MEMORANDUM

EUGENE WATER & ELECTRIC BOARD

Rely on us.

TO: Commissioners Schlossberg, Brown, Carlson, Barofsky and McRae

FROM: Frank Lawson, CEO/General Manager; Rod Price, Chief Operating Officer; Karen Kelley, Water Manager

DATE: March 30, 2021 (April 6, 2021 Board Meeting)

SUBJECT: Record of Decision: E. 40th Water Storage Tank Siting and Construction Timing

OBJECTIVE: Endorsement

Issue

The Board is asked to "endorse" a Record of Decision (attached) by which the General Manager, based on Staff and Management recommendation, concurs with the identified tank siting locations and the construction of both tanks concurrently commencing in 2021.

Background

A Record of Decision is a tool to communicate, within EWEB and/or the Board of Commissioners and the public, decisions made by management that may have significant impact or interest. Based on neighborhood impacts and interest, Management determined a formal Record of Decision related to tank siting location and construction sequencing and timing is appropriate.

Discussion

A comprehensive history of the project can be found at http://www.eweb.org/community-and-environment/water-reliability-projects/water-storage-improvements/e-40th.

Over the next decade, EWEB plans significant upgrades to the existing water storage systems at College Hill and Hawkins Hill, and a new water storage facility near East 40th Avenue and Patterson Street. The proposed projects will be built to robust seismic standards, providing 45 million gallons of resilient, safe water storage to Eugene residents. Although these water storage facilities are in the hills of Eugene, they serve the entire community of approximately 200,000 people, hundreds of businesses, 50 schools, 20 urgent care and hospital facilities and more than 100 parks.

In 2021, EWEB will start construction on partially-buried water tanks on an undeveloped property near East 40th Avenue and Patterson St. New water storage tanks are one of several investments EWEB is making to ensure that we can meet critical community needs in the event of an earthquake, including having water available for fire suppression and drinking water distribution points.

The property, which EWEB purchased in the 1950s specifically for this use, is more than 10 acres and approximately 2.5 acres will be used for water storage. The rest of the property will remain in its current natural state or be enhanced.

While this project benefits all Eugene residents, it will have direct impacts on surrounding neighbors. Throughout planning, construction and restoration, EWEB will continue to be transparent and communicate regularly with neighbors, as well as listen to input from community members on matters that are within their influence.

Much public outreach has taken place on this project including multiple neighbor mailings, direct response to customer inquiries, neighborhood meetings, articles and meetings with neighborhood associations and other government officials. Over the past year, Commissioners have received periodic formal project updates from Staff, and have had two in-person interactive site visits, the most recent being on March 3, 2021.

Recommendations

Management requests the Board endorse the Record of Decision supporting the Staff and Management recommendation that EWEB move forward with the recommended tank siting locations, as presented in the Record of Decision Attachment A, Figure 2, and the decision to construct both tanks concurrently commencing in 2021, as this approach results in the lowest overall cost for EWEB's customer-owners, will be overall less impactful on the immediate neighbors, and results in the least impact to the environment."

Requested Board Action

Via "hand raise", the Board is being asked to "endorse" the Record of Decision as presented by the General Manager.

MEMORANDUM

EUGENE WATER & ELECTRIC BOARD

Rely on us.

TO: Commissioners Schlossberg, Brown, Carlson, Barofsky and McRae
Executive Team, EWEB Managers, Water Engineering

FROM: Frank Lawson, CEO/General Manager

DATE: March 30, 2021

SUBJECT: **Record of Decision: E. 40th Water Storage Tank Site(s) and Construction Timing**

The following engineering and/or operational decision(s) are hereby formalized and communicated. A Record of Decision is a tool to communicate, within EWEB and/or the Board of Commissioners and the public, decisions made by management that may have significant public impact or interest.

RECORD OF DECISION

Title: E. 40th Water Storage Tank Siting and Construction Timing

Decision: Based on Staff and Management recommendations, with concurrence from both the Chief Operating Officer and Chief Financial Officer, the CEO/General Manager concurs with the recommended tank siting locations, as presented in the Attachment A, Figure 2, and the decision to construct both tanks concurrently commencing in 2021.

Effective Date: April 5, 2021

Expected Impact: A Triple-Bottom-Line (TBL) assessment for tank siting alternatives was completed by external consultant in concurrence with Staff review (Attachment B). A second TBL, completed by EWEB staff, assessed the construction timing of the two storage tanks. Attachment A presents Staff's summary of the TBL's, with a final recommendation for tank siting as described in Figure 2 and to pursue Alternative B for constructing both tanks now. The primary benefits to EWEB customers of this decision are as follows:

- Saves approximately $1,400,000 (2021 Net Present Value)
- Single disruptive period; avoids a second round of neighborhood disruption
- Road wear and tear coincides with City of Eugene street repairs (e.g. Hilyard)
- 2,100 fewer truck loads removed (noise, street damage, carbon reduction)
- Tank construction coincides well with State required Water Master Planning schedule (2025)
- Preserves as much Oak Woodland Habitat as possible (identified as a Strategy Habitat by the Oregon Department of Fish and Wildlife)

The primary disadvantages of the decision are the extended construction period of 3 years (although comparatively 4 years if staggered over 10 years) and may require EWEB to work with Oregon Health Authority if construction issues delay the closing of College Hill.

Referenced Attachment(s):

A. Memorandum: *"E. 40th Ave Storage Tank Final Siting and Tank Construction Sequencing"*; Karen Kelley, March 12, 2021 (Prepared by Laura Farthing, PE; Reviewed by Wally McCullough, PE)

B. Memorandum & Reports – *"E. 40th Avenue 7.5 MG Storage Tank Project – Triple Bottom Line Site"*; Michael L. McKillip, PE, Murraysmith, Inc. (includes Ecological Inventory Report from DOWL, Arborist Report from Carmeron McCarthy Landscape Architecture & Planning, Geotechnical Investigation and Seismic Hazard Study from Foundation Engineering, Inc.)

Method of Implementation: Record of Decision (Board of Commissioner Endorsement)

Decision Maker(s): Frank Lawson, CEO/General Manager

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Frank J. Lawson
CEO & General Manager
Eugene Water & Electric Board

MEMORANDUM

EUGENE WATER & ELECTRIC BOARD
WATER ENGINEERING
Rely on us.

DATE: March 12, 2021

TO: Frank Lawson, CEO/General Manager
Rod Price, Chief Operating Officer

FROM: Karen Kelley, Water Operations Manager

PREPARED BY: Laura Farthing, Engineer (CE), Sr.

REVIEWED BY: Wally McCullough, Water Engineering Supervisor

SUBJECT: E. 40th Ave Storage Tank Final Siting and Tank Construction Sequencing

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OBJECTIVE

The objective of this memorandum (memo) is present the findings of the triple bottom line assessment (TBL) used to finalize tank siting and to discuss the economic, environmental, and social aspects of sequencing the construction for 15 million gallons (MG) of water storage at the Eugene Water & Electric Board's (EWEB) E. 40th Ave Storage Tank site.

BACKGROUND

As part of the 2015 Water System Master Plan (Master Plan), staff identified a resilient spine for the water system. EWEB has been working on strengthening the resilient spine for the last 10 years and has completed improvements at both Hayden Bridge raw water intakes, and at the Hayden Bridge Filtration plant including adding standby power capabilities and constructing a new disinfection system. With most of the work completed at the intakes and the filtration plant, we have been shifting focus to the distribution system, particularly on the transmission mains and the base level storage tanks.

The Master Plan as amended in 2020 created a construction and sequencing plan to create distributed base level storage to enhance reliability, redundancy and improve operations of EWEB's base level system. This included the construction of six 7.5-million-gallon storage tanks at E. 40th Ave, Hawkins Hill and College Hill distributed across these sites. See Figure 1 for the timing of construction.

STORAGE TANK SITING

Staff started the planning and design process in 2019 for the first E. 40th Ave storage tank and completed a site layout looking into the future for constructing the second tank in 2030. The site layout and tank placement were verified through a Tiple Bottom Line (TBL) assessment completed by Murray Smith Associates in early 2021. The TBL included ranking three constructable alternatives based on criteria developed by EWEB and MSA, which included relative costs, excavation requirements, and impacts to immediate neighbors. The TBL showed that the tank siting in Figure 2 below had the highest ranking because it requires the least amount of rock excavation, impacts the viewshed for the fewest number of adjacent neighbors, preserves the ridgeline, and protects the largest amount of the Oak Woodland habitat which is identified as a Strategy Habitat by the Oregon Department of Fish and Wildlife. The TBL memo is attached for reference.

During this process EWEB staff was directed to evaluate the economic, social, and environmental impacts of two alternatives:

- Alternative A: Construct one tank now and one tank in 2030
- Alternative B: Construction both tanks at E. 40th now

The following sections will discuss this evaluation.

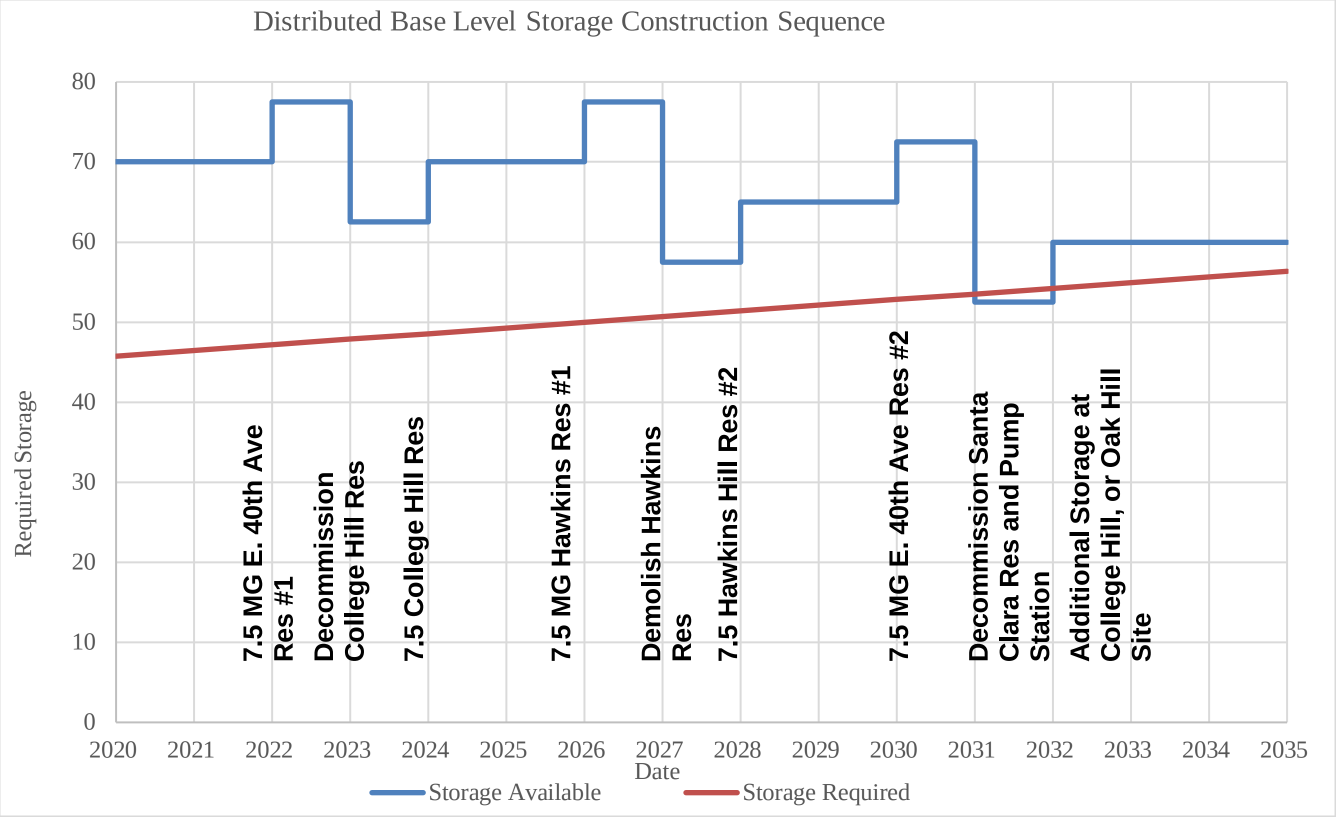
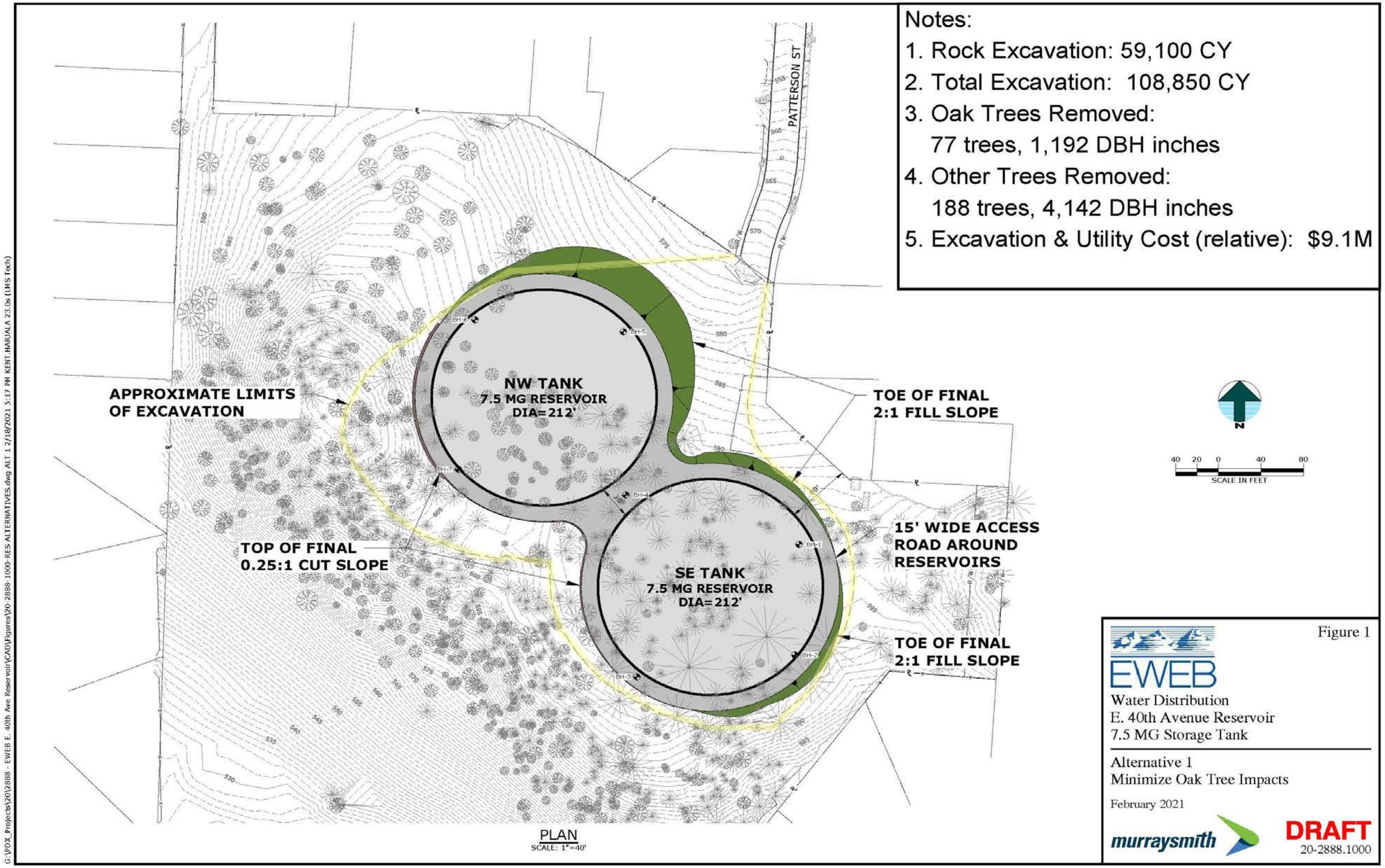


Figure 1. Master Plan Water Storage Tank Program



Notes:

1. Rock Excavation: 59,100 CY
2. Total Excavation: 108,850 CY
3. Oak Trees Removed:
   77 trees, 1,192 DBH inches
4. Other Trees Removed:
   188 trees, 4,142 DBH inches
5. Excavation & Utility Cost (relative): $9.1M

Figure 1

EWEB

Water Distribution
E. 40th Avenue Reservoir
7.5 MG Storage Tank

Alternative 1
Minimize Oak Tree Impacts

February 2021

murraysmith

DRAFT
20-2888.1000

Figure 2. Final Tank Placement

TANK CONSTRUCTION SEQUENCING ALTERNATIVES DISCUSSION

The following sections discuss the two alternatives for site development and the major components of work.

Alternative A – Construct the SE tank now and the NW tank in 2030 (Status Quo)

The Alternative A sequence includes building one tank now and the second tank in 2030, which is the option currently included in the Capital Improvements Plan (CIP). This alternative includes the following elements:

- Tree removal, controlled drilling and blasting for the SE and NW tanks now
- Excavation and rock removal for the SE Tank. Note that rock and soil will remain in place within the footprint of the NW tank until the time of construction
- Construction of a new 36-inch transmission main down Patterson St. to the SE Tank, including a new valve vault with provisions for seismic valves located at the site entrance
- Construction of the SE Tank
- Backfilling around the SE Tank
- Landscaping around and temporary site restoration as required in the footprint of the NW Tank where blasting occurred

EWEB has determined that constructing the SE Tank first allows for a logical progression of site development. The SE Tank (See Figure 2 for tank locations) is the more space constrained location, making it the more difficult and expensive tank to construct. Building that tank first leaves ample room to stage construction equipment, run utilities, and protect nearby residences which reduces construction duration and costs. If the NW tank was constructed first, it would take up a significant portion of the middle of the site, making construction of utilities to the SE tank from Patterson St. incredibly difficult given the space constraints (the utilities would be almost 20 feet below grade at the tank location), access for construction equipment would be limited and working around an existing tank increases the cost and duration of construction. This sequencing also allows for the most flexibility in the future since a large portion of the site will remain undeveloped and easily accessible. For these reasons EWEB staff has recommended constructing the SE Tank first.

EWEB staff is recommending completing the tree removal and blasting for both tanks at the beginning of construction of Alternative A. The site is characterized by hard rock. There are two options for rock removal: mechanical means or controlled drilling and blasting. While mechanical means for rock removal (drilling a perforated grid and using a pneumatic hammer attached to an excavator to split the rock) may be possible on this site, it is an incredibly loud process and is estimated to take 4 to 5 times longer than blasting, just to complete excavation for the SE Tank. This would be incredibly hard on the surrounding neighborhood and would not work with EWEB’s schedule to have a tank in service by the end of 2023. The fastest and most effective means to remove hard rock is to use controlled blasting. It is recommended the blasting be done for both tanks at once regardless of the sequencing of tank construction because blasting costs exponentially increase the closer you get to a structure and the overall costs of blasting have in recent years been increasing at a rate of 12 percent per year.

The construction of the SE Tank including blasting for the NW Tank and pipeline construction is estimated to take approximately 2 years. The estimated duration for select construction activities are outlined below.

- 6-8 months for tree removal, controlled drilling and blasting for both tanks and excavation including rock removal and hauling for the SE Tank
- 1 year for the NW Tank construction
- 2 months for backfilling
- 1 month for landscaping

The estimated costs for the major components of work and the present value (PV) of the costs associated with Alternative A are summarized in Table 1. The costs for the NW tank were inflated to 2030 dollars using a 5.5 percent inflation rate which is consistent with current pre-pandemic trends. The costs were discounted back to 2021 dollars using a discount rate of 5 percent per EWEB's Finance Department's recommendation. Note these are not total project costs; these are relative costs for project elements that change between the two alternatives.

This alternative does not have any impacts on the current CIP since this alternative has already been included and accounted for.

Table 1. Alternative A Selected Project Costs

Item of Work	**SE Tank Costs, in millions of dollars**	**2021 Costs NW Tank, millions of dollars**	**2031 NW Tank, millions of dollars**	**PV NW Tank, millions of dollars**
Blasting for both tanks	$4.5	-	-	-
Tank One	$5.8	-	-	-
Tank Two		$5.8	$9.9	$6.1
Excavation/Backfill for Tank One	$1.7	-	-	-
Excavation/Backfill for Tank Two		$2.3	$4.0	$2.4
Utilities for Tank One	$0.2	-	-	
Utilities for Tank Two		$0.2	$0.3	$0.2
Site Restoration for Tank One	$0.2	-	-	-
Site Restoration for Tank Two		$0.2	$0.3	$0.2
Total	**$12.4**	$8.5	$14.5	**$8.9**
Project Total	**$21.3**			

Alternative B – Construct Both Tanks Concurrently

Alternative B includes constructing both the SE and NW tanks concurrently. The work generally includes:

- Tree removal, controlled drilling and blasting, excavating including rock removal for the SE and NW tanks now
- Construction of a new 36-inch transmission main down Patterson St. to both tanks, including construction of a new valve vault with provisions for seismic valves located at the site entrance
- Construction of the SE and NW Tanks
- Landscaping and restoration work for the site

The construction of both tanks and the associated pipeline is estimated to take approximately 2.5-3 years. Estimated duration for select construction activities are outlined below.

- 6-12 months for drilling, blasting and excavation including rock removal and hauling for both tanks
- 1-1.25 years for tank construction
- 3 months for backfilling
- 1 month for landscaping

The relative costs for Alternative B are presented in Table 2 below. Note these are not total project costs; these are relative costs for project elements that change between the two alternatives.

Table 2. Alternative B Selected Project Costs

Item of Work	**2021 Two Tank Costs in millions**
Blasting for both tanks	$4.5
Tank One	$5.5
Tank Two	$5.5
Excavation/Backfill for Both Tanks	$3.7
Utilities for Both Tanks	$0.4
Site Restoration for Both Tanks	$0.3
Total	**$19.9**

Alternative Economic, Social, and Environmental Impact Comparison

The following sections discuss the economic, social, and environmental impacts between the two alternatives.

Economic Impacts

The cost of $21.3 million dollars associated with the present value of Alternative A is approximately 7 percent higher than the estimated $19.9 million cost associated with Alternative B. These numbers may change through time given that the inflation and the discount rate assumptions may change. Alternative B has inherent savings in mobilization costs, reduced earthwork and backfilling quantities, reduced costs associated with tank construction efficiencies, and reduced site restoration work.

The current Water Capital Plan (CIP) has yearly expenditures consistent with the Water Master Plan--one tank at E. 40th Ave. in 2021-2022 then one tank at College Hill in 2024-2025 both at a projected cost of approximately $12.5 Million. The total amount in the 5-year CIP for the first two tanks is thus $25 Million.

Changing to Alternative B would require moving a portion of 2024-2025 funds to the 2022-2023 time frame.

Social Impacts

There are non-economic factors associated with both Alternatives which include impacts to neighbors and the overall program.

Neighbor Impacts

This is a large infrastructure project being constructed in the middle of an established residential neighborhood. Both alternatives will be impactful to adjacent neighbors in near term due to construction impacts and in the long term because of viewshed and site changes.

The immediate neighbors will be acutely impacted by construction due to noise, dust, and general disruption of a usually quiet site. These impacts are temporary as construction will eventually end. The best way to mitigate construction impacts is to limit the duration of construction work, limit truck traffic, and to select tank siting to limit particularly disruptive phases of work, in this case the earthwork. Alternative A allows for an 8-year break between major construction projects, but the construction duration for the total project would be longer than constructing both tanks now. The total duration for Alternative A will be approximately 4 years. The duration for Alternative B is approximately 3 years. Doing both tanks at once reduces construction impacts by about a year but does not allow for a break in construction activities. Three years is a long time to have a construction project in a residential neighborhood. In addition, there may be timing issues associated with Alternative B and how the tanks are constructed, since one tank needs to be in service by the end of 2023 to facilitate taking College Hill offline. If there are schedule issues once construction of Alternative B is underway, it will be critical for EWEB staff to communicate early in the process with the Oregon Health Authority's (OHA) Drinking Water Program, the jurisdiction having authority over the water system. The worst-case scenario is that the OHA puts EWEB under a bilateral compliance agreement which is an enforcement action that allows us to work with them to reasonably extend the date that College Hill needs to be out of service, which is not ideal from a customer confidence standpoint. Even though there will be a break from construction activities with Alternative A, the overall duration of the project is longer, it will be incredibly disruptive to come back and start over.

Alternative A only includes rock removal, excavation, and backfilling for the SE Tank in the near term and some area within the footprint of the NW Tank to allow for construction access. Because a portion of the NW tank will need to be excavated and backfilled (mainly the area of excavation to accommodate construction access for the first tank), the project adds an additional approximately 21,000 cubic yards (cy) of excavation and backfilling work which results in an additional 2,100 truck trips, when compared to Alternative B. Spreading the construction out could result in a need to repair Patterson St twice which is the main construction site entrance. Table 3 summaries the estimated earthwork quantities. A truck trip is assumed to be a standard 10 cy dump truck.

Alternative B allows EWEB to construct both tanks and complete all heavy truck traffic on nearby streets prior to Hilyard St being repaved in 2024 and allows us to complete repairs to Patterson St only once as part of the pipeline construction. There are also opportunities to route truck traffic through the site rather than only having one access point, which reduces the impact to neighbors on Patterson St but increases the impacts to neighbors along the northern property line. Table 3 summarizes earth work quantities.

Table 3. Estimated Earthwork Quantities

	Alternative A Earthwork Quantities			**Alternative B Earthwork Quantities**	**Difference Between Alternatives**
	SE Tank	NW Tank	Total	Total	
Rock Excavation (CY)*	35,830	17,370	53,200	53,200	-
Soil Excavation (CY)*	21,335	36,300	57,635	46,600	11,035
Backfill (CY)	27,600	30,100	67,700	57,700	10,000
Truck Trips	8,476	8,377	17,853	15,750	2,135
*Includes a 30% bulking factor to convert in-situ quantities to truck quantities					

These projects will permanently change how the site looks and how it is used by neighbors. The impacts to the site and its uses are similar between both Alternatives and with time and as houses sell and new neighbors move in, the site will just be known as a storage tank site.

Water Storage Improvement Program Impacts

There are no impacts to the overall program with Alternative A, constructing one tank now and one tank in the future. Alternative B will require a change to the sequencing of the construction of storage. Under Alternative B, College Hill would be decommissioned and left in place at the end of 2023. Construction at Hawkins would start after the tanks at E. 40th are complete. During this time EWEB will begin work on a new Master Plan which would include an evaluation of the program impacts.

Environmental Impacts

Both Alternatives have similar environmental impacts associated with them. These are large infrastructure projects that affect the public health of the entire community; there is no way to construct them without having any impact.

The main impact to the environment comes from the need to remove approximately 25 percent of the trees on the site. Each Alternative includes mitigation efforts to offset the impacts of the lost carbon sequestration capacity and overall impacts of tree removal. There will be a loss of carbon sequestration capacity in the short term on the site, but EWEB is incorporating the following mitigation strategies into the project:

- Planting new trees on the site
- Working with Friends of Trees and other agencies to plant trees in other locations within the community
- Thinning forested areas where appropriate to encourage the growth of trees that had previously been shaded by the Doug Firs
- Leaving large downed wood and creating snags on the site to the greatest extent possible, which has the added benefit of providing woodpecker and salamander habitat
- Assessing trees on the perimeter of the excavation to determine if they can be saved during the construction process

In addition to mitigation efforts on this site EWEB is engaged in larger scale projects that will have a greater impact on the community as a whole. For example, EWEB has created a partnership with the University of Oregon's Soil, Plant and Atmospheric (SPA) lab to set up an experimental site to determine which type of planting and management strategies are most effective at carbon draw down. The intent is to scale up the findings to other sites around the region and to eventually create a local carbon market. EWEB is also investing significant resources to replant the forests in the area of the Holiday Farm Fire along the McKenzie River.

Alternative A has the added environmental impact due to the additional 2,100 truck trips which will increase CO_2 emissions associated with the overall project when compared to Alternative B.

Alternative B allows for the site to be relandscaped and enhanced at once rather than separating the work, which saves costs and allows the site to start healing from the disturbance faster.

Overall, both Alternatives have impacts, but Alternative B allows restoration to happen sooner and all at the same time.

Table 3 below provides a summary of the major impacts for comparison.

Table 3. Impact Summary Table

Impact	Alternative A	Alternative B
Economic	$21.3 million	$19.9 million
Social	**Advantages** • There will be an 8-year break between construction projects	**Advantages** • Requires less earthwork • Work coincides with City of Eugene road work on Hilyard St, which allows for road repairs after the construction project • Patterson St. and the neighbor's neighbors along Patterson St. will only be disrupted once. • Requires 2,100 fewer truck trips
	Disadvantages • Requires more earthwork resulting in longer overall construction duration of 4 years total • 2,100 additional truck trips • Area disrupted twice which will be difficult on immediate neighbors • Patterson St could require repairs after the second construction project which will be disruptive to neighbors	**Disadvantages** • Disruptive for 3 straight years • May cause timing issues with taking College Hill out of service by the end of 2023
Environmental	**Advantages** • Gives the site restoration work 8 years to become established before restoration of the site after the second tank is constructed	**Advantages** • 2,100 fewer truck trips which results in lower CO_2 emissions • Restoration can happen all at the same time and then be left alone to become established
	Disadvantages • Loss of trees for both tanks now, which could be a wasted effort if the program changes before the second tank is constructed • 21,000 cy of additional earthwork, which results in removal of backfill that was installed as part of the SE	**Disadvantages** • Loss of trees for both tanks now

	tank construction with little room to stockpile the material and reuse it • 2,100 additional truck trips equaling increased CO_2 emissions • Site disturbed twice which is disruptive to wildlife • Restoration happens in two phases • Patterson St. could need to be repaved twice	

RECOMMENDATIONS

It is recommended that EWEB move forward with Alternative B and construct both tanks now because this alternative results in the lowest overall cost for EWEB's customer owners, will be easier overall on the immediate neighbors, and results in the least impact to the environment.

Memorandum

Date: March 16, 2021

Project: 20-2888

To: Ms. Laura Farthing, PE
Eugene Water & Electric Board

From: Michael L. McKillip, PE
Murraysmith

Reviewed By: Tom Boland, PE, PMP
Murraysmith

Re: E. 40th Avenue 7.5 MG Storage Tank Project – Triple Bottom Line Site Configuration Evaluation

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Introduction

The Eugene Water & Electric Board's (EWEB) 2015 Water System Master Plan identified the need for two new water storage tanks located on an EWEB owned property south of East 40th Avenue at the terminus of Patterson Street in Eugene, OR. The site was purchased with the intent to construct water storage. EWEB has determined that the site will have two storage tanks, one in the near-term, and the second tank in the longer-term future. The new 7.5 million-gallon (MG) storage tanks will become part of EWEB's resilient backbone and provide a reliable and resilient water source to Eugene residents for generations to come. This memorandum documents the criteria used to configure the site layout and evaluates four alternative site layout configurations considering social, environmental and financial considerations as well as meeting all technical feasibility requirements.

Site Description

The 10.7-acre site is located south of E 40th Avenue in southeast Eugene (Map ID 18031720, Tax Lot 1000). While EWEB has planned water storage at the site for decades, the site is currently accessible by the public and is used as an informal park.

Surrounding Area and Site Access

The site is a forested hillside surrounded by residential homes and is currently open to the public for daytime recreational use. The 34 adjacent lots are developed, single-family homes. The site has a ridgeline in approximately the center of the property. The southern portion of the ridgeline is forested at the top and overlooks the Spencer Butte Middle School and is visible from numerous residential homes. Maintaining the attractive ridgeline view is a consideration in locating the new tanks on the site.

The site is accessed from Patterson Street, which will also be the alignment of new water and stormwater utilities associated with use of the tank site. A significant volume of truck traffic along Patterson Street will be unavoidable during tank construction. Truck traffic will be associated with removal of excavated soil and rock, deliveries of concrete, and import of structural backfill. There is also a utility easement located in the NW corner of the property that connects directly to E 40th Avenue. However, use of this alignment will be evaluated during pre-design, but does not affect the evaluation of the tanks siting alternatives.

Site Conditions

Based on the geotechnical investigation and preliminary grading plans, the tank construction will require a large quantity of deep rock excavation and a high volume of truck traffic during construction. The rock is solid and blasting will be required for economical and efficient rock removal. Minimizing the needed rock removal for construction of the new tank and associated utilities is a strong consideration in selecting tank locations if there is a significant difference in required rock excavation quantities.

The site has grassy, sloping meadows in the northeast and southwest portions. Along the ridgeline are tall stands of Douglas fir and oak tree habitat which make the site a valued park-like setting for local residents. Apart from posts and chain to limit vehicle access at the south end of Patterson Street, the site does not have any existing improvements.

Site Ecology

An evaluation of the natural features at the site was prepared to support incorporation of ecological values with the tank site selection (DOWL, January 2021). The evaluation used a combination of desktop material reviews, information solicited from neighbors, and a site field investigation conducted in October 2020. The on-site vegetation was characterized by regularly mown meadows in the northeast and southwest corners, mature Douglas fir forest at the top of the ridge, mixed evergreen and deciduous forest on the south facing slope of the ridge; and oak woodland occupying the lowest portion of the ridge.

There were no observations of federally listed threatened or endangered species that would be expected to occupy the site; nor were there species or habitat for federally or state listed threatened or endangered species. The site, unlike many urban sites, did not have dominant non-native invasive species.

The evaluation noted the presence of oak habitat, which was once common in the Willamette Valley, but is now rare. The professional ecologists report had the following findings:

- “emphasized the regional significance of the oak habitat, and the importance of preserving and managing it.
- noted that the Oregon Conservation Strategy identifies prairie, savanna, and oak woodlands as conservation priorities in the Willamette Valley.
- stated that conifer encroachment is threatening the oak habitat, strongly recommended that Douglas fir at the site be thinned to follow best management practices for reducing fire hazard, and improving habitat value for native wildlife.”

While several large Douglas fir trees were observed on top of the ridge in the middle of the site, the forested community provided low ecological value compared to the adjacent oak woodland.

An arborist report was prepared by Cameron McCarthy Landscape Architecture & Planning (September 2020). It noted two major woodlands: Douglas fir and oak. The Douglas fir woodland was characterized as a healthy mix of young and old trees, dead trees and openings. A few different species were also seen. Thinning of the forest would benefit some of the younger trees. The oak woodland has some open canopy space and the Douglas fir woodland will take over without maintenance. The report recommended removing Douglas firs that are outcompeting oaks for light and space, specifically any Douglas Fir within 10 feet of an oak canopy.

General Tank Siting and Site Layout Assumptions

Siting a drinking water storage tank requires numerous technical considerations to include the tank elevation and dimensions, associated improvements such as piping, access roads and stormwater management, as well as constructability issues. These considerations are further discussed below.

Elevation Requirements - Gravity-supplied drinking water storage relies on hydraulic pressure to serve customers. The amount of pressure at the customer’s tap is proportional to how much higher the tank is than the customer. For EWEB’s base level this pressure is 45 to 120 pounds per square inch (psi) depending upon the elevation of the customer. When there are multiple tanks serving the same pressure zone, it is optimal to have their overflow elevations match. It is also optimal to have the height of the tanks be the same. This optimizing filling operations and allows for efficient turnover of the tanks to protect water quality. As the service area for the E. 40th Avenue Tanks is already established, these values are already determined. The tank floor and overflow elevations should be 577 and 607 feet (NGVD 1929), respectively, to match other existing and planned tanks in the service area. To provide the desired 7.5 MG of storage, the resulting inside diameter is 210 feet with an outside diameter of 212 feet. The lowest existing ground elevation suitable is approximately the floor elevation of 577 feet. The site elevations vary between 528 at the lowest point on the south side of the property and 620 at the highest point. As the southwest corner of the property has elevations below this needed elevation, that portion of the property is unsuitable to construct the tank at the correct elevation.

Excavation Requirements - The tank construction will require deep excavation, regardless of where the tanks are placed on the site, which requires careful consideration of the construction cut slopes and truck access to the bottom of the excavation.. From the geotechnical study of the site, the rock is anticipated to support a horizontal (H) to vertical (V) cut slope of ¼H:1V, which will allow for a relatively small excavation footprint and not require temporary shoring or construction easements. The soil overlying the rock cut will need to be sloped at 2H:1V or will require shoring or other mitigation methods such as soil nail walls, which at this time is out of the scope of this project to consider. The bottom of the excavation will be 572 feet, which allows for sufficient compacted subgrade and underdrain piping. The anticipated top of the cut slopes are shown in **Figures 1** through **Figures 3** for Alternatives 1 through 3.

Access & Piping Requirements - The bottom of the excavation will be near 572 feet, which is close to the elevation at Patterson Street, so the construction access road will be a largely flat road, regardless of where the tanks are placed, but will require some additional excavation between Patterson Street and the tanks as the ground slopes up to the tanks. The water and drain piping invert elevations (or bottom of pipe) will be approximately 572 feet at the tank. When possible, the road and temporary access will be collocated to minimize rock excavation. However, with the planned two tanks, not all of the piping will be feasibly collocated. Also, the further the tanks are from Patterson Street, the more piping length and temporary access road length are required.

A transmission main between the tank site and the water transmission system will be installed in Patterson Street. Once on-site, the supply main will be split near a control valve vault to provide separate inlet/outlets to each tank. It is also anticipated that a new stormwater drain line will be installed in Patterson Street to handle on-site stormwater as well as provide capacity for the combined tank emergency overflow and drain line.

Site surface runoff will be collected from the impervious tank roofs and access roadway surfaces and treated per City of Eugene water quality standards. It is anticipated that a water quality treatment swale or basin will be located west of the site access to Patterson Street. This location will provide for minimized routing of flows, locate the facilities for good maintenance access, and will not require further tree impacts. The planned stormwater facilities will also intercept current site runoff that reaches Patterson Street.

Backfill Requirements - After the tank is constructed, it will require significant imported backfill to restore the site to as close to the existing topography as feasible. Depending upon the tank location, the backfill may need to be sloped more than the existing 3H:1V slope on the northeast portion of the site. It is anticipated that the tank will be designed without a significant differential backfill (or height variation between the front and back of the structure) which increases cost. This will result in a wall exposure of approximately 15 to 20 feet on the downhill, northeast side of the tanks. For estimating purposes, a 2H:1V permanent fill slope was assumed. For ease of alternative comparisons, backfill assumed the same tank wall exposure for all tanks.

An access road from Patterson Street up to the tanks with an access road around the perimeter of the tanks is anticipated. As the access around the tanks will be within the excavation limits, no further tree impacts are required for the perimeter access construction.

Siting Options

Within the assumptions presented for the general tank siting and site layout, four alternative configurations were evaluated. The four alternatives represent the major options available and are subject to minor adjustments as part of final design. These alternatives will be evaluated using the criteria subsequently presented. Each alternative has two tanks which can be referred to as the northwest tank and the southeast tank within each alternative.

Alternative 1

Alternative 1 locates the tanks largely in the center of the property and as far east as practical to minimize impacts to the oak habitat. The southeast tank is located 60 feet from the closest property to provide distance for construction excavation and shoring, and to mitigate visual impacts to the closest neighbors. The locations are shown in **Figure 1**.

This configuration requires the removal of 5,334 inches of total tree quantity as measured in diameter breast height (DBH). DBH is a measurement standard used to quantify the tree size at 4.5 feet off the ground. Alternative 1 requires the removal of 77 oak trees and 265 total trees, which is approximately 25 percent of the number of trees on the site. The removed trees includes large trees, defined as over 24 inches in DBH, numbering 8 oaks and 38 other tree species.

Alternative 1 has negligible visual impacts as viewed from the south of the property. Approximately 9 neighbors to the east, north and west will be able to see the above-ground portions of either or both of the tanks.

This configuration allows for feasible construction and permanent access roads. The below ground utilities can be located largely within the needed excavation for tank construction access, which minimizes the length of the utilities and added rock excavation requirements.

Alternative 2

Alternative 2 locates the tanks approximately 45 feet to the northwest compared to Alternative 1. Alterative 2 seeks to minimize impacts to the ridge top and balance impacts to the oaks and the largest Douglas firs. The southeast tank is located at least 60 feet from the closest property to provide distance for construction excavation and shoring, and to mitigate visual impacts to the closest neighbor. The locations are shown in **Figure 2**.

This configuration requires the removal of 5,309 inches (DBH) of total trees to include 96 oaks and 166 other tree species (263 total trees) and includes 11 large oaks and 36 large trees of other species.

Alternative 2 has negligible visual impacts as viewed from the south of the property. Approximately 10 neighbors to the east, north and west will be able to see the above-ground portions of either or both of the tanks.

This configuration allows for feasible construction and permanent access roads. The below ground utilities can be located largely within the needed excavation for tank construction access, which minimizes the length of the utilities and added rock excavation requirements.

Alternative 3

Alternative 3 locates the tanks to the northwest to maximize retaining the largest Douglas fir trees, although it has the largest impact on the oak habitat. The northwest tank is located 60 feet from the closest property to provide distance for construction excavation and shoring, and to mitigate visual impacts to the closest neighbor. The locations are shown in **Figure 3**.

This configuration requires the removal of 5,520 inches of total trees to include 112 oak and 147 other species (259 total) and requires the removal of 28 large Douglas firs and 16 oaks over 24 inches in DBH.

Alternative 3 has negligible visual impacts as viewed from the south of the property. Approximately 11 neighbors to the east, north and west will be able to see the above-ground portions of either or both of the tanks. Compared to Alternative 1, Alternative 3 has more visual impacts to the neighbors to the west and north, but negligible benefit to the neighbors to the east.

This configuration allows for feasible construction and permanent access roads. The below ground utilities can be located largely within the needed excavation for tank construction access, which minimizes the length of the utilities and added rock excavation requirements.

Alternative 4

Alternative 4 locates the tanks furthest south while maintaining the required elevation for adequate service pressure. The SE tank is located 160 feet from the closest property to minimize visual impacts to the closest neighbor while maintaining proper elevation.

This configuration requires the removal of 7,100 inches of total trees to include 83 oak and 218 other species (301 total) and requires the removal of 53 large Douglas firs and 3 oaks over 24 inches in DBH.

While this alternative reduces visual impact to the adjacent property owners to the north and west, Alternative 4 does have a large visual impact as viewed from the south of the property. This configuration requires removal of most of the trees along the ridgeline when viewed from the south and northeast. Approximately 23 adjacent neighbors along all sides of the property will be able to see the above-ground portions of the tanks, and the tank will be visible to the vast general public from the south.

This configuration allows for feasible construction and permanent access roads. However, this configuration requires the most general excavation of the four alternatives, both for the tank and underground ground utilities, which would need to be routed along the easement from E. 40th

Ave. Due to the distance from Patterson Street, the length of the utilities is greater than the other alternatives.

Because of the anticipated large excavation quantities, additional costs and impact to the ridgeline viewshed, a figure for Alternative 4 was not formally developed and it was excluded from further analysis.

Evaluation Criteria

Evaluation criteria include social, environmental and financial components as discussed below:

Social

S1 – Minimize visual impact to Viewshed: Project impacts will be both removal of existing trees and installation of partially buried tanks. Minimizing permanent visual impacts will entail preservation of high aesthetic value trees and minimizing the number of neighbors who have changes to their viewshed.

S2 – Minimize truck traffic impacts to neighbors: Construction truck trips are generated by the removal of mass excavation spoils and the import of backfill material. Minimizing truck trips will entail selecting tank locations with lower existing ground elevations, which will require less excavation and backfill.

S3 – Minimize other construction impacts to neighbors: In addition to truck trips through residential neighborhoods, other construction impacts include associated noise, dust and vibration. While there are common industry best practices that will be used to control noise, dust and vibration, minimizing these impacts entails locating as much construction away from affected properties as feasible.

S4 – Minimize construction duration: During construction, there will be temporary visual impacts, construction traffic, noise, dust, vibration and disruption on Patterson Street during utility installation. Minimizing construction duration as it relates to tank location corresponds directly to minimizing tree removal, excavation and backfill quantities.

Environmental

E1 – Minimize impacts to oak trees and associated habitat: The ecological study of the site noted that the oak habitat had a higher ecological value over the Douglas fir habitat. Minimizing the removal of the oak habitat reduces the impacts to this tree species and the associated habitat.

E2 – Minimize impacts to Douglas fir trees and associated habitat: The ecological study of the site noted that the Douglas fir habitat had a lower ecological value over the oak habitat. Minimizing the removal of the Douglas fir habitat reduces the impacts to this tree species and the associated habitat.

E3 – Minimize overall tree impacts: Construction of the tanks will require removal of many trees, where each tree can be quantified by its size in inches DBH. Minimizing overall tree impacts entails the alternatives with the smallest combined DBH, regardless of tree species.

E4 – Minimize truck traffic and carbon dioxide emissions: Construction equipment and trucks use diesel engines which generate carbon dioxide emissions. The amount of emissions generated by work activities can be considered to be proportional to the amount of soil and rock moved, as quantified by truck trips. Minimizing carbon dioxide emissions entails minimizing the required number of truck trips.

Financial

F1 – Minimize Construction Cost: Construction costs include several major components: earthwork, tank structure, utility improvements, site improvements, landscaping, and instrumentation & controls. Of these, earthwork and the tank structure are the largest components. Minimizing construction costs amongst the alternatives is predominantly driven by the quantity of rock excavation, total excavation and required backfill. The length of buried utilities from the tanks to their connection at Patterson Street is also a consideration.

Impacts

The major impacts that are used in the evaluation are excavation quantities with associated truck trips, and tree impacts.

Excavation Quantities & Truck Trips

The available boring data (FEI, January 2021, attached) was used to evaluate the depth to rock and generate rock quantity estimates. Each tank was assumed to require an excavation to an elevation of 572 feet with a circumference of 232 feet (tank diameter plus 10-foot clearance for construction equipment access). The construction cut slope was ¼H:1V to the existing rock surface and subsequently 2H:1V in the soil to the ground surface. Quantities of rock and soil also included an access corridor from Patterson Street as shown on **Figure 1** through **Figure 3** using a 1H:1V construction slope at the sides of temporary construction access. These figures also show the extent of the anticipated cut slope which will impact trees. The estimated quantities are reported in **Table 1**. While the amount of rock and total excavation varies between each individual tank location, for each alternative, the combined two tank rock and total excavation required was similar amongst the alternatives. The backfill quantities are similar amongst the three alternatives.

For estimating purposes, a truck trip is assumed to be 10 CY (cubic yards) of excavated material with a 30 percent bulking factor added to it. For truck trip estimation, half the total backfill quantity for each alternative was assumed to be stored on-site for the construction of the first tank. During construction of the second tank, the site will be more constrained and off-site storage of backfill material is assumed. Truck trips associated with the concrete work are not included as it does not vary amongst the alternatives. A relative comparison of truck trips will be used in the evaluation;

however, as the truck trips reported in **Table 1** are similar, this will not be a differentiating consideration.

Table 1
Excavation Quantities & Truck Trips

	Alternative 1	Alternative 2	Alternative 3
Rock Excavation (CY)	53,200	55,300	57,800
Soil Excavation (CY)	46,600	45, 500	43,100
Total Excavation with 30% Bulking Factor (CY)	129,740	131,040	131,170
Backfill (CY)	58,800	56,100	55,000
Estimated Truck Trips	16,796	16,751	16,692

Tree Impacts

For each alternative, the trees within the excavation or final grading area that would need to be removed were identified. Table 2 presents the number of trees removed by size and the total number of inches of trees. The total quantities of trees, as measured in trunk thickness, is similar amongst Alternatives 1, 2 and 3. Alternative 1 has the smallest impact on oaks and Alternative 3 has the largest. Alternative 3 removes approximately 50 percent more total number of oak trees. Alternatives 1, 2 and 3 also have a similar number of large (24”+) trees that would need to be removed.

Table 2
Tree Impacts

	Alternative 1	Alternative 2	Alternative 3
Trees Removed in Inches (DBH)			
Oak	1,192	1,592	1,941
Douglas Fir & Others	4,142	3,717	3,579
Total	5,334	5,309	5,520
Total Number of Trees Removed	265	262	259
Number of Oak Trees Removed	77 total	96 total	112 total
Under 12" DBH	33	39	41
12 to 24" DBH	36	46	55
25 to 32" DBH	7	8	10
33 to 40" DBH	0	1	2
41 to 48" DBH	1	1	2
49 to 56" DBH	0	0	0
57 to 62" DBH	0	1	1
63 to 70" DBH	0	0	0
71 to 78" DBH	0	0	1
Number of Other Trees Removed	188 total	166 total	147 total
Under 12" DBH	64	50	50
12 to 24" DBH	86	80	69
25 to 32" DBH	22	23	19
33 to 40" DBH	8	8	6
41 to 48" DBH	3	2	3
49 to 56" DBH	2	2	0
57 to 62" DBH	1	1	0
63 to 70" DBH	1	0	0
71 to 78" DBH	1	0	0

Financial Impacts

A relative cost comparison will be used to evaluate the financial criterion. Amongst the alternatives, the differentiating costs will be associated with the earthwork and length of utilities from Patterson Street to the tanks. **Table 3** presents the major differential cost categories and total differential cost for each alternative. Access and utilities have similar costs for Alternatives 1 through 3, with Alternative 4 being higher due to the distance from Patterson Street. Rock removal was more extensive the more northwest the NW tank is located resulting in Alternative 3 being the most expensive. Largely due to the rock excavation costs, Alternative 3 is the most expensive location and Alternative 1 the least expensive.

Table 3
Differential Construction Costs

	Alternative 1	Alternative 2	Alternative 3
Access Road to Tanks	$ 4,000	$ 4,000	$ 4,000
Utilities	$ 280,000	$ 263,000	$ 280,000
Rock Excavation and Removal	$ 6,384,000	$ 6,636,000	$ 6,936,000
Soil Excavation and Removal	$ 1,631,000	$ 1,593,000	$ 1,5090500
Backfill	$ 1,176,000	$ 1,122,000	$ 1,100,000
Total	$ 9,475,000	$ 9,618,000	$ 9,829,000

Evaluation Results

Evaluation criteria are applied a weight factor and a score to generate a total weighted score to identify the alternative that best meets the criteria. **Table 4** shows the criteria matrix to include the criteria, criteria weight and weighted score by alternative as well as the total weighted score.

