DETERMINATION OF NON-SIGNIFICANCE
(DNS) TUM-23-1260
PSE BARNES LAKE SUBSTATION
REBUILD/EXPANSION

Description of Proposal: Rebuild and expand the Barnes Lake Substation to extend and increase the capacity and life of the sub-station to meet growing demand in the area.

Applicant: Trevor Lessard, 1140 N 94th St., Seattle, WA 98103.

Location of Proposal: 1697 2nd Ave SW, Tumwater, WA 98512. Parcel number 09080011003.

Lead agency: City of Tumwater, Community Development Department.
As provided by RCW 43.21C.240 and WAC 197-11-158, the lead agency has determined that the requirements for environmental analysis, protection, and mitigation measures have been adequately addressed in the applicable development regulations and comprehensive plan adopted under RCW 36.70A and in other local, state, or federal laws or rules. Therefore, this proposal is not likely to have a probable significant adverse impact on the environment. An Environmental Impact Statement is not required under RCW 43.21C.030(2)(c), and the lead agency will not require additional mitigation measures under SEPA. This decision was made after review of a completed environmental checklist and other information on file with the lead agency. This information is available to the public on request.

This DNS is issued under WAC 197-11-355, the optional DNS process. No comment period is provided with this DNS pursuant to WAC 197-11-355(4)(a).

Date: May 24, 2024

Responsible Official:

Mike Matlock, AICP
Community Development Director

Contact person: Alex Baruch, Senior Planner, 360-754-4180
555 Israel Road SW Tumwater, WA 98501

Appeals of this DNS must be made to the City Clerk, no later than May 31, 2024, by 5:00 p.m. All appeals shall be in writing, be signed by the appellant, be accompanied by a filing fee, and set forth the specific basis for such appeal, error alleged and relief requested.

CITY OF TUMWATER
555 ISRAEL RD. SW, TUMWATER, WA 98501
Email: cdd@ci.tumwater.wa.us
(360) 754-4180

TUM-____-__________

DATE STAMP

RECEIVED BY: __________

Any person proposing to develop in the incorporated limits of the City of Tumwater is required to submit an environmental checklist unless the project is exempt as specified in WAC 197-11-800 (Categorical Exemptions) of the State Environmental Policy Act Rules. **SUBMITTAL REQUIREMENTS** are as follows:

1. **A COMPLETE ENVIRONMENTAL CHECKLIST.** If the project is located within the Port of Olympia property, the checklist must also be signed by a representative of the Port.
2. **FEE OF $880.00 TO BE PAID UPON SUBMITTAL.** This includes the Public Notice fee.
3. **NAME AND ADDRESS LIST OF PROPERTY OWNERS WITHIN 300 FEET OF THE SUBJECT PROPERTY.**

SEPA ENVIRONMENTAL CHECKLIST

Purpose of checklist

Governmental agencies use this checklist to help determine whether the environmental impacts of your proposal are significant. This information is also helpful to determine if available avoidance, minimization, or compensatory mitigation measures will address the probable significant impacts or if an environmental impact statement will be prepared to further analyze the proposal.

Instructions for applicants

This environmental checklist asks you to describe some basic information about your proposal. Please answer each question accurately and carefully, to the best of your knowledge. You may need to consult with an agency specialist or private consultant for some questions. **You may use “not applicable” or "does not apply" only when you can explain why it does not apply and not when the answer is unknown.** You may also attach or incorporate by reference additional studies reports. Complete and accurate answers to these questions often avoid delays with the SEPA process as well as later in the decision-making process.

The checklist questions apply to **all parts of your proposal,** even if you plan to do them over a period of time or on different parcels of land. Attach any additional information that will help describe your proposal or its environmental effects. The agency to which you submit this checklist may ask you to explain your answers or provide additional information reasonably related to determining if there may be significant adverse impact.

Instructions for lead agencies

Please adjust the format of this template as needed. Additional information may be necessary to evaluate the existing environment, all interrelated aspects of the proposal and an analysis of adverse impacts. The checklist is considered the first but not necessarily the only source of information needed to make an adequate threshold determination. Once a threshold determination is made, the lead agency is responsible for the completeness and accuracy of the checklist and other supporting documents.

Use of checklist for nonproject proposals

For nonproject proposals (such as ordinances, regulations, plans and programs), complete the applicable parts of sections A and B, plus the Supplemental Sheet for Nonproject Actions (Part D). Please completely answer all questions that apply and note that the words "project," "applicant," and "property or site" should be read as "proposal," "proponent," and "affected geographic area," respectively. The lead agency may exclude (for non-projects) questions in “Part B: Environmental Elements” that do not contribute meaningfully to the analysis of the proposal.

A. Background [Find help answering background questions]

1. Name of proposed project, if applicable:

Barnes Lake Substation Rebuild and Expansion

2. Name of applicant:

Puget Sound Energy (PSE)

3. Address and phone number of applicant and contact person:

Trevor Lessard
Puget Sound Energy
1140 N. 94th Street
Seattle, WA 98103
206-390-9660

4. Date checklist prepared:

10/31/2023

5. Agency requesting checklist:

City of Tumwater

6. Proposed timing or schedule (including phasing, if applicable):

The project is anticipated to occur in 2024 in one phase after permits have been obtained.

7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.

There are no planned future additions or expansions related to this proposal.

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

- Wetland Reconnaissance Field Report (GeoEngineers, July 25, 2022)
- Results of 2022 Mazama Pocket Gopher (MPG) Study (West Fork Environmental, September 28, 2022)
- Geotechnical Engineering Services Report (GeoEngineers, April 20, 2023)

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain.

None Known

10. List any government approvals or permits that will be needed for your proposal, if known.

- Landscape Plan
- Fence Variance
- Shoreline Exemption – temporary stockpile only
- Critical Area Report – evidence of no critical areas present or impacted
- SEPA Checklist
- Formal Site Plan
- Site Development/Grading Permit

Building Permit

11. Give a brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)

The scope of work includes two components intended to meet the dual goals for the substation project. The first is to replace the damaged and old equipment within the substation to ensure reliable power supply and public safety. The second is to expand the substation, thereby increasing the capacity the substation can provide to the growing service area. Overall, PSE's project will include the replacement of one existing transformer, associated equipment, and concrete foundations for this equipment; the addition of another transformer, associated equipment, and new concrete foundations for said equipment; a bump out of the fence along the backside (north end) of the substation to accommodate the control house relocation; replacing the existing chain link fence with new fencing that is anticlimb and reduces the sightline into the substation; installing a new infiltration pond behind the substation to manage stormwater; and amendments to the landscaping plan to account for the new design proposal, discouragement of trespassers on the property, and future access improvements to the substation.

12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

The location of the project is 1697 (South) 2nd Ave SW, Tumwater, WA 98512
Parcel # 09080011003
T/R/S: 18N / 02W / 29

B. Environmental Elements

1. Earth

a. General description of the site:

The ground surface within the currently fenced substation portion of the site is relatively flat; the ground surface in the undeveloped areas west and north of the substation slopes gently down to the west and north.

Circle or highlight one: Flat, rolling, hilly, steep slopes, mountainous, other:

b. What is the steepest slope on the site (approximate percent slope)?

10 percent (%) slope along the western portion of the property northwest of the existing substation, but typically less than 3%.

c. What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them, and note any agricultural land of long-term commercial significance and whether the proposal results in removing any of these soils.

Based on the geotechnical subsurface explorations, subsurface conditions consist of fill and recessional outwash. The fill generally consists of loose to medium sand with variable silt and gravel content. The underlying recessional outwash generally consists of medium dense to dense sand with variable silt content. (GeoEngineers 2023). Mapped soils in the area consist of Nisqually loamy fine sand (0 to 3% slopes) (USDA Natural Resources Conservation Service, Web Soil Survey on-line mapper).

There is no agricultural land on the site.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

Based on the relatively flat grades in the vicinity of the site, the site is not within erosion or landslide hazard areas and there are no indications of unstable soils in the immediate vicinity (GeoEngineers 2023).

e. Describe the purpose, type, total area, and approximate quantities and total affected area of any filling, excavation, and grading proposed. Indicate source of fill.

Earthwork (Cubic Yards)	
Total Cut	2,190
Total Fill	2,030
Total Earthwork	4,220
Impervious Surfaces (Square Feet)	

New Impervious Surface	2,550
Replaced Impervious Surface	15,000
Total Impervious Surface	17,550
Disturbed Area (Square Feet)	
Total Disturbed Area	41,300

f. Could erosion occur because of clearing, construction, or use? If so, generally describe.

There could be a temporary increase in erosion as soil is disturbed and stockpiled during construction.

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

After improvements, the project site will have 17,550 square feet of impervious surface, compared to the existing 15,000 square feet. After construction, approximately 34 percent% of the parcel will be covered with impervious surface.

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any.

Temporary erosion and sedimentation (TESC) best management practices (BMPs) will be installed to prevent erosion and sedimentation, such as a stabilized construction entrance, perimeter silt fence and stockpile covering. Additional concrete handling BMPs will be used and are also referenced in Drawing D-22017.

2. Air Find help answering air questions

a. What types of emissions to the air would result from the proposal during construction, operation, and maintenance when the project is completed? If any, generally describe and give approximate quantities if known.

Construction activities may temporarily generate small amounts of dust emissions from excavation, bare soil or general traffic of the vehicles used on site. This increase in activity on site also may temporarily generate carbon dioxide (CO_2) emissions from the vehicles and machinery used during construction.

Operation and maintenance may result in infrequent CO_2 emissions from vehicles that enter the site.

b. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.

There are no off-site sources of emissions that will affect the proposed project.

c. Proposed measures to reduce or control emissions or other impacts to air, if any.

Dust may be controlled with light water spray, if necessary. Construction equipment are expected to meet Washington State Department of Transportation (WSDOT) standards for emissions.

Meet development guide regulations for BMPs during construction.

3. Water Find help answering water questions

a. Surface Water: Find help answering surface water questions

1. Is there any surface water body on or in the immediate vicinity of the site (including year-

round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

Barnes Lake is approximately 100 feet north of the northernmost extent of the PSE-owned parcel.

2. **Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.**

While no work will occur within the 200-foot shoreline buffer of the lake, temporary soil stockpiling is proposed that will spill over into this area. The proposed stockpile within the design is only the maximum proposed extent, it is unlikely PSE will use the entire proposed area for stockpiling, further reducing the actual incursion into the shoreline buffer.

Limited to max amount of stockpile cy within shoreline.

3. **Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.**

Wetlands were not identified in the project vicinity and there will be no fill or dredge material that would be placed in or removed from Barnes Lake.

4. **Will the proposal require surface water withdrawals or diversions? Give a general description, purpose, and approximate quantities if known.**

There are no plans for surface water withdrawals or diversions as part of this proposal.

5. **Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.**

The proposed project is not located within a 100-year floodplain.

6. **Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.**

No discharge of waste material will occur to surface waters.

b. Ground Water: [Find help answering ground water questions]

1. **Will groundwater be withdrawn from a well for drinking water or other purposes? If so, give a general description of the well, proposed uses and approximate quantities withdrawn from the well. Will water be discharged to groundwater? Give a general description, purpose, and approximate quantities if known.**

No discharge or withdrawal of groundwater is likely to be necessary during construction. The geotechnical borings found groundwater to be at a depth of at least 16 feet below ground surface.

2. **Describe waste material that will be discharged into the ground from septic tanks or other**

sources, if any (domestic sewage; industrial, containing the following chemicals…; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

No waste material will be discharged.

c. Water Runoff (including stormwater):

a) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

Source of runoff may include stormwater runoff from precipitation during construction. It is unlikely that stormwater runoff will need to be collected and disposed of during construction because stormwater readily infiltrates into the permeable site soil.

b) Could waste materials enter ground or surface waters? If so, generally describe.

No.

c) Does the proposal alter or otherwise affect drainage patterns in the vicinity of the site? If so, describe.

No, the proposed project will not significantly alter or otherwise affect drainage patterns in the vicinity of the site. Currently, stormwater generally infiltrates on site because of the permeable soils. The proposed size of the project/new impervious area is triggering the proposed additional biofiltration stormwater facilities that will be installed, but the current drainage pattern of infiltration will be unchanged.

d) Proposed measures to reduce or control surface, ground, and runoff water, and drainage pattern impacts, if any.

During construction, the perimeter silt fence will be used to prevent runoff from the site from entering Barnes Lake.

Stormwater and runoff discharge for the completed project will be self-mitigated through installation of the proposed bioretention cell that will provide water quality treatment and stormwater retention/flow abatement.

4. Plants [Find help answering plants questions]

a. Check the types of vegetation found on the site:

☒ **deciduous tree: alder, maple, aspen, other *Oregon white oak***
☒ **evergreen tree: fir, cedar, pine, other**
☒ **shrubs *snowberry, Oregon grape, salal, Scots broom, Himalyan blackberry***
☒ **grass *reed canarygrass, sweet vernalgrass***
☐ **pasture**

☐ crop or grain
☐ orchards, vineyards, or other permanent crops.
☐ wet soil plants: cattail, buttercup, bullrush, skunk cabbage, other
☐ water plants: water lily, eelgrass, milfoil, other
☐ other types of vegetation *English ivy, ribwort, common dandelion, cats ear*

b. What kind and amount of vegetation will be removed or altered?

The project will impact mowed grass for construction of the stormwater pond and existing landscape screening the rear substation fence line will be removed, as well as landscaping vegetation along the existing substation fence line cut back as needed to widen the substation footprint.

c. List threatened and endangered species known to be on or near the site.

No threatened or endangered plant species or critical habitat is known to be on or near the site.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any.

Existing trees will be protected during construction with tree protection fencing.

Temporarily disturbed areas will likely consist of herbaceous grass areas and will be reseeded and stabilized as needed after construction has been completed. No shrubs or trees will be removed as a result of the project.

e. List all noxious weeds and invasive species known to be on or near the site.

Minor Scots broom was identified on the site, which is listed as a noxious week by the Washington Invasive Species Council. Although not listed as noxious by either the Washington council or the Thurston County Noxious Weed Control Board, Himalayan blackberry can be invasive and was identified within the project area. No other known noxious or invasive weeds have been identified on the project site.

5. Animals

List any birds and other animals that have been observed on or near the site or are known to be on or near the site.

Examples include:

- **Birds: hawk, heron, eagle, songbirds, other:**
- **Mammals: deer, bear, elk, beaver, other:**
- **Fish: bass, salmon, trout, herring, shellfish, other:** ***Fish are in Barnes Lake to the north***

a. List any threatened and endangered species known to be on or near the site.

No threatened and endangered species are known to be on or near the site.

b. Is the site part of a migration route? If so, explain.

The project corridor is within the Pacific Flyway.

c. Proposed measures to preserve or enhance wildlife, if any.

Areas of temporary buffer disturbance (grassy areas) will be stabilized and seeded. Out of precaution, Puget Sound Energy contracted pocket gopher surveys at the site. West Fork Environmental did not identify evidence of Mazama (Olympia) pocket gophers during surveys conducted in 2022 or in 2023. Additionally, based on communication between PSE and City staff, there are no known gophers or gopher-supporting soils near the project site. Therefore, no measures to preserve or enhance wildlife are proposed.

d. List any invasive animal species known to be on or near the site.

No known invasive animal species are known to be on or near the site.

6. Energy and Natural Resources [Find help answering energy and natural resource questions]

1. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

The completed project will be an electrical substation and will use electricity.

2. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

No, the project will not affect the potential use of solar energy by adjacent properties.

3. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any.

All substation lighting will be LEDs with photocell sensors to trigger operation only during night conditions. This site does not represent a significant energy demand and therefore energy conservation options are extremely limited.

7. Environmental Health [Find help with answering environmental health questions]

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur because of this proposal? If so, describe.

The proposed expansion of the substation will not create any known environmental health hazards. The facilities will be designed, constructed and operated in accordance with all applicable federal, state and local regulations and safety codes.

1. Describe any known or possible contamination at the site from present or past uses.

Representative soil samples were obtained in July 2022 to characterize potential contaminants typically found on a substation property prior to the proposed site work. Eight composite, shallow soil samples were obtained from the geotechnical borings completed at the four corners of the property. Based on chemical analytical data for the samples, diesel-range petroleum hydrocarbons and polychlorinated biphenyl compounds (PCBs) were not detected. Lube oil-range petroleum hydrocarbons were detected at a concentration less than the MTCA Method A soil cleanup level for unrestricted site use in the shallow (less than 4 feet) soil sample from the boring completed in the northwest corner of the substation.

On November 11, 2022, approximately 1,000 gallons of mineral oil were released to the soil within the Barnes Lake Substation when a vandal shot a hole in a pad-mounted transformer. A vacuum truck was mobilized to remove the oil that pooled on the surface within the substation and the stained concrete foundation was cleaned. Approximately 2 cubic yards of impacted soil at the surface were excavated and removed from the site for disposal at a permitted facility. PSE intends to complete a cleanup of soil that was impacted by infiltrating mineral oil during the proposed project excavation activities.

2. Describe existing hazardous chemicals/conditions that might affect project development and design. This includes underground hazardous liquid and gas transmission pipelines located within the project area and in the vicinity.

No known existing hazardous chemicals or conditions might affect the project development or design.

3. Describe any toxic or hazardous chemicals that might be stored, used, or produced during the project's development or construction, or at any time during the operating life of the project.

The transformer at the substation contains mineral oil. Mineral oil is a regulated contaminant in Washington.

Additionally, machinery or vehicles used for construction use gasoline or diesel for fuel. The fuel of excavating equipment may be from a slip tank installed in the bed of a service truck.

4. Describe special emergency services that might be required.

Special emergency services will likely not be required for the project. Emergency services currently available (emergency medical, fire response and security) will continue to serve this site.

5. Proposed measures to reduce or control environmental health hazards, if any.

There are no environmental health hazards anticipated as a result of the proposed actions and therefore, no measures are proposed.

b. Noise

1. What types of noise exist in the area which may affect your project (for example: traffic, equipment, operation, other)?

No existing noise will affect the proposed project.

2. **What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site)?**

A short-term increase in noise will result from construction activities, which will include the use of heavy equipment.

There will be no long-term change in noise from PSE's site use as an electrical substation resulting from the proposed project.

3. **Proposed measures to reduce or control noise impacts, if any.**

Construction will be completed within normal daytime weekday work hours allowed within city code.

8. Land and Shoreline Use Find help answering land and shoreline use questions

a. **What is the current use of the site and adjacent properties? Will the proposal affect current land uses on nearby or adjacent properties? If so, describe.**

The site is currently used as an electrical substation. Adjacent properties are commercial in use to the east, west and south, with a condominium complex located northwest of the site. Barnes Lake and surrounding natural shoreline buffer are located north of the site. Because land use is not changing, the proposal will not affect the current land use on nearby or adjacent properties.

b. **Has the project site been used as working farmlands or working forest lands? If so, describe. How much agricultural or forest land of long-term commercial significance will be converted to other uses because of the proposal, if any? If resource lands have not been designated, how many acres in farmland or forest land tax status will be converted to nonfarm or nonforest use?**

The site has not been used for working farmlands or working forest lands since 1973 when the substation was constructed. No resource lands, farmland or forest land tax status will be converted as a result of the proposed project.

1. **Will the proposal affect or be affected by surrounding working farm or forest land normal business operations, such as oversize equipment access, the application of pesticides, tilling, and harvesting? If so, how?**

No, the project will not affect or be affected by surrounding working farm or forest land business operations.

c. **Describe any structures on the site.**

The existing substation facility contains existing PSE electrical distribution lines, transformers and poles with an asphalt driveway. A 8 foot by 6 foot, prefabricated control house is also located on the subject property.

d. **Will any structures be demolished? If so, what?**

The existing substation fencing, concrete foundations and associated electrical structures will be removed.

e. What is the current zoning classification of the site?

GC (General Commercial)

f. What is the current comprehensive plan designation of the site?

Commercial

g. If applicable, what is the current shoreline master program designation of the site?

No proposed work will occur within the 200-foot shoreline buffer of Barnes Lake, which is designated by the City of Tumwater's Shoreline Master Program as a freshwater lake system shoreline (although temporary stockpiling of soil will spill into this area), with a shoreline master program designation of Urban Intensity near the site.

h. Has any part of the site been classified as a critical area by the city or county? If so, specify.

Barnes Lake is over 200 feet north of the project footprint, except for some temporary soil stockpiling during construction. Wetland habitat may occur offsite to the north along the fringe of Barnes Lake; however, wetland or stream habitat has not been observed on the project parcel.

The site is located within a wellhead protection area and is a High Groundwater Review Area.

i. Approximately how many people would reside or work in the completed project?

None

j. Approximately how many people would the completed project displace?

None

k. Proposed measures to avoid or reduce displacement impacts, if any.

Not applicable

l. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any.

The project aligns with existing and projected land use plans per the City's Comprehensive Plan Land Use Map. In addition, land use is not changing as a result of the project; the site is currently used as an electrical substation and will continue to be used as a substation when the proposed project is completed.

m. Proposed measures to reduce or control impacts to agricultural and forest lands of long-term commercial significance, if any.

Not applicable; there should be no impacts to agricultural and forest lands as a result of the proposed project.

9. Housing [Find help answering housing questions]

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

No housing units will be provided.

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

No housing units will be eliminated.

c. Proposed measures to reduce or control housing impacts, if any.

Not applicable.

10. Aesthetics [Find help answering aesthetics questions]

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

The tallest component on the property are the two dead end towers located on the north end of the substation, standing at 35 feet in height.

b. What views in the immediate vicinity would be altered or obstructed?

Views in the immediate vicinity will not be altered or obstructed as a result of the proposed project.

c. Proposed measures to reduce or control aesthetic impacts, if any.

No measures are proposed since no aesthetic impacts will result from the project.

11. Light and Glare [Find help answering light and glare questions]

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

No light or glare produced by the completed project to any adjacent property or roadway will result because of the presence of vegetative screening that will be required.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

No, light or glare from the project is not expected to be a safety hazard or interfere with views.

Will be required to meet Tumwater standards for lighting.

c. What existing off-site sources of light or glare may affect your proposal?

None.

d. Proposed measures to reduce or control light and glare impacts, if any.

None are proposed.

12. Recreation [Find help answering recreation questions]

a. What designated and informal recreational opportunities are in the immediate vicinity?

There are no known designated or informal recreational opportunities at or adjacent to the proposed project.

b. Would the proposed project displace any existing recreational uses? If so, describe.

No, the project will not displace existing recreational uses.

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any.

There should be no impact to recreation resulting from the proposed project; therefore, no measures are proposed.

13. Historic and Cultural Preservation [Find help answering historic and cultural preservation questions]

a. Are there any buildings, structures, or sites, located on or near the site that are over 45 years old listed in or eligible for listing in national, state, or local preservation registers? If so, specifically describe.

The proposed PSE Barnes Lake Substation Rebuild and Expansion is located at 1697 (South) 2nd Ave SW, Tumwater, 98512, parcel number 09080011003. A records search undertaken to determine if any buildings, structures or sites are located within the project area or nearby used the Washington Department of Archaeology and Historic Preservation (DAHP) Washington Information System for Architectural and Archaeological Records Data (WISAARD) as well as historical maps and aerial photographs available through on-line search tools. In addition, review of the PSE Archives was completed. There are no historical buildings, structures, or sites known to be within the project boundary. Thirty-four historic properties have been previously recorded within a one-mile radius of the project area. None is within the project footprint, and none was determined eligible for the National Register of Historic Places or Washington Register of Historic Places.

b. Are there any landmarks, features, or other evidence of Indian or historic use or occupation? This may include human burials or old cemeteries. Are there any material evidence, artifacts, or areas of cultural importance on or near the site? Please list any professional studies conducted at the site to identify such resources.

There are records of eleven cultural resource assessments completed within 1 mile of the Barnes Lake Substation project (Table 1 below).

The closest cemetery is approximately one-half mile southwest of the project site. Union Cemetery, also referred to as Pioneer Calvary Cemetery, is recorded as an archaeological site (TN 298).

TN 470, a historic debris archaeological site, is approximately 0.94-mile northeast of the project area. It contains wood, charcoal, metal, glass and other historic debris that dates prior to 1900.

No other archaeological sites have been recorded within 1 mile of the project site.

The project area is within the traditional territory of the Squaxin Island Tribe and the Nisqually Indian Tribe. There are several significant place names within the traditional territories, but none is in the project area. The nearest are the water ways near Deschutes River, including SpEkwa 'L (Tumwater Falls), and the waters around Puget Sound to the north. The area is significant to both Tribes because of the ancestral uses of the land that connect people to their culture.

In addition, several historic events occurred in the area as non-native immigrants settled the area. Early settlers arrived in the area near Tumwater Falls in 1845. The Donation Land Claim Act (DLCA) played an important role in settlement affecting the project area and immediate prairie areas to the south. Bush Prairie in the immediate vicinity of Barnes Lake Substation was part of the DLCA. The 1850 Donation Land Claim Act excluded all but white men from claiming land. A petition signed by 55 members of the Washington Territorial Legislature led to a bill passed by Congress on April 7, 1855, acknowledging the Bush land Claim (Oldman, posted 2/01/2004, historylink.org, essay 5646, [George Bush settles with his family at Bush Prairie near Tumwater in November 1845. - HistoryLink.org]).

According to the September 9, 1853 General Land Office (GLO) surveys done in the area, other land claims were also near the project site. In addition, the road to Cowlitz ran just east of the project area and headed north/south. The abundance of prairies noted on the GLO surveys likely supports the fact that native traditional uses of the area were significant prior to settlement and are likely still important today. See Figure 1 below.

Figure 1. 1853 GLO map overlaid on approximate location of substation.

NADB	Author	Title	Resource Identified
1686860	Kate Shantry	Cultural Resources Assessment for the E Street Outfall Project, Tumwater, 2015	TN 470, historic debris
1685337	Jennifer Chambers	Cultural Resources Assessment for the Cleveland Avenue Stormwater Outfall Retrofit Project Olympia, 2014	None
1696495	Bathany Mathews	Cultural Resource Assessment for the Capitol Boulevard Lot 4 Multifamily Development, Tumwater, Thurston County, WA, 2022	None
1690202	Sandra Pentney	Phase I Archaeological Survey of the COL Edith M. Nuttall Army Reserve Center (WA038/53945), Tumwater, 2015	None
1688023	Jana Futch	Revised Draft Archaeological Sensitivity Assessment of Selected Facilities in WA, 88th Regional Support Command, 2014	None
1689526	Carol Schultze	Cultural Resources Inventory for Capitol Boulevard/Trosper Rd Intersection Improvements, City of Tumwater, 2017	None

1687263	Melanie Diedrich	Archaeological Monitoring for the Reclaimed Water Storage Project, Tumwater, 2015	None
1696851	Brain Durkin and Chrisanne Beckner	X St and Capital Blvd CR Report 20220425, 2022	None
1697176	Colin Higashi, et al.	Cultural Resource Assessment for the 5945 Littlerock Road SW Development Project, Tumwater, Thurston County, Washington, 2022	TN 298, Union Cemetery, Pioneer Calvary Cemetery
1697105	Colin Higashi, et al.	Cultural Resource Assessment for the Union-Calvary Pioneer Cemetery Project, Tumwater, Thurston County, Washington, 2022	TN 298, Union Cemetery, Pioneer Calvary Cemetery
1352036	Jennifer Wilson	Results of Burial Identification Investigations at the Union Cemetery/Pioneer-Calvary Cemetery, 2008	TN 298, Union Cemetery, Pioneer Calvary Cemetery

Table 1. Cultural Resource Studies within 1 mile of Project Site.

c. Describe the methods used to assess the potential impacts to cultural and historic resources on or near the project site. Examples include consultation with tribes and the department of archeology and historic preservation, archaeological surveys, historic maps, GIS data, etc.

The PSE Archaeologist completed a literature review for the project area. This included a search of the WISAARD database for all cultural resource assessment reports, archaeological records, General Land Office maps, probability data, cemetery data, and historic property inventory records data within 1 mile of the project site. The PSE Archaeologist reviewed Squaxin Island Tribe and Nisqually Indian Tribe webpages, Thurston County Maps, historical map tools, university special collections, and BLM GLO databases for relevant information pertaining to the area.

The PSE Archaeologist also conducted a review of the PSE Library and Archives for relevant information related to this project. This includes ethnographic literature in the form of manuscripts, reports, books, and documents as well as Kroll Map Books and other PSE company-related materials relevant to this area.

The PSE Archaeologist reviewed geotechnical data including a report prepared for the project location (GeoEngineers 2023).

The PSE Archaeologist contacted the Squaxin Island Tribe and Nisqually Indian Tribe cultural resource departments to provide information about the project, proposed cultural resource fieldwork, and SEPA checklist process on October 16, 2023.

d. Proposed measures to avoid, minimize, or compensate for loss, changes to, and disturbance to resources. Please include plans for the above and any permits that may be required.

PSE conducted a field assessment on November 20, 2023 at the Barnes Lake Substation. PSE sent fieldwork notification via email to the Nisqually and Squaxin cultural resource professionals in order to allow them to join. PSE archaeologist excavated four probes and conducted pedestrian surveys in the expansion area of the substation. PSE archaeologist observed sparse very small pieces of Styrofoam and asphalt and undiagnostic glass fragments in the redeposited silt loam. The survey identified no significant cultural resources.

PSE forwarded a summary of the findings to the Nisqually and Squaxin cultural resource professionals on November 28, 2023. The PSE archaeologist drafted a Cultural Resource Assessment report and plans to submit this for review by DAHP and Tribal cultural resource departments once finalized and prior to any construction work.

PSE archaeologists will also prepare an Inadvertent Discovery Plan and implement it in accordance with applicable regulations, including RCW 68.60, RCW 27.44, and RCW 68.50.

14. Transportation Find help with answering transportation questions

a. Identify public streets and highways serving the site or affected geographic area and describe proposed access to the existing street system. Show on site plans, if any.

The project is located along South 2nd Avenue SW, north of Trosper Road SW. The site is accessed via an asphalt driveway from South 2nd Avenue SW.

b. Is the site or affected geographic area currently served by public transit? If so, generally describe. If not, what is the approximate distance to the nearest transit stop?

According to Google Maps, the closest transit stop is approximately 1 mile north of the project site near the intersection of Linwood Ave SW and South 2nd Avenue SW.

c. **Will the proposal require any new or improvements to existing roads, streets, pedestrian, bicycle, or state transportation facilities, not including driveways? If so, generally describe (indicate whether public or private).**

No new improvements are required as part of this proposal.

d. **Will the project or proposal use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.**

The project will not use any water, rail or air transportation.

e. **How many vehicular trips per day would be generated by the completed project or proposal? If known, indicate when peak volumes would occur and what percentage of the volume would be trucks (such as commercial and nonpassenger vehicles). What data or transportation models were used to make these estimates?**

The project will not generate any additional vehicular trips than the current substation, which includes infrequent use by operations and maintenance staff using commercial pickup trucks.

f. **Will the proposal interfere with, affect, or be affected by the movement of agricultural and forest products on roads or streets in the area? If so, generally describe.**

The project will not interfere with, affect or be affected by the movement of agricultural and forest products.

g. **Proposed measures to reduce or control transportation impacts, if any.**

No negative transportation impacts are anticipated.

15. Public Services [Find help answering public service questions]

a. **Would the project result in an increased need for public services (for example: fire protection, police protection, public transit, health care, schools, other)? If so, generally describe.**

No additional need for public services would result from the project.

b. **Proposed measures to reduce or control direct impacts on public services, if any.**

Not applicable.

16. Utilities [Find help answering utilities questions]

a. **Circle utilities currently available at the site: electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other:**

b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

No new utilities are proposed as part of this project, although the existing facility will be expanded. The scope of work includes two components intended to meet the dual goals for Puget Sound Energy's electrical substation project. The first is to replace the damaged and old equipment within the substation to ensure reliable power supply and public safety. The second is to expand the substation, thereby increasing the capacity the substation can provide to the growing service area. The project will include new stormwater facilities to meet treatment and detention requirements for the new impervious surfaces.

C. Signature [Find help about who should sign]

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

X Trevor Lessard

Type name of signee: Trevor Lessard

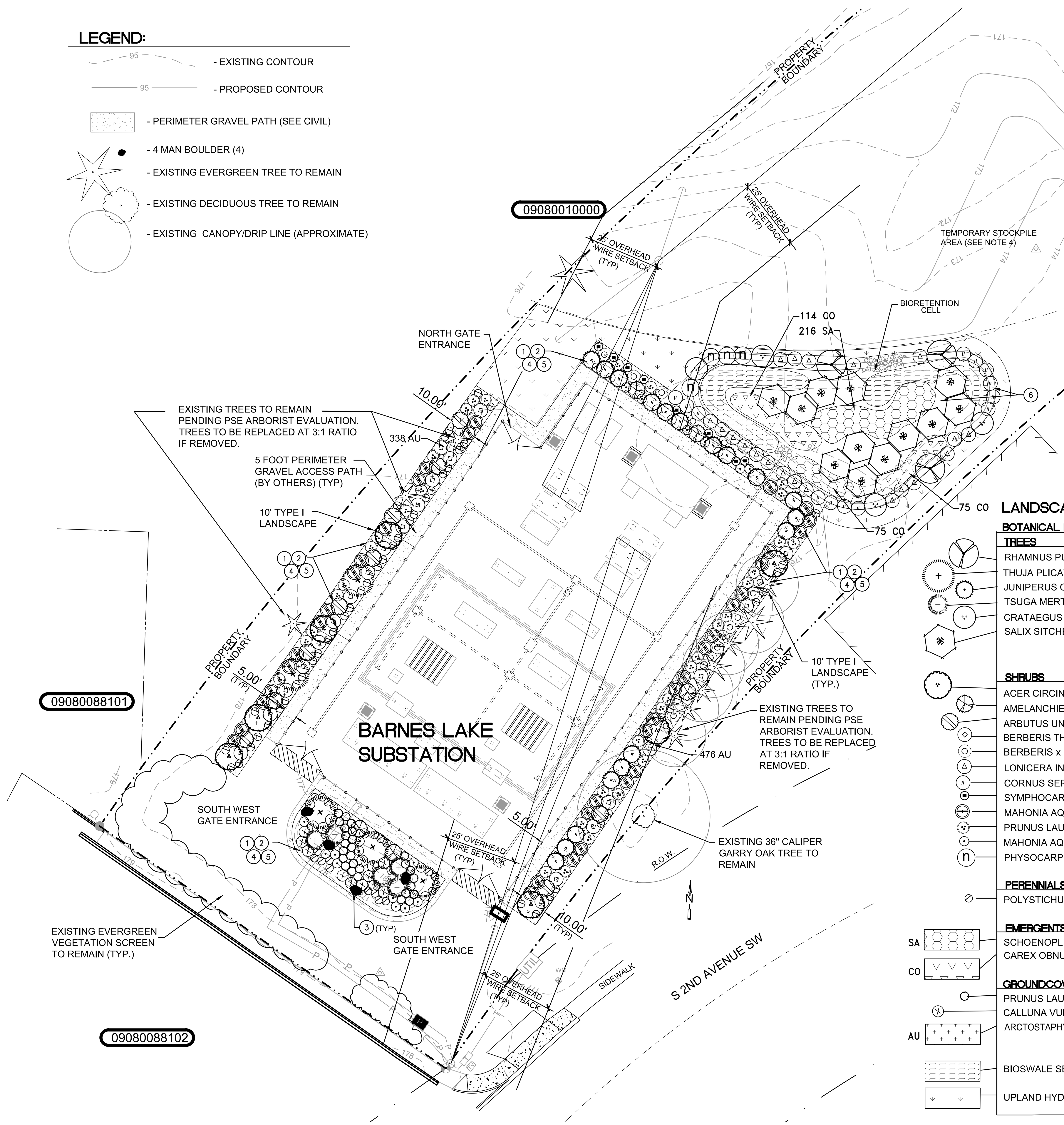
Position and agency/organization: Municipal Land Planner, Puget Sound Energy (PSE)

Date submitted: 03/28/2024

Agency Reviewer:
Alex Baruch, Senior Planner, City of Tumwater
May 20, 2024

LEGEND:

- EXISTING CONTOUR
- PROPOSED CONTOUR
- PERIMETER GRAVEL PATH (SEE CIVIL)
- 4 MAN BOULDER (4)
- EXISTING EVERGREEN TREE TO REMAIN
- EXISTING DECIDUOUS TREE TO REMAIN
- EXISTING CANOPY/DRIP LINE (APPROXIMATE)



CONSTRUCTION NOTES

1. CLEAR AND GRUB PROPOSED PLANTING BED AREAS
2. PREPARE PLANTING BED PER DETAIL 3, SHEET 2
3. INSTALL FOUR MAN BOULDERS PER DETAIL 5, SHEET 2
4. INSTALL TREES, SHRUBS AND GROUNDCOVER'S PER PLANTING DETAILS, SHEET 2
5. INSTALL 3" UNIFORM DEPTH WOOD CHIP MULCH PER DETAIL 3, SHEET 2
6. PREPARE BIORETENTION SOIL PER DETAIL 1, SHEET D-22022_03.

GENERAL NOTES

1. SEE LANDSCAPE PLANT SCHEDULE THIS SHEET
2. SEE PLANTING NOTES AND DETAILS SHEET 2
3. ALL PLANTING AREAS SHALL BE IRRIGATED WITH A PERMANENT WATER- EFFICIENT IN-GROUND IRRIGATION SYSTEM, SEE IRRIGATION PLAN, SHEETS 3 AND 4.
4. NOTE: ANY AREA DISTURBED BY TEMPORARY STOCKPILING OPERATIONS SHALL BE RESTORED AND RE-SEEDED USING "UPLAND HYDROSEED MIX". SEE SEED MIX, SHEET 2.

LANDSCAPE PLANT SCHEDULE

BOTANICAL NAME	COMMON NAME	SIZE	COND.	SPACING	QTY.	REMARKS
TREES						
RHAMNUS PURSHIANA	CASCARA	2" CAL. MIN.	B&B	AS SHOWN	3	SINGLE LEADER, WELL-BRANCHED TO TOP
THUJA PLICATA 'EXCELSA'	EXCELSA WESTERN RED CEDAR	6' HT. MIN.	B&B	AS SHOWN	5	SINGLE LEADER, WELL-BRANCHED TO TOP
JUNIPERUS CHINENSIS	SPARTAN JUNIPER	6' HT. MIN.	B&B	AS SHOWN	18	SINGLE LEADER, WELL-BRANCHED TO TOP
TSUGA MERTENSIANA	MOUNTAIN HEMLOCK	6' HT. MIN.	B&B	AS SHOWN	5	SINGLE LEADER, WELL-BRANCHED TO TOP
CRATAEGUS DOUGLASII	BLACK HAWTHORN	48" HT. MIN.	5 GAL.	AS SHOWN	4	SINGLE LEADER, WELL-BRANCHED TO TOP
SALIX SITCHENSIS	SITKA WILLOW	48" HT. MIN.	2 GAL.	AS SHOWN	12	
SHRUBS						
ACER CIRCINATUM	VINE MAPLE	48" HT. MIN.	5 GAL.	AS SHOWN	7	MULTI-STEMMED
AMELANCHIER ALNIFOLIA	SERVICEBERRY	48" HT. MIN.	5 GAL.	AS SHOWN	5	MULTI-STEMMED
ARBUTUS UNEDO	STRAWBERRY TREE	48" HT. MIN.	5 GAL.	AS SHOWN	10	FULL, WELL BRANCHED, LAYOUT PER PLAN
BERBERIS THUNBERGII	JAPANESE BARBERRY	36" HT. MIN.	5 GAL.	4'-5' O.C.	23	FULL, WELL BRANCHED, LAYOUT PER PLAN
BERBERIS x GLADWYNENSIS 'WILLIAM PENN'	WILLIAM PENN BARBERRY	18" HT. MIN.	2 GAL.	AS SHOWN	14	FULL, WELL BRANCHED, LAYOUT PER PLAN
LONICERA INVOLUCRATA	BLACK TWINBERRY	24" HT. MIN.	2 GAL.	4'-5' O.C.	20	FULL, WELL BRANCHED, LAYOUT PER PLAN
CORNUS SERICEA	RED OSIER DOGWOOD	24" HT. MIN.	2 GAL.	4'-5' O.C.	13	FULL, WELL BRANCHED, LAYOUT PER PLAN
SYMPHOCARPUS ALBUS	SNOWBERRY	24" HT. MIN.	2 GAL.	4'-5' O.C.	8	FULL, WELL BRANCHED, LAYOUT PER PLAN
MAHONIA AQUIFOLIUM	TALL OREGON GRAPE	24" HT. MIN.	2 GAL.	4'-5' O.C.	37	FULL, WELL BRANCHED, LAYOUT PER PLAN
PRUNUS LAUROCERACUS 'OTTO LUYKEN'	OTTO LUYKEN ENGLISH LAUREL	18" HT. MIN.	2 GAL.	AS SHOWN	35	FULL, WELL BRANCHED, LAYOUT PER PLAN
MAHONIA AQUIFOLIUM 'COMPACTA'	COMPACT OREGON GRAPE	18" HT. MIN.	2 GAL.	AS SHOWN	26	FULL, WELL BRANCHED, LAYOUT PER PLAN
PHYSOCARPUS CAPITATUS	PACIFIC NINEBARK	24" HT. MIN.	2 GAL.	4'-5' O.C.	4	FULL, WELL BRANCHED, LAYOUT PER PLAN
PERENNIALS						
POLYSTICHUM MINUTUM	SWORD FERN	18" HT. MIN.	1 GAL.	AS SHOWN	74	FULL, WELL BRANCHED
EMERGENTS						
SA — SCHOENOPLECTUS ACUTUS	HARDSTEM BULRUSH	6" HT. MIN.	4" POT	18" O.C.	291	FULL, WELL BRANCHED
CO — CAREX OBNUPTA	SLOUGH SEDGE	6" HT. MIN.	4" POT	18" O.C.	189	FULL, WELL BRANCHED
GROUNDCOVER						
PRUNUS LAUROCERASUS 'MT. VERNON'	DWARF LAUREL	12"-18" SPREAD	1 GAL.	36" O.C.	27	FULL, WELL BRANCHED, LAYOUT PER PLAN
CALLUNA VULGARIS 'FIREFLY'	FIREFLY HEATHER	10" MIN. SPREAD	I GAL.	24" O.C.	15	FULL AND BUSHY
AU — ARCTOSTAPHYLOS UVA-URSI	KINNIKINNICK	10" MIN. SPREAD	I GAL.	24" O.C.	814	FULL AND BUSHY
BIOSWALE SEED MIX					37 CY 857 SF	SEE SEED MIX, SHEET 2
UPLAND HYDROSEED MIX					2,445 SF	SEE SEED MIX, SHEET 2

811 Know what's below. Call before you dig.

NORTH

GRAPHIC SCALE (IN FEET): 20 0 20 40 80

STATE OF WASHINGTON — JONATHAN C. GAGE — LANDSCAPE ARCHITECT — EXP. 03/17/2026 — 3-22-24

DAVID EVANS AND ASSOCIATES INC.
14432 SE Eastgate Way, Suite 400
Bellevue Washington 98007
Phone: 425.519.6500

WO NUMBER: 101139063		
REVISION DESCRIPTION:		
REV 1: 100% SUBMITTAL		
		DATE
CADD	GREGORY KING	03/2024
LAND ARCH	JON GAGE	03/2024
REVIEWED	J. KNOLL	2024.03.26 16:18:21-07'00'
APPROVED	J. HENRY	2024.03.26 16:48:21-07'00'

LANDSCAPE PLAN
BARNES LAKE SUBSTATION

PUGET SOUND ENERGY — SUBSTATION ENGINEERING DEPARTMENT

DRAWING NO: D-22027 — REV NO: 1 — SHEET: 1 OF 4
SCALE: 1"=20'-0" — CLASS: SITE — FILE NO:
CADD NO: D-22027_01.DWG — CODE: BAR

INTERNAL USE

PUGET SOUND ENERGY
The Energy To Do Great Things

Puget Sound Energy
P.O. Box 97034
Bellevue, WA 98009-9734

PSE.com

March 25th, 2024

City of Tumwater
Department of Community Development
555 Israel Rd SW
Tumwater, WA 98501

RE: PSE Barnes Lake Substation Rebuild and Expansion

To Whom It May Concern:

PSE is seeking the following permits for our proposal to rebuild and expand its Barnes Lake Substation, located at 1697 S 2nd Ave SW (Parcel # 09080011003): *building permit, site development/grading permit, shoreline substantial exemption, and SEPA.* In addition to the respective permit applications, this application package also includes the *site plan, landscape plan, drainage report, a frontage improvement exhibit, and lighting plans.*

PSE is proposing to rebuild and expand its Barnes Lake Substation for multiple purposes. First, certain pieces of equipment, including the existing transformer have been damaged and require replacement to avoid potential failure and major outages to our customers. Second, replacing the other aging equipment at this time while the substation is taken offline allows PSE to avoid future outages due to failing equipment. In total, PSE is planning to replace one transformer, associated equipment, and all associated concrete foundations as part of this replacement component.

In addition to replacing the existing substation equipment, PSE is also planning to expand the existing footprint and the capacity of the substation to accommodate growing customer demand in the area. Growing the substation's capacity involves adding a new transformer, associated equipment, and adding associated concrete foundations. This new equipment will be located within the existing footprint of the substation. The substation will be expanded along its north fence line to accommodate the relocated control house, and make room for the rest of the equipment mentioned above. Expanding the substation's capacity is paramount to continue supplying electricity to the quickly growing community the substation supports.

In addition to the components above, PSE will replace the existing 6-foot high, chain link fence with new, 8-foot high, anti-climb fence. This new fence is necessary to prevent theft of PSE equipment and materials and continue to maintain public safety. This new fence type helps reduce site lines into the substation due to its tighter weave compared to a standard chain link fence. This will improving screening of the facility from the public and help guard against trespassing and theft at the facility.

PSE also proposes to add new catch basins within the substation and its driveway as well as a new infiltration pond behind the substation to improve stormwater management. This new stormwater infrastructure will help capture and contain stormwater on the site and help it infiltrate into the ground. This will reduce stormwater runoff from leaving the site and protect city infrastructure as well as nearby waterbodies.

Lastly, PSE is proposing a new landscape plan for this site. This landscape plan is designed to screen the facility from the public, discourage trespassing, and offer stormwater assistance in congruency with the infiltration pond, while allowing for PSE to perform future maintenance and operations on the facility as needed. PSE has accommodated the city's request to maintain as many full grown trees as possible, only removing and replacing landscaping that is necessary due to conflicts with construction.

As part of construction, PSE will utilize a portion of the large lawn behind the substation for temporary stockpiling of materials from the site. The stockpile will be minimized where and when possible to reduce impacts to the 200-foot shoreline buffer of Barnes Lake to the north. Stockpile materials in this area will only include clean fill excavated from the site. While all of the substation and its proposed scope of work occurs outside of this shoreline designation, the proposed, maxed extent of the stockpile does project into this area. Only this component triggers the need for a shoreline exemption. PSE qualifies for the exemption via WAC 173-27-040(2)(a) which provides exemption for work under a certain dollar amount. PSE is providing an exhibit that shows the total cost PSE predicts will occur within the shoreline designation. PSE will not have any in-water work, stockpile will occur only within the designated area, and will be minimized where and when possible to protect this shoreline buffer.

During construction, PSE will employ all necessary Construction Stormwater BMPs on the site to reduce impacts off the site during work. BMPs include marking off the project work area, silt fencing around the project's perimeter, marking trees for protection, reducing exposed soils where and when possible, and covering all exposed soils after construction is complete and revegetation according to the proposed landscape plan. Construction is planned to occur between the months of April and September 2024. This largely places the majority of work within Western Washington's dry season, further reducing stormwater impacts for most of the project duration.

If you have any questions, please feel free to contact me at trevor.lessard@pse.com or 206-390-9660.

Sincerely,

Trevor Lessard
Municipal Land Planner
PUGET SOUND ENERGY

GeoEngineers 1101 Fawcett Avenue, Suite 200 Tacoma, Washington 98402 253.383.4940	**Field Report**		File Number: 0186-685-01
	Project: Barnes Lake Substation		Date: 7.25.2022
	Owner: Puget Sound Energy	Time of Arrival: 9:30	Report Number: 1
Prepared by: Courtney Stoker	Location: PSE Barnes Lake Substation	Time of Departure: 10:15	Page: 1 of 3
Purpose of visit: Wetland reconnaissance	Weather: Clear 80 F	Travel Time: 1 hr r/t	Permit Number:

Upon arrival to the site I assessed personal safety hazards: ☒ Yes or ☐ Referred to Site Safety Plan and Safety Tailgate if applicable

Safety Hazards Were Addressed by : ☒ Staying Alert to Construction and Equipment Hazards ☐ Other (describe)

One GeoEngineers biologist met on-site with Heidy Barnett from West Fork Environmental to conduct wetland habitat reconnaissance of Parcel Number 09020011003 in Thurston County, Washington. The parcel contains a PSE substation at the southern end and a mowed field with undulating topography that gently slopes to the north. Barnes Lake occurs offsite to the north. Representative site photographs are provided below.

Observations:

During the site reconnaissance, the parcel was investigated for observations of wetland habitat including dominance of hydrophytic vegetation, hydrologic indicators, and hydric soils. Habitat near the substation at the southern end of the parcel contained predominantly upland vegetation including cultivated cedar trees, maple (*Acer sp.*) saplings, Himalayan blackberry (*Rubus armenaicus*), and salal (*Gaultheria shallon*). North of the substation, the parcel is undeveloped containing a field of mowed grasses generally sloping north towards Barnes Lake. No hydrophytic vegetation or indicators of hydrology were observed within the mowed field portion of the parcel.

A fence and posts with Wetland Protection signs were observed northwest of the mowed area, with unmowed grasses and shrubs occurring on the north side of the signs. The Wetland Protection signs are assumed to be associated the United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) mapped emergent wetland occurring on the fringe of Barnes Lake. No hydrophytic grasses were observed within the unmowed portion, and soils appeared light brown in color with no observed redoximorphic features. The shrub fringe occurring northeast of the unmowed grasses consisted of predominantly Facultative Upland (FACU) species such as snowberry (*Symphoricarpos albus*), oceanspray (*Holodiscus discolor*), and Oregon grape (*Mahonia nervosa*), with an oak (*Quercus garryana*) canopy. Soils appeared light brown in color with no observed redoximorphic features. No signs of wetland hydrologic indicators were identified in either the unmowed grass or shrub areas.

Wetland habitat may occur offsite to the north along the fringe of Barnes Lake, however wetland habitat was not observed to extend onto the project parcel.

Summary:

No wetland habitat was identified within the project parcel. A lake fringe wetland may occur offsite to the north, and the associated regulated wetland buffer may extend onto the project parcel.

☐ THIS FIELD REPORT IS PRELIMINARY A preliminary report is provided solely as evidence that field observation was performed. Observations and/or conclusions and/or recommendations conveyed in the final report may vary from and shall take precedence over those indicated in a preliminary report.	FIELD REPRESENTATIVE Courtney Stoker	DATE 7/25/2022
X THIS FIELD REPORT IS FINAL A final report is an instrument of professional service. Any conclusions drawn from this report should be discussed with and evaluated by the professional involved.	REVIEWED BY Shawn Mahugh	DATE 7/25/2022

Attachments:

Distribution:

Figure 1. Project parcel from the north end looking south toward the substation

Figure 2. Shrub fringe at northern edge of parcel, with Wetland Protection sign visible

Figure 3. Typical vegetation within the shrub fringe area- showing snowberry, oceanspray, and oak, with Barnes Lake visible in the background.

Figure 4. Wetland Protection sign with unmowed grasses and a shrub fringe occurring beyond the sign.

Subject: Results of 2022 Mazama Pocket Gopher Study
Report Date: September 28, 2022
Landowner: Puget Sound Energy
Site Address: No site address
Consultant: West Fork Environmental (Heidy Barnett)

1.0 Study Purpose

A Mazama pocket gopher (MPG) study was requested to support permitting for potential earthwork stockpiling related to the substation. On July 25, August 25, and September 26, 2022, West Fork Environmental conducted a survey to detect activity of MPG on parcel 09080011003 (1.2 acres) in Tumwater, Washington (Figure 1).

2.0 Methods

2.1 MPG Method and Soil Type

The parcel currently has a cement parking lot, fenced and graveled substation and a small routinely mowed lawn area. The parcel is maintained and operated by Puget Sound Energy.

Survey methods followed the survey guidance provided by United States Fish and Wildlife Service (USFWS April 2018).

- The soil type on the parcel was Nisqually loamy fine sand, 0 to 3% slopes (more preferred by MPG), based on the data obtained from Thurston County GeoData (Figure 1, Table 2).
- The WDFW PHS database did not show MPG detections within 600 feet of the parcel (Figure 5).

During the survey West Fork Environmental staff waled transects across all open areas of the parcel looking for mounds as described under the USFWS recommended MPG survey protocol (Figure 2-4). We did not have access to the secured substation area, but heavy gravel is present throughout and no potential MPG habitat was observed within the fence (see photos).

3.0 Results

3.1 Mazama Pocket Gopher

During the surveys, no MPG mounds were identified on the parcel (see datasheets). Many mole mounds and likely mole mounds were observed on all surveys. Mole mounds were identified by circular shape, clumpy soils, linear pattern across the ground, and vertical entrance tunnels. Likely mole mounds were older and weathered but had a circular shape.

3.2 Vegetation

Plant species observed on the subject parcel included. One Oregon oak tree (*Quercus garryana*) is located at the front of the substation along S Second Avenue.

Common Name	*Scientific Name*	Common Name	*Scientific Name*
Douglas-fir	*Pseudotsuga menziesii*	Ribwort	*Plantago lanceolata*
Western redcedar	*Thuja plicata*	Common dandelion	*Taraxacum officinale*
Oregon white oak	*Quercus garryana*	Catsear	*Hypochaeris radicata*
Snowberry	*Symphoricarpos albus*	Himalayan blackberry	*Rubus armeniacus*
Oregon grape	*Mahonia aquifolium*	Scots broom	*Cytisus scoparius*
Salal	*Gaultheria shallon*	Reed canarygrass	*Phalaris arundinacea*
English ivy	*Hedera helix*	Sweet vernalgrass	*Anthoxanthum odoratum*

4.0 Conclusions

No MPG mounds were observed on the parcel on either site visit. The results of this survey are based on standardized methodologies and follow guidance provided by the USFWS and the Washington Department of Fish and Wildlife provided during June 2018 training. All findings presented within this report are subject to the final review and approval of the City of Tumwater pocket gopher review. If you have any questions regarding the information provided within this document, please contact our office at (360) 753-0485.

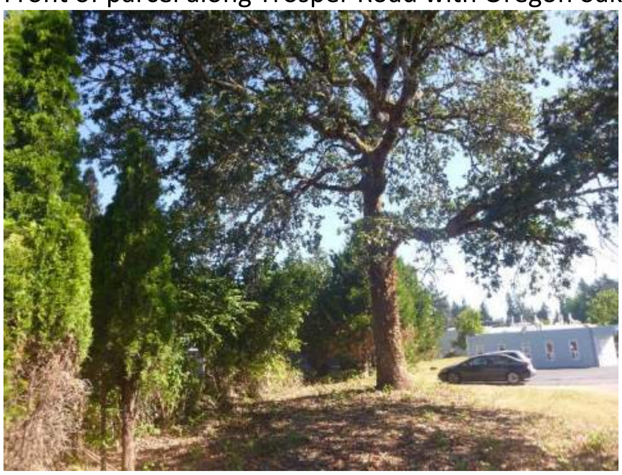
Sincerely,

Heidy Barnett
Sr. Biologist

Attachments: Representative site photos, survey transects, datasheets

Site Photos


Front of parcel along Trosper Road with Oregon oak tree (left) and fenced substation (right).




Oregon oak canopy at front of parcel (left) and Oregon oak on parcel to the west with dripline along parcel boundary (right).


Substation.


Stormwater drainage on northwest side of parcel (left) and grassy field at the north end of the parcel (right, looking south towards substation).




Representative mole mounds.

Figure 1. Parcel location and soil types.

Table 2. Pocket gopher and prairie soil list requiring survey as provided by the Thurston County Planning review guidance.

SCS_Code	Soil Type	Gopher Review	Prairie Review
1	Alderwood gravelly sandy loam, 0 to 3% slopes	Less preferred	
2	Alderwood gravelly sandy loam, 3 to 15% slopes	Less preferred	
5	Baldhill very stony sandy loam, 0 to 3% slopes		X
6	Baldhill very stony sandy loam, 3 to 15% slopes		X
7	Baldhill very stony sandy loam, 15 to 30% slopes		X
8	Baldhill very stony sandy loam, 30 to 50% slopes		X
20	Cagey loamy sand	More preferred	X
32	Everett very gravelly sandy loam, 0 to 3% slopes	Less preferred	X
33	Everett very gravelly sandy loam, 3 to 15% slopes	Less preferred	X
42	Grove very gravelly sandy loam, 3 to 15% slopes		X
46	Indianola loamy sand, 0 to 3% slopes	More preferred	X
47	Indianola loamy sand, 3 to 15% slopes	Less preferred	X
51	Kapowsin silt loam, 3 to 15% slopes	Less preferred	
65	McKenna gravelly silt loam, 0 to 5% slopes	Less preferred	
73	Nisqually loamy fine sand, 0 to 3% slopes	More preferred	X
74	Nisqually loamy fine sand, 3 to 15% slopes	More preferred	X
75	Norma fine sandy loam	Less preferred	
76	Norma silt loam	Less preferred	
109	Spana gravelly loam	Less preferred	X
114	Spanaway-Nisqually complex, 2 to 10% slopes	More preferred	X
110	Spanaway gravelly sandy loam, 0 to 3% slopes	More preferred	X
111	Spanaway gravelly sandy loam, 3 to 15% slopes	More preferred	X
112	Spanaway stony sandy loam, 0 to 3% slopes	Less preferred	X
113	Spanaway stony sandy loam, 3 to 15% slopes	Less preferred	X
126	Yelm fine sandy loam, 0 to 3% slopes	Less preferred	
127	Yelm fine sandy loam, 3 to 15% slopes	Less preferred	
117	Tenino gravelly loam, 3 to 15% slopes		X

Figure 2. Survey tracks from July 25, 2022.

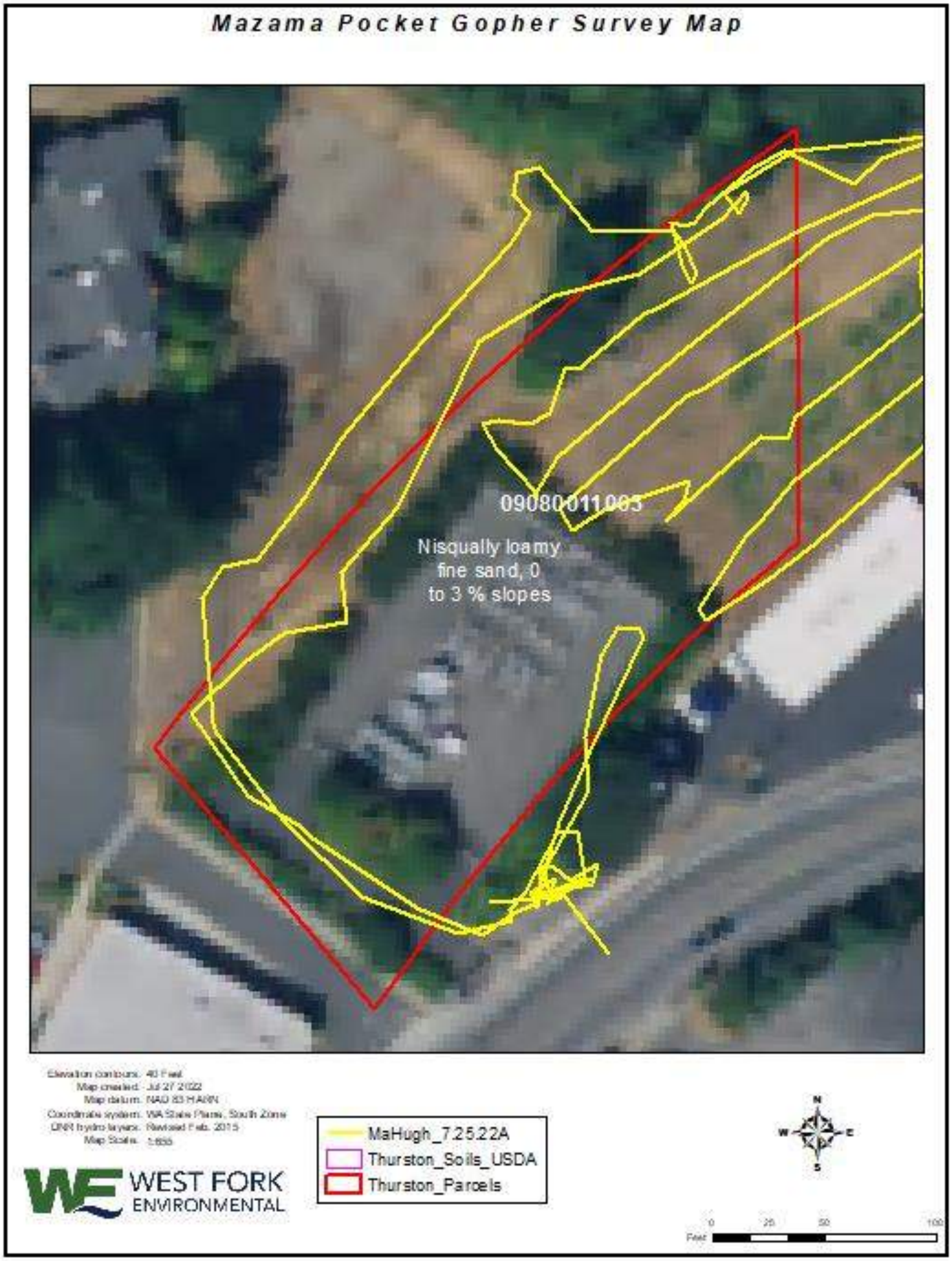


Figure 3. Survey tracks from August 25, 2022.

