PRELIMINARY DRAINAGE REPORT

FOR

SAIA Motor Freight Terminal

Marysville, WA 98271

June 23, 2022

Parcel Nos.: APN 30050400300200

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PREPARED FOR:

CITY OF MARYSVILLE
COMMUNITY DEVELOPMENT DEPARTMENT
80 COLUMBIA AVENUE
MARYSVILLE, WA 98270

PREPARED BY:

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ZACHARY KANNAN, PE (WA)

Project Engineer's Certification

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

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Disclosure Statement:

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Table of Contents

1.0 PROJECT OVERVIEW

1.1 SITE LOCATION AND DESCRIPTION

The SAIA Freight Terminal project proposes to develop the existing 11.01-acre, light industrial (LI) zoned property into a distribution/warehouse facility with associated office space. The project site is in Marysville, Washington on the northeast corner of State Avenue and 128th Street NE within Snohomish County, see the Vicinity Map in Appendix A. The proposed site will be served by a detention pond for flow control and a proprietary water quality device for runoff treatment. The entire site is intended to be disturbed as there are no critical areas or respective buffer areas that need to remain undisturbed.

1.2 EXISTING SITE CONDITIONS

The existing site is undeveloped and is covered with grass meadows and sparse forested land. The site is flat and experiences shallow ponding. Runoff ultimately exits the site as sheet flow into an offsite vegetated ditch along the southern property limits. The ditch discharges into a culvert which runs south under 128th Street NE and then west under State Avenue. A regional detention facility is located east of the site which the proposed work will not disturb. The site has a notably high ground water table that prevents any practical development to occur at existing grade.

The surrounding area has commercial land use and medium-density single family residential land use. Most of the soils are classified as Custer, fine sandy loam. See the NRCS Soil Survey in Appendix 1, Attachment 6. The site does not contribute to and is not within immediate vicinity of any surface water tributaries.

The project site is not located within a FEMA Special Flood Hazard Area (SFHA) and is mapped on FEMA Flood Insurance Rate Map (FIRM) Panel 53061C0710F, effective date 6/19/2020. The site lies within an unshaded FEMA Zone X. The nearest flood zone is the Zone A floodplain for the Quilceda Creek about 0.25 miles away. See FIRM Panel in Appendix A, Attachment 5.

1.3 PROPOSED SITE DESIGN

The proposed site land coverage can be seen below in Table 1.

Table 1. Summary of Proposed Land Coverage Area

Land Use Type	Square feet (sf)	Area (ac)
Asphalt	125,356	2.88
Concrete	178,592	4.10
Building/Roof	25,200	0.58
Landscaped/Open Space	122,461	3.45
Total Impervious	329,328	7.56
Total Pervious	150,267	3.45
Total Site	479,595	11.01

Stormwater runoff from most of the site will route into a detention pond through a system of catch basins and underground pipes. The facility is sized to release water at a rate which passes Washington's Department of Ecology's stream protection flow duration requirement. An outlet structure will be designed to match this flowrate for pond. Flow will then be treated for runoff treatment downstream of the detention pond. Treated runoff will then outfall into an existing manhole along State Avenue. A small bypass area (primarily grassed area) will not be captured by the proposed facilities due to depth constraints.

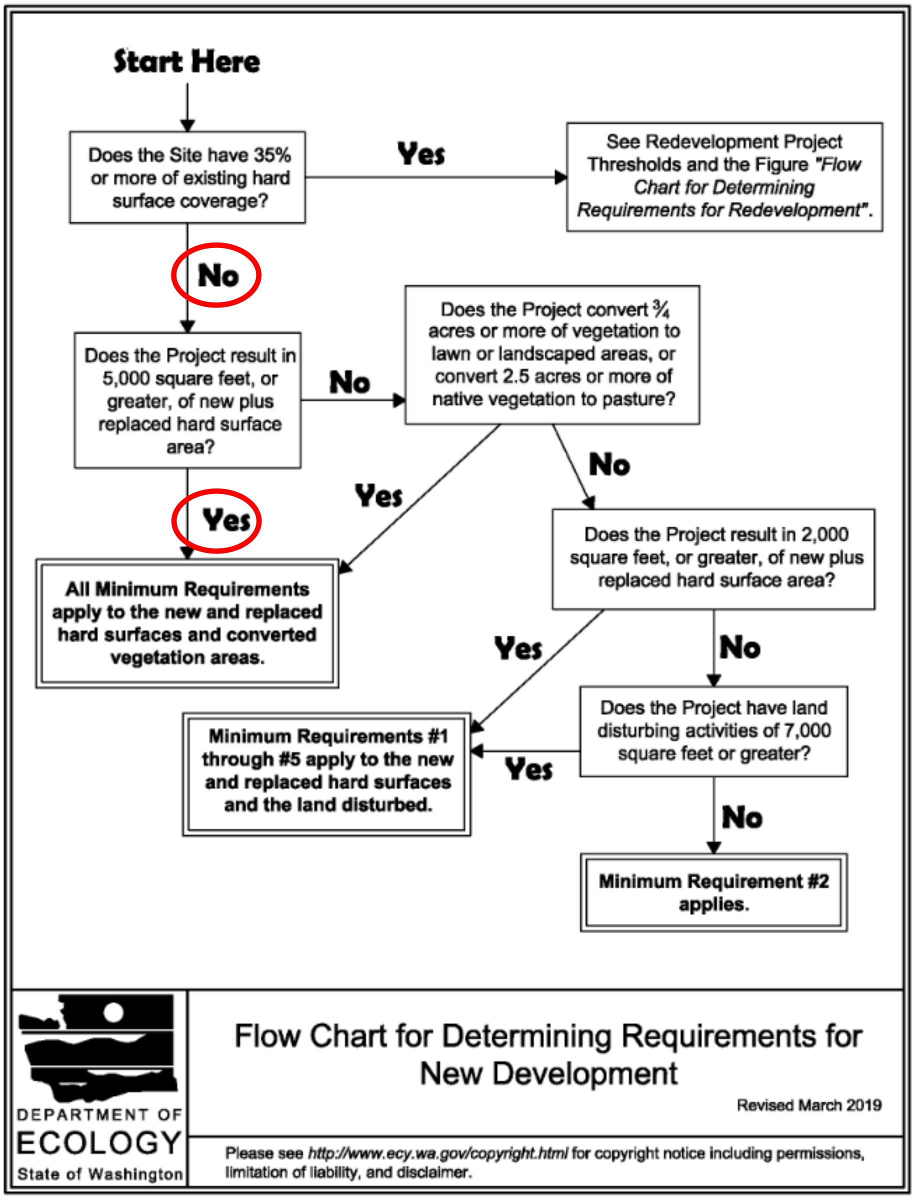
1.4 ENVIRONMENTAL CONSIDERATIONS

No wetlands, natural streams, or fish and wildlife habitat conversation areas were identified within the site's vicinity.

1.5 NEW DEVELOPMENT FLOW CHART

Figure I-3.1 of the SWMMWW below details the project requirements for new development. The site does not have greater than 35% of existing hard surface coverage and the project exceeds 5,000 square feet in new hard surface area, therefore all Minimum Requirements apply.

Figure I-3.1: Flow Chart for Determining Requirements for New Development



2.0 MINIMUM REQUIREMENT COMPLIANCE

The Minimum Requirements for new development sites are set forth in I-3.4 of the Washington State Department of Ecology 2019 Stormwater Management Manual for Western Washington (SWMMWW). The project's intended methods of Minimum Requirement compliance are listed below:

MR1: Stormwater Site Plan Preparation

The project will comply with MR1 by submitting this report. The contents of this Stormwater Site Plan contain all the technical information and analyses required by Ecology for new development stormwater compliance.

MR2: Construction Stormwater Pollution Prevention Plan (SWPPP)

The project will comply with MR2 by preparing a Construction SWPPP. The document will explain and justify the pollution prevention decisions made for the project. Erosion will be controlled, and sediment and other pollutants will be prevented from leaving the site during the construction phase of the project. Fully functional stormwater BMPs will be developed upon completion of construction. Further details can be found within the SWPPP. The full SWPPP will be provided with Final Drainage Report.

MR3: Source Control of Pollution

The project will comply with MR 3 by applying applicable source control BMPs to the site. There are no identified illicit discharges on site beyond those required to treat stormwater runoff as required my MR6. Qualified personnel will conduct routine inspections and assess onsite BMPs.

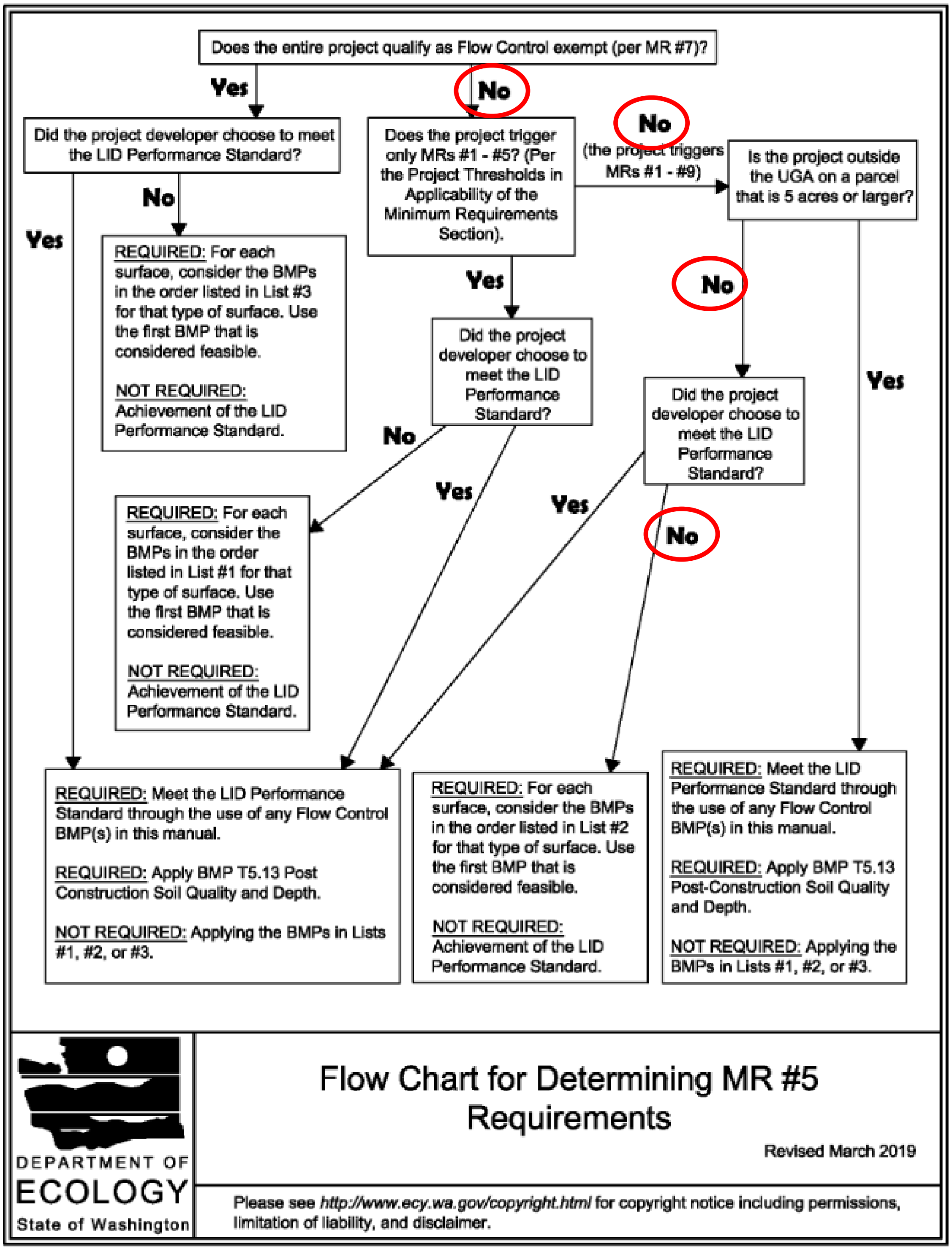
MR4: Preservation of Natural Drainage Systems and Outfalls

TDA 1 will maintain existing drainage patterns on site. Runoff will naturally flow south across the site. The outfall for TDA 1 will discharge to pipe within State Avenue, 300-feet upstream of natural outfall structure. Western bypass flows will route into the existing vegetated ditch along the western property front, which will discharge into the existing culvert along the southwestern property corner.

MR5: On-site Stormwater Management (OSM)

Figure I-3.3 of the SWMMWW below details the compliance requirements for MR5. The project is within the urban growth area (UGA) and chooses not to meet the LID performance standard. The project will implement on-site stormwater management list #2 to the extent feasible. Due to the high water table, bioretention, permeable pavements, and downspout full infiltration are infeasible. The remaining dispersion BMPs are also infeasible because the site will not be able to provide the 2-ft wide transition zones and 10-ft wide vegetated buffers required for dispersion BMPs. Post-Construction Soil Quality and Depth (BMP T5.13) will be provided to lawn and landscaped areas.

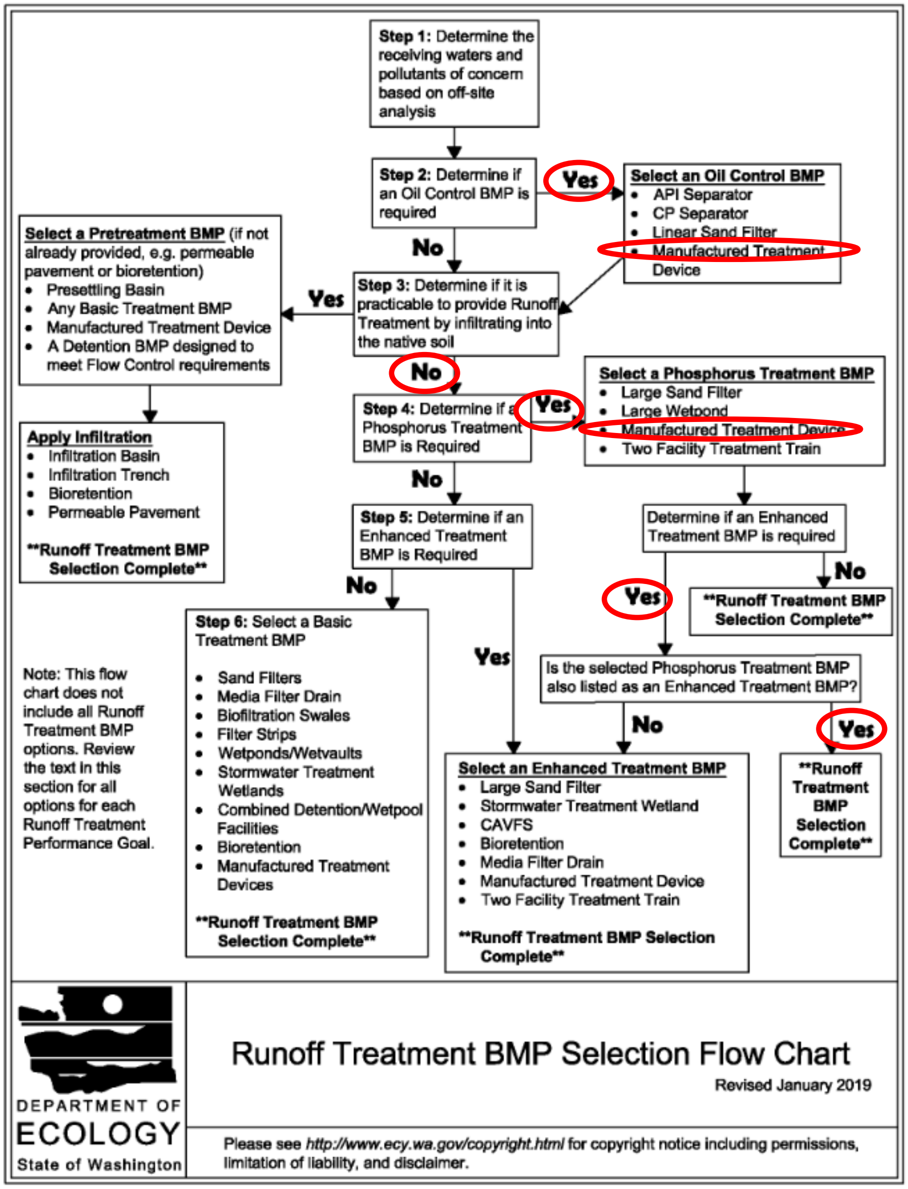
Figure I-3.3: Flow Chart for Determining MR #5 Requirements



MR6: Runoff Treatment

Figure III-1.1 of the SWMMWW below details the runoff treatment requirements (MR6) for TDA 1. Oldcastle BioPod BioFilters will be used as a manufactured treatment devices downstream of detention.

Figure III-1.1: Runoff Treatment BMP Selection Flow Chart



MR7: Flow Control

The project will comply with MR7 by matching developed discharge rates and durations to pre-existing rates and durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow (Flow Control Performance Standard). The Flow Control for the entire site is achieved through the detention pond and flow control structure. See Section 4 for more details.

MR8: Wetlands Protection

No wetlands exist onsite. MR8 does not apply.

MR9: Operation and Maintenance (O&M)

An operation and maintenance manual for the proposed Runoff Treatment and Flow Control BMPs will be provided with the Final Drainage Report in order to ensure that Stormwater Management BMPs are properly maintained and operated. For all Flow Control and Runoff Treatment BMPs in which the applicant identifies operation and maintenance to be the responsibility of a private party, a declaration of covenant and grant of easement will be provided.

3.0 OFF-SITE ANALYSIS

The initial qualitative off-site analysis was conducted in order to assess the potential off-site water quality, erosion, slope stability, and drainage impacts associated with the project. The analysis extends from the site's immediate vicinity to one-quarter mile downstream of the site's existing outfall. See Appendix A, Attachment 4 for the Off-Site Analysis Map which includes the downstream flow path, tributary drainage areas, and site photos.

The west and south side of the site are bound by vegetated roadside ditches, both with approximate top widths of 3 feet (Figures 1 & 2). The site is extremely flat but ultimately will sheet flow into the southern ditch. The southern ditch also conveys outflow from the offsite regional detention facility east of the project site (Figure 3). The regional detention facility collects water from a neighboring commercial facility and residential properties. The two ditches converge and enter a 12" PVC culvert at the corner of the 128th Street NE and State Avenue, and cross 128th Street NE to the south (Figure 4). On the southern side of 128th Avenue NE, a similar roadway ditch routes residential runoff west. The 12" PVC crossing and the southern ditch tie into a 24" PVC culvert that crosses west across State Avenue. The pipe outfalls into a vegetative roadside ditch along the western shoulder of State Avenue (Figures 6 & 7). The ditch drains to Quilceda Creek, which discharges to Ebey Slough and then to Possession Sound.

No runoff from adjacent properties enter the project site. Discharge from the regional facility does not enter the site. Regional outflow flows along the southern ditch across the property line, and there are no signs of overcapacity or overtopping onto the project site. There were no signs of sedimentation and erosion along the roadside ditches.

Flooding has been a historic issue in the Quilceda watershed. Flooding occurs as a result of the high regional water table in the Marysville Trough. During the fall and winter, the water table is at or near the surface in hydric and Custer soils. If roadside ditches are in conditions that cannot properly drain, there is risk for flooding and roadway overtopping downstream. Continued maintenance of downstream roadway ditches within public right-of-way will help mitigate the risk of flooding.

4.0 PERMANENT STORMWATER CONTROL

4.1 SUMMARY SECTION

Totals for each TDA used in the permanent stormwater design are provided below:

Area to Detention	
Surface Type	**Area (ac)**
Converted Vegetation	3.45
Non-Pollution-Generating Hard Surfaces (NPGHS)	0.58
Pollution-Generating Hard Surfaces (PGIS)	6.98
Total	**11.01**

Bypass Area	
Surface Type	**Area (ac)**
Converted Vegetation	TBD
Non-Pollution-Generating Hard Surfaces (NPGHS)	TBD
Pollution-Generating Hard Surfaces (PGIS)	TBD
Total	**TBD**

4.2 PERFORMANCE STANDARDS AND GOALS

The performance goals used to design the Runoff Treatment BMPs are provided below:

Step 1: Receiving Waters and Pollutants of Concern Based on Off-Site Analysis
The site lies in the Quilceda Watershed which drains to the Ebey Slough. Quilceda Creek was listed as impaired on the State of Washington 1998 303d list for pH, dissolved oxygen, and fecal coliform. The dissolved oxygen levels are attributed to elevated nitrate, nitrite, and phosphorus nutrients.

Step 2: Oil Control Treatment BMP
Oil control is required for the proposed land use of the project. The Proposed land use of the project intends to provide an area for commercial or industrial parking, storage, or maintenance of 25 or more vehicles that are over 10 tons gross weight. Treatment will be provided upstream of the detention facility. Further details regarding oil control will be provided in the Final Drainage report.

Step 3: Infiltrating into the Native Soil
Runoff treatment is not practicable through infiltration of native soils. The site has a high ground water table that prevents efficient infiltration. See Appendix C, Attachment 1 for the full geotechnical report.

Step 4: Phosphorus Treatment BMP
Phosphorus Treatment BMP is required for the site. Treatment will be provided through OldCastle BioPod Biofilters (manufactured treatment device). Ecology's TAPE lists these devices with a General Use Level Designation (GULD) for phosphorus treatment. See Appendix C, Attachment 3 for the full Ecology GULD.

Step 5: Enhanced Treatment BMP
Enhanced Treatment BMP is required for the site. Treatment will be provided through OldCastle BioPod Biofilters (manufactured treatment device). Ecology's TAPE lists these devices with a General Use Level Designation (GULD) for enhanced treatment. See Appendix C, Attachment 3 for the full Ecology GULD.

4.3 LOW IMPACT DEVELOPMENT FEATURES

The project is within the urban growth area (UGA) and chooses not to meet the LID performance standard. The project will implement on-site stormwater management list #2 to the extent feasible. All lawn and landscaped areas will be amended with imported soils in order to meet the requirements of BMP T5.13. These soils will regain stormwater functions in the post development landscape. The organic matter composition will reduce pollution through prevention. The project is within the urban growth area (UGA) and chooses not to meet the LID performance standard for roofs and other hard surfaces. Due to the high groundwater table, bioretention, permeable pavements, and downspout full infiltration are infeasible. The remaining dispersion BMPs are also infeasible because the site will not be able to provide the 2-ft wide transition zones and 10-ft wide vegetated buffers required for dispersion BMPs.

4.4 FLOW CONTROL SYSTEM

The flow control system is a detention pond that spans the entire south side of the site. The pond was designed in two components due to the irregular shape of the available space. The western portion of the pond is 137' x 143' x 6' and the eastern portion of the pond is 612' x 51' x 6'. A full detail of the system will be provided with the Final Drainage Report. A 4' riser with an 18" outfall pipe will release flow at a controlled rate to a flow restrictor. The structure will restrict flows to the Runoff Treatment BMP and bypass the remaining high flows.

4.5 RUNOFF TREATMENT SYSTEM

The Runoff Treatment BMP will be an Oldcastle BioPod Biofilter system. A full detail of the system will be provided with the Final Drainage Report. The structure will receive online post detention flows. The BioPod will be sized to treat the entire 2-year flow rate leaving the detention pond and to bypass up to the 100-year flow rate. Full design details regarding the proposed runoff treatment will be provided in the Final Drainage report.

4.6 SOURCE CONTROL

There are no activities planned on site which require source control; therefore, this requirement is not applicable to the project.

4.7 CONVEYANCE SYSTEM ANALYSIS AND DESIGN

Onsite runoff will be routed through a series of catch basins and underground pipes. Pipes will be designed with adequate cover and capacity that provides sufficient flows and velocities are met. Specific conveyance design calculations will be provided in the Final Drainage report.

ATTACHMENTS AND APPENDICES

APPENDIX A: MAPS

ATTACHMENT NO. 1 – VICINITY MAP

ATTACHMENT NO. 2 – PRE-DEVELOPMENT DRAINAGE AREA MAP

ATTACHMENT NO. 3 – POST-DEVELOPMENT DRAINAGE AREA MAP

ATTACHMENT NO. 4 – OFF-SITE ANALYSIS MAP

ATTACHMENT NO. 5 – FEMA FLOOD INSURANCE RATE MAP (FIRM)

ATTACHMENT NO. 6 – SOILS MAP

APPENDIX B: CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN (SWPPP)

APPENDIX C: SPECIAL REPORTS & STUDIES

ATTACHMENT NO. 1 – GEOTECHNICAL REPORT (BY OTHERS)