The Criteria Weight Factor (A) used the following weighting:

1 = Least importance

2 = Average importance

3 = Most importance

The Criteria Scoring Approach (B) used the following scoring:

Social: 1 = least satisfies criteria, 2 = somewhat satisfies criteria, 3 = mostly satisfies criteria

Environmental: 1 = least satisfies, 2 = somewhat satisfies; 3 = mostly satisfies criteria

Financial: 1 = highest cost, 2 = similar cost, 3 = lowest cost

The Total Weighted Score (C) is the sum of the criteria weights and scores for each alternative.

Table 4 Evaluation Matrix

Criteria			Alternative 1		Alternative 2		Alternative 3	
		(A) Criteria Weight (1 - 3)	Minimize Oak Impacts		Minimize Ridge Impacts & Balance Tree Impacts		Minimize Fir Impacts	
			(B) Score (1 - 3)	Weighted Score (1 - 9)	(B) Score (1 - 3)	Weighted Score (1 - 9)	(B) Score (1 - 3)	Weighted Score (1 - 9)
Social								
S1	Minimize Visual Impacts to Viewshed	3	3	9	2	6	2	6
S2	Minimize Truck Traffic Impacts to Neighbors	1	2	2	2	2	2	2
S3	Minimize Other Construction Impacts to Neighbors	1	3	3	2	2	1	1
S4	Minimize Construction Duration	1	2	2	2	2	2	2
Environmental								
E1	Minimize Impacts to Oak Tree and Associated Habitat	3	3	9	2	6	1	3
E2	Minimize Impacts to Douglas Firs and Associated Habitat	1	1	1	2	2	3	3
E3	Minimize Overall Tree Impacts	2	2	4	2	4	2	4
E4	Minimize Truck Traffic and CO2 Emissions	1	2	2	2	2	2	2
Financial								
F1	Minimize Construction Cost	3	3	9	2	6	1	3
(C)	Total Weighted Score		Alt 1 =	41	Alt 2 =	32	Alt 3 =	26

Conclusions

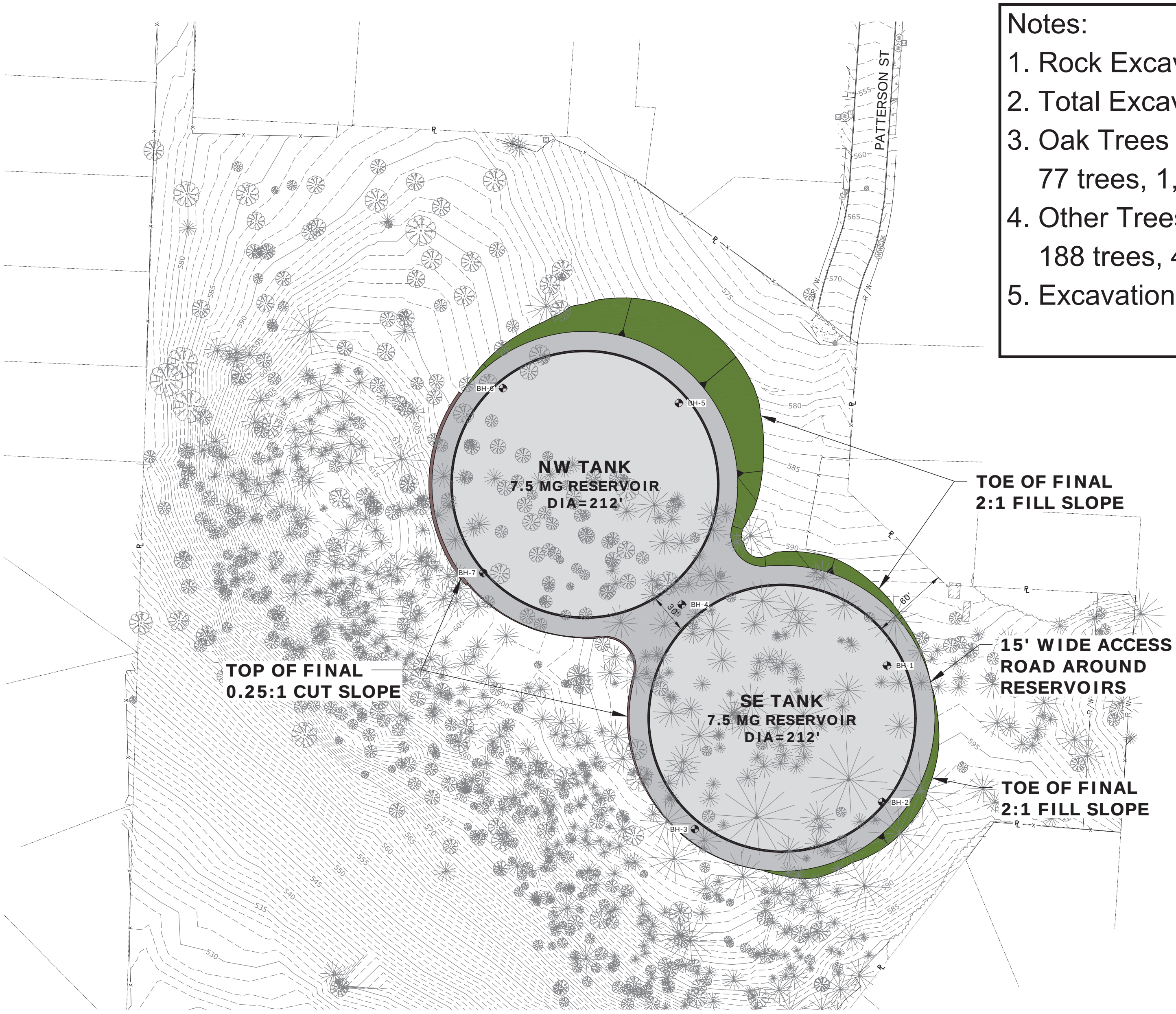
Based on the evaluation scoring, Alternative 1 is the highest scoring and Alternative 3 is the lowest scoring. Alternative 1 provides the least impact on the oak habitat and the least visual impact on adjacent neighbors. While Alternative 1 also scored as the least expensive option, the small cost difference amongst the alternatives does not make any alternative unpractical and does not drive the selection of the preferred alternative.

Attachments:

- Figures 1, 2 and 3
- Draft Ecological Inventory Report, DOWL, January 28, 2021
- Arborist report, Cameron McCarthy Landscape Architecture & Planning, September 2020
- Geotechnical Investigation and Seismic Hazard Study, Foundation Engineering, Inc., March 12, 2021

Notes:

1. Rock Excavation: 53,200 CY
2. Total Excavation: 99,800 CY
3. Oak Trees Removed:
   77 trees, 1,192 DBH inches
4. Other Trees Removed:
   188 trees, 4,142 DBH inches
5. Excavation & Utility Cost (relative): $9.5M



PLAN
SCALE: 1"=40'

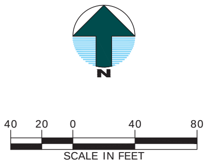


Figure 1

EWEB

Water Distribution
E. 40th Avenue Reservoir
7.5 MG Storage Tank

Alternative 1
Minimize Oak Tree Impacts

March 2021

murraysmith

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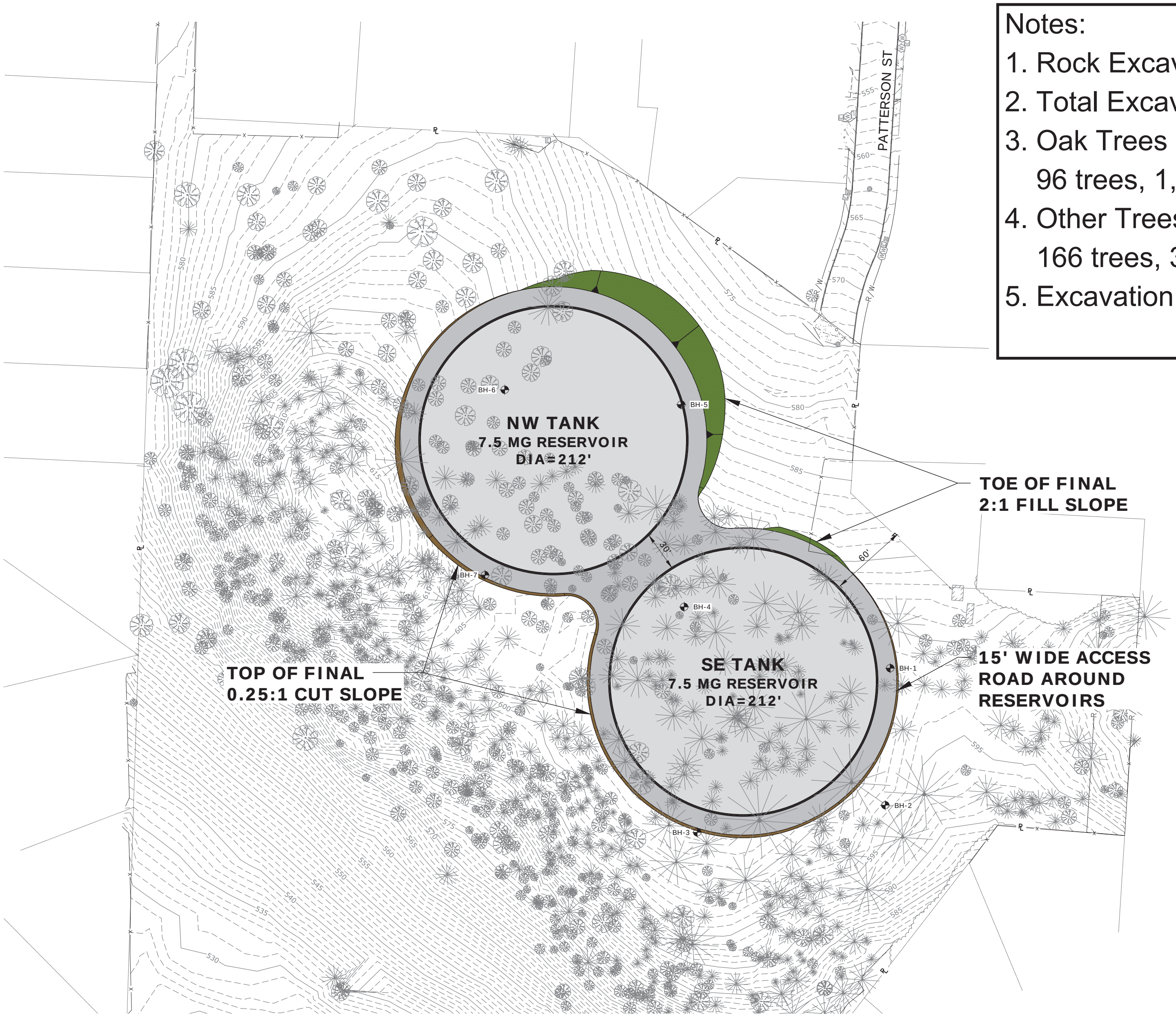
Notes:

1. Rock Excavation: 55,300 CY
2. Total Excavation: 100,800 CY
3. Oak Trees Removed:
   96 trees, 1,592 DBH inches
4. Other Trees Removed:
   166 trees, 3,717 DBH inches
5. Excavation & Utility Cost (relative): $9.6M



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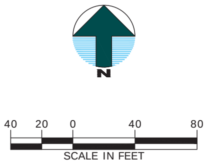

Figure 2

EWEB

Water Distribution
E. 40th Avenue Reservoir
7.5 MG Storage Tank

Alternative 2
Balance Tree Impacts

March 2021

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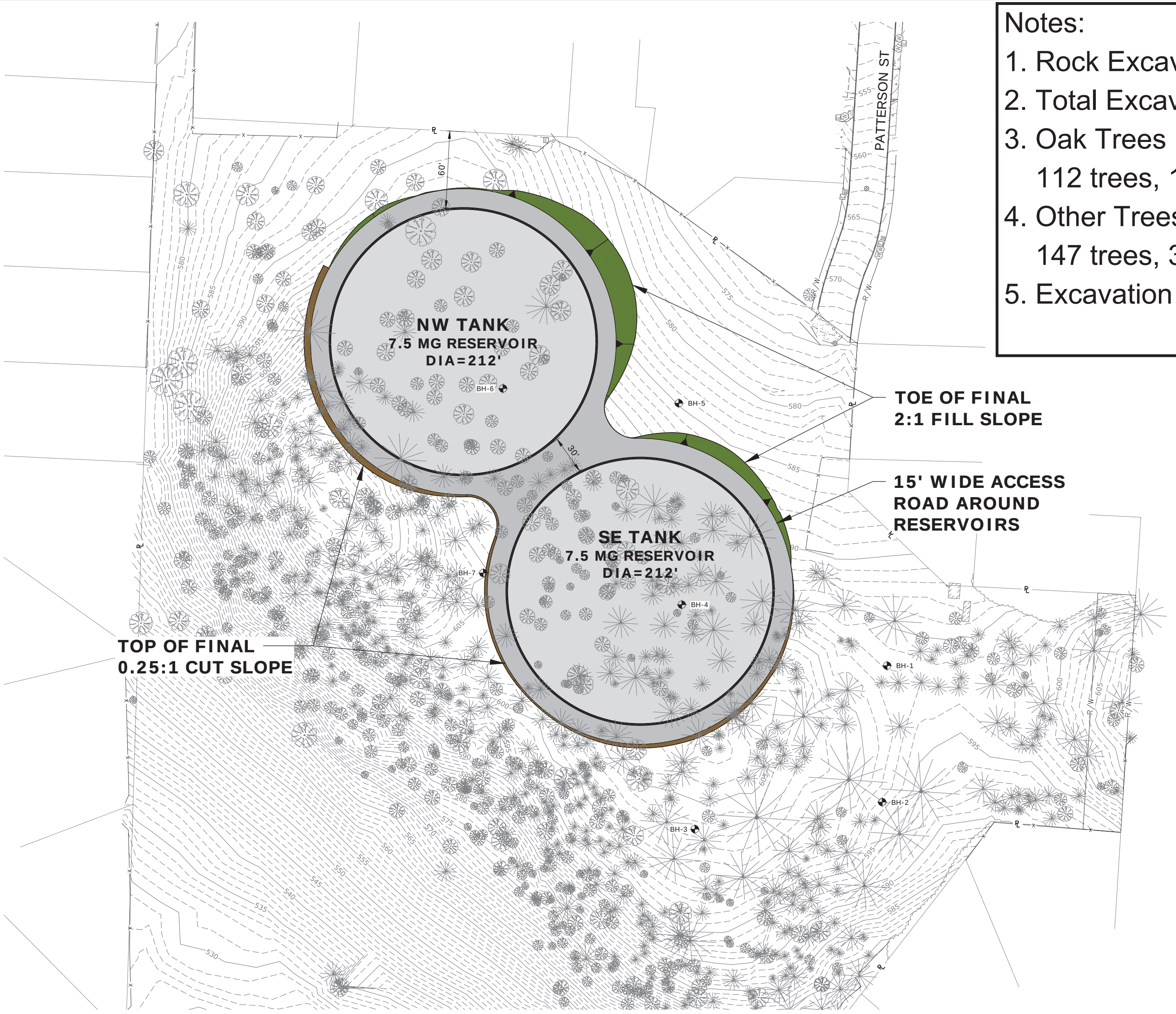

PLAN

SCALE: 1"=40'

Notes:

1. Rock Excavation: 57,800 CY
2. Total Excavation: 100,900 CY
3. Oak Trees Removed:
   112 trees, 1,941 DBH inches
4. Other Trees Removed:
   147 trees, 3,579 DBH inches
5. Excavation & Utility Cost (relative): $9.8M

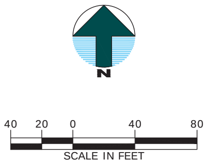

Figure 3

EWEB

Water Distribution
E. 40th Avenue Reservoir
7.5 MG Storage Tank

Alternative 3
Minimize Fir Tree Impacts

March 2021

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EUGENE WATER & ELECTRIC BOARD

ECOLOGICAL INVENTORY REPORT

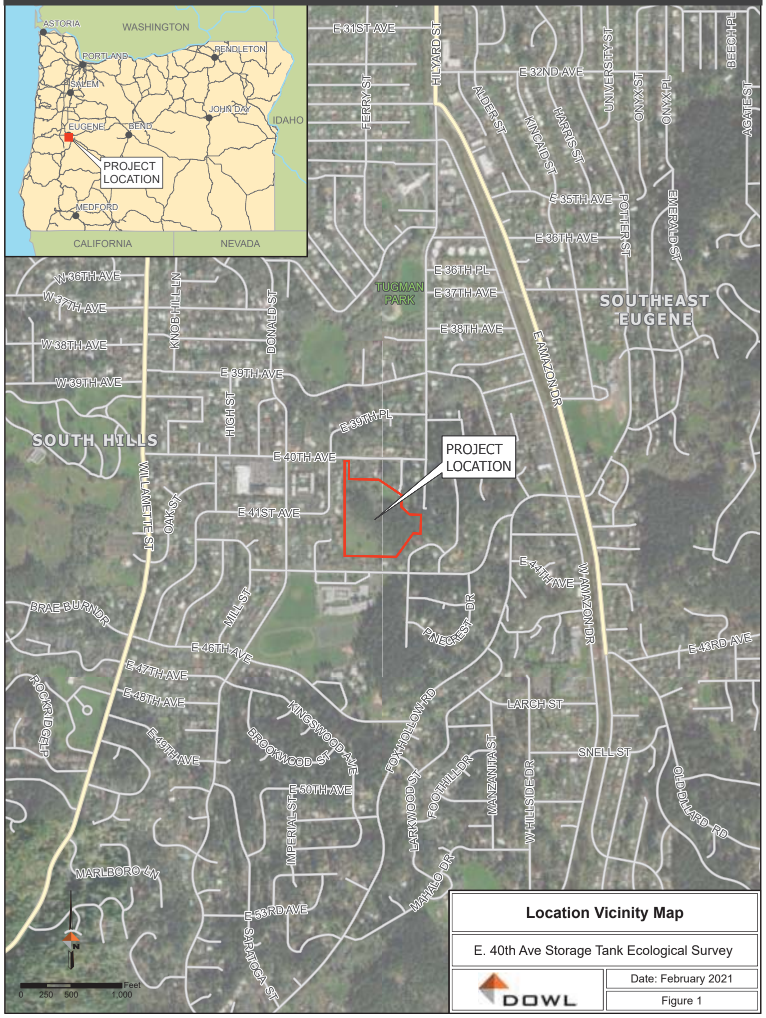
Final – February 2021

Feb. 11, 2021

INTRODUCTION

At the request of the Eugene Water and Electric Board (EWEB), DOWL has prepared this report documenting and evaluating the natural features on a 10-acre, undeveloped, parcel of land in south Eugene that was acquired by EWEB in the 1950s for future water storage. The site occupies a block bounded by East 40th Avenue to the north, Hilyard Street to the east, East 43rd Avenue to the south, and Ferry Street to the west (Figure 1, Vicinity Map).

FIGURE 1: VICINITY MAP



The open space provided by the East 40th Avenue site is popular with nearby residents and EWEB is seeking to minimize impacts to the natural features of the site while providing necessary infrastructure improvements (Photo 1, Ridgetop Informal Trail).

PHOTO 1: RIDGETOP INFORMAL TRAIL

The purpose of this report is to provide EWEB with a detailed description of the site so that ecological values can be factored into final tank siting decisions.

BACKGROUND

EWEB is Oregon's largest customer-owned utility. EWEB provides water and electricity to the Eugene community, as well as parts of east Springfield and the McKenzie River valley. As a public utility EWEB is chartered by the City of Eugene to serve the interests of its citizens by providing reliable, affordable water and electricity for its customers.

The EWEB water distribution system currently includes four base level water storage tanks that provide storage for the entire distribution system. The existing tanks are Hayden Bridge (15 million gallons (MG) constructed in 2001); College Hill (15 MG constructed in 1939); Hawkins Hill (20 MG constructed in 1961); and Santa Clara (20 MG constructed in 1974).

Three of the tanks have significant structural issues and are expected to fail during an earthquake event. Hydraulic issues exist which result in inefficient filling and draining cycles, affecting water quality. In addition, due to a leaking roof and potential water quality issues, the Oregon Health Authority Drinking Water Services requires EWEB to repair or decommission College Hill by the end of 2023.

Through the 2015 Water Master Plan effort and subsequent structural evaluations, it has been determined that replacing the large base level tanks with multiple smaller, distributed tanks would provide resilient and redundant facilities, enhance operations, and improve water quality.

As part of their 10-year Capital Improvement Pan (CIP), EWEB intends to construct one new 7.5 MG tank with the potential for a second tank in the future, on the East 40th Avenue site. In addition to the new tank or tanks, the CIP also includes construction of a new 36-inch diameter water transmission main between West Amazon Street and the intersection of East 40th Avenue and Patterson Street. The transmission main work is being timed to coincide with planned City of Eugene street projects.

ASSESSMENT METHODS

Desktop Review of Published Materials

Prior to the on-site natural resources inventory, DOWL Environmental Specialists conducted a desktop review of published materials related to the site. Reviewed published materials included:

- East 40th Avenue Arborist Report (Cameron McCarthy, 2020)
- Historical aerial photos
- Current aerial photos of the City
- US Fish & Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) (USFWS 2020)
- Oregon Department of Agriculture (ODA) Threatened and Endangered Plant Species List (ODA, 2020)
- Willamette Valley Oak and Prairie Cooperative (WVOPC) Strategic Action Plan (WVOPC, 2020)
- Wildlife-Habitat Relationships in Oregon and Washington (O'Neil and Johnson, 2001)
- Oregon Department of Fish & Wildlife (ODFW) Oregon Conservation Strategy (ODFW, 2016)

Information Solicited from Neighbors and Others

To augment the information that would be collected during the on-site investigation, DOWL solicited, via email, information regarding plant and animal observations from neighbors and other individuals and organizations with knowledge of the site. On October 13, 2020 EWEB emailed 48 neighbors requesting information that they would be willing to share with DOWL regarding their knowledge of the site's natural features. In addition, DOWL contacted Dr. Bart Johnson a Landscape Architecture and Ecology professor at the University of Oregon who has conducted research with students at the site for the past 20 years.

Field Investigation

On October 8th and 9th, 2020 DOWL Environmental Specialists visited the site to map the vegetation and characterize and evaluate the existing on-site ecological conditions, including wildlife species, wildlife habitat and plant communities. The DOWL team conducted a series of meander surveys to gain an understanding of the entire parcel. During the surveys the team noted plant species present, physical/structural characteristics of the vegetation, evidence of disturbance, relative health of the trees and understory vegetation, and the locations of individual habitats and associated plant communities.

Conducting a series of site visits throughout an entire year would have resulted in a more complete inventory of species that occupy or use the site. However, a fairly robust list of likely species for a small site can be developed based on habitats that are present. A particular set of habitats will support a fairly predictable set of species. While butterflies and spring wildflowers could not be inventoried during the fall site visit, their presence is documented in the species lists provided by neighbors and local experts familiar with the site.

Using the information collected during the meander surveys, a topographic map, the results of the tree survey that was included with the Arborist Report (Cameron McCarthy 2020), and GIS, DOWL developed a map of plant communities present on the site.

ASSESSMENT RESULTS

Desktop Review

Historic Vegetation

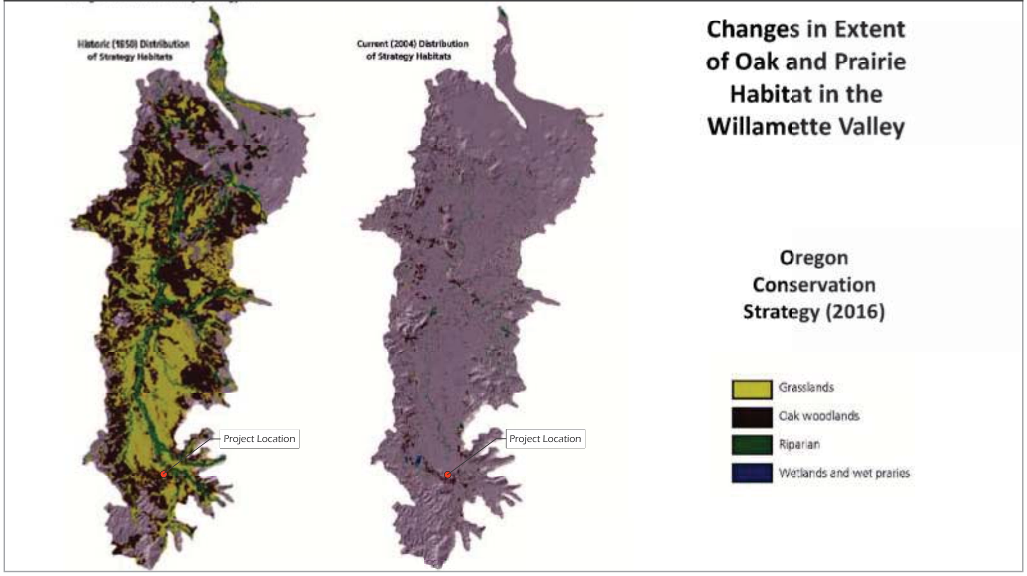
According to multiple sources and as reported in the 2020 Willamette Valley Oak and Prairie Cooperative Strategic Action Plan (WVOPC 2020), prior to Euro-American settlement in the mid-1800s, large expanses of grassland and oak-dominated habitats covered the floor of the Willamette Valley, forming a complex mosaic of upland and wet prairie, oak savanna, and oak woodland mixed with broad bands of riparian forest lining major rivers. In general, open prairie occupied a central position within the valley bottom surrounded by bands of savanna and woodland, transitioning to conifer forest on the valley fringes and on some north facing hillslopes. Based on information derived from the General Land Office (GLO) survey notes from the 1850s, it is estimated that 61 percent (1,461,469 acres) of the valley floor was occupied by oak or prairie habitat at the time.

Early naturalists and settlers to the Willamette Valley described wide expanses of prairie interspersed with oak savanna and oak woodland, which Native Americans maintained by setting low intensity fires. The native inhabitants of the valley influenced the vegetation over thousands of years by initiating frequent fires to burn off brushy vegetation in order to improve conditions for hunting, gathering, and possibly travel. During this period, a diverse community of animals and plants evolved that could withstand or even depend upon regular fire including fire-resistant oak.

After settlers moved into the valley in the mid-1800s and began suppressing fires, many of the oak and prairie dominated landscapes were gradually overtaken by conifers and other woody vegetation or converted to farms and cities.

The extent of oak and prairie habitat is greatly diminished in the valley and now covers less than 10% of its historic range (Figure 2, Willamette Valley Change in Extent of Oak and Prairie; Figure 3 Eugene Change in Extent of Oak and Prairie Habitat). What remains is generally found in highly fragmented patches and in most cases is significantly impacted by invasive species and colonizing woody vegetation.

FIGURE 2: WILLAMETTE VALLEY CHANGE IN EXTENT OF OAK AND PRAIRIE



Arborist Report

The Arborist Report prepared for the site in 2019 and 2020 by Cameron McCarthy Landscape Architecture & Planning (Appendix A) described two distinct woodlands on the site—one dominated by Douglas fir and the other dominated by oak. The report included a detailed tree inventory map that identified individual trees by species and size. In addition, the report included recommendations for maintaining or improving the health of the woodlands as well as recommendations for minimizing impacts to trees during proposed site development activities.

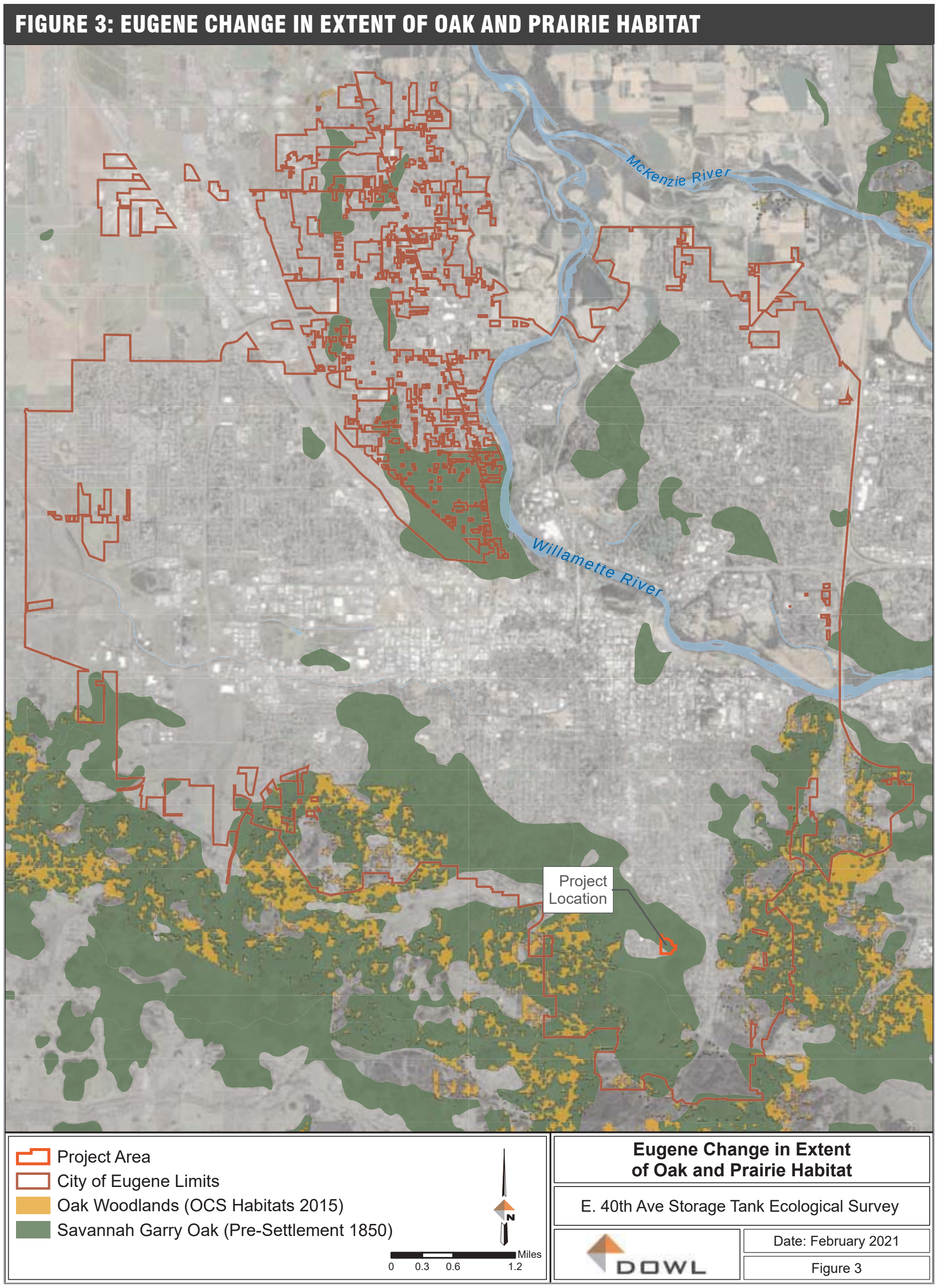
State and Federal Threatened and Endangered Species

The State of Oregon and the federal government maintain separate lists of Threatened and Endangered (T&E) species. These are species that are at some degree of risk of becoming extinct.

The Oregon Department of Fish and Wildlife (ODFW) maintains a list of native wildlife species in Oregon that have been determined to be either "threatened" or "endangered" according to criteria set forth by rule (OAR 635-100-0105). State threatened and endangered plant listings are handled through the Oregon Department of Agriculture, and most State invertebrate listings are handled through the USFWS and the Oregon Biodiversity Information Center.

Under federal law the U.S. Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration (NOAA) share responsibility for implementing the federal Endangered Species Act of 1973. In general, USFWS has oversight for terrestrial and freshwater species and NOAA for marine and anadromous species. In addition to information about species already listed, the USFWS-Oregon Field Office maintains lists of candidate species and Species of Concern.

FIGURE 3: EUGENE CHANGE IN EXTENT OF OAK AND PRAIRIE HABITAT



The USFWS Information, Planning, and Consultation (IPaC) system generates lists of species and other resources such as critical habitat (collectively referred to as trust resources), under the USFWS jurisdiction that are known or expected to be on or near a project area. The list may also include trust resources that occur outside the project area but that could potentially be directly or indirectly impacted by activities in the project area. According to the USFWS, determining the likelihood and extent of effects a property may have on trust resources typically requires gathering additional site-specific and project-specific information such as vegetation/species surveys.

The IPaC report (Appendix B) for the East 40th Avenue site identified three threatened or endangered birds, one fish, one insect and four plant species that could potentially occupy the site. Species identified by the USFWS IPaC system for the East 40th Avenue site, along with their federal and state listing status are listed in Table 1.

Table 1. Listed Species Identified by USFWS as Potentially Occurring Near East 40th Avenue Site

Species	Listing Status		Habitat
	Federal	Oregon	
BIRDS			
Marbled murrelet *Brachyramphus marmoratus*	Threatened	Threatened	Old-growth Douglas fir forest
Northern spotted owl *Strix occidentalis caurina*	Threatened	Threatened	Old-growth Douglas fir forest
Yellow-billed cuckoo *Coccyzus americanus*	Threatened	Not Listed	Riparian deciduous forests
FISH			
Bull trout *Salvelinus confluentus*	Threatened	Not Listed	Cold water streams
INSECTS			
Fender's Blue Butterfly *Icaricia icarioides fenderi*	Endangered	Endangered	Habitats that support perennial Lupine species
PLANTS			
Bradshaw's Desert-parsley *Lomatium bradshawii*	Endangered	Endangered	Wet prairie
Kincaid's Lupine *Lupinus sulphureus ssp. kincaidii*	Threatened	Threatened	Upland prairie remnants
Nelson's Checker-mallow *Sidalcea nelsoniana*	Threatened	Threatened	Wet prairies and stream sides
Willamette Daisy *Erigeron decumbens*	Endangered	Endangered	Wet prairie grasslands and drier upland prairie sites

Input from Neighbors and Others Familiar with Site

In response to the solicitation for information about the site from local experts and from neighbors DOWL and EWEB received responses from three community members with extensive professional Pacific northwest ecological experience and knowledge, and six neighbors. A summary of the comments received are presented below. Direct transcripts of the full comments received, as well as all species lists provided by the commenters are presented in Appendix C.

Neighbors

Neighbors reported that the site supports many different species of birds and butterflies, as well as deer, racoons, and wild turkeys. One neighbor noted that during the 1960's quail, pheasants, skinks, snakes, and tree frogs were common; and that deer, raccoons and wild turkeys are a more recent addition. That same neighbor noted that there are fewer species of wildflowers now than in the 1960's and 1970's.

Concerns expressed by neighbors regarding tank construction on the site included the loss of the existing Douglas fir forest; the potential for decreased safety and property values; the potential for tank construction and operation to have a negative effect on the current ecosystem; and a concern that the timing of the natural resources site investigation during the fall likely resulted in many species common on the site not being accounted for.

Professional Ecologists

The following professionals provided input regarding the site: Jeff Krueger; Dr Bart Johnson; and Ed Alverson. Jeff Krueger works closely with the Willamette Valley Oak and Prairie Cooperative, managing the development of a valley-wide strategic action plan to protect and enhance oak and prairie habitats.

Dr. Bart Johnson is a Landscape Architecture and Ecology professor at the University of Oregon who has conducted research with students at the site for the past 20 years. Ed Alverson is a local naturalist who works as the Natural Areas Coordinator for the Lane County Parks Division. Each of the professional ecologists:

- Emphasized the regional significance of the oak habitat, and the importance of preserving and managing it.
- Noted that the Oregon Conservation Strategy identifies prairie, savanna, and oak woodlands as conservation priorities in the Willamette Valley.
- Stated that conifer encroachment is threatening the oak habitat, and strongly recommended that Douglas-fir at the site be thinned to follow best management practices for reducing fire hazard, and improving habitat value for native wildlife.

Jeff Krueger explained that the Willamette Valley Oak and Prairie Cooperative Strategic Plan notes the rapid decline and degradation of these once common oak and prairie habitats across the valley and calls for identification and conservation of remnant oak and prairie habitats where they exist and for the management of these properties in a way that preserves and enhances the oak and prairie vegetation over the long-term. Mr. Krueger encouraged EWEB to support the valley-wide efforts to protect this valuable and rapidly declining habitat type locally, including East 40th Avenue site, and the at-risk wildlife species it supports (e.g., native pollinators, Western bluebirds, white-breasted nuthatch, etc.).

Dr. Bart Johnson provided a plant species list generated by his students over the years and noted that the site contains a large proportion of native species, including three native bunchgrasses that are valued as cornerstones of local upland native prairies and Oregon white oak savannas. He also noted that the City of Eugene has made the acquisition and restoration of prairie and oak habitats one of its top conservation, recreation and educational priorities, and strongly urged EWEB to work with the city to strengthen the habitat and civic value of the neighborhood through prairie and oak habitat restoration.

Ed Alverson pointed out that the presence of ponderosa pine and California black oak in addition to the Oregon white oak is unique to the Willamette Valley and recommended that efforts be taken to preserve these species, in addition to the Oregon white oak. Mr. Alverson noted that while the East 40th Avenue site is a relatively small parcel, it is worth considering the value of small sites to conservation goals, as part of a diverse strategy and a complement to large protected tracts; and that for oak-associated birds, the habitat on the EWEB parcel is part of a larger habitat block that includes remnant oak stands located on nearby residential lots.

Mr. Alverson also noted the presence on the site of one individual of spurge laurel, a very problematic non-native species that can be extremely invasive in oak woodlands and recommended that given its potential for being an invader it would be good to prioritize inventory and removal of this species in a management plan.

Local Conservation Groups Input

This report will be shared with the public as well as local conservation organizations.

ON-SITE OBSERVATIONS

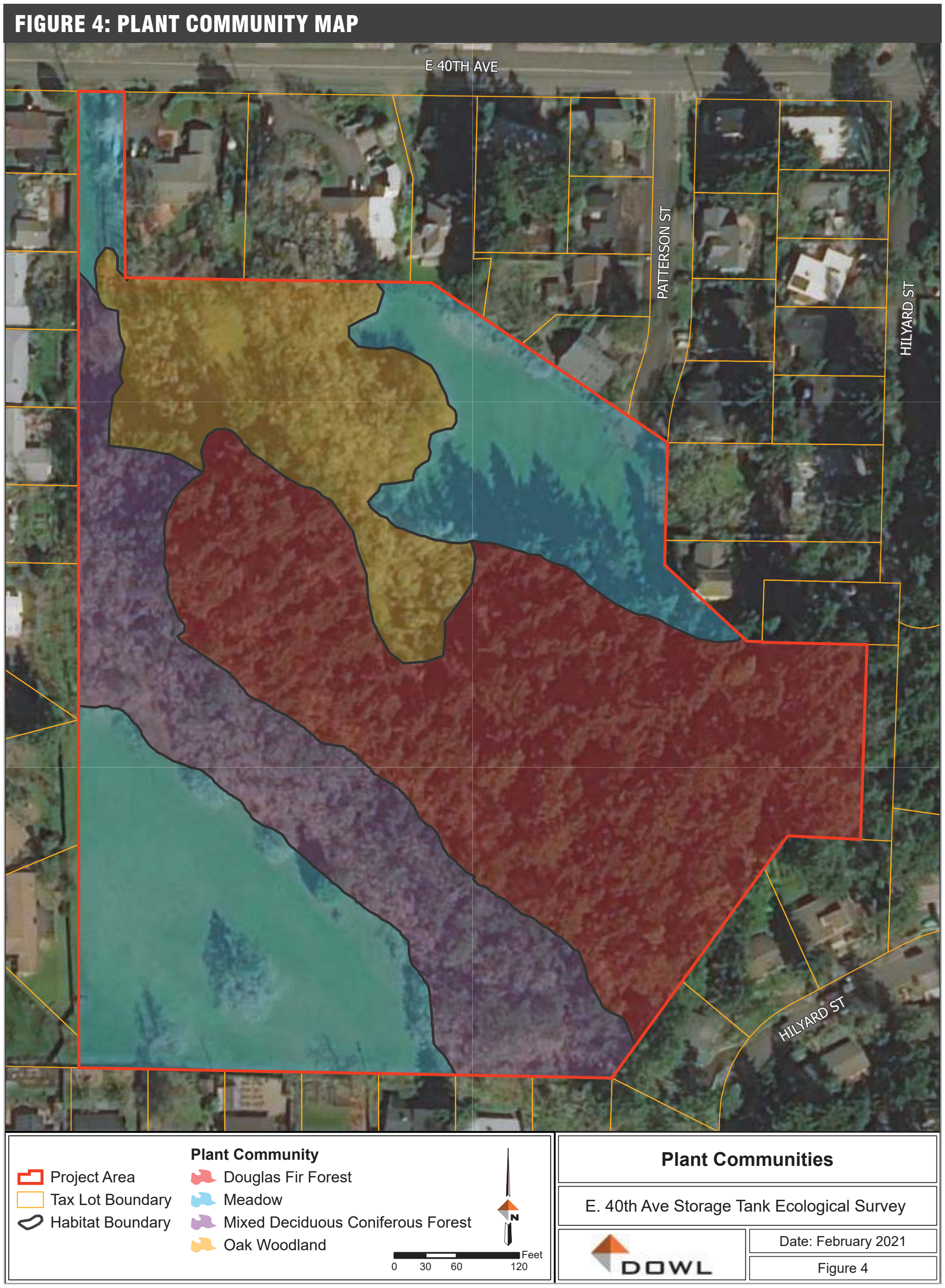
The project site is bordered on all sides by residential development. The nearest surrounding streets are East 40th Avenue to the north, Hilyard Street to the east, East 43rd Avenue on the south, and Ferry Street on the west. The site is characterized by a steep sided topographic ridge that is oriented northwest to southeast across the site. The middle of the ridgetop includes a slight topographic depression, with comparatively higher ground to the northwest and southeast of the depression. The northeast and southwest corners of the site are relatively flat.

On-site vegetation is characterized by regularly mown meadows in the northeast and southwest corners; mature Douglas fir forest on the top of the ridge; mixed evergreen and deciduous forest on the south facing slope of the ridge; and oak woodland/oak savanna occupying the topographically lowest portion of the ridge, extending down the north side of the ridge and extending beyond the northern boundary of the site.

Based on the conditions observed on the site, the trust resources identified in the IPaC report and presented in Table 1 would not be expected to occur on the site. None of these species or their primary habitats (old-growth forest, remnant prairie, wet prairie, cold water streams, or riparian forests) were identified during the site investigation or were reported as having been observed by neighbors or others contacted about the site.

While the regularly mown areas on the east and west sides of the site could potentially be enhanced/restored to support dry prairie habitat conditions, based on the presence of only a few prairie species and the predominance of non-native grasses and forbs these areas would not be considered dry prairie habitat. Historic disturbance and regular mowing have effectively removed any native prairie habitat that may have existed on the site in the past. However, based on the observed conditions the potential to reestablish dry prairie habitat on this site does exist.

FIGURE 4: PLANT COMMUNITY MAP



Wildlife-Habitat Types

Several classification systems for describing habitats and vegetation types exist, and for this project DOWL employed the classification system described in Oregon and Washington Wildlife Species and Their Habitats (O'Neil and Johnson 2001). The O'Neil and Johnson system used a cluster analysis procedure that considered 541 native breeding species and 119 Pacific Northwest vegetation, land use, and marine groupings to identify 32 wildlife-habitat types.

DOWL identified the following three wildlife-habitat types recognized under the O'Neil and Johnson classification system on the East 40th Avenue site:

- **Westside grassland** occupying the northeast and southwest corners of the site
- **Westside lowland conifer-deciduous forest** on the top of the ridge, and on the south facing slope of the ridge; and
- **Westside oak and Douglas-fir forest** occupies the lowest portion of the ridge and extends down the north side of the ridge and continues beyond the north edge of the site.

Within the three wildlife-habitat types DOWL identified the following four distinct plant communities (Figure 4, Plant Community Map).

1.Douglas Fir Forest

This plant community is located on the top of the ridge that dominates the site and is characterized by a mostly closed single-layer tree canopy. This plant community supports relatively few native shrubs and little understory herbaceous vegetation. The overstory is dominated by large even-aged Douglas fir, with a few smaller Douglas firs, occasional big-leaf maple, Himalayan blackberry, trailing blackberry, occasional snowberry, Oregon grape, ornamental cherry, and English ivy in the understory. The eastern third of this plant community is composed almost completely of large Douglas firs. The central and western portions of this area support a somewhat more mixed assemblage of trees including big-leaf maple, and California black oak.

On the western slope of the ridge a more-recently disturbed area is characterized by small trees including Douglas fir saplings, ornamental cherry, Oregon ash, cultivated pear saplings, English ivy, and Himalayan blackberry.

The conifer-dominated plant community is expanding to the north and northwest into the oak-dominated plant community.

PHOTO 2: INTERIOR OF DOUGLAS FIR FOREST

PHOTO 3: ENGLISH IVY

PHOTO 4: DOUGLAS FIR FOREST CANOPY

While it does contain large trees, the Douglas fir forest present on the E. 40th Avenue site is not considered to be old-growth or late successional forest. Old-growth and late successional are interchangeable terms used to describe forests that have existed for many years, usually 200 years at least, and that have over time developed a complex structure. Late successional or old growth forests typically include very large diameter living trees, some with broken tops; living trees with large bark pockets and obvious signs of decay, and a high percentage of standing dead trees (snags) with large cavities or that are mostly hollow. These forests often include a sub canopy that includes smaller shade-tolerant trees, and a well-developed herbaceous understory. According to the Oregon Conservation Strategy, late successional mixed conifer forests are defined by plant species composition, overstory tree age and size, and the forest structure. They include characteristics such as a multi-layered tree canopy, shade-tolerant tree species growing in the understory, large-diameter trees, and a high volume of dead wood, such as snags and logs. Late Successional Conifer Forests are older forests (hundreds of years old), generally occurring below 3,500 feet, but sometimes occurring up to 4,000 feet. Western hemlock is almost always co-dominant and usually dominates the understory. The understory typically supports shrub and forb species, such as vine maple, salal, sword fern, Cascade Oregon grape, western rhododendron, huckleberries, twinflower, vanilla leaf, and oxalis. In the absence of disturbance, Douglas-fir forests eventually will convert to western hemlock .

The conifer forest on the East 40th Avenue site contains some large Douglas fir trees but does not contain very large diameter trees, or more than just a few trees with broken tops, or any large trees with obvious signs of decay. The relatively low percentage of standing dead trees, the lack of an understory layer of smaller shade -tolerant trees, and the very minimal herbaceous understory are features that do not support characterizing the site as late successional/old-growth forest.

2.Mixed Deciduous Coniferous Dry Forest

The mixed deciduous coniferous dry forest occupies the southern edge of the ridgetop and extends down the southern slope of the ridge. This plant community is characterized by a relatively closed, multi-layered tree canopy. The overstory is dominated by Pacific madrone, big-leaf maple, Oregon white oak, California black oak, and ponderosa pine of varying heights; the understory includes Oregon ash seedlings, smaller Pacific madrones, small cherry trees, snowberry, honeysuckle,

PHOTO 5: INTERIOR OF MIXED FOREST

PHOTO 6: SOUTHERN EDGE OF MIXED FOREST ***(NOTE PONDEROSA PINE)***

PHOTO 7: LARGE OREGON WHITE OAK IN OAK WOODLAND

PHOTO 8: OAK WOODLAND

and Oregon grape. The outer southern edges of this plant community also support Oregon white oaks. The presence of ponderosa pine in this forest is somewhat notable as this native pine is becoming less common in the Willamette Valley and is recognized by ecologists as a species that should be promoted and managed for when possible.

3.Oak Woodland

The central portion of the ridgetop and the northern slope of the ridge extending to the northwest corner of the site support an oak-dominated plant community. The oak dominated habitat ranges from oak woodland characterized by mature, relatively widely-spaced Oregon white oaks and a sparse shrub understory and grasses beneath; to oak woodland dominated by somewhat more-closely spaced Oregon white oaks and California black oaks with a more dense shrub understory, to a few areas of very widely-spaced oaks with a grass-dominated understory. The areas of very widely spaced oaks could be classified as oak savanna or as a continuation of the oak woodland; however, both oak woodland and oak savanna are recognized as threatened Willamette Valley habitats prioritized for protection and restoration.

The edges of the oak dominated plant communities adjacent to the Douglas fir forest are being overtopped and outcompeted by rapidly encroaching Douglas fir trees. In addition, the understory of the oak habitat contains poison oak and English ivy, both of which are threats to the survival of the native species.

4.Meadow

The northeast and southwest corners of the site support a regularly mown meadow. The meadows are characterized by grasses and weedy forbs including fescue, bluegrass, dandelion, and Queen Anne’s lace. Local naturalists report that these areas support three native bunchgrass species that are considered cornerstone species of native Willamette Valley upland prairies, as well as wildflowers including camas, western buttercup, and fawn lily. While these native plant species do not dominate the meadows, their presence suggests these area could be managed in such a way as to reestablish a native prairie habitat that could support additional native plants as well as insects including butterflies and other native pollinator species.

