Mahler Water Reclamation Facility (MWRF) Interim Improvements

ADDENDUM NO. 2

FOR

SLUDGE BLEND TANK DESIGN-BUILD

To: All Prospective Bidders

The following clarifications, changes, additions and/or deletions are hereby made a part of the Contract Documents issued for the above referenced project as fully and completely as if the same were fully set forth therein.

This Addendum consists of 114 pages, including this cover page.

BIDDER QUESTIONS

Q1. What duration is the warranty bond required to be?
A1. The warranty bond shall cover a 5-year period that commences upon substantial completion. See item 1 below.

Q2. When will the site be available for site work to begin? The fence will need to be removed, the steel tank demolished and hauled off, a vault relocated and the filter bed removed. Do you see this happening before mid-late February?
A2. An additional addendum will be issued for demolition work and tree removal to be included as a part of this contract. The bid opening date is being extended, see items 4-6 below.

Q3. Will calculations for the handrailing system be required?
A3. Handrail calculations shall be required per specification 05 52 00 section 1.04.

Q4. Will other railing fittings be considered as approved equals?
A4. Equivalent railing fitting products will be considered after bid award as long as the products meet applicable codes and requirements. See specification 05 52 00 Handrail.

Q5. Will the Contractor be responsible for providing ultimate water tightness (hydraulic/leak) testing?
A5. Water tightness testing shall be a 2-step process:

1. Contractor shall be responsible providing water tightness (hydraulic/leak) testing of the tank with mechanical piping penetrations sealed per specifications 13 34 00 sections 1.03D, 3.05 and drawing sheet S-001. See item 3 below**.**
2. Contractor shall NOT be responsible for water tightness (hydraulic/leak) testing following installation of mechanical piping. Testing following mechanical piping installation shall be the responsibility of the Contractor completing those improvements following substantial completion of the new sludge blend tank.

Q6. Is the sack finish required on both the interior and exterior of the tank?
A6. Concrete finishes shall comply with drawing sheet S-001. Contractor shall notify the Owner's Engineer of Record about any repair areas prior to making repairs as noted on S-001. Sack finish of all concrete surfaces is not necessarily required, but may be required at areas with honeycombing, rock pockets, etc. Sack finish may be required for repairs described on S-001. The extent, size and location of repair areas will be determined by the Owner's Engineer-of-Record upon visual inspection.

CHANGES AND ADDITIONS AND/OR DELETIONS

Additions are shown in underline. Deletions are shown in strikeout.

1. EJCDC D-700 Article 6 Section 6.01B 1:

Change: "The warranty bond period will extend to a date ~~one~~ five years after Substantial Completion of the Work."

2. Drawing Sheet S-001:

Change: "WARRANTY: THE CONTRACTOR RESPONSIBLE FOR THE DESIGN AND CONSTRUCTION OF THE REINFORCED CONCRETE RESERVOIR SHALL GUARANTEE ALL MATERIALS AND WORKMANSHIP FOR A PERIOD OF ~~ONE~~ FIVE YEARS AFTER COMPLETION, ACCEPTANCE, TESTING AND FILLING OF THE RESERVOIR."

3. Specification 13 34 00 Reinforced Cast-in-Place Concrete Tank, section 3.05:

Add: "E. See drawing sheet S-001."

4. EJCDC C-111 Advertisement for Bids
Change: "Bids for the construction of the Project will be received at Sweet Home City Hall located at 3225 Main Street, Sweet Home, OR 97386, until January ~~10~~ 24, 2023 at 2:00 pm local time."

5. EJCDC C-430 Bid Bond (Penal Sum Form)
Change: "Bid Due Date: January ~~10~~ 24, 2023"

6. Specification 00 43 37 – First-Tier Subcontractor Disclosure Form
Change: "Bid Closing: January ~~10~~ 24, 2023 at 2:00 p.m.
Disclosure Submittal Deadline: January ~~10~~ 24, 2023 at 4:00 p.m."

7. **Exhibit D, the December 2022 Geotechnical Engineering Report shall be added to the Contract Documents.**

End of Addendum No. 2

January 06, 2023

Mr. Greg Springman, Public Works Director

Date

Exhibit D

Geotechnical Engineering Report

City of Sweet Home
Mahler Water Reclamation Facility Improvements

Geotechnical Engineering Report

Final Submittal

Prepared for

WEST YOST
Water. Engineered.

December 2022

This page intentionally left blank.

Table of Contents

List of Tables

List of Figures

Appendices

Acronyms and Abbreviations

ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
bgs	below ground surface
bpf	blows per foot
CDF	controlled density fill
CLSM	controlled low strength material
CSZ	Cascadia Subduction Zone
g	standard acceleration due to gravity
GDR	Geotechnical Data Report
GER	Geotechnical Engineering Report
H	height of buried wall
H_w	submerged portion of buried wall
IBC	International Building Code
$I_{S(50)}$	point load index
LBVS	Little Butte Volcanic Series
M	earthquake magnitude
MCE	maximum credible earthquake
MJA	McMillen Jacobs Associates
NHSMP	National Seismic Hazard Mapping Project
No.	number
N-value	standard penetration test blows to advance final foot
OAR	Oregon Administrative Rules
ODOT	Oregon Department of Transportation
OSHA	Occupational Safety and Health Administration
OSSC	Oregon Structure Specialty Code
PGA	peak ground acceleration
pci	pounds per cubic inch
psi	pounds per square inch
RMR	Rock Mass Rating
RQD	Rock Quality Designation
SEI	Structural Engineering Institute
SPT	Standard Penetration Test
USGS	United States Geological Survey
West Yost	West Yost Associates, Inc.
WRF	Wastewater Reclamation Facility

Distribution

To:	Preston Van Meter, P.E. West Yost Associates, Inc.
From:	Wolfe Lang, P.E., G.E. McMillen Jacobs Associates
Prepared By:	Jeff Quinn, P.E. McMillen Jacobs Associates
Reviewed By:	Wolfe Lang, P.E., G.E. McMillen Jacobs Associates

Revision Log

Revision No.	Date	Revision Description
Final Submittal	July 22, 2022	Final Submittal to West Yost
Final Submittal, Rev. No. 1	December XX, 2022	Final Submittal Incorporating Site Revisions

1.0 Introduction

1.1 General

McMillen Jacobs Associates (MJA) has been retained by West Yost Associates, Inc. (West Yost) to provide geotechnical engineering services for the City of Sweet Home Mahler Water Reclamation Facility Improvements project. The project owner is the City of Sweet Home. The Project site location is shown in the Vicinity Map, Figure 1. This Geotechnical Engineering Report (GER) presents the results of our field explorations, laboratory testing, geotechnical analyses, and design and construction recommendations. Detailed discussions of site explorations, site geology, and laboratory testing is summarized in a Geotechnical Data Report (GDR) prepared by MJA, dated July 2022.

1.2 Project Description

The City of Sweet Home Mahler Water Reclamation Facility (WRF) is located at 1357 Pleasant Valley Road, in Sweet Home, Oregon. The WRF has been in service since 1947 with two major upgrades completed in 1974 and 1994 (Brown & Caldwell, 2016). Our project understanding is based on our communication with West Yost and the 90 percent submittal plans entitled *Mahler Water Reclamation Facility Improvements Project – Phase 1*, dated June 2022, prepared by West Yost. The proposed WRF improvements are shown in Figure 2. We were not provided with structural loading information for the above WRF improvements. We understand the WRF is to remain operational during construction of the proposed improvements.

The proposed WRF improvements include the following:

- *Main Electrical and Blower (MEB) Building*: The 22- by 67.5-foot MEB Building will be located within the north-central part of the WRF site. The interior of the building will be supported on a 6-inch-thick slab on grade foundation, while the perimeter of the structure will be supported on a 1.5-foot-wide continuous spread footing. A new generator, which will be installed on the north side of the MEB Building, will be supported on 12- by 28-foot, 12-inch-thick reinforced concrete slab on grade with thickened edges. Site grades will be raised up to approximately 6 feet in this area to facilitate construction of the MEB Building, with approximately 4 to 6 feet of fill placed below the building footprint. The approximately 6-foot-tall fill slope on the east side of the MEB Building will descend at 2H:1V (horizontal:vertical).
- *Influent Pump Station (IPS)*: The new, 40- by 56-foot IPS will be constructed just north of the existing IPS, within the southeast corner of the WRF site. The approximate southern half of the IPS structure, which supports above-grade piping, will be supported on a 12-inch-thick reinforced concrete slab on grade with thickened edges. The approximate northern half of the IPS structure, which houses five submerged pumps, will be supported on a 28-inch-thick reinforced concrete slab with a base elevation of approximately 491.2 feet (e.g., about 26.2 feet below grade).
- *Sludge Blend Tank*: The new, 28-foot diameter sludge blend tank will be constructed in the southeast corner of the WRF site just east of the solids building. The sludge blend tank will be

approximately 25 feet tall and will be supported on a 1.5-foot-thick, reinforced concrete mat foundation with a base elevation of approximately 515.3 feet (e.g., about 1.5 feet below grade).

- *Digested Sludge Holding Tank*: The new, 36-foot diameter sludge blend tank will be constructed in the southeast corner of the WRF site just north of the sludge blend tank. The sludge blend tank will be approximately 26 feet tall and will be supported on a 1.5-foot-thick, reinforced concrete mat foundation with a base elevation corresponding to approximately 1.5 feet below grade.
- *Solids Building Expansion*: The existing solids building will be enlarged from its existing 22- by 37-foot plan dimensions to approximately 32- by 57-foot plan dimensions and will be supported on a shallow foundation system consisting of perimeter footings and an interior slab-on-grade.
- *40*-foot Diameter Digestor: The new digestor will be constructed within the footprint of the existing, approximately 55-foot diameter digestor (DG1) in the southeast corner of the WRF site. We understand that the existing foundation will be used to support the new digestor structure.
- *Temporary Generator*: A temporary electrical generator, supported on an 18-inch-thick reinforced concrete slab, will be installed on the south side of existing Secondary Clarifier SC60.
- *Existing Bathroom Relocation*: The existing bathroom, currently along the northern fence line and east of the existing entrance gate, will be moved to the north side of the boat ramp access road.
- *Retaining Walls*: To support new fills placed for site grading, as well as proposed cuts, there are six retaining walls (designated Wall 1 through Wall 6) proposed as part of the improvements. The retaining walls will be cast-in-place, reinforced concrete cantilevered walls ranging in height from 2.5 to 6.75 feet.
- *Existing Structures/Facilities to Remain In Use*: Secondary Clarifier Nos. 1 through 3; RAS/WAS Pump Station; Aeration Basin; Chlorine Contact Chamber; Administration and Operations Building; Sand Filters; Lime Silo; and the electrical building on the south side of existing SC60.
- *Proposed Piping Improvements*: 12-inch storm drain;10-inch storm drain; 8-inch to 36-inch sanitary sewer; 12-inch IPS forcemain to headworks (HDPE pipe); 24-inch RS IPS to Headworks (HDPE pipe); 6-inch PS forcemain; 12-inch RDPS; 6-inch SL-WAS; 6-inch SL-D forcemain; 4-inch PSC; and 10-inch DIP waterline relocation.
- *Demolition of the Following Existing Structures*: Backwash Storage; Waste Backwash Storage; the approximately 25- by 50-foot storage building on the west side of the WRF site; and several buildings clustered together in the central portion of the WRF site including the carport, an approximately 40- by 40-foot CMU building, an approximately 25- by 50-foot Quonset Hut storage building, and an approximately 15- by 35-foot shed.
- *Primary Clarifier*: The new primary clarifier will consist of an approximately 65- by 85-foot reinforced concrete tank structure. The base depth of the new primary clarifier will be approximately 9.5 to 22.5 feet below existing site grades and will be supported on an 18-inch-thick, reinforced concrete mat foundation system. The primary clarifier will be expanded to the north (designated Primary Clarifier 4) at a future date.
- *Secondary Clarifier 90 (SC90)*: SC90 will consist of an approximately 95-foot diameter, 17-foot-tall reinforced concrete tank structure. SC90 will be a primarily below-grade structure, with the tank walls being about 2 feet above finish grade. The base depth of the SC90 will be

approximately 15 feet below existing site grades and will be supported on a reinforced concrete mat foundation.

- *Building A (O&M and Controls)*: This 40- by 120-foot building, oriented northeast-southwest, will be constructed at the west end of the WRF site and will be an at-grade structure supported on an interior slab-on-grade. The perimeter of the structure and interior load-bearing walls will be supported on shallow spread footings.
- *Building A (Headworks and Dewatering)*: This 40- by 120-foot building, oriented southeast-northwest, will abut the southeast corner of the O&M and Controls building to form the leg of the L-shaped Building A. This will be an at-grade structure supported on an interior slab-on-grade. The perimeter of the structure and interior load-bearing walls will be supported on shallow spread footings.
- *SC90 WAS and RAS Pump Stations*: Each of these two pump stations will be an approximately 10-foot diameter reinforced concrete vault structure with a base depth of approximately 16.5 feet below existing site grades and will be supported on a reinforced concrete mat foundation.
- *Existing Secondary Clarifier SC60 RAS/WAS Pump Station*: This pump station will be an approximately 10- by 20-foot reinforced concrete vault structure with a base depth of approximately 12.5 feet below existing site grades and will be supported on a reinforced concrete mat foundation.
- *Aeration Basin No. 3*: Aeration Basin No. 3 will consist of an approximately 40- by 75-foot reinforced concrete structure. The base depth of Aeration Basin No. 3 will be approximately 13 to 18 feet below existing site grades and will be supported on a reinforced concrete mat foundation. Aeration Basin No. 3 will be expanded to the north (designated Aeration Basin No. 4) at a future time and will likely be founded at the same depth as Aeration Basin No. 3.
- *Tertiary Filters*: The tertiary filters will be housed in an approximately 25- by 35-foot reinforced concrete tank structure. The base depth of Aeration Basin No. 3 will be approximately 18 feet below existing site grades and will be supported on a reinforced concrete mat foundation.
- *Tertiary Building, UV Disinfection, and UW Storage*: These facilities will be located adjacent to one another within an approximate 35- by 40-foot area. The UW Storage and UV Storage facilities will be constructed within the existing chlorine contact chamber. The portion of the Tertiary Building housing the utility water pumps will likely be approximately 7 feet below existing site grades.
- *Outfall*: The outfall pipe leads from the UV disinfection chamber to the South Santiam River. This will be part of a future project phase.
- *Other Improvements*: The approximate western half of the WRF site, an area north of the boat ramp access drive, and a narrow area along the south site boundary will be surfaced with gravel. In addition, new asphalt pavements along the entrance road from Pleasant Valley Road and within most of the WRF site; new concrete curbs and sidewalks; two new entrance gates; and a new chain-link fence.

1.3 Purpose and Scope of Work

The purpose of this investigation was to characterize the subsurface conditions at the site and develop geotechnical design recommendations for the proposed project. Specifically, our scope of work included the following:

- Assess soil seismic profile (site classification) and parameters in accordance with the 2019 Oregon Structure Specialty Code (OSSC) to support structural design. If the site is potentially liquefiable, the soil seismic profile will be only for the facilities with seismic periods less than 0.5 second.
- Evaluate the liquefaction potential and liquefaction-induced effects, such as seismic-induced settlements, lateral spreading, and potential reduction in soil bearing capacity.
- Evaluate static and seismic soil bearing capacity, subgrade modulus, and total and differential settlements for the proposed foundations and facilities.
- Provide recommendations and design criteria for shallow foundation systems.
- Provide static and seismic lateral earth pressure recommendations for the embedded walls of the proposed structures.
- Provide lateral load resistance recommendations, including passive earth pressure and coefficient of friction.
- Provide recommendations for shoring and dewatering of deep excavations.
- Provide recommendations for site preparation, grading, drainage, and wet-weather earthwork procedures.
- Provide engineered fill recommendations and compaction criteria for the foundations.

2.0 Field and Laboratory Investigation

2.1 Subsurface Exploration

Initial exploratory borings were completed by Western States Soil Conservation (WSSC) of Hubbard, Oregon using a truck-mounted CME-75 drill rig. The explorations were completed between April 30 and May 2, 2018. This exploration program included advancing five boreholes, designated B-1 through B-5, and fifteen probe-holes, designated P-01 through P-15. The boreholes were advanced using mud-rotary drilling and HQ rock coring techniques to depths ranging from 5.8 to 23 feet bgs. The probe-holes were advanced using hollow-stem auger drilling techniques and extended to between 2.5 and 15 feet bgs (top of bedrock).

Additional air-track probe holes were advanced on October 29, 2019 by McCallum Rock Drilling of Salem, Oregon using a Furakawa 900 track-mounted drill rig. This exploration program included advancing 12 air-track probe holes (designated P-16 through P-27) to depths ranging from 11 to 26 feet bgs.

On June 20, 2022, eight additional probe-holes (designated P-28 through P-35) were advanced by PLI Systems of Hillsboro, Oregon using a truck-mounted Mobile B59 drill rig. The probe-holes were advanced using hollow-stem auger drilling techniques and extended to between 3.7 and 19 feet bgs.

On November 22, 2022, one additional probe-hole (designated P-36) was advanced by WSSC using a truck-mounted CME-75 drill rig. P-36 was advanced using hollow-stem auger drilling techniques and extended to 11.5 feet bgs.

Details of the exploration and sampling intervals are provided in the project GDR (McMillen Jacobs, 2022). The exploration locations are shown in Figure 2 and the exploration logs are provided in Appendix A.

2.2 Piezometers

Two-inch diameter piezometers were installed in two boreholes to allow for long-term, stabilized groundwater level measurements. Piezometers were installed in the following boreholes:

- Boring B-3, screened between 9 and 12 feet bgs.
- Boring B-5, screened between 5.5 and 8.5 feet bgs.

2.3 Laboratory Testing

Field samples obtained from exploratory borings were delivered to the MJA Portland office for further examination and storage. Each of the samples was re-examined and compared to the field boring log description to confirm the field classifications and maintain consistency. Representative samples were then selected for laboratory testing. Testing was performed on soil and rock samples from boreholes B-1, B-3, and B-5. The laboratory test results are provided in Appendix B. The laboratory testing included the following index and strength property tests, performed in accordance with relevant ASTM standards:

- Moisture content analyses (ASTM D 2216).
- Atterberg limits tests (ASTM D 4318).
- Point load tests of rock core (ASTM D 5731).
- Unconfined compressive strength of intact rock core (ASTM D 7012).

Point load testing was performed by MJA. All other laboratory testing was performed by Northwest Testing, Inc. of Wilsonville, Oregon. Laboratory test results are presented in Appendix B.

3.0 Site Conditions

3.1 Site Description

The site is currently occupied by the existing WRF, located on the south bank of the South Santiam River near its confluence with Ames Creek. The site is fenced around its perimeter and is bordered by the Albany and Eastern railroad tracks to the south, a boat ramp access road to the north (and the South Santiam River beyond), a private property to the west, and Ames Creek to the east. In general, the site slopes gently from the west to the east (i.e., towards Ames Creek) and gently from the south to the north (i.e., towards the South Santiam River). The eastern two-thirds of the site (in which the existing aeration basin and the clarifiers are located) is situated on a relatively level terrace that generally sits 5 to 7 feet lower than the western one-third of the site and approximately 10 feet above Ames Creek to the east.

A paved access road runs along the north side of the site, from the Pleasant Valley Road WRF entrance at the west end of the site to the boat ramp and recreation use area at the north-northeast end of the site. The paved WRF road, heading south from the access road from the main entrance gate, provides access to the main areas within the WRF. Bedrock is exposed along the South Santiam River and Ames Creek approximately 100 feet to the north-northeast of the site. Exposed bedrock on the riverbank slopes steeply into the river.

3.2 Geological Setting

The project is located in the foothills of the Western Cascades, a north-south trending physiographic region that stretches from northern California to British Columbia, tucked between the Willamette Valley to the west and the younger High Cascades to the east. The Western Cascades in Oregon were formed by a series of volcanic events from approximately 35 to 17 million years ago. The region is marked by densely forested hills dissected by the region's many rivers (Madin, 1990; Schlicker and Deacon, 1967; Wilson, 1998; Popowski, 1996). A detail description of the geological setting of the site is described in the project GDR (McMillen Jacobs, 2019).

3.3 Subsurface Conditions

The materials encountered in the explorations were grouped into three geotechnical units: Pavement, Fill, and Basalt (Little Butte Volcanic Series – Tholeiitic Basalt). These units have been defined by their geologic origin, stratigraphic position, engineering properties, and their distribution in the subsurface. Variations in subsurface conditions may exist between the locations of the borings. Contacts between the units may be more gradational than shown in the boring logs in Appendix A. The SPT N-values, shown on the boring logs and discussed below, are reported as counted in the field (uncorrected). Photos of rock core samples are provided in Appendix C. Cross sections of subsurface conditions are shown in Figures 3A through 3F. The following sections describe each geotechnical unit in greater detail.

3.3.1 Pavement

Asphalt concrete (AC) was encountered in 12 borings, as described in the boring logs in Appendix A. The AC pavement ranged from about 4 to 6 inches in thickness and was typically underlain by about 4 inches of crushed rock base. Portland Cement Concrete (PCC) pavement was encountered in three borings (B-1, P-27, and P-36). In B-1, the PCC pavement was about 18 inches thick and underlain by about 12 inches of crushed rock base. In P-27 and P-36, the PCC pavement section was about 6 inches thick.

3.3.2 Fill

Undocumented fill materials were present in all the explorations and were likely placed for site grading and development. We observed highly variable fill depths across the site, extending from the existing ground surface to depths ranging from 2 to 16.5 feet bgs. Additionally, the fill depths often varied considerably over short distances. The fill was underlain by bedrock, and generally consisted of silt with variable amounts of organics, lean to fat clay with variable amounts of sand and gravel, sand and gravel with variable amounts of silt and clay, and organic soil with variable amounts of sand. Undocumented fill refers to materials placed without (available) records of subgrade conditions or evaluation of compaction. Standard Penetration Tests (SPTs) conducted within the fill yielded N-values ranged from 0 to 45 blows per foot (bpf). The higher N-values were generally recorded at the fill-bedrock contact.

3.3.3 Boulders

Based on drilling action and slow advancement rates, we believe that large cobbles or boulders were encountered between 7.5 to 9 feet bgs in boring P-36, located in the southeast corner of the WRF site.

3.3.4 Basalt - Little Butte Volcanic Series Tholeiitic Basalt

The Little River Butte Volcanic Series (LRBV) in the project area consists of tholeiitic basalt and is bedrock in this area. The basalt was encountered beneath the fill in all the explorations. The depth to the LRBV ranged from 2.0 feet to 16.5 feet bgs.

The unconfined compressive strength of the basalt varied between approximately 7,000 psi and 26,000 psi with an average value of approximately 19,000 psi. The results of point load tests indicate that the Point Load Index ($I_{S(50)}$) of the basalt ranged between approximately 270 psi and 715 psi, with an average value of 510 psi. We suspect the lower value of unconfined compressive strengths may correspond to failure along the weak planes. Definition of rock strength and depth to bedrock at each exploration are provided in Table 3-1 and Table 3-2, respectively. The basalt characteristics are discussed in more details in Section 3.4. The depth to bedrock is also included on the geologic cross sections shown in Figures 3A through 3F.

Table 3-1. Definition of Rock Strength Descriptions

Grade[1]	Approximate Uniaxial Compressive Strength (psi)	Qualitative Description
R0	35 – 150	Extremely Weak
R1	150 – 700	Very Weak
R2	700 – 3,600	Weak
R3	3,600 – 7,200	Medium Strong
R4	7,200 – 14,500	Strong
R5	14,500 – 36,000	Very Strong
R6	>36,000	Extremely Strong

[1] Rock strength grades from Brown (1981).

Table 3-2. Depth of Fill / Depth to Rock Summary

Exploration ID	Associated Structure(s)	Ground Surface Elevation (feet)	Depth to Rock (feet)	Rock Surface Elevation (feet)
B-1	--	516.5	2.5	514.0
B-2	SC90 WAS Pump Station	518.3	16.5	501.8
B-3	Primary Clarifier	529.9	11	518.9
B-4	Building A – O&M & Controls	538.6	4.5	534.1
B-5	MEB Building	528.8	8.5	520.3
P-01	--	517.3	11	506.3
P-02	--	526.1	11.5	514.6
P-03	Primary Clarifier	530.4	16	514.4
P-04	Building A – Headworks & Dewatering	530.8	7.5	523.3
P-05	Building A – Headworks & Dewatering	533.1	3.5	529.6
P-06	Building A – O&M & Controls	536.2	3.5	532.7
P-07	--	538.0	2.5	535.5
P-08	Building A – O&M & Controls	535.3	7.5	527.8
P-09	--	530.5	4	526.5
P-10	--	530.1	5.5	524.6
P-11	MEB Building	529.8	5.5	524.3
P-12	MEB Building	526.4	5	521.4
P-13	Future Aeration Basin No. 4	523.6	8.5	515.1
P-14	Aeration Basin No. 3	521.7	5.5	516.2
P-15	--	519.1	2.5	516.6
P-16	IPS	517.1	12.0	505.1
P-17	--	516.5	6.0	510.5
P-18	SC90, SC60 RAS/WAS Pump Station	518.5	9.0	509.5
P-19	--	518.0	6.0	512.0
P-20	SC90 RAS Pump Station	525.4	8.0	517.4
P-21	Primary Clarifier, Aeration Basin No. 3	521.8	6.0	515.8
P-22	Aeration Basin No. 3	518.5	7.0	511.5
P-23	Primary Clarifier	530.4	15.0	515.4
P-24	MEB Building	529.7	3.0	526.7
P-25	Future Outfall	506.4	2.0	504.4
P-26	Future Outfall	507.2	3.0	504.2
P-27	--	516.6	10.0	506.6
P-28	IPS	516.5	11.0	505.5
P-29	IPS	517.3	12.5	504.8
P-30	SC90	519.8	11.0	508.8
P-31	SC90	520.8	10.0	510.8
P-32	Primary Clarifier, Future Primary Clarifier No. 4	530.4	10.0	520.4
P-33	Future Outfall	529.6	3.5	526.1
P-34	Tertiary Filters	516.9	15.0	501.9
P-35	-	517.5	6.0	511.5
P-36	Sludge Blend Tank	516.8	10.8	506.0

3.4 Rock Mass Classification

Two rock mass classification systems, Rock Quality Designation (RQD) and Rock Mass Rating (RMR), were used to evaluate and characterize rock mass conditions for providing recommendations regarding ground behavior, excavation methods, and design of the embedded walls. These classifications were originally developed for tunneling but are useful in estimating rock excavatability.

3.4.1 Rock Quality Designation (RQD)

RQD values are a modified core recovery in which only core lengths equal to or longer than 4 inches are measured in an individual core run (Bieniawaski, 1989). RQD values are presented on the boring logs in Appendix A. The RQD ranged from 42 to 86 percent, indicating “poor” to “good” rock quality, with an average RQD of 67 percent, indicating a “fair” condition of the rock.

3.4.2 Rock Mass Rating (RMR) System

The RMR (Bieniawaski, 1989) is a rating system that considers six numerical rock mass inputs including: strength of intact rock, RQD, discontinuity spacing, condition of discontinuities, orientation of discontinuities relative to excavation, and groundwater conditions. An RMR range of 60 to 70 was estimated for the encountered conditions, indicating a “good” rock condition. RMR calculation sheets summarizing input and results are included in Appendix D.

3.5 Groundwater

Groundwater observation wells were installed in borings B-3 and B-5. Initial groundwater levels recorded on May 2, 2018, with subsequent levels recorded on October 29, 2019, and June 20, 2022. We also observed groundwater in nine other exploration locations, as summarized in Table 3-3. Groundwater levels are noted on the boring logs in Appendix A.

Groundwater levels may vary with precipitation, the time of year, and/or other factors. Generally, groundwater highs occur near the end of the wet season in late spring and groundwater lows occur near the end of the dry season in the early fall.

Table 3-3. Groundwater Level Measurements

Boring ID	Piezometer	Borehole Elevation (feet)	Depth to Groundwater (feet)			Groundwater Elevation (feet)		
			May 2, 2018	Oct 29, 2019	June 20, 2022	May 2, 2018	Oct 29, 2019	June 20, 2022
B-2	No	518.3	2.5	-	-	515.8	-	-
B-3	Yes	529.9	2.9	3.6	8.2	527.0	526.3	521.7
B-4	No	538.6	2.0	-	-	536.6	-	-
B-5	Yes	528.8	5.0	7.0	6.8	523.8	521.8	522.0
P-03	No	530.4	8.5	-	-	521.9	-	-
P-09	No	530.5	3.0	-	-	527.5	-	-
P-13	No	523.6	6.0	-	-	517.6	-	-
P-15	No	519.1	2.5	-	-	516.6	-	-
P-29	No	517.3	-	-	10.5	-	-	506.8
P-31	No	520.8	-	-	9.2	-	-	511.6
P-32	No	530.4	-	-	9.7	-	-	520.7

4.0 Seismic and Geologic Hazard Evaluation

4.1 General

The seismic hazards evaluation was performed in general accordance with the 2019 Oregon Structure Specialty Code (OSSC, 2019) and ASCE's Minimum Design Loads for Buildings and Other Structures, 2016 Edition (ASCE/SEI 7-16). The OSSC requires evaluating the seismic hazards for the Maximum Credible Earthquake (MCE) having a 2% probability of exceedance in a 50-year period (2,475-year return period).

4.2 Regional Seismicity

The Pacific Northwest is a seismically active region that has three principal seismic sources: (1) the Cascadia Subduction Zone (CSZ) megathrust, which represents the interface between the subducting Juan de Fuca plate and the overriding North American plate; (2) faults located within the Juan de Fuca plate (referred to as CSZ intraplate or intraslab sources); and (3) crustal faults principally in the North American plate (Wong and Silva, 1998).

4.3 Site Classifications

The project site was assigned a seismic site class following code-based procedures in ASCE/SEI 7-16, Chapter 20 (2016). Site class is used to categorize common subsurface conditions into broad classes to which ground motion attenuation and amplification effects are assigned. Site class accounts for the conditions encountered in the upper 100 feet of the subsurface profile. Shallow bedrock was encountered during the subsurface investigation and most of the structures are anticipated to be supported on the bedrock. Therefore, a Site Class B is appropriate for design purposes.

4.4 Seismic Design Parameters

The 2019 OSSC requires that spectral response accelerations be developed based on the ASCE 7-16. We developed spectral response accelerations using the online ASCE 7 Hazard Tool, which references ground motion procedures in accordance with ASCE 7-16 and is based on the USGS 2014 National Seismic Hazard Mapping Project (NSHMP) developed for the Maximum Considered Earthquake (MCE) (Peterson et. al., 2014). The MCE consists of ground motions (accelerations) with a 2-percent probability of exceedance in 50 years (return period of 2,475 years). The recommended spectral acceleration parameters for use in structural design are provided in Table 4-1. For pipeline design we recommend using a Peak Ground Velocity (PGV) of 10 inches per second.

Table 4-1. 2019 OSSC MCE Spectral Acceleration Parameters for Site Class B

Parameter	0.2 Second	1 Second
Mapped MCE_R (Rock site)	S_S = 0.63 g	S_1 = 0.34 g
Site Coefficients	F_a = 0.9	F_v = 0.8
Site-Adjusted MCE_R	S_{MS} = 0.57 g	S_{M1} = 0.27 g
Design MCE_R	S_{DS} = 0.38 g	S_{D1} = 0.18 g
Mapped MCE_G PGA (Rock Site)	0.29 g	
Site Coefficient F_{PGA}	0.9	
Site-adjusted MCE_G PGA	0.26 g	

4.5 Liquefaction

4.5.1 Overview

Liquefaction is a phenomenon affecting saturated, granular soils in which cyclic, rapid shearing from an earthquake results in a drastic loss of shear strength and a transformation from a granular solid mass to a viscous, heavy fluid mass. The results of soil liquefaction include loss of shear strength, loss of soil materials through sand boils, flotation of buried chambers/pipes, and post liquefaction settlement.

