No. 200 Sieve (%F)

Selected samples were "washed" through the U.S. No. 200 sieve to estimate the relative percentages of coarse- and fine-grained particles in the soil. The percent passing value represents the percentage by weight of the sample finer than the U.S. No. 200 sieve (fines). The tests were conducted in general accordance with ASTM D 1140, and the results are shown on the exploration logs in Appendix A, Field Explorations (Figures A-2 and A-3) at the respective sample depths.

Moisture Content

The moisture content of selected samples was determined in general accordance with ASTM D 2216. The test results are used to aid in determining the moisture content of the soil, soil classification and correlation with other pertinent engineering soil properties. The test results are presented on the exploration logs at the respective sample depths.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Boring Number	Depth (feet)	Moisture (%)	Soil Description
◆	B-1	5	18	Silty Sand (SM)
■	B-1	10	9	Poorly graded Sand with silt (SP-SM)
▲	B-1	20	24	Poorly graded Sand (SP)

AASHTO ACCREDITED

The grain size analysis results were obtained in general accordance with ASTM C 136. GeoEngineers 17425 NE Union Hill Road Ste 250, Redmond, WA 98052

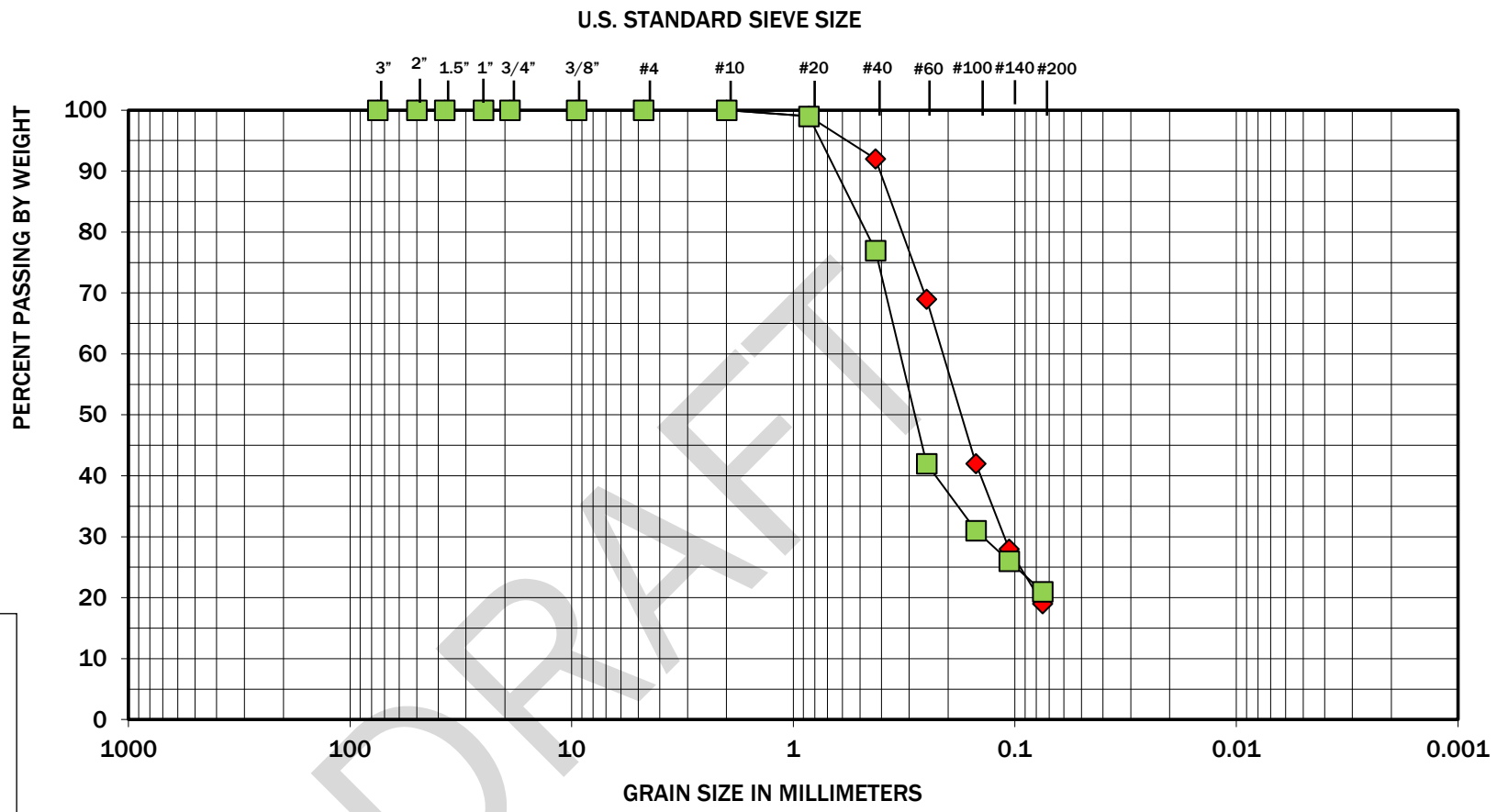
GeoEngineers

Lacey Lift Station 6

Lacey, Washington

Sieve Analysis Results

Figure-B-1



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Boring Number	Depth (feet)	Moisture (%)	Soil Description
◆	B-2	15	26	Silty Sand (SM)
■	B-2	20	23	Silty Sand (SM)