ATTACHMENT NO. 2 – ECOLOGY GULD – OLDCASTLE BIOPOD BIOFILTER

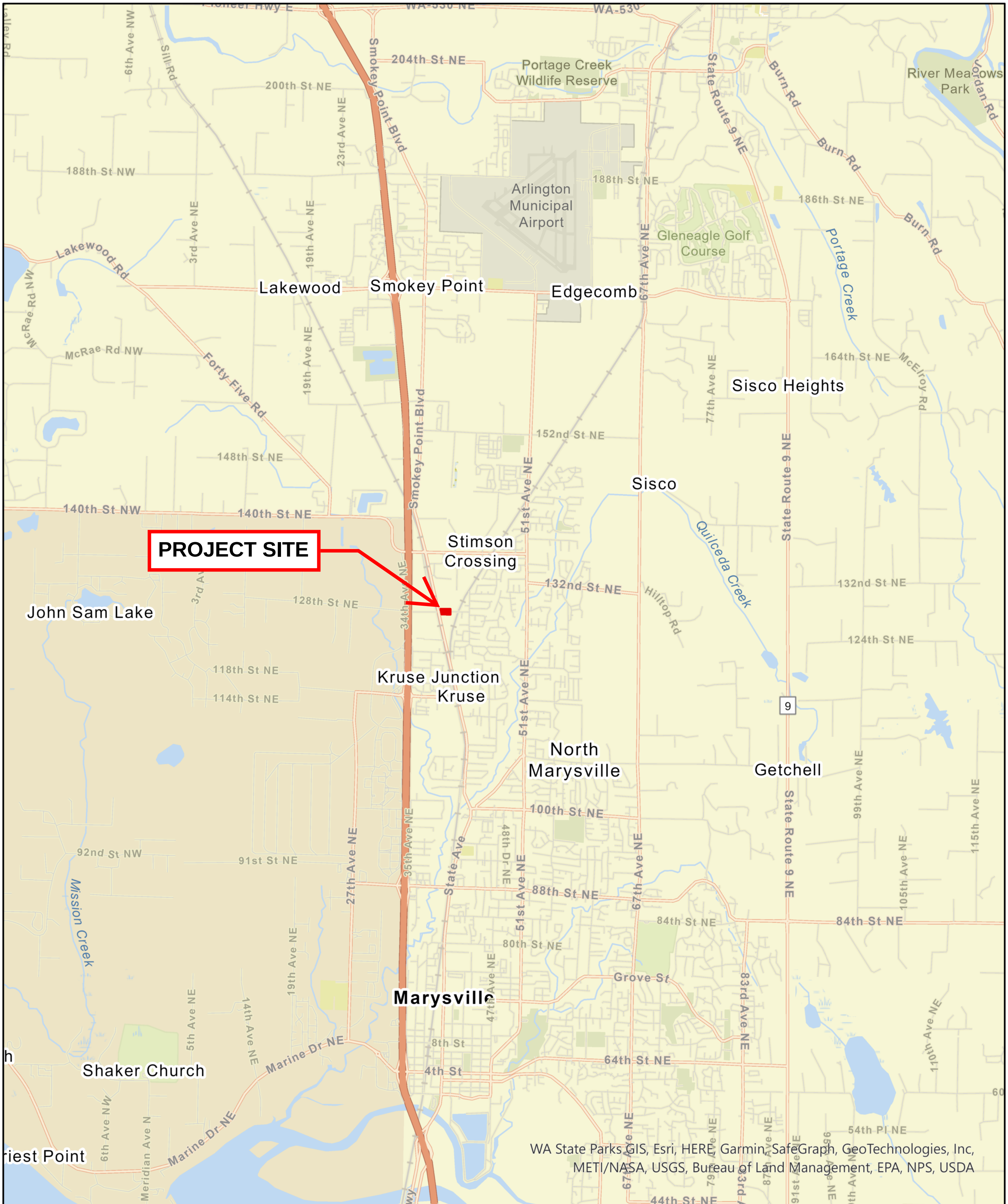
APPENDIX D: OPERATIONS & MAINTENANCE

ATTACHMENT NO. 1 – OPERATIONS & MAINTENANCE MANUAL

ATTACHMENT NO. 2 – MAINTENANCE COVENANT FORM

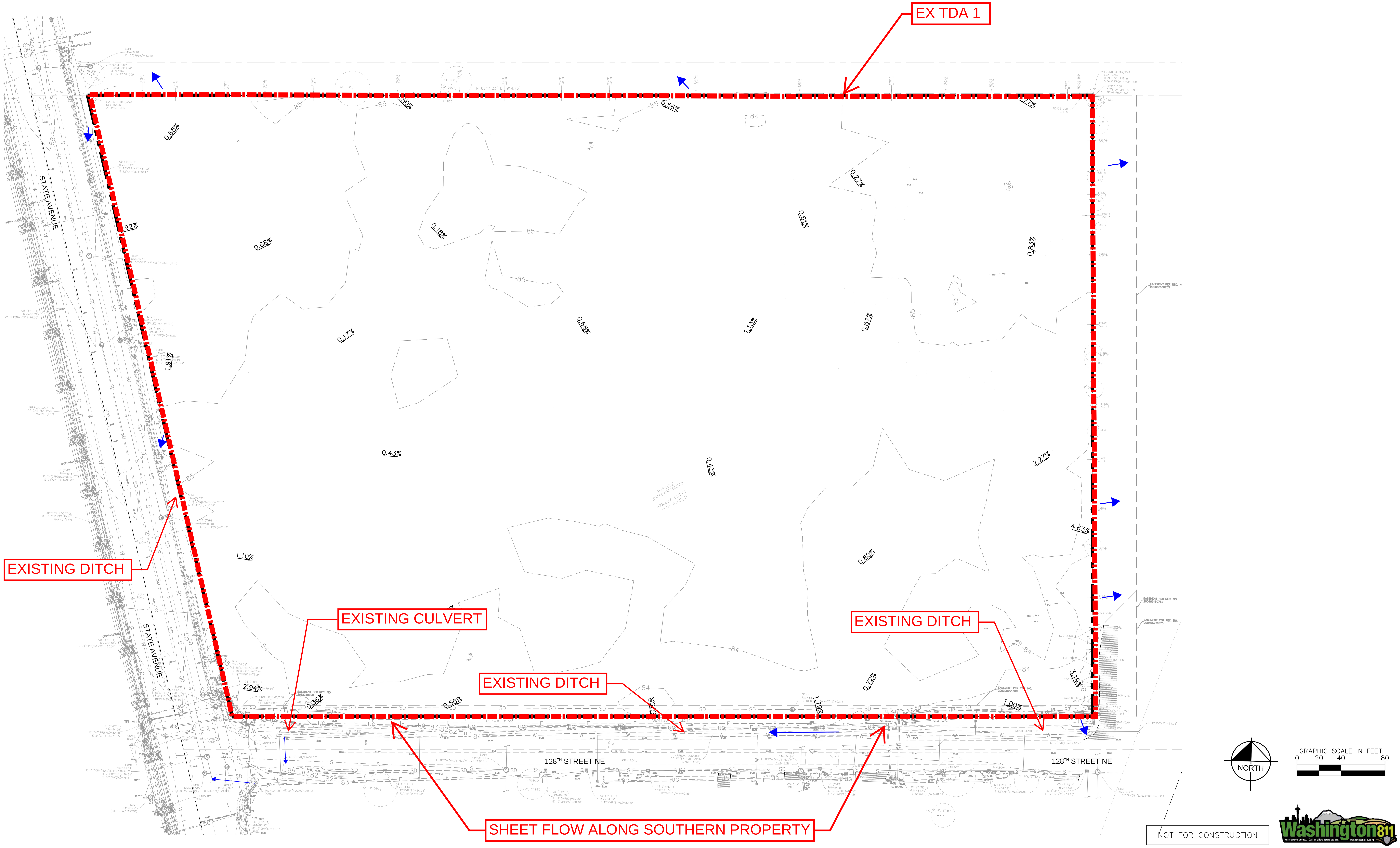
APPENDIX E: WWHM2012 MODEL OUTPUT

APPENDIX A: MAPS



Project SAIA Marysville
Vicinity Map

Kimley»Horn



No.	REVISIONS	DATE	BY

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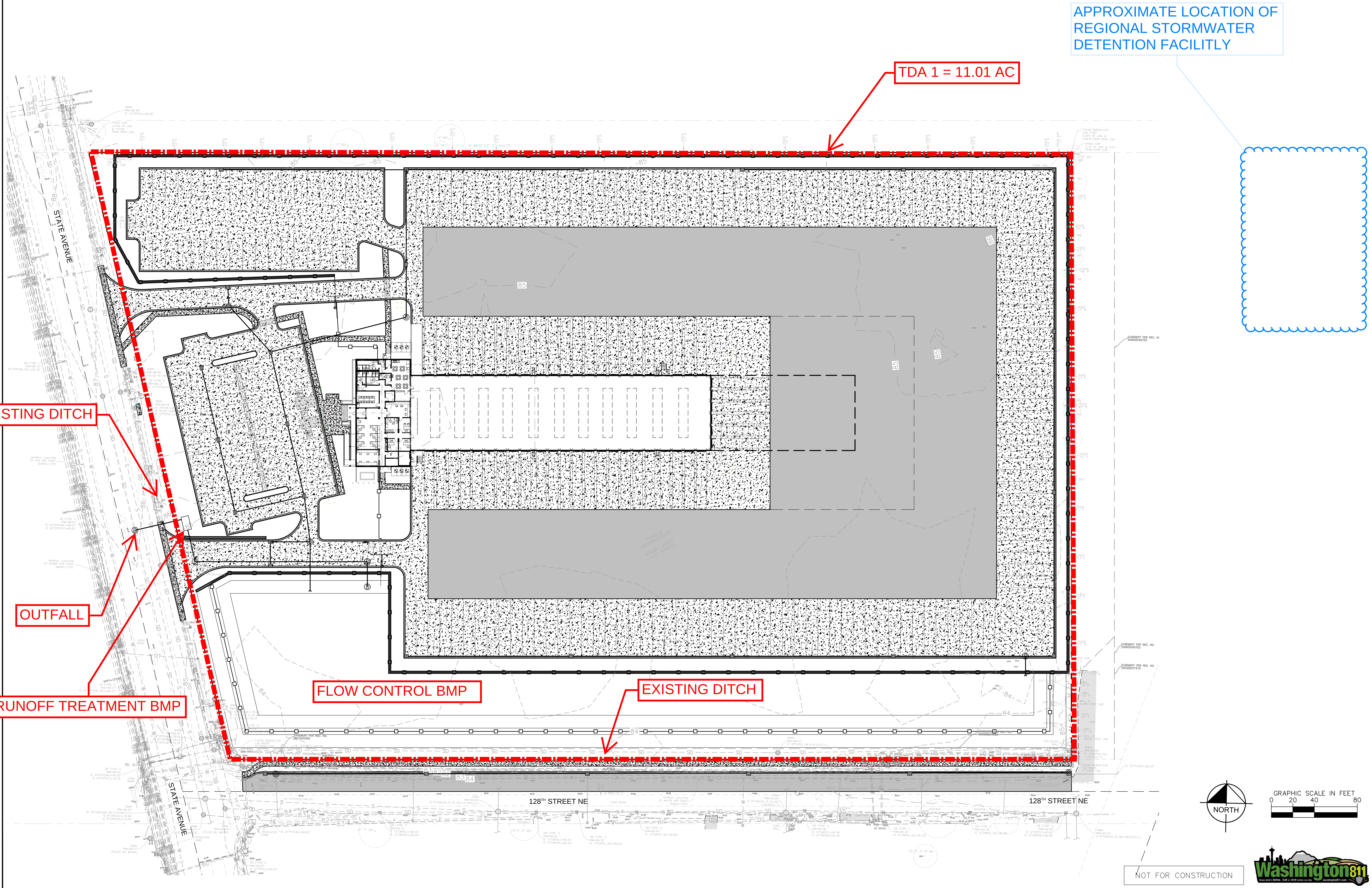
CHRISTOPHER THOMAS ... STATE OF WASHINGTON, 54945, REGISTERED PROFESSIONAL ENGINEER

KHA PROJECT 090046000
DATE 06/23/2022
SCALE AS SHOWN
DESIGNED BY CR
DRAWN BY JR
CHECKED BY CM

PRE-DEVELOPED DRAINAGE AREA MAP

SAIA MARYSVILLE
PREPARED FOR SAIA FREIGHT LTL
CITY OF MARYSVILLE WASHINGTON

SHEET NUMBER
2.0



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KHA PROJECT 090046000
DATE 06/23/2022
SCALE AS SHOWN
DESIGNED BY CR
DRAWN BY JR
CHECKED BY CM

GRADING & DRAINAGE PLAN

SAIA MARYSVILLE
PREPARED FOR SAIA FREIGHT LTL
CITY OF MARYSVILLE WASHINGTON

SHEET NUMBER
3.0

Project SAIA Marysville
Off-site Map

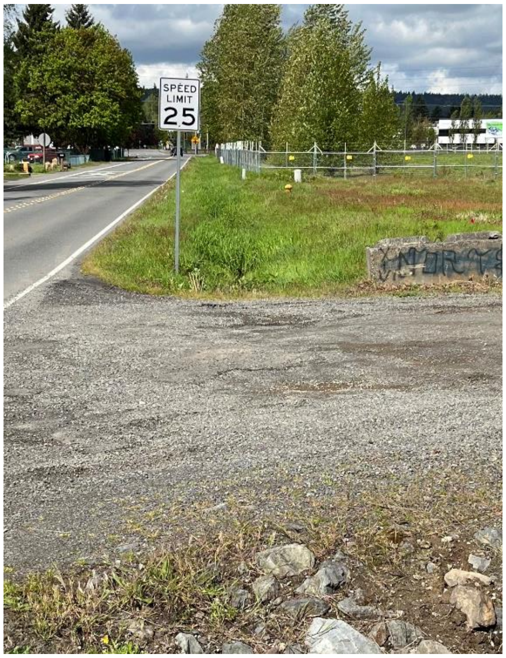


Figure 1. North of 128th Street NE channel downstream

Figure 2. State Avenue channel upstream

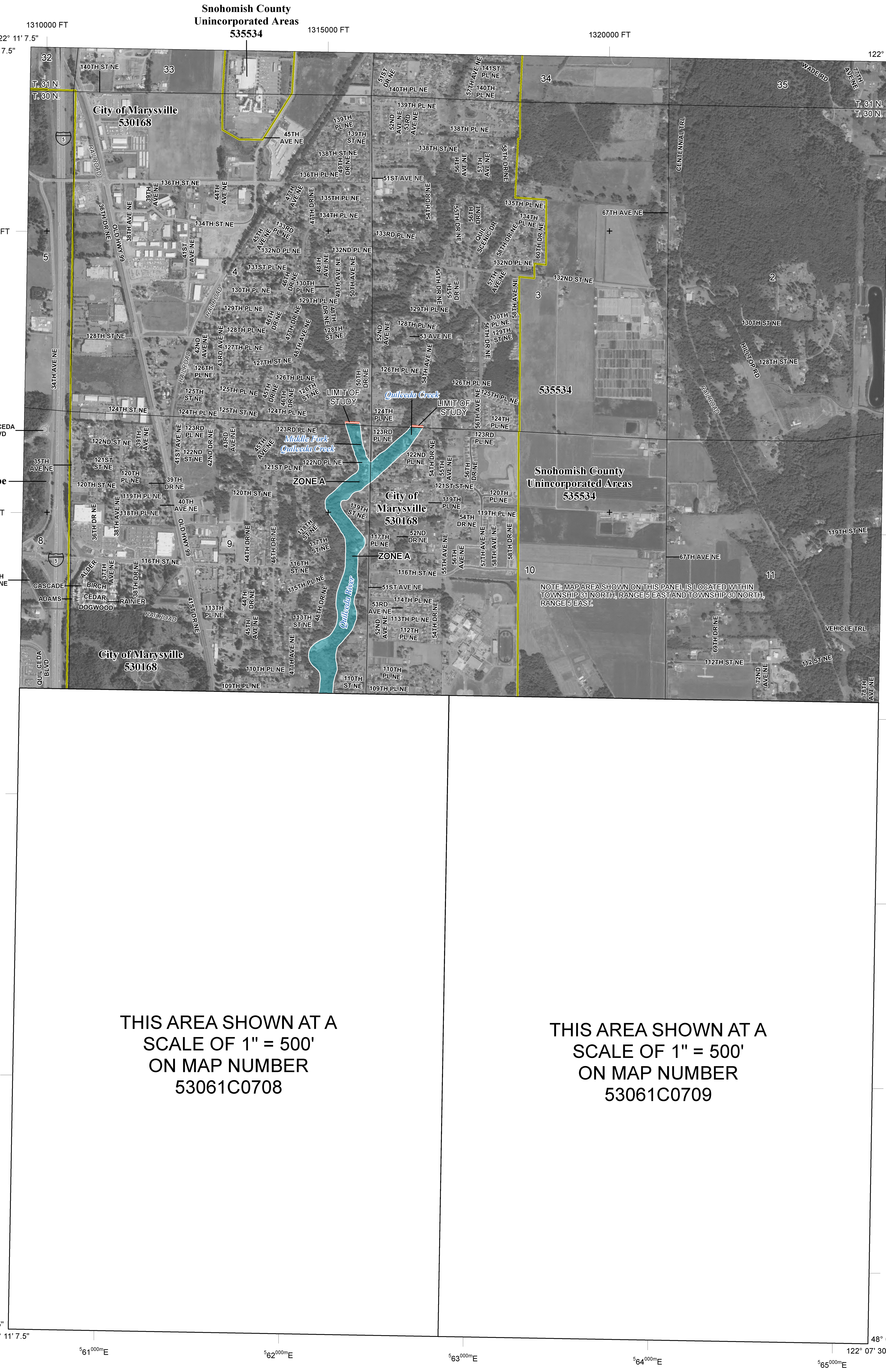
Figure 3. Regional detention pond outfall

Figure 4. South of 128th Street NE channel upstream

Figure 5. 128th Street NE channels converging

Figure 6. Inlet to channel along State Avenue

Figure 7. Channel along State Avenue downstream



FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR ZONE DESCRIPTIONS AND INDEX MAP

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTPS://MSC.FEMA.GOV

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A,V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee See Notes. *Zone X*
OTHER AREAS	NO SCREEN Areas Determined to be Outside the 0.2% Annual Chance Floodplain *Zone X*
	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Accredited or Provisionally Accredited Levee, Dike, or Floodwall
	Non-accredited Levee, Dike, or Floodwall
	E 18.2 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation (BFE)
	8 Coastal Transect
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
	513 Base Flood Elevation Line (BFE)
OTHER FEATURES	Limit of Study
	Jurisdiction Boundary

NOTES TO USERS

For information and questions about this Flood Insurance Rate Map (FIRM), available products associated with this FIRM, including historic versions, the current map date for each FIRM panel, how to order products, or the National Flood Insurance Program (NFIP) in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Flood Map Service Center website at https://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates refer to the Flood Insurance Study Report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

Base map information shown on this panel was provided by the USDA-FSA Aerial Photography Field Office. This information was derived from digital orthophotography at a scale of 1:12,000 and 1-meter pixel resolution from photography dated 2009.

SCALE

Map Projection:
NAD 1983 StatePlane Washington North FIPS 4601 Feet;
Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 1,000 feet 1:12,000

0 1,000 2,000 4,000 Feet

0 255 510 1,020 Meters

PANEL LOCATOR

* PANEL NOT PRINTED

FEMA
National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

SNOHOMISH COUNTY, WASHINGTON
AND INCORPORATED AREAS

PANEL **710** OF **1575**

FEMA

Panel Contains:

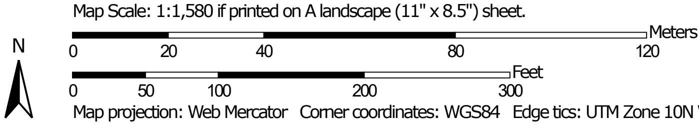
COMMUNITY	NUMBER	PANEL	SUFFIX
MARYSVILLE, CITY OF	530168	0710	F
SNOHOMISH COUNTY	535534	0710	F
TULALIP TRIBE	530225	0710	F

VERSION NUMBER
2.3.2.1

MAP NUMBER
53061C0710F

MAP REVISED
JUNE 19, 2020

Map Scale: 1:1,580 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 23, Aug 31, 2021

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 26, 2018—Oct 16, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
13	Custer fine sandy loam	C/D	11.9	100.0%
Totals for Area of Interest			**11.9**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX B: CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN (SWPPP)

APPENDIX C: SPECIAL REPORTS & STUDIES

Geotechnical Engineering Report

SAIA LTL Freight Terminal
Smokey Point Boulevard and 128th Avenue NE
Marysville, Washington

December 27, 2021
Terracon Project No. 81215171

Prepared for:

SAIA LTL Freight
Johns Creek, Georgia

Prepared by:

Terracon Consultants, Inc.
Mountlake Terrace, Washington

December 27, 2021

SAIA LTL Freight
11465 Johns Creek Parkway
Suite 330
Johns Creek, Georgia 30097

Attn: Brett Rabe – Sr. Real Estate Manager
E: brabe@saia.com

Re: Geotechnical Engineering Report
SAIA LTL Freight Terminal
Smokey Point Boulevard and 128th Avenue NE
Marysville, Washington
Terracon Project No. 81215171

Dear Mr. Rabe:

We have developed the geotechnical engineering report for the above referenced project. The study was performed in general accordance with Terracon Proposal No. P81215171 dated October 5, 2021. This report presents the findings of the subsurface explorations and provides geotechnical recommendations concerning earthwork, the design and construction of building foundations, floor slabs, and pavements for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

for

Dong-Soo Lee, P.E.
Senior Geotechnical Engineer

David A. Baska, Ph.D., P.E.
Senior Engineering Consultant

REPORT TOPICS

Note: This report was originally delivered in a web-based format. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Note: Refer to each individual Attachment for a listing of contents.

REPORT SUMMARY

Topic [1]	Overview Statement [2]
Project Description	The project involves the construction of a warehouse with office space and a large parking lot for trucks, trailers and cars at the proposed site which is approximately 11 acres. The project includes a single-story warehouse building with a footprint of about 19,620 square feet, which includes an office space of about 3,000 square feet. A building expansion is proposed to the east. The parking lot for the proposed development included 100 stalls for trailer trucks, 25 stalls for tractor trucks, 42 stalls for cars/vans and 2 ADA stalls. The project also involves a construction of detention pond which approximately 71,000 square feet.
Geotechnical Characterization	**Subsurface conditions prior to early site grading generally consist of the following:** ▪ 1 ft of dark brown, silty sand topsoil, generally upper ¼ ft is sod. ▪ Topsoil is underlain by a 1½ to 2½ ft of loose silty sand. ▪ Beneath the silty sand unit exists loose to medium dense sand with variable silt content to about 35 to 40 ft, and is further underlain by dense sand to roughly 61½ ft. ▪ Silty sand and sandy silt interbeds between 20 and 61½ ft. ▪ **Groundwater existed as shallow as 4½ feet** below the initial ground surface.
Earthwork	▪ **Remove** upper 1 ft of topsoil, including thicker portions of sod and organic-rich soils. ▪ Existing granular soils can be reused for engineered fill, **but may be moisture sensitive due to an appreciable fines content** (percent passing the #200 sieve). ▪ **Near-surface soils may be moisture sensitive** and could become unstable when exposed to excessive moisture and/or disturbance. ▪ **Utility trenching may require dewatering** efforts due to the shallow groundwater table.
Shallow Foundations	Summary of foundation recommendations (Refer to **Shallow Foundations**) Allowable bearing pressures for shallow foundation: ▪ Structural fill: **2,500** psf Expected static settlement: **< 1** inch total, **<** ½ inch differential Detect and remove sod as noted in **Earthwork**

Topic [1]	Overview Statement [2]
Liquefaction	**Post-liquefaction settlement of 2 to 4½ inches is estimated for the design-level event.** The differential settlement is anticipated to be about **2½** inches. Based on communication with the structural engineer, the post-liquefaction settlement estimated is tolerable for the proposed structure constructed as **spread footings with seismic ties**.
Pavements	We understand both asphalt and concrete pavement sections will be considered. Based on assumed traffic (please verify the value in pavement section of Project Description), the minimum standard pavement sections for a **20-year** design life are as follows: ▪ **Minimum 12 inches** of compacted subgrade with **minimum CBR** of **12** ▪ **4-in.** AC over **9-in.** granular base for flexible pavement – employee parking ▪ **5-in.** AC over **8-in.** granular base for flexible pavement – truck travel lanes, trailer parking areas ▪ **6½-in.** PCC over **8-in.** granular base for rigid pavement – dock aprons ▪ **7½-in.** PCC over **8-in.** granular base for rigid pavement – truck travel lanes, entry/exit aprons
General Comments	This section contains important information about the limitations of this geotechnical engineering report.

1. If the reader is reviewing this report as a pdf, the topics above can be used to access the appropriate section of the report by simply clicking on the topic itself.
2. This summary is for convenience only. It should be used in conjunction with the entire report for design purposes.

Geotechnical Engineering Report

SAIA LTL Freight Terminal
Smokey Point Boulevard and 128th Avenue NE
Marysville, Washington

Terracon Project No. 81215171
December 27, 2021

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed SAIA LTL Freight Terminal to be located at Smokey Point Boulevard and 128th Avenue NE in Marysville, Washington. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Site preparation and earthwork
- Foundation design and construction
- Floor slab design and construction
- Corrosivity
- Groundwater conditions
- Seismic considerations and liquefaction
- Lateral earth pressures
- Stormwater management
- Pavement design and construction

The geotechnical engineering scope of services for this project included the advancement of 5 soil borings to depths of approximately 16½ to 61½ feet below existing grades (bgs), 8 test pits to depths ranging from approximately 5 to 7 feet bgs, and cone penetration testing (CPT) to depths ranging from 102 to 102½ ft.

Maps showing the site and exploration locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring and test pit logs and as separate graphs in the **Exploration Results** section of this report.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located at the northeast corner of the intersection of Smokey Point Boulevard and 128th Street NE in Marysville, Washington. This location is approximately ¼ mile east of Interstate 5, and approximately 9 miles north of downtown Everett. Lot Size: 11 acres Latitude: 48.11196, Longitude: -122.17771 (see **Site Location**)
Existing Improvements	The site is currently undeveloped outside of a small paved parking lot near the northeast corner of the lot.
Current Ground Cover	Grass, brush and trees
Existing Topography	Approximately 4 feet of elevation change across the site with higher elevations generally along the northern and eastern property lines. In the southeast region of the site (TP-08) is about 2 to 3 feet higher than other area. Central region of the site (B-P08p and B-B03) is about 3 to 4 feet lower than other area. Further discussion is presented in the **Geotechnical Characterization**.
Geology	Our review of geologic maps indicates subsurface conditions which consist of Pleistocene continental glacial drift comprised primarily of outwash sand with variable gravel, silt and clay content (i.e., Marysville Sand Member).

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	▪ Email communication with SAIA ▪ Conceptual plan was provided by Ware Malcomb ▪ Structural loading condition was provided by email from Structural Design Group dated November 11, 2021

Item	Description
Project Description	The proposed development is located on a 11 acres lot and will include a new office and warehouse building surrounded by truck and trailer parking. The proposed dimensions of the building are about 60 feet by 277 feet for the warehouse and 60 ft by 50 ft for the office building. Pavement around the building may include a concrete apron; asphalt pavement is proposed elsewhere in the trucking yard. Street access into the site would be provided from Smokey Point Boulevard which bounds the west side of the site. A detention basin is proposed along the southern end of the site.
Proposed Structure	Warehouse building with a footprint of about 16,620 ft^2 and an office building of about 3,000 ft^2. The warehouse will be elevated about 4 feet from the surrounding grade to accommodate truck loading and unloading. Both structures are slab-on-grade (non-basement).
Building Construction	The proposed warehouse is to be constructed of concrete tilt-up panels founded on strip and spread footings with seismic ties. The proposed office building will consist of a one-story, wood or metal frame structure supported on strip and spread footings connected with seismic ties. Floors would be concrete slab-on-grade.
Finished Floor Elevation	Not known at this time, assumed to be at or near existing grades following the early grading contract.
Maximum Loads	The loading information was provided to Terracon by the structural engineer: ▪ **Columns:** 100 kips ▪ **Walls:** 5 kips per linear foot (klf) ▪ **Slabs:** 150 pounds per square foot (psf)
Grading/Slopes	Based on the November 2021 email from D.F. Chase, fill will be placed to raise grades by roughly 3 to 4 feet. In some areas along the parking area, there will be cuts of 1 ft or less and roughly 1 to 2 feet of fill will be placed.

Item	Description
Pavements	Paved drive lanes and parking will be constructed on approximately 8 acres of the parcel. We understand **20-year** designs for both rigid (concrete) and flexible (asphalt) pavement sections will be considered. **Vehicular data was not provided. Based on similar project experience, we assumed the following truck data (please confirm):** ▪ Anticipated traffic for the proposed facility: ○ Autos/light trucks: 100 vehicles per day ○ Light delivery and trash truck: 15 vehicles per week ○ Tractor-trailer trucks (5-axle, 80 kip) Heavy Duty: 50 vehicles/day, Medium Duty: 25 vehicles/day ○ Tractor-trailer trucks (3-axle, 45 kip) Heavy Duty: 100 vehicles/day, Medium Duty: 50 vehicles/day
Applicable Building Code and Minimum Design Load Standard	2018 International Building Code (2018 IBC) 2016 ASCE Standard ASCE/SEI 7-16 (ASCE 7-16)
Estimated Start of Construction	Building construction in 2022

GEOTECHNICAL CHARACTERIZATION

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** section and the GeoModel can be found in the **Figures** section of this report. As noted in **General Comments**, the characterization is based upon widely spaced exploration points across the site, and variations are likely.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Topsoil**	Silty Sand (SM), with sod and organics, roots and rootlets, very dark brown, moist
2	**Silty Sand**	Brown to dark brown, moist, loose to medium dense, with organics, fine to medium grained

3	**Sand**	Mostly poorly graded sand with varying quantities of silt, trace gravel, loose to dense, fine to medium grained, occasional medium to coarse grained and well graded sand

Existing fill was not encountered in our explorations. However, **if any existing fill is encountered during construction,** this material should be removed prior to fill placement.

Groundwater Conditions

Groundwater was encountered in all borings and test pits. The level of groundwater in the boreholes was observed while drilling and after completion or installation of wells. The water levels observed in the explorations can be found on the boring logs and test pit logs in **Exploration Results** and are summarized below.

Exploration Number	Approximate Depth to Groundwater	
	While Drilling/Excavating [1, 2]	After Drilling or Observed in Well [1, 3]
B-B01	6½	--
B-B03	5	--
B-P08p	--	4½
B-D13p	6½	6
B-D14p	6½	6
TP-01	6½	--
TP-02	6	--
TP-03	6½	--
TP-04	6	--
TP-05	6	--
TP-06	6½	--
TP-07	7	--
TP-08	5	--

1. Feet below ground surface.
2. Inferred from change in sample moisture or from evidence of free water on drilling equipment.
3. Measured using water level indicator.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs.

The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

GEOTECHNICAL OVERVIEW

The site is underlain primarily by loose to medium dense sand to about 40 feet with shallow groundwater, **rendering the site susceptible to liquefaction during a design-level seismic event.** The free-field estimate of liquefaction-induced settlement is estimated to be about **2 to 4½ inches** for the upper 50 feet of the soil profile. The resulting differential settlement is estimated to be roughly **2½ inches**.