4.5.2 Liquefaction Hazard

The Project site is underlain by competent basalt bedrock, encountered at shallow depths, overlain by variable amounts of fill. However, there are localized areas of the site that are underlain by fill extending to depths up to about 16.5 feet bgs, as indicated in Table 3-2. Our liquefaction analyses indicated that the loose/soft fill materials below the groundwater table are potentially liquefiable. Since the fill materials are not laterally continuous, widespread soil liquefaction is not considered to be a hazard at the site.

Anticipated foundation conditions for the proposed structures are summarized in Table 6-1. The excavations required to facilitate construction of the below-grade structures will effectively remove the potentially liquefiable soils and these structures will be founded on basalt bedrock. Therefore, the risk of liquefaction is negligible for the below-grade structures. For the at-grade structures (i.e., Building A and the MEB Building), the total anticipated liquefaction-induced settlement is on the order of 1 inch with differential settlement on the order of ½ inch and occurring across the slab-on-grade foundation and across the long axis of these buildings. For the IPS, the approximate southern half of which will be supported on a slab-on-grade foundation, we anticipate the total liquefaction-induced settlement will be on the order of 1 inch, with differential settlement on the order of ½ inch and occurring across the slab-on-grade foundation.

We evaluated liquefaction susceptibility using SPT-based methods presented by Boulanger and Idriss (2014), as well as Idriss and Boulanger (2008). Our analyses considered the aggregate seismic event (or MCE), a design-level event that considers the cumulative effect from all seismic sources in the region for the indicated probability of exceedance (i.e., 2 percent in 50 years). The spectral acceleration parameters for the MCE are summarized in Table 4-1. Estimating the ground surface PGA was accomplished using aggregated probabilistic data for design-level earthquakes available at the USGS Unified Hazard Tool website. The resulting aggregate seismic event used in our liquefaction susceptibility and settlement analyses had an earthquake magnitude of 8.3 and peak ground acceleration (PGA) of 0.29 g. Groundwater was modeled as the seasonal high level at each boring/probe location, based on groundwater measurements and observations discussed in Section 3.5.

4.6 Other Seismic Hazards

Due to the shallow bedrock and overall gently-sloping site, we conclude that other seismic hazards are negligible. These seismic hazards include seismically-induced landslides, liquefaction (apart from the localized areas discussed above), lateral spreading, ground motion amplification, and surface rupture. The nearest Class A fault mapped by the USGS is the Owl Creek Fault, located approximately 25 miles west of the site. Therefore, fault rupture is not considered a hazard to the project.

5.0 Conclusions and Key Geotechnical Considerations

Based on the results of our field explorations and analyses, the site can be developed as described in Section 1.2 of this report, provided the recommendations presented in this report are incorporated into the design and development. We conclude the primary geotechnical considerations are the presence of highly variable and weak undocumented fill materials and the associated excessive settlement of the at-grade structures due to static and seismic loading. Other important considerations for the Project include the presence of shallow groundwater and shallow strong to very strong basalt bedrock.

5.1 Settlement Potential of At-Grade Structures

Due to the presence of highly variable undocumented fill materials across the site, we conclude there is a risk for uneven subgrade response from structural loads for at-grade structures. Adverse effects resulting from uneven subgrade response of the soils could take the form of excessive total and differential static settlement and/or bearing capacity failure. In addition, there is the potential for localized liquefaction-induced settlement within the undocumented fill materials below the at-grade structures. Therefore, we do not recommend the proposed at-grade structures (discussed in Section 1.2) be supported by shallow spread footing, slab-on-grade, or mat foundations without subgrade improvement in the form of the over-excavation of a minimum of 3 feet of undocumented fill. For the critical structures, such as the IPS and MEB Building, complete over-excavation of the undocumented fill and replacement with compacted structural fill are recommended to mitigate potential static and liquefaction-induced settlements. For the Sludge Blend Tank and the Digested Sludge Holding Tank, we recommend that the undocumented fill materials be over-excavated to 5 feet bgs and replaced with a crushed rock mat section.

Foundation recommendations for mitigating excessive settlement for the at-grade structures are presented in Section 6.2 and in Section 6.3 for the Sludge Blend Tank and the Digested Sludge Holding Tank.

5.1.1 Liquefaction-Induced Settlement

Potentially liquefiable soil is present in isolated areas (i.e., where undocumented fill materials are present) below the proposed at-grade structures. As discussed in Section 4.5, the results of our liquefaction-induced settlement analyses indicated up to 1 inch of total vertical settlement, and about ½ inch of differential settlement for the portion of the IPS supported on a slab-on-grade foundation, as well as for the MEB Building and Building A.

5.1.2 Static Settlement

Building A: Below the Building A footprint, the undocumented fill extends to depths ranging from 2.5 to 7.5 feet and are generally less than 4.5 feet. We estimated that about ½ to 1½ inch settlement may develop within the building footprint with the differential settlement of about 1 inch across the building. For Building A, we recommend to over-excavate of a minimum of 3 feet of undocumented fill and replace with compacted structural fill. This will reduce the total static settlement to less than 1 inch and differential settlement to less than ½ inch.

IPS Structure: The portion of the IPS that will be supported on a slab-on-grade foundation is underlain by 8 to 12 feet of soft, predominately fine-grained fill materials which may develop up to about 2 inches of static settlement. The adjacent portion of the IPS will be founded at a depth of about 26 feet on hard basalt bedrock and is not expected to develop any settlement. Therefore, there is the potential for up to 2 inches of differential settlement between the at-grade and below-grade portions of the IPS, which could affect structural performance as well as excessive movement of the pipes and their connections. We recommend complete over-excavation of the undocumented fill materials below the at-grade portion of the IPS to mitigate the potential for static differential settlement.

MEB Building: About 4 to 6 feet of fill will be placed below the MEB Building footprint to achieve the desired finish grade. The fill placement will induce stress increases (up to approximately 800 psf) on the soft, compressible fill materials that extend up to about 8.5 feet below existing site grades below the MEB Building footprint. We anticipate consolidation settlement on the order of 3 inches may occur due to the fill placement, with differential settlement of up to 1½ inches across the building. To mitigate the potential for total and differential static settlement, we recommend complete over-excavation of the undocumented fill materials below the MEB Building prior to mass grading operations.

Sludge Blend Tank and Digested Sludge Holding Tank: The 28-foot diameter Sludge Blend Tank and the 36-foot diameter and the Digested Sludge Holding Tank are underlain by undocumented fill materials extending to about 10.75 feet bgs, based on boring P-36. The proposed bottom-of-slab depths for both tanks is approximately 1.5 feet bgs (i.e., at-grade structures). If founded on existing conditions, settlements of the tanks will likely range from about 2 to 2.5 inches, and differential settlement ranging from 1 to 1.25 inch. To reduce respective total and differential settlements to less than 1 inch and ½ inch, we recommend the undocumented fill materials be over-excavated to 5 feet bgs and replaced with a reinforced crushed rock section as discussed in Section 6.3.

5.2 Shallow Groundwater

Due to the presence of shallow groundwater at the subject site, we anticipate temporary excavations will likely require dewatering, depending on the time of year construction takes place. Recommendations for groundwater control during construction are presented in Section 7.4.

5.3 Basalt Bedrock

The explorations encountered strong to very strong (R4 to R5) basalt bedrock at depths ranging from 2.0 to 16.5 feet across the site. We understand that excavations for the proposed improvements are anticipated to be up to 24 feet bgs (e.g., for the primary clarifier). Therefore, rock excavation will be required. Due to its strong to very strong nature, we anticipate that the basalt bedrock will not be rippable by typical construction equipment and will require drilling and blasting. Recommendations for rock excavation are presented in Section 7.0.

6.0 Design Recommendations

6.1 Foundation Recommendations for Below-Grade Structures

Based on the 90 percent submittal plans for the project, the below-grade structures will be supported on reinforced mat foundations. Spread footing foundations may also be used for foundation support of the below-grade structures. Recommendations for these types of foundations are presented in the following sections. Table 6-1 presents a summary of the anticipated foundation conditions for the proposed below-grade structures.

Table 6-1. Anticipated Foundation Conditions for Below-Grade Structures

Structure[1]	Bottom Depth (feet bgs)	Relevant Boring(s)	Depth to Rock[5] (feet)	Anticipated Foundation Conditions	Anticipated Rock Excavation (feet)[6]
IPS[2]	1.5	P-01, P-16, P-28, P-29	11 to 12.5	Fill	0
	26.2			Bedrock	14 to 15
Primary Clarifier[3]	9.5 to 22.5	B-3, P-03, P-21, P-23, P-32	6 to 16	Bedrock	Up to 15
Aeration Basin No. 3	13 to 18	P-14, P-21	5.5 to 6	Bedrock	7 to 12
SC90	15 (Assumed)	P-18, P-30, P-31	9 to 11	Bedrock	4 to 6
SC90 RAS PS	16.5	P-20	8	Bedrock	8.5
SC90 WAS PS	16.5	B-2	Unknown	Bedrock	0
SC60 RAS/WAS PS	12.5	P-18	9	Bedrock	4
Tertiary Filters	18	P-34	15	Bedrock	3
Tertiary Building[4]	7	n/a	n/a	Fill or bedrock	n/a

Notes:

1. Bottom depths for structures based on 90 percent submittal plans and from West Yost via email on July 19, 2022.
2. The approximate southern half of the IPS will be supported on a slab-on-grade and the approximate northern half of the IPS will be founded below grade at about 26.2 feet bgs.
3. The deepest excavation is on the west side of the primary clarifier where depth to rock ranges from about 11 to 16 feet, whereas the shallowest excavation is on the east side where the depth to rock is about is about 6 feet.
4. Due to access and existing utility and access conflicts, explorations were not able to be completed near this facility.
5. Based on results of geotechnical investigation, fill depth at the site is highly variable and therefore, depth to rock may vary significantly over short distances.
6. Only to foundation bottom elevation; likely additional excavation required below for piping, leveling course, etc.

6.1.1 Subgrade Preparation

Satisfactory subgrade support for spread footings or mat foundations associated with the proposed below-grade structures can be obtained on basalt bedrock or on imported structural fill that is properly placed and compacted on the bedrock. Based on our understanding of planned foundation depths for below grade we anticipate that bedrock will likely be encountered in all below grade structure excavations. The geotechnical engineer or his representative should be contacted to observe subgrade conditions prior to placement of forms, reinforcement steel, or structural fill.

If fill materials are present below the proposed bottom-of-foundation elevation, remaining existing fill materials should be over-excavated and replaced with imported structural fill back to required elevation.

All granular pads for footings should be constructed a minimum of 6 inches wider on each side of the footing for every vertical foot of over-excavation.

Bedrock surfaces that will support spread and continuous footings should be cut as level and as smooth as practical. Placement of foundation concrete on extremely rough bedrock surfaces is not recommended, particularly for strip or continuous footings. For spread and continuous footings, we recommend a minimum of 2 inches, and not more than 12 inches, of heavily compacted, imported structural fill be placed as a leveling course where relatively smooth and level bedrock surfaces cannot be achieved during excavation. For mat foundations, we recommend a minimum 6-inch-thick layer of imported structural fill be placed as a leveling course where relatively smooth and level bedrock surfaces cannot be achieved during excavation.

6.1.2 Minimum Footing Width & Embedment

Minimum spread footing widths should be in conformance with the current OSSC. As a guideline, we recommend individual spread footings have a minimum width of 24 inches, and continuous wall footings have a minimum width of 18 inches. All footings should be founded at least 18 inches below the lowest permanent adjacent grade to develop lateral capacity and for frost protection.

6.1.3 Bearing Pressure & Settlement

Spread footings associated with below-grade structures founded as recommended in Section 6.1.1 should be proportioned for a maximum allowable bearing pressure of 5,000 pounds per square foot (psf). This bearing pressure is a net bearing pressure, applies to the total of dead and long-term live loads, and may be increased by one-third when considering seismic or wind loads.

For spread footings associated with below-grade structures founded as recommended in Section 6.1, we estimate total static settlements to be 1 inch or less, with differential settlements between adjacent columns and/or bearing walls on the order of 0.5 inch or less.

6.1.4 Design Parameters for Mat Foundations and Floor Slabs

For the imported structural fill (including leveling course) thickness of 12-inch or less overlying the bedrock surface, we recommend a maximum modulus of vertical subgrade reaction of 300 pounds per cubic inch (pci) be used for design of mat foundations and floor slabs. For structural fill thickness more than 12 inches, such as in the over-excavation and backfill to foundation level areas, we recommend the modulus of vertical subgrade reaction to be reduced to 250 pci. The subgrade modulus values represent anticipated values, which would be obtained in a standard in situ plate test with a 1-foot square plate. Use of this subgrade modulus for floor slab design should include appropriate modifications based on dimensions as necessary.

For design of the mat foundations supporting the Sludge Blend Tank and the Digested Sludge Holding Tank, a modulus of vertical subgrade reaction of 250 pci may be used, an allowable bearing capacity of 2,000 psf may be used, if applicable. These values assume that these two tanks will be supported on improved subgrade consisting of a crushed rock mat section as discussed in Section 6.3.

6.2 Foundation Recommendations for At-Grade Structures

Shallow foundation support for the at-grade structures can be derived from shallow spread footings or mat foundations. Recommendations for these types of foundations are presented in the following sections and a summary of the proposed at-grade structures is provided in Table 6-2.

Table 6-2. Anticipated Foundation Conditions for At-Grade Structures

Structure[1]	Bottom Depth (feet bgs)	Relevant Boring(s)	Depth to Rock (feet)	Anticipated Foundation Conditions	Anticipated Rock Excavation (feet)[4]
IPS[2]	1.5	P-01, P-16, P-28, P-29	11 to 12.5	Fill	0
	26.2			Bedrock	14 to 15
MEB Building[3]	1.5	B-5, P-12, P-24	3 to 8.5	Fill	0
Sludge Blend Tank	1.5	P-36	10.8	Fill	0
Digested Sludge Holding Tank	1.5	P-36	10.8	Fill	0
Building A (O&M and Controls)	1.5 (e.g., at-grade)	B-4, P-06, P-08	3.5 to 7.5	Fill	0
Building A (Headworks & Dewatering)	1.5 (e.g., at-grade)	P-04, P-05	3.5 to 7.5	Fill	0

Notes:
1. Bottom depths for structures based on 90 percent submittal plans provided by West Yost.
2. The approximate southern half of the IPS will be supported on a slab-on-grade and the approximate northern half of the IPS will be founded below grade at about 26.2 feet bgs.
3. The MEB building will be an at-grade structure and built on approximately 5 feet of new fill.
4. Only to foundation bottom elevation; likely additional excavation required below for piping, leveling course, etc.

6.2.1 Subgrade Preparation

Satisfactory subgrade support for spread footings or mat and slab-on-grade foundations associated with the proposed at-grade structures can be obtained by over-excavating a minimum of 3 feet of the undocumented fill materials and replacing it with properly placed and compacted structural fill. For the on-grade portion of the IPS and MEB Building, complete over-excavation of the undocumented fill and replacement with compacted structural fill are recommended. All granular pads for footings should be constructed a minimum of 6 inches wider on each side of the footing for every vertical foot of over-excavation. The geotechnical engineer or his representative should be contacted to observe subgrade conditions prior to placement of forms, reinforcement steel, or structural fill.

For any at-grade structure excavation that reaches bedrock, see Section 6.1.1 for subgrade preparation for bedrock surfaces.

6.2.2 Minimum Footing Width & Embedment

Minimum spread footing widths should be in conformance with the current OSSC. As a guideline, we recommend individual spread footings have a minimum width of 24 inches, and continuous wall footings have a minimum width of 18 inches. All footings should be founded at least 18 inches below the lowest permanent adjacent grade to develop lateral capacity and for frost protection.

6.2.3 Bearing Pressure & Settlement

Spread footings associated with at-grade structures founded as recommended in Section 6.2 should be proportioned for a maximum allowable bearing pressure of 2,000 pounds per square foot (psf). This bearing pressure is a net bearing pressure, applies to the total of dead and long-term live loads, and may be increased by one-third when considering seismic or wind loads.

For spread footings associated with at-grade structures founded as recommended in Section 6.2.1, we estimate total static settlements to be 1 inch or less, with differential settlements between adjacent columns and/or bearing walls on the order of 0.5 inch or less.

6.2.4 Design Parameters for Mat Foundations and Floor Slabs

For the recommended minimum 36-inch-thick layer of imported structural fill (including leveling course) overlying the undocumented fill materials, we recommend a maximum modulus of vertical subgrade reaction of 175 pounds per cubic inch (pci) be used for design of mat foundations and floor slabs. The subgrade modulus values represent anticipated values, which would be obtained in a standard in situ plate test with a 1-foot square plate. Use of this subgrade modulus for floor slab design should include appropriate modifications based on dimensions as necessary.

6.3 Foundation Recommendations for Sludge Blend Tank and Digested Sludge Holding Tank

We recommend the upper 5 feet of undocumented fill materials be removed (i.e., over-excavation of 3.5 feet) to construct a crushed rock mat section to support the Sludge Blend Tank and Digested Sludge Holding Tank. The crushed rock mat section is shown in Figure 8. Subgrade areas should be cleanly cut to firm undisturbed soil. Additional over-excavation may be required locally, especially if organic materials, construction debris, or other unsuitable materials are encountered.

Once the upper 5 feet of undocumented fill materials have been removed, the exposed subgrade surface should be rolled with a self-propelled, smooth-drum compaction equipment to recompact the subgrade to at least 92 percent of ASTM D1557. The over-excavation and subgrade compaction should be observed by a representative of the geotechnical engineer.

After the over-excavation and subgrade is approved, a strong geotextile, such as Mirafi RS580i that provides both separation/filtration and reinforcement, should be installed directly on the prepared subgrade. The overlap of the geotextile should be at least 2 feet.

After the placement of the geotextile, construction of the crushed rock mat section should follow immediately to protect the prepared subgrade. The reinforcement geotextile should consist of two layers of Mirafi RS580i (or its equivalent). The overlap of the geogrid should be at least 2 feet. The first layer of geogrid should be placed directly on the prepared subgrade, and the second layer should be at 3 feet above the first layer.

Fill materials used in the crushed rock mat section should be clean, 1½-inch minus Dense Graded Aggregates structural fill (see Section 7.6.2 for additional recommendations) and should be compacted to 92 percent of ASTM D1557. The 1½-inch minus structural fill should be placed in maximum lifts of 12 inches of loose material and should be placed such that construction equipment does not operate directly on the geotextile and rock spread such that the geotextile is not damaged or pulled apart at joints. Each lift of subgrade stabilization material should be tested by an experienced geotechnical engineering representative prior to placement of subsequent lifts.

6.4 Retaining Walls

There are six retaining walls, Wall 1 through Wall 6, proposed as part of the WRF improvements. The retaining walls will be cast-in-place, reinforced concrete cantilevered walls ranging in height from 2.5 to 6.75 feet and with footing widths ranging from 3 feet to 6 feet. The retaining walls will retain backfill heights ranging from 2 feet to 6.25 feet. We understand the retaining walls are being designed by West Yost.

The following sections and information in this report should be referenced, regarding to the design and construction of the retaining walls:

- Lateral earth pressure recommendations provided in Table 6-3;
- Retaining wall footing design and subgrade preparation should be in general accordance with Sections 6.2.1, 6.2.2, and 6.2.3 of this report;
- Lateral/sliding resistance recommendations are provided in Section 6.6; and
- Retaining wall backfill recommendations are provided in Section 7.6.3.

6.5 Uplift & Flotation Considerations

6.5.1 Below Grade Structures

Below-grade, water-tight structures should be designed to resist uplift forces during periods of high groundwater. Forces resisting uplift include self-weight of the structure and one of following two options for backfill soils. The selection depends on the geometry of the foundation behind the embedded walls:

1. When the foundation wall includes a perimeter lip (or heel) extending beyond the back face of the foundation wall, the self-weight of a soil wedge can be included. The wedge is defined by the area from the back face of the foundation wall to a plane projected upwards from the heel of the footing at an angle of 20 degrees outward from vertical. An average soil unit weight of 120 pcf

above the design groundwater level is recommended for this evaluation. A buoyant soil unit weight of 70 pcf should be used below the design groundwater level.

2. When the foundation wall *does not* include a heel, shear resistance should be evaluated using a friction coefficient of 0.4 between the structure wall and backfill in conjunction with the at-rest lateral earth pressure distribution provided in Figure 4.

A schematic showing these buoyancy resistance options is provided in Figure 5. For the evaluation of buoyancy, a design groundwater level at the ground surface is recommended. This is due, in part, to the potential for water to collect in the wall backfill and subgrade. Although water will likely dissipate into the formation, the dissipation rate may be slower than the collection rate, leading to temporary hydrostatic and uplift pressures below structure foundations.

However, this uplift resistance by either frictional or weight approach may not be sufficient due to the large footprints of some of the structures (e.g., the SC90, Aeration Basin No. 3, and Primary Clarifier structures), or structurally unfavorable for the base slab design. In this case, an underdrain system and/or pressure relief valves may need to be considered. If an underdrain system is to be considered during design, we recommend that the system consist of an 18-inch-thick layer of drain rock overlain by 6 inches of leveling course below the foundations and slabs, with 4-inch diameter perforated pipes located at the mid-height of the drainage layer. The pipes should be connected to a manhole with a pump system. The pump system can be turned on prior to maintenance for hydrostatic pressure relief and dewatering. The underdrain system can also be used as leak detection system under structures. A typical underdrain system is shown in Figure 6. More details about the underdrain system should be provided in the project plans and specifications if an underdrain system is to be utilized.

6.5.2 Pipeline Structures

Since the ground water level (modeled at the ground surface) is above the proposed pipeline structures, a check against buoyancy of the empty pipe was performed. We calculated a Factor of Safety (FOS) against flotation based on the most conservative buried pipe structure case (the 24-inch diameter RS IPS to Headworks HDPE pipeline with 3 feet of pipe cover). Our calculations showed a FOS greater than 3.5 for this buried pipe case. Therefore, we conclude that the potential flotation risk of buried pipeline structures is low.

Although the FOS against floatation is acceptable for the above, worst-case scenario, there are typically minimum depth of cover requirements to protect pipelines from traffic and structural surcharge loading. Therefore, construction live load and traffic load during the project life should be considered in the design.

6.6 Lateral Earth Pressures – Embedded Walls & Retaining Walls

Backfill material placed behind the below-grade structures, vaults, ancillary structures, as well as the proposed retaining walls should consist of free-draining crushed aggregate conforming to Section 00510.12 in the most recent OSSC. We recommend using a high groundwater level at the site ground surface in the calculation of lateral earth pressures for embedded walls. Table 6-3 summarizes our recommended lateral earth pressure values, expressed as the equivalent fluid pressures.

Table 6-3. Recommended Lateral Earth Pressures

Design Condition	Groundwater Condition	Static At-rest Pressure (psf)	Static Surcharge Pressure (psf)	Additional Seismic Pressure (psf)	Hydrostatic Pressure (psf)
At-Rest Earth Pressure	Above Groundwater	$50(H-H_W)$	0.4q	17H	--
	Below Groundwater	$50(H-H_W) + 28H_W$	0.4q	17H	$62H_W$
Active Earth Pressure	Above Groundwater	$29(H-H_W)$	0.22q	10H	--
	Below Groundwater	$29(H-H_W)+16H_W$	0.22q	10H	$62H_W$

General Notes:
1. H = total height of buried wall.
2. H_W = submerged portion of buried wall

Our recommended lateral earth pressures assume imported, free-draining crushed aggregate and finished backfill slopes flatter than 4H:1V (horizontal:vertical). The equivalent fluid earth pressures and seismic earth pressures increase with depth in a hydrostatic, triangular pressure distribution with the resultant force acting at approximately 0.3H above the base of the wall (where H is the total height of the wall). The pressure distribution of the surcharge loads is a constant value of lateral pressure resulting from the vertical, surface surcharge loads (q) with the resultant lateral surcharge force acting approximately at a height above the base of the wall equal to one-half the total wall height. Walls that extend below the anticipated high/perched groundwater level of 2.5 feet bgs should also include the hydrostatic groundwater loading. The distribution and resultant of the backfill, groundwater, and seismic earth pressure are shown on Figure 4.

6.7 Lateral Resistance – At-Grade and Below-Grade Structures

Lateral resistances for at-grade and below-grade structures can be provided by frictional resistance between the base of the foundation and the crushed rock/structural fill material, and through soil passive resistance around the embedded portion of the structure for below-grade structures. For base frictional resistance, an allowable friction factor of 0.60 for cast-in-place concrete foundations on the crushed rock/structural fill material may be used, and an allowable friction factor of 0.40 for pre-cast concrete foundations on the crushed rock/structural fill material may be used.

The design value for passive pressure should not exceed the value of 150D (in units of psf, where D is the depth of the embedment), due to the large amounts of movement necessary to mobilize full passive resistance. This value incorporates a factor of safety (FOS) of 3 from the ultimate value. Unless in paved areas, the upper 12 inches should not be used in calculating passive resistance because construction and post-construction activities often disturb this region.

6.8 Pipeline Structures

6.8.1 Pipeline Subgrade Support

The subgrade along the pipelines is anticipated to consist of basalt or fill materials (i.e., soft clayey soil, or very loose silty sand). Basalt will support the pipeline without any modifications. For areas where the trench subgrade consists of soft subgrade conditions, we recommend subgrade stabilization in general accordance with Section 7.6.6. The new pipeline construction will not result in a net increase in pressure at the base of the pipeline, and therefore pipe settlement under static conditions is expected to be negligible.

6.8.2 Pipe Zone Geotechnical Design Parameters

Flexible pipes derive their load carrying capacity from their interaction with the pipe zone backfill as the pipe deflects under load and pushes laterally against the soil. Load carrying capacity depends on the depth of the pipe, the surrounding soil conditions, the type and density of the backfill, and the thickness of compacted pipe zone backfill between the pipe and the native soil/rock in the trench wall. Based on the anticipated subsurface soil types and relative densities, we have developed the following geotechnical design parameters to be used for pipeline design.

Table 6-4. Pipeline Design Parameters

Property	Undocumented Fill Soils	Basalt Bedrock	Granular Backfill	CLSM
Moist Unit Weight, γ_m (pcf)	115	165	135	125
Saturated Unit Weight, γ_{sat} (pcf)	120	165	140	125
Friction Angle, ϕ (degrees)	30	45	38	34
Modulus of Soil Reaction, E’ (psi)	700	>10,000	2400	3,000

The design parameters presented in Table 6-4 are appropriate for use in the Iowa Deflection formula (Spangler, 1941) and are consistent with American Water Works Association Manual M11 (2004).

6.8.3 Trench Width

Distance between the pipe springline and trench sidewall should be wide enough to allow for inspection, adequate backfill compaction, and field density testing. For granular backfill the minimum distance between the pipe springline and the trench sidewall should be as follows:

- Pipe diameter ≥ 36 inches: 18 inches
- Pipe diameter <36 inches and ≥ 24 inches: 12 inches
- Pipe diameter <24 inches: 9 inches

Where Controlled Low Strength Material (CLSM) is used as backfill, the trench width should extend a minimum 9 inches beyond the pipe springline for pipes with diameters greater than 36 inches. For pipes with diameters smaller than 36 inches, the trench width should extend a minimum 6 inches beyond the pipe springline.

6.8.4 Pipeline Backfill Material

We recommend that the pipe bedding and pipe zone in the trench be constructed with imported, well-graded crushed rock, such as ¾- inch minus crushed aggregate conforming to Section 02630.10 in the most recent OSSC.

7.0 Construction Recommendations

Recommendations provided herein are for planning purposes. We assume that we will be provided an opportunity to complete our recommendations once the project details are finalized. All specifications referenced in this section referred to 2021 Oregon Standard Specifications for Construction (ODOT, 2021). We recommend completing the construction during dry season when the groundwater is at the lowest.

7.1 Site Preparation

All areas to be excavated, filled, or used as a subgrade should be stripped. Prior to stripping and excavation, utilities should be located and rerouted as necessary, and any abandoned pipes or utility conduits should be removed or stabilized in a manner that does not adversely affect performance of new facilities. Demolition of any existing buildings and foundations associated with former structures should include complete removal of all structural elements, including foundations and concrete slabs. Although we anticipate that a majority of the subgrade supporting the proposed improvements will consist of basalt bedrock, the following paragraphs are applicable to those areas in which subgrade conditions will consist of the existing, on-site undocumented fill materials (i.e., pavement/hardscaping areas, etc.).

Due to the moisture-sensitive nature of the existing on-site fill materials, all stripping and excavations should be performed using a smooth-edge excavator working from areas where material has yet to be removed. Stripping and excavation should remove surficial organic soil (sod and topsoil), trees/roots, asphalt pavement and base rock, and any loose/soft materials as determined by a qualified geotechnical engineering representative. Subgrade areas should be cleanly cut to firm, undisturbed soil. Should construction take place during wet weather, we recommend that a representative of the geotechnical engineer be present to observe the subgrade in order to evaluate whether additional preparation is indicated.

Placement of crushed rock should follow immediately after site grading in order to provide protection of the sensitive subgrade soil during construction activities. In temporary construction traffic areas, the placement of a 12-inch-thick granular working base is generally recommended. For heavily traveled construction traffic areas, thicker sections (i.e. 18 to 24 inches) and geotextile fabrics are recommended. Generally, four to six inches of crushed rock is sufficient in foot traffic areas.

7.2 Excavation

The site is underlain by fill, extending from the ground surface to depths ranging from 2.0 to 16.5 feet bgs. The fill is underlain by strong to very strong (R4 to R5) basalt. We anticipate that maximum excavation depths for the proposed improvements will be on the order of 20 feet bgs. Therefore, rock excavation will be required.

Rippability is the ease with which rock can be mechanically excavated, and it is influenced by numerous rock parameters, including unconfined compressive strength, degree of weathering, fracturing, abrasiveness, and spacing of discontinuities. Uniaxial compressive strength test results of the basalt bedrock ranged from 7,000 to 26,000 psi, with an average value of 19,000 psi. The results of Point Load

Index ($I_{S(50)}$) testing ranged from approximately 270 and 715 psi, with an average value of 510 psi, which correlate to uniaxial compressive strengths of approximately 5,100 to 17,150 psi. The results of strength tests, in conjunction with observed joint spacing and degree of weathering indicate the rock is not rippable by typical construction equipment. Therefore, rock excavation will likely require drilling and blasting.

The contractor should be responsible for selecting appropriate rock excavation techniques that prevent damage to existing facilities and minimizes over-break or over-cut beyond the excavation limits. Protruding rock of more than 4 inches above the specified subgrade elevation should not be allowed. Any large protrusions should be removed. In addition, the selection of excavation methods and procedures should consider the impact to the subgrade preparation.

7.3 Temporary Excavation Support

All excavations should be in accordance with applicable OSHA and state regulations. It is the contractor's responsibility to select the excavation methods, to monitor site excavations for safety, and to provide any shoring required to protect personnel and nearby, existing structures. A competent person, as defined by Oregon OSHA, is an individual that can identify existing and predictable excavation-related hazards and has the authority to take prompt corrective measures to eliminate such hazards. McMillen Jacobs' Project role does not include review or oversight of excavation safety. As summarized in Table 6-1, the base depths of the proposed below-grade structures are up to about 26 feet below existing site grades and may require excavation depths on the order of up to 30 feet.

Due to the depth of the proposed structures, depth to groundwater, and site restraints, temporary excavation support will likely be required for some excavations within the existing fill. For excavations extending into basalt bedrock, the rock can be cut at slopes as steep as vertical. For the undocumented fill materials, an OSHA soil type of "C" should be used; with a maximum allowable temporary cut slop of 1.5H:1V (horizontal:vertical) if fully dewatered.

Our opinions for the excavation support discussed above are for planning purposes only. The contractor should be responsible for the stability of temporary excavations and the actual means and methods to protect excavations and that temporary slopes comply with applicable local, state, and federal safety regulations, including the current Occupational Safety and Health Administration (OSHA) Excavation and Trench Safety Standards. Lateral earth pressures for design of the temporary excavation support within fill are provided in Figure 7.