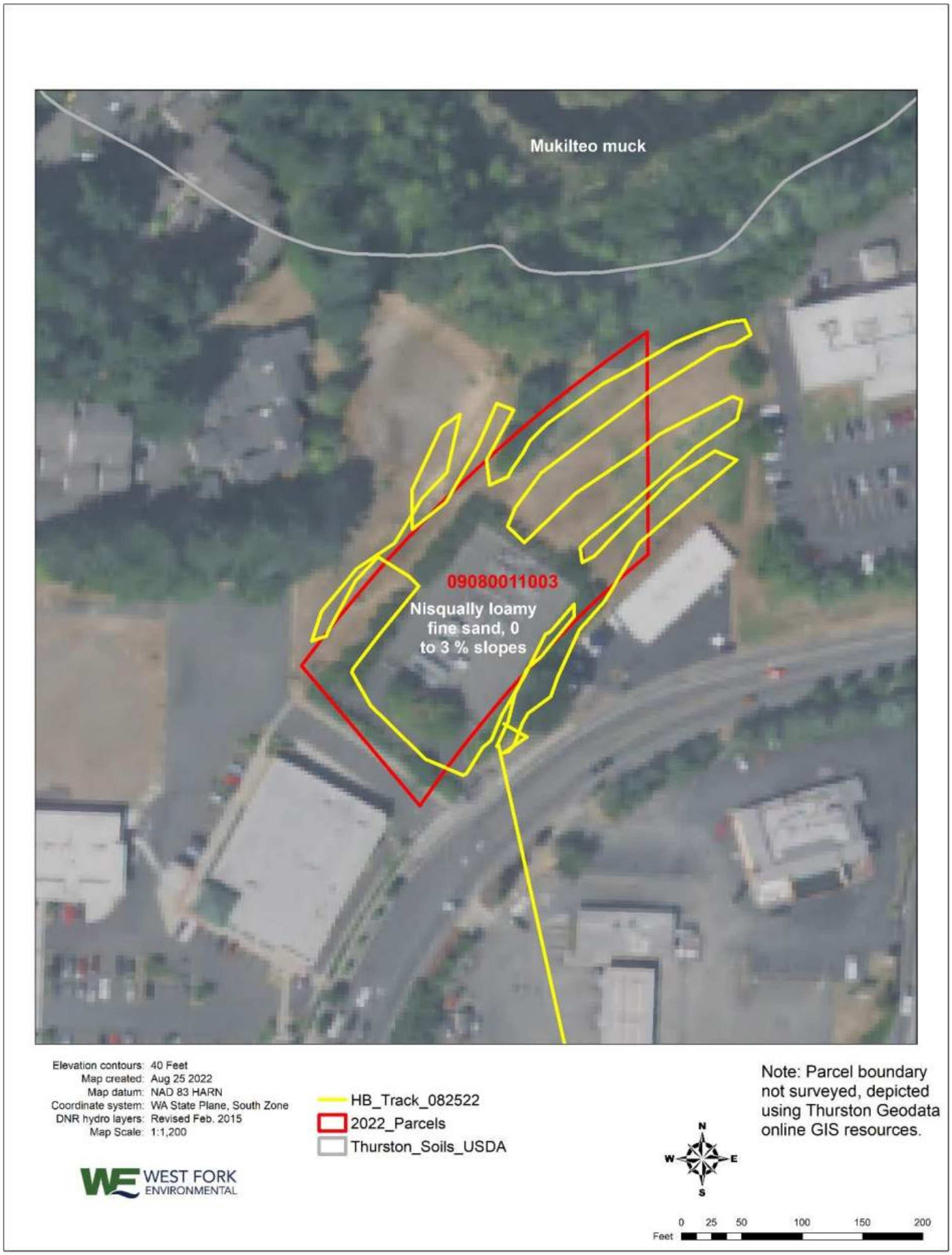


Figure 4. Survey tracks from September 25, 2022.

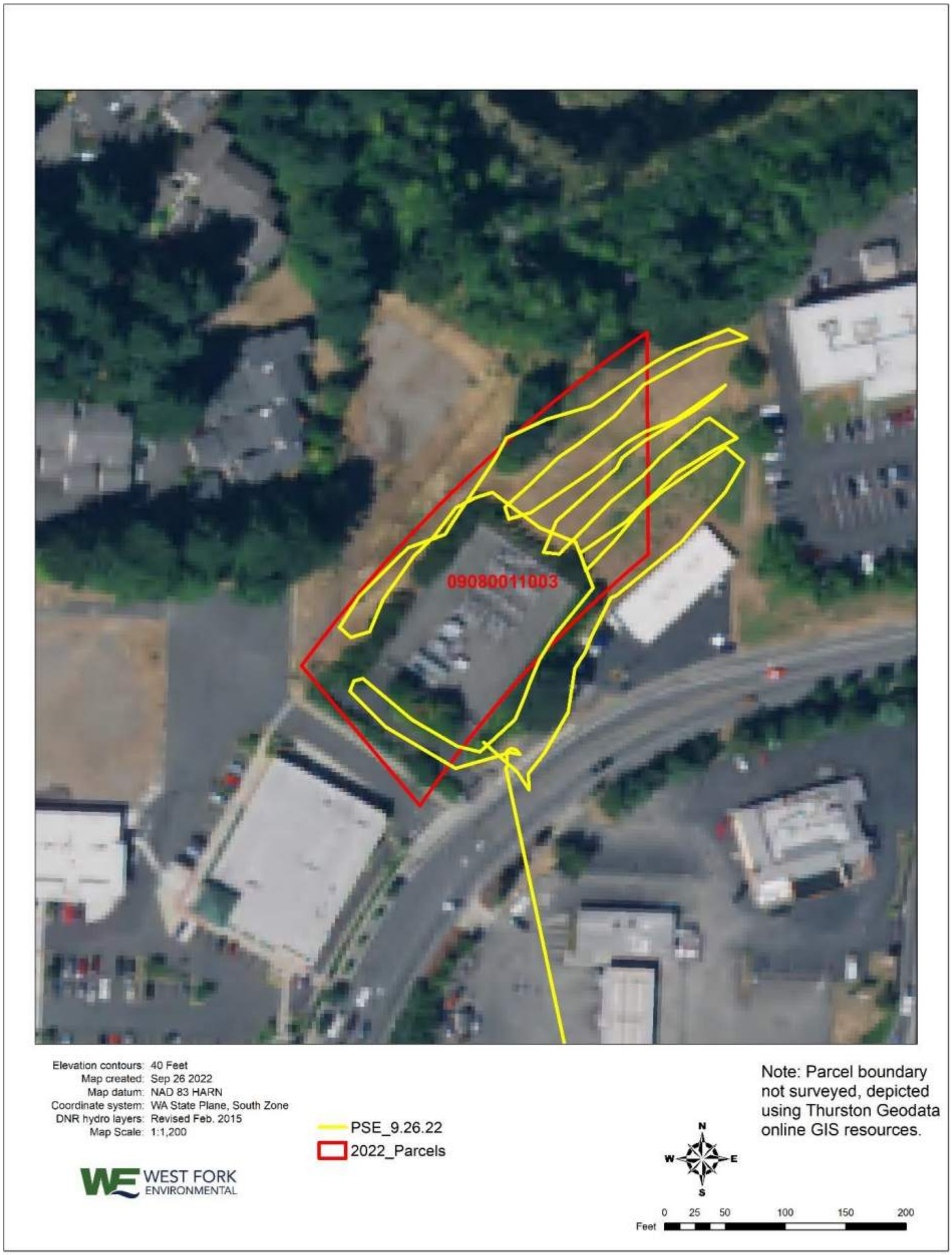
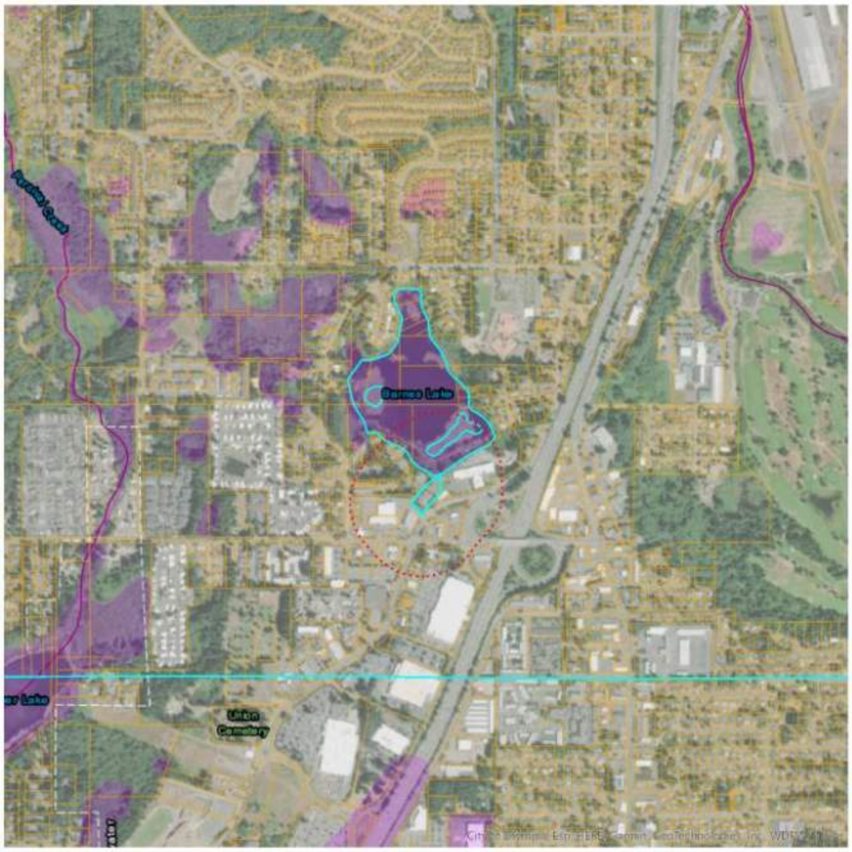


Figure 5. Results of Washington Department of Fish and Wildlife Prioirty Habitats and Species database report (areas withing 600 feet of the parcel).

Priority Habitats and Species on the Web



Buffer radius: 600 Feet

Report Date: 07/27/2022, Parcel ID: 09080011003

PHS Species/Habitats Overview:

Occurence Name	Federal Status	State Status	Sensitive Location
Freshwater Emergent Wetland	N/A	N/A	No
Lake	N/A	N/A	No
Big brown bat	N/A	N/A	Yes
Little Brown Bat	N/A	N/A	Yes
Yuma myotis	N/A	N/A	Yes

Datasheets

2021 Thurston County Mazama Pocket Gopher Screening Field Form **Site Visit Date:** 7-25-22

Site Name and Parcel #	**Parcel #:** 9080011003 **Project #:** **Site/Landowner:** PSE
How were the data collected? (circle the method for each)	**Transect:** Trimble **Garmin** Aerial **Mounds** Trimble **Garmin** Aerial **Notes:** continuous tracks recorded
Field Team Personnel: (Indicate all staff present, CIRCLE who filled out form)	**Name:** Heidy Barnett **Name:** **Name:**
Others onsite (name/affiliation)	Courtney Stokes (GeoEngineers)
Site visit # **(CIRCLE all that apply)**	**1st** 2nd Unable to screen **Notes:**
Do onsite conditions preclude the need for further visits?	Yes **No** Dense woody cover that encompasses the entire site (trees/shrubs) that appears to preclude any potential MPG use. Impervious Compacted Graveled Flooded Other ____________ Notes:
Describe visibility for mound detection:	Poor Fair **Good** Notes:
Request mowing? (CIRCLE and DESCRIBE WHERE MOWING IS NEEDED and SHOW ON AERIAL PHOTO	Yes **No** N/A Notes: Site mowed 2 weeks ago.

Page 1 of 2

7-25-22
(9080011003)

Mounds observed over the whole site are characteristic of:	MPG Mounds	Likely MPG Mounds	Indeterminate	Likely Mole Mounds	Mole Mounds
Quantify or describe amount of each type and approx. # of mounds *Group = 3 mounds or more*	0	0	0	16	30
	No MPG mounds (circle)				
MPG mounds in GPS? (CIRCLE and DESCRIBE) If MPG mounds present, entered in GPS?	None All Most Some Notes: No MPG mounds observed. Yes No N/A				
Does woody vegetation onsite match aerial photo?	Yes No - describe differences and show on parcel map/aerial:				
What portion(s) of the property was screened? (CIRCLE and DESCRIBE)	All Part - describe and show on parcel map/aerial: Did not survey gravel area of substation, fenced & gated				
Notes -	Describe, and show on parcel map/aerial if applicable:				
Team reviewed and agreed to data recorded on form? (CIRCLE, and EXPLAIN if "No")	Yes No Reviewed by initials: [illegible] ____ ____ ____ Notes:				

Information provided by Thurston County Government

Page 2 of 2

2021 Thurston County Mazama Pocket Gopher Screening Field Form **Site Visit Date:** 8-25-22

Site Name and Parcel #	**Parcel #:** 09080011003 **Project #:** **Site/Landowner:** PSE
How were the data collected? **(circle the method for each)**	**Transect:** Trimble **Garmin** Aerial **Mounds** Trimble **Garmin** Aerial **Notes:** continous tracks recorded
Field Team Personnel: **(Indicate all staff present, CIRCLE who filled out form)**	**Name:** Heidi Garrett **Name:** **Name:**
Others onsite (name/affiliation)	—
Site visit # **(CIRCLE all that apply)**	1st **2nd** Unable to screen **Notes:**
Do onsite conditions preclude the need for further visits?	Yes **No** Dense woody cover that encompasses the entire site (trees/shrubs) that appears to preclude any potential MPG use. Impervious Compacted Graveled Flooded Other ______ Notes:
Describe visibility for mound detection:	Poor Fair **Good** Notes:
Request mowing? **(CIRCLE and DESCRIBE WHERE MOWING IS NEEDED and SHOW ON AERIAL PHOTO**	Yes **No** N/A Notes:

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8-25-22

Mounds observed over the whole site are characteristic of:	MPG Mounds	Likely MPG Mounds	Indeterminate	Likely Mole Mounds	Mole Mounds
Quantify or describe amount of each type and approx. # of mounds *Group = 3 mounds or more*	0	0	0	19	17
	No MPG mounds (circle)				
MPG mounds in GPS? (CIRCLE and DESCRIBE) If MPG mounds present, entered in GPS?	None All Most Some Notes: No MPG mounds observed. Yes No N/A				
Does woody vegetation onsite match aerial photo?	Yes No - describe differences and show on parcel map/aerial:				
What portion(s) of the property was screened? (CIRCLE and DESCRIBE)	All Part - describe and show on parcel map/aerial:				
Notes -	Describe, and show on parcel map/aerial if applicable:				
Team reviewed and agreed to data recorded on form? (CIRCLE, and EXPLAIN if "No")	Yes No Reviewed by initials: HS ____ ____ ____ Notes:				

Information provided by Thurston County Government

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2021 Thurston County Mazama Pocket Gopher Screening Field Form   Site Visit Date: 9.26.22

Site Name and Parcel #	Parcel #: 908001003 Project #: Site/Landowner: PSE
How were the data collected? (circle the method for each)	Transect: Trimble Garmin Aerial Mounds Trimble Garmin Aerial Notes: continuous tracks recorded
Field Team Personnel: (Indicate all staff present, CIRCLE who filled out form)	Name: Heidy Barnett Name: Name:
Others onsite (name/affiliation)	—
Site visit # (CIRCLE all that apply)	1st 2nd 3rd Unable to screen Notes:
Do onsite conditions preclude the need for further visits?	Yes No Dense woody cover that encompasses the entire site (trees/shrubs) that appears to preclude any potential MPG use. Impervious Compacted Graveled Flooded Other Notes:
Describe visibility for mound detection:	Poor Fair Good Notes:
Request mowing? (CIRCLE and DESCRIBE WHERE MOWING IS NEEDED and SHOW ON AERIAL PHOTO	Yes No N/A Notes:

Page 1 of 2

9-26-22

Mounds observed over the whole site are characteristic of:	MPG Mounds	Likely MPG Mounds	Indeterminate	Likely Mole Mounds	Mole Mounds
Quantify or describe amount of each type and approx. # of mounds *Group = 3 mounds or more*	0	0	0	+9 +5 |||| 19	|||| |||| +7 +3 20
	No MPG mounds (circle)			circular wetland	circular vertical entrance linear pattern

MPG mounds in GPS? (CIRCLE and DESCRIBE) If MPG mounds present, entered in GPS?	None All Most Some Notes: No MPG mounds observed. Yes No N/A
Does woody vegetation onsite match aerial photo?	Yes No - describe differences and show on parcel map/aerial:
What portion(s) of the property was screened? (CIRCLE and DESCRIBE)	All Part - describe and show on parcel map/aerial: · Did not survey gravel fence substation area
Notes -	Describe, and show on parcel map/aerial if applicable:
Team reviewed and agreed to data recorded on form? (CIRCLE, and EXPLAIN if "No")	Yes No Reviewed by initials: HE Notes:

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...ovided by Thurston County Government

Technical Memorandum

To: Trevor Lessard, PSE; Jessica Jackson, PSE

From: Ian Welch, HDR

Date: November 8, 2023

Subject: Barnes Lake Substation Pocket Gopher Survey

1.0 Introduction

Puget Sound Energy (PSE) has requested that HDR conduct a Mazama pocket gopher (MPG) (*Thomomys mazama*) protocol survey for the Barnes Lake Substation Rebuild Project and prepare a memo to report the results. This technical memo provides documentation of methods and findings of the Mazama pocket gopher protocol surveys that were conducted on the project property, in August, September, and October 2023.

The project is located in the city of Tumwater, in Thurston County, Washington. The project is situated on an approximately 1.7 acre parcel with approximately 0.4 acres of the property currently covered by the existing substation and paved driveway. The remaining grass and vegetated areas on the parcel were surveyed.

2.0 Methods

Existing information on the soils, land use, and any documented MPG occurrence in the project corridor and surrounding area were reviewed prior to conducting the field surveys using Thurston County GIS soil data, aerial imagery, and Washington State Department of Fish and Wildlife (WDFW) Priority Habitats and Species (PHS) online database (WDFW 2023).

Biologists from HDR trained and certified for MPG protocol surveys by USFWS conducted the survey to determine occupancy. Survey methodology followed the Mazama pocket gopher screening protocol outlined in the 2018 USFWS "Guidance for Assessing Potential Take of Mazama Pocket Gophers in Thurston and Pierce Counties". Due to the presence of preferred soils for MPG, 3 surveys were required at least 30 days apart unless gopher mounds were detected, in which case subsequent surveys would not be required.

The entire property outside the fenced area of the existing substation was surveyed during all three surveys.

3.0 Results

The entire property is mapped as having 'more preferred' soils for MPG. Habitat in the project corridor matches what is shown in aerial imagery and was comprised of mowed grass with some areas of dense Himalayan blackberry (*Rubus armeniacus*) near the north and northeast end, and trees and shrubs along the perimeter of the property. The northern edge of the property borders on a small depression wetland which is not suitable habitat for MPG. The open grassy area where the proposed project would occur provides suitable MPG habitat and is within preferred soils.

The results of the protocol surveys were that no MPG mounds were observed during any of the three surveys. As a result of these surveys, it is determined that MPG is not currently present on the property. This result is valid for 1 year following the surveys, and therefore extends to October 31, 2024. If work is slated to occur after this period, the survey protocol would need to be repeated.

4.0 References

U.S. Fish and Wildlife Service. 2018. Guidance for Assessing Potential Take of Mazama Pocket Gophers in Thurston and Pierce Counties. April 20, 2018.

Washington Department of Fish and Wildlife (WDFW). 2023. Priority Habitats and Species Mapper. Available online at https://wdfw.wa.gov/mapping/phs/. Accessed August 2023.

PUGET SOUND ENERGY

Stormwater Site Plan

Drainage Report

Barnes Lake Substation

Project Site Location:
1697 2nd Ave SW
Tumwater, WA

100% Submittal
Revised: March 26, 2024

Applicant:
Puget Sound Energy
355 110th Ave NE
Bellevue, WA 98004

Contact:
Chantal Banfield (Project Manager)
Phone: 425-465-1218
Email: chantal.banfield@pse.com

Project Engineer:
Jackson Knoll, P.E.
Phone: 425-380-9772
Email: jackson.knoll@pse.com

Stormwater Site Plan
Drainage Report
Barnes Lake Substation
Puget Sound Energy

Prepared by:

Jackson Knoll, P.E.

Reviewed by:

Jason Henry, P.E.

I hereby state that this Drainage Control Plan for *Barnes Lake Substation* has been prepared by me or under my supervision and meets the standard of care and expertise that is usual and customary in this community for professional engineers. I understand that the City of Tumwater does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities prepared by me.

TABLE OF CONTENTS

SECTION 1 PROPOSED PROJECT DESCRIPTION

Puget Sound Energy (PSE) is proposing to construct improvements at Barnes Lake substation to replace aging equipment, increase the substation capacity, and mitigate settlement issues. Barnes Lake substation is an existing 115kV – 12.5kV distribution substation located on a 1.2 acre parcel (no. 09080011003) at 1697 2nd Ave SW in the City of Tumwater.

Improvements will result in a complete rebuild of the substation in its existing location, including replacement of all existing equipment. The substation will also be expanded to the northeast for addition of a new control building, and a second transformer will be added to increase capacity. A spill prevention control and countermeasure (SPCC) system will be installed for both of the new transformers to provide secondary containment. Substation perimeter fencing will also be upgraded from chain link fabric to welded wire mesh for enhanced security. Finally, the substation rebuild will be used as an opportunity to mitigate settlement of the substation yard that has occurred gradually since the station was originally constructed in 1974. Overexcavation for new foundations will extend up to eight feet below the transformers and two feet below other lightly loaded equipment foundations based on geotechnical recommendations. Overexcavated soil is anticipated to be suitable for re-use and will be stockpiled on-site until it can be backfilled and re-compacted. Please reference Section 2 – Existing Conditions Description and the site geotechnical reports prepared by GeoEngineers (Attachment 3) for additional information on the settlement and proposed mitigation.

Stormwater requirements for the project were determined using the City of Tumwater Drainage Design and Erosion Control Manual (DDECM), revised July 2022. The improvements are classified as new development and will result in greater than 5,000 square feet of new plus replaced hard surface area, requiring application of all eleven minimum requirements. A complete tabulation of surface area impacts is included in Figure 3 and a summary of the applicable minimum requirements is included on page 5 of this report.

In order to manage stormwater and comply with the minimum requirements, a bioretention cell is proposed to treat and infiltrate stormwater runoff. The bioretention was sized to infiltrate 100% of the runoff from the new and replaced hard surfaces and converted vegetation areas, constituting nearly the entire substation yard along with the surrounding lawn and landscape areas. The bioretention cell will be located northeast of the substation, behind the expanded yard area and new control building. A new stormwater conveyance system will be installed to collect and convey runoff to the bioretention cell, including Type 1 catch basins and six inch diameter pipe. The conveyance system will also drain the transformer SPCC area via perforated six inch diameter pipes and an oil stop valve. The bioretention cell and conveyance system are described in more detail in Sections 4 and 6 respectively and design calculations are included in Appendix 1.

Figure 1: Vicinity Map

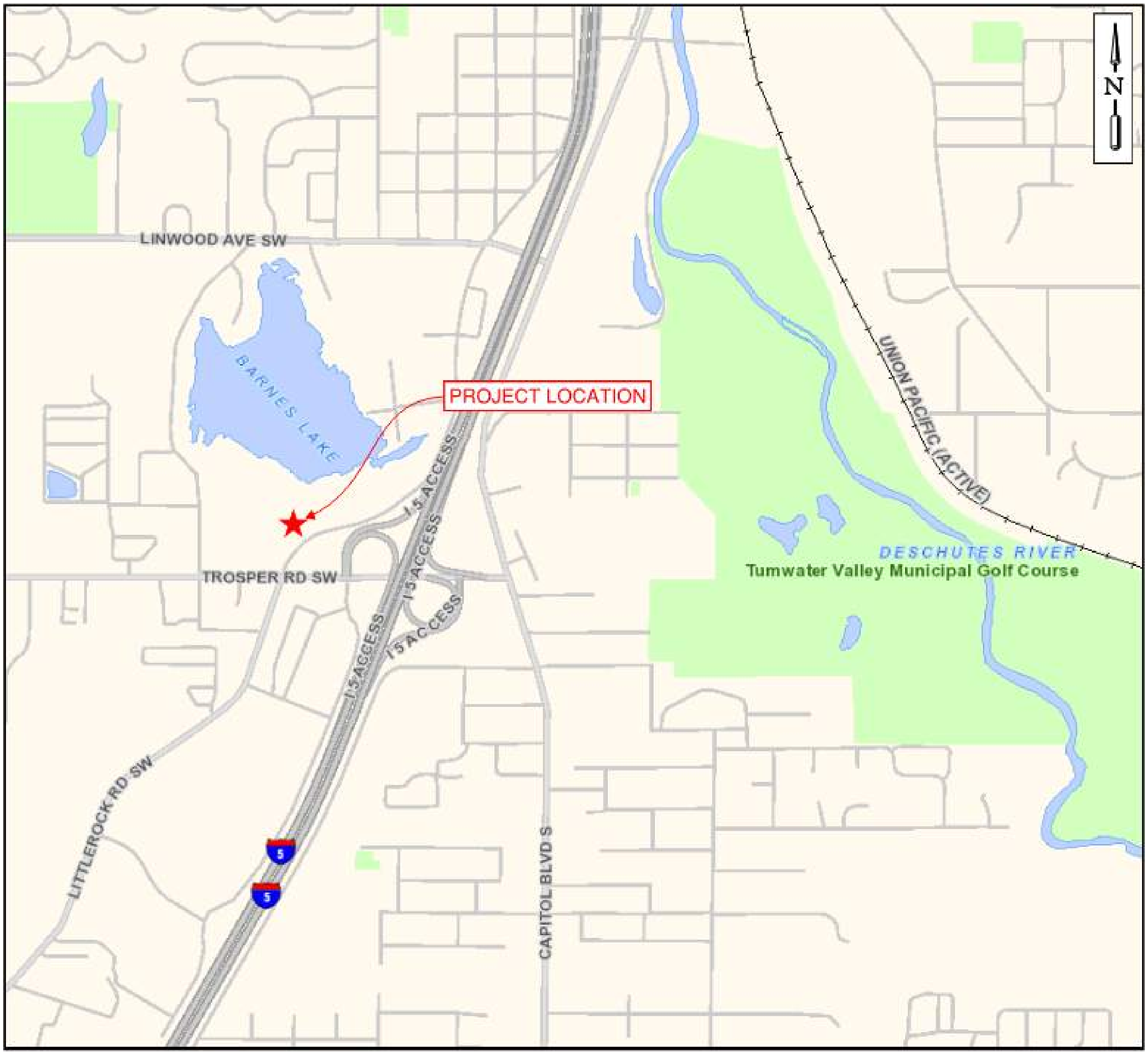


Figure 2: Proposed Site Conditions

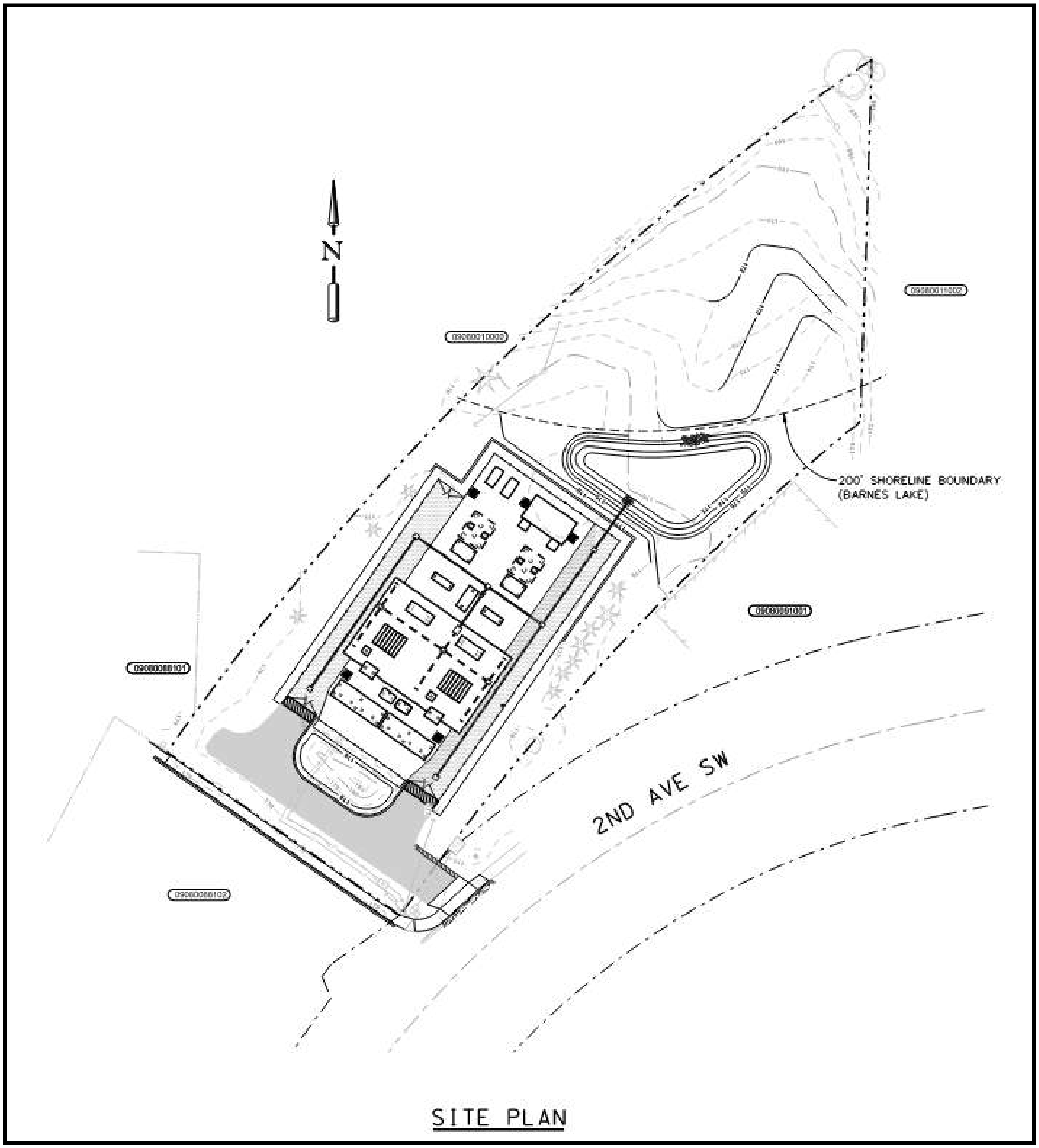


Figure 3: Area Quantity Take-Offs

Existing Conditions

Area	Units	
	Square Feet	Acres
Hard Surface Area (Existing Substation and Access Driveways)	17,500	0.4
Pervious Surface Area (Lawn and Landscaping)	34,800	0.8
Total Site Area	52,300	1.2

Proposed Improvements

Area	Units	
	Square Feet	Acres
New Hard Surface Area (Substation Expansion Area)	4,900	0.11
Replaced Hard Surface Area (Existing Substation - Replaced Foundations, Transformer SPCC Area, Overexcavation areas)	13,500	0.31
Total New + Replaced Hard Surface Area	18,400	0.42
New Pervious Surface Area	0	0
Replaced Pervious Surface Area (Landscaping, Bioretention Area)	9,700	0.22
Temporary Stockpile Area (Temporary disturbance, Restored to existing conditions)	9,700	0.22
Total New + Replaced Pervious Surface Area	19,400	0.44
Total Disturbed Area	37,800	0.86

PROJECT APPLICABILITY – NEW DEVELOPMENT VS. REDEVELOPMENT

The proposed project at Barnes Lake substation falls under the definition of New Development as the site has less than 35% existing hard surface coverage. Figure 2.1 from the City of Tumwater DDECM was utilized to determine the applicable minimum requirements for the project. See **Figure 5: Flow Chart for Determining Requirements for New Development.** Per the flow chart, the project is required to satisfy all Minimum Requirements for new and replaced hard surfaces and converted vegetation areas.

Additionally, based on guidance in Section 2.3.2 of the City of Tumwater DDECM and pre-application discussions, the City of Tumwater has required that runoff from the existing asphalt substation driveway be collected and mitigated to the extent practicable. See Section 4 and Section 6 of this report for additional information.

Figure 5: Flow Chart for Determining Requirements for New Development

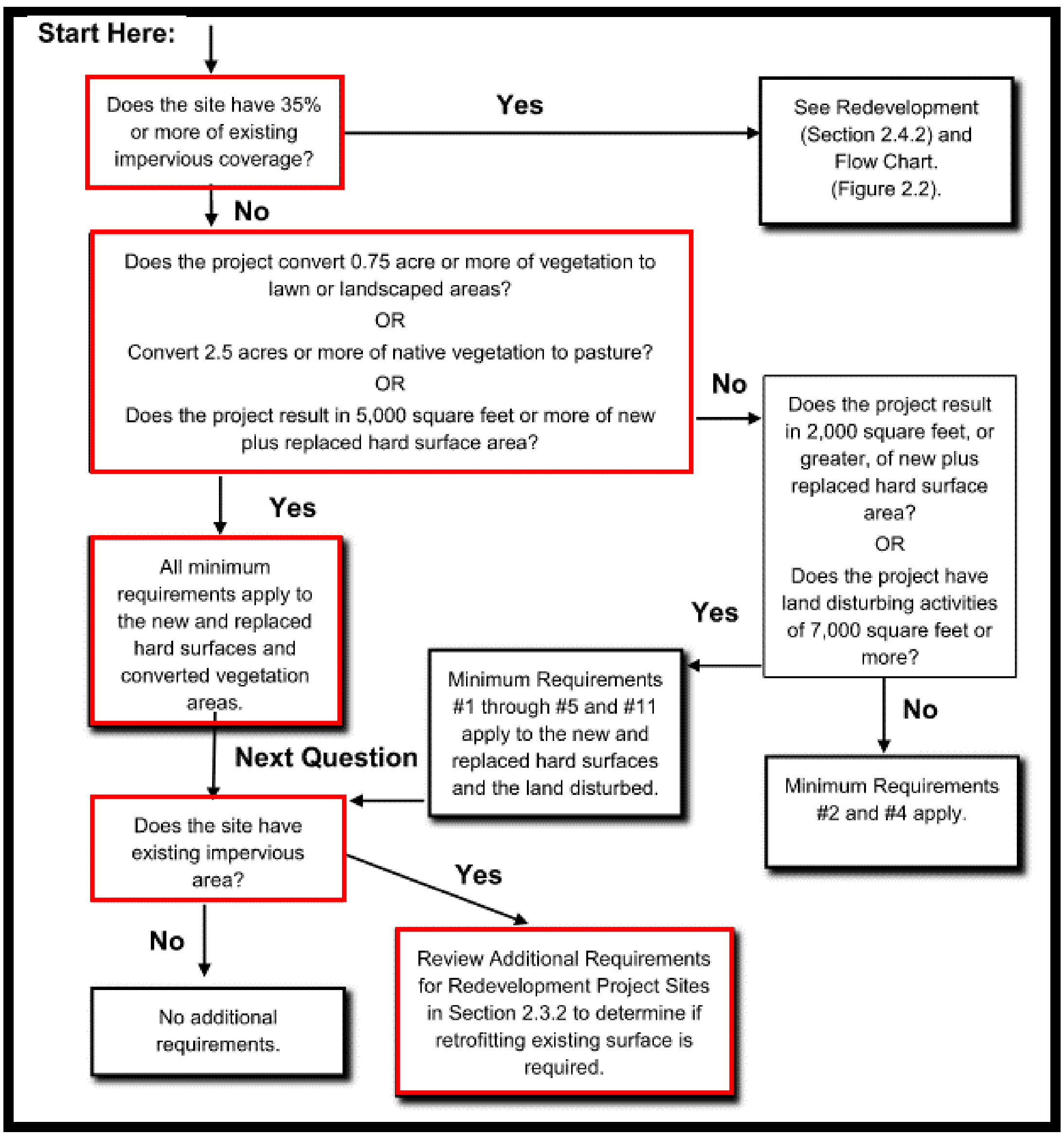


Figure 2.1. Flow Chart for Determining Requirements for New Development.

MINIMUM REQUIREMENTS (MRs) SUMMARY

MINIMUM REQUIREMENT 1 – Stormwater Site Planning
This Drainage Report and the accompanying construction plans comprise the Stormwater Site Plan.

MINIMUM REQUIREMENT 2 – Construction Stormwater Pollution Prevention Plan
A Construction Stormwater Pollution Prevention Plan (CSWPPP) in compliance with Minimum Requirement 2 has been prepared for this project. The CSWPPP is included as Attachment 2 to this report.

MINIMUM REQUIREMENT 3 – Source Control of Pollution
The insulating mineral oil of the two 115kV - 12.5kV power transformers is a potential source of pollutants on-site. To mitigate this, an SPCC (Spill Prevention Control & Countermeasure) containment area will be constructed around the transformers. The SPCC area will consist of a 16 inch deep concrete containment curb surrounding the transformers that will hold oil in the event of a spill or leak. The containment area will be lined with bentonite geotextile to prevent oil from infiltrating and will be filled with crushed rock that will act as a fire suppressant. Under normal operation, the SPCC area will collect and convey stormwater through an oil stop valve to the substation conveyance system, discharging to the bioretention cell. In the event of an oil spill the oil stop valve will close, preventing stormwater from leaving the SPCC area and containing oil until crews arrive. The SPCC area is designed to hold 110% of the transformer oil volume within the voids of the crushed rock, with 4 inches of freeboard.

MINIMUM REQUIREMENT 4 – Preservation of Natural Drainage Systems and Outfalls
The project will maintain discharge of stormwater runoff at the natural location on site to the extent practicable. The existing substation site does not contain any defined natural drainage features, but generally slopes north towards Barnes Lake which directly borders the site. There is no stormwater system for the existing substation. The site soils consist of medium sands, classified as Type A by NRCS, which are highly infiltrative. Due to the infiltration capacity of the underlying soils, it is likely that the majority of runoff is contained on the site and infiltrates, with any excess water flowing off the site to the northeast and into Barnes Lake.

Runoff from the proposed improvements will be collected and conveyed to a new bioretention cell located northeast of the expanded substation yard. The bioretention is designed to infiltrate 100% of the runoff from the substation yard, SPCC area, and surrounding lawn and landscaped areas, maintaining existing runoff patterns. The bioretention cell will include an emergency overflow weir which will direct any overflow north towards Barnes Lake in the event that infiltration capacity is exceeded or the facility becomes plugged and fails. See Section 3 of this report for the project off-site analysis and Section 4 for additional information on the bioretention cell.

MINIMUM REQUIREMENT 5 – On-Site Stormwater Management
The project triggers Minimum Requirements 1-9, thus per Section 2.4.6 of the City of Tumwater DDECM the project is required to meet the Low Impact Development Performance Standard and apply the post construction soil quality BMP OR implement feasible BMPs from List #2 in order to meet Minimum Requirement 5. The project will meet the LID Performance Standard to satisfy Minimum Requirement 5. See Section 4 of this report for additional information.

MINIMUM REQUIREMENT 6 – Runoff Treatment
The project does not propose any new pollution generating surfaces nor are there any existing surfaces on the site considered to be pollution generating. However, the project is a commercial/industrial use proposing to infiltrate stormwater within ¼ mile of a fresh water body with existing aquatic life use (Barnes Lake). Per Steps 5e and 5f in Section 4.2 of the City of Tumwater DDECM, this requires phosphorus control and enhanced treatment for stormwater runoff generated by any type of surface on site. The project will utilize a bioretention cell with a high-performance soil mix to satisfy these treatment requirements. See Section 4 of this report and the design calculations in Appendix 1 for additional information on the bioretention cell.

MINIMUM REQUIREMENT 7 – Flow Control
The project will utilize a bioretention cell for stormwater management designed to fully infiltrate 100% of the 100-year, 24-hour storm, exceeding the flow control discharge requirements of Minimum Requirement 7. See Section 4 of this report and the design calculations in Appendix 1 for additional information on the bioretention cell.

MINIMUM REQUIREMENT 8 – Wetlands Protection
The project proposes to infiltrate 100% of the stormwater runoff from the substation and does not discharge directly or indirectly through a conveyance system to a wetland. Thus Minimum Requirement 8 is not applicable.

MINIMUM REQUIREMENT 9 – Operation and Maintenance
An operation and maintenance manual for the proposed stormwater BMPs has been prepared in compliance with Section 3.3.3 and Volume V of the City of Tumwater DDECM. All stormwater BMPs proposed by the project are private facilities and PSE will be responsible for all required maintenance and operation. The manual is included in this report for reference as Attachment 4.

MINIMUM REQUIREMENT 10 – Financial Liability
PSE will provide performance bonding for the proposed drainage facilities as required by the City of Tumwater.

MINIMUM REQUIREMENT 11 – Off-Site Analysis and Mitigation
An off-site analysis was completed for the project and is included in Section 3 of this report.

SECTION 2 EXISTING CONDITIONS DESCRIPTION

The project site currently consists of the existing Barnes Lake substation, associated asphalt access driveway, landscaping, and undeveloped lawn areas. The property is bordered to the north by Barnes Lake, to the south by 2nd Ave SW, and to the east and west by commercial development. See **Figure 6: Existing Conditions Map**.

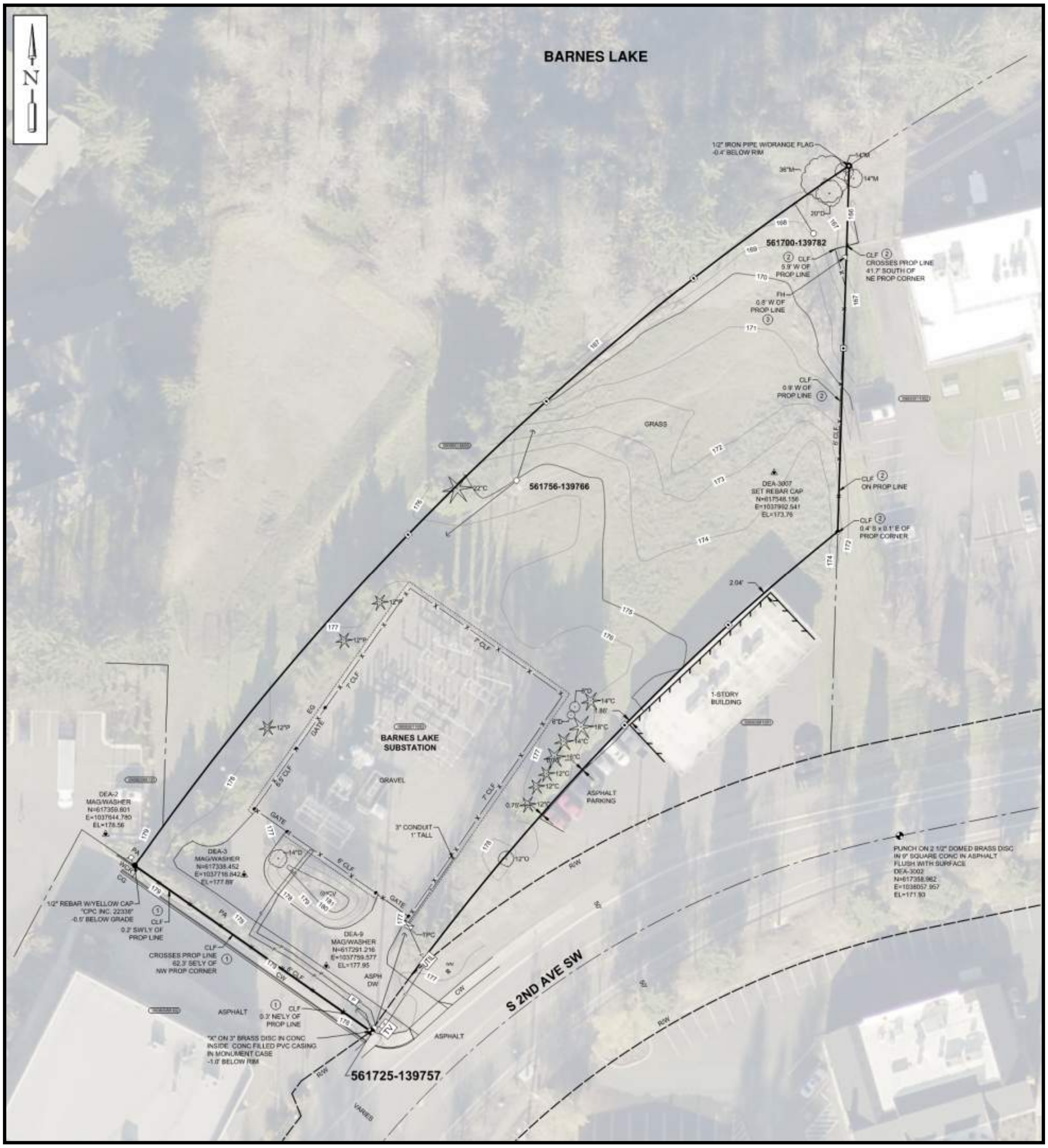
The southwestern half of the site contains the existing substation and is relatively flat at approximately EL 177.00. The existing substation is gravel surfaced with a seven foot high chain link perimeter security fence and an asphalt driveway providing access from 2nd Ave SW. The substation is surrounded on all sides by landscape screening consisting of small trees and shrubs. The existing developed substation area occupies approximately 0.4 acres of the property. The northeastern half of the site is undeveloped lawn, sloping gently away from the substation and towards Barnes Lake which directly borders the site to the north. The site is located within the five year capture zone of a City of Tumwater wellhead protection area and is directly upstream of Barnes Lake.

A geotechnical investigation consisting of both field and laboratory testing was conducted for the project by GeoEngineers. Multiple rounds of field testing and soils reports were completed by GeoEngineers, in 2007 and 2022, which are both included in this report for reference as Attachment 3. Initial geotechnical explorations in 2007 were undertaken to investigate the cause of settlement within the substation yard which has been occurring gradually since the substation was constructed. After analyzing a series of borings drilled in and around the substation, GeoEngineers determined the cause of the settlement to be unsuitable fill material containing organics and debris, placed improperly within a former gully which ran through the substation site prior to its original development in 1972. The improper fill material resulted in the formation of voids, causing the filled areas of the site to settle over time. As part of the proposed project, new equipment foundations will be overexcavated and a stabilizing geogrid will be installed to mitigate settlement in accordance with GeoEngineers' recommendations. Reference the soils reports in Attachment 3 for additional information.

Outside of the settlement analysis, geotechnical investigation determined the site soils to consist of loose to medium sands with variable silt and gravel content, underlain by recessional outwash. Groundwater was observed in borings at a depth of 16 to 22 feet below ground surface. The site soils are highly infiltrative and are classified as Type A by NRCS. GeoEngineers determined design infiltration rates for the site using the Soil Grain Size Analysis Method per Volume V – Appendix A of the City of Tumwater DDECM. The initial K_{sat} was estimated as 10 to 38 in/hr and the recommended design infiltration rate is 3 in/hr with appropriate safety and correction factors applied.

There is no stormwater system on the existing site. Due to the infiltration capacity of the underlying soils, the majority of stormwater is contained on the site and infiltrates. Any excess runoff exceeding the infiltration capacity of the native soils flows off the site to the north and into Barnes Lake.

Figure 6: Existing Conditions Map



SECTION 3 VICINITY ANALYSIS AND SUBBASIN DESCRIPTION

TASK 1 – DEFINE AND MAP THE STUDY AREA

Overview

The project site is a 1.2 acre property consisting of an existing substation surrounded by lawn areas and landscaping. Proposed improvements include a rebuild of the existing substation and an expansion of the substation yard to the northeast. The project will create greater than 5,000 square feet of new plus replaced impervious surface, which requires an off-site analysis per Minimum Requirement 11 of the City of Tumwater DDECM.

The boundary of the off-site analysis extends downstream of the project site to the receiving water (Barnes Lake) which is within one half mile of the site. Areas upstream of the site were not studied as the project will not create any backwater effects and upstream areas do not contribute any significant amount of runoff to the project site. See **Figure 7: Downstream Analysis Table** and **Figure 8: Downstream Analysis Map**.

TASK 2 – REVIEW AVAILABLE INFORMATION ON THE STUDY AREA

Soils

Soils on site consist of a layer of fill composed of loose to medium sands with variable silt and gravel content, overlying recessional outwash consisting of medium dense to dense sand. The soils are highly infiltrative and are classified as Type A by NRCS, with a recommended design infiltration rate of 3 in/hr determined by grain size analysis. A geotechnical report has been prepared for the project by GeoEngineers and is included as Attachment 3 to this report for reference.

FEMA Floodplain maps

FEMA mapping indicates that the substation property is located within Zone X – Area of Minimal Flood Hazard.

Wetlands and Streams

The Thurston County GIS web application and the National Wetlands Inventory do not indicate any wetlands or streams on the substation property. Additionally, a wetland reconnaissance was conducted on site by GeoEngineers and no wetland habitat was observed on the project parcel. The field report does note that Barnes Lake and its associated wetland areas are located offsite immediately adjacent to the substation, to the northeast. Reference the GeoEngineers Wetland Reconnaissance Field Report in Appendix 3 for additional information.

Other Critical Areas

The substation site is located within the five year capture zone of a wellhead protection area per City of Tumwater mapping.

TASK 3 – FIELD INSPECT THE STUDY AREA

A site visit was made on May 3, 2023 to conduct a field inspection. Weather conditions on the date of inspection were clear and sunny.

TASK 4 – DESCRIBE THE DRAINAGE SYSTEM

Upstream Drainage Analysis

Based on field inspection and a desktop review of the site topographic survey and available GIS information, there is no significant source of upstream runoff to the project site. The upstream site is a commercial development which has its own stormwater system that collects and routes stormwater runoff to an infiltration pond northwest of the substation.

Stormwater from the proposed improvements will be collected by a new conveyance system within the substation and will flow to a bioretention cell for treatment and infiltration. The bioretention cell and stormwater conveyance system are designed with capacity for the 100-year, 24-hour storm, thus no backwater effects are expected. Any overflow from the bioretention cell will be directed away from surrounding properties and towards Barnes Lake.

Downstream Drainage Analysis

Runoff from the project will be collected and routed to a bioretention cell located on the site northeast of the substation. The bioretention cell is designed to fully infiltrate 100% of the runoff from the new and replaced hard surfaces and replaced vegetation areas proposed by the project.

The bioretention cell will have an emergency overflow weir, designed to pass the 100-year developed peak flow in the event that the bioretention facility becomes plugged and fails to infiltrate. In the event of an overflow, stormwater would follow a flowpath across the gently sloping undeveloped lawn area on PSE property northeast of the substation. After roughly 250 feet, stormwater would flow into Barnes Lake which is the natural receiving water for any runoff from the site that doesn't currently infiltrate.

The field inspection was ended at this point of discharge, as Barnes Lake does not have a surface outlet to follow further downstream. No existing or potential conveyance capacity or erosion issues were identified along the emergency overflow path from the proposed bioretention cell to Barnes Lake. The lake itself does experience water quality issues and is a phosphorus sensitive water body according to assessments completed by the City of Tumwater and the Barnes Lake Management District. Although runoff from the substation site will not be directly discharged to Barnes Lake, enhanced water quality treatment and phosphorus control is required by the City of Tumwater DDECM for stormwater infiltration within ¼ mile a freshwater body with existing aquatic life use. The proposed bioretention cell will meet both enhanced and phosphorus treatment requirements. Additionally, a high performance bioretention soil mix approved by the Washington Department of Ecology for phosphorus sensitive areas will be utilized to prevent export of phosphorus from composted materials into the underlying soils.

Figure 7: Downstream Analysis Table

DOWNSTREAM ANALYSIS DRAINAGE SYSTEM TABLE – BARNES LAKE SUBSTATION

Symbol See Map, Figure 8	**Drainage Component Type**	**Drainage Component Description**	**Distance from site discharge**	**Existing Problems**	**Potential Problems**	**Observations**
1	Emergency Overflow Location of Proposed Bioretention Cell	Emergency overflow weir, sized to pass 100-YR developed peak flow.	0 FT	None	None	
2	Overflow Path from Bioretention Cell	Gently sloping (2% - 5%) vegetated lawn area northeast of substation on PSE property.	0 – 250 FT	None	None	
3	Discharge Point to Barnes Lake	Heavily vegetated shore of Barnes Lake immediately north of substation property.	250 FT	None	None	

Figure 8: Downstream Analysis Map

SECTION 4 FLOW CONTROL AND WATER QUALITY FACILITY SIZING

The Barnes Lake substation project is classified as new development and proposes greater than 5,000 square feet of new plus replaced hard surface area, which requires application of all Minimum Requirements of the City of Tumwater DDECM to the new and replaced hard surfaces and converted vegetation areas on-site. The City of Tumwater has also required that runoff from the existing asphalt driveway be collected and mitigated to the extent practicable.

The primary stormwater performance standards required for the project are MR #5 – On-Site Stormwater Management, MR #6 – Runoff Treatment, and MR #7 – Flow Control. A bioretention cell (Ecology BMP T7.30) is proposed for stormwater management and will satisfy the requirements of Minimum Requirements #5, #6, and #7. The bioretention cell was designed using the 2012 Western Washington Hydrology Model (WWHM12) to fully infiltrate stormwater runoff from the proposed improvements and a portion of the existing asphalt driveway, with a bottom area of approximately 2,070 square feet, a maximum ponding depth of one foot, and one foot of freeboard. Refer to the sections below for additional information on the bioretention facility and how the performance standards of each Minimum Requirement are addressed. See Appendix 1 for detailed calculations including the WWHM Project Report and a basin map outlining the on-site areas included in the bioretention sizing.

MINIMUM REQUIREMENT 5 – ON SITE STORMWATER MANAGEMENT

In order to meet Minimum Requirement #5, projects triggering Minimum Requirements #1 through #9 are required to use the LID Performance Standard and post-construction soil quality and depth BMP, OR apply BMPs from List #2.

This project will choose to comply with the LID Performance Standard in order to meet Minimum Requirement #5, which requires matching developed discharge durations to the range of pre-developed discharge rates from 8 percent of the 2-year peak flow to 50 percent of the 2-year peak flow. This will be accomplished by the proposed bioretention cell which is designed to fully infiltrate 100% of the runoff from the proposed improvements. Reference the WWHM Project Report in Appendix 1 for detailed calculations demonstrating compliance with the LID Performance Standard.

Additionally, the project will implement the post-construction soil quality and depth BMP (Ecology BMP T5.13) to the maximum extent practicable. Undisturbed soil will be retained and protected by high visibility fence in areas outside the limits of work, while topsoil stripped during grading will be stockpiled on site and used for restoration of disturbed areas. Reference the Soil Management Plan in Appendix 2 for additional information on how post-construction soil quality will be implemented.

MINIMUM REQUIREMENT 6 – RUNOFF TREATMENT

Minimum Requirement #6 requires construction of stormwater treatment facilities for projects in which the total pollution-generating hard surface (PGHS) is 5,000 square feet or more in a threshold discharge area OR where the total of pollution-generating pervious surfaces (PGPS) are 0.75 acres or more in a threshold discharge area.

The project does not propose any surfaces which meet the definition of pollution-generating per the City of Tumwater DDECM. However, the project is a commercial/industrial site using infiltration within ¼ mile of a fresh water body with existing aquatic life use (Barnes Lake). Per Steps 5e and 5f in Section 4.2 of the City of Tumwater DDECM, this requires phosphorus control and enhanced treatment for stormwater runoff generated by any type of surface on site.

Based on treatment menus in Sections 4.3.3 and 4.3.4 of the DDECM, bioretention is a suitable treatment facility for both phosphorus control and enhanced treatment. All runoff collected on-site will be routed to the new bioretention cell for treatment and infiltration. The bioretention cell will be constructed using an imported soil mix as the native soils on site do not meet suitability criteria required for water quality treatment. The imported soil will meet the criteria for a high performance bioretention mix, which was approved by the Washington Department of Ecology in May 2021 for use in phosphorus control areas. For additional information on the high performance soil mix, see Department of Ecology Publication 21-10-023 included in Appendix 3 for reference. Detailed water quality calculations for the bioretention cell are also included in the WWHM Project Report in Appendix 1.

MINIMUM REQUIREMENT 7 – FLOW CONTROL

The project proposes greater than 10,000 square feet of effective impervious surface within a threshold discharge area which requires achievement of the standard flow control requirement for Western Washington. Per Section 2.4.8 of the City of Tumwater DDECM the project falls into discharge Category "A" – Discharge to a Fresh Water Body, which requires matching developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50 percent of the 2-year peak flow up to the full 50-year peak flow.

The bioretention cell was sized using WWHM12 to fully infiltrate 100% of the runoff from the proposed improvements, exceeding the standard flow control discharge requirements. Reference the WWHM Project Report in Appendix 1 for detailed calculations demonstrating compliance with the standard flow control requirement.

SECTION 5 AESTHETIC CONSIDERATIONS FOR FACILITIES

The bioretention facility will be located along the rear substation fence line and will be incorporated into the landscape screening for the substation. The bioretention landscaping design was prepared by a licensed landscape architect using plant species, sizing, and spacing that are in accordance with Sections 9.6.12 and V-F.5 of the City of Tumwater DDECM.

For additional information on the bioretention landscaping design, reference the substation landscape plan (drawing D-22027) included in the Site Development Drawings as Attachment 1 to this report.

SECTION 6 CONVEYANCE SYSTEM ANALYSIS AND DESIGN

A new stormwater system will be constructed to collect and convey runoff to the bioretention cell for treatment and infiltration. The conveyance system will include Type 1 catch basins to collect runoff from the substation yard, as well as a system of perforated pipes to drain stormwater from the transformer secondary containment (SPCC) area. Two catch basins located on the southwest side of the substation near the main access gates will also collect runoff from a portion of the existing asphalt driveway. A thickened edge will be installed along the inside of the driveway to help direct runoff to these catch basins utilizing the slope of the existing asphalt. For additional information, reference the WWHM basin map included in Appendix 1 which shows the approximate area of the existing asphalt driveway that is collected by the new substation conveyance system.

Conveyance pipes outside of the SPCC area will be six inch diameter HDPE pipe with corrugated exterior and smooth interior, while perforated pipes inside the SPCC area will be six inch diameter SCH 80 PVC. All conveyance pipes will be laid at a minimum slope of 0.5%. The conveyance system will discharge to the new bioretention cell which is designed to fully infiltrate 100% of stormwater runoff. The bioretention cell does include an emergency overflow weir designed to pass the 100-year developed peak flow from the site in the event the facility becomes plugged and fails.

Calculations demonstrating the capacity of the conveyance pipes and emergency overflow weir are included in Appendix 1.

SECTION 7 COVENANTS, DEDICATIONS, EASEMENTS

The project proposes a new bioretention stormwater management BMP which will be constructed on the substation site. The bioretention cell is a private stormwater facility that will be maintained by PSE. This requires establishment of a maintenance covenant which will be recorded using the City of Tumwater's *Stormwater Maintenance Agreement Form*, included as Attachment 5 to this report.

No additional covenants, dedications, or easements are proposed or required for the project.

SECTION 8 AGREEMENTS AND GUARANTEES

PSE will provide the necessary performance bonding and financial guarantees for the project consistent with Minimum Requirement #10 of the City of Tumwater DDECM.

SECTION 9 OTHER PERMITS OR CONDITIONS PLACED ON THE PROJECT

The project is expected to require the following permits and reviews:

- Site Plan Review – City of Tumwater
- Site Development Grading – City of Tumwater
- Building – City of Tumwater (for substation MPAC Enclosure and Fencing)
- SEPA checklist

ATTACHMENT 1

Site Development Drawings

ATTACHMENT 2

Construction SWPPP Report

Construction Stormwater Pollution Prevention Plan
(CSWPPP) Narrative Report

Barnes Lake Substation

Project Site Location:
1697 2nd Ave SW
Tumwater, WA

100% Submittal
Revised: March 26, 2024

Applicant:
Puget Sound Energy
355 110th Ave NE
Bellevue, WA 98004

Contact:
Chantal Banfield (Project Manager)
Phone: 425-465-1218
Email: chantal.banfield@pse.com

Project Engineer:
Jackson Knoll, P.E.
Phone: 425-380-9772
Email: jackson.knoll@pse.com

Contractor:
Johansen Construction Company

Construction Stormwater Pollution Prevention Plan (CSWPPP) Narrative Report

Barnes Lake Substation
Puget Sound Energy

Prepared by:

Jackson Knoll, P.E.

Reviewed by:

Jason Henry, P.E.

I hereby state that this Construction Stormwater Pollution Prevention Plan for *Barnes Lake Substation* has been prepared by me or under my supervision and meets the standard of care and expertise that is usual and customary in this community for professional engineers. I understand that the City of Tumwater does not and will not assume liability for the sufficiency, suitability, or performance of Construction SWPPP BMPs prepared by me.

TABLE OF CONTENTS

SECTION 1 GENERAL PROJECT INFORMATION

Project Contacts

Name	*Company*	*Project Role*	*Phone*	*Email*
Chantal Banfield	PSE	Project Manager	425-465-1218	chantal.banfield@pse.com
Jackson Knoll	PSE	Civil Engineer	425-380-9772	jackson.knoll@pse.com
Cody Spence	PSE	Construction Manager	425-466-8946	cody.spence@pse.com
HDR*	HDR	CESCL	___________*	______________________*
Johansen**	Johansen CC	Contractor	___________**	______________________**

*HDR will be utilized for CESCL services and will designate a contact prior to construction.
**Johansen was selected as the project Contractor and will designate a contact prior to construction.

Project Description

Puget Sound Energy (PSE) is proposing to rebuild Barnes Lake substation to replace aging equipment, increase the substation capacity, and mitigate settlement issues. Improvements will include replacement of all equipment within the existing substation. The substation will also be expanded to the northeast for addition of a new control building, and a second transformer will be added to increase capacity. A spill prevention control and countermeasure (SPCC) system will be installed for both of the new transformers to provide secondary containment. Substation perimeter fencing will also be upgraded from chain link fabric to welded wire mesh for enhanced security. Finally, new equipment foundations will be overexcavated to mitigate settlement issues within the substation yard. Soil removed by overexcavation will be stockpiled on site during construction and will be re-used as backfill to the extent feasible.

Existing Conditions

The Barnes Lake substation site is a 1.2 acre parcel at 1697 2nd Ave SW within the City of Tumwater. The southwestern half of the site contains the existing substation and is relatively flat at approximately EL 177.00. The existing substation is gravel surfaced with a seven foot high chain link perimeter security fence and an asphalt driveway providing access from 2nd Ave SW. The substation is surrounded on all sides by landscape screening consisting of small trees and shrubs. The existing developed substation area occupies approximately 0.4 acres of the property. The northeastern half of the site is undeveloped lawn, sloping gently away from the substation (approximately 2% to 5%) and towards Barnes Lake which directly borders the site to the north. The site is located within the five year capture zone of a City of Tumwater wellhead protection area and is upstream of Barnes Lake and its associated wetlands, although there are no known wetland areas present on the substation site itself.

Adjacent Areas

The substation site is bordered to the north by Barnes Lake, to the south by 2nd Ave SW, and to the east and west by commercial development (strip mall and a Walgreens). The commercial areas upstream of the site have their own stormwater system which collects and routes stormwater runoff to an infiltration pond northwest of the substation. Downstream of the project site, stormwater flows roughly 250 feet through the gently sloping lawn area northeast of the substation, before flowing directly into Barnes Lake.

Critical Areas

There are no known critical areas present on the substation site itself, however Barnes Lake and its associated wetlands are immediately adjacent to the site to the north. The 200 foot shoreline buffer for the lake extends over the northern corner of the parcel and is shown on the site plans.

Extreme care will be taken to prevent sediment laden runoff from leaving the site and entering the lake during construction. The BMPs described in this report must be in place prior to beginning any clearing or grading activities and must be monitored during and after storm events to ensure they are functioning properly. See Section 2 of this report for additional information on protection of the Barnes Lake critical areas during construction.

Soil

The site soils consist of loose to medium sands with variable silt and gravel content (SP-SM), underlain by recessional outwash. Groundwater was observed in borings at a depth of 16 to 22 feet below ground surface and is expected to vary seasonally. The site soils are highly infiltrative and are classified as Type A by NRCS.

Potential Erosion Problem Areas

The project area with the greatest potential for erosion is the northeast half of the site where soil removed during overexcavation for new foundations may be temporarily stockpiled if there is insufficient space to store the excavated soil within the existing substation footprint. The stockpile will be stabilized by plastic covering when not in use and silt fence will be installed downstream to retain any sediment on the site. The stockpile area must be monitored during construction and additional BMPs implemented as necessary to ensure that sediment and sediment-laden water do not leave the site. Any stockpiled soil not re-used as fill on site will be exported and areas outside of the substation footprint disturbed by stockpiling will be restored and re-seeded following construction. See Section 2 of this report for additional information on BMPs to control erosion of temporary stockpiles.