GeoEngineers

Figure-B-2

Lacey Lift Station 6

Lacey, Washington

Sieve Analysis Results

AASHTO ACCREDITED

The grain size analysis results were obtained in general accordance with ASTM C 136. GeoEngineers 17425 NE Union Hill Road Ste 250, Redmond, WA 98052

APPENDIX C
Report Limitations and Guidelines for Use

APPENDIX C
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

Read These Provisions Closely

It is important to recognize that the geoscience practices (geotechnical engineering, geology and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

Geotechnical Services are Performed for Specific Purposes, Persons and Projects

This report has been prepared for Murraysmith, Inc. for the Lift Station 6 Replacement project in Lacey, Washington. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Lift Station 6 Replacement project, and its schedule and budget, our services have been executed in accordance with our agreement with Murraysmith, Inc. dated March 10, 2022 which was executed on March 21, 2022, and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A Geotechnical Engineering or Geologic Report is based on a Unique Set of Project-Specific Factors

This report has been prepared for the Lift Station 6 Replacement project in Lacey, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- Not prepared for you,
- Not prepared for your project,
- Not prepared for the specific site explored, or
- Completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- The function of the proposed structure;

1 Developed based on material provided by GBA, GeoProfessional Business Association; www.geoprofessional.org.

- Elevation, configuration, location, orientation or weight of the proposed structure;
- Composition of the design team; or
- Project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

Environmental Concerns are Not Covered

Unless environmental services were specifically included in our scope of services, this report does not provide any environmental findings, conclusions, or recommendations, including but not limited to, the likelihood of encountering underground storage tanks or regulated contaminants.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Geotechnical and Geologic Findings are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

Geotechnical Engineering Report Recommendations are Not Final

We have developed the following recommendations based on data gathered from subsurface investigation(s). These investigations sample just a small percentage of a site to create a snapshot of the subsurface conditions elsewhere on the site. Such sampling on its own cannot provide a complete and accurate view of subsurface conditions for the entire site. Therefore, the recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions. If another party performs field observation and confirms our expectations, the other party must take full responsibility for both the observations and recommendations. Please note, however, that another party would lack our project-specific knowledge and resources.

A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable but separating logs from the report can create a risk of misinterpretation.

Give Contractors a Complete Report and Guidance

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving contractors the complete geotechnical engineering or geologic report, including these "Report Limitations and Guidelines for Use." When providing the report, you should preface it with a clearly written letter of transmittal that:

- Advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- Encourages contractors to conduct additional study to obtain the specific types of information they need or prefer.

Contractors are Responsible for Site Safety on Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as

they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

Information Provided by Others

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

SUF

S O U N D U R B A N F O R E S T R Y, LLC

Appraisals ~ Site Planning ~ Urban Landscape Design and Management
Environmental Education ~ Risk Assessment

1/31/2023

City of Lacey
Puna Clarke, Utility Engineer
420 College St SE
Lacey, WA 98503

RE: City of Lacey Lift Station 6 Rehabilitation Project Tree Removal and Protection,

Ms. Clarke:

Upon your request, I have conducted an assessment within the City's Lift Station 6 property at 5611 32nd Ct SE. I visited the site and met with you on January 11, 2023 to discuss the project and evaluate the trees of concern within adjacent parcels that may be affected by the associated activities or considered risks. This report presents my findings and recommendations.

5609 32nd Ct SE

While at the site, the property owner at 5609 32nd Ct SE requested that a pine tree be removed because it had lost branches in the past and currently has a few dead branches hanging in the canopy. This tree is noted as #1 on the attached site plan.

Tree #1: 13" Scots pine. This tree is in overall fair condition with no indications of decay, disease or major structural issues. The dead and/or damaged branches within the canopy can be mitigated with crown clean pruning. This pruning will reduce the risk associated with this tree.

5605 32nd Ct SE

There are three trees within this property of concern to the resident, particularly Tree #2.

Tree #2: 32" western red cedar. Approximate height of 80' with 30% live canopy ratio (LCR). The overall structure of this tree is poor. Its main stem splits into co-dominant leaders at 50' with 2' of inclusion at the union. The tree leans toward the lift station drive and the adjacent property at 5609 32nd Ct SE. Potential targets include the drive at 12' and house at 38'. It is considered a "high" risk.

Tree #3: 30" Douglas fir. Approximate height of 120' with 25% LCR. This tree is in fair condition. No indications of decay, disease or structural issues. This tree will not be affected by the project and is considered a moderate risk.

Tree #4: 34" western red cedar. Approximate height of 110' with 20% LCR. No indications of decay, disease or structural issues. This tree will not be affected by the project nor is it considered a risk.

Comments

I recommend that Tree #2 be removed due to its risk rating and the conflict with the proposed security fence location. The stump should be grinded to 16-18" below grade to provide clearance for the fence. I see no reason to remove the other three assessed trees.

Please contact me should you have any questions.

Sincerely,

Kevin M. McFarland, Principal
Consulting Urban Forester/ISA Certified Arborist PN-0373 & ISA Tree Risk Assessor Qualified
City of Lacey Contracted Tree Protection Professional
Sound Urban Forestry, LLC
P.O. Box 489
Tahuya, WA 98588

Locations of Assessed Trees