7.4 Groundwater Control

Groundwater measurements made during explorations indicate groundwater levels between 2.5 and 8.5 feet bgs across the site. Groundwater levels during construction may be higher than these, especially during the wet seasons. Excavations for structures are anticipated to extend to approximately 20 feet below the ground surface. Therefore, the excavations will encounter groundwater.

Soil within the excavations are primarily fine-grained with isolated zones of sandy soils. These materials are not anticipated to produce significant volumes of water. However, due to the size of the work area and shallow groundwater, it is anticipated that dewatering systems including sump-pumps or well points may be required.

7.5 Blasting Plan

Based on the conditions encountered in the borings, the contractor may select to use drilling and blasting methods for excavation. The drilling and blasting must conform to the requirements in Section 00335 of the most recent OSSC. The Contractor must submit a blasting plan prepared by a person qualified and experienced in blasting work at least 14 days before beginning of drilling and blasting work. The blasting plan must provide details of drilling and blasting pattern, vibration, flyrock, noise reduction method, blast area security measures, and traffic control.

Drilling and blasting activities generate vibrations. Blast designs must be developed to limit vibrations to levels that do not adversely influence existing nearby structures. Blast designs involve interrelated parameters including round length, blast hole size, spacing, location, explosive strength, and the delay and firing sequence. Delays are used to detonate fractions of seconds after blast initiation to make sure each charge will fire into a cavity created by an earlier charge.

If blasting is used, nearby structures should be pre-surveyed for documenting the existing conditions. Seismographs that are specifically designed to monitor construction blasting should be used during construction to monitor blast vibrations to verify that actual vibration levels are within an acceptable range at critical structures. If a blast results in unacceptable vibrations, special modifications to the blasting procedures should be made, such as using different delay patterns, reduction in size of individual blasts, shorter and/or smaller diameter blast holes, closer spacing of blast holes, reduction of explosives, or a combination thereof as necessary to improve results.

7.6 Fill Materials & Compaction Criteria

We anticipate that various fill materials will be used for the construction of this project and that their specific locations and placement criteria will be described in the construction plans and specifications. The following sections describe general fill criteria that are subject to modification under specific design recommendations and the development of construction plans and specifications.

7.6.1 On-Site Soils – General Use

The on-site fill materials are not suitable for re-use as structural fill, though they may be separated and stockpiled for use in non-structural or appropriate landscape applications.

7.6.2 Imported Structural Fill – General Use

Imported structural fill should conform with the requirements of ODOT 1½-inch or ¾-inch minus Dense Graded Aggregates as defined in Section 02630-10.

Imported structural fill should be placed in maximum lifts of 8 inches of loose material. Unless otherwise noted, structural fill should be compacted to 92 percent of ASTM D1557 (i.e., Modified Proctor). Proper moisture conditioning and the use of vibratory equipment will facilitate compaction of these materials.

Each lift of imported structural fill should be tested by a qualified testing agency prior to placement of subsequent lifts. This fill condition should extend horizontally outward beyond the exterior perimeter of the building and footings a distance equal to the height of the fill or 3 feet, whichever is greater.

7.6.3 Embedded Wall & Retaining Wall Backfill

Embedded wall and retaining wall backfill (wall backfill) should consist of should consist of free-draining crushed aggregate conforming to Section 00510.12 in the most recent OSSC and be compacted to a minimum of 90 percent of the maximum dry density, as determined by ASTM D 1557. Wall backfill placed within 3 feet of the wall should be compacted in lifts less than 6-inches thick using hand-operated tamping equipment (e.g., jumping jack or vibratory plate compactors). If flat work (e.g., sidewalks or pavements) is placed atop the wall backfill, we recommend that the upper 2 feet of material be compacted to 95 percent of the maximum dry density, as determined by ASTM D 1557.

7.6.4 Bedding and Pipe Zone Backfill

We recommend that pipe bedding consist of imported structural fill as described above, such as ¾-inch minus crushed aggregate base material. We recommended a minimum 6 inches of bedding below the invert of the pipe. If weak subgrade conditions are encountered, subgrade stabilization may be necessary, as discussed in Section 7.6.6.

Above the pipe bedding zone, an imported structural fill as described above should be used for the pipe zone which typically extends at least 12 inches above the top of the pipe, or as determined by West Yost or the pipe manufacturer.

Bedding and pipe zone materials should be compacted to 90 percent of the maximum dry density, as determined by ASTM D 1557.

7.6.5 Trench Backfill

Trench backfill above the pipe zone should consist of imported structural fill as described above, with a maximum particle size of ¾ inch, and with less than 8 percent material passing the U.S. Standard No. 200 Sieve. As a guideline, trench backfill should be placed in 12- to 18-inch lifts. The earthwork contractor may elect to use alternative lift thicknesses based on their experience with specific equipment and fill material conditions during construction in order to achieve the required compaction. Trench backfill materials should be compacted to 95 percent of the maximum dry density, as determined by ASTM D1557.

7.6.6 Subgrade Stabilization

If groundwater is present at the base of utility excavations, trench base stabilization material should be placed. Trench base stabilization material should consist of a minimum of 12 inches of well-graded granular material (with a maximum particle size of 3 inches and less than 5 percent material passing the U.S. Standard No. 4 Sieve) underlain by a layer of non-woven geotextile placed directly over the subgrade. The material should be free of organic matter and other deleterious material, placed in one lift, and compacted until well keyed. Vibratory compaction equipment is not recommended due to risk of additional disturbance to the subgrade. A reinforcement geotextile should be used below the aggregate as described in Section 7.7.2.

7.6.7 Controlled Low-Strength Material (CLSM)

CLSM is a self-compacting, cementitious material that is typically considered when backfilling localized areas. CLSM is sometimes referred to as “controlled density fill” or CDF. Due to its flowable characteristics, CLSM typically can be placed in restricted-access excavations where placing and compacting fill is difficult. If chosen for use at this site, we recommend the CLSM conform with Section 00442 in the most recent OSSC. The geotechnical engineer’s representative should observe placement of the CLSM and obtain samples for compression testing in accordance with ASTM D4832. As a guideline, for each day’s placement, two compressive strength specimens from the same CLSM sample should be tested. The results of the two individual compressive strength tests should be averaged to obtain the reported 28-day compressive strength. If CLSM is considered for use on this site, please contact the geotechnical engineer for site-specific and application-specific recommendations.

7.6.8 Pavement Materials – Asphalt & Base Course

Asphalt pavement and base course materials should conform to the requirements set forth in the most recent Oregon SSC guidelines. Base course material should consist of a well-graded, 1½-inch or ¾-inch-minus, crushed rock, having less than 5 percent material passing the No. 200 sieve. Base course material should be moisture conditioned to within 2 percent of optimum moisture content and compacted by mechanical means to a minimum of 95 percent of the material's maximum dry density, as determined in accordance with ASTM D 1557. Base coarse materials should be placed in layers that, when compacted, do not exceed about 8 inches. The asphalt pavement should be compacted to at least 92 percent of the material’s theoretical maximum density as determined in accordance ASTM D 2041 (Rice Specific Gravity).

7.7 Geotextiles

7.7.1 Separation Geotextiles

In general, the widespread use of separation geotextiles is not anticipated for the project. However, they may be required in localized areas of trench seepage or for protection of subgrade, or in other areas identified during construction. They are not required for typical trench construction. If used, separation geotextiles should consist of a “needle-punched”, non-woven separation fabric meeting the requirements for nonwoven drainage geotextiles, as shown in Table 02320-4 in OSSC Section 02320.

7.7.2 Reinforcement Geotextiles

A reinforcement geotextile system should be installed beneath subgrade stabilization backfill within the pipeline trenches. We recommend a single-layer system consisting of a strong geotextile, such as Mirafi RS380i, that provides both separation/filtration and reinforcement. The reinforcement/separation geotextile should be installed on the base of the trench and extend up to the top of the subgrade stabilization zone (below bedding) at a minimum. Reinforcement geotextiles should meet the requirements for Type 2, woven riprap geotextiles, as shown in Table 02320-2 in ODOT OSSC Section 02320 (ODOT, 2021).

For construction of the crushed rock mat section to support the Sludge Blend Tank and the Digested Sludge Holding Tank, we recommend using the Mirafi RS580i geotextile, which is very similar to the Mirafi RS380i discussed above, but has a higher tensile strength and modulus.

7.8 Wet Weather Construction

For planning purposes, the wet season should be considered to extend from late September to late June. It is our experience that dry weather working conditions should prevail between early July and the middle of September.

The soils encountered within the project area are highly moisture sensitive and will degrade after being traversed by construction equipment during periods of wet weather or wet conditions. Therefore, during or after wet weather, it will likely be necessary to import granular materials for structural fill or to protect exposed subgrade materials. Delays in site earthwork activities should be anticipated during periods of heavy rainfall. If earthwork is performed during extended periods of wet weather or in wet conditions, we recommend the following:

- Cover the base of trenches within soil with trench stabilization material.
- Excavations should be protected from surface water runoff by placing sandbags or by other means to promote runoff of precipitation away from work areas and to prevent ponding of water in excavations.
- Plastic covers, sloping, ditching, sumps, dewatering, and other measures should be employed in work areas as necessary to permit timely completion of work. Bales of straw and/or geotextile silt fences should be used to control surface soil movement and erosion.
- Excavations (specifically trench excavations) should be completed in small sections and backfilled at the end of each day to reduce exposure to wet conditions.
- Excavation or the removal of unsuitable soil should be followed promptly by placement and compaction of trench or foundation stabilization fill.
- The size and type of construction equipment used may have to be limited to minimize soil disturbance.

8.0 Closure

This report has been prepared for the exclusive use of the City of Sweet Home and West Yost Associates, Inc. in connection with the Sweet Home Wastewater Treatment Plant – Final Design project. The data presented in this report is based on the subsurface conditions encountered during our site explorations. The data presented herein is intended to support the design of the proposed improvements. McMillen Jacobs Associates is not responsible for the interpretation of the data contained in this report by anyone; as such interpretations are dependent on each person's subjectivity.

The geotechnical engineering evaluations and interpretations are completed within the limitations of McMillen Jacobs Associates approved scope of work, schedule and budget. The services rendered by McMillen Jacobs Associates have been performed in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing under similar conditions in the same area. The construction recommendations are considered preliminary and provided for planning purposes only. McMillen Jacobs Associates is not responsible for the use of this report in connection with anything other than the project at the location described above.

MCMILLEN JACOBS ASSOCIATES

REGISTERED PROFESSIONAL ENGINEER
80569PE
OREGON
June 7, 2012
JEFFREY P. QUINN
EXPIRES: 12/31/2022

Wolfe Lang, P.E., G.E.
Principal Geotechnical Engineer

Jeff Quinn, P.E.
Senior Project Engineer

9.0 References

ASTM Standard, 2017, ASTM International, West Conshohocken, PA, 2017, www.astm.org.

Bieniawski, Z.T., 1989, Engineering Rock Mass Classifications, John Wiley and Sons, New York, 251 p.

Brown E.T. (Ed). 1981, Rock characterization, testing and monitoring - ISRM suggested methods, 171-183. Oxford, Pergoman.

Brown and Caldwell, 2016, City of Sweet Home Waste Water Facilities Plan, December 2016.

Oregon Department of Consumer and Business Services & The International Code Council, 2019, Oregon Structural Specialty Code, 2014 Edition (OSSC 2019).

Oregon Department of Transportation, 2018, Oregon Standard Specifications for Construction, 2018 Edition.

American Society of Civil Engineers (ASCE/SEI 7-16). 2016. Minimum Design Loads for Buildings and Other Structures. Boulanger, R.W. and Idriss, I.M., 2014. *CPT and SPT Based Liquefaction Triggering Procedures, Report No. UCD/CGM 14-01*, Center for Geotechnical Modeling, Department of Civil and Environmental Engineering, UC Davis, April 2014.

Boulanger, R.W. and Idriss, I.M., 2014. *CPT and SPT Based Liquefaction Triggering Procedures, Report No. UCD/CGM 14-01*, Center for Geotechnical Modeling, Department of Civil and Environmental Engineering, UC Davis, April 2014.

Idriss, I. M. and Boulanger, R. W., 2008. *Soil Liquefaction during Earthquakes*. Earthquake Engineering Research Institute, Oakland, California.

International Code Council, Inc., 2012, International Building Code, 2012 Edition (IBC 2012).

Madin, I.P., 1990. Earthquake-Hazard Geology Maps of the Portland metropolitan Area, Oregon: Oregon Department of Geology and Mineral Industries Open-File Report O-90-02.

Occupational Safety and Health Administration (OSHA), 2014. *OSHA Technical Manual (OTM), Section V: Chapter 2.* United States Department of Labor, Washington, D.C.

Oregon Department of Transportation (ODOT), 2021. *Oregon Standard Specifications for Construction* (OSSC).

Petersen, M.D., A.D. Frankel, S.C. Harmsen, C.S. Mueller, K.M. Haller, R.L. Wheeler, R.L. Wesson, Y. Zeng, O.S. Boyd, D.M. Perkins, N. Luco, E.H. Field, C.J. Wills, & K.S. Rukstales (2008), “Documentation for the 2008 Update of the United States National Seismic Hazard Maps,” U.S. Geological Survey Open-File Report 2008-1128, 61 p.

Popowski, T.A., 1996. Geology, Structure, and Tectonic History if the /Tualatin Basin, Northwestern Oregon: Corvallis, Oregon, Oregon State University Master’s Thesis.

Schlicker, H.G. and Deacon, R.J., 1967. Engineering Geology of the Tualatin Valley Region, Oregon: Oregon Department of Geology and Mineral Industries Bulletin 60.

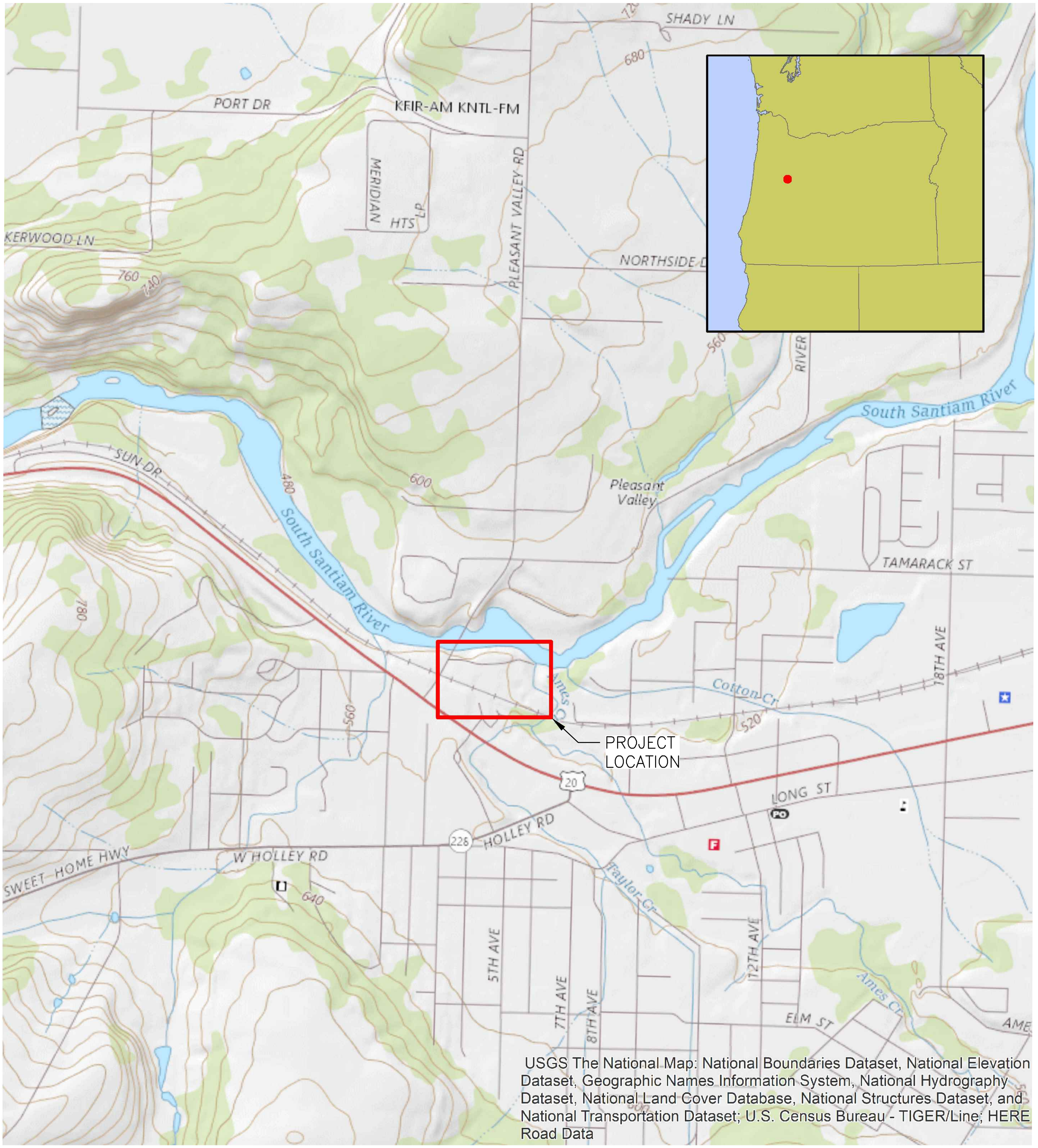
Spangler, M. G., 1941. *The Structural Design of Flexible Pipe Culverts.* Iowa Engineering Experiment Station Bulletin No. 153.

United States Geological Survey (USGS), 2018. U.S. Seismic Design Maps, https://earthquake.usgs.gov/designmaps/beta/us/

United States Geological Survey, Coterminous U.S. 2015 (v4.0x) Interactive Deaggregations, accessed July 5, 2018: https://earthquake.usgs.gov/hazards/interactive/

Wong, I. G., and Silva, W. J., 1998. *Earthquake Ground Shaking Hazards in the Portland and Seattle Metropolitan Areas.* American Society of Civil Engineering Geotechnical Special Publication ASCE, no. 75, Vol. 1, p. 66-78.

Figures



USGS The National Map: National Boundaries Dataset, National Elevation Dataset, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; U.S. Census Bureau - TIGER/Line; HERE Road Data

PROJECT VICINITY MAP

SCALE: NTS

N

McMILLEN JACOBS ASSOCIATES

CITY OF SWEET HOME

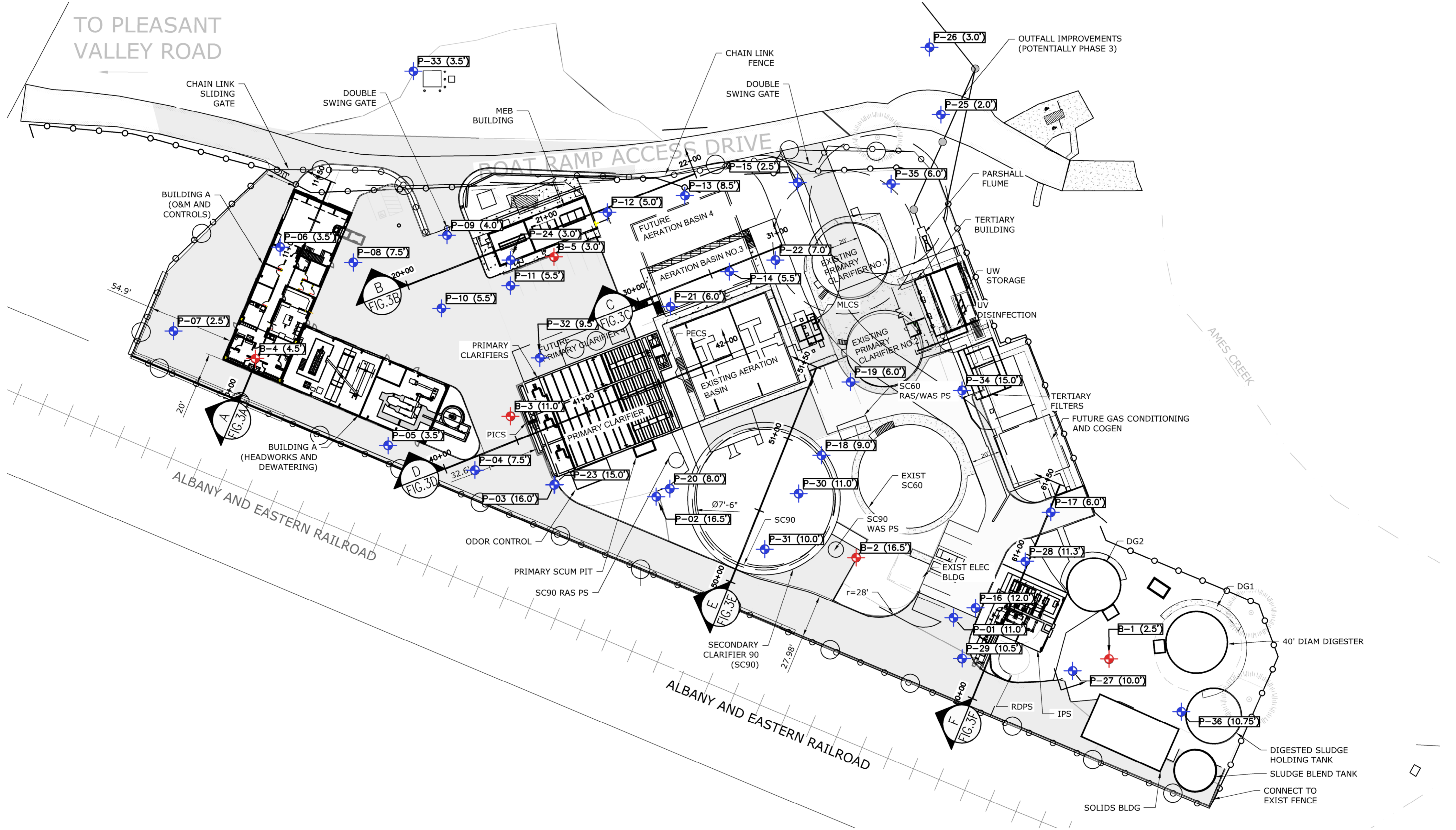
MAHLER WATER RECLAMATION FACILITY IMPROVEMENTS

GEOTECHNICAL ENGINEERING REPORT
PROJECT VICINITY MAP

FIG.1

DEC 2022

Path: C:\Users\cburke\Box\Jobs\6367.0 Sweet Home WWTP Final Design Review\900 Design Technology\970_Xrefs\Fig.1 – Vicinity map.dwg Plot date: Jul 21, 2022, CAD User: cburke



LEGEND:

B–1 (XX.X') ⌖ BOREHOLE LOCATION (DEPTH TO ROCK IN FT)

P–01 (XX.X') ⌖ PROBE–HOLE LOCATION (DEPTH TO ROCK IN FT)

EXPLORATION PLAN

SCALE: 1"=60'

0' 60' 120'

A
—

N

McMILLEN JACOBS ASSOCIATES

CITY OF SWEET HOME

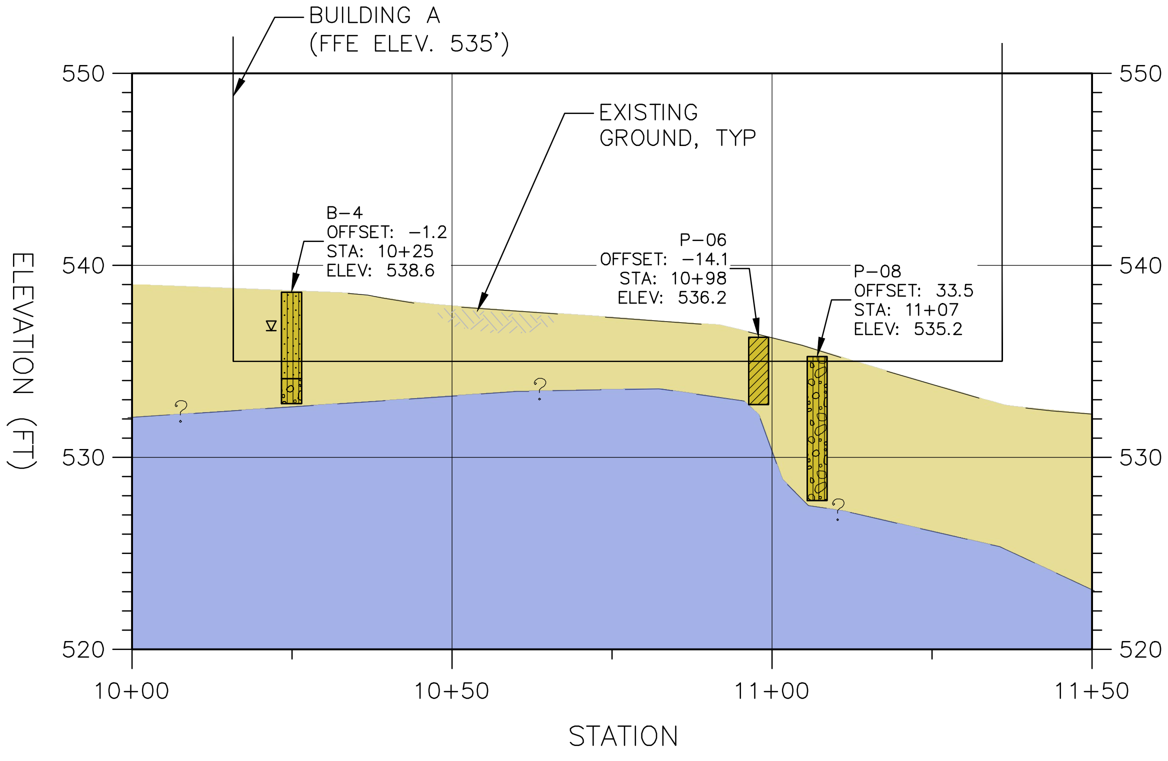
MAHLER WATER RECLAMATION FACILITY IMPROVEMENTS

GEOTECHNICAL ENGINEERING REPORT
EXPLORATION PLAN

FIG.2

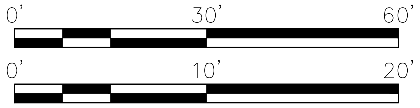
DEC 2022

Path: C:\Users\HughonMadeleine\Box\Jobs\6367.0 Sweet Home WWTP Final Design Review\900 Design Technology\970_Xrefs\SITE PLAN.dwg Plot date: Dec 14, 2022, CAD User: HughonMadeleine



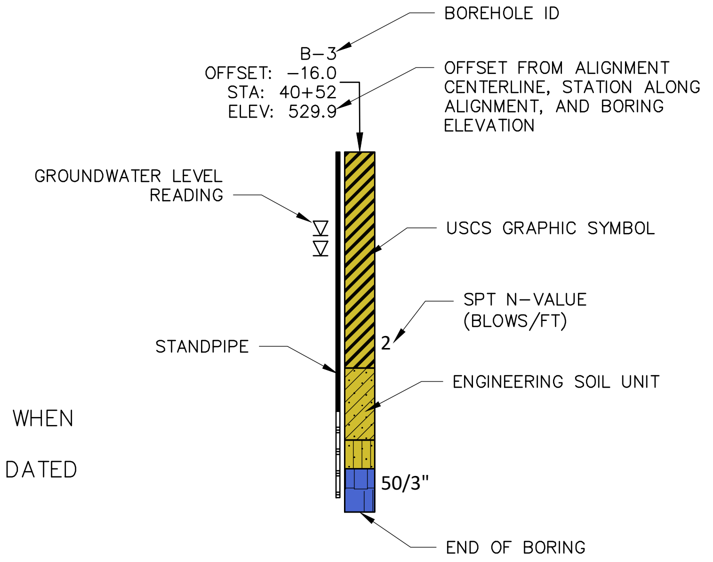
GEOLOGIC PROFILE STA 10+00 TO 11+50

SCALE: 1"=30' HORIZ
1"=10' VERT



A
FIG.2

BORING/PROBE-HOLE LEGEND:



STRATIGRAPHIC LEGEND:

- ▨ WELL-GRADED GRAVEL (GW)
- ▨ SILTY GRAVEL (GM)
- ▨ CLAYEY GRAVEL (GC)
- ▨ SILTY SAND (SM)
- ▨ CLAYEY SAND (SC)
- ▨ SILT (ML)
- ▨ LEAN CLAY (CL)
- ▨ LOW PLASTICTIY ORGANIC CLAY (OL)
- ▨ FAT CLAY (CH)
- ▨ BASALT
- 🟨 FILL
- 🟦 BASALT

NOTES:

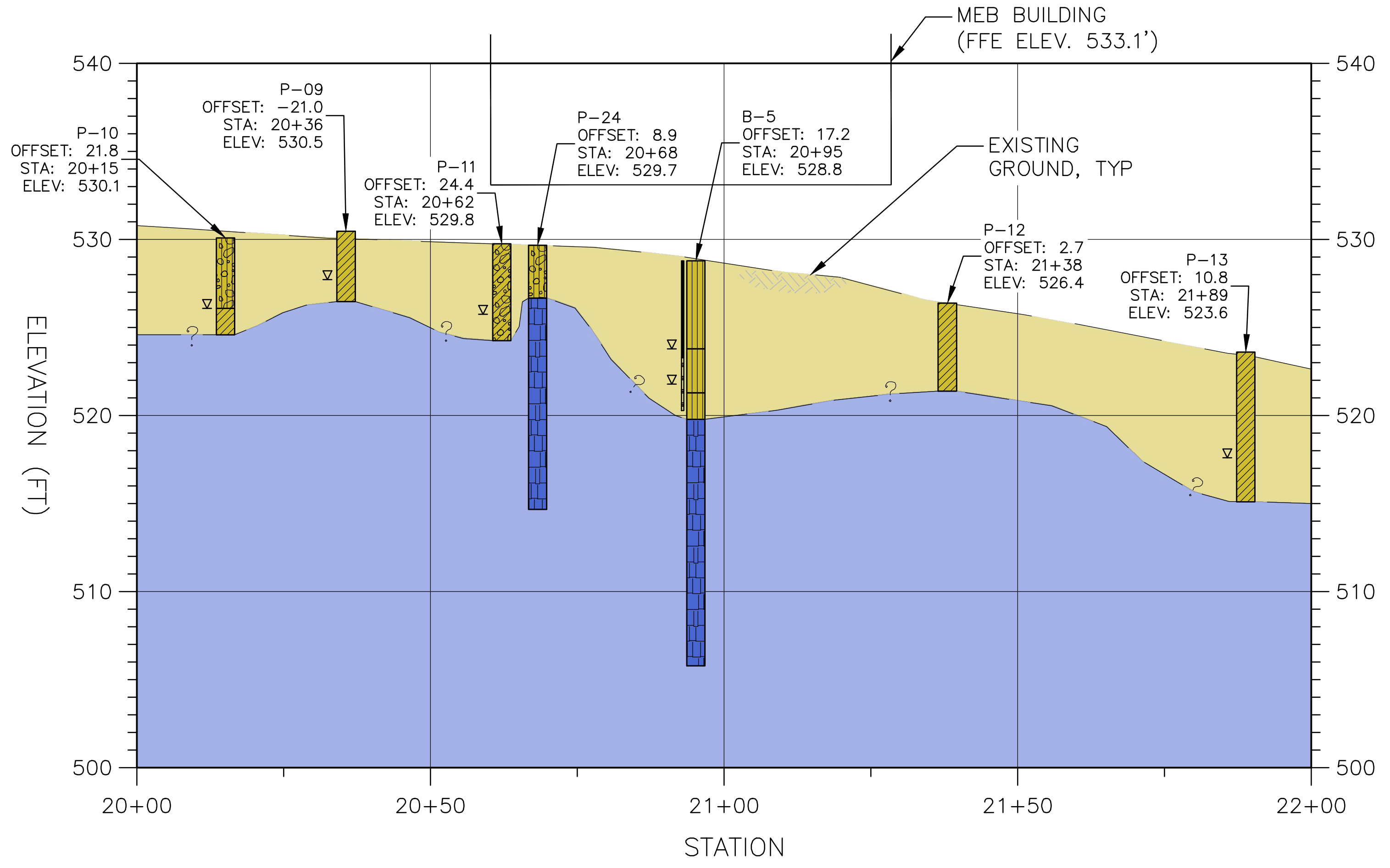
1. BOREHOLE LOCATIONS ARE APPROXIMATE.
2. BOREHOLE LOCATIONS ARE PROJECTED PERPENDICULAR TO ALIGNMENT.
3. OFFSETS ARE NEGATIVE LEFT OF ALIGNMENT AND POSITIVE RIGHT OF ALIGNMENT WHEN TRAVELING IN THE DIRECTION OF INCREASING STATION.
4. ALIGNMENT IS BASED ON 90% DRAWINGS PROVIDED BY WEST YOST ASSOCIATES, DATED JUNE 2022.