SECTION 2 THIRTEEN CONSTRUCTION SWPP ELEMENTS

Element 1: Preserve Vegetation / Mark Clearing Limits
Prior to construction, the project clearing limits as shown on the TESC plan (D-22017 SHT 1) will be clearly flagged. The native duff layer, topsoil, and groundcover will be preserved to the maximum extent feasible in existing undeveloped areas within the clearing limits that do not require grading. Additionally, a vegetated buffer area will be provided between the clearing limits and the northern property line closest to Barnes Lake to reduce the proximity of clearing and grading activities to the lake and help control velocities of any runoff leaving the site in this direction. High visibility fence will be installed to delineate clearing limits along this buffer zone adjacent to the lake and will also be installed for tree protection around existing trees to remain that are inside the limits of work.

<u>BMPs to be used on-site:</u>
BMP C101 – Preserving Natural Vegetation
BMP C102 – Buffer Zones
BMP C103 – High-Visibility Fence

Element 2: Establish Construction Access
The site has an existing 20 foot wide asphalt driveway for access to the substation from 2nd Ave SW. Construction access to the site will be limited to one entry/exit point via this asphalt driveway which will provide a stabilized entrance for construction occurring within the existing substation. Any sediment tracked off-site will be cleaned at the end of each work day.

<u>BMPs to be used on-site:</u>
BMP C105 – Stabilized Construction Access

Element 3: Control Flow Rates
Site soils are highly infiltrative loose to medium sands which are classified as Type A by NRCS. The infiltration capacity of the native soils will help prevent significant volumes of surface runoff from being generated during construction. A bioretention cell is proposed for permanent infiltration of stormwater, which will be protected during construction using high visibility silt fence. Any surface runoff that does occur will likely flow towards the northeastern portion of the site, which slopes between 2% - 5% towards Barnes Lake. A vegetated buffer will be maintained along this side of the site to help reduce runoff flow rates and encourage infiltration of stormwater on-site.

<u>BMPs to be used on-site:</u>
BMP C102 – Buffer Zones

Element 4: Install Sediment Controls
The project site slopes to the north towards Barnes Lake. Vegetation in this area along the northern property line will be preserved to increase the removal of sediment from any runoff leaving the site in this direction. Silt fence will also be installed along the downstream (northern) limits of construction to capture sediment from any runoff before it leaves the site.

BMPs to be used on-site:
BMP C233 – Silt Fence

Element 5: Stabilize Soils
All exposed and unworked soils will be stabilized by application of BMPs that protect the soil from erosion. These BMPs will include seeding, mulching, and plastic covering as appropriate. The native groundcover and topsoil layer will be preserved to the maximum extent feasible in areas not requiring grading. In disturbed areas not receiving alternative surfacing, including the temporary stockpile area, soils will be restored by re-spreading native topsoil and scarifying subsoil in accordance with Ecology BMP T5.13 Post-Construction Soil Quality and Depth. These areas will be permanently stabilized following construction by mulching and seeding to restore pre-existing groundcover. Disturbed areas inside the substation will be permanently stabilized with clean 1-1/2" crushed rock as soon as grading is complete. Temporary stockpiles will be covered with plastic sheeting at all times when not in use. No soils will remain exposed and unworked for more than 7 days during the dry season from May 1st to September 30th or 2 days during the wet season from October 1st to April 30th.

BMPs to be used on-site:
BMP C120 – Temporary and Permanent Seeding
BMP C121 – Mulching
BMP C123 – Plastic Covering

Element 6: Protect Slopes
The existing substation pad is approximately flat, while the undeveloped portion of the site slopes gradually to the north at slopes between 2%-5% towards Barnes Lake. The site does not contain any natural steep slope areas and no significant permanent cut or fill slopes are proposed. The temporary stockpile will be constructed with 2H:1V slopes up to a maximum height of 10 feet which will be protected during construction using plastic covering when not in use.

BMPs to be used on-site:
BMP C123 – Plastic Covering

Element 7: Protect Drain Inlets
There are no existing drain inlets on the site, but there are nine Type 1 catch basins proposed in the substation yard. Catch basin inlet protection will be installed in the new catch basins as they are constructed. Inlets will be inspected weekly at a minimum and daily during storm events and cleaned or replaced when sediment has filled one-third of the available storage.

BMPs to be used on-site:
BMP C220 – Inlet Protection

Element 8: Stabilize Channels and Outlets
There are no existing ditches or channels on site and none are proposed by the project. There is one stormwater outfall proposed at the bioretention cell. Outlet protection in the form of a rock riprap pad will be installed at the outfall discharge point as it is constructed.

<u>BMPs to be used on-site:</u>
BMP C209 – Outlet Protection

Element 9: Control Pollutants
All pollutants that occur on-site during construction will be handled and disposed of in a manner that does not cause contamination of stormwater. No vehicle maintenance is anticipated to take place onsite during construction. Any required vehicle maintenance will take place offsite at a PSE or contractor service yard. No stationary fueling tanks will be kept onsite and construction equipment will be refueled only with 5 gallon cans during working hours. Concrete work will occur onsite for construction of new substation equipment foundations. Concrete handling measures in accordance with BMP C151 will be implemented and a concrete washout area has been designated on the TESC plan. Concrete washout will primarily occur offsite to the extent practicable and when required, onsite washout will only occur in an Eco-pan container (or equivalent) in the designated washout area.

<u>BMPs to be used on-site:</u>
BMP C151 – Concrete Handling
BMP C154 – Concrete Washout Area

Element 10: Control Dewatering
Per the project geotechnical investigation, groundwater was observed in borings at depths between 16 and 22 feet below ground surface. Excavations for the project will be comparatively shallow and significant groundwater is not expected to be encountered. The deepest excavation will reach approximately 8 feet below ground surface for overexcavation of the transformer and circuit switcher foundations.

Groundwater levels are anticipated to vary as a function of precipitation and season. If any dewatering is necessary, water will be pumped to a baker tank or equivalent containment vessel and then transported off-site for legal disposal.

Element 11: Maintain BMPs
All erosion and sediment control BMPs will be maintained and repaired as needed to assure continued performance of their intended function. Maintenance and repair shall be conducted in accordance with City of Tumwater BMP standards. Sediment control BMPs will be inspected weekly or after a runoff-producing event during the dry season and daily during the wet season. All erosion and sediment control BMPs will be removed within 30 days after final site stabilization is achieved or after the BMPs are no longer needed. Disturbed soil areas resulting from removal of BMPs or vegetation will be permanently stabilized as described in Element 5: Stabilize Soils.

Element 12: Manage the Project
All BMPs will be inspected, maintained, and repaired as needed to assure continued performance of their intended function. By the initiation of construction, this Construction SWPPP will identify the CESCL (see Section 1 of this report) who will be present on site or on call at all times to assess and manage the CSWPPP measures.

Whenever inspection and/or monitoring reveals that the BMPs identified in the Construction SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, this SWPPP will be modified, as appropriate, in a timely manner. The Construction SWPPP will be retained on-site and will be modified whenever there is a significant change in the design, construction, operation, or maintenance of any BMP.

<u>BMPs to be used on-site:</u>
BMP C150 – Materials on Hand
BMP C160 – Certified Erosion and Sediment Control Lead
BMP C162 – Scheduling

Element 13: Protect Low Impact Development BMPs
The project proposes a bioretention cell for infiltration of stormwater, located just northeast of the expanded substation footprint. It is crucial that the bioretention facility is protected during construction to ensure that it is fully functional and will infiltrate stormwater as designed after construction is complete.

The following practices will be implemented to protect the bioretention cell from compaction and sedimentation during construction:

- The bioretention area will be protected from compaction and sedimentation during construction. High visibility silt fence will be installed around the bioretention area to clearly identify it, limit disturbance by construction traffic, and capture any sediment transported by upstream surface runoff.
- Excavation of the bioretention facility will be performed by equipment operating adjacent to it. No heavy equipment with narrow tracks or tires is allowed within the bioretention footprint.
- Excavation of the bioretention facility to final grade will occur only after all disturbed areas in the up-gradient project area have been permanently stabilized. The bioretention facility shall not be used as a sediment control facility during construction.

<u>BMPs to be used on-site:</u>
BMP C103 – High-Visibility Fence

SECTION 3 CONSTRUCTION PHASING

Construction of the project will be completed in one phase. The intended sequence of construction activities is listed below. Note that actual construction sequencing may vary at the discretion of the contractor and PSE construction manager.

1. Hold pre-construction meeting.
2. Mobilize to site and install initial erosion and sediment control BMPs. At a minimum, high visibility fencing for tree protection must be installed prior to beginning demolition.
3. Demolish and remove existing substation foundations. Remove existing landscaping.
4. Remove northern section of existing substation fence as required to facilitate access from the existing entrance driveway, through the substation, to the temporary stockpile area. Install temporary construction fencing as required to secure site during construction.
5. Strip vegetation and topsoil from substation expansion area, including rough grading of new bioretention area, and complete overexcavation for new substation equipment foundations.
6. Stockpile soil approved by Geotechnical Engineer for re-use as backfill on site within the substation footprint or northeast of the substation if necessary. Export soil that is unsuitable for re-use off-site for disposal.
7. Compact bottom of overexcavation areas and install stabilizing geo-grid. Backfill overexcavation areas up to subgrade level using stockpiled material.
8. Install new foundations, conduits, grounding, storm drainage, and SPCC system within substation yard.
9. Remove remainder of existing substation chain link fence and install new welded wire security fence and gates. Install associated fence grounding including substation perimeter ground.
10. Stabilize substation yard by installing yard rock surfacing and driveway top course up to finished grade, including surfacing of 5 foot substation shoulder outside of fence.
11. Complete excavation and finished grading for new bioretention area and restoration of the temporary stockpile area. Install storm outfall to bioretention area. Export any unused stockpile material off-site for disposal.
12. Install new substation structures and equipment on foundations.
13. Install new landscaping and mulch and seed for permanent site stabilization.
14. De-mobilize from site and remove erosion and sediment control BMPs.

SECTION 4 CONSTRUCTION SCHEDULE

Civil construction is expected to begin in late April 2024 and last for approximately 3 to 4 months, in accordance with the sequencing described in Section 3 – Construction Phasing.

Above ground assembly of the substation, including erection of steel structures and installation of new equipment will occur after the majority of the civil construction is complete and the site has been stabilized. This phase of construction will last for approximately 5 months, after which the new substation will be commissioned and re-energized.

SECTION 5 FINANCIAL/OWNERSHIP RESPONSIBILITES

The substation and all proposed improvements are under the ownership of Puget Sound Energy. PSE will provide the necessary performance bonding and financial guarantees for the project consistent with Minimum Requirement #10 of the City of Tumwater DDECM.

SECTION 6 ENGINEERING CALCULATIONS

No temporary erosion and sediment control BMPs requiring engineering calculations are proposed. Refer to the project Drainage Report for all calculations associated with the permanent stormwater control system.

SECTION 7 INSPECTION CHECKLISTS AND MONITORING FORMS

The project CESCL shall utilize inspection forms which include the following information at a minimum:

- Inspection date/time.
- Weather information; general conditions during inspection and approximate amount of precipitation since the last inspection.
- A summary or list of all BMPs implemented, including observations of all erosion/sediment control structures or practices. The following shall be noted:
  - Locations of BMPs inspected
  - Locations of BMPs that need maintenance
  - Locations of BMPs that failed to operate as designed or intended
  - Locations of where additional or different BMPs are required
- Visual monitoring results, including a description of discharged stormwater.
- The presence of suspended sediment, turbid water, discoloration, and oil sheen shall be noted, as applicable.
- Any water quality monitoring performed during inspection.
- General comments and notes, including a brief description of any BMP repairs, maintenance or installations made as a result of the inspection.

ATTACHMENT 3

Soils Report

Geotechnical Engineering Services

Barnes Lake Substation Improvements
Tumwater, Washington

for
Puget Sound Energy

April 20, 2023

GeoEngineers
Earth Science + Technology

Geotechnical Engineering Services

Barnes Lake Substation Improvements
Tumwater, Washington

for
Puget Sound Energy

April 20, 2023

GeoEngineers

2101 4th Avenue, Suite 950
Seattle, Washington 98121
206.728.2674

Geotechnical Engineering Services

Barnes Lake Substation Improvements
Tumwater, Washington

File No.

April 20, 2023

Prepared for:

Puget Sound Energy
35131 SE Center Street SQE-OTC
Snoqualmie, Washington 98065

Attention: Jackson Knoll, PE and Jason Henry, PE

Prepared by:

GeoEngineers, Inc.
2101 4th Avenue, Suite 950
Seattle, Washington 98121
206.728.2674

4/20/23

Timothy D. Bailey, PE
Senior Geotechnical Engineer

David S. Phelps, PE
Principal Geotechnical Engineer

TDB:DSP:leh

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APPENDICES

1.0 INTRODUCTION

This report summarizes the results of our geotechnical services associated with the proposed improvements to the existing Puget Sound Energy (PSE) Barnes Lake Substation. The site is located on Thurston County parcel 09080011003 on 2nd Avenue SW in Tumwater, Washington and is shown in relation to the surrounding area on the Vicinity Map, Figure 1. The site is about 200 feet north of the intersection of 2nd Avenue SW and Trosper Road SW. Existing features are shown on the Site Plan, Figure 2.

Our understanding of the current project is based on discussions with Jason Henry and review of drawings showing the existing substation and proposed improvements. We understand there is maintenance replacement planned at the existing substation, with a replacement control house, transformer, and circuit switcher. As part of the maintenance, the substation will be prepared for a future second bank of equipment in addition to the current single bank. The existing substation has experienced significant settlement (up to ½-foot settlement in areas), and we have discussed potential options for mitigating settlement. We provided conceptual options to PSE for deep foundations or overexcavation. We understand PSE has decided to complete overexcavation below the area of the replacement equipment.

GeoEngineers previously prepared a geotechnical report for this site dated January 12, 2007. We also prepared a final version of this report dated August 30, 2022. This report incorporates and supersedes our previous reports. GeoEngineers prepared a separate environmental soil characterization report for this site.

2.0 SCOPE OF SERVICES

Our services were completed in accordance with our proposal dated May 9, 2022. Our scope of services includes:

- Completing four borings at the site;
- Completing laboratory testing on selected soil samples from the borings;
- Providing geotechnical conclusions and recommendations for the proposed improvements; and
- Preparing this report.

3.0 FIELD EXPLORATIONS AND LABORATORY TESTING

3.1. Field Explorations

Subsurface conditions at the site were evaluated by completing four exploratory borings (GEI-1-22 through GEI-4-22) to depths of 26½ to 51½ feet below the ground surface (bgs). A description of the field exploration program and summary boring logs are presented in Appendix A. The boring locations are shown on the Site Plan, Figure 2.

3.2. Laboratory Testing

Soil samples were obtained during the recent exploration program and taken to GeoEngineers' Redmond laboratory for further evaluation. Selected samples were tested for the determination of moisture content and grain-size distribution (sieve analysis). A description of the laboratory testing and the test results are presented in Appendix A or on the boring logs.

3.3. Previous Explorations

Subsurface conditions at the site were previously evaluated by completing four exploratory borings (1, 2A, 2B and 3) to depths of 2½ to 26½ feet bgs as part of our geotechnical study in 2007 (GeoEngineers 2007). These previous boring logs and supporting laboratory data are presented in Appendix B. The boring locations are shown on the Site Plan, Figure 2.

4.0 SITE CONDITIONS

4.1. Geology

We reviewed available geologic maps, including the geologic map of the Tumwater quadrangle (Walsh 2003). Surficial soils in the project vicinity are mapped on the geologic map as Vashon recessional sand and minor silt (Qgos).

Surficial soils are shown on the United States Department of Agriculture (USDA) soils mapping as Nisqually loamy fine sand, 0 to 3 percent slopes, per (Thurston County GIS).

4.2. Geologically Hazardous Areas

We reviewed the geologically hazardous area definitions presented in City of Tumwater Municipal Code Section 16.20.040. Based on the relatively flat grades in the vicinity of the site, the site is not within erosion or landslide hazard areas. Based on the sandy saturated soils below the site, which have a moderate to high risk of liquefaction, it is our opinion the site is within a seismic liquefaction hazard area and therefore potential liquefaction should be considered in design of the proposed improvements. Based on the United States Geological Survey (USGS) fault database, the site is not located within or near a mapped fault.

Based on Thurston County mapping, the site is located within a wellhead protection area. The site is mapped within a zone that is a 5-year-flow distance from a potable water well. Proposed activities on this site should not adversely affect aquifer recharge.

The proposed work is located within the footprint of the existing substation and therefore it is our opinion there are no permanent impacts to geologically hazardous areas.

4.3. Surface Conditions

The site (Thurston County Parcel No. 09080011003) is on the north side of 2nd Avenue SW, with commercial buildings to the east, south, and west and an undeveloped parcel and Barnes Lake to the north. The site is accessed by a paved road off 2nd Avenue SW.

The ground surface within the fenced portion of the existing substation is relatively level. The ground surface slopes down gently on the west and north sides of the substation. Vegetation around the perimeter of the substation generally consists of shrubs and low trees.

4.4. Subsurface Conditions

Based on our subsurface explorations, subsurface conditions consist of fill and recessional outwash extending to the depths explored. The fill generally consists of loose to medium sand with variable silt and gravel content extending to depths of 8½ to 19½ bgs in the current and previous borings. The underlying recessional outwash generally consists of medium dense to dense sand with variable silt content.

The soils encountered the subsurface explorations are generally classified as sand per the USDA textural triangle.

4.5. Groundwater

Groundwater was observed at a depth of between 16 to 19 feet bgs in the current borings and at 21 to 22 feet in the previous borings. Groundwater levels are anticipated to vary as a function of precipitation, season, and other factors.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1. General

Based on our explorations, testing, and evaluation, it is our opinion that the site can be improved as proposed provided that the considerations and recommendations presented in this report are incorporated in the project design and construction. A summary of geotechnical considerations is provided below.

- Settlement of portions of the substation appears to be due to the presence of voids located near the contact between the fill and the native soils. There may have been vegetation (such as trees or brush) that were left in place during fill placement. Overexcavation of the area of proposed improvements and replacement with structural fill is recommended, with overexcavation depths varying depending on the equipment settlement sensitivity.
- The site is underlain by potentially liquefiable soils, and the proposed overexcavation and replacement with structural fill, along with the addition of a geogrid will provide a stiffer layer that will help mitigate potential seismic liquefaction-induced settlement at the ground surface.
- Shallow or mat foundations constructed on new fill placed and compacted in overexcavated areas are suitable for support of equipment.
- Infiltration is feasible on site outside the existing substation footprint.

This summary is presented for introductory purposes only and should be used in conjunction with the complete recommendations presented in this report.

5.2. Earthquake Engineering

5.2.1. 2018 IBC Seismic Design Information

We recommend the 2018 International Building Code (IBC) parameters for Soil Profile Type, short period spectral response acceleration (S_S), 1-second period spectral response acceleration (S_1), and Seismic Coefficients F_A and F_V presented in Table 1.

TABLE 1. 2018 IBC PARAMETERS

2018 IBC Parameter	Recommended Value
Soil Profile Type	D
Short Period Spectral Response Acceleration, S_S (percent g)	139.4
1-Second Period Spectral Response Acceleration, S_1 (percent g)	52.1
Seismic Coefficient, F_A	1.2
Seismic Coefficient, F_V	1.78
Site Modified Peak Ground Acceleration, PGA_M (percent g)	72.1

Note:

The above spectral response accelerations are based on data from American Society of Civil Engineers (ASCE) 7-16 seismic maps, which is the basis of IBC 2018 seismic parameters.

5.2.2. Liquefaction and Liquefaction-Induced Settlement

Liquefaction refers to the condition when 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 the water table. Liquefaction usually results in loss of bearing capacity, resulting in settlement of structures that are supported on foundations within or above the liquefied soils.

We evaluated the liquefaction potential of the site using the Simplified Procedure (Youd et al. 2001). The Simplified Procedure is 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 against liquefaction is determined by dividing the CRR by the CSR. Liquefaction hazards, including settlement and related effects, were evaluated when the factor of safety against liquefaction was calculated as less than 1.2.

Based on our liquefaction analysis, it is our opinion that there is moderate to high potential for liquefaction of the loose to medium dense sand below the groundwater table during the design earthquake (magnitude 7.75 with peak ground acceleration [PGA_M] of 0.721g). We anticipate that this liquefaction could result in up to 11 inches of settlement. This settlement could occur unevenly, but it is our opinion the 20-foot-layer of non-liquefiable material below the substation site will significantly reduce and mitigate the risk of differential settlement at the ground surface.

5.3. Earthwork

5.3.1. Overexcavation and Geogrid

For areas of the substation supporting settlement-sensitive structures, we recommend overexcavation to remove voids and unsuitable fill, with the slope geometry as discussed in the Temporary Slopes section.

- Below the transformer and circuit switch structures (for both the current bank and the proposed future second bank), we recommend the overexcavation extend to a depth of 8 feet bgs, with the zone of overexcavation extending laterally a distance of 8 feet from the edges of the proposed foundations. This depth of overexcavation is based on voids encountered in previous borings 1 and 3 (both boring logs show a void at 7½ feet).
- Below the switch stand foundations and below the proposed control house, we recommend the overexcavation extend to a depth of 2 feet below the bottom of these foundations, with the zone of overexcavation extending laterally a distance of 2 feet from the edges of the proposed foundations.

We recommend the base of the overexcavation be evaluated by GeoEngineers to confirm unsuitable soils and debris have been removed. The base of the overexcavation should be compacted with a vibratory roller and a reinforcing geogrid should be placed on the compacted subgrade prior to placement of structural fill within the excavation. As discussed above in the Liquefaction and Liquefaction-Induced Settlement section, there is a risk of differential settlement under seismic conditions.

The purpose of the geogrid is to provide a stiff layer to help redistribute loads and mitigate settlement in the event of seismic liquefaction-induced settlement. We recommend the geogrid consist of a high strength biaxial material suitable for foundation reinforcement (Tensar Biaxal Geogrid BX1100 or approved equivalent). We recommend the geogrid be placed at the base of overexcavation for all foundation areas noted above.

5.3.2. Reuse of On-site Soils

We anticipate excavated sandy soils can be reused as structural fill to backfill the excavation, provided the soils are free of organics and provided the soils are not contaminated. Unsuitable materials should be removed from the excavated soil prior to stockpiling soil for reuse. We understand excavated soils will be stockpiled on the adjacent undeveloped portion of this parcel. Soil stockpiles should be covered to protect the soil from becoming wet from rainfall. Refer to the Weather Considerations section below for additional recommendations. Refer to our separate environmental soil characterization report for additional details regarding soil reuse on site.

5.3.3. Structural Fill

5.3.3.1. Materials

Materials used for support of structures or pavements or for utility trench backfill are classified as structural fill. Structural fill material quality varies depending upon its use as described below:

1. On-site soils will likely be suitable for reuse as structural fill, although cobbles and boulders larger than 6 inches in diameter should be removed prior to reuse as structural fill, along with any organics.
2. Imported gravel borrow for structural fill should conform to PSE Base Course Aggregate Specification 1275.1310 as described in Table 2 below:

TABLE 2. PSE BASE COURSE AGGREGATE SPECIFICATION

U.S. Standard Sieve Size	Percent Passing (by weight)
3 inch	100
¾ inch	70-90
⅜ inch	60-80
¼ inch	50-70
U.S. No. 40	< 30
U.S. No. 200	< 5

3. Structural fill placed as yard surfacing material should be angular crushed rock conforming to PSE Yard Course Crushed Aggregate Specification 1275.1330 as described in Table 3 below:

TABLE 3. PSE YARD COURSE CRUSHED AGGREGATE SPECIFICATION

U.S. Standard Sieve Size	Percent Passing (by weight)
1½ inch	100
1 inch	60 to 100
¾ or ⅝ inch	0 to 35
⅜ inch	0 to 5

5.3.3.2. Fill Placement and Compaction Criteria

Structural fill should be mechanically compacted to a firm, non-yielding condition. In general, structural fill should be placed in loose lifts not exceeding 8 to 10 inches in thickness. Each lift should be conditioned to the proper moisture content and compacted to the specified density before placing subsequent lifts. Structural fill should be compacted to the following criteria:

- Structural fill for the yard area should be compacted to 95 percent of the maximum dry density (MDD) (ASTM International [ASTM] D 1557).

We recommend that a representative from our firm be present during probing of the exposed subgrade soils prior to the placement of structural fill and during the placement of structural fill. Our representative would evaluate the adequacy of the subgrade soils and identify areas needing further work, perform in-place moisture-density tests in the fill to evaluate if the work is being done in accordance with the compaction specifications, and advise on any modifications to procedures that may be appropriate for the prevailing conditions.

5.3.4. Erosion and Sedimentation Control

Potential sources or causes of erosion and sedimentation depend upon construction methods, slope length and gradient, amount of soil exposed and/or disturbed, soil type, construction sequencing and weather.

Temporary erosion protection should be used and maintained in areas with exposed or disturbed soils to help reduce the potential for erosion and reduce transport of sediment to adjacent areas and receiving waters. Permanent erosion protection should be provided by re-establishing vegetation or surfacing with rock.

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

5.3.5. Weather Considerations

The on-site soils contain a sufficient percentage of fines (silt) to be moderately moisture sensitive. If the moisture content of these soils is appreciably above the optimum moisture content, these soils could become unstable. During wet weather, operation of equipment on these soils will be difficult, and it may be difficult to meet the required compaction criteria.

The wet weather season generally begins in early November and continues through March in Western Washington; however, periods of wet weather may occur during any month of the year. The optimum earthwork period for these types of soils is typically July through October. If wet weather earthwork is unavoidable, we recommend that the ground surface in and around the work area be sloped so that surface water is directed away from the work area. The ground surface should be graded such that areas of ponded water do not develop. Stockpiles should be covered. Exposed surfaces should be compacted to reduce the amount of water infiltration. 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.

5.3.6. Temporary Slopes

In our opinion, soils encountered at the site are classified as Type C soil, in accordance with the provisions of Title 296 WAC (Washington Administrative Code), Part N, “Excavation, Trenching and Shoring.” We recommend that temporary slopes in excess of 4 feet in height excavated in the on-site soils be inclined no steeper than 2H:1V (horizontal to vertical) due to the relatively low fines content. Flatter slopes may be necessary if localized sloughing occurs. For open cuts at the site we recommend that:

- No traffic, construction equipment, stockpiles or material storage be allowed at the top of the cut slopes within a horizontal distance of at least 5 feet from the top of the cut.
- Exposed soil along the slope be protected from surface erosion using waterproof tarps or plastic sheeting.
- Construction activities be scheduled so that the length of time the temporary cut is left open is kept as short as possible.
- Erosion control measures be implemented as appropriate such that runoff from the site is reduced to the extent practical.
- Surface water is diverted away from the excavation.
- The condition of the slopes be observed periodically by a geotechnical engineer to confirm adequate stability.

Because the contractor has control of the construction operations, the contractor should be made responsible for the stability of cut slopes, as well as the safety of the excavations. All shoring and temporary slopes must conform to applicable local, state, and federal safety regulations.

5.4. Shallow and Mat Foundations

5.4.1. General

We recommend that conventional shallow or mat foundations be supported on a minimum of 2 feet of compacted structural fill.

5.4.2. Bearing Pressure

Allowable Stress Design. Shallow and mat foundations supported on structural fill as recommended may be designed using an allowable soil bearing pressure of 6,000 pounds per square foot (psf). The allowable soil bearing pressures apply to the total of dead and long-term live loads and may be increased by up to one-third for transient loads such as wind or seismic forces.

A subgrade modulus of 200 pounds per cubic inch (pci) may be used for the design of mat foundations. These values incorporate a factor of safety of approximately 2. The Allowable Stress Design (ASD) bearing pressure will not correspond directly to the Load and Resistance Factor Design (LRFD) bearing pressure due to the difference in design approach between these methods.

Load and Resistance Factor Design. A bearing capacity chart for shallow foundations is presented in Figure 3. The chart is based on a square footing of varying sizes. We recommend the LRFD resistance factors listed in Table 4 below be used when evaluating strength, service, and extreme limit states for shallow foundations. The chart was developed in accordance with American Association of State and Highway Transportation Officials (AASHTO) methods, in conjunction with Washington State Department of Transportation (WSDOT) standards, as summarized in the WSDOT Geotechnical Design Manual.

TABLE 4. LRFD SPREAD FOOTING RESISTANCE FACTORS

Limit State	Resistance Factor ϕ		
	Shear Resistance to Sliding	Bearing	Passive Pressure Resistance to Sliding
Strength	0.8	0.45	0.5
Service	1.0	1.0	1.0
Extreme	0.9	0.9	0.9

5.4.3. Embedment

We recommend that the bottom of foundations be embedded at least 12 inches below the lowest adjacent grade for frost protection, per Thurston County design criteria.

5.4.4. Settlement

Provided all loose soil is removed and the subgrade is prepared as recommended below, we estimate that the post-construction settlement of shallow foundations will be on the order of ½ to 1 inch. Differential settlements between comparably loaded foundations are expected to be less than 1 inch.

5.4.5. Lateral Resistance

Lateral foundation loads may be resisted by passive resistance on the sides of foundations and by friction on the base of the foundations. For foundations supported on native soils or on structural fill placed and compacted in accordance with our recommendations, the allowable frictional resistance may be computed using a coefficient of friction of 0.45 applied to vertical dead-load forces.

The allowable passive resistance may be computed using an equivalent fluid density of 300 pounds per cubic foot (pcf) (triangular distribution) if these elements are poured directly against native soils or surrounded by compacted structural fill. The structural fill should extend out from the face of the foundation element for a distance at least equal to three times the height of the element and be compacted to at least 95 percent of the MDD.

The above coefficient of friction and passive equivalent fluid density values incorporate a factor of safety of approximately 1.5.

5.5. Stormwater Management

We understand stormwater will be infiltrated on site using a biofiltration swale located north of the proposed substation fence. As noted previously, the site is within a wellhead protection area. The proposed stormwater facility location is outside the limits of known or suspected contamination around the existing substation equipment and groundwater flow is likely towards the north, away from the substation and towards Barnes Lake.

The soils at the site are Type A sandy soils and based on the borings, groundwater is approximately 16 to 22 feet below existing grade. Both these conditions are favorable for infiltration.

The sandy soils have negligible cation exchange capacity (CEC) and do not meet the requirements for stormwater treatment. CEC testing was not completed, but based on our experience, the low fines content and lack of organics is consistent with low CEC.

We estimated the initial saturated hydraulic conductivity (K_{sat}) of the Type A sandy soils underlying this area using the equation provided in the City of Tumwater Drainage Design and Erosion Control Manual Volume V, Appendix V-A.3. Based on this equation, K_{sat} is estimated at 0.01 to 0.03 cm/s (10 to 38 in/hr). Applying safety factors with $F_{testing}$ = 0.4 for grain size analysis, $F_{geometry}$ = 1.0, $F_{plugging}$ = 0.8 for fine sands and loamy sands, the resulting design rate is estimated at 3.2 to 12. 2 inches per hour.

We recommend using a design rate of 3 inches per hour, to be confirmed if required during construction with a pilot infiltration test at the proposed stormwater facility location.

5.6. Pavement Design Recommendations

For the access drive, we recommend the following hot mix asphalt (HMA) pavement section, if required. Additionally, we recommend a WSDOT Superpave asphalt binder grade of PG 58-22. This pavement section assumes infrequent passenger vehicle and truck traffic. Please contact us if specific traffic loading should be considered in the pavement design.

- 3 inches HMA, Class B or similar
- 1.5 inches top course
- 4.5 inches base course

6.0 LIMITATIONS

We have prepared this report for the exclusive use of PSE and their authorized agents for the proposed Barnes Lake Substation Improvements in Tumwater, 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, Report Limitations and Guidelines for Use, for additional information pertaining to use of this report.

7.0 REFERENCES

American Society of Civil Engineers, 2016, “Minimum Design Loads and Associated Criteria for Buildings and Other Structures, ASCE/SE 7-2016.”

City of Tumwater Drainage Design and Erosion Control Manual Volume V Stormwater BMPs, July 2022.

City of Tumwater Municipal Code, accessed August 16, 2022 from web site: https://www.codepublishing.com/QA/Tumwater/#!/Tumwater16/.

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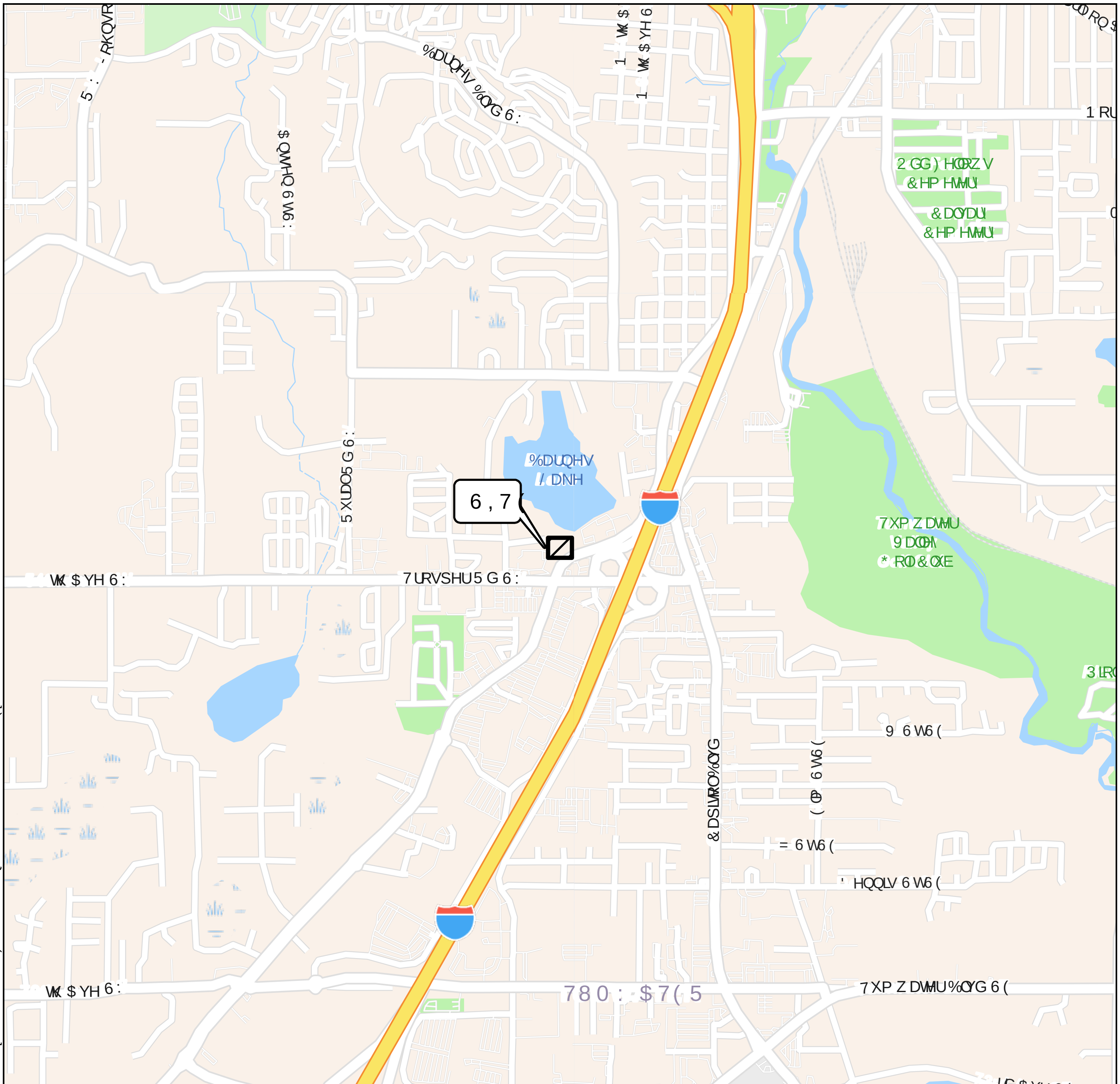
International Code Council, 2018, "International Building Code."

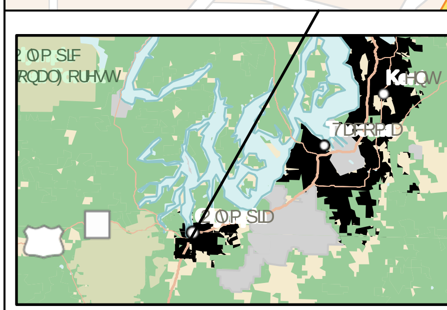
Thurston County Permitting Map, accessed August 16, 2022 from web site: https://map.co.thurston.wa.us/Html5Viewer/Index.html?viewer=Permitting.Main.

U.S. Geological Survey, Quaternary fault and fold database of the United States, accessed August 16, 2022, from web site: https://www.usgs.gov/programs/earthquake-hazards/faults.

Walsh, T.J. et al, 2003, "Geologic map of the Tumwater 7.5-minute quadrangle, Thurston County, Washington," Washington Division of Geology and Earth Resources Open File Report 2003-25.

FIGURES





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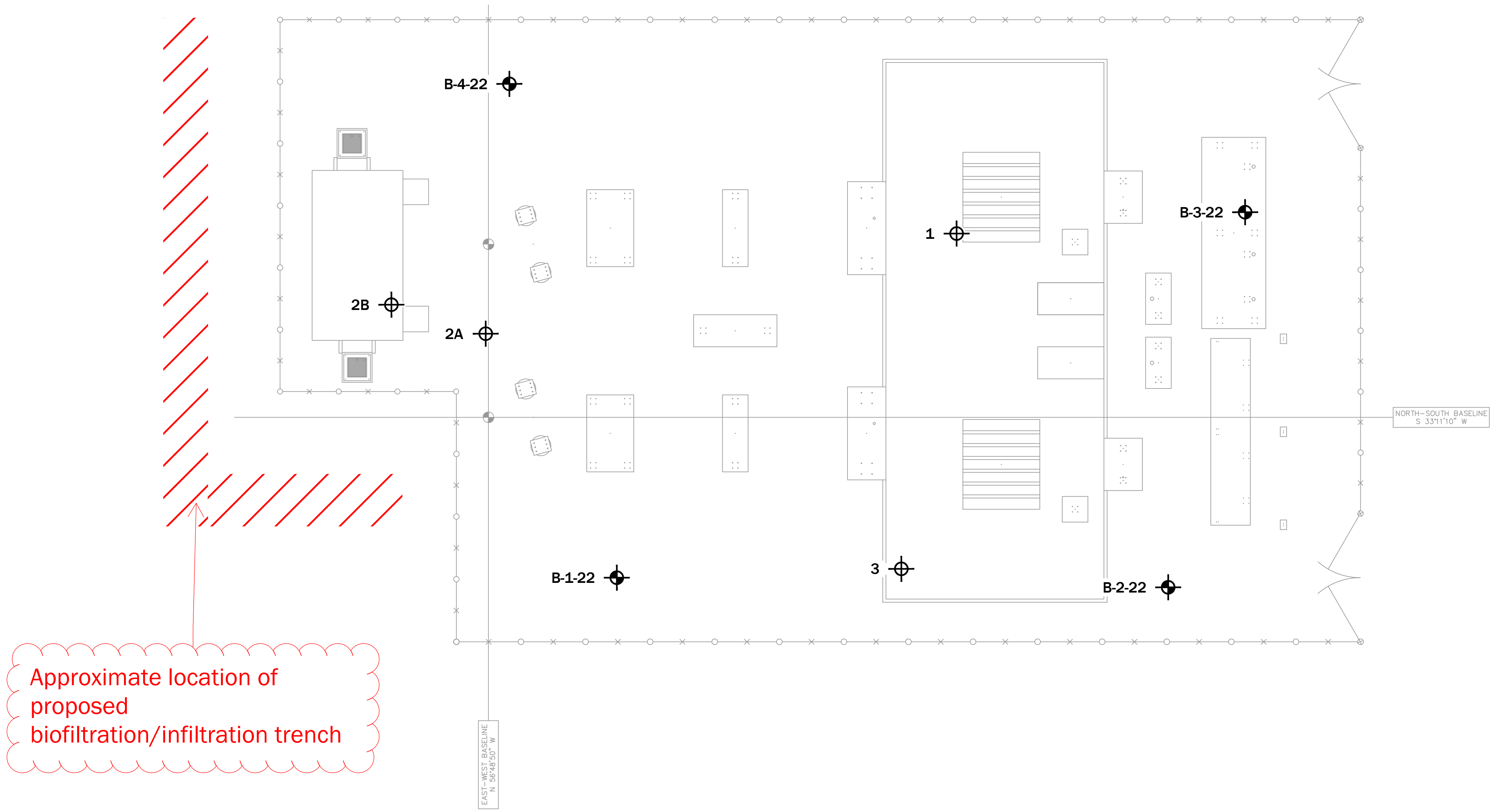
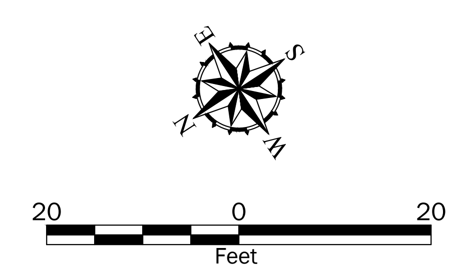


Legend

1 — Boring Completed by GeoEngineers, Inc., 2006

B-1-22 — Boring by GeoEngineers, Inc., 2022



Notes:

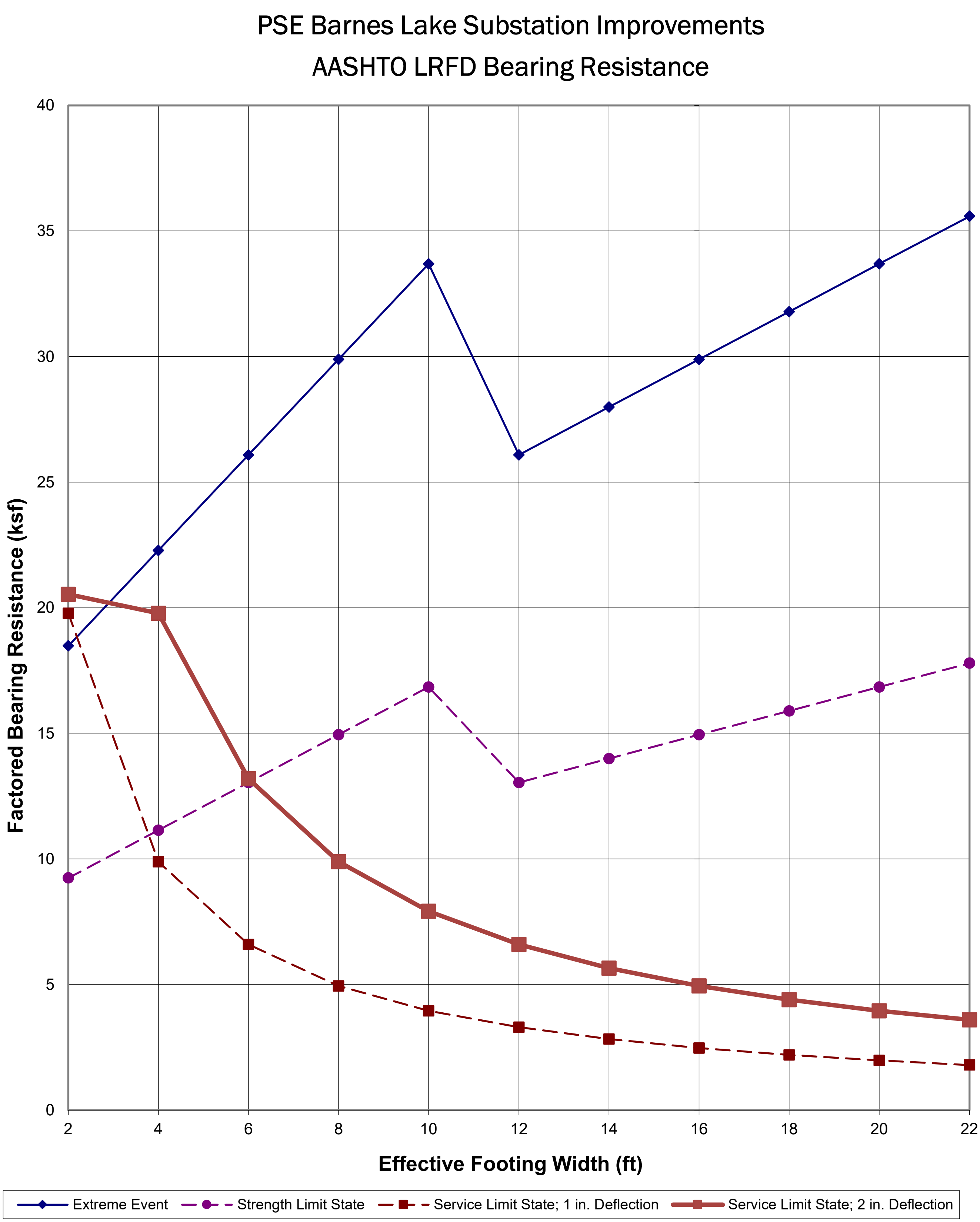
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers,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

Site Plan

Barnes Lake Substation Improvements
Tumwater, Washington

GEOENGINEERS

Figure 2



GeoEngineers
Earth Science + Technology

Shallow Foundation Design

Figure 3

APPENDICES

APPENDIX A
Field Explorations and Laboratory Testing

APPENDIX A
FIELD EXPLORATIONS AND LABORATORY TESTING

Field Explorations

Subsurface conditions at the site were evaluated by completing four borings (GEI-1-22 through GEI-4-22). The borings were completed by Cascade Drilling of Bothell, Washington, on April 14, 2022. The approximate exploration locations are shown on the Site Plan, Figure 2.

Borings

The borings were completed with hollow-stem auger drilling methods using a track-mounted drill rig, with sampling completed using a downhole hammer with a 2.4-inch inner diameter, 3-inch outer diameter sampler. Blowcounts were adjusted to equivalent standard penetration test (SPT) N-values. The borings were continuously observed by one of our geologists who examined and classified the soils encountered, obtained representative soil samples, observed groundwater conditions during drilling and prepared a detailed log of each boring.

Soils encountered in the borings were visually classified in accordance with the classification system described in Figure A-1. A key to the exploration log symbols is also presented in Figure A-1. The logs of the borings are presented in Figures A-2 through A-5. The logs reflect our interpretation of the field conditions and the results of laboratory testing and evaluation of samples. They also indicate the depths at which the soil types or their characteristics change, although the change might actually be gradual. The ground surface elevations shown on the logs were estimated from the base map provided and used on the Site Plan, Figure 2.

The borings were backfilled by the driller in accordance with Washington State Department of Ecology standards.

Groundwater Conditions

Observations of groundwater conditions were made during drilling and are noted on the exploration logs; these observations represent a short-term condition that may not be representative of the long-term groundwater conditions at the site. Groundwater conditions observed during drilling should be considered approximate.

Laboratory Testing

Soil samples obtained from the field explorations were transported to our laboratory and examined to confirm or modify field classifications, as well as to evaluate index properties of the soil samples. Representative samples were selected for laboratory testing consisting of the determination of grain-size distribution (sieve analysis). The tests were performed in general accordance with test methods of the ASTM International (ASTM) procedures.

Sieve Analyses

Sieve analyses were performed on selected samples in general accordance with ASTM D 6913 to determine the sample grain-size distribution. The wet sieve analysis method was used to determine the percentage of soil greater than the U.S. No. 200 mesh sieve. The results of the sieve analyses were plotted, were classified in general accordance with the Unified Soil Classification System (USCS) and are presented in Figure A-6.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	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
	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

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.

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

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 7/26/2022	End 7/26/2022	Total Depth (ft) 51.5	Logged By NJO / Checked By TDB	Driller Cascade Drilling	Drilling Method Hollow-stem Auger

Surface Elevation (ft) 180 Vertical Datum NAVD88	Hammer Data: Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment: CME 55 Track Rig
Easting (X) 1037793 Northing (Y) 617463	System Datum: WA State Plane South NAD83 (feet)	See "Remarks" section for groundwater observed

Notes: Blowcounts converted to equivalent SPT values, 3-inch sampler used

Elevation (feet)	Depth (feet)	Recovered (in)	Blows/foot	Sample Name / Testing	Group Classification	Material Description	Sheen	Headspace Vapor (ppm)	Remarks
180	0				RX	4 inches yard rock			Hand dug to 2½ feet
					SP-SM	Brown fine sand with silt and occasional gravel (loose to medium dense, moist) (fill)			
		12	18	1			NS		
175	5	18	8	2		Grades to loose	NS		
		18	18	3		Grades to medium dense	NS		
170	10	18	22	4	SM	Brown silty fine sand with trace organic matter (medium dense, moist) (recessional outwash)	NS		Oxidation staining
					SP-SM	Brownish gray fine sand with silt (medium dense, moist to wet)			
		18	23	5			NS		
165	15	18	18	6			NS		
						Grades to wet			Groundwater observed at approximately 16½ feet below ground surface during drilling
160	20	18	18	7			NS		
					SP-SM	Gray fine to medium sand (medium dense to dense, wet)			
155	25	18	12	8 MC; SA			NS		% Fines = 4, % Moisture = 21
150	30	18	19	9			NS		
145	35								

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

Log of Boring B-1-22

GeoEngineers

Project: PSE Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-01

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	35		18	10		10				NS		Water added due to heaving sand, blowcount no representative due to heave
140	40		18	12		11				NS		Water added due to heaving sand, blowcount no representative due to heave
135	45		12	44		12			Grades to dense	NS		
130	50		12	22		13			Grades to medium dense	NS		

Date:8/18/22 Path:P:\0\0186685\GINT\018668501.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_ENVIRONMENTAL_STANDARD_NO_GW

Log of Boring B-1-22 (continued)

GeoEngineers

Project: PSE Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-01

Drilled	Start 7/27/2022	End 7/27/2022	Total Depth (ft) 26.5	Logged By NJO / Checked By TDB	Driller Cascade Drilling	Drilling Method Hollow-stem Auger

Surface Elevation (ft) / Vertical Datum	180 / NAVD88	Hammer Data	Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment	CME 55 Track Rig
Easting (X) / Northing (Y)	1037742 / 617393	System Datum	WA State Plane South NAD83 (feet)	See "Remarks" section for groundwater observed	

Notes: Blowcounts converted to equivalent SPT values, 3-inch sampler used

Elevation (feet)	Depth (feet)	Recovered (in)	Blows/foot	Sample Name / Testing	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
180	0				RX	4 inches yard rock			Hand dug to 2½ feet
					SP-SM	Brown fine sand with silt (medium dense, moist) (fill)			
		18	11	1			NS		
175	5	18	11	2			NS		
		18	14	3			NS		
170	10	0	31	4	SM	Brown silty fine sand (dense, moist) (recessional outwash)	NS		
					SP-SM	Brownish gray fine sand with silt (medium dense, moist to wet)			
		18	29	5 MC; SA			NS		% Fines = 8, % Moisture = 9
165	15	0	25	6			NS		
						Grades to wet			Groundwater observed at approximately 19 feet below ground surface during drilling
160	20	18	26	7			NS		
155	25	18	23	8			NS		

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

Log of Boring B-2-22

GeoEngineers

Project: PSE Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-01

Drilled	Start 7/27/2022	End 7/27/2022	Total Depth (ft) 26.5	Logged By NJO, Checked By TDB	Driller Cascade Drilling	Drilling Method Hollow-stem Auger

Surface Elevation (ft) / Vertical Datum	180 / NAVD88	Hammer Data	Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment	CME 55 Track Rig
Easting (X) / Northing (Y)	1037783 / 617350	System Datum	WA State Plane South NAD83 (feet)	See "Remarks" section for groundwater observed	

Notes: Blowcounts converted to equivalent SPT values, 3-inch sampler used

Elevation (feet)	Depth (feet)	Recovered (in)	Blows/foot	Sample Name / Testing	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
180	0				RX	4 inches yard rock			Hand dug to 5 feet
					SP-SM	Brown fine sand with silt (loose to medium dense, moist) (fill)			
				1			NS		
175	5	18	8	2			NS		
		18	11	3 MC; SA		Grades to medium dense	NS		% Fines = 42, % Moisture = 20
					SM	Brown silty fine sand (medium dense, moist) (recessional outwash)			
170	10	18	19	4			NS		
					SP-SM	Brownish gray fine sand with silt (medium dense, moist to wet)			
		18	22	5			NS		
165	15	18	19	6			NS		
						Grades to wet			Groundwater observed at approximately 19 feet below ground surface during drilling
160	20	18	21	7			NS		
155	25	18	17	8			NS		

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

Log of Boring B-3-22

GeoEngineers

Project: PSE Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-01

Drilled	Start 7/27/2022	End 7/27/2022	Total Depth (ft) 26.5	Logged By NJO / Checked By TDB	Driller Cascade Drilling	Drilling Method Hollow-stem Auger

Surface Elevation (ft) 180 / Vertical Datum NAVD88	Hammer Data: Rope & Cathead, 140 (lbs) / 30 (in) Drop	Drilling Equipment: CME 55 Track Rig	
Easting (X) 1037865 / Northing (Y) 617432	System Datum: WA State Plane South, NAD83 (feet)	See "Remarks" section for groundwater observed	

Notes: Blowcounts converted to equivalent SPT values, 3-inch sampler used

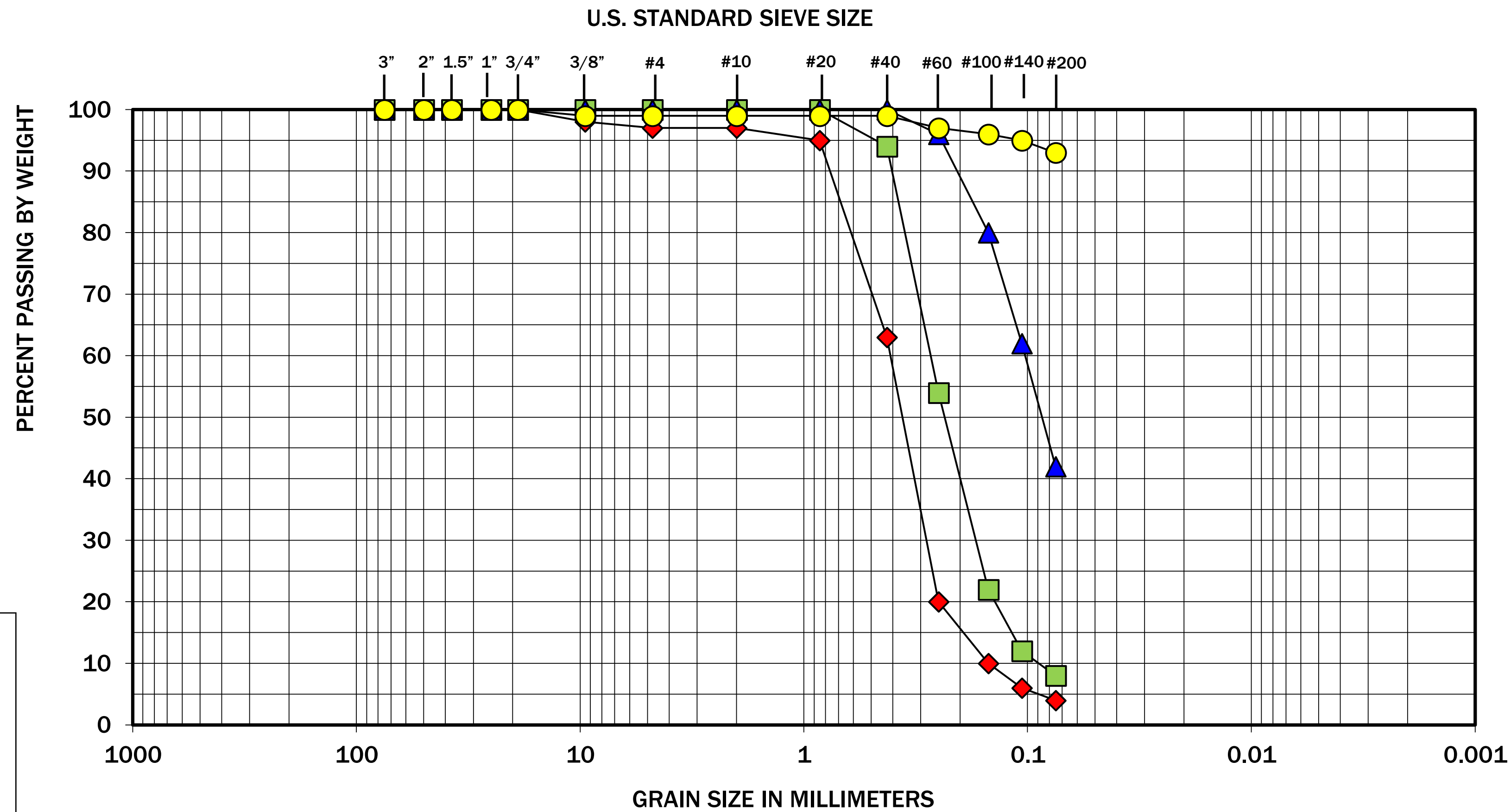
Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0							RX	4 inches yard rock			Hand dug to 2½ feet
								SP-SM	Brown fine sand with silt and trace organic matter (medium dense, moist) (fill)			
			18	12		1				NS		
175	5		18	10		2		SP-SM	Brown fine sand with silt and trace organic matter (medium dense, moist) (fill)	NS		
			18	16		3				NS		
170	10		18	26		4 / MC; SA		ML	Brown silt (very stiff, moist) (recessional outwash)	NS		% Fines = 93, % Moisture = 28
								SP-SM	Brownish gray fine sand with silt (medium dense, moist to wet)			
			18	19		5				NS		
165	15		18	25		6				NS		
									Grades to wet			Groundwater observed at approximately 19 feet below ground surface during drilling
160	20		18	23		7				NS		
155	25		18	27		8				NS		

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

Log of Boring B-4-22

GEOENGINEERS

Project: PSE Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-01



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Boring Number	Depth (feet)	Moisture (%)	Soil Description
◆	B-1	25	21	Poorly graded fine to medium sand (SP)
■	B-2	12.5	9	Poorly graded fine sand with silt (SP-SM)
▲	B-3	7.5	20	Silty fine sand (SM)
●	B-4	10.5	28	Silt (ML)

Note: This report may not be reproduced, except in full, without written approval of GeoEngineers, Inc. Test results are applicable only to the specific sample on which they were performed, and should not be interpreted as representative of any other samples obtained at other times, depths or locations, or generated by separate operations or processes.

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

AASHTO ACCREDITED

Sieve Analysis Results

PSE Barnes Lake Substation
Tumwater, Washington

GeoEngineers

Figure A-6

APPENDIX B
Previous Explorations

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 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
	CC	Cement Concrete
	AC	Asphalt Concrete
	CR	Crushed Rock/ Quarry Spalls
	TS	Topsoil/ Forest Duff/Sod

Measured groundwater level in exploration, well, or piezometer

Groundwater observed at time of exploration

Perched water observed at time of exploration

Measured free product in well or piezometer

Stratigraphic Contact

Distinct contact between soil strata or geologic units

Gradual change between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

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.

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

Laboratory / Field Tests

%F	Percent fines
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
OC	Organic content
PM	Permeability or hydraulic conductivity
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen
NT	Not Tested

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

Date(s) Drilled	09/21/06	Logged By	NER	Checked By	SWH
Drilling Contractor	Geologic Drill	Drilling Method	SPT	Sampling Methods	Grab & SPT
Auger Data	2-1/4 inch ID	Hammer Data	140 lb hammer/30 in drop	Drilling Equipment	Acker Portable Rig
Total Depth (ft)	26.5	Surface Elevation (ft)	173	Groundwater Elevation (ft)	152
Vertical Datum		Datum/ System		Easting(x): Northing(y):	

Elevation feet	Depth feet	SAMPLES: Recovered (in)	SAMPLES: Blows/foot	SAMPLES: Sample Number	Water Level	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
	0					GP	Gray coarse gravel ballast (loose, dry)			
				1		SP-SM	Brown fine sand with silt and organics (loose, moist) (fill)			Hand cleared
170				2						
		12	4	3						
	5	18	6	4						
								9		SA
165		12	0	5			Void at 7.5 feet (1-foot deep)			
	10					SP/SM	Brown fine to medium sand with silt and occasional organics (loose to medium dense, moist) (fill)			
		12	11	6		SP-SM	Brown to gray fine sand with silt (medium dense, moist) (Recessional Outwash) (native)			
160		18	14	7						
	15	12	13	8						
155		18	11	9				8		SA
	20	12	14	10	▼					
150										
	25	12	14	11		SP	Gray fine to medium sand with gravel (medium dense, wet) (Recessional Outwash)			Rough drilling
145										
	30									
140										
	35									

Note: See Figure A-1 for explanation of symbols.

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LOG OF BORING 1

GeoEngineers

Project: Barnes Lake Substation

Project Location: Tumwater, Washington

Project Number: 0186-685-00

Figure A-2

Sheet 1 of 1

Date(s) Drilled	09/21/06	Logged By	NER	Checked By	SWH
Drilling Contractor	Geologic Drill	Drilling Method	SPT	Sampling Methods	Grab
Auger Data	2-1/4 inch ID	Hammer Data	140 lb hammer/30 in drop	Drilling Equipment	Acker Portable Rig
Total Depth (ft)	2.5	Surface Elevation (ft)	173	Groundwater Elevation (ft)	Not Encountered
Vertical Datum		Datum/ System		Easting(x): Northing(y):	

Elevation feet	Depth feet	SAMPLES: Interval	SAMPLES: Recovered (in)	SAMPLES: Blows/foot	SAMPLES: Sub-Sample / Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
	0							GP	Gray coarse gravel ballast (loose, dry) (fill)			
					1			SW-SM	Dark brown fine to coarse sand with silt and occasional gravel (medium dense, moist) (fill)			Encountered concrete slab at 2.5 feet bgs
170												
	5											
165												
	10											
160												
	15											
155												
	20											
150												
	25											
145												
	30											
140												
	35											

Note: See Figure A-1 for explanation of symbols.

LOG OF BORING 2A

GEOENGINEERS

Project: Barnes Lake Substation

Project Location: Tumwater, Washington

Project Number: 0186-685-00

Figure A-3

Date(s) Drilled	09/21/06	Logged By	NER	Checked By	SWH
Drilling Contractor	Geologic Drill	Drilling Method	SPT	Sampling Methods	Grab & SPT
Auger Data	2-1/4 inch ID	Hammer Data	140 lb hammer/30 in drop	Drilling Equipment	Acker Portable Rig
Total Depth (ft)	23	Surface Elevation (ft)	173	Groundwater Elevation (ft)	151
Vertical Datum		Datum/ System		Easting(x): Northing(y):	

Elevation feet	Depth feet	SAMPLES: Recovered (in)	Blows/foot	Sub-Sample / Sample Number	Water Level	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
	0					WD	Woody bark (fill)			
						SW-SM	Dark brown fine to coarse sand with silt and occasional gravel (loose, moist) (fill)			
170		12	3	1, 2						Hand cleared
	5					SP-SM	Brown fine sand with silt and occasional gravel (loose, moist) (fill)			
		18	6	3						
165		18	3	4						
	10									
		6	2	5			Wood debris			
160		18	2	6						
	15						Occasional wood debris			
		12	3	7						
155		18	9	8			Glass fragments			
	20					SP-SM	Gray fine sand with silt (loose, moist) (Recessional Outwash) (native)			
		14	9	9	▼			8		SA
150										
	25									
145										
	30									
140										
	35									

Note: See Figure A-1 for explanation of symbols.