PHOTO 9: OAK SAVANNA

PHOTO 10: SOUTHWAEST MEADOW

PHOTO 11: NORTHEAST MEADOW

Table 2. Wildlife-Habitat Types Identified on East 40th Avenue Site

Wildlife-Habitat Type (O'Neil and Johnson 2001)	**Location**	**Plant Community Name** Dominant Species	**Structure**	**Current Habitat Condition**
Westside Grassland	Northeast and southwest corners of site	**Meadow** Fescue, bluegrass, dandelion, Queen-Anne's lace	Closed (>70% cover) single-layer canopy	Low. Mostly non-native species, regularly disturbed (mowing)
Westside Lowland Conifer-Deciduous Forest	Ridgetop	**Mature Douglas fir forest** Douglas fir, salal, low Oregon grape, sword fern	Closed canopy (>70% cover); single-layer tree canopy; large mostly even-aged trees with high canopy, few lower branches, and furrowed bark.	Moderate. Little shrub or herbaceous understory; few snags; little downed wood; low understory plant species diversity; little disturbance
Westside Lowland Conifer-Deciduous Forest	South facing slope of the ridge	**Mixed coniferous deciduous forest** Big-leaf maple, Pacific madrone, Oregon white oak, California black oak; Ponderosa pine; snowberry, western hazel	Closed canopy (>70% canopy closure); multi-layer canopy (trees, shrubs, herbs)	Moderate. little disturbance;
Westside Oak and Douglas-Fir Forest	At lowest elevation on the ridgetop, extending down north side of ridge, continuing off-site to the north	**Oak woodland** Oregon white oak, California black oak, cherry	Open (<70% closure) canopy;	Moderate to High; relatively few invasive species; healthy oaks but conifers are advancing and shading the oaks

Observed Wildlife

DOWL observed the following wildlife species during the October 2020 site investigation: white-breasted nuthatch, red breasted sapsucker, northern flicker, scrub jay, pileated woodpecker, hairy or downy woodpecker, Steller's jay, American crow, black-capped chickadee, ruby-crowned kinglet, western gray squirrel, and black-tailed deer. The white-breasted nuthatch and western gray squirrel are recognized by the Oregon Department of Fish & Wildlife as Sensitive species and are identified in the Oregon Conservation Strategy as a high priority for conservation and recovery efforts in the Willamette Valley ecoregion. Both the white-breasted nuthatch and the western gray squirrel are oak woodland-dependent species.

Table 3. Wildlife Observed on East 40th Avenue Site

Wildlife Species	State Status	Typical Habitat	Oregon Conservation Strategy Status
White-Breasted Nuthatch	Sensitive	Occupies oak forests and woodlands	High priority for conservation & recovery efforts in the Willamette Valley ecoregion
Northern Flicker	N/A	Occupies open forests and forest edges adjacent to open country, typically avoid dense forests. It is a common resident throughout Oregon.	N/A
Red Breasted Sapsucker	N/A	Occupies moist coniferous coastal forest and mixed deciduous-coniferous coastal forest west of the Cascade crest. Nest cavities are typically in large snags or live trees with decayed interiors. It is a fairly common breeder in the northern part of the state from the coast to the Cascades and south to the southern Cascades	N/A
Scrub Jay	N/A	Occupies deciduous, scrubby, open or semi-open terrain with thick brush, neighborhoods, gardens, farms, often near oaks.	N/A
Pileated Woodpecker	N/A	Prefers mature forests and younger forests with large snags and logs, requiring large diameter snags for nesting and foraging.	N/A
Hairy or Downy Woodpecker	N/A	Found mostly at low to moderate elevations in deciduous and mixed deciduous-coniferous forests throughout much of the state, and less often in coniferous forests.	N/A
Steller's Jay	N/A	A common resident in mesic and dry conifer and mixed conifer-hardwood forests from valley floors to near timberline. Nests in trees or shrubs and often places the nest near the trunk and within 10-16 feet from the ground.	N/A

Wildlife Species	State Status	Typical Habitat	Oregon Conservation Strategy Status
American Crow	N/A	Very common resident west of the Cascades in interior valleys, urban areas, and along the coast and is a fairly common resident throughout the Coast Range lowlands and in the west cascade foothills.	N/A
Black-Capped Chickadee	N/A	Resides at low to moderate elevations in western Oregon from the Willamette Valley and coastal counties to Douglas County, in mixed and deciduous woods; willow thickets, groves, shade trees.	N/A
Ruby Crowned Kinglet	N/A	Breeds in high elevation forests, primarily east of the Cascade crest, where it is common in summer, and in the Blue, Wallowa, and locally in the Warner mountains. It is frequently found late in spring in areas where they do not breed and is found throughout Oregon in winter.	N/A
Western Gray Squirrel	Sensitive	Occupies forests where there are maples, tanoak, madrone, Douglas-fir, white fir, and pines. They prefer older oak trees with large limbs and continuous canopy cover to facilitate movement.	High priority for conservation & recovery efforts in the Willamette Valley ecoregion
Black-Tailed Deer	N/A	Typically found in brushy areas at the edges of forests and chaparral thickets, not in dense forests; recently disturbed habitats such as clear cuts or burns, with their characteristic grasses, forbs, and shrubs.	N/A

Regional Significance of On-Site Wildlife-Habitat Types

As described above, the East 40th Avenue site supports Douglas fir forest, mixed deciduous coniferous forest, oak woodland, and meadow. The Oregon Department of Fish & Wildlife's Oregon Conservation Strategy (OCS), a blueprint for conservation in Oregon, identifies oak woodland as a Strategy Habitat that is important for the continued existence of some of Oregon's species of greatest conservation need.

The OCS also identifies Late Successional Coniferous Forest as a strategy Habitat but based on the age of the trees (most likely less than 150 years old), the single or at most two canopy layers, and the relative lack of snags and the lack of very large diameter trees, the on-site Douglas fir forest would not be considered a late successional coniferous forest recognized by the OCS.

The goals of the OCS are to maintain healthy fish and wildlife populations by maintaining and restoring functioning habitats, preventing declines of at-risk species, and reversing declines in these resources where possible. The OCS identifies 11 Strategy Habitats, including Oak woodlands, that provide important benefits to Strategy Species, which are defined as having small or declining populations, are at-risk, and/or are of management concern. The OCS lists oak and grassland dependent species as high priority for conservation and recovery efforts in the Willamette Valley ecoregion.

According to the OCS, oak woodlands have been impacted by conversion to other land uses, invasive species, and vegetation changes due to fire suppression. As a result of conifer plantings and changes in fire frequency and intensity after European settlement, Douglas-fir now dominates in many areas of the Willamette Valley foothills. Oak habitats are being converted to agriculture, residential, and other uses in the Willamette Valley, the Coast Range foothills, and the coastal hills in southern Oregon.

Because much of the remaining oak woodlands are in private ownership and maintenance of these habitats requires active management, cooperative incentive-based approaches are crucial to conservation. Loss of oaks, particularly large-diameter, open-structured trees valuable to wildlife, is of particular concern because oak trees have a slow growth rate, slowing restoration success. In addition, reproduction and recruitment of younger trees are poor in many areas.

In addition to OCS the Willamette Valley Oak and Prairie Cooperative which includes representatives from organizations including ODFW, the City of Eugene, and the Natural Resources Conservation Service recognizes the importance and relative rarity of oak woodlands and has developed a strategy for protecting and restoring these habitats in the Willamette Valley.

Species and Habitats of Special Concern& Applicable Environmental Regulations

USFWS IPaC did not identify federally listed threatened or endangered species that would be expected to occupy the site; and no species or habitat for federally or state listed threatened or endangered species were observed.

The site does support nesting habitat for birds protected under the federal Migratory Bird Treaty Act (MBTA), administered by the United States Fish & Wildlife Service (USFWS). Under the MBTA it is illegal to pursue, possess, injure or kill migratory birds. Most wild birds, with the exception of European starlings, house sparrows, and rock doves, that will be encountered in Oregon are protected under the MBTA. In western Oregon, vegetation clearing in areas that could support nesting birds covered under the MBTA is typically prohibited between March 1 and July 31 to avoid destroying active bird nests and harming nesting migratory birds. EWEB is committed to timing tree removal and other activity that could disturb nesting migratory birds, to avoid nesting season.

On-site Habitat Functions and Values

Brief descriptions of the habitat value provided by each plant community are presented below. Possible habitat enhancement or restoration approaches for each plant community are listed in Table 4. Once the locations for the new water storage tanks are determined, more detailed approaches to restoring and enhancing the remaining habitats can be developed.

Mature Coniferous Forest

Due to the single overstory canopy layer, relatively closed canopy and relatively low diversity of understory species, the mature Douglas-fir forest provides moderate habitat value.

Mixed Deciduous Dry Forest on South-facing Slope

Due to the multiple canopy layers present and the diversity of species including broadleaved evergreen, broad-leaved deciduous, and evergreen conifer trees. Species include including California black oak and Ponderosa pine, and several native understory shrub species, the mixed deciduous forest on the south facing slope provides moderate to high habitat value.

Oak Woodland

Due to the relatively wide spacing of the trees, and the open and relatively weed-free understory, the oak woodland on the northwest side of the property provides moderate to high habitat value. This area also offers good opportunities for habitat restoration/enhancement due to its relatively healthy condition.

Meadow

Due to the predominance of non-native herbs and grasses and regular mowing, the meadow community provides relatively low habitat value. However, due to the presence of well-drained soils and some native dry prairie species, this area offers opportunities for prairie establishment/enhancement.

Table 4. Possible Restoration/Enhancement Approaches

Wildlife-Habitat Type (O'Neil and Johnson 2001)	**Possible Restoration/Enhancement Approaches**	**Resulting Habitat Condition** New Habitat Features
Westside lowland conifer-deciduous forest (Mature Douglas-fir forest)	• Create canopy openings. • Thin to protect oak woodland from shading and to reduce fire risk. • Plant shade intolerant trees, shrubs and herbs in the new openings. • Create snags. • Leave downed wood. • Control invasive species.	**Moderate to High** Additional canopy strata: understory trees, shrubs, herbs. Increased species diversity (shade-intolerant trees, shrubs, herbs). New structural habitat. New ground-level habitat for amphibians, insects, fungi.
Westside lowland conifer-deciduous forest (Mixed coniferous deciduous forest)	• Create canopy openings. • Plant shade intolerant trees shrubs and herbs in the new openings. Protect Ponderosa pine and California black oak; manage habitat to promote these species. • Control invasive species.	**High** Increased species diversity. Preservation and maintenance of relatively uncommon Willamette Valley habitat containing ponderosa pine and California black oak. Diversified structural habitat. New ground-level habitat for amphibians, insects, fungi.
Westside oak and Douglas-fir forest (Oak woodland)	• Control invasive species. • Maintain open understory—continue mowing. • Remove encroaching Douglas firs and other woody invaders.	**High** Relatively healthy oak woodland community is maintained.
Westside grassland (Meadow)	• Plant oaks and native understory shrubs. • Plant native upland prairie species. • Limit mowing.	**Moderate to High.** New oak savannah habitat (relatively uncommon plant community) established. Increased species diversity. New structural habitat . New upland prairie habitat established. Increased pollinator habitat.

SUMMARY/CONCLUSIONS

Several habitats exist on the site; unlike many undeveloped urban sites, the site is dominated mostly by native plants . No threatened or endangered species are known to occupy the site however the white-breasted nuthatch and the western gray squirrel which are both recognized as Sensitive by ODFW were observed on site in October 2020, and the site provides nesting habitat for birds protected under the Migratory Bird Protection Act.

Despite the large size of some of the individual trees in the Douglas fir forest on top of ridge in the middle of the site, this forested community does not provide particularly high habitat value when compared with the adjacent on-site oak woodland. Oak woodlands were once common in the Willamette Valley but are now relatively rare, and have been identified by state and local resource protection agencies as priority habitats for protection and restoration. Each habitat identified on the site could benefit from enhancement or restoration efforts.

NEXT STEPS

Once the location of the water storage tanks is confirmed, DOWL will identify and quantify the potential impacts to onsite natural resources and work with EWEB to identify impact avoidance, minimization, and mitigation/restoration opportunities.

Potential mitigation/restoration strategies could include

- Enhancing the oak habitat by removing ivy and poison oak and removing conifers that are currently shading the edges of the oak woodland
- Creating openings in the remaining Douglas forest canopy to create conditions that would favor additional light-tolerant plant species to establish
- Repurposing felled trees as installed snags to provide additional structural habitat in the currently snag-deficient forest
- Enhancing the meadow area to provide pollinator habitat, and potentially recreate an oak savanna habitat.

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Willamette Valley Oak and Prairie Cooperative. 2020. *Willamette Valley Oak and Prairie Cooperative Strategic Action Plan.*

APPENDIX A - ARBORIST REPORT

CAMERON McCARTHY LANDSCAPE ARCHITECTURE & PLANNING | 160 East Broadway ▪ Eugene Oregon 97401 v 541.485.7385 ▪ f 541.485.7389 | www.cameronmccarthy.com

Aug 26, 2019
UPDATE: Sep 09, 2020

City of Eugene
Eugene, Oregon

RE: EWEB 40th Ave, Arborist Report

Introduction:
This report was prepared for a future development of an EWEB owned parcel of land, Map 18031720, Tax Lot 01000. The property is located in the Southeast neighborhood of Eugene. It is nestled within and surrounded by a residential neighborhood. The site can be best accessed at the end of Patterson Street, off of 40th Ave.

Tree Felling Criteria for this project are presented below. Tree diameters in the reports are the diameter at 4.5 feet above grade (DBH) and for trees larger than 6-inches in DBH within private property and 2-inch in DBH within the public right of way. Tree diameters for multi-stemmed trees are the sum of the 3 largest stems at 4.5 feet above grade. Limbs counted are identified before the DBH measurement in parentheses. For example, a double stemmed tree that has a total DBH of 10-inches would be noted as (2) 10". A triple stemmed 10" DBH tree would be noted as (3) 10". Please see the Tree Inventory Plan, Diagram A, for the Tree's corresponding identification number and Tables A-F (UPDATE) with additional notes pertaining to each individual tree. Tree species, diameter size, and health/condition are identified in those attached tables.

The study for this report evaluated the health of trees within the private property.

Observations:
A variety of trees are present on site. Most of the trees are either natives or naturalized species. Tree species on the site include the following trees: Western Service Berry (*Amelanchier alnifolia*), Pacific Madrone (*Arbutus menziesii*), Single Seed Hawthorn (*Crataegus monogyna*), Oregon Ash (*Fraxinus latifolia*), Ponderosa Pine (*Pinus ponderosa*), Cherry (Prunus sp.), Douglas Fir (*Pseudotsuga menziesii*), Pear (*Pyrus sp.*), Oregon White Oak (*Quercus garryana*), and California Black Oak (*Quercus kelloggii*).

UPDATE: Species also include Bigleaf Maple (*Acer macrophyllum*).

The site is currently an undeveloped natural area comprised of woodlands along the ridgeline and meadows on the northeast and southwest corners of the property. It appears some maintenance and care has been given to the site. Few noxious species were seen. Evidence suggests that occasional mowing occurs which helps keeps the noxious species that were seen at bay. Walkers frequent the pedestrian trails winding along the ridgeline in the middle of the woodland. There are two distinct woodlands on the site: a Douglas fir woodland and an Oak woodland. Overlap of the two occurs. Both types of forests are very indicative of this area in the Pacific Northwest and this site has both. Prior to European settlement, the Oak woodland was the predominant type of woodland in the Willamette Valley. Since then, without the historic burning of the Willamette Valley, a natural succession to Douglas Fir woodlands has prevailed.

Douglas Fir Woodland

Oak Woodland

The Douglas fir woodland is a healthy mix of young trees and old trees, dead trees, and openings. While predominately Douglas fir, a few different species were also seen. There are several areas in the forest where trees are thick and compete for light, nutrients, soil, and water. Very thin canopies with vegetation only at the tops are the result of this. Thinning of the forest in several locations would benefit some of the younger trees and could help to create a stronger forest. Trees to consider thinning would be those with damaged tops, those with multiple tops, those that are competing heavily with their neighbors for space/sunlight, those with disease or pest, those physically resting on others, and those with any sort of health defect that renders them of less value than another.

Co-dominant leaders

Open understory: bramble

Canopies: some opening & some overcrowding

UPDATE: The relatively open understory of the Douglas fir woodland is teeming with *Toxicodendron diversilobum* (Poison Oak), *Hedera helix* (English Ivy) and blackberry species, in addition to the usual innocuous natives. In addition to Poison Oak and English Ivy, Wisteria and Honeysuckle vines were also noted as climbing several of the trees. English Ivy in particular causes bark damage when allowed to climb unchecked, and removal is difficult without causing more harm to the tree. There were several cases of extreme ivy infestation. This noxious species should be brought under control to avoid spread and damage to the woodland over time.

The Oak woodland has some open canopy spaces with the help of maintenance and storm damage. Without maintenance, the Douglas fir woodland could and would take over. Some thinning has occurred either by restoration efforts or due to storm damage. Opening up the canopy and allowing for more horizontal growth can benefit an Oak woodland. Most of the dieback on the Oaks is due to the Douglas firs outcompeting the Oaks for available sunlight, nutrients, and space. To help strengthen the Oak woodland, it is recommended to remove the Douglas firs that are outcompeting the oaks, meaning, any Douglas Fir that is within 10 ft of an Oak's canopy, should be removed if it is deemed a priority to keep the Oaks. The understory under the Oaks has been maintained as well, more so than within the Douglas fir forest.

Oak woodland with grass understory

The majority of the oaks had skeletonized leaves which is indicative of pests. As the trees are more mature, the trees did not seem to be significantly affected by the pest damage. In addition, the majority of the Oaks had galls caused by oak apple gall wasps. Galls usually occur on leaves and stems, but also may occur on flowers, fruits, twigs, branches, trunks, and roots. Gall-making insects are generally not considered pests as they do not damage the oak tree host but may cause earlier defoliation. Although there are some insecticides registered for use against gall-making insects, their use is generally unwarranted, and not recommended here. Furthermore, pesticides may kill beneficial insects that help control gall-making insects and could damage the health of the woodland's ecosystem.

Oakleaf Galls

Insects

Skeletonized leaves

The understory is thin, with a mix of native understory and noxious species, comprised of *Rubus ursinus*, the native blackberry and *Rubus armeniacus*, Himalayan blackberry. In addition and much to my dismay, a healthy amount of *Toxicodendron diversilobum*, Poison Oak is scattered around. Mowing has helped keep the understory controlled, but there are still areas of thick poision oak which made it difficult to take some tree measurements. Honeysuckle vines were also seen climbing on at least a dozen of the Oaks. Noxious species with the ability to do tree damage include *Hedera helix*, English Ivy. For a forest of this size, little ivy was seen but it's location was tracked and can be seen more precisely within the individual tree data tables. Without proper maintenance, English Ivy has the ability to take over and can damage the full woodland of trees. Currently, it has a scattered existence throughout the woodland.

Possible Nest in Oak

Inosculation

English Ivy beginning to climb

Poison Oak vines climbing trunk

English Ivy climbing trunk

Fir outcompeting Oaks

With a couple of exceptions, the trees themselves are only in decent health. It's typical of these trees to have uneven, high arching, narrow, and thin canopies. This type of canopy forms as such in response to the sunlight condition available for growth. With limited space, trees can only get so wide. On the contrary to only decent individual tree health, the health of the woodland is good. Together, the trees form a very large mature canopy. Deadwood on the trees is what would be typical for a forest as opposed to the safety and maintenance requirements of an urban environment. Dead snags are throughout which provide good habitat.

The trees at the edge of the woodland are quite possibly the most important. They provide support and protection to the interior stand of trees. They provide wind cover for the tall, spindly, less structurally sound trees that could bend or blow over in storms. If a portion of the site is cut for development, the new edge of the woodland would be subject to failures of individual trees as they are not adapted to be perimeter trees. Significant limbs could fail as their existing windbreak would be missing. As with many things biological, the impacts could be immediate or delayed for years. Frequently, tree decline due to construction is on a delayed time table. As with all trees, adequate health and safety monitoring of the trees is the only way to reduce risk. To mitigate the impacts of the inner woodland becoming a perimeter tree, it is recommended to plant new trees along the perimeter.

Natural Areas:
This site is a natural area surrounded by a neighborhood that is home to many bird species. Many bird nests and woodpecker homes were seen.

Erosion considerations:
This site is on slopes greater than 10 percent along the south side of the ridgeline. Development is being considered with this in mind. Soils should be evaluated to determine if soils are more prone to erosion. Tree removal in these areas could have implications on surface runoff. Erosion control measures will be required to prevent erosion. The design team, the Contractor, and the City will need to work together to ensure proper erosion control measures are put into place immediately following the removal of any of the trees along these slopes.

Recommendations:
Care shall be taken during construction around existing trees to remain. The location of significant roots can be determined during the planning phase and creative designs can be implemented to accommodate the expansion of these major roots. The goal to reduce impacts to the soil and root system can be achieved through various methods. Fencing will reduce impacts to the soil and root systems during construction. Excavation options to reduce root damage to the trees being preserved include hydraulic or air spading, horizontal boring, and hand digging for soil removal without cutting or damaging roots of 1-1/2-inches or larger. Horizontal boring at a depth of at least 24-inches is optimal. A thick layer of mulch should be applied to the zone of protection to feed the tree and keep moisture levels intact during the construction period.

Cut and Fill in and around existing tree roots can affect the overall health of the tree. While cut is most intrusive, as it directly eliminates an energy (food and water) source, fill can also impact feeder roots in trees. Trees are better equipped to adapt to fill than cut. If fill is required, it is recommended to keep fill materials at least 10-ft from the base of the tree and to infill either by hand or with use of heavy equipment where only the bucket enters the protected area, and the weight of the machinery stays outside the tree protection area to avoid soil compaction. No more than 30% of the tree's root zone should be impacted with cut or fill for optimal health of the tree.

Tree protection measures and construction access accommodations shall be fine-tuned after the site design has been refined. Coordination between the arborist, planners/designers, and the contractor is critical to protecting the trees to remain to the greatest extent practicable. Respect for the designated protection zone is critical to ensure the long-term health of the tree. All too often I'll see the designated protection zone impacted for 'just a day' or 'just one time'. Impact using heavy equipment can severely impact the soils and can be all it takes to kill the tree 5 to 10 years down the road.

Living limbs shall be pruned for construction late in the dormant season or very early in spring before leaves form. Growth is maximized during these seasonal times and wounds will have the ability to close at a faster rate, meaning there will be less available time for pathogens to get established which cause more harm to the tree. Flowering trees should be pruned after blooming. Routine maintenance pruning of dead or dying branches can be done at any time.

Tree removal is recommended if more than 30% of their critical root zones will be impacted to accommodate construction. The design team will identify trees to be removed.

To mitigate tree removal, the landscape plan should replace trees per jurisdictional requirement to restore the urban forest. Strategic planting of new trees could help windproof the remaining stand of trees.

Assumptions and Limiting Conditions:

- The data given in this report reflects an opinion of the conditions present on-site at the time of inspection. The inspection was limited to visual examination only without excavation, probing, or coring. There is no warranty or guarantee, expressed or implied, that problems or deficiencies of the trees on the property may not arise in the future.
- Care has been taken to obtain all information from reliable sources. The consultant can neither guarantee nor be responsible for the accuracy and completeness of the information provided by others.
- Consultant shall not be required to give testimony or to attend court by reason of any report unless subsequent contractual arrangements are made, including payment of additional fees.
- Missing pages or alteration of any report invalidates entire report.
- Possession of a report does not imply a right of publication without the written consent of the consultant.
- Neither all nor any part of the contents of this report, nor a copy thereof, shall be conveyed to the public through advertising, public relations, news, sales or other media, or for a larger database without the expressed written consent of the consultant.

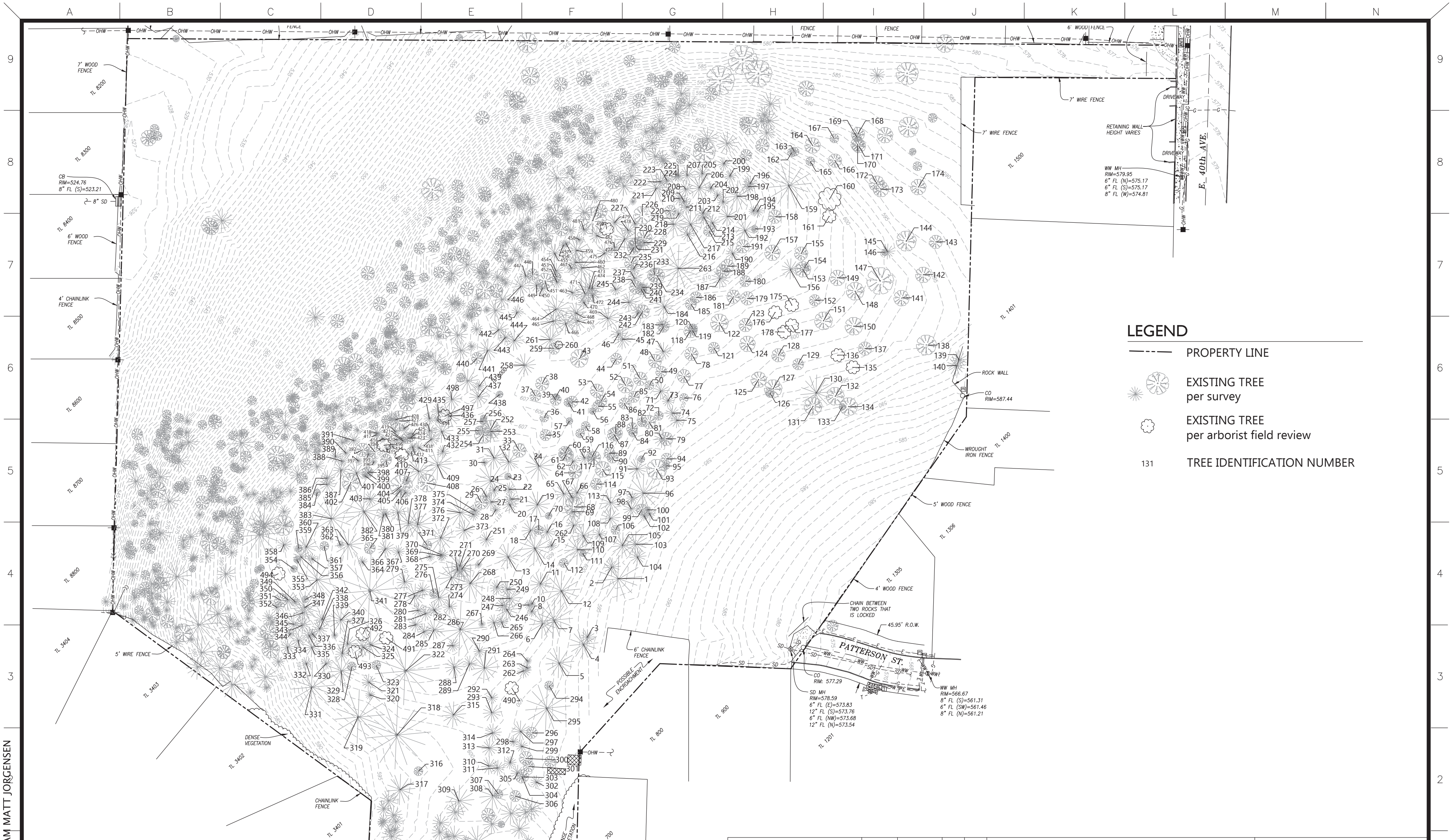
Regards,

K McAlister

UPDATE:

Kristena McAlister
ISA Certified Arborist, PN 7734A

Matthew Jorgensen
ISA Certified Arborist, PN-8810A



LEGEND

- PROPERTY LINE
- EXISTING TREE per survey
- EXISTING TREE per arborist field review
- 131 TREE IDENTIFICATION NUMBER

EWEB

FUNC	BY	CHK	APP
DES	KMc	MJ	CM
DWN	KM	MJ	CM
STANDARDS CHECK			

LINE IS 1 INCH
AT FULL SIZE
(IF NOT 1" - SCALE ACCORDINGLY)

WATER SYSTEMS
RESERVOIRS

EWEB WORK ORDER NO. 19-070-PSC
DATE: 09/09/20
SCALE: 1'=40'-0"
DWG NO: 37619
PROJECT SHEET NO: DIAGRAM_A
REV 0

9/10/2020 11:11 AM MATT JORGENSEN

	Genus & Species	Common Name	DBH (in)	CANOPY (ft)	Health/ Condition *	Arborist Notes	Ivy on trunk	Thin/sparse canopy	Co-dominant Leader	Surface Roots	% Deadwood	Suckers
1	Pseudotsuga menziesii	Douglas Fir	48	58	2	surface roots have stripped bark, pruning needed. Lean towards north for sun	✓			✓	50%	
2	Pseudotsuga menziesii	Douglas Fir	18	30	2	dead top with new growth		✓	✓		10%	
3	Prunus avium	Mazzard Cherry	15	50	2	40 degree lean west, cavity at buttress roots				✓	15%	
4	Pinus ponderosa	Ponderosa Pine	30	30	2	narrow canopy		✓			40%	
5	Pseudotsuga menziesii	Douglas Fir	28	35	3	uneven canopy, possible girdling roots	✓	✓			10%	
6	Pseudotsuga menziesii	Douglas Fir	30	49	2	high branching		✓			15%	
7	Pseudotsuga menziesii	Douglas Fir	38	50	2	sap, dead lower limbs		✓			25%	
8	Pseudotsuga menziesii	Douglas Fir	9	13	2	2-inch vine of poison oak on tree trunk		✓			10%	
9	Pseudotsuga menziesii	Douglas Fir	8	10	2	top branching only		✓			10%	
10	Pseudotsuga menziesii	Douglas Fir	8	13	2	top branching only		✓			10%	
11	Pseudotsuga menziesii	Douglas Fir	28	42	2	fruiting fungus at buttress roots, poison oak vine, insect damage		✓			40%	
12	Pseudotsuga menziesii	Douglas Fir	38	53	2	poison oak at base		✓			40%	
13	Pseudotsuga menziesii	Douglas Fir	26	35	2	blackberry and ivy at base	✓	✓		✓	40%	
14	Pseudotsuga menziesii	Douglas Fir	36	33	2	vines on trunk 30-40 feet up trunk, new lion tailing/flagging on trunk		✓			40%	
15	Pseudotsuga menziesii	Douglas Fir	8	15	2	thin canopy		✓	✓		40%	
16	Pseudotsuga menziesii	Douglas Fir	13	20	2	thin canopy		✓		✓	40%	
17	Pseudotsuga menziesii	Douglas Fir	9	30	2	wilting leaves		✓		✓	10%	
18	Prunus avium	Mazzard Cherry	20	25	2	blackberries at base, very thin canopy, abrasions from neighboring tree					35%	
19	Pseudotsuga menziesii	Douglas Fir	22	35	2	poison oak at base		✓			30%	
20	Pseudotsuga menziesii	Douglas Fir	18	20	2	exposed wood at trunk flares, sap, rock outcropping at base		✓			30%	
21	Pseudotsuga menziesii	Douglas Fir	17	15	2	water sprouts on trunk, uneven canopy, foliage on SW only, surface roots with bark damage		✓		✓	20%	
22	Pseudotsuga menziesii	Douglas Fir	12	15	2	dead top		✓			20%	
23	Pseudotsuga menziesii	Douglas Fir	(2) 11	30	2	wound at base of trunk with exposed wood, wilting leaves		✓			15%	
24	Pseudotsuga menziesii	Douglas Fir	32	45	3			✓			25%	
25	Pseudotsuga menziesii	Douglas Fir	10	15	2			✓			15%	
26	Pseudotsuga menziesii	Douglas Fir	9	15	2	uneven canopy		✓			15%	
27	Pseudotsuga menziesii	Douglas Fir	17	20	2			✓			20%	
28	Pseudotsuga menziesii	Douglas Fir	10	15	2		✓	✓			40%	
29	Quercus kelloggii	California Black Oak	12	12	1	deadwood, exposed wood, dead top, no canopy		✓			75%	
30	Pseudotsuga menziesii	Douglas Fir	8	15	2	poison oak vine on trunk, top is likely dead		✓			15%	
31	Pseudotsuga menziesii	Douglas Fir	22	30	2	branching (waterspouts), possible decay at base		✓			25%	
32	Pseudotsuga menziesii	Douglas Fir	20	30	2	high canopy					10%	
33	Quercus garryana	Oregon White Oak	30	40	2	uneven canopy, lean west, shaded on east side (no branching) due to limited canopy space					5%	
34	Pseudotsuga menziesii	Douglas Fir	30	45	3	trunk flare exposed					20%	
35	Quercus garryana	Oregon White Oak	11	22	1	uneven canopy, w/SW lean, ivy to top of tree	✓				0%	
36	Quercus garryana	Oregon White Oak	12	N/A	0	dead					100%	
37	Quercus garryana	Oregon White Oak	18	25	2	Nest in tree (unknown if nest has current resident) included bark, exposed wood, decay	✓		✓		50%	
38	Quercus garryana	Oregon White Oak	12	20	2	decay, broken limbs, deadwood	✓				20%	
39	Quercus garryana	Oregon White Oak	(3) 20	28	2	bark injury with decay, small cavity, possible nest on middle trunk					10%	
40	Prunus avium	Mazzard Cherry	6	24	2	growing within oak tree and canopy intertwined, poor form					10%	
41	Quercus garryana	Oregon White Oak	8	19	2	thin canopy, high branching, growing close to neighboring clump, small cavity, decay, exposed wood, fungus					0%	
42	Quercus garryana	Oregon White Oak	(3) 28	51	2	another 10" tree removed, clump form, shared canopy, trunk injury					10%	
43	Quercus kelloggii	California Black Oak	18	36	2	large dead branch on west side, cavity, south lean					25%	
44	Quercus garryana	Oregon White Oak	(2) 21	23	1						60%	
45	Pseudotsuga menziesii	Douglas Fir	19	N/A	0	full of conks on trunk, snag remains intact			✓		100%	
46	Pseudotsuga menziesii	Douglas Fir	17	N/A	0	full of conks on trunk, snag remains intact					100%	
47	Pseudotsuga menziesii	Douglas Fir	17	N/A	0	full of conks on trunk, snag remains intact					100%	
48	Quercus garryanna	Oregon White Oak	(2) 24	32	3	poison oak vine growing up tree trunk					10%	

Plan ID	Genus & Species	Common Name	DBH (in)	CANOPY (ft)	Health/ Condition*	Arborist Notes	Ivy on trunk	Thin/sparse canopy	Co-dominant Leader	Surface Roots	% Deadwood	Suckers
49	Quercus garryana	Oregon White Oak	10	21	2	poison oak and blackberry at base					20%	
50	Quercus garryana	Oregon White Oak	6	8	1	top of tree dead, alive first 10-ft in height only, deadwood and decay					60%	
51	Quercus garryana	Oregon White Oak	12	31	2	poison oak, deadwood, and decay					5%	
52	Quercus garryana	Oregon White Oak	18	31	3	ivy and V-shaped crotch at codominant union	✓		✓		5%	
53	Quercus garryana	Oregon White Oak	15	N/A	0	tree cut at base, likely due to storm destruction					100%	
54	Quercus garryana	Oregon White Oak	10	32	2	deadwood, gauls with insects, decay, uneven canopy	✓				10%	
55	Quercus garryana	Oregon White Oak	12	15	2	tons of ivy damage, large limb broken off with clean cut	✓				15%	
56	Prunus avium	Mazzard Cherry	(3) 14	32	2	ivy up to top of tree, multistemmed (5) stems, decay at base	✓				15%	
57	Quercus garryanna	Oregon White Oak	10	N/A	n/a	tree cut at base					100%	
58	Quercus garryana	Oregon White Oak	9	17	2	high canopy	✓				10%	
59	Fraxinius latifolia	Oregon Ash	9	17	3	even form with some deadwood					15%	
60	Quercus garryanna	Oregon White Oak	15	N/A	0	dead, cut at base likely due to storm damage					100%	
61	Quercus garryana	Oregon White Oak	(2) 30	N/A	0	dead, cut at base likely due to storm damage					100%	
62	Pseudotsuga menziesii	Douglas Fir	11	26	2	branches crossing with oak, bark damage from oak falling		✓			30%	
63	Pseudotsuga menziesii	Douglas Fir	12	40	2	crossing limbs in canopy					30%	
64	Quercus garryana	Oregon White Oak	12	30	2	co-mingling with Doug fir, bark injury		✓			5%	
65	Pseudotsuga menziesii	Douglas Fir	18	35	2	uneven canopy					30%	
66	Pseudotsuga menziesii	Douglas Fir	16	35	2	uneven canopy		✓			30%	
67	Pseudotsuga menziesii	Douglas Fir	8	15	2	growing up between oak branches/canopy		✓			10%	
68	Quercus garryana	Oregon White Oak	28	45	1	mostly dead with some high foliage, decay at base	✓				65%	
69	Pseudotsuga menziesii	Douglas Fir	24	40	2	extremely high canopy, needs pruning	✓	✓			30%	
70	Prunus avium	Mazzard Cherry	8	24	3	wilting leaves					5%	
71	Pseudotsuga menziesii	Douglas Fir	18	N/A	0	fungus					100%	
72	Quercus garryanna	Oregon White Oak	17	40	2	high arching canopy, poison oak vines growing up trunk					10%	
73	Pseudotsuga menziesii	Douglas Fir	12	18	1	uneven canopy, dead top					50%	
74	Pseudotsuga menziesii	Douglas Fir	12	N/A	0	poison oak growing up trunk, mower damage on roots				✓	100%	
75	Pseudotsuga menziesii	Douglas Fir	13	N/A	0	dead, snag remains intact, fungus growing up on trunk					100%	
76	Prunus avium	Mazzard Cherry	8	20	2	poor form, crossing branches, uneven canopy, bark damage, lean north					20%	
77	Quercus kelloggii	California Black Oak	14	30	2	broken limbs, lean n / NW, decay in deadwood					20%	
78	Quercus garryana	Oregon White Oak	12	30	2	thick poison oak vines climbing up trunk, trunk union with V-crotch			✓		10%	
79	Quercus garryana	Oregon White Oak	16	23	2	poison oak, poor form, inosculation of trunks					10%	
80	Pseudotsuga menziesii	Douglas Fir	16	N/A	0	dead snag with fruiting fungus bodies					100%	
81	Quercus garryana	Oregon White Oak	22	60	2	thin but wide canopy, broken limbs due to storm damage					20%	
82	Prunus avium	Mazzard Cherry	8	20	2	wilted / curled leaves, lean northwest, leaning into oak (tree 81), exposed wood					10%	
83	Quercus garryana	Oregon White Oak	10	22	2	uneven, thin, sparse canopy	✓	✓			20%	
84	Prunus avium	Mazzard Cherry	8	20	2	even canopy, upright form, limbs crossing over neighboring oak					15%	
85	Quercus garryana	Oregon White Oak	8	20	1	uneven canopy, inundated with ivy	✓				20%	
86	Quercus garryana	Oregon White Oak	10	20	1	uneven canopy, inundated with ivy	✓				20%	
87	Quercus garryana	Oregon White Oak	16	31	2	blackberry, poison oak, missile toe, thin high canopy	✓				15%	
88	Quercus garryana	Oregon White Oak	14	25	2	thin, high canopy, broken limb with decay, uneven canopy	✓				10%	
89	Quercus garryana	Oregon White Oak	14	N/A	0	tree cut at base, stump only remains					100%	
90	Quercus garryana	Oregon White Oak	10	10	2	uneven canopy, blackberry, small cavity at base					30%	
91	Pseudotsuga menziesii	Douglas Fir	20	40	2	insect damage on bark, poison oak vines climbing up trunk			✓		20%	
92	Amelanchier alnifolia	Western Service Berry	(2) 12	25	2	sap, insect trap from USDA, inosculation of branching, decay with fungus	✓				30%	
93	Quercus kelloggii	California Black Oak	32	32	2	major decay, cavities, deadwood, poison oak, blackberry, competing with nearby Prunus	✓				50%	
94	Prunus avium	Mazzard Cherry	11	35	2	bark damage, exposed wood, broken central leader, leaf curl					50%	
95	Prunus avium	Mazzard Cherry	7	20	2	uneven canopy, curled leaves, decay with broken limbs, nest					25%	
96	Pseudotsuga menziesii	Douglas Fir	44	50	3	uneven canopy, edge condition tree, more sun, new central leader	✓				20%	
97	Arbutus menziesii	Pacific Madrone	10	25	3	small cavity providing habitat, exposed wood at another cavity, lean west, uneven canopy					10%	

EWEB

FUNC	BY	CHK	APP
DES	KMc	MJ	CM
DWN	KM	MJ	CM

STANDARDS CHECK

LINE IS 1 INCH
AT FULL SIZE
(IF NOT 1" - SCALE ACCORDINGLY)

WATER SYSTEMS
RESERVOIRS

EWEB WORK ORDER NO. 19-070-PSC

DATE: 09/09/20

SCALE: 1'=40'-0"

DWG NO: 37619

PROJECT SHEET NO: TABLE_A

REV 0

9/10/2020 11:19 AM MATT JORGENSEN

Plan ID	Genus & Species	Common Name	DBH (in)	CANOPY (ft)	Health/ Condition*	Arborist Notes	Ivy on trunk	Thin/sparse canopy	Co-dominant Leader	Surface Roots	% Deadwood	Suckers
98	Pseudotsuga menziesii	Douglas Fir	19	30	2	sap by broken limbs, blackberry, poison oak					10%	
99	Prunus avium	Mazzard Cherry	10	25	2	curving form, competing for light, uneven canopy, exposed wood at damaged bark				✓	5%	
100	Pseudotsuga menziesii	Douglas Fir	8	20	1	poor form, uneven canopy, no central leader, one sided canopies reaching for light					40%	
101	Pseudotsuga menziesii	Douglas Fir	12	25	2	poor form, uneven canopy, no central leader, one sided canopies reaching for light	✓				15%	
102	Pseudotsuga menziesii	Douglas Fir	10	20	2	poor form, uneven canopy reaching for light, thin foliage	✓				30%	
103	Pseudotsuga menziesii	Douglas Fir	30	35	2	bald faced hornet nest on ivy vines climbing trunk, honeysuckle vine, one sided canopy	✓				15%	
104	Pinus ponderosa	Ponderosa Pine	18	25	2	possible nest, uneven canopy, blackberry, poison oak, honeysuckle vines on trunk	✓				30%	
105	Pseudotsuga menziesii	Douglas Fir	30	35	2	blackberry, poison oak, possible nest	✓				30%	
106	Prunus avium	Mazzard Cherry	10	30	3	poison oak, Oregon grape at base, uneven canopy, cavity at base, exposed wood, nice form				✓	15%	
107	Pseudotsuga menziesii	Douglas Fir	10	25	2	competing for sunlight, sparse foliage		✓			15%	
108	Pseudotsuga menziesii	Douglas Fir	24	35	2	poison oak vine, high canopy, hummingbird interest in tree					5%	
109	Pseudotsuga menziesii	Douglas Fir	26	40	2	dead ivy on trunk with bark damage, poison oak at base of tree	✓				15%	
110	Pseudotsuga menziesii	Douglas Fir	30	50	2	high canopy, sparse canopy, poison oak			✓		25%	
111	Prunus avium	Mazzard Cherry	8	30	2	tons of sap at base, lean west with curled trunk, crossing branches					20%	
112	Prunus avium	Mazzard Cherry	(2) 17	45	2	poor form, bark injury with exposed wood, broken central leader					5%	✓
113	Pseudotsuga menziesii	Douglas Fir	34	50	2	high canopy, poison oak, uneven canopy	✓				30%	
114	Prunus avium	Mazzard Cherry	10	30	2	ivy, blackberry, poison oak, sap at wound on trunk, exposed wood	✓				15%	
115	Quercus kelloggii	California Black Oak	16	30	2	high canopy, dead limbs, lean to south, cavity, smaller leaves on top indicative of decline	✓				30%	
116	Quercus kelloggii	California Black Oak	18	0	0	tree cut at base, stump only remains					100%	
117	Quercus kelloggii	California Black Oak	12	0	0	tree cut at base, stump only remains					100%	
118	Quercus garryana	Oregon White Oak	12	20	2	uneven canopy, decay, shared canopy with neighboring trees		✓			20%	✓
119	Quercus garryana	Oregon White Oak	8	17	2	uneven canopy, shared canopy with neighboring trees		✓			10%	✓
120	Quercus garryana	Oregon White Oak	10	15	2	uneven canopy, shared canopy with neighboring trees		✓			10%	✓
121	Quercus garryana	Oregon White Oak	(2) 24	30	3	1 of the 2 trunks has a broken top, gauls, skeletonized leaves					5%	
122	Quercus garryana	Oregon White Oak	18	50	3	open form, some broken limbs with decay, thin high canopy, gauls, skeletonized leaves					15%	
123	Quercus garryana	Oregon White Oak	12	22	2	bark damage with exposed wood in a couple locations, uneven canopy, gauls, skeletonized leaves, trunk leaning for available sunlight					15%	
124	Quercus garryana	Oregon White Oak	16	40	2	uneven branching, twisted branching structure, gauls, skeletonized leaves					15%	
125	Quercus garryana	Oregon White Oak	15	40	2	uneven canopy, leaning towards available light, decay at broken limbs, gauls, skeletonized leaves					10%	✓
126	Quercus garryana	Oregon White Oak	(3) 18	20	2	inosculation, growing under neighbor, uneven canopy, deep cavity in center reader, poor form, gauls, skeletonized leaves			✓		10%	
127	Quercus kelloggii	California Black Oak	(2) 45	62	3	some dead limbs with decay, open even canopy	✓				15%	
128	Quercus garryana	Oregon White Oak	(2) 24	34	3	gauls, skeletonized leaves	✓				15%	
129	Quercus garryana	Oregon White Oak	(3) 38	42	2	gauls, skeletonized leaves, poison oak vine up tree, sparse canopy, watersprouts	✓				20%	
130	Pseudotsuga menziesii	Douglas Fir	38	50	2	3 smaller Prunus avium at base of tree, open wound with sap, broken limbs high up in canopy	✓		✓	✓	5%	
131	Quercus garryana	Oregon White Oak	(3) 60	42	3	gauls, skeletonized leaves, wide open canopy, branching towards meadow, bark damage					5%	
132	Quercus garryana	Oregon White Oak	(3) 72	50	2	center cavity competing with fir for space / light, bark damage with exposed wood	✓				50%	
133	Quercus garryana	Oregon White Oak	(3) 15	15	2	clump of 3, uneven canopy, poor form, gauls, skeletonized leaves					15%	
134	Prunus avium	Mazzard Cherry	16	36	2	exposed wood with mower damage, small deadwood					15%	
135	Quercus garryana	Oregon White Oak	12	20	2	gauls, skeletonized leaves, heavy with lichen, bark damage					20%	
136	Quercus garryana	Oregon White Oak	19	40	3	uneven canopy, gauls, skeletonized leaves					10%	
137	Quercus garryana	Oregon White Oak	(2) 26	34	2	leaning south, gauls, skeletonized leaves		✓			10%	
138	Quercus garryana	Oregon White Oak	21	38	4	full even canopy, lower limbs present, gauls, skeletonized leaves, debris pile beneath					10%	
139	Pseudotsuga menziesii	Douglas Fir	20	30	4	one canopy, two trunks, storm damage with broken limbs					5%	
140	Pseudotsuga menziesii	Douglas Fir	16	30	4	one canopy, two trunks (with tree 141), storm damage with broken limbs					5%	
141	Quercus garryana	Oregon White Oak	18	48	3	one canopy, two trunks (with tree 140)					5%	
142	Quercus garryana	Oregon White Oak	18	40	2	slightly uneven canopy, leaf miners					5%	
143	Quercus garryana	Oregon White Oak	(2) 32	55	3	exposed wood with decay, gauls, skeletonized leaves, multiple trunk injuries					10%	
144	Quercus kelloggii	California Black Oak	26	55	3	vinca minor at base of tree, sparse but broad canopy, decay in limbs, possible nest					5%	
145	Pseudotsuga menziesii	Douglas Fir	14	25	3	tall canopy, young adventitious shoots / sprouts at 4-ft height off trunk					5%	
146	Crataegus monogyna	Single Seed Hawthorn	(2) 13	25	2	poor form, crossing branches					20%	
147	Quercus garryana	Oregon White Oak	24	55	3	large open canopy					5%	
148	Quercus garryana	Oregon White Oak	18	45	3	leaning southwest, bark damage with exposed wood, cavity, gauls, skeletonized leaves					5%	
149	Quercus garryana	Oregon White Oak	(2) 29	33	2	sparse canopy, upright form		✓			10%	
150	Quercus garryana	Oregon White Oak	16	35	3	bark damage (but into wood), gauls, skeletonized leaves					10%	
151	Quercus garryana	Oregon White Oak	16	35	3	injury with exposed wood at base, gauls, skeletonized leaves		✓			15%	
152	Prunus avium	Mazzard Cherry	11	30	2	trunk callus, bleeding bark injury thick with sap, thin canopy, dry					20%	
153	Quercus garryana	Oregon White Oak	15	36	2	crowded by neighbors, decay, sparse canopy, gauls, skeletonized leaves					20%	
154	Prunus avium	Mazzard Cherry	10	40	2	phloem problems with sap pustules, uneven canopy, broken central leader				✓	20%	
155	Quercus garryana	Oregon White Oak	(3) 42	40	2	upright form, cavity with included bark, damage to surface roots					15%	
156	Pseudotsuga menziesii	Douglas Fir	16	40	2	thin foliage but dense branching, damage to surface roots				✓	20%	
157	Quercus garryana	Oregon White Oak	15	23	2	exposed buttress root flare, sparse canopy, poor form, premature color, gauls, skeletonized leaves			✓	✓	20%	
158	Quercus garryana	Oregon White Oak	15	35	2	exposed wood at trunk injuries, blackberry understory, gauls, skeletonized leaves	✓				20%	
159	Pseudotsuga menziesii	Douglas Fir	48	50	2	storm damage with broken limbs, high canopy, adventitious shoots off trunk, poison oak vines on trunk, insect holes in bark					20%	
160	Quercus kelloggii	California Black Oak	36	58	3	large snag in trunk, uneven form					15%	
161	Arbutus menziesii	Pacific Madrone	9	23	3	bark damage with exposed wood, blackberry, poison oak at base, even canopy					5%	
162	Quercus garryana	Oregon White Oak	10	20	2	shared canopy with tree 163, thin upright canopy, woodpecker damage, gauls, skeletonized leaves					5%	
163	Quercus garryana	Oregon White Oak	11	20	2	shared canopy with tree 162, gauls, skeletonized leaves					5%	
164	Quercus garryana	Oregon White Oak	(2) 30	30	3	exposed wood at base, bark damage, uneven full canopy with decay, gauls, skeletonized leaves					15%	
165	Quercus garryana	Oregon White Oak	(3) 32	44	3	poison oak and honeysuckle vines on trunk, upright form, canopy is high with gauls, skeletonized leaves					5%	
166	Quercus garryana	Oregon White Oak	13	38	3	umbrella shaped canopy, cavity at base, trunk flare with damage and expose wood, gauls, skeletonized leaves					10%	
167	Quercus garryana	Oregon White Oak	(2) 21	24	2	uneven canopy with dead snag as third trunk, gauls, skeletonized leaves					20%	
168	Quercus garryana	Oregon White Oak	17	30	3	gauls, skeletonized leaves, shared canopy					5%	
169	Quercus garryana	Oregon White Oak	9	25	3	gauls, skeletonized leaves, shared canopy					15%	
170	Quercus garryana	Oregon White Oak	15	31	2	gauls, skeletonized leaves, shared canopy, exposed wood with decay and fungus					10%	
171	Quercus garryana	Oregon White Oak	14	37	3	gauls, skeletonized leaves, shared canopy, broken limbs due to recent storm damage					15%	
172	Quercus garryana	Oregon White Oak	15	35	3	ivy at base, insects on decay, bark damage with exposed wood, thin canopy					5%	
173	Quercus garryana	Oregon White Oak	16	40	2	ivy at base, adventitious shoots off trunk, uneven canopy					5%	
174	Quercus garryana	Oregon White Oak	(2) 33	56	2	adventitious shoots, thin canopy within inner branching / center or crown due to storm damage, horizontal form					10%	
175	Quercus garryana	Oregon White Oak	12	21	2	gauls, skeletonized leaves, bark damage, exposed wood at base, decay, uneven canopy					15%	
176	Quercus garryana	Oregon White Oak	17	34	2	sparse canopy, bark damage, exposed wood, 2 large limbs as dead snags, woodpecker holes, boring insects					20%	
177	Quercus garryana	Oregon White Oak	(2) 24	46	2	fungus, decay, skeletonized leaves, gauls, uneven canopy, one sided canopy, honeysuckle vines					20%	
178	Quercus garryana	Oregon White Oak	18	45	3	uneven canopy, gauls, skeletonized leaves					10%	