McMILLEN
JACOBS
ASSOCIATES

CITY OF SWEET HOME
MAHLER WATER RECLAMATION FACILITY IMPROVEMENTS
GEOTECHNICAL ENGINEERING REPORT
GEOLOGIC PROFILE
BUILDING A

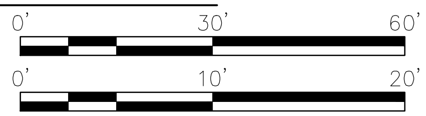
FIG.3A
DEC 2022

Path: C:\Users\cburke\Box\Jobs\6367.0 Sweet Home WWTP Final Design Review\900 Design Technology\970_Xrefs\PROFILES.dwg Plot date: Jul 22, 2022, CAD User: cburke



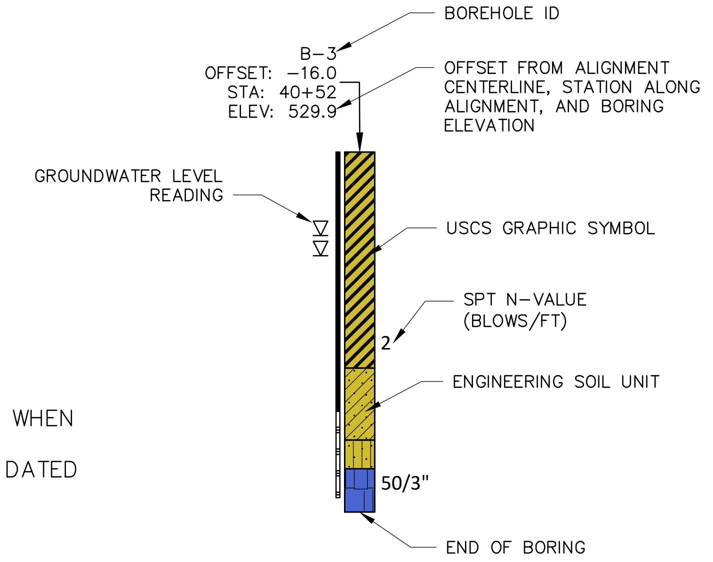
GEOLOGIC PROFILE STA 20+00 TO 22+00

SCALE: 1"=30' HORIZ
1"=10' VERT



B
FIG.2

BORING/PROBE-HOLE LEGEND:



STRATIGRAPHIC LEGEND:

- ▨ WELL-GRADED GRAVEL (GW)
- ▨ SILTY GRAVEL (GM)
- ▨ CLAYEY GRAVEL (GC)
- ▨ SILTY SAND (SM)
- ▨ CLAYEY SAND (SC)
- ▨ SILT (ML)
- ▨ LEAN CLAY (CL)
- ▨ LOW PLASTICTIY ORGANIC CLAY (OL)
- ▨ FAT CLAY (CH)
- ▨ BASALT
- 🟨 FILL
- 🟦 BASALT

NOTES:

1. BOREHOLE LOCATIONS ARE APPROXIMATE.
2. BOREHOLE LOCATIONS ARE PROJECTED PERPENDICULAR TO ALIGNMENT.
3. OFFSETS ARE NEGATIVE LEFT OF ALIGNMENT AND POSITIVE RIGHT OF ALIGNMENT WHEN TRAVELING IN THE DIRECTION OF INCREASING STATION.
4. ALIGNMENT IS BASED ON 90% DRAWINGS PROVIDED BY WEST YOST ASSOCIATES, DATED JUNE 2022.

McMILLEN JACOBS ASSOCIATES

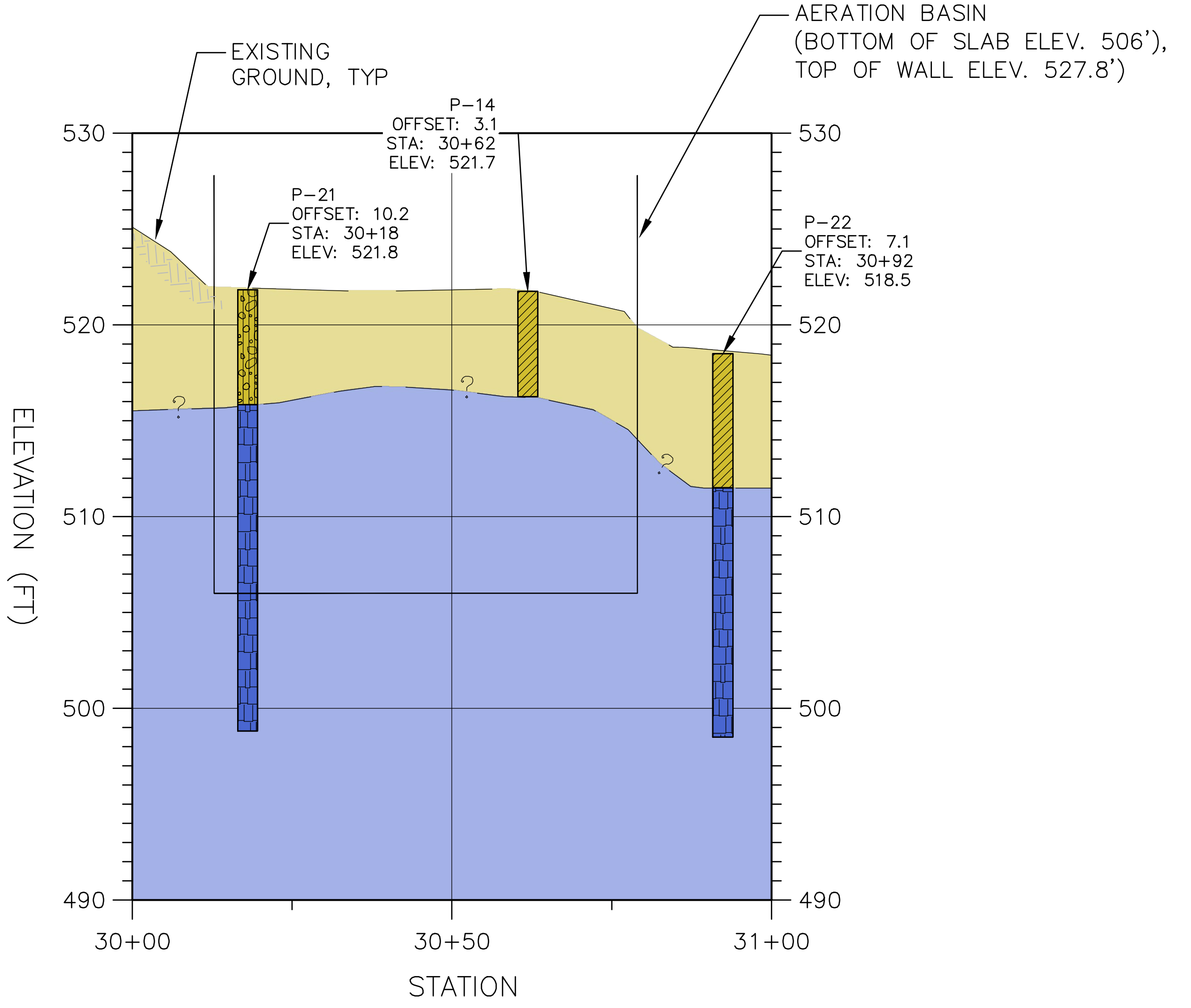
CITY OF SWEET HOME
MAHLER WATER RECLAMATION FACILITY IMPROVEMENTS

GEOTECHNICAL ENGINEERING REPORT
GEOLOGIC PROFILE
MEB BUILDING

FIG.3B

DEC 2022

Path: C:\Users\cburke\Box\Jobs\6367.0 Sweet Home WWTP Final Design Review\900 Design Technology\970_Xrefs\PROFILES.dwg Plot date: Jul 22, 2022, CAD User: cburke



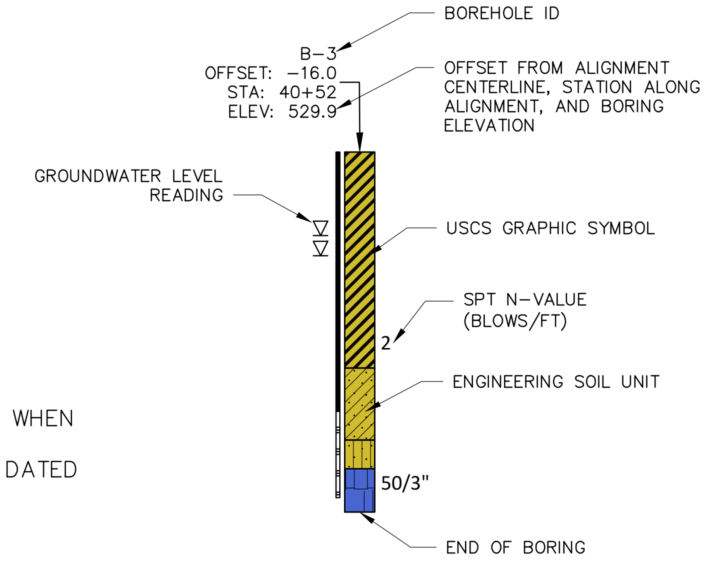
GEOLOGIC PROFILE STA 30+00 TO 31+00

SCALE: 1"=30' HORIZ
1"=10' VERT

0' 30' 60'
0' 10' 20'

C
FIG.2

BORING/PROBE–HOLE LEGEND:



STRATIGRAPHIC LEGEND:

- ▨ WELL–GRADED GRAVEL (GW)
- ▨ SILTY GRAVEL (GM)
- ▨ CLAYEY GRAVEL (GC)
- ▨ SILTY SAND (SM)
- ▨ CLAYEY SAND (SC)
- ▨ SILT (ML)
- ▨ LEAN CLAY (CL)
- ▨ LOW PLASTICTIY ORGANIC CLAY (OL)
- ▨ FAT CLAY (CH)
- ▨ BASALT
- 🟨 FILL
- 🟦 BASALT

NOTES:

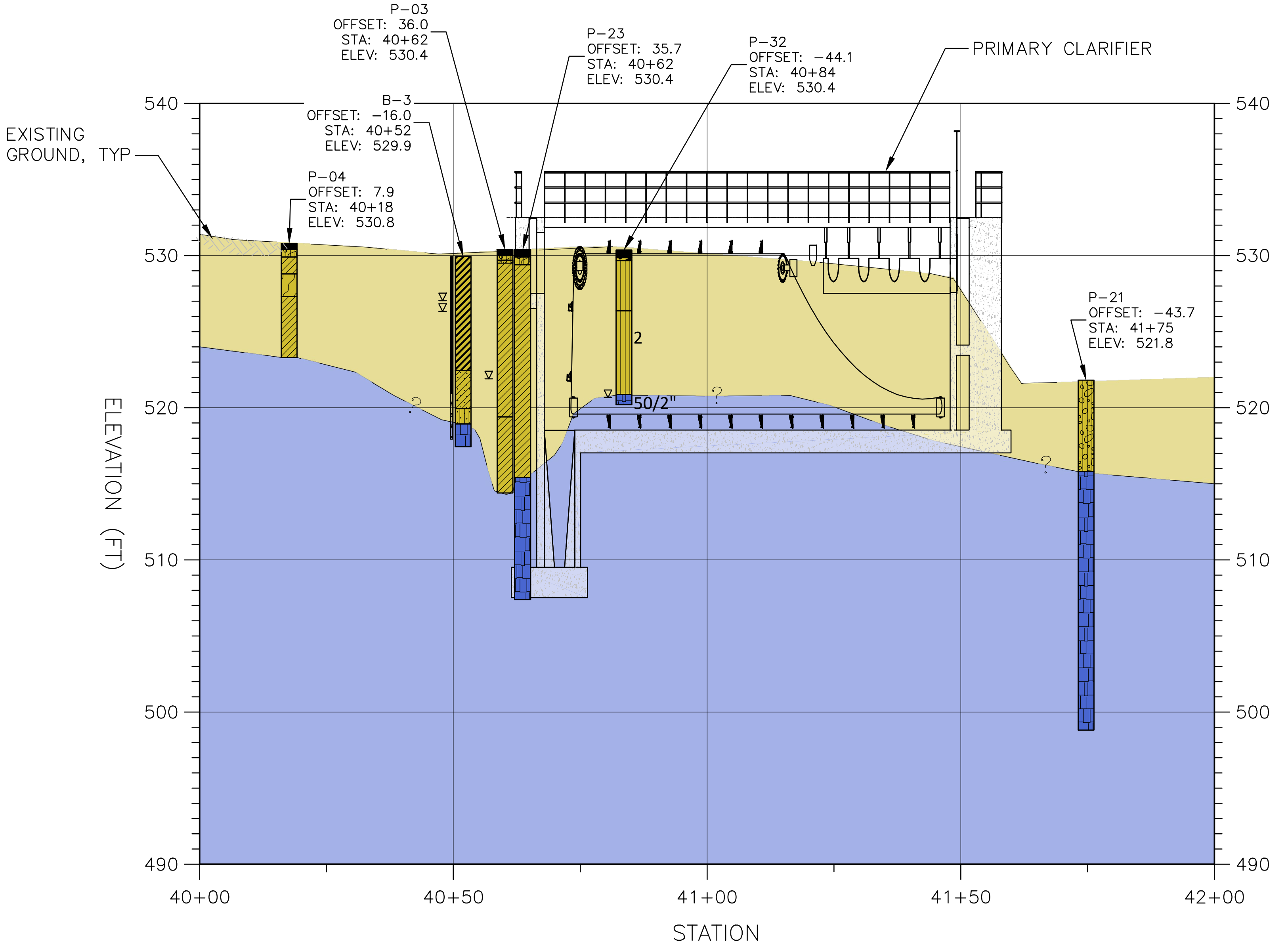
1. BOREHOLE LOCATIONS ARE APPROXIMATE.
2. BOREHOLE LOCATIONS ARE PROJECTED PERPENDICULAR TO ALIGNMENT.
3. OFFSETS ARE NEGATIVE LEFT OF ALIGNMENT AND POSITIVE RIGHT OF ALIGNMENT WHEN TRAVELING IN THE DIRECTION OF INCREASING STATION.
4. ALIGNMENT IS BASED ON 90% DRAWINGS PROVIDED BY WEST YOST ASSOCIATES, DATED JUNE 2022.

McMILLEN JACOBS ASSOCIATES

CITY OF SWEET HOME
MAHLER WATER RECLAMATION FACILITY IMPROVEMENTS
GEOTECHNICAL ENGINEERING REPORT
GEOLOGIC PROFILE
AERATION BASIN NO. 3

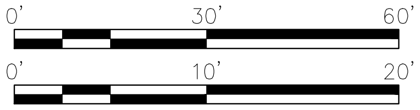
FIG.3C
DEC 2022

Path: C:\Users\cburke\Box\Jobs\6367.0 Sweet Home WWTP Final Design Review\900 Design Technology\970_Xrefs\PROFILES.dwg Plot date: Jul 22, 2022, CAD User: cburke



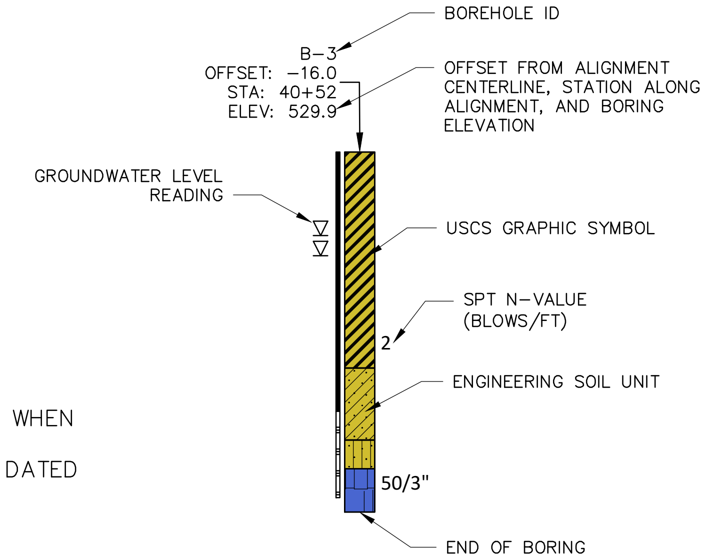
GEOLOGIC PROFILE STA 40+00 TO 42+00

SCALE: 1"=30' HORIZ
1"=10' VERT



D
FIG.2

BORING/PROBE–HOLE LEGEND:



STRATIGRAPHIC LEGEND:

▨ WELL–GRADED GRAVEL (GW)
▨ SILTY GRAVEL (GM)
▨ CLAYEY GRAVEL (GC)
▨ SILTY SAND (SM)
▨ CLAYEY SAND (SC)
▨ SILT (ML)
▨ LEAN CLAY (CL)
▨ LOW PLASTICTIY ORGANIC CLAY (OL)
▨ FAT CLAY (CH)
▨ BASALT
🟨 FILL
🟦 BASALT

NOTES:

1. BOREHOLE LOCATIONS ARE APPROXIMATE.
2. BOREHOLE LOCATIONS ARE PROJECTED PERPENDICULAR TO ALIGNMENT.
3. OFFSETS ARE NEGATIVE LEFT OF ALIGNMENT AND POSITIVE RIGHT OF ALIGNMENT WHEN TRAVELING IN THE DIRECTION OF INCREASING STATION.
4. ALIGNMENT IS BASED ON 90% DRAWINGS PROVIDED BY WEST YOST ASSOCIATES, DATED JUNE 2022.

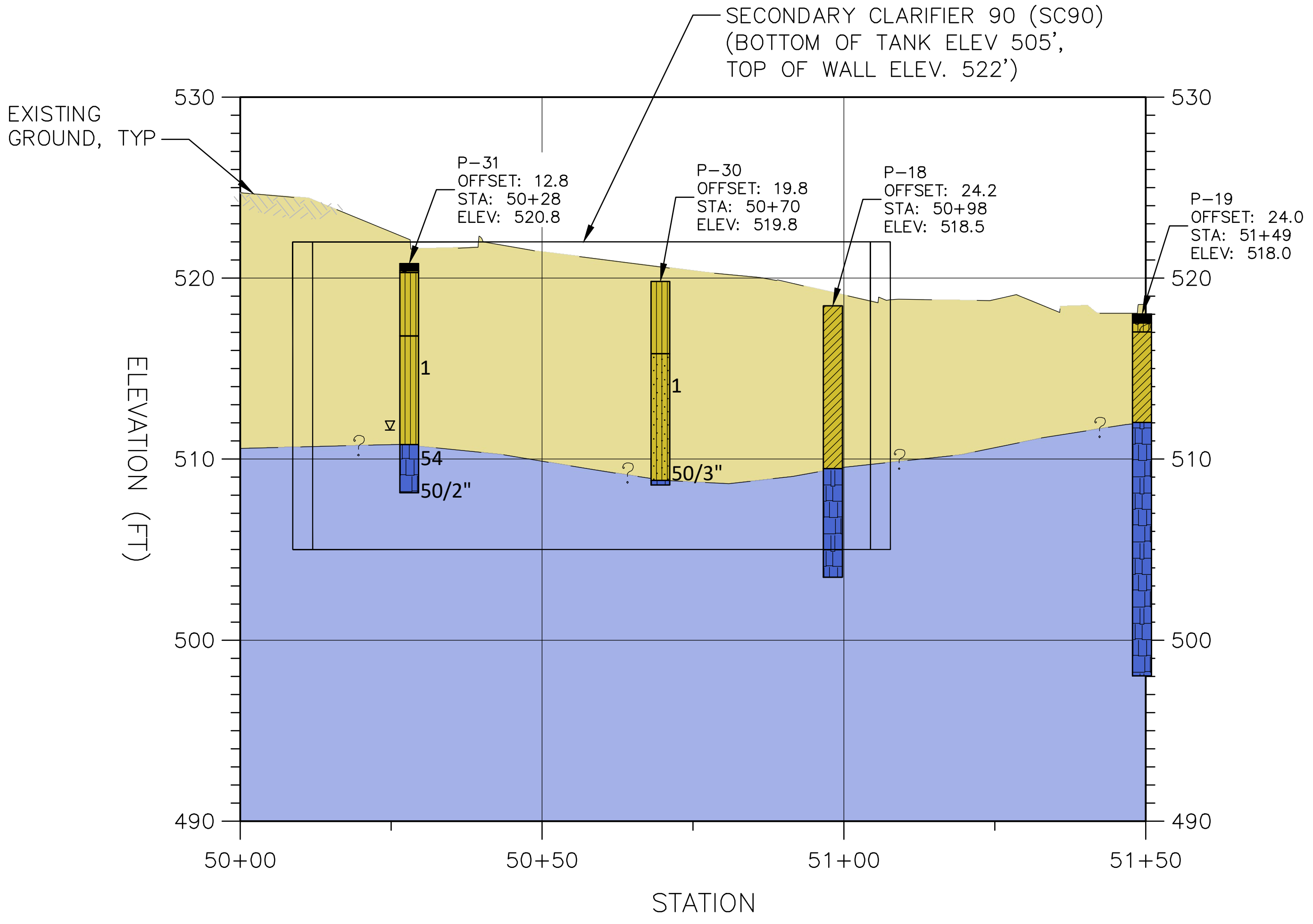
McMILLEN
JACOBS
ASSOCIATES

CITY OF SWEET HOME
MAHLER WATER RECLAMATION FACILITY IMPROVEMENTS
GEOTECHNICAL ENGINEERING REPORT
GEOLOGIC PROFILE
PRIMARY CLARIFIER

FIG.3D

DEC 2022

Path: C:\Users\cburke\Box\Jobs\6367.0 Sweet Home WWTP Final Design Review\900 Design Technology\970_Xrefs\PROFILES.dwg Plot date: Jul 22, 2022, CAD User: cburke



GEOLOGIC PROFILE STA 50+00 TO 51+50

SCALE: 1"=30' HORIZ
1"=10' VERT

0' 30' 60'
0' 10' 20'

E
FIG.2

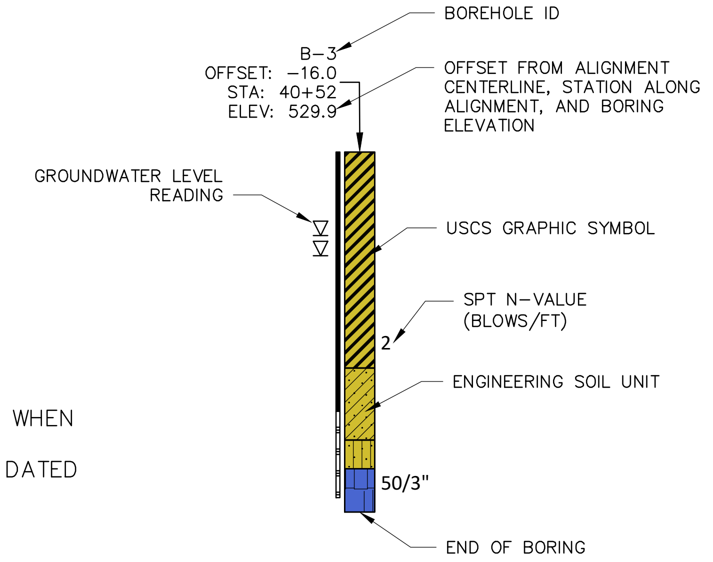
STRATIGRAPHIC LEGEND:

- ▨ WELL–GRADED GRAVEL (GW)
- ▨ SILTY GRAVEL (GM)
- ▨ CLAYEY GRAVEL (GC)
- ▨ SILTY SAND (SM)
- ▨ CLAYEY SAND (SC)
- ▥ SILT (ML)
- ▨ LEAN CLAY (CL)
- ▨ LOW PLASTICTIY ORGANIC CLAY (OL)
- ▨ FAT CLAY (CH)
- ▦ BASALT
- 🟨 FILL
- 🟦 BASALT

NOTES:

1. BOREHOLE LOCATIONS ARE APPROXIMATE.
2. BOREHOLE LOCATIONS ARE PROJECTED PERPENDICULAR TO ALIGNMENT.
3. OFFSETS ARE NEGATIVE LEFT OF ALIGNMENT AND POSITIVE RIGHT OF ALIGNMENT WHEN TRAVELING IN THE DIRECTION OF INCREASING STATION.
4. ALIGNMENT IS BASED ON 90% DRAWINGS PROVIDED BY WEST YOST ASSOCIATES, DATED JUNE 2022.

BORING/PROBE–HOLE LEGEND:



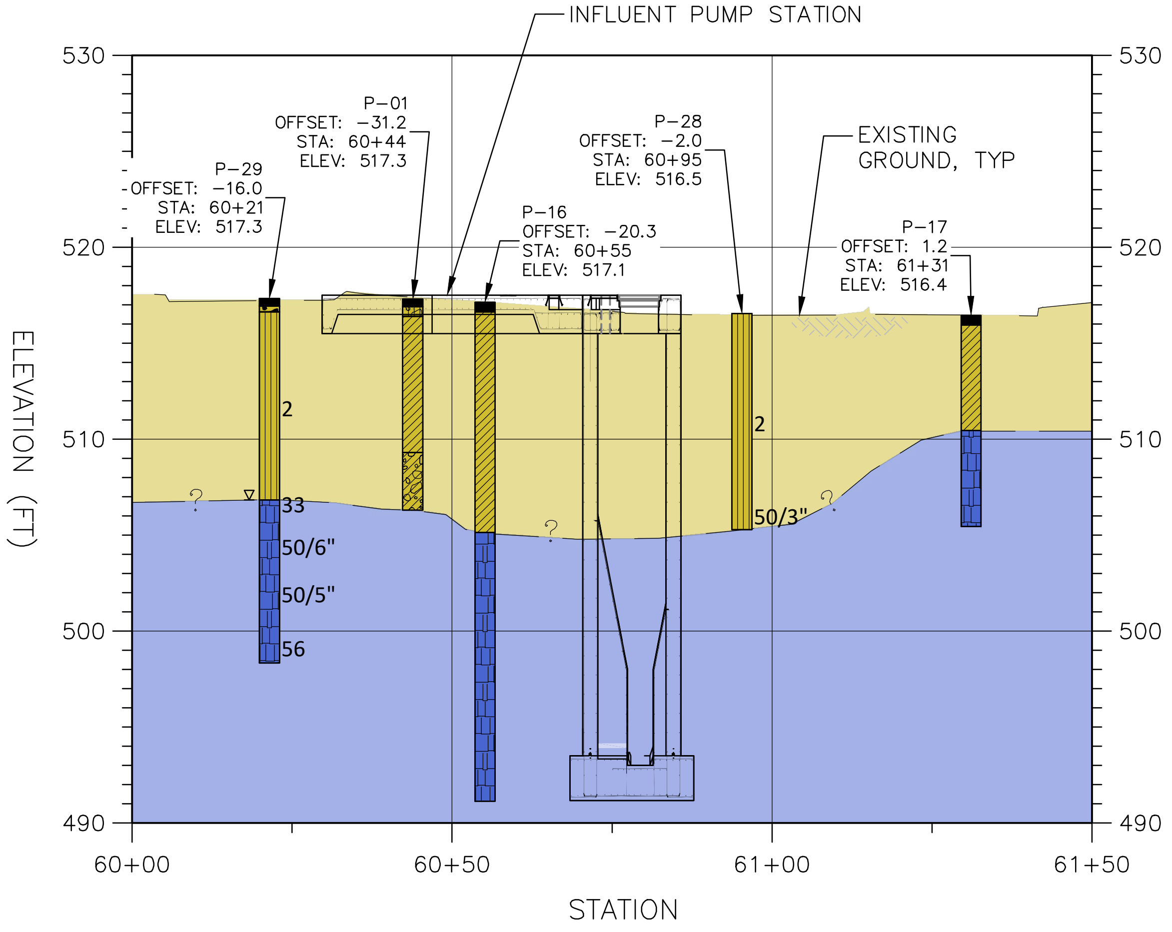
McMILLEN
JACOBS
ASSOCIATES

CITY OF SWEET HOME
MAHLER WATER RECLAMATION FACILITY IMPROVEMENTS
GEOTECHNICAL ENGINEERING REPORT
GEOLOGIC PROFILE
SECONDARY CLARIFIER 90 (SC90)

FIG.3E

DEC 2022

Path: C:\Users\cburke\Box\Jobs\6367.0 Sweet Home WWTP Final Design Review\900 Design Technology\970_Xrefs\PROFILES.dwg Plot date: Jul 22, 2022, CAD User: cburke



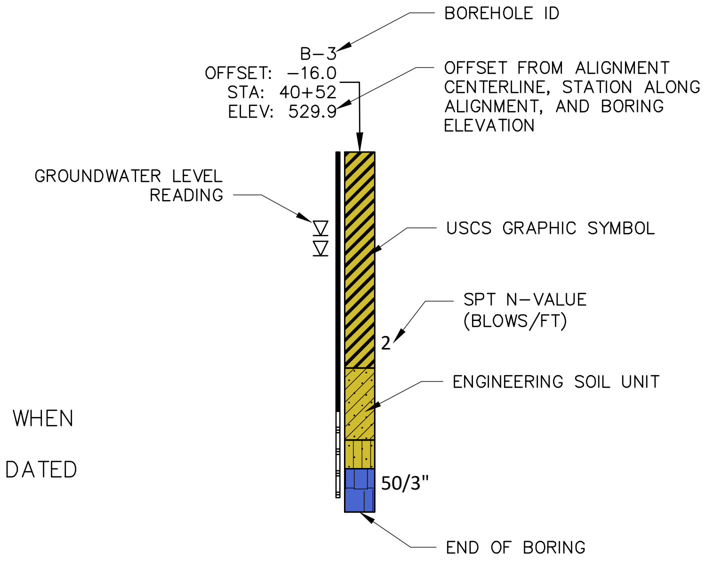
GEOLOGIC PROFILE STA 60+00 TO 61+50

SCALE: 1"=30' HORIZ
1"=10' VERT

0' 30' 60'
0' 10' 20'

F
FIG.2

BORING/PROBE-HOLE LEGEND:



STRATIGRAPHIC LEGEND:

▨ WELL-GRADED GRAVEL (GW)
▨ SILTY GRAVEL (GM)
▨ CLAYEY GRAVEL (GC)
▨ SILTY SAND (SM)
▨ CLAYEY SAND (SC)
▨ SILT (ML)
▨ LEAN CLAY (CL)
▨ LOW PLASTICTIY ORGANIC CLAY (OL)
▨ FAT CLAY (CH)
▨ BASALT
🟨 FILL
🟦 BASALT

NOTES:

1. BOREHOLE LOCATIONS ARE APPROXIMATE.
2. BOREHOLE LOCATIONS ARE PROJECTED PERPENDICULAR TO ALIGNMENT.
3. OFFSETS ARE NEGATIVE LEFT OF ALIGNMENT AND POSITIVE RIGHT OF ALIGNMENT WHEN TRAVELING IN THE DIRECTION OF INCREASING STATION.
4. ALIGNMENT IS BASED ON 90% DRAWINGS PROVIDED BY WEST YOST ASSOCIATES, DATED JUNE 2022.