Our understanding through discussion with the structural engineer is that this amount of settlement is tolerable by both the office building and warehouse structures. Therefore, shallow foundations can be founded on compacted structural fill. **We recommend that spread footings be connected with seismic ties.** Further discussion is provided in the **Seismic Considerations** section.

Due to the shallow water table, **we recommend grading be limited** to only what is necessary to level the site. The upper 1 foot of the topsoil unit is largely sod and **should be removed** prior to subgrade preparation for site preparation and paving. The soils present at the subgrade elevation are **likely to be moisture sensitive due** to the significant fines content and **may become unstable** when exposed to excessive moisture and/or disturbance such as construction traffic. Therefore, we recommend earthwork be performed during warmer and drier months to facilitate more workable site conditions.

Additionally, effective drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues. If grading is performed during the winter months, **an increased risk for possible undercutting and replacement** of unstable subgrade will persist. Additional site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

The **Shallow Foundations** section addresses support of the building bearing on native soil or compacted structural fill. The slab-on-grade support of the building is discussed in the **Floor Slabs** section of this report.

Seasonal high groundwater levels should be considered in the civil engineering design for site grading, utility construction, and pavements. A flexible pavement system and a rigid pavement system are recommended for this site. The **Pavements** section addresses the design of pavement systems.

Specific conclusions and recommendations regarding these geotechnical considerations, as well as other geotechnical aspects of design and construction of foundation systems and other earthwork related phases of the project are outlined in the following sections.

The recommendations contained in this report are based upon the results of field and laboratory testing (presented in **Exploration Results**), engineering analyses, and our current understanding of the proposed project. ASTM and Washington State Department of Transportation (WSDOT) specification codes cited herein respectively refer to the current manual published by the American Society for Testing & Materials and the current edition of the *Standard Specifications for Road, Bridge, and Municipal Construction, (M41-12)*.

SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on the Seismic Design Category. Site Class is required to determine the Seismic Design Category for a structure. The Site Class is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Chapter 20 of ASCE 7.

Description	Value
International Building Code (IBC) Site Classification [1, 2]	**F [2]**
Site Latitude	48.111944
Site Longitude	-122.17686
S_S – Short Period Spectral Acceleration	1.085 g
S_1 – 1-Second Period Spectral Acceleration	0.387 g
F_a – Short Period Site Coefficient for Site Class D [2]	1.066
F_v –1-Second Period Site Coefficient for Site Class D [2]	-
PGA - ASCE 7, Peak Ground Acceleration	0.46 g
F_{PGA} – Peak Ground Acceleration Site Coefficient	1.14

Description	Value

1. The IBC requires a site profile extending to a depth of 100 feet for seismic site classification. Borings were extended to a maximum depth of 51 ½ feet and later CPT probes were extended to over 100 feet. The site properties below the boring depth to 51 ½ feet were estimated based on the CPT probes.

   Site Class F applies to any profile having (1) soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays and collapsible weakly cemented soils, (2) at least 10 feet of peats and/or highly organic clays, (3) at least 25 feet of very high plasticity clays, or (4) at least 120 feet of soft to medium stiff clays.
2. These values were obtained using online seismic design maps and tools provided by OSHPD (https://seismicmaps.org/) on 11/02/2021. ASCE 7 allows site coefficients F_a and F_v to be determined assuming that liquefaction does not occur for structures with fundamental periods of vibration less than 0.5 second. Based on the results of the exploration program, Site Class D may be used to determine the values of F_a and F_v. The fundamental period of vibration for the structure should be verified by the structural engineer.

Surface-Fault Rupture

The hazard of damage from onsite fault rupture appears to be low based on review of the USGS Earthquake Hazards Program Quaternary Faults and Folds Database available online (https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=5a6038b3a1684561a9b0aadf88412fcf) accessed on November 2, 2021. The closest mapped fault is the Southern Whidbey Island fault zone, which lies approximately 13 miles to the southwest of the proposed project site.

Liquefaction

Liquefaction is the phenomenon where **saturated soils develop high porewater pressures during seismic shaking and lose their strength characteristics.** This phenomenon generally occurs in areas of high seismicity, where groundwater is shallow and loose granular soils or relatively non-plastic fine-grained soils are present. We evaluated liquefaction triggering using the simplified procedure originally developed by Seed and Idriss (1971) and refined over time with additional case histories (e.g., Boulanger and Idriss, 2014). The CLiq software developed by GeoLogismiki and used by Terracon on this project applies the simplified procedure to CPT data and also allows for computation of post-liquefaction settlements.

Based on our analyses, the hazard of liquefaction of the site soils is **moderate to high** during a design level earthquake and is most likely to trigger between 3 feet and 25 feet below the ground surface, with some thinner zones between the depths of 25 and 50 feet (i.e., interbedded silt and sand). We estimate approximately **2 to 4½ inches** of post-liquefaction settlement. From this total settlement, roughly **2½ inches** of differential settlement is inferred. Based on our understanding of the regional geology and the alluvial and post-glacial deposits of the site, we anticipate the liquefaction hazard is sitewide.

We evaluated the lateral spread hazard using the multilinear regression equations of Youd et al. (2002). The site appears to have a ground slope of about ½ percent. Given this ground slope condition, we estimate lateral spread displacements of about 12 inches. If a topographic survey of the site indicates a greater slope, we should be contacted to review our estimate of lateral spread displacements.

Based on our discussion with the structural engineer, the free-field, post-seismic, displacements associated with the design seismic event are deemed tolerable for the proposed structures. We recommend that spread footings be **connected with seismic ties** and any utilities connected to the proposed structures be designed with **flexible connections** to reduce damage during a seismic event. Foundation recommendations are provided in the **Shallow Foundations** section.

EARTHWORK

Earthwork will include clearing and grubbing, removal of the topsoil unit and organic-rich soils encountered above silty sand unit, fill placement for raising site grades, and excavations for foundation elements and utility trenches. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria as necessary to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements.

Site Preparation

Prior to placing fill, existing vegetation, topsoil (sod and root mats), and organic-rich soils should be removed. Complete stripping of the sod portion of the topsoil should be performed in all non-landscape areas. Based on our explorations, the depth of stripping is approximately 12 inches, but greater stripping depths may be encountered during earthwork construction. This material should be either wasted from the site or re-used in proposed landscape areas.

The subgrade should be proofrolled with an adequately loaded vehicle such as a fully-loaded tandem-axle dump truck prior to placing fill. The proofrolling should be performed under the observation of the Geotechnical Engineer. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Excessively wet or dry material should either be removed or moisture conditioned and recompacted.

Fill Material Types

Fill required to achieve design grade should be classified as structural fill and common fill. again, Stratum was not used earlier. Model layer 1 is topsoil that cannot be used as fill is material used below, or within 10 feet of structures and apertures, pavements, and constructed slopes. Common fill is material used to achieve grade outside of these areas. Earthen materials used for structural, common, and free-draining granular fill should meet the following material property requirements:

Fill Type	Recommended Materials	Acceptable Location for Placement
Structural Fill	9-03.9(1) *Ballast* [1] 9-03.9(3) *Crushed Surfacing Base Course* [1] 9-03.12(1)A *Gravel Backfill for Foundations Class A* [1] 9-03.14(1) *Gravel Borrow* [1] On-site Soils (i.e. Model Layer 3) [2, 3]	Beneath and adjacent to structural slabs, foundations, building appurtenances, and pavement subgrades
Common Fill	Section 9-03.14(3) *Common Borrow* [1] On-site Soils (i.e. Model Layer 3) [2 ,3]	Grade filling, utility trench backfill outside the building foundation and appurtenances
Free-Draining Granular Fill	Structural Fill [4] 9-03.12(2) *Gravel Backfill for Walls* [1] 9-03.12(4) *Gravel Backfill for Drains* [1]	Backfilling in wet weather, drainage layers for walls, sump drains, footing drains [5]

1. WSDOT Standard Specifications.
2. Structural and common fill should consist of approved materials free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site.
3. May contain local areas of higher fines content that could make this material moisture sensitive. Particles with a nominal diameter greater than about 3 in. should be removed.
4. Material provided must be specified to be less than 5-percent passing the #200 sieve for the portion of material passing the #4 sieve.
5. Minimum particle size must be greater than drain pipe perforations.

Fill Compaction Requirements

Structural and common fill should meet the following compaction requirements.

Item	Structural and Free-Draining Fill	Common Fill
Maximum Lift Thickness	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used	Same as Structural fill

Item	Structural and Free-Draining Fill	Common Fill
Minimum Compaction Requirements [1]	95% of max. below foundations and floor slabs and within 1 foot of finished pavement subgrade 90% of max. above foundations and more than 1 feet below finished pavement subgrade	90% of maximum dry density
Water Content Range [1]	Typically, within 2% of optimum	As required to achieve min. compaction requirements

1. Maximum density and optimum water content as determined by the **modified** Proctor test (ASTM D 1557).

Utility Trench Backfill

All trenches should be wide enough to allow for compaction around the haunches of the pipe, or material such as pea gravel (provided this is allowed by the pipe manufacturer) should be used below the spring line of the pipes to eliminate the need for mechanical compaction in this portion of the trenches. If water is encountered in the excavations, it should be removed prior to fill placement. **Due to the higher groundwater table, utility trenching may be difficult without implementing dewatering efforts.** Trench side walls may be unstable if excavations are performed below the groundwater.

Placement and compaction of recommended materials for utility trench backfill should be in accordance with the recommendations presented herein for **Earthwork**. In our opinion, the initial lift thickness should not exceed one foot unless recommended by the manufacturer to protect utilities from damage by compacting equipment. Light, hand-operated compaction equipment in conjunction with thinner fill lift thicknesses may be utilized on backfill placed above utilities if damage resulting from heavier compaction equipment is of concern. **Flexible connections for utilities that pass through building foundations are recommended to reduce potential stress associated with differential settlement that may occur** between the building foundation and the improvements located outside of the building footprint.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Due to the high groundwater table, raising of site grades was performed during the early grading efforts described previously. The contractor should **maintain effective grading** to promote drainage throughout construction. Water retained next to the building **can result in soil movements greater than those discussed** in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks.

Gutters and downspouts should be routed into tightline pipes that discharge either directly into a municipal storm drain or to an alternative drainage facility. Splash-blocks should also be considered below hose bibs and water spigots.

Site grades should be established such that surface water is directed away from foundation and pavement subgrades to prevent an increase in the water content of the soils. Adequate positive drainage diverting water from structures, open cuts, and slopes should be established to prevent erosion, ground loss, and instability. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork.

After building construction and landscaping, **final grades should be verified** to document effective drainage has been achieved. Where paving or flatwork abuts the structure a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. **Construction traffic over the completed subgrades should be avoided.** The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations.
Water collecting over, or adjacent to, construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted, prior to floor slab construction. If excessive deflection on the native subgrade is encountered in haul roads, a geotextile and/or quarry spalls may be necessary.

The high groundwater table may affect excavation efforts, especially for utility trenches, if advanced through to roughly 6 feet or more feet below the current ground surface. If this is the case, the high groundwater table and permeable sand **will make dewatering efforts difficult and impact trench wall stability.**

Site development should avoid or limit trenching and excavation depths that will encounter groundwater to the extent practical. If this is unavoidable, the contractor may want to consider installing groundwater monitoring wells **(piezometers).**

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, “Excavations” and its appendices, and in accordance with any applicable local, and/or state regulations. Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations.

Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

On-going earthwork efforts to raise site grades have been observed under the observation of Terracon. Future earthwork efforts should continue to be monitored under the observation of Terracon. **Each lift of compacted fill should be tested** for density and water content, evaluated, and reworked as necessary until the specified degree of compaction is achieved prior to placement of additional lifts.

In areas of foundation excavations, the bearing subgrade should be evaluated by the Terracon. In the event that unanticipated conditions are encountered, Terracon should recommend mitigation options.
In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Wet Weather Earthwork

The near-surface soils have variable fines content based on our visual observations and lab testing and **are considered moisture sensitive**. The soils will exhibit moderate erosion potential and may be transported by running water. Silt fences and other best-management practices will be necessary to control erosion and sediment transport during construction.

The suitability of soils used for structural fill depends primarily on their grain-size distribution and moisture content when they are placed. As the fines content (the soil fraction passing the U.S. No. 200 Sieve) increases, soils become more sensitive to small changes in moisture content.

Soils containing more than about 5 percent fines (by weight) cannot be consistently compacted to a firm, unyielding condition when the moisture content is more than 2 percentage points above or below optimum. Optimum moisture content is the moisture content at which the maximum dry density for the material is achieved in the laboratory by the ASTM D1557 test procedure.

If inclement weather or in situ soil moisture content prevents the use of on-site material as structural fill, we recommend use of materials specified in **Fill Material Types** for free-draining granular fill. Additionally, stockpiled soils should be protected with polyethylene sheeting anchored to withstand local wind conditions and preservation of the soil's moisture content.

SHALLOW FOUNDATIONS

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations. We recommend that spread footings be connected with seismic ties.

Design Parameters – Compressive Loads

Description	Spread Footing with Seismic Ties	Wall Footing
Net allowable bearing pressure [1, 2] ▪ Structural fill	▪ 2,500 psf	▪ 2,500 psf
Minimum dimensions	24 inches	24 inches
Minimum thickness of structural fill under the footings	24 inches	24 inches
Minimum embedment below finished grade [3]	18 inches	18 inches
Approximate static total settlement from foundation loads for condition specified [4]	<1 inch	<1 inch
Estimated static differential settlement from foundation loads [4]	About 2/3 of total settlement	
Ultimate passive pressure [5, 6] ▪ Compacted structural fill	400 pcf (equivalent fluid unit weight)	
Ultimate coefficient of sliding friction [7]	0.40	

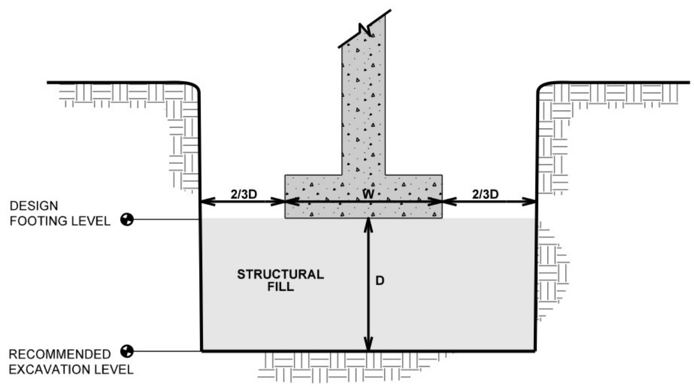
Description	Spread Footing with Seismic Ties	Wall Footing

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied. These bearing pressures can be increased by 1/3 for transient loads unless those loads have been factored to account for transient conditions. Assumes that exterior grades are relatively level adjacent to the structure.
2. Values provided are for maximum loads noted in **Project Description**.
3. For frost protection and to reduce the effects of seasonal moisture variations in the subgrade soils. For perimeter footing and footings beneath unheated areas. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
4. Differential settlements are as measured over a span of 50 feet. We should review the settlement estimates after the foundation plan has been prepared by the structural engineer.
5. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face.
6. Passive resistance in the upper 2 feet of the soil profile should be neglected.
7. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.

Foundation Construction Considerations

As noted in **Earthwork**, the footing excavations should be evaluated under the observation of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. **Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.**

If unsuitable bearing soils are encountered at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils. Over-excavation for structural fill placement below footings should be conducted as shown below. The over-excavation should be backfilled up to the footing base elevation as recommended in the **Earthwork** section.

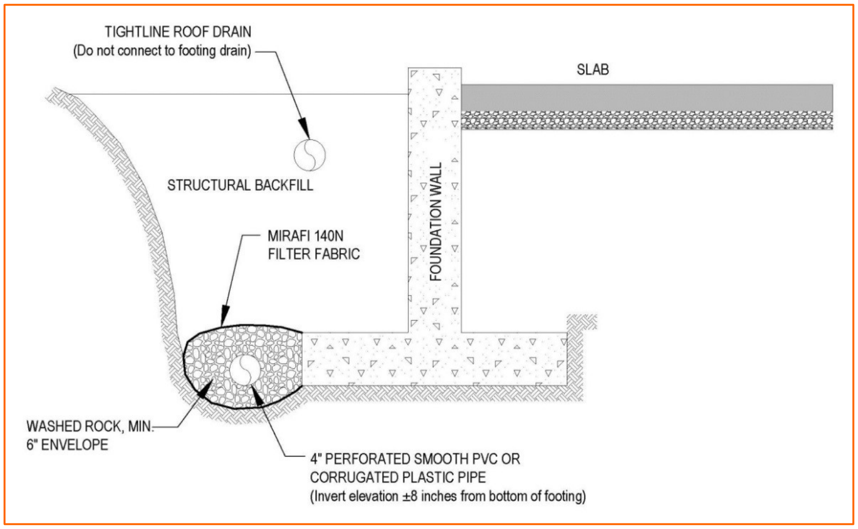


OVER-EXCAVATION / BACKFILL ZONE

NOTE: EXCAVATIONS ARE SHOWN VERTICAL; HOWEVER, THE SIDEWALLS SHOULD BE SLOPED AS NECESSARY FOR SAFETY

Foundation Drains

We recommend the building be encircled with a perimeter foundation drain to collect exterior seepage water. This drain should consist of a 4-inch diameter perforated pipe within an envelope of washed rock, extending at least 6 inches on all sides of the pipe. The washed rock should conform to WSDOT Section 9-03.12(4), Gravel Backfill for Drains or 9-03.12(5), Gravel Backfill for Drywells. The washed rock envelope should be wrapped with filter fabric (such as Mirafi 140N, or equal) to reduce the migration of fines from the surrounding soil. Ideally, the drain invert would be installed no more than 8 inches above or below the base of the perimeter footings. The perimeter foundation drain **should not** be connected to roof downspout drains and should be constructed to discharge into the site storm water system or other appropriate outlet. These recommendations are summarized in the figure below:



FLOOR SLABS

Design parameters for floor slabs assume the requirements for **Earthwork** have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

Floor Slab Design Parameters

Item	Description
Floor Slab Support [1]	Minimum 6 inches of capillary break material (see **Fill Material Types** for Free-Draining Granular Fill) Compacted to at least 95% of maximum dry density (ASTM D 1557) Minimum 18 inches of structural fill under the capillary break is recommended.
Estimated Modulus of Subgrade Reaction [2]	▪ 115 pounds per square inch per inch (psi/in) for point loads ▪ 30 psi/in for distributed loads

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. For large area loads, assume the modulus of subgrade reaction for distributed loads.

The use of a vapor retarder is recommended beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture.

When conditions warrant the use of a vapor retarder, the slab designer should **refer to ACI 302 and/or ACI 360** for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. **For additional recommendations refer to the ACI Design Manual**. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Floor Slab Construction Considerations

Finished subgrade within and for at least 10 feet beyond the floor slab should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

Terracon should observe the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

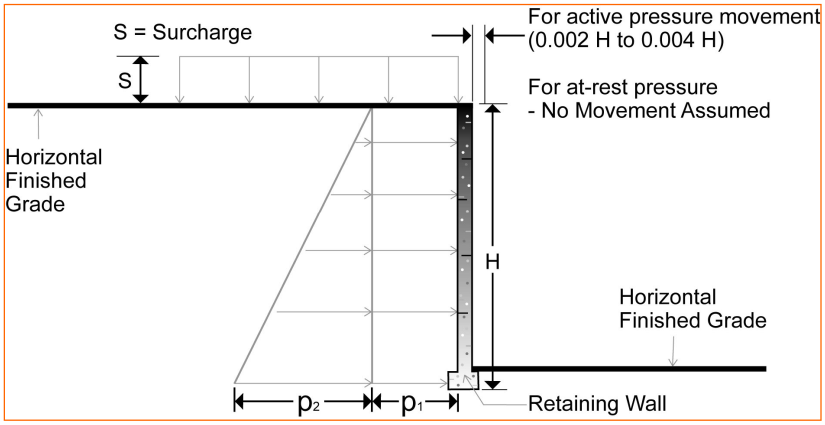
LATERAL EARTH PRESSURES

Design Parameters

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown.

Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top.

The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).



Lateral Earth Pressure Design Parameters			
Earth Pressure Condition [1]	**Coefficient for Backfill Type** [2]	**Uniform Pressure** [3, 4, 5] **p_1 (psf)**	**Effective Fluid Pressures (psf)** [2, 4, 5, 6]
Active (Ka)	0.28	(0.28)S	(35)H
At-Rest (Ko)	0.44	(0.44)S	(55)H
Passive (Kp)	3.2	---	(400)H
Seismic	---	(7)H – Active (12)H – At-Rest	---

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance.
2. Uniform, horizontal backfill, compacted to at least 92 percent of the ASTM D 1557 maximum dry density, rendering a maximum unit weight of 125 pcf.
3. Uniform surcharge, where S is surcharge pressure.
4. Loading from heavy compaction equipment is not included.
5. No safety factor is included in these values.
6. Values are in addition to static earth pressures.

STORMWATER MANAGEMENT

Terracon attempted to perform infiltration testing per the Snohomish County Drainage Manual (Jan. 2016); however, **due to the presence of shallow groundwater, the test could not be completed** as recommended by the manual. The high ground water table **renders the site infeasible** for infiltration of stormwater.

Another option for stormwater management appears to be onsite storage with discharge into the city sewer system. **An onsite detention vault would likely need to be anchored at the base due to uplift pressures from the shallow groundwater.** Should this option be considered by SAIA, Terracon can provide recommendations for the design of ground anchors via an addendum to this geotechnical engineering report.

PAVEMENTS

General Pavement Comments

Pavement designs are provided for the traffic loading and pavement design life presented in **Project Description**. A critical aspect of pavement performance is site preparation. Pavement designs, noted in this section, must be applied to the site, which has been prepared as recommended in the **Earthwork** section. The recommended designs of Asphaltic Concrete (AC) and Portland Cement Concrete (PCC) pavements are based on the 1993 AASHTO guidelines.

Design Traffic

Standard equivalent single-axle loads (ESALs) were estimated using the 1993 *Guideline for Design of Pavement Structures* by the American Association of State Highway and Transportation Officials (AASHTO, 1993). **Based on the assumed (please confirm) traffic loading conditions,** a 20-yr design life, an annual growth rate of 1%, and the facility operating 5 days per week, we estimate a maximum design loading of 500,000 flexible ESALs.

Site-specific vehicular data was not provided by the client. We assumed the vehicular data based on our experience with similar projects. If traffic volumes will exceed the assumed values, **Terracon should be notified to provide pavement sections designed for higher levels of traffic.**

Pavement Design

Based on laboratory testing of near-surface soils and imported fill, we have selected a design CBR value of 12. **Any imported or borrow source fill placed below the proposed pavements should have a CBR value of at least 12.**

Flexible Pavement

The binder grade for AC (asphalt) mixes was verified using the online version of LTPPBind.

Recommended Minimum Flexible (asphalt) Pavement Section			
Layer	Thickness (inches)		Material Specification
	Employee Parking	Truck Drive Lanes	
Compacted Subgrade [1]	12	12	Suitable subgrade soil (see **Earthwork**) compacted to 95% of Modified Proctor Maximum Dry Density; -2 to +2% Optimum Moisture Content
Crushed Aggregate Base	9	8	WSDOT: 9-03.9(3) Base Course
Hot Mix Asphalt [2]	4	5	WSDOT: 9-03.8(2) ¾-inch HMA with PG 64H-22 asphalt binder

1. May vary based on observations following proof-rolling.
2. Asphalt surface course only.

Rigid Pavement

We recommend that Portland cement concrete (PCC) pavement be used for entrance and exit apron sections, dumpster pads, loading dock aprons, and any other areas where extensive wheel maneuvering or repeated channelized loading are expected.

Recommended Minimum Rigid (concrete) Pavement Sections			
Layer	Thickness (inches)		Material Specification
	Dock Apron	Truck Drive Lanes, Entry/Exit Aprons	
Compacted Subgrade [1]	12	12	Suitable subgrade soil (see **Earthwork**) compacted to 95% of Modified Proctor Maximum Dry Density; -2 to +2% Optimum Moisture Content
Crushed Aggregate Base	8	8	WSDOT: 9-03.9(3) Base Course
PCC [2]	6½	7½	Minimum 28-day unconfined compressive strength of 4,000 pounds per sq. inch (psi)

1. May vary based on observations following proof-rolling.
2. Unreinforced PCC surface **with 1" smooth dowels at mid-depth of transverse joints.**

Adequate reinforcement and number of longitudinal and transverse control joints should be placed in the rigid pavement in accordance with ACI requirements. **Smooth dowels** should be placed at mid-depth of transverse joints for truck drive lanes. For dock aprons, **the joints parallel to the dock face** shall be considered to be the transverse direction.

Although not required for structural support, the base course layer is recommended to help reduce potential for slab curl, shrinkage cracking, subgrade "pumping" through joints, and provide a working surface for paving. These thicknesses assume the subgrade is properly prepared and compacted as noted above.

Proper joint spacing will also be required to prevent excessive slab curling and shrinkage cracking. All joints should be sealed to prevent entry of foreign material and dowelled where necessary for load transfer.

The minimum pavement sections outlined above were determined based on post-construction traffic loading conditions. These pavement sections **do not account** for heavy construction traffic during development. **A partially constructed structural section that is subjected to heavy construction traffic can result in pavement deterioration and premature distress or failure.**

Our experience indicates this pavement construction practice can result in pavements that will **not perform** as intended. Considering this information, several alternatives are available to mitigate the impact of heavy construction traffic prior to pavement construction, including:

- Using thicker sections to account for the construction traffic after paving,
- Using some method of soil stabilization to improve the support characteristics of the pavement subgrade,
- Routing heavy construction traffic around paved areas, or
- Delaying paving operations until as near the end of construction as is feasible.

Dumpster Pads: The dumpster pad should be large enough to support the wheels of the truck which will bear the load of the dumpster. The **minimum thickness** of PCC pavement should be 6 inches of concrete (min. 4,000 psi strength) and underlain by a minimum of 8 inches of crushed aggregate base course (use WSDOT 9.03.9(3)).

Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration.

In addition, the pavement subgrade **should be graded** to provide positive drainage within the granular base section. **Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.**

We recommend drainage improvements be included at the bottom of crushed aggregate base (when used) at the storm structures to aid in removing water that may enter this layer. Drainage could consist of small diameter weep holes excavated around the perimeter of the storm structures. The weep holes should be excavated at the elevation of the crushed aggregate base and soil interface.

The excavation should be covered with crushed aggregate encompassed in Mirafi 140NL, or an approved equal, which will aid in reducing the amount of fines that enter the storm system.

Pavement Maintenance

The pavement sections represent **minimum recommended thicknesses** and, as such, periodic maintenance should be anticipated. Therefore, **preventive maintenance should be planned and provided for** through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment.

Maintenance consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance (e.g. surface sealing). Preventive maintenance is usually the priority when implementing a pavement maintenance program.

Additional engineering observation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required. Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 3%.
- Subgrade and pavement surfaces should have a minimum 2% slope to promote proper surface drainage.
- Install joint sealant and seal cracks immediately.
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration into subgrade soils.

CORROSIVITY

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. The laboratory test results are attached at the end of this report. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Analyte Tested	Test Method	Test Results [1]		
		B-B03	TP-5	TP-8
		2.5 to 6 ft	2.5 to 3 ft	2.5 to 3 ft
pH	AWWA 4500H	7.1	6.6	6.5
Water Soluble Sulfates (mg/kg)	ASTM C1580	77	56	28
Sulfides (mg/kg)	AWWA 4500-S D	0	0	0
Chlorides (mg/kg)	ASTM D512	45	28	25
Red-Ox [2]	AWWA 2580	718	717	725
Total Salts (mg/kg)	AWWA 2540	83	84	52
Resistivity (ohm-cm)	ASTM G57	18430	27160	51410

AWWA = American Water Works Association

ASTM = American Society for Testing and Materials

1. Depth below existing grades prior to early grading activities.
2. Reduction-Oxidation potential (positive values indicates an oxidizing environment).

The fill soils placed as part of the early grading efforts are generally sand with silt and silty sand with little to no-plasticity. **Resistivity and corrosivity testing were not performed on the imported fills**. If this testing is desired, **a soil sample can be obtained at any time prior to final design** and tested at our laboratory.