EWEB

FUNC	BY	CHK	APP
DES	KMc	MJ	CM
DWN	KM	MJ	CM

STANDARDS CHECK

LINE IS 1 INCH
AT FULL SIZE
(IF NOT 1" - SCALE ACCORDINGLY)

WATER SYSTEMS
RESERVOIRS

EWEB WORK ORDER NO. 19-070-PSC

DATE: 09/09/20

SCALE: 1'=40'-0"

DWG NO: 37619

PROJECT SHEET NO: TABLE_B

REV 0

9/10/2020 11:20 AM MATT JORGENSEN

Plan ID	Genus & Species	Common Name	DBH (in)	CANOPY (ft)	Health/ Condition*	Arborist Notes	Ivy on trunk	Thin/sparse canopy	Co-dominant Leader	Surface Roots	% Deadwood	Suckers
179	Quercus garryana	Oregon White Oak	14	35	3	upright form, competing for sunlight, gauls, skeletonized leaves					10%	
180	Quercus garryana	Oregon White Oak	11	15	1	upright form, fungal decay, no limbs left on trunk, tree in decline					10%	
181	Quercus garryana	Oregon White Oak	14	32	3	gauls, skeletonized leaves, high canopy with bark damage with exposed wood					5%	
182	Quercus garryana	Oregon White Oak	(2) 18	25	1	tree in decline, 2 snags present, exfoliating bark, tree is outcompeted by Douglas Fir					50%	
183	Pseudotsuga menziesii	Douglas Fir	18	35	2	Poison oak around base of tree & vining up trunk, thin foliage, bleeding sap at injury with exposed wood					25%	
184	Pseudotsuga menziesii	Douglas Fir	26	40	2	poison oak cines on trunk, high canopy, conk 10-ft up trunk on the uphill side of tree					10%	
185	Quercus garryana	Oregon White Oak	12	20	2	gauls, skeletonized leaves, flimsy, bark damage with exposed wood, decay on deadwood, uneven canopy, growing as one canopy with Tree 186					5%	
186	Quercus garryana	Oregon White Oak	13	20	2	gauls, skeletonized leaves, uneven canopy, bark damage with exposed wood, growing as one canopy with Tree 185					10%	
187	Pseudotsuga menziesii	Douglas Fir	26	40	3	adventitious shoots off trunk					15%	
188	Quercus garryana	Oregon White Oak	(2) 20	N/A	0	snag remains, no foliage present					100%	
189	Pseudotsuga menziesii	Douglas Fir	18	40	2	poison oak vines up trunk of tree, bleeding sap at bark injury without exposed wood, dead branches hanging,					10%	
190	Pseudotsuga menziesii	Douglas Fir	17	40	2	high canopy with dead limbs down low, blackberry understory					10%	
191	Quercus kelloggii	California Black Oak	16	40	2	deadwood with decay and fungus, twisting form, poison oak bines at base					30%	
192	Pseudotsuga menziesii	Douglas Fir	26	35	2	thick ivy 30-ft up tree trunk, bleeding sap, bark damage	✓				10%	
193	Prunus avium	Mazzard Cherry	8	30	2	poor form, woodpecker activity	✓				10%	
194	Pseudotsuga menziesii	Douglas Fir	8	15	1	significant lean uphill on neighboring Douglas fir, dead top, poor structural integrity					15%	
195	Pseudotsuga menziesii	Douglas Fir	10	15	2	uneven, one-sided canopy, shelf fungus at base to 20-ft in height, honeysuckle vines				✓	10%	
196	Pseudotsuga menziesii	Douglas Fir	24	30	3	uneven, one sided canopy growing together as one canopy with tree 197					5%	
197	Pseudotsuga menziesii	Douglas Fir	18	30	3	uneven, one sided canopy growing together as one canopy with tree 196					10%	
198	Pseudotsuga menziesii	Douglas Fir	36	45	2	prolific conk growth on trunk of tree, bark damage from leaning tree 194, poison oak vines					15%	
199	Pseudotsuga menziesii	Douglas Fir	14	25	2	uneven canopy, adventitious shoots off trunk, n central leader					10%	
200	Pseudotsuga menziesii	Douglas Fir	10	40	2	even canopy with sparse thin foliage, poison oak climbing					15%	
201	Pseudotsuga menziesii	Douglas Fir	18	35	2	poison oak vines on trunk, thin canopy	✓				20%	
202	Pseudotsuga menziesii	Douglas Fir	12	25	2	poison oak vines, thin, high canopy, uneven sparse canopy		✓			5%	
203	Pseudotsuga menziesii	Douglas Fir	9	25	2	think, uneven canopy, poison oak vines climbing		✓			5%	
204	Pseudotsuga menziesii	Douglas Fir	10	25	1	conks on trunk, uneven thing canopy, poison oak vines		✓			15%	
205	Pseudotsuga menziesii	Douglas Fir	18	30	2	poison oak climbing, conks, broken central leader with new growth, adventitious shoots off trunk, possible nest		✓			15%	
206	Pseudotsuga menziesii	Douglas Fir	28	35	2	honey suckle and poison oak vines on trunk, small cavity at base of tree		✓			15%	
207	Pseudotsuga menziesii	Douglas Fir	20	35	2	uneven canopy, broken central leader		✓			15%	
208	Pseudotsuga menziesii	Douglas Fir	18	30	2	honey suckle and poison oak on trunk, uneven canopy, adventitious shoots off trunk		✓			10%	
209	Pseudotsuga menziesii	Douglas Fir	20	30	2	honey suckle and poison oak on trunk, uneven canopy, adventitious shoots off trunk		✓			10%	
210	Pseudotsuga menziesii	Douglas Fir	14	25	2	uneven canopy, thin at top, blackberries and poison oak understory		✓			20%	
211	Pseudotsuga menziesii	Douglas Fir	16	25	2	poison oak on trunk, sparse foliage		✓			10%	
212	Pseudotsuga menziesii	Douglas Fir	16	25	2	conks, poison oak climbing, uneven thin canopy		✓			15%	
213	Pseudotsuga menziesii	Douglas Fir	16	30	2	adventitious shoots off trunk, bark damage, poison oak vines					10%	
214	Pseudotsuga menziesii	Douglas Fir	17	30	2	poison oak vines, decay on trunk, fungus, uneven canopy					10%	
215	Quercus garryana	Oregon White Oak	11	25	2	poor form, uneven canopy, lanky in form, decay, tree is being outcompeted by Douglas firs					15%	
216	Pseudotsuga menziesii	Douglas Fir	14	30	2	uneven canopy, conks on trunk		✓			10%	
217	Pseudotsuga menziesii	Douglas Fir	28	50	2	uneven canopy, two top		✓			20%	
218	Pseudotsuga menziesii	Douglas Fir	26	40	2	curbed trunk, some browning foliage, fungus on trunk, poison oak, uneven					15%	

Plan ID	Genus & Species	Common Name	DBH (in)	CANOPY (ft)	Health/ Condition*	Arborist Notes	Ivy on trunk	Thin/sparse canopy	Co-dominant Leader	Surface Roots	% Deadwood	Suckers
219	Pseudotsuga menziesii	Douglas Fir	8	20	2	uneven canopy, thin foliage / branching, outcompeted for sun / canopy space		✓			5%	
220	Quercus kelloggii	California Black Oak	12	40	2	leaning, high canopy, skeletal leaves, shaded out					5%	
221	Pseudotsuga menziesii	Douglas Fir	36	50	3	high canopy, water sprouts, insect damage on trunk, honeysuckle, poison oak climbing trunk					15%	
222	Pseudotsuga menziesii	Douglas Fir	22	40	2	poison oak vines, bleeding sap, uneven canopy, adventitious shoots off trunk		✓			15%	
223	Pseudotsuga menziesii	Douglas Fir	16	30	2	uneven canopy, only foliage on tree is extremely high, bleeding sap, fungus		✓			20%	
224	Pseudotsuga menziesii	Douglas Fir	11	25	2	uneven canopy, adventitious shoots off trunk, broken top bent over		✓			15%	
225	Pseudotsuga menziesii	Douglas Fir	13	30	2	broken top / dead top		✓			30%	
226	Quercus kelloggii	California Black Oak	28	40	3	decay and insects on broken limbs, minor leaf damage, poison oak and blackberry at base					15%	
227	Pseudotsuga menziesii	Douglas Fir	7	25	2	bark injury with exposed wood, sap, sparse canopy		✓			15%	
228	Quercus kelloggii	California Black Oak	16	30	2	major lean, uneven canopy, poison oak at base					25%	
229	Pseudotsuga menziesii	Douglas Fir	19	40	2	wide canopy, sparse foliage, poison oak climbing with blackberry		✓			20%	
230	Quercus garryana	Oregon White Oak	16	25	2	poison oak climbing, uneven canopy with lean, sparse foliage		✓			5%	
231	Quercus garryana	Oregon White Oak	16	25	2	poison oak climbing, twisted form, woodpecker house / hole, animal cavity					5%	
232	Quercus garryana	Oregon White Oak	9	N/A	0	snag remains, no foliage present					100%	
233	Quercus garryana	Oregon White Oak	21	45	2	upright, uneven canopy, tree shaded out, decay with boring insects on deadwood					15%	
234	Quercus kelloggii	California Black Oak	17	20	1	leaning, uneven canopy, shaded out, little foliage left					30%	
235	Quercus kelloggii	California Black Oak	(2) 32	55	2	lean with one, upright with other trunk, shaded out					10%	
236	Pseudotsuga menziesii	Douglas Fir	15	30	2	poison oak vines, broken top, uneven canopy		✓			10%	
237	Pseudotsuga menziesii	Douglas Fir	16	30	2	poison oak vines, uneven thing canopy		✓			30%	
238	Quercus kelloggii	California Black Oak	18	25	2	split bark with decay, broken limbs, shaded out, sparse foliage					30%	
239	Pseudotsuga menziesii	Douglas Fir	9	20	2	uneven canopy, poison oak and blackberry at base		✓			10%	
240	Pseudotsuga menziesii	Douglas Fir	13	30	2	uneven canopy, poison oak and blackberry at base	✓	✓			20%	
241	Quercus garryana	Oregon White Oak	8	20	1	tree is leaning, resting on neighboring fir, exposed wood with insects, uneven canopy and sparse foliage, tree is shaded out, upper half of tree is dead					40%	
242	Quercus kelloggii	California Black Oak	16	30	2	severe lean. Resting on tree 243, tree in decline, decay, cavities at base of tree					30%	
243	Pseudotsuga menziesii	Douglas Fir	16	56	2	uneven canopy, high canopy, lots of dead lower limbs, oak resting on it					15%	
244	Pseudotsuga menziesii	Douglas Fir	18	35	2	bark damage with oak leaning on it, poison oak at base, fungus on limbs		✓			20%	
245	Pseudotsuga menziesii	Douglas Fir	(2) 24	40	2	nail in trunk, broken leader on one of trunks, thing canopy		✓			25%	
246	Pseudotsuga menziesii	Douglas Fir	24	40	3	thin canopy, wood nailed into trunk					15%	
247	Pseudotsuga menziesii	Douglas Fir	16	25	2	one sided canopy		✓			15%	
248	Pseudotsuga menziesii	Douglas Fir	26	30	2	twisted trunk, poison oak vines up trunk, bark damage		✓			15%	
249	Pseudotsuga menziesii	Douglas Fir	15	25	2	dead top, one sided		✓			20%	
250	Pseudotsuga menziesii	Douglas Fir	14	30	2	one sided canopy		✓			10%	
251	Pseudotsuga menziesii	Douglas Fir	14	35	2	dead / missing top, thin foliage	✓				5%	
252	Quercus garryana	Oregon White Oak	18	40	2	growing with fir, boring insects, high canopy, uneven canopy, cavity high in tree					15%	
253	Pseudotsuga menziesii	Douglas Fir	28	50	2	high canopy, growing with oak tree 252			✓		15%	
254	Quercus kelloggii	California Black Oak	19	40	2	high arching canopy, uneven, reaching for light, thin foliage					10%	
255	Prunus avium	Mazzard Cherry	10	30	2	reaching for light					10%	
256	Prunus avium	Mazzard Cherry	6	25	2	reaching for light					5%	
257	Prunus avium	Mazzard Cherry	6	25	2	reaching for light, splitting bark					5%	
258	Pseudotsuga menziesii	Douglas Fir	26	45	3	high branching structure, browning foliage, possible nest					10%	
259	Quercus garryana	Oregon White Oak	12	20	2	blackberry / poison oak, uneven canopy, high canopy					15%	
260	Quercus garryana	Oregon White Oak	14	20	2	blackberry / poison oak					10%	
261	Pseudotsuga menziesii	Douglas Fir	20	25	2	poison oak vines up trunk					20%	

EWEB

FUNC	BY	CHK	APP
DES	KMc	MJ	CM
DWN	KM	MJ	CM
STANDARDS CHECK			

LINE IS 1 INCH
AT FULL SIZE
(IF NOT 1" - SCALE ACCORDINGLY)

WATER SYSTEMS
RESERVOIRS

EWEB WORK ORDER NO. 19-070-PSC
DATE: 09/09/20
SCALE: 1'=40'-0"
DWG NO: 37619
PROJECT SHEET NO: TABLE_C
REV 0

Plan ID	Genus & Species	Common Name	DBH (in)	CANOPY (ft)											
262	Pseudotsuga menziesii	Douglas Fir	13	22	2.0	central leader broken, thin canopy, blackberries at base	X	X				10%			
263	Pseudotsuga menziesii	Douglas Fir	8	17	2.0	leaning, uneven canopy, leader bent, ivy/vinca/blackberry at base		X				5%			
264	Pseudotsuga menziesii	Douglas Fir				dead									
265	Pseudotsuga menziesii	Douglas Fir	11	21	2.0	blackberry, poison oak, one sided canopy due to crowding	X	X				5%			
266	Pseudotsuga menziesii	Douglas Fir	13	24	2.0	blackberrry, poison oak, ivy, watersprouts, few lower limbs	X	X				5%			
267	Pseudotsuga menziesii	Douglas Fir	8	13	1.0	blackberrry, poison oak, ivy, dead central leader	X	X				15%			
268	Pseudotsuga menziesii	Douglas Fir	32	45	3.0	blackberrry, poison oak, ivy						25%			
269	Pseudotsuga menziesii	Douglas Fir	6	9	2.0	poison oak		X				5%			
270	Pseudotsuga menziesii	Douglas Fir	14	12	2.0	blackberrry, poison oak, ivy, many watersprouts close to trunk, tight canopy, one sided/uneven canopy due to crowding		X				5%			
281	Pseudotsuga menziesii	Douglas Fir	20	48	2.0	blackberrry, poison oak, ivy, many watersprouts close to trunk, tight canopy, one sided/uneven canopy due to crowding						20%			
272	Pseudotsuga menziesii	Douglas Fir	10	13	2.0	blackberrry, poison oak, ivy, many watersprouts close to trunk, tight canopy, one sided/uneven canopy due to crowding		X				5%			
273	Pseudotsuga menziesii	Douglas Fir	26	30	2.0	blackberrry, poison oak, watersprouts, one sided		X				15%			
274	Pseudotsuga menziesii	Douglas Fir	12	9	2.0	blackberrry, poison oak, ivy, watersprouts, one sided, crowding						5%			
275	Pseudotsuga menziesii	Douglas Fir	16	20	2.0	blackberrry, poison oak, high thin canopy	X	X				15%			
276	Prunus avium	Mazzard Cherry	9	30	2.0	blackberrry, bark damage, one sided, crowding						5%			
277	Pseudotsuga menziesii	Douglas Fir	12	18	2.0	blackberry, high canopy, crowded, watersprouts		X				30%			
278	Pseudotsuga menziesii	Douglas Fir	21	30	2.0	blackberry, one sided, bark injury at base, bark peeling, sap seeping	X					25%			
279	Pseudotsuga menziesii	Douglas Fir	16	27	2.0	blackberrry, poison oak, lower limbs dead	X	X				35%			
280	Pseudotsuga menziesii	Douglas Fir	12	14	1.0	blackberrry, poison oak, dead central leader, one sided, bark injury with sap dripping, watersprouts		X				15%			
281	Pseudotsuga menziesii	Douglas Fir	13	10	2.0	blackberrry, poison oak, compartmentalized bark damage, high canopy, watersprouts		X				10%			
282	Pseudotsuga menziesii	Douglas Fir	14	20	2.0	blackberrry, poison oak, one sided	X	X				10%			
283	Pseudotsuga menziesii	Douglas Fir	11	21	2.0	blackberrry, poison oak, ivy, dead central leader, boring insect presence, sap, one sided		X		X		10%			
284	Pseudotsuga menziesii	Douglas Fir	15	20	2.0	blackberrry, poison oak, ivy, one sided						5%			
285	Pseudotsuga menziesii	Douglas Fir	14	18	2.0	blackberrry, poison oak, ivy, one sided						5%			
286	Pseudotsuga menziesii	Douglas Fir	36	45	2.0	blackberrry, poison oak, watersprouts, broken lower side limbs	X					20%			
287	Pseudotsuga menziesii	Douglas Fir	X	X	0.0	snag									
288	Pseudotsuga menziesii	Douglas Fir	18	32	2.0	blackberry, poison oak, dangling deadwood, one sided				X		5%			
289	Pseudotsuga menziesii	Douglas Fir	12	18	2.0	blackberrry, poison oak, one sided, bark damage, sap dripping	X					5%			
290	Pseudotsuga menziesii	Douglas Fir	12	20	1.0	blackberrry, poison oak, one sided, dead central leader	X					5%			
291	Pseudotsuga menziesii	Douglas Fir	25	30	2.0	blackberrry, poison oak, thistle, cut/stacked wood at base	X	X				5%			
292	Pseudotsuga menziesii	Douglas Fir	10	15	1.0	blackberrry, poison oak, bark damage, exposed wood/injuries, geranium, broken leader, insect damage, one sided	X	X				10%			
293	Pseudotsuga menziesii	Douglas Fir	20	20	2.0	blackberrry, broken central leader, broken side branch				X		5%			
294	Quercus kelloggii	California Black Oak	9	12	2.0	vinca, inosculation at base, (1) trunk removed (formerly 2 low codominant), skelotonized leaves, wood decay, exposed wood at cut						10%			
295	Pseudotsuga menziesii	Douglas Fir	54	40	3.0	evidence of boring insects, minimal sap dripping, insects on dead limbs	X					15%			
296	Prunus avium	Mazzard Cherry	8	33	2.0	broken central leader, leaning				X		10%			
297	Pinus ponderosa	Ponderosa Pine	18	25	2.0	wisteria climbing 20', high canopy, cage embedded in bark						5%			
298	Pseudotsuga menziesii	Douglas Fir	8	18	1.0	dead leader, spindly, declining		X				10%			
299	Pseudotsuga menziesii	Douglas Fir	11	8	2.0	bark damage, sign, sap, dead leader, high branching		X				5%			
300	Prunus avium	Mazzard Cherry	15	30	2.0	one sided, looking for light, insect/wildlife presence, boring insects									
301	Prunus avium	Mazzard Cherry	10	24	2.0	insects, galls on trunk, big lean, broken at top						5			
302	Pseudotsuga menziesii	Douglas Fir	12	20	2.0	one sided, ivy, blackberry, woodpile at trunk, boring insect presence, bark damage, leader damaged	X	X				15			
303	Pseudotsuga menziesii	Douglas Fir	8	10	2.0	blackberrry, shaded out	X	X				5			
304	Quercus kelloggii	California Black Oak	14	15	1.0	broken top, dead at top, watersprouts, fighting for light, leaning	X					30			
305	Pseudotsuga menziesii	Douglas Fir	14	21	2.0	watersprouts, high canopy, blackberry, shaded out						10			
306	Prunus avium	Mazzard Cherry	11	30	2.0	big lean, blackberry, searching for light	X					15			
307	Prunus avium	Mazzard Cherry	9	25	2.0	bark damage, one sided, blackberry, poison oak, broken limbs, crowded									
308	Pseudotsuga menziesii	Douglas Fir	31	34	2.5	blackberrry, poison oak,						15			
309	Pseudotsuga menziesii	Douglas Fir	28	35	2.0	major ivy climbing very high, poison oak, severe bark damage from ivy, one sided	X				X	10			
310	Pseudotsuga menziesii	Douglas Fir	16	26	2.0	blackberry, boring isect presence, sap dripping, one sided, watersprouts, crowded	X					15			
311	Pseudotsuga menziesii	Douglas Fir	16	25	2.0	blackberry, poison oak,		X				15			
312	Pseudotsuga menziesii	Douglas Fir	13	27	1.5	nest, large bark fissures, broken leader				X		10			
313	Pseudotsuga menziesii	Douglas Fir	15	20	2.0	one sided		X				5			
314	Pseudotsuga menziesii	Douglas Fir	18	32	2.0	snag adjacent, broken top		X		X		5			
315	Pseudotsuga menziesii	Douglas Fir	26	39	2.0	blackberry, lean, curved trunk	X					10			
316	Prunus avium	Mazzard Cherry	(2) 17	25	2.0	both leaders broken at top, blackberry				X					
317	Pseudotsuga menziesii	Douglas Fir	26	30	2.0	watersprouts, high canopy, poison oak, minimal lower branching, shaded in past		X				10			
318	Pseudotsuga menziesii	Douglas Fir	72	60	2.5	extreme poison oak, insects and decay on deadwood	X					15-20			
319	Pseudotsuga menziesii	Douglas Fir	66	60	3.0	poison oak, honeysuckle, decay and insects on deadwood						15-20			
320	Pseudotsuga menziesii	Douglas Fir	8	19	2.0	blackberrry, poison oak, one sided		X				5			
321	Pseudotsuga menziesii	Douglas Fir	14	15	2.0	high canopy, one sided		X				5			
322	Pseudotsuga menziesii	Douglas Fir	55	60	2.5	blackberrry, wildlife/woodpecker damage sap dripping, broken deadwood with decay/insects	X					15			
323	Acer macrophyllum	Bigleaf Maple	(2) 11	30	2.0	second leader at base, shaded		X		X		5			
324	Pseudotsuga menziesii	Douglas Fir	24	40	2.5	bark damage at buttress root		X				15			
325	Pseudotsuga menziesii	Douglas Fir	18	15	2.0	one sided, narrow, shaded/crowded, poison oak	X	X				15			
326	Pseudotsuga menziesii	Douglas Fir	21	24	2.0	watersprouts, curved trunk, poison oak, blackberry, bark damage, sap dripping	X					10			
327	Pseudotsuga menziesii	Douglas Fir	9	18	2.0	damaged central leader, poison oak	X	X				10			
328	Acer macrophyllum	Bigleaf Maple	8	35	2.0	crowded, blackberry, broken central leader, broken lower limb						10			
329	Pseudotsuga menziesii	Douglas Fir	24	35	2.5	blackberrry, honeysuckle, poison oak	X					15			
330	Pseudotsuga menziesii	Douglas Fir	10	10	1.0	watersprouts, central leader questionable	X	X				15			
331	Pseudotsuga menziesii	Douglas Fir	41	40	2.5	blackberrry	X					20			
332	Pseudotsuga menziesii	Douglas Fir	7	15	2.0	watersprouts, high canopy, bark damage, broken leader, bark damage at base, ivy, blackberry									
333	Pseudotsuga menziesii	Douglas Fir	13	20	2.0	blackberrry, poison oak, ivy, one sided, sap dripping	X	X							
334	Pseudotsuga menziesii	Douglas Fir	13	20	2.0	bark damage at base, blackberry, honeysuckle, watersprouts, old broken leader		X				20			
335	Pseudotsuga menziesii	Douglas Fir	19	30	2.0	one sided, high canopy	X	X				20			
336	Pseudotsuga menziesii	Douglas Fir	13	20	2.0	blackberrry, poison oak, leaning, one sided, leader dead, crowded, watersprouts	X	X				15			
337	Pseudotsuga menziesii	Douglas Fir	7	6	1.0	blackberrry, poison oak, dead leader, watersprouts, minimal branching		X				20			
338	Pseudotsuga menziesii	Douglas Fir	16	25	2.0	blackberrry, poison oak, cotoneaster, downed wood		X				25			
339	Pseudotsuga menziesii	Douglas Fir	8	10	1.0	blackberrry, poison oak, honeysuckle	X	X				25			
340	Pseudotsuga menziesii	Douglas Fir	26	35	2.0							20			
341	Pseudotsuga menziesii	Douglas Fir	60	86	2.5	many cut/pruned limbs, sap dripping, broken limbs						10			
342	Pseudotsuga menziesii	Douglas Fir	14	25	2.0	blackberrry, poison oak, watersprouts, one sided						20			
343	Pseudotsuga menziesii	Douglas Fir	15	12	2.0	blackberrry, watersprouts, narrow, honeysuckle		X				10			
344	Pseudotsuga menziesii	Douglas Fir	8	8	1.0	blackberrry, dead leader, declining		X				50			
345	Pseudotsuga menziesii	Douglas Fir	20	25	2.0	sap dripping, codominant leader (one died)		X		X		20			
346	Pseudotsuga menziesii	Douglas Fir	22	30	2.0	one sided, crowded, poison oak, sap dripping		X				15			
347	Pseudotsuga menziesii	Douglas Fir	28	35	2.0	one sided, crowded, poison oak, sap dripping		X				15			
348	Acer macrophyllum	Bigleaf Maple	6	30	2.0	leaning, looking for light, blackberry, poison oak									
349	Pseudotsuga menziesii	Douglas Fir	8	10	1.0	dead leader, watersprouts, one sided						10			
350	Pseudotsuga menziesii	Douglas Fir	18	25	2.0	blackberrry, poison oak,		X				15			
351	Quercus kelloggii	California Black Oak	12	25	2.0	big lean, small canoy at very top		X				10			
352	Pseudotsuga menziesii	Douglas Fir	11	20	1.0	2 broken leaders, dead leader, one sided, downed wood, leaning, dangling deadwood		X				20			
353	Pseudotsuga menziesii	Douglas Fir	39	45	2.5	buttress root decay and insects, sap dripping, old broken limbs, honeysuckle, poison oak		X			X	20			
354	Quercus kelloggii	California Black Oak	(2) 11	25	2.0	crowded, 2 trunks emerge at base						20			
355	Prunus avium	Mazzard Cherry	(2) 10	20	2.0	both central leaders broken						35			
356	Pseudotsuga menziesii	Douglas Fir	15	25	2.0	one sided				X		15			
357	Pseudotsuga menziesii	Douglas Fir	9	20	2.0	broken central leader, watersprouts, decay at base, old suckers have died, cavity		X				20			
358	Pseudotsuga menziesii	Douglas Fir	14	20	2.0	poison oak, leader declining, gunstock at base, not vigorous		X				15			
359	Acer macrophyllum	Bigleaf Maple	6	25	2.0	poison oak, watersprouts, crowded						5			
360	Pseudotsuga menziesii	Douglas Fir	22	30	2.0	one sided, early gunstocking occurred, poison oak						15			
361	Prunus avium	Mazzard Cherry	9	25	2.5	splitting bark at bottom of trunk, watersprouts, poison oak						10			
362	Pseudotsuga menziesii	Douglas Fir	8	10	1.0	shaded out/crowded, central leader dead		X				40			
363	Pseudotsuga menziesii	Douglas Fir	29	40	2.5	cuts on bark (possible hatchet), nails in trunk, sign hung on trunk, heavy sap drip						15			
364	NOT PRESENT														
365	Acer macrophyllum	Bigleaf Maple	13	40	1.5	standing water in cavity at base with rot, chopping/carving in bark, many bad limbs with damage, blackberry,						25			X
366	Pseudotsuga menziesii	Douglas Fir	17	30	2.0	bark damage from people, sap drippin, nails in trunk, poison oak		X				15			

EWEB

FUNC	BY	CHK	APP
DES	KMc	MJ	CM
DWN	KM	MJ	CM

STANDARDS CHECK

LINE IS 1 INCH
AT FULL SIZE
(IF NOT 1" - SCALE ACCORDINGLY)

WATER SYSTEMS
RESERVOIRS

EWEB WORK ORDER NO. 19-070-PSC
DATE: 09/09/20
SCALE: 1'=40'-0"
DWG NO: 37619
PROJECT SHEET NO: TABLE_D
REV 0

9/10/2020 11:23 AM MATT JORGENSEN

Plan ID	Genus & Species	Common Name	DBH (in)	CANOPY (ft)											
367	Pseudotsuga menziesii	Douglas Fir	11	20	2.0	blackberrry, poison oak,		X				20			
368	Pseudotsuga menziesii	Douglas Fir	8	20	2.0	blackberry, watersprouts, broken central leader, one sided		X				10			
369	Pseudotsuga menziesii	Douglas Fir	(2) 18	20	2.0	one sided, dead leader, blackberry, poison oak		X				10			
370	NOT PRESENT														
371	Quercus kelloggii	California Black Oak	8	30	2.0	blackberrry, poison oak, bark damage, leanding, looking for light						10			
372	Pseudotsuga menziesii	Douglas Fir	27	45	2.5	blackberrry, poison oak, honeysuckle		X				15			
373	Pseudotsuga menziesii	Douglas Fir	18	25	2.0	blackberrry, poison oak, one codominant leader dead		X		X		20			
374	Pseudotsuga menziesii	Douglas Fir	12	20	2.0	blackberrry, poison oak, one sided		X				10			
375	Pseudotsuga menziesii	Douglas Fir	10	20	2.0	blackberrry, poison oak, one sided, central leader weak or dead		X				10			
376	Pseudotsuga menziesii	Douglas Fir	22	35	2.0	poison oak, one sided, dangling deadwood, decay on deadwood	X					20			
377	Pseudotsuga menziesii	Douglas Fir	29	50	2.0	blackberrry, poison oak, one sided, watersprouts, bark damage at base at buttress roots, sap dripping, decay						10			
378	Pseudotsuga menziesii	Douglas Fir	29	50	2.0	blackberrry, poison oak, one sided				X		15			
379	Pseudotsuga menziesii	Douglas Fir	16	25	2.0	blackberrry, poison oak, one sided, watersprouts, brokel leader		X				15			
380	Pseudotsuga menziesii	Douglas Fir	7	15	1.0	blackberrry, poison oak, bark damage, very one sided, broken leader		X				20			
381	Pseudotsuga menziesii	Douglas Fir	16	25	2.0	blackberrry, poison oak, bark damage, very one sided	X					20			
382	Pinus ponderosa	Ponderosa Pine	36	30	3.0	good condition	X					5			
383	Pseudotsuga menziesii	Douglas Fir	39	50	3.0	lower half one sided, watersprouts	X				X	15			
384	Quercus kelloggii	California Black Oak	6	10	2.0	blackberrry, poison oak, leaning, looking for light, cavity, leaf skeletonizing present		X							
385	Pseudotsuga menziesii	Douglas Fir	18	30	2.0	poison oak, OR grape, snowberry, one sided	X	X				10			
386	Pseudotsuga menziesii	Douglas Fir	14	25	2.0	blackberrry, poison oak, one sided, watersprouts	X	X				10			
387	Pseudotsuga menziesii	Douglas Fir	15	25	2.0	reaching for light, growing through oak canopy, poison oak, little bark damage, sap dripping, one sided		X				10			
388	Pseudotsuga menziesii	Douglas Fir	8	20	1.5	blackberrry, poison oak, watersprouts, broken central leader		X				20			
389	Pseudotsuga menziesii	Douglas Fir	9	20	1.5	blackberrry, poison oak, one sided, dead central leader	X	X		X		10			
390	Pseudotsuga menziesii	Douglas Fir	8	20	1.0	dead central leader, watersprouts	X	X				25			
391	Pseudotsuga menziesii	Douglas Fir	12	25	2.0	high canopy, minor sap bleeding		X				15			
392	Quercus kelloggii	California Black Oak	(2) 32	50	2.0	multi trunk (codominant from base, 3 but one is dead), lean south, cavity in center between leaders, skeletonized leaves, growing through firs, cavity at base with standing water, nails in trunk, fungus present, insect presence, poison oak, blackberry, weeds in cavity, watersprouts				X		10			
393	Pseudotsuga menziesii	Douglas Fir	10	20	2.0	broken central leader, crowded, one sided, watersprouts, oak leaning on trunk, poison oak	X	X				15			
394	Quercus kelloggii	California Black Oak	13	40	2.0	leaning, bark damage, 3" deep cavity, skeletonized leaves, watersprouts, shaded, crowded						15			
395	Quercus kelloggii	California Black Oak	13	25	2.0	leaning, crowded, shaded, touching other trees, large old cut at base (compartmentalized), poison oak		X				15			
396	Pseudotsuga menziesii	Douglas Fir	8	20	1.0	watersprouts, crispy top, conks, poison oak		X		X		30			
397	Pseudotsuga menziesii	Douglas Fir	6	20	1.0	central leader broken, poison oak, one sided, watersprouts, crooked trunk		X				15			
398	Pseudotsuga menziesii	Douglas Fir	11	15	2.0	poison oak, watersprouts, one sided		X				20			
399	Quercus kelloggii	California Black Oak	11	20	1.5	large dead limbs, leaning, needs light, skeletonized leaves, poison oak, decay at base and old limbs, insect presence		X				30			
400	Pseudotsuga menziesii	Douglas Fir	9	10	2.0	one sided, poison oak, watersprouts		X				10			
401	Pseudotsuga menziesii	Douglas Fir	20	35	2.5	blackberrry, poison oak,						10			
402	Quercus kelloggii	California Black Oak	20	35	2.0	dieback, shaded, reaching for light, one sided	X					25			
403	Pseudotsuga menziesii	Douglas Fir	14	40	1.5	blackberrry, poison oak, broken central leader		X		X		20			
404	Quercus kelloggii	California Black Oak	24	40	2.0	blackberrry, poison oak, many large dead/broken limbs, major lean, light starved, crowded, watersprouts		X				30			
405	Pseudotsuga menziesii	Douglas Fir	11	25	2.0	blackberrry, poison oak, watersprouts, broken central leader				X		15			
406	Pseudotsuga menziesii	Douglas Fir	11	30	2.0	blackberrry, poison oak, one sided, broken central leader	X					10			
407	Pseudotsuga menziesii	Douglas Fir	10	25	2.0	blackberrry, poison oak, ones sided, watersprouts, central leader dying		X		X		15			
408	Quercus kelloggii	California Black Oak	24	60	2.0	blackberrry, poison oak, deep cavity at base where old codominant leader was, shaded but tall		X				20			
409	Pseudotsuga menziesii	Douglas Fir	28	35	2.0	blackberrry, poison oak, dieback, decay on dead limbs, smooth brown lesions on trunk		X				20			
410	Pinus ponderosa	Ponderosa Pine	40	50	3.0	blackberrry, poison oak, looks good	X					15			
411	Pseudotsuga menziesii	Douglas Fir	9	20	2.0	blackberrry, poison oak,watersprouts, bent leader dying, one sided		X				10			
412	Pseudotsuga menziesii	Douglas Fir	7	15	1.5	one sided, high small canopy, crowded watersprouts, growing through oak canoy		X				10			
413	Quercus kelloggii	California Black Oak	(2) 20	30	1.5	blackberrry, poison oak, watersprouts, bark damage, low crotch, skeletonized leaves, leaning, shaded, multistem		X		X		50			
414	Pseudotsuga menziesii	Douglas Fir	8	20	1.5	blackberrry, poison oak, one sided, central leaders broken, watersprouts		X				40			
415	Pseudotsuga menziesii	Douglas Fir	8	20	1.5	blackberrry, poison oak, one sided, central leaders broken, watersprouts		X				40			

Plan ID	Genus & Species	Common Name	DBH (in)	CANOPY (ft)											
416	Pseudotsuga menziesii	Douglas Fir	7	20	1.5	one sided, broken top, watersprouts		X				25			
417	Pseudotsuga menziesii	Douglas Fir	6	20	1.5	one sided, watersprouts, central leader declining, dieback		X				20			
418	Pseudotsuga menziesii	Douglas Fir	15	30	2.0	one sided						10			
419	Pseudotsuga menziesii	Douglas Fir				dead									
420	Pseudotsuga menziesii	Douglas Fir				dead									
421	Pseudotsuga menziesii	Douglas Fir	7	15	1.5	bent central leader, one sided, dying top, crowded		X							
422	Pseudotsuga menziesii	Douglas Fir	6	15	1.5	watersprouts, one sided, leader dying, crowded		X							
423	Quercus kelloggii	California Black Oak	11	25	1.5	major lean, big cut at base, major decay/insects		X				25			
424	Quercus kelloggii	California Black Oak	8	25	2.0	leaning on fir, crowded, looking for light, skeletonized leaves (minimal)						15			
425	Pseudotsuga menziesii	Douglas Fir	10	20	2.0	oak leaning on trunk, one sided, poison oak						10			
426	Pseudotsuga menziesii	Douglas Fir	8	25	2.0	one sided, watersprouts, crowded, broken central leader						5			
427	Quercus kelloggii	California Black Oak	16	30	2.0	old codominant leader is dead, decay, cavity with debris, boring insect presence, crowding, reaching for light						15			
428	Pseudotsuga menziesii	Douglas Fir	13	30	2.0	watersprouts, one sided, crooked trunk, broken central leader									
429	Pseudotsuga menziesii	Douglas Fir	9	20	2.0	watersprouts, one sided, crooked trunk		X				10			
430	Pseudotsuga menziesii	Douglas Fir	13	20	1.0	many conks, decay fungi, one sided, watersprouts						25			
431	Pseudotsuga menziesii	Douglas Fir	15	25	2.0	high canopy, poison oak		X				15			
432	Pseudotsuga menziesii	Douglas Fir	11	30	1.5	watersprouts, central leader dying, one sided		X				30			
433	Pseudotsuga menziesii	Douglas Fir	20	30	2.0	bent trunk, gunstocking, old leader injury, one sided, watersprouts, poison oak						15			
434	Pseudotsuga menziesii	Douglas Fir	12	25	2.0	high canopy						15			
435	Pseudotsuga menziesii	Douglas Fir	15	20	2.0	one sided, watersprouts		X				15			
436	Pseudotsuga menziesii	Douglas Fir	22	35	2.0	one sided						15			
437	Pseudotsuga menziesii	Douglas Fir	20	40	2.0	uneven canopy, poison oak	X					10			
438	Prunus avium	Mazzard Cherry	8	26	2.0	bark damage on trunk, blackberry						5			
439	Pseudotsuga menziesii	Douglas Fir	8	25	1.5	watersprouts, dying central leader		X				30			
440	Quercus garryana	Oregon White Oak	12	30	2.0	major poison oak, tight limb angles	X					20			
441	Pseudotsuga menziesii	Douglas Fir	24	40	2.5	watersprouts, has space to grow						15			
442	Pseudotsuga menziesii	Douglas Fir	16	25	2.0	poison oak, one sided	X								
443	Pseudotsuga menziesii	Douglas Fir	13	25	2.0	codominant leaders at 2 points: 1/3 and 2/3 up trunk, poison oak, one sided	X	X		X		10			
444	Pseudotsuga menziesii	Douglas Fir	(2) 35	35	2.0	multistem, one sided, V crotch low on tree, poison oak, blackberry, debris in crotch	X			X		15			
445	Pseudotsuga menziesii	Douglas Fir	11	25	2.0	dieback		X				20			
446	Pseudotsuga menziesii	Douglas Fir	16	25	2.0	one sided, low gunstocking, high canopy						15			
447	Pseudotsuga menziesii	Douglas Fir	14	25	2.0	adjacent/touching a snag, one sided, bent central leader, leaning, crooked trunk, watersprouts						20			
448	Quercus kelloggii	California Black Oak	11	25	2.0	deep cavity at base with conk, watersprouts, dieback, skeletonized leaves, leaning, low light		X				5			
449	Pseudotsuga menziesii	Douglas Fir	14	30	2.0	crowded, poison oak					X	10			
450	Pseudotsuga menziesii	Douglas Fir	14	35	2.0	poison oak, one sided, crooked trunk, multiple central leader deaths				X	X	20			
451	Quercus kelloggii	California Black Oak	(2) 30	40	2.0	nails in trunk, one dead leader (third), cavity with standing water, fourth and fifth leaders gone and remnants decaying, deep 12"+ cavity, poison oak				X		25			
452	Pseudotsuga menziesii	Douglas Fir	11	30	1.0	sap bleeding, bark damage, dead central leader		X				40			
453	Quercus garryana	Oregon White Oak	9	15	2.0	dead previously codominant leader at base, decay, leaning, needs light, crowded, skeletonized leaves, poison oak						10			
454	Pseudotsuga menziesii	Douglas Fir	15	25	2.0	dead branches, scraggly		X				25			
455	Pseudotsuga menziesii	Douglas Fir	17	35	2.0	one sided, watersprouts, oison oak						15			
456	Pseudotsuga menziesii	Douglas Fir	6	15	2.0	broken top, watersprouts, one sided, poison oak		X				5			
457	Pseudotsuga menziesii	Douglas Fir	6	15	1.0	broken top, watersprouts, one sided, poison oak		X				5			
458	Pseudotsuga menziesii	Douglas Fir	10	15	1.0	sap bleeding at branch wound, watersprouts, broken central leader, thin high canopy		X				15			
459	Pseudotsuga menziesii	Douglas Fir	18	30	2.0	one sided					X	15			
460	Pseudotsuga menziesii	Douglas Fir	19	25	2.0	one sided, poison oak						10			
461	Pseudotsuga menziesii	Douglas Fir	8	25	2.0	central leader broken, watersprouts, bark damage at base		X				15			
462	Pseudotsuga menziesii	Douglas Fir	21	40	2.0	one sided down low						10			
463	Pseudotsuga menziesii	Douglas Fir	14	25	2.0	poison oak, one sided, watersprouts, broken central leader						5			
464	Pseudotsuga menziesii	Douglas Fir	23	35	2.0	poison oak, one sided	X				X	15			
465	Pseudotsuga menziesii	Douglas Fir	23	40	2.0	poison oak, one sided down low						15			
466	Pseudotsuga menziesii	Douglas Fir	18	35	2.0	poison oak, one sided						10			
467	Pseudotsuga menziesii	Douglas Fir	20	35	2.0	one sided	X					10			

EWEB

FUNC	BY	CHK	APP
DES	KMc	MJ	CM
DWN	KM	MJ	CM

STANDARDS CHECK

LINE IS 1 INCH
AT FULL SIZE
(IF NOT 1" - SCALE ACCORDINGLY)

WATER SYSTEMS
RESERVOIRS

EWEB WORK ORDER NO. 19-070-PSC

DATE: 09/09/20

SCALE: 1'=40'-0"

DWG NO: 37619

PROJECT SHEET NO: TABLE_E

REV 0

9/10/2020 11:23 AM MATT JORGENSEN

Plan ID	Genus & Species	Common Name	DBH (in)	CANOPY (ft)												
468	Pseudotsuga menziesii	Douglas Fir	18	25	2.0	old broken central leader, crooked trunk	X					15			
469	Pseudotsuga menziesii	Douglas Fir	20	35	2.0	broken limb down low	X					15-20			
470	Pseudotsuga menziesii	Douglas Fir	12	25	1.5	poison oak, one sided	X	X				20			
471	Pseudotsuga menziesii	Douglas Fir	17	25	2.0	poison oak, one sided, crowded		X				15-20			
472	Pseudotsuga menziesii	Douglas Fir	13	25	2.0	poison oak, one sided, crowded		X				20			
473	Pseudotsuga menziesii	Douglas Fir	21	30	2.0	watersprouts, crowded		X				15			
474	Pseudotsuga menziesii	Douglas Fir	11	15	1.5	broken central leader, one sided, watersprouts, crowded		X				15			
475	NOT PRESENT														
476	Pseudotsuga menziesii	Douglas Fir	20	30	2.0	poison oak		X				30			
477	Pseudotsuga menziesii	Douglas Fir	18	30	2.0	poison oak, watersprouts, one sided						25			
478	Pseudotsuga menziesii	Douglas Fir	16	30	2.0	one sided, high canopy, bark injury high on trunk (falling tree?)						10			
479	Pseudotsuga menziesii	Douglas Fir	21	40	2.0	one sided, big madrone leaning on trunk, conk, decay		X		X		10			
480	Quercus kelloggii	California Black Oak	23	50	2.5	competition for light with firs, crowded, leaning					X	5			
481	Pseudotsuga menziesii	Douglas Fir	12	25	1.5	one sided, broken top, watersprouts		X				20			
482	Pseudotsuga menziesii	Douglas Fir	17	35	2.0	high canopy		X				15			
483	NOT USED														
484	NOT USED														
485	NOT USED														
486	NOT USED														
487	NOT USED														
488	NOT USED														
489	NOT USED														
490	Pseudotsuga menziesii	Douglas Fir	40	40	2.0	blackberry, poison oak, dead central leader, heavy insect presence, gunstocking, insect/wildlife presence on snag, exposed wood, sap dripping dense canopy	X					20			
491	Pseudotsuga menziesii	Douglas Fir	8	20	1.0	poison oak, blackberry, dead leader, one sided	X	X				20			
492	Pseudotsuga menziesii	Douglas Fir	18	15	1.0	poison oak, bark damage, fungal conk, decay, sap dripping, watersprouts, leader dead	X	X				15			
493	Pseudotsuga menziesii	Douglas Fir	9	20	1.0	blackberry, poison oak, dead leader with codominant new leaders	X			X		15			
494	Pseudotsuga menziesii	Douglas Fir	13	25	2.0	broken central leader, old suckers at base, 9" deep cavity		X				20			
495	Quercus kelloggii	California Black Oak	17	35	2.0	watersprouts, major lean south, reaching for light, compartmentalized bark damage, damage at base, cavities, blackberry, poison oak		X				15			
496	Pseudotsuga menziesii	Douglas Fir	8	25	1.5	blackberry, poison oak, dead top, one sided				X		25			
497	Pseudotsuga menziesii	Douglas Fir	12	15	2.0	one sided, watersprouts		X				10			
498	Pseudotsuga menziesii	Douglas Fir	17	25	2.0	high canopy		X		X		15			
499	Pseudotsuga menziesii	Douglas Fir	9	20	1.0	multiple bark injuries, bleeding sap, broken central leader, watersprouts, one sided		X							

*Condition		
5 =	excellent	perfect form, little to no deadwood, all limbs have good attachments, no sign of decay
4 =	very good	good form, multi-leader, but with good attachment, 10% or less large deadwood
3 =	good	unbalanced or incomplete crown, tight limb angles, 15-20% larger deadwood
2 =	poor	Evidence of some decay, 20-30% larger deadwood, history of being topped.
1 =	very poor	Structurally unsound, extensive decay, dieback, poor form, unbalanced or greatly reduced crown.

9/10/2020 11:24 AM MATT JORGENSEN

EWEB

FUNC	BY	CHK	APP
DES	KMc	MJ	CM
DWN	KM	MJ	CM
STANDARDS CHECK			

LINE IS 1 INCH
AT FULL SIZE
(IF NOT 1" - SCALE ACCORDINGLY)

WATER SYSTEMS
RESERVOIRS

EWEB WORK ORDER NO. 19-070-PSC
DATE: 09/09/20
SCALE: 1'=40'-0"
DWG NO: 37619
PROJECT SHEET NO: TABLE_F
REV 0

APPENDIX B - IPAC REPORT

EWEB

DOWL

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Oregon Fish And Wildlife Office
2600 Southeast 98th Avenue, Suite 100
Portland, OR 97266-1398
Phone: (503) 231-6179 Fax: (503) 231-6195
https://www.fws.gov/oregonfwo/articles.cfm?id=149489416

In Reply Refer To:
Consultation Code: 01EOFW00-2021-SLI-0206
Event Code: 01EOFW00-2021-E-00407
Project Name: E 40th Ave tank

February 03, 2021

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq*.).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq*.), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to investigate opportunities for incorporating conservation of threatened and endangered species into project planning processes as a means of complying with the Act. If you have questions regarding your responsibilities under the Act, please contact the Endangered Species Division at the Service's Oregon Fish and Wildlife Office at (503) 231-6179. For information regarding listed marine and anadromous species under the jurisdiction of NOAA Fisheries Service, please see their website (http://www.nwr.noaa.gov/habitat/habitat_conservation_in_the_nw/habitat_conservation_in_the_nw.html).

Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Oregon Fish And Wildlife Office
2600 Southeast 98th Avenue, Suite 100
Portland, OR 97266-1398
(503) 231-6179

Project Summary

Consultation Code:	01EOFW00-2021-SLI-0206
Event Code:	01EOFW00-2021-E-00407
Project Name:	E 40th Ave tank
Project Type:	WATER SUPPLY / DELIVERY
Project Description:	water tank construction

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@44.0100168,-123.08344807263985,14z

Counties: Lane County, Oregon

Endangered Species Act Species

There is a total of 9 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Birds

NAME	STATUS
Marbled Murrelet *Brachyramphus marmoratus* Population: U.S.A. (CA, OR, WA) There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/4467	Threatened
Northern Spotted Owl *Strix occidentalis caurina* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/1123	Threatened
Yellow-billed Cuckoo *Coccyzus americanus* Population: Western U.S. DPS There is **proposed** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/3911	Threatened

Fishes

NAME	STATUS
Bull Trout *Salvelinus confluentus* Population: U.S.A., conterminous, lower 48 states There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/8212	Threatened

Insects

NAME	STATUS
Fender's Blue Butterfly *Icaricia icarioides fenderi* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/6659	Endangered

Flowering Plants

NAME	STATUS
Bradshaw's Desert-parsley *Lomatium bradshawii* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/5743	Endangered
Kincaid's Lupine *Lupinus sulphureus ssp. kincaidii* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/3747	Threatened
Nelson's Checker-mallow *Sidalcea nelsoniana* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/7340	Threatened
Willamette Daisy *Erigeron decumbens* There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/6270	Endangered

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

APPENDIX C - COMMENTS FROM NEIGHBORS AND LOCAL NATURALISTS

From: Jeff Krueger [redacted]>
Sent: Monday, November 30, 2020 5:24 PM
To: Laura.Farthing@EWEB.ORG; Lizzie Zemke; Jennifer.Connors@EWEB.ORG
Subject: [EXT] Elliot Hill Vegetation Management

Hello all. I am a landscape architect and ecologist and live in south Eugene about a half mile from Elliot Hill. I have often enjoyed visiting this fantastic natural site in the heart of the city. I understand you're determining future management priorities on this property and I wanted to weigh in.

In a professional capacity, I have been working closely with the Willamette Valley Oak and Prairie Cooperative (https://willamettepartnership.org/wvopc/) for a number of years, managing the development of a valley-wide Strategic Action Plan to protect and enhance this rapidly declining habitat type. This plan notes the rapid decline and degradation of these once common habitats across the valley and calls for identification and conservation of remnant oak and prairie habitats where they exist (Elliot Hill) and for the management of these properties in a way that preserves and enhances the oak and prairie vegetation over the long-term. In particular, the plan calls for reduced conifer encroachment, which shade and eventually kill the oaks, and for controlling invasive vegetation such as non-native trees (e.g., cherry and hawthorn) and shrubs (e.g., blackberry and Scotch broom).

I would encourage EWEB to support our valley-wide efforts to protect this valuable and rapidly declining habitat type locally, including Elliot Hill, and the at-risk wildlife species it supports (e.g., native pollinators, Western bluebirds, white-breasted nuthatch, etc.).

Thank you for your careful consideration of this issue and for all the EWEB does for our community.

Best, Jeff Krueger ([redacted])

From: Bart Johnson <[redacted]>
Sent: Friday, November 27, 2020 7:44 PM
To: Lizzie Zemke
Cc: Laura Farthing
Subject: Re: [EXT] Re: forested site on E. 40th in south Eugene
Attachments: MNRS_Elliott_Tugman[1].jpg; Elliot Hill plant list 2001.xlsx

Lizzie and Laura,

Thanks for the reminder and apologies for not being able to respond sooner.

I went back to my class files, located our plant species list from spring 2001 and formatted for your use (attached). This data was collected from a set of randomly-located 1 m2 plots, and thus not intended to be a complete species list. You'll see that the site contains a large proportion of native species, including three native bunchgrasses that are valued as cornerstones of our upland native prairies and Oregon white oak savannas, and uncommon in natural areas inside Eugene city limits. There are also some beautiful prairie and oak-pine savanna wildflowers including camas, western buttercup, fawn lily and native onions. I've done less observations of animals at the site but have seen both Western gray squirrel, one of 20 mammals listed as strategy species in Oregon, and White-breasted (Slender-billed) Nuthatch, one of 58 birds listed as Oregon strategy species, both of which depend on Oregon white oak habitats. Both are officially listed as sensitive species in Oregon.

I've been conducting class projects at Elliot (EWEB) Hill for nearly 25 years now. The main reason is that it is a key remnant of our Willamette Valley oak savanna, which has been identified as one of the most important strategy habitats for conservation in the State of Oregon (https://www.oregonconservationstrategy.org/). Our savanna and prairie grasslands were the dominant ecosystems of the Willamette Valley floor and foothills prior to Euro-American settlement (circa 1840) and are listed as among the most imperiled ecosystems on North America, have suffered approximately 95% loss since that time. Elliot Hill was singled out in the Eugene Metro Natural Resource Study (circa 2000) as part of the Elliot Hill/Tugman Park oak complex. Both these two natural areas and much of the intervening neighborhoods are the core of a neighborhood with substantial remnant savanna oaks still persisting in residential yards.

One of the key threats to remaining oak habitats in Oregon is invasion from Douglas-fir, which represents an important but still common forest type in the Pacific Northwest. This is exactly the situation at Elliot Hill. I've watched as Douglas-fir have continued to overtop and suppress the oaks at Elliot Hill, killing many in the process. Ponderosa pine, another important savanna species is also sensitive to Douglas-fir invasion and suffering at Elliot Hill as a consequence. Given that oak savanna and prairie are high-priority Oregon strategy habitats, my hope has long been that EWEB or the city would manage the site to restore oak savanna and woodland. This doesn't necessarily mean I would advocate that all Douglas-fir should be removed from the site. There are a few large, Douglas-fir on the site and, having a minor Douglas-fir component to oak savanna and woodland can also benefit some native species such as the western gray squirrel. There are also areas on the eastern edge of the site that have completely converted to Douglas-fir and thus pose less of a current threat to the oaks than the areas where oak and ponderosa pine are still alive. However, as a fire ecologist I would also strongly recommend that Douglas-fir at the site be thinned to follow best management practices for reducing fire hazard, which generally means at least 10' of space between tree crowns to reduce the threat of a crown fire. Such thinning would also allow the Douglas-fir to retain their lower branches and deeper canopies, improving habitat value for native wildlife.

In summary, Elliot Hill is a remnant of our once extensive prairie and oak savanna ecosystems. These ecosystems are top conservation priorities in the state of Oregon and the nation. They also provide high recreational and aesthetic values, as evidenced by the open oak woodland on the north of the site. The City of Eugene has made the acquisition and restoration of prairie and oak habitats one of its top conservation, recreation and educational priorities. I strongly urge EWEB to work with the city to strengthen the habitat and civic value of the Elliot Hill-Tugman Park neighborhood through prairie and oak habitat restoration.

Please feel free to contact me if you have any questions. If there is anywhere else I should submit these comments to have them entered into the public record, please let me know.

Sincerely,

Bart Johnson

--
Bart R. Johnson, Ph.D. MLA
Professor
Department of Landscape Architecture
University of Oregon
[redacted]

From: Lizzie Zemke <lzemke@dowl.com>
Date: Friday, November 27, 2020 at 3:38 PM
To: Bart Johnson [redacted]
Subject: RE: [EXT] Re: forested site on E. 40th in south Eugene

Hi Bart
I am getting close to having a draft report for EWEB about their site on east 40th Ave. I spent a long and enjoyable day in October walking through the site and noting plant communities etc. and have what I think is a good description and assessment of the conditions out there. It would be really helpful at this point for me to see a plants and animals lists for the site—I saw a white-breasted nuthatch, a sapsucker and several other bird species while I was out there but because I was there for only a day I am sure there are many regular visitors that I missed.

Also it would be helpful to hear your thoughts on the relative habitat value provided by the different plant communities on the site and your thoughts, if you have any, on potential restoration and enhancement approaches for whatever habitat remains once the water tanks are constructed.

I know you said you were busy until after December 1st, so I am wondering if you would have time sometime next week to talk with me about the site? I will submit a draft to EWEB with a few gaps that still need to be filled on Monday. One of those yet-to-be-filled gaps will be for input that I receive from you and from some local environamtal organizations.
Thanks!

-Lizzie

Lizzie Zemke, PWS, CERP
Environmental Specialist

DOWL

(425) 869-2670 | office
(425) 947-8523 | direct

From: Bart Johnson <[redacted]>
Sent: Friday, November 6, 2020 6:42 PM
To: Lizzie Zemke <lzemke@dowl.com>
Subject: [EXT] Re: forested site on E. 40th in south Eugene

WARNING: External Sender - use caution when clicking links and opening attachments.

Lizzie, I'd be happy to speak with you or provide commentary. What are your timelines? I've got a lot of tight deadlines until early December but if this is a critical time for you lets talk soon.

bart

From: Lizzie Zemke <lzemke@dowl.com>
Date: Friday, November 6, 2020 at 1:56 PM
To: Bart Johnson [redacted]
Subject: forested site on E. 40th in south Eugene

Hi Mr. Johnson
I am working with Laura Farthing at EWEB on a project to locate a new water tank on a forested EWEB-owned site in Eugene that I understand you and your students are familiar with. Neighbors of the site are understandably very interested in preserving as much of the forest as possible and my job is to prepare a report and map that describes and evaluates the on-site habitat, identify wildlife species that use the site, and help EWEB site the tank in the least environmentally-damaging location possible.

I have visited the site and am in the process of developing a map of the plant communities I observed. I observed a number of bird species during my site visit and neighbors have shared their wildlife observations with me as well. I am wondering if you might have additional information about the site that you would be willing to share with me either via email or a phone call.

Any information you might be able provide would be much appreciated! Thanks!

Lizzie Zemke, PWS, CERP
Environmental Specialist

DOWL
(425) 869-2670 | office
(425) 947-8523 | direct
8410 154th Avenue NE Ste 120
Redmond, WA 98052

www.dowl.com

From: Edward Alverson <[redacted]>
Sent: Sunday, December 13, 2020 3:38 PM
To: ALVERSON Edward R; Bart Johnson; Laura.Farthing@EWEB.ORG; Lizzie Zemke; Jennifer.Connors@EWEB.ORG
Subject: [EXT] Re: Elliot Hill comments to EWEB due
Attachments: EWEB Elliot Hill 2013 crop.jpg; EWEB Elliot Hill 1990 crop.jpg; EWEB Elliot Hill 1960 crop.jpg

Laura and Lizzie – I hope it is not too late to follow up on this topic. I was able to get out to the site last weekend, so now I have a better handle on the site characteristics and context. The Elliot Hill parcel includes upland prairie, oak savanna, oak and mixed oak-conifer woodland/forest, and conifer forest. All of these habitats are of value but it is the prairie, savanna, and oak woodland this is particularly important to highlight, given that these habitat types were formerly very extensive in the Willamette Valley but have experienced extreme reduction in extent (90% to 99%) due to agriculture, urbanization, and fire suppression. Indeed, the Elliot Hill property is a remnant of a formerly extensive mosaic of prairie and savanna that was found in that part of Eugene, indications of which are evidenced by native oaks persisting in people's yards and other developed properties. The condition of the landscape is well documented from the original government land surveys in the 1850's (I can provide more site-specific detail on the 1850's surveys if that would be helpful.

I've also attached aerial photos from 1960, 1990, and 2013 to provide some perspective on the very substantial change that has impacted the oak habitat on the parcel in recent years as conifers have taken over areas that previously were oak-dominated. This photo sequence speaks to the need for active management of oak habitats to sustain their continued existence as conifers expand their territory in the face of fire exclusion.

If you haven't already seen it, the Oregon Conservation Strategy (https://oregonconservationstrategy.org) is a good starting point as it identified prairie and savanna (under "Grasslands") and oak woodlands as conservation priorities in the Willamette Valley. The presence of ponderosa pine and California black oak is also significant; these species are often associated with Oregon white oak in Lane County but are absent (black oak) or very scattered (ponderosa pine) elsewhere in the Willamette Valley.

If you go to the Compass mapping tool and zoom in to the Elliot Hill site you will see that the property is located within the West Eugene Conservation Opportunity Area. Further detail on conservation priorities for Willamette Valley prairie and oak habitats can be found in the Willamette Valley Oak-Prairie Cooperative Strategic Action Plan, which was completed earlier this year: https://willamettepartnership.org/wvopc/

While Elliot Hill is a relatively small parcel, it is worth considering the value of small sites to conservation goals, as part of a diverse strategy and a complement to large protected tracts. And, in some cases (such as for oak-associated birds) the habitat on the EWEB parcel may be part of a larger habitat block that includes remnant oak stands located on nearby residential lots. A recent journal article published in the Proceedings of the National Academy of Sciences highlights the value of small habitat remnants for conservation, and specifically references the Willamette Valley as a case in point: https://www.pnas.org/content/pnas/116/3/909.full.pdf

Also I might mention that if habitat conservation is not be the primary purpose for EWEB owning this property, figuring out how to incorporate multiple objectives is an important challenge. This is actually true for many sites in the Willamette Valley where multiple objectives need to be accommodated. This can take a bit of extra effort, but given how much of the historic prairie and oak habitat in the Willamette

Valley has been lost in the past 170 years, it is important. I'd be happy to provide further information or feedback on the site if that would be helpful. Getting a more complete handle on species that are present on the property would be really useful thing for developing and implementing a management plan. For example, when I visited the property last weekend I observed several very problematic non-native species, including ivy, shining geranium, and spurge laurel. Ivy is pretty easy to remove, and shining geranium is very difficult once established. I only saw one plant of spurge laurel, which can be extremely invasive in oak woodlands. Given its potential for being an invader it would be good to prioritize inventory and removal of this species in a management plan.

Feel free to follow up with me if I can be of any further assistance.

Ed Alverson

[EXTERNAL ⚠]

The closest to a formal point of contact for the EWEB report and recommendations are Laura and Lizzie.

Laura Farthing <Laura.Farthing@EWEB.ORG>

Lizzie Zemke <lzemke@dowl.com>
Jennifer Connors <Jennifer.Connors@EWEB.ORG>

Of them, Laura is the lead contact from what I can tell and is the one completing the draft report.

The other route is one she gave below. I'm going to take my submitted comments and also submit them through one of the links provided:

"As discussed, here is the link that includes the instructions to contact EWEB's board. There are options to email your commissioner directly, to contact the board directly, and if you scroll down to the information about the upcoming board meeting there is a link to a form for providing public comment. http://www.eweb.org/about-us/board-of-commissioners"

Best, Bart

Patrick Keller

From: stephen anderson [redacted] >
Sent: Wednesday, October 14, 2020 7:39 PM
To: Lizzie Zemke
Subject: Re: [EXT] Ecological Study

Lizzie,
Here is the list....we have lived here for 21 years, and can attest that nearly all of the wildlife listed are regular residents of these woods...not just passing through. We find it strange that the sequence of the tanks is exactly backwards, if they truly wish to protect habitat. Obviously, one day, all three tanks will need to be completed, but there is no good reason to locate the first tank right in the stand of old growth trees that will devastate much of the crucial habitat for animals that live here now. It would not seem unreasonable to ask for a reversal of the tank sequence in light of this fact. We are willing to bet it didn't even cross the minds of the engineers to think outside their initial plan, which did not take into account the present timber grove....except for the fact that it is in the way. Please keep us apprised of your progress, call if you have any questions.

Stephen Anderson
[redacted]
Eugene, OR 97405

[redacted]

Birds and animals of EWEB Hilyard

Varied Thrush
Robin
Hairy Woodpecker
Downy Woodpecker
Pileated Woodpecker
Towhee
Chickadees
Barred Owl
Western Screech Owls
Stellar’s Jay
Yellow-rumped warbler
Bush Tit
Ruby-crowned Kinglet
Allen’s Hummingbird
Western Flicker
Cedar Waxwing
Evening Grosbeak
Sharp-shinned Hawk
Oregon Junco
Pygmy Nuthatch
Red-breasted Sapsucker
Grey Squirrel
Raccoon

Opossum
Black-tailed Deer
White-crowned Sparrow
Vaux’s Swift
Violet-green Swallow
Scrub Jay
Lesser Goldfinch
Song Sparrow
Chestnut-backed Chickadee
Common Bush-tit
Rio Grand Turkey
Great Horned Owl
Cooper’s Hawk

On Wed, Oct 14, 2020 at 1:25 PM Lizzie Zemke <lzemke@dowl.com> wrote:

> Hello Mr. Anderson
>
> Thanks for getting back to me. Please do forward your bird and animal sightings list to me. We would like as much additional information about the site as we can get!
>
> -Lizzie
>
> **Lizzie Zemke, PWS, CERP**
> Environmental Specialist
>
> **DOWL**
> (425) 869-2670 | office
> (425) 947-8523 | direct
>
> ---
>
> **From:** stephen anderson [redacted]>
> **Sent:** Tuesday, October 13, 2020 4:37 PM
> **To:** Lizzie Zemke <lzemke@dowl.com>
> **Subject:** [EXT] Ecological Study
>
>
>
> I have a list of the birds and animals we regularly see in these EWEB woods. Several of our neighbors compared what we know and see. Please contact me, if I'm this is where my list should be forwarded. Also, given the tank locations already laid out, a pertinent question comes to mind: given the devastating impact of the present location of tank number one on the present habitat used by many of the denizens on our list, why wouldn't it be possible to reverse the tank numbers, which would leave intact for many more years the habitat that birds such as our Pileated Woodpeckers depend upon. I'm guessing it's a question that the engineers never even considered, but for those of us living here it would make a world of difference in the coming decades. It's a question that deserves an answer. Also, I find it curious

that the wildlife/ecological survey is being done this late in the year, when many of our birds have already begun their migrations, and aren't here to be considered.

Stephen Anderson

[redacted]

Patrick Keller

From: Carol Anne Anderson [redacted] >
Sent: Thursday, October 15, 2020 4:46 PM
To: Lizzie Zemke
Subject: [EXT] EWEB Response regarding Flora and Fauna

WARNING: External Sender - use caution when clicking links and opening attachments.

Thank you for your interest in obtaining information from those of us who reside adjacent to or near the E 40th EWEB property in Eugene.

Though my family has lived here for 45 years, I know little about the wildlife except that it is to be enjoyed. I have few comments.

Regarding plant life. Our family has enjoyed the many trees and a lovely display of buttercups in the springtime. There also are some low-growing lilies at that time. In late summer the family enjoyed picking blackberries until the poison oak overwhelmed us. I would suggest that keeping the ground below the trees or dead trees cleaned would be smart for maintenance and fire prevention.

Regarding animals. There are entirely too many raccoons and plenty of squirrels. A neighbor has put up some sort of bat home (for lack of the proper name) which is not appreciated. The birds are nice. Most specifically, we have enjoyed the flickers which visit our garden annually. We always assumed it was the same pair who visited. But this year when smoke was so thick from fires, we noticed a flock of thirty or more stop by en route out of the area. A wonder to see.

We worry about vagrants for our property safety and appeal. There are teens who like to hang out in the warm months. Some have had little campfires and there.

Thank you for listening. I'm sure many of my neighbors are much more informed and educated in this area. Good luck.

Carol Anderson

Patrick Keller

From: David de Lorenzo [redacted] >
Sent: Saturday, October 17, 2020 5:34 PM
To: Lizzie Zemke
Cc: Martha Dickey
Subject: [EXT] Fauna and Flora Information re: EWEB Project
Attachments: Species Observed at 4260 Hilyard Street.docx

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Hi Lizzie,

My wife, Martha, and I live on property that abuts the EWEB property on which they intend to build water storage tanks.

I understand that you are requesting information about wildlife that lives in this vicinity. I am writing to provide you with a list of the fauna and flora that **we have observed at our home** since we moved here in September 2016. That list is attached with this email.

We are quite concerned about the impact this project will have on the species listed on the attached. This area is a comprehensive ecosystem that supports these species and the major changes being planned to the area will have a rippling effect on that entire system.

Let me know if you have any questions.

cheers,

David
+++++++
David de Lorenzo & Martha Dickey
[redacted]
Eugene, OR 97405
[redacted]
+++++++

Please send your input to me by Monday, Oct. 26 at the email address below.

Additionally, if you are aware of anyone else who might have specific natural resource or wildlife use information to share about the site, please feel free to forward this message and my contact information to them. Thank you for your help, I hope to hear back from you soon!

Lizzie Zemke, PWS, CERP
DOWL Environmental Specialist
lzemke@dowl.com

From: Mary Ann Hanson [redacted]>
Sent: Wednesday, October 14, 2020 2:51 PM
To: Lizzie Zemke
Subject: [EXT] EWEB Water Storage Improvement Project historical information on site flora and fauna

Hello,

I am one of EWEB's neighbors living at the foot of Elliott Hill. My parents bought this house about 1963 and lived here until their deaths a few years ago. I was a teenager when we moved here from another part of the Eugene area and lived in the family home until I married and moved away. My husband and I returned in 1993 to help my aging parents. We still live here. So I have a fairly long history with what we always called "The Hill." As a young person I loved nature and everything about it, so I collected insects, flowers, etc.

I remember how different The Hill was in 1963. There were quail, pheasants, skinks, snakes and tree frogs. I don't remember deer, raccoons, or wild turkeys being present, but surely they were here in smaller numbers. There was an occasional opossum and possible a skunk - the odor was distinctive!

I do miss the butterflies - I only counted six or seven species this year. That is related to your work though, as many host plants are gone. The wild flowers were legion at first. There were many fewer houses then, of course. Here is a brief list of those I remember:

Achillea millefolium
Aquilegia formosa
Berberis (repens?)
Camassia quamash (blue but one white flowered plant) Claytonia lanceolata (pink)
Corallorhiza striata Dichelostemma congestum Dodecatheon dentatum (I remember they were
pink though) Erythronium oreganum Fritillaria lanceolata Goodyera oblongifolia Iris tenax
Lupinus bicolor Plantago lanceolata Prunella vulgaris Ranunculus sp.
Rosa (two forms)
Saxifraga sp.
Sidalcea sp.
Tellima grandiflora
Trillium ovatum
Viola sempervirens?

Cornus nuttallii
Ribes sanguineum

Mary Ann Hanson [redacted]

From: stephen anderson [redacted] >
Sent: Tuesday, October 13, 2020 4:37 PM
To: Lizzie Zemke
Subject: [EXT] Ecological Study

I have a list of the birds and animals we regularly see in these EWEB woods. Several of our neighbors compared what we know and see. Please contact me, if I'm this is where my list should be forwarded. Also, given the tank locations already laid out, a pertinent question comes to mind: given the devastating impact of the present location of tank number one on the present habitat used by many of the denizens on our list, why wouldn't it be possible to reverse the tank numbers, which would leave intact for many more years the habitat that birds such as our Pileated Woodpeckers depend upon. I'm guessing it's a question that the engineers never even considered, but for those of us living here it would make a world of difference in the coming decades. It's a question that deserves an answer. Also, I find it curious that the wildlife/ecological survey is being done this late in the year, when many of our birds have already begun their migrations, and aren't here to be considered.

Stephen Anderson

[redacted]

Patrick Keller

From: Carol Anne Anderson <[redacted]>
Sent: Tuesday, October 20, 2020 3:52 PM
To: Lizzie Zemke
Subject: Re: [EXT] EWEB Response regarding Flora and Fauna

Thank you for your kind follow up.

Of course I neglected to mention the obvious deer and the horrible rats.

Cheers. Have fun.

On Tue, Oct 20, 2020 at 1:56 PM Lizzie Zemke <lzemke@dowl.com> wrote:

> Hello Ms. Anderson
>
> Thanks so much for letting us know your thoughts on the E 40th Ave site. I saw several flickers out there myself when I visited a week or so ago, but the sight of 30 must have been impressive! We will keep you informed as the project progresses.
>
> -Lizzie
>
> **Lizzie Zemke, CERP**
> Environmental Specialist
>
> **DOWL**
> (425) 869-2670 | office
> (425) 947-8523 | direct
>
> ---
>
> **From:** Carol Anne Anderson [redacted]
> **Sent:** Thursday, October 15, 2020 4:46 PM
> **To:** Lizzie Zemke <lzemke@dowl.com>
> **Subject:** [EXT] EWEB Response regarding Flora and Fauna
>
> *WARNING: External Sender - use caution when clicking links and opening attachments.*
>
> Thank you for your interest in obtaining information from those of us who reside adjacent to or near the E 40th EWEB property in Eugene.
>
> Though my family has lived here for 45 years, I know little about the wildlife except that it is to be enjoyed. I have few comments.

Regarding plant life. Our family has enjoyed the many trees and a lovely display of buttercups in the springtime. There also are some low-growing lilies at that time. In late summer the family enjoyed picking blackberries until the poison oak overwhelmed us. I would suggest that keeping the ground below the trees or dead trees cleaned would be smart for maintenance and fire prevention.

Regarding animals. There are entirely too many raccoons and plenty of squirrels. A neighbor has put up some sort of bat home (for lack of the proper name) which is not appreciated. The birds are nice. Most specifically, we have enjoyed the flickers which visit our garden annually. We always assumed it was the same pair who visited. But this year when smoke was so thick from fires, we noticed a flock of thirty or more stop by en route out of the area. A wonder to see.

We worry about vagrants for our property safety and appeal. There are teens who like to hang out in the warm months. Some have had little campfires and there.

Thank you for listening. I'm sure many of my neighbors are much more informed and educated in this area. Good luck.

Carol Anderson

From: Laura Farthing <Laura.Farthing@EWEB.ORG>
Sent: Sunday, October 18, 2020 4:31 PM
To: Lizzie Zemke
Cc: Jennifer Connors
Subject: [EXT] Fwd: Reminder: E. 40th Ecological Study

WARNING: External Sender - use caution when clicking links and opening attachments.

See below.

Thanks,

Laura

Begin forwarded message:

> **From:** Jackie Mikalonis [redacted]
> **Date:** October 18, 2020 at 2:53:02 PM PDT
> **To:** Water Storage <water.storage@EWEB.ORG>
> **Subject: Re: Reminder: E. 40th Ecological Study**
>
> Caution: This email originated from outside of the organization
>
> Lizzie,
>
> Thank you for the opportunity to provide feedback. As an adjacent property owner I may have information useful to the study. Please let me know what and how the data should be organized. Thank you.
>
> Jackie Mikalonis
> [redacted]
> Eugene
>
> Sent from my iPhone
>
> > On Oct 17, 2020, at 1:23 PM, Eugene Water & Electric Board <water.storage@eweb.org> wrote:

DOWL

dowl.com

PEOPLE
WHO MAKE
IT HAPPEN

Foundation Engineering, Inc.
Professional Geotechnical Services

Laura Farthing, P.E.
Senior Engineer – Water
Eugene Water & Electric Board
4200 Roosevelt Boulevard
Eugene, Oregon 97440

March 12, 2021

East 40th Avenue Storage Tank
Geotechnical Investigation and Seismic Hazard Study
Eugene, Oregon

Project No.: 2201086

Dear Ms. Farthing:

We have completed the requested geotechnical investigation and seismic hazard study for the above-referenced project. Our report includes a description of our work, a discussion of the site conditions, a summary of laboratory testing, and a discussion of engineering analyses. Recommendations for site preparation and foundation design and construction are also provided.

A seismic hazard study was also completed to identify potential geologic and seismic hazard and evaluate the effect those hazards may have on the proposed site. The study fulfills the requirements presented in the 2019 Oregon Structural Specialty Code (OSSC 2019) for site-specific seismic hazard reports for essential and hazardous facilities, and major and special-occupancy structures. The 2019 OSSC is based on the 2018 International Building Code and ASCE 7-16. Results of the study (provided in Appendix D) indicate there are no geologic or seismic hazards that require special design consideration or would preclude construction of the proposed reservoir.

There are numerous values in geotechnical investigations that are approximate including calculated parameters, measured lengths, soil layer depths, elevations, and strength measurements. For brevity, the symbol "±" is used throughout this report to represent the words approximate or approximately when discussing these values.

It has been a pleasure assisting you with this phase of your project. Please do not hesitate to contact us if you have any questions or if you require further assistance.

Sincerely,

FOUNDATION ENGINEERING, INC.

Mallory L. McAdams, E.I.T.
Geotechnical Staff

David L. Running, P.E., G.E.
Senior Geotechnical Engineer

GEOTECHNICAL INVESTIGATION AND SEISMIC HAZARD STUDY

EAST 40TH AVENUE STORAGE TANK
EUGENE, OREGON

BACKGROUND

The Eugene Water & Electric Board (EWEB) is planning to construct one or two new reservoir tanks on a currently undeveloped property located at the south terminus of Patterson Street, south of E 40th Avenue in Eugene, Oregon. The site location is shown on Figure 1A (Appendix A). The proposed site layout including two tanks is shown on Figure 2A (Appendix A). The new 7.5-million-gallon tanks will have a diameter of 210 feet and will extend up to 35 feet below the current grades with a bottom of tank elevation of El. 577.

A preliminary investigation of the site was conducted by Branch Engineering. That investigation included five borings advanced using a track-mounted air-rotary drill rig. The drilling was able to confirm the presence of bedrock, but the use of air-rotary precluded the ability to obtain rock core samples. Therefore, additional exploratory drilling was required to provide more detailed information for design and construction.

EWEB is the project owner and Murraysmith is the lead design consultant. EWEB retained Foundation Engineering, Inc. to conduct a geotechnical investigation for the project. Our scope of work was outlined in a proposal dated October 1, 2020, and authorized by Personal Services Contract # 20-200-Q.

The geotechnical investigation included exploratory drilling and laboratory testing, described in subsequent sections of this report. Preliminary information from the investigation was provided to EWEB to assist them with their preliminary planning and selection of the tank locations. We understand EWEB is currently considering constructing a tank on the west side of the site and constructing a second tank on the east side in the future. This report includes analyses and design and construction recommendations that can be used for both tanks.

LOCAL GEOLOGY

Detailed discussions of the local and regional geology, tectonic setting, local faulting, historical seismicity, seismic hazards, and design earthquakes are included in the Site-specific Seismic Hazard Study report (Appendix D). References cited in this section are found in Appendix D. An abbreviated discussion of the local geology is provided below.

The project site is located within the southern Willamette Valley, ±3 miles south of the Willamette River in South Eugene. Local geologic mapping indicates the project site is underlain by bedrock of the Fisher Formation (Yeats et al., 1996; Madin and

Murray, 2006; McClaughry et al., 2010). The Fisher Formation consists of volcaniclastic sedimentary rocks and tuffs with interfingering andesitic to basaltic flows, and the rocks can be deeply weathered or hydrothermally altered (Walker and Duncan, 1989; Yeats et al., 1996; Madin and Murray, 2006).

The subsurface conditions encountered in our explorations are consistent with the mapped local geology. Basalt and associated volcanics encountered within the explorations are interpreted to be the Fisher Formation based on the local geologic mapping. Details of the subsurface conditions are provided in the Subsurface Conditions section below and in the exploration logs (Appendix B).

FIELD EXPLORATION

We drilled seven exploratory borings (BH-1 through BH-7) at the site between November 9 and November 15, 2020. BH-1 through BH-3 were drilled near the proposed east tank, BH-5 through BH-7 were drilled near the proposed west tank, and BH-4 was drilled between the two tanks. The explorations extended to depths of ±30 to 52 feet. The individual drilling depths were selected to extend below the planned bottom of tank elevations. The boring locations are shown on Figure 2A. The ground elevations at the boring locations were estimated based on the topographic survey contours.

The borings were drilled using a CME-55 track-mounted drill rig with mud-rotary drilling and HQ-sized wire-line coring methods. Soil samples were obtained at 2½-foot intervals using a split-spoon sampler in conjunction with the Standard Penetration Test (SPT). The SPT provides an indication of the relative stiffness or density of the soil. Continuous, HQ-wire line rock coring was completed once coreable rock was encountered.

The borings were continually logged during drilling. The final logs (Appendix B) were prepared based on a review of the field logs and the results of the laboratory testing, and an examination of the soil and rock samples in our office. Upon completion of drilling, the boreholes were backfilled with bentonite chips and bentonite grout, in accordance with Oregon Water Resources Department (OWRD) guidelines.

LABORATORY TESTING

The laboratory testing included moisture content, percent fines, and Atterberg Limits tests to help classify the soils according to the Unified Soil Classification System (USCS) and estimate their overall engineering properties. Non-tested samples were visually classified in accordance with ASTM D2487 and ASTM D2488. USCS symbols shown on the boring logs for untested samples should be considered approximations. The test results are summarized in Table 1C (Appendix C). The moisture contents are also shown on the boring logs (Appendix B).

Nineteen unconfined compression (q_u) tests were completed on rock core samples to evaluate the bedrock strength. Six tests were conducted with continuous stress-strain measurements to evaluate the elastic properties of the rock in addition to the peak q_u values. The other thirteen tests focused on the maximum q_u values only. The stress-strain curves are plotted on Figures 1C through 6C (Appendix C) and the q_u values for each of the tests and core sample information are summarized in Table 2C (Appendix C). The test results indicate unconfined compressive strengths ranging from ±8,216 to 26,388 psi, consistent with strong (R4) to very strong (R5) rock.

SUMMARY OF SURFACE AND SUBSURFACE CONDITIONS

Surface Conditions

The site is located on the northern slope of an undeveloped, 10-acre parcel south of E 40th Avenue. Survey information provided by EWEB indicates the crest of the hill lies at ±El. 620. At the planned tank locations, the ground surface slopes down to the northeast with ±5:1(H:V) to ±10:1(H:V) slopes. South of the planned tank locations the ground surface slopes more steeply down to the southwest with slopes as steep as ±2.5:1(H:V). The ground surface is predominately covered in grass and several large trees. A meadow occupies the northern extent of the site.

Subsurface Conditions

We developed a series of cross-sections across the site utilizing topographic data provided by EWEB and subsurface information from the borings. The cross-section locations are shown on Figure 2A. The cross-sections, shown on Figures 3A through 5A (Appendix A), indicate the site is underlain by a thin mantle of topsoil followed by residual soil (i.e., bedrock that has decomposed in place to the consistency of soil) and bedrock of the Fisher Formation. The topsoil consists of soft to stiff sandy silt. The residual soil includes medium dense to very dense silty sand with rock fragments and hard clayey silt with rock fragments.

Bedrock was encountered at depths of ±0.5 to 11 feet in most of the borings. The exception was BH-7, which encountered bedrock at ±32.5 feet. The estimated ground surface elevations, exploration depths, and bedrock elevations for each of the borings are shown on the boring logs and the cross-sections. The data is also summarized in Table 1B (Appendix B).

The bedrock is predominantly comprised of medium strong to very strong (R3 to R5) basalt. Extremely weak to very weak (R0 to R1) silty sandstone was encountered above the basalt in BH-3. Very weak to weak (R1 to R2) silty sandstone underlies the basalt in BH-6 at ±38 feet. In BH-7, very weak (R1) sandy siltstone was encountered below the residual soil from ±32.5 to 38 feet, followed by very weak (R1) silty sandstone to ±39.9 feet and weak (R2) basalt breccia to ±44.6 feet. The basalt breccia in BH-7 is underlain by strong to very strong (R4 to R5) basalt to the bottom of the boring.

The joint spacing typically ranges from close to moderately close. Rock Quality Designation (RQD) values vary with location and depth and range from 0 to 100%. The overall average RQD value is ±48%. An information sheet is included in Appendix B providing descriptions of the weathering, rock hardness, jointing, and RQD criteria used in our evaluation of the bedrock. Photos of the rock core are shown in Photos 1B through 29B (Appendix B).

Ground Water

Mud-rotary drilling techniques precluded measurement of ground water levels in the borings during drilling. Based on the subsurface conditions, we anticipate water perches on the shallow bedrock in the wet, winter months. The perched water may disappear in the dry, summer months.

DISCUSSION

Rock excavation will be the key geotechnical consideration. We understand the planned finish floor (FF) elevation is El. 577 for both tanks. The excavations for the tanks will extend 5 feet below the FF elevation (i.e., to El. 572) to provide room beneath the floor slab for utilities, a granular leveling layer, a leak detection layer, and a foundation drain layer.

Surface elevations near the planned tank locations range from ±El. 583 to El. 606. Therefore, excavation depths ranging from ±11 to 34 feet will be required. Based on the subsurface information from our boings, we anticipate excavations will extend ±0.5 to 24 feet below the bedrock surface at the west tank location and ±14 to 26 feet below the bedrock surface at the east tank location.

The unconfined compression (q_u) test results indicate q_u values ranging from ±8,216 to 26,357 psi, with an average of ±19,666 psi. The joint spacing in the bedrock typically ranged from close (i.e., 2 to 12 inches) to moderately close (i.e., 1 to 3 feet).

Based on the rock hardness and the joint spacing, we anticipate it will not be practical to excavate the rock by digging with an excavator bucket alone. We believe it will be necessary to fracture the rock prior to excavating. Potential rock fracturing methods include hammering the rock with a hydraulic ram, drilling and splitting, or controlled blasting. Considering the overall volume of the bedrock to removed, we believe controlled blasting will be the most practical method for breaking up the bedrock. We met on site with a blasting contractor and representatives of EWEB and Murraysmith to discuss the conditions. It was concluded blasting will be feasible. It was also determined if EWEB elects to build one tank now and another in the future, blasting could be used as part of the current work to pre-fracture the rock within the second tank footprint. This would allow future site grading for the second tank to be completed with only minor rock excavation and without the need for additional blasting. For this scenario, blasting would be completed in the second tank footprint and the blasted material would be left in place.

The proposed east tank will require a deep excavation within ±60 to 80 feet of the property lines. Our borings in this area (BH-1, BH-2, and BH-4) encountered soft to stiff sandy silt (topsoil) to ±0.5 to 3.3 feet, followed by medium dense to very dense silty sand with rock fragments and some boulders (residual soil) to depths of ±9 to 11 feet. Medium strong to very strong (R3 to R5) basalt was encountered below the residual soil. The topsoil and residual soil correspond to an OR-OSHA Class C soil. OR-OSHA recommends a maximum temporary cut slope of 1.5:1(H:V) in this material. The basalt will likely satisfy the OR-OSHA criterion for stable rock where it is not disturbed. OR-OSHA allows vertical cuts in stable rock. The site layout and subsurface conditions should provide sufficient room to grade the temporary cut slopes to OR-OSHA standards without the need for shoring.

ENGINEERING ANALYSIS

Seismic Design

A detailed seismic hazard study was completed for the site and the findings are summarized in Appendix D. The study concluded there are no seismic hazards that would preclude construction of the proposed reservoir tanks, provided the earthwork is completed as recommended herein.

Site Response Spectra. We developed site response spectra for the site in accordance with the AWWA D110-13(R18) Section 4.3. The AWWA D110-13 site response is separated into components with an impulsive component representing the structure with 5% damping and a convective component with 0.5% damping representing the fluid contents.

Based on the interpreted cross-sections, we anticipate the tank will be underlain by medium strong to very strong (R3 to R5) basalt or a thin layer of very weak (R1) silty sandstone and sandy siltstone or weak (R2) basalt breccia followed by medium strong to very strong (R3 to R5) basalt. We have concluded the subsurface conditions correspond to an AWWA Site Class B.

AWWA D110-13 references ASCE 7-05 for seismic design. Seismic design in ASCE 7-05 utilizes USGS 2002 seismic maps. For our evaluation of the tank site, we used the updated USGS 2014 maps referenced in ASCE 7-16 and OSSC 2019 to provide the spectral accelerations consistent with the current building codes. Risk-targeted maximum considered earthquake (MCE_R) ground motions on bedrock were obtained using modified USGS 2014 maps with 2% probability of exceedance in 50 years (i.e., a ±2,475-year return period). The modifications include factors to adjust the spectral accelerations to account for directivity and risk. Murraysmith also requested maximum considered earthquake (MCE) ground motions for a 10% probability of exceedance in 50 years (i.e., a ±475-year return period). Spectral accelerations for this return period were obtained from the USGS interactive deaggregation website (USGS, 2014) using maps which include modification for directivity.

To develop the site response spectra, spectral accelerations at the ground surface are adjusted using F_a and F_v values selected from ASCE 7-16 Tables 11-4-1 and 11-4-2. ASCE 7-16 stipulates F_a and F_v values be taken as 1.0 for rock conditions consistent with a Site Class B, where site-specific velocity measurements are not completed.

The AWWA D110-13 site response spectra for impulsive and convective components with MCE_R ground motions with 2% probability of exceedance in 50 years are shown on Figure 6A (Appendix A). The site response spectra with MCE ground motions with 10% probability of exceedance in 50 years are shown on Figure 7A (Appendix A).

Vertical Accelerations. Vertical accelerations may be analyzed based on AWWA D110-13 Section 4.5 and Equation 4-36, with a B coefficient taken as 2/3. The coefficient of vertical acceleration (C_v) may be calculated from Equations 4-37 and 4-38 using spectral accelerations (S_{DS} and S_{D1}) from Figures 6A and 7A.

Liquefaction. Liquefiable soils typically consist of saturated, loose sands and non-plastic or low plasticity silt (i.e., a PI of less than 8). The site is underlain by medium dense to very dense residual soil followed by relatively shallow bedrock. These materials are not susceptible to liquefaction. Therefore, there is no liquefaction hazard at the site.

Bearing Capacity and Settlement

We anticipate the new tank will have a concrete floor and a ring footing supporting the perimeter wall. Interior column footings may also be required. The proposed tank foundations will bear on compacted crushed rock underlain by bedrock consisting of medium strong to very strong (R3 to R5) basalt or very weak (R1) sandy siltstone, or on a leveling course. We recommend assuming a conservative allowable bearing pressure of 30 ksf for design. The allowable bearing pressure may be increased by one-third for the evaluation of transient loads (i.e., seismic and wind).

We anticipate foundation settlement will be less than ½ inch if the foundations are designed and constructed as recommended herein. The settlement will occur immediately as the tank is filled with water.

Sliding Coefficient and Passive Resistance for Footings

The footings will bear on a leveling course of compacted crushed rock. For sliding analysis, we recommend using a coefficient of friction of 0.5 between the base of the footings and the crushed rock.

Passive resistance of the backfill in front of the buried footings was calculated as an equivalent fluid density equal to γ*K_p, where γ is the unit weight of the backfill and K_p is the passive earth pressure coefficient. We anticipate the footings will be backfilled with compacted Select Fill surrounded by bedrock. For these conditions, we calculated the passive pressure on the footings assuming a soil unit weight (γ) of 130 pcf an internal friction angle of (ϕ) of 36 degrees. The calculations indicate the ultimate passive resistance may be modeled using an equivalent fluid density of ±500 pcf.

The passive resistance may be combined with the sliding resistance at the base of the footings to evaluate the overall lateral resistance, however, the sliding and ultimate passive resistances will develop with different displacements. The sliding resistance will develop with very small transitional movement. Development of the ultimate passive resistance on the footings may require a lateral displacement corresponding to 1% of the buried footing height, assuming dense, compacted crushed rock backfill.

Lateral Earth Pressures for Buried Walls

Lateral earth pressures will be imparted on the buried tank walls from the backfill. We assume the backfill will consist of compacted Select Fill extending a minimum of 10 feet beyond the tank wall, surrounded by compacted, native backfill. To calculate lateral earth pressure on the buried walls, we assumed a γ of 130 pcf, ϕ of 36 degrees, and a wall friction angle (δ) of 22 degrees. Both static and seismic loading conditions were analyzed, as discussed below.

Static Loading. For load combinations where static loading is evaluated, the wall deflection may not be sufficient to fully mobilize active earth pressure conditions. Therefore, we recommend designing the walls using at-rest earth pressures. The static lateral earth pressure on the walls may be calculated as k_o*γ, assuming an at-rest earth pressure coefficient (k_o) of 0.41 and a γ of 130 pcf. This corresponds to an equivalent fluid density of 53 pcf. The resultant of the at-rest pressure acts at H/3 above the base of the wall, where H is the buried height of the wall.

Seismic Loading. For load combinations where seismic loading is considered, it is customary to assume the wall deflection will be sufficient to mobilize active earth pressures. A study of seismic earth pressures on deep building basements (Lew et al. 2010) concluded, total dynamic earth pressure on buried walls may be modeled as triangular distribution calculated as k_{ae}*γ. The total dynamic earth pressure (k_{ae}*γ) may be divided into a static active earth pressure component (k_a*γ) and a seismic thrust component (Δk_{ae}*γ), where: $\Delta k_{ae} = k_{ae} - k_a$. The resultants of both the static and seismic thrust components act at H/3 above the base of the wall.

We completed Generalized Limit Equilibrium (GLE) analysis using Slide 5.0 software to back-calculate $k_{ae}*\gamma$. A pseudo-static horizontal acceleration coefficient (k_h) of 0.3g was assumed for the analysis based on the USGS Maximum Credible Earthquake (MCE) peak ground acceleration and a Site Class B. No reduction in k_h was assumed for displacement. We believe this is a conservative assumption. The failure surface was assumed to extend through the wall backfill. A horizontal line load was applied at the wall location at a height of H/3 above the base of the wall to represent the lateral resistance provided by the wall. The line load corresponding to a FS of 1.0 was used to back-calculate $k_{ae}*\gamma$.

The results of the GLE analysis indicate the total dynamic earth pressure can be modeled using an equivalent fluid density of 49 pcf, which corresponds to a k_{ae} of 0.38, assuming a γ of 130 pcf for the wall backfill. The total dynamic earth pressure may be divided into a static active earth pressure component ($k_a*\gamma$) modeled using a k_a of 0.24 and an equivalent fluid density of 31 pcf and a seismic thrust component modeled using a Δk_{ae} of 0.14 and an equivalent fluid density of 18 pcf. Table 1 summarizes the recommended lateral earth pressures for static and seismic design.

Table 1. Lateral Earth Pressure Parameters for Buried Walls

Parameter	Source	Value
At-Rest Earth Pressure Coefficient, k_o	$1-\sin\phi$	0.41
At-Rest Equivalent Fluid Density (Static Design)	$k_o*\gamma_{backfill}$	53 pcf
Total Dynamic Earth Pressure Coefficient, k_{ae}	GLE Analysis	0.38
Active Earth Pressure Coefficient, k_a	$\tan^2(45 - \phi/2)$	0.24
Active Equivalent Fluid Density (Static Component of Total Dynamic Earth Pressure)	$k_a*\gamma_{backfill}$	31 pcf
Seismic Thrust Earth Pressure Coefficient, Δk_{ae}	$\Delta k_{ae} = k_{ae} - k_a$	0.14
Seismic Thrust Equivalent Fluid Density (Seismic Component of Total Dynamic Earth Pressure)	$\Delta k_{ae}*\gamma_{backfill}$	18 pcf

RECOMMENDATIONS

Design and construction recommendations are provided in the following sections. We recommend contractors be provided a copy of this report to review the site conditions and recommendations for site preparation and foundation construction.

General Earthwork

1. Select Fill as defined in this report should consist of ¾ or 1-inch minus, clean (i.e., less than 5% passing the #200 U.S. Sieve), well-graded, angular crushed rock. We should be provided a gradation sheet for this material for approval prior to delivery to the site.

2. Granular Site Fill should consist of approved soil and rock taken from on-site excavations that are free of construction debris, organics, or other deleterious materials. This material may be used for general site grading outside foundation areas and as backfill around the tank beginning 10 feet (measured horizontally) from the tank perimeter. Rock fragments in the fill should be limited to a maximum diameter of 6 inches. The suitability of Site Fill for reuse should be confirmed by a Foundation Engineering representative at the time of construction.

3. Drain Rock should consist of ¾ to 1½-inch, clean (less than 2% passing the #200 sieve), open-graded, angular, crushed quarry rock. Other gradations may be acceptable, provided the rock is durable and free draining. We should be provided a gradation sheet for this material for approval prior to delivery to the site.

4. Subsurface Drainage Geotextile should be a non-woven geotextile with Mean Average Roll Value (MARV) strength properties meeting the requirements of an AASHTO M 288-17 Class 3 geotextile (Subsurface Drainage Geotextile), with a maximum AOS of 0.3 mm (max average roll value) and a permittivity greater than 0.1 sec^{-1}. We should be provided a specification sheet on the selected geotextile for approval prior to delivery to the site.

5. Compact all fill in loose lifts not exceeding 12 inches. The lift thickness should be reduced to 6 inches where light or hand-operated equipment is used. Compact all fill to a minimum of 95% relative compaction. The maximum dry density of ASTM D 698 should be used as the standard for estimating relative compaction. The moisture content of the fill should be adjusted to within ±2% of its optimum value prior to compaction.

Field density tests should be run frequently to confirm adequate compaction of the fill. Compaction of granular fill that contains open-graded rock or aggregate too coarse for density testing should be evaluated by observation of the compaction method and by proof-rolling, where practical, using a loaded 10-yd^3 dump truck or other heavy construction vehicle approved by Foundation Engineering. Areas of pumping or deflection observed beneath the truck wheels may be reworked or overexcavated and replaced with compacted Select Fill and proof-rolled again.

Foundation Design and Construction

6. Design the tank using the seismic design parameters and response spectrum shown on Figures 6A and 7A and the lateral earth pressures in Table 1.

7. Design the footings using an allowable bearing pressure of 30 ksf. This value may be increased by one-third for transient loads. The allowable bearing pressure assumes the footings will bear on bedrock or on compacted Select Fill underlain by bedrock. Assume the foundation settlement will be less than ±½ inch.

8. Use a coefficient of sliding friction of 0.5 between the bottom of the footings and slab and the compacted Select Fill. Calculate the ultimate passive resistance for the buried tank footings using an equivalent fluid density of 500 pcf. Assume it may require a lateral displacement of 1% of the buried footing height to mobilize the ultimate passive resistance.

9. Use a modulus of subgrade reaction, k_s of 400 pci, for floor slab design. This value assumes the floor slab will be constructed on compacted Select Fill underlain by bedrock.

Foundation Preparation

10. Use controlled blasting to fracture the bedrock within the tank footprints. If current construction will be limited to one tank, blasted rock within the future tank footprint may be left in place. The design and sequencing of the blasting should be provided by a qualified blasting contractor.

11. Excavate the tank footprint to the planned finish subgrade elevation. We understand the excavation will extend at least 10 feet beyond the tank perimeter to provide room for construction. Remove all loose rock and debris exposed at the subgrade level prior to backfilling.

12. Install a perimeter foundation drain and place Drain Rock to construct the foundation drain layer and tank leak detection layer beneath the tank as shown on the plans. Compact the Drain rock until it is visibly dense and unyielding. The adequacy of the compaction should be verified by a Foundation Engineering representative.

13. Cap the tank leak detection layer with a minimum of 6 inches of compacted Select Fill to provide a leveling layer beneath the footings and floor slab. Place and compact the Select Fill in lifts as recommended in Item 5.