McMILLEN
JACOBS
ASSOCIATES

CITY OF SWEET HOME
MAHLER WATER RECLAMATION FACILITY IMPROVEMENTS

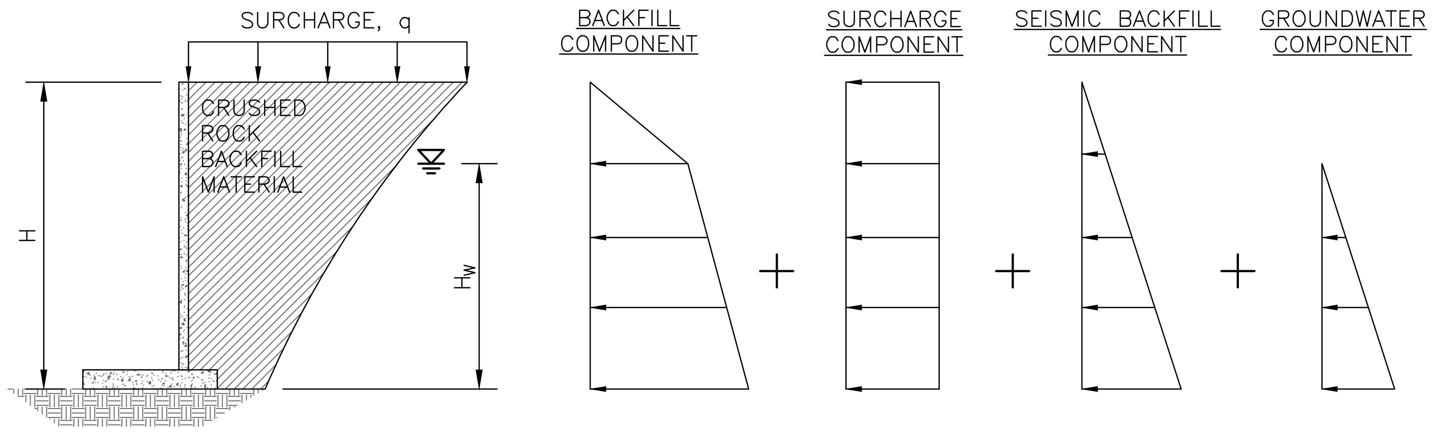
GEOTECHNICAL ENGINEERING REPORT
GEOLOGIC PROFILE
INFLUENT PUMP STATION

FIG.3F

DEC 2022

Path: C:\Users\cburke\Box\Jobs\6367.0 Sweet Home WWTP Final Design Review\900 Design Technology\970_Xrefs\PROFILES.dwg Plot date: Jul 22, 2022, CAD User: cburke

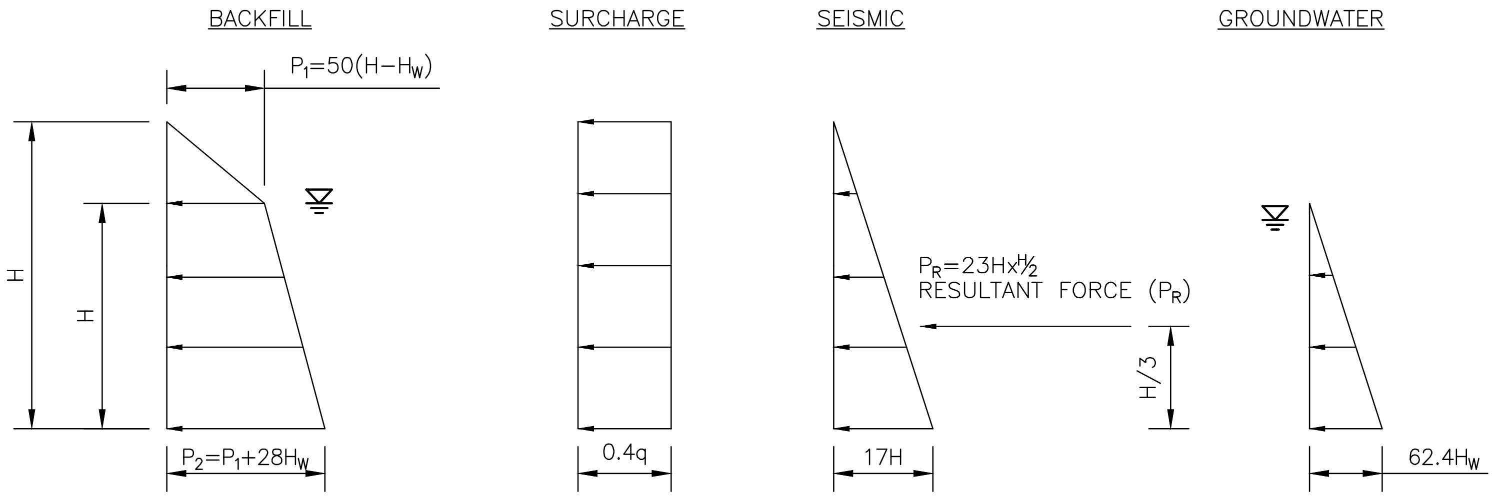
LATERAL EARTH PRESSURES ON EMBEDDED WALLS & STRUCTURES



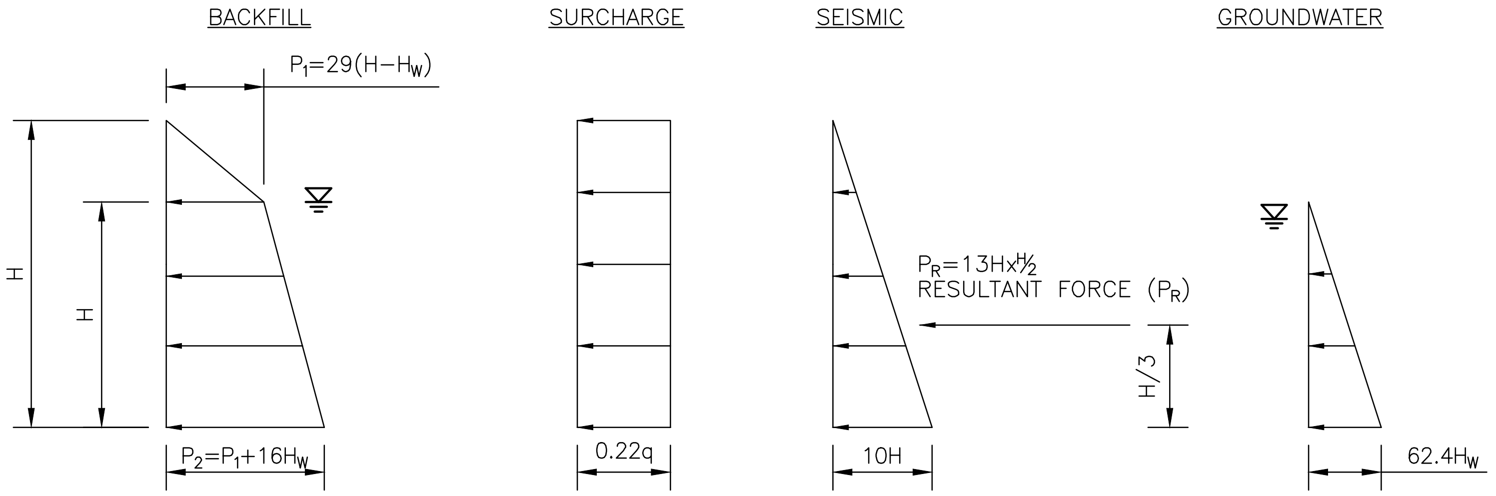
NOTES:

1. UNITS ARE POUNDS PER SQUARE FOOT (PSF).
2. BACKFILL PRESSURES BASED ON IMPORTED CRUSHED ROCK.
3. HEIGHT OF GROUNDWATER, H_W, SHOULD BE TAKEN AT GROUND SURFACE.

RESTRAINED (NON–YIELDING) EMBEDDED WALLS & STRUCTURES



NON–RESTRAINED (YIELDING) BASEMENT WALLS



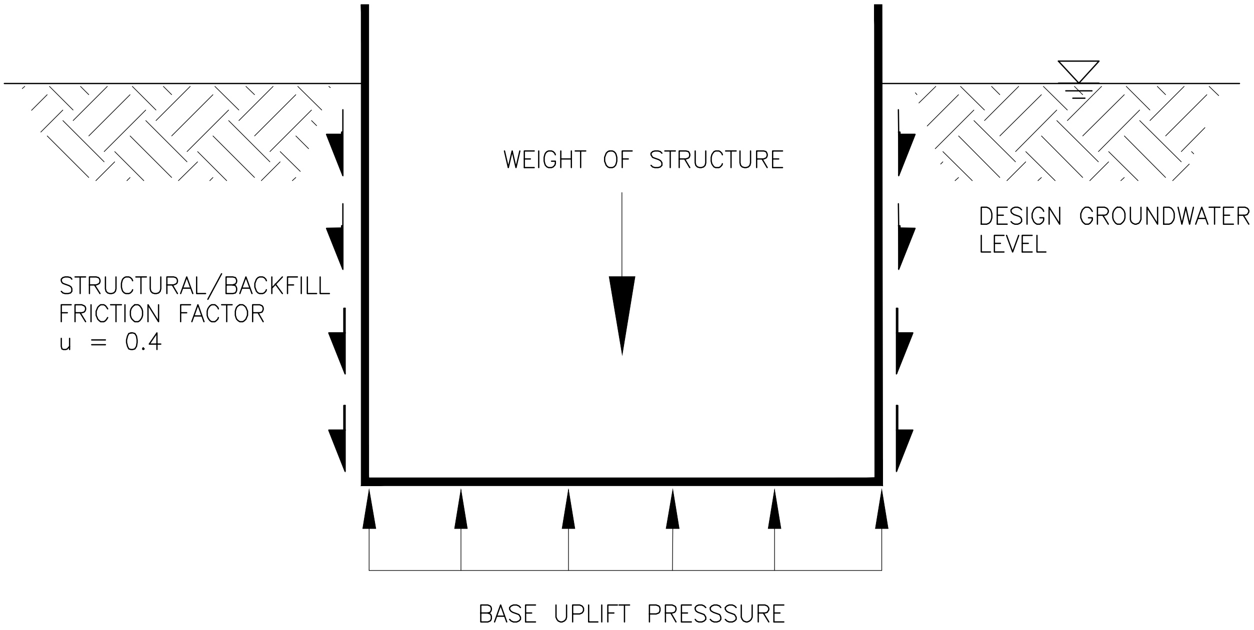
McMILLEN JACOBS ASSOCIATES

CITY OF SWEET HOME
MAHLER WATER RECLAMATION FACILITY IMPROVEMENTS
GEOTECHNICAL ENGINEERING REPORT
LATERAL EARTH PRESSURES FOR EMBEDDED WALLS

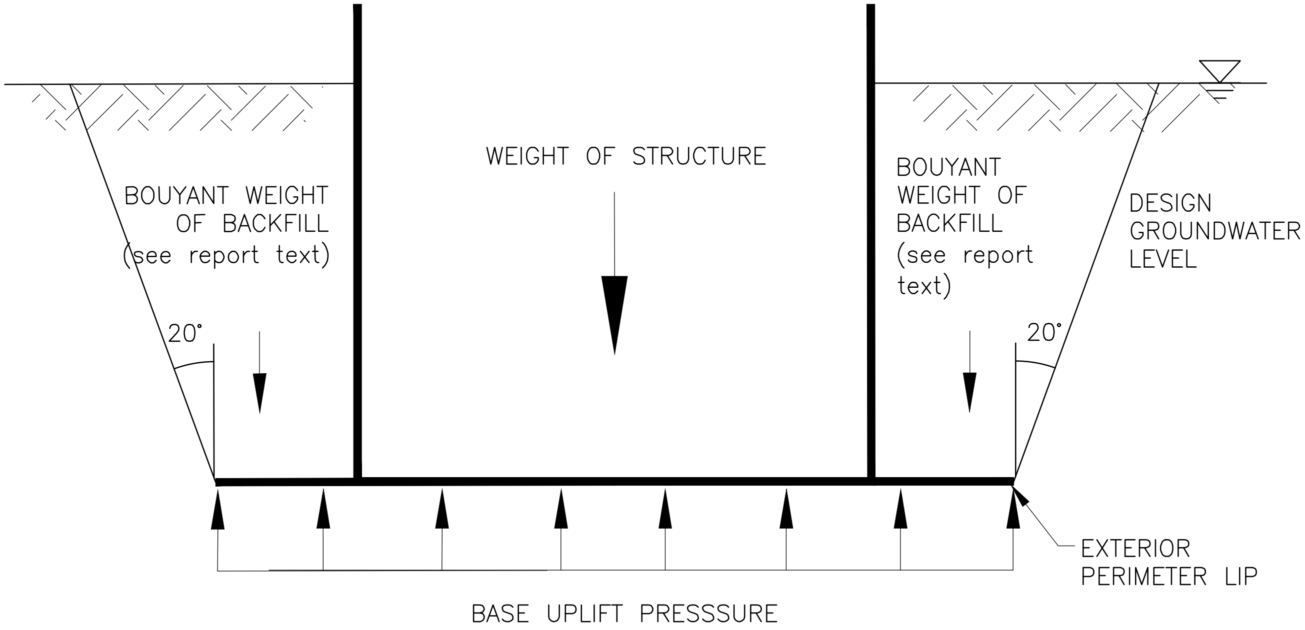
FIG.4

DEC 2022

Path: C:\Users\cburke\Box\Jobs\6367.0 Sweet Home WWTP Final Design Review\900 Design Technology\970_Xrefs\Fig.4 – Lateral Earth Pressures.dwg Plot date: Jul 22, 2022, CAD User: cburke



STRUCTURE WITHOUT EXTERIOR PERIMETER LIP



STRUCTURE WITH EXTERIOR PERIMETER LIP

HYDROSTATIC UPLIFT PRESSURE AND RESISTANT FORCES

SCALE: NTS

McMILLEN JACOBS ASSOCIATES

CITY OF SWEET HOME

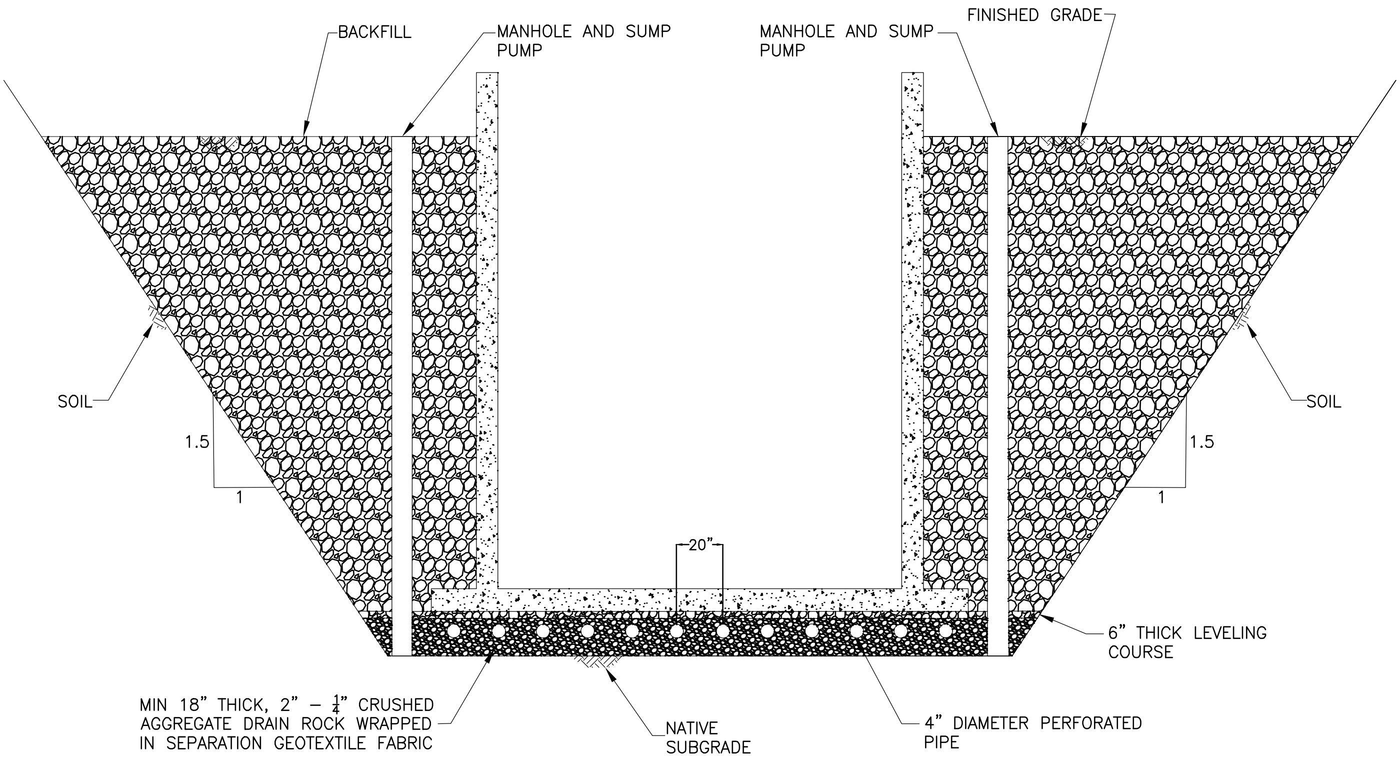
MAHLER WATER RECLAMATION FACILITY IMPROVEMENTS

GEOTECHNICAL ENGINEERING REPORT
LATERAL EARTH PRESSURE DIAGRAM
HYDROSTATIC UPLIFT PRESSURE AND RESISTING FORCES

FIG.5

DEC 2022

Path: C:\Users\cburke\Box\Jobs\6367.0 Sweet Home WWTP Final Design Review\900 Design Technology\970_Xrefs\Fig.5 – Hydrostatic Uplift.dwg Plot date: Jul 22, 2022, CAD User: cburke



UNDERDRAIN SYSTEM

SCALE: NTS

McMILLEN JACOBS ASSOCIATES

CITY OF SWEET HOME

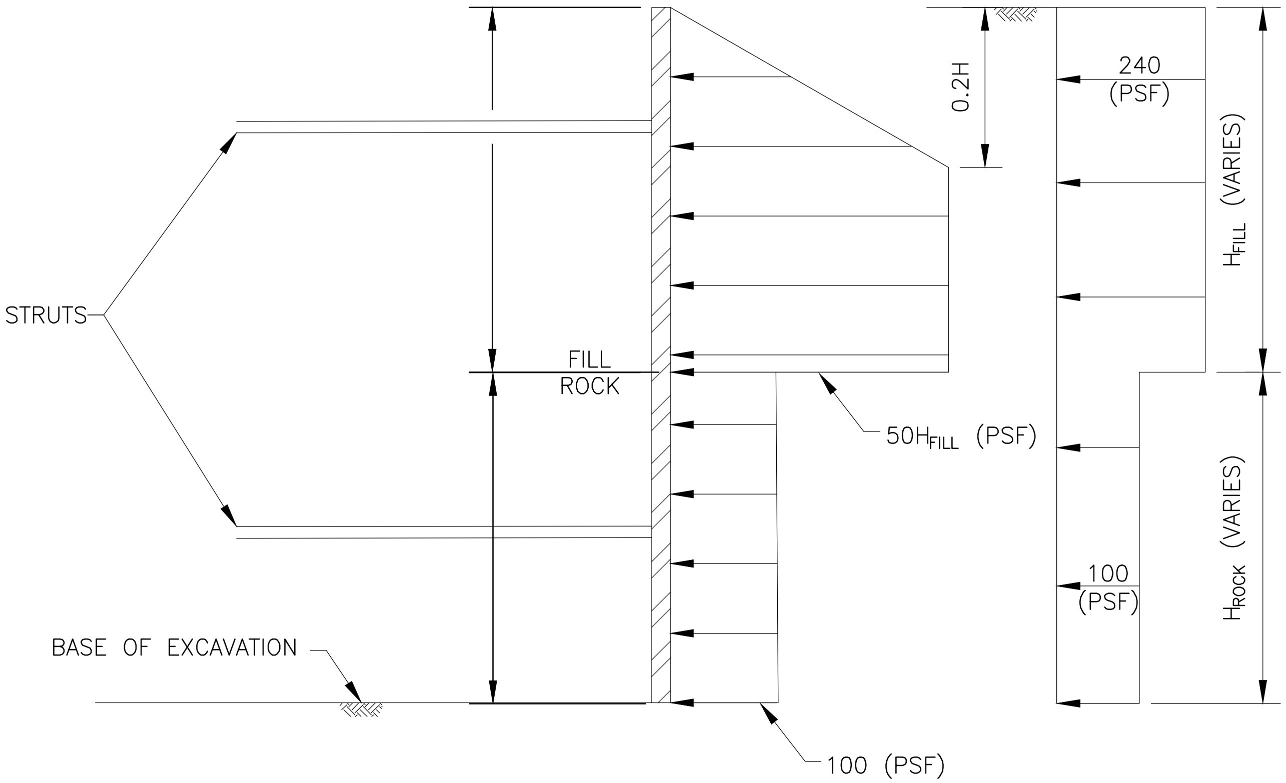
MAHLER WATER RECLAMATION FACILITY IMPROVEMENTS

GEOTECHNICAL ENGINEERING REPORT
CONCEPTUAL UNDERDRAIN SYSTEM

FIG.6

DEC 2022

Path: C:\Users\cburke\Box\Jobs\6367.0 Sweet Home WWTP Final Design Review\900 Design Technology\970_Xrefs\Fig.6 – Conceptual Underdrain System.dwg Plot date: Jul 22, 2022, CAD User: cburke



APPARENT LATERAL EARTH PRESSURE DIAGRAM – TEMPORARY SHORING

SCALE: NTS

NOTES:

1. EARTH PRESSURE DIAGRAM ASSUMES BRACED EXCAVATION SUPPORT.
2. SURCHARGE LOAD MAY VARY BASED ON CONTRACTOR EQUIPMENT LOADS.
3. EARTH PRESSURE DIAGRAM ASSUMES LEVEL GROUND BEHIND SHORING.
4. EARTH PRESSURE DIAGRAM DOES NOT CONSIDER GROUNDWATER – GROUNDWATER PRESSURE SHOULD BE ADDED IF GROUNDWATER IS PRESENT.

McMILLEN JACOBS ASSOCIATES

CITY OF SWEET HOME

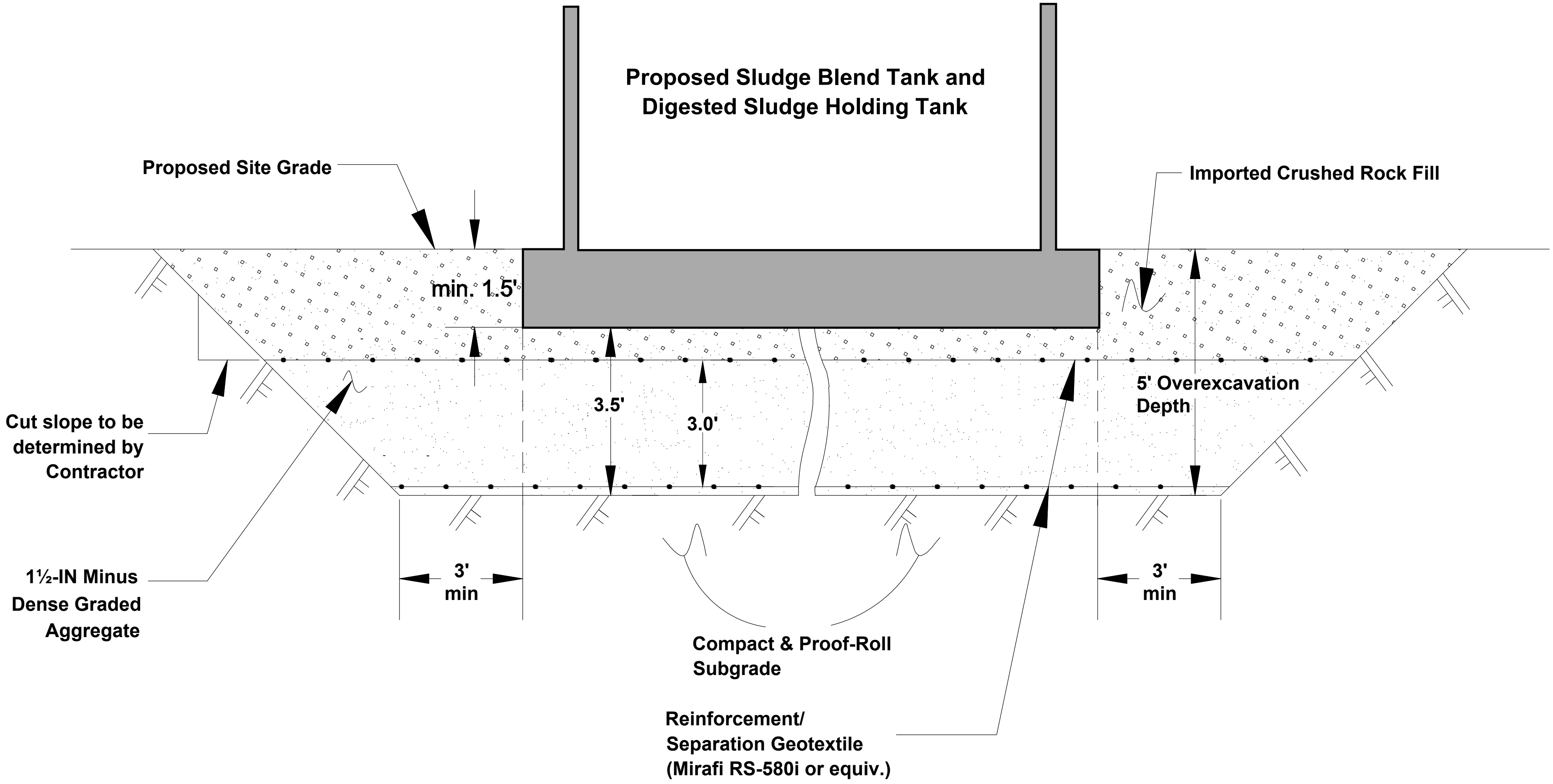
MAHLER WATER RECLAMATION FACILITY IMPROVEMENTS

GEOTECHNICAL ENGINEERING REPORT
LATERAL EARTH PRESSURE DIAGRAM
TEMPORARY SHORING

FIG.7

DEC 2022

Path: C:\Users\cburke\Box\Jobs\6367.0 Sweet Home WWTP Final Design Review\900 Design Technology\970_Xrefs\Fig.7 – Temporary Shoring.dwg Plot date: Jul 22, 2022, CAD User: cburke



NOTES

1. Upon reaching bottom of 5-foot overexcavation, compact exposed subgrade surface with heavy roller compactor or excavator-mounted hoe pack.
2. Subgrade stabilization material should be placed in 12-inch loose lifts.

NOT TO SCALE

McMILLEN JACOBS ASSOCIATES

CITY OF SWEET HOME
MAHLER WATER RECLAMATION FACILITY IMPROVEMENTS

GEOTECHNICAL ENGINEERING REPORT
CRUSHED ROCK MAT SECTION

FIG.8

DEC 2022

Appendix A

Boring Logs

McMILLEN
JACOBS
ASSOCIATES

Key to Log of Borings and Descriptive Terms for Soils
Project: 5834.0 Sweet Home WWTP Schematic Design
Sweet Home, OR

Soil Legend

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS Based on ASTM D2488 & D2487)					
MAJOR DIVISIONS			GROUP/SYMBOL		TYPICAL DESCRIPTION
COARSE-GRAINED SOILS (50% or more retained on No. 200 sieve)	GRAVELS (more than 50% retained on No. 4 sieve)	CLEAN GRAVELS (less than 5% fines)	GW	▨	WELL-GRADED GRAVEL
			GP	▨	POORLY GRADED GRAVEL
		GRAVELS (with 5 to 12% fines)	GW-GM	▨	WELL-GRADED GRAVEL WITH SILT
			GW-GC	▨	WELL-GRADED GRAVEL WITH CLAY
			GP-GM	▨	POORLY GRADED GRAVEL WITH SILT
			GP-GC	▨	POORLY GRADED GRAVEL WITH CLAY
		GRAVELS WITH FINES (more than 12% fines)	GM	▨	SILTY GRAVEL
			GC	▨	CLAYEY GRAVEL
	SANDS (less than 50% retained on No. 4 sieve)	CLEAN SANDS (less than 5% fines)	SW	▨	WELL-GRADED SAND
			SP	▨	POORLY GRADED SAND
		SANDS (with 5 to 12% fines)	SW-SM	▨	WELL-GRADED SAND WITH SILT
			SW-SC	▨	WELL-GRADED SAND WITH CLAY
			SP-SM	▨	POORLY GRADED SAND WITH SILT
			SP-SC	▨	POORLY GRADED SAND WITH CLAY
		SANDS WITH FINES (more than 12% fines)	SM	▨	SILTY SAND
			SC	▨	CLAYEY SAND
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS & CLAYS (liquid limit less than 50)	INORGANIC	ML	▥	SILT
			CL	▨	LEAN CLAY
		ORGANIC	OL	▨	LOW PLASTICITY ORGANIC CLAY
	SILTS & CLAYS (liquid limit greater than 50)	INORGANIC	MH	▥	ELASTIC SILT
			CH	▨	FAT CLAY
		ORGANIC	OH	▨	HIGH PLASTICITY ORGANIC CLAY
	SILT/CLAY (liquid limit between 12 and 25)	INORGANIC	CL-ML	▨	CLAYEY SILT / SILTY CLAY
HIGHLY ORGANIC SOILS	PRIMARILY ORGANIC MATTER		PT	▨	PEAT

Notes:

1. Dual symbols (symbols separated by a hyphen, e.g. SP-SM, slightly silty fine SAND) are used for soils between 5% and 12% fines or when liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Moisture Content

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch.
Moist	Damp but no visible water.
Wet	Visible free water, usually from below water table.