GENERAL COMMENTS

This report (including all attachments) should be read in its entirety. Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction.

Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken. Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended.

Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others.

If changes in the nature, design, or location of the project are planned, **our conclusions and recommendations shall not be considered valid** unless we review the changes and either verify or modify our conclusions in writing.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Exploration Type	Exploration Number	Exploration Depth [1]	Location
Test Pits	TP-01	6½	Parking/driveway area
	TP-02	6	
	TP-03	6 ½	
	TP-04	6	
	TP-05	6 ½	
	TP-06	6 ½	
	TP-07	7	
	TP-08	5	
Soil Borings	B-B01	41 ½	Planned building area
	B-B03	61 ½	
Groundwater Monitoring Well	B-P08p	16 ½	Parking/driveway area
	B-D13p	16 ½	Proposed Detention pond
	B-D14p	16 ½	
Seismic Cone Penetration Test [2]	C-B01	102	Planned building area
Cone Penetration Test	C-B02	102 ½	Parking/driveway area /future expansion

1. Feet below existing ground surface.
2. Shear wave velocity testing was performed during cone advancement.

Exploration Layout and Elevations: Unless otherwise noted, Terracon personnel provided the exploration layout. Coordination were obtained a handheld GPS unit (estimated horizontal accuracy of about ±2 feet) and approximate elevations were obtained by interpolation from the topographic site plan obtained from the City of Marysville GIS database (5-foot contours). If elevations and a more precise exploration layout are desired, we recommend explorations be surveyed.

Borehole Procedure: We advanced the borings with a truck-mounted drill rig using continuous flight hollow stem augers. Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter.

In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. We observed and recorded groundwater levels and sampling. For safety purposes, borings B-B01 and B-B03 were backfilled with bentonite chips after their completion. Groundwater monitoring wells were installed in boring B-P08p, B-D13p and B-D14p.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Test Pit Procedures: Test pits were advanced via an excavator outfitted with a toothed bucket. The test pit sidewalls and excavated soil were observed by a Terracon field engineer and characterized accordingly in the test pit logs. Groundwater seepage depths as well as fill, debris, and other deleterious materials observed are described in the logs as well.

Excavated soils were stockpiled in the vicinity of the pit for further observation and for convenient backfilling. The density/consistency of the soil was inferred through frequent probing of the base of the excavations for the upper 4 feet. Thereafter, soil density presented on the logs are inferred from probing observations and excavator level of effort during test pit advancement.

Test pits were typically terminated upon contacting groundwater. Bulk samples were collected for CBR testing and to evaluate potential reuse of onsite soils. Our exploration team prepared draft test pit logs in the field (i.e. field logs) as part of standard operations. Field logs included visual classifications of soils encountered during exploration, and our interpretation of subsurface conditions between samples. Final test pit logs, prepared from field logs, represent the geotechnical engineer's interpretation, and include modifications based on observations and laboratory testing results.

Cone Penetration Testing (CPT) Procedures: Advancement of the cone instrument was performed through a porthole in the approximate center of a truck rig. The truck is outfitted with a hydraulic press that continuously advances a standardized and calibrated cone at a constant rate. During advancement, a near-continuous profile of data was collected for cone tip and side friction resistance exerted on the cone by the soils as well as the in-situ pore water pressure generated during cone advancement.

The tip, side friction, and pore water data are interpreted using empirical correlations to derive soil engineering properties for the full length of cone advancement. Additionally, estimates of groundwater level were made through measuring the dissipation of excess pore water pressure that is generated during cone advancement. The data collected was used to estimate a soil behavior type which is used to infer the classification of the soils encountered (i.e. sand, silt, clay, etc.) and to estimate geotechnical engineering parameters as well as to performed liquefaction analysis.

A data report of the CPT results was provided to Terracon by the CPT subcontractor and are included herein. Soil samples were not obtained during performance of CPTs. See **Supplemental Information** for the ConeTec report. CPT-B01 is a seismic cone penetration test (sCPT) in which shear wave velocity testing was performed during cone advancement.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil strata, as necessary, for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods were applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils (Hydrometer)
- ASTM D1883 Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils
- ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (part of CBR test)

The laboratory testing program often included examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Note: All attachments are one page unless noted above.

SITE LOCATION

SAIA LTL Freight Terminal ■ Marysville, Washington

December 27, 2021 ■ Terracon Project No. 81215171

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN

SAIA LTL Freight Terminal ■ Marysville, Washington

December 27, 2021 ■ Terracon Project No. 81215171

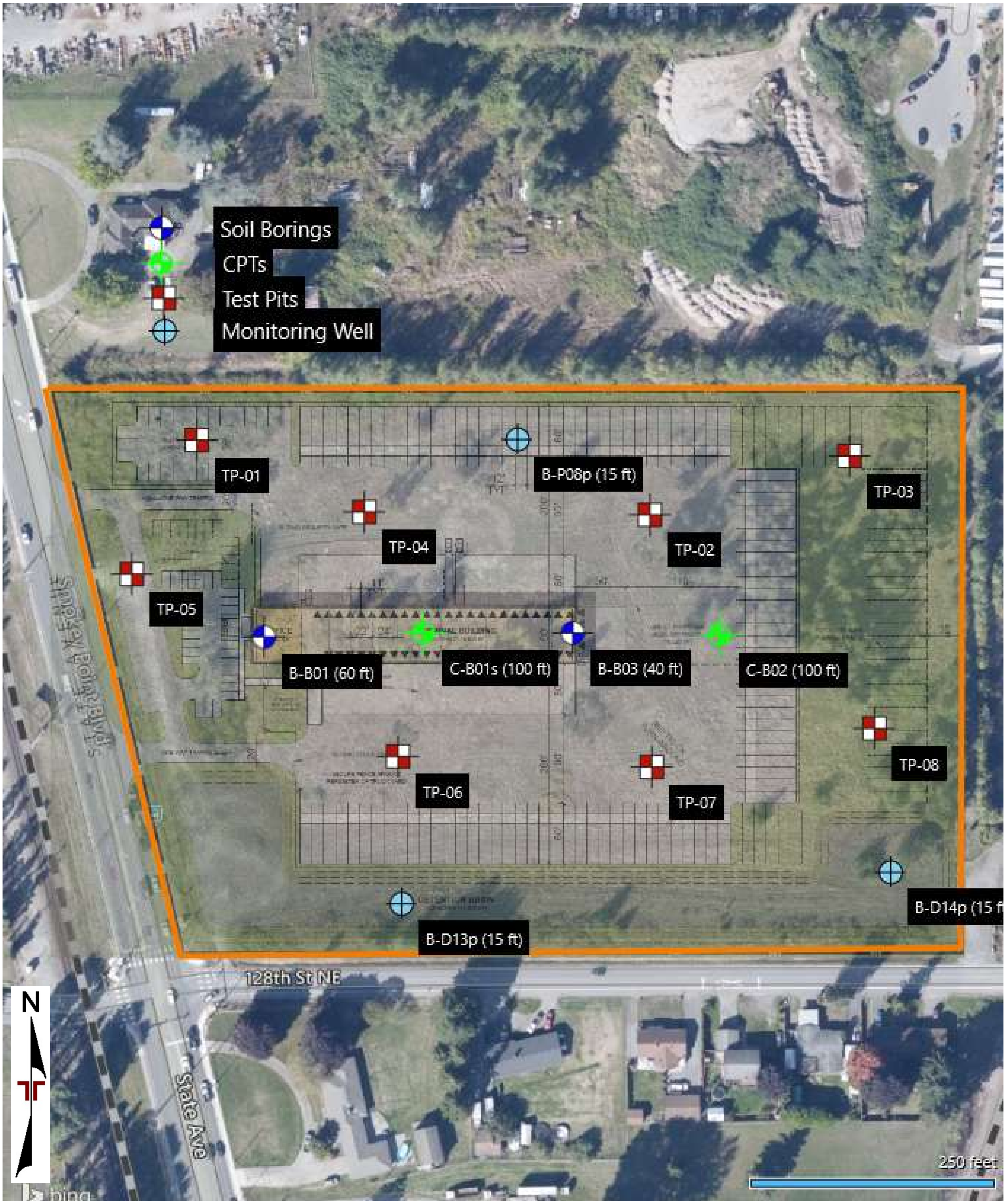


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

BORING LOG NO. B-B01

PROJECT: SAIA Motor Freight Terminal

CLIENT: SAIA LTL Freight
Johns Creek, GA

SITE: Smokey Point Blvd and 128th St NE
Marysville, WA

LOCATION See Exploration Plan

Latitude: 48.1120° Longitude: -122.1788°

Approximate Surface Elev.: 85 (Ft.) +/-

MODEL LAYER	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)
1	0.2	**TOPSOIL**, dark brown, moist, loose to medium dense, Silty Sand (SM), with roots and rootlets	85+/-
2	2.8	**SILTY SAND (SM)**, with organics, fine grained, dark brown, moist, loose to medium dense trace organics, medium dense	82+/-
3	10.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, trace gravel, fine grained, brown, moist, medium dense fine to coarse grained, brownish gray to gray fine to coarse grained sand, fine to coarse grained gravel wet, dense	75+/-
3	20.0	**POORLY GRADED SAND (SP)**, trace gravel, fine to medium grained, brownish gray to gray, wet, medium dense fine grained at 15-1/2 ft easy drilling	65+/-
3	25.0	**SILTY SAND (SM)**, trace gravel, fine to medium grained, dark gray, wet, dense, sand interbedded with silt layers	60+/-

Sample No.	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	PERCENT FINES
S-1	16	3-6-5 N=11	25.6	
S-2	16	3-5-9 N=14		
S-3	15	6-13-19 N=32		
S-4	13	3-6-6 N=12	18.5	4
S-5	16	4-12-19 N=31		
S-6	12	5-15-27 N=42	16.1	21

Water level observed while drilling at approximately 6 ft (shown by the ▽ symbol in the log).

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with bentonite grout upon completion

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
21905 64th Ave W, Ste 100
Mountlake Terrace, WA

Boring Started: 10-14-2021 | Boring Completed: 10-14-2021

Drill Rig: | Driller: EDI Environmental

Project No.: 81215171

BORING LOG NO. B-B01

PROJECT: SAIA Motor Freight Terminal

CLIENT: SAIA LTL Freight Johns Creek, GA

SITE: Smokey Point Blvd and 128th St NE Marysville, WA

LOCATION See Exploration Plan

Latitude: 48.1120° Longitude: -122.1788°

Approximate Surface Elev.: 85 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / DESCRIPTION / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	Sample No.	WATER CONTENT (%)	PERCENT FINES
3		**POORLY GRADED SAND WITH SILT (SP-SM)**, trace gravel, fine to medium grained, dark gray, wet, medium dense			X	11	9-9-11 N=20	S-7		
			30		X	9	11-12-17 N=29	S-8		
		dense	35		X	10	6-16-16 N=32	S-9		
		41.5 … 43.5+/-	40		X	10	16-16-27 N=43	S-10		
		Boring Terminated at 41.5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with bentonite grout upon completion

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

While drilling

Terracon
21905 64th Ave W, Ste 100
Mountlake Terrace, WA

Boring Started: 10-14-2021	Boring Completed: 10-14-2021
Drill Rig:	Driller: EDI Environmental
Project No.: 81215171	

BORING LOG NO. B-B03

PROJECT: SAIA Motor Freight Terminal

CLIENT: SAIA LTL Freight Johns Creek, GA

SITE: Smokey Point Blvd and 128th St NE Marysville, WA

LOCATION See Exploration Plan

Latitude: 48.1120° Longitude: -122.1776°

Approximate Surface Elev.: 85 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	Sample No.	WATER CONTENT (%)	PERCENT FINES
1	0.2	**TOPSOIL**, dark brown, moist, loose to medium dense, Silty Sand (SM), with roots and rootlets	85+/-								
2	1.5	**SILTY SAND (SM)**, with organics, dark brown, moist, loose to medium dense	83.5+/-								
3		**WELL GRADED SAND WITH SILT (SW-SM)**, fine grained, light brown, moist, medium dense				X	11	4-5-6 N=11	S-1		
		fine to medium grained, wet		5	▽						
		gray				X	9	3-5-6 N=11	S-2	22.3	11
	7.5	**POORLY GRADED SAND WITH SILT (SP-SM)**, trace gravel, fine to medium grained, gray, wet medium dense	77.5+/-			X	9	5-5-6 N=11	S-3	22.7	10
		medium to coarse grained		10		X	10	5-9-7 N=16	S-4		
		coarse grained, dense		15		X	5	5-9-24 N=33	S-5	19.1	6
		medium dense medium to coarse grained at 20-1/2 ft		20		X	17	5-8-13 N=21	S-6		
				25							

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with bentonite grout upon completion

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Inferred from change in sample moisture*

Terracon

21905 64th Ave W, Ste 100
Mountlake Terrace, WA

Boring Started: 10-15-2021	Boring Completed: 10-15-2021
Drill Rig:	Driller: EDI Environmental
Project No.: 81215171	

BORING LOG NO. B-B03

PROJECT: SAIA Motor Freight Terminal

CLIENT: SAIA LTL Freight Johns Creek, GA

SITE: Smokey Point Blvd and 128th St NE Marysville, WA

LOCATION See Exploration Plan

Latitude: 48.1120° Longitude: -122.1776°

Approximate Surface Elev.: 85 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	Sample No.	WATER CONTENT (%)	PERCENT FINES
3		**POORLY GRADED SAND WITH SILT (SP-SM)**, trace gravel, fine to medium grained, gray, wet *(continued)* fine to medium grained, gray, dense			X	17	5-10-23 N=33	S-7	24.7	6
		trace gravel, medium dense	30		X	17	2-4-16 N=20	S-8		
			35		X	17	5-6-9 N=15	S-9		
		medium to coarse grained, dense	40		X	16	10-11-23 N=34	S-10		
		fine grained, very dense	45		X	16	26-37-42 N=79	S-11		
			50							

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with bentonite grout upon completion

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Inferred from change in sample moisture*

Terracon
21905 64th Ave W, Ste 100
Mountlake Terrace, WA

Boring Started: 10-15-2021	Boring Completed: 10-15-2021
Drill Rig:	Driller: EDI Environmental
Project No.: 81215171	

BORING LOG NO. B-B03

PROJECT: SAIA Motor Freight Terminal

CLIENT: SAIA LTL Freight Johns Creek, GA

SITE: Smokey Point Blvd and 128th St NE Marysville, WA

LOCATION See Exploration Plan

Latitude: 48.1120° Longitude: -122.1776°

Approximate Surface Elev.: 85 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	Sample No.	WATER CONTENT (%)	PERCENT FINES
3		**POORLY GRADED SAND WITH SILT (SP-SM)**, trace gravel, fine to medium grained, gray, wet *(continued)* medium to coarse grained, gray, dense				X	15	16-27-17 N=44	S-12		
	55.0	**SILTY SAND (SM)**, fine grained, gray, wet, dense	30+/-	55		X	17	18-20-23 N=43	S-13		
	60.5	**POORLY GRADED SAND (SP)**, medium grained, gray, wet, dense	24.5+/-	60		X	16	11-11-29 N=40	S-14		
	61.5	***Boring Terminated at 61.5 Feet***	23.5+/-								

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with bentonite grout upon completion

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *Inferred from change in sample moisture*

Terracon
21905 64th Ave W, Ste 100
Mountlake Terrace, WA

Boring Started: 10-15-2021	Boring Completed: 10-15-2021
Drill Rig:	Driller: EDI Environmental
Project No.: 81215171	

BORING LOG NO. B-P08p

PROJECT: SAIA Motor Freight Terminal

CLIENT: SAIA LTL Freight Johns Creek, GA

SITE: Smokey Point Blvd and 128th St NE Marysville, WA

LOCATION See Exploration Plan

Latitude: 48.1125° Longitude: -122.1777°

Approximate Surface Elev.: 85 (Ft.) +/-

MODEL LAYER	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	INSTALLATION DETAILS	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	Sample No.	WATER CONTENT (%)	PERCENT FINES
1	0.2	**TOPSOIL**, dark brown, moist, loose to medium dense, Silty Sand (SM), with roots and rootlets	85+/-	Bentonite Chips								
2		**SILTY SAND (SM)**, with organics, fine to medium grained, dark brown, moist, loose to medium dense										
		light brown, moist, loose					X	10	4-4-4 N=8	S-1	20.9	21
	5.0		80+/-		5	∇						
3		**POORLY GRADED SAND (SP)**, light brown, wet, medium dense										
		medium to coarse grained, gray					X	16	5-6-8 N=14	S-2		
		trace gravel, coarse grained		Sand Filter			X	17	2-10-15 N=25	S-3		
		dense		Screen	10		X	18	11-20-25 N=45	S-4		
					15		X	4	13-26-23 N=49	S-5		
	16.5		68.5+/-									

Boring Terminated at 16.5 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Groundwater monitoring well installed

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

Groundwater monitoring well monument is approximately 3ft above the groundsurface

WATER LEVEL OBSERVATIONS

∇ *At completion of drilling*

Terracon
21905 64th Ave W, Ste 100
Mountlake Terrace, WA

Boring Started: 10-15-2021	Boring Completed: 10-15-2021
Drill Rig:	Driller: EDI Environmental
Project No.: 81215171	

BORING LOG NO. B-D13p

PROJECT: SAIA Motor Freight Terminal

CLIENT: SAIA LTL Freight Johns Creek, GA

SITE: Smokey Point Blvd and 128th St NE Marysville, WA

LOCATION See Exploration Plan

Latitude: 48.1112° Longitude: -122.1781°

Approximate Surface Elev.: 84 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	INSTALLATION DETAILS	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Sample No.	WATER CONTENT (%)
1	0.2	**TOPSOIL**, dark brown, moist, loose, Silty Sand (SM), with roots and rootlets	84+/-	Bentonite Chips			Hand		12.1
2	1.5	**SILTY SAND (SM)**, with organics, dark brown, moist, loose	82.5+/-						
3		**POORLY GRADED SAND WITH SILT (SP-SM)**, brown, moist, loose					X	S-1	13.0
					5	While drilling / After 24 hours	X	S-2	
		wet							
		medium dense		Sand Filter			X	S-3	
				Screen	10		X	S-4	
		very dense			15		X	S-5	
	16.5		67.5+/-						

Boring Terminated at 16.5 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Groundwater monitoring well installed

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

Groundwater monitoring well monument is approximately 3ft above the groundsurface

WATER LEVEL OBSERVATIONS

- *While drilling*
- *After 24 hours*

Terracon
21905 64th Ave W, Ste 100
Mountlake Terrace, WA

Boring Started: 10-14-2021	Boring Completed: 10-14-2021
Drill Rig:	Driller: EDI Environmental
Project No.: 81215171	

BORING LOG NO. B-D14p

PROJECT: SAIA Motor Freight Terminal

CLIENT: SAIA LTL Freight Johns Creek, GA

SITE: Smokey Point Blvd and 128th St NE Marysville, WA

LOCATION See Exploration Plan

Latitude: 48.1113° Longitude: -122.1760°

Approximate Surface Elev.: 85 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	INSTALLATION DETAILS	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Sample No.	WATER CONTENT (%)
1	0.2	**TOPSOIL**, dark brown, moist, loose to medium dense, Silty Sand (SM), with roots and rootlets	85+/-	Bentonite Chips					
2	1.5	**SILTY SAND (SM)**, with organics, dark brown, moist, loose to medium dense	83.5+/-						
3		**POORLY GRADED SAND WITH SILT (SP-SM)**, brown, moist, loose					X	S-1	
		medium dense			5				
		wet				▽ ▽	X	S-2	
				Sand Filter			X	S-3	
		dense		Screen	10		X	S-4	
	16.5		68.5+/-		15		X	S-5	

Boring Terminated at 16.5 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Groundwater monitoring well installed

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

Groundwater monitoring well monument is approximately 3ft above the groundsurface

WATER LEVEL OBSERVATIONS

▽ *While drilling*

▽ *After installation of well*

Terracon

21905 64th Ave W, Ste 100
Mountlake Terrace, WA

Boring Started: 10-14-2021	Boring Completed: 10-14-2021
Drill Rig:	Driller: EDI Environmental
Project No.: 81215171	

TEST PIT LOG NO. TP-01

PROJECT: SAIA Motor Freight Terminal

CLIENT: SAIA LTL Freight
Johns Creek, GA

SITE: Smokey Point Blvd and 128th St NE
Marysville, WA

LOCATION See Exploration Plan

Latitude: 48.1125° Longitude: -122.1790°

Approximate Surface Elev.: 85 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Sample No.	WATER CONTENT (%)
1		1.0	**TOPSOIL**, with organics, brown, moist, Silty Sand (SM), with roots	84+/-					
3			**POORLY GRADED SAND (SP)**, light brown to gray, transitions to gray with increasing depth						
			gray						
			trace gravel, medium to coarse grained, light gray, loose				Grab	S-1	
					5				
		6.5		78.5+/-		▽			
			Test Pit Terminated at 6.5 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Excavation

Abandonment Method:
Test pit backfilled with excavated soil

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While excavating*

Terracon

21905 64th Ave W, Ste 100
Mountlake Terrace, WA

Test Pit Started: 10-14-2021	Test Pit Completed: 10-14-2021
Excavator:	Operator: Green Earthworks
Project No.: 81215171	

TEST PIT LOG NO. TP-02

PROJECT: SAIA Motor Freight Terminal

**CLIENT: SAIA LTL Freight
Johns Creek, GA**

**SITE: Smokey Point Blvd and 128th St NE
Marysville, WA**

LOCATION See Exploration Plan

Latitude: 48.1123° Longitude: -122.1773°

Approximate Surface Elev.: 84 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Sample No.	WATER CONTENT (%)
1		1.5	**TOPSOIL**, with organics, brown, moist, Silty Sand (SM), with roots	82.5+/-					
3			**POORLY GRADED SAND (SP)**, medium grained, brownish gray, moist						
			trace gravel, loose				(hand)	S-1	
					5				
		6.0	gray	78+/-		▽			
			Test Pit Terminated at 6 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Excavation

Abandonment Method:
Test pit backfilled with excavated soil

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While excavating*

Terracon
21905 64th Ave W, Ste 100
Mountlake Terrace, WA

Test Pit Started: 10-14-2021	Test Pit Completed: 10-14-2021
Excavator:	Operator: Green Earthworks
Project No.: 81215171	

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 81215171 SAIA MOTOR FREIGH.GPJ TERRACON_DATATEMPLATE.GDT 12/2/21

TEST PIT LOG NO. TP-03

PROJECT: SAIA Motor Freight Terminal

CLIENT: SAIA LTL Freight Johns Creek, GA

SITE: Smokey Point Blvd and 128th St NE Marysville, WA

LOCATION See Exploration Plan

Latitude: 48.1125° Longitude: -122.1762°

Approximate Surface Elev.: 85.5 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Sample No.	WATER CONTENT (%)
1		1.0	**TOPSOIL**, with organics, dark brown, moist, Silty Sand (SM), with roots	84.5+/-					
3			**POORLY GRADED SAND (SP)**, dark brown, moist						
			trace gravel, fine to medium grained, light brown and light gray, loose to medium dense				Grab	S-1	
			trace gravel, coarse grained, brownish gray, loose to medium dense		5		Grab	S-2	
		6.5		79+/-		▽			
			Test Pit Terminated at 6.5 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Excavation

Abandonment Method:
Test pit backfilled with excavated soil

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While excavating*

Terracon
21905 64th Ave W, Ste 100
Mountlake Terrace, WA

Test Pit Started: 10-14-2021	Test Pit Completed: 10-14-2021
Excavator:	Operator: Green Earthworks
Project No.: 81215171	

TEST PIT LOG NO. TP-04

PROJECT: SAIA Motor Freight Terminal

CLIENT: SAIA LTL Freight
Johns Creek, GA

SITE: Smokey Point Blvd and 128th St NE
Marysville, WA

LOCATION See Exploration Plan

Latitude: 48.1123° Longitude: -122.1783°

Approximate Surface Elev.: 85 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Sample No.	WATER CONTENT (%)
		1.0	**TOPSOIL**, with organics, brown, moist, Silty Sand (SM), with roots	84+/-					
3			**POORLY GRADED SAND (SP)**, light gray, moist						
			fine to medium grained, brown, loose to medium dense				Grab	S-1	
		6.0	trace gravel, gray	79+/-	5	▽			
			Test Pit Terminated at 6 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Excavation

Abandonment Method:
Test pit backfilled with excavated soil

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While excavating*

Terracon
21905 64th Ave W, Ste 100
Mountlake Terrace, WA

Test Pit Started: 10-14-2021	Test Pit Completed: 10-14-2021
Excavator:	Operator: Green Earthworks
Project No.: 81215171	

TEST PIT LOG NO. TP-05

PROJECT: SAIA Motor Freight Terminal

CLIENT: SAIA LTL Freight
Johns Creek, GA

SITE: Smokey Point Blvd and 128th St NE
Marysville, WA

LOCATION See Exploration Plan

Latitude: 48.1122° Longitude: -122.1792°

Approximate Surface Elev.: 85 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Sample No.	WATER CONTENT (%)
1		1.0	**TOPSOIL**, with organics, dark brown, moist, Silty Sand (SM), with roots	84+/-					
2		2.0	**SILTY SAND (SM)**, brown, moist, increasing coarse material with depth	83+/-			Grab	S-1	19.0
3			**POORLY GRADED SAND (SP)**, trace gravel, medium to coarse grained, light brown to gray, moist				Grab	S-2	
					5				
		6.5	coarse grained, gray	78.5+/-		▽	Grab	S-3	
			Test Pit Terminated at 6.5 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Excavation

Abandonment Method:
Test pit backfilled with excavated soil

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While excavating*

Terracon
21905 64th Ave W, Ste 100
Mountlake Terrace, WA

Test Pit Started: 10-14-2021	Test Pit Completed: 10-14-2021
Excavator:	Operator: Green Earthworks
Project No.: 81215171	

TEST PIT LOG NO. TP-06

PROJECT: SAIA Motor Freight Terminal

CLIENT: SAIA LTL Freight
Johns Creek, GA

SITE: Smokey Point Blvd and 128th St NE
Marysville, WA

LOCATION See Exploration Plan

Latitude: 48.1116° Longitude: -122.1782°

Approximate Surface Elev.: 85 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Sample No.	WATER CONTENT (%)
1		1.0	**TOPSOIL**, with organics, dark brown, moist, Silty Sand (SM), with roots	84+/-					
2		2.0	**SILTY SAND (SM)**, trace gravel, light brown, moist	83+/-					
3			**POORLY GRADED SAND (SP)**, trace gravel, fine to medium grained, loose to medium dense				Grab	S-1	
					5				
		6.5	coarse grained, gray, wet	78.5+/-		▽	Grab	S-2	
			Test Pit Terminated at 6.5 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Excavation

Abandonment Method:
Test pit backfilled with excavated soil

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While excavating*

Terracon
21905 64th Ave W, Ste 100
Mountlake Terrace, WA

Test Pit Started: 10-14-2021	Test Pit Completed: 10-14-2021
Excavator:	Operator: Green Earthworks
Project No.: 81215171	

TEST PIT LOG NO. TP-07

PROJECT: SAIA Motor Freight Terminal

**CLIENT: SAIA LTL Freight
Johns Creek, GA**

**SITE: Smokey Point Blvd and 128th St NE
Marysville, WA**

LOCATION See Exploration Plan

Latitude: 48.1116° Longitude: -122.1771°

Approximate Surface Elev.: 84 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Sample No.	WATER CONTENT (%)
1		1.0	**TOPSOIL**, with organics, dark brown, moist, Silty Sand (SM), with roots	83+/-					
2		1.5	**SILTY SAND (SM)**, light brown, moist	82.5+/-					
3			**POORLY GRADED SAND (SP)**, brownish gray, moist, loose to medium dense with Silty Sand lenses increased coarse grained material with depth						
							Grab	S-1	
					5				
			brown to gray						
		7.0		77+/-		▽			
			Test Pit Terminated at 7 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Excavation

Abandonment Method:
Test pit backfilled with excavated soil

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While excavating*

Terracon
21905 64th Ave W, Ste 100
Mountlake Terrace, WA

Test Pit Started: 10-14-2021

Test Pit Completed: 10-14-2021

Excavator:

Operator: Green Earthworks

Project No.: 81215171

TEST PIT LOG NO. TP-08

PROJECT: SAIA Motor Freight Terminal

CLIENT: SAIA LTL Freight Johns Creek, GA

SITE: Smokey Point Blvd and 128th St NE Marysville, WA

LOCATION See Exploration Plan

Latitude: 48.1117° Longitude: -122.1760°

Approximate Surface Elev.: 85 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	Sample No.	WATER CONTENT (%)
1		1.0	**TOPSOIL**, with organics, dark brown, moist, Silty Sand (SM), with roots	84+/-					
2		2.5	**SILTY SAND (SM)**, light brown, moist	82.5+/-					
3		5.0	**POORLY GRADED SAND (SP)**, fine to medium grained, light brown to gray, moist, loose	80+/-	5	▽	Grab	S-1	
			Test Pit Terminated at 5 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Excavation

Abandonment Method:
Test pit backfilled with excavated soil

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While excavating*

Terracon
21905 64th Ave W, Ste 100
Mountlake Terrace, WA

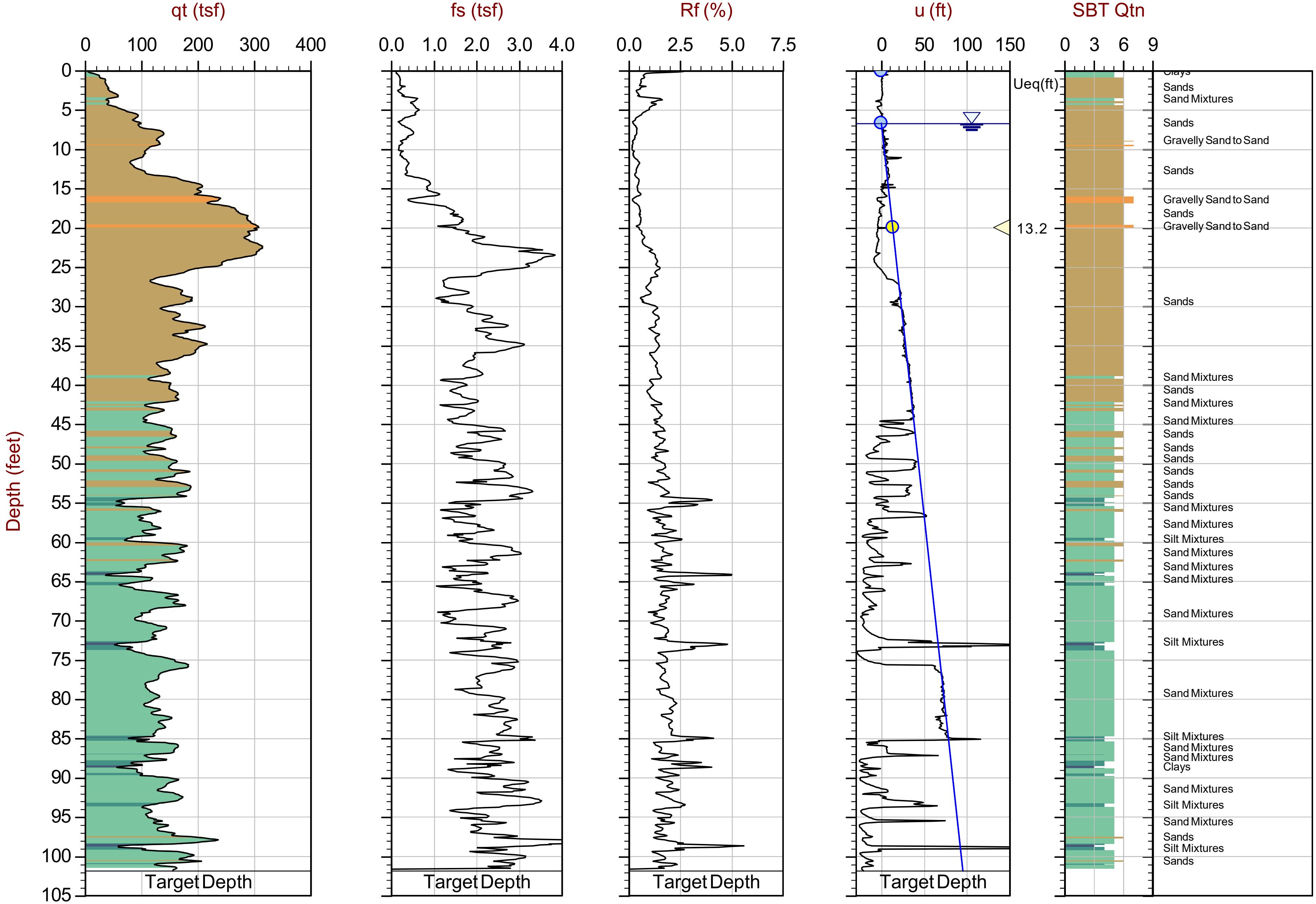
Test Pit Started: 10-14-2021	Test Pit Completed: 10-14-2021
Excavator:	Operator: Green Earthworks
Project No.: 81215171	

ConeTec

Terracon

Job No: 21-59-23130
Date: 2021-10-15 08:45
Site: SAIA Freight Terminal

Sounding: CPT-B01
Cone: 730:T1500F15U35



Max Depth: 31.050 m / 101.87 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-59-23130_SP01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 48.11194 Long: -122.17801

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

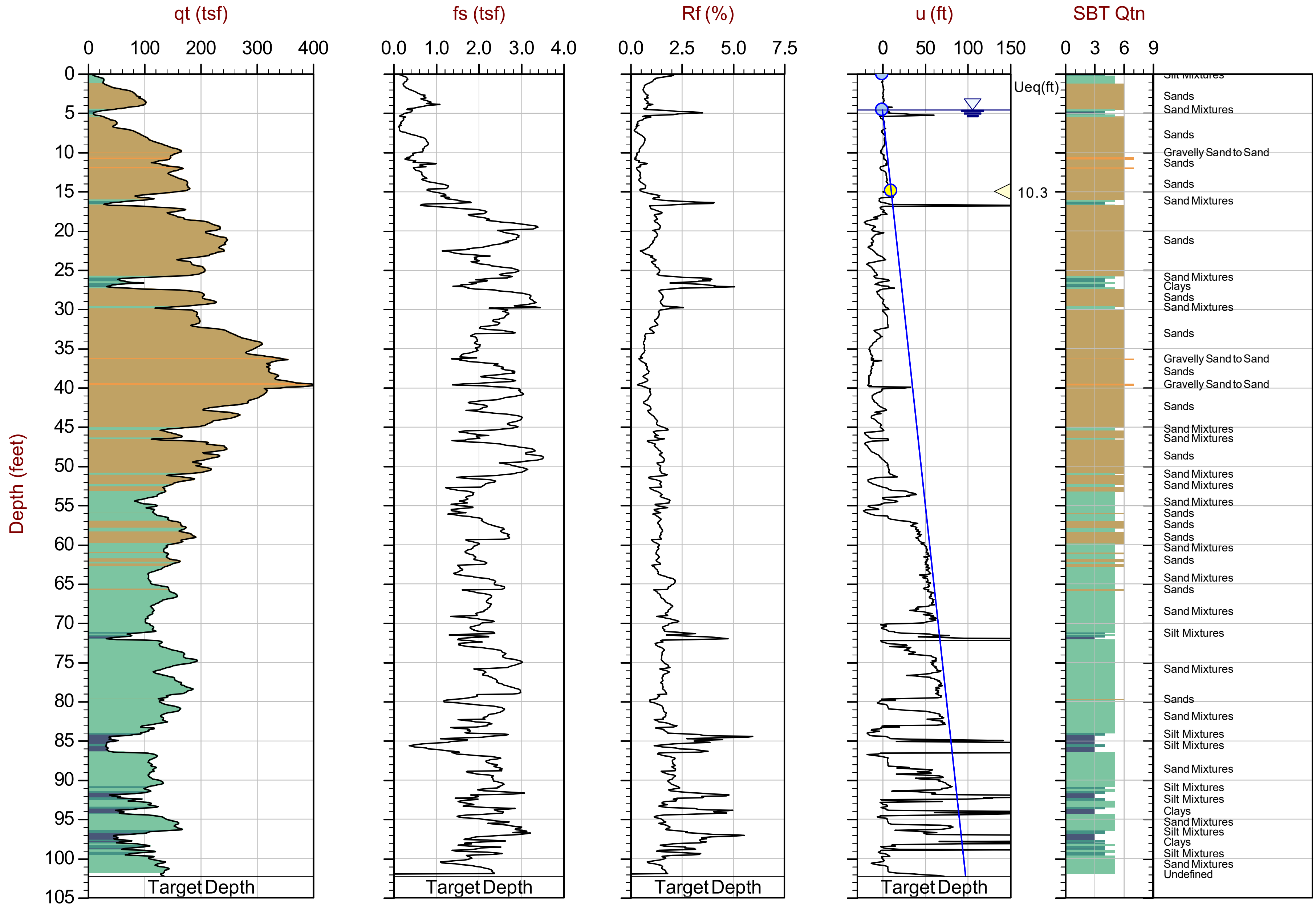
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Terracon

Job No: 21-59-23130
Date: 2021-10-15 10:19
Site: SAIA Freight Terminal

Sounding: CPT-B02
Cone: 730:T1500F15U35



Max Depth: 31.175 m / 102.28 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-59-23130_CP02.COR
Unit Wt: SBTQtn (PKR2009)

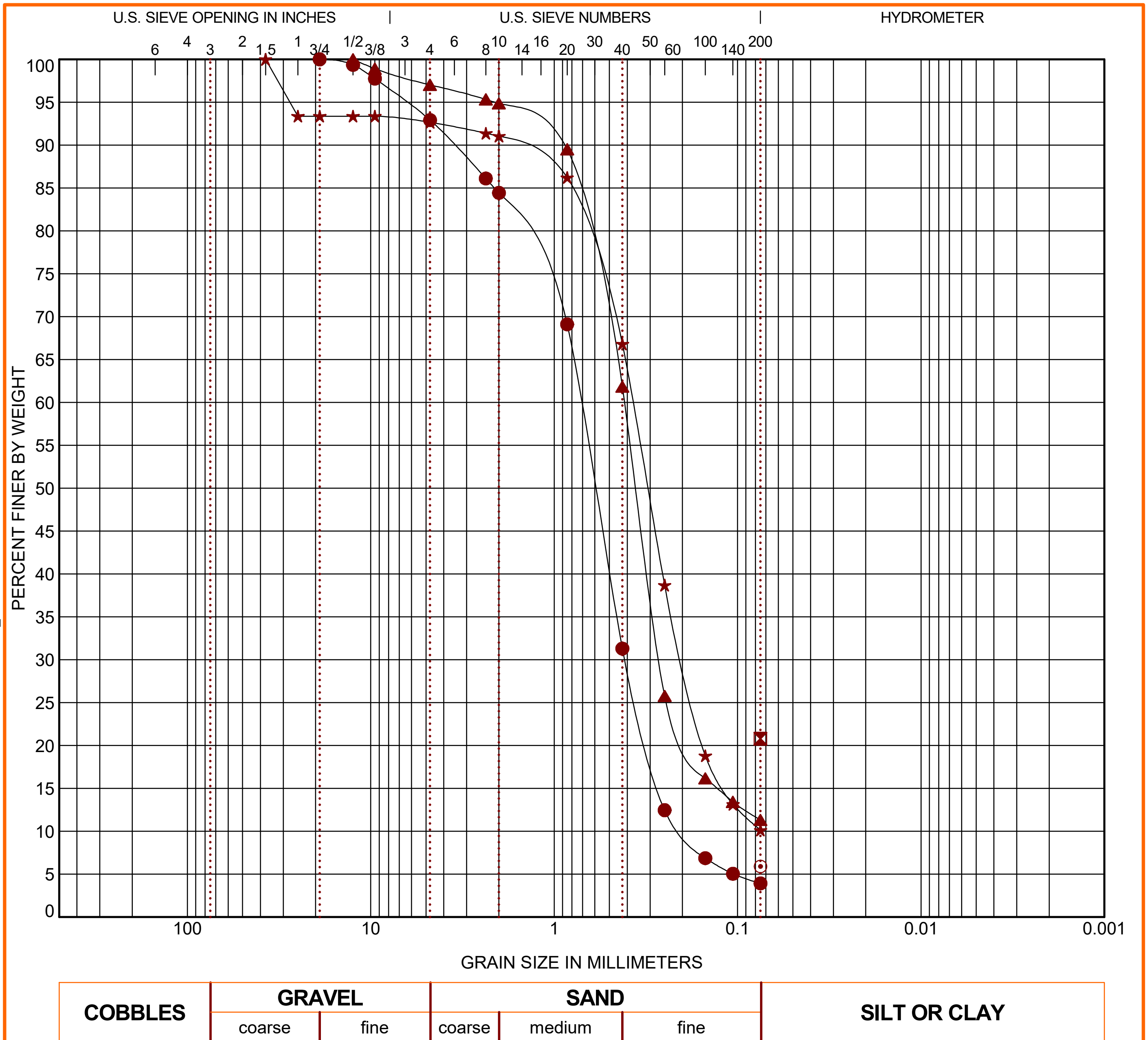
SBT: Robertson, 2009 and 2010
Coords: Lat: 48.11194 Long: -122.17686

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



	Boring ID	Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	B-B01	10 - 11.5	POORLY GRADED SAND (SP)	18.5				1.17	3.60
⊠	B-B01	20 - 21.5	SILTY SAND (SM)	16.1					
▲	B-B03	5 - 6.5	WELL GRADED SAND with SILT (SW-SM)	22.3				2.84	6.85
★	B-B03	7.5 - 9	POORLY GRADED SAND with SILT (SP-SM)	22.7				1.45	5.06
⊙	B-B03	15 - 16.5	POORLY GRADED SAND with SILT (SP-SM)	19.1					

	Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Silt	%Fines	%Clay
●	B-B01	10 - 11.5	19	0.719	0.41	0.2	0.0	7.1	89.0		3.9	
⊠	B-B01	20 - 21.5	0.075								20.8	
▲	B-B03	5 - 6.5	12.5	0.414	0.266		0.0	3.0	85.7		11.3	
★	B-B03	7.5 - 9	37.5	0.374	0.2		0.0	7.3	82.5		10.1	
⊙	B-B03	15 - 16.5	0.075								5.9	

PROJECT: SAIA Motor Freight Terminal

SITE: Smokey Point Blvd and 128th St NE
Marysville, WA

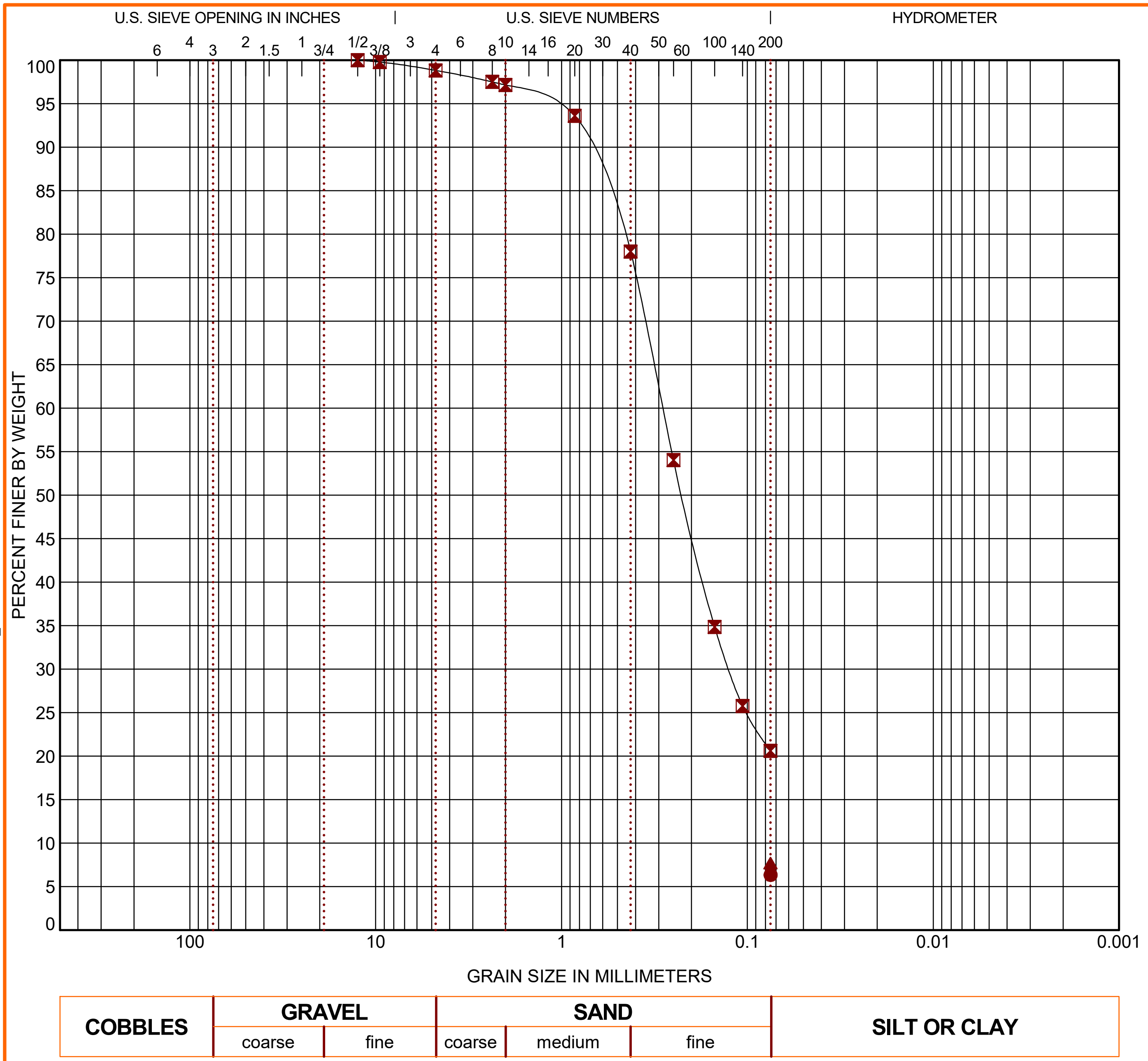
Terracon
21905 64th Ave W, Ste 100
Mountlake Terrace, WA

PROJECT NUMBER: 81215171

CLIENT: SAIA LTL Freight
Johns Creek, GA

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



	Boring ID	Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	B-B03	25 - 26.5	POORLY GRADED SAND with SILT (SP-SM)	24.7					
⊠	B-P08p	2.5 - 4	SILTY SAND (SM)	20.9					
▲	B-D13p	2.5 - 4	POORLY GRADED SAND with SILT (SP-SM)	13.0					

	Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Silt	%Fines	%Clay
●	B-B03	25 - 26.5	0.075								6.3	
⊠	B-P08p	2.5 - 4	12.5	0.285	0.125		0.0	1.2	78.2		20.6	
▲	B-D13p	2.5 - 4	0.075								7.7	

PROJECT: SAIA Motor Freight Terminal

SITE: Smokey Point Blvd and 128th St NE
Marysville, WA

Terracon
21905 64th Ave W, Ste 100
Mountlake Terrace, WA

PROJECT NUMBER: 81215171

CLIENT: SAIA LTL Freight
Johns Creek, GA

MATERIALS TESTING & CONSULTING, INC.

Client:	Terracon	**Date:**	November 1, 2021
Address:	21905 64th Ave W, Suite 100	**Project:**	SAIA
	Mountlake Terrace, WA 98043	**Project #:**	21B279-03
Attn:	Nithybhan Chandaresan	**Sample #:**	B21-2276
Revised on:		**Date sampled:**	October 20, 2021

As requested MTC, Inc. has performed the following test(s) on the sample referenced above. The testing was performed in accordance with current applicable AASHTO or ASTM standards as indicated below. The results obtained in our laboratory were as follows below or on the attached pages:

	Test(s) Performed:	Test Results		Test(s) Performed:	Test Results
X	Sieve Analysis	Please See Attached Report		Sulfate Soundness	
X	Proctor	116.1 pcf at 11.3%		Bulk Density & Voids	
	Sand Equivalent			WSDOT Degradation	
	Fracture Count			LA Abrasion	
	Moisture Content		**X**	CBR	Please See Attached Report
	Specific Gravity, Coarse				
	Specific Gravity, Fine				
	Hydrometer Analysis				
	Atterberg Limits				

If you have any questions concerning the test results, the procedures used, or if we can be of any further assistance please call on us at the number below.

Respectfully Submitted,
Meghan Blodgett-Carrillo
WABO Supervising Laboratory Technician

MATERIALS TESTING & CONSULTING, INC.

Sieve Report

Project:	SAIA	**Date Received:**	20-Oct-21
Project #:	21B279-03	**Sampled By:**	Client
Client:	Terracon	**Date Tested:**	21-Oct-21
Source:	Not Reported - CBR	**Tested By:**	K. Mendez
Sample#:	B21-2276		

Unified Soil Classification System, ASTM-2487
SM, Silty Sand
Sample Color:
brown

ACCREDITED Certificate #: 1366.01

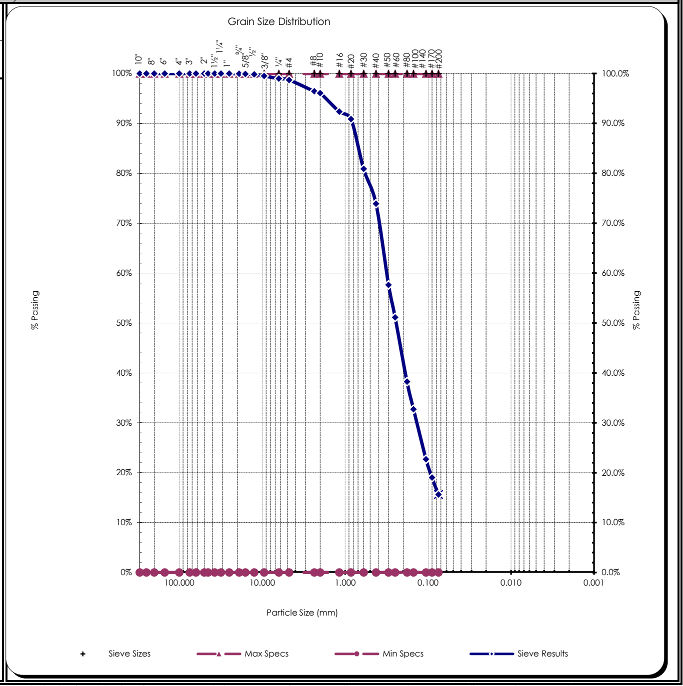
ASTM D2216, ASTM D2419, ASTM D4318, ASTM D5281

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ = 0.024 mm	% Gravel = 1.3%	Coeff. of Curvature, C_C = 1.25	
$D_{(10)}$ = 0.048 mm	% Sand = 83.1%	Coeff. of Uniformity, C_U = 6.63	
$D_{(15)}$ = 0.072 mm	% Silt & Clay = 15.6%	Fineness Modulus = 1.42	
$D_{(30)}$ = 0.138 mm	Liquid Limit = n/a	Plastic Limit = n/a	
$D_{(50)}$ = 0.244 mm	Plasticity Index = n/a	Moisture %, as sampled = n/a	
$D_{(60)}$ = 0.318 mm	Sand Equivalent = n/a	Req'd Sand Equivalent =	
$D_{(90)}$ = 0.829 mm	Fracture %, 1 Face = n/a	Req'd Fracture %, 1 Face =	
Dust Ratio = 15/71	Fracture %, 2+ Faces = n/a	Req'd Fracture %, 2+ Faces =	

ASTM C136, ASTM D6913, ASTM C117

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00	100%	100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00	100%	100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00	100%	100%	100.0%	0.0%
3/4"	19.00	100%	100%	100.0%	0.0%
5/8"	16.00		100%	100.0%	0.0%
1/2"	12.50	100%	100%	100.0%	0.0%
3/8"	9.50	99%	99%	100.0%	0.0%
1/4"	6.30		99%	100.0%	0.0%
#4	4.75	99%	99%	100.0%	0.0%
#8	2.36		96%	100.0%	0.0%
#10	2.00	96%	96%	100.0%	0.0%
#16	1.18		92%	100.0%	0.0%
#20	0.850	91%	91%	100.0%	0.0%
#30	0.600		81%	100.0%	0.0%
#40	0.425	74%	74%	100.0%	0.0%
#50	0.300		58%	100.0%	0.0%
#60	0.250	51%	51%	100.0%	0.0%
#80	0.180		38%	100.0%	0.0%
#100	0.150	33%	33%	100.0%	0.0%
#140	0.106		23%	100.0%	0.0%
#170	0.090		19%	100.0%	0.0%
#200	0.075	15.6%	15.6%	100.0%	0.0%



Comments:

Reviewed by:
Meghan Blodgett-Carrillo

Proctor Report

Project: SAIA	**Date Received:** 20-Oct-21	**Unified Soils Classification System, ASTM D-2487**	
Project #: 21B279-03	**Sampled By:** Client	SM, Silty Sand	
Client: Terracon	**Date Tested:** 21-Oct-21	**Sample Color**	
Source: Not Reported - CBR	**Tested By:** K. Mendez	brown	
Sample#: B21-2276			

Sample Prepared:	Moist: X	Manual:	
	Dry:	Mechanical: X	
Test Standard:	ASTM D698:	AASHTO T 99:	Method
	ASTM D 1557: X	AASHTO T 180:	A

Assumed Sp. Gr. 2.50

Point Number	Percent Moisture	Dry Density
1	8.3 %	111.4
2	10.4 %	115.5
3	12.4 %	115.8
4	14.2 %	111.8

Uncorrected Proctor Value

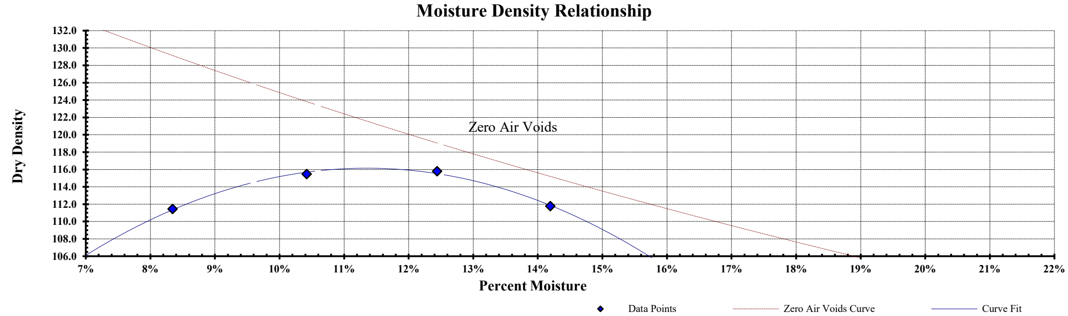
Max. Dry Density		Optimum Moist
116.1	**lbs/ft³**	**11.3 %**

Value w/ Oversize Correction Applied

Max. Dry Density		Optimum Moist
N/A	**lbs/ft³**	**N/A**

ACCREDITED
Certificate #: 1366.01

Moisture Density Relationship



ASTM C136

Sieve US	Size mm	Percent Passing	Specifications Max	Min
12.00"	300.00		100 %	0 %
10.00"	250.00		100 %	0 %
8.00"	200.00		100 %	0 %
6.00"	150.00		100 %	0 %
4.00"	100.00	100 %	100 %	0 %
3.00"	75.00		100 %	0 %
2.50"	63.00		100 %	0 %
2.00"	50.00	100 %	100 %	0 %
1.75"	45.00		100 %	0 %
1.50"	37.50		100 %	0 %
1.25"	31.50		100 %	0 %
1.00"	25.00	100 %	100 %	0 %
3/4"	19.00	100 %	100 %	0 %
5/8"	16.00		100 %	0 %
1/2"	12.50	100 %	100 %	0 %
3/8"	9.50	99 %	100 %	0 %
1/4"	6.30		100 %	0 %
#4	4.75	99 %	100 %	0 %
#8	2.36		100 %	0 %
#10	2.00	96 %	100 %	0 %
#16	1.18		100 %	0 %
#20	0.850	91 %	100 %	0 %
#30	0.600		100 %	0 %
#40	0.425	74 %	100 %	0 %
#50	0.300		100 %	0 %
#60	0.250	51 %	100 %	0 %
#80	0.180		100 %	0 %
#100	0.150	33 %	100 %	0 %
#140	0.106		100 %	0 %
#170	0.090		100 %	0 %
#200	0.075	15.6 %	100.0 %	0.0 %

ASTM D4718, Misc. Oversize Correction Values

% Oversize Mat'l: 1%

% Oversize Retained	Corrected Density	Optimum Moisture
5%	117.6	10.8%
10%	119.2	10.3%
15%	120.8	9.7%
20%	122.4	9.2%
25%	124.1	8.6%
30%	125.8	8.1%

Specs: No Specs **Meets Specs? N/A**

% Gravel: 1.3%	C_C: 1.25	$D_{(10)}$: 0.048
% Sand: 83.1%	C_U: 6.63	$D_{(30)}$: 0.138
% Silt&Clay: 15.6%	FM: 1.42	$D_{(60)}$: 0.318
LL: n/a	PL: n/a	PI: n/a
Sand Equivalent: n/a	Req'd Sand Equivalent:	
Fracture %, 1 Face: n/a	Req'd Fracture %, 1 Face:	
Fracture %, 2+ Faces: n/a	Req'd Fracture %, 2+ Faces:	

Comments:

Reviewed by: Meghan Blodgett-Carrillo

MATERIALS TESTING & CONSULTING, INC.