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LOG OF BORING 2B

GeoEngineers

Project: Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-00

Figure A-4
Sheet 1 of 1

Date(s) Drilled	09/21/06	Logged By	NER	Checked By	SWH
Drilling Contractor	Geologic Drill	Drilling Method	SPT	Sampling Methods	Grab & SPT
Auger Data	2-1/4 inch ID	Hammer Data	140 lb hammer/30 in drop	Drilling Equipment	Acker Portable Rig
Total Depth (ft)	17.5	Surface Elevation (ft)	173	Groundwater Elevation (ft)	Not Encountered
Vertical Datum		Datum/ System		Easting(x): Northing(y):	

Elevation feet	Depth feet	SAMPLES: Interval	SAMPLES: Recovered (in)	SAMPLES: Blows/foot	SAMPLES: Sub-Sample Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
	0							GP	Gray coarse gravel ballast (loose, dry) (fill)			
					1			SW-SM	Dark brown fine to coarse sand with silt, occasional gravel and asphalt debris (soft, moist) (fill)			Hand cleared
170			20	5	2							
								SP-SM	Dark brown fine sand with silt and occasional organics (loose, moist) (fill)			
	5		18	6	3							
								SM	Light brown silty fine sand (loose, moist) (fill)			
165			18	7	4				Void at 7.5 feet (1-foot deep)	13		SA
	10		12	11	5				Grades to medium dense			
								SP	Gray medium sand (medium dense, moist) (Recessional Outwash) (native)			
160			18	15	6							
	15		12	13	7							
155												
	20											
150												
	25											
145												
	30											
140												
	35											

Note: See Figure A-1 for explanation of symbols.

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LOG OF BORING 3

GeoEngineers

Project: Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-00

Figure A-5
Sheet 1 of 1

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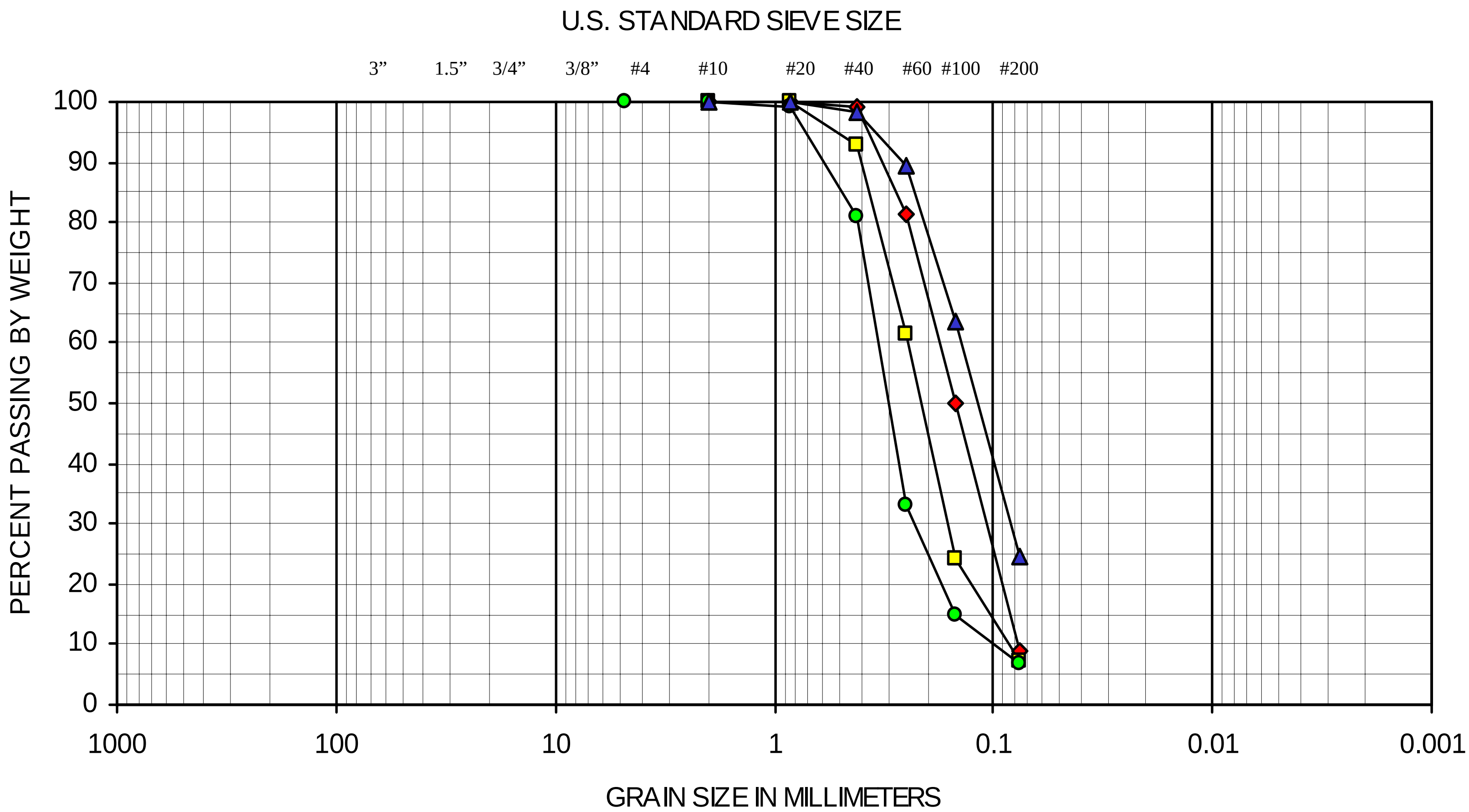
FIGURE A-6

SIEVE ANALYSIS RESULTS



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	1	7	Brown sand with silt (SP-SM)
■	1	18	Brown sand with silt (SP-SM)
●	2B	22	Brown sand with silt (SP-SM)
▲	3	8	Brown silty sand (SM)

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.

Geotechnical Services Are Performed for Specific Purposes, Persons and Projects

This report has been prepared for the exclusive use of Puget Sound Energy and their authorized agents. This report may be made available to prospective contractors for their bidding or estimating purposes, but our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with which there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A Geotechnical Engineering or Geologic Report Is Based on a Unique Set of Project-Specific Factors

This report has been prepared for the proposed improvements to the Barnes Lake Substation located on 2nd Avenue SW in Tumwater, 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, do not 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.

---

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

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

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

If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

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 manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

Most 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 subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

Geotechnical Engineering Report Recommendations Are Not Final

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from GeoEngineers' professional judgment and opinion. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by GeoEngineers should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having GeoEngineers confer with appropriate members of the design team after submitting the report. Also retain GeoEngineers to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having GeoEngineers participate in pre-bid and preconstruction conferences, and by 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. To prevent errors or omissions, the logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

Give Contractors a Complete Report and Guidance

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

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 to adjacent properties.

Read These Provisions Closely

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory “limitations” provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these “Report Limitations and Guidelines for Use” apply to your project or site.

Geotechnical, Geologic and Environmental Reports Should Not Be Interchanged

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.

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.

If Client desires these specialized services, they should be obtained from a consultant who offers services in this specialized field.

GEOTECHNICAL ENGINEERING SERVICES
SETTLEMENT INVESTIGATION AND MITIGATION
BARNES LAKE SUBSTATION
TUMWATER, WASHINGTON

JANUARY 12, 2007

FOR
PUGET SOUND ENERGY

GEOENGINEERS

File No. 0186-685-00

Geotechnical Engineering Services
File No. 0186-685-00

January 12, 2007

Prepared for:

Puget Sound Energy
P.O. Box 90868, EST-O4W
Bellevue, Washington 98009-0868

Attention: Fred Lunki

Prepared by:

GeoEngineers, Inc.
1101 South Fawcett Avenue, Suite 200
Tacoma, Washington 98402
(253) 383-4940

GeoEngineers, Inc.

FOR **Stephen W. Helvey, LG, LEG, LHG**
Senior Engineering Geologist

Bo McFadden, PE, LEG
Principal

JEROME J. McFADDEN JR. STATE OF WASHINGTON 26693 REGISTERED PROFESSIONAL ENGINEER

1/12/07

EXPIRES 3/4/07

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SETTLEMENT INVESTIGATION AND MITIGATION
BARNES LAKE SUBSTATION
TUMWATER, WASHINGTON
FOR
PUGET SOUND ENERGY

INTRODUCTION AND BACKGROUND

This report presents the results of our geotechnical engineering study at Puget Sound Energy's (PSE) Barnes Lake Substation. The site consists of a rectangular property, oriented southwest-northeast, located about 200 feet north of the intersection of South 2nd Avenue and 54th Avenue SW in Tumwater, Washington. Barnes Lake is located about 150 feet north of the site. The approximate location of the site is shown in the Vicinity Map, Figure 1. The general substation layout is shown on the Site Plan, Figure 2. Our services were requested by Fred Lunki of PSE.

The substation presently consists of electrical transmission equipment, including a feeder rack, one regulator, one capacitor bank and one large transformer in the south part of the site. Switch and fuse stands, bus supports and two dead-end towers are located in the center and north parts of the site. These features are supported on concrete pads that are on shallow foundations. The ground surface within the substation is covered with crushed rock. The perimeter of the substation is defined by a steel fence. We understand future improvements to the site may include a second transformer, just east of the existing transformer.

Prior to our recent site work, we observed significant indications of settlement throughout the facility. The settlement appeared to be greatest through the center of the site, oriented in a southwest to northeast direction and decreases outward from this axis to the west and east edges of the site. A small depression was observed just east of the centerline of the site, northeast of the capacitor bank. We understand that the settlement has not yet affected the operational capabilities of the substation, but it is a concern for future development and operation at the site.

SCOPE OF SERVICES

We completed the following activities during this study:

1. Attended a site meeting and reviewed available pertinent geologic maps, reports and literature.
2. Completed four hollow-stem auger power borings to depths of 2.5 to 26.5 feet to evaluate the condition of the underlying fill and native soil at the site.
3. Performed laboratory tests on selected samples of site soils from the explorations. The tests included four gradation and four moisture tests.
4. Evaluated the subsurface data with respect to the observed settlement features.
5. Developed an opinion regarding the cause of the settlement and the potential for future settlement.
6. Provided options to mitigate settlement for the existing structures and to prevent and/or limit settlement for the proposed transformer.

7. Developed foundation design recommendations for the proposed transformer, including allowable soil bearing pressures and settlement estimates for mat foundations and conventional shallow spread (strip) footings, as appropriate.
8. Provided this report.

SITE CONDITIONS

SURFACE CONDITIONS

The site is located within a commercial/residential area of Tumwater, Washington. We understand that the substation was constructed in 1974, based on plans you provided. The site was relatively flat with a slight downward slope to the northeast prior to site development, based on our review of a topographic map of the site, dated December 26, 1972. A "dirt pile" existed in the north part of the site in 1972, based on the map. Relatively steep, planer slopes existed along the north and northeast property boundaries in 1972. These slopes and the "dirt pile" are indicators that the site is underlain by fill.

Finish grade at the site is at about Elevation 174 feet. The site is presently fenced and surfaced with crushed rock.

MAPPED GEOLOGIC CONDITIONS

Geologic materials at the site were evaluated by reviewing the "Geologic Map of the Tumwater 7.5-minute Quadrangle, Thurston County, Washington," by Timothy J. Walsh, Robert L. Logan, Henry W. Schasse and Michael Polenz 2003. Native geologic materials mapped at and near the site consist of Latest Vashon recessional sand and minor silt (map symbol Qgos). This deposit consists of sand with some gravel and silt that was deposited in streams and deltas flowing from glacial lakes.

SUBSURFACE CONDITIONS

General

Subsurface conditions at the site were explored by completing four exploratory borings on September 21, 2006 at the approximate locations shown in Figure 2. Details regarding the subsurface exploration program are included in Appendix A. Summary logs of the explorations are also included in Appendix A.

Soil

Soil encountered in the borings consists of fill over native soils. Three of the borings were drilled through the fill to the underlying native materials. Boring 2A was terminated on a concrete slab encountered at a depth of 2.5 feet.

The fill encountered in borings 1, 2B and 3 generally consists of loose fine sand with silt, wood debris, organics and glass fragments. Voids, approximately 1-foot thick each, were encountered in two of the borings (1 and 3) at depths of about 7.5 feet each. The voids may be areas where organic debris within the fill has decomposed over time, leaving the void. Boring 1 was drilled in a "sinkhole" area, possibly indicating the encountered void was once larger.

The thickness of the fill varied from 11 feet in boring 1 to about 19 feet in boring 2B. Native soil beneath the fill consists of loose to medium dense sand with variable silt. This material was encountered beneath the fill to the full depth explored in borings 1, 2B and 3. The native material is similar in composition to the overlying fill, based on laboratory testing, indicating that the fill may have been derived from a nearby source.

Groundwater

Groundwater was encountered at depths ranging from 21 to 22 feet in borings 1 and 2B. Groundwater was not encountered in the other borings. We expect groundwater levels to vary with season and with precipitation. A review of hydrogeologic data for a nearby site indicates that groundwater within the Latest Vashon recessional sand layer varies by about 5 feet on a seasonal basis.

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

Based on the results of our subsurface exploration and analyses, it is our opinion that settlement at the site has occurred due to a substantial and variable thickness of fill, consisting of loose sand with organic material and other debris (glass). The site may have been the former location of a narrow gully or ravine, oriented generally north to south, which was filled prior to 1972. The distribution of settlement features at the site appears to mirror the geometry of the former gully, in that the greatest settlement appears to have occurred along the centerline of the filled gully, where the greatest thickness of fill appears to exist.

It is unknown whether settlement is continuing to occur at the site. However, it is likely that the average magnitude of on-going settlement, if it is occurring, is relatively small based on the age of the facility (32 years) and the composition of the fill. However, the presence of voids in the fill also indicate the potential for significant settlement.

Based on the composition of the fill (sand) it is likely that settlement at the site is due primarily to water flowing either through or into the loose sand, thereby partially consolidating the material and causing the observed settlements. This likely occurs due to infiltration of stormwater into the sand fill during rainfall events and the rise and fall of the shallow groundwater table into and out of the fill.

Additional settlement at the site is possible if new facilities, such as the new transformer, are constructed in areas where structures do not currently exist. We understand that the settlement has not yet affected the operational capabilities of the substation. It is, therefore, our opinion that mitigation of the existing settlements is likely not needed, however, additional foundation loads and site work could increase the magnitude of settlement and should be considered during design of future improvements.

We understand that a new transformer will be located in the southeast part of the facility, east of the existing transformer. The 115 kV and 230 kV transformers typically used by PSE for new substations produce soil bearing pressures in the range of 1,000 to 1,200 pounds per square foot (psf).

Options that could be considered to reduce the risk of future settlement include:

- Partial overexcavation of existing fill in the area of the proposed improvements and replacement of the material with structural fill and geogrid reinforcement.
- Subgrade improvement using drilled aggregate piers in footing and slab areas.
- Subgrade improvements using small diameter steel pipe piles.

Based on the understood location of the proposed transformer, and the likely construction activities at the site, we recommend that the substation be taken off-line during construction activities. The following sections of this report include recommendations for mat/slab foundation support for the new transformer at the site and general recommendations for overexcavation, drilled aggregate piers and steel pipe piles to support heavily loaded foundations.

SHALLOW FOUNDATION SUPPORT

Allowable Bearing Pressure

We recommend that the new capacitor banks and fuse stands at the site be supported on conventional mat/slab foundations bearing on at least a 12-inch thickness of densely compacted crushed gravel (base course aggregate or yard course described below) placed over a compacted subgrade. The zone of crushed gravel should extend laterally beyond the footing edges a horizontal distance at least equal to the thickness of the fill. The crushed gravel should meet the requirements of "yard surfacing material" presented above. We recommend that the upper 12-inch thickness of existing fill be compacted to at least 95 percent of maximum dry density (MDD) prior to placing the crushed rock fill. The mat/slab foundations may be designed using an allowable soil bearing value of 1,500 psf although the actual loads will be about 85 to 150 psf for the dimensions and loads described previously. The allowable soil bearing values apply to the total of dead and long-term live loads and may be increased by up to one-third for transient loads such as wind or seismic forces. A subgrade modulus of 200 pounds per cubic inch (pci) may be used for the design of mat/slab foundations.

Embedment

In general, we recommend that the bottom of foundations be founded at least 24 inches below the lowest adjacent grade for frost protection. The foundation embedment depth may be reduced to 12 inches for small, lightly loaded footings where frost action will not affect equipment performance or an additional 12-inch thickness of non-frost susceptible gravel may be placed below the foundations to achieve an embedment of 24 inches. The crushed gravel should meet the requirements of "yard surfacing material" presented above.

Settlement

Provided all loose soil is removed and the subgrade is prepared as recommended in the "Construction Considerations" section below, we estimate that the total settlement of shallow mat/slab foundations will be on the order of 1/2 inch. Differential settlements are expected to be less than 1/2 inch.

Lateral Resistance

Lateral loads transmitted to the shallow footings by seismic events or wind loads can be resisted by passive resistance on the sides of the footings and by friction on the base of the footings and slabs. Passive resistance may be evaluated using an equivalent fluid density of 350 pounds per cubic foot (pcf) provided the footings are surrounded by undisturbed dense to very dense native soil, dense existing fill, or by structural fill compacted to at least 95 percent of MDD (per American Society for Testing and Materials [ASTM] D 1557). Frictional resistance of footings, mat foundations and slabs may be evaluated using 0.30 for the coefficient of base friction. The above values are allowable values and incorporate a factor of safety of about 1.5.

Construction Considerations

If loose soil areas are present at the foundation subgrade elevation, the loose areas should be removed and replaced with additional crushed gravel fill. In such instances, the zone of fill should extend laterally beyond the footing edges a horizontal distance at least equal to the thickness of the fill. We also recommend that the upper 12-inch thickness of existing fill, when exposed at subgrade elevation, be compacted to at least 95 percent of MDD prior to placing the crushed rock fill.

We recommend the condition of all foundation excavations be observed by a representative from our firm to evaluate if the work is completed in accordance with our recommendations and that the subsurface conditions are as anticipated.

DEEP FOUNDATION SUPPORT OPTIONS

General

Based on the potential for unacceptable total and differential settlements at the site, we offer three potential foundation support options for the new transformer. These foundation support options consist of the following:

- Partial overexcavation of existing fill beneath the footings and replacement with structural fill.
- Subgrade improvement using drilled aggregate piers in footing and slab areas.
- Supporting the mat foundations on pin piles.

Specific geotechnical design parameters for these footing support options are provided in the following sections.

Overexcavation and Replacement

This footing support system consists of overexcavating the existing fill in footing areas to a minimum depth of 8 feet, and to a lateral distance of 8 feet beyond the edges of the footing. The resulting excavation is backfilled with structural fill. Placement and compaction of structural fill should be completed as recommended in the “Structural Fill” section of this report.

Provided the mat foundation are supported on the above-recommended structural fill prism, we recommend an allowable soil bearing pressure of 2,500 psf be used for design.

We estimate settlement of spread footings designed as recommended should be less than 1/2 to 3/4 inch provided subgrade preparation and fill placement is performed in accordance with the recommendations in this report. Because of the variable thickness of existing fill at the site, differential settlements could be similar in range to the estimated total settlement.

Drilled Aggregate Piers

Drilled aggregate piers can be used to support foundation loads at the site. The aggregate piers should extend through the existing fill to the underlying medium dense native soils.

Installation of the aggregate piers typically includes drilling 2- to 3-foot-diameter holes and filling them with crushed aggregate. This material is placed into the hole in thin lifts and compacted using a hydraulic densification system to create a column (pier) of crushed aggregate. The drilled aggregate pier system should support the typical foundation and slab loads (1,500 psf to 3,000 psf) and reduce the potential for unacceptable post-construction settlement.

Drilled aggregate pier systems are typically proprietary. The number and layout of drilled aggregate piers to support the structure is typically established by a specialty contractor such as Geopier Foundations Inc., based on our geotechnical information and the proposed building layout and loads.

Steel Pipe Piles

Another alternative for providing support for conventional spread footings and mat foundations is small diameter steel piles (pin piles). Pin piles are typically 2- to 3-inch-diameter galvanized steel pipe driven with a pneumatic or hydraulic hammer to practical refusal. Pin piles may also be installed by jacking. The capacity of the pile is largely a function of the size of the pipe and the driving force applied. Typically, allowable capacities of 4,000 pounds for a 2-inch pile and 12,000 pounds or more for a 3-inch pile are achievable. It would also be possible to install 4- to 6-inch-diameter piles to achieve greater capacities (20,000 to 30,000 pounds). Lateral capacity and settlement of footings supported on piers or piles will depend on the configuration of the system used.

EARTHWORK

Excavation Considerations

Fill was encountered across the substation site in the explorations. We anticipate that the fill soils can be excavated with conventional excavation equipment, such as trackhoes. While cobbles and boulders were not observed in the explorations, they may also be encountered and the contractor should be prepared to remove them where necessary.

Clearing and Grubbing

Removal and demolition of existing substation structures, if necessary, should include removal of foundation elements. Existing voids or new depressions created during site preparation should be cleaned of loose soil or debris and backfilled with structural fill.

Subgrade Preparation

In areas where structural fill (crushed gravel) is to be placed, the upper 12 inches of existing subgrade soils should be compacted and evaluated prior to fill placement through either probing or proof-rolling with heavy, rubber-tired construction equipment. Likewise, the exposed subgrade in the proposed foundation areas for structures should be evaluated after site grading is complete. Probing should be used to evaluate the subgrades where proof-rolling is not possible or if site grading takes place during wet weather. Soft zones noted during proof-rolling or probing should be excavated and replaced with compacted structural fill.

Erosion and Sedimentation Control

Potential sources or causes of erosion and sedimentation depend upon construction methods, slope length and gradient, amount of soil exposed and/or disturbed, soil type, construction sequencing and weather. We anticipate that there will be little risk of erosion during construction of the capacitor bank and fuse stand structures because the site is flat and the surface is paved with crushed rock. However, a temporary erosion control plan should be designed in accordance with applicable city and/or county standards. The plan should incorporate basic planning principles, including:

- Scheduling grading and construction to reduce soil exposure;
- Retaining existing vegetation whenever feasible;
- Revegetating or mulching denuded areas;
- Directing runoff away from denuded areas;
- Minimizing the length and steepness of slopes with exposed soils;

- Decreasing runoff velocities;
- Confining sediment to the project site; and
- Inspecting and maintaining control measures frequently.

Until the permanent erosion protection is established (reestablish crushed rock surfacing) and the site is stabilized, site monitoring should be performed by qualified personnel to evaluate the effectiveness of the erosion control measures and 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.

Structural Fill

Materials

Materials used to raise site grades, if necessary, placed to support structures or pavements, or used for utility trench backfill is classified as structural fill for the purpose of this report. Structural fill material quality varies depending upon its use as described below:

1. On-site soils may be used as structural fill during dry weather. On-site soils (sand with silt) may also be used during wet weather provided that they can be moisture conditioned to meet compaction specifications. If the on-site soils cannot be moisture conditioned, imported gravel borrow (Washington State Department of Transportation [WSDOT] Standard Specifications Section 9-03.14(1)) should be used.
2. Structural fill placed as crushed surfacing when needed below pavements should conform to Section 9-03.9(3) of the 2006 WSDOT Standard Specifications. Pavement base course aggregate should conform to PSE Specification 1275.3110.
3. Structural fill placed as yard surfacing material should conform to PSE Specification 1275.1330 as described in the following table:

US Standard Sieve Size	Percent Passing (by weight)
1-1/2 inches	100
1 inch	90 to 100
3/4 inch	0 to 15
3/8 inch	0 to 5

Fill Placement and Compaction Criteria

Structural fill should be mechanically compacted to a firm, non-yielding condition. In general, structural fill should be placed in loose lifts not exceeding 8 to 10 inches in thickness. Each lift should be conditioned to the proper moisture content and compacted to the specified density before placing subsequent lifts. Structural fill should be compacted to the following criteria:

1. Structural fill placed below foundations, pavement areas or to establish yard grades should be compacted to at least 95 percent of the MDD estimated in accordance with ASTM D 1557. Structural fill placed to form finished slopes should also be compacted to at least 95 percent of the MDD.

2. Structural fill placed behind retaining walls should be compacted to between 90 to 92 percent of the MDD estimated in accordance with ASTM D 1557. Hand operated compactors should be used within 5 feet behind the wall.
3. Structural fill (including utility trench backfill) placed outside of areas where foundations, roadways, parking and yard areas are to be located should be compacted to at least 90 percent of the MDD estimated in accordance with ASTM D 1557.
4. Crushed rock base course placed as structural fill below pavements should be compacted to at least 95 percent of the MDD estimated in accordance with ASTM D 1557.

We recommend that a representative from our firm be present during proof-rolling and/or probing of the exposed subgrade soils in structure and pavement areas prior to the placement of structural fill and also during the placement of structural fill. Our representative would evaluate the adequacy of the subgrade soils and identify areas needing further work, perform in-place moisture-density tests in the fill to evaluate if the work is being done in accordance with the compaction specifications, and advise on any modifications to procedures that may be appropriate for the prevailing conditions.

Weather Considerations

The fill and native soils contain a moderate to low percentage of fines (silt) and may be moisture sensitive. When the moisture content of these soils is appreciably above the optimum moisture content, these soils can become unstable. Operation of equipment on these soils under wet conditions may be difficult, and it will be difficult to meet the required compaction criteria under these conditions. Additionally, disturbance of these near-surface soils should be expected if earthwork is completed during periods of wet weather.

The wet weather season generally begins in October and continues through May in the Puget Sound region; however, periods of wet weather may occur during any month of the year. The optimum earthwork period for these types of soils is typically June through September. If wet weather earthwork is unavoidable, we recommend that:

- Stockpiles of on-site soils that will be used as structural fill during wet weather be covered with plastic sheeting to protect them from rain.
- If on-site soils cannot be moisture conditioned to meet compaction requirements during wet weather, imported gravel borrow should be used as discussed previously.
- The ground surface in and around the work area be sloped so that surface water is directed away from the work area. The ground surface should be graded such 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.

Temporary Slopes

The soils encountered at the site are classified as Type C soil in accordance with the provisions of Title 296-155 WAC (Washington Administrative Code), Part N, "Excavation, Trenching, and Shoring." We recommend that temporary slopes in excess of 4 feet in height be inclined no steeper than 1-1/2H:1V (horizontal:vertical). Flatter slopes may be necessary if localized sloughing occurs. For open cuts at the site we recommend that:

- No traffic, construction equipment, stockpiles or building supplies be allowed at the top of cut slopes within a distance of at least 5 feet from the top of the cut.
- Exposed soil along the slope be protected from surface erosion using waterproof tarps or plastic sheeting.
- Construction activities be scheduled so that the length of time the temporary cut is left open is kept as short as possible.
- Erosion control measures be implemented as appropriate such that runoff from the site is reduced to the extent practical.
- Surface water is diverted away from the excavation.
- The general condition of the slopes be observed periodically by a geotechnical engineer to confirm adequate stability.

Since the contractor has control of the construction operations, the contractor should be made responsible for the stability of cut slopes, as well as the safety of the excavations. All shoring and temporary slopes must conform to applicable local, state and federal safety regulations.

Permanent Slopes

We recommend that permanent cut and fill slopes be constructed no steeper than 2H:1V. To achieve uniform compaction, we recommend that fill slopes be overbuilt slightly and subsequently cut back to expose properly compacted fill.

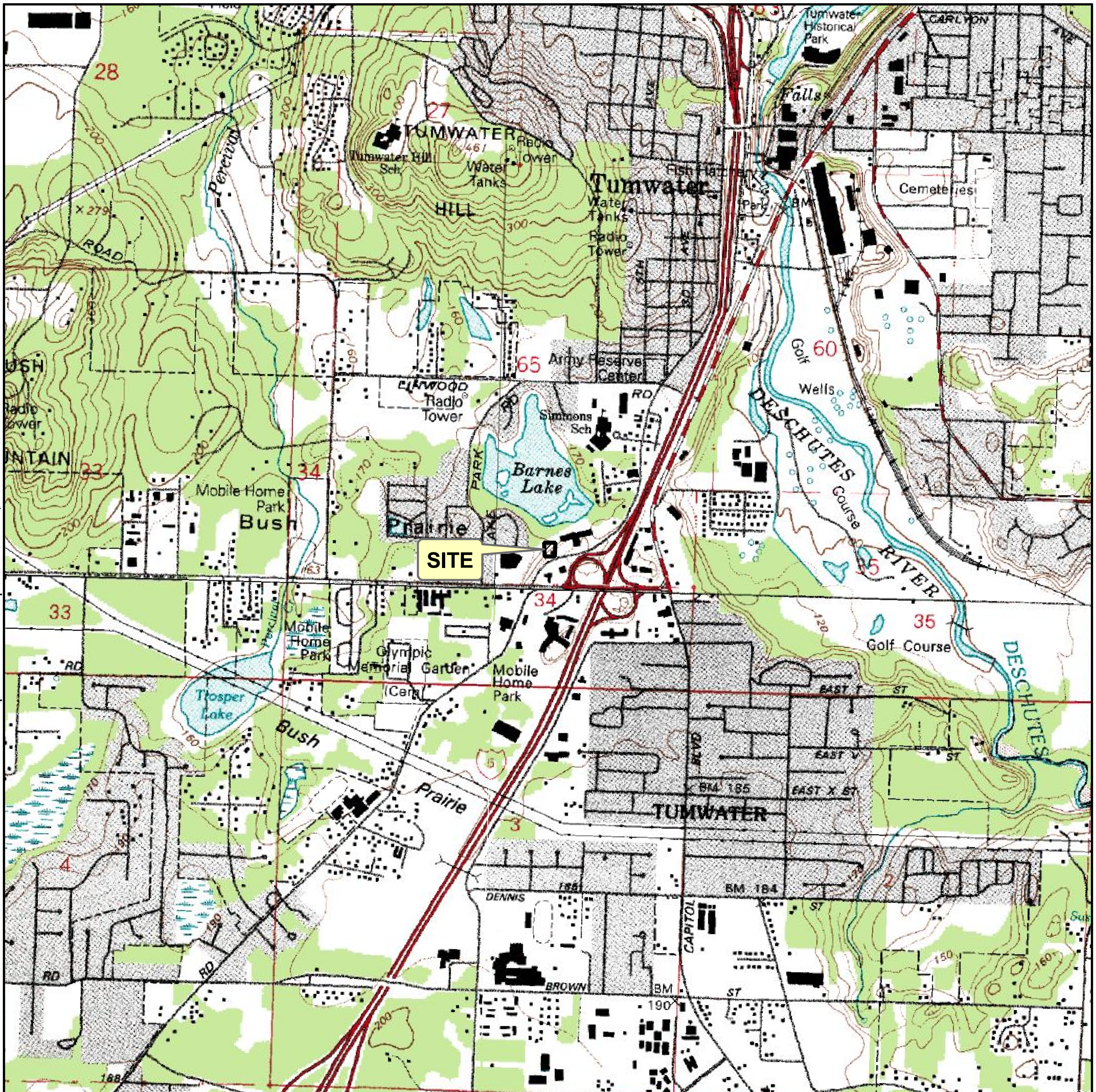
To reduce erosion, newly constructed slopes should be planted or hydroseeded shortly after completion of grading. Until the vegetation is established, some sloughing and raveling of the slopes should be expected. This may require localized repairs and reseeding. Temporary covering, such as clear heavy plastic sheeting, jute fabric, loose straw or excelsior matting should be used to protect the slopes during periods of rainfall.

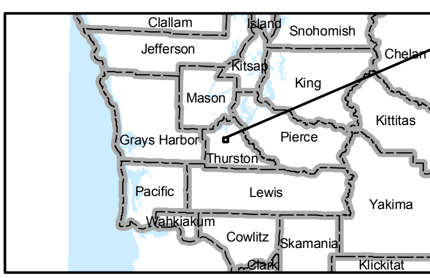
LIMITATIONS

We have prepared this report for the exclusive use of Puget Sound Energy and their authorized agents for the proposed improvements to the Barnes Lake Substation in Tumwater, 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 B titled “Report Limitations and Guidelines for Use” for additional information pertaining to use of this report.





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Feet

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.
3. It is unlawful to copy or reproduce all or any part thereof, whether for personal use or resale, without permission.

Data Sources: Interstates, state routes, and roads from TIGER 2000. County boundaries, cities, and waterbodies from Department of Ecology. USGS topo map provided by TerraServer (DRG-Scale4m).

Lambert Conformal Conic, Washington State Plane North, North American Datum 1983

Vicinity Map

Barnes Lake Substation
Tumwater, Washington

GeoEngineers

Figure 1

Map Revised: September 27, 2006

Path: 0\0186685\00\GIS\018668500_FIG-1.mxd

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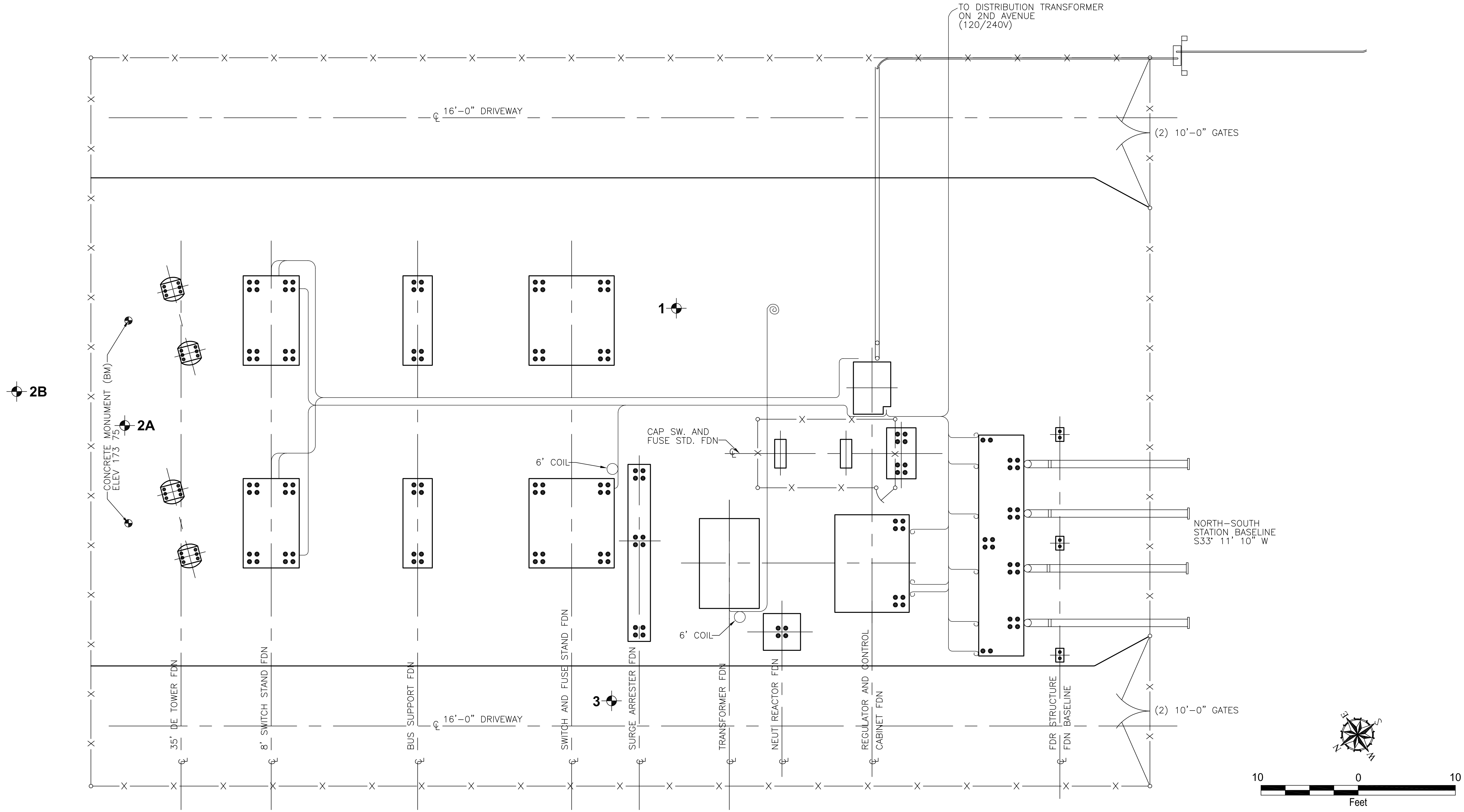

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Reference: Drawing created by

Legend

1 ⊕ Boring number and approximate location

Site Plan

Barnes Lake Substation
Tumwater, Washington

GEOENGINEERS

Figure 2

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APPENDIX A
FIELD EXPLORATIONS AND LABORATORY TESTING

APPENDIX A
FIELD EXPLORATIONS AND LABORATORY TESTING

FIELD EXPLORATIONS

Subsurface soil and groundwater conditions were explored at the substation site by completing four power borings (1, 2A, 2B and 3) on September 21, 2006. The borings were completed using portable hollow-stem auger drilling equipment owned and operated by Geologic Drill Exploration, Inc. of Nine Mile Falls, Washington. The borings were completed to depths ranging from about 2.5 to 26.5 feet below the ground surface (bgs). The exploration locations were mapped by pacing distances from site property corners. Boring locations should be considered approximate and are shown on the Site Plan, Figure 2.

The borings were continuously monitored by our representative who maintained a log of subsurface conditions, visually classified the soils encountered and obtained representative soil samples during drilling. It was difficult to advance the borings due to the density and granular nature of the site soils.

Representative samples were obtained of each soil type encountered in the borings using a 1.5-inch-inside diameter split-spoon (SPT) sampler driven into the ground using a 140-pound hammer, free-falling a vertical distance of 30 inches. The number of hammer blows required to drive the sampler the final 12 inches, or other indicated distance, is recorded on the boring logs.

Soils encountered were visually classified in general accordance with the classification system described in Figure A-1. A key to the boring log symbols is also presented in Figure A-1. The boring logs are presented in Figures A-2 through A-5. The logs are based on our interpretation of the field and laboratory data and indicate the various types of soils encountered. They also indicate the depths at which the soils or their characteristics change, although the change might actually be gradual. The densities noted on the boring logs are based on correlation to the blow counts. The ground surface elevations shown on the logs are based on topographic information provided by PSE. The borings were backfilled in general accordance with local regulatory requirements.

LABORATORY TESTING

Soil samples obtained from the borings were brought to our laboratory to confirm field classifications. Selected samples were tested to determine their moisture content and grain size distribution in general accordance with applicable American Society for Testing and Materials (ASTM) standards. The results of select laboratory testing were used to aid in soil classification and for correlation with other engineering soil properties.

The moisture content of selected samples was determined in general accordance with ASTM Test Method D 2216. The test results are presented in the respective boring logs in Appendix A. Grain-size distribution sieve analyses was conducted in general accordance with ASTM Test Method D 1140. The result of the grain size sieve analyses are presented in Figure A-6.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	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
	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
	CC	Cement Concrete
	AC	Asphalt Concrete
	CR	Crushed Rock/ Quarry Spalls
	TS	Topsoil/ Forest Duff/Sod

Measured groundwater level in exploration, well, or piezometer

Groundwater observed at time of exploration

Perched water observed at time of exploration

Measured free product in well or piezometer

Stratigraphic Contact

Distinct contact between soil strata or geologic units

Gradual change between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

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.

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

Laboratory / Field Tests

%F	Percent fines
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
OC	Organic content
PM	Permeability or hydraulic conductivity
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen
NT	Not Tested

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

Date(s) Drilled	09/21/06	Logged By	NER	Checked By	SWH
Drilling Contractor	Geologic Drill	Drilling Method	SPT	Sampling Methods	Grab & SPT
Auger Data	2-1/4 inch ID	Hammer Data	140 lb hammer/30 in drop	Drilling Equipment	Acker Portable Rig
Total Depth (ft)	26.5	Surface Elevation (ft)	173	Groundwater Elevation (ft)	152
Vertical Datum		Datum/ System		Easting(x): Northing(y):	

Elevation feet	Depth feet	SAMPLES: Interval	SAMPLES: Recovered (in)	SAMPLES: Blows/foot	SAMPLES: Sub-Sample Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
	0							GP	Gray coarse gravel ballast (loose, dry)			
		Grab			1			SP-SM	Brown fine sand with silt and organics (loose, moist) (fill)			Hand cleared
170					2							
		SPT	12	4	3							
	5	SPT	18	6	4							
165		SPT	12	0	5				Void at 7.5 feet (1-foot deep)	9		SA
	10	SPT	12	11	6			SP/SM	Brown fine to medium sand with silt and occasional organics (loose to medium dense, moist) (fill)			
								SP-SM	Brown to gray fine sand with silt (medium dense, moist) (Recessional Outwash) (native)			
160		SPT	18	14	7							
	15	SPT	12	13	8							
155		SPT	18	11	9					8		SA
	20	SPT	12	14	10	▼						
150												
	25	SPT	12	14	11			SP	Gray fine to medium sand with gravel (medium dense, wet) (Recessional Outwash)			Rough drilling
145												
	30											
140												
	35											

Note: See Figure A-1 for explanation of symbols.

V6_GTBORING P:\0\0186685\00\FINALS\018668500.GPJ GEIV6_1.GDT 11/16/06

LOG OF BORING 1

GeoEngineers

Project: Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-00

Figure A-2
Sheet 1 of 1

Date(s) Drilled	09/21/06	Logged By	NER	Checked By	SWH
Drilling Contractor	Geologic Drill	Drilling Method	SPT	Sampling Methods	Grab
Auger Data	2-1/4 inch ID	Hammer Data	140 lb hammer/30 in drop	Drilling Equipment	Acker Portable Rig
Total Depth (ft)	2.5	Surface Elevation (ft)	173	Groundwater Elevation (ft)	Not Encountered
Vertical Datum		Datum/ System		Easting(x): Northing(y):	

Elevation feet	Depth feet	SAMPLES: Interval	SAMPLES: Recovered (in)	SAMPLES: Blows/foot	SAMPLES: Sub-Sample Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
	0							GP	Gray coarse gravel ballast (loose, dry) (fill)			
					1			SW-SM	Dark brown fine to coarse sand with silt and occasional gravel (medium dense, moist) (fill)			
170												Encountered concrete slab at 2.5 feet bgs
	5											
165												
	10											
160												
	15											
155												
	20											
150												
	25											
145												
	30											
140												
	35											

Note: See Figure A-1 for explanation of symbols.

LOG OF BORING 2A

GEOENGINEERS

Project: Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-00

Figure A-3
Sheet 1 of 1

Date(s) Drilled	09/21/06	Logged By	NER	Checked By	SWH
Drilling Contractor	Geologic Drill	Drilling Method	SPT	Sampling Methods	Grab & SPT
Auger Data	2-1/4 inch ID	Hammer Data	140 lb hammer/30 in drop	Drilling Equipment	Acker Portable Rig
Total Depth (ft)	23	Surface Elevation (ft)	173	Groundwater Elevation (ft)	151
Vertical Datum		Datum/ System		Easting(x): Northing(y):	

Elevation feet	Depth feet	SAMPLES: Recovered (in)	Blows/foot	Sub-Sample Sample Number	Water Level	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
173	0					WD	Woody bark (fill)			
						SW-SM	Dark brown fine to coarse sand with silt and occasional gravel (loose, moist) (fill)			
170		12	3	1 2						Hand cleared
	5					SP-SM	Brown fine sand with silt and occasional gravel (loose, moist) (fill)			
		18	6	3						
165		18	3	4						
	10	6	2	5			Wood debris			
160		18	2	6						
	15	12	3	7			Occasional wood debris			
155		18	9	8			Glass fragments			
	20					SP-SM	Gray fine sand with silt (loose, moist) (Recessional Outwash) (native)			
		14	9	9	▼			8		SA
150										

Elevation scale: 170, 165, 160, 155, 150, 145, 140. Depth scale: 0, 5, 10, 15, 20, 25, 30, 35.

Note: See Figure A-1 for explanation of symbols.

LOG OF BORING 2B

GeoEngineers

Project: Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-00

Figure A-4
Sheet 1 of 1

Date(s) Drilled	09/21/06	Logged By	NER	Checked By	SWH
Drilling Contractor	Geologic Drill	Drilling Method	SPT	Sampling Methods	Grab & SPT
Auger Data	2-1/4 inch ID	Hammer Data	140 lb hammer/30 in drop	Drilling Equipment	Acker Portable Rig
Total Depth (ft)	17.5	Surface Elevation (ft)	173	Groundwater Elevation (ft)	Not Encountered
Vertical Datum		Datum/ System		Easting(x): Northing(y):	

Elevation feet	Depth feet	SAMPLES: Interval	Recovered (in)	Blows/foot	Sub-Sample Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
	0							GP	Gray coarse gravel ballast (loose, dry) (fill)			
					1			SW-SM	Dark brown fine to coarse sand with silt, occasional gravel and asphalt debris (soft, moist) (fill)			Hand cleared
170			20	5	2							
								SP-SM	Dark brown fine sand with silt and occasional organics (loose, moist) (fill)			
	5		18	6	3							
								SM	Light brown silty fine sand (loose, moist) (fill)			
165			18	7	4				Void at 7.5 feet (1-foot deep)	13		SA
	10		12	11	5				Grades to medium dense			
								SP	Gray medium sand (medium dense, moist) (Recessional Outwash) (native)			
160			18	15	6							
	15		12	13	7							

Note: See Figure A-1 for explanation of symbols.

LOG OF BORING 3

GeoEngineers

Project: Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-00

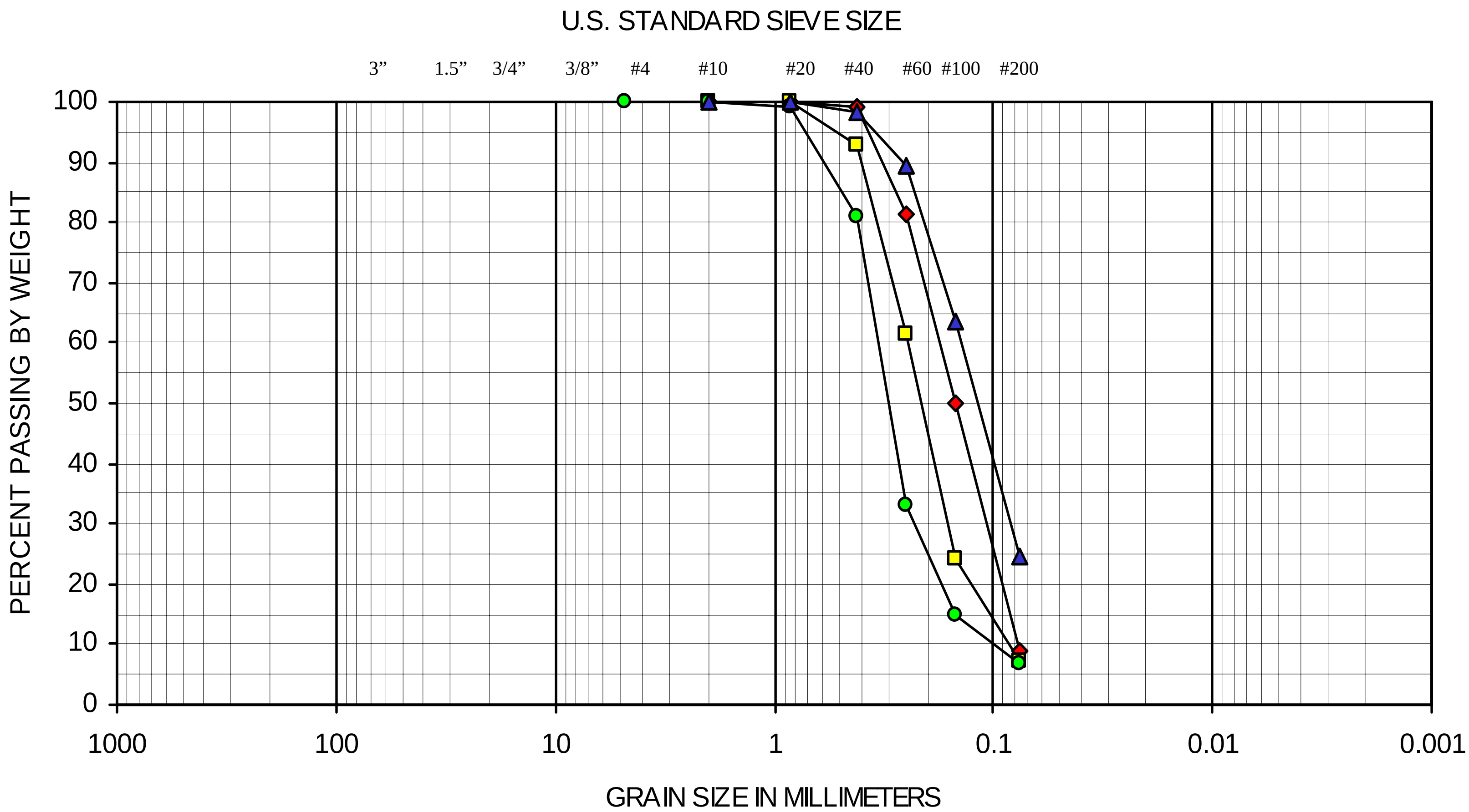
Figure A-5

TACO:\0\0186685\00\Finals\018668500FigureA6.ppt SWH:MES:tt 11706

GEOENGINEERS

FIGURE A-6

SIEVE ANALYSIS RESULTS



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	1	7	Brown sand with silt (SP-SM)
■	1	18	Brown sand with silt (SP-SM)
●	2B	22	Brown sand with silt (SP-SM)
▲	3	8	Brown silty sand (SM)

GeoEngineers

Appendix B

Report Limitations And Guidelines For Use

APPENDIX B
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.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report has been prepared for the exclusive use of Puget Sound Energy and their authorized agents. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

This report has been prepared for the planned improvements to the existing Barnes Lake Substation in Tumwater, 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, do not 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;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

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 manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

MOST 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 subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from GeoEngineers' professional judgment and opinion. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by GeoEngineers should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having GeoEngineers confer with appropriate members of the design team after submitting the report. Also retain GeoEngineers to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having GeoEngineers participate in pre-bid and preconstruction conferences, and by 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. To prevent errors or omissions, the logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

GIVE CONTRACTORS A COMPLETE REPORT AND GUIDANCE

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

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 to adjacent properties.

READ THESE PROVISIONS CLOSELY

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

GEOTECHNICAL, GEOLOGIC AND ENVIRONMENTAL REPORTS SHOULD NOT BE INTERCHANGED

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.

BIOLOGICAL POLLUTANTS

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention, or assessment of the presence of Biological Pollutants in or around any structure. Accordingly, this report includes no interpretations, recommendations, findings, or conclusions for the purpose of detecting, preventing, assessing, or abating Biological Pollutants. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.

ATTACHMENT 4

Maintenance and Source Control Manual

PUGET SOUND ENERGY

Maintenance and Source Control Manual

Barnes Lake Substation

Project Site Location:
1697 2nd Ave SW
Tumwater, WA

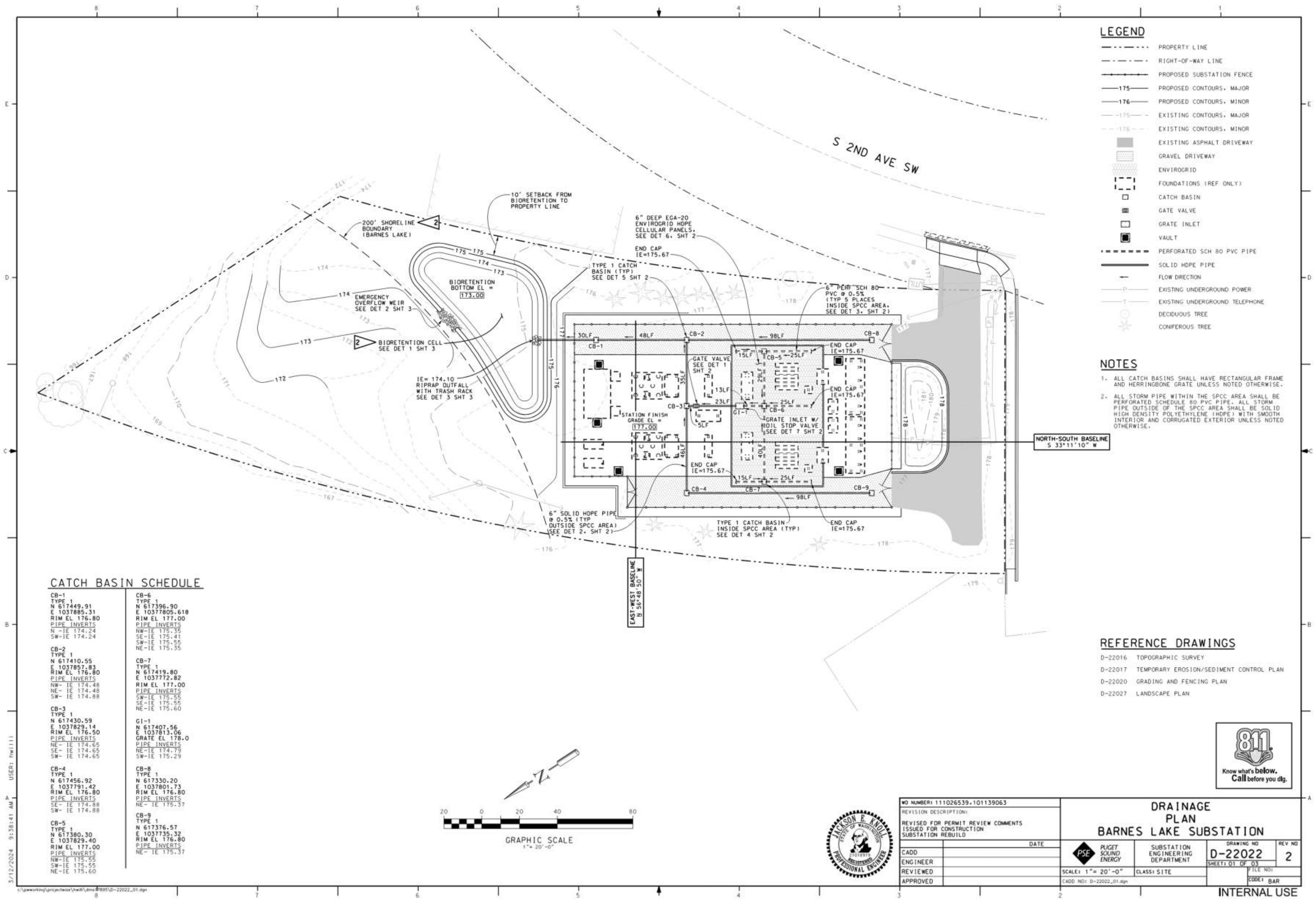
Parcel No. 09080011003
City of Tumwater Permit No. TUM-23-1260

Date of Preparation:
March 26, 2024

Owner:
Puget Sound Energy
355 110th Ave NE
Bellevue, WA 98004

Project Engineer:
Jackson Knoll, P.E.
Phone: 425-380-9772
Address: 35131 SE Center Street
Snoqualmie, WA 98065
Email: jackson.knoll@pse.com

SITE MAP



S 2ND AVE SW
LEGEND
PROPERTY LINE
RIGHT-OF-WAY LINE
PROPOSED SUBSTATION FENCE
PROPOSED CONTOURS, MAJOR
PROPOSED CONTOURS, MINOR
EXISTING CONTOURS, MAJOR
EXISTING CONTOURS, MINOR
EXISTING ASPHALT DRIVEWAY
GRAVEL DRIVEWAY
ENVIROGRID
FOUNDATIONS (REF ONLY)
CATCH BASIN
GATE VALVE
GRATE INLET
VAULT
PERFORATED SCH 80 PVC PIPE
SOLID HDPE PIPE
FLOW DIRECTION
EXISTING UNDERGROUND POWER
EXISTING UNDERGROUND TELEPHONE
DECIDUOUS TREE
CONIFEROUS TREE
NOTES
1. ALL CATCH BASINS SHALL HAVE RECTANGULAR FRAME AND HERRINGBONE GRATE UNLESS NOTED OTHERWISE.
2. ALL STORM PIPE WITHIN THE SPCC AREA SHALL BE PERFORATED SCHEDULE 80 PVC PIPE. ALL STORM PIPE OUTSIDE OF THE SPCC AREA SHALL BE SOLID HIGH DENSITY POLYETHYLENE (HDPE) WITH SMOOTH INTERIOR AND CORRUGATED EXTERIOR UNLESS NOTED OTHERWISE.
NORTH-SOUTH BASELINE S 33°11'10" W
EAST-WEST BASELINE S 56°48'50" E
10' SETBACK FROM BIORETENTION TO PROPERTY LINE
200' SHORELINE BOUNDARY (BARNES LAKE)
6" DEEP EGA-20 ENVIROGRID HDPE CELLULAR PANELS. SEE DET 6, SHT 2
END CAP IE=175.67
TYPE 1 CATCH BASIN (TYP) SEE DET 5 SHT 2
BIORETENTION BOTTOM EL = 173.00
EMERGENCY OVERFLOW WEIR SEE DET 2 SHT 3
6" PERF SCH 80 PVC @ 0.5% (TYP 5 PLACES INSIDE SPCC AREA. SEE DET 3, SHT 2)
BIORETENTION CELL SEE DET 1 SHT 3
IE= 174.10 RIPRAP OUTFALL WITH TRASH RACK SEE DET 3 SHT 3
GATE VALVE SEE DET 1 SHT 2
STATION FINISH GRADE EL = 177.00
GRATE INLET W/ OIL STOP VALVE SEE DET 7 SHT 2
6" SOLID HDPE PIPE @ 0.5% (TYP OUTSIDE SPCC AREA) SEE DET 2, SHT 2)
TYPE 1 CATCH BASIN INSIDE SPCC AREA (TYP) SEE DET 4 SHT 2
CB-1
CB-2
CB-3
CB-4
CB-5
CB-6
CB-7
CB-8
CB-9
GI-1
30LF
48LF
98LF
15LF
25LF
13LF
23LF
5LF
REFERENCE DRAWINGS
D-22016 TOPOGRAPHIC SURVEY
D-22017 TEMPORARY EROSION/SEDIMENT CONTROL PLAN
D-22020 GRADING AND FENCING PLAN
D-22027 LANDSCAPE PLAN
Know what's below. Call before you dig.
CATCH BASIN SCHEDULE
CB-1 TYPE 1 N 617449.91 E 1037885.31 RIM EL 176.80 PIPE INVERTS N -IE 174.24 SW-IE 174.24
CB-2 TYPE 1 N 617410.55 E 1037857.83 RIM EL 176.80 PIPE INVERTS NW- IE 174.48 NE- IE 174.48 SW- IE 174.88
CB-3 TYPE 1 N 617430.59 E 1037829.14 RIM EL 176.50 PIPE INVERTS NE- IE 174.65 SE- IE 174.65 SW- IE 174.65
CB-4 TYPE 1 N 617456.92 E 1037791.42 RIM EL 176.80 PIPE INVERTS SE- IE 174.88 SW- IE 174.88
CB-5 TYPE 1 N 617380.30 E 1037829.40 RIM EL 177.00 PIPE INVERTS NW-IE 175.55 SW-IE 175.55 NE-IE 175.60
CB-6 TYPE 1 N 617396.90 E 10377805.618 RIM EL 177.00 PIPE INVERTS NW-IE 175.35 SE-IE 175.41 SW-IE 175.55 NE-IE 175.35
CB-7 TYPE 1 N 617419.80 E 1037772.82 RIM EL 177.00 PIPE INVERTS SW-IE 175.55 SE-IE 175.55 NE-IE 175.60
GI-1 N 617407.56 E 1037813.06 GRATE EL 178.0 PIPE INVERTS NE-IE 174.79 SW-IE 175.29
CB-8 TYPE 1 N 617330.20 E 1037801.73 RIM EL 176.80 PIPE INVERTS NE- IE 175.37
CB-9 TYPE 1 N 617376.57 E 1037735.32 RIM EL 176.80 PIPE INVERTS NE- IE 175.37
GRAPHIC SCALE 1" = 20'-0"
WO NUMBER: 111026539.101139063
REVISION DESCRIPTION:
REVISED FOR PERMIT REVIEW COMMENTS
ISSUED FOR CONSTRUCTION
SUBSTATION REBUILD
DATE
CADD
ENGINEER
REVIEWED
APPROVED
DRAINAGE PLAN
BARNES LAKE SUBSTATION
PUGET SOUND ENERGY
SUBSTATION ENGINEERING DEPARTMENT
DRAWING NO D-22022
SHEET: 01 OF 03
REV NO 2
SCALE: 1" = 20'-0"
CLASS: SITE
CADD NO: D-22022_01.dgn
FILE NO:
CODE: BAR
INTERNAL USE
3/12/2024 9:38:41 AM USER: hwilli

TABLE OF CONTENTS

SECTION 1 PROJECT DESCRIPTION

General Project Overview

The development project requiring this Maintenance and Source Control Manual is a rebuild of Puget Sound Energy's existing Barnes Lake substation. The rebuilt substation is a loop through distribution station with an 18,400 square foot footprint containing two 115kV – 12.5kV transformers, a 14 foot x 26 foot prefabricated control building, and various other pieces of electrical equipment. The project is located entirely on one lot at 1697 2nd Ave SW in the City of Tumwater, parcel no. 09080011003.

Description of Stormwater System

The project includes a new stormwater system to manage runoff from the substation. The stormwater system consists of nine Type 1 catch basins and six inch diameter pipe for collection and conveyance of runoff from the substation yard and asphalt driveways, as well as a bioretention cell for treatment and infiltration of stormwater.

A secondary containment (SPCC) area for the substation transformers is also part of the stormwater system. The SPCC area consists of a concrete curb surrounding the transformers, filled with crushed rock and sealed with an impervious bentonite liner. Under normal operations, stormwater is drained from the containment area by six inch diameter perforated pipes, through an oil stop valve and manual gate valve, to the stormwater conveyance system which discharges to the bioretention cell. In the event of an oil spill the oil stop valve will close, preventing stormwater from leaving the SPCC area and containing oil until crews arrive.

The bioretention cell provides water quality treatment and flow control for the site. It is designed to infiltrate 100% of the stormwater runoff conveyed to it, with a maximum ponding depth of one foot and one foot of freeboard. The bioretention utilizes three layers of soil media for filtration and treatment of stormwater, consisting of 2 inches of compost, 18 inches of high performance bioretention soil mix, and a 12 inch polishing layer. In the event that the bioretention facility becomes plugged and fails to infiltrate, an emergency overflow weir is included to safely convey stormwater across the site towards Barnes Lake, approximately 250 feet north of the substation.

SECTION 2 MAINTENANCE IMPORTANCE AND INTENT

The importance of maintenance for the proper functioning of stormwater control facilities cannot be over-emphasized. A substantial portion of failures (clogging of filters, resuspension of sediments, loss of storage capacity, etc.) are due to inadequate maintenance. Stormwater BMP maintenance is essential to ensure that BMPs function as intended throughout their full life cycle.

The fundamental goals of maintenance activities are to ensure the entire flow regime and treatment facilities designed for this site continue to fully function. For this site these include:

- Maintain designed stormwater infiltration capacity
- Maintain designed stormwater detention/retention volume
- Maintain ability of storm facility to attenuate flow rates
- Maintain ability to safely convey design stormwater flows
- Maintain ability to treat stormwater runoff quality
- Preserve soil and plant health, as well as stormwater flow contact with plant and soil systems
- Clearly identify systems so they can be protected
- Keep maintenance costs low
- Prevent large-scale or expensive stormwater system failures
- Prevent water quality violations or damage to downstream properties

SECTION 3 RESPONSIBLE PARTIES

Puget Sound Energy (PSE) is responsible for the maintenance and operation of all stormwater structures and BMP's on the site.

Specifically, PSE Substation Operations is responsible for overseeing maintenance of stormwater structures inside the fenced substation yard, while PSE Vegetation Management will manage maintenance of the bioretention BMP located outside of the substation as well as all other landscaping and vegetation onsite.

PSE Substation Civil Engineering will be responsible for conducting annual inspections of the stormwater facilities onsite, logging the condition of facility components, and coordinating required maintenance activities with Substation Operations or Vegetation Management as appropriate.