Gradation

Gradation	Description
Well-Graded	Approximately equal amounts of all grain sizes
Poorly Graded	Predominately one size (uniformly graded) or a wide range of sizes with a missing intermediate size (gap-graded)

Grain Size

Term	Grain Size	Example
Boulder	Greater than 12" (30cm)	Basketball or Larger
Cobble	3" - 12" (75mm - 30cm)	Fist to Basketball
Gravel Coarse	¾" - 3" (20mm - 75mm)	Thumb to Fist Sized
Gravel Fine	No. 4 Sieve - ¾" (5mm - 20mm)	Pea to Thumb Sized
Sand Coarse	No. 10 Sieve - No. 4 Sieve (2mm - 5mm)	Rock Salt to Pea Sized
Sand Medium	No. 40 Sieve - No. 10 Sieve (0.4mm - 2mm)	Sugar to Rock Salt
Sand Fine	No. 200 sieve - No. 40 sieve (0.08mm - 0.4mm)	Flour to Sugar
Fines	Passing No. 200 Sieve (0.08mm)	Grains Not Visible

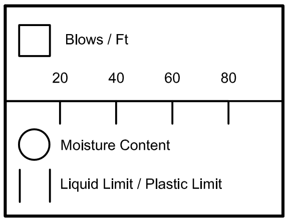
Relative Consistency

Fine - Grained Soils	
Relative Density	N, SPT Blows/Foot
Very Soft	< 2
Soft	2 - 4
Medium Stiff	4 - 8
Stiff	8 - 15
Very Stiff	15 - 30
Hard	> 30

Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛" (3mm) thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Test Symbols



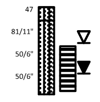
Relative Density

Coarse - Grained Soils	
Relative Density	N, SPT Blows/Foot
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	> 50

Backfill Symbols

■	Asphalt
▨	Neat Cement
░	Bentonite Chips

High/Low Water Level
Screened Well Interval



▽	High Water Level
▼	Low Water Level
▤	Slotted Well Section

McMILLEN JACOBS ASSOCIATES

Key to Boring Logs - Rock

Rock Strength

Description	Recognition	Uniaxial Compressive Strength (psf)
Extremely Weak Rock	Indented by thumbnail	30 to 150
Very Weak Rock	Peeled by pocket knife	150 to 700
Weak Rock	Peeled with difficulty by pocket knife	700 to 3,600
Moderately Strong Rock	Indented 5 mm with sharp end of pick	3,600 to 7,200
Strong Rock	One hammer blow to fracture	7,200 to 14,500
Very Strong Rock	Many hammer blows to fracture	14,500 to 36,000
Extremely Strong Rock	Only chipped by hammer blows	> 36,000

Core Recovery Calculation (%)

$$\frac{\Sigma \text{ Length of recovered core}}{\text{Total Length of core run}} \text{ x100}$$

RQD Calculation (%)

$$\frac{\Sigma \text{ Length of core pieces} > 4 \text{ in.}}{\text{Total Length of core run}} \text{ x100}$$

Rock Weathering

Residual Soil	Entirely decomposed to secondary minerals; material can be easily broken by hand
Completely Weathered	Almost entirely decomposed to secondary minerals; material can be granulated by hand
Highly Weathered	More than half of the rock is decomposed
Moderately Weathered	Rock is discolored and noticeably weakened, but less than half is decomposed
Slightly Weathered	Rock is slightly discolored, but not noticeably lower in strength than fresh rock
Fresh	Rock shows no discoloration, loss of strength, or other effect of weathering or alteration

Discontinuity Type

J	Joint
FJ	Joint along foliation
S	Shear
F	Fault
HJ	Healed joint
MB	Mechanical break
B	Joint along bedding

Rock Fracture Spacing

Extremely Close Spacing	Fractures spaced less than 1 inch apart
Very Close Spacing	Fractures spaced 1 to 2.5 inches apart
Close Spacing	Fractures spaced 2.5 to 8 inches apart
Moderate Spacing	Fractures spaced 8 inches to 2 feet apart
Wide Spacing	Fractures spaced 2 to 6.5 feet apart
Very Wide Spacing	Fractures spaced 6.5 to 20 feet apart
Extremely Wide Spacing	Fractures spaced greater than 20 feet apart

Sample Symbols

▮▮	HQ3 Rock Coring

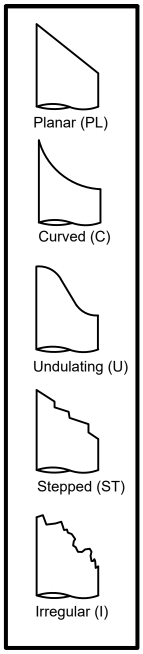
Lithology Graphics

Basalt	▥	Core Loss/ No Recovery	☐

Surface Roughness

Slickensided	Surface has smooth, glassy finish with visual evidence of striations
Smooth	Surface appears smooth and feels so to the touch
Slightly Rough	Asperities on discontinuity surfaces are distinguishable and can be felt
Rough	Ridges and side-angle steps are evident, surface feels very abrasive
Very Rough	Near vertical steps and ridges occur on discontinuity surface

Fracture Shape



Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring B-1

Date(s) Drilled	**04/30/2018**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Irizarry**	Checked By	**K. Elliott**
Drilling Method/ Rig Type	**Mud Rotary and HQ Wireline/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**	Total Depth of Borehole	**13.5 ft**		
Hole Diameter	**4.00 in**	Hammer Weight/Drop (lb/in.)/Type	**140 lb / 30 in / Automatic**	Ground Surface Elevation/Datum	**516.5 ft**		
Location	**Survey**	Coordinates	**7617396.39 E, 275319.73 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC ▏LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
									Concrete - 18" thick (Pavement)		
								GM	Dense, moist, gray Silty Gravel (GM); Fine to coarse angular gravel, low plasticity silt (Base Aggregate)		At 2.5 feet very slow, very rough drilling. At 3.5 feet switch to rock coring.
512	5		100	RUN 1					BASALT, very strong (R5), slightly weathered to fresh, moderately to highly fractured, planar, stepped, smooth to rough joints with very narrow apertures (Little Butte Volcanic Series - Tholeiitic Basalt) *Run 1: 3.5-8.5 feet.* *RQD = 59%*		From 5.20 feet to 6.30 feet, UCS = 25,300 psi.
507	10		80	RUN 2					*Run 2: 8.5 -13.5 feet:* *RQD = 42%* *Planar and irregular, smooth to slightly rough joints.*		
502	15										Borehole completed at 13.5ft. below ground surface (bgs).
497	20										
492	25										
487	30										

McMILLEN JACOBS ASSOCIATES

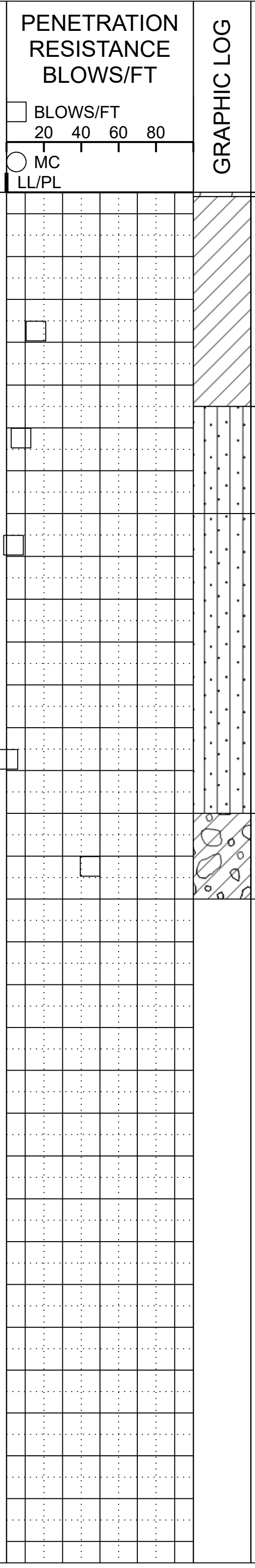
Boring B-1

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring B-2

Date(s) Drilled **05/01/2018**	Geotechnical Consultant **McMillen Jacobs Associates**	Logged By **J. Irizarry**	Checked By **K. Elliott**
Drilling Method/ Rig Type **Mud Rotary/CME 75**	Drilling Contractor **Western States Soil Conservation, Inc.**	Total Depth of Borehole **16.5 ft**	
Hole Diameter **4.00 in**	Hammer Weight/Drop (lb/in.)/Type **140 lb / 30 in / Automatic**	Ground Surface Elevation/Datum **518.2 ft**	
Location **Survey**	Coordinates **7617232.28 E, 275385.44 N**	Elevation Source **Site Survey**	



ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS
		0					OL/ OH	Organic Soil (OL/OH); Mulch (Fill)	
	5/2/2018 1 ▼		⧗	47	S1	7-5-11 (N=16)	CL	Very stiff, moist, brown to gray brown, Sandy LEAN CLAY with Gravel (CL); Medium plasticity, medium to low toughness, fine to coarse sand, fine angular gravel (Fill)	
514		5	⧗	27	S2	2-4-4 (N=8)	SM	Loose, moist to wet, brown, Silty SAND with Gravel (SM); Fine to coarse sand, fine angular gravel, medium plasticity, slow dilatancy (Fill)	
			⧗	53	S3	2-3-1 (N=4)	SM	Very loose, wet, brown, Silty SAND (SM); Fine to medium sand, low plasticity fines, rapid dilatancy (Fill) *At 10.0 grades to orange-brown, occurrence of trace, fine, angular gravel, and slow dilatancy.*	
509		10	⧗	73	S4	2-0-0 (N=WOR)			
			⧗	33	S5	0-0-1 (N=1)			
504		15	⧗	100	S5	17-18-27 (N=45)	GC	Very dense, moist, gray and olive-brown, CLAYEY GRAVEL with Sand (GC); Fine to coarse angular gravel, fine to coarse sand, medium plasticity fines (Fill)	
									Borehole completed at 16.5ft. below ground surface (bgs).
499		20							
494		25							
489		30							

BACKFILL INFORMATION

McMILLEN JACOBS ASSOCIATES

Boring B-2

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring B-3

Date(s) Drilled	**05/02/2018**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Irizarry**	Checked By	**K. Elliott**
Drilling Method/ Rig Type	**Mud Rotary/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**	Total Depth of Borehole	**12.5 ft**		
Hole Diameter	**4.00 in**	Hammer Weight/Drop (lb/in.)/Type	**140 lb / 30 in / Automatic**	Ground Surface Elevation/Datum	**529.9 ft**		
Location	**Survey**	Coordinates	**7617007.93 E, 275477.18 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
									CH	Soft, moist, gray with trace orange mottles, Sandy FAT CLAY (CH); High plasticity, medium toughness, fine sand, occasional organics (Fill)		
	[illegible]			53	S1	3-2-1 (N=3)						
525		5		60	S2	0-1-1 (N=2)				*At 5.0 feet grades to scattered woody organics.*		
				100	S3	1-1-1 (N=2)			SC	Very loose, moist to wet, gray, CLAYEY SAND (SC); Fine to medium sand, medium plasticity and medium toughness fines, occasional 1-inch sandy lenses of slow dilatancy (Fill)		
520		10		87	S4	0-16-49 (N=65)			SM	Medium dense, wet, red-brown, SILTY SAND (SM); Fine to medium sand, low plasticity fines, slow dilatancy (Fill)		
				0	S5	50/0" (Refusal)				Dark gray basalt chips in cuttings (Little Butte Volcanic Series - Tholeiitic Basalt)		At 11.0 feet very rough , very slow drilling.
												Borehole completed at 12.5ft. below ground surface (bgs).
515		15										
510		20										
505		25										
500		30										

McMILLEN JACOBS ASSOCIATES

Boring B-3

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring B-4

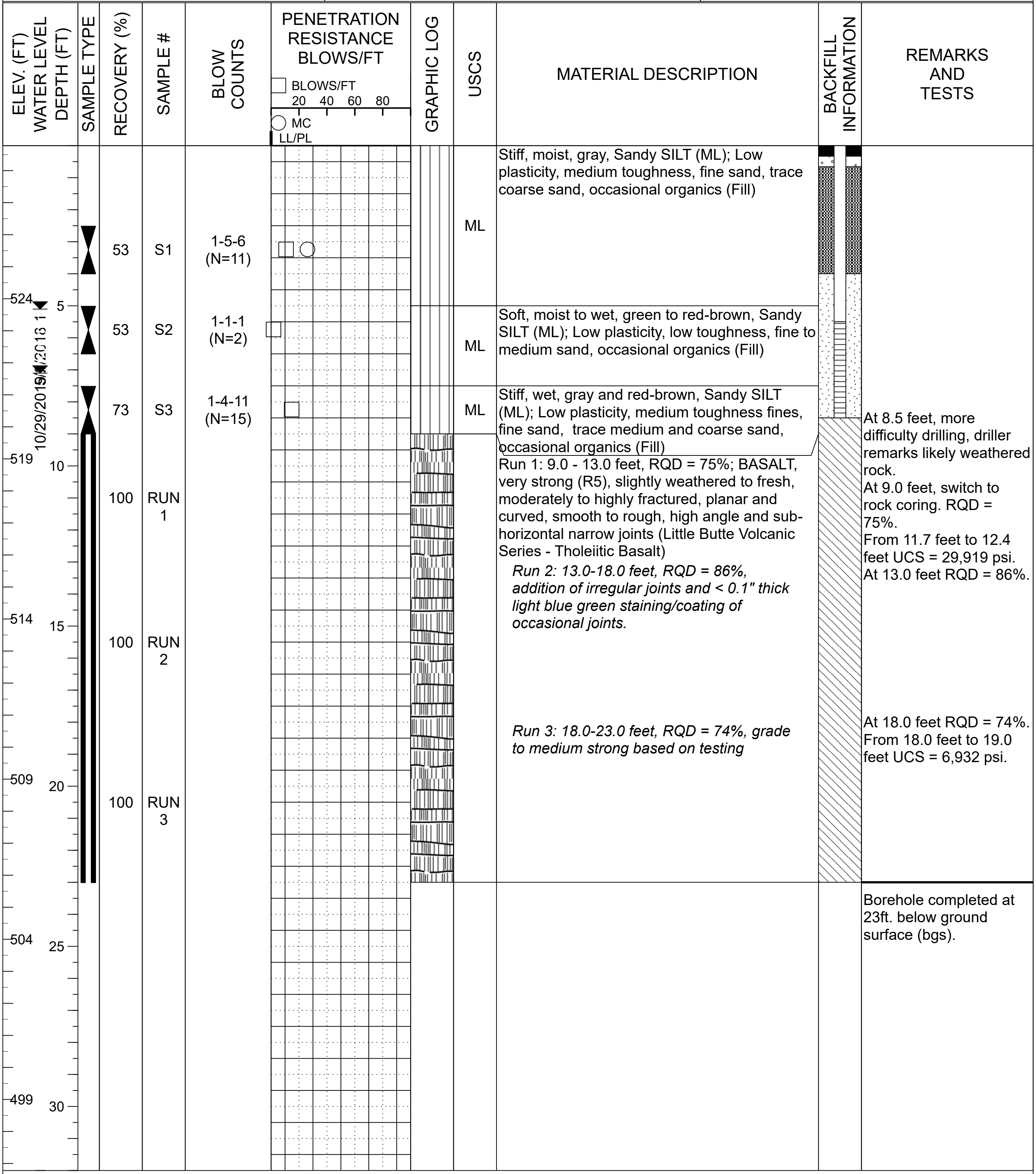
Date(s) Drilled	**05/01/2018**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Irizarry**	Checked By	**K. Elliott**
Drilling Method/ Rig Type	**Mud Rotary/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**	Total Depth of Borehole	**5.8 ft**		
Hole Diameter	**4.00 in**	Hammer Weight/Drop (lb/in.)/Type	**140 lb / 30 in / Automatic**	Ground Surface Elevation/Datum	**538.6 ft**		
Location	**Survey**	Coordinates	**7616842.35 E, 275514.57 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
	▼ 5/2/2018 1		⧗	20	S1	7-10-7 (N=17)	☐		SM	Medium dense, moist to wet, dark gray, SILTY SAND with Gravel (SM); Fine to medium sand, fine angular gravel, low plasticity fines, slow dilatancy, scattered organics (Fill)		
534		5	⧗	120	S2	28-50/3" (Refusal)			GM	Very dense, moist, gray and orange, SILTY GRAVEL with Sand (GM); Fine to coarse gravel, fine to coarse sand, medium plasticity fines (Fill)		At 4.5 feet very slow, very rough drilling.
												Borehole completed at 5.8ft. below ground surface (bgs).
529		10										
524		15										
519		20										
514		25										
509		30										

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring B-5

Date(s) Drilled **05/02/2018**	Geotechnical Consultant **McMillen Jacobs Associates**	Logged By **J. Irizarry**	Checked By **K. Elliott**
Drilling Method/ Rig Type **Mud Rotary and HQ Wireline/CME 75**	Drilling Contractor **Western States Soil Conservation, Inc.**	Total Depth of Borehole **23.0 ft**	
Hole Diameter **4.00 in**	Hammer Weight/Drop (lb/in.)/Type **140 lb / 30 in / Automatic**	Ground Surface Elevation/Datum **528.8 ft**	
Location **Survey**	Coordinates **7617036.16 E, 275580.52 N**	Elevation Source **Site Survey**	



ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS
			53	S1	1-5-6 (N=11)	ML	Stiff, moist, gray, Sandy SILT (ML); Low plasticity, medium toughness, fine sand, trace coarse sand, occasional organics (Fill)	
524	5		53	S2	1-1-1 (N=2)	ML	Soft, moist to wet, green to red-brown, Sandy SILT (ML); Low plasticity, low toughness, fine to medium sand, occasional organics (Fill)	
			73	S3	1-4-11 (N=15)	ML	Stiff, wet, gray and red-brown, Sandy SILT (ML); Low plasticity, medium toughness fines, fine sand, trace medium and coarse sand, occasional organics (Fill)	At 8.5 feet, more difficulty drilling, driller remarks likely weathered rock.
519	10		100	RUN 1			Run 1: 9.0 - 13.0 feet, RQD = 75%; BASALT, very strong (R5), slightly weathered to fresh, moderately to highly fractured, planar and curved, smooth to rough, high angle and sub-horizontal narrow joints (Little Butte Volcanic Series - Tholeiitic Basalt)	At 9.0 feet, switch to rock coring. RQD = 75%. From 11.7 feet to 12.4 feet UCS = 29,919 psi.
514	15		100	RUN 2			*Run 2: 13.0-18.0 feet, RQD = 86%, addition of irregular joints and < 0.1" thick light blue green staining/coating of occasional joints.*	At 13.0 feet RQD = 86%.
509	20		100	RUN 3			*Run 3: 18.0-23.0 feet, RQD = 74%, grade to medium strong based on testing*	At 18.0 feet RQD = 74%. From 18.0 feet to 19.0 feet UCS = 6,932 psi.
504	25							Borehole completed at 23ft. below ground surface (bgs).
499	30							

Boring B-5

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-01

Date(s) Drilled	**04/30/2018**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Irizarry**	Checked By	**K. Elliott**
Drilling Method/ Rig Type	**4-1/4" Hollow stem auger/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**	Total Depth of Borehole	**11.0 ft**		
Hole Diameter	**4.25 in**	Hammer Weight/Drop (lb/in.)/Type		Ground Surface Elevation/Datum	**517.3 ft**		
Location	**Survey**	Coordinates	**7617295.47 E, 275346.48 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
									Asphalt (Pavement)		
								GM	Dense, gray, Silty GRAVEL (GM); (Base Aggregate)		
513	5	✋		S1				CL	Very soft to soft, moist, brown, LEAN CLAY with Sand (CL); Low plasticity, medium toughness, fine sand, trace medium sand, occasional organics (Fill)		At 9.0 feet driller remarks that the material stiffens.
508	10							GC	Very loose to loose, moist to wet, gray brown, CLAYEY GRAVEL with Sand (GC); Fine to coarse angular basalt gravel, fine to coarse sand, low plasticity fines (Fill)		At 10.0 feet, driller remarks that the material feels like rock but the auger is able to continue to spin. Auger refusal at 11 feet.
											Borehole completed at 11ft. below ground surface (bgs).
503	15										Grab samples obtained from auger cuttings during exploration. Reported relative density and apparent consistency based on reactions while drilling.
498	20										
493	25										
488	30										

McMILLEN JACOBS ASSOCIATES

Boring P-01

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-02

Date(s) Drilled	**05/01/2018 - 01/05/2018**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Irizarry**	Checked By	**K. Elliott**
Drilling Method/ Rig Type	**4-1/4" Hollow stem auger/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**	Total Depth of Borehole	**11.5 ft**		
Hole Diameter	**4.25 in**	Hammer Weight/Drop (lb/in.)/Type		Ground Surface Elevation/Datum	**526.1 ft**		
Location	**Survey**	Coordinates	**7617102.54 E, 275424.97 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC ▮ LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
522 517	5 10						▨	CL	Soft to very soft, moist, brown to light brown, Sandy LEAN CLAY with Gravel (CL); Low plasticity, fine angular gravel, occasional organics (Fill)	▨	At 2.5 feet very slow, very rough drilling. Auger refusal at 11.5 feet.
512 507 502 497	15 20 25 30										Borehole completed at 11.5ft. below ground surface (bgs). Grab samples obtained from auger cuttings during exploration. Reported relative density and apparent consistency based on reactions while drilling.

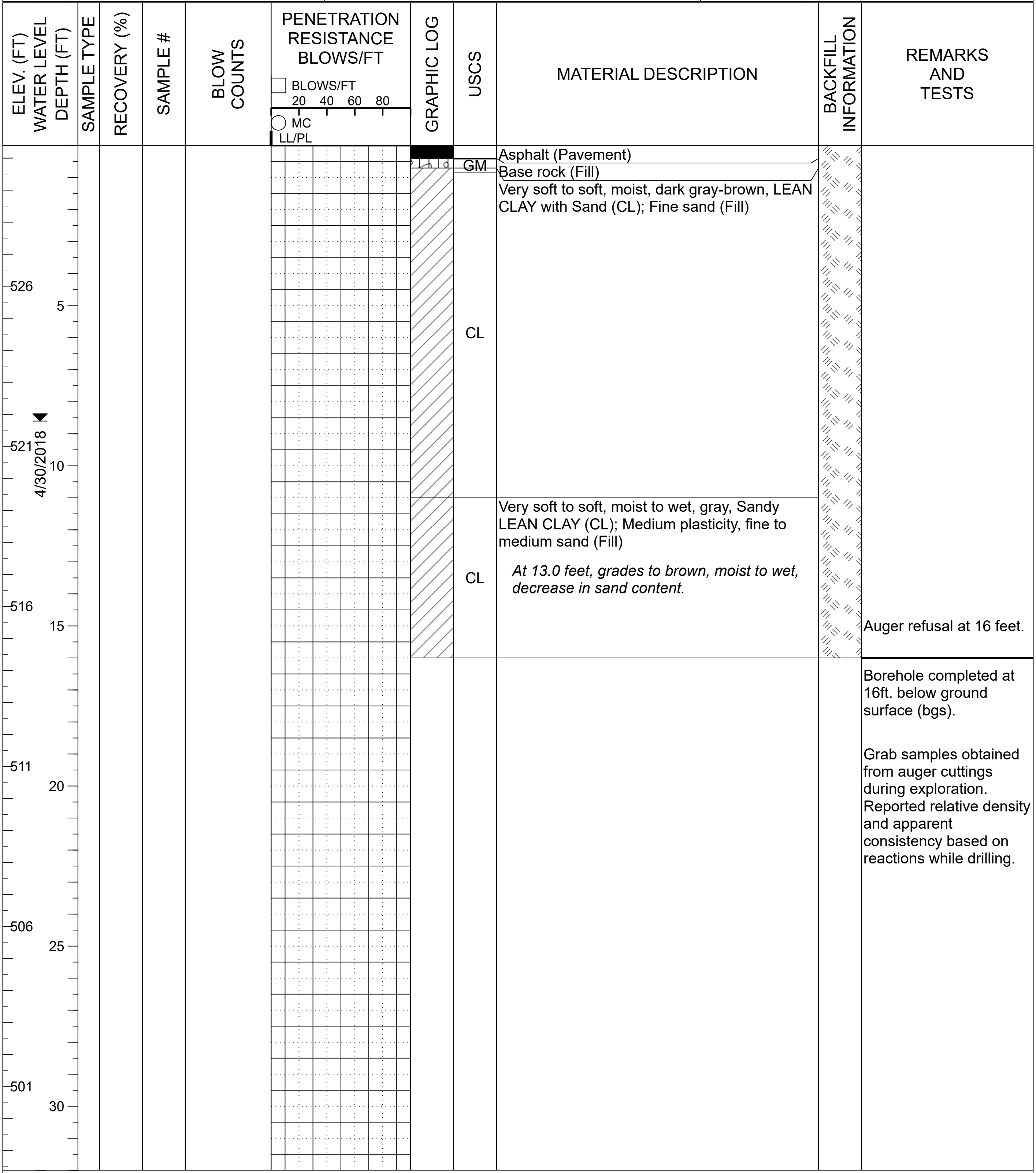
McMILLEN JACOBS ASSOCIATES

Boring P-02

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-03

Date(s) Drilled	**04/30/2018**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Irizarry**	Checked By	**K. Elliott**
Drilling Method/ Rig Type	**4-1/4" Hollow stem auger/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**	Total Depth of Borehole	**16.0 ft**		
Hole Diameter	**4.25 in**	Hammer Weight/Drop (lb/in.)/Type		Ground Surface Elevation/Datum	**530.4 ft**		
Location	**Survey**	Coordinates	**7617036.27 E, 275432.54 N**	Elevation Source	**Site Survey**		



Asphalt (Pavement)

Base rock (Fill)

Very soft to soft, moist, dark gray-brown, LEAN CLAY with Sand (CL); Fine sand (Fill)

Very soft to soft, moist to wet, gray, Sandy LEAN CLAY (CL); Medium plasticity, fine to medium sand (Fill)

At 13.0 feet, grades to brown, moist to wet, decrease in sand content.

Auger refusal at 16 feet.

Borehole completed at 16ft. below ground surface (bgs).

Grab samples obtained from auger cuttings during exploration. Reported relative density and apparent consistency based on reactions while drilling.

McMILLEN JACOBS ASSOCIATES

Boring P-03

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-04

Date(s) Drilled	**04/30/2018 - 04/30/2018**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Irizarry**	Checked By	**K. Elliott**
Drilling Method/ Rig Type	**4-1/4" Hollow stem auger/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**	Total Depth of Borehole	**7.5 ft**		
Hole Diameter	**4.25 in**	Hammer Weight/Drop (lb/in.)/Type		Ground Surface Elevation/Datum	**530.8 ft**		
Location	**Survey**	Coordinates	**7616984.89 E, 275442.28 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
										Asphalt - 5" thick (Pavement)		
									GM	Dense, moist, gray Silty GRAVEL (GM); Fine to coarse angular gravel, low plasticity silt, 5 inches thick (Base Aggregate)		
									CL	Very soft to soft, moist, dark gray-brown, LEAN CLAY (CL); (Fill)		
			✋		S1				OL/OH	Hard, moist, brown, Organic Soil with Sand (OL/OH); Frequent hard wood in clay (Fill)		At 2.5 feet driller remarks that material becomes stiffer, woody material began smoking so driller added water to hole, very slow drilling. Organic chemical odor in the wood fiber of Sample 1.
526		5	✋		S2				CL	Very soft to soft, moist, green-brown with brown-orange mottles, LEAN CLAY (CL); Low plasticity, fine sand, trace medium sand (Fill)		Auger refusal at 7.5 feet.
521		10										Borehole completed at 7.5ft. below ground surface (bgs). Grab samples obtained from auger cuttings during exploration. Reported relative density and apparent consistency based on reactions while drilling.
516		15										
511		20										
506		25										
501		30										

McMILLEN JACOBS ASSOCIATES

Boring P-04

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-05

Date(s) Drilled	**05/01/2018 - 05/01/2018**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Irizarry**	Checked By	**K. Elliott**
Drilling Method/ Rig Type	**4-1/4" Hollow stem auger/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**	Total Depth of Borehole	**3.5 ft**		
Hole Diameter	**4.25 in**	Hammer Weight/Drop (lb/in.)/Type		Ground Surface Elevation/Datum	**533.1 ft**		
Location	**Survey**	Coordinates	**7616928.58 E, 275458.29 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC ❘ LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
							▨	CL	Very soft to soft, moist, brown to light brown, LEAN CLAY with Sand (CL); Low plasticity, medium toughness, fine sand, trace coarse angular gravel, occasional organics (Fill)	▨	Auger refusal at 3.5 feet.
529	5										Borehole completed at 3.5ft. below ground surface (bgs). Grab samples obtained from auger cuttings during exploration. Reported relative density and apparent consistency based on reactions while drilling.
524	10										
519	15										
514	20										
509	25										
504	30										

McMILLEN JACOBS ASSOCIATES

Boring P-05

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-06

Date(s) Drilled	**04/30/2018 - 04/30/2018**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Irizarry**	Checked By	**K. Elliott**
Drilling Method/ Rig Type	**4-1/4" Hollow stem auger/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**	Total Depth of Borehole	**3.5 ft**		
Hole Diameter	**4.25 in**	Hammer Weight/Drop (lb/in.)/Type		Ground Surface Elevation/Datum	**536.2 ft**		
Location	**Survey**	Coordinates	**7616858.52 E, 275586.88 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC ▌LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
			✋		S1			▨	CL	Stiff, moist to wet, brown, LEAN CLAY (CL); Low plasticity, medium toughness, trace fine to medium sand, fine gravel, occasional woody organics (Fill)	▨	Auger refusal at 3.5 feet.
532		5										Borehole completed at 3.5ft. below ground surface (bgs). Grab samples obtained from auger cuttings during exploration. Reported relative density and apparent consistency based on reactions while drilling.
527		10										
522		15										
517		20										
512		25										
507		30										

McMILLEN JACOBS ASSOCIATES

Boring P-06

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-07

Date(s) Drilled	**04/30/2018**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Irizarry**	Checked By	**K. Elliott**

Drilling Method/ Rig Type	**4-1/4" Hollow stem auger/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**	Total Depth of Borehole	**2.5 ft**
Hole Diameter	**4.25 in**	Hammer Weight/Drop (lb/in.)/Type		Ground Surface Elevation/Datum	**538.0 ft**
Location	**Survey**	Coordinates	**7616789.32 E, 275532.46 N**	Elevation Source	**Site Survey**

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
									GM	Very loose to loose, moist, dark brown, SILTY GRAVEL with Sand (GM); Angular fine to coarse gravel with cobbles, low plasticity fines (Fill)		Auger refusal at 2.5 feet.
												Borehole completed at 2.5ft. below ground surface (bgs). Grab samples obtained from auger cuttings during exploration. Reported relative density and apparent consistency based on reactions while drilling.
533		5										
528		10										
523		15										
518		20										
513		25										
508		30										

Boring P-07

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-08

Date(s) Drilled	**04/30/2018**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Irizarry**	Checked By	**K. Elliott**
Drilling Method/ Rig Type	**4-1/4" Hollow stem auger/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**	Total Depth of Borehole	**7.5 ft**		
Hole Diameter	**4.25 in**	Hammer Weight/Drop (lb/in.)/Type		Ground Surface Elevation/Datum	**535.2 ft**		
Location	**Survey**	Coordinates	**7616905.96 E, 275577.01 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC ▏LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
		0–7.5						▨	GM	Very loose to loose, moist, dark brown, SILTY GRAVEL with Sand (GM); Fine to coarse angular to subangular gravel, fine to coarse sand, low plasticity fines, occasional woody organics (Fill)	▨	Slight petroleum odor while drilling.
531												
		5	✋		S1							
												Auger refusal at 7.5 feet.
												Borehole completed at 7.5ft. below ground surface (bgs). Grab samples obtained from auger cuttings during exploration. Reported relative density and apparent consistency based on reactions while drilling.
526												
		10										
521												
		15										
516												
		20										
511												
		25										
506												
		30										

MCMILLEN JACOBS ASSOCIATES

Boring P-08

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-09

Date(s) Drilled	**05/01/2018**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Irizarry**	Checked By	**K. Elliott**
Drilling Method/ Rig Type	**4-1/4" Hollow stem auger/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**	Total Depth of Borehole	**4.0 ft**		
Hole Diameter	**4.25 in**	Hammer Weight/Drop (lb/in.)/Type		Ground Surface Elevation/Datum	**530.5 ft**		
Location	**Survey**	Coordinates	**7616966.80 E, 275594.59 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
								▨	CL	Moist, gray-brown, Sandy LEAN CLAY with Gravel (CL); Low plasticity, fine to coarse sand, fine angular gravel, scattered organics (Fill)	▨	Slight petroleum odor. Auger refusal at 4 feet.
	▼ 5/2/2018		✋		S1			▨			▨	
526		5										Borehole completed at 4ft. below ground surface (bgs). Grab samples obtained from auger cuttings during exploration. Reported relative density and apparent consistency based on reactions while drilling.
521		10										
516		15										
511		20										
506		25										
501		30										

McMILLEN JACOBS ASSOCIATES

Boring P-09

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-10

Date(s) Drilled	**04/30/2018**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Irizarry**	Checked By	**K. Elliott**

Drilling Method/ Rig Type	**4-1/4" Hollow stem auger/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**	Total Depth of Borehole	**5.5 ft**
Hole Diameter	**4.25 in**	Hammer Weight/Drop (lb/in.)/Type		Ground Surface Elevation/Datum	**530.1 ft**
Location	**Survey**	Coordinates	**7616963.18 E, 275547.22 N**	Elevation Source	**Site Survey**

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
									GM	Very loose to loose, moist, brown, SILTY GRAVEL with Sand (GM); Fine to coarse gravel, fine and coarse sand, low plasticity. (Fill)		
526	5/1/2018 1	5							CL	Very soft to soft, wet, gray-brown, LEAN CLAY with Sand (CL); Low plasticity, fine sand, trace angular fine angular gravel. (Fill)		Auger refusal at 5.5 feet.
521		10										Borehole completed at 5.5ft. below ground surface (bgs). Grab samples obtained from auger cuttings during exploration. Reported relative density and apparent consistency based on reactions while drilling.
516		15										
511		20										
506		25										
501		30										