CBR Report

Project:	SAIA	**Date Received:**	20-Oct-21
Project #:	21B279-03	**Sampled By:**	Client
Client:	Terracon	**Date Tested:**	21-Oct-21
Source:	Not Reported - CBR	**Tested By:**	K. Mendez
Sample#:	B21-2276		

Unified Soils Classification System, ASTM D-2487
SM, Silty Sand
Sample Color
brown

ACCREDITED
Certificate #: 1366.01

CBR Load Ring
Calibrated 3/2/2021
y=mx+b

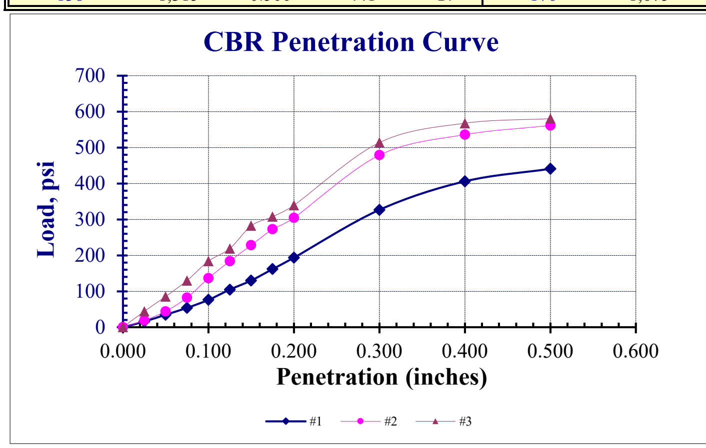
m	b
9.465011	9.224079

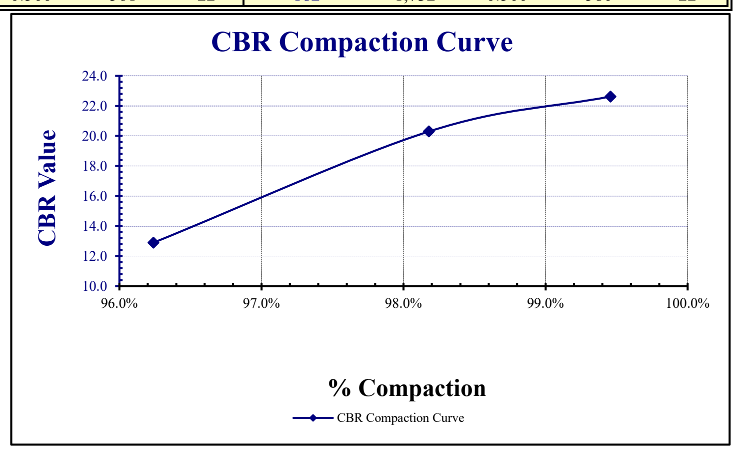
California Bearing Ratio, ASTM 1883

			Blows/Lift	Blows/Lift	Blows/Lift	
Test Standard			**10**	**25**	**56**	
AASHTO T 99:		Weight of Mold + Soils:	27.3	25.9	25.8	lbs
ASTM D 698:		Weight of Mold:	17.8	16.2	16.0	lbs
AASHTO T 180:		Wet Weight of Soils:	9.5	9.7	9.8	lbs
ASTM D 1557:	X	Wet Density:	126.6	130.0	131.5	lbs/ft^3
Method:	A	% Moisture:	13.2%	14.0%	13.8%	
		Dry Density:	**111.8**	**114.0**	**115.5**	lbs/ft^3
Sample Prepared		**% Compaction:**	**96.2%**	**98.2%**	**99.5%**	
Moist:	X	Initial Swell Reading:	0.37	0.6	0.45	
Dry:		Final Swell Reading:	0.384	0.611	0.454	
Manual:		**% Swell:**	0.31%	0.24%	0.09%	
Mechanical:	X	**CBR Value:**	12.9	20.3	22.6	
		Adjusted CBR Value:				

Max. Dry Density		Optimum Moist.
116.1	lbs/ft^3	**11.3%**

Dial Reading	#1 Load	Depth Inches	#1 psi	CBR Value	Dial Reading	#2 Load	Depth Inches	#2 psi	CBR Value	Dial Reading	#3 Load	Depth Inches	#3 psi	CBR Value
0	0	0.000	0		0	0	0.000	0		0	0	0.000	0	
4	47	0.025	16		5	57	0.025	19		13	132	0.025	44	
10	104	0.050	35		13	132	0.050	44		26	255	0.050	86	
16	161	0.075	54		25	246	0.075	82		40	388	0.075	130	
23	227	0.100	76	**8**	42	407	0.100	136	**14**	57	549	0.100	184	**18**
32	312	0.125	105		57	549	0.125	184		68	653	0.125	219	
40	388	0.150	130		71	681	0.150	228		88	842	0.150	282	
50	482	0.175	162		85	814	0.175	273		96	918	0.175	308	
60	577	0.200	193	**13**	95	908	0.200	304	**20**	106	1,013	0.200	339	**23**
102	975	0.300	327	**17**	150	1,429	0.300	479	**25**	161	1,533	0.300	514	**27**
127	1,211	0.400	406	**18**	168	1,599	0.400	536	**23**	178	1,694	0.400	568	**25**
138	1,315	0.500	441	**17**	176	1,675	0.500	561	**22**	182	1,732	0.500	580	**22**





Comments: ______________________________

Reviewed by: ______________________________
Meghan Blodgett-Carrillo

750 Pilot Road, Suite F
Las Vegas, Nevada 89119
(702) 597-9393

Terracon GeoReport

Client
SAIA LTL Freight

Project
SAIA Motor Freight Terminal

Sample Submitted By: Terracon (81) **Date Received:** 11/19/2021 **Lab No.: 21-0887**

Results of Corrosion Analysis

Sample Number	S-1	S-2	S-1
Sample Location	B-B03	TP-5	TP-8
Sample Depth (ft.)	2.5-6.0	2.5-3.0	2.5-3.0
pH Analysis, ASTM G 51	7.10	6.60	6.48
Water Soluble Sulfate (SO4), ASTM C 1580 (mg/kg)	77	56	28
Sulfides, AWWA 4500-S D, (mg/kg)	Nil	Nil	Nil
Chlorides, ASTM D 512, (mg/kg)	45	28	25
Red-Ox, ASTM G 200, (mV)	+718	+717	+725
Total Salts, AWWA 2520 B, (mg/kg)	83	84	52
Saturated Minimum Resistivity, ASTM G 57, (ohm-cm)	18430	27160	51410

Analyzed By: N. Campo
Nathan Campo
Engineering Technician II

SUPPORTING INFORMATION

Contents:

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAIA Motor Freight Terminal ■ Marysville, WA

Terracon Project No. 81215171

SAMPLING	WATER LEVEL	FIELD TESTS
Grab Sample; Standard Penetration Test	**Water Initially Encountered** **Water Level After a Specified Period of Time** **Water Level After a Specified Period of Time** **Cave In Encountered** Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	**N** Standard Penetration Test Resistance (Blows/Ft.) **(HP)** Hand Penetrometer **(T)** Torvane **(DCP)** Dynamic Cone Penetrometer **UC** Unconfined Compressive Strength **(PID)** Photo-Ionization Detector **(OVA)** Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

LOCATION AND ELEVATION NOTES

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		**CONSISTENCY OF FINE-GRAINED SOILS** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (tsf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

RELEVANCE OF SOIL BORING LOG

The soil boring logs contained within this document are intended for application to the project as described in this document. Use of these soil boring logs for any other purpose may not be appropriate.

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification: Group Symbol	Soil Classification: Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]	GW	Well-graded gravel [F]
			$Cu < 4$ and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]	SW	Well-graded sand [I]
			$Cu < 6$ and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	$PI > 7$ and plots on or above "A" line [J]	CL	Lean clay [K, L, M]
			$PI < 4$ or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: 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.

[D] Sands with 5 to 12% fines require dual symbols: 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.

[E] $Cu = D_{60}/D_{10} \quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains $\geq$ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains $\geq$ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains $\geq$ 30% plus No. 200 predominantly sand, add "sandy" to group name.

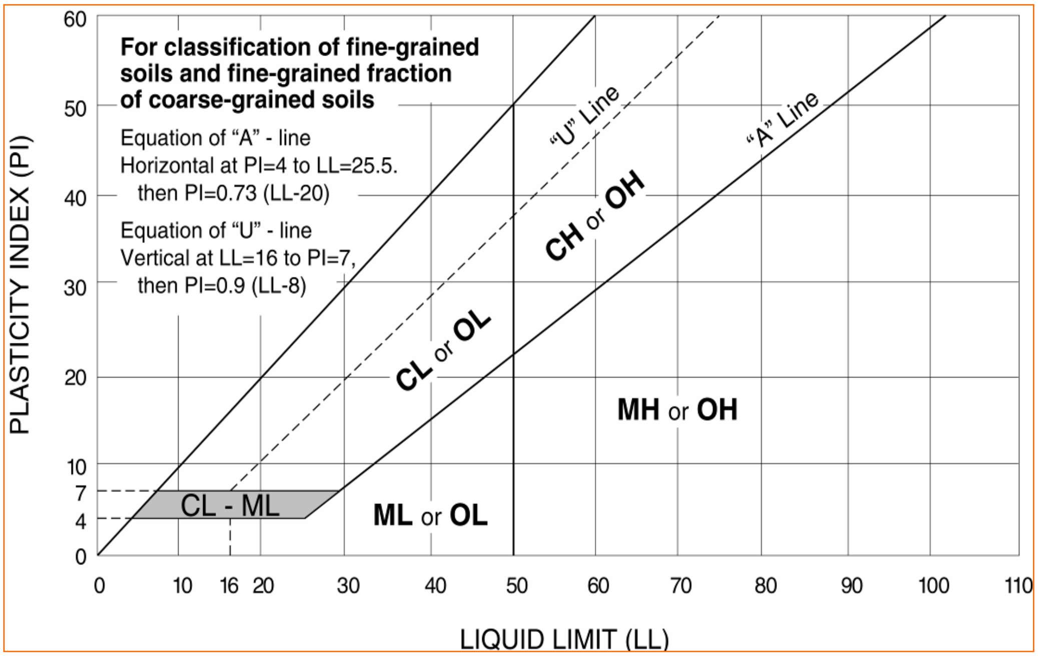
[M] If soil contains $\geq$ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] $PI \geq 4$ and plots on or above "A" line.

[O] $PI < 4$ or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



For classification of fine-grained soils and fine-grained fraction of coarse-grained soils
Equation of "A" - line
Horizontal at PI=4 to LL=25.5.
then PI=0.73 (LL-20)
Equation of "U" - line
Vertical at LL=16 to PI=7,
then PI=0.9 (LL-8)
"U" Line
"A" Line
CH or OH
CL or OL
MH or OH
ML or OL
CL - ML
PLASTICITY INDEX (PI)
LIQUID LIMIT (LL)
0
4
7
10
20
30
40
50
60
0
10
16
20
30
40
50
60
70
80
90
100
110

PRESENTATION OF SITE INVESTIGATION RESULTS

SAIA Freight Terminal

Prepared for:

Terracon Consultants, Inc.

ConeTec Job No: 21-59-23130

Project Start Date: 15-OCT-2021
Project End Date: 15-OCT-2021
Report Date: 21-OCT-2021

Prepared by:

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ConeTec

Introduction

The enclosed report presents the results of the site investigation program conducted by ConeTec Inc. for Terracon Consultants, Inc. at 4127 128th St NE, Marysville, WA 98271. The program consisted of cone penetration tests and seismic cone penetration tests.

Project Information

Project	
Client	Terracon Consultants, Inc.
Project	SAIA Freight Terminal
ConeTec project number	21-59-23130

An aerial overview from Google Earth including the CPTu test locations is presented below.

Rig Description	Deployment System	Test Type
C20-30Ton Truck Rig	Integrated Push Cylinders	CPTu

Coordinates		
Test Type	Collection Method	EPSG Number
CPTu	Consumer grade GPS	4326

Cone Penetrometers Used for this Project						
Cone Description	Cone Number	Cross Sectional Area (cm^2)	Sleeve Area (cm^2)	Tip Capacity (bar)	Sleeve Capacity (bar)	Pore Pressure Capacity (bar)
730: T1500F15U35	730	15.0	225	1500	15	35
Cone 730 was used for all CPTu soundings						

Cone Penetration Test (CPTu)	
Depth reference	Depths are referenced to the existing ground surface at the time of each test.
Tip and sleeve data offset	0.1 meter This has been accounted for in the CPT data files.
Additional plots	• Normalized plots with Qtn and Norm: Fr(%) • Advanced plots with Ic, Su, phi and N(60)/N1(60) • Soil Behaviour Type (SBT) scatter plots • Seismic shear wave (Vs) plots • Seismic shear wave (Vs) Wave Trace plots

Calculated Geotechnical Parameter Tables	
Additional information	The Normalized Soil Behaviour Type Chart based on Q_{tn} (SBT Q_{tn}) (Robertson, 2009) was used to classify the soil for this project. A detailed set of calculated CPTu parameters have been generated and are provided in Excel format files in the release folder. The CPTu parameter calculations are based on values of corrected tip resistance (q_t) sleeve friction (f_s) and pore pressure (u_2). Effective stresses are calculated based on unit weights that have been assigned to the individual soil behaviour type zones and the assumed equilibrium pore pressure profile.

Limitations

This report has been prepared for the exclusive use of Terracon Consultants, Inc. (Client) for the project titled “SAIA Freight Terminal”. The report’s contents may not be relied upon by any other party without the express written permission of ConeTec Inc. (ConeTec). ConeTec has provided site investigation services, prepared the factual data reporting and provided geotechnical parameter calculations consistent with current best practices. No other warranty, expressed or implied, is made.

The information presented in the report document and the accompanying data set pertain to the specific project, site conditions and objectives described to ConeTec by the Client. In order to properly understand the factual data, assumptions and calculations, reference must be made to the documents provided and their accompanying data sets, in their entirety.

Cone penetration tests (CPTu) are conducted using an integrated electronic piezocone penetrometer and data acquisition system manufactured by Adara Systems Ltd., a subsidiary of ConeTec.

ConeTec's piezocone penetrometers are compression type designs in which the tip and friction sleeve load cells are independent and have separate load capacities. The piezocones use strain gauged load cells for tip and sleeve friction and a strain gauged diaphragm type transducer for recording pore pressure. The piezocones also have a platinum resistive temperature device (RTD) for monitoring the temperature of the sensors, an accelerometer type dual axis inclinometer and two geophone sensors for recording seismic signals. All signals are amplified and measured with minimum sixteen-bit resolution down hole within the cone body, and the signals are sent to the surface using a high bandwidth, error corrected digital interface through a shielded cable.

ConeTec penetrometers are manufactured with various tip, friction and pore pressure capacities in both 10 cm^2 and 15 cm^2 tip base area configurations in order to maximize signal resolution for various soil conditions. The specific piezocone used for each test is described in the CPT summary table presented in the first appendix. The 15 cm^2 penetrometers do not require friction reducers as they have a diameter larger than the deployment rods. The 10 cm^2 piezocones use a friction reducer consisting of a rod adapter extension behind the main cone body with an enlarged cross sectional area (typically 44 millimeters diameter over a length of 32 millimeters with tapered leading and trailing edges) located at a distance of 585 millimeters above the cone tip.

The penetrometers are designed with equal end area friction sleeves, a net end area ratio of 0.8 and cone tips with a 60 degree apex angle.

All ConeTec piezocones can record pore pressure at various locations. Unless otherwise noted, the pore pressure filter is located directly behind the cone tip in the "u_2" position (ASTM Type 2). The filter is six millimeters thick, made of porous plastic (polyethylene) having an average pore size of 125 microns (90-160 microns). The function of the filter is to allow rapid movements of extremely small volumes of water needed to activate the pressure transducer while preventing soil ingress or blockage.

The piezocone penetrometers are manufactured with dimensions, tolerances and sensor characteristics that are in general accordance with the current ASTM D5778 standard. ConeTec's calibration criteria also meets or exceeds those of the current ASTM D5778 standard. An illustration of the piezocone penetrometer is presented in Figure CPTu.

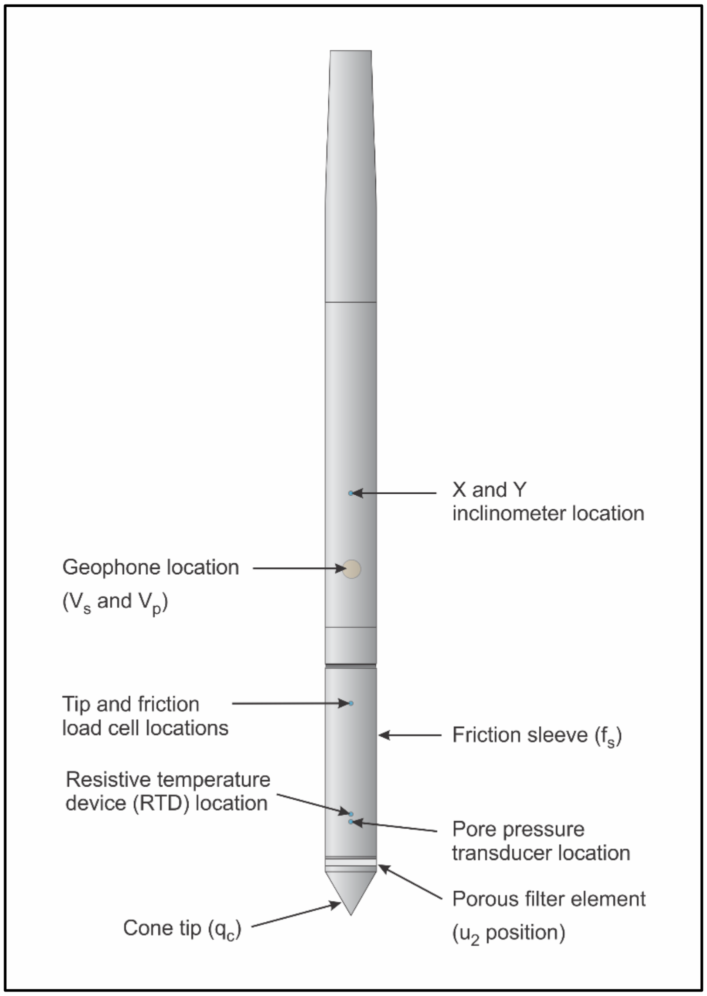

Figure CPTu. Piezocone Penetrometer (15 cm^2)

The ConeTec data acquisition systems consist of a Windows based computer and a signal interface box and power supply. The signal interface combines depth increment signals, seismic trigger signals and the downhole digital data. This combined data is then sent to the Windows based computer for collection and presentation. The data is recorded at fixed depth increments using a depth wheel attached to the push cylinders or by using a spring loaded rubber depth wheel that is held against the cone rods. The typical recording interval is 2.5 centimeters; custom recording intervals are possible.

The system displays the CPTu data in real time and records the following parameters to a storage media during penetration:

- Depth
- Uncorrected tip resistance (q_c)
- Sleeve friction (f_s)
- Dynamic pore pressure (u)
- Additional sensors such as resistivity, passive gamma, ultra violet induced fluorescence, if applicable

All testing is performed in accordance to ConeTec's CPTu operating procedures which are in general accordance with the current ASTM D5778 standard.

Prior to the start of a CPTu sounding a suitable cone is selected, the cone and data acquisition system are powered on, the pore pressure system is saturated with silicone oil and the baseline readings are recorded with the cone hanging freely in a vertical position.

The CPTu is conducted at a steady rate of two centimeters per second, within acceptable tolerances. Typically one meter length rods with an outer diameter of 1.5 inches (38.1 millimeters) are added to advance the cone to the sounding termination depth. After cone retraction final baselines are recorded.

Additional information pertaining to ConeTec's cone penetration testing procedures:

- Each filter is saturated in silicone oil under vacuum pressure prior to use
- Baseline readings are compared to previous readings
- Soundings are terminated at the client's target depth or at a depth where an obstruction is encountered, excessive rod flex occurs, excessive inclination occurs, equipment damage is likely to take place, or a dangerous working environment arises
- Differences between initial and final baselines are calculated to ensure zero load offsets have not occurred and to ensure compliance with ASTM standards

The interpretation of piezocone data for this report is based on the corrected tip resistance (q_t), sleeve friction (f_s) and pore water pressure (u). The interpretation of soil type is based on the correlations developed by Robertson et al. (1986) and Robertson (1990, 2009). It should be noted that it is not always possible to accurately identify a soil behavior type based on these parameters. In these situations, experience, judgment and an assessment of other parameters may be used to infer soil behavior type.

The recorded tip resistance (q_c) is the total force acting on the piezocone tip divided by its base area. The tip resistance is corrected for pore pressure effects and termed corrected tip resistance (q_t) according to the following expression presented in Robertson et al. (1986):

$$q_t = q_c + (1\text{-}a) \bullet u_2$$

where: q_t is the corrected tip resistance
q_c is the recorded tip resistance
u_2 is the recorded dynamic pore pressure behind the tip (u_2 position)
a is the Net Area Ratio for the piezocone (0.8 for ConeTec probes)

The sleeve friction (f_s) is the frictional force on the sleeve divided by its surface area. As all ConeTec piezocones have equal end area friction sleeves, pore pressure corrections to the sleeve data are not required.

The dynamic pore pressure (u) is a measure of the pore pressures generated during cone penetration. To record equilibrium pore pressure, the penetration must be stopped to allow the dynamic pore pressures to stabilize. The rate at which this occurs is predominantly a function of the permeability of the soil and the diameter of the cone.

The friction ratio (R_f) is a calculated parameter. It is defined as the ratio of sleeve friction to the tip resistance expressed as a percentage. Generally, saturated cohesive soils have low tip resistance, high friction ratios and generate large excess pore water pressures. Cohesionless soils have higher tip resistances, lower friction ratios and do not generate significant excess pore water pressure.

A summary of the CPTu soundings along with test details and individual plots are provided in the appendices. A set of files with calculated geotechnical parameters were generated for each sounding based on published correlations and are provided in Excel format in the data release folder. Information regarding the methods used is also included in the data release folder.

For additional information on CPTu interpretations and calculated geotechnical parameters, refer to Robertson et al. (1986), Lunne et al. (1997), Robertson (2009), Mayne (2013, 2014) and Mayne and Peuchen (2012).

Shear wave velocity (Vs) testing is performed in conjunction with the piezocone penetration test (SCPTu) in order to collect interval velocities. For some projects seismic compression wave velocity (Vp) testing is also performed.

ConeTec's piezocone penetrometers are manufactured with one horizontally active geophone (28 hertz) and one vertically active geophone (28 hertz). Both geophones are rigidly mounted in the body of the cone penetrometer, 0.2 meters behind the cone tip. The vertically mounted geophone is more sensitive to compression waves.

Shear waves are typically generated by using an impact hammer horizontally striking a beam that is held in place by a normal load. In some instances, an auger source or an imbedded impulsive source may be used for both shear waves and compression waves. The hammer and beam act as a contact trigger that initiates the recording of the seismic wave traces. For impulsive devices an accelerometer trigger may be used. The traces are recorded in the memory of the cone using a fast analog to digital converter. The seismic trace is then transmitted digitally uphole to a Windows based computer through a signal interface box for recording and analysis. An illustration of the shear wave testing configuration is presented in Figure SCPTu-1.

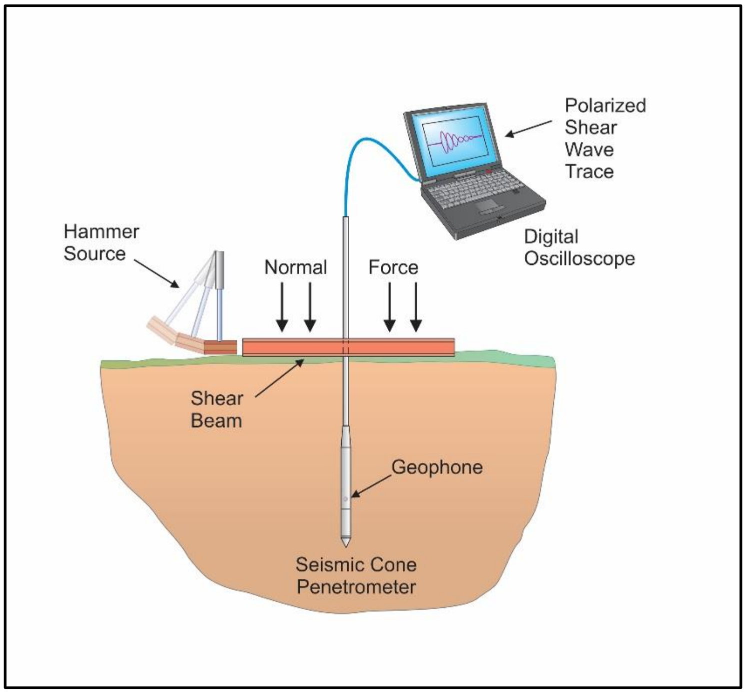

Figure SCPTu-1. Illustration of the SCPTu system

All testing is performed in accordance to ConeTec's SCPTu operating procedures which are in general accordance with the current ASTM D5778 and ASTM D7400 standards.

Prior to the start of a SCPTu sounding, the procedures described in the Cone Penetration Test section are followed. In addition, the active axis of the geophone is aligned parallel to the beam (or source) and the horizontal offset between the cone and the source is measured and recorded.

Prior to recording seismic waves at each test depth, cone penetration is stopped and the rods are decoupled from the rig to avoid transmission of rig energy down the rods. Typically, five wave traces for each orientation are recorded for quality control and uncertainty analysis purposes. After reviewing wave traces for consistency the cone is pushed to the next test depth (typically one meter intervals or as requested by the client). Figure SCPTu-2 presents an illustration of a SCPTu test.

For additional information on seismic cone penetration testing refer to Robertson et al. (1986).