Contact Information:

PSE Substation Operations
Red Bonnette - Supervisor of Substation Operations, Southwest Region
Phone: (360) 475-7089
Email: red.bonnette@pse.com

PSE Vegetation Management
Janet Brown – Project Manager, Substations
Phone: (360) 348-5151
Email: janet.brown@pse.com

PSE Substation Engineering
Jackson Knoll – Civil Engineer
Phone: (425) 380-9772
Email: jackson.knoll@pse.com

A copy of this Maintenance and Source Control Manual will be kept onsite by PSE Substation Operations in the Barnes Lake substation control building at 1697 2nd Ave SW Tumwater, WA 98512. PSE Substation Engineering and Vegetation Management will also maintain local copies of this manual for reference.

Note: A copy of this manual must be made available for inspection by the City of Tumwater upon request.

SECTION 4 FACILITIES REQUIRING MAINTENANCE

Type 1 Catch Basin

Quantity and Location: 9 - 6 within substation yard, 3 inside SPCC area

Description: Pre-cast concrete structure used to capture surface runoff and also serving as a sump to capture sediment and debris at storm pipe junctions.

Rock Pad Energy Dissipater

Quantity and Location: 1 - Within bioretention cell at outfall pipe from substation stormwater system.

Description: Layer of angular stone used to armor, stabilize, and protect the soil surface of the bioretention cell against erosion and scour from concentrated stormwater discharge.

Debris Barrier (Trash Rack)

Quantity and Location: 1 - Within bioretention cell at outfall pipe from substation stormwater system.

Description: Metal structure on a pipe outlet used to prevent unwanted animals, material, and other debris from entering the stormwater system.

Bioretention Cell

Quantity and Location: 1 - Northeast of substation, behind rear fence line. Vehicle access is through the substation, utilizing 16 foot swing gate in north corner.

Description: Bioretention areas are shallow stormwater systems with an engineered soil mix and plants that function by storing stormwater as surface ponding before it filters through the amended soil layers and infiltrates into the underlying native soil. Bioretention areas are designed to both control stormwater volume and to provide water quality treatment.

SECTION 5 MAINTENANCE INSTRUCTIONS

The stormwater system owner (owner) must review and apply the maintenance requirements contained in the Stormwater Maintenance Agreement. The owner shall inspect all stormwater facilities annually and maintain them at their own expense. The owner shall complete and file an inspection and maintenance form with the city following inspection and maintenance. When inspections indicate a maintenance need, the owner shall complete all maintenance within one year for typical maintenance of facilities, within six months for catch basins, and within two years for maintenance that requires capital construction of greater than $25,000.

Steps for Inspection and Maintenance

1. Identify

   Stormwater facilities and components requiring inspection are listed in Section 4 of this manual and are shown on the Site Map in Section 1. Detailed engineering drawings for the site are also attached to this Manual for further reference if needed.

2. Inspect

   Conduct an inspection of the facilities and components identified in this manual. It will be the responsibility of PSE Substation Civil Engineering to conduct inspections. Refer to the following Stormwater Maintenance Facility Checklists, which describe the maintenance standards for each component. For each facility, note on the Inspection and Maintenance Checklist the condition of the facility (good, fair, or poor) and any problems or other observations.

3. Maintain

   For all facility components, if the inspection indicates maintenance is needed, have the work performed by the appropriate personnel. Work on facilities inside the substation should be coordinated through PSE Substation Operations, while work involving landscaping or vegetation should be coordinated through PSE Vegetation Management. Note the action taken and the date, and record this information on the Log Sheet. Mark the check boxes on the Inspection and Maintenance Checklist corresponding to the maintenance accomplished on each facility.

4. Submit

   Inspections should be completed once per year using the Private Stormwater Facility Inspection Form. The form can be filled out online or printed out and mailed to the City of Tumwater. Forms are due by August 31st each year. The forms can be accessed here: https://www.ci.tumwater.wa.us/departments/water-resources-sustainability/water-resources/stormwater/stormwater-programs/private-system-maintenance.

   Submit hardcopies of the completed inspection form to: Tumwater Water Resources, 555 Israel Road SW, Tumwater, WA 98501. The completed checklist may be mailed, e-mailed (if available), or delivered in person to Tumwater City Hall, Water Resources and Sustainability counter (basement).

Stormwater Maintenance Facility Checklists

1m. Bioretention Cells, Swales, and Planter Boxes

Bioretention areas are shallow stormwater systems with a designed soil mix and plants adapted to the local climate and soil moisture conditions. They are designed to mimic a forested condition by controlling stormwater through detention, infiltration, and evapotranspiration. Most routine maintenance procedures are typical landscape care activities.

Bioretention Cells, Swales, and Planter Boxes

Drainage System Feature	Problem or Defect	Conditions to Check For	Maintenance Required (Y/N)	What To Do for Desired Condition	Date Maintenance Completed
General	Trash	Trash and debris present.		Remove and properly dispose of all trash and debris.	
Concrete Sidewalls	Cracks or Failure in Concrete Planter Reservoir	Cracks wider than 0.5 inch or maintenance/inspection personnel determine that the planter is not structurally sound.		Repair or replace concrete.	
Rockery Sidewalls	Unstable Rockery	Rock walls are insecure.		Stabilize rockery sidewalls (may require consultation with professional engineer, particularly for walls 4 feet or greater in height).	
Earthen Side Slopes and Berms	Failure in Earthen Reservoir (embankments, dikes, berms, and side slopes)	Erosion (gullies/rills) greater than 2 inches around inlets, outlet, and alongside slopes.		Eliminate the source of erosion and stabilize damaged area (regrade, rock, vegetation, erosion control blanket). For deep channels or cuts (over 3 inches in ponding depth), deploy temporary erosion control measures until permanent repairs can be made.	
		Erosion of sides causes slope to become a hazard.		Eliminate the hazard and stabilize the slopes.	
		Settlement greater than 3 inches (relative to undisturbed sections of berm).		Restore the design height with additional mulch.	

Bioretention Cells, Swales, and Planter Boxes					
Drainage System Feature	**Problem or Defect**	**Conditions to Check For**	**Maintenance Required (Y/N)**	**What To Do for Desired Condition**	**Date Maintenance Completed**
Earthen Side Slopes and Berms	Failure in Earthen Reservoir (embankments, dikes, berms, and side slopes) (continued)	Downstream face of berm or embankment wet, seeps or leaks evident.		Plug holes are compact berm. May require consultation with professional engineer, particularly for larger berms.	
		Any evidence of rodent holes or water piping around holes if facility acts as dam or berm.		Remove rodents (see "Pests: Insects/Rodents") and repair/compact berm.	
Ponding Area	Sediment or Debris Accumulation	Accumulation of sediment or debris to extent that infiltration rate is reduced (see "Ponded water") or surface storage capacity significantly impacted.		Clean sediment out to restore facility shape and depth. Replace damaged vegetation and mulched. Identify and control the source of sediment (if feasible).	
	Leaf Accumulation	Accumulated leaves in facility.		Remove leaves clogging outlet structure that impede water flow.	
	Basin Inlet via Surface Flow	Soil is exposed or signs of erosion are visible.		Control and repair sources of erosion.	
Curb Cut Inlet	Sediment or Debris Accumulation	Sediment, vegetation, or debris partially or fully blocking inlet structure.		Clear curb cut of debris. Identify source of the blockage and take action to prevent future blockages.	
Splashblock Inlet	Water Not Properly Directed to Facility	Water is not being directed properly to the facility and away from the inlet structure.		Reconfigure blocks to direct water to facility and away from structure.	
	Erosion	Water disrupts soil media.		Reconfigure/repair splashblock.	
Inlet/ Outlet Pipe	Damaged Pipe	Pipe is damaged.		Repair/replace pipe. Ensure no cracks more than 0.25 inch wide at the joint of inlet/outlet pipes exist.	
	Clogged Pipe	Pipe is clogged.		Clear pipe of roots or debris. Identify source of the blockage and take action to prevent future blockages.	
Inlets/ Outlet and Access Pathways	Blocked Access	Maintain access for inspections.		Clear vegetation within 1 foot of inlets and outlets. Maintain access pathways.	

Bioretention Cells, Swales, and Planter Boxes					
Drainage System Feature	**Problem or Defect**	**Conditions to Check For**	**Maintenance Required (Y/N)**	**What To Do for Desired Condition**	**Date Maintenance Completed**
Ponding Area	Erosion	Water disrupts soil media.		Address cause of erosion or scour. Maintain a cover of rock or cobbles or other erosion protection measure (e.g., matting) to protect the ground where concentrated water enters or exits the facility (e.g., a pipe, curb cut, or swale).	
Trash Rack	Trash or Debris Accumulation	Trash or debris present on trash rack.		Clean and dispose trash.	
	Damaged Trash Rack	Bar screen damaged or missing.		Repair or replace barrier to design standards.	
Check Dams and Weirs	Sediment or Debris Accumulation	Sediment, vegetation, or debris accumulated at or blocking (or having the potential to block) check dam, weir, or orifice.		Clear blockage. Identify the source of the blockage and take actions to prevent future blockages.	
	Erosion	Erosion and/or undercutting is present.		Address the cause of erosion or undercutting. Repair check dam or weir.	
	Unlevel Top of Weir	Grade board or top of weir damaged or not level.		Restore weir to level position.	
Flow Spreader	Sediment Accumulation	Sediment blocks 35 percent or more of ports/notches or, sediment fills 35 percent or more of sediment trap.		Remove and dispose of sediment.	
	Damaged or Unlevel Grade Board/Baffle	Grade board/baffle damaged or not level.		Remove and reinstall board/baffle to level position.	
Overflow/ Emergency Spillway	Sediment or Debris Accumulation	Overflow spillway is partially or fully plugged with sediment or debris.		Remove sediment or debris in overflow.	
	Erosion	Native soil is exposed or other signs of erosion damage are present.		Repair erosion and stabilize surface of spillway.	
	Missing Spillway Armament	Spillway armament is missing.		Replace armament.	

Bioretention Cells, Swales, and Planter Boxes					
Drainage System Feature	**Problem or Defect**	**Conditions to Check For**	**Maintenance Required (Y/N)**	**What To Do for Desired Condition**	**Date Maintenance Completed**
Underdrain	Blocked Underdrain	Plant roots, sediment or debris reducing capacity of underdrain. Prolonged surface ponding (see "Bioretention Soil").		Remove sediment and debris from underdrains and orifices.	
Bioretention Soil	Ponded Water	Excessive ponding water: Water overflows during storms smaller than the design event or ponded water remains in the basin 48 hours or longer after the end of a storm.		Identify and address the cause of ponded water: 1. Remove leaf or debris buildup 2. Clear underdrain 3. Investigate other water inputs (e.g., groundwater, illicit connections) 4. Verify contributing area If steps #1–4 do not solve the problem, repair and replant imported bioretention soil.	
	Protection of Soil	Maintenance requiring entrance into the facility footprint.		Perform maintenance without compacting bioretention soil media.	
Vegetation	Bottom Swale and Upland Slope Vegetation	Less than 75 percent of swale bottom is covered with healthy/surviving vegetation.		Address cause of poor vegetation growth. Replant bioretention area as necessary to obtain 75 percent survival rate or greater. Ensure plant selection is appropriate for site growing conditions.	
Trees and Shrubs	Causing Problems for Operation of Facility	Large trees and shrubs interfere with operation of the basin or access for maintenance.		Trees and shrubs Prune or remove large trees and shrubs so they do not hinder facility performance or maintenance activities.	
	Dead Trees and Shrubs	Standing dead vegetation is present.		Ensure trees and shrubs do not hinder facility performance or maintenance activities. Remove dead vegetation and address cause of dead vegetation. Ensure specific plants with high mortality rate are replaced with more appropriate species.	

Bioretention Cells, Swales, and Planter Boxes					
Drainage System Feature	**Problem or Defect**	**Conditions to Check For**	**Maintenance Required (Y/N)**	**What To Do for Desired Condition**	**Date Maintenance Completed**
Trees and Shrubs Adjacent to Vehicle Travel Areas (or areas where visibility needs to be maintained)	Safety Issues	Vegetation causes some visibility (line of sight) or driver safety issues.		Maintain appropriate height for sight clearance. Ensure regular pruning maintains visual sight lines for safety or clearance along a walk or drive. Remove or transplant tree or shrub if presenting a continual safety hazard.	
Emergent Vegetation	Conveyance Blocked	Vegetation compromises conveyance. Cattails cover more than 25% of the facility surface.		Clear conveyance of emergent plants. Consider replanting with plants that allow conveyance.	
Mulch	Lack of Mulch	Bare spots (without much cover) are present or mulch covers less than 2 inches.		Ensure facility has a maximum 3-inch layer of an appropriate type of mulch and mulch is kept away from woody stems.	
Vegetation	Accumulation of Clippings	Any grass or other vegetation clippings left in the facility.		Remove and properly dispose of clippings.	
	Weeds	Weeds are present (unless on edge and providing erosion control).		Ensure weed material is removed and disposed of. It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality.	

Bioretention Cells, Swales, and Planter Boxes					
Drainage System Feature	**Problem or Defect**	**Conditions to Check For**	**Maintenance Required (Y/N)**	**What To Do for Desired Condition**	**Date Maintenance Completed**
Noxious Weeds	Poisonous Vegetation and Noxious Weeds	Any poisonous or nuisance vegetation which may constitute a hazard to the public. Any evidence of noxious weeds as defined in the Thurston County Noxious Weed List: https://www.co.thurston.wa.us/tcweeds/weed-list.htm		Eliminate danger of poisonous vegetation where maintenance personnel or the public might normally be. Completely remove invasive, noxious, or nonnative vegetation in accordance with applicable regulations. *(Coordinate with Thurston County Health Department.)* Do not spray chemicals on vegetation without guidance or city approval. It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality. (Apply requirements of adopted integrated pest management policies for the use of herbicides.) *Complete eradication of noxious weeds may not be possible.*	
Excessive Vegetation	Adjacent Facilities Compromised	Low-lying vegetation growing beyond facility edge onto sidewalks, paths, or street edge poses pedestrian safety hazard or may clog adjacent permeable pavement surfaces due to associated leaf litter, mulch, and soil.		Trim groundcovers and shrubs at facility edge. Ensure excessive leaf litter is removed.	
	Causes Facility to Not Function Properly	Excessive vegetation density inhibits stormwater flow beyond design ponding or becomes a hazard for pedestrian and vehicular circulation and safety.		Ensure pruning and/or thinning vegetation maintains proper plant density and aesthetics. Remove or replace plants that are weak, broken, or not true to form in-kind. Ensure appropriate plants are present.	
Irrigation (if any)	Routine maintenance	Irrigation system present.		Refer to manufacturer's instructions for O&M.	

Bioretention Cells, Swales, and Planter Boxes					
Drainage System Feature	**Problem or Defect**	**Conditions to Check For**	**Maintenance Required (Y/N)**	**What To Do for Desired Condition**	**Date Maintenance Completed**
Plant Watering	Plant Establishment	Plant establishment period (1–3 years).		Water plants as necessary during periods of no rain to ensure plant establishment.	
Summer Watering (after establishment)	Drought Period	Longer term period (3+ years).		Water plants as necessary during drought conditions and water trees up to 5 years after planting.	
Spill Prevention and Response	Spill Prevention	Storage or use of potential contaminants in the vicinity of facility.		Implement spill prevention measures whenever handling or storing potential contaminants.	
	Spill Response	Any evidence of contaminants such as oil, gasoline, concrete slurries, paint, etc.		Clean spills up as soon as possible to prevent contamination of stormwater. *(Coordinate source control, removal, and/or cleanup with City of Tumwater Spill Reporting Hotline 360-754-4150, Moderate Risk Waste Program at Thurston County Environmental Health 360-754–4111, and/or Dept. of Ecology Spill Response 800-424-8802.)*	
Safety	Safety (slopes)	Erosion of sides causes slope to exceed 1:3 or otherwise becomes a hazard.		Take actions to eliminate the hazard such as regrade the slope or vegetate to reduce erosion.	
	Safety (hydraulic structures)	Hydraulic structures (pipes, culverts, vaults, etc.) become a hazard to children playing in and around the facility.		Take actions to eliminate the hazard (such as cover and secure any openings).	
Aesthetics	Aesthetics	Damage/vandalism/debris accumulation.		Restore facility to original aesthetic conditions.	
	Edging	Grass is starting to encroach on swale.		Repair edging.	
Pest Control	Pests: Insects/ Rodents	Pest of concern is present and impacting facility function.		Remove pests and return facility to original functionality. *Manage pests in compliance with adopted integrated pest management policies.*	

Bioretention Cells, Swales, and Planter Boxes					
Drainage System Feature	**Problem or Defect**	**Conditions to Check For**	**Maintenance Required (Y/N)**	**What To Do for Desired Condition**	**Date Maintenance Completed**
Pest Control	Mosquitoes	Standing water remains in the basin for more than three days following storms.		Remove standing water if possible. For mosquito control, eliminate stagnant water or apply larvicide that contains Bti. *Apply insecticides in compliance with adopted integrated pest management policies.*	

2b. Catch Basins

These structures are typically located in the streets. The City of Tumwater is responsible for routine maintenance of the pipes and structures in the public rights-of-way, while the property owner or homeowners' association is responsible for maintenance of pipes and catch basins in private areas and for keeping the grates clear of debris in all areas.

Catch Basins

Drainage System Feature	Problem or Defect	Conditions to Check For	Maintenance Required (Y/N)	What To Do for Desired Condition	Date Maintenance Completed
General	Trash and Debris	Trash, leaves, or debris which is located immediately in front of the catch basin opening or is blocking inflow capacity of the basin by more than 10 percent.		Remove trash, leaves and debris located directly in front of catch basin or on grate.	
		Trash or debris (in basin) that exceeds 33 percent of the sump depth as measured from bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches of clearance from the debris surface to the invert of the lowest pipe.		Remove and properly dispose of all trash and debris. Refer to "Volume IV Appendix IV-C: Recommendations for Management of Street Wastes" for proper disposal of sediment from street runoff.	
		Trash or debris in any inlet or outlet pipe blocking more than 33 percent (one-third) of its height.		Remove and properly dispose of all trash and debris.	
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).		Remove dead animals, etc., present within the catch basin.	
	Sediment	Sediment (in basin) exceeds 33 percent of sump depth as measured from the bottom of basin to invert of lowest pipe into or out of basin, but in no case less than a minimum of 6 inches of clearance from the sediment surface to the invert of lowest pipe.		Remove and properly dispose of sediment in the catch basin. Refer to "Volume IV Appendix IV-C: Recommendations for Management of Street Wastes" for proper disposal of sediment from street runoff.	

Catch Basins					
Drainage System Feature	**Problem or Defect**	**Conditions to Check For**	**Maintenance Required (Y/N)**	**What To Do for Desired Condition**	**Date Maintenance Completed**
General	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 0.25 inch (intent is to make sure no material is running into basin).		Patch or seal top slab as needed. Re-set grate frame as needed.	
	Structure Damage to Frame and/or Top Slab	Frame not sitting flush on top slab, i.e., separation of more than 0.75 inch of the frame from the top slab. Frame not securely attached.		Repair or re-set frame as needed.	
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person determines structure is unsound.		Replace or repair basin to design standard.	
		Grout fillet has separated or cracked wider than 0.5 inch and longer than 1 foot at the joint of any inlet/outlet pipe, or any evidence of soil entering basin.		Re-grout pipe and secure at basin wall.	
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.		Replace or repair basin to design standards.	
	Vegetation	Vegetation growing across and blocking more than 10 percent of the basin opening.		Remove vegetation blocking opening to basin.	
		Vegetation growing in inlet/outlet pipe joints that is more than 6 inches tall and less than 6 inches apart.		Remove vegetation or root growth.	
	Contamination and Pollution	Presence of contaminants such as oil, gasoline, concrete slurries, paint, obnoxious color, odor, or sludge.		Locate the source of the pollution and remove contaminants or pollutants present. *Report and coordinate source control, removal, and/or cleanup with City of Tumwater Spill Reporting Hotline 360-754-4150, Moderate Risk Waste Program at Thurston County Environmental Health 360-754–4111, and/or Dept. of Ecology Spill Response 800-424-8802.*	

Catch Basins					
Drainage System Feature	**Problem or Defect**	**Conditions to Check For**	**Maintenance Required (Y/N)**	**What To Do for Desired Condition**	**Date Maintenance Completed**
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.		Ensure catch basin cover is in place and secured.	
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 0.5 inch of thread.		Repair/replace locking mechanism as needed.	
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)		Use blunt force with a hammer or similar tool to loosen lid.	
Ladder	Ladder Rungs Unsafe	Maintenance person judges that ladder is unsafe due to missing rungs, misalignment, rust, or cracks. Ladder must be fixed or secured immediately.		Repair or replace ladder to specifications. Ensure it is safe to use as determined by inspection personnel.	
Metal Grates	Grate Opening Unsafe	Grate with opening wider than 0.875 (7/8) inch.		Ensure grate opening meets design standards. Repair or replace grate as needed.	
	Trash and Debris	Trash and debris that is blocking more than 20 percent of grate surface inlet capacity.		Remove and properly dispose of all trash and debris.	
	Damaged or Missing	Grate missing or broken member(s) of the grate.		Repair or replace grate as needed. Ensure grate is in place and meets design standards.	

2c. Debris Barriers (trash racks)

A metallic screen or similar structural device used to prevent debris from entering a pipe, spillway or other hydraulic structure.

Debris Barriers (trash racks)					
Drainage System Feature	**Problem or Defect**	**Conditions to Check For**	**Maintenance Required (Y/N)**	**What To Do for Desired Condition**	**Date Maintenance Completed**
General	Trash and Debris	Trash or debris that is plugging more than 20 percent of the openings in the barrier.		Remove and properly dispose of all trash and debris.	
Metal Bars on Debris Barrier	Damaged/ Missing Bars	Bars are bent out of shape more than 3 inches.		Repair or replace bars in place with no bends more than 0.75 inch.	
		Bars are missing or entire barrier missing.		Replace bars as needed according to design.	
		Bars are loose and rust is causing 50 percent deterioration to any part of barrier.		Repair or replace barrier to design standards.	
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe.		Replace barrier if missing. Firmly attach barrier to pipe.	

2d. Energy Dissipators

Typically a rock splash pad at a pipe end or other discharge location, to reduce the velocity and energy of flowing water and prevent erosion. Other means of energy dissipation include drop manholes, stilling basins, and check dams.

Energy Dissipators					
Drainage System Feature	**Problem or Defect**	**Conditions to Check For**	**Maintenance Required (Y/N)**	**What To Do for Desired Condition**	**Date Maintenance Completed**
External:					
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area 5 square feet or larger, or any exposure of native soil.		Repair/replace rock pad to design standards.	
	Erosion	Soil erosion in or adjacent to rock pad.		Repair/replace rock pad to design standards. Repair eroded area.	

3a. Conveyance Pipes, Culverts, Ditches, and Swales

These features contain and direct the flow of water from one location to another.

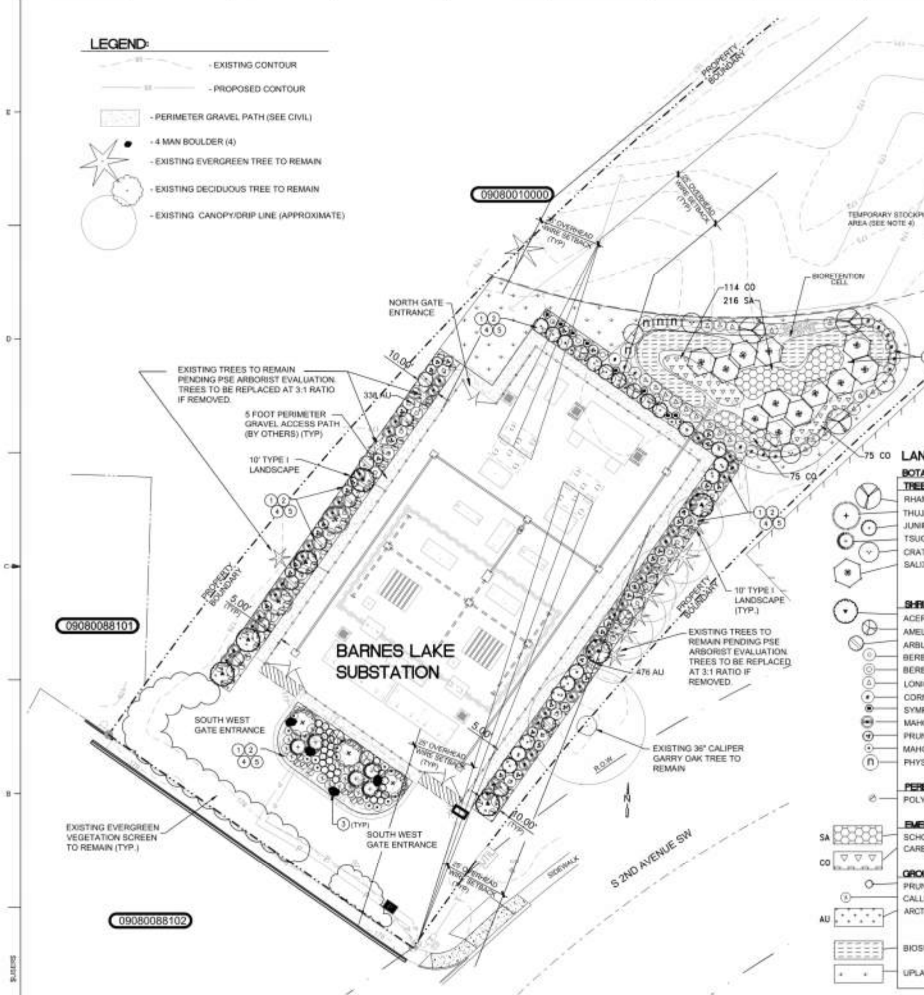
Conveyance Pipes, Culverts, Ditches, and Swales					
Drainage System Feature	**Problem or Defect**	**Conditions to Check For**	**Maintenance Required (Y/N)**	**What To Do for Desired Condition**	**Date Maintenance Completed**
Pipes	Sediment, Debris, and Vegetation	Accumulated sediment should not exceed 20 percent of the diameter of the pipe. Vegetation should not reduce free movement of water through pipes. Ensure that the protective coating is not damaged or rusted. Dents should not significantly impede flow. Pipe should not have major cracks or flaws allowing water to leak out.		Clean out pipes of all sediment and debris. Remove all vegetation so that water flows freely through pipes. Repair or replace pipe as needed.	

SECTION 6 VEGETATION MAINTENANCE

Copies of the substation Landscape Plan and Details are included for reference below. The Landscape Plan depicts the locations and species of plants, trees and shrubs on the substation site and within the bioretention cell. Maintenance requirements are listed on the Landscape Detail sheet. PSE Vegetation Management is responsible for monitoring the condition of vegetation on the site and coordinating maintenance as required.

Contact:

PSE Vegetation Management
Janet Brown – Project Manager, Substations
Phone: (360) 348-5151
Email: janet.brown@pse.com



CONSTRUCTION NOTES

(1) CLEAR AND GRUB PROPOSED PLANTING BED AREAS

(2) PREPARE PLANTING BED PER DETAIL 3, SHEET 2

(3) INSTALL FOUR MAN BOULDERS PER DETAIL 5, SHEET 2

(4) INSTALL TREES, SHRUBS AND GROUNDCOVERS PER PLANTING DETAILS, SHEET 2

(5) INSTALL 3" UNIFORM DEPTH WOOD CHIP MULCH PER DETAIL 3, SHEET 2

(6) PREPARE BIORETENTION SOIL PER DETAIL 1, SHEET D-22022_03.

GENERAL NOTES

1. SEE LANDSCAPE PLANT SCHEDULE THIS SHEET
2. SEE PLANTING NOTES AND DETAILS SHEET 2
3. ALL PLANTING AREAS SHALL BE IRRIGATED WITH A PERMANENT WATER- EFFICIENT IN-GROUND IRRIGATION SYSTEM, SEE IRRIGATION PLAN, SHEETS 3 AND 4.
4. NOTE: ANY AREA DISTURBED BY TEMPORARY STOCKPILING OPERATIONS SHALL BE RESTORED AND RE-SEEDED USING "UPLAND HYDROSEED MIX". SEE SEED MIX, SHEET 2.

LANDSCAPE PLANT SCHEDULE

BOTANICAL NAME	COMMON NAME	SIZE	COND.	SPACING	QTY.	REMARKS
TREES						
RHAMNUS PURSHIANA	CASCARA	2" CAL. MIN.	B&B	AS SHOWN	3	SINGLE LEADER, WELL-BRANCHED TO TOP
THUJA PLICATA 'EXCELSA'	EXCELSA WESTERN RED CEDAR	6' HT. MIN.	B&B	AS SHOWN	5	SINGLE LEADER, WELL-BRANCHED TO TOP
JUNIPERUS CHINENSIS	SPARTAN JUNIPER	6' HT. MIN.	B&B	AS SHOWN	18	SINGLE LEADER, WELL-BRANCHED TO TOP
TSUGA MERTENSIANA	MOUNTAIN HEMLOCK	6' HT. MIN.	B&B	AS SHOWN	5	SINGLE LEADER, WELL-BRANCHED TO TOP
CRATAEGUS DOUGLASII	BLACK HAWTHORN	48" HT. MIN.	5 GAL.	AS SHOWN	4	SINGLE LEADER, WELL-BRANCHED TO TOP
SALIX SITCHENSIS	SITKA WILLOW	48" HT. MIN.	2 GAL.	AS SHOWN	12	
SHRUBS						
ACER CIRCINATUM	VINE MAPLE	48" HT. MIN.	5 GAL.	AS SHOWN	7	MULTI-STEMMED
AMELANCHIER ALNIFOLIA	SERVICEBERRY	48" HT. MIN.	5 GAL.	AS SHOWN	5	MULTI-STEMMED
ARBUTUS UNEDO	STRAWBERRY TREE	48" HT. MIN.	5 GAL.	AS SHOWN	10	FULL, WELL BRANCHED, LAYOUT PER PLAN
BERBERIS THUNBERGII	JAPANESE BARBERRY	36" HT. MIN.	5 GAL.	4'-5' O.C.	23	FULL, WELL BRANCHED, LAYOUT PER PLAN
BERBERIS x GLADWYNENSIS 'WILLIAM PENN'	WILLIAM PENN BARBERRY	18" HT. MIN.	2 GAL.	AS SHOWN	14	FULL, WELL BRANCHED, LAYOUT PER PLAN
LONICERA INVOLUCRATA	BLACK TWINBERRY	24" HT. MIN.	2 GAL.	4'-5' O.C.	20	FULL, WELL BRANCHED, LAYOUT PER PLAN
CORNUS SERICEA	RED OSIER DOGWOOD	24" HT. MIN.	2 GAL.	4'-5' O.C.	13	FULL, WELL BRANCHED, LAYOUT PER PLAN
SYMPHOCARPUS ALBUS	SNOWBERRY	24" HT. MIN.	2 GAL.	4'-5' O.C.	8	FULL, WELL BRANCHED, LAYOUT PER PLAN
MAHONIA AQUIFOLIUM	TALL OREGON GRAPE	24" HT. MIN.	2 GAL.	4'-5' O.C.	37	FULL, WELL BRANCHED, LAYOUT PER PLAN
PRUNUS LAUROCERACUS 'OTTO LUYKEN'	OTTO LUYKEN ENGLISH LAUREL	18" HT. MIN.	2 GAL.	AS SHOWN	35	FULL, WELL BRANCHED, LAYOUT PER PLAN
MAHONIA AQUIFOLIUM 'COMPACTA'	COMPACT OREGON GRAPE	18" HT. MIN.	2 GAL.	AS SHOWN	26	FULL, WELL BRANCHED, LAYOUT PER PLAN
PHYSOCARPUS CAPITATUS	PACIFIC NINEBARK	24" HT. MIN.	2 GAL.	4'-5' O.C.	4	FULL, WELL BRANCHED, LAYOUT PER PLAN
PERENNIALS						
POLYSTICHUM MINUTUM	SWORD FERN	18" HT. MIN.	1 GAL.	AS SHOWN	74	FULL, WELL BRANCHED
EMERGENTS						
SA SCHOENOPLECTUS ACUTUS	HARDSTEM BULRUSH	6" HT. MIN.	4" POT	18" O.C.	291	FULL, WELL BRANCHED
CO CAREX OBNUPTA	SLOUGH SEDGE	6" HT. MIN.	4" POT	18" O.C.	189	FULL, WELL BRANCHED
GROUNDCOVER						
PRUNUS LAUROCERASUS 'MT. VERNON'	DWARF LAUREL	12"-18" SPREAD	1 GAL.	36" O.C.	27	FULL, WELL BRANCHED, LAYOUT PER PLAN
CALLUNA VULGARIS 'FIREFLY'	FIREFLY HEATHER	10" MIN. SPREAD	I GAL.	24" O.C.	15	FULL AND BUSHY
AU ARCTOSTAPHYLOS UVA-URSI	KINNIKINNICK	10" MIN. SPREAD	I GAL.	24" O.C.	814	FULL AND BUSHY
BIOSWALE SEED MIX					37 CY 857 SF	SEE SEED MIX, SHEET 2
UPLAND HYDROSEED MIX					2,445 SF	SEE SEED MIX, SHEET 2

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14432 SE Eastgate Way, Suite 400
Bellevue Washington 98007
Phone: 425.519.6500

WO NUMBER: 101139083
REVISION DESCRIPTION
REV 1: 100% SUBMITTAL

		DATE
CADD	GREGORY KING	03/2024
LAND ARCH	JON GAGE	03/2024
REVIEWED		
APPROVED		

LANDSCAPE PLAN
BARNES LAKE SUBSTATION

PUGET SOUND ENERGY — SUBSTATION ENGINEERING DEPARTMENT

DRAWING NO: D-22027 REV NO: 1
SHEET: 1 OF 4
SCALE: 1"=20'-0" CLASS: SITE
CODE: BAR

INTERNAL USE

LANDSCAPE NOTES

GENERAL

1. ALL WORK SHALL BE DONE AS SHOWN IN THE DRAWINGS AND IN CONFORMANCE WITH THE PUGET SOUND ENERGY (PSE) GENERAL PROVISIONS AND STANDARD LANDSCAPE SPECIFICATIONS FOR THIS PROJECT. THE DRAWINGS SHALL TAKE PRECEDENCE OVER THE SPECIFICATIONS SHOULD THEY CONFLICT.

SITE PREPARATION

1. INSTALL TEMPORARY EROSION AND SEDIMENT CONTROLS IN CONFORMANCE WITH THE PROJECT'S STORMWATER POLLUTION PREVENTION PLAN.

2. A PRECONSTRUCTION MEETING BETWEEN THE OWNER'S REPRESENTATIVE AND CONTRACTOR SHALL OCCUR PRIOR TO CONSTRUCTION.

3. ALL EXISTING UNDERGROUND POWER LINES SHALL BE LOCATED AND FLAGGED BY CONTRACTOR PRIOR TO ANY EARTH WORK IN THE PLANTING AREAS.

4. CLEAR AND GRUB EXISTING VEGETATION IN AREAS TO BE PLANTED WHERE SHOWN ON THE PLAN.

5. GRUB TO A DEPTH SUFFICIENT TO REMOVE ALL LARGE ROOTS, ROOT CROWNS, AND OTHER VEGETATIVE MATERIAL. ALL VEGETATIVE MATERIAL SHALL BE REMOVED FROM SITE. MANUALLY CLEAR AND GRUB ONLY AROUND TREES TO REMAIN IN ORDER TO MINIMIZE DAMAGE TO ROOT SYSTEM. PSE REPRESENTATIVE SHALL APPROVE METHOD.

6. WHERE SHOWN ON THE PLANS, PLANTING BEDS SHALL BE AMENDED WITH 8" OF TOPSOIL TILLED INTO 4" OF EXISTING SOIL TO FINISHED GRADE. TOPSOIL SHALL BE 3-WAY MIX TOPSOIL CONSISTING OF 40%-60% LOAM, 15%-20% COMPOST, AND 15%-20% SAND BY VOLUME PASSING A 1/2" SCREEN. (TOPSOILS NORTHWEST OR APPROVED EQUAL). REMOVE EXCESS EXISTING SOIL AND ALL ROCKS OR ANY OTHER MATERIAL GREATER THAN 2" (IN ANY DIMENSION) AND DISPOSE OFF-SITE. COMPACT BETWEEN 75% AND 80%. OWNER'S REPRESENTATIVE SHALL APPROVE PRIOR TO PLANT INSTALLATION.

7. RAKE PLANTING BED AREAS TO A SMOOTH, UNIFORM SURFACE.

PLANTING GENERAL

1. ALL PLANT MATERIALS SHALL CONFORM TO THE AMERICAN NURSERY LANDSCAPE ASSOCIATION (ANLA) STANDARDS FOR NURSERY STOCK (ANSI Z 60.1-2004) FOR GRADE AND SIZE UNLESS NOTED OTHERWISE ON PLAN.

2. SUBSTITUTIONS SHALL BE AUTHORIZED BY THE OWNER'S REPRESENTATIVE. IF PLANTS ARE NOT AVAILABLE, SUBMIT SUBSTITUTIONS TO OWNER'S REPRESENTATIVE FOR APPROVAL.

3. PLANT MATERIALS SHALL BE INSPECTED AT THE NURSERY, OR PROJECT SITE, BY THE OWNER'S REPRESENTATIVE PRIOR TO INSTALLATION. INSPECTION MAY INCLUDE, BUT IS NOT LIMITED TO, APPROPRIATE NUMBER OF TRUNKS FOR THE SPECIES; CROWN; HEALTH AND VIGOR; ROOT STRUCTURE AND VIGOR.

4. IN THE EVENT OF VARIATION BETWEEN THE PLANT SCHEDULE AND THE NUMBER OF PLANTS SHOWN ON THE PLANS, THE PLANS SHALL CONTROL.

5. THE CONTRACTOR SHALL VERIFY THAT PLANT INSTALLATION CONDITIONS ARE SUITABLE WITHIN PLANTING AREAS. THE CONTRACTOR SHALL NOTIFY THE OWNER'S REPRESENTATIVE OF ANY UNSATISFACTORY CONDITIONS AND ADDRESS THEM PRIOR TO START OF PLANTING. BEGINNING OF WORK CONSTITUTES VERIFICATION THAT CONDITIONS ARE SATISFACTORY.

6. THE CONTRACTOR SHALL PROVIDE LANDSCAPE AS-BUILT DRAWING MARKUPS LEGIBLY MARKED TO RECORD ACTUAL INSTALLATION. DRAWINGS SHALL INDICATE PLANT LOCATIONS REFERENCED TO PROJECT IMPROVEMENTS. IDENTIFY FIELD CHANGES AUTHORIZED BY OWNER'S REPRESENTATIVE. LANDSCAPE DRAWING SHALL BE SUBMITTED TO OWNER'S REPRESENTATIVE AT SUBSTANTIAL COMPLETION WALK THROUGH.

PLANTING INSTALLATION

1. OWNER'S REPRESENTATIVE SHALL APPROVE THE METHOD AND LAYOUT OF PLANTING IN THE PLANTING AREAS PRIOR TO PLANT INSTALLATION.

2. ALL TREES AND SHRUBS IN THE PLANTING AREAS SHALL BE INSTALLED PER THE PLANS AND AS SHOWN IN THE PLANTING DETAILS.

3. ADD GRANULAR 14-MONTH SLOW RELEASE, HIGH NITROGEN FERTILIZER (OSMOCOTE 14-14-14 OR APPROVED EQUAL) TO SHRUB AND TREE PITS PRIOR TO BACKFILL. APPLY PER MANUFACTURER'S WRITTEN INSTRUCTIONS.

4. APPLY PRE-EMERGENT HERBICIDE (SNAPSHOT OR APPROVED EQUIVALENT) TO ALL NON-WETLAND BUFFER PLANTING BEDS PER MANUFACTURER'S WRITTEN INSTRUCTIONS FOR WEED CONTROL. PRIOR TO BARK MULCH APPLICATION.

5. DRESS ALL PLANTING AREAS UNIFORMLY WITH 3" OF MEDIUM BARK MULCH AS SHOWN AND THE PLAN. SUBMIT SAMPLE TO OWNER'S REPRESENTATIVE FOR APPROVAL. BARK MULCH SHALL BE DERIVED FROM DOUGLAS FIR, PINE, OR HEMLOCK, MEETING THE FOLLOWING LOOSE VOLUME GRADATION.

SCREEN	PERCENT PASSING	
	MIN.	MAX.
NO.4	0	100
2"	95	30

6. AN AUTOMATIC WATER-EFFICIENT IRRIGATION SYSTEM SHALL BE INSTALLED PER THE IRRIGATION PLAN.

SEEDING

1. HYDROSEED AREAS AS SHOWN ON THE PLANS WITH THE SPECIFIED SEED MIX. GRASSES SHALL CONFORM TO THE STANDARDS FOR "CERTIFIED" GRADE SEED OR BETTER AS OUTLINED IN THE WA STATE DEPARTMENT OF AGRICULTURE "RULES FOR SEED CERTIFICATION", LATEST EDITION. ALL SEED INSTALLERS AND VENDORS MUST HAVE A BUSINESS LICENSE ISSUED BY WA STATE DEPARTMENT OF LICENSING WITH A "SEED DEALER" ENDORSEMENT. SEEDING SHALL OCCUR BETWEEN MARCH 15 AND OCTOBER 15. THE CONTRACTOR SHALL BE RESPONSIBLE TO ENSURE A HEALTHY STAND OF GRASS OTHERWISE THE CONTRACTOR SHALL REAPPLY THE HYDROSEED AT NO ADDITIONAL COST. APPLY PER RATES SPECIFIED ABOVE.

BOULDERS

ROCK SHALL BE CLEAN, NATURALLY OCCURRING, ROUNDED STREAMBED BOULDERS, FREE OF CRACKS, MEETING THE FOLLOWING APPROXIMATE SIZES:

ROCK TYPE	APPROX. SIZE
FOUR MAN	36"- 48"

APPROXIMATE SIZE CAN BE DETERMINED BY TAKING THE AVERAGE DIMENSION OF THREE AXES:

$$\text{APPROX. SIZE} = \frac{\text{LENGTH + WIDTH + THICKNESS}}{3}$$

WARRANTY

1. THE CONTRACTOR SHALL WARRANT ALL MATERIALS AND WORKMANSHIP FOR A PERIOD OF ONE YEAR FROM FINAL ACCEPTANCE. THE CONTRACTOR IS RESPONSIBLE FOR ALL PLANTS AND MATERIALS DURING INSTALLATION AND THE WARRANTY PERIOD.

2. CONTRACTOR SHALL WARRANT ALL PLANT MATERIALS TO REMAIN ALIVE AND HEALTHY DURING THIS PERIOD. THE CONTRACTOR SHALL REPLACE ALL DEAD OR UNHEALTHY PLANTS, PER PLANS AND AS IDENTIFIED BY THE OWNER'S REPRESENTATIVE DURING THE ONE YEAR WARRANTY INSPECTION.

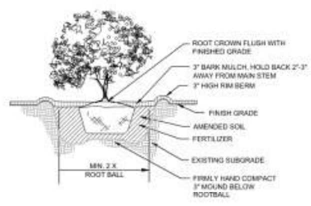
3. CONTRACTOR SHALL SCHEDULE FINAL WARRANTY INSPECTION WITH OWNER'S REPRESENTATIVE WITHIN ONE MONTH PRIOR TO END OF WARRANTY PERIOD.

MAINTENANCE

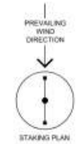
1. THE CONTRACTOR WILL BE RESPONSIBLE FOR LANDSCAPE MAINTENANCE FROM FINAL ACCEPTANCE THROUGH THE WARRANTY PERIOD. MAINTENANCE SHALL OCCUR AS FOLLOWS:
NOVEMBER - FEBRUARY = ONE VISIT PER MONTH;
MARCH - MAY = TWO VISITS PER MONTH;
JUNE - AUGUST = WEEKLY;
SEPTEMBER - OCTOBER = TWO VISITS PER MONTH.

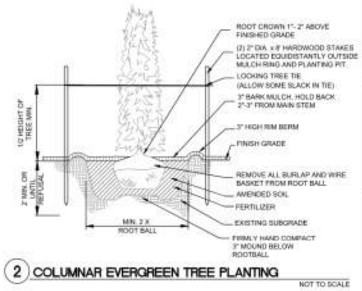
2. MAINTENANCE WILL OCCUR IN ALL AREAS BETWEEN THE PROPERTY BOUNDARY AND THE SUBSTATION FENCE. MAINTENANCE WILL INCLUDE: LITTER PICK UP, FERTILIZER, WEEDING, SPRAYING, RE-SETTLING, AND STAKING OF UNSTABLE PLANTS INCLUDING PLANTS THAT HAVE BEEN BLOWN OVER, AND OTHER MAINTENANCE NECESSARY TO ASSURE HEALTHY PLANT GROWTH THROUGHOUT THE WARRANTY PERIOD.

3. ALL PLANT MATERIALS SHALL BE IRRIGATED BY THE CONTRACTOR THOROUGHLY WHEN PLANTED AND UNTIL FINAL ACCEPTANCE. THE OWNER WILL BE RESPONSIBLE THEREAFTER. ALL PLANTS SHALL RECEIVE AT LEAST ONE INCH OF WATER PER WEEK DURING THE FIRST GROWING SEASON (MAY 15 TO OCTOBER 15).

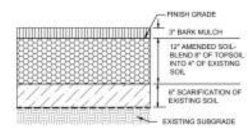


1 SHRUB PLANTING
NOT TO SCALE

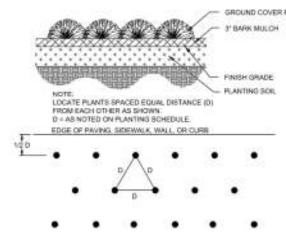




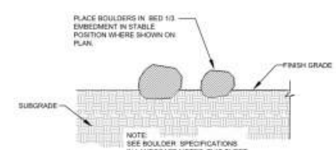
2 COLUMNAR EVERGREEN TREE PLANTING
NOT TO SCALE



3 PLANTING SOIL PREPARATION
NOT TO SCALE



4 GROUND COVER PLANTING LAYOUT
NOT TO SCALE



5 BOULDER INSTALLATION
NOT TO SCALE

BIOSWALE HYDROSEED MIX

KIND/VARIETY	% BY WEIGHT	MIN.% GERMINATION
BECKMANNIA SYZIGACHNE	15	90
DESCHAMPSIA CESPITOSA	20	90
ELYMUS GLAUCUS	18	90
FESTUCA RUBRA VAR. RUBRA	20	90
HORDEUM BRACHYANTHERUM	12	90
GLYCERIA OCCIDENTALIS	15	90

APPLICATION RATE:	30 LBS/ACRE
CANFOR WOOD CELLULOSE ECO-FIBER MULCH:	1,800 LBS/ACRE
NUTRICULTURE SEED STARTER FERTILIZER (16-45-7):	60 LBS/ACRE
CANFOR ECO-TAC GUAR TACKIFIER:	80 LBS/ACRE

UPLAND HYDROSEED MIX

KIND/VARIETY	% BY WEIGHT	MIN. % GERM
FESTUCA ARUNDINACEA VAR. (SEVERAL VARIETIES	45	90
FESTUCA SPP. (MANY MUSTANG SILVERADO)	30	90
FESTUCA RUBRA	20	90
BUCHLOE DACTYLOIDES	5	90

APPLICATION RATE:	120 LBS/ACRE
CANFOR WOOD CELLULOSE ECO-FIBER MULCH:	1,800 LBS/ACRE
NUTRICULTURE SEED STARTER FERTILIZER (16-45-7):	60 LBS/ACRE
CANFOR ECO-TAC GUAR TACKIFIER:	80 LBS/ACRE
STAY MOIST MOISTURE RETENTION AGENT	60 LBS/ACRE

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14432 SE Eastgate Way, Suite 400
Bellevue Washington 98007
Phone: 425.519.6500

WO NUMBER: 101139063		
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REV 1: 100% SUBMITTAL		
		DATE
CADD	GREGORY KING	03/2024
LAND ARCH	JON GAGE	03/2024
REVIEWED		
APPROVED		

LANDSCAPE NOTES AND PLANTING DETAILS
BARNES LAKE SUBSTATION

PUGET SOUND ENERGY — SUBSTATION ENGINEERING DEPARTMENT
DRAWING NO: D-22027 — REV NO: 1 — SHEET: 2 OF 4
SCALE: N/A — CLASS: SITE — CODE: BAR

INTERNAL USE

SECTION 7 POLLUTION SOURCE CONTROL MEASURES

Standard principles of pollution prevention from Volume IV of the City of Tumwater Drainage Design and Erosion Control Manual that are relevant to the substation are described below and should be implemented on the site as required.

- **Clean up spills quickly**

  Promptly contain and cleanup solid and liquid pollutant leaks and spills on any exposed soil, vegetation, or paved area. Promptly repair or replace all leaking connections, pipes, hoses, valves, etc. which could contaminate stormwater.

- **Locate activities as far as possible from surface drainage paths**

  Activities located as far as possible from known drainage paths, ditches, streams, other water bodies, and drains will be less likely to pollute, since it will take longer for material to reach the drainage feature. This provides more time to react in the event of a spill, or may protect the local waters long enough for you to clean up the area around the activity. Remember that groundwater protection is important throughout Tumwater, no matter where the activity is located, so the actions taken on this site on a day-today basis are always important, even in dry weather.

- **Maintain stormwater drainage systems**

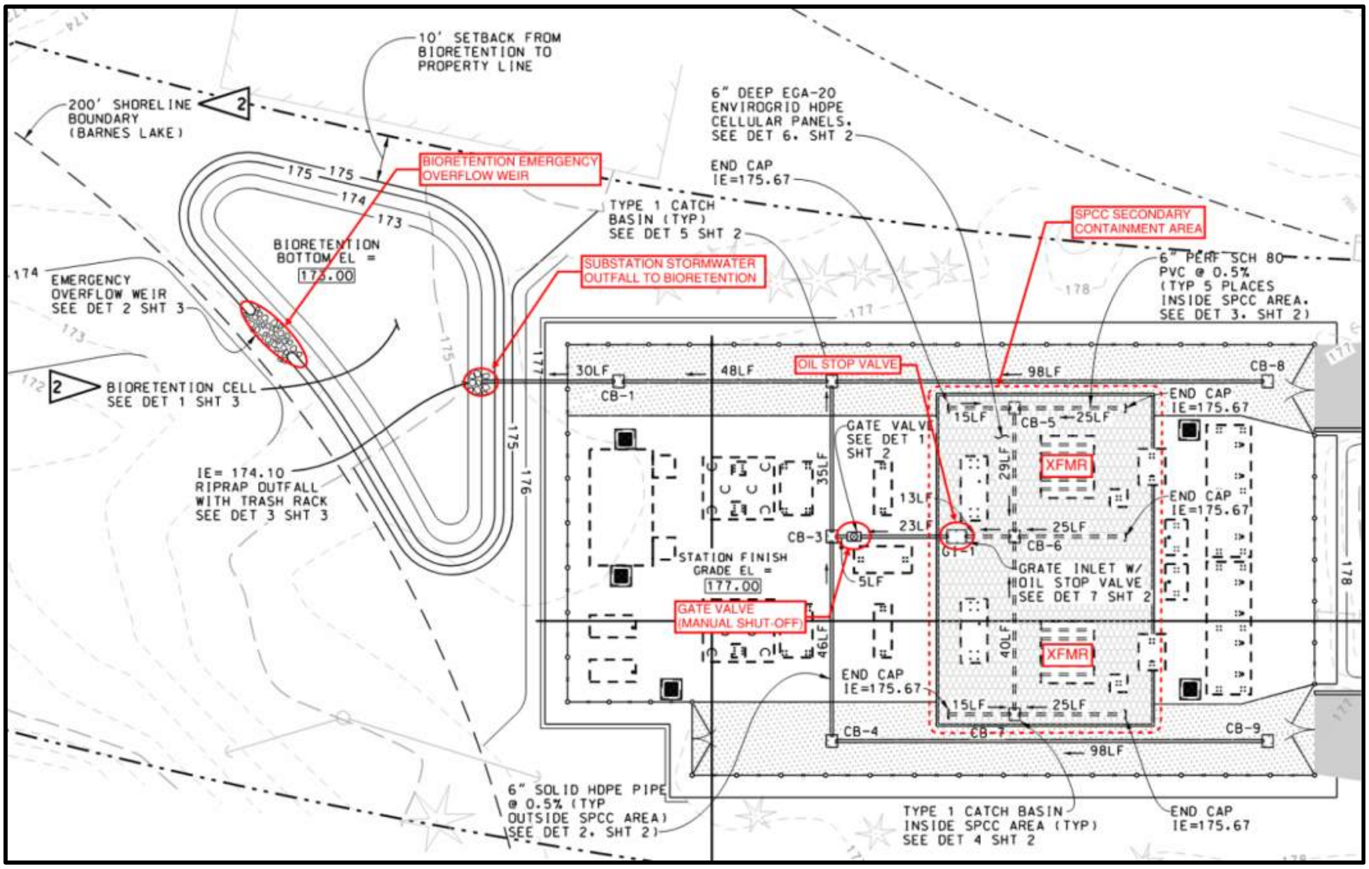
  Pollutants can concentrate over time in storm drainage facilities such as catch basins, vaults, ditches, and storm drains. When a large storm event occurs, turbulent runoff can mobilize these pollutants and carry them to receiving waters. Develop and implement maintenance practices, inspections, and schedules for treatment devices. Clean oils, debris, sludge, etc., from all BMP systems regularly, including catch basins, settling/detention basins, oil/water separators, boomed areas, and conveyance systems, to prevent the contamination of stormwater. Promptly repair or replace all substantially damaged secondary containment or any other drainage areas that are subjected to pollutant material leaks or spills.

Spill Prevention Control and Countermeasure (SPCC) System

The substation power transformers represent the primary source of potential pollutants on the site. Each 115kV – 12.5kV transformer contains approximately 4,726 gallons of insulating mineral oil within the main transformer tank and the radiators. A Spill Prevention Control and Countermeasure (SPCC) system is provided as secondary containment for the transformers. This system consists of a 16 inch deep concrete containment curb surrounding the transformers designed to hold oil in the event of a spill or leak. The containment area is lined with bentonite geotextile to prevent oil from infiltrating and is filled with crushed rock that acts as a fire suppressant by limiting exposure of any spilled oil to air.

The SPCC curb is designed to contain 110% of the transformer oil volume within the voids of the crushed rock, with 4 inches of freeboard. Under normal operation, the SPCC area will collect and convey stormwater through an oil stop valve to the substation conveyance system, discharging to the bioretention cell. The oil stop valve operates on the difference in specific gravity between water and oil. While the valve floats in an open position in water, it will sink and close off the SPCC curb drainage system in the event the valve vault fills with oil. A gate valve is also located just downstream of the oil stop valve which can be manually operated to isolate the SPCC containment area in the event of a spill.

SPCC System Map



For additional details on the SPCC system and oil stop valve, reference the engineering plans attached to this Manual. Manufacturer's operation and maintenance instructions for the oil stop valve are also attached.

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AFL INDUSTRIES
1101 West 13th Street
Riviera Beach, Florida 33404
(561) 844-5200

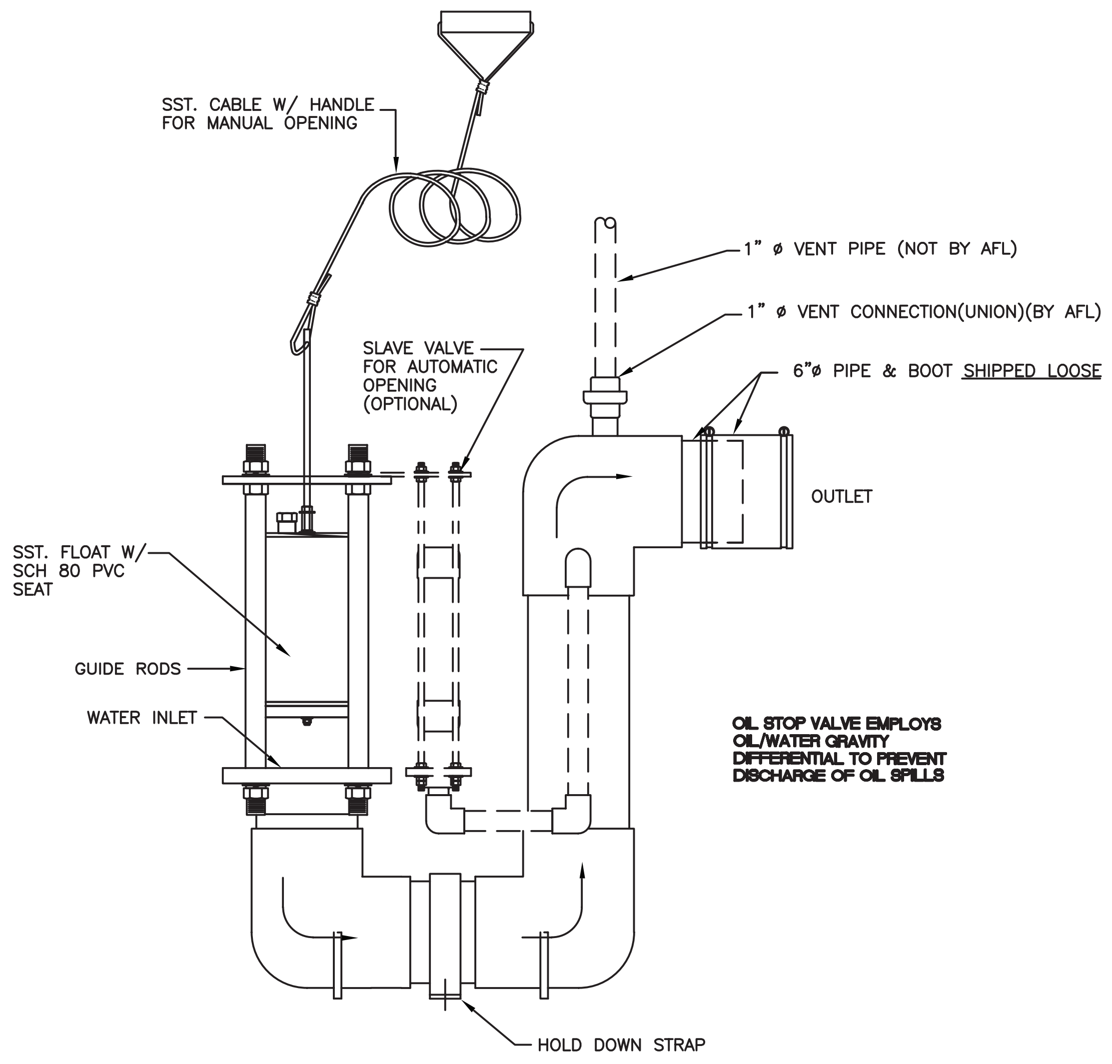
PRODUCT BULLETIN NO. 8-05.B.1 A

AFL OIL STOP VALVE

PVC MODELS
FLOW RATES 0-600 GPM

FUNCTION

PREVENTS DISCHARGE OF SEPARATED OIL TO SEWERS/STREAMS



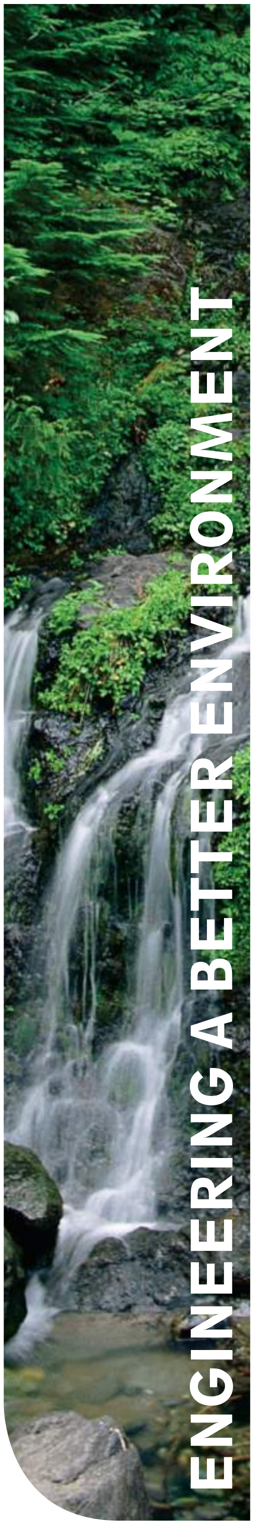
SIDE VIEW

FEATURES

Dependable Gravity Operation
Single Moving Part
Large Flow Capacity
Self-Opening (Slave Valve Option)
No Power Requirement
Corrosion Resistant Construction
Sizes: 4", 6" and 8"

Large, unpredictable oil spills can defeat the most conservatively designed pollution control system, but while the cost of such a system can be prohibitive, the consequences of not controlling a spill can be equally catastrophic. The AFL/Clark Oil Stop Valve (OSV) is designed to solve these problems.

PRODUCT BULLETIN NO. 8-05.B.1 A



Oil Stop Valves confine even large oil spills to the premises. The OSV is available from AFL prepackaged in a fiberglass catch basin or as an option on AFL oil/water separators. In addition, the OSV is available separately for installation in existing separators, catch basins or manholes.

The OSV has only one moving part, a ballasted float set at a specific gravity between that of oil and water. When an oil spill occurs, the float loses buoyancy as the oil level increases until it finally seats itself on the discharge port. Thus the oil spill is confined.

The Oil Stop Valve is fabricated from non-corrosive PVC and stainless steel. Standard sizes are 4″, 6″ and 8″.

Consider the OSV for those application where oil spills are possible, but unpredictable such as electrical transformers, oil storage areas, and transportation fueling systems. The Oil Stop Valve is the most cost effective method to prevent a major disaster.

OSV Options

SLAVE VALVE - The slave is added to an Oil Stop Valve to allow the main float to reopen. Due to lack of water the main float will close. When additional rain water enters the sump, the salve valve float will open and allow water to enter the Oil Stop Valve Body. As the water level rises the main float will open due to water pressure pushing up against the bottom of the main float. In the event of an oil spill, the slave valve float and the main float will close containing the spill.

LEVEL SWITCH

FREEZE PROTECTION

HOW TO PICK THE PROPER VALVE TYPE & SIZE FOR YOUR APPLICATION

PVC

PVC models are the most economical way to prevent bulk hydrocarbon spills. Corrosion resistant PVC construction is an ideal choice for warm climates.

STAINLESS STEEL NOT EXTENDED

Stainless steel not extended models are used in lieu of PVC units in colder climates which may eliminate the necessity for an electric freeze protection package.

STAINLESS STEEL EXTENDED

Stainless steel extended model is our most popular valve if fire is possible. By extending the pipe thru the sump wall, there is no connection inside the sump to burn and fail.

VALVE SIZE	(MAX) FLOW RATE
4″ DIAMETER	160 GPM
6″ DIAMETER	360 GPM
8″ DIAMETER	600 GPM

WARNING: EXCEEDING THESE FLOW RATES MAY CAUSE PREMATURE CLOSING.

AFL RECOMMENDS:

- Sanitary catch basin used to prevent premature valve closure due to leakage.
- 4′ diameter catch basin for the OSV-4 and OSV-6, and a 5′ diameter for the OSV-8.