McMILLEN JACOBS ASSOCIATES

Boring P-10

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-11

Date(s) Drilled	**04/30/2018 - 04/30/2018**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Irizarry**	Checked By	**K. Elliott**
Drilling Method/ Rig Type	**4-1/4" Hollow stem auger/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**	Total Depth of Borehole	**5.5 ft**		
Hole Diameter	**4.25 in**	Hammer Weight/Drop (lb/in.)/Type		Ground Surface Elevation/Datum	**529.8 ft**		
Location	**Survey**	Coordinates	**7617007.94 E, 275561.88 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
									GC	Very loose to loose, moist to wet, brown to gray brown, Clayey GRAVEL with Sand (GC); Fine to coarse gravel, fine to coarse sand (Fill)		
525	5/1/2018 1	5			S1							Auger refusal at 5.5 feet.
												Borehole completed at 5.5ft. below ground surface (bgs). Grab samples obtained from auger cuttings during exploration. Reported relative density and apparent consistency based on reactions while drilling.
520		10										
515		15										
510		20										
505		25										
500		30										

Boring P-11

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-12

Date(s) Drilled	**04/30/2018**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Irizarry**	Checked By	**K. Elliott**

Drilling Method/ Rig Type	**4-1/4" Hollow stem auger/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**	Total Depth of Borehole	**5.0 ft**
Hole Diameter	**4.25 in**	Hammer Weight/Drop (lb/in.)/Type		Ground Surface Elevation/Datum	**526.4 ft**
Location	**Survey**	Coordinates	**7617070.84 E, 275609.56 N**	Elevation Source	**Site Survey**

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC ┃ LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
							▨	CL	Very soft to soft, moist, brown, Gravelly LEAN CLAY with Sand (CL); Low plasticity, fine to coarse angular gravel, fine to coarse sand (Fill)	▨	Auger refusal at 5 feet.
522	5	✋		S1							
											Borehole completed at 5ft. below ground surface (bgs). Grab samples obtained from auger cuttings during exploration. Reported relative density and apparent consistency based on reactions while drilling.
517	10										
512	15										
507	20										
502	25										
497	30										

McMILLEN JACOBS ASSOCIATES

Boring P-12

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-13

Date(s) Drilled **04/30/2018 - 04/30/2018**	Geotechnical Consultant **McMillen Jacobs Associates**	Logged By **J. Irizarry**	Checked By **K. Elliott**
Drilling Method/ Rig Type **4-1/4" Hollow stem auger/CME 75**	Drilling Contractor **Western States Soil Conservation, Inc.**	Total Depth of Borehole **8.5 ft**	
Hole Diameter **4.25 in**	Hammer Weight/Drop (lb/in.)/Type	Ground Surface Elevation/Datum **523.6 ft**	
Location **Survey**	Coordinates **7617121.16 E, 275620.34 N**	Elevation Source **Site Survey**	

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
								▨	CL	Very soft to soft, moist to wet, dark brown to gray brown, Sandy LEAN CLAY with Gravel (CL); Low plasticity, fine to coarse sand, fine angular gravel (Fill)	▨	Loose gravelly material begins caving at the ground surface.
519		5										
	▼ 5/6/2018 1											
												Auger refusal at 8.5 feet.
514		10										Borehole completed at 8.5ft. below ground surface (bgs). Grab samples obtained from auger cuttings during exploration. Reported relative density and apparent consistency based on reactions while drilling.
509		15										
504		20										
499		25										
494		30										

McMILLEN JACOBS ASSOCIATES

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-14

Date(s) Drilled	**05/01/2018**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Irizarry**	Checked By	**K. Elliott**
Drilling Method/ Rig Type	**4-1/4" Hollow stem auger/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**	Total Depth of Borehole	**5.5 ft**		
Hole Diameter	**4.25 in**	Hammer Weight/Drop (lb/in.)/Type		Ground Surface Elevation/Datum	**521.7 ft**		
Location	**Survey**	Coordinates	**7617149.97 E, 275571.01 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC ▮ LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
							▨	CL	Very soft to soft, wet, gray-brown, Sandy LEAN CLAY with Gravel (CL); Low plasticity, fine to coarse sand, fine angular gravel (Fill)		Observed groundwater at approximately 4.0 feet water present, difficult to measure due to gravel.
517	5	✋		S1							Auger refusal at 5.5 feet.
											Borehole completed at 5.5ft. below ground surface (bgs). Grab samples obtained from auger cuttings during exploration. Reported relative density and apparent consistency based on reactions while drilling.
512	10										
507	15										
502	20										
497	25										
492	30										

Boring P-14

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-15

Date(s) Drilled	**04/30/2018**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Irizarry**	Checked By	**K. Elliott**
Drilling Method/ Rig Type	**4-1/4" Hollow stem auger/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**	Total Depth of Borehole	**2.5 ft**		
Hole Diameter	**4.25 in**	Hammer Weight/Drop (lb/in.)/Type		Ground Surface Elevation/Datum	**519.1 ft**		
Location	**Survey**	Coordinates	**7617194.34 E, 275628.88 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
		0–2.5							GC	Very loose to loose, moist to wet, brown, CLAYEY GRAVEL with Sand (GC); Fine angular gravel, fine to coarse sand (Fill)		Auger refusal at 2.5 feet.
515	4/30/2018 ▽	5										Borehole completed at 2.5ft. below ground surface (bgs). Grab samples obtained from auger cuttings during exploration. Reported relative density and apparent consistency based on reactions while drilling.
510		10										
505		15										
500		20										
495		25										
490		30										

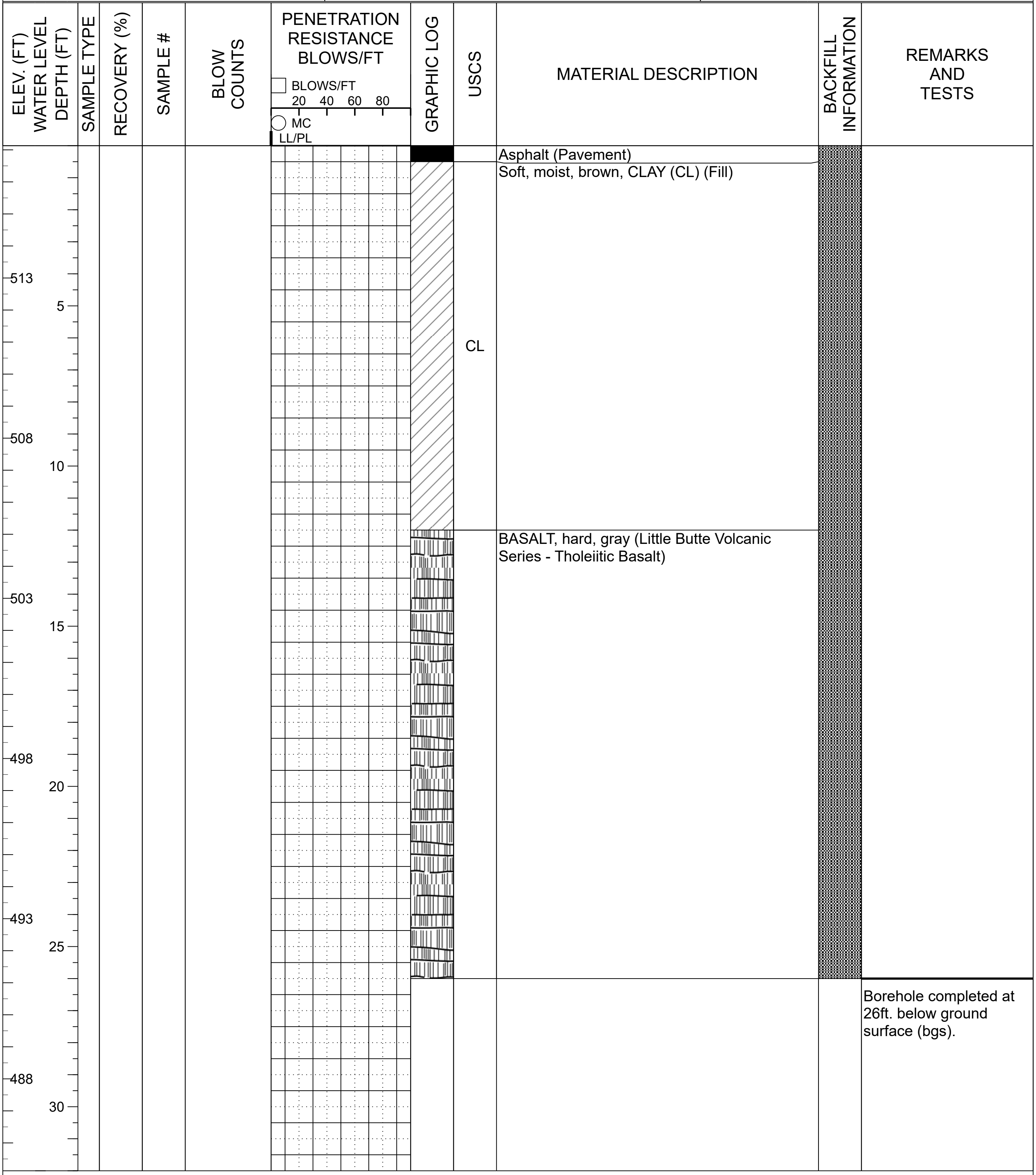
McMILLEN JACOBS ASSOCIATES

Boring P-15

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-16

Date(s) Drilled	**10/29/2019**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**L. Ferguson**	Checked By	**J. Quinn**
Drilling Method/ Rig Type	**Air Track Probe/Furukawa HCR900**	Drilling Contractor	**McCallum Rock Drilling**	Total Depth of Borehole	**26.0 ft**		
Hole Diameter	**3.00 in**	Hammer Weight/Drop (lb/in.)/Type	**N/A**	Ground Surface Elevation/Datum	**517.1 ft**		
Location	**Sweet Home WWTP**	Coordinates	**7617309.79 E, 275352.81 N**	Elevation Source	**Site Survey**		



Asphalt (Pavement)

Soft, moist, brown, CLAY (CL) (Fill)

BASALT, hard, gray (Little Butte Volcanic Series - Tholeiitic Basalt)

Borehole completed at 26ft. below ground surface (bgs).

Boring P-16

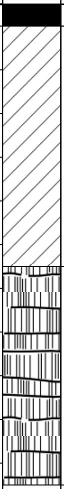
Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-17

Date(s) Drilled	**10/29/2019**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**L. Ferguson**	Checked By	**J. Quinn**
Drilling Method/ Rig Type	**Air Track Probe/Furukawa HCR900**	Drilling Contractor	**McCallum Rock Drilling**	Total Depth of Borehole	**11.0 ft**		
Hole Diameter	**3.00 in**	Hammer Weight/Drop (lb/in.)/Type	**N/A**	Ground Surface Elevation/Datum	**516.4 ft**		
Location	**Sweet Home WWTP**	Coordinates	**7617358.56 E, 275414.92 N**	Elevation Source	**Site Survey**		

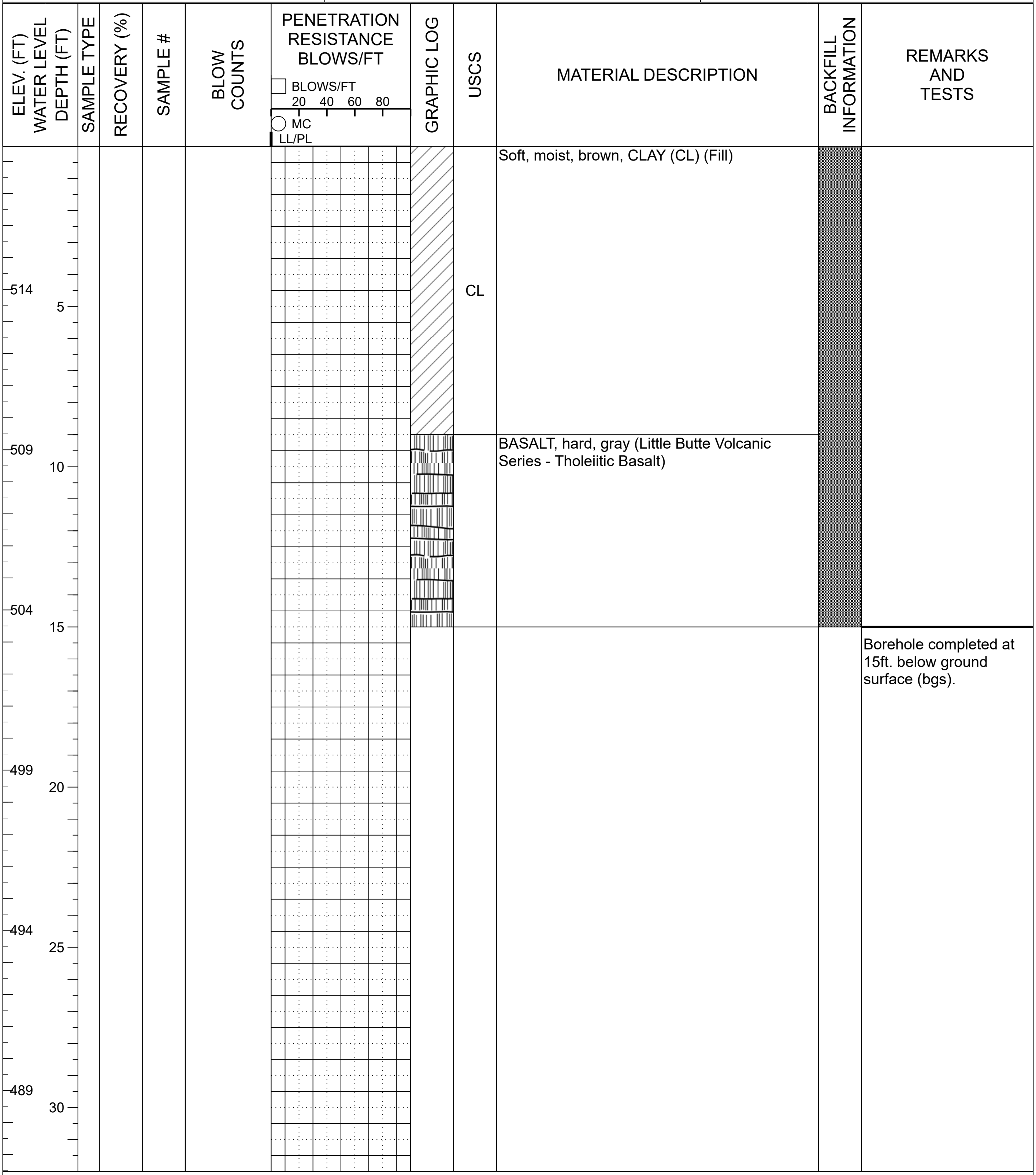
ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
									Asphalt (Pavement)		
								CL	Soft, moist, brown, CLAY (CL) (Fill)		
512	5										
									Basalt, hard, gray (Little Butte Volcanic Series - Tholeiitic Basalt)		
507	10										
											Borehole completed at 11ft. below ground surface (bgs).
502	15										
497	20										
492	25										
487	30										



Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-18

Date(s) Drilled	**10/29/2019**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**L. Ferguson**	Checked By	**J. Quinn**
Drilling Method/ Rig Type	**Air Track Probe/Furukawa HCR900**	Drilling Contractor	**McCallum Rock Drilling**	Total Depth of Borehole	**15.0 ft**		
Hole Diameter	**3.00 in**	Hammer Weight/Drop (lb/in.)/Type	**N/A**	Ground Surface Elevation/Datum	**518.5 ft**		
Location	**Sweet Home WWTP**	Coordinates	**7617209.77 E, 275451.86 N**	Elevation Source	**Site Survey**		



DEPTH (FT)	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS
0 – 9	CL	Soft, moist, brown, CLAY (CL) (Fill)	
9 – 15		BASALT, hard, gray (Little Butte Volcanic Series - Tholeiitic Basalt)	
15			Borehole completed at 15ft. below ground surface (bgs).

McMILLEN JACOBS ASSOCIATES

Boring P-18

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-19

Date(s) Drilled	**10/29/2019**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**L. Ferguson**	Checked By	**J. Quinn**
Drilling Method/ Rig Type	**Air Track Probe/Furukawa HCR900**	Drilling Contractor	**McCallum Rock Drilling**	Total Depth of Borehole	**20.0 ft**		
Hole Diameter	**3.00 in**	Hammer Weight/Drop (lb/in.)/Type	**N/A**	Ground Surface Elevation/Datum	**518.0 ft**		
Location	**Sweet Home WWTP**	Coordinates	**7617228.61 E, 275499.48 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
									Asphalt (Pavement)		
								GM	Medium dense, gray, silty GRAVEL (GM) (Fill)		
								CL	Soft, moist, brown, CLAY (CL) (Fill)		
514											
	5										
									BASALT, hard, gray (Little Butte Volcanic Series - Tholeiitic Basalt)		
509											
	10										
504											
	15										
499											
	20										Borehole completed at 20ft. below ground surface (bgs).
494											
	25										
489											
	30										

McMILLEN JACOBS ASSOCIATES

Boring P-19

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-20

Date(s) Drilled	**10/29/2019**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**L. Ferguson**	Checked By	**J. Quinn**
Drilling Method/ Rig Type	**Air Track Probe/Furukawa HCR900**	Drilling Contractor	**McCallum Rock Drilling**	Total Depth of Borehole	**20.0 ft**		
Hole Diameter	**3.00 in**	Hammer Weight/Drop (lb/in.)/Type	**N/A**	Ground Surface Elevation/Datum	**525.4 ft**		
Location	**Sweet Home WWTP**	Coordinates	**7617111.38 E, 275430.15 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
								CL	Soft, moist, brown, CLAY (CL) (Fill)		
521	5										
									BASALT, hard, gray (Little Butte Volcanic Series - Tholeiitic Basalt)		
516	10										
511	15										
506	20										Borehole completed at 20ft. below ground surface (bgs).
501	25										
496	30										

Boring P-20

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-21

Date(s) Drilled	**10/29/2019**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**L. Ferguson**	Checked By	**J. Quinn**
Drilling Method/ Rig Type	**Air Track Probe/Furukawa HCR900**	Drilling Contractor	**McCallum Rock Drilling**	Total Depth of Borehole	**23.0 ft**		
Hole Diameter	**3.00 in**	Hammer Weight/Drop (lb/in.)/Type	**N/A**	Ground Surface Elevation/Datum	**521.8 ft**		
Location	**Sweet Home WWTP**	Coordinates	**7617111.78 E, 275548.31 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
								GM	Loose, gray, silty GRAVEL (GM) (Fill)		
517	5										
									BASALT, hard, gray (Little Butte Volcanic Series - Tholeiitic Basalt)		
512	10										
507	15										
502	20										
											Borehole completed at 23ft. below ground surface (bgs).
497	25										
492	30										

McMILLEN JACOBS ASSOCIATES

Boring P-21

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-22

Date(s) Drilled	**10/29/2019**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**L. Ferguson**	Checked By	**J. Quinn**
Drilling Method/ Rig Type	**Air Track Probe/Furukawa HCR900**	Drilling Contractor	**McCallum Rock Drilling**	Total Depth of Borehole	**20.0 ft**		
Hole Diameter	**3.00 in**	Hammer Weight/Drop (lb/in.)/Type	**N/A**	Ground Surface Elevation/Datum	**518.5 ft**		
Location	**Sweet Home WWTP**	Coordinates	**7617179.82 E, 275578.51 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC ▮ LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
								CL	Soft, moist, brown, slightly sandy CLAY (CL) (Fill)		
514	5										
									BASALT, hard, gray (Little Butte Volcanic Series - Tholeiitic Basalt)		
509	10										
504	15										
499	20										Borehole completed at 20ft. below ground surface (bgs).
494	25										
489	30										

McMILLEN JACOBS ASSOCIATES

Boring P-22

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-23

Date(s) Drilled	**10/29/2019**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**L. Ferguson**	Checked By	**J. Quinn**
Drilling Method/ Rig Type	**Air Track Probe/Furukawa HCR900**	Drilling Contractor	**McCallum Rock Drilling**	Total Depth of Borehole	**23.0 ft**		
Hole Diameter	**3.00 in**	Hammer Weight/Drop (lb/in.)/Type	**N/A**	Ground Surface Elevation/Datum	**530.4 ft**		
Location	**Sweet Home WWTP**	Coordinates	**7617036.68 E, 275432.95 N**	Elevation Source	**Site Survey**		

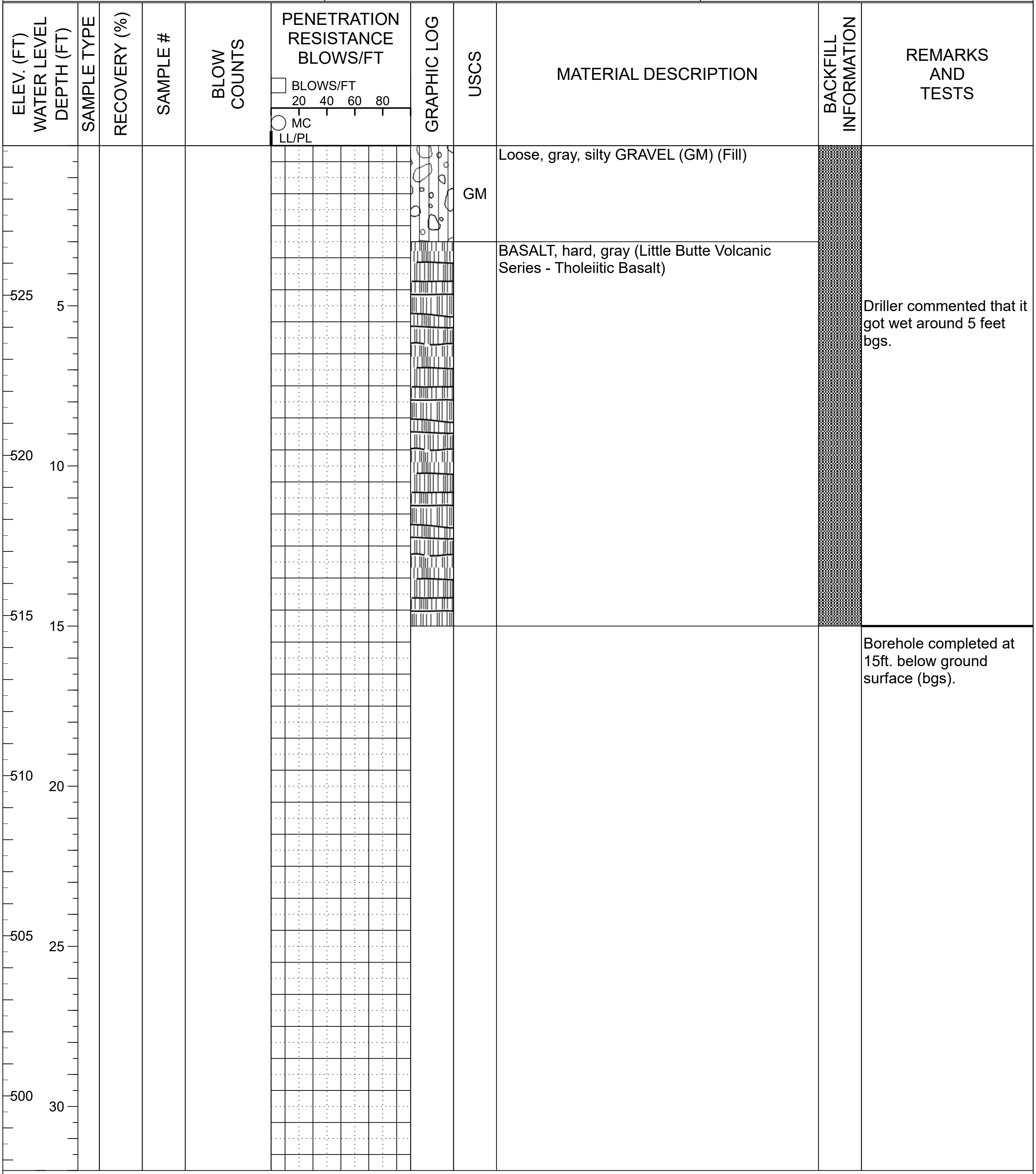
ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC ▮ LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
									Asphalt (Pavement)		
								GM	Medium dense, gray, slightly silty GRAVEL (GM) (Fill)		
								CL	Soft, moist, brown, CLAY (CL) (Fill)		
526	5										
521	10										
516	15								BASALT, hard, gray (Little Butte Volcanic Series - Tholeiitic Basalt)		
511	20										There was no return of rock chips until 22 feet bgs. Driller commented that the hole was being plugged by dirt and preventing return of rock fragments.
506	25										Borehole completed at 23ft. below ground surface (bgs).
501	30										

McMILLEN JACOBS ASSOCIATES

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-24

Date(s) Drilled	**10/30/2019**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**L. Ferguson**	Checked By	**J. Quinn**
Drilling Method/ Rig Type	**Air Track Probe/Furukawa HCR900**	Drilling Contractor	**McCallum Rock Drilling**	Total Depth of Borehole	**15.0 ft**		
Hole Diameter	**3.00 in**	Hammer Weight/Drop (lb/in.)/Type	**N/A**	Ground Surface Elevation/Datum	**529.7 ft**		
Location	**Sweet Home WWTP**	Coordinates	**7617008.03 E, 275578.53 N**	Elevation Source	**Site Survey**		



DEPTH (FT)	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS
0	GM	Loose, gray, silty GRAVEL (GM) (Fill)	
3		BASALT, hard, gray (Little Butte Volcanic Series - Tholeiitic Basalt)	
5			Driller commented that it got wet around 5 feet bgs.
15			Borehole completed at 15ft. below ground surface (bgs).

McMILLEN JACOBS ASSOCIATES

Boring P-24

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-25

Date(s) Drilled	**10/29/2019**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**L. Ferguson**	Checked By	**J. Quinn**
Drilling Method/ Rig Type	**Air Track Probe/Furukawa HCR900**	Drilling Contractor	**McCallum Rock Drilling**	Total Depth of Borehole	**15.0 ft**		
Hole Diameter	**3.00 in**	Hammer Weight/Drop (lb/in.)/Type	**N/A**	Ground Surface Elevation/Datum	**506.4 ft**		
Location	**Pleasant Valley Boat Ramp**	Coordinates	**7617287.27 E, 275672.91 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
									Asphalt (Pavement)		
								GM	Medium dense, gray, silty GRAVEL (GM) (Fill)		
									BASALT, hard, gray (Little Butte Volcanic Series - Tholeiitic Basalt)		
											Borehole completed at 15ft. below ground surface (bgs).

ELEV. (FT)	DEPTH (FT)
502	5
497	10
492	15
487	20
482	25
477	30

McMILLEN JACOBS ASSOCIATES

Boring P-25

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-26

Date(s) Drilled	**10/29/2019**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**L. Ferguson**	Checked By	**J. Quinn**
Drilling Method/ Rig Type	**Air Track Probe/Furukawa HCR900**	Drilling Contractor	**McCallum Rock Drilling**	Total Depth of Borehole	**23.0 ft**		
Hole Diameter	**3.00 in**	Hammer Weight/Drop (lb/in.)/Type	**N/A**	Ground Surface Elevation/Datum	**507.2 ft**		
Location	**Pleasant Valley Boat Ramp**	Coordinates	**7617279.85 E, 275716.52 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
								GM	Medium dense, gray, silty GRAVEL (GM) (Fill)	▒	
									BASALT, fractured, gray (Little Butte Volcanic Series - Tholeiitic Basalt)	▒	
503										▒	
	5									▒	Driller comments that between 5 and 12 feet bgs seemed like highly fractured rock.
498										▒	
	10									▒	
									BASALT, hard, gray (Little Butte Volcanic Series - Tholeiitic Basalt)	▒	
493										▒	
	15									▒	
488										▒	
	20									▒	
											Borehole completed at 23ft. below ground surface (bgs).
483											
	25										
478											
	30										

McMILLEN JACOBS ASSOCIATES

Boring P-26

Sheet 1 of 1

Project: Sweet Home WWTP Schematic Design
Project Location: Sweet Home, OR
Project Number: 5834.0

Log of Boring P-27

Date(s) Drilled	**10/29/2019**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**L. Ferguson**	Checked By	**J. Quinn**
Drilling Method/ Rig Type	**Air Track Probe/Furukawa HCR900**	Drilling Contractor	**McCallum Rock Drilling**	Total Depth of Borehole	**26.0 ft**		
Hole Diameter	**3.00 in**	Hammer Weight/Drop (lb/in.)/Type	**N/A**	Ground Surface Elevation/Datum	**516.6 ft**		
Location	**Sweet Home WWTP**	Coordinates	**7617372.72 E, 275312.04 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
	0								Concrete (Pavement)		
								CL	Soft, moist, brown, slightly sandy CLAY (CL) (Fill)		
512	5										
507	10								BASALT, hard, gray (Little Butte Volcanic Series - Tholeiitic Basalt)		
502	15										
497	20										
492	25										
	26										Borehole completed at 26ft. below ground surface (bgs).
487	30										

Boring P-27

Project: Sweet Home WWTP Final Design Review
Project Location:
Project Number: 6367.0

Log of Boring P-28

Date(s) Drilled	**06/20/2022 - 06/20/2022**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**A. Judy**	Checked By	**J. Quinn**
Drilling Method/ Rig Type	**8.25" Hollow Stem Auger/CME 75**	Drilling Contractor	**PLI Systems, Inc.**	Total Depth of Borehole	**11.2 ft**		
Hole Diameter	**8.25 in**	Hammer Weight/Drop (lb/in.)/Type	**140 lb / 30 in / Automatic**	Ground Surface Elevation/Datum	**516.5 ft**		
Location	**See Figure 2 Site Plan**	Coordinates	**7617342.00 E, 275383.00 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC | LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
										Soft, moist, brown, SILT (ML); low plasticity, trace fine gravel, trace fine sand, trace wood fibers. (Fill)		
512		5										
			⧗	67	SPT-1	1-1-1 (N=2)	☐		ML	*Becomes gray mottled at 5.5 feet.*		
			✋	100	G-1							
507		10	⧗	64	SPT-2	1-7-50/3" (Refusal)				*10 - 11 feet: sample consists of approx. 50% wood fibers by volume.*		
										Auger refusal at 11.25 feet on basalt bedrock.		Borehole completed at 11.25ft. below ground surface (bgs).
502		15										
497		20										
492		25										
487		30										

McMILLEN JACOBS ASSOCIATES

Boring P-28

Project: Sweet Home WWTP Final Design Review
Project Location:
Project Number: 6367.0

Log of Boring P-29

Date(s) Drilled	06/20/2022 - 06/20/2022	Geotechnical Consultant	McMillen Jacobs Associates	Logged By	A. Judy	Checked By	J. Quinn
Drilling Method/ Rig Type	8.25" Hollow Stem Auger/CME 75	Drilling Contractor	PLI Systems, Inc.	Total Depth of Borehole	19.0 ft		
Hole Diameter	8.25 in	Hammer Weight/Drop (lb/in.)/Type	140 lb / 30 in / Automatic	Ground Surface Elevation/Datum	517.3 ft		
Location	See Figure 2 Site Plan	Coordinates	7617301.00 E, 275320.00 N	Elevation Source	Site Survey		

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
										Asphalt - 5" thick (Pavement)		
										Base Aggregate - 3" thick (Fill)		
									ML	Soft, moist, brown, SILT (ML); low plasticity, trace fine gravel, trace fine sand, trace wood fibers. (Fill)		
513				100	G-1							
		5		20	SPT-1	1-0-2 (N=2)	☐					
				100	G-2							
508		10								*Becomes wet at 10 feet.*		Auger grinding below 10 - 15 feet.
	▼			33 100	SPT-2 G-3	0-7-26 (N=33)	☐			BASALT; very weak, dark brown, highly weathered to decomposed (Little Butte Volcanic Series - Tholeiitic Basalt)		
				70	SPT-3	50/12" (Refusal)						
503		15		98	SPT-4	26-50/5" (Refusal)				*Penetration rate decreases significantly at 15 feet; stronger rock inferred below this depth.*		Smooth, slow drilling below 15 feet.
				87	SPT-5	12-23-33 (N=56)	☐			*Becomes dark blue-gray at 18 feet.*		
498		20										Borehole completed at 19ft. below ground surface (bgs).
493		25										
488		30										