Excavations/Shoring/Dewatering/Backfill

14. Excavations should be shored or sloped in accordance with OR-OSHA requirements to protect workers. The excavations around the perimeter of the existing tank are expected to encounter topsoil and/or residual soil underlain by basalt, sandstone, or siltstone. Material disturbed by blasting may also be encountered in a portion of the excavation if the rock at the future tank location is blasted and left in place.

    The topsoil and residual soil include soft to stiff sandy silt and medium dense to dense silty sand. This material corresponds to an OR-OSHA Class C soil. We anticipate a Site Class C will also be appropriate for material in the future tank location that is disturbed by blasting and left in place. OR-OSHA recommends a maximum temporary cut slope of 1.5:1(H:V) in Class C soil. Suitable cut slopes will have to be confirmed in the field at the time of construction.

    The bedrock will likely satisfy the OR-OSHA criterion for stable rock, where it is not disturbed. OSHA allows vertical cuts in stable rock. The configuration of suitable rock cut slopes will need to be confirmed at the time of construction. Loose material should be scaled from the cut slopes, as needed, to protect workers from falling rock.

15. The bedrock underlying the proposed tank is typically medium strong (R3) to very strong (R5), very close to moderately close-jointed, and slightly weathered. Based on the rock hardness and the joint spacing, it should be assumed it will not be practical to excavate the rock by digging with an excavator bucket alone, and it will be necessary to fracture the rock prior to excavating. The contractor should select the appropriate rock excavation method. The laboratory testing completed to date on rock core samples indicates q_u values ranging from ±8,216 to 26,388 psi. However, harder rock may be encountered.

16. Water is likely to perch above the bedrock during wet weather. Therefore, the need for dewatering should be anticipated if the work is completed in the wet winter or spring months.

17. Use Select Fill to backfill around the tank within ±10 feet of the walls. Granular Site Fill may be used to backfill outside this zone. Compact the backfill as recommended in Item 5.

Foundation Drainage

Water from surface runoff will collect within the granular backfill around the perimeter of the tank and beneath the tank, which may result in hydrostatic pressure on the floor slab and sidewalls. A perimeter drain is recommended to remove the perched water in the event the tank needs to be drained. The perimeter drain should be constructed as described below:

18. Install a foundation drain along the perimeter of the tank. The drain should consist of a 6-inch diameter, perforated HDPE or PVC pipe. The flowline of the pipe should be set near the bottom of the excavation. The pipe should be bedded in at least 4 inches of Drain Rock and backfilled to within 6 inches of the ground surface with Drain Rock. The mass of Drain Rock should be wrapped in a Subsurface Drainage Geotextile that laps at least 12 inches at the top.

19. Provide clean-outs at appropriate locations for future maintenance of the drainage system.

20. Discharge the water from the drain system away from the tank in a manner that will not cause local erosion or ponding at the outlet of the drainpipe.

DESIGN REVIEW/CONSTRUCTION OBSERVATION/TESTING

We should be provided the opportunity to review all drawings and specifications that pertain to site preparation and foundation construction. Site preparation will require field confirmation of the subgrade conditions beneath the tanks. That confirmation should be done by a Foundation Engineering representative. Mitigation of any subgrade pumping will also require engineering review and judgment. Frequent field density tests should be run on all engineered fill. Compaction of fill that is too coarse or variable for density testing should be evaluated by observation of the compaction method and proof-rolling with a loaded dump truck or other approved vehicle.

VARIATION OF SUBSURFACE CONDITIONS, USE OF THIS REPORT, AND WARRANTY

The analysis, conclusions, and recommendations contained herein assume the subsurface profiles observed in the borings are representative of the site conditions. The above recommendations assume we will have the opportunity to review final drawings and be present during construction to confirm the assumed soil and ground water conditions in the excavations. No changes in the enclosed recommendations should be made without our approval. We will assume no responsibility or liability for any engineering judgment, inspection, or testing performed by others.

This report was prepared for the exclusive use of the Eugene Water & Electric Board and their design consultants for the East 40th Avenue Storage Tank project in Eugene, Oregon. Information contained herein should not be used for other sites or for unanticipated construction without our written consent. This report is intended for planning and design purposes as described herein. Contractors using this information to estimate construction quantities or costs do so at their own risk. Our services do not include any survey or assessment of potential surface contamination or contamination of the soil or ground water by hazardous or toxic materials. We assume those services, if needed, have been completed by others.

Our work was done in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

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Appendix A

Figures

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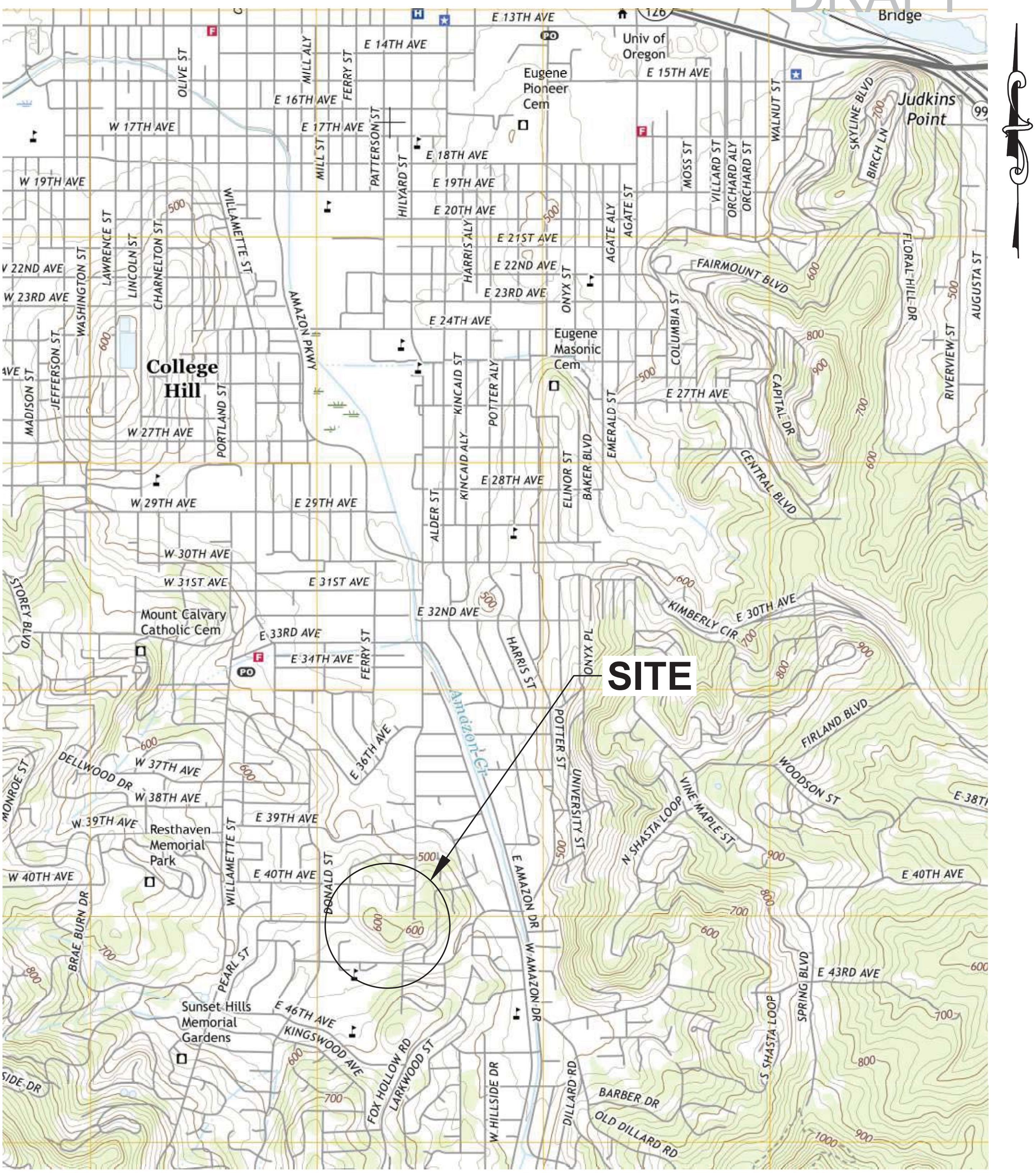

Note: Base map obtained from the USGS website (https://ngmdb.usgs.gov).

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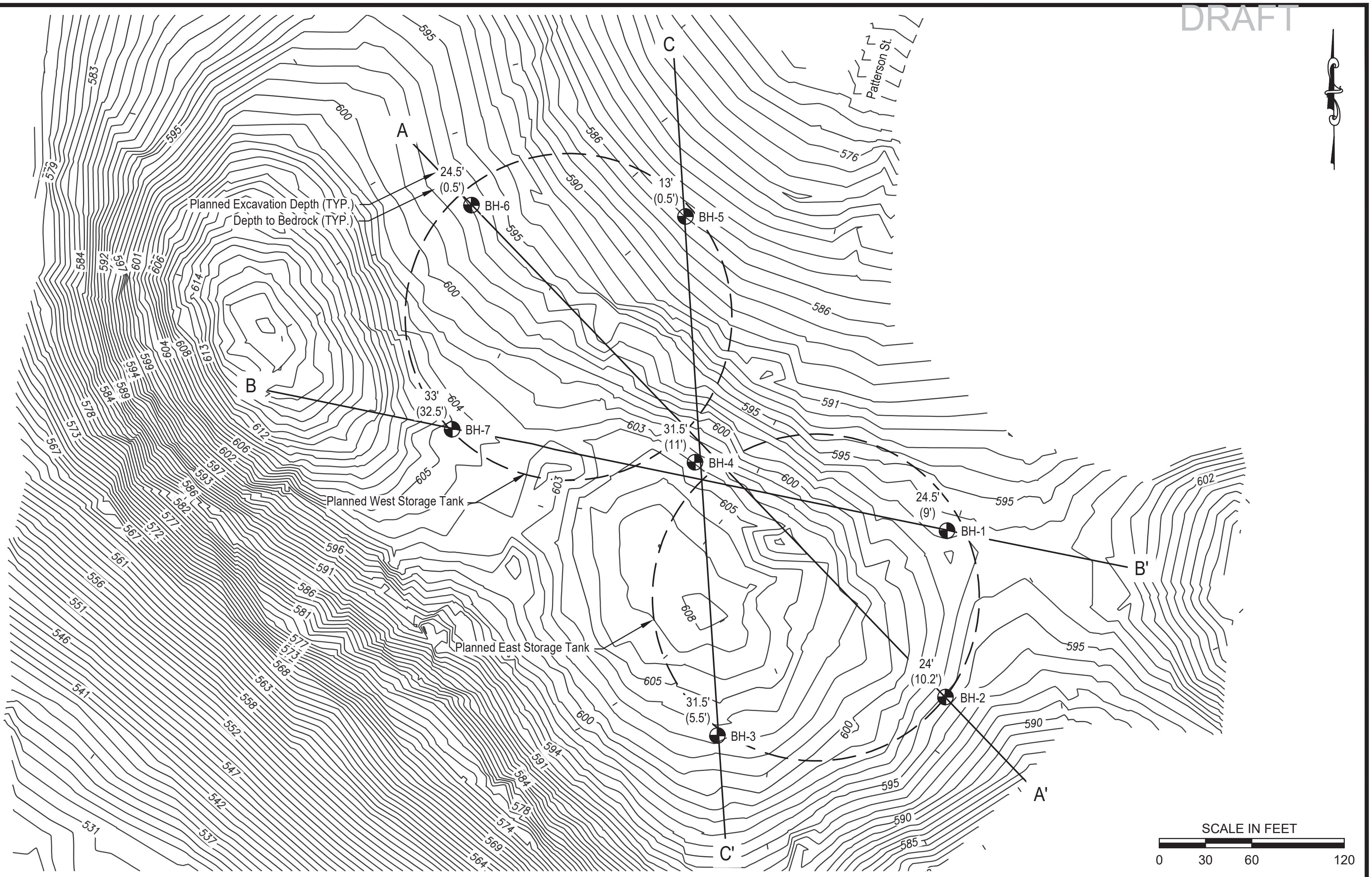
VICINITY MAP

EAST 40TH AVE STORAGE TANK
EUGENE, OREGON

FIGURE NO.
1A

PROJECT NO.	DATE:	DRAWN BY:
2201086	Nov. 24, 2020	MLM

FILE:Figure 1A (11-23-20).dwg



NOTES:
1. BORING LOCATIONS WERE ESTABLISHED REFERENCING EXISTING LANDMARKS AND ARE APPROXIMATE.
2. SEE REPORT FOR A DISCUSSION OF SUBSURFACE CONDITIONS.
3. BASE MAP WAS PROVIDED BY MURRAYSMITH. ELEVATIONS REFERENCE NGVD29.

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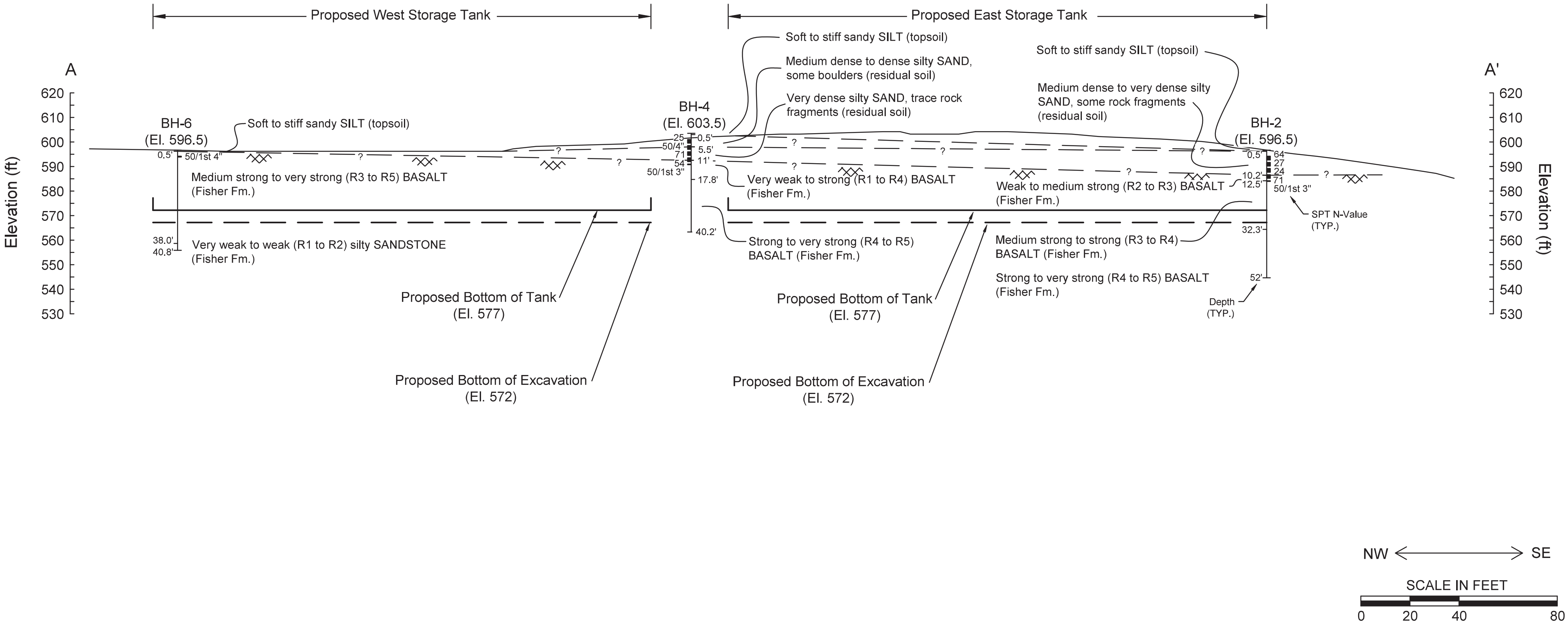
PROJECT NO.	DATE:	DRAWN BY:
2201086	Jan. 27, 2021	MLM

SITE LAYOUT AND BORING LOCATIONS

EAST 40TH AVENUE STORAGE TANK
EUGENE, OREGON

FIGURE NO.
2A

FILE:Figure 2A NGVD29 (2-24-21).dwg



NOTES:

1. SURFACE PROFILE IS BASED ON TOPOGRAPHIC DATA PROVIDED BY EWEB. ELEVATIONS REFERENCE NGVD29.
2. SUBSURFACE CROSS-SECTION WAS INTERPRETED BASED ON THE CONDITIONS ENCOUNTERED IN BH-2, BH-4, AND BH-6.
3. SEE REPORT FOR A DISCUSSION OF SITE CONDITIONS.

FILE: 40th Ave X-sections (1-27-21).dwg

Foundation Engineering, Inc.
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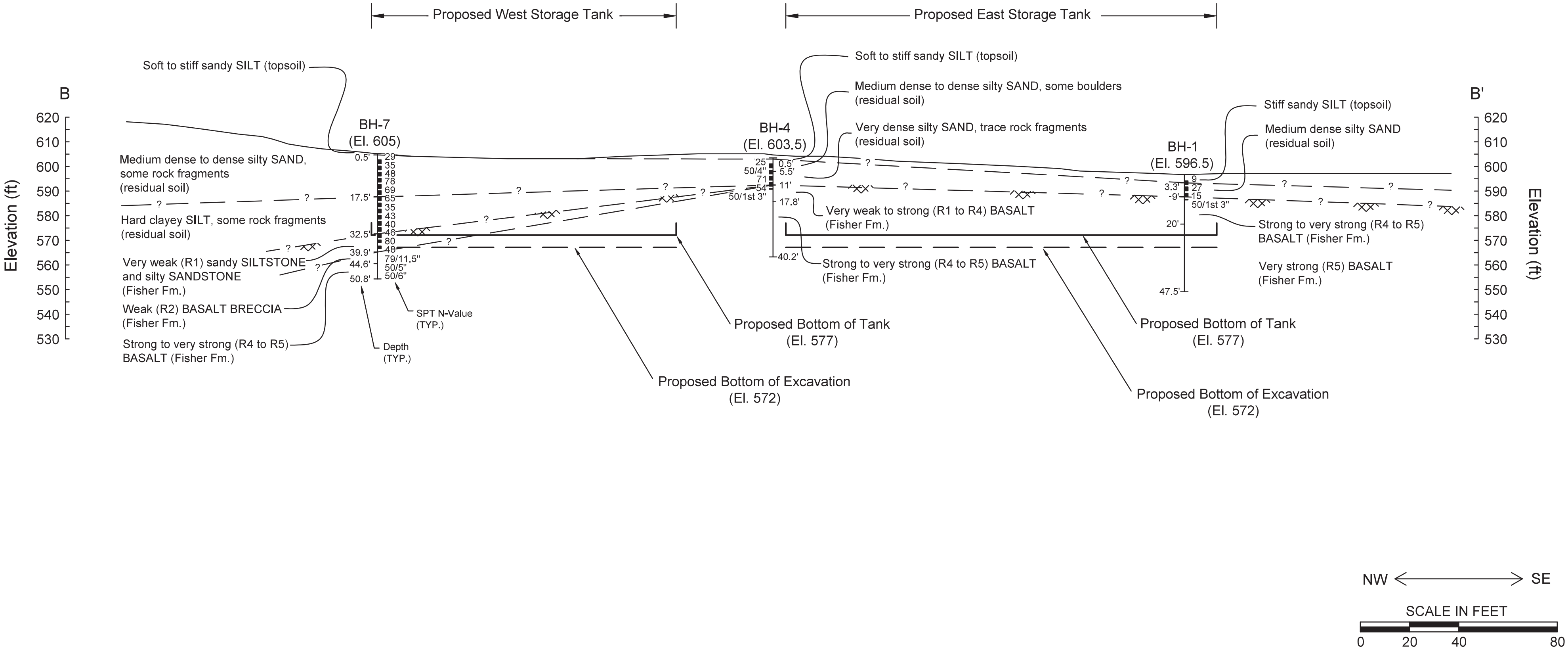
PROJECT NO.	DATE:	DRAWN BY:
2201086	Jan. 28, 2021	MLM

CROSS-SECTION A-A'

EAST 40TH AVENUE STORAGE TANK
EUGENE, OREGON

FIGURE NO.
3A



NOTES:
1. SURFACE PROFILE IS BASED ON TOPOGRAPHIC DATA PROVIDED BY EWEB. ELEVATIONS REFERENCE NGVD29.
2. SUBSURFACE CROSS-SECTION WAS INTERPRETED BASED ON THE CONDITIONS ENCOUNTERED IN BH-1, BH-4, AND BH-7.
3. SEE REPORT FOR A DISCUSSION OF SITE CONDITIONS.

FILE: 40th Ave X-sections (1-27-21).dwg

Foundation Engineering, Inc.
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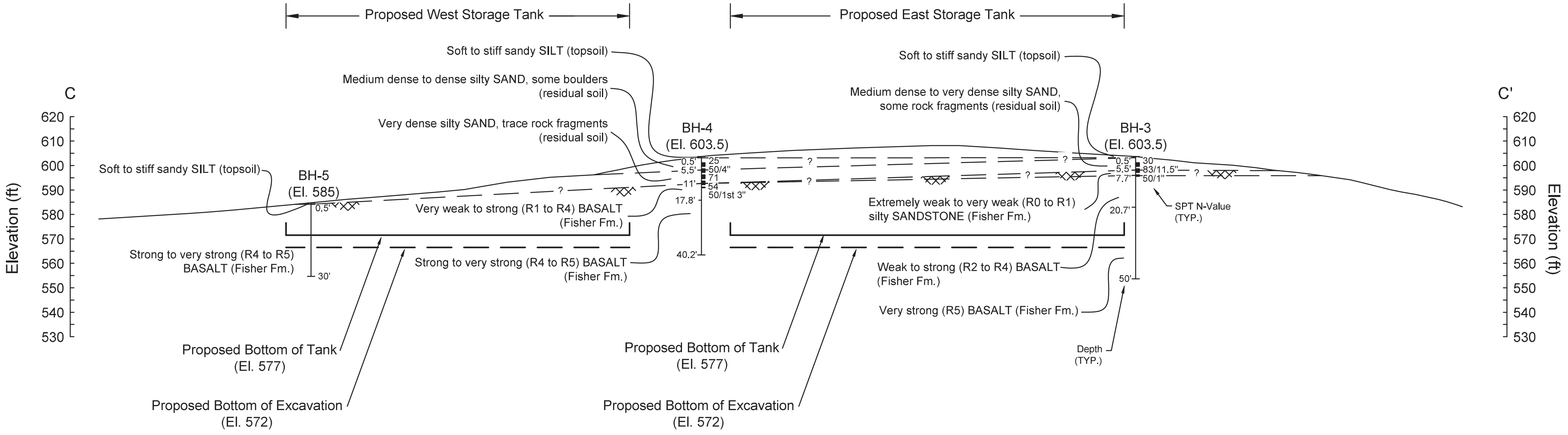
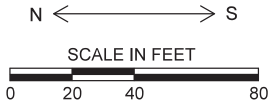
PROJECT NO.	DATE:	DRAWN BY:
2201086	Jan. 28, 2021	MLM

CROSS-SECTION B-B'

EAST 40TH AVENUE STORAGE TANK
EUGENE, OREGON

FIGURE NO.
4A





NOTES:

1. SURFACE PROFILE IS BASED ON TOPOGRAPHIC DATA PROVIDED BY EWEB. ELEVATIONS REFERENCE NGVD29.
2. SUBSURFACE CROSS-SECTION WAS INTERPRETED BASED ON THE CONDITIONS ENCOUNTERED IN BH-3, BH-4, AND BH-5.
3. SEE REPORT FOR A DISCUSSION OF SITE CONDITIONS.

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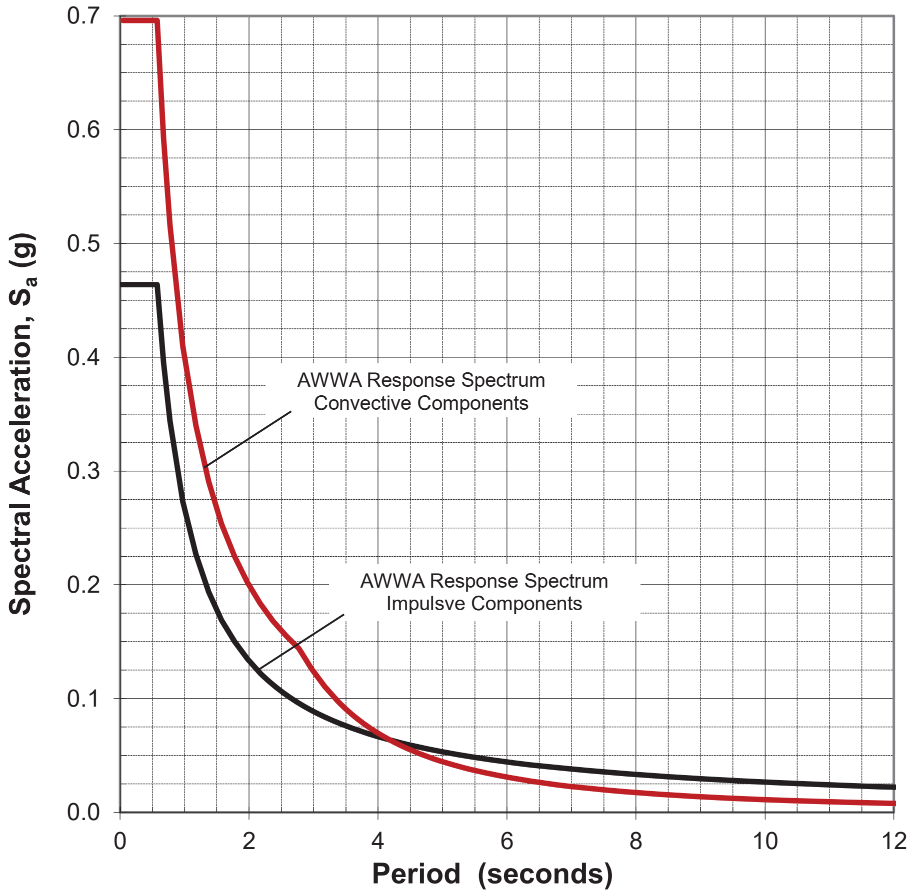
PROJECT NO.	DATE:	DRAWN BY:
2201086	Jan. 28, 2021	MLM

CROSS-SECTION C-C'

EAST 40TH AVENUE STORAGE TANK
EUGENE, OREGON

FIGURE NO.
5A

FILE: 40th Ave X-sections (1-27-21).dwg



Notes:

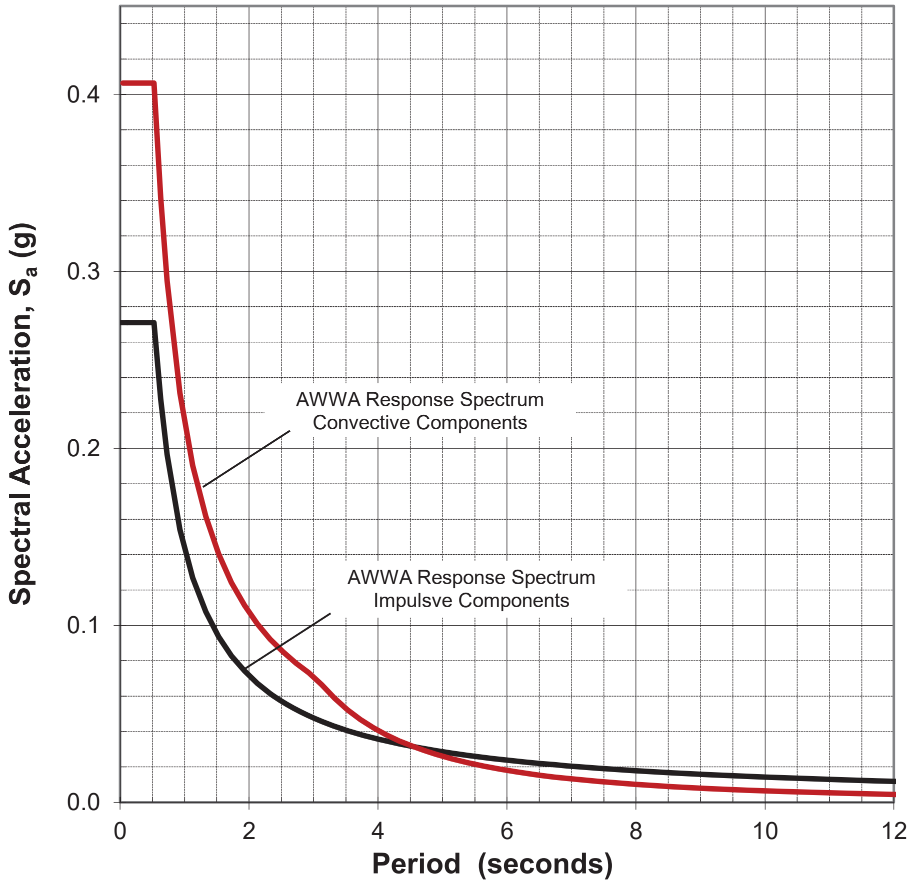
1. The Design Response Spectra are based on the General Procedure in AWWA D110-13 Section 4.3 with a 2% probability of exceedence in 50 years.
2. The following parameters were used for the impulsive component response spectrum:

Site Class= B Damping = 5%

S_S = 0.70	F_a = 1.00	S_{MS} = 0.70	S_{DS} = 0.46
S_1 = 0.40	F_v = 1.00	S_{M1} = 0.40	S_{D1} = 0.27

3. S_S and S_1 values indicated in Note 2 are USGS 2014 risk-targeted MCE spectral accelerations available from https//:seismicmaps.org.
4. F_a and F_v were selected from ASCE 7-16 Tables 11.4-1 and 11.4-2 based on the S_S and S_1 values. S_{DS} and S_{D1} values include a 2/3 reduction on S_{MS} and S_{M1} as discussed in AWWA Section 4.3.
5. The response spectrum for the conductive components was calculated based on AWWA D110-13 Eqs. 4-19 and 4-20.
6. Site location is: Latitude 44.0099, Longitude -123.0835.

FIGURE 6A
AWWA D110-13 SITE RESPONSE SPECTRA
2% Probability of Exceedence in 50 years
East 40th Avenue Storage Tank
Eugene, Oregon
Project No.: 2201086



Notes:

1. The Design Response Spectra are based on the General Procedure in AWWA D110-13 Section 4.3 with a 10% probability of exceedence in 50 years.
2. The following parameters were used for the impulsive component response spectrum:

   Site Class= B Damping = 5%

   S_S = 0.27 F_a = 1.00 S_{XS} = 0.27

   S_1 = 0.14 F_v = 1.00 S_{X1} = 0.14
3. S_S and S_1 values indicated in Note 2 are USGS 2014 MCE spectral accelerations corrected for directivity available from https//:seismicmaps.org.
4. F_a and F_v were selected from ASCE 7-16 Tables 11.4-1 and 11.4-2 based on the S_S and S_1 values.
5. The response spectrum for the conductive components was calculated based on AWWA D110-13 Eqs. 4-19 and 4-20.
6. Site location is: Latitude 44.0099, Longitude -123.0835.

FIGURE 7A
AWWA D110-13 SITE RESPONSE SPECTRA
10% Probability of Exceedence in 50 years
East 40th Avenue Storage Tank
Eugene, Oregon
Project No.: 2201086

Appendix B

Boring Logs and Corebox Photos

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DISTINCTION BETWEEN FIELD LOGS AND FINAL LOGS

A field log is prepared for each boring or test pit by our field representative. The log contains information concerning sampling depths and the presence of various materials such as gravel, cobbles, and fill, and observations of ground water. It also contains our interpretation of the soil conditions between samples. The final logs presented in this report represent our interpretation of the contents of the field logs and the results of the sample examinations and laboratory test results. Our recommendations are based on the contents of the final logs and the information contained therein and not on the field logs.

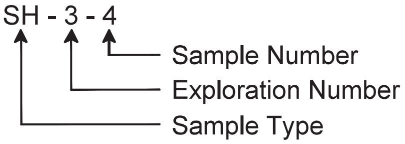
VARIATION IN SOILS BETWEEN TEST PITS AND BORINGS

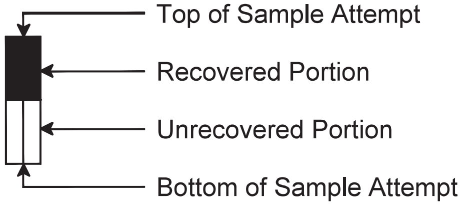
The final log and related information depict subsurface conditions only at the specific location and on the date indicated. Those using the information contained herein should be aware that soil conditions at other locations or on other dates may differ. Actual foundation or subgrade conditions should be confirmed by us during construction.

TRANSITION BETWEEN SOIL OR ROCK TYPES

The lines designating the interface between soil, fill or rock on the final logs and on subsurface profiles presented in the report are determined by interpolation and are therefore approximate. The transition between the materials may be abrupt or gradual. Only at boring or test pit locations should profiles be considered as reasonably accurate and then only to the degree implied by the notes thereon.

SAMPLE OR TEST SYMBOLS





C - Pavement Core Sample
CS - Rock Core Sample
OS - Oversize Sample (3-inch O.D. split-spoon)
S - Grab Sample
SH - Thin-walled Shelby Tube Sample
SS - Standard Penetration Test Sample
(2-inch O.D. split-spoon)

▲ Standard Penetration Test Resistance equals the number of blows a 140 lb. weight falling 30 in. is required to drive a standard split-spoon sampler 1 ft. Practical refusal is equal to 50 or more blows per 6 in. of sampler penetration.

● Water Content (%)

FIELD SHEAR STRENGTH TEST

Shear strength measurements on test pit side walls, blocks of soil or Shelby tube samples are typically made with Torvane or Field Vane shear devices.

WATER TABLE

▼ Water Table Location

(1/31/16) Date of Measurement

TYPICAL SOIL/ROCK SYMBOLS

▩ Concrete	▥ Silt	▨ Basalt
▢ Organics	░ Sand	▒ Sandstone
▨ Clay	▓ Gravel	▤ Siltstone

UNIFIED SOIL CLASSIFICATION SYMBOLS

G - Gravel
S - Sand
M - Silt
C - Clay
Pt - Peat

W - Well Graded
P - Poorly Graded
L - Low Plasticity
H - High Plasticity
O - Organic

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SYMBOL KEY

EXPLORATION LOGS

Explanation of Common Terms Used in Soil Descriptions

Field Identification	Cohesive Soils			Granular Soils	
	SPT*	S_u** (tsf)	Term	SPT*	Term
Easily penetrated several inches by fist.	0 - 2	< 0.125	Very Soft	0 - 4	Very Loose
Easily penetrated several inches by thumb.	2 - 4	0.125 - 0.25	Soft	4 - 10	Loose
Can be penetrated several inches by thumb with moderate effort.	4 - 8	0.25 - 0.50	Medium Stiff	10 - 30	Medium Dense
Readily indented by thumb but penetrated only with great effort.	8 - 15	0.50 - 1.0	Stiff	30 - 50	Dense
Readily indented by thumbnail.	15 - 30	1.0 - 2.0	Very Stiff	> 50	Very Dense
Indented with difficulty by thumbnail.	> 30	> 2.0	Hard		

* SPT N-value in blows per foot (bpf)

** Undrained shear strength

Term	Soil Moisture Field Description
Dry	Absence of moisture. Dusty. Dry to the touch.
Damp	Soil has moisture. Cohesive soils are below plastic limit and usually moldable.
Moist	Grains appear darkened, but no visible water. Silt/clay will clump. Sand will bulk. Soils are often at or near plastic limit.
Wet	Visible water on larger grain surfaces. Sand and cohesionless silt exhibit dilatancy. Cohesive soil can be readily remolded. Soil leaves wetness on the hand when squeezed. Soil is wetter than the optimum moisture content and above the plastic limit.

Term	PI	Plasticity Field Test
Non-plastic	0 - 3	Cannot be rolled into a thread at any moisture.
Low Plasticity	3 - 15	Can be rolled into a thread with some difficulty.
Medium Plasticity	15 - 30	Easily rolled into thread.
High Plasticity	> 30	Easily rolled and re-rolled into thread.

Term	Soil Structure Criteria
Stratified	Alternating layers at least ¼ inch thick.
Laminated	Alternating layers less than ¼ inch thick.
Fissured	Contains shears and partings along planes of weakness.
Slickensided	Partings appear glossy or striated.
Blocky	Breaks into small lumps that resist further breakdown.
Lensed	Contains pockets of different soils.

Term	Soil Cementation Criteria
Weak	Breaks under light finger pressure.
Moderate	Breaks under hard finger pressure.
Strong	Will not break with finger pressure.

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SOIL DESCRIPTIONS

COMMON TERMS

Explanation of Common Terms Used in Rock Descriptions

Field Identification		UCS (psi)	Strength	Hardness (ODOT)
Indented by thumbnail.	R0	< 100	Extremely Weak	Extremely Soft
Crumbles under firm blows with geological hammer. Can be peeled by a pocket knife.	R1	100 - 1,000	Very Weak	Very Soft
Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with geological hammer.	R2	1,000 - 4,000	Weak	Soft
Cannot be scraped or peeled with a pocket knife, specimen can be fractured with a single blow of geological hammer.	R3	4,000 - 8,000	Medium Strong	Medium Hard
Specimen requires more than one blow of geological hammer to fracture it.	R4	8,000 - 16,000	Strong	Hard
Specimen requires many blows of geological hammer to fracture it.	R5	> 16,000	Very Strong	Very Hard

Term (ODOT)	Weathering Field Identification
Fresh	Crystals are bright. Discontinuities may show some minor surface staining. No discoloration in rock fabric.
Slightly Weathered	Rock mass is generally fresh. Discontinuities are stained and may contain clay. Some discoloration in rock fabric.
Moderately Weathered	Significant portions of rock show discoloration and weathering effects. Crystals are dull and show visible chemical alteration. Discontinuities are stained and may contain secondary mineral deposits.
Highly Weathered (Predominately Decomposed)	Rock can be excavated with geologist's pick. All discontinuities exhibit secondary mineralization. Complete discoloration of rock fabric. Surface of core is friable and usually pitted due to washing out of highly altered minerals by drilling water.
Decomposed	Rock mass is completely decomposed. Original rock "fabric" may be evident (relict texture). May be reduced to soil with hand pressure.

Spacing (metric)	Spacing (imperial)	Spacing Term	Bedding/Foliation
< 6 cm	< 2 in.	Very Close	Very Thin (Laminated)
6 cm - 30 cm	2 in. - 1 ft.	Close	Thin
30 cm - 90 cm	1 ft. - 3 ft.	Moderately Close	Medium
90 cm - 3.0 m	3 ft - 10 ft.	Wide	Thick
> 3.0 m	> 10 ft.	Very Wide	Very Thick (Massive)

Vesicle Term	Volume
Some vesicles	5 - 25%
Highly vesicular	25 - 50%
Scoriaceous	> 50%

Stratification Term	Description
Lamination	< 1 cm (0.4 in.) thick beds
Fissile	Preferred break along laminations
Parting	Preferred break parallel to bedding
Foliation	Metamorpic layering and segregation of minerals

RQD %	Designation	RQD %	Designation
0 - 25	Very Poor	75 - 90	Good
25 - 50	Poor	90 - 100	Excellent
50 - 75	Fair		

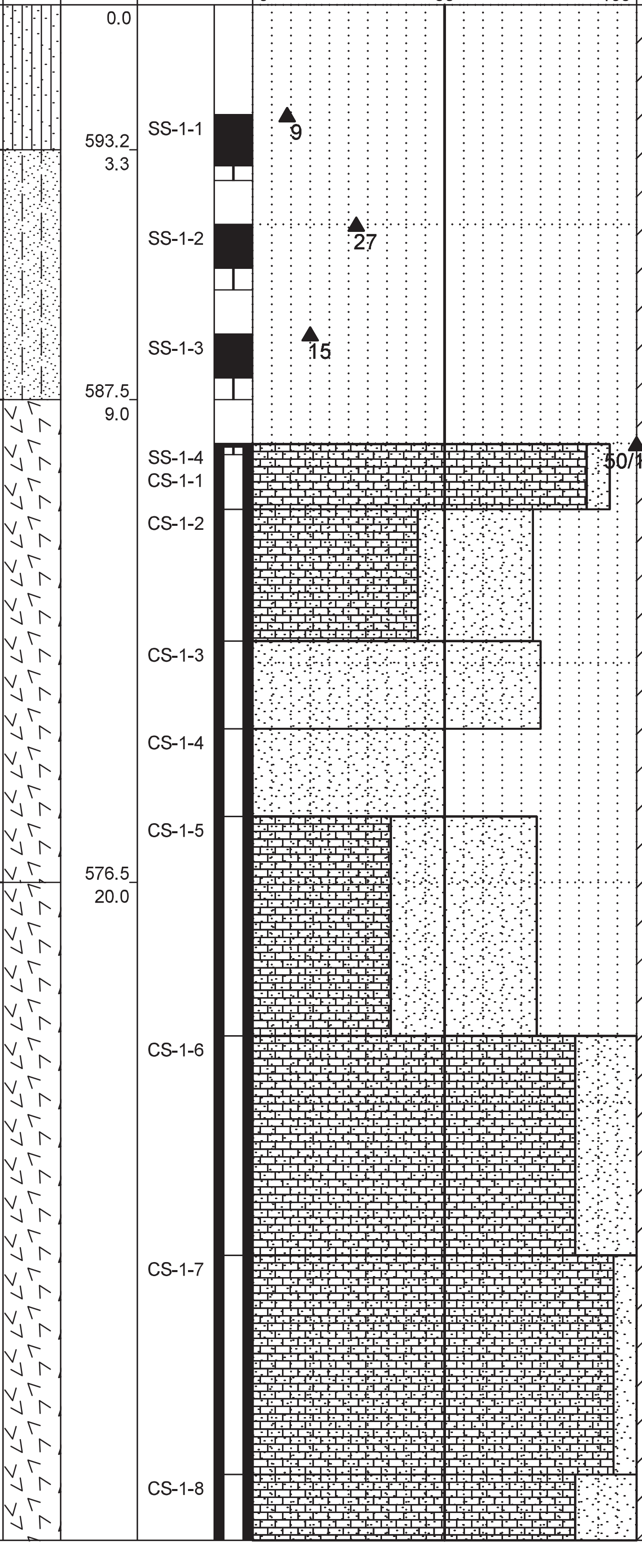
Rock Quality Designation (RQD) is the cumulative length of intact rock core pieces 4 inches or longer excluding breaks caused by drilling and handling divided by run length, expressed as a percentage.

Foundation Engineering, Inc.
Professional Geotechnical Services

ROCK DESCRIPTIONS

COMMON TERMS

Depth Feet	Soil and Rock Description and Comments	Log	Elev. Depth 596.5	Samples	▲ SPT, N-Value ☐ Recovery ● Moisture, % ⊞ RQD., % 0 50 100	Backfill/ Installations/ Water Table
1 2 3	Stiff sandy SILT, scattered organics (ML); brown and iron-stained, damp to moist, low plasticity, fine sand, organics consist of fine roots and wood fragments, (topsoil).		0.0	SS-1-1	9	Backfilled with bentonite chips
4 5 6 7 8 9	Medium dense silty SAND (SM); light grey and iron-stained, damp, non-plastic to low plasticity silt, fine sand, (residual soil). Fine to coarse sand-sized basalt rock fragments below ±5.3 feet. Relict rock texture below ±7.5 feet.		593.2 3.3	SS-1-2 SS-1-3	27 15	
10 11 12 13 14 15 16 17 18 19	Strong to very strong (R4 to R5) BASALT; dark grey-brown, moderately to slightly weathered, very close to close joints are planar to irregular, rough, open, and iron-stained, (Fisher Formation). Occasional ±30 to 60 degree joints from ±10.5 to 15.5 feet. Occasional vertical joints from ±17.5 to 18.5 feet.		587.5 9.0	SS-1-4 CS-1-1 CS-1-2 CS-1-3 CS-1-4 CS-1-5	50/1st 3"	
20 21 22 23 24 25 26 27 28 29 30 31 32 33 34	Very strong (R5) BASALT; dark grey, slightly weathered to fresh, very close to close joints are planar to irregular, rough, and open to closed, (Fisher Formation). Occasional ±30 to 60 degree joints from ±20.5 to 44 feet. Joint calcite mineralization below ±21.5 feet. Vertical joint from ±23.5 to 24.5 feet. Close joints are planar to irregular, rough, open to closed. Some calcite-healed joints below ±23.5 feet. Dark pinkish-grey from ±29 to 30.5 feet.		576.5 20.0	CS-1-6 CS-1-7 CS-1-8		



Project No.: 2201086

Surface Elevation: 596.5 feet (Approx.)

Date of Boring: November 9, 2020

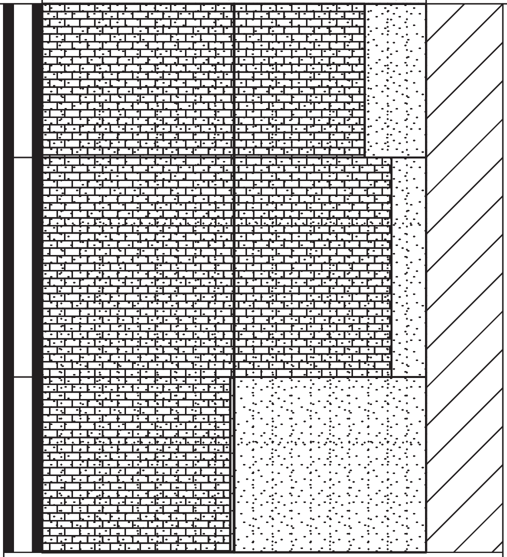
Boring Log: BH-1

East 40th Avenue Storage Tank

Eugene, Oregon

Foundation Engineering, Inc.

Depth Feet	Soil and Rock Description and Comments	Log	Elev. Depth	Samples	▲ SPT, N-Value ☐ Recovery ● Moisture, % ⊞ RQD., % 0 50 100	Backfill/ Installations/ Water Table
			561.5			
36						
37						
38						
39				CS-1-9		
40						
41						
42						
43	Some iron- and manganese-stained joints below ±42.7 feet.					
44				CS-1-10		
45	Vertical joints at ±43.5 and 46.5 feet.					
46						
47			549.0 47.5			
	BOTTOM OF BORING					



Project No.: 2201086

Surface Elevation: 596.5 feet (Approx.)

Date of Boring: November 9, 2020

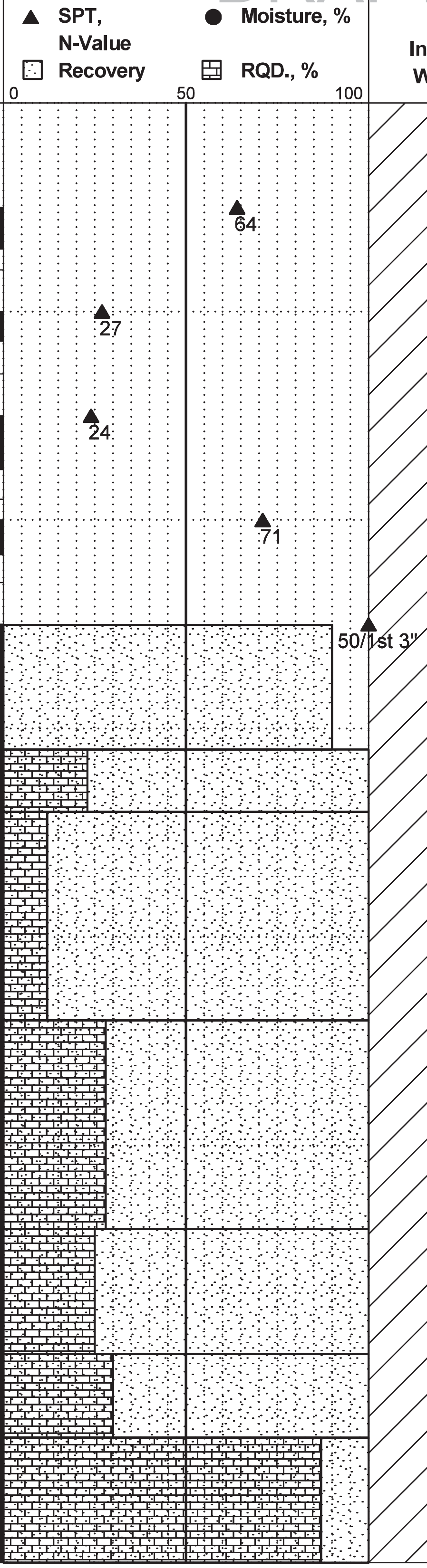
Foundation Engineering, Inc.

Boring Log: BH-1

East 40th Avenue Storage Tank

Eugene, Oregon

Depth Feet	Soil and Rock Description and Comments	Elev. Depth	Samples	Backfill/ Installations/ Water Table
0		596		Backfilled with bentonite chips
0–0.5	Soft to stiff sandy SILT, scattered organics (ML); brown, moist to wet, low to medium plasticity, fine sand, organics consist of fine roots, (topsoil).	595.5 0.5		
0.5–10.2	Medium dense to very dense silty SAND, some rock fragments (SM); light brown and iron-stained, damp to moist, non-plastic to low plasticity silt, fine sand, fine sand- to coarse angular to subangular gravel-sized basalt rock fragments, (residual soil). Relict rock texture at ±8 feet. Iron-stained, high plasticity sandy clay lens with fine sand at ±10 feet.	585.8 10.2	SS-2-1 (±2.5 ft) SS-2-2 (±5 ft) SS-2-3 (±7.5 ft) SS-2-4 (±10 ft)	
10.2–12.5	Weak to medium strong (R2 to R3) BASALT; dark grey, slightly weathered, (Fisher Formation).	583.5 12.5		
12.5–32.3	Medium strong to strong (R3 to R4); BASALT; dark grey, moderately to slightly weathered, very close to close joints are planar to irregular, rough, open to closed, and iron-stained, (Fisher Formation). Occasional ±30 to 60 degree joints below ±12.6 feet. Occasional vertical joints from ±18.5 to 22.5 feet and ±27 to 32 feet. Moderately to highly weathered from ±29 to 29.2 feet.	563.7 32.3	SS-2-5 CS-2-1 (±12.5 ft) CS-2-2 (±15.5 ft) CS-2-3 (±17 ft) CS-2-4 (±22 ft) CS-2-5 (±27 ft) CS-2-6 (±30 ft) CS-2-7 (±32 ft)	
32.3–34	Strong to very strong (R4 to R5) BASALT; dark grey, slightly weathered to fresh, close to moderately close joints are planar, rough, and open to closed, some iron-stained joints, (Fisher Formation).			