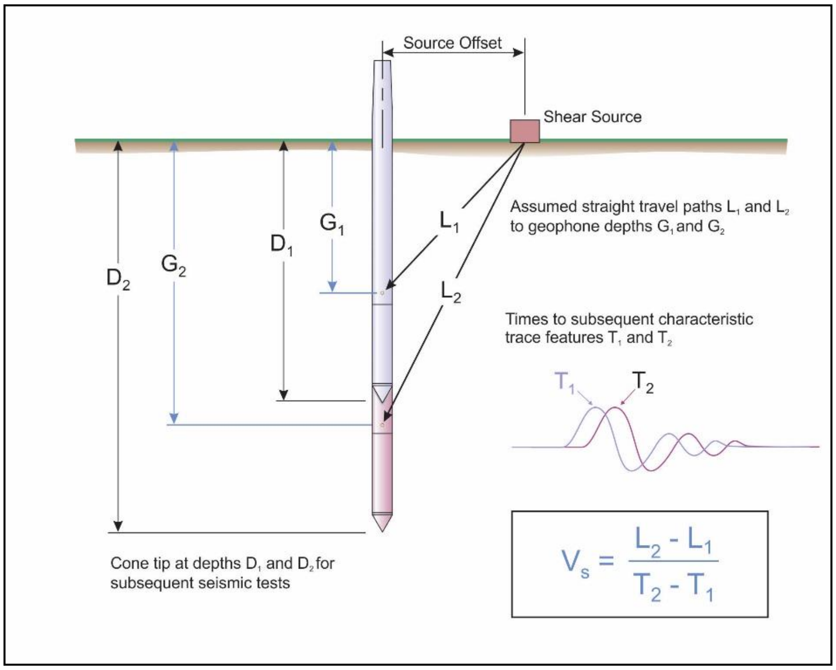

Figure SCPTu-2. Illustration of a seismic cone penetration test

Calculation of the interval velocities are performed by visually picking a common feature (e.g. the first characteristic peak, trough, or crossover) on all of the recorded wave sets and taking the difference in ray path divided by the time difference between subsequent features. Ray path is defined as the straight line distance from the seismic source to the geophone, accounting for beam offset, source depth and geophone offset from the cone tip.

For all SCPTu soundings that have achieved a depth of at least 100 feet (30 meters), the average shear wave velocity to a depth of 100 feet ($\bar{v}_s$) has been calculated and provided for all applicable soundings using the following equation presented in ASCE (2010).

$$\bar{v}_s = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{v_{si}}}$$

where: $\bar{v}_s$ = average shear wave velocity ft/s (m/s)

d_i = the thickness of any layer between 0 and 100 ft (30 m)

v_{si} = the shear wave velocity in ft/s (m/s)

$\sum_{i=1}^{n} d_i$ = the total thickness of all layers between 0 and 100 ft (30 m)

Average shear wave velocity, $\bar{v}_s$ is also referenced to V_{s100} or V_{s30}.

The layer travel times refers to the travel times propagating in the vertical direction, not the measured travel times from an offset source.

Tabular results and SCPTu plots are presented in the relevant appendix.

The cone penetration test is halted at specific depths to carry out pore pressure dissipation (PPD) tests, shown in Figure PPD-1. For each dissipation test the cone and rods are decoupled from the rig and the data acquisition system measures and records the variation of the pore pressure (u) with time (t).

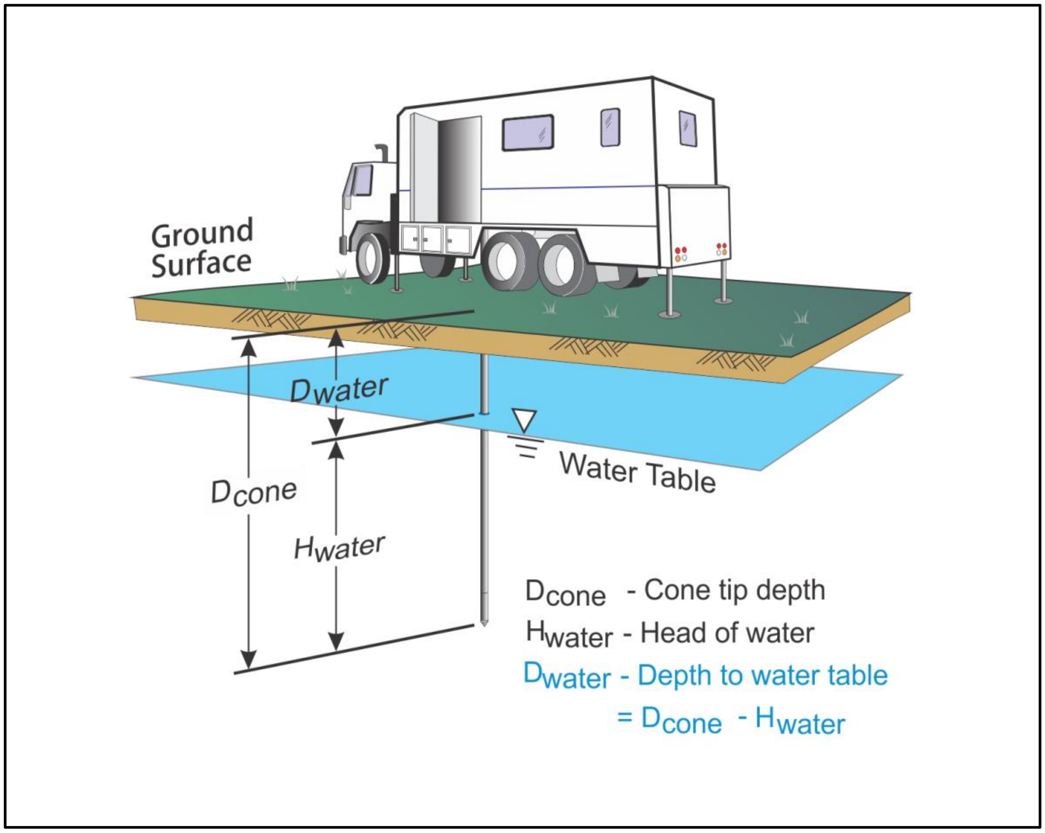

Figure PPD-1. Pore pressure dissipation test setup

Pore pressure dissipation data can be interpreted to provide estimates of ground water conditions, permeability, consolidation characteristics and soil behavior.

The typical shapes of dissipation curves shown in Figure PPD-2 are very useful in assessing soil type, drainage, in situ pore pressure and soil properties. A flat curve that stabilizes quickly is typical of a freely draining sand. Undrained soils such as clays will typically show positive excess pore pressure and have long dissipation times. Dilative soils will often exhibit dynamic pore pressures below equilibrium that then rise over time. Overconsolidated fine-grained soils will often exhibit an initial dilatory response where there is an initial rise in pore pressure before reaching a peak and dissipating.

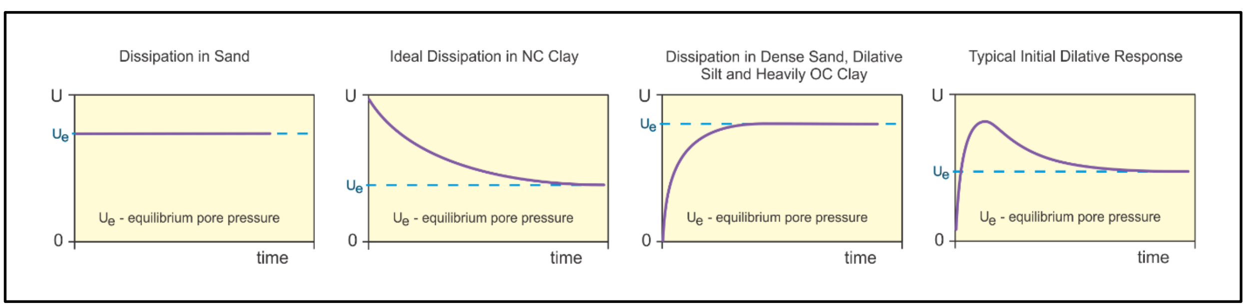

Figure PPD-2. Pore pressure dissipation curve examples

In order to interpret the equilibrium pore pressure (u_{eq}) and the apparent phreatic surface, the pore pressure should be monitored until such time as there is no variation in pore pressure with time as shown for each curve in Figure PPD-2.

In fine grained deposits the point at which 100% of the excess pore pressure has dissipated is known as t_{100}. In some cases this can take an excessive amount of time and it may be impractical to take the dissipation to t_{100}. A theoretical analysis of pore pressure dissipations by Teh and Houlsby (1991) showed that a single curve relating degree of dissipation versus theoretical time factor (T*) may be used to calculate the coefficient of consolidation (c_h) at various degrees of dissipation resulting in the expression for c_h shown below.

$$c_h = \frac{T^* \cdot a^2 \cdot \sqrt{I_r}}{t}$$

Where:
T* is the dimensionless time factor (Table Time Factor)
a is the radius of the cone
I_r is the rigidity index
t is the time at the degree of consolidation

Table Time Factor. T* versus degree of dissipation (Teh and Houlsby (1991))

Degree of Dissipation (%)	20	30	40	50	60	70	80
T* (u_2)	0.038	0.078	0.142	0.245	0.439	0.804	1.60

The coefficient of consolidation is typically analyzed using the time (t_{50}) corresponding to a degree of dissipation of 50% (u_{50}). In order to determine t_{50}, dissipation tests must be taken to a pressure less than u_{50}. The u_{50} value is half way between the initial maximum pore pressure and the equilibrium pore pressure value, known as u_{100}. To estimate u_{50}, both the initial maximum pore pressure and u_{100} must be known or estimated. Other degrees of dissipations may be considered, particularly for extremely long dissipations.

At any specific degree of dissipation the equilibrium pore pressure (u at t_{100}) must be estimated at the depth of interest. The equilibrium value may be determined from one or more sources such as measuring the value directly (u_{100}), estimating it from other dissipations in the same profile, estimating the phreatic surface and assuming hydrostatic conditions, from nearby soundings, from client provided information, from site observations and/or past experience, or from other site instrumentation.

For calculations of c_h (Teh and Houlsby (1991)), t_{50} values are estimated from the corresponding pore pressure dissipation curve and a rigidity index (I_r) is assumed. For curves having an initial dilatory response in which an initial rise in pore pressure occurs before reaching a peak, the relative time from the peak value is used in determining t_{50}. In cases where the time to peak is excessive, t_{50} values are not calculated.

Due to possible inherent uncertainties in estimating I_r, the equilibrium pore pressure and the effect of an initial dilatory response on calculating t_{50}, other methods should be applied to confirm the results for c_h.

Additional published methods for estimating the coefficient of consolidation from a piezocone test are described in Burns and Mayne (1998, 2002), Jones and Van Zyl (1981), Robertson et al. (1992) and Sully et al. (1999).

A summary of the pore pressure dissipation tests and dissipation plots are presented in the relevant appendix.

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Robertson, P.K., Sully, J.P., Woeller, D.J., Lunne, T., Powell, J.J.M. and Gillespie, D.G., 1992, “Estimating coefficient of consolidation from piezocone tests”, Canadian Geotechnical Journal, 29(4): 539-550. DOI: 10.1139/T92-061.

Robertson, P.K., 2009, "Interpretation of cone penetration tests – a unified approach", Canadian Geotechnical Journal, Volume 46: 1337-1355. DOI: 10.1139/T09-065.

Sully, J.P., Robertson, P.K., Campanella, R.G. and Woeller, D.J., 1999, "An approach to evaluation of field CPTU dissipation data in overconsolidated fine-grained soils", Canadian Geotechnical Journal, 36(2): 369-381. DOI: 10.1139/T98-105.

Teh, C.I., and Houlsby, G.T., 1991, "An analytical study of the cone penetration test in clay", Geotechnique, 41(1): 17-34. DOI: 10.1680/geot.1991.41.1.17.

The appendices listed below are included in the report:

- Cone Penetration Test Summary and Standard Cone Penetration Test Plots
- Normalized Cone Penetration Test Plots
- Advanced Cone Penetration Test Plots with Ic, Su(Nkt), Phi and N(60)Ic/N1(60)Ic
- Seismic Cone Penetration Test Plots
- Seismic Cone Penetration Test Shear Wave (Vs) Tabular Results
- Seismic Cone Penetration Test Shear Wave (Vs) Traces
- Soil Behavior Type (SBT) Scatter Plots
- Pore Pressure Dissipation Summary and Pore Pressure Dissipation Plots

Cone Penetration Test Summary and Standard Cone Penetration Test Plots

CONETEC

Job No: 21-59-23130
Client: Terracon Consultants, Inc.
Project: SAIA Freight Terminal
Start Date: 15-Oct-2021
End Date: 15-Oct-2021

CONE PENETRATION TEST SUMMARY

Sounding ID	File Name	Date	Cone	Assumed [1] Phreatic Surface (ft)	Final Depth (ft)	Shear Wave Velocity Tests	Latitude[2] (deg)	Longitude[2] (deg)
CPT-B01	21-59-23130_SP01	15-Oct-2021	730: T1500F15U35	6.7	101.9	31	48.11194	-122.17801
CPT-B02	21-59-23130_CP02	15-Oct-2021	730: T1500F15U35	4.6	102.3		48.11194	-122.17686
Totals	2 soundings				204.2	31		

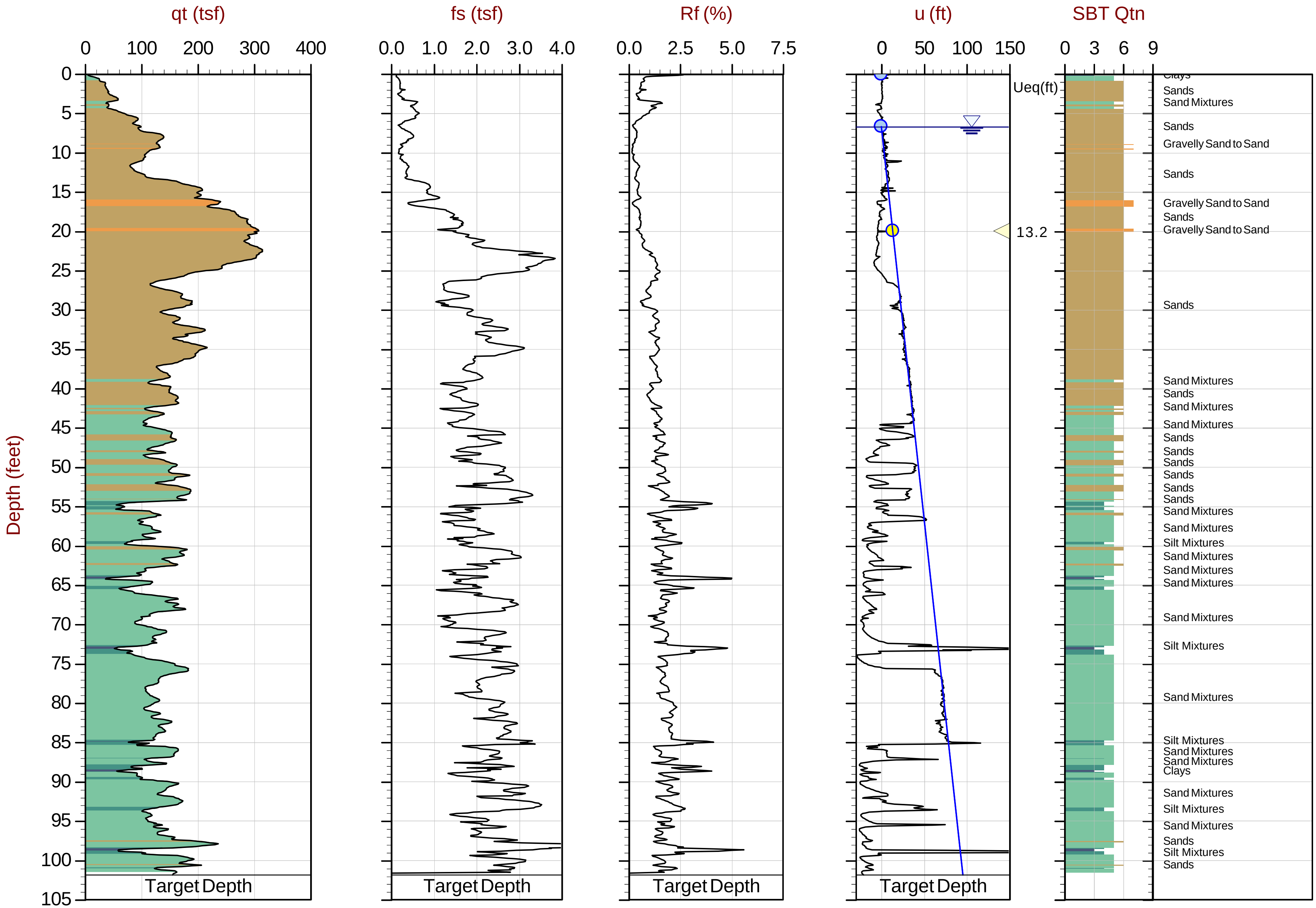
1. Phreatic surface based on pore pressure dissipation test unless otherwise noted. Hydrostatic profile applied to interpretation tables
2. Coordinates were collected using a handheld GPS - WGS 84 Lat/Long

CONETEC

Terracon

Job No: 21-59-23130
Date: 2021-10-15 08:45
Site: SAIA Freight Terminal

Sounding: CPT-B01
Cone: 730:T1500F15U35



Max Depth: 31.050 m / 101.87 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-59-23130_SP01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 48.11194 Long: -122.17801

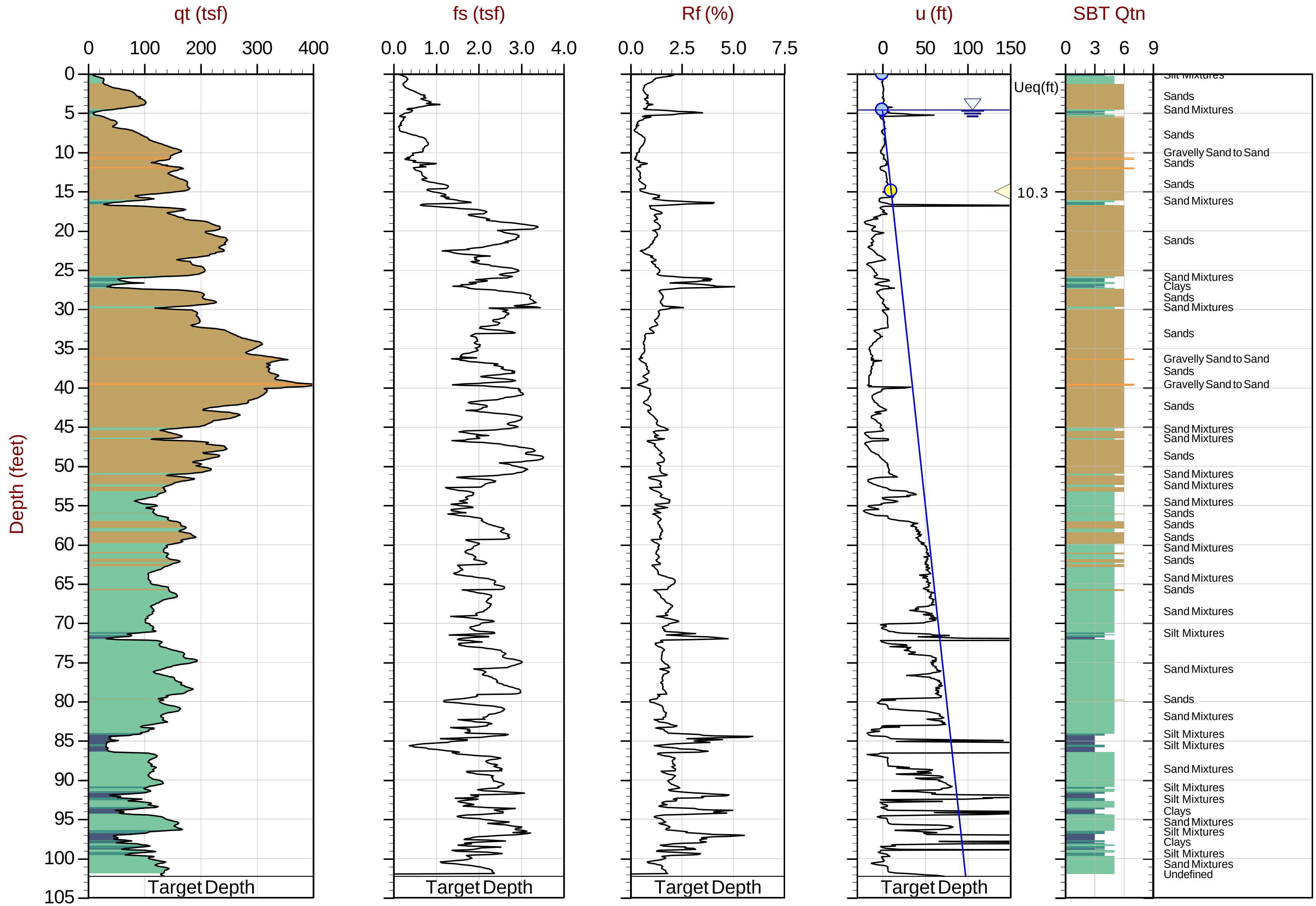
Equilibrium Pore Pressure (Ueq) Assumed Ueq Dissipation, Ueq achieved Dissipation, Ueq not achieved Hydrostatic Line

The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Terracon

Job No: 21-59-23130
Date: 2021-10-15 10:19
Site: SAIA Freight Terminal
Sounding: CPT-B02
Cone: 730:T1500F15U35



Max Depth: 31.175 m / 102.28 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-59-23130_CP02.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 48.11194 Long: -122.17686

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Normalized Cone Penetration Test Plots

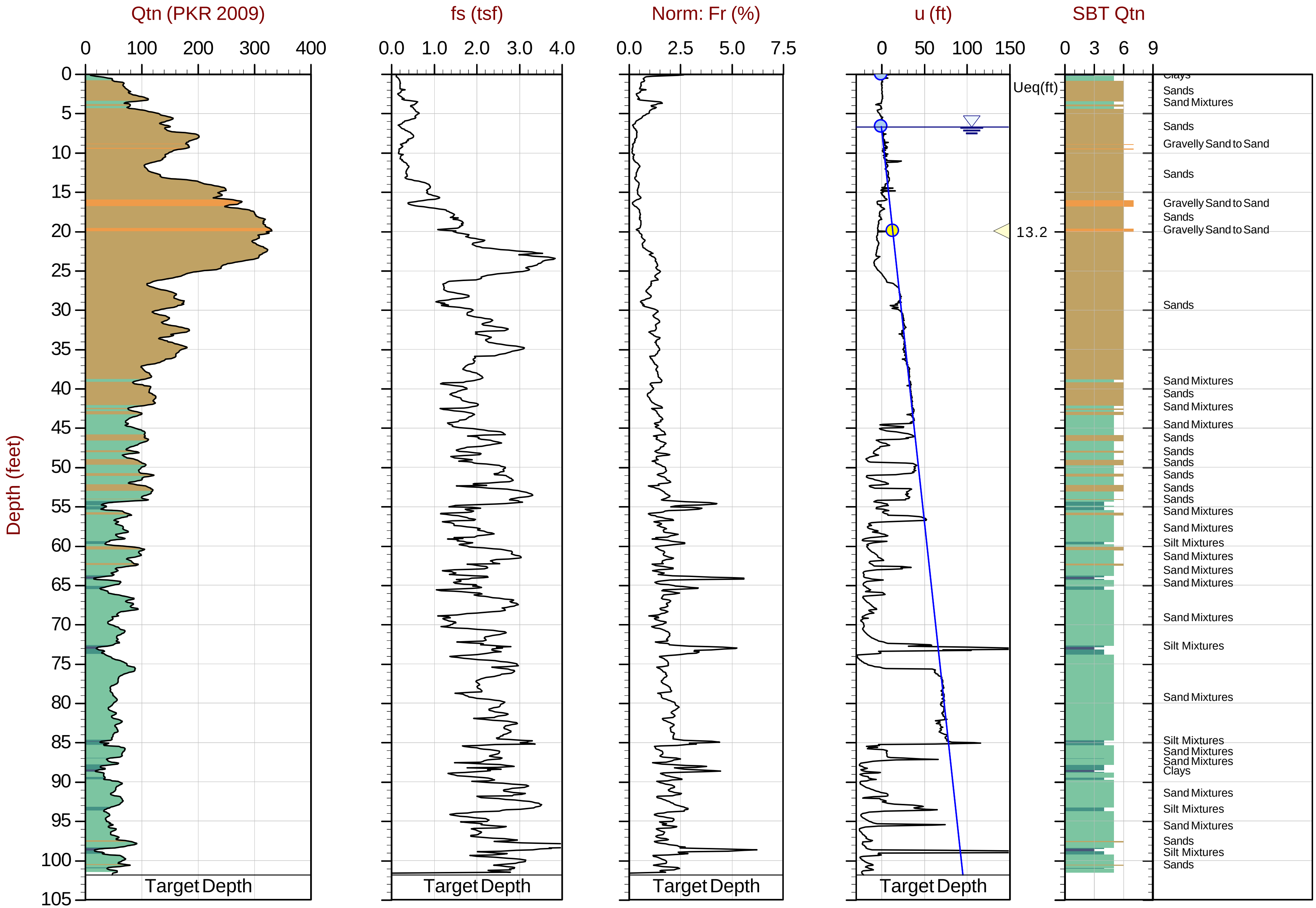
ConeTec

CONETEC

Terracon

Job No: 21-59-23130
Date: 2021-10-15 08:45
Site: SAIA Freight Terminal

Sounding: CPT-B01
Cone: 730:T1500F15U35



Max Depth: 31.050 m / 101.87 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-59-23130_SP01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 48.11194 Long: -122.17801

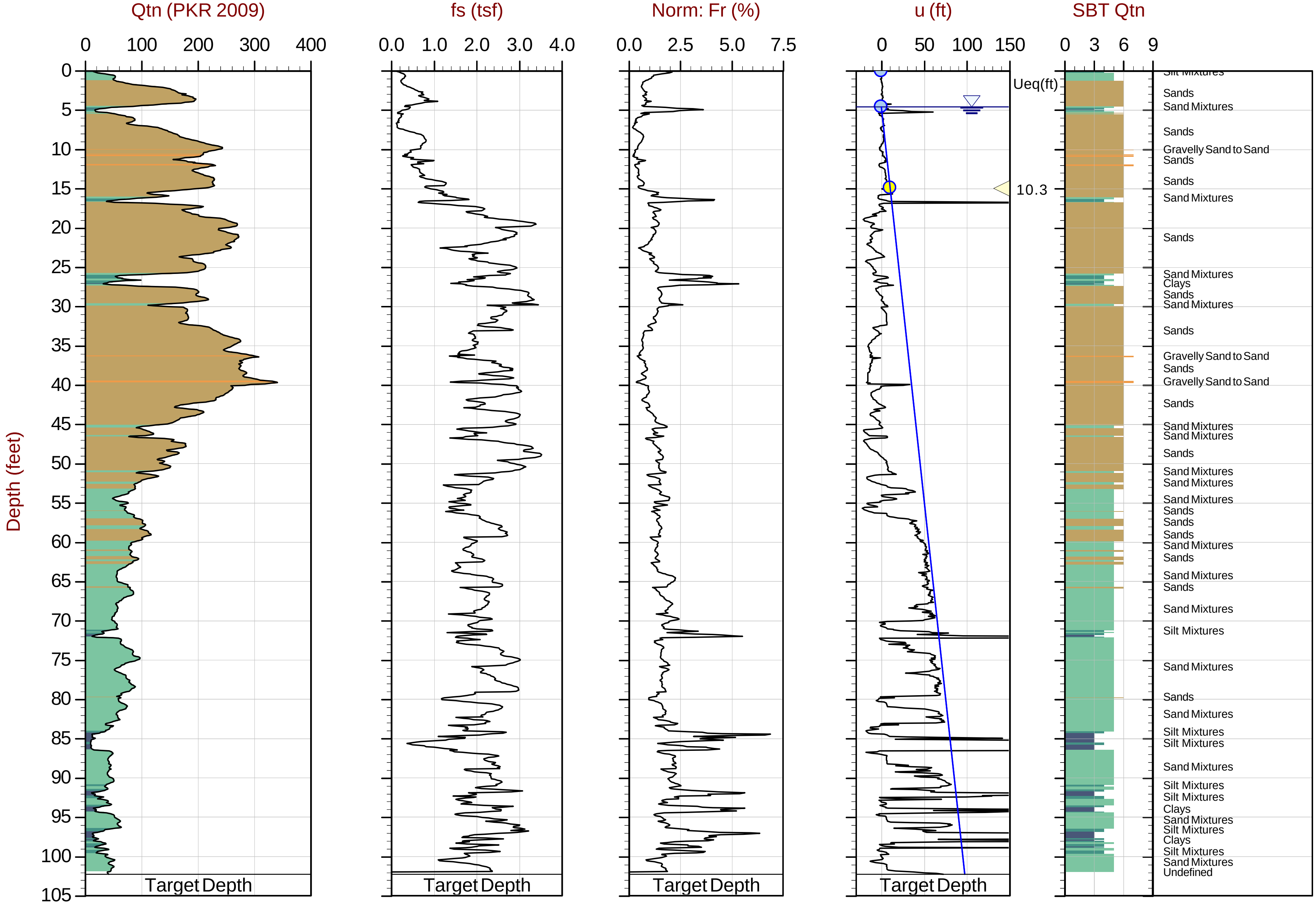
Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Terracon