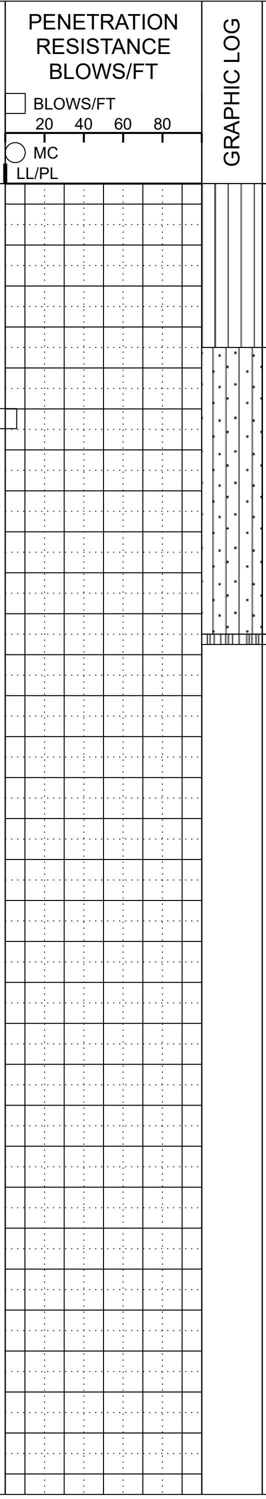
McMILLEN JACOBS ASSOCIATES

Boring P-29

Project: Sweet Home WWTP Final Design Review
Project Location:
Project Number: 6367.0

Log of Boring P-30

Date(s) Drilled	**06/20/2022 - 06/20/2022**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By **A. Judy**	Checked By **J. Quinn**
Drilling Method/ Rig Type	**8.25" Hollow Stem Auger/CME 75**	Drilling Contractor	**PLI Systems, Inc.**	Total Depth of Borehole	**11.2 ft**
Hole Diameter	**8.25 in**	Hammer Weight/Drop (lb/in.)/Type	**140 lb / 30 in / Automatic**	Ground Surface Elevation/Datum	**519.8 ft**
Location	**See Figure 2 Site Plan**	Coordinates	**7617195.00 E, 275427.00 N**	Elevation Source	**Site Survey**



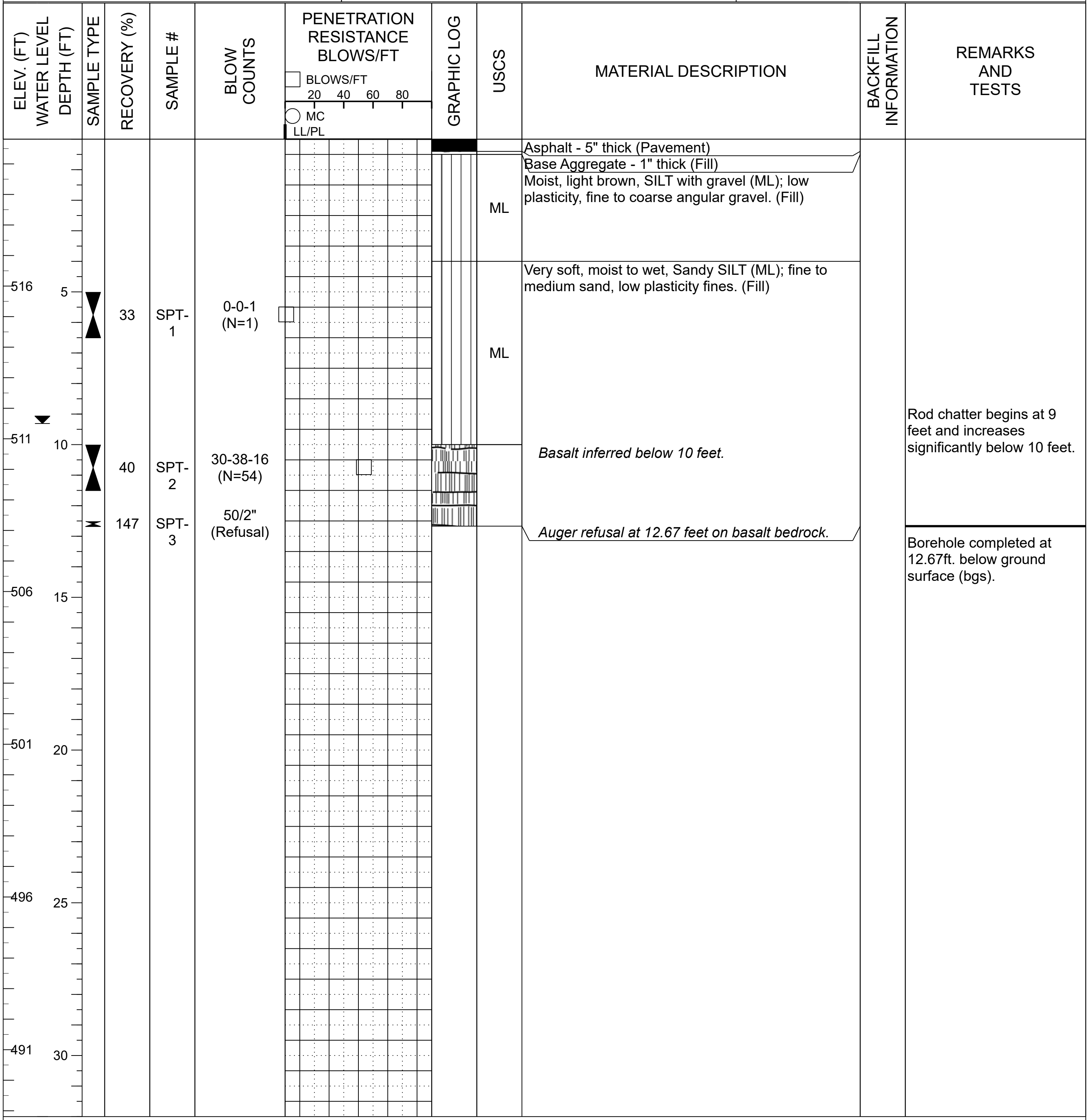
ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
							ML	Moist, light brown, SILT with gravel (ML); low plasticity, fine to coarse angular gravel. (Fill)		
			✋	100	G-1					
							SM	Very soft, wet, light brown, Silty SAND (SM); fine to medium sand, low plasticity fines. (Fill)		
515		5	⧗	100	SPT-1	1-0-1 (N=1)				
510		10	⧗	40	SPT-2	8-11-50/3" (Refusal)				
								Basalt inferred below 11 feet. *Auger refusal at 11.25 feet on basalt bedrock.*		Borehole completed at 11.25ft. below ground surface (bgs).
505		15								
500		20								
495		25								
490		30								

Boring P-30

Project: Sweet Home WWTP Final Design Review
Project Location:
Project Number: 6367.0

Log of Boring P-31

Date(s) Drilled **06/20/2022 - 06/20/2022**
Geotechnical Consultant **McMillen Jacobs Associates**
Logged By **A. Judy**
Checked By **J. Quinn**
Drilling Method/Rig Type **8.25" Hollow Stem Auger/CME 75**
Drilling Contractor **PLI Systems, Inc.**
Total Depth of Borehole **12.7 ft**
Hole Diameter **8.25 in**
Hammer Weight/Drop (lb/in.)/Type **140 lb / 30 in / Automatic**
Ground Surface Elevation/Datum **520.8 ft**
Location **See Figure 2 Site Plan**
Coordinates **7617173.00 E, 275391.00 N**
Elevation Source **Site Survey**



ELEV. (FT)	DEPTH (FT)	RECOVERY (%)	SAMPLE #	BLOW COUNTS	USCS	MATERIAL DESCRIPTION	REMARKS AND TESTS
						Asphalt - 5" thick (Pavement)	
						Base Aggregate - 1" thick (Fill)	
					ML	Moist, light brown, SILT with gravel (ML); low plasticity, fine to coarse angular gravel. (Fill)	
516	5	33	SPT-1	0-0-1 (N=1)	ML	Very soft, moist to wet, Sandy SILT (ML); fine to medium sand, low plasticity fines. (Fill)	Rod chatter begins at 9 feet and increases significantly below 10 feet.
511	10	40	SPT-2	30-38-16 (N=54)		*Basalt inferred below 10 feet.*	
		147	SPT-3	50/2" (Refusal)		*Auger refusal at 12.67 feet on basalt bedrock.*	Borehole completed at 12.67ft. below ground surface (bgs).

McMILLEN JACOBS ASSOCIATES

Boring P-31

Sheet 1 of 1

Project: Sweet Home WWTP Final Design Review
Project Location:
Project Number: 6367.0

Log of Boring P-32

Date(s) Drilled	**06/20/2022 - 06/20/2022**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**A. Judy**	Checked By	**J. Quinn**
Drilling Method/ Rig Type	**8.25" Hollow Stem Auger/CME 75**	Drilling Contractor	**PLI Systems, Inc.**	Total Depth of Borehole	**10.2 ft**		
Hole Diameter	**8.25 in**	Hammer Weight/Drop (lb/in.)/Type	**140 lb / 30 in / Automatic**	Ground Surface Elevation/Datum	**530.4 ft**		
Location	**See Figure 2 Site Plan**	Coordinates	**7617027.00 E, 275515.00 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC ▏LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
										Asphalt - 6" thick (Pavement)		
										Base Aggregate - 2" thick (Fill)		
			✋	100	G-1				ML	Moist, dark brown, SILT with gravel (ML); low plasticity, fine to coarse gravel. (Fill)		
526												
		5		100	SPT-1	0-1-1 (N=2)	☐		ML	Soft, moist, gray, SILT (ML); low plasticity, trace fine sand. (Fill) *Becomes gray at 4.5 feet.*		
521	▼											Rod chatter below 9.5 feet bgs.
		10		47	SPT-2	50/2" (Refusal)				*Auger refusal at 10.17 feet on basalt bedrock.*		Borehole completed at 10.17ft. below ground surface (bgs).
516		15										
511		20										
506		25										
501		30										

McMILLEN JACOBS ASSOCIATES

Boring P-32

Sheet 1 of 1

Project: Sweet Home WWTP Final Design Review
Project Location:
Project Number: 6367.0

Log of Boring P-33

Date(s) Drilled	**06/20/2022 - 06/20/2022**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**A. Judy**	Checked By	**J. Quinn**
Drilling Method/ Rig Type	**8.25" Hollow Stem Auger/CME 75**	Drilling Contractor	**PLI Systems, Inc.**	Total Depth of Borehole	**3.7 ft**		
Hole Diameter	**8.25 in**	Hammer Weight/Drop (lb/in.)/Type	**140 lb / 30 in / Automatic**	Ground Surface Elevation/Datum	**529.6 ft**		
Location	**See Figure 2 Site Plan**	Coordinates	**7616945.00 E, 275701.00 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC | LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
									GM	Moist, brown, Silty GRAVEL (GM); fine to coarse gravel, non-plastic fines. (Fill)		Strong rod chatter from ground surface to 3.5 feet bgs.
				100	G-1							
				0	SPT-1	50/2" (Refusal)				*Basalt inferred below 3.5 feet.* *Auger refusal at 3.67 feet on basalt bedrock.*		Auger bit grinding at 3.5 feet.
525		5										Borehole completed at 3.67ft. below ground surface (bgs).
520		10										
515		15										
510		20										
505		25										
500		30										

McMILLEN JACOBS ASSOCIATES

Project: Sweet Home WWTP Final Design Review
Project Location:
Project Number: 6367.0

Log of Boring P-34

Date(s) Drilled	**06/20/2022 - 06/20/2022**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**A. Judy**	Checked By	**J. Quinn**
Drilling Method/ Rig Type	**8.25" Hollow Stem Auger/CME 75**	Drilling Contractor	**PLI Systems, Inc.**	Total Depth of Borehole	**15.0 ft**		
Hole Diameter	**8.25 in**	Hammer Weight/Drop (lb/in.)/Type	**140 lb / 30 in / Automatic**	Ground Surface Elevation/Datum	**516.9 ft**		
Location	**See Figure 2 Site Plan**	Coordinates	**7617301.00 E, 275494.00 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
										Asphalt - 5" thick (Pavement)		
										Base Aggregate - 2" thick (Fill)		
									GM	Moist, brown, Silty GRAVEL (GM); fine to coarse gravel, low plasticity fines. (Fill)		
									ML	Soft to very soft, moist, brown, SILT (ML); low plasticity, trace fine sand. (Fill)		
				100	G-1							
512		5		40	SPT-1	1-1-3 (N=4)	☐					
507		10		33	SPT-2	1-0-1 (N=1)	☐			*Becomes very soft, grades to Silt with sand at 10 feet.*		
502		15		100	SPT-3	50/2" (Refusal)				*Auger refusal at 15 feet on basalt bedrock.*		Borehole completed at 15ft. below ground surface (bgs).
497		20										
492		25										
487		30										

McMILLEN JACOBS ASSOCIATES

Project: Sweet Home WWTP Final Design Review
Project Location:
Project Number: 6367.0

Log of Boring P-35

Date(s) Drilled	**06/20/2022 - 06/20/2022**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**A. Judy**	Checked By	**J. Quinn**
Drilling Method/ Rig Type	**8.25" Hollow Stem Auger/CME 75**	Drilling Contractor	**PLI Systems, Inc.**	Total Depth of Borehole	**7.1 ft**		
Hole Diameter	**8.25 in**	Hammer Weight/Drop (lb/in.)/Type	**140 lb / 30 in / Automatic**	Ground Surface Elevation/Datum	**517.5 ft**		
Location	**See Figure 2 Site Plan**	Coordinates	**7617255.00 E, 275628.00 N**	Elevation Source	**Site Survey**		

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
									GM	Moist, dark gray and brown, Silty GRAVEL (GM); fine to coarse gravel. (Fill)		Rod chatter from ground surface to 5 feet bgs.
									ML	Soft, moist, brown, SILT (ML); low plasticity, trace fine sand. (Fill)		
513		5										
				60	SPT-1	0-1-2 (N=3)	☐					Rod chatter and difficulty anvancing auger below 6 feet.
										Basalt inferred below 6 feet.		
				0	SPT-2	50/1" (Refusal)				*Auger refusal at 7.08 feet on basalt bedrock.*		Borehole completed at 7.08ft. below ground surface (bgs).
508		10										
503		15										
498		20										
493		25										
488		30										

Boring P-35

Sheet 1 of 1

Project: Sweet Home WWTP Final Design Review
Project Location:
Project Number: 6367.0

Log of Boring P-36

Date(s) Drilled	**11/22/2022**	Geotechnical Consultant	**McMillen Jacobs Associates**	Logged By	**J. Quinn**
Checked By	**J. Quinn**	Drilling Method/ Rig Type	**8.25" Hollow Stem Auger/CME 75**	Drilling Contractor	**Western States Soil Conservation, Inc.**
Total Depth of Borehole	**11.6 ft**	Hole Diameter	**8.00 in**	Hammer Weight/Drop (lb/in.)/Type	**140 lb / 30 in / Automatic**
Ground Surface Elevation/Datum	**516.77 ft**	Location	**SE Corner of WWTP Site**	Coordinates	**7617443.00 E, 275286.00 N**
Elevation Source	**Site Survey**				

ELEV. (FT)	WATER LEVEL	DEPTH (FT)	SAMPLE TYPE	RECOVERY (%)	SAMPLE #	BLOW COUNTS	PENETRATION RESISTANCE BLOWS/FT ☐ BLOWS/FT 20 40 60 80 ○ MC LL/PL	GRAPHIC LOG	USCS	MATERIAL DESCRIPTION	BACKFILL INFORMATION	REMARKS AND TESTS
								▒		Concrete - 6" thick (Pavement)		
								●		Base Aggregate - 6" thick (Fill)		
								▨	CL	Stiff, moist, brown with orange mottling, LEAN CLAY (CL); low to medium plasticity, trace coarse rounded gravel, trace fine sand. (Fill)		
			⧗	55	SPT-1	2-8-7 (N=15)	☐	▨				
-5		5						▨		*Becomes medium stiff at 5 feet bgs.*		
			⧗	50	SPT-2	2-3-4 (N=7)	☐	▨				
			⧗	60	SPT-3	50/5" (Refusal)		▨		*Boulders/cobbles likely from 7.5 to 9.0 feet bgs.*		Slow, difficult drilling from 7.5 to 9 feet bgs.
								▨		*Becomes stiff at 9.0 feet bgs.*		Drillers cracked auger transfer rod at approximately 8.5 feet bgs. Abandoned original boring at 8.5 feet bgs due to being off vertical alignment and moved about 4 feet west to re-drill boring.
			⧗	100	SPT-4	3-3-9 (N=12)	☐	▨				
-10		10						▨		*Becomes gray with rootlets at 10 feet bgs.*		
								▥		*Basalt inferred below 10.75 feet bgs.*		Difficult, slow drilling below 10.75 feet bgs. 30 minutes to advance from 10.75 to 11.5 feet bgs.
			—	800	SPT-5	50/0" (Refusal)		▥				
												Borehole completed at 11.6ft. below ground surface (bgs).

McMILLEN JACOBS ASSOCIATES

Boring P-36

Sheet 1 of 1

Appendix B

Laboratory Test Results

Northwest Testing, Inc.
A Division of Northwest Geotech, Inc.
9120 SW Pioneer Court, Suite B, Wilsonville, Oregon 97070 | ph: 503.682.1880 fax: 503.682.2753 | www.nwgeotech.com

TECHNICAL REPORT

Report To:	Mr. Farid Sariosseiri McMillen Jacobs Associates 1500 SW First Avenue, Suite 750 Portland, Oregon 97201	**Date:** **Lab No:**	5/14/18 18-108
Project:	Laboratory Testing – Sweet Home WWTP 5834.0	**Project No.:**	2286.1.1

Report of: Atterberg limits, moisture content, and compressive strength of rock

Sample Identification

NTI completed Atterberg limits, moisture content, and compressive strength of rock testing on samples delivered to our laboratory on May 9, 2018 by a McMillen Jacobs Associates representative. Testing was performed in accordance with the standards indicated. Our laboratory test results are summarized on the following tables and attached pages.

Laboratory Test Results

Atterberg Limits (ASTM D 4318)

Sample ID	Liquid Limit	Plastic Limit	Plasticity Index
B-3 S-2 @ 5 – 6.5 ft.	51	28	23
B-5 S-1 @ 2.5 – 4 ft.	44	28	16

Moisture Content of Soil (ASTM D 2216)

Sample ID	Moisture Content (Percent)
B-3 S-2 @ 5 – 6.5 ft.	44.8
B-5 S-1 @ 2.5 – 4 ft.	26.3

Copies: Addressee

TECHNICAL REPORT

Report To: Mr. Farid Sariosseiri
McMillen Jacobs Associates
1500 SW First Avenue, Suite 750
Portland, Oregon 97201

Date: 5/14/18

Lab No: 18-108

Project: Laboratory Testing – Sweet Home WWTP 5834.0

Project No.: 2286.1.1

Laboratory Testing

Compressive Strength of Intact Rock Core Specimens (ASTM D 7012 Method C)

Sample ID	Diameter (inches)	Height (inches)	Rate of Loading (lbs/s)	Uniaxial Compressive Strength (psi)
B-1 R-1 @ 5.2 – 6.3 ft.	2.41	4.88	100	25,302

Photo1: As received sample

Photo 2: Test sample before testing

Photo 3: Test sample after testing

TECHNICAL REPORT

Report To: Mr. Farid Sariosseiri
McMillen Jacobs Associates
1500 SW First Avenue, Suite 750
Portland, Oregon 97201

Date: 5/14/18

Lab No: 18-108

Project: Laboratory Testing – Sweet Home WWTP 5834.0

Project No.: 2286.1.1

Laboratory Testing

Compressive Strength of Intact Rock Core Specimens
(ASTM D 7012 Method C)

Sample ID	Diameter (inches)	Height (inches)	Rate of Loading (lbs/s)	Uniaxial Compressive Strength (psi)
B-5 R-1 @ 11.7 – 12.4 ft.	2.41	4.85	100	25,919

Photo1: As received sample

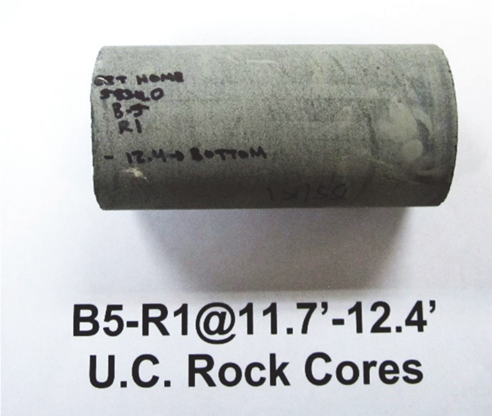


Photo 2: Test sample before testing

Photo 3: Test sample after testing

Laboratory Testing

Northwest Testing, Inc.
A Division of Northwest Geotech, Inc.
9120 SW Pioneer Court, Suite B, Wilsonville, Oregon 97070 | ph: 503.682.1880 fax: 503.682.2753 | www.nwgeotech.com

TECHNICAL REPORT

Report To: Mr. Farid Sariosseiri
McMillen Jacobs Associates
1500 SW First Avenue, Suite 750
Portland, Oregon 97201

Date: 5/14/18

Lab No: 18-108

Project: Laboratory Testing – Sweet Home WWTP 5834.0

Project No.: 2286.1.1

Compressive Strength of Intact Rock Core Specimens
(ASTM D 7012 Method C)

Sample ID	Diameter (inches)	Height (inches)	Rate of Loading (lbs/s)	Uniaxial Compressive Strength (psi)
B-5 R-2 @ 18 – 19 ft.	2.41	4.86	100	6932

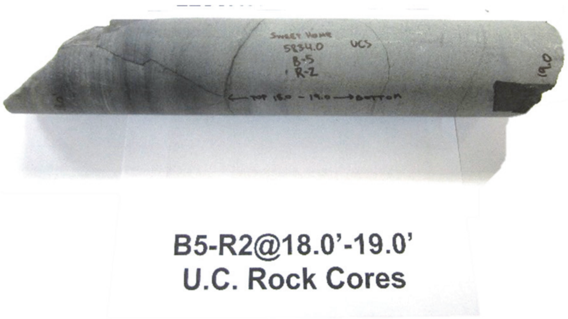
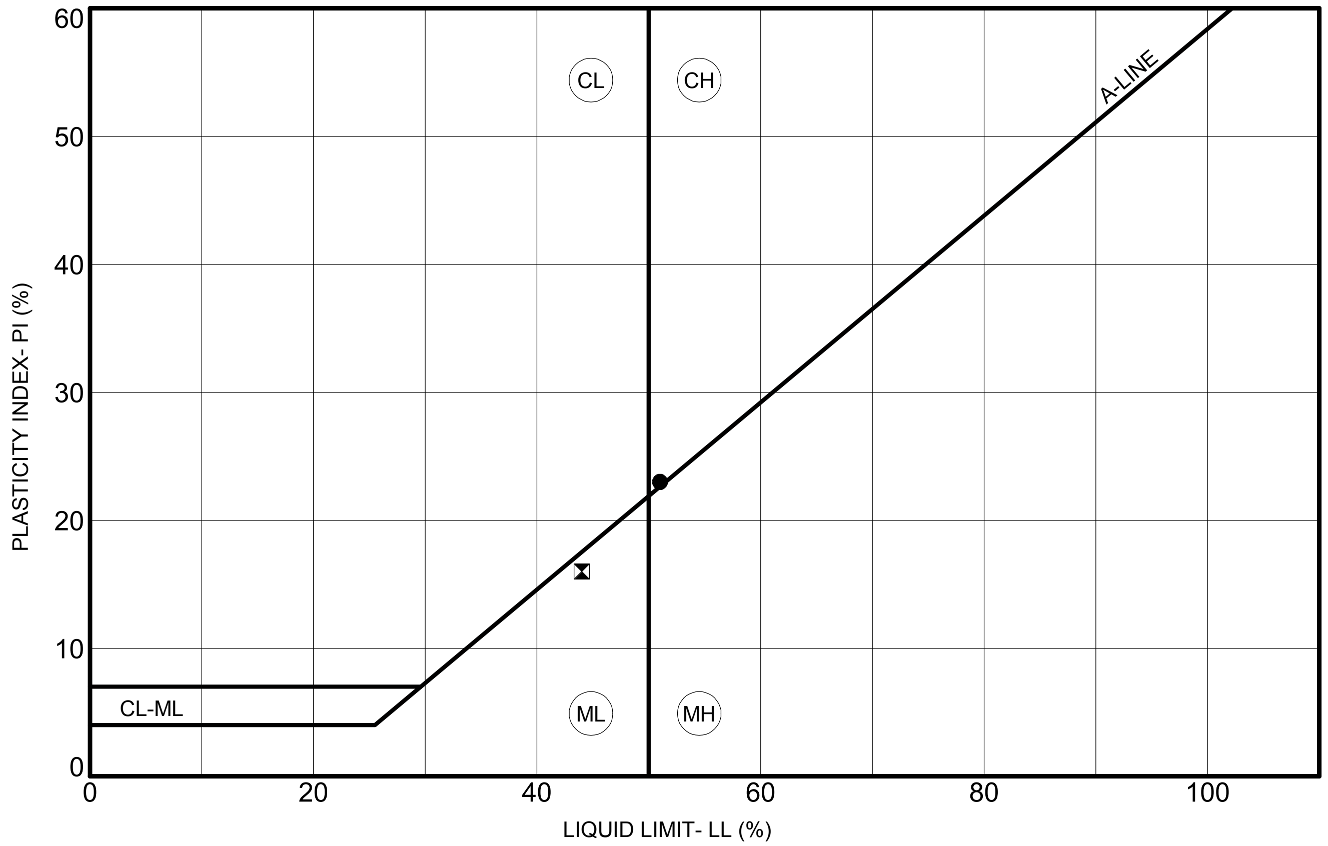


Photo1: As received sample

Photo 2: Test sample before testing

Photo 3: Test sample after testing

REVIEWED BY: Bridgett Adame



Sample ID		Depth (ft)	Moisture Content %	LL	PL	PI	% Pass #200	Classification
●	**B-03**	**5.0**	**(44.8)**	**51**	**28**	**23**		**CH**
⧗	**B-05**	**2.5**	**(26.3)**	**44**	**28**	**16**		**ML**

McMILLEN
JACOBS
ASSOCIATES

1500 SW 1ST AVE STE 750
PORTLAND, OR 97201
TELEPHONE: 503.384.2906

ATTERBERG LIMITS

Project: Waste Water Treatment Plant - Schematic Design
Number: 5834.0
Sample Location: Sweet Home
Testing Agency: Northwest Testing, Inc.

Point Load Strength Index Test Results ASTM D-5731

PROJECT:	Sweet Home WWTP	**LAB SAMPLE NO.:**	
PROJECT NO.:	5834.0	**SAMPLE NO.:**	5834.0 - B-5
PROJECT LOCATION:	Sweet Home, OR	**SAMPLE DESCRIP:**	Basalt
SAMPLED BY:	Julia Irizarry	**DATE REPORTED:**	5/11/2018
DATE SAMPLED:	5/2/2018	**REPORTED BY:**	Devin Roth

Sample No.	**Test Number**	**Test Type***	**Rock Type**	**Width, W**	**Depth or Diameter, D**	**Failure Load, P**	**De^2**	**Point Load Strength Index, $I_{s(50)}$**	**Uniaxial Compressive Strength, UCS**
				(in)	(in)	(lbs)	(in^2)	(psi)	(psi)
1	1	d	Basalt	5.31	2.36	5959	10313	513	12563
2	2	d	Basalt	5.91	2.36	3828	11459	304	7437
2B	3	d	Basalt	3.23	2.36	5158	6264	653	13717
3	4	d	Basalt	10.04	2.36	5104	19481	268	5098
3B	5	d	Basalt	5.59	2.36	6882	10848	569	13951
5	6	d	Basalt	6.69	2.36	8044	12987	579	13315
6	7	d	Basalt	5.12	2.36	4598	9931	407	9778
7	8	d	Basalt	4.13	2.36	6830	8021	714	17138
8	9	d	Basalt	11.42	2.36	8044	22154	383	9185
9	10	d	Basalt	5.20	2.36	7882	10084	690	14493
							Min	**268**	**5098**
							Max	**714**	**17138**
							Avg	**508**	**11667**

Size Corrected Point Load Index, Is($_{50}$)

$I_{s(50)}$ = **508** **psi** or **73,159** **psf** or **3.5** **MPa**

Mean Uniaxial Compressive Strength, σ_c

σ_c = **11,667** **psi** or **1,680,111** **psf** or **80** **MPa**

*Test Type

d = diametral
a = axial
b = block
l= lump

Appendix C

Rock Core Photos

BOREHOLE B-01, 3.5 TO 13.5 FEET

BOREHOLE B-05, 9.0 TO 16.3 FEET

McMILLEN
JACOBS
ASSOCIATES

SWEET HOME WWTP SCHEMATIC DESIGN
GEOTECHNICAL DATA REPORT

JULY 2022

CORE PHOTOGRAPHS

FIGURE
C - 1

BOREHOLE B-05, 16.3 TO 23 FEET

McMILLEN JACOBS ASSOCIATES

SWEET HOME WWTP SCHEMATIC DESIGN
GEOTECHNICAL DATA REPORT

JULY 2022

CORE PHOTOGRAPHS

FIGURE
C - 2

Appendix D

RMR Calculation

The Rock Mass Rating System

Geomechanics Classification of Rock Masses

After Z.T. Bieniawski, 1989

McMILLEN JACOBS ASSOCIATES

1500 SW First Avenue, Suite 750, Portland, OR

Project: **Sweet Home WWTP**
Location:
Rock Type: **Bedded Volcaniclastics**
Date: **5/16/2018**
Boring: **B-1 &B-5**
Elevation, ft:
Geologist/Engineer: **Farid Sariosseiri**

Rock Mass Property Input

Strength of Intact Rock, Mpa	135
Point Load ?	N
Uniaxial Compressive ?	Y
Bieniawski Rating	12
RQD, %	67
Bieniawski Rating	13
Discontinuity Spacing, mm	150
Bieniawski Rating	7

Conditions of Discontinuitites	**Rating**
1. Very rough surfaces, not continuous, no separation, and unweathered rock walls.	**30**
2. Slightly rough surfaces, separation < 1 mm, and slightly weathered walls.	**25**
3. Slightly rough surface, separation < 1 mm, and highly weathered walls.	**20**
4. Slickenslided surfaces -or- gouge (infilling), 1-5 mm thick -or- separation 1-5 mm and continuous.	**10**
5. Soft gouge > 5 mm -or- separation > 5 mm and continuous	**0**
Bieniawski Rating?	25

Groundwater Conditions	**Rating**
Conditions include:	
A. Inflow per 10 m of tunnel length (L/m),	
B. Ratio of joint water pressure to σ_1,	
C. General conditions.	
1. No inflow -or- 0 ratio -or- completely dry.	**15**
2. < 10 L/min -or- < 10 ratio -or- damp.	**10**
3. 10-25 L/min inflow -or- 0.1-0.2 ratio -or- wet.	**7**
4. 22-125 L/min inflow -or- 0.2-0.5 ratio -or- dripping.	**4**
5. > 125 L/min inflow -or- > 0.5 ratio -or- flowing.	**0**
Bieniawski Rating?	15

Orientation of Discontinuities	**Rating** Tunnels	 Foundations	 Slopes
Very Favorable	**0**	**0**	**0**
Favorable	**-2**	**-2**	**-5**
Fair	**-5**	**-7**	**-25**
Unfavorable	**-10**	**-15**	**-50**
Very Unfavorable	**-12**	**-25**	**-60**
Bieniawski Rating?	-5		

Overall RMR	67	
Class	II	**Good Rock**

GSI 62