Project No.: 2201086

Surface Elevation: 596.0 feet (Approx.)

Date of Boring: November 10, 2020

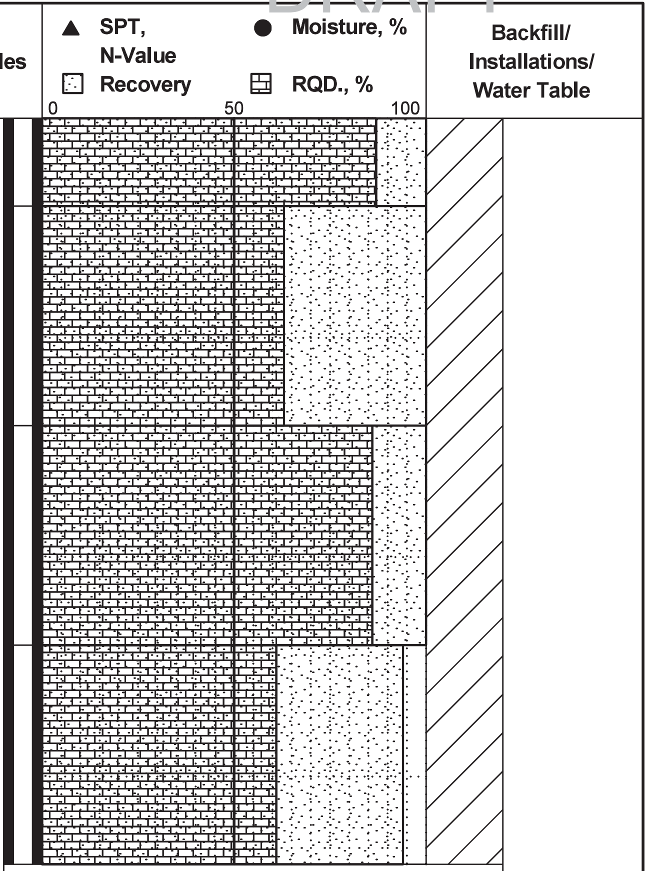
Foundation Engineering, Inc.

Boring Log: BH-2

East 40th Avenue Storage Tank

Eugene, Oregon

Depth Feet	Soil and Rock Description and Comments	Elev. Depth 561	Samples
36			
37			CS-2-8
38			
39	Occasional ±30 to 60 degree joints from ±38.5 to 51 feet.		
40			
41			
42	Occasional iron-stained joints below ±42 feet.		CS-2-9
43			
44			
45			
46			
47			CS-2-10
48			
49			
50			
51			
52	BOTTOM OF BORING	544.0 52.0	



Project No.: 2201086

Surface Elevation: 596.0 feet (Approx.)

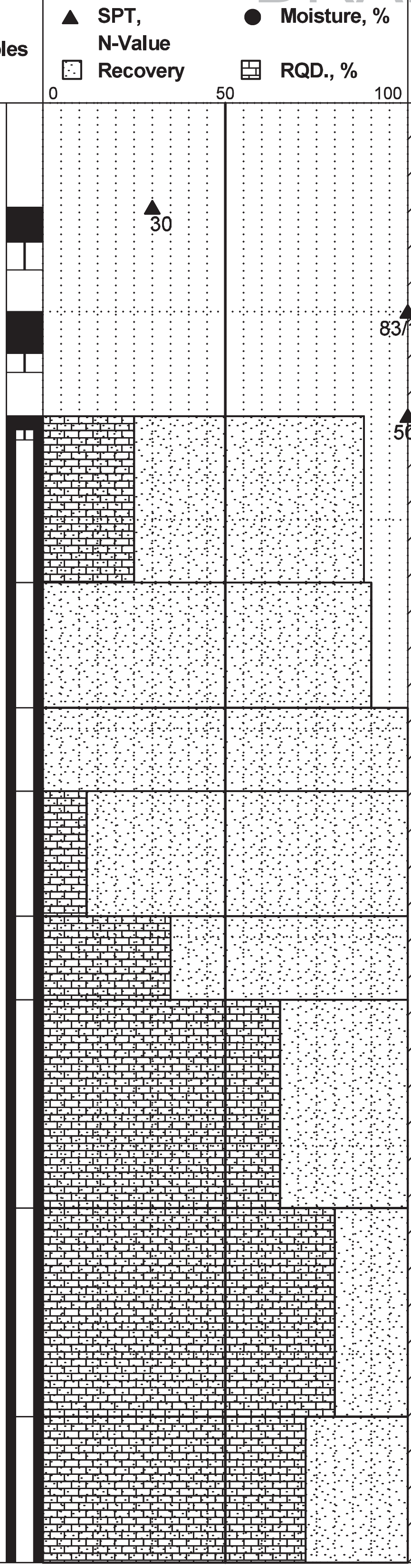
Date of Boring: November 10, 2020

Boring Log: BH-2

East 40th Avenue Storage Tank

Eugene, Oregon

Depth Feet	Soil and Rock Description and Comments	Elev. Depth	Samples	SPT, N-Value	Backfill/ Installations/ Water Table
		603.5			
1	Soft to stiff sandy SILT, scattered organics (ML); brown, moist to wet, low to medium plasticity, fine sand, organics consist of fine roots, (topsoil).	603.0 0.5			Backfilled with bentonite chips
2	Medium dense to very dense silty SAND, some rock fragments (SM); whitish-grey and iron-stained, damp, non-plastic to low plasticity silt, fine sand, fine sand- to coarse angular to subangular gravel-sized basalt rock fragments, (residual soil).				
3			SS-3-1	30	
4					
5					
6	Extremely weak to very weak (R0 to R1) silty SANDSTONE; light brown and iron-stained, highly to moderately weathered, (Fisher Formation).	598.0 5.5	SS-3-2	83/11½"	
7					
8	Medium strong (R3) BASALT; dark grey-brown, highly to moderately weathered, very close to close joints are irregular, rough, open, iron-stained, and silt-infilled, (Fisher Formation).	595.8 7.7	SS-3-3 CS-3-1	50/1"	
9					
10					
11	Strong (R4), dark grey, fresh, and moderately close joints from ±8.3 to 9.3 feet. Occasional vertical joints below ±11.5 feet.				
12			CS-3-2		
13					
14					
15	Weak to medium strong (R2 to R3), grey, and moderately weathered silty sandstone from ±14.1 to 16.5 feet and ±17.6 to 18.0 feet.		CS-3-3		
16					
17			CS-3-4		
18					
19	Dark pinkish-grey below ±18.2 feet.				
20			CS-3-5		
21	Very strong (R5) BASALT; dark grey, slightly weathered to fresh, close to moderately close joints are planar, rough, open, and iron-stained, (Fisher Formation).	582.8 20.7			
22			CS-3-6		
23					
24					
25					
26					
27			CS-3-7		
28					
29					
30	Occasional healed joints below ±30 feet.				
31					
32			CS-3-8		
33	Very close to close joints are planar to irregular, rough, and open to closed. Some silt-infilled joints from ±30.1 to 45.3 feet.				
34					



Project No.: 2201086

Surface Elevation: 603.5 feet (Approx.)

Date of Boring: November 11, 2020

Boring Log: BH-3

East 40th Avenue Storage Tank

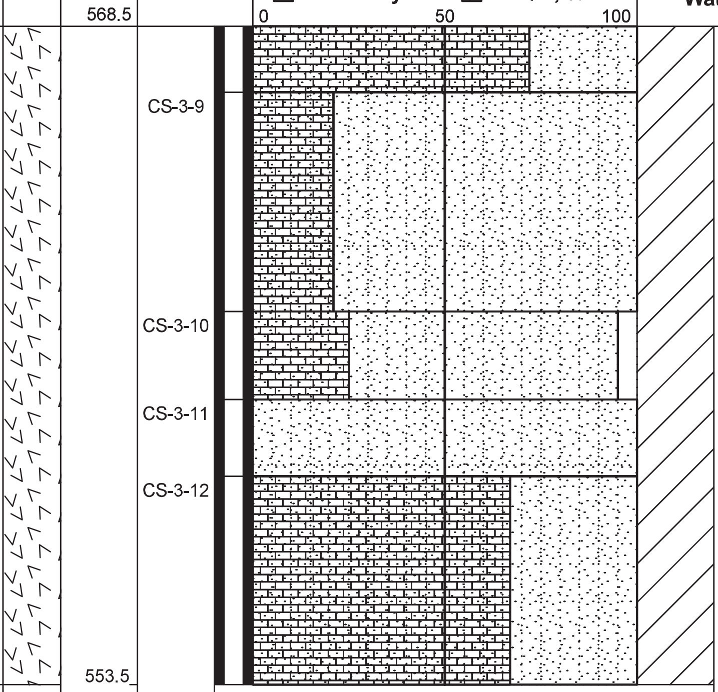
Eugene, Oregon

Foundation Engineering, Inc.

Depth Feet	Soil and Rock Description and Comments	Log	Elev. Depth 568.5	Samples
36				
37				CS-3-9
38				
39				
40				
41				
42	Vertical joint from ±41.5 to 42.5 feet.			CS-3-10
43				
44				CS-3-11
45				CS-3-12
46	Very close to moderately close joints below ±45.5 feet.			
47				
48				
49				
50	BOTTOM OF BORING		553.5 50.0	

▲ SPT, N-Value ● Moisture, % ⬚ Recovery ⊞ RQD., %

Backfill/ Installations/ Water Table



Project No.: 2201086

Surface Elevation: 603.5 feet (Approx.)

Date of Boring: November 11, 2020

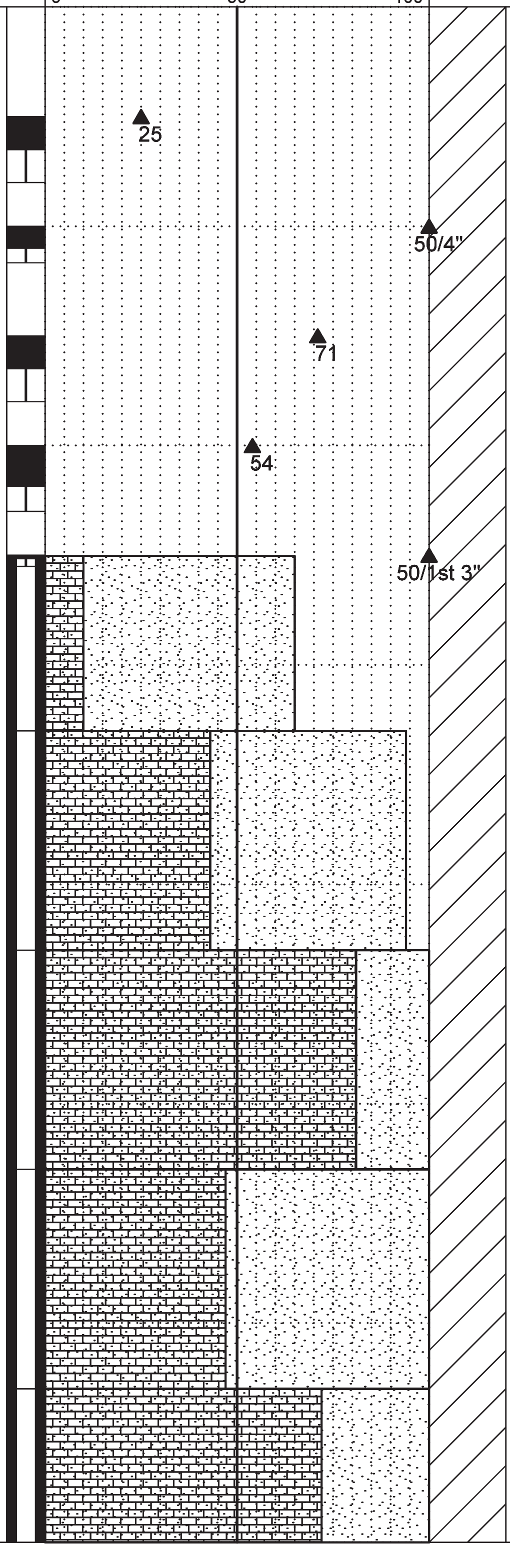
Boring Log: BH-3

East 40th Avenue Storage Tank

Eugene, Oregon

Foundation Engineering, Inc.

Depth Feet	Soil and Rock Description and Comments	Log	Elev. Depth	Samples	▲ SPT, N-Value ⬚ Recovery ● Moisture, % ⊞ RQD., % (0 / 50 / 100)	Backfill/ Installations/ Water Table
			603.5			
1	Soft to stiff sandy SILT, scattered organics (ML); brown, moist to wet, low to medium plasticity, fine sand, organics consist of fine roots, (topsoil).		603.0 0.5			Backfilled with bentonite chips
2–5	Medium dense to dense silty SAND, some boulders (SM); brown to light brown and iron-stained, damp, non-plastic to low plasticity silt, fine sand, basalt boulders, (residual soil).		598.0 5.5	SS-4-1 SS-4-2	25 50/4"	
6–10	Very dense silty SAND, trace rock fragments (SM); light brown and iron-stained, damp, non-plastic to low plasticity silt, fine sand, fine to coarse angular to subangular gravel-sized basalt rock fragments, relict sandstone texture, (residual soil).		592.5 11.0	SS-4-3 SS-4-4	71 54	
11–17	Medium strong to strong (R3 to R4) BASALT; dark grey-brown, moderately to slightly weathered, (Fisher Formation). Very weak (R1), light brown, and highly to moderately weathered sandstone with fine sand along vertical joint from ±13.9 to 16.3 feet. Very close to close joints are planar to irregular, rough, and open to closed below ±13.9 feet. Occasional ±30 to 60 degree joints below ±17.3 feet.		585.7 17.8	SS-4-5 CS-4-1 CS-4-2	50/1st 3"	
18–34	Strong to very strong (R4 to R5) BASALT; dark grey to pinkish-grey, slightly weathered, very close to close joints are planar to irregular, rough, open to closed, and iron-stained, (Fisher Formation). Silt-infilled joint at ±29.5 feet. Close to moderately close joints from ±31.5 to 35.5 feet.			CS-4-3 CS-4-4 CS-4-5		



Project No.: 2201086

Surface Elevation: 603.5 feet (Approx.)

Date of Boring: November 12, 2020

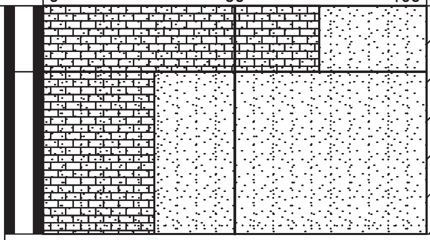
Foundation Engineering, Inc.

Boring Log: BH-4

East 40th Avenue Storage Tank

Eugene, Oregon

Depth Feet	Soil and Rock Description and Comments	Log	Elev. Depth 568.5	Samples	▲ SPT, N-Value ● Moisture, % ☐ Recovery ⊞ RQD., % 0 50 100	Backfill/ Installations/ Water Table
36						
37	Dark pinkish-grey and some healed and silt-infilled joints below ±36.7 feet.			CS-4-6		
38						
39						
40			563.3			
	BOTTOM OF BORING		40.2			



Project No.: 2201086

Surface Elevation: 603.5 feet (Approx.)

Date of Boring: November 12, 2020

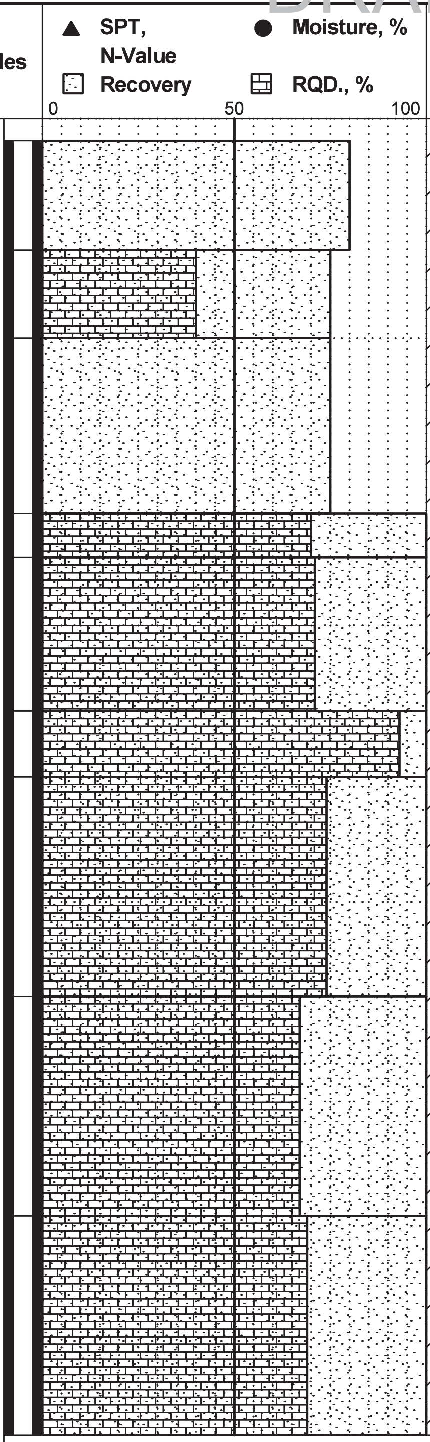
Foundation Engineering, Inc.

Boring Log: BH-4

East 40th Avenue Storage Tank

Eugene, Oregon

Depth Feet	Soil and Rock Description and Comments	Elev. Depth	Samples	Backfill/ Installations/ Water Table
		585		
1	Soft to stiff sandy SILT, scattered organics (ML); brown, moist to wet, low to medium plasticity, fine sand, organics consist of fine roots, (topsoil).	584.5 0.5	CS-5-1	Backfilled with bentonite chips
2	Strong to very strong (R4 to R5) BASALT; dark grey, moderately to slightly weathered, very close to close joints are irregular, rough, open to closed, and iron-stained, some silt-infilled joints, (Fisher Formation).			
3			CS-5-2	
4				
5	Occasional ±60 degree joints from ±0.5 to 3.7 feet.		CS-5-3	
6	Planar to irregular joints below ±6 feet.			
7				
8				
9	Dark pinkish-grey from ±8 to 8.5 feet and ±12.3 to 13 feet.		CS-5-4	
10	Occasional ±30 to 60 degree joints below ±9 feet.		CS-5-5	
11				
12				
13				
14			CS-5-6	
15	Slightly weathered to fresh and very close to moderately close joints below ±15 feet.		CS-5-7	
16				
17				
18				
19				
20			CS-5-8	
21				
22				
23				
24	Some healed joints below ±24 feet.			
25			CS-5-9	
26				
27				
28				
29				
30	BOTTOM OF BORING	555.0 30.0		



Project No.: 2201086

Surface Elevation: 585.0 feet (Approx.)

Date of Boring: November 15, 2020

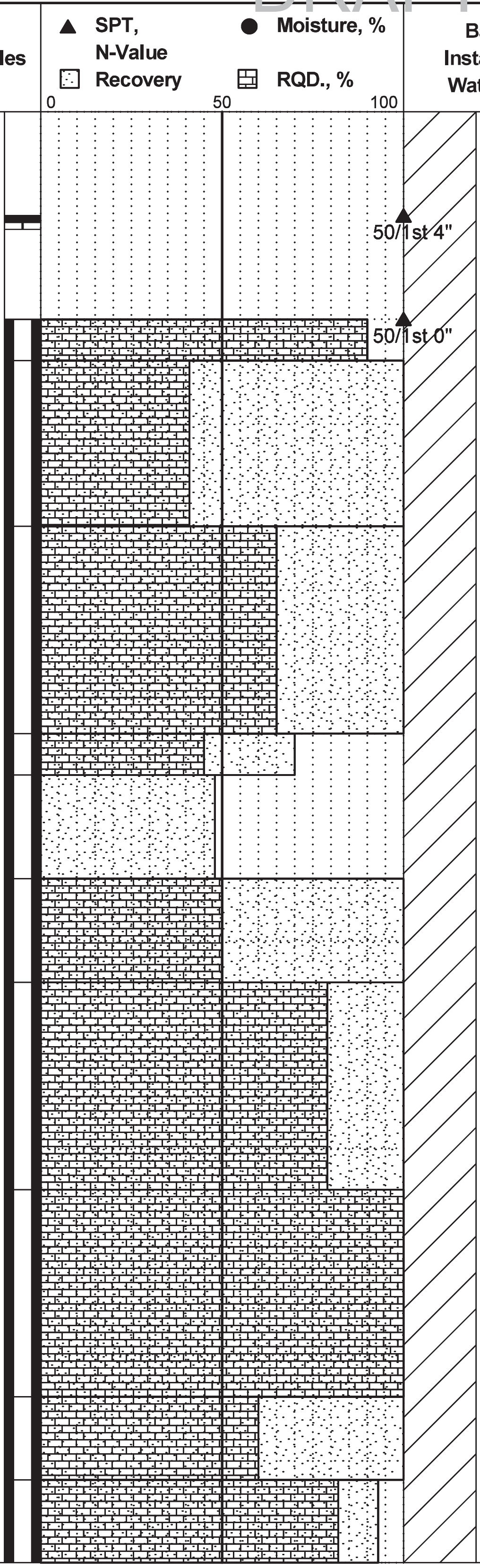
Boring Log: BH-5

East 40th Avenue Storage Tank

Eugene, Oregon

Foundation Engineering, Inc.

Depth Feet	Soil and Rock Description and Comments	Elev. Depth	Samples	Backfill/ Installations/ Water Table
		596.5		
1	Soft to stiff sandy SILT, scattered organics (ML); brown, moist to wet, low to medium plasticity, fine sand, organics consist of fine roots, (topsoil).	596.0 0.5		Backfilled with bentonite chips
2	Strong to very strong (R4 to R5) BASALT; dark grey, moderately to slightly weathered, (Fisher Formation).			
3			SS-6-1	
4				
5				
6	Slightly weathered and very close to moderately close joints are planar to irregular, rough, open to closed, and iron-stained below ±5 feet.		SS-6-2 CS-6-1 CS-6-2	
7	Occasional ±30 to 60 degree joints from ±6 to 9.7 feet.			
8	Vertical joint from ±6 to 8 feet.			
9				
10		586.5		
11	Strong to very strong (R4 to R5) BASALT; dark grey, slightly weathered, close joints are planar to irregular, rough, open to closed, iron-stained, and silt-infilled, (Fisher Formation).	10.0	CS-6-3	
12				
13	Dark pinkish-grey from ±10 to 11 feet.			
14				
15	Occasional ±30 to mostly 60 degree joints from ±10 to 36.2 feet.		CS-6-4	
16	Medium strong (R3) and moderately weathered from ±15.8 to 18.5 feet.		CS-6-5	
17				
18				
19			CS-6-6	
20	Vertical joint from ±19.4 to 20.3 feet.			
21			CS-6-7	
22				
23				
24	Healed joint from ±22 to 23 feet.			
25				
26			CS-6-8	
27				
28				
29	Close to moderately close joints from ±24.1 to 28.5 feet.			
30				
31			CS-6-9	
32				
33			CS-6-10	
34				



Project No.: 2201086

Surface Elevation: 596.5 feet (Approx.)

Date of Boring: November 14, 2020

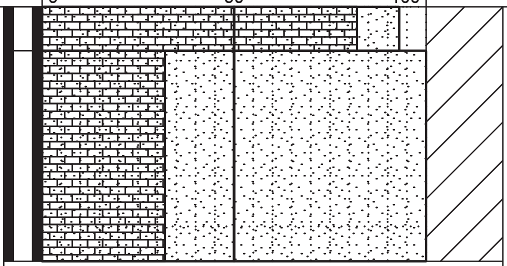
Foundation Engineering, Inc.

Boring Log: BH-6

East 40th Avenue Storage Tank

Eugene, Oregon

Depth Feet	Soil and Rock Description and Comments	Log	Elev. Depth 561.5	Samples	▲ SPT, N-Value ● Moisture, % ☐ Recovery ⊞ RQD., % 0 50 100	Backfill/ Installations/ Water Table
36	Dark grey to dark pinkish-grey below ±35.6 feet.			CS-6-11		
37						
38	Healed joint at ±37.4 feet.		558.5 38.0			
	Very weak to weak (R1 to R2) silty SANDSTONE; pinkish-grey, moderately weathered, close joints are irregular, rough, and open, (Fisher Formation).					
39						
40	Volcanic gravel-sized clasts below ±40 feet.		555.7 40.8			
	BOTTOM OF BORING					



Project No.: 2201086

Surface Elevation: 596.5 feet (Approx.)

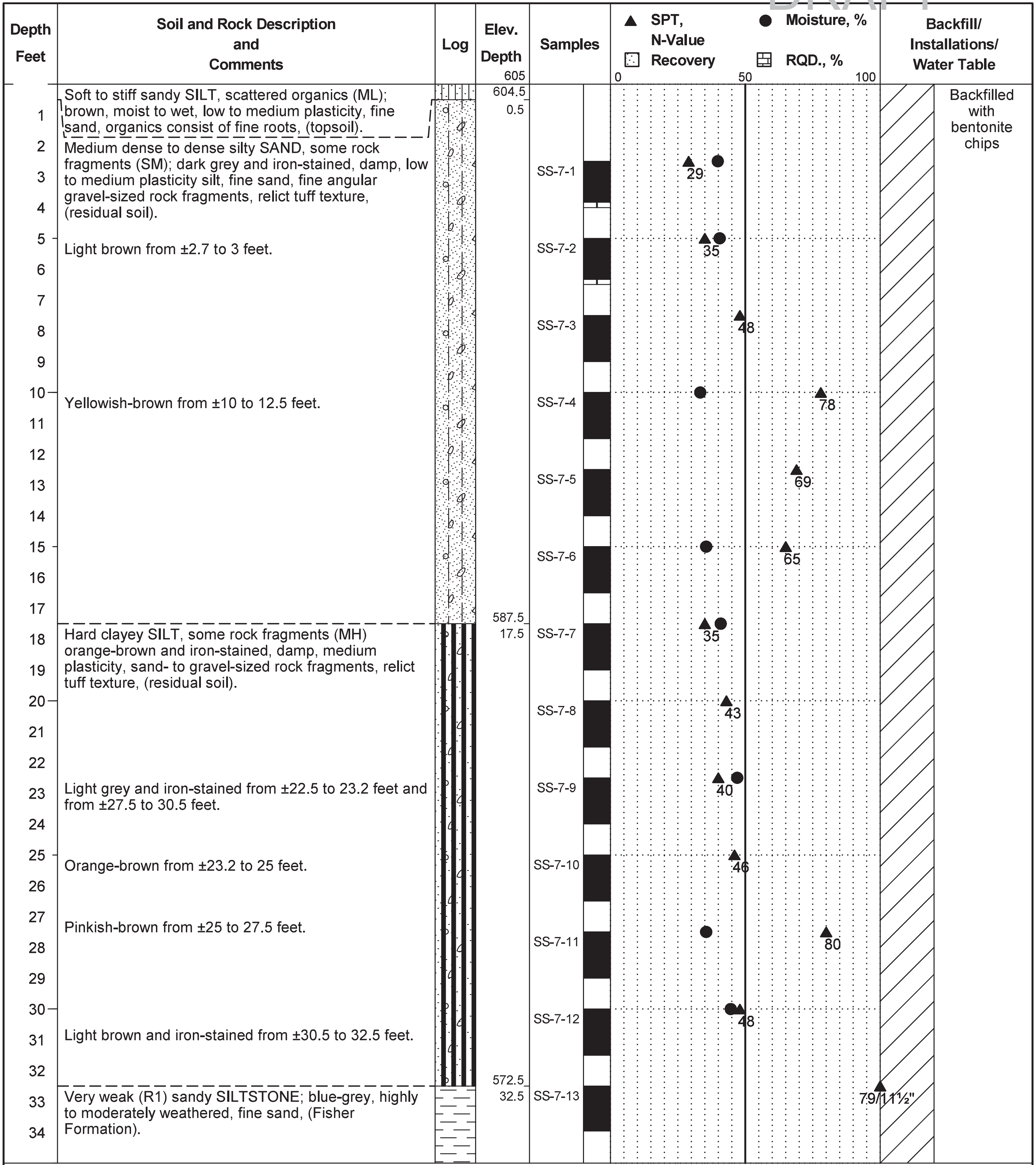
Date of Boring: November 14, 2020

Foundation Engineering, Inc.

Boring Log: BH-6

East 40th Avenue Storage Tank

Eugene, Oregon



Soft to stiff sandy SILT, scattered organics (ML); brown, moist to wet, low to medium plasticity, fine sand, organics consist of fine roots, (topsoil).

Medium dense to dense silty SAND, some rock fragments (SM); dark grey and iron-stained, damp, low to medium plasticity silt, fine sand, fine angular gravel-sized rock fragments, relict tuff texture, (residual soil).

Light brown from ±2.7 to 3 feet.

Yellowish-brown from ±10 to 12.5 feet.

Hard clayey SILT, some rock fragments (MH) orange-brown and iron-stained, damp, medium plasticity, sand- to gravel-sized rock fragments, relict tuff texture, (residual soil).

Light grey and iron-stained from ±22.5 to 23.2 feet and from ±27.5 to 30.5 feet.

Orange-brown from ±23.2 to 25 feet.

Pinkish-brown from ±25 to 27.5 feet.

Light brown and iron-stained from ±30.5 to 32.5 feet.

Very weak (R1) sandy SILTSTONE; blue-grey, highly to moderately weathered, fine sand, (Fisher Formation).

Backfilled with bentonite chips

Project No.: 2201086

Surface Elevation: 605.0 feet (Approx.)

Date of Boring: November 14, 2020

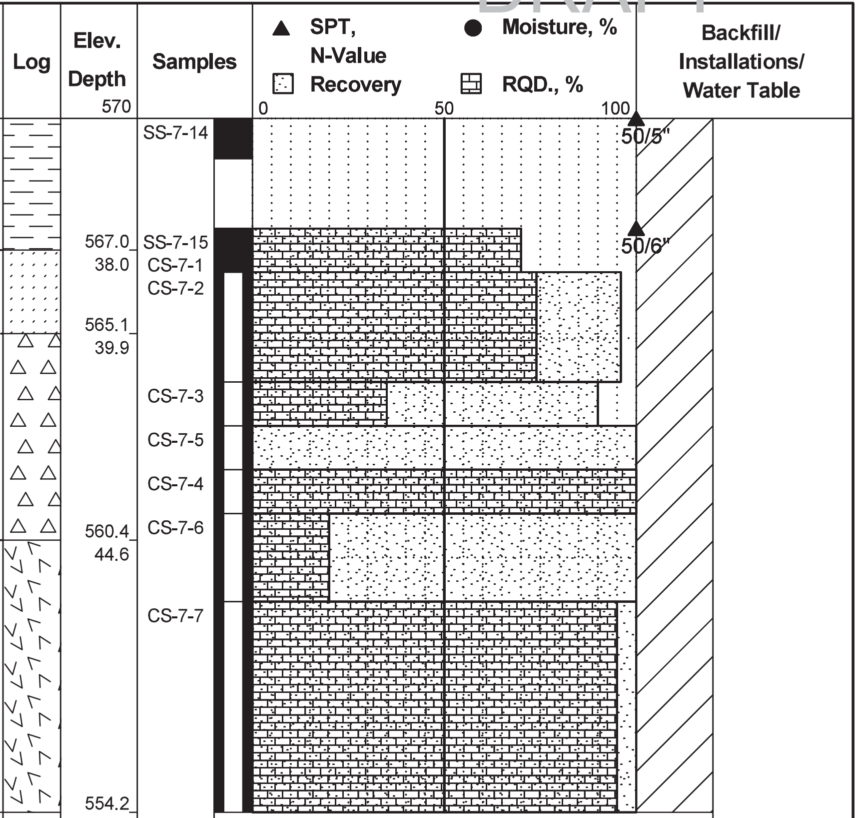
Boring Log: BH-7

East 40th Avenue Storage Tank

Eugene, Oregon

Foundation Engineering, Inc.

Depth Feet	Soil and Rock Description and Comments	Elev. Depth 570	Samples
	Dark grey below ±35 feet.		SS-7-14
36			
37	Shaly below ±37.5 feet.		
38	Very weak (R1) silty SANDSTONE; blue-grey and iron-stained, moderately weathered, very close to close joints are irregular, rough, and closed, fine to medium sand, (Fisher Formation). Occasional gravel-sized angular basalt clasts below ±38.5 feet. Slickensides at ±39 feet.	567.0 38.0	SS-7-15 CS-7-1 CS-7-2
39			
40		565.1 39.9	
41			CS-7-3
42	Weak (R2) BASALT BRECCIA; dark grey, slightly weathered, very close to close joints are irregular, rough to very rough, and open to closed, (Fisher Formation).		CS-7-5
43			CS-7-4
44		560.4 44.6	CS-7-6
45	Strong to very strong (R4 to R5) BASALT; dark grey, slightly weathered, very close to moderately close joints are irregular, rough, and open to closed, (Fisher Formation). Slickensides at ±44.6 to 44.9 feet. Calcite veining from ±45 to 46 feet.		
46			CS-7-7
47			
48			
49			
50		554.2 50.8	
	BOTTOM OF BORING		



Project No.: 2201086

Surface Elevation: 605.0 feet (Approx.)

Date of Boring: November 14, 2020

Foundation Engineering, Inc.

Boring Log: BH-7

East 40th Avenue Storage Tank

Eugene, Oregon

Photo 1B. BH-1 from 10.0 to 23.3 ft - Box 1 of 5

Photo 2B. BH-1 from 23.3 to 30.9 ft - Box 2 of 5

Photo 3B. BH-1 from 30.9 to 38.5 ft - Box 3 of 5

Photo 4B. BH-1 from 38.5 to 46.3 ft - Box 4 of 5

Photo 5B. BH-1 from 46.3 to 47.5 ft - Box 5 of 5

Photo 6B. BH-2 from 12.5 to 21.3 ft - Box 1 of 5

Photo 7B. BH-2 from 21.3 to 30.7 ft - Box 2 of 5

Photo 8B. BH-2 from 30.7 to 39.8 ft – Box 3 of 5

Photo 9B. BH-2 from 39.8 to 48.8 ft - Box 4 of 5

Photo 10B. BH-2 from 48.8 to 52.0 ft - Box 5 of 5

Photo 11B. BH-3 from 7.5 to 17.1 ft - Box 1 of 5

Photo 12B. BH-3 from 17.1 to 25.4 ft - Box 2 of 5

Photo 13B. BH-3 from 25.4 to 33.5 ft - Box 3 of 5

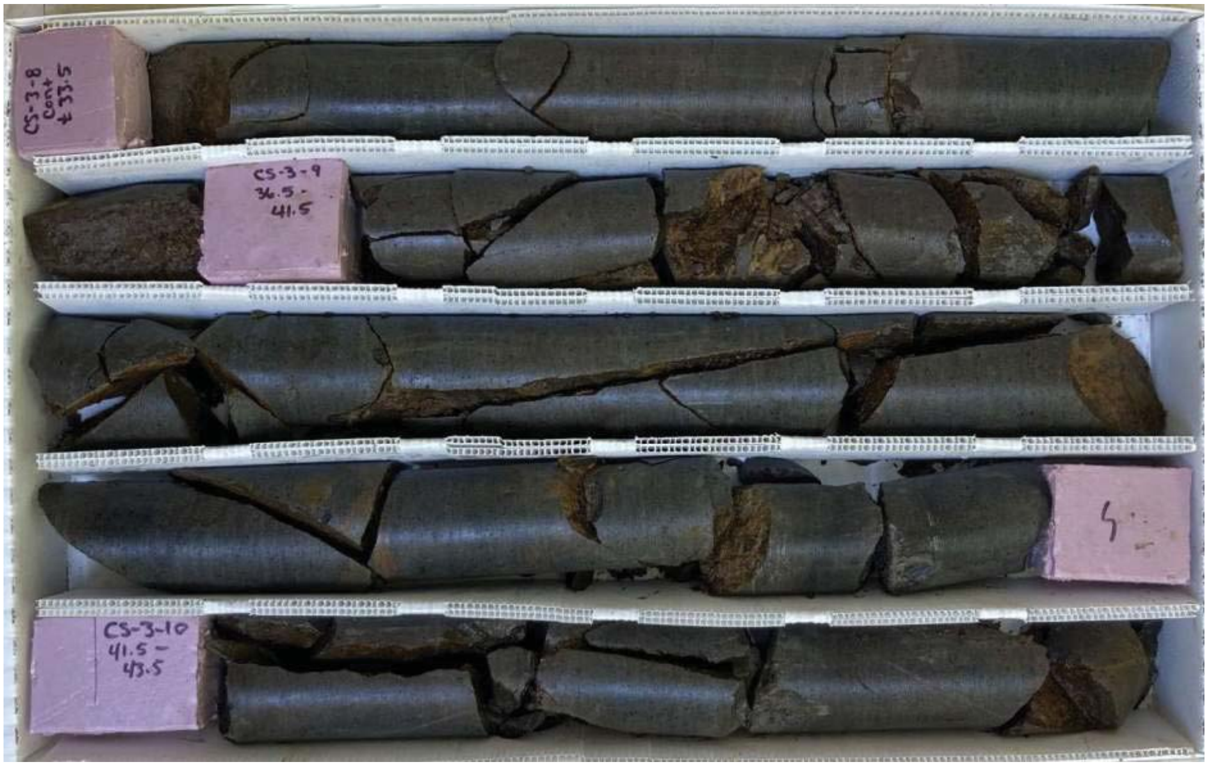


Photo 14B. BH-3 from 33.5 to 43.5 ft - Box 4 of 5

Photo 15B. BH-3 from 43.5 to 50.0 ft - Box 5 of 5

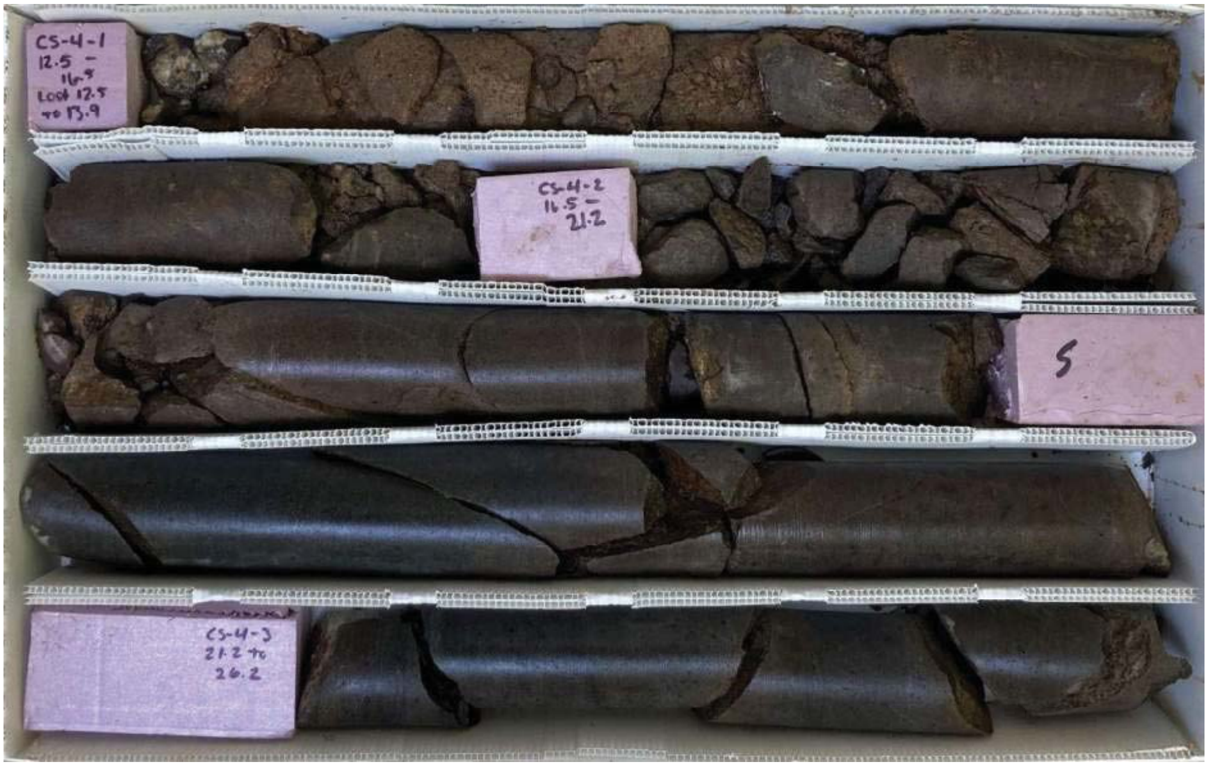


Photo 16B. BH-4 from 12.5 to 23.0 ft - Box 1 of 3

Photo 17B. BH-4 from 23.0 to 31.5 ft - Box 2 of 3

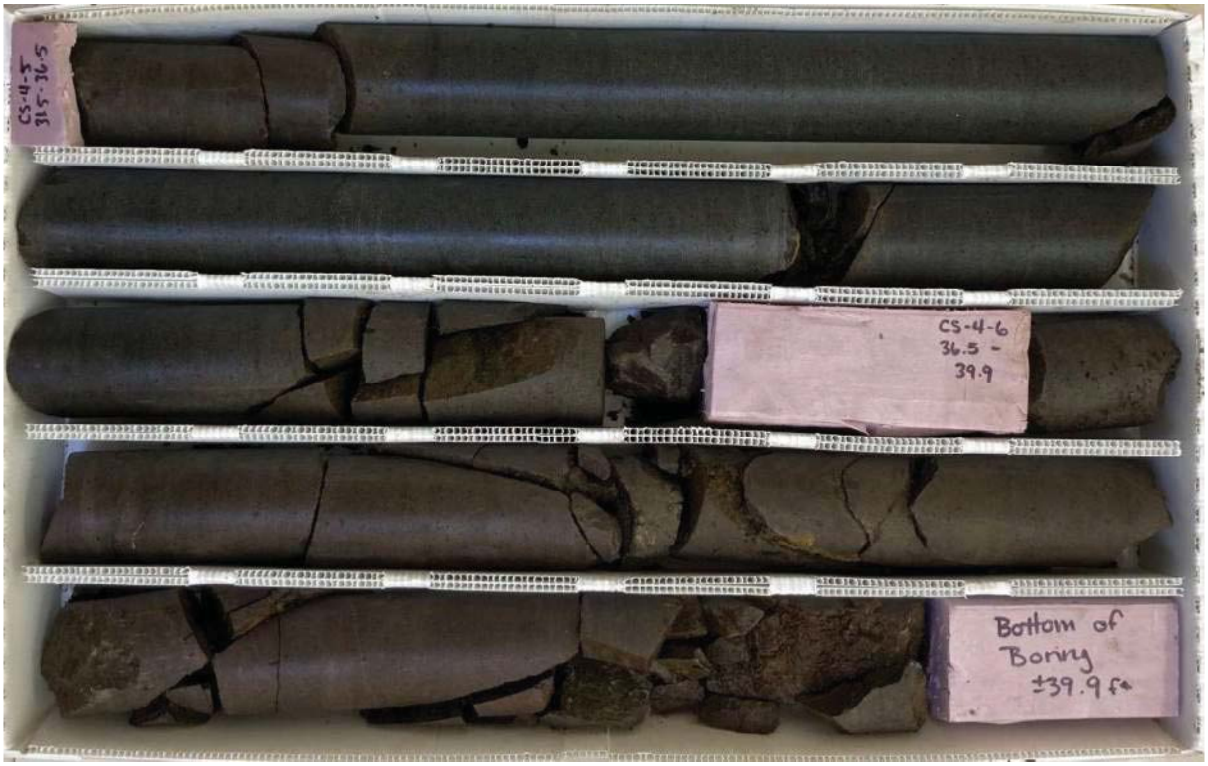


Photo 18B. BH-4 from 31.5 to 39.9 ft - Box 3 of 3

Photo 19B. BH-5 from 0.5 to 11.8 ft - Box 1 of 4

Photo 20B. BH-5 from 11.8 to 20.0 ft - Box 2 of 4

Photo 21B. BH-5 from 20.0 to 29.0 ft - Box 3 of 4

Photo 22B. BH-5 from 29.0 to 30.0 ft - Box 4 of 4

Photo 23B. BH-6 from 5.0 to 11.8 ft - Box 1 of 5

Photo 24B. BH-6 from 11.8 to 23.2 ft - Box 2 of 5

Photo 25B. BH-6 from 23.2 to 31.0 ft - Box 3 of 5

Photo 26B. BH-6 from 31.0 to 39.4 ft - Box 4 of 5

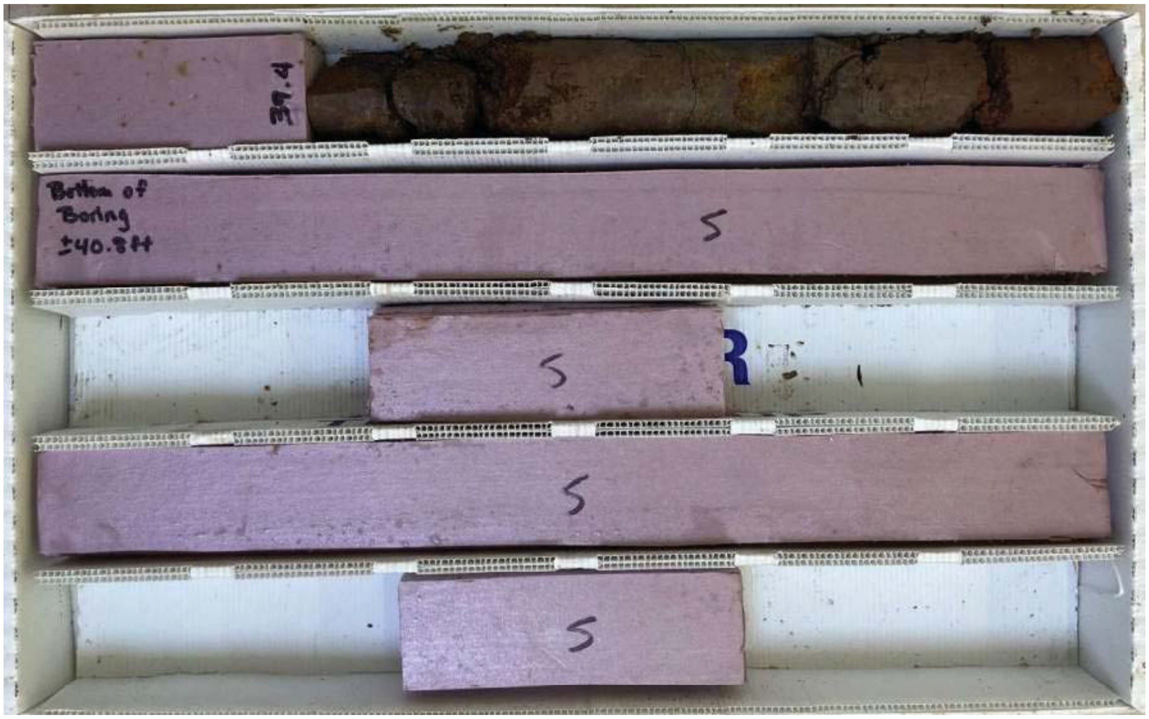


Photo 27B. BH-6 from 39.4 to 40.8 ft - Box 5 of 5

Photo 28B. BH-7 from 37.5 to 46.0 ft - Box 1 of 2

Photo 29B. BH-7 from 46.0 to 50.8 ft - Box 2 of 2

Table 1B. Summary of Boring and Bedrock Elevations

Boring	Estimated Ground Surface Elevation (ft)	Maximum Depth of Boring (ft)	Estimated Bottom of Boring Elevation (ft)	Depth to Bedrock (ft)	Estimated Bedrock Elevation (ft)
BH-1	±El. 596.5	±47.5	±El. 549.0	±9.0	±El. 587.5
BH-2	±El. 596.0	±52.0	±El. 544.0	±10.2	±El. 585.8
BH-3	±El. 603.5	±50.0	±El. 553.5	±5.5	±El. 598.0
BH-4	±El. 603.5	±40.2	±El. 563.3	±11.0	±El. 592.5
BH-5	±El. 585.0	±30.0	±El. 555.0	±0.5	±El. 584.5
BH-6	±El. 596.5	±40.8	±El. 555.7	±0.5	±El. 596.0
BH-7	±El. 605.0	±50.8	±El. 554.2	±38.0	±El. 567.0

Appendix C

Laboratory Testing

Foundation Engineering, Inc.
Professional Geotechnical Services

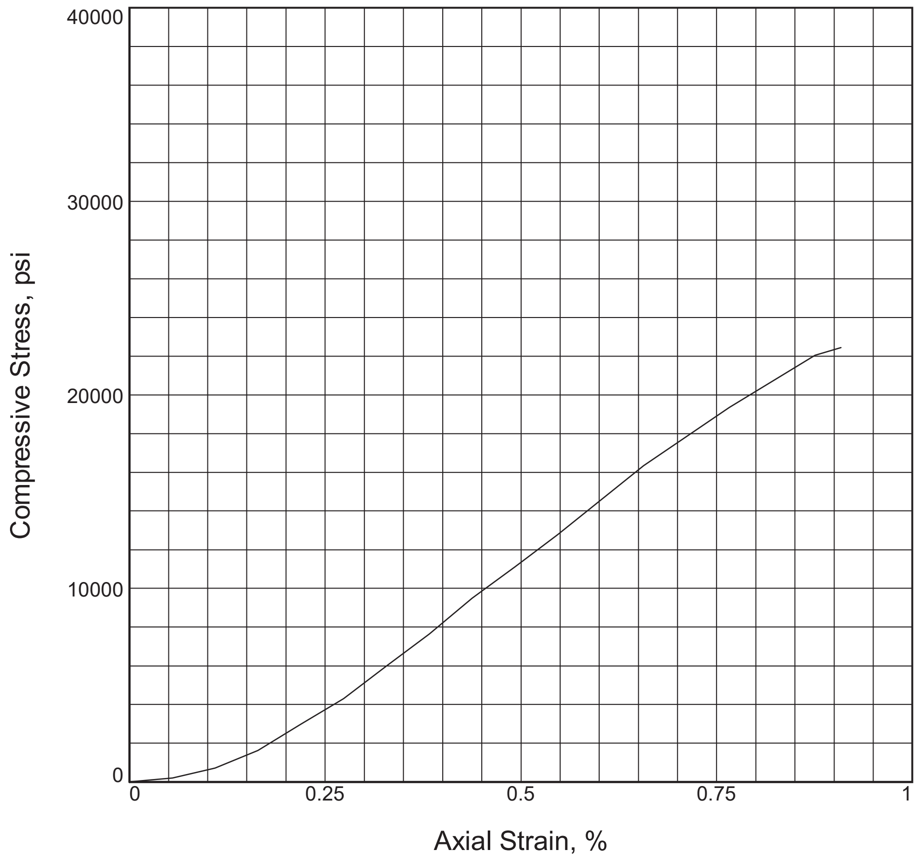
Table 1C. Moisture Contents (ASTM D 2216)