Job No: 21-59-23130
Date: 2021-10-15 10:19
Site: SAIA Freight Terminal
Sounding: CPT-B02
Cone: 730:T1500F15U35



Max Depth: 31.175 m / 102.28 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-59-23130_CP02.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 48.11194 Long: -122.17686

Equilibrium Pore Pressure (Ueq) Assumed Ueq Dissipation, Ueq achieved Dissipation, Ueq not achieved Hydrostatic Line

The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

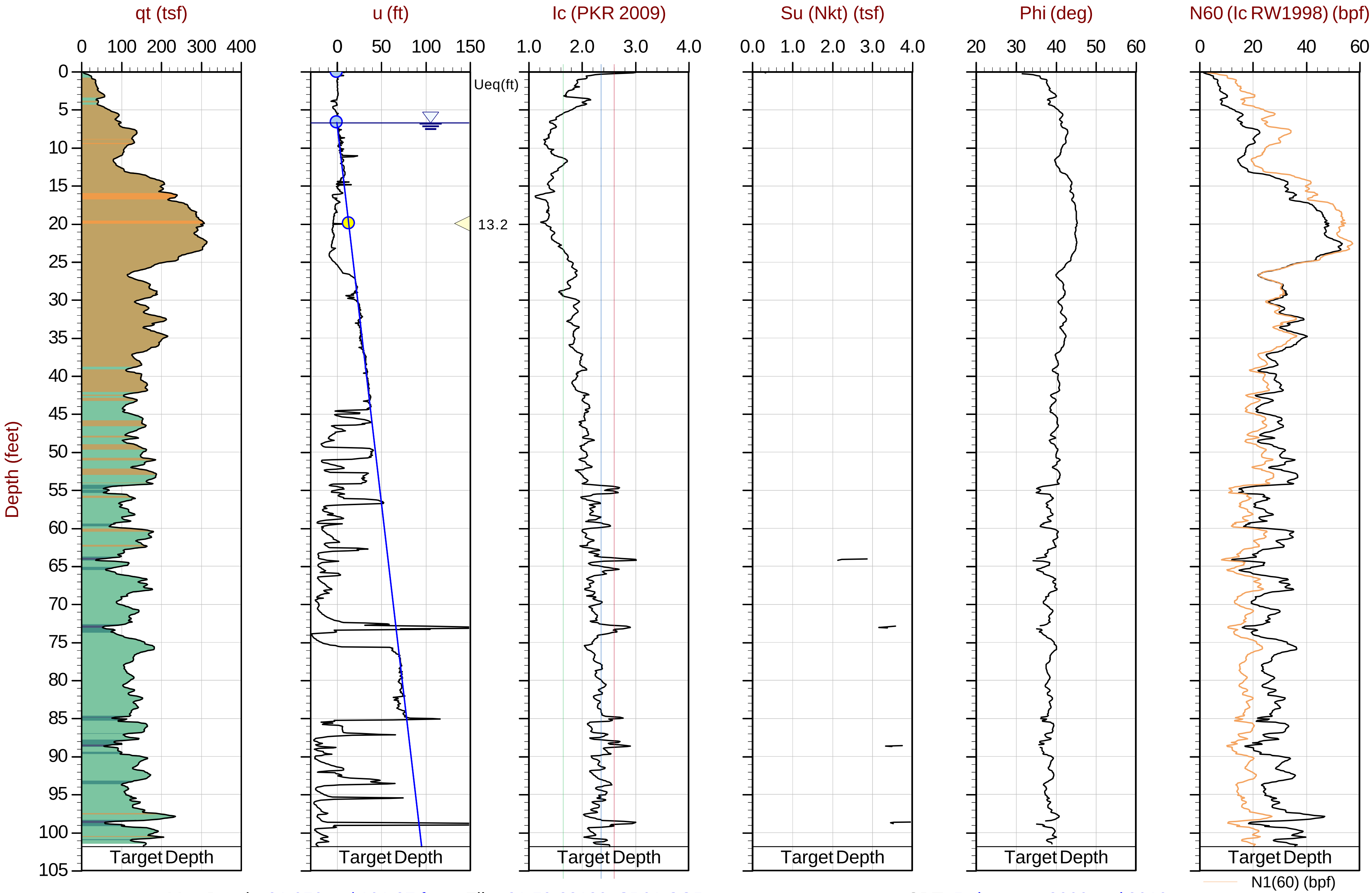
Advanced Cone Penetration Test Plots with Ic, Su, Phi and N(60)/N1(60)

CONETEC

Terracon

Job No: 21-59-23130
Date: 2021-10-15 08:45
Site: SAIA Freight Terminal

Sounding: CPT-B01
Cone: 730:T1500F15U35



Max Depth: 31.050 m / 101.87 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-59-23130_SP01.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt: 15.0

SBT: Robertson, 2009 and 2010
Coords: Lat: 48.11194 Long: -122.17801

Equilibrium Pore Pressure (Ueq) Assumed Ueq Dissipation, Ueq achieved Dissipation, Ueq not achieved Hydrostatic Line

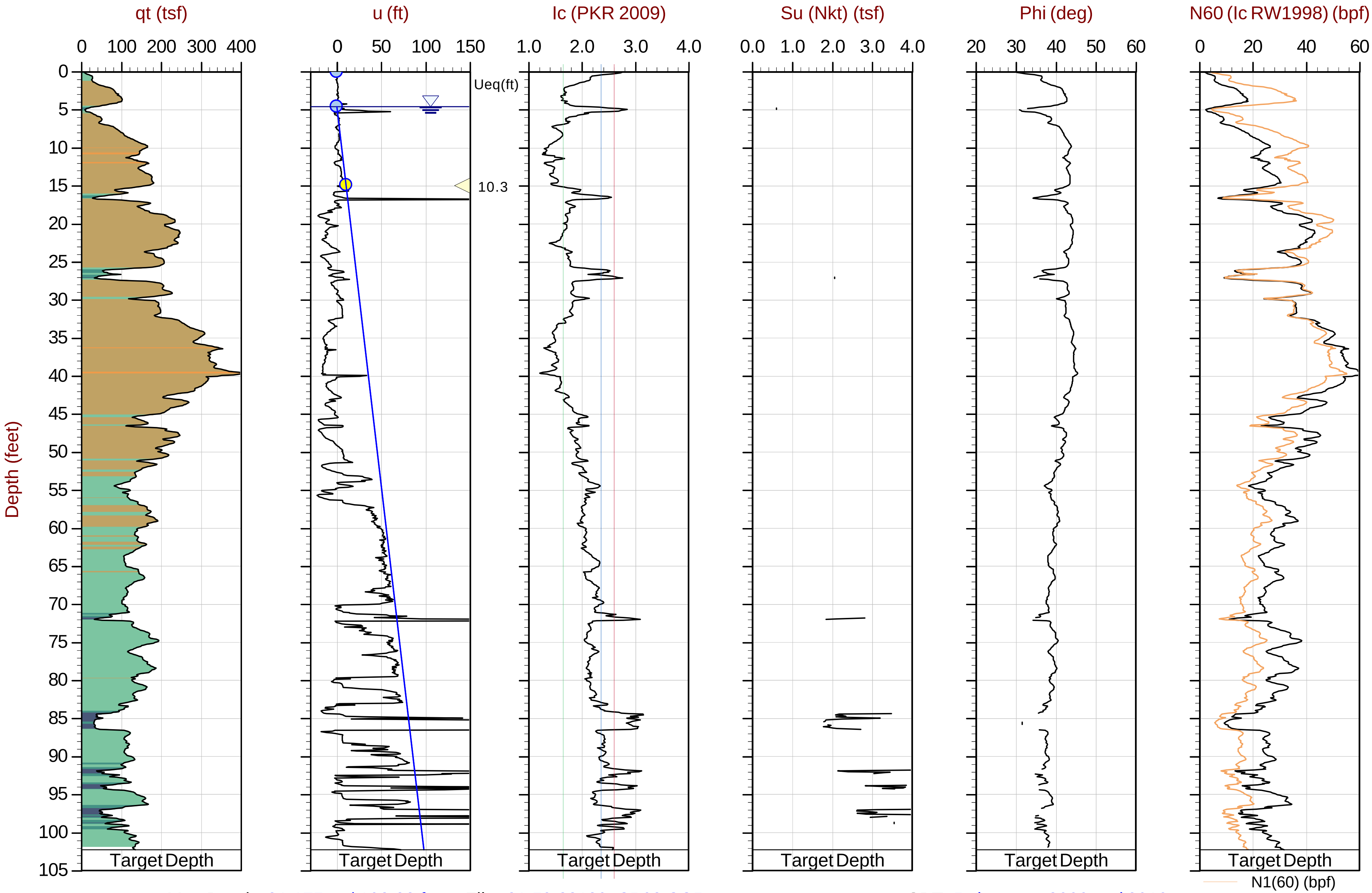
The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

Terracon

Job No: 21-59-23130
Date: 2021-10-15 10:19
Site: SAIA Freight Terminal

Sounding: CPT-B02
Cone: 730:T1500F15U35



Max Depth: 31.175 m / 102.28 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-59-23130_CP02.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt: 15.0

SBT: Robertson, 2009 and 2010
Coords: Lat: 48.11194 Long: -122.17686

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

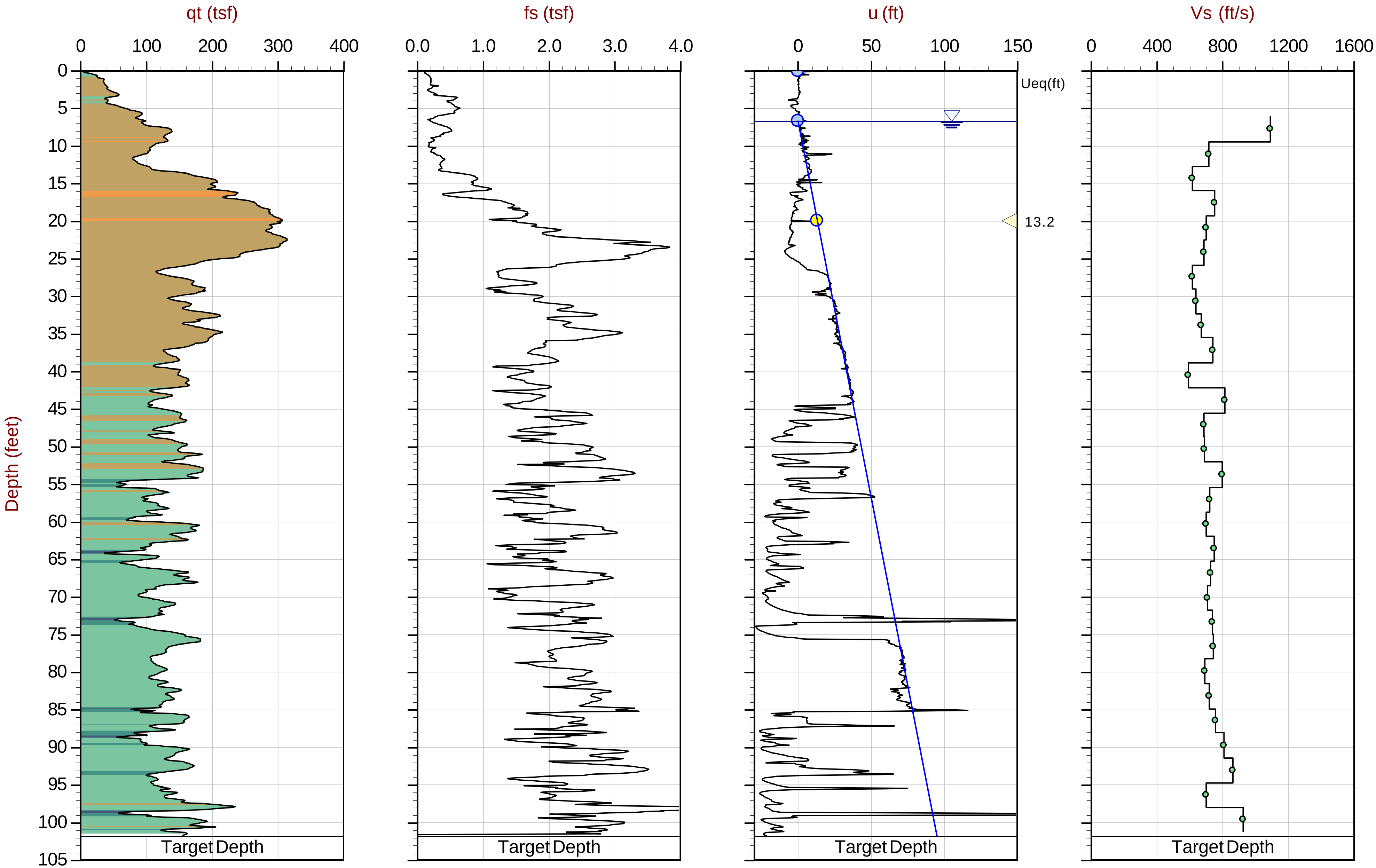
Seismic Cone Penetration Test Plots

CONETEC

Terracon

Job No: 21-59-23130
Date: 2021-10-15 08:45
Site: SAIA Freight Terminal

Sounding: CPT-B01
Cone: 730:T1500F15U35



Max Depth: 31.050 m / 101.87 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-59-23130_SP01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: Lat: 48.11194 Long: -122.17801

Equilibrium Pore Pressure (Ueq) | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Hydrostatic Line

The reported coordinates were acquired from hand-held GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Seismic Cone Penetration Test Shear Wave (Vs) Tabular Results

Job No:	21-59-23130	
Client:	Terracon Consultants, Inc.	
Project:	SAIS Freight Terminal	
Sounding ID:	CPT-B01	
Date:	15-Oct-2021	

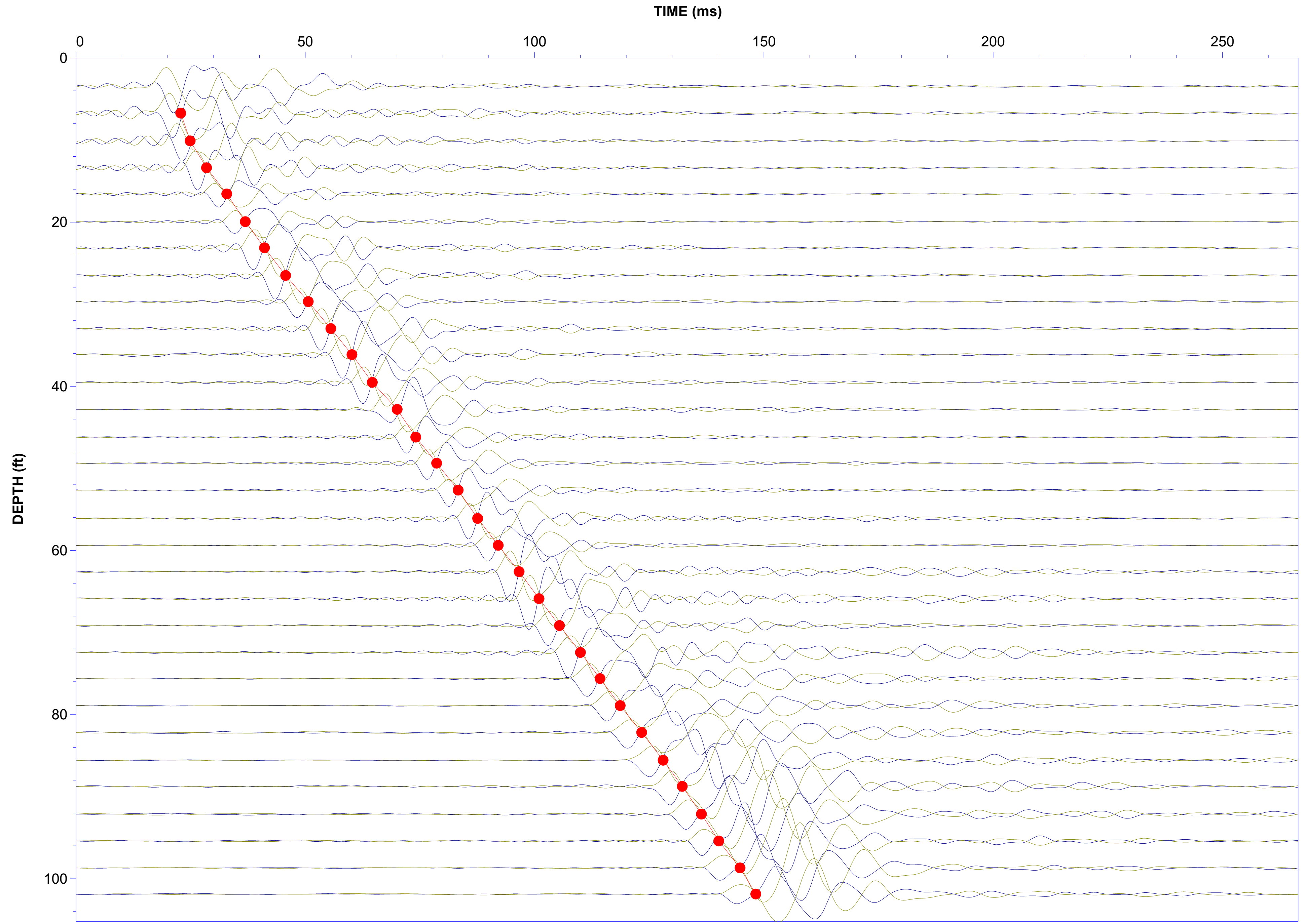
Seismic Source:	Beam
Source Offset (ft):	8.69
Source Depth (ft):	0.00
Geophone Offset (ft):	0.66

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Ray Path Difference (ft)	Travel Time Interval (ms)	Interval Velocity (ft/s)
6.73	6.07	10.60			
10.10	9.45	12.84	2.24	2.05	1092
13.39	12.73	15.41	2.58	3.59	718
16.57	15.91	18.13	2.72	4.40	617
19.95	19.29	21.16	3.03	4.03	752
23.13	22.47	24.10	2.94	4.20	700
26.51	25.85	27.27	3.18	4.62	687
29.69	29.04	30.31	3.03	4.91	618
32.97	32.32	33.46	3.16	4.94	638
36.15	35.50	36.55	3.08	4.59	671
39.53	38.88	39.84	3.29	4.43	743
42.81	42.16	43.05	3.21	5.42	592
46.19	45.54	46.36	3.31	4.06	816
49.38	48.72	49.49	3.13	4.56	686
52.66	52.00	52.72	3.23	4.69	690
56.10	55.45	56.12	3.40	4.26	798
59.38	58.73	59.37	3.24	4.48	723
62.60	61.94	62.55	3.18	4.54	701
65.88	65.22	65.80	3.25	4.34	749
69.16	68.50	69.05	3.25	4.46	729
72.44	71.78	72.31	3.26	4.58	710
75.62	74.97	75.47	3.16	4.27	740
78.90	78.25	78.73	3.26	4.38	744
82.18	81.53	81.99	3.26	4.70	694
85.56	84.91	85.35	3.36	4.67	720
88.75	88.09	88.52	3.17	4.18	757
92.13	91.47	91.88	3.36	4.16	809
95.41	94.75	95.15	3.27	3.78	863
98.69	98.03	98.42	3.27	4.66	702
101.87	101.21	101.59	3.17	3.42	926

Seismic Cone Penetration Test Shear Wave (Vs) Traces

Job No: 21-59-23130 Client: Terracon Consultants, Inc. Project: SAIA Freight Terminal Sounding: CPT-B01 Filter: 10 - 180 Hz
Date: 15-OCT-2021



Soil Behavior Type (SBT) Scatter Plots

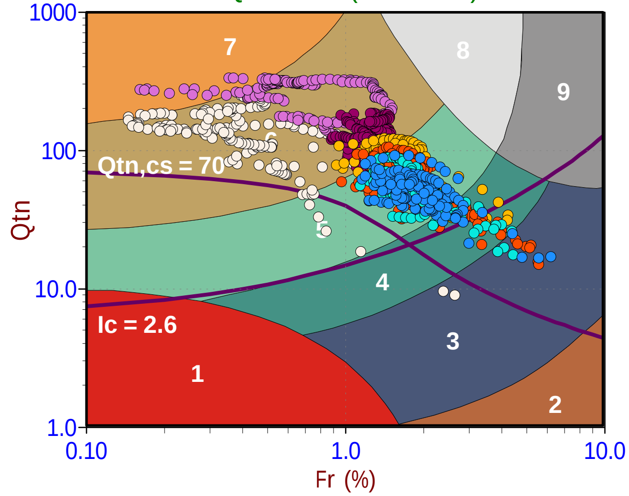
CONETEC

Terracon

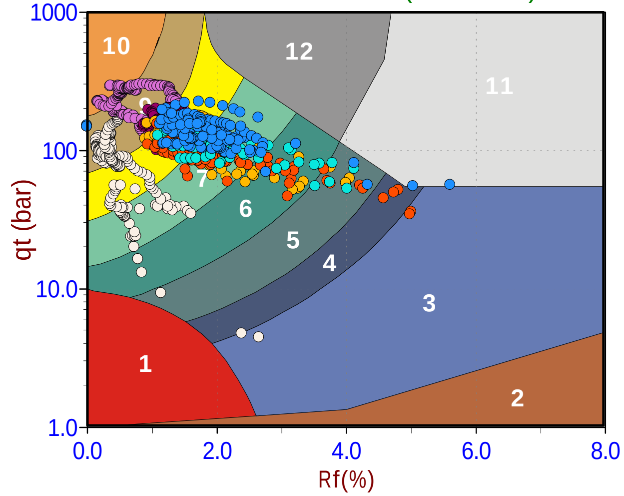
Job No: 21-59-23130
Date: 2021-10-15 08:45
Site: SAIA Freight Terminal

Sounding: CPT-B01
Cone: 730:T1500F15U35

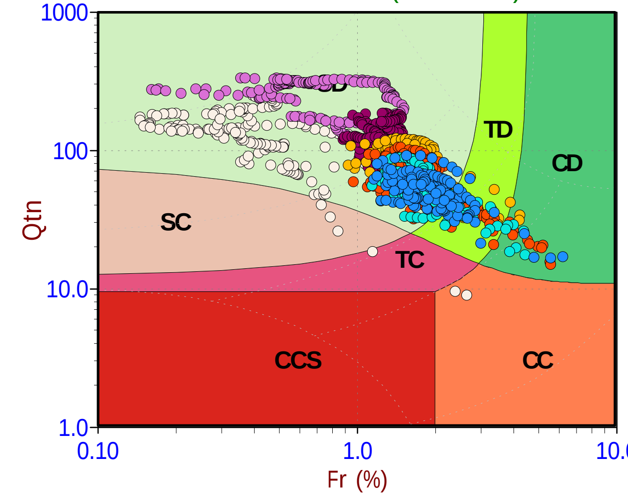
Qtn Chart (PKR 2009)



Standard SBT Chart (UBC 1986)



Modified SBTn (PKR 2016)



Depth Ranges

- >0.0 to 15.0 ft
- >15.0 to 30.0 ft
- >30.0 to 45.0 ft
- >45.0 to 60.0 ft
- >60.0 to 75.0 ft
- >75.0 to 90.0 ft
- >90.0 to 105.0 ft
- >105.0 to 120.0 ft
- >120.0 to 135.0 ft
- >135.0 to 150.0 ft
- >150.0 ft

Legend

- Sensitive, Fine Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand

Legend

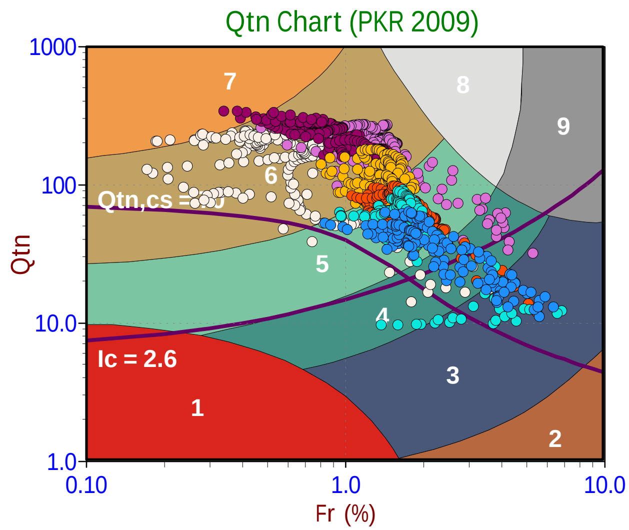
- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)

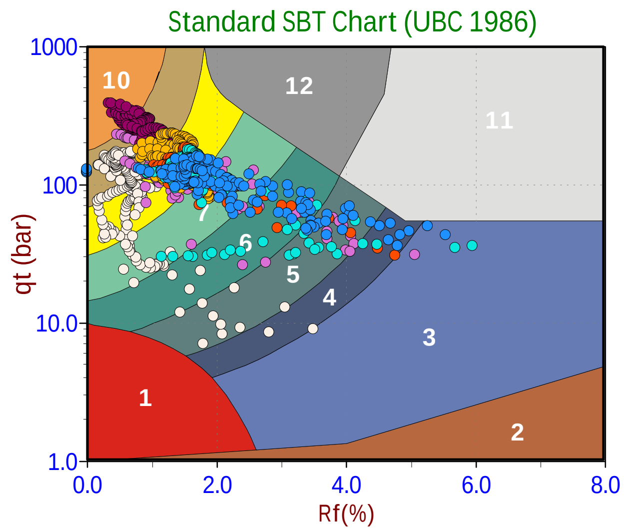
ConeTec

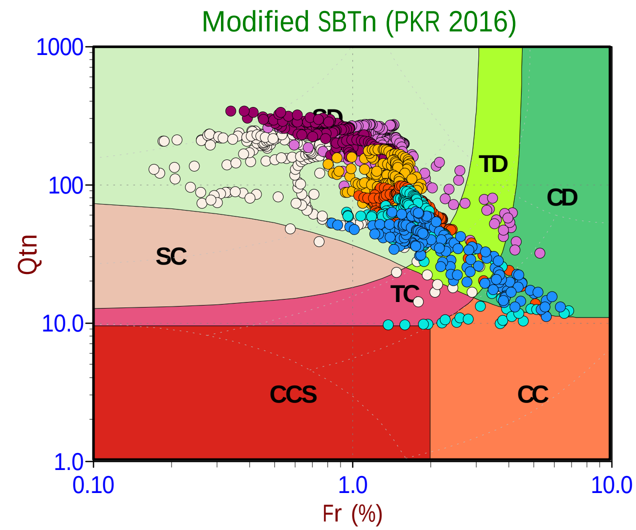
Terracon

Job No: 21-59-23130
Date: 2021-10-15 10:19
Site: SAIA Freight Terminal

Sounding: CPT-B02
Cone: 730:T1500F15U35







Depth Ranges

- >0.0 to 15.0 ft
- >15.0 to 30.0 ft
- >30.0 to 45.0 ft
- >45.0 to 60.0 ft
- >60.0 to 75.0 ft
- >75.0 to 90.0 ft
- >90.0 to 105.0 ft
- >105.0 to 120.0 ft
- >120.0 to 135.0 ft
- >135.0 to 150.0 ft
- >150.0 ft

Legend

- Sensitive, Fine Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand

Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)

Pore Pressure Dissipation Summary and Pore Pressure Dissipation Plots

Job No: 21-59-23130
Client: Terracon Consultants, Inc.
Project: SAIA Freight Terminal
Start Date: 15-Oct-2021
End Date: 15-Oct-2021

CPTu PORE PRESSURE DISSIPATION SUMMARY