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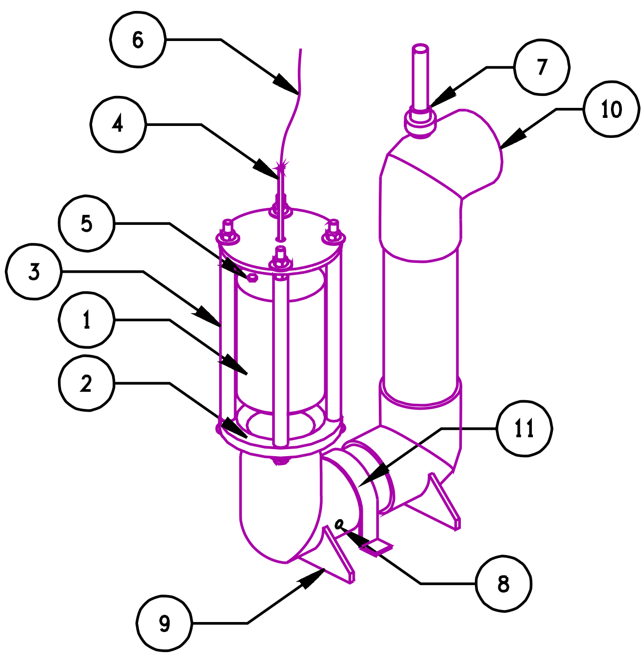

ASSEMBLY LIST

1. FLOAT
2. FLOAT SEAT
3. RETAINING RODS
4. FLOAT GUIDE
5. BALLAST ACCESS HOLE
6. 1/8"ø MANUAL RELEASE CABLE
7. 1"ø SIPHON BREAKER UNION
   (SIPHON BREAKER PIPE NOT BY AFL.)
8. WEEP HOLE
9. LEGS
10. DISCHARGE ELBOW
11. HOLD-DOWN STRAP

INSTALLATION INSTRUCTIONS:

NOTE: OSV discharge pipe (Plain ends) are shipped loose (not glued to the discharge elbow). The contractor, at his discretion, may solvent glue to the valve discharge elbow, or select other suitable means for connecting OSV discharge to outlet pipe.

a) Plain End Connections

All valves with plain end connections are supplied with PVC coupling and two stainless steel worm drive hose clamps. Slide the coupling on valve discharge and install the clamps by sliding them on the coupling.

Line up the valve discharge with outlet pipe, leave 1/4" gap between pipe ends, and slide this coupling and clamp on the outlet pipe. Do not tighten the hose clamps at this time.

b) Flanged End Connections

Line up the flange bolt holes, insert a gasket and bolt flanges. Do not tighten bolts at this time.

WARNING: FLANGES SUPPLIED WITH THE VALVES ARE FLAT FACE; MAKE SURE THE MATING FLANGE IS OF THE SAME DESIGN. USE OF RAISED FLANGES WILL BREAK THE PVC FLANGES.

C. Anchorage

1. OSV valves are supplied with hold down straps, which are designed to secure the valves to the concrete. After the valve has been lined up with outlet nozzle, install the strap on the valve body and use the two holes as a template for locating the anchor bolts.

2. Remove straps and drill in anchors.

3. Replace the strap and bolt down the strap.

D. Siphon Breaker

1. Siphon breaker connection is located on the valve discharge elbow and is furnished with a union to facilitate installation of siphon breaker pipe.

2. In order to calculate siphon breaker pipe length, determine the maximum liquid level in the sump/tank at a spill condition, subtract elevation of the top of the OSV discharge pipe from maximum liquid level and add 1'-6".

   After the length of the pipe has been cut, attach the pipe to the union using PVC solvent cement.

   Install the siphon breaker pipe on the valve and support it as required.
   NOTE: Ideally, the top of the pipe should be as close to grade as possible.

   WARNING: IMPROPER SIPHON PIPE ELEVATION WILL RESULT IN OIL DISCHARGE THROUGH THE SIPHON BREAKER DURING SPILL CONDITION.

CAPACITIES

A minimum recommended water level, sufficient to completely submerge the float housing, is required for proper operation of the OSV. Operation at less than the minimum recommended water level will reduce the capacity of the OSV.

The recommended operating flow rate versus its associated head loss is shown in **Figures 2.01** through **2.03**.

NOTE: For the valve to operate properly at required flow(s), the valve discharge pipe centerline must be below the liquid level at a distance equal to (or greater than) the associated head loss.

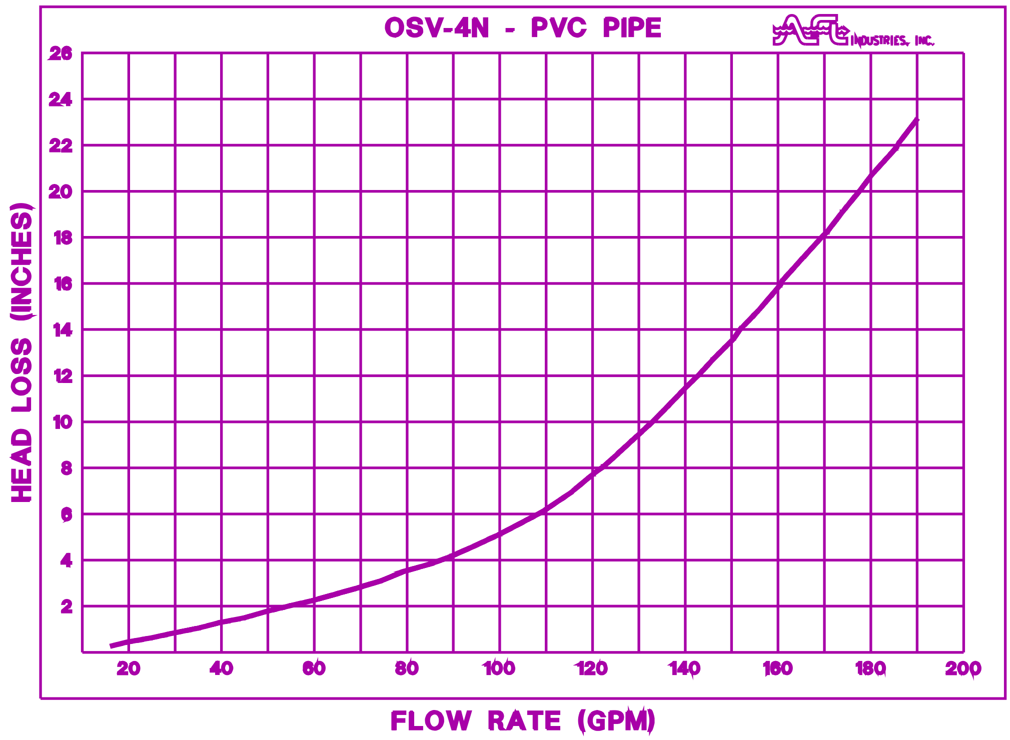

Figure: 2.01 OSV-4 HEAD LOSS VS. FLOW RATE

WARNING: IF THE VALVE IS OPERATED AT GREATER THAN DESIGN OR RECOMMENDED FLOWS IT MAY SHUT OFF AUTOMATICALLY, WHICH MAY NECESSITATE THAT THE VALVE BE REOPENED MANUALLY.

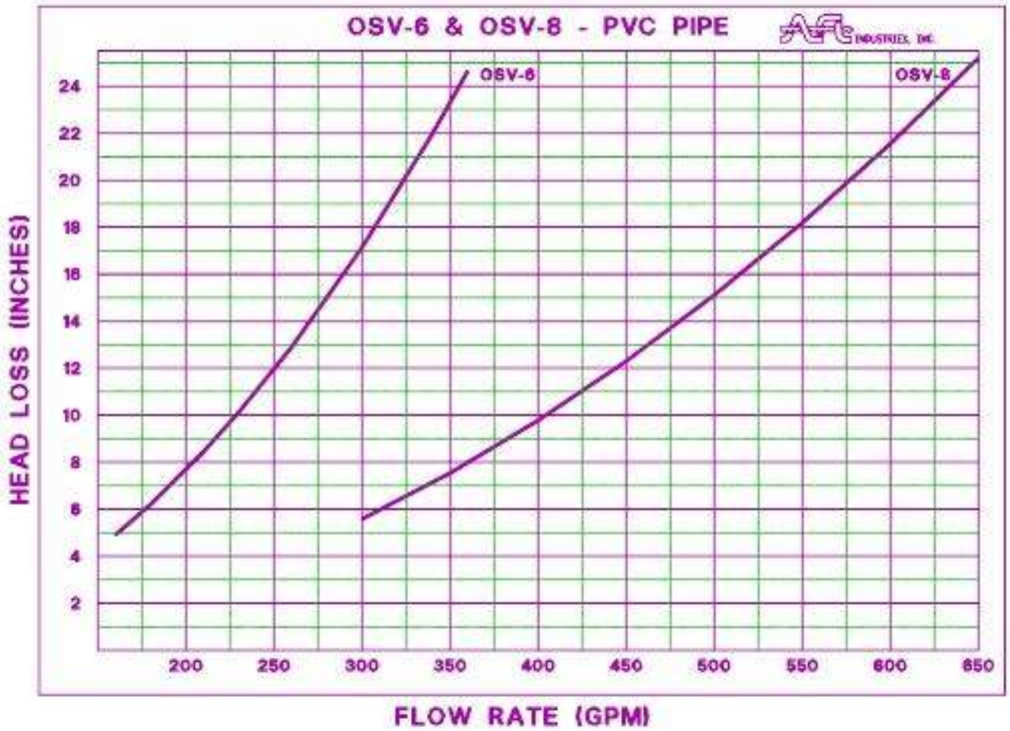

FIG. 2.02

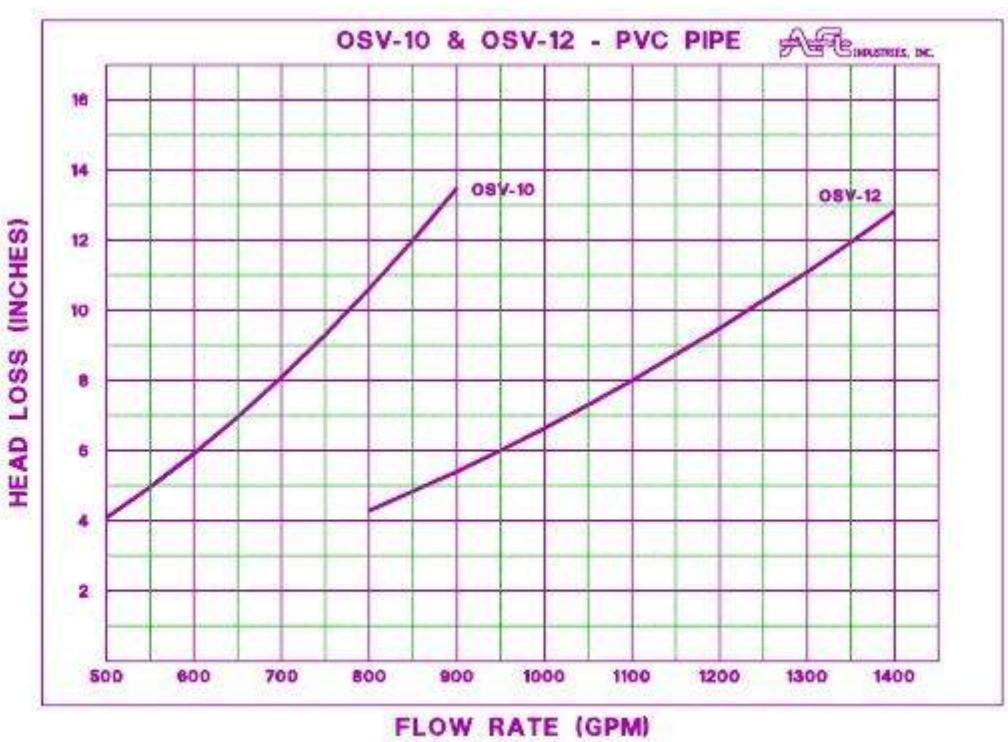

FIG. 2.03

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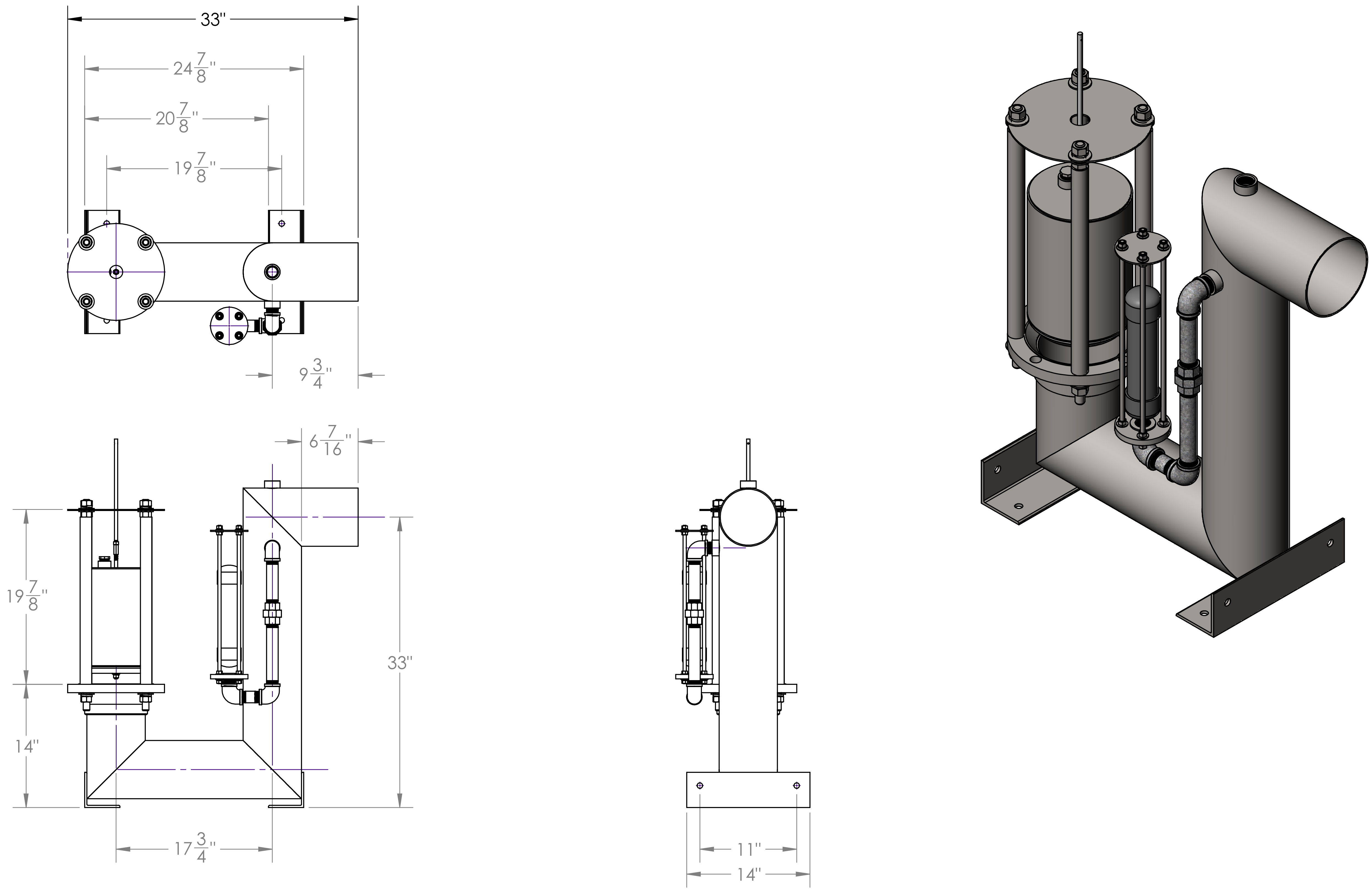
1101 West 13th St.
RIVIERA BEACH, FL 33414

OSV MAINTENANCE

Please read entire page before performing maintenance

1. Remove floating debris.
2. Remove solids from bottom of sump as required. 6” of build up maximum.
3. With water level in sump at outlet invert gently push guide rod downwards approximately 6”. This will allow float to come in contact with the bottom flange.
4. Release guide rod. The rod should rise up to the original position. If this procedure was successful the valve is in proper working order. Occasionally the float will stay seated on the bottom flange when pushed down. Simply pull upwards on the stainless steel cable attached to the guide rod. This will break the suction and allow the float to rise. If when attempting to push guide rod downwards and it appears to be stuck, pull up on stainless steel cable to raise the float again approximately 6”. If float rises release cable. If the float sinks it is inoperable and must be replaced.
5. This procedure should be performed at least yearly.
6. No other maintenance is required.



AFL INDUSTRIES, INC.
1101 WEST 13TH STREET
RIVIERA BEACH, FLORIDA 33404

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ± 1/32
ANGULAR: X° ± 1°
TWO PLACE DECIMAL ± .250
THREE PLACE DECIMAL ± .125

INTERPRET GEOMETRIC TOLERANCING PER: ASME Y14.5M
MATERIAL
FINISH
DO NOT SCALE DRAWING

UPPER ASSEMBLY
USED ON

PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF RGF ENVIRONMENTAL, INC. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF RGF ENVIRONMENTAL, INC. IS PROHIBITED.

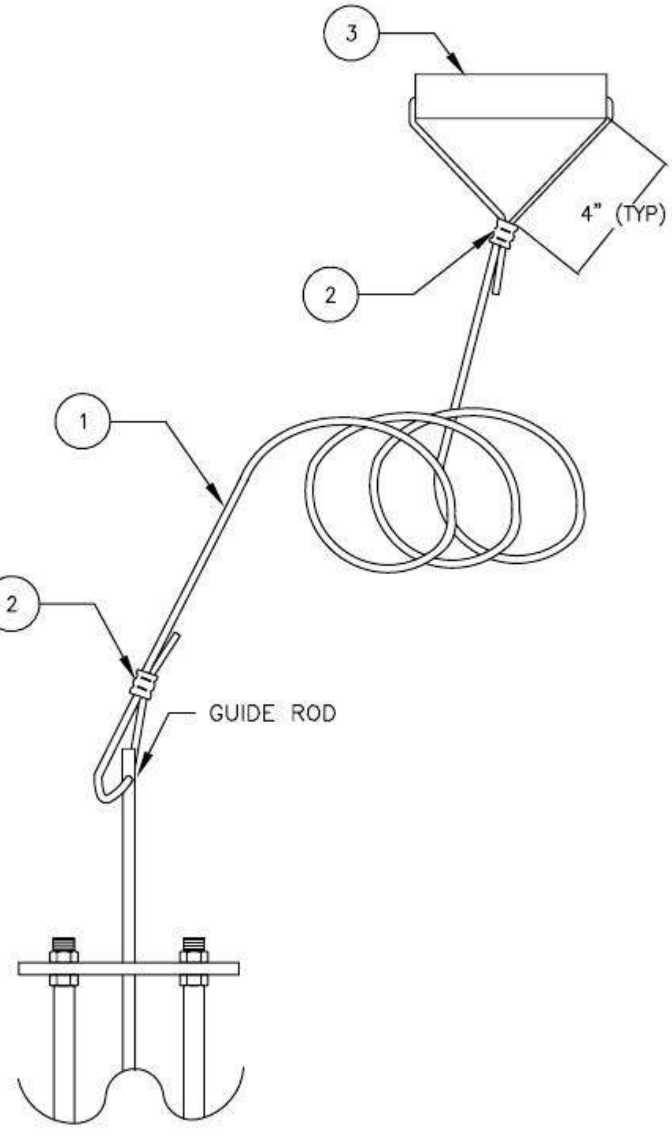
	NAME	DATE
DRAWN	JRH	08/12/2015
APPROVED	SJS	08/14/2015

THIRD ANGLE PROJECTION

TITLE:
OSV 6" SS SV
GENERAL ARRANGEMENT

SIZE	DWG. NO.	REV
B	OSV-6IN SS SV	-

SHEET 1 OF 1



QTY	ITEM	DESCRIPTION	MAT
1	1	CABLE 1/16"ø X 10' LG.	S.S.
2	2	CRIMP FOR 1/16"ø CABLE	S.S.
1	3	1/2" SCH 80 PIPE X 4" LONG	PVC

INDUSTRIES, INC.

SCALE: NONE	THIS DRAWING AND SPECIFICATION IS THE PROPERTY OF AFL INDUSTRIES. 1751 WEST 10TH STREET, RIVIERA BEACH, FLA. 33404 AND SHALL NOT BE REPRODUCED WITHOUT WRITTEN PERMISSION.	DRAWN BY:
DATE:		CHECKED BY:
MODEL: FLOAT GUIDE LIFT CABLE		AFL JOB No. AFL
JOB: AFL		DRAWING No.

ATTACHMENT 5

Establishment of Maintenance Covenant

Note: City of Tumwater to provide appropriate Stormwater Maintenance Agreement form for establishment of maintenance covenant. PSE to record maintenance covenant as required prior to final construction approval of the project.

APPENDIX 1

Design Calculations

WWHM Basin Map

WWHM2012

PROJECT REPORT

General Model Information

WWHM2012 Project Name: Barnes Lake Rebuild WWHM

Site Name:	Barnes Lake Substation
Site Address:	1697 2nd Ave SW
City:	Tumwater, WA
Report Date:	10/26/2023
Gage:	Courthouse
Data Start:	1955/10/01
Data End:	2011/09/30
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2023/01/27
Version:	4.2.19

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year

Landuse Basin Data
Predeveloped Land Use

Predeveloped Site

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Forest, Flat	0.61
Pervious Total	0.61
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.61

Mitigated Land Use

Developed Site

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
PARKING FLAT	0.48
Impervious Total	0.48
Basin Total	0.48

Bypass Area

Bypass:	Yes
GroundWater:	No
Pervious Land Use	acre
A B, Pasture, Flat	0.13
Pervious Total	0.13
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.13

Routing Elements
Predeveloped Routing

Mitigated Routing

Bioretention 1

Bottom Length:	45.50 ft.
Bottom Width:	45.50 ft.
Material thickness of first layer:	0.16
Material type for first layer:	SMMWW 12 in/hr
Material thickness of second layer:	1.5
Material type for second layer:	SMMWW 12 in/hr
Material thickness of third layer:	1
Material type for third layer:	Sand
Infiltration On	
Infiltration rate:	3
Infiltration safety factor:	1
Wetted surface area On	
Total Volume Infiltrated (ac-ft.):	103.458
Total Volume Through Riser (ac-ft.):	0.003
Total Volume Through Facility (ac-ft.):	103.461
Percent Infiltrated:	100
Total Precip Applied to Facility:	12.169
Total Evap From Facility:	5.249

Underdrain not used
Discharge Structure
Riser Height: 1 ft.
Riser Diameter: 12 in.
Element Flows To:
Outlet 1 Outlet 2

Bioretention Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.0475	0.0000	0.0000	0.0000
0.0518	0.0480	0.0011	0.1452	0.0000
0.1036	0.0485	0.0023	0.1467	0.0000
0.1553	0.0490	0.0034	0.1482	0.0000
0.2071	0.0495	0.0046	0.1497	0.0000
0.2589	0.0500	0.0058	0.1512	0.0000
0.3107	0.0505	0.0070	0.1527	0.0000
0.3624	0.0510	0.0082	0.1542	0.0008
0.4142	0.0515	0.0094	0.1558	0.0010
0.4660	0.0520	0.0106	0.1573	0.0017
0.5178	0.0525	0.0118	0.1588	0.0018
0.5696	0.0530	0.0131	0.1604	0.0027
0.6213	0.0535	0.0143	0.1619	0.0033
0.6731	0.0540	0.0156	0.1635	0.0041
0.7249	0.0546	0.0169	0.1650	0.0055
0.7767	0.0551	0.0182	0.1666	0.0058
0.8284	0.0556	0.0195	0.1682	0.0080
0.8802	0.0561	0.0208	0.1698	0.0085
0.9320	0.0566	0.0222	0.1714	0.0107
0.9838	0.0572	0.0235	0.1730	0.0124
1.0356	0.0577	0.0249	0.1746	0.0140
1.0873	0.0582	0.0263	0.1762	0.0173
1.1391	0.0588	0.0276	0.1778	0.0179
1.1909	0.0593	0.0290	0.1794	0.0223
1.2427	0.0598	0.0304	0.1810	0.0236

1.2944	0.0604	0.0319	0.1827	0.0276
1.3462	0.0609	0.0333	0.1843	0.0310
1.3980	0.0615	0.0348	0.1860	0.0337
1.4498	0.0620	0.0362	0.1876	0.0398
1.5016	0.0626	0.0377	0.1893	0.0406
1.5533	0.0631	0.0392	0.1910	0.0480
1.6051	0.0637	0.0407	0.1926	0.0507
1.6569	0.0642	0.0422	0.1943	0.0569
1.7087	0.0648	0.0435	0.1960	0.0629
1.7604	0.0654	0.0449	0.1977	0.0668
1.8122	0.0659	0.0462	0.1994	0.0769
1.8640	0.0665	0.0476	0.2011	0.0778
1.9158	0.0671	0.0490	0.2028	0.0891
1.9676	0.0676	0.0504	0.2046	0.0938
2.0193	0.0682	0.0518	0.2063	0.0995
2.0711	0.0688	0.0532	0.2080	0.1036
2.1229	0.0693	0.0546	0.2098	0.1132
2.1747	0.0699	0.0561	0.2115	0.1185
2.2264	0.0705	0.0575	0.2133	0.1335
2.2782	0.0711	0.0590	0.2150	0.1353
2.3300	0.0717	0.0605	0.2168	0.1513
2.3818	0.0723	0.0620	0.2186	0.1585
2.4336	0.0729	0.0635	0.2204	0.1706
2.4853	0.0734	0.0650	0.2222	0.1841
2.5371	0.0740	0.0665	0.2240	0.1916
2.5889	0.0746	0.0681	0.2258	0.1988
2.6407	0.0752	0.0696	0.2276	0.2009
2.6924	0.0758	0.0735	0.2294	0.2028
2.7442	0.0764	0.0775	0.2312	0.0026
2.7960	0.0770	0.0814	0.2331	0.0053
2.8478	0.0776	0.0854	0.2349	0.0079
2.8996	0.0783	0.0895	0.2367	0.0106
2.9513	0.0789	0.0935	0.2386	0.0133
3.0031	0.0795	0.0976	0.2404	0.0160
3.0549	0.0801	0.1018	0.2423	0.0187
3.1067	0.0807	0.1059	0.2442	0.0214
3.1584	0.0813	0.1101	0.2461	0.0241
3.2102	0.0820	0.1144	0.2479	0.0269
3.2620	0.0826	0.1186	0.2498	0.0296
3.3138	0.0832	0.1229	0.2517	0.0324
3.3656	0.0838	0.1272	0.2536	0.0352
3.4173	0.0845	0.1316	0.2555	0.0380
3.4691	0.0851	0.1360	0.2575	0.0408
3.5209	0.0857	0.1404	0.2594	0.0436
3.5727	0.0864	0.1449	0.2613	0.0465
3.6244	0.0870	0.1494	0.2633	0.0493
3.6762	0.0877	0.1539	0.2652	0.0522
3.7280	0.0883	0.1584	0.2672	0.0551
3.7798	0.0890	0.1630	0.2691	0.0580
3.8316	0.0896	0.1677	0.2711	0.0609
3.8833	0.0903	0.1723	0.2731	0.0638
3.9351	0.0909	0.1770	0.2750	0.0667
3.9869	0.0916	0.1817	0.2770	0.0697
4.0387	0.0922	0.1865	0.2790	0.0726
4.0904	0.0929	0.1913	0.2810	0.0756
4.1422	0.0936	0.1961	0.2830	0.0786
4.1940	0.0942	0.2010	0.2850	0.0816
4.2458	0.0949	0.2059	0.2870	0.0846

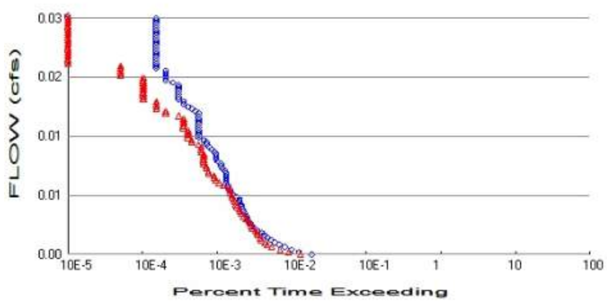
4.2976	0.0956	0.2108	0.2891	0.0876
4.3493	0.0962	0.2158	0.2911	0.0906
4.4011	0.0969	0.2208	0.2931	0.0937
4.4529	0.0976	0.2258	0.2952	0.0968
4.5047	0.0983	0.2309	0.2972	0.0998
4.5564	0.0989	0.2360	0.2993	0.1029
4.6082	0.0996	0.2411	0.3014	0.1060

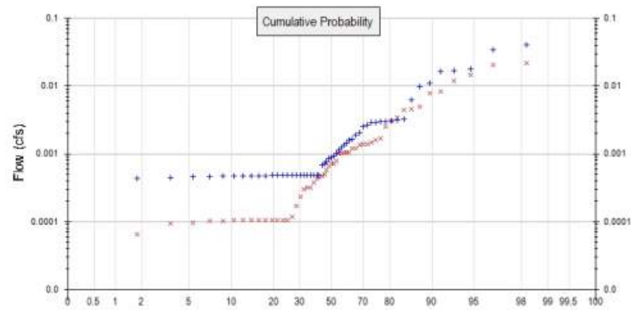
Bioretention Hydraulic Table

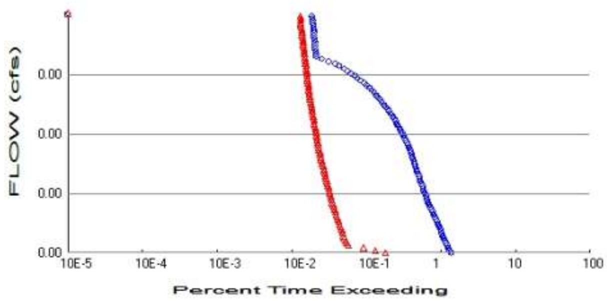
Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**To Amended(cfs)**	**Infilt(cfs)**
4.6082	0.0475	0.2411	0.0000	0.3034	0.1091
4.6600	0.1003	0.2463	0.0000	0.3034	0.1123
4.7118	0.1010	0.2515	0.0000	0.3055	0.1124
4.6600	0.1239	0.2854	0.0000	0.1480	0.0000

Surface retention 1

Analysis Results
POC 1







+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 0.61
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.13
Total Impervious Area: 0.48

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.001152
5 year	0.003578
10 year	0.007055
25 year	0.015584
50 year	0.027023
100 year	0.045517

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.000597
5 year	0.00248
10 year	0.005472
25 year	0.013199
50 year	0.023786
100 year	0.040958

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1956	0.002	0.001
1957	0.000	0.001
1958	0.001	0.003
1959	0.001	0.001
1960	0.003	0.002
1961	0.003	0.001
1962	0.000	0.000
1963	0.003	0.008
1964	0.003	0.001
1965	0.003	0.003
1966	0.000	0.000
1967	0.016	0.008
1968	0.003	0.005
1969	0.000	0.000
1970	0.000	0.000
1971	0.003	0.001
1972	0.034	0.015
1973	0.000	0.000
1974	0.010	0.004
1975	0.000	0.000
1976	0.002	0.001
1977	0.000	0.000
1978	0.001	0.001
1979	0.000	0.000
1980	0.001	0.000
1981	0.002	0.001
1982	0.001	0.001
1983	0.001	0.001
1984	0.011	0.002
1985	0.000	0.000
1986	0.001	0.002
1987	0.003	0.001
1988	0.000	0.000
1989	0.000	0.000
1990	0.003	0.001
1991	0.018	0.012
1992	0.000	0.000
1993	0.001	0.001
1994	0.000	0.000
1995	0.000	0.000
1996	0.041	0.021
1997	0.000	0.000
1998	0.000	0.000
1999	0.001	0.000
2000	0.000	0.000
2001	0.000	0.000
2002	0.001	0.001
2003	0.001	0.000
2004	0.017	0.022
2005	0.000	0.000
2006	0.000	0.000
2007	0.006	0.005
2008	0.000	0.000
2009	0.000	0.000
2010	0.000	0.000
2011	0.002	0.001

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.0409	0.0219
2	0.0342	0.0205
3	0.0178	0.0146
4	0.0166	0.0119
5	0.0164	0.0082
6	0.0110	0.0079
7	0.0099	0.0049
8	0.0063	0.0045
9	0.0033	0.0045
10	0.0032	0.0035
11	0.0031	0.0030
12	0.0030	0.0025
13	0.0030	0.0017
14	0.0029	0.0016
15	0.0029	0.0015
16	0.0027	0.0014
17	0.0025	0.0014
18	0.0021	0.0014
19	0.0019	0.0012
20	0.0016	0.0012
21	0.0016	0.0011
22	0.0014	0.0010
23	0.0014	0.0010
24	0.0012	0.0010
25	0.0011	0.0010
26	0.0010	0.0008
27	0.0009	0.0007
28	0.0009	0.0007
29	0.0008	0.0007
30	0.0008	0.0006
31	0.0007	0.0005
32	0.0007	0.0005
33	0.0005	0.0005
34	0.0005	0.0004
35	0.0005	0.0004
36	0.0005	0.0003
37	0.0005	0.0003
38	0.0005	0.0003
39	0.0005	0.0002
40	0.0005	0.0002
41	0.0005	0.0001
42	0.0005	0.0001
43	0.0005	0.0001
44	0.0005	0.0001
45	0.0005	0.0001
46	0.0005	0.0001
47	0.0005	0.0001
48	0.0005	0.0001
49	0.0005	0.0001
50	0.0005	0.0001
51	0.0005	0.0001
52	0.0005	0.0001
53	0.0005	0.0001
54	0.0004	0.0001

55	0.0004	0.0001
56	0.0004	0.0000

LID Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0001	26705	3532	13	Pass
0.0001	25644	2580	10	Pass
0.0001	24741	1813	7	Pass
0.0001	23681	1133	4	Pass
0.0001	22876	1082	4	Pass
0.0001	22071	1032	4	Pass
0.0001	21344	1009	4	Pass
0.0001	20775	978	4	Pass
0.0001	20205	951	4	Pass
0.0001	19675	927	4	Pass
0.0001	19114	905	4	Pass
0.0001	18648	883	4	Pass
0.0002	18077	853	4	Pass
0.0002	17511	834	4	Pass
0.0002	16885	813	4	Pass
0.0002	16251	799	4	Pass
0.0002	15693	775	4	Pass
0.0002	15129	754	4	Pass
0.0002	14611	736	5	Pass
0.0002	14110	720	5	Pass
0.0002	13743	710	5	Pass
0.0002	13274	690	5	Pass
0.0002	12863	676	5	Pass
0.0002	12530	661	5	Pass
0.0002	12206	648	5	Pass
0.0002	11895	638	5	Pass
0.0002	11613	630	5	Pass
0.0002	11338	617	5	Pass
0.0002	10980	600	5	Pass
0.0002	10719	586	5	Pass
0.0002	10429	577	5	Pass
0.0002	10181	563	5	Pass
0.0002	9930	555	5	Pass
0.0003	9692	547	5	Pass
0.0003	9427	541	5	Pass
0.0003	9150	532	5	Pass
0.0003	8919	520	5	Pass
0.0003	8740	506	5	Pass
0.0003	8536	497	5	Pass
0.0003	8324	487	5	Pass
0.0003	8129	481	5	Pass
0.0003	7956	473	5	Pass
0.0003	7752	469	6	Pass
0.0003	7544	455	6	Pass
0.0003	7348	449	6	Pass
0.0003	7126	442	6	Pass
0.0003	6920	439	6	Pass
0.0003	6682	432	6	Pass
0.0003	6411	429	6	Pass
0.0003	6175	423	6	Pass
0.0003	5952	417	7	Pass
0.0003	5687	413	7	Pass
0.0003	5482	410	7	Pass

0.0004	5233	400	7	Pass
0.0004	4986	394	7	Pass
0.0004	4832	392	8	Pass
0.0004	4646	388	8	Pass
0.0004	4449	382	8	Pass
0.0004	4179	376	8	Pass
0.0004	3982	369	9	Pass
0.0004	3772	367	9	Pass
0.0004	3586	362	10	Pass
0.0004	3358	360	10	Pass
0.0004	3140	354	11	Pass
0.0004	2983	347	11	Pass
0.0004	2800	344	12	Pass
0.0004	2649	339	12	Pass
0.0004	2484	337	13	Pass
0.0004	2343	332	14	Pass
0.0004	2158	331	15	Pass
0.0004	1987	330	16	Pass
0.0004	1825	324	17	Pass
0.0004	1636	321	19	Pass
0.0004	1505	318	21	Pass
0.0005	1380	316	22	Pass
0.0005	1231	315	25	Pass
0.0005	1110	310	27	Pass
0.0005	982	308	31	Pass
0.0005	848	306	36	Pass
0.0005	743	301	40	Pass
0.0005	617	300	48	Pass
0.0005	495	297	60	Pass
0.0005	420	294	70	Pass
0.0005	415	291	70	Pass
0.0005	412	288	69	Pass
0.0005	406	286	70	Pass
0.0005	404	283	70	Pass
0.0005	403	281	69	Pass
0.0005	400	280	70	Pass
0.0005	395	276	69	Pass
0.0005	392	275	70	Pass
0.0005	392	272	69	Pass
0.0005	389	270	69	Pass
0.0005	387	268	69	Pass
0.0006	383	265	69	Pass
0.0006	381	260	68	Pass
0.0006	379	259	68	Pass
0.0006	376	258	68	Pass
0.0006	371	258	69	Pass
0.0006	366	256	69	Pass

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0006	366	256	69	Pass
0.0008	243	177	72	Pass
0.0011	196	137	69	Pass
0.0014	160	106	66	Pass
0.0016	133	92	69	Pass
0.0019	115	87	75	Pass
0.0022	103	77	74	Pass
0.0024	95	74	77	Pass
0.0027	84	69	82	Pass
0.0030	78	67	85	Pass
0.0032	68	64	94	Pass
0.0035	62	59	95	Pass
0.0038	57	57	100	Pass
0.0040	54	54	100	Pass
0.0043	51	52	101	Pass
0.0046	50	48	96	Pass
0.0049	48	45	93	Pass
0.0051	46	42	91	Pass
0.0054	44	40	90	Pass
0.0057	43	39	90	Pass
0.0059	42	36	85	Pass
0.0062	41	35	85	Pass
0.0065	39	34	87	Pass
0.0067	39	33	84	Pass
0.0070	36	31	86	Pass
0.0073	32	31	96	Pass
0.0075	30	29	96	Pass
0.0078	29	29	100	Pass
0.0081	27	28	103	Pass
0.0083	27	24	88	Pass
0.0086	26	21	80	Pass
0.0089	26	19	73	Pass
0.0091	26	18	69	Pass
0.0094	26	18	69	Pass
0.0097	26	15	57	Pass
0.0099	25	15	60	Pass
0.0102	23	14	60	Pass
0.0105	22	14	63	Pass
0.0107	22	13	59	Pass
0.0110	20	13	65	Pass
0.0113	19	13	68	Pass
0.0115	19	13	68	Pass
0.0118	19	13	68	Pass
0.0121	18	12	66	Pass
0.0123	17	12	70	Pass
0.0126	15	12	80	Pass
0.0129	14	11	78	Pass
0.0131	14	9	64	Pass
0.0134	13	9	69	Pass
0.0137	11	8	72	Pass
0.0139	11	8	72	Pass
0.0142	11	8	72	Pass
0.0145	11	8	72	Pass

0.0147	11	7	63	Pass
0.0150	11	7	63	Pass
0.0153	11	7	63	Pass
0.0155	11	7	63	Pass
0.0158	11	7	63	Pass
0.0161	11	6	54	Pass
0.0163	11	4	36	Pass
0.0166	10	4	40	Pass
0.0169	9	3	33	Pass
0.0171	8	3	37	Pass
0.0174	7	3	42	Pass
0.0177	7	3	42	Pass
0.0179	6	2	33	Pass
0.0182	6	2	33	Pass
0.0185	6	2	33	Pass
0.0187	6	2	33	Pass
0.0190	6	2	33	Pass
0.0193	6	2	33	Pass
0.0195	6	2	33	Pass
0.0198	5	2	40	Pass
0.0201	4	2	50	Pass
0.0203	4	2	50	Pass
0.0206	4	1	25	Pass
0.0209	4	1	25	Pass
0.0211	4	1	25	Pass
0.0214	3	1	33	Pass
0.0217	3	1	33	Pass
0.0219	3	0	0	Pass
0.0222	3	0	0	Pass
0.0225	3	0	0	Pass
0.0227	3	0	0	Pass
0.0230	3	0	0	Pass
0.0233	3	0	0	Pass
0.0236	3	0	0	Pass
0.0238	3	0	0	Pass
0.0241	3	0	0	Pass
0.0244	3	0	0	Pass
0.0246	3	0	0	Pass
0.0249	3	0	0	Pass
0.0252	3	0	0	Pass
0.0254	3	0	0	Pass
0.0257	3	0	0	Pass
0.0260	3	0	0	Pass
0.0262	3	0	0	Pass
0.0265	3	0	0	Pass
0.0268	3	0	0	Pass
0.0270	3	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
retention 1 POC	☐	94.15			☐	100.00			
Total Volume Infiltrated		94.15	0.00	0.00		100.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

Model Default Modifications

Total of 0 changes have been made.

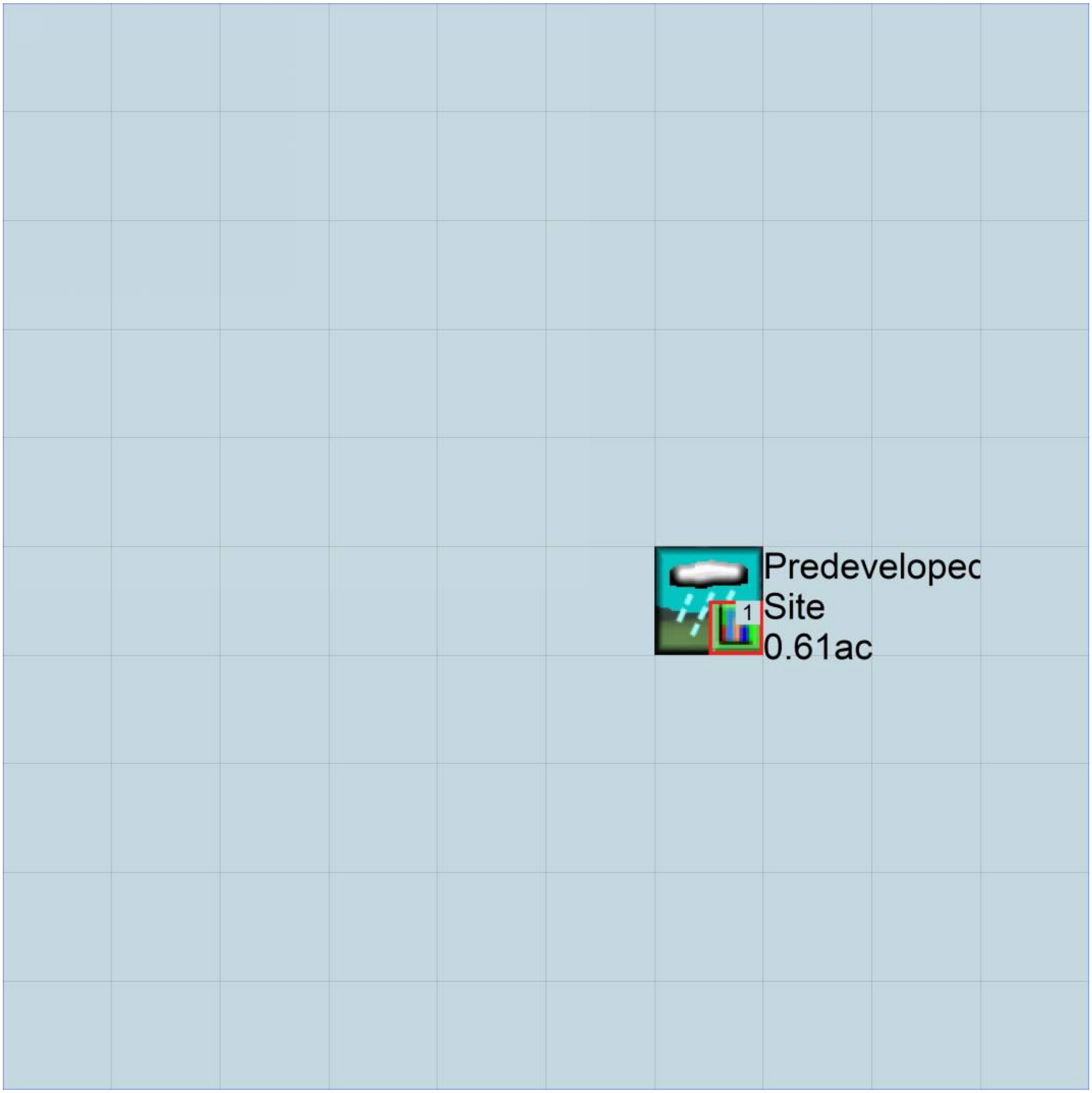
PERLND Changes

No PERLND changes have been made.

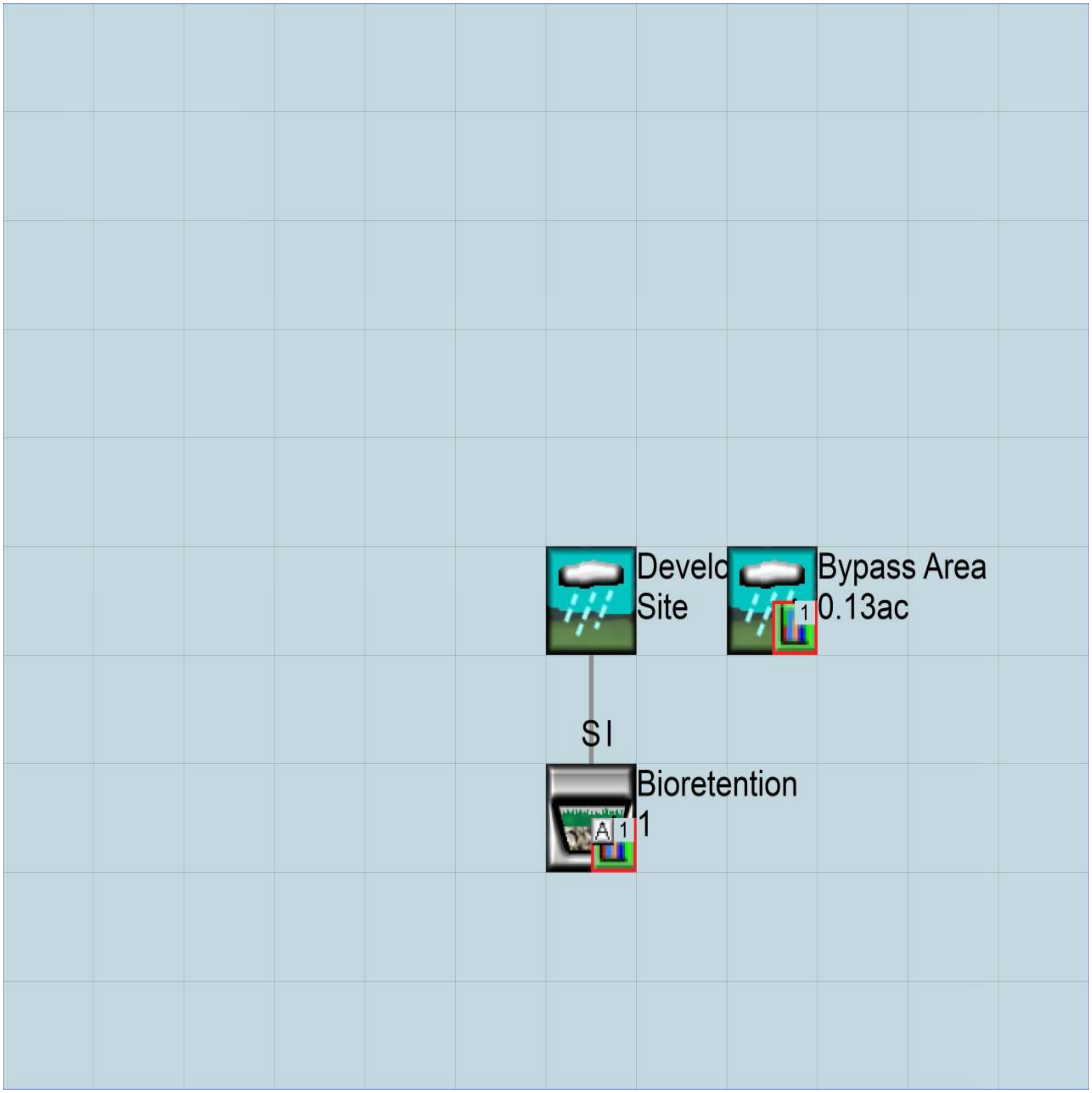
IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1955 10 01        END    2011 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   Barnes Lake Rebuild WWHM.wdm
MESSU      25   PreBarnes Lake Rebuild WWHM.MES
           27   PreBarnes Lake Rebuild WWHM.L61
           28   PreBarnes Lake Rebuild WWHM.L62
           30   POCBarnes Lake Rebuild WWHM1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND       1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Predeveloped Site           MAX                   1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                            User  t-series Engl Metr ***
                                             in  out          ***
    1      A/B, Forest, Flat       1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
    1         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
    1         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
    1         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
    1              0         5         2       400      0.05       0.3     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    1              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                   ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    1            0.2       0.5      0.35         0       0.7       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
             ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
    1              0         0         0         0         3         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out            ***
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
  END IWAT-STATE1
```

```
END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Predeveloped Site***
PERLND   1                        0.61     COPY   501     12
PERLND   1                        0.61     COPY   501     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *        *  *  *  *  *        ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
```

```
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1955 10 01        END    2011 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   Barnes Lake Rebuild WWHM.wdm
MESSU      25   MitBarnes Lake Rebuild WWHM.MES
           27   MitBarnes Lake Rebuild WWHM.L61
           28   MitBarnes Lake Rebuild WWHM.L62
           30   POCBarnes Lake Rebuild WWHM1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      IMPLND      11
      PERLND       4
      GENER        2
      RCHRES       1
      RCHRES       2
      COPY         1
      COPY       501
      COPY       601
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Surface retention  1        MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  601         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
    2        24
  END OPCODE
  PARM
    #    #         K ***
    2             0.
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
    4     A/B, Pasture, Flat      1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
```

```
    4         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
    4         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
    4         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
    4              0         5       1.5       400      0.05       0.3     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    4              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    4           0.15       0.5       0.3         0       0.7       0.4
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
    4              0         0         0         0         3         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                    User  t-series Engl Metr ***
                                     in  out           ***
   11      PARKING/FLAT           1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
   11         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
   11         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
   11         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
```

```
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
   11           400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
   11             0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
   11             0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Developed Site***
IMPLND  11                        0.48     RCHRES   1      5
Basin  2***
PERLND   4                        0.13     COPY   501     12
PERLND   4                        0.13     COPY   601     12
PERLND   4                        0.13     COPY   501     13
PERLND   4                        0.13     COPY   601     13

******Routing******
IMPLND  11                        0.48     COPY     1     15
RCHRES   1                           1     RCHRES   2      8
RCHRES   2                           1     COPY   501     17
RCHRES   1                           1     COPY   501     17
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1
GENER    2 OUTPUT TIMSER      .0011111     RCHRES   1     EXTNL  OUTDGT 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                         in  out                             ***
    1     Surface retentio-008    3    1    1    1   28    0    1
    2     Bioretention  1         2    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
    2         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL   PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL   PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
    2         4    0    0    0    0    0    0    0    0    0    1    9
```

```
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                         ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *        ***
    1        0  1  0  0    4  5  6  0  0       0  1  0  0  0       2  1  2  2  2
    2        0  1  0  0    4  5  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1              1      0.01       0.0       0.0       0.0       0.0
    2              2      0.01       0.0       0.0       0.0       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                            ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1           0         4.0  5.0  6.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    2           0         4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
*** User-Defined Variable Quantity Lines
***                          addr
***                        <------>
*** kwd  varnam optyp  opn  vari  s1 s2 s3 tp multiply  lc ls ac as agfn ***
  <****> <----> <----> <-> <----><-><-><-><-><--------> <><-> <><-> <--> ***
  UVQUAN vol2   RCHRES   2 VOL              4
  UVQUAN v2m2   GLOBAL     WORKSP  1        3
  UVQUAN vpo2   GLOBAL     WORKSP  2        3
  UVQUAN v2d2   GENER    2 K       1        3
*** User-Defined Target Variable Names
***                addr or                       addr or
***               <------>                      <------>
*** kwd   varnam ct  vari  s1 s2 s3  frac oper     vari  s1 s2 s3  frac oper
  <****>  <----><-> <----><-><-><-> <---> <-->    <----><-><-><-> <---> <-->
  UVNAME  v2m2    1 WORKSP  1         1.0 QUAN
  UVNAME  vpo2    1 WORKSP  2         1.0 QUAN
  UVNAME  v2d2    1 K       1         1.0 QUAN
*** opt foplop dcdts  yr mo dy hr mn d t   vnam  s1 s2 s3 ac quantity  tc  ts rp
  <****><-><--><><-><--> <> <> <> <><><>  <----><-><-><-><-><--------> <> <-><->
  GENER   2                               v2m2            =  3670.15
*** Compute remaining available pore space
  GENER   2                               vpo2            =  v2m2
  GENER   2                               vpo2           -=  vol2
*** Check to see if VPORA goes negative; if so set VPORA = 0.0
IF (vpo2 < 0.0) THEN
  GENER   2                               vpo2            =  0.0
END IF
*** Infiltration volume
  GENER   2                               v2d2            =  vpo2
END SPEC-ACTIONS
FTABLES
  FTABLE      2
   53    5
     Depth      Area    Volume  Outflow1  Outflow2  Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)     (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.086716  0.000000  0.000000  0.000000
  0.051209  0.085899  0.001121  0.000000  0.000000
  0.102418  0.085038  0.002256  0.000000  0.000000
  0.153626  0.084182  0.003407  0.000000  0.000000
  0.204835  0.083330  0.004573  0.000000  0.000000
  0.256044  0.082482  0.005755  0.000000  0.000000
  0.307253  0.081638  0.006952  0.000000  0.000000
```

0.358462	0.080799	0.008165	0.000000	0.000814
0.409670	0.079965	0.009393	0.000000	0.000953
0.460879	0.079134	0.010638	0.000000	0.001663
0.512088	0.078308	0.011898	0.000000	0.001797
0.563297	0.077486	0.013175	0.000000	0.002684
0.614505	0.076669	0.014467	0.000000	0.003311
0.665714	0.075856	0.015776	0.000000	0.004058
0.716923	0.075047	0.017101	0.000000	0.005484
0.768132	0.074243	0.018443	0.000000	0.005837
0.819341	0.073443	0.019801	0.000000	0.007980
0.870549	0.072647	0.021176	0.000000	0.008535
0.921758	0.071855	0.022567	0.000000	0.010706
0.972967	0.071068	0.023976	0.000000	0.012419
1.024176	0.070286	0.025401	0.000000	0.014000
1.075385	0.069507	0.026843	0.000000	0.017323
1.126593	0.068733	0.028303	0.000000	0.017920
1.177802	0.067963	0.029780	0.000000	0.022267
1.229011	0.067198	0.031274	0.000000	0.023642
1.280220	0.066437	0.032786	0.000000	0.027566
1.331429	0.065680	0.034315	0.000000	0.031035
1.382637	0.064928	0.035862	0.000000	0.033670
1.433846	0.064180	0.037427	0.000000	0.039836
1.485055	0.063436	0.039009	0.000000	0.040646
1.536264	0.062697	0.040610	0.000000	0.048020
1.587473	0.061961	0.042229	0.000000	0.050741
1.638681	0.061231	0.043865	0.000000	0.056851
1.689890	0.060504	0.045313	0.000000	0.062882
1.741099	0.059782	0.046777	0.000000	0.066752
1.792308	0.059065	0.048257	0.000000	0.076850
1.843516	0.058351	0.049753	0.000000	0.077796
1.894725	0.057642	0.051266	0.000000	0.089094
1.945934	0.056937	0.052795	0.000000	0.093788
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2.048352	0.055541	0.055902	0.000000	0.103618
2.099560	0.054849	0.057481	0.000000	0.113198
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2.201978	0.053479	0.060689	0.000000	0.133532
2.253187	0.052800	0.062319	0.000000	0.135269
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2.355604	0.051456	0.065629	0.000000	0.158520
2.406813	0.050790	0.067310	0.000000	0.170624
2.458022	0.050129	0.069008	0.184073	0.184073
2.509231	0.049472	0.070723	0.191643	0.191643
2.560440	0.048819	0.072457	0.198838	0.198838
2.611648	0.048170	0.074207	0.200851	0.200851
2.660000	0.047526	0.084255	0.202760	0.202760

END FTABLE 2
FTABLE 1
41 6

Depth (ft)	Area (acres)	Volume (acre-ft)	Outflow1 (cfs)	Outflow2 (cfs)	Outflow3 (cfs)	Velocity (ft/sec)	Travel Time*** (Minutes)***
0.000000	0.047526	0.000000	0.000000	0.000000	0.002629		
0.051209	0.087585	0.004463	0.000000	0.086083	0.002629		
0.102418	0.088458	0.008970	0.000000	0.087709	0.005272		
0.153626	0.089336	0.013523	0.000000	0.089335	0.007927		
0.204835	0.090218	0.018120	0.000000	0.090960	0.010596		
0.256044	0.091105	0.022763	0.000000	0.092586	0.013278		
0.307253	0.091996	0.027451	0.000000	0.094212	0.015972		
0.358462	0.092891	0.032185	0.000000	0.095838	0.018680		
0.409670	0.093790	0.036965	0.000000	0.097464	0.021402		
0.460879	0.094694	0.041791	0.000000	0.099090	0.024136		
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0.563297	0.096515	0.051582	0.000000	0.102342	0.029643		
0.614505	0.097432	0.056548	0.000000	0.103968	0.032417		
0.665714	0.098353	0.061561	0.000000	0.105594	0.035204		
0.716923	0.099279	0.066621	0.000000	0.107220	0.038003		
0.768132	0.100209	0.071729	0.000000	0.108845	0.040816		
0.819341	0.101143	0.076885	0.000000	0.110471	0.043642		

```
  0.870549  0.102081  0.082088  0.000000  0.112097  0.046481
  0.921758  0.103024  0.087340  0.000000  0.113723  0.049333
  0.972967  0.103971  0.092640  0.000000  0.115349  0.052199
  1.024176  0.104923  0.097988  0.039879  0.116975  0.055077
  1.075385  0.105879  0.103386  0.218967  0.118601  0.057969
  1.126593  0.106839  0.108832  0.472396  0.120227  0.060873
  1.177802  0.107804  0.114328  0.770858  0.121853  0.063791
  1.229011  0.108772  0.119873  1.088234  0.123479  0.066722
  1.280220  0.109746  0.125468  1.397744  0.125105  0.069666
  1.331429  0.110723  0.131113  1.674111  0.126731  0.072623
  1.382637  0.111705  0.136808  1.897926  0.128356  0.075593
  1.433846  0.112691  0.142554  2.061390  0.129982  0.078577
  1.485055  0.113682  0.148350  2.175074  0.131608  0.081573
  1.536264  0.114677  0.154197  2.306475  0.133234  0.084583
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WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP
WDM      2 PREC     ENGL    1              RCHRES   1     EXTNL  PREC
WDM      1 EVAP     ENGL    0.5            RCHRES   1     EXTNL  POTEV
WDM      1 EVAP     ENGL    0.76           RCHRES   2     EXTNL  POTEV

END EXT SOURCES

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<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   2 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      1 1        1      WDM   1001 FLOW     ENGL      REPL
RCHRES   2 HYDR   O      2 1        1      WDM   1002 FLOW     ENGL      REPL
RCHRES   2 HYDR   STAGE  1 1        1      WDM   1003 STAG     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1004 STAG     ENGL      REPL
RCHRES   1 HYDR   O      1 1        1      WDM   1005 FLOW     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
COPY   601 OUTPUT MEAN   1 1     48.4      WDM    901 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
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<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
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IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK        8
RCHRES     OFLOW  OVOL   2                 RCHRES         INFLOW IVOL
  END MASS-LINK    8

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
```

```
PERLND     PWATER IFWO        0.083333      COPY          INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO        0.083333      COPY          INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       17
RCHRES     OFLOW  OVOL   1                  COPY          INPUT  MEAN
  END MASS-LINK   17

END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

Disclaimer

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Clear Creek Solutions, Inc.
6200 Capitol Blvd. Ste F
Olympia, WA. 98501
Toll Free 1(866)943-0304
Local (360)943-0304

www.clearcreeksolutions.com

6" DIA Stormwater Conveyance Pipe Capacity Check

The substation conveyance system was designed conservatively with the capacity to convey the 100-year developed peak flow from the site. Manning's equation with an "n" coefficient of 0.012 for plastic pipe was used to determine the flow that a six inch pipe with a slope of 0.5% can convey when flowing full:

$Q_{MAX} = (1.49 / n) * A * R^{2/3} * S^{1/2}$

> Q_{MAX} = Pipe capacity flowing full (cfs)
> n = Manning's coefficient
> A = cross sectional area (sf)
> R = hydraulic radius (ft)
> S = slope (ft/ft)

<u>6" DIA Conveyance Pipes at Minimum 0.5% Slope:</u>

$Q_{MAX} = (1.49 / 0.012) * 0.196 * 0.125^{2/3} * 0.005^{1/2}$

Q_{MAX} = 0.429 cfs

100-YR Developed Peak Flow (per WWHM12 Flow Frequency Results) = 0.419 cfs

$\boxed{0.430 \text{ cfs} > 0.419 \text{ cfs}}$

Bioretention Cell Emergency Overflow Capacity Check

The bioretention cell includes an emergency overflow weir designed to pass the 100-year developed peak flow from the site in the event the facility becomes plugged and fails. The broad crested weir equation was used to determine the capacity of the emergency overflow spillway:

$Q_{MAX} = C * (2g)^{1/2} * [(2/3 * L * H^{3/2}) + (8/15 * \tan\theta * H^{5/2})]$

> Q_{MAX} = capacity of overflow weir (cfs)
> C = discharge coefficient = 0.6
> g = gravity = 32.2 ft/s^2
> L = length of weir (ft)
> H = height of water over weir (ft) (min = 0.2 ft)
> θ = angle of side slopes

<u>4 FT Long Overflow Weir with 3:1 Side Slopes:</u>

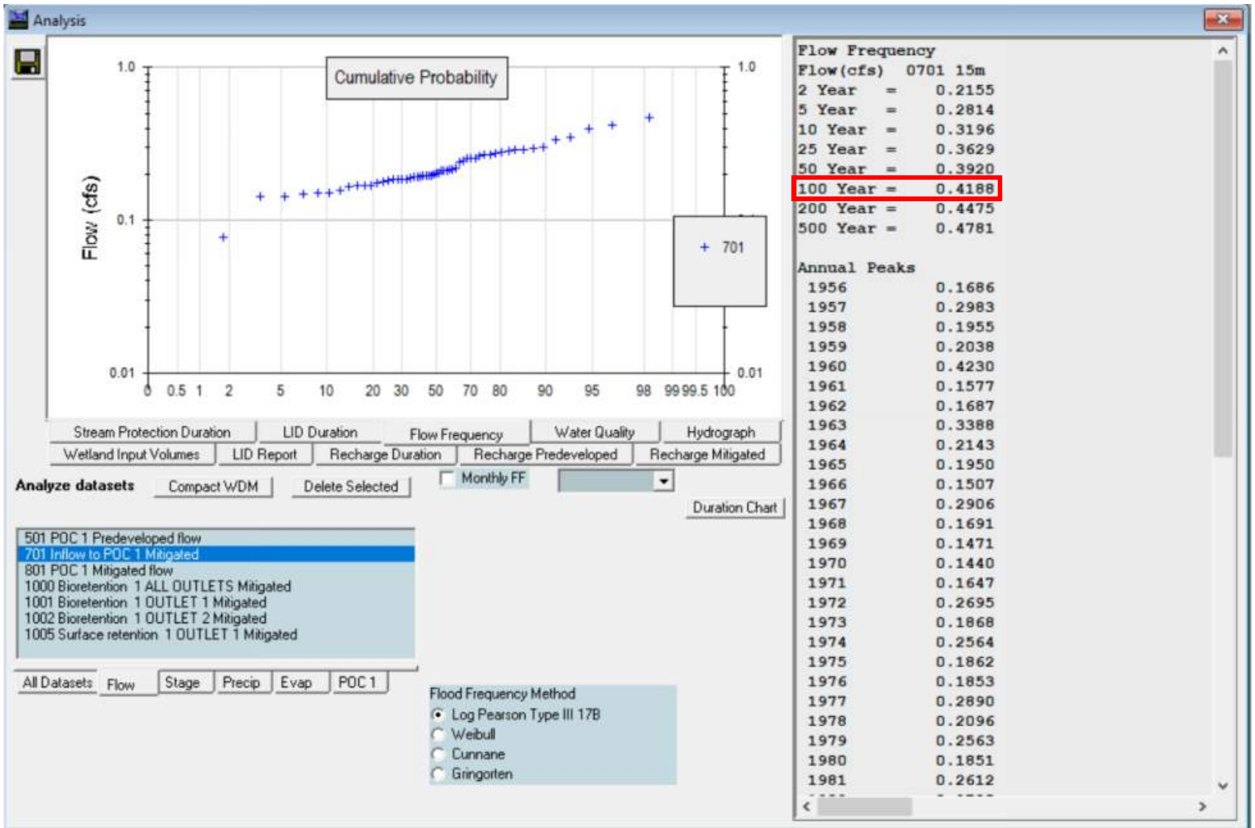
$Q_{MAX} = 0.6 * (2*32.2)^{1/2} * [(2/3 * 4 * 0.2^{3/2}) + (8/15 * 3 * 0.2^{5/2})]$

Q_{MAX} = 1.29 cfs

100-YR Developed Peak Flow (per WWHM12 Flow Frequency Results) = 0.419 cfs

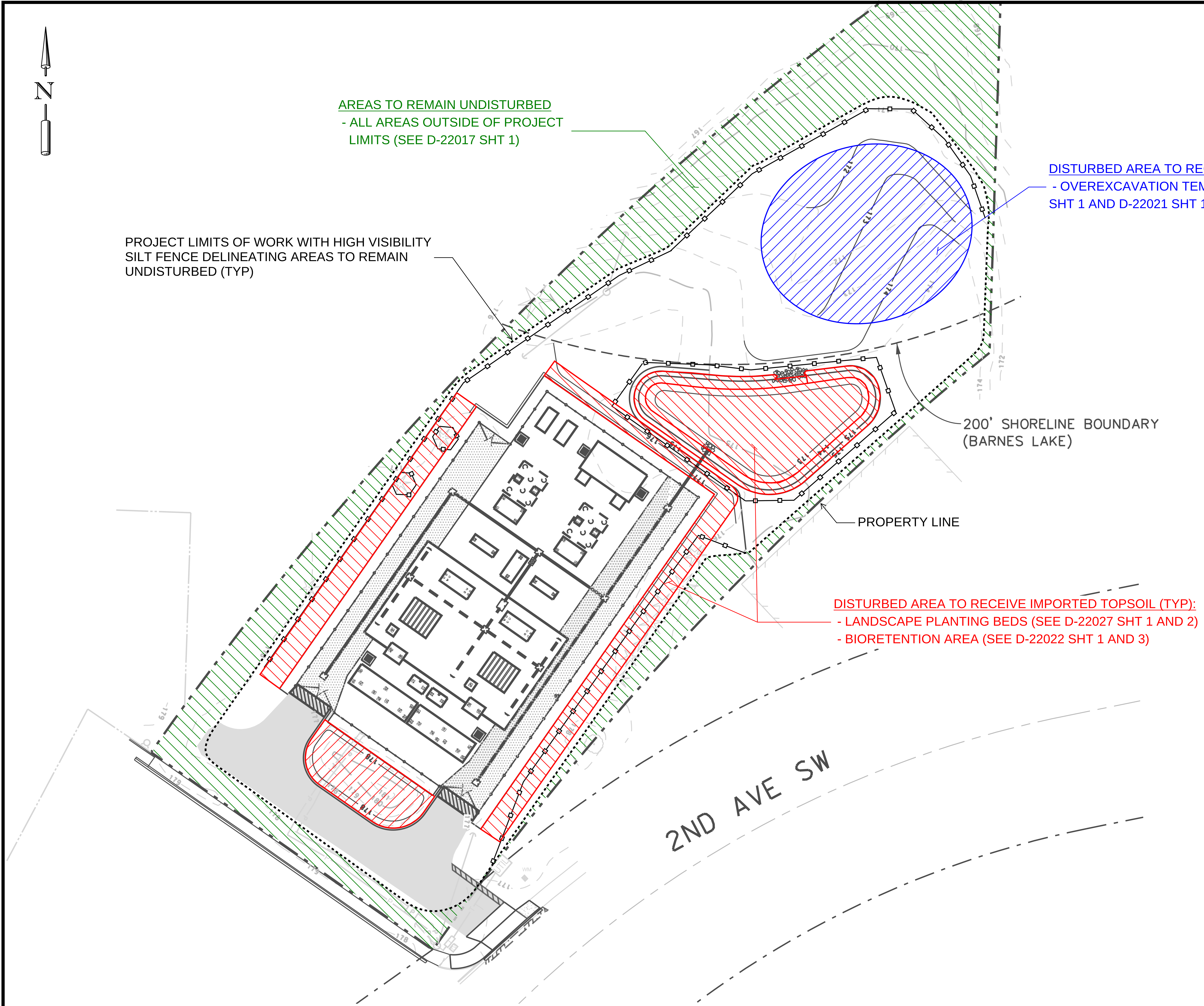
$\boxed{1.29 \text{ cfs} > 0.419 \text{ cfs}}$

WWHM Flow Frequency Results – Inflow to POC



APPENDIX 2

Soil Management Plan



PLAN

NTS

APPROXIMATE COMPOST AND MULCH QUANTITIES:

LANDSCAPE PLANTING BEDS

- MULCH = 50 CY
- COMPOST AMENDED TOPSOIL = 140 CY

BIORETENTION AREA

- MULCH = 10 CY
- COMPOST AMENDED TOPSOIL = 20 CY

TOTAL

- MULCH = 60 CY
- COMPOST AMENDED TOPSOIL = 160 CY

NOTE:
WITHIN PLANTING BEDS, MULCH LAYER IS 3" UNDERLAIN BY 8" OF AMENDED TOPSOIL BLENDED INTO 4" OF NATIVE SOIL

WITHIN BIORETENTION AREA, MULCH LAYER IS 2" IN AREA ABOVE MAX WATER SURFACE AND COMPOST LAYER IS 2" IN AREA BELOW MAX WATER SURFACE.