Sample Number	Sample Depth (ft)	Moisture Content (percent)
SS-7-1	2.5 – 4.0	39.8
SS-7-2	5.0 – 6.5	40.5
SS-7-4	10.0 – 11.5	33.3
SS-7-6	15.0 – 16.5	35.5
SS-7-7	17.5 – 19.0	40.9
SS-7-9	22.5 – 24.0	47.0
SS-7-11	27.5 – 29.0	35.5
SS-7-12	30.0 - 31.5	44.6

Table 2C. Summary of Unconfined Compressive Strengths

Boring	Sample Number	Sample Depth (ft)	Rock Description	Wet Density (pcf)	Unconfined Compressive Strength (psi)
BH-1	CS-1-1	11.3 – 11.7	R5 BASALT	172.0	22,922
BH-1	CS-1-5	21.3 - 21.7	R5 BASALT	176.1	18,854
BH-1	CS-1-6	25.8 - 26.2	R5 BASALT	174.9	22,444
BH-2	CS-2-4	23.5 - 23.9	R3 - R4 BASALT	174.4	8,216
BH-3	CS-3-1	7.7 - 8.1	R4 BASALT	175.5	10,623
BH-3	CS-3-6	24.3 - 24.7	R5 BASALT	176.3	22,753
BH-3	CS-3-7	27.1 - 27.5	R5 BASALT	176.7	26,388
BH-3	CS-3-8	32.0 - 32.4	R5 BASALT	177.0	24,092
BH-4	CS-4-3	23.1 - 23.5	R5 BASALT	175.5	23,395
BH-4	CS-4-4	28.4 - 28.8	R4 - R5 BASALT	177.6	16,853
BH-4	CS-4-5	33.6 - 34.0	R5 BASALT	178.3	24,787
BH-5	CS-5-2	3.8 - 4.2	R5 BASALT	176.7	26,357
BH-5	CS-5-5	11.1 - 11.5	R4 BASALT	173.8	10,320
BH-5	CS-5-8	20.7 - 21.1	R5 BASALT	175.7	23,548
BH-6	CS-6-2	8.1 - 8.5	R5 BASALT	175.7	20,029
BH-6	CS-6-3	11.1 - 11.5	R4 - R5 BASALT	175.0	16,049
BH-6	CS-6-7	24.1 - 24.5	R5 BASALT	176.3	19,948
BH-6	CS-6-8	27.5 - 27.9	R5 BASALT	175.9	19,677
BH-7	CS-7-7	50.3 - 50.7	R4 - R5 BASALT	173.2	16,398

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psi	22444			
Failure strain, %	0.9			
Strain rate, %/min.	0.25			
Water content, %	1.4			
Wet density, pcf	174.9			
Dry density, pcf	172.5			
Specimen diameter, in.	2.38			
Specimen height, in.	4.57			
Height/diameter ratio	1.92			

Description: BASALT

Type: Rock Core

Project No.: 2206001-638

Date Sampled:

Remarks:
Weak jointing reduced viability of sample.
L/D Ratio - 1:1.923

Figure 1C

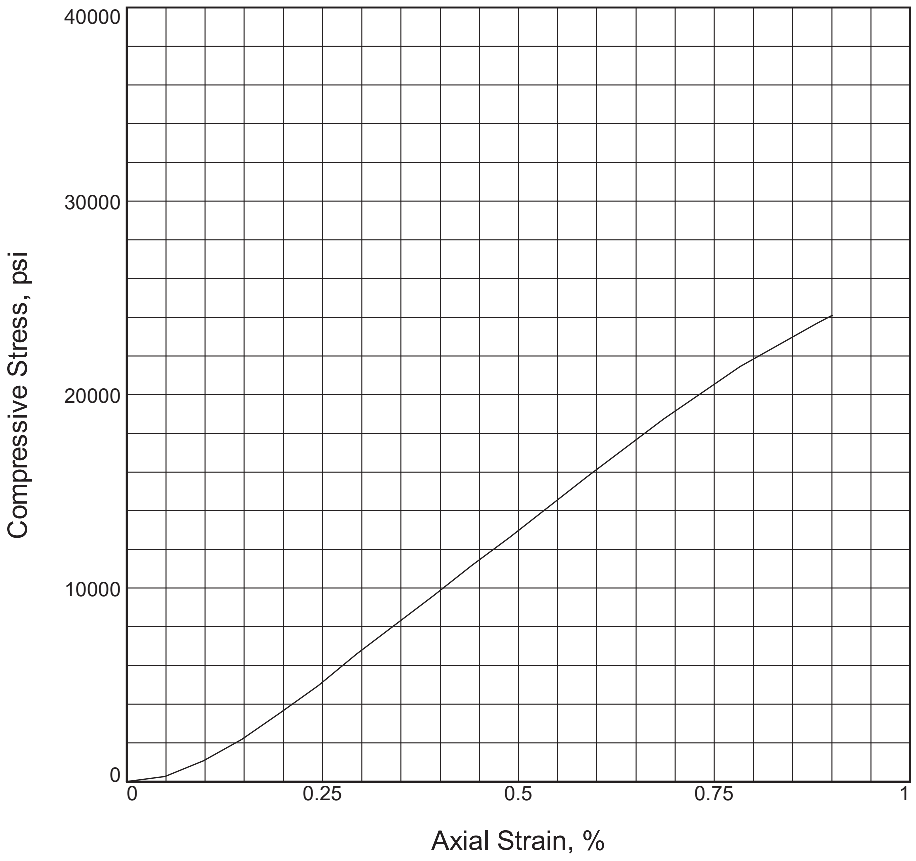
Client: Foundation Engineering, Inc. (Project No.: 2201086)

Project: East 40th Avenue Storage Tank

Source of Sample: 8077 **Depth:** 25.8'-26.2'
Sample Number: CS-1-6

UNCONFINED COMPRESSION TEST
FEI Testing & Inspection, Inc.
Corvallis, OR

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psi	24092			
Failure strain, %	0.9			
Strain rate, %/min.	0.25			
Water content, %	1.0			
Wet density, pcf	177.0			
Dry density, pcf	175.3			
Specimen diameter, in.	2.37			
Specimen height, in.	5.11			
Height/diameter ratio	2.15			

Description: BASALT

Type: Rock Core

Project No.: 2206001-638

Date Sampled:

Remarks:

Figure 2C

Client: Foundation Engineering, Inc. (Project No.: 2201086)

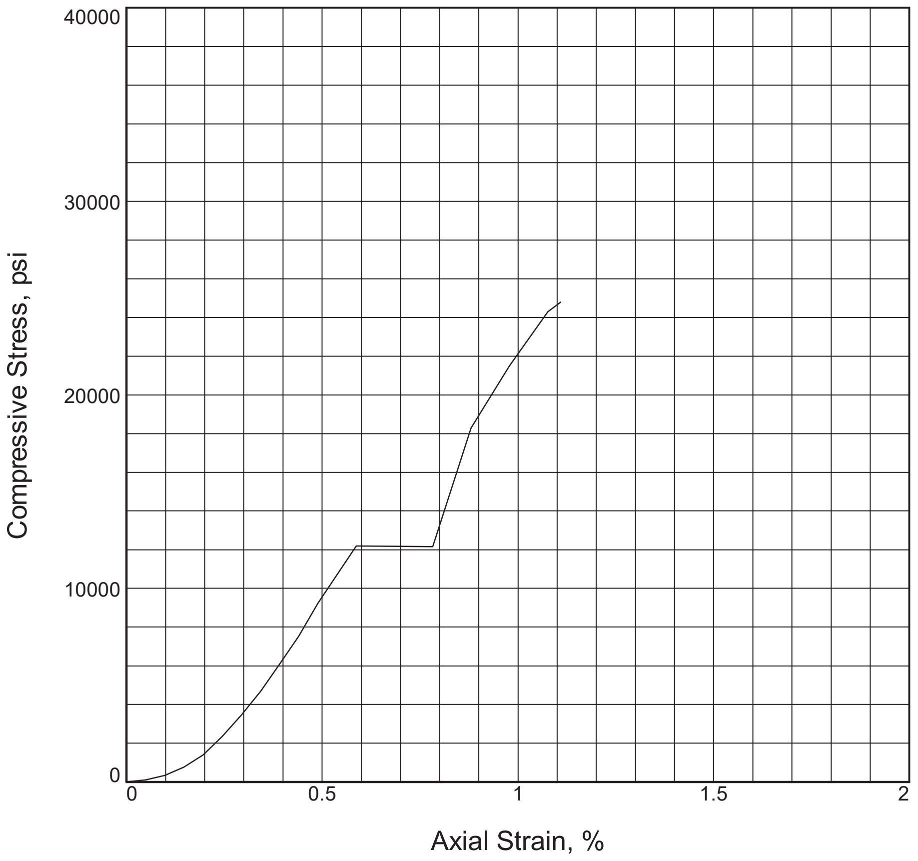
Project: East 40th Avenue Storage Tank

Source of Sample: 8077 **Depth:** 32.0'-32.4'

Sample Number: CS-3-8

UNCONFINED COMPRESSION TEST
FEI Testing & Inspection, Inc.
Corvallis, OR

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psi	24787			
Failure strain, %	1.1			
Strain rate, %/min.	0.25			
Water content, %	0.7			
Wet density, pcf	178.3			
Dry density, pcf	177.1			
Specimen diameter, in.	2.38			
Specimen height, in.	5.11			
Height/diameter ratio	2.15			

Description: BASALT

Type: Rock Core

Project No.: 2206001-638
Date Sampled:

Remarks:
Initial fracture caused dial guage to jump approximately 0.0050 in., from 0.0350-0.0400. Unable to collect data from this portion of test.

Figure 3C

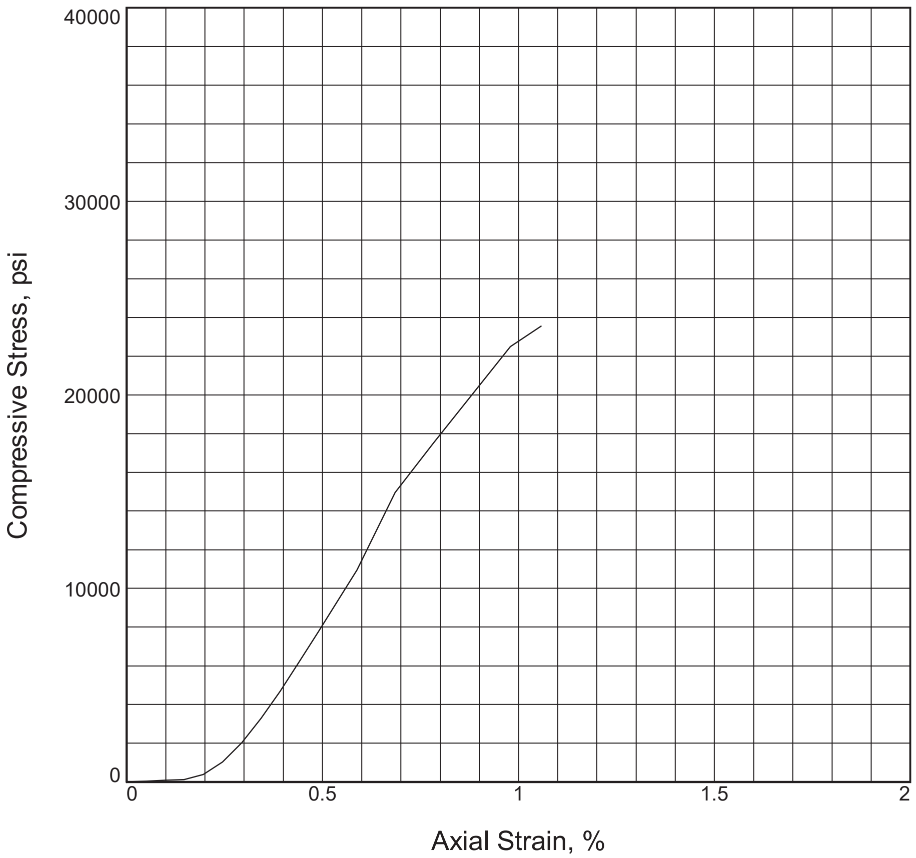
Client: Foundation Engineering, Inc. (Project No.: 2201086)

Project: East 40th Avenue Storage Tank

Source of Sample: 8077 **Depth:** 33.6'-34.0'
Sample Number: CS-4-5

UNCONFINED COMPRESSION TEST
FEI Testing & Inspection, Inc.
Corvallis, OR

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psi	23548			
Failure strain, %	1.1			
Strain rate, %/min.	0.25			
Water content, %	1.2			
Wet density, pcf	175.7			
Dry density, pcf	173.6			
Specimen diameter, in.	2.38			
Specimen height, in.	5.11			
Height/diameter ratio	2.15			

Description: BASALT

Type: Rock Core

Project No.: 2206001-638
Date Sampled: 11/09/20-11/14/20
Remarks:

Figure 4C

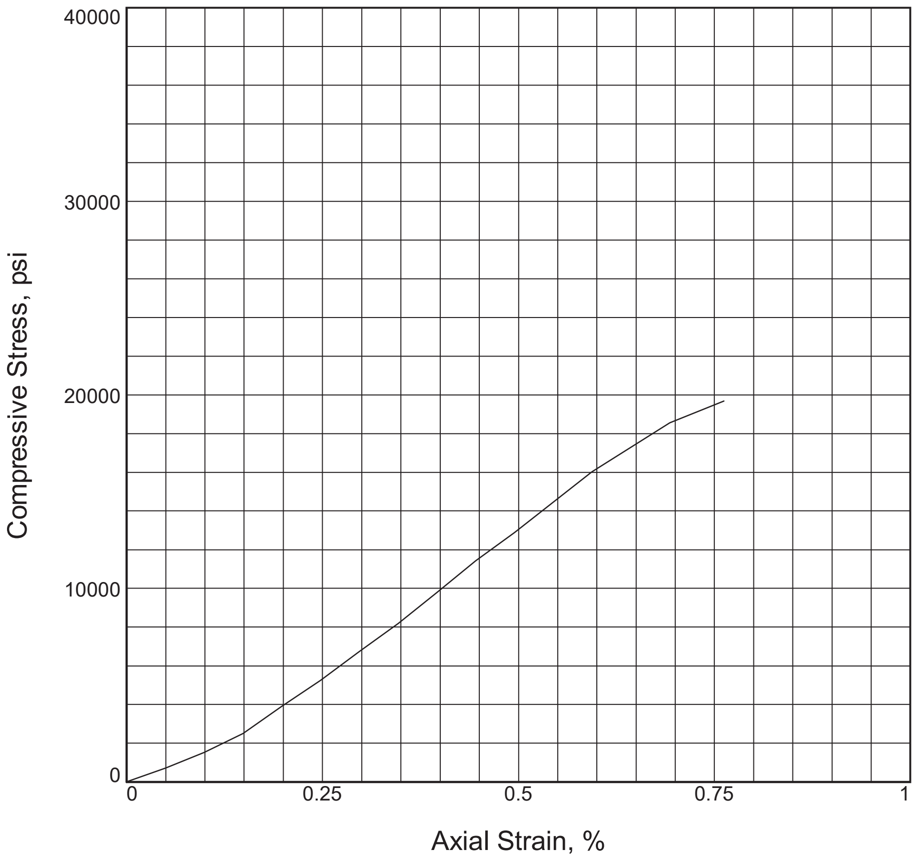
Client: Foundation Engineering, Inc. (Project No.: 2201086)

Project: East 40th Avenue Storage Tank

Source of Sample: 8077 **Depth:** 20.7'-21.1'
Sample Number: CS-5-8

UNCONFINED COMPRESSION TEST
FEI Testing & Inspection, Inc.
Corvallis, OR

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psi	19677			
Failure strain, %	0.8			
Strain rate, %/min.	0.25			
Water content, %	0.9			
Wet density, pcf	175.9			
Dry density, pcf	174.3			
Specimen diameter, in.	2.38			
Specimen height, in.	5.05			
Height/diameter ratio	2.12			

Description: BASALT

Type: Rock Core

Project No.: 2206001-638
Date Sampled:
Remarks:

Client: Foundation Engineering, Inc. (Project No.: 2201086)

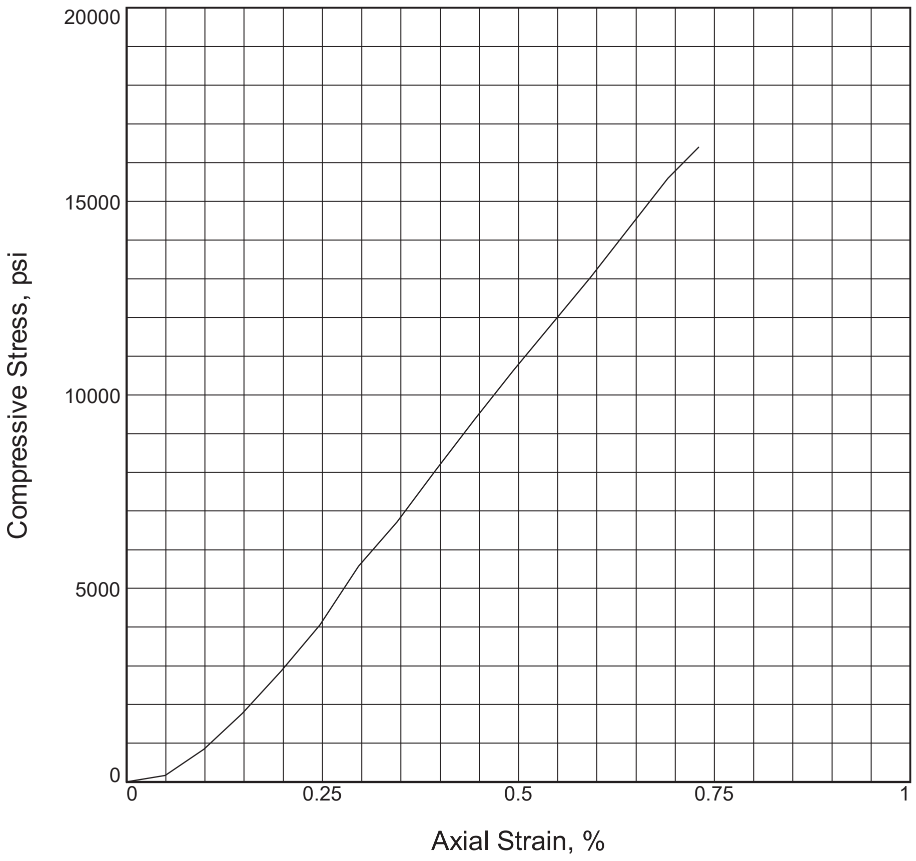
Project: East 40th Avenue Storage Tank

Source of Sample: 8077 **Depth:** 27.5'-27.9'
Sample Number: CS-6-8

UNCONFINED COMPRESSION TEST
FEI Testing & Inspection, Inc.
Corvallis, OR

Figure 5C

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psi	16398			
Failure strain, %	0.7			
Strain rate, %/min.	0.25			
Water content, %	2.3			
Wet density, pcf	173.2			
Dry density, pcf	169.4			
Specimen diameter, in.	2.38			
Specimen height, in.	5.07			
Height/diameter ratio	2.13			

Description: BASALT

Type: Rock Core

Project No.: 2206001-638
Date Sampled:
Remarks:

Figure 6C

Client: Foundation Engineering, Inc. (Project No.: 2201086)

Project: East 40th Avenue Storage Tank

Source of Sample: 8077 **Depth:** 50.3'-50.7'
Sample Number: CS-7-7

UNCONFINED COMPRESSION TEST
FEI Testing & Inspection, Inc.
Corvallis, OR

Appendix D

Seismic Hazard Study

Foundation Engineering, Inc.
Professional Geotechnical Services

SEISMIC HAZARD STUDY

EAST 40TH AVENUE STORAGE TANK
EUGENE, OREGON

INTRODUCTION

This seismic hazard study was completed to identify potential geologic and seismic hazards and evaluate the effect those hazards may have on the proposed project. The study fulfills the requirements presented in the 2019 Oregon Structural Specialty Code (OSSC), Section 1803 for site-specific seismic hazard reports for essential and hazardous facilities and major and special-occupancy structures (OSSC, 2019).

The following sections provide a discussion of the local and regional geology, seismic and tectonic setting, earthquakes, and seismic hazards. A detailed discussion of the subsurface conditions at the project location, including exploration logs, is provided in the main report.

LITERATURE REVIEW

Available geologic and seismic publications and maps were reviewed to characterize the local and regional geology and evaluate relative seismic hazards at the site. Information from geotechnical and seismic hazard investigations previously conducted by others at the site and by Foundation Engineering in the surrounding area were also reviewed.

Regional Geology

The site is located within the Willamette Valley, which is a broad, north-south-trending basin separating the Coast Range to the west from the Cascade Range to the east. The project site is near the southern extent of the Willamette Valley.

At the western margin of Oregon is the Cascadia Subduction Zone (CSZ). The CSZ is a converging, oblique plate boundary where the Juan de Fuca oceanic plate is being subducted beneath the western edge of the North American continental plate (Geomatrix Consultants, 1995). The CSZ extends from central Vancouver Island, in British Columbia, Canada, through Washington and Oregon to Northern California in the United States (Atwater, 1970). The movement of the subduction zone has resulted in accretion, folding, faulting, and uplift of oceanic and other sediments on the western margin of the North American plate.

In the early Eocene (±55 million years ago), the present location of the Willamette Valley was part of a broad continental shelf extending west from the Western Cascades beyond the present coastline (Orr and Orr, 1999). Basement rock underlying most of the north-central portion of the Valley includes the Siletz River Volcanics (early to middle Eocene, ±50 to 58 million years old), which erupted as part of a submarine oceanic island-arc (Bela, 1979; Yeats et al., 1996). The thickness of the basement volcanic rock is unknown; however, it is estimated to be ±3 to 4 miles thick (Yeats et al., 1996).

The island-arc collided with, and was accreted to, the western margin of the converging North American plate near the end of the early Eocene. Volcanism subsided and a forearc basin was created and infilled to the south with marine sediments of the Eugene Formation and terrestrial sedimentary and volcanic deposits of the Fisher Formation and Little Butte Volcanics throughout the late Eocene and Oligocene (Orr and Orr, 1999; Wiley, 2008). These sediments typically overlie but are also interbedded with younger Tertiary volcanics in the Eugene area.

After emerging from a gradually shallowing ocean, the marine sediments and volcanic formations were covered by the terrestrial Columbia River Basalt (CRB). The CRB poured through the Columbia Gorge from northeastern Oregon and southeastern Washington and spread as far south as Salem, Oregon (±17 to 10 million years ago, middle to late Miocene) (Tolan et al., 2000). Uplift and folding of the Coast Range and the Western Cascades during the late Miocene formed the trough-like configuration of the Willamette Valley (Orr and Orr, 1999; O'Connor et al., 2001; Wiley, 2008; McClaughry et al., 2010).

Following the formation of the Willamette Valley, thick layers of Pliocene gravel filled the Southern Valley (McClaughry et al., 2010). The deposits were then incised by the Willamette River, forming alluvial terraces. In the Pleistocene (±1.6 million to 10,000 years ago), the Central and Southern Valley was refilled with fan-delta gravel, originating from the melting glaciers in the Cascade Range. The Willamette and McKenzie Rivers in the Eugene area incised deeply into the fan-delta deposits during the Quaternary and deposited recent alluvium adjacent to the river banks and major tributaries (Madin and Murray, 2006).

Also, during the Pleistocene (over 15,000 years ago), catastrophic flood deposits mantled the Willamette Valley floor as far south as Eugene (Hampton, 1972; Yeats et al., 1996; O'Connor et al., 2001; McClaughry et al., 2010). These deposits originated from a series of glacial-outburst floods that periodically drained Glacial Lake Missoula in western Montana (Allen et al., 2009). The older flood deposits, typically found within the Portland Basin, usually consist of layers of cobbles/boulders, gravel, and sand during a time period when the river(s) had sufficiently high flow to move large boulders (i.e., erratics) and coarser material. In the Southern Willamette Valley, turbid floodwater eventually settled, depositing a relatively thick layer (50 to 100 feet) of silt and clay, which has been named Willamette Silt (Orr and Orr, 1999).

Local Geology

The reservoir site is near the top of a ridge composed of northwestern-trending mounds with a shallow saddle between. Local geologic mapping indicates the site is underlain by bedrock of the Fisher Formation (Yeats et al., 1996; Madin and Murray, 2006; McClaughry et al., 2010). The Fisher Formation consists of volcaniclastic sedimentary rocks and tuffs with interfingering andesitic to basaltic flows, and the rocks can be deeply weathered or hydrothermally altered (Walker and Duncan, 1989; Yeats et al., 1996; Madin and Murray, 2006).

The subsurface conditions encountered in our exploratory borings are consistent with the mapped local geology. Basalt and associated volcanics encountered within the explorations are interpreted to be the Fisher Formation based on the local geologic mapping. Details are provided in the Subsurface Conditions section of the main report and on the boring logs in Appendix B.

Seismic Setting and Local Faulting

We completed a literature review of nearby faults to evaluate the seismic setting and identify the potential seismic sources. The US Geological Survey (USGS) website includes an interactive deaggregation tool, which allows evaluation of the contribution of the various seismic sources to the overall seismic hazard (USGS, 2014). The USGS interactive deaggregation indicates the seismic hazard at the site is dominated by the CSZ (USGS, 2014). A discussion of these earthquake sources is provided below.

Cascadia Subduction Zone (CSZ). The site is ±110 miles east of the surface expression of the CSZ. The CSZ is a converging, oblique plate boundary where the Juan de Fuca plate is being subducted beneath the western edge of the North American plate. It is estimated the average rate of subduction of the Juan de Fuca plate under the North American plate is ±37 mm/year northeast, based on Pacific and Mid-Ocean Ridge velocities, geodetic studies of convergence, and magnetic anomalies of the Juan de Fuca plate (Personius and Nelson, 2006; DeMets et al., 2010). The CSZ extends ±700 miles from central Vancouver Island in British Columbia, Canada, through Washington and Oregon to Northern California (Atwater, 1970).

Crustal Faults. Crustal faults are fractures within the North American plate. Numerous faults are presented on local and regional geologic maps. However, not all faults are considered to be active. Because the historical earthquake record is so short, active faults are identified by geologic mapping and seismic surveys.

The USGS has defined four fault classifications based on evidence for displacement within the Quaternary (<1.6 million years) in their US fault database (Palmer, 1983; Personius et al., 2003). The fault classes are defined as follows:

- ***Class A*** – Faults with geologic evidence supporting tectonic movement in the Quaternary known or presumed to be associated with large-magnitude earthquakes.

- ***Class B*** – Faults with geologic evidence that demonstrates the existence of a fault or suggests Quaternary deformation, but either: 1) the fault might not extend deep enough to be a potential source of significant earthquakes or 2) the current evidence is too strong to confidently classify the fault as a Class C but not strong enough to classify it as a Class A.

- ***Class C*** – Faults with insufficient evidence to demonstrate 1) the existence of a tectonic fault, or 2) Quaternary movement or deformation associated with the feature.

- ***Class D*** – Geologic evidence indicates the feature is not a tectonic fault or feature.

Class A and B faults are included in the USGS fault database and interactive fault map. USGS considers 17 features in Oregon to be Class C faults (USGS, 2006a). The Class C Harrisburg anticline is ±19 miles north-northwest of the site. The USGS does not consider any features in Oregon as Class D (USGS, 2006a).

Local geologic maps indicate no faults are mapped beneath the site (Walker and Duncan, 1989; Yeats et al., 1996; Madin and Murray, 2006). A few concealed and inferred crustal faults have been mapped within ±10 miles of the site; however, none of the nearby faults show any evidence of movement in the last ±1.6 million years (Palmer, 1983; Geomatrix Consultants, 1995; Personius et al., 2003; USGS, 2006a).

Four potentially active Quaternary Class A and B crustal fault zones have been mapped by the USGS within ±40 miles of the site (Palmer, 1983; Geomatrix Consultants, 1995; Personius et al., 2003; USGS, 2006a). These faults are listed in Table 1D. Figure 1D shows the approximate surface projection locations of these faults.

Table 1D. USGS Class A and Class B Crustal Faults within a ±40-mile Radius of the Site (1)

Fault Name and Class	Fault Number	Approximate Length (miles)	Approximate Distance and Direction from Site (miles) (2)	Last Known Deformation (years) (3)	Slip Rate (mm/yr)
Upper Willamette River (B)	863	±27	±24 SE	<1.6 million years	<0.20
Owl Creek (A)	870	±9	±33 N-NW	<750,000	<0.20
Corvallis (B)	869	±25	±38 NW	<1.6 million years	<0.20
Unnamed faults near Sutherlin (B)	862	±17	±39 SW	<750,000	<0.20

(1) Fault data based on Personius et al., 2003 and USGS, 2006a and b.

(2) Distance and direction from site to nearest surface projection of the fault.

(3) Quaternary time period defined at <1.6 million years based on the 1983 Geologic Time Scale (Palmer, 1983).

Historic Earthquakes

Available information indicates the CSZ is capable of generating earthquakes along the inclined interface between the two plates (interface) and within the descending Juan de Fuca plate (intraplate) (Weaver and Shedlock, 1996). The fault rupture may occur along a portion or the entire length of the CSZ (Weaver and Shedlock, 1996).

CSZ Interface Earthquakes. The estimated maximum magnitude of a CSZ interface earthquake is up to a moment magnitude (M_w) 9.3 (Petersen et al., 2014). No significant interface (subduction zone) earthquakes have occurred on the CSZ in historic times. However, several large-magnitude (>M ~8.0, M = unspecified magnitude scale) subduction zone earthquakes are thought to have occurred in the past few thousand years. This is evidenced by tsunami inundation deposits, combined with evidence for episodic subsidence along the Oregon and Washington coasts (Peterson et al., 1993; Atwater et al., 1995).

Numerous detailed studies of coastal subsidence, tsunami, and turbidite deposits estimate a wide range of CSZ earthquake recurrence intervals. Turbidite deposits in the Cascadia Basin have been investigated to help develop a paleoseismic record for the CSZ and estimate recurrence intervals for interface earthquakes (Adams, 1990; Goldfinger et al., 2012). A study of offshore turbidites from the last ±10,000 years suggests the return period for interface earthquakes varies with location and rupture length. That study estimated an average recurrence interval of ±220 to 380 years for an interface earthquake on the southern portion of the CSZ, and an average recurrence interval of ±500 to 530 years for an interface earthquake extending the entire length of the CSZ (Goldfinger et al., 2012). Older, deep-sea cores have been re-examined more recently, and the findings may indicate greater Holocene stratigraphy variability along the Washington coast (Atwater et al., 2014). Additional research by Goldfinger for the northern portion of the CSZ suggests a recurrence interval of ±340 years for the northern Oregon Coast (Goldfinger et al., 2016). The most recent CSZ interface earthquake occurred ±321 years ago (January 26, 1700) (Nelson et al., 1995; Satake et al., 1996).

CSZ Intraplate Earthquakes. Intraplate (Intraslab or Wadati-Benioff Zone) earthquakes occur within the Juan de Fuca plate at depths of ±28 to 37 miles (Weaver and Shedlock, 1996). The maximum estimated magnitude of an intraplate earthquake is about M_w 7.5 (Petersen et al., 2014). The available record for intraplate earthquakes in Oregon is limited. The available data indicates a M_b = 4.6 (compressional body wave magnitude) event occurred in 1963, located ±23 miles east of Salem at a depth of ±29 miles (Barnett et al., 2009). Based on its depth, this earthquake may be considered an intraplate event. The Puget Sound region of Washington State has experienced three intraplate events in the last ±72 years, including a surface wave magnitude (M_s) 7.1 event in 1949 (Olympia), a M_s 6.5 event in 1965 (Seattle/Tacoma) (Wong and Silva, 1998), and a M_w 6.8 event in 2001 (Nisqually) (Dewey et al., 2002).

Crustal Earthquakes. Crustal earthquakes dominate Oregon's seismic history. Crustal earthquakes occur within the North American plate, typically at depths of ±6 to 12 miles. The estimated maximum magnitude of a crustal earthquake in the Willamette Valley and adjacent physiographic regions is about M_w 7.0 (Petersen et al., 2014). Only two historic crustal events in Oregon have reached Richter local magnitude (M_L) 6 (the 1936 Milton-Freewater M_L 6.1 earthquake and the 1993 Klamath Falls M_L 6.0 earthquake) (Wong and Bott, 1995). The majority of Oregon’s larger crustal earthquakes are in the M_L 4 to 5 range (Wong and Bott, 1995).

Table 2D summarizes earthquakes with a M of 4.0 or greater or Modified Mercalli Intensity (MMI) of V or greater, that have occurred within a ±50-mile radius of Eugene in the last ±188 years (Johnson et al., 1994; USGS, 2013). Note that the referenced earthquake catalogs are a composite of different earthquake catalogs and seismic networks; therefore, data errors may exist. Complete historic earthquake records may not yet be included in the referenced earthquake catalogs. Therefore, it is possible some earthquakes may not be included in Table 2D.

Table 2D. Historic Earthquakes Within a ±50-mile Radius of Eugene (1)

Year	Month	Day	Hour	Minute	Latitude	Longitude	Depth (miles)	Magnitude or Intensity (2)
1921	02	25	20	00	44.4	-122.4	unknown	MMI = V
1942	05	13	01	52	44.5	-123.3	unknown	MMI = V
1961	08	19	04	56	44.7	-122.5	unknown	M = 4.5
2015	07	04	15	42	44.1	-122.8	5.0	$M_L = 4.1$

(1) The site is located at Latitude 44.009714, Longitude -123.083273.

(2) M = unspecified magnitude, M_b = compressional body wave magnitude, M_c = primary coda magnitude, M_L = local Richter magnitude, and MMI = Modified Mercalli Intensity at or near epicenter.

It should be noted that seismic events in Oregon were not comprehensively documented until the 1840's (Wong and Bott, 1995). Earthquake epicenters located in Oregon from the late 1920's to 1962 were limited due to the number of and the distance between seismographs, the number of recording stations, and uncertainty in travel times. Therefore, information recorded during that time suggests only earthquakes with magnitudes >5 would be recorded in Oregon (Bela, 1979). Oregon State University (OSU) likely had the first station installed in 1946, and the first modern seismograph was installed at OSU in 1962 (Wong and Bott, 1995; Barnett et al., 2009). According to Wong and Bott (1995), seismograph stations sensitive to smaller earthquakes ($M_L \leq 4$ to 5) were not implemented in northwestern Oregon until 1979 when the University of Washington expanded their seismograph network to Oregon. The local Richter magnitude (M_L) of events occurring prior to the establishment of seismograph stations have been estimated based on correlations between magnitude and MMI. Some discrepancy exists in the correlations.

Table 3D summarizes distant, strong earthquakes felt in the Eugene area (Bott and Wong, 1993; Stover and Coffman, 1993; Wiley et al., 1993; Dewey et al., 1994; Wong and Bott, 1995; Black, 1996; Dewey et al., 2002). None of these events caused significant, reportable damage in Eugene or surrounding area.

Table 3D. Distant Earthquakes Felt in the Eugene Area

Earthquake	Modified Mercalli Intensities (MMI)
2001 Nisqually, Washington	II to III
1993 Klamath Falls, Oregon	IV
1993 Scotts Mills, Oregon	IV
1965 Seattle – Tacoma, Washington	I to IV
1962 Portland, Oregon	I to IV
1961 Lebanon/Albany, Oregon	IV
1949 Olympia, Washington	IV
1873 Crescent City, California	V

Seismic and Geologic Hazards

Section 1803.7 of the OSSC 2019 requires the evaluation of risks from a range of seismic hazards including landslides, earthquake-induced landslides, liquefaction and lateral spread, seismic-induced settlement or subsidence, fault rupture, earthquake-induced flooding and inundation, and local ground motion amplification (OSSC, 2019).

We have developed conclusions regarding the seismic hazards based on the subsurface profiles encountered in our borings at the project site. The conclusions are also based on our knowledge of the site geology, a review of previous geotechnical and seismic studies performed in the area, and available geologic hazard maps (including information available from DOGAMI).

DOGAMI has completed geologic and seismic hazard studies, which include Lane County (Burns et al., 2008), and provides online hazard information through HazVu, LiDAR, and SLIDO viewers (Black et al., 2000; DOGAMI, 2016, 2017, 2018). The above-mentioned maps and viewers refer to some, but do not cover all of the seismic hazards. The information available from DOGAMI is only considered a guide and does not have precedence over site-specific evaluations. In the following sections, information from the available seismic hazard maps is provided along with our site-specific evaluations for comparison.

The relative earthquake hazard is based on the combined effects of ground shaking amplification and earthquake-induced landslides with a range in hazard from Zone A (highest hazard) to Zone D (lowest hazard). Based on the DOGAMI mapping, the site is within Zone D (lowest hazard) for the overall, relative earthquake hazard (Black et al., 2000).

Landslides and Earthquake-Induced Landslides. The proposed tanks will be located near the top of a tree-covered ridge with minor undergrowth. Steep to gentle slopes below the ridge are mostly grass-covered. LiDAR imagery shows smooth, gentle slopes for most of the site with the north portion of the site being relatively flat (DOGAMI, 2017). There are no historic or mapped landslides at the site (Burns et al., 2008; DOGAMI, 2016; Calhoun et al., 2018). The regional landslide hazard map indicates no deep landslide susceptibility (>15 feet deep) at the site, and the susceptibility for shallow (<15 feet deep) landslides is considered low to moderate along the ridgeline (DOGAMI, 2016, 2018).

The site is underlain topsoil/residual soil followed by shallow, predominately very weak (R1) to very strong (R5) bedrock. Based on the site conditions and the absence of mapped or historic landslides and instability features, we believe the risk of landslides or earthquake-induced landslides is very low. The new tanks will be supported on bedrock. Therefore, we believe the risk of slope instability impacting the tanks is negligible.

Liquefaction, Settlement, and Lateral Spread. Soil liquefaction occurs when loose, saturated cohesionless soil experiences a significant loss of strength during strong ground shaking. The strength loss is associated with rapid densification of the soil and corresponding development of high pore water pressure, which can lead to the soil behaving like a viscous fluid. Liquefiable soils typically consist of saturated, loose, clean sand and non-plastic to low plasticity silt with a plasticity index (PI) typically less than 8.

A very thin topsoil mantle overlies residual soil followed by shallow, weak to moderately strong bedrock. The underlying residual soil is typically medium dense to very dense or hard and is not expected to be liquefiable due to its density and strength, and the absence of shallow groundwater.

The new tanks will be supported on bedrock. Therefore, the risk of liquefaction impacting the tanks is nil. The HazVu site indicates no liquefaction susceptibility in the project area; (Burns et al., 2008; DOGAMI, 2018).

Lateral spread is a liquefaction-induced hazard, which occurs when soil or blocks of soil are displaced down slope or toward a free face (such as a riverbank) along a liquefied layer. The lateral spread hazard at this site is considered nil due to the absence of a liquefaction hazard.

Subsidence. Ground subsidence is a regional phenomenon resulting from a large magnitude CSZ earthquake. It occurs because the subduction of the oceanic crust beneath the continental crust compresses the continental crust and pushes it upward. Prior to the earthquake, the continental crust is held in this position by friction at the CSZ interface. When the earthquake occurs, that frictional bond breaks allowing the continental crust to drop. The subsidence hazard map included in the Oregon Resilience Plan (OSSPAC, 2013), indicates the ground subsidence in the Eugene area during a M_w 9 CSZ earthquake could be up to 1 foot. Ground subsidence cannot be mitigated. Therefore, it should be assumed the site and surrounding area could drop by up to 1 foot during a large magnitude CSZ earthquake.

Fault Rupture. The risk of fault rupture is expected to be low due to the lack of known active faulting beneath the site (Personius et al., 2003; Madin and Murray, 2006; USGS, 2006b, a; McClaughry et al., 2010). The closest potentially active (Class A) crustal fault is the Owl Creek fault, which is ±33 miles north of the site.

Tsunami / Seiche/ Earthquake-Induced Flooding. Tsunami are waves created by a large-scale displacement of the sea floor due to earthquakes, landslides, or volcanic eruptions (Priest, 1995). Tsunami inundation is not applicable to this site because Eugene is not on the Oregon Coast. Seiche (the back and forth oscillations of a water body during a seismic event) is also not a local hazard due to the absence of large bodies of water near the site.

According to HazVu, there is no localized flood potential for the Effective FEMA 100-year flood at or near the site (DOGAMI, 2018). Earthquake-induced flooding related to the failure of other structures (e.g., dams) or shallow ground water and subsidence does not apply to the site.

Local Ground Motion Amplification. Ground motion amplification is the influence of a soil deposit on the earthquake motion. As seismic energy propagates up through the soil strata, the ground motion is typically increased (i.e., amplified) or decreased (i.e., attenuated) to some extent. Based on the presence of limited topsoil and residual soil followed by shallow, very weak (R1) to very strong (R5) bedrock, it is our opinion the amplification hazard is low and is consistent with an OSSC/IBC Site Class B (i.e., bedrock with a shear wave velocity (V_s) between 2,500 and 5,000 ft/s). The DOGAMI hazard studies also indicate the amplification susceptibility for the site is low (NEHRP Site Class B) (Black et al., 2000; Burns et al., 2008). The site is expected to experience strong ground shaking during a CSZ earthquake due to its proximity to the CSZ (DOGAMI, 2018). See the main report for more discussion on the site response.

SEISMIC DESIGN

Design Earthquakes

The OSSC 2019, Section 1803.3.2.1, requires the design of structures classified as essential or hazardous facilities and of major and special occupancy structures to address, at a minimum, the following earthquakes:

Crustal:	A shallow crustal earthquake on a real or assumed fault near the site with a minimum M_W 6.0 or the design earthquake ground motion acceleration determined in accordance with the OSSC 2019 Section 1613.
Intraplate:	A CSZ intraplate earthquake with M_W of at least 7.0.
Interface:	A CSZ interface earthquake with a M_W of at least 8.5.

The design maximum considered earthquake ground motion maps provided in the OSSC 2019, are based on modified (risk-targeted) 2014 maps prepared by the USGS for an earthquake with a 2% probability of exceedance in 50 years (i.e., a ±2,475-year return period) for design spectral accelerations (USGS, 2014). The modifications include factors to adjust the spectral accelerations to account for directivity and risk.

The 2014 USGS maps were established based on probabilistic studies and include aggregate hazards from a variety of seismic sources. The interactive deaggregation search tool on the USGS National Earthquake Hazard Mapping website allows the breakdown of earthquake sources to be identified (USGS, 2014).

Interactive deaggregation of the 2,475-year return period USGS spectral acceleration maps indicate the seismic hazard at the site is dominated by the CSZ, contributing ±82% to the overall aggregate hazard. Crustal earthquakes were included in the studies but were not considered to be a principal seismic hazard at this site. The CSZ scenarios considered ranged from M_w 8.5 to 9.3, located ±43 to 68 miles west of the site.

The earthquake magnitudes and source-to-site distances used to generate the 2014 USGS maps satisfy the requirements of OSSC 2019. Seismic design parameters and AWWA D110-13 design response spectra are discussed in the Site Response Spectra section of the main report and are shown on Figure 6A and 7A (Appendix A).

CONCLUSION

Based on the findings presented herein, it is our opinion there are no geologic or seismic hazards that would preclude the design and construction of the proposed project. This site-specific seismic hazard investigation for the East 40th Avenue Storage Tanks, Eugene, Oregon, was prepared by Brooke Running, R.G., C.E.G.

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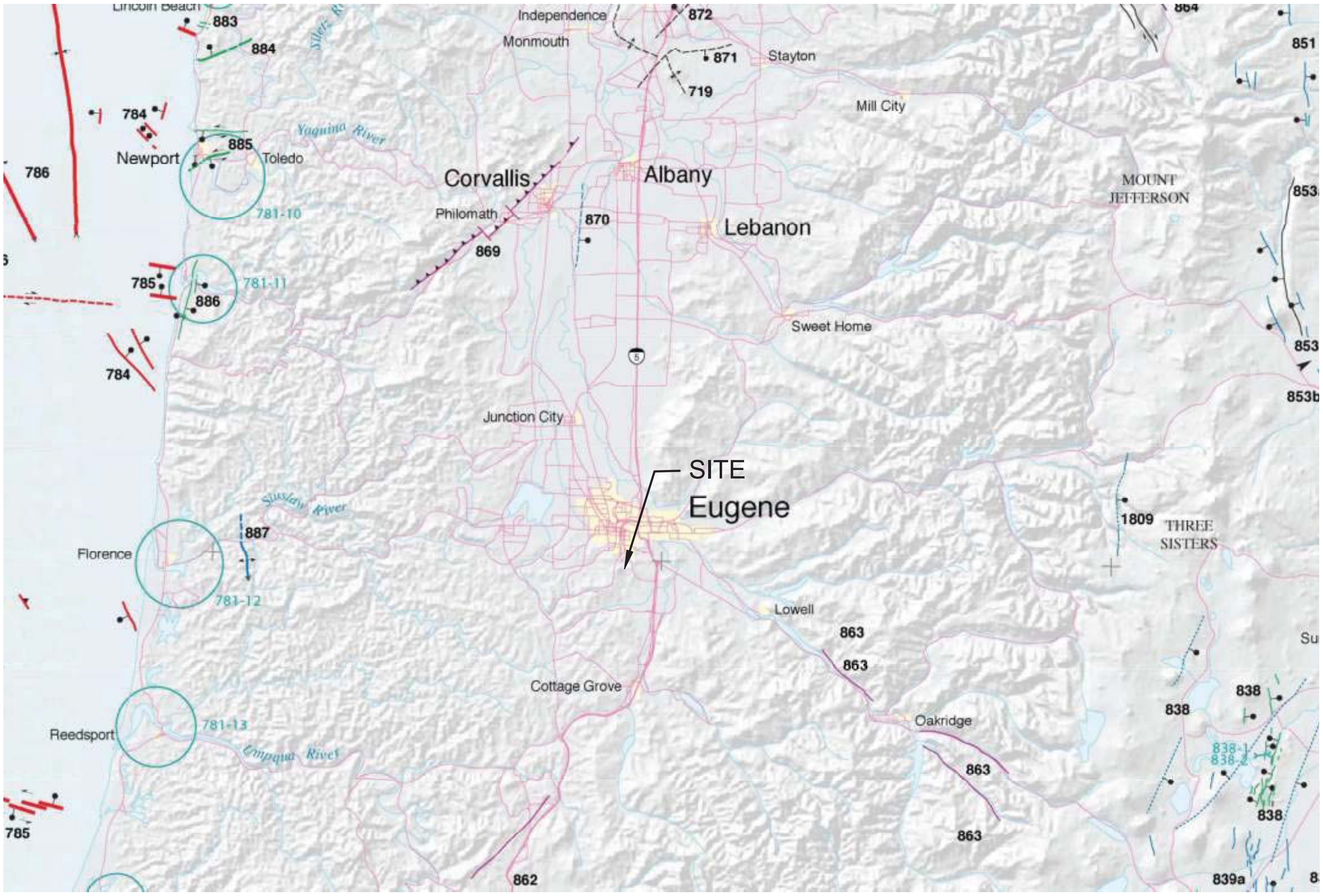

NOTES:

1. PORTION OF MAP BASED ON MAP OF QUATERNARY FAULTS AND FOLDS IN OREGON (PERSONIUS ET AL., 2003).
2. SEE SITE-SPECIFIC SEISMIC HAZARD STUDY FOR A DISCUSSION OF LOCAL FAULTING.
3. FAULTS: #862 = UNNAMED FAULTS NEAR SUTHERLIN; #863 = UPPER WILLAMETTE RIVER, #869 = CORVALLIS, AND #870 = OWL CREEK.
4. MAP IS NOT TO SCALE.

MAP LEGEND:

TIME OF MOST RECENT SURFACE RUPTURE

- Holocene (<10,000 years) or post last glaciation (<15,000 years); no historic ruptures in Oregon to date
- Late Quaternary (<130,000 years; post penultimate glaciation)
- Late and middle Quaternary (<750,000 years)
- Quaternary, undifferentiated (<1,600,000 years)
- Class B structure (age or origin uncertain)

SLIP RATE

- >5mm/year
- 1.0-5.0 mm/year
- 0.2-1.0 mm/year
- <0.2mm/year

TRACE

- Mostly continuous at map scale
- Mostly discontinuous at map scale
- Inferred or concealed

STRUCTURE TYPE & RELATED FEATURES

- Normal or high-angle reverse fault
- Strike-slip fault
- Thrust fault
- Anticlinal fold
- Synclinal fold
- Monoclinal fold
- Plunge direction of fold
- Fault section marker

CULTURAL AND GEOGRAPHIC FEATURES

- Divided highway
- Primary or secondary road
- Permanent river or stream
- Intermittent river or stream
- Permanent or intermittent lake

DETAILED STUDY SITES

- 731-2 Trench site
- 781-2 Subsuction zone study site

Foundation Engineering, Inc.
Professional Geotechnical Services

PROJECT NO.	DATE:	DRAWN BY:
2201086	Mar. 9, 2021	BKR

QUARTERNARY CRUSTAL FAULT MAP

SOUTHERN WILLAMETTE VALLEY
EAST 40TH AVENUE STORAGE TANK
EUGENE, OREGON

FIGURE NO.
1D