BARNES LAKE SUBSTATION
SOIL MANAGEMENT PLAN

APPENDIX 3

Supplemental Reports and Information

Guidance on using new high performance bioretention soil mixes

By

Douglas Howie, PE and Brandi Lubliner, PE

For the

Water Quality Program

Washington State Department of Ecology

Olympia, Washington

May 2021
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DEPARTMENT OF ECOLOGY
State of Washington

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Cover photo credit

- Brandi Lubliner, November 2018: Bioretention facility in Olympia, WA

Related Information

- Publication 13-10-017: Focus on Bioretention Soil Media[1]
- Ecology's stormwater manuals: https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Stormwater-manuals

Contact Information

Douglas Howie, PE and Brandi Lubliner, PE
Water Quality Program
P.O. Box 47600
Olympia, WA 98504-7600
Phone: 360-407-6600

Website[2]: Washington State Department of Ecology

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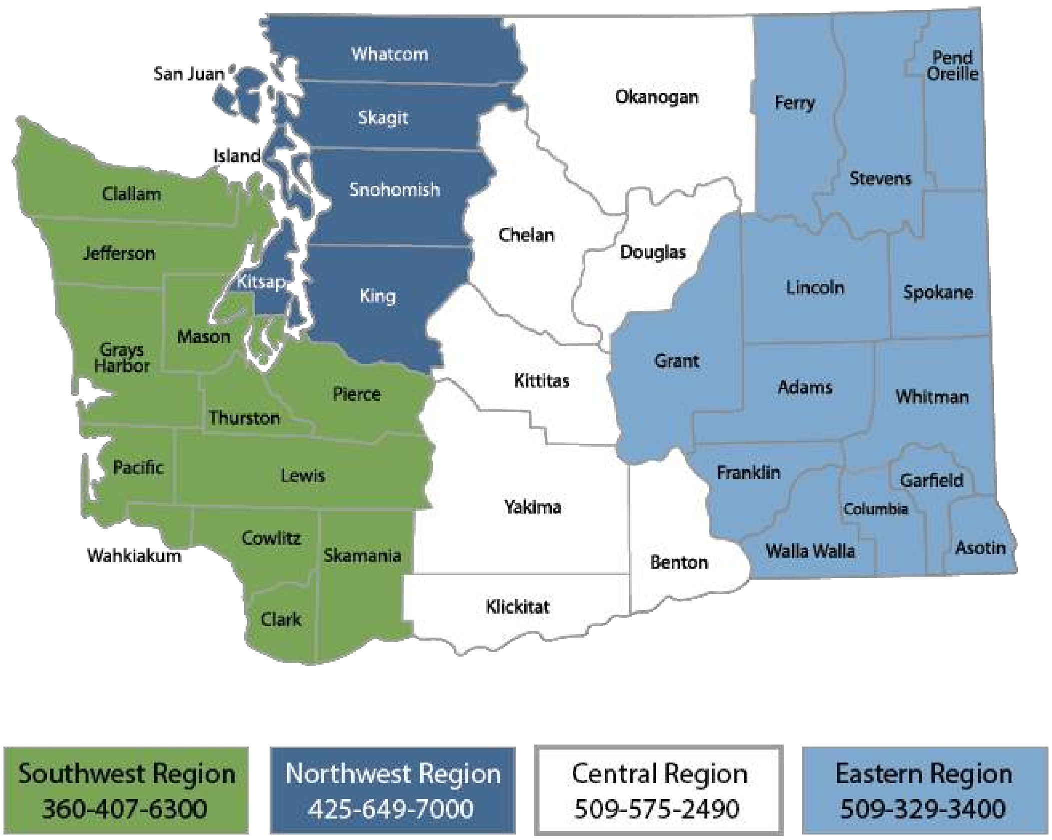
[1] https://apps.ecology.wa.gov/publications/SummaryPages/1310017.html
[2] www.ecology.wa.gov/contact

Department of Ecology's Regional Offices

Map of Counties Served



Region	Counties served	Mailing Address	Phone
Southwest	Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Mason, Lewis, Pacific, Pierce, Skamania, Thurston, Wahkiakum	PO Box 47775 Olympia, WA 98504	360-407-6300
Northwest	Island, King, Kitsap, San Juan, Skagit, Snohomish, Whatcom	3190 160th Ave SE Bellevue, WA 98008	425-649-7000
Central	Benton, Chelan, Douglas, Kittitas, Klickitat, Okanogan, Yakima	1250 W Alder St Union Gap, WA 98903	509-575-2490
Eastern	Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman	4601 N Monroe Spokane, WA 99205	509-329-3400
Headquarters	Across Washington	PO Box 46700 Olympia, WA 98504	360-407-6000

Table of Contents

2021 update on bioretention soil mixes

This 2021 bioretention report provides information on new alternative bioretention soil mix (BSM) that can be used in locations near phosphorus-sensitive waterbodies. This report provides the specifications for the new BSM, treatment performance of the new BSM, and the regulatory status in the municipal stormwater NPDES permit program.

Background on existing requirements

In 2013, Ecology published guidance based on findings from grant-funded studies that a best management practice (BMP) called bioretention used to treat stormwater runoff exports nitrogen, phosphorus, and some dissolved copper. The 2013 bioretention focus sheet advised stormwater managers, designers, and permittees to not use bioretention in project locations with surface discharges to phosphorous-sensitive receiving waters (Ecology, 2013). In May 2016, Ecology updated the same focus sheet, advising that a minimum one-quarter mile distance from phosphorus-sensitive receiving waters would be needed for bioretention BMPs if the site's underlying soils did not meet the site suitability criteria for runoff treatment or if the design used an underdrain that would route to those waters (Ecology, 2016). Ecology updated the stormwater manuals in 2019 to reflect the 2016 focus sheet update.

Phosphorus-sensitive receiving waters is not a defined term but is meant to be inclusive of surface waters such as lakes or wetlands that are sensitive to eutrophication and those that are being managed to control phosphorus inputs such as a lake management plan, algal bloom management plan, and water clean-up plan.

Bioretention is a commonly used BMP to treat and infiltrate stormwater onsite. Bioretention is BMP T7.30 in the 2019 Stormwater Management Manual for Western Washington (SWMMWW) and BMP T5.31 and F6.23 in the 2019 Stormwater Management Manual for Eastern Washington (SWMMEW), (stormwater manuals). Bioretention uses low impact development (LID) principles, provides runoff treatment, and controls runoff flows. Few stormwater BMPs satisfy all three stormwater management objectives, which is a primary reason bioretention is so commonly used in Washington State. The BSM itself is the 'filter layer', and can be composed of either a default or a custom mix per the stormwater manuals.

The default BSM specification is 60% sand and 40% compost by volume (default BSM), and it provides filtration of stormwater to achieve runoff treatment. The 2019 stormwater manuals discourage use of this default BSM in bioretention facilities at locations within one-quarter mile of a phosphorus-sensitive receiving water if the underlying soils do not meet site suitability criteria for runoff treatment, due to the phosphorus export from the compost material. The initial export of phosphorus from the newly mixed default BSM occurs in quantities of concern for downstream phosphorus-sensitive surface waters such as lakes and wetlands. The 2019 stormwater manuals also advise against underdrains in bioretention with the default BSM when the under-drained water would be routed to a phosphorus-sensitive receiving water due to the phosphorus export from the compost material. There are no changes to the existing guidance on use of the default BSM for bioretention in this publication.

Research since 2016 on the default BSM

The default BSM has been robustly studied locally. Early research indicated nitrogen, phosphorus, and copper export from the default BSM (we now know the compost fraction of the BSM) can occur at levels of concern for receiving waters (Herrera, 2016; King County 2017; Davis and McIntyre, 2016; King County 2019). Studies show that over time, the concentrations of nutrient export from the BSM decreases (King County and Herrera, 2020; McIntyre et al., 2020). Evaluations of other parameters show that the BSM provides substantial reduction in pollutants: 80-100% reduction of total suspended solids, total lead (Pb) and zinc (Zn), fecal coliform, E.coli, and a variety of organic compounds including PAHs and PCBs (King County 2017; Davis and McIntyre, 2016; King County, 2020; King County and Herrera , 2020; McIntyre et al., 2020).

Copper

Concentrations of dissolved copper (Cu) exported from the default BSM are a concern within the first year (Herrera, 2016). However, recent research on bioavailability shows that enough dissolved carbon from the default BSM is also exported during the establishment phase of a new bioretention BMP to effectively bind metals, making them unavailable to harm biota (Davis and McIntyre, 2016; McIntyre et al., 2020). McIntyre et al., 2020 found that bioretention BMPs with vegetation provide some additional dissolved copper treatment.

Stormwater treatment effectiveness studies are commonly designed to report on percent change in concentration when comparing effluent to influent concentrations, inadvertently making influent concentration a predictor of BMP success. As a result, improper conclusions can be made. For example, influent and effluent copper concentrations are often very low numbers and while results may be statistically significant they may not be environmentally relevant, i.e. a 50% difference between the values of 1 ug/L vs 2 ug/L. With this in mind, Ecology does not consider the mixed results regarding dissolved copper treatment combined with the information on bioavailability to be compelling enough to drop the metals treatment (also known as enhanced treatment in the SWMMWW) designation for bioretention built with imported compost.

Nutrients

The compost and, to a lesser extent, the mulch overlay, are reported to be the source of the nitrogen and phosphorus export from the bioretention BMP designs. This is unsurprising, as compost provides nutrients and water holding capacity for plant growth. However, the dissolved inorganic (ortho) phosphorus leaching condition appears to decrease substantially after 2 years for bioretention with plants, and after one year for bioretention with a fungal inoculated mulch amendment (McIntyre et al., 2020).

Filtration rate

Ecology’s guidance for bioretention design and sizing relies on a given initial infiltration rate for the BSM of 12 inches per hour. Site-specific safety factors are then applied to ensure the size of the BMP is adequate for flow control for the lifespan of the BMP, to prevent under-sizing, and to prevent excessive maintenance needs. We have learned over the last decade from local studies that BSM filtration rates start much higher and slow down incrementally, but to a varied extent after initial establishment and use. Ecology does not yet know the full lifespan (under proper maintenance) of bioretention BMPs regionally. SAM studies on properly installed and maintained bioretention BMPs that are up to 10-12 years old appear to maintain double digit infiltration rates with the exception of trash, seasonal freezing, and leaf litter blockages (Taylor et al., 2018 and 2020). Future SAM studies will evaluate the end-of-life timeframes for both flow control and runoff treatment. At this time Ecology’s guidance remains the same, to use 12 inches per hour as the initial filtration rate and apply site-specific safety factors, with the intent to prolong the functional lifespan of the BMP.

Development of an alternative BSM

Ecology and the Stormwater Action Monitoring (SAM) program have funded research since 2013 and 2015 respectively to find new alternative BSMs that will not export nutrients or copper. This new guidance is based on the following studies:

- Ecology stormwater Grants of Regional or Statewide Significance program funded a study with Kitsap County (Herrera, 2015) to evaluate BSM components and blends to form the basis of an alternative BSM.
- SAM funded King County to test alternative BSMs in a bench-scale study. The goals were: low phosphorus export, treatment of suspended solids and metals treatment, affordability, and reduced toxicity to aquatic life. The phosphorus export reduction goal was met using iron aggregate and activated alumina in a ‘polishing layer’ (King County and Herrera, 2020).
- Ongoing Ecology grants to the City of Bellingham and Whatcom County are evaluating full-scale bioretention performance using high performance media to treat phosphorus and meet phosphorus TMDL goals in Lake Whatcom.

Approved high performance bioretention soil mix

Ecology approves of the high performance bioretention soil mixes (HPBSMs) shown in Table1.

Table 1. Approved high performance BSM (HPBSM) for runoff treatment in bioretention

Performance Goals for Runoff Treatment	Achieves suspended solids treatment (≥80% reduction)	Achieves dissolved metal treatment (≥30% copper and ≥60% zinc reduction)	Achieves phosphorus treatment (≥50% reduction)	Achieves additional LID objectives and water quality objectives [a]
Type 1: 18" HPBSM Primary layer. HPBSM primary layer consists of 70% sand, 20% coir, and 10% high carbon wood ash (biochar) by volume.	X	X		
Type 2: 18" HPBSM Primary layer plus 12" HPBSM Polishing Layer. HPBSM Polishing layer consists of 90% sand, 7.5% activated alumina, and 2.5% iron aggregate by volume.	X	X	X	
Type 3: 18" HPBSM Primary Layer plus 12" HPBSM Polishing Layer plus 2"Compost Surface Layer [b, c]. Compost must meet bioretention compost specifications in Ecology's stormwater manuals.	X	X	X	X

[a] The 2" Compost Surface layer is anticipated to improve success of plantings, due to improved water holding capacity (McIntyre et al., 2020). Additionally, based on the King County and Herrera, 2020 study this mix was successful in meeting all treatment goals (basic, copper, zinc, and phosphorus) as well as some protection against the acute toxicity to *C. dubia* and *D. rerio* found in the influent (untreated) stormwater.
[b] Do not use the HPBSM Primary Layer (Type 1) with the Compost Surface Layer without the HPBSM Polishing Layer. The HPBSM Polishing Layer is necessary to limit phosphorus and nitrogen export from the Compost Surface Layer.
[c] Carbon or organic matter components of the mixes such as compost and mulch are believed to be an important factor to capture organic compounds in stormwater runoff (King County and Herrera, 2020, McIntyre et al., 2020).

Current guidance for municipal stormwater permittees

Stormwater infrastructure is usually publically funded and Ecology recognizes the need for confidence in bioretention effectiveness for flow control and runoff treatment.

Bioretention BMPs are among the most cost-effective stormwater management options, but we do not yet know their full life span. We anticipate it to be in the range of 20-40 years. Ecology will continue to require permittees to remove barriers to LID in their codes and local ordinances. Ecology continues to support the use of bioretention within the 2019 SWMMWW and 2019 SWMMEW.

These three HPBSM options are now approved for use as the engineered soil layer for bioretention BMP designs in Washington State.

Use of HPBSM in bioretention BMPs ***is*** allowed within one-quarter mile of a known or suspected phosphorus-sensitive receiving water. Designers can install the HPBSM Polishing

Layer directly beneath the HPBSM Primary Layer, or as the second stage in a two-stage treatment train to attain treatment of phosphorus in stormwater runoff.

This document on HPBSM specifications is available in the interactive online stormwater manuals as an “Additional Resource”.

Ecology anticipates incorporating these alternatives for BSM in the bioretention BMP design when we next update the stormwater manuals. Ecology requests that project proponents report back any issues they may have with obtaining materials that meet these specifications so that we can further refine the criteria prior to the next manual updates.

Appendix 1: High Performance Bioretention Soil Media (HPBSM) Specifications

This appendix provides the specifications for making the HPBSM that were studied as part of the SAM study. King County, Herrera Environmental Consultants, Inc. and Whatcom County are acknowledged for working with Ecology to develop and test specifications for this publication.

The high performance bioretention soil mixes (HPBSM) shown in Table 1 are the engineered soil layer for bioretention BMP designs in Washington State to achieve specific runoff treatment performance goals. Two of the three new BSM types are approved for phosphorus treatment.

Figures 1 and 2 present typical cross sections of the HPBSM. Figure 1 is an example of the HPBSM with the primary layer but no polishing layer or compost layer (Type 1), and Figure 2 is a typical cross section of the HPBSM with the primary layer, polishing layer, and compost layer (Type 3).

Figure 1. Typical Cross Section of Type 1 HPBSM

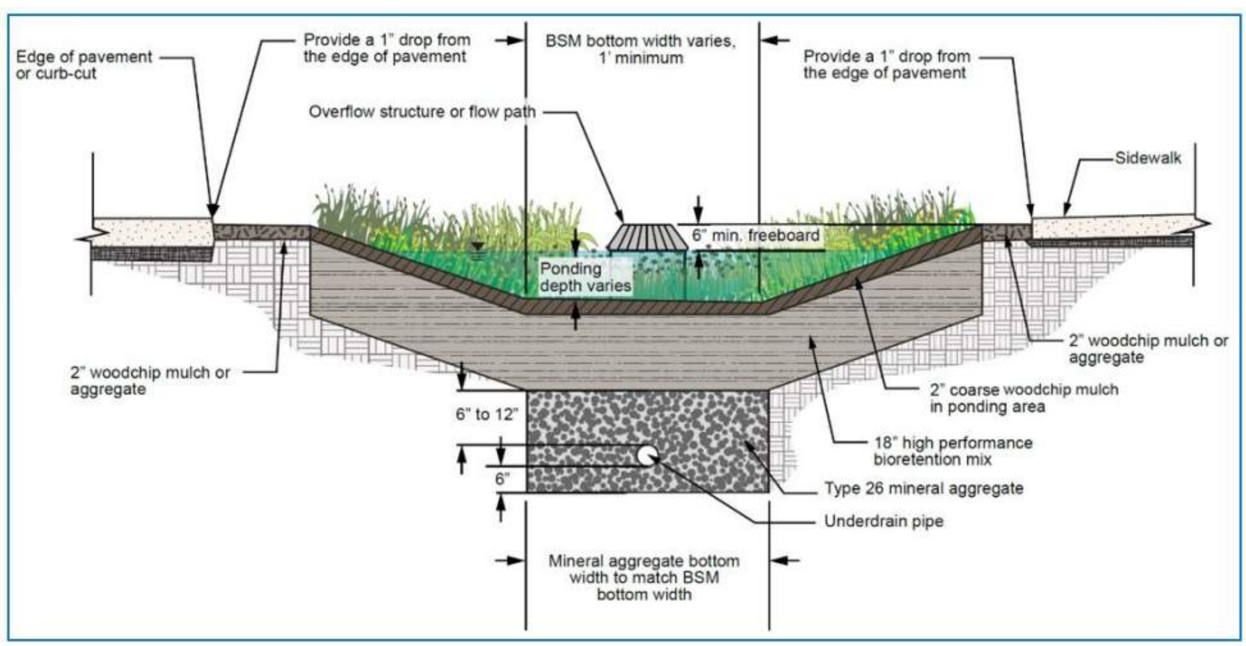
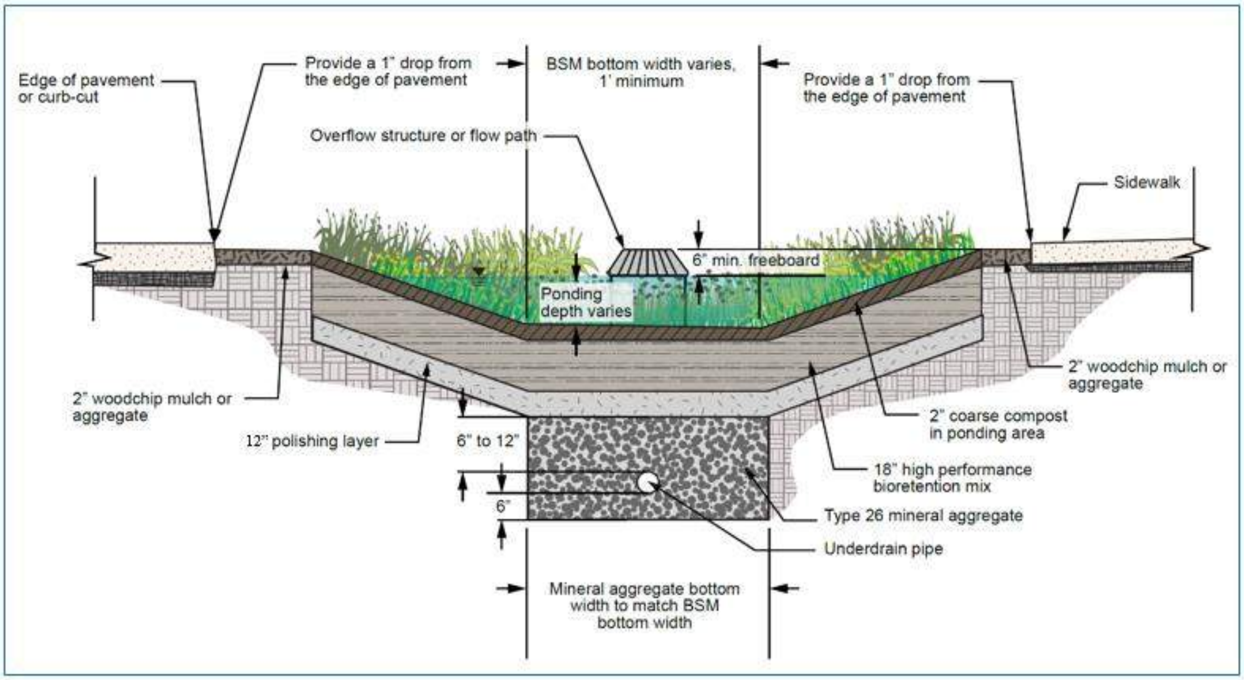


Figure 2. Typical Cross Section of Type 3 HPBSM



Type 1: HPBSM Primary Layer

The HPBSM Primary Layer media should be a blend of the following components in the following ratios:

Component	Ratio (by volume)
Filter Sand	70% (+/- 3%)
Coconut Coir Fiber	20% (+/- 2%)
High Carbon Wood Ash	10% (+/- 1%)

Coconut Coir Fiber

The Coconut Coir Fiber should be double rinsed and buffered, meeting the following requirements for quality:

Test / Method	Testing Responsibility [a]	Criterion	Requirement
Synthetic Precipitation Leaching Protocol (EPA Method 1312) and EPA Method 353.2	Proponent	NO_3+NO_2	0.15 mg/L (Max.)
Synthetic Precipitation Leaching Protocol (EPA Method 1312) and NEMI Method SM 4500-P E-99	Proponent	Total Phosphorus	0.15 mg/L (Max.)
		Ortho-phosphorus	0.15 mg/L (Max.)
Synthetic Precipitation Leaching Protocol (EPA Method 1312) and EPA Method 200.8 UCT-KED	Proponent	Copper	10 µg/L (Max.)
Test Methods for the Examination of Compost and Composting (TMECC) Method 04.10-A	Manufacturer	Electrical Conductivity	1.0 mmhos/cm (Max.)

[a] Though the manufacturer will provide many of the tests indicated in this table, project proponents are encouraged to test the exact material which will be provided for their projects. Manufacturer tests are only run periodically on the source material not on the exact material supplied for the project.

Filter Sand

The aggregate shall be sand meeting the gradation below and the requirements of Section 9-03.1(2)B (Class 1) of the Washington State Department of Transportation Standard Specifications, and shall have a Coefficient of Uniformity of four (minimum). The filter sand gradation tolerances herein apply to the aggregate in the HPBSM Primary Layer media as well as the HPBSM Polishing Layer media (if used):

Sieve Size	Percent Passing Min.	Percent Passing Max.
3/8”	99	100
No. 4	95	100
No. 8	68	86
No. 16	47	65
No. 30	27	42
No. 50	9	20
No. 100	0	7
No. 200	0	2.5

The filter sand shall be thoroughly cleaned and free of dirt, clay, silt, asphalt, organic material, or other foreign matter and all aggregate passing the No. 200 sieve size shall be non-plastic. The filter sand shall meet the following requirements for quality:

Test / Method	Testing Responsibility [a]	Criterion	Requirement
Synthetic Precipitation Leaching Protocol (EPA Method 1312) and EPA Method 353.2	Proponent	NO3+NO2	0.15 mg/L (Max.)
Synthetic Precipitation Leaching Protocol (EPA Method 1312) and NEMI Method SM 4500-P E-99	Proponent	Total Phosphorus	0.15 mg/L (Max.)
		Ortho-phosphorus	0.15 mg/L (Max.)
Synthetic Precipitation Leaching Protocol (EPA Method 1312) and EPA Method 200.8 UCT-KED	Proponent	Copper	10 µg/L (Max.)

[a] Though the supplier will provide many of the tests indicated in this table, project proponents are encouraged to test the exact material which will be provided for their projects. Supplier tests are only run periodically on the source material not on the exact material supplied for the project. This is particularly important for the aggregate gradation which has the strongest influence on system hydraulics.

High Carbon Wood Ash (Biochar)

The High Carbon Wood Ash (HCWA) should consist of screened and processed organic and inorganic residue remaining after the thermal processing of biomass in an oxygen-controlled environment. The biomass feed-stocks should be limited to clean cellulosic material from the 1) woody by-products of pacific northwest forestry operations (including cut residues left after a timber harvest, cut trees that are not marketable as lumber), 2) chipped trees and brush from biomass reduction operations (i.e. commercial tree trimming), and 3) agricultural residues such as nut shells, straw, orchard pruning, seeds, hulls, and pits. The biomass feedstocks should not include any post-consumer or post-industrial sourced woody biomass (i.e., construction or demolition waste, wood contaminated with paints or sealers, metal, plastic, or other deleterious materials).

The HCWA should be classified as a "Class 1" Biochar following the International Biochar Initiative (IBI) guidelines (IBI 2015).

The HCWA should be sourced from a producer with at least 5-years of experience producing HCWA for soil amendments and/or water filtration and meet the following requirements for quality and grading:

Test / Method	Testing Responsibility [a]	Criterion	Requirement
Synthetic Precipitation Leaching Protocol (EPA Method 1312) and EPA Method 353.2	Proponent	NO3+NO2	0.15 mg/L (Max.)
Synthetic Precipitation Leaching Protocol (EPA Method 1312) and NEMI Method SM 4500-P E-99	Proponent	Total Phosphorus	0.15 mg/L (Max.)
		Ortho-phosphorus	0.15 mg/L (Max.)
Synthetic Precipitation Leaching Protocol (EPA Method 1312) and EPA Method 200.8 UCT-KED	Proponent	Copper	10 µg/L (Max.)
Total C and H analysis by dry combustion-elemental analyzer (EPA Method 440.0). Inorganic C analysis by determination of CO_2-C content with 1N HCl, as outlined in ASTM D4373 Standard Test Method for Rapid Determination of Carbonate Content of Soils. Organic C calculated as Total C – Inorganic C.	Manufacturer	Organic Carbon (C_{org})	60% (Min.)
		H: C_{org}	0.7 (Max.)
Proximate Analysis (ASTM D1762)	Manufacturer	Volatile matter	20% (Max.)
		Ash	40% (Max.)
Metals (EPA Method 6020)	Manufacturer	Arsenic	20 ppm (Max.)

		Cadmium	10 ppm (Max.)
		Lead	150 ppm (Max.)
		Mercury	8 ppm (Max.)
		Molybdenum	9 ppm (Max.)
		Nickel	210 ppm (Max.)
		Selenium	18 ppm (Max.)
		Zinc	1400 ppm (Max.)
Total polycyclic aromatic hydrocarbons by US EPA 8270 (2007) using Soxhlet extraction (US EPA 3540) and 100% toluene as the extracting solvent	Manufacturer	PAH	300 ppm (Max.)
Dioxins/Furans TEQ EPA 8290 (2007)	Manufacturer	PCDD/Fs	17 ppb WHO-TEQ [b] (Max.)
Cation Exchange Capacity (USEPA Method 9081)	Manufacturer	milliequivalents CEC/100 g dry soil	Report
Gradation (ASTM D422)	Manufacturer	# 6	100% Passing
		#100	10 % Passing (Max.)

[a] Though the manufacturer will provide many of the tests indicated in this table, project proponents are encouraged to test the exact material which will be provided for their projects. Manufacturer tests are only run periodically on the source material not on the exact material supplied for the project.

[b] Toxic Equivalency (TEQ) is calculated by multiplying the concentration of each PCDD/F by its World Health Organization (WHO) Toxic Equivalency Factor (TEF) and summing the products.

HPBSM Polishing Layer

The HPBSM Polishing Layer media should be a blend of the following components in the following ratios:

Component	Ratio (by volume)
Filter Sand	91% (+/- 1%)
Activated Alumina	6.5% (+1% / - 0%)
Iron Aggregate	2.5% (+0% / -0.25%)

The HPBSM Polishing Layer media should be mechanically blended to produce a homogeneous mix by a blending vendor/contractor with at least 5-years of soil blending experience.

Activated Alumina

The Activated Alumina should meet the following requirements for quality and grading:

Test / Method	Testing Responsibility [a]	Criterion	Requirement
Synthetic Precipitation Leaching Protocol (EPA Method 1312) and EPA Method 353.2	Proponent	NO_3+NO_2	0.1 mg/L (Max.)
Synthetic Precipitation Leaching Protocol (EPA Method 1312) and NEMI Method SM 4500-P E-99	Proponent	Total Phosphorus	0.1 mg/L (Max.)
		Ortho-phosphorus	0.1 mg/L (Max.)
Synthetic Precipitation Leaching Protocol (EPA Method 1312) and EPA Method 200.8 UCT-KED	Proponent	Copper	1 µg/L (Max.)
Producer Analysis	Manufacturer	Alumina (Al_2O_3) content	90% (Min.)
	Manufacturer	Bulk density	760 Kg/m^3 (Min.)
	Manufacturer	Surface area	300 m^2/g (Min.)
Gradation (ASTM D422)	Manufacturer	#14 US Standard Sieve	100% Passing
	Manufacturer	#28 US Standard Sieve	0% Passing

[a] Though the manufacturer will provide many of the tests indicated in this table, project proponents are encouraged to test the exact material which will be provided for their projects. Manufacturer tests are only run periodically on the source material not on the exact material supplied for the project.

Iron Aggregate

The Iron Aggregate should be ground Iron meeting the following requirements for quality and grading:

Test / Method	Testing Responsibility [a]	Criterion	Requirement
Synthetic Precipitation Leaching Protocol (EPA Method 1312) and EPA Method 353.2	Proponent	NO3+NO2	0.1 mg/L (Max.)
Synthetic Precipitation Leaching Protocol (EPA Method 1312) and NEMI Method SM 4500-P E-99	Proponent	Total Phosphorus	0.1 mg/L (Max.)
	Proponent	Ortho-phosphorus	0.1 mg/L (Max.)
Synthetic Precipitation Leaching Protocol (EPA Method 1312) and EPA Method 200.8 UCT-KED	Proponent	Copper	1 µg/L (Max.)
Producer Analysis	Manufacturer	Iron Content by weight	80% - 97%
Gradation (ASTM D422) or Producer Analysis	Manufacturer	#4	100% passing
	Manufacturer	#8	95 -100% passing
	Manufacturer	#16	75-90% passing
	Manufacturer	#30	25-45% passing
	Manufacturer	#50	0-10% passing
	Manufacturer	#100	0-5% passing
	Manufacturer	#200	0-2.5% passing

[a] Though the manufacturer will provide many of the tests indicated in this table, project proponents are encouraged to test the exact material which will be provided for their projects. Manufacturer tests are only run periodically on the source material not on the exact material supplied for the project.

Underdrain

If the project proponent plans to bed an underdrain below the HPBSM Polishing Layer, it should be minimum 4-inch Schedule 40 PVC slotted well screen with a maximum slot width of 0.030 inches and a minimum open area of 9 square inches per foot. This underdrain can serve cells with a bottom area 4-15 feet wide depending on infiltration rate.

Blending, Delivery, Protection, and Placement

The blending, handling, and placement of the HPBSM Primary and Polishing Layers needs to be done carefully to ensure a successful installation. The contractor should prepare a Blending, Delivery, Protection, and Placement plan and submit it to the designer for review. The HPBSM Primary and Polishing HPBSM Layer media shall be mechanically blended to produce a homogeneous mix by a blending vendor/contractor with soil blending experience. The blending should occur on an impervious (asphalt or concrete) surface pad that has been thoroughly washed clean (e.g., pressure washed) prior to blending or in purpose-built soil blending equipment that has been washed. The blending pad shall be large enough to be able to turn and mix the media without introducing contamination. The blending pad shall be free of standing water before blending and shall be protected from stormwater run-on from areas off of/adjacent to the pad.

The measurement of the components to be blended shall be by dry weight on scale equipment capable of measuring within 1 pound or in full vessels of a known volume. Estimating the volumes of materials of partially full buckets or vessels shall not be used. Prior to blending, the coconut coir fiber shall be loose and hydrated such that its density is 4-5 pounds per cubic foot. The materials shall be blended until they are in a homogenous mixed state and then protected from contamination or saturation during storage, delivery, stockpiling, and placement.

The HPBSM layers should not be placed if the area is frozen, has standing water, is excessively wet or saturated, or has been subjected to more than 1/2 inch of precipitation within 48 hours before placement, unless approved otherwise by the Engineer. Do not place the HPBSM layers if adequate temporary erosion and sediment control measures are not in place to protect the media from contamination by silt laden run-off.

Place HPBSM layers loosely and evenly, no deeper than these specifications unless otherwise approved by the Engineer, on a properly prepared subgrade. After each lift, rake the surface to a uniform grade. Consolidate the entire surface area of each lift by boot compaction or a lawn roller and rake again to scarify before placing subsequent lifts or planting.

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GeoEngineers 1101 Fawcett Avenue, Suite 200 Tacoma, Washington 98402 253.383.4940	**Field Report**		File Number: 0186-685-01
	Project: Barnes Lake Substation		Date: 7.25.2022
	Owner: Puget Sound Energy	Time of Arrival: 9:30	Report Number: 1
Prepared by: Courtney Stoker	Location: PSE Barnes Lake Substation	Time of Departure: 10:15	Page: 1 of 3
Purpose of visit: Wetland reconnaissance	Weather: Clear 80 F	Travel Time: 1 hr r/t	Permit Number:

Upon arrival to the site I assessed personal safety hazards: ☒ Yes or ☐ Referred to Site Safety Plan and Safety Tailgate if applicable

Safety Hazards Were Addressed by : ☒ Staying Alert to Construction and Equipment Hazards ☐ Other (describe)

One GeoEngineers biologist met on-site with Heidy Barnett from West Fork Environmental to conduct wetland habitat reconnaissance of Parcel Number 09020011003 in Thurston County, Washington. The parcel contains a PSE substation at the southern end and a mowed field with undulating topography that gently slopes to the north. Barnes Lake occurs offsite to the north. Representative site photographs are provided below.

Observations:

During the site reconnaissance, the parcel was investigated for observations of wetland habitat including dominance of hydrophytic vegetation, hydrologic indicators, and hydric soils. Habitat near the substation at the southern end of the parcel contained predominantly upland vegetation including cultivated cedar trees, maple (*Acer sp.*) saplings, Himalayan blackberry (*Rubus armenaicus*), and salal (*Gaultheria shallon*). North of the substation, the parcel is undeveloped containing a field of mowed grasses generally sloping north towards Barnes Lake. No hydrophytic vegetation or indicators of hydrology were observed within the mowed field portion of the parcel.

A fence and posts with Wetland Protection signs were observed northwest of the mowed area, with unmowed grasses and shrubs occurring on the north side of the signs. The Wetland Protection signs are assumed to be associated the United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) mapped emergent wetland occurring on the fringe of Barnes Lake. No hydrophytic grasses were observed within the unmowed portion, and soils appeared light brown in color with no observed redoximorphic features. The shrub fringe occurring northeast of the unmowed grasses consisted of predominantly Facultative Upland (FACU) species such as snowberry (*Symphoricarpos albus*), oceanspray (*Holodiscus discolor*), and Oregon grape (*Mahonia nervosa*), with an oak (*Quercus garryana*) canopy. Soils appeared light brown in color with no observed redoximorphic features. No signs of wetland hydrologic indicators were identified in either the unmowed grass or shrub areas.

Wetland habitat may occur offsite to the north along the fringe of Barnes Lake, however wetland habitat was not observed to extend onto the project parcel.

Summary:

No wetland habitat was identified within the project parcel. A lake fringe wetland may occur offsite to the north, and the associated regulated wetland buffer may extend onto the project parcel.

☐ THIS FIELD REPORT IS PRELIMINARY A preliminary report is provided solely as evidence that field observation was performed. Observations and/or conclusions and/or recommendations conveyed in the final report may vary from and shall take precedence over those indicated in a preliminary report.	FIELD REPRESENTATIVE Courtney Stoker	DATE 7/25/2022
X THIS FIELD REPORT IS FINAL A final report is an instrument of professional service. Any conclusions drawn from this report should be discussed with and evaluated by the professional involved.	REVIEWED BY Shawn Mahugh	DATE 7/25/2022

Attachments:

Distribution:

Figure 1. Project parcel from the north end looking south toward the substation

Figure 2. Shrub fringe at northern edge of parcel, with Wetland Protection sign visible

Figure 3. Typical vegetation within the shrub fringe area- showing snowberry, oceanspray, and oak, with Barnes Lake visible in the background.

Figure 4. Wetland Protection sign with unmowed grasses and a shrub fringe occurring beyond the sign.

Source(s):
- Washington Department of Ecology
- Thurston County 2022 Imagery

Coordinate System: NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet

Legend

- Field Verified OHWM
- Shoreline Jurisdiction
- Parcel Boundary

N

0 60

Feet

OHWM

Barnes Lake Substation Improvements
Tumwater, Washington

GEOENGINEERS

Figure 1

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Geotechnical Engineering Services

Barnes Lake Substation Improvements
Tumwater, Washington

for
Puget Sound Energy

April 20, 2023

GeoEngineers
Earth Science + Technology

Geotechnical Engineering Services

Barnes Lake Substation Improvements
Tumwater, Washington

for
Puget Sound Energy

April 20, 2023

GeoEngineers

2101 4th Avenue, Suite 950
Seattle, Washington 98121
206.728.2674

Geotechnical Engineering Services

Barnes Lake Substation Improvements
Tumwater, Washington

File No.

April 20, 2023

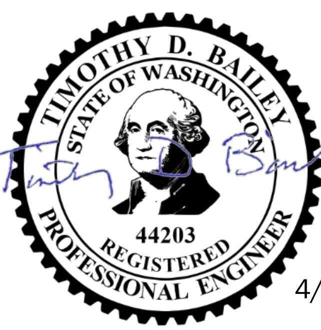
Prepared for:

Puget Sound Energy
35131 SE Center Street SQE-OTC
Snoqualmie, Washington 98065

Attention: Jackson Knoll, PE and Jason Henry, PE

Prepared by:

GeoEngineers, Inc.
2101 4th Avenue, Suite 950
Seattle, Washington 98121
206.728.2674



4/20/23

Timothy D. Bailey, PE
Senior Geotechnical Engineer

David S. Phelps, PE
Principal Geotechnical Engineer

TDB:DSP:leh

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APPENDICES

1.0 INTRODUCTION

This report summarizes the results of our geotechnical services associated with the proposed improvements to the existing Puget Sound Energy (PSE) Barnes Lake Substation. The site is located on Thurston County parcel 09080011003 on 2nd Avenue SW in Tumwater, Washington and is shown in relation to the surrounding area on the Vicinity Map, Figure 1. The site is about 200 feet north of the intersection of 2nd Avenue SW and Trosper Road SW. Existing features are shown on the Site Plan, Figure 2.

Our understanding of the current project is based on discussions with Jason Henry and review of drawings showing the existing substation and proposed improvements. We understand there is maintenance replacement planned at the existing substation, with a replacement control house, transformer, and circuit switcher. As part of the maintenance, the substation will be prepared for a future second bank of equipment in addition to the current single bank. The existing substation has experienced significant settlement (up to ½-foot settlement in areas), and we have discussed potential options for mitigating settlement. We provided conceptual options to PSE for deep foundations or overexcavation. We understand PSE has decided to complete overexcavation below the area of the replacement equipment.

GeoEngineers previously prepared a geotechnical report for this site dated January 12, 2007. We also prepared a final version of this report dated August 30, 2022. This report incorporates and supersedes our previous reports. GeoEngineers prepared a separate environmental soil characterization report for this site.

2.0 SCOPE OF SERVICES

Our services were completed in accordance with our proposal dated May 9, 2022. Our scope of services includes:

- Completing four borings at the site;
- Completing laboratory testing on selected soil samples from the borings;
- Providing geotechnical conclusions and recommendations for the proposed improvements; and
- Preparing this report.

3.0 FIELD EXPLORATIONS AND LABORATORY TESTING

3.1. Field Explorations

Subsurface conditions at the site were evaluated by completing four exploratory borings (GEI-1-22 through GEI-4-22) to depths of 26½ to 51½ feet below the ground surface (bgs). A description of the field exploration program and summary boring logs are presented in Appendix A. The boring locations are shown on the Site Plan, Figure 2.

3.2. Laboratory Testing

Soil samples were obtained during the recent exploration program and taken to GeoEngineers' Redmond laboratory for further evaluation. Selected samples were tested for the determination of moisture content and grain-size distribution (sieve analysis). A description of the laboratory testing and the test results are presented in Appendix A or on the boring logs.

3.3. Previous Explorations

Subsurface conditions at the site were previously evaluated by completing four exploratory borings (1, 2A, 2B and 3) to depths of 2½ to 26½ feet bgs as part of our geotechnical study in 2007 (GeoEngineers 2007). These previous boring logs and supporting laboratory data are presented in Appendix B. The boring locations are shown on the Site Plan, Figure 2.

4.0 SITE CONDITIONS

4.1. Geology

We reviewed available geologic maps, including the geologic map of the Tumwater quadrangle (Walsh 2003). Surficial soils in the project vicinity are mapped on the geologic map as Vashon recessional sand and minor silt (Qgos).

Surficial soils are shown on the United States Department of Agriculture (USDA) soils mapping as Nisqually loamy fine sand, 0 to 3 percent slopes, per (Thurston County GIS).

4.2. Geologically Hazardous Areas

We reviewed the geologically hazardous area definitions presented in City of Tumwater Municipal Code Section 16.20.040. Based on the relatively flat grades in the vicinity of the site, the site is not within erosion or landslide hazard areas. Based on the sandy saturated soils below the site, which have a moderate to high risk of liquefaction, it is our opinion the site is within a seismic liquefaction hazard area and therefore potential liquefaction should be considered in design of the proposed improvements. Based on the United States Geological Survey (USGS) fault database, the site is not located within or near a mapped fault.

Based on Thurston County mapping, the site is located within a wellhead protection area. The site is mapped within a zone that is a 5-year-flow distance from a potable water well. Proposed activities on this site should not adversely affect aquifer recharge.

The proposed work is located within the footprint of the existing substation and therefore it is our opinion there are no permanent impacts to geologically hazardous areas.

4.3. Surface Conditions

The site (Thurston County Parcel No. 09080011003) is on the north side of 2nd Avenue SW, with commercial buildings to the east, south, and west and an undeveloped parcel and Barnes Lake to the north. The site is accessed by a paved road off 2nd Avenue SW.

The ground surface within the fenced portion of the existing substation is relatively level. The ground surface slopes down gently on the west and north sides of the substation. Vegetation around the perimeter of the substation generally consists of shrubs and low trees.

4.4. Subsurface Conditions

Based on our subsurface explorations, subsurface conditions consist of fill and recessional outwash extending to the depths explored. The fill generally consists of loose to medium sand with variable silt and gravel content extending to depths of 8½ to 19½ bgs in the current and previous borings. The underlying recessional outwash generally consists of medium dense to dense sand with variable silt content.

The soils encountered the subsurface explorations are generally classified as sand per the USDA textural triangle.

4.5. Groundwater

Groundwater was observed at a depth of between 16 to 19 feet bgs in the current borings and at 21 to 22 feet in the previous borings. Groundwater levels are anticipated to vary as a function of precipitation, season, and other factors.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1. General

Based on our explorations, testing, and evaluation, it is our opinion that the site can be improved as proposed provided that the considerations and recommendations presented in this report are incorporated in the project design and construction. A summary of geotechnical considerations is provided below.

- Settlement of portions of the substation appears to be due to the presence of voids located near the contact between the fill and the native soils. There may have been vegetation (such as trees or brush) that were left in place during fill placement. Overexcavation of the area of proposed improvements and replacement with structural fill is recommended, with overexcavation depths varying depending on the equipment settlement sensitivity.
- The site is underlain by potentially liquefiable soils, and the proposed overexcavation and replacement with structural fill, along with the addition of a geogrid will provide a stiffer layer that will help mitigate potential seismic liquefaction-induced settlement at the ground surface.
- Shallow or mat foundations constructed on new fill placed and compacted in overexcavated areas are suitable for support of equipment.
- Infiltration is feasible on site outside the existing substation footprint.

This summary is presented for introductory purposes only and should be used in conjunction with the complete recommendations presented in this report.

5.2. Earthquake Engineering

5.2.1. 2018 IBC Seismic Design Information

We recommend the 2018 International Building Code (IBC) parameters for Soil Profile Type, short period spectral response acceleration (S_S), 1-second period spectral response acceleration (S_1), and Seismic Coefficients F_A and F_V presented in Table 1.

TABLE 1. 2018 IBC PARAMETERS

2018 IBC Parameter	Recommended Value
Soil Profile Type	D
Short Period Spectral Response Acceleration, S_S (percent g)	139.4
1-Second Period Spectral Response Acceleration, S_1 (percent g)	52.1
Seismic Coefficient, F_A	1.2
Seismic Coefficient, F_V	1.78
Site Modified Peak Ground Acceleration, PGA_M (percent g)	72.1

Note:

The above spectral response accelerations are based on data from American Society of Civil Engineers (ASCE) 7-16 seismic maps, which is the basis of IBC 2018 seismic parameters.

5.2.2. Liquefaction and Liquefaction-Induced Settlement

Liquefaction refers to the condition when 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 the water table. Liquefaction usually results in loss of bearing capacity, resulting in settlement of structures that are supported on foundations within or above the liquefied soils.

We evaluated the liquefaction potential of the site using the Simplified Procedure (Youd et al. 2001). The Simplified Procedure is 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 against liquefaction is determined by dividing the CRR by the CSR. Liquefaction hazards, including settlement and related effects, were evaluated when the factor of safety against liquefaction was calculated as less than 1.2.

Based on our liquefaction analysis, it is our opinion that there is moderate to high potential for liquefaction of the loose to medium dense sand below the groundwater table during the design earthquake (magnitude 7.75 with peak ground acceleration [PGA_M] of 0.721g). We anticipate that this liquefaction could result in up to 11 inches of settlement. This settlement could occur unevenly, but it is our opinion the 20-foot-layer of non-liquefiable material below the substation site will significantly reduce and mitigate the risk of differential settlement at the ground surface.

5.3. Earthwork

5.3.1. Overexcavation and Geogrid

For areas of the substation supporting settlement-sensitive structures, we recommend overexcavation to remove voids and unsuitable fill, with the slope geometry as discussed in the Temporary Slopes section.

- Below the transformer and circuit switch structures (for both the current bank and the proposed future second bank), we recommend the overexcavation extend to a depth of 8 feet bgs, with the zone of overexcavation extending laterally a distance of 8 feet from the edges of the proposed foundations. This depth of overexcavation is based on voids encountered in previous borings 1 and 3 (both boring logs show a void at 7½ feet).
- Below the switch stand foundations and below the proposed control house, we recommend the overexcavation extend to a depth of 2 feet below the bottom of these foundations, with the zone of overexcavation extending laterally a distance of 2 feet from the edges of the proposed foundations.

We recommend the base of the overexcavation be evaluated by GeoEngineers to confirm unsuitable soils and debris have been removed. The base of the overexcavation should be compacted with a vibratory roller and a reinforcing geogrid should be placed on the compacted subgrade prior to placement of structural fill within the excavation. As discussed above in the Liquefaction and Liquefaction-Induced Settlement section, there is a risk of differential settlement under seismic conditions.

The purpose of the geogrid is to provide a stiff layer to help redistribute loads and mitigate settlement in the event of seismic liquefaction-induced settlement. We recommend the geogrid consist of a high strength biaxial material suitable for foundation reinforcement (Tensar Biaxal Geogrid BX1100 or approved equivalent). We recommend the geogrid be placed at the base of overexcavation for all foundation areas noted above.

5.3.2. Reuse of On-site Soils

We anticipate excavated sandy soils can be reused as structural fill to backfill the excavation, provided the soils are free of organics and provided the soils are not contaminated. Unsuitable materials should be removed from the excavated soil prior to stockpiling soil for reuse. We understand excavated soils will be stockpiled on the adjacent undeveloped portion of this parcel. Soil stockpiles should be covered to protect the soil from becoming wet from rainfall. Refer to the Weather Considerations section below for additional recommendations. Refer to our separate environmental soil characterization report for additional details regarding soil reuse on site.

5.3.3. Structural Fill

5.3.3.1. Materials

Materials used for support of structures or pavements or for utility trench backfill are classified as structural fill. Structural fill material quality varies depending upon its use as described below:

1. On-site soils will likely be suitable for reuse as structural fill, although cobbles and boulders larger than 6 inches in diameter should be removed prior to reuse as structural fill, along with any organics.
2. Imported gravel borrow for structural fill should conform to PSE Base Course Aggregate Specification 1275.1310 as described in Table 2 below:

TABLE 2. PSE BASE COURSE AGGREGATE SPECIFICATION

U.S. Standard Sieve Size	Percent Passing (by weight)
3 inch	100
¾ inch	70-90
⅜ inch	60-80
¼ inch	50-70
U.S. No. 40	< 30
U.S. No. 200	< 5

3. Structural fill placed as yard surfacing material should be angular crushed rock conforming to PSE Yard Course Crushed Aggregate Specification 1275.1330 as described in Table 3 below:

TABLE 3. PSE YARD COURSE CRUSHED AGGREGATE SPECIFICATION

U.S. Standard Sieve Size	Percent Passing (by weight)
1½ inch	100
1 inch	60 to 100
¾ or ⅝ inch	0 to 35
⅜ inch	0 to 5

5.3.3.2. Fill Placement and Compaction Criteria

Structural fill should be mechanically compacted to a firm, non-yielding condition. In general, structural fill should be placed in loose lifts not exceeding 8 to 10 inches in thickness. Each lift should be conditioned to the proper moisture content and compacted to the specified density before placing subsequent lifts. Structural fill should be compacted to the following criteria:

- Structural fill for the yard area should be compacted to 95 percent of the maximum dry density (MDD) (ASTM International [ASTM] D 1557).

We recommend that a representative from our firm be present during probing of the exposed subgrade soils prior to the placement of structural fill and during the placement of structural fill. Our representative would evaluate the adequacy of the subgrade soils and identify areas needing further work, perform in-place moisture-density tests in the fill to evaluate if the work is being done in accordance with the compaction specifications, and advise on any modifications to procedures that may be appropriate for the prevailing conditions.

5.3.4. Erosion and Sedimentation Control

Potential sources or causes of erosion and sedimentation depend upon construction methods, slope length and gradient, amount of soil exposed and/or disturbed, soil type, construction sequencing and weather.

Temporary erosion protection should be used and maintained in areas with exposed or disturbed soils to help reduce the potential for erosion and reduce transport of sediment to adjacent areas and receiving waters. Permanent erosion protection should be provided by re-establishing vegetation or surfacing with rock.

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

5.3.5. Weather Considerations

The on-site soils contain a sufficient percentage of fines (silt) to be moderately moisture sensitive. If the moisture content of these soils is appreciably above the optimum moisture content, these soils could become unstable. During wet weather, operation of equipment on these soils will be difficult, and it may be difficult to meet the required compaction criteria.

The wet weather season generally begins in early November and continues through March in Western Washington; however, periods of wet weather may occur during any month of the year. The optimum earthwork period for these types of soils is typically July through October. If wet weather earthwork is unavoidable, we recommend that the ground surface in and around the work area be sloped so that surface water is directed away from the work area. The ground surface should be graded such that areas of ponded water do not develop. Stockpiles should be covered. Exposed surfaces should be compacted to reduce the amount of water infiltration. 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.

5.3.6. Temporary Slopes

In our opinion, soils encountered at the site are classified as Type C soil, in accordance with the provisions of Title 296 WAC (Washington Administrative Code), Part N, “Excavation, Trenching and Shoring.” We recommend that temporary slopes in excess of 4 feet in height excavated in the on-site soils be inclined no steeper than 2H:1V (horizontal to vertical) due to the relatively low fines content. Flatter slopes may be necessary if localized sloughing occurs. For open cuts at the site we recommend that:

- No traffic, construction equipment, stockpiles or material storage be allowed at the top of the cut slopes within a horizontal distance of at least 5 feet from the top of the cut.
- Exposed soil along the slope be protected from surface erosion using waterproof tarps or plastic sheeting.
- Construction activities be scheduled so that the length of time the temporary cut is left open is kept as short as possible.
- Erosion control measures be implemented as appropriate such that runoff from the site is reduced to the extent practical.
- Surface water is diverted away from the excavation.
- The condition of the slopes be observed periodically by a geotechnical engineer to confirm adequate stability.

Because the contractor has control of the construction operations, the contractor should be made responsible for the stability of cut slopes, as well as the safety of the excavations. All shoring and temporary slopes must conform to applicable local, state, and federal safety regulations.

5.4. Shallow and Mat Foundations

5.4.1. General

We recommend that conventional shallow or mat foundations be supported on a minimum of 2 feet of compacted structural fill.

5.4.2. Bearing Pressure

Allowable Stress Design. Shallow and mat foundations supported on structural fill as recommended may be designed using an allowable soil bearing pressure of 6,000 pounds per square foot (psf). The allowable soil bearing pressures apply to the total of dead and long-term live loads and may be increased by up to one-third for transient loads such as wind or seismic forces.

A subgrade modulus of 200 pounds per cubic inch (pci) may be used for the design of mat foundations. These values incorporate a factor of safety of approximately 2. The Allowable Stress Design (ASD) bearing pressure will not correspond directly to the Load and Resistance Factor Design (LRFD) bearing pressure due to the difference in design approach between these methods.

Load and Resistance Factor Design. A bearing capacity chart for shallow foundations is presented in Figure 3. The chart is based on a square footing of varying sizes. We recommend the LRFD resistance factors listed in Table 4 below be used when evaluating strength, service, and extreme limit states for shallow foundations. The chart was developed in accordance with American Association of State and Highway Transportation Officials (AASHTO) methods, in conjunction with Washington State Department of Transportation (WSDOT) standards, as summarized in the WSDOT Geotechnical Design Manual.

TABLE 4. LRFD SPREAD FOOTING RESISTANCE FACTORS

Limit State	Resistance Factor ϕ		
	Shear Resistance to Sliding	Bearing	Passive Pressure Resistance to Sliding
Strength	0.8	0.45	0.5
Service	1.0	1.0	1.0
Extreme	0.9	0.9	0.9

5.4.3. Embedment

We recommend that the bottom of foundations be embedded at least 12 inches below the lowest adjacent grade for frost protection, per Thurston County design criteria.

5.4.4. Settlement

Provided all loose soil is removed and the subgrade is prepared as recommended below, we estimate that the post-construction settlement of shallow foundations will be on the order of ½ to 1 inch. Differential settlements between comparably loaded foundations are expected to be less than 1 inch.

5.4.5. Lateral Resistance

Lateral foundation loads may be resisted by passive resistance on the sides of foundations and by friction on the base of the foundations. For foundations supported on native soils or on structural fill placed and compacted in accordance with our recommendations, the allowable frictional resistance may be computed using a coefficient of friction of 0.45 applied to vertical dead-load forces.

The allowable passive resistance may be computed using an equivalent fluid density of 300 pounds per cubic foot (pcf) (triangular distribution) if these elements are poured directly against native soils or surrounded by compacted structural fill. The structural fill should extend out from the face of the foundation element for a distance at least equal to three times the height of the element and be compacted to at least 95 percent of the MDD.

The above coefficient of friction and passive equivalent fluid density values incorporate a factor of safety of approximately 1.5.

5.5. Stormwater Management

We understand stormwater will be infiltrated on site using a biofiltration swale located north of the proposed substation fence. As noted previously, the site is within a wellhead protection area. The proposed stormwater facility location is outside the limits of known or suspected contamination around the existing substation equipment and groundwater flow is likely towards the north, away from the substation and towards Barnes Lake.

The soils at the site are Type A sandy soils and based on the borings, groundwater is approximately 16 to 22 feet below existing grade. Both these conditions are favorable for infiltration.

The sandy soils have negligible cation exchange capacity (CEC) and do not meet the requirements for stormwater treatment. CEC testing was not completed, but based on our experience, the low fines content and lack of organics is consistent with low CEC.

We estimated the initial saturated hydraulic conductivity (K_{sat}) of the Type A sandy soils underlying this area using the equation provided in the City of Tumwater Drainage Design and Erosion Control Manual Volume V, Appendix V-A.3. Based on this equation, K_{sat} is estimated at 0.01 to 0.03 cm/s (10 to 38 in/hr). Applying safety factors with $F_{testing}$ = 0.4 for grain size analysis, $F_{geometry}$ = 1.0, $F_{plugging}$ = 0.8 for fine sands and loamy sands, the resulting design rate is estimated at 3.2 to 12. 2 inches per hour.

We recommend using a design rate of 3 inches per hour, to be confirmed if required during construction with a pilot infiltration test at the proposed stormwater facility location.

5.6. Pavement Design Recommendations

For the access drive, we recommend the following hot mix asphalt (HMA) pavement section, if required. Additionally, we recommend a WSDOT Superpave asphalt binder grade of PG 58-22. This pavement section assumes infrequent passenger vehicle and truck traffic. Please contact us if specific traffic loading should be considered in the pavement design.

- 3 inches HMA, Class B or similar
- 1.5 inches top course
- 4.5 inches base course

6.0 LIMITATIONS

We have prepared this report for the exclusive use of PSE and their authorized agents for the proposed Barnes Lake Substation Improvements in Tumwater, 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, Report Limitations and Guidelines for Use, for additional information pertaining to use of this report.

7.0 REFERENCES

American Society of Civil Engineers, 2016, "Minimum Design Loads and Associated Criteria for Buildings and Other Structures, ASCE/SE 7-2016."

City of Tumwater Drainage Design and Erosion Control Manual Volume V Stormwater BMPs, July 2022.

City of Tumwater Municipal Code, accessed August 16, 2022 from web site: https://www.codepublishing.com/QA/Tumwater/#!/Tumwater16/.

GeoEngineers, Inc. January 12, 2007, "Geotechnical Engineering Services, Settlement Investigation and Mitigation, Barnes Lake Substation, Tumwater, Washington."

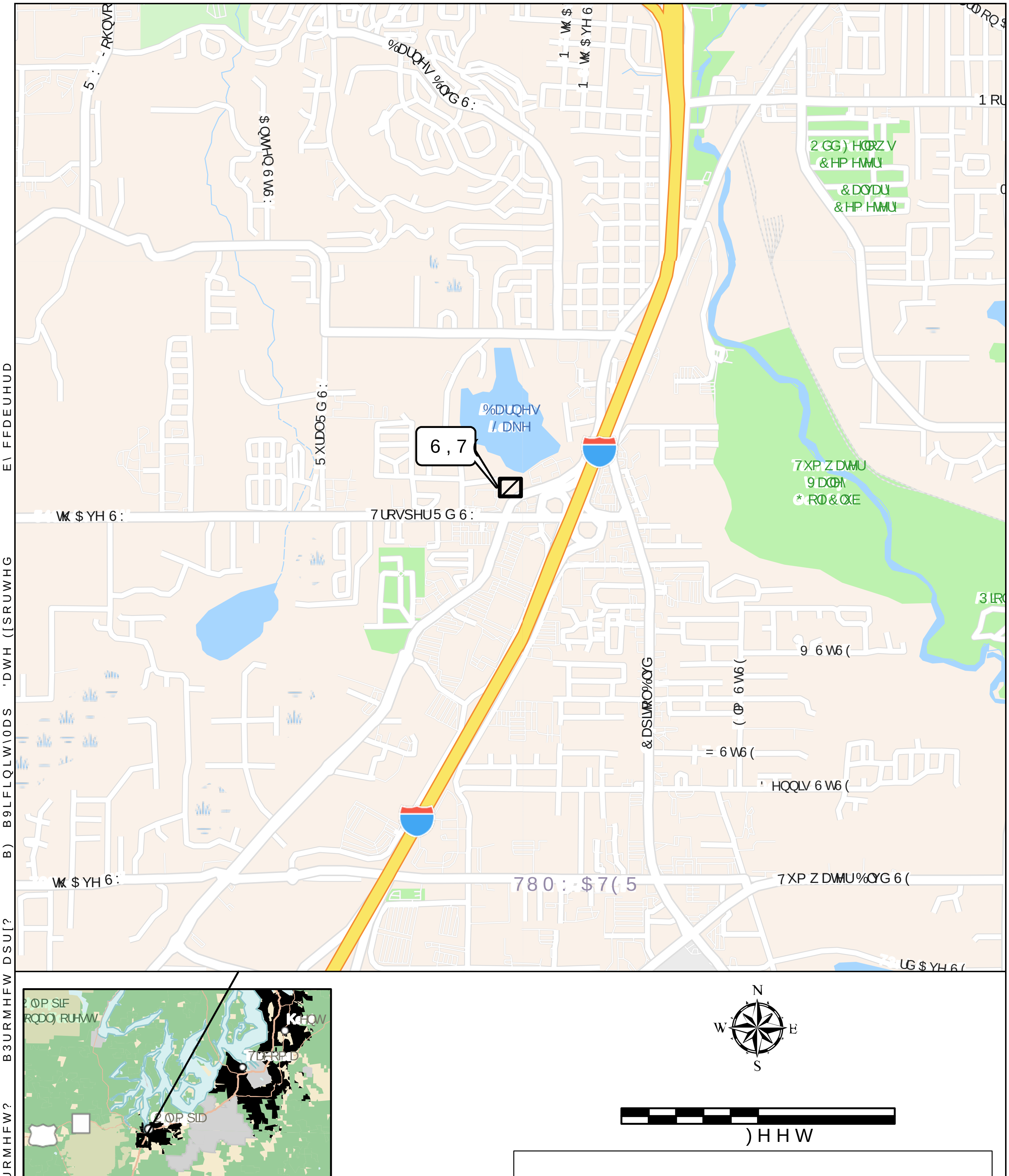
International Code Council, 2018, "International Building Code."

Thurston County Permitting Map, accessed August 16, 2022 from web site: https://map.co.thurston.wa.us/Html5Viewer/Index.html?viewer=Permitting.Main.

U.S. Geological Survey, Quaternary fault and fold database of the United States, accessed August 16, 2022, from web site: https://www.usgs.gov/programs/earthquake-hazards/faults.

Walsh, T.J. et al, 2003, "Geologic map of the Tumwater 7.5-minute quadrangle, Thurston County, Washington," Washington Division of Geology and Earth Resources Open File Report 2003-25.

FIGURES



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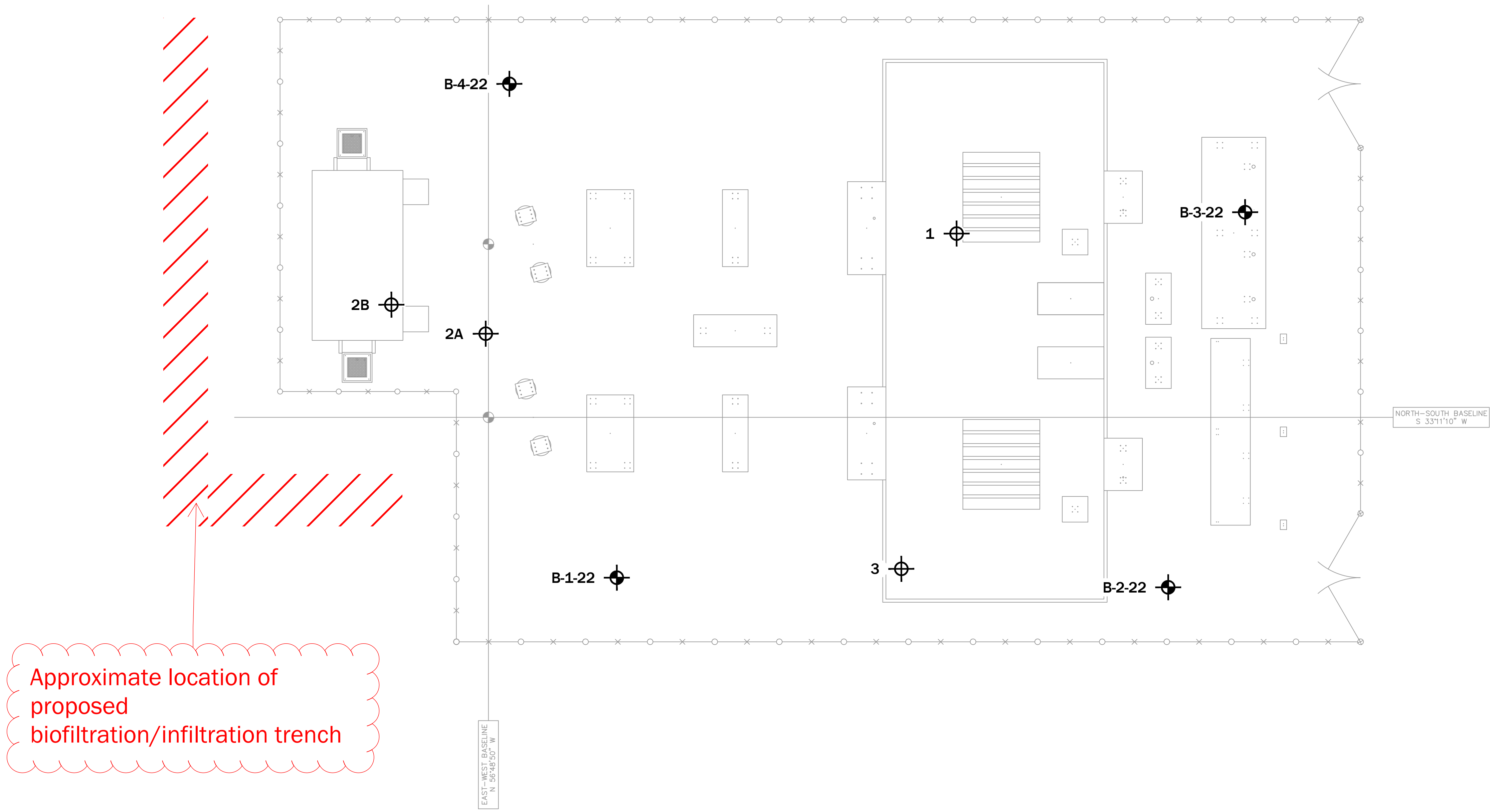
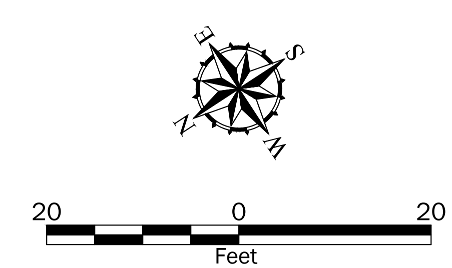


Legend

1 — Boring Completed by GeoEngineers, Inc., 2006

B-1-22 — Boring by GeoEngineers, Inc., 2022



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.

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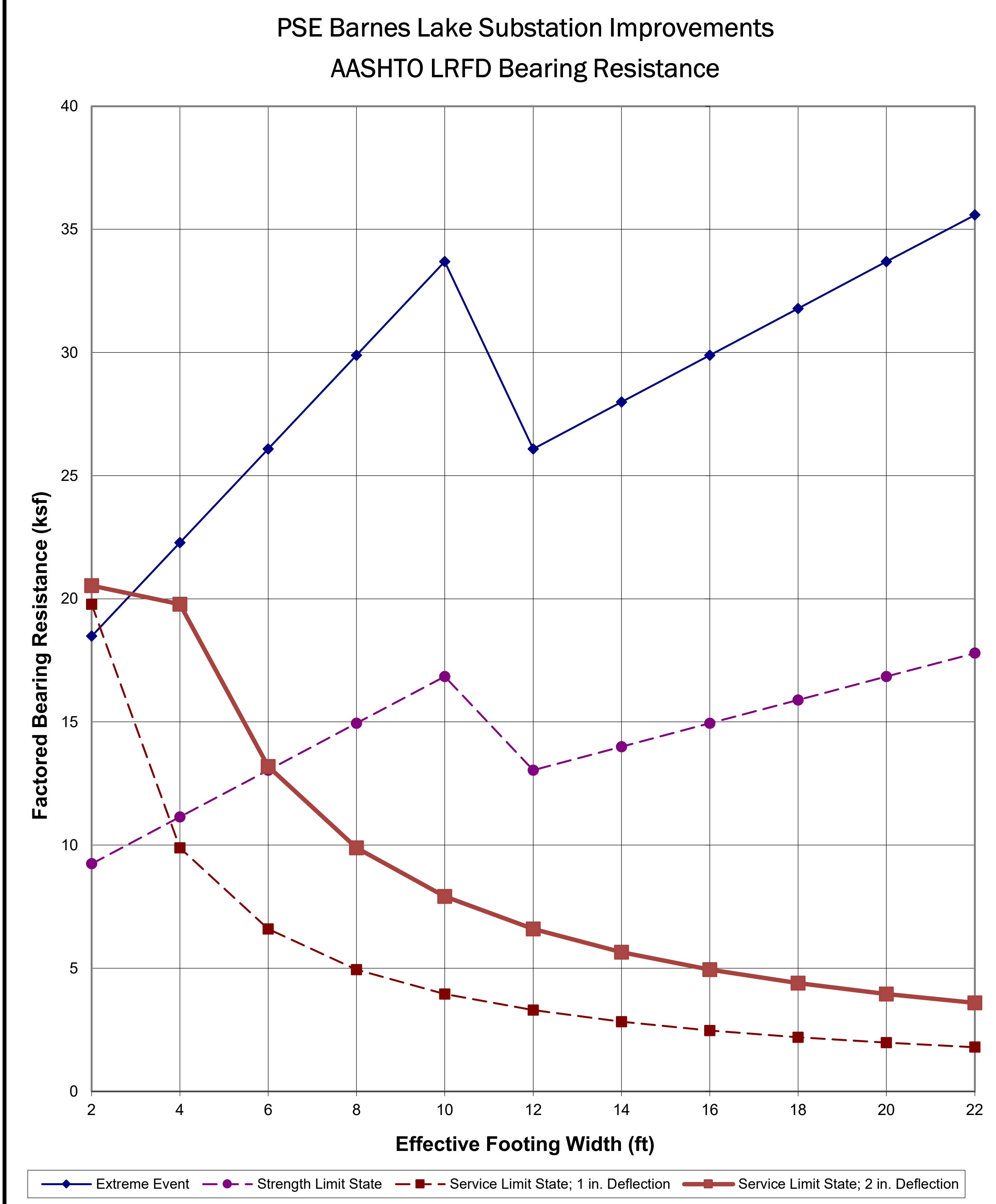
Site Plan

Barnes Lake Substation Improvements
Tumwater, Washington

GEOENGINEERS

Figure 2



GeoEngineers
Earth Science + Technology

Shallow Foundation Design

Figure 3

APPENDICES

GeoEngineers

APPENDIX A
Field Explorations and Laboratory Testing

APPENDIX A
FIELD EXPLORATIONS AND LABORATORY TESTING

Field Explorations

Subsurface conditions at the site were evaluated by completing four borings (GEI-1-22 through GEI-4-22). The borings were completed by Cascade Drilling of Bothell, Washington, on April 14, 2022. The approximate exploration locations are shown on the Site Plan, Figure 2.

Borings

The borings were completed with hollow-stem auger drilling methods using a track-mounted drill rig, with sampling completed using a downhole hammer with a 2.4-inch inner diameter, 3-inch outer diameter sampler. Blowcounts were adjusted to equivalent standard penetration test (SPT) N-values. The borings were continuously observed by one of our geologists who examined and classified the soils encountered, obtained representative soil samples, observed groundwater conditions during drilling and prepared a detailed log of each boring.

Soils encountered in the borings were visually classified in accordance with the classification system described in Figure A-1. A key to the exploration log symbols is also presented in Figure A-1. The logs of the borings are presented in Figures A-2 through A-5. The logs reflect our interpretation of the field conditions and the results of laboratory testing and evaluation of samples. They also indicate the depths at which the soil types or their characteristics change, although the change might actually be gradual. The ground surface elevations shown on the logs were estimated from the base map provided and used on the Site Plan, Figure 2.

The borings were backfilled by the driller in accordance with Washington State Department of Ecology standards.

Groundwater Conditions

Observations of groundwater conditions were made during drilling and are noted on the exploration logs; these observations represent a short-term condition that may not be representative of the long-term groundwater conditions at the site. Groundwater conditions observed during drilling should be considered approximate.

Laboratory Testing

Soil samples obtained from the field explorations were transported to our laboratory and examined to confirm or modify field classifications, as well as to evaluate index properties of the soil samples. Representative samples were selected for laboratory testing consisting of the determination of grain-size distribution (sieve analysis). The tests were performed in general accordance with test methods of the ASTM International (ASTM) procedures.

Sieve Analyses

Sieve analyses were performed on selected samples in general accordance with ASTM D 6913 to determine the sample grain-size distribution. The wet sieve analysis method was used to determine the percentage of soil greater than the U.S. No. 200 mesh sieve. The results of the sieve analyses were plotted, were classified in general accordance with the Unified Soil Classification System (USCS) and are presented in Figure A-6.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	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
	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

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.

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

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

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Figure A-1

Drilled	Start 7/26/2022	End 7/26/2022	Total Depth (ft) 51.5	Logged By NJO Checked By TDB	Driller Cascade Drilling	Drilling Method Hollow-stem Auger

Surface Elevation (ft) 180 Vertical Datum NAVD88	Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment CME 55 Track Rig
Easting (X) 1037793 Northing (Y) 617463	System Datum WA State Plane South NAD83 (feet)	See "Remarks" section for groundwater observed

Notes: Blowcounts converted to equivalent SPT values, 3-inch sampler used

Elevation (feet)	Depth (feet)	FIELD DATA: Recovered (in)	Blows/foot	Sample Name / Testing	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
180	0				RX	4 inches yard rock			Hand dug to 2½ feet
					SP-SM	Brown fine sand with silt and occasional gravel (loose to medium dense, moist) (fill)			
		12	18	1			NS		
175	5	18	8	2		Grades to loose	NS		
		18	18	3		Grades to medium dense	NS		
170	10	18	22	4	SM	Brown silty fine sand with trace organic matter (medium dense, moist) (recessional outwash)	NS		Oxidation staining
					SP-SM	Brownish gray fine sand with silt (medium dense, moist to wet)			
		18	23	5			NS		
165	15	18	18	6			NS		
						Grades to wet			Groundwater observed at approximately 16½ feet below ground surface during drilling
160	20	18	18	7			NS		
					SP-SM	Gray fine to medium sand (medium dense to dense, wet)			
155	25	18	12	8 MC; SA			NS		% Fines = 4, % Moisture = 21
150	30	18	19	9			NS		
145	35								

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

Log of Boring B-1-22

GeoEngineers

Project: PSE Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-01

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	35		18	10		10				NS		Water added due to heaving sand, blowcount no representative due to heave
140	40		18	12		11				NS		Water added due to heaving sand, blowcount no representative due to heave
135	45		12	44		12			Grades to dense	NS		
130	50		12	22		13			Grades to medium dense	NS		

Log of Boring B-1-22 (continued)

GeoEngineers

Project: PSE Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-01

Drilled	Start 7/27/2022	End 7/27/2022	Total Depth (ft) 26.5	Logged By NJO Checked By TDB	Driller Cascade Drilling	Drilling Method Hollow-stem Auger

Surface Elevation (ft) Vertical Datum	180 NAVD88	Hammer Data	Rope & Cathead 140 (lbs) / 30 (in) Drop	Drilling Equipment	CME 55 Track Rig
Easting (X) Northing (Y)	1037742 617393	System Datum	WA State Plane South NAD83 (feet)	See "Remarks" section for groundwater observed	

Notes: Blowcounts converted to equivalent SPT values, 3-inch sampler used

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0							RX	4 inches yard rock			Hand dug to 2½ feet
								SP-SM	Brown fine sand with silt (medium dense, moist) (fill)			
			18	11		1				NS		
175	5		18	11		2				NS		
			18	14		3				NS		
170	10		0	31		4		SM	Brown silty fine sand (dense, moist) (recessional outwash)	NS		
								SP-SM	Brownish gray fine sand with silt (medium dense, moist to wet)			
			18	29		5 MC; SA				NS		% Fines = 8, % Moisture = 9
165	15		0	25		6				NS		
									Grades to wet			Groundwater observed at approximately 19 feet below ground surface during drilling
160	20		18	26		7				NS		
155	25		18	23		8				NS		

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

Log of Boring B-2-22

GeoEngineers

Project: PSE Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-01

Drilled	Start 7/27/2022	End 7/27/2022	Total Depth (ft)	26.5	Logged By NJO / Checked By TDB	Driller: Cascade Drilling	Drilling Method: Hollow-stem Auger
Surface Elevation (ft) / Vertical Datum	180 / NAVD88		Hammer Data	Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment	CME 55 Track Rig
Easting (X) / Northing (Y)	1037783 / 617350		System Datum	WA State Plane South NAD83 (feet)		See "Remarks" section for groundwater observed	

Notes: Blowcounts converted to equivalent SPT values, 3-inch sampler used

Elevation (feet)	Depth (feet)	Recovered (in)	Blows/foot	Sample Name / Testing	Group Classification	Material Description	Sheen	Headspace Vapor (ppm)	Remarks
180	0				RX	4 inches yard rock			Hand dug to 5 feet
					SP-SM	Brown fine sand with silt (loose to medium dense, moist) (fill)			
				1			NS		
175	5	18	8	2			NS		
		18	11	3 / MC; SA		Grades to medium dense	NS		% Fines = 42, % Moisture = 20
					SM	Brown silty fine sand (medium dense, moist) (recessional outwash)			
170	10	18	19	4			NS		
					SP-SM	Brownish gray fine sand with silt (medium dense, moist to wet)			
		18	22	5			NS		
165	15	18	19	6			NS		
						Grades to wet			Groundwater observed at approximately 19 feet below ground surface during drilling
160	20	18	21	7			NS		
155	25	18	17	8			NS		

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

Log of Boring B-3-22

GEOENGINEERS

Project: PSE Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-01

Drilled	Start 7/27/2022	End 7/27/2022	Total Depth (ft) 26.5	Logged By NJO / Checked By TDB	Driller Cascade Drilling	Drilling Method Hollow-stem Auger

Surface Elevation (ft) 180 / Vertical Datum NAVD88	Hammer Data: Rope & Cathead, 140 (lbs) / 30 (in) Drop	Drilling Equipment: CME 55 Track Rig
Easting (X) 1037865 / Northing (Y) 617432	System Datum: WA State Plane South, NAD83 (feet)	See "Remarks" section for groundwater observed

Notes: Blowcounts converted to equivalent SPT values, 3-inch sampler used

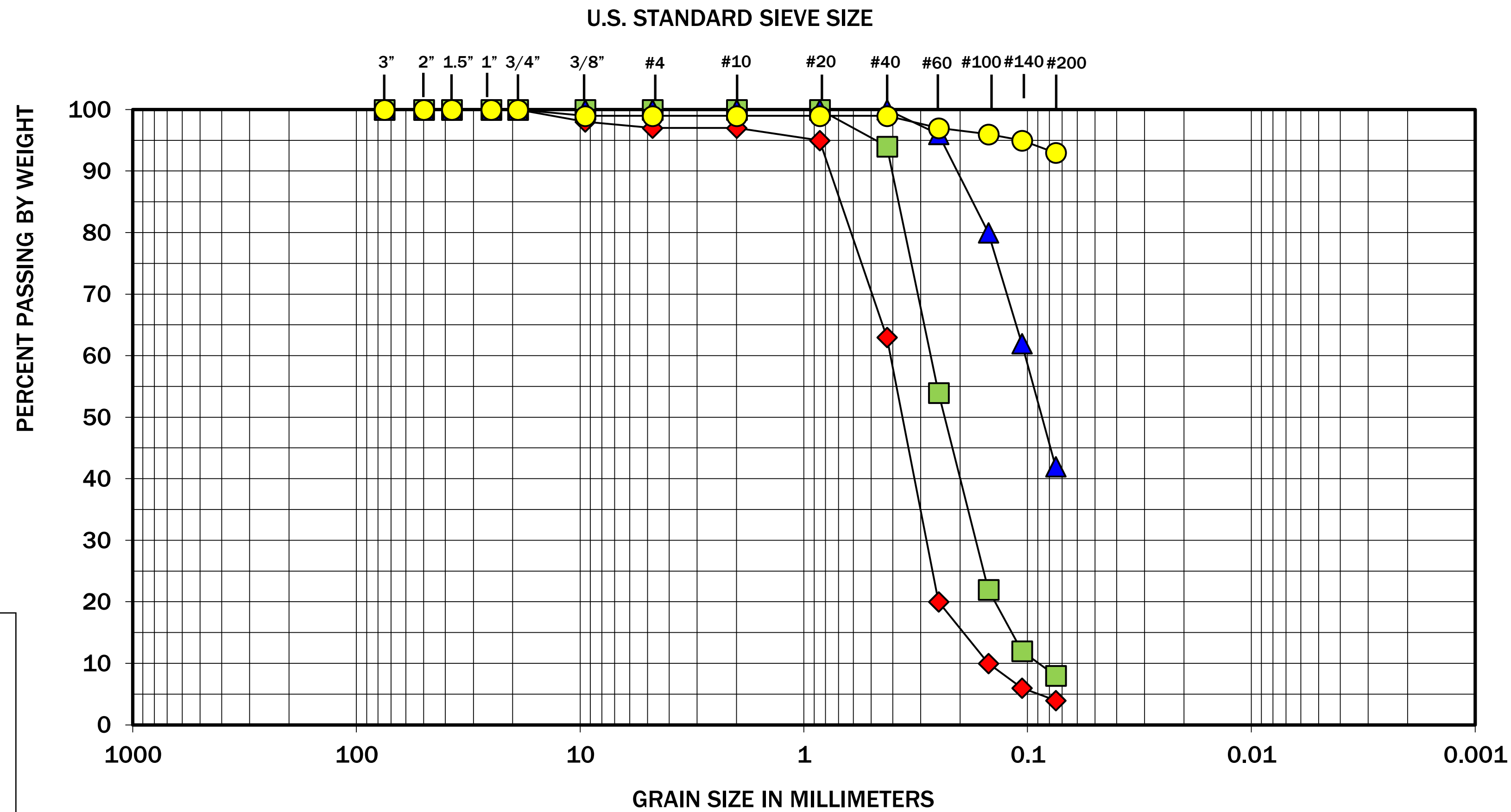
Elevation (feet)	Depth (feet)	Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0						RX	4 inches yard rock			Hand dug to 2½ feet
							SP-SM	Brown fine sand with silt and trace organic matter (medium dense, moist) (fill)			
		18	12		1				NS		
175	5	18	10		2		SP-SM	Brown fine sand with silt and trace organic matter (medium dense, moist) (fill)	NS		
		18	16		3				NS		
170	10	18	26		4 MC; SA		ML	Brown silt (very stiff, moist) (recessional outwash)	NS		% Fines = 93, % Moisture = 28
							SP-SM	Brownish gray fine sand with silt (medium dense, moist to wet)			
		18	19		5				NS		
165	15	18	25		6				NS		
160	20	18	23		7			Grades to wet	NS		Groundwater observed at approximately 19 feet below ground surface during drilling
155	25	18	27		8				NS		

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

Log of Boring B-4-22

GeoEngineers

Project: PSE Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-01



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Boring Number	Depth (feet)	Moisture (%)	Soil Description
◆	B-1	25	21	Poorly graded fine to medium sand (SP)
■	B-2	12.5	9	Poorly graded fine sand with silt (SP-SM)
▲	B-3	7.5	20	Silty fine sand (SM)
●	B-4	10.5	28	Silt (ML)

AASHTO ACCREDITED

Note: This report may not be reproduced, except in full, without written approval of GeoEngineers, Inc. Test results are applicable only to the specific sample on which they were performed, and should not be interpreted as representative of any other samples obtained at other times, depths or locations, or generated by separate operations or processes.

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

Sieve Analysis Results

PSE Barnes Lake Substation
Tumwater, Washington

GeoEngineers

Figure A-6

APPENDIX B
Previous Explorations

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	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
	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
	CC	Cement Concrete
	AC	Asphalt Concrete
	CR	Crushed Rock/ Quarry Spalls
	TS	Topsoil/ Forest Duff/Sod

Measured groundwater level in exploration, well, or piezometer

Groundwater observed at time of exploration

Perched water observed at time of exploration

Measured free product in well or piezometer

Stratigraphic Contact

Distinct contact between soil strata or geologic units

Gradual change between soil strata or geologic units

Approximate location of soil strata change within a geologic soil unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

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.

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

Laboratory / Field Tests

%F	Percent fines
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
OC	Organic content
PM	Permeability or hydraulic conductivity
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen
NT	Not Tested

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

Date(s) Drilled	09/21/06	Logged By	NER	Checked By	SWH
Drilling Contractor	Geologic Drill	Drilling Method	SPT	Sampling Methods	Grab & SPT
Auger Data	2-1/4 inch ID	Hammer Data	140 lb hammer/30 in drop	Drilling Equipment	Acker Portable Rig
Total Depth (ft)	26.5	Surface Elevation (ft)	173	Groundwater Elevation (ft)	152
Vertical Datum		Datum/ System		Easting(x): Northing(y):	

Elevation feet	Depth feet	Recovered (in)	Blows/foot	Sample Number	Water Level	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft³	OTHER TESTS AND NOTES
	0					GP	Gray coarse gravel ballast (loose, dry)			
				1		SP-SM	Brown fine sand with silt and organics (loose, moist) (fill)			Hand cleared
170				2						
		12	4	3						
	5	18	6	4						
165		12	0	5			Void at 7.5 feet (1-foot deep)	9		SA
	10					SP/SM	Brown fine to medium sand with silt and occasional organics (loose to medium dense, moist) (fill)			
		12	11	6		SP-SM	Brown to gray fine sand with silt (medium dense, moist) (Recessional Outwash) (native)			
160		18	14	7						
	15	12	13	8						
155		18	11	9				8		SA
	20	12	14	10	▼					
150										
	25	12	14	11		SP	Gray fine to medium sand with gravel (medium dense, wet) (Recessional Outwash)			Rough drilling
145										
	30									
140										
	35									

Note: See Figure A-1 for explanation of symbols.

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LOG OF BORING 1

GeoEngineers

Project: Barnes Lake Substation

Project Location: Tumwater, Washington

Project Number: 0186-685-00

Figure A-2

Sheet 1 of 1

Date(s) Drilled	09/21/06	Logged By	NER	Checked By	SWH
Drilling Contractor	Geologic Drill	Drilling Method	SPT	Sampling Methods	Grab
Auger Data	2-1/4 inch ID	Hammer Data	140 lb hammer/30 in drop	Drilling Equipment	Acker Portable Rig
Total Depth (ft)	2.5	Surface Elevation (ft)	173	Groundwater Elevation (ft)	Not Encountered
Vertical Datum		Datum/ System		Easting(x): Northing(y):	

Elevation feet	Depth feet	SAMPLES: Interval	SAMPLES: Recovered (in)	SAMPLES: Blows/foot	SAMPLES: Sub-Sample / Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
	0							GP	Gray coarse gravel ballast (loose, dry) (fill)			
					1			SW-SM	Dark brown fine to coarse sand with silt and occasional gravel (medium dense, moist) (fill)			
170												Encountered concrete slab at 2.5 feet bgs
	5											
165												
	10											
160												
	15											
155												
	20											
150												
	25											
145												
	30											
140												
	35											

Note: See Figure A-1 for explanation of symbols.

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LOG OF BORING 2A

GEOENGINEERS

Project: Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-00

Figure A-3
Sheet 1 of 1

Date(s) Drilled	09/21/06	Logged By	NER	Checked By	SWH
Drilling Contractor	Geologic Drill	Drilling Method	SPT	Sampling Methods	Grab & SPT
Auger Data	2-1/4 inch ID	Hammer Data	140 lb hammer/30 in drop	Drilling Equipment	Acker Portable Rig
Total Depth (ft)	23	Surface Elevation (ft)	173	Groundwater Elevation (ft)	151
Vertical Datum		Datum/ System		Easting(x): Northing(y):	

Elevation feet	Depth feet	SAMPLES: Recovered (in)	Blows/foot	Sub-Sample / Sample Number	Water Level	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
	0					WD	Woody bark (fill)			
						SW-SM	Dark brown fine to coarse sand with silt and occasional gravel (loose, moist) (fill)			
170		12	3	1, 2						Hand cleared
	5					SP-SM	Brown fine sand with silt and occasional gravel (loose, moist) (fill)			
		18	6	3						
165		18	3	4						
	10	6	2	5			Wood debris			
160		18	2	6						
	15	12	3	7			Occasional wood debris			
155		18	9	8			Glass fragments			
	20					SP-SM	Gray fine sand with silt (loose, moist) (Recessional Outwash) (native)			
		14	9	9	▼			8		SA
150										
	25									
145										
	30									
140										
	35									

Note: See Figure A-1 for explanation of symbols.

LOG OF BORING 2B

GeoEngineers

Project: Barnes Lake Substation
Project Location: Tumwater, Washington
Project Number: 0186-685-00

Figure A-4
Sheet 1 of 1

Date(s) Drilled	09/21/06	Logged By	NER	Checked By	SWH
Drilling Contractor	Geologic Drill	Drilling Method	SPT	Sampling Methods	Grab & SPT
Auger Data	2-1/4 inch ID	Hammer Data	140 lb hammer/30 in drop	Drilling Equipment	Acker Portable Rig
Total Depth (ft)	17.5	Surface Elevation (ft)	173	Groundwater Elevation (ft)	Not Encountered
Vertical Datum		Datum/ System		Easting(x): Northing(y):	

Elevation feet	Depth feet	SAMPLES: Interval	Recovered (in)	Blows/foot	Sub-Sample Sample Number	Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft^3	OTHER TESTS AND NOTES
	0							GP	Gray coarse gravel ballast (loose, dry) (fill)			
					1			SW-SM	Dark brown fine to coarse sand with silt, occasional gravel and asphalt debris (soft, moist) (fill)			Hand cleared
170			20	5	2							
								SP-SM	Dark brown fine sand with silt and occasional organics (loose, moist) (fill)			
	5		18	6	3							
								SM	Light brown silty fine sand (loose, moist) (fill)			
165			18	7	4				Void at 7.5 feet (1-foot deep)	13		SA
	10		12	11	5				Grades to medium dense			
160			18	15	6			SP	Gray medium sand (medium dense, moist) (Recessional Outwash) (native)			
	15		12	13	7							
155												
	20											
150												
	25											
145												
	30											
140												
	35											

Note: See Figure A-1 for explanation of symbols.

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LOG OF BORING 3

GEOENGINEERS

Project: Barnes Lake Substation

Project Location: Tumwater, Washington

Project Number: 0186-685-00

Figure A-5

Sheet 1 of 1

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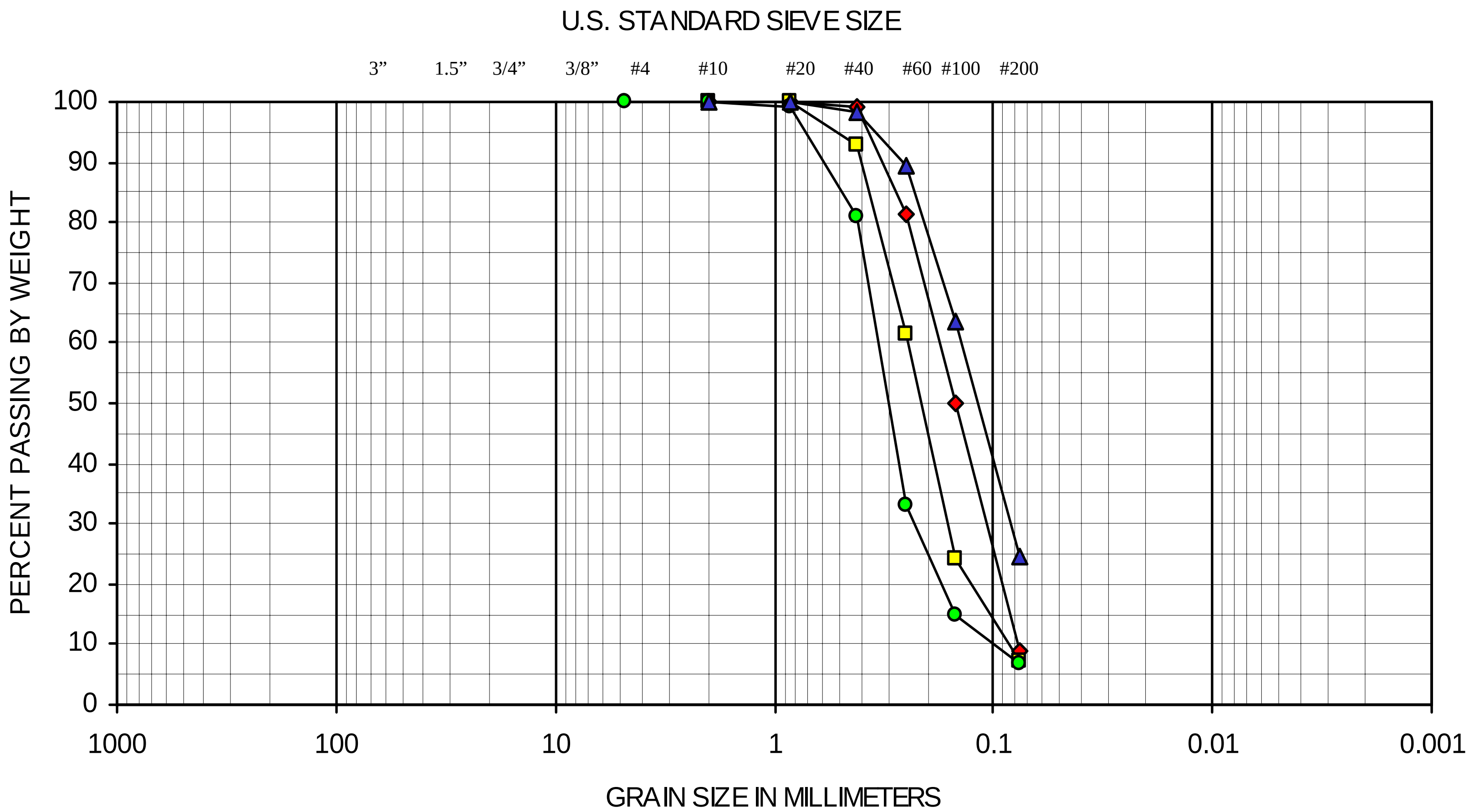

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	1	7	Brown sand with silt (SP-SM)
■	1	18	Brown sand with silt (SP-SM)
●	2B	22	Brown sand with silt (SP-SM)
▲	3	8	Brown silty sand (SM)

SIEVE ANALYSIS RESULTS

FIGURE A-6

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.

Geotechnical Services Are Performed for Specific Purposes, Persons and Projects

This report has been prepared for the exclusive use of Puget Sound Energy and their authorized agents. This report may be made available to prospective contractors for their bidding or estimating purposes, but our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with which there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A Geotechnical Engineering or Geologic Report Is Based on a Unique Set of Project-Specific Factors

This report has been prepared for the proposed improvements to the Barnes Lake Substation located on 2nd Avenue SW in Tumwater, 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, do not 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.

---

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

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

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

If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

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 manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

Most 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 subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

Geotechnical Engineering Report Recommendations Are Not Final

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from GeoEngineers' professional judgment and opinion. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by GeoEngineers should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having GeoEngineers confer with appropriate members of the design team after submitting the report. Also retain GeoEngineers to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having GeoEngineers participate in pre-bid and preconstruction conferences, and by 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. To prevent errors or omissions, the logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

Give Contractors a Complete Report and Guidance

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

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 to adjacent properties.

Read These Provisions Closely

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

Geotechnical, Geologic and Environmental Reports Should Not Be Interchanged

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.

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.

If Client desires these specialized services, they should be obtained from a consultant who offers services in this specialized field.

GeoEngineers

AGENCY USE ONLY

Date received:

Agency reference #: ______

Tax Parcel #(s): ______

WASHINGTON STATE
Joint Aquatic Resources Permit Application (JARPA) Form[1,2] [help]

USE BLACK OR BLUE INK TO ENTER ANSWERS IN THE WHITE SPACES BELOW.

Part 1–Project Identification

1. Project Name (A name for your project that you create. Examples: Smith's Dock or Seabrook Lane Development) [help]
PSE Barnes Lake Substation Rebuild & Expansion

Part 2–Applicant

The person and/or organization responsible for the project. [help]

2a. Name (Last, First, Middle)			
Trevor Lessard			
2b. Organization (If applicable)			
Puget Sound Energy			
2c. Mailing Address (Street or PO Box)			
1140 N 94th St			
2d. City, State, Zip			
Seattle, WA 98103			
2e. Phone (1)	**2f.** Phone (2)	**2g.** Fax	**2h.** E-mail
206-390-9660			Trevor.Lessard@pse.com

[1]Additional forms may be required for the following permits:

- If your project may qualify for Department of the Army authorization through a Regional General Permit (RGP), contact the U.S. Army Corps of Engineers for application information (206) 764-3495.
- Not all cities and counties accept the JARPA for their local Shoreline permits. If you need a Shoreline permit, contact the appropriate city or county government to make sure they accept the JARPA.

[2]To access an online JARPA form with [help] screens, go to http://www.epermitting.wa.gov/site/alias__resourcecenter/jarpa_jarpa_form/9984/jarpa_form.aspx.

For other help, contact the Governor's Office for Regulatory Innovation and Assistance at (800) 917-0043 or help@oria.wa.gov.

Part 3–Authorized Agent or Contact

Person authorized to represent the applicant about the project. (Note: Authorized agent(s) must sign 11b of this application.) [help]

3a. Name (Last, First, Middle)			
Trevor Lessard			
3b. Organization (If applicable)			
Puget Sound Energy			
3c. Mailing Address (Street or PO Box)			
1140 N 94th St			
3d. City, State, Zip			
Seattle, WA 98103			
3e. Phone (1)	**3f.** Phone (2)	**3g.** Fax	**3h.** E-mail
206-390-9660			Trevor.Lessard@pse.com

Part 4–Property Owner(s)

Contact information for people or organizations owning the property(ies) where the project will occur. Consider both **upland and aquatic** ownership because the upland owners may not own the adjacent aquatic land. [help]

☑ Same as applicant. (Skip to Part 5.)

☐ Repair or maintenance activities on existing rights-of-way or easements. (Skip to Part 5.)

☐ There are multiple upland property owners. Complete the section below and fill out JARPA Attachment A for each additional property owner.

☐ Your project is on Department of Natural Resources (DNR)-managed aquatic lands. If you don't know, contact the DNR at (360) 902-1100 to determine aquatic land ownership. If yes, complete JARPA Attachment E to apply for the Aquatic Use Authorization.

4a. Name (Last, First, Middle)			
4b. Organization (If applicable)			
4c. Mailing Address (Street or PO Box)			
4d. City, State, Zip			
4e. Phone (1)	**4f.** Phone (2)	**4g.** Fax	**4h.** E-mail

Part 5–Project Location(s)

Identifying information about the property or properties where the project will occur. [help]

☐ There are multiple project locations (e.g. linear projects). Complete the section below and use JARPA Attachment B for each additional project location.

5a. Indicate the type of ownership of the property. (Check all that apply.) [help]			
☑ Private ☐ Federal ☐ Publicly owned (state, county, city, special districts like schools, ports, etc.) ☐ Tribal ☐ Department of Natural Resources (DNR) – managed aquatic lands (Complete JARPA Attachment E)			
5b. Street Address (Cannot be a PO Box. If there is no address, provide other location information in 5p.) [help]			
1669 S 2nd Ave SW			
5c. City, State, Zip (If the project is not in a city or town, provide the name of the nearest city or town.) [help]			
Tumwater, WA 98512			
5d. County [help]			
Thurston			
5e. Provide the section, township, and range for the project location. [help]			
¼ Section	**Section**	**Township**	**Range**
	65	T18	R02W
5f. Provide the latitude and longitude of the project location. [help] • Example: 47.03922 N lat. / -122.89142 W long. (Use decimal degrees - NAD 83)			
47.000773 N lat. / -122.915724 W long.			
5g. List the tax parcel number(s) for the project location. [help] • The local county assessor's office can provide this information.			
09080011003			

5h. Contact information for all adjoining property owners. (If you need more space, use JARPA Attachment C.) [help]

Name	Mailing Address	Tax Parcel # (if known)
Tumwater RH LLC	845 106th Ave NE STE 100 Bellevue, WA 98004	09080010000
WSDOT	PO Box 47365 Olympia, WA 98504	09080011002
Grimm Enterprises LLC	1677 S 2nd Ave SW Tumwater, WA 98512	09080091001
702 Trosper Road Venture LLC	PO Box 2195 Ketchum, ID 83340	09080088102

5i. List all wetlands on or adjacent to the project location. [help]	
None	
5j. List all waterbodies (other than wetlands) on or adjacent to the project location. [help]	
Barnes Lake	
5k. Is any part of the project area within a 100-year floodplain? [help]	
☐ Yes ☑ No ☐ Don't know	
5l. Briefly describe the vegetation and habitat conditions on the property. [help]	
The largest portion of the property consists of managed, grass lawn. Landscape trees surround the substation for visual screening while coniferous and deciduous trees buffer Barnes Lake to the north.	
5m. Describe how the property is currently used. [help]	
Electrical Substation.	
5n. Describe how the adjacent properties are currently used. [help]	
Commercial businesses to south and east. WSDOT facility to the northeast. Barnes Lake to the north.	
5o. Describe the structures (above and below ground) on the property, including their purpose(s) and current condition. [help]	
The property consists of PSE's Barnes Lake electric substation, with necessary equipment to facilitate electricity delivery to customers within the region.	
5p. Provide driving directions from the closest highway to the project location, and attach a map. [help]	
From I-5, take exit 102 onto Trosper Rd SW and head west. Turn right onto S 2nd Ave SW, then destination is on the left in 72 feet.	

Part 6–Project Description

6a. Briefly summarize the overall project. You can provide more detail in 6b. [help]
PSE is proposing to rebuild and expand its Barnes Lake substation. All existing equipment in the substation will be replaced with new equipment and a new perimeter fence. PSE will bump out the backend of the substation to make room for a second transformer and bus equipment to expand the capacity of the substation. A stormwater pond will be created behind the substation to provide for stormwater management.

6b. Describe the purpose of the project and why you want or need to perform it. [help]
The purpose of the rebuild and expansion is re replace old and damaged equipment with new materials and extend the life of the substation. The expansion is necessary to increase capacity of the substation to better meet the growing demand of the region. Note, the substation rebuild and expansion sections, along with the stormwater pond occur outside of the 200-ft shoreline buffer. PSE is only proposing a temporary stockpile within the shoreline buffer which will be removed to restored to its original condition after work is complete.

6c. Indicate the project category. (Check all that apply) [help]

☐ Commercial ☐ Residential ☐ Institutional ☐ Transportation ☐ Recreational

☑ Maintenance ☐ Environmental Enhancement

6d. Indicate the major elements of your project. (Check all that apply) [help]

☐ Aquaculture	☐ Culvert	☐ Float	☐ Retaining Wall (upland)
☐ Bank Stabilization	☐ Dam / Weir	☐ Floating Home	☐ Road
☐ Boat House	☐ Dike / Levee / Jetty	☐ Geotechnical Survey	☐ Scientific Measurement Device
☐ Boat Launch	☐ Ditch	☐ Land Clearing	☐ Stairs
☐ Boat Lift	☐ Dock / Pier	☐ Marina / Moorage	☐ Stormwater facility
☐ Bridge	☐ Dredging	☐ Mining	☐ Swimming Pool
☐ Bulkhead	☐ Fence	☐ Outfall Structure	☑ Utility Line
☐ Buoy	☐ Ferry Terminal	☐ Piling/Dolphin	
☐ Channel Modification	☐ Fishway	☐ Raft	

☑ Other: Electric Substation

6e. Describe how you plan to construct each project element checked in 6d. Include specific construction methods and equipment to be used. [help] • Identify where each element will occur in relation to the nearest waterbody. • Indicate which activities are within the 100-year floodplain.
For all work within the shoreline buffer of Barnes Lake, PSE will have a temporary stockpile that will extend from the back end of the existing substation toward the lake. However no portion of the stockpile will extend beyond the existing grassy area.
6f. What are the anticipated start and end dates for project construction? (Month/Year) [help] • If the project will be constructed in phases or stages, use JARPA Attachment D to list the start and end dates of each phase or stage.
Start Date: Start of Q2 2024 End Date: End of Q3 2024 ☐ See JARPA Attachment D
6g. Fair market value of the project, including materials, labor, machine rentals, etc. [help]
$9.76M
6h. Will any portion of the project receive federal funding? [help] • **If yes**, list each agency providing funds.
☐ Yes ☑ No ☐ Don't know

Part 7–Wetlands: Impacts and Mitigation

☐ Check here if there are wetlands or wetland buffers on or adjacent to the project area.
(If there are none, skip to Part 8.) [help]

7a. Describe how the project has been designed to avoid and minimize adverse impacts to wetlands. [help]
☐ Not applicable
7b. Will the project impact wetlands? [help]
☐ Yes ☐ No ☐ Don't know
7c. Will the project impact wetland buffers? [help]
☐ Yes ☐ No ☐ Don't know

7d. Has a wetland delineation report been prepared? [help]

- **If Yes**, submit the report, including data sheets, with the JARPA package.

☐ Yes ☐ No

7e. Have the wetlands been rated using the Western Washington or Eastern Washington Wetland Rating System? [help]

- **If Yes**, submit the wetland rating forms and figures with the JARPA package.

☐ Yes ☐ No ☐ Don't know

7f. Have you prepared a mitigation plan to compensate for any adverse impacts to wetlands? [help]

- **If Yes**, submit the plan with the JARPA package and answer 7g.
- **If No, or Not applicable**, explain below why a mitigation plan should not be required.

☐ Yes ☐ No ☐ Don't know

7g. Summarize what the mitigation plan is meant to accomplish, and describe how a watershed approach was used to design the plan. [help]

7h. Use the table below to list the type and rating of each wetland impacted, the extent and duration of the impact, and the type and amount of mitigation proposed. Or if you are submitting a mitigation plan with a similar table, you can state (below) where we can find this information in the plan. [help]

Activity (fill, drain, excavate, flood, etc.)	Wetland Name[1]	Wetland type and rating category[2]	Impact area (sq. ft. or Acres)	Duration of impact[3]	Proposed mitigation type[4]	Wetland mitigation area (sq. ft. or acres)

[1] If no official name for the wetland exists, create a unique name (such as "Wetland 1"). The name should be consistent with other project documents, such as a wetland delineation report.
[2] Ecology wetland category based on current Western Washington or Eastern Washington Wetland Rating System. Provide the wetland rating forms with the JARPA package.
[3] Indicate the days, months or years the wetland will be measurably impacted by the activity. Enter "permanent" if applicable.
[4] Creation (C), Re-establishment/Rehabilitation (R), Enhancement (E), Preservation (P), Mitigation Bank/In-lieu fee (B)

Page number(s) for similar information in the mitigation plan, if available: ______________________________

7i. For all filling activities identified in 7h, describe the source and nature of the fill material, the amount in cubic yards that will be used, and how and where it will be placed into the wetland. [help]

7j. For all excavating activities identified in 7h, describe the excavation method, type and amount of material in cubic yards you will remove, and where the material will be disposed. [help]

Part 8–Waterbodies (other than wetlands): Impacts and Mitigation

In Part 8, "waterbodies" refers to non-wetland waterbodies. (See Part 7 for information related to wetlands.) [help]

☑ Check here if there are waterbodies on or adjacent to the project area. (If there are none, skip to Part 9.)

8a. Describe how the project is designed to avoid and minimize adverse impacts to the aquatic environment. [help]
☐ Not applicable
PSE does not have any construction proposed within the aquatic environment. PSE has only planned for the maximum extent of an onsite stockpile to potentially expand into the 200 foot buffer of Barnes Lake. The stockpile will extend only into the existing, managed lawn of the substation property. PSE will perform most of the construction work during Q2 and Q3 of 2024, which are typically the drier months of the year. PSE will also install temporary erosion/sediment controls around the stockpile to prevent impacts to the nearby lake. Once the stockpile is no longer needed, PSE will seed and cover any disturbed areas of the lawn with hay, allowing grass to reestablish cover.
8b. Will your project impact a waterbody or the area around a waterbody? [help]
☐ Yes ☑ No

8c. Have you prepared a mitigation plan to compensate for the project's adverse impacts to non-wetland waterbodies? [help]

- **If Yes**, submit the plan with the JARPA package and answer 8d.
- **If No, or Not applicable,** explain below why a mitigation plan should not be required.

☐ Yes ☑ No ☐ Don't know

PSE plans for a temporary stockpile expansion into the shoreline buffer only. This disturbance is minimal, will be properly managed, and temporary.

8d. Summarize what the mitigation plan is meant to accomplish. Describe how a watershed approach was used to design the plan.

- If you already completed 7g you do not need to restate your answer here. [help]

NA – See above.

8e. Summarize impact(s) to each waterbody in the table below. [help]

Activity (clear, dredge, fill, pile drive, etc.)	Waterbody name[1]	Impact location[2]	Duration of impact[3]	Amount of material (cubic yards) to be placed in or removed from waterbody	Area (sq. ft. or linear ft.) of waterbody directly affected
NA					

[1] If no official name for the waterbody exists, create a unique name (such as "Stream 1") The name should be consistent with other documents provided.
[2] Indicate whether the impact will occur in or adjacent to the waterbody. If adjacent, provide the distance between the impact and the waterbody and indicate whether the impact will occur within the 100-year flood plain.
[3] Indicate the days, months or years the waterbody will be measurably impacted by the work. Enter "permanent" if applicable.

8f. For all activities identified in 8e, describe the source and nature of the fill material, amount (in cubic yards) you will use, and how and where it will be placed into the waterbody. [help]

NA – no fill will occur within the waterbody.

8g. For all excavating or dredging activities identified in 8e, describe the method for excavating or dredging, type and amount of material you will remove, and where the material will be disposed. [help]
NA – no excavation or dredging will occur within the waterbody.

8h. Have you prepared a Water Quality Monitoring Plan (WQMP) for all in-water work (below ordinary high water), over water work or discharges to waters of the state? ☐ Yes ☑ No If NO describe the monitoring that you will be conducting including parameters, equipment and locations, or explain why monitoring will not be necessary. [help]
NA – no in water work will occur and temporary erosion and sediment controls will be in place to prevent stormwater from leaving PSE's construction area.

Part 9–Additional Information

Any additional information you can provide helps the reviewer(s) understand your project. Complete as much of this section as you can. It is ok if you cannot answer a question.

9a. If you have already worked with any government agencies on this project, list them below. [help]

Agency Name	Contact Name	Phone	Most Recent Date of Contact
City of Tumwater	Alex Baruch	360-754-4180	12/11/2023

9b. Are any of the wetlands or waterbodies identified in Part 7 or Part 8 of this JARPA on the Washington Department of Ecology's 303(d) List? [help]

- **If Yes,** list the parameter(s) below.
- If you don't know, use Washington Department of Ecology's Water Quality Assessment tools at: https://ecology.wa.gov/Water-Shorelines/Water-quality/Water-improvement/Assessment-of-state-waters-303d.

☑ Yes ☐ No

70682 – Total Phosphorus

9c. What U.S. Geological Survey Hydrological Unit Code (HUC) is the project in? [help]

- Go to http://cfpub.epa.gov/surf/locate/index.cfm to help identify the HUC.

17110016

9d. What Water Resource Inventory Area Number (WRIA #) is the project in? [help]

- Go to https://ecology.wa.gov/Water-Shorelines/Water-supply/Water-availability/Watershed-look-up to find the WRIA #.

13 - Deschutes

9e. Will the in-water construction work comply with the State of Washington water quality standards for turbidity? [help]

- Go to https://ecology.wa.gov/Water-Shorelines/Water-quality/Freshwater/Surface-water-quality-standards/Criteria for the standards.

☐ Yes ☐ No ☑ Not applicable

9f. If the project is within the jurisdiction of the Shoreline Management Act, what is the local shoreline environment designation? [help]

- If you don't know, contact the local planning department.
- For more information, go to: https://ecology.wa.gov/Water-Shorelines/Shoreline-coastal-management/Shoreline-coastal-planning/Shoreline-laws-rules-and-cases.

☑ Urban ☐ Natural ☐ Aquatic ☐ Conservancy ☐ Other: ____________________

9g. What is the Washington Department of Natural Resources Water Type? [help]

- Go to http://www.dnr.wa.gov/forest-practices-water-typing for the Forest Practices Water Typing System.

☑ Shoreline ☐ Fish ☐ Non-Fish Perennial ☐ Non-Fish Seasonal

9h. Will this project be designed to meet the Washington Department of Ecology's most current stormwater manual? [help]

- **If No**, provide the name of the manual your project is designed to meet.

☑ Yes ☐ No

Name of manual: ____________________

9i. Does the project site have known contaminated sediment? [help]

- **If Yes**, please describe below.

☑ Yes ☐ No

There is a potential oil spill on site due to recent damage to PSE's facility. No contaminated soils is expected within the shoreline buffer. PSE plans to test all soils excavated during work for contamination. All contaminated soils well be segregated and removed from site and disposed of properly. Only clean soil will be allowed for reuse during civil work.
9j. If you know what the property was used for in the past, describe below. [help]
Electric Substation.
9k. Is the project located in or adjacent to a designated state or federal contaminated site or clean-up site. (e.g. MTCA or CERCLA)? [help] • **If Yes**, provide any additional details below.
☐ Yes ☑ No
9l. Has a cultural resource (archaeological) survey been performed on the project area? [help] • **If Yes**, attach it to your JARPA package.
☑ Yes ☐ No

9m. Name each species listed under the federal Endangered Species Act that occurs in the vicinity of the project area or might be affected by the proposed work. [help]
None

9n. Name each species or habitat on the Washington Department of Fish and Wildlife's Priority Habitats and Species List that might be affected by the proposed work. [help]
None

Part 10–SEPA Compliance and Permits

Use the resources and checklist below to identify the permits you are applying for.

- Online Project Questionnaire at http://apps.oria.wa.gov/opas/.
- Governor's Office for Regulatory Innovation and Assistance at (800) 917-0043 or help@oria.wa.gov.
- For a list of addresses to send your JARPA to, click on agency addresses for completed JARPA.

10a. Compliance with the State Environmental Policy Act (SEPA). (Check all that apply.) [help] • For more information about SEPA, go to https://ecology.wa.gov/regulations-permits/SEPA-environmental-review.
☐ A copy of the SEPA determination or letter of exemption is included with this application.
☑ A SEPA determination is pending with __Tumwater__ (lead agency). The expected decision date is __part of PSE application__.
☐ I am applying for a Fish Habitat Enhancement Exemption. (Check the box below in 10b.) [help]
☐ This project is exempt (choose type of exemption below). ☐ Categorical Exemption. Under what section of the SEPA administrative code (WAC) is it exempt? ____________________ ☐ Other: ____________________
☐ SEPA is pre-empted by federal law.

10b. Indicate the permits you are applying for. (Check all that apply.) [help]

LOCAL GOVERNMENT

Local Government Shoreline permits:

☐ Substantial Development ☐ Conditional Use ☐ Variance

☑ Shoreline Exemption Type (explain): WAC 173-27-040(2)(a) – Cost Exemption

Other City/County permits:

☐ Floodplain Development Permit ☐ Critical Areas Ordinance

STATE GOVERNMENT

Washington Department of Fish and Wildlife:

☐ Hydraulic Project Approval (HPA) ☐ Fish Habitat Enhancement Exemption – Attach Exemption Form

Washington Department of Natural Resources:

☐ Aquatic Use Authorization

Complete JARPA Attachment E and submit a check for $25 payable to the Washington Department of Natural Resources. **Do not send cash.**

Washington Department of Ecology:

☐ Section 401 Water Quality Certification

☐ Authorization to impact waters of the state, including wetlands (Check this box if the proposed impacts are to waters not subject to the federal Clean Water Act)

FEDERAL AND TRIBAL GOVERNMENT

United States Department of the Army (U.S. Army Corps of Engineers):

☐ Section 404 (discharges into waters of the U.S.) ☐ Section 10 (work in navigable waters)

United States Coast Guard:

For projects or bridges over waters of the United States, contact the U.S. Coast Guard at:

☐ Bridge Permit: D13-SMB-D13-BRIDGES@uscg.mil

☐ Private Aids to Navigation (or other non-bridge permits): D13-SMB-D13-PATON@uscg.mil

United States Environmental Protection Agency:

☐ Section 401 Water Quality Certification (discharges into waters of the U.S.) on tribal lands where tribes do not have treatment as a state (TAS)

Tribal Permits: (Check with the tribe to see if there are other tribal permits, e.g., Tribal Environmental Protection Act, Shoreline Permits, Hydraulic Project Permits, or other in addition to CWA Section 401 WQC)

☐ Section 401 Water Quality Certification (discharges into waters of the U.S.) where the tribe has treatment as a state (TAS).

Part 11–Authorizing Signatures

Signatures are required before submitting the JARPA package. The JARPA package includes the JARPA form, project plans, photos, etc. [help]

11a. Applicant Signature (required) [help]

I certify that to the best of my knowledge and belief, the information provided in this application is true, complete, and accurate. I also certify that I have the authority to carry out the proposed activities, and I agree to start work only after I have received all necessary permits.

I hereby authorize the agent named in Part 3 of this application to act on my behalf in matters related to this application. ___TL______ (initial)

By initialing here, I state that I have the authority to grant access to the property. I also give my consent to the permitting agencies entering the property where the project is located to inspect the project site or any work related to the project. ___TL______ (initial)

Trevor Lessard		3/25/2024
Applicant Printed Name	Applicant Signature	Date

11b. Authorized Agent Signature [help]

I certify that to the best of my knowledge and belief, the information provided in this application is true, complete, and accurate. I also certify that I have the authority to carry out the proposed activities and I agree to start work only after all necessary permits have been issued.

Trevor Lessard		3/25/2024
Authorized Agent Printed Name	Authorized Agent Signature	Date

11c. Property Owner Signature (if not applicant) [help]

Not required if project is on existing rights-of-way or easements (provide copy of easement with JARPA).

I consent to the permitting agencies entering the property where the project is located to inspect the project site or any work. These inspections shall occur at reasonable times and, if practical, with prior notice to the landowner.

Trevor Lessard (on behalf of PSE)		3/25/2024
Property Owner Printed Name	Property Owner Signature	Date

18 U.S.C §1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of the United States knowingly falsifies, conceals, or covers up by any trick, scheme, or device a material fact or makes any false, fictitious, or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious, or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than 5 years or both.

If you require this document in another format, contact the Governor's Office for Regulatory Innovation and Assistance (ORIA) at (800) 917-0043. People with hearing loss can call 711 for Washington Relay Service. People with a speech disability can call (877) 833-6341. ORIA publication number: ORIA-16-011 rev. 09/2018

Project: Barnes Lake Substation - Stockpiling Value Estimate

	Estimated Price	Unit	Quantity	Estimated Value
Materials				
Silt Fence	$ 1.50	LF	254	$381
Plastic Covering	$ 0.07	SF	7753	$543
Hydroseeding	$ 0.65	SY	983	$639

ESC Total: **$1,563**

	Quantity	Unit	
Construction Time Required within Shoreline			
Stockpile Volume	750	CY	
Equipment Haul Volume	5.25	CY	- JD 544 Mid Size Wheel Loader
Number of Trips Required in Shoreline	143	-	
Travel Distance (total round trip distance)	130	ft	- Distance traveled within shoreline area
Travel Speed	10	mph	
Travel Speed	14.7	ft/s	
Travel Time per Round Trip	8.84	seconds	
Total Travel Time	1263	seconds	
Total Travel Time	21.06	hours	
Dump Cycle Time	2.20	seconds	
Number of Round Trips Required in Shoreline	143	-	
Total Dump Cycle Time	314.29	seconds	
Total Dump Cycle Time	5.24	hours	
Total Time Required within Shoreline	26.29	hours	

	Unit Price	Unit	Quantity	Cost	
Equipment and Labor					
Equipment	$ 56.73	HR	26.29	$1,492	- Source: Johansen Construction PSE Equipment Rates
Operator	$ 105.97	HR	26.29	$2,786	- Source: Johansen Construction PSE Labor Rates

Grading Total: **$4,278**

SUMMARY OF COSTS			
I	**Erosion Sediment Control**		**$1,563**
III	**Equipment and Labor**		**$4,278**

$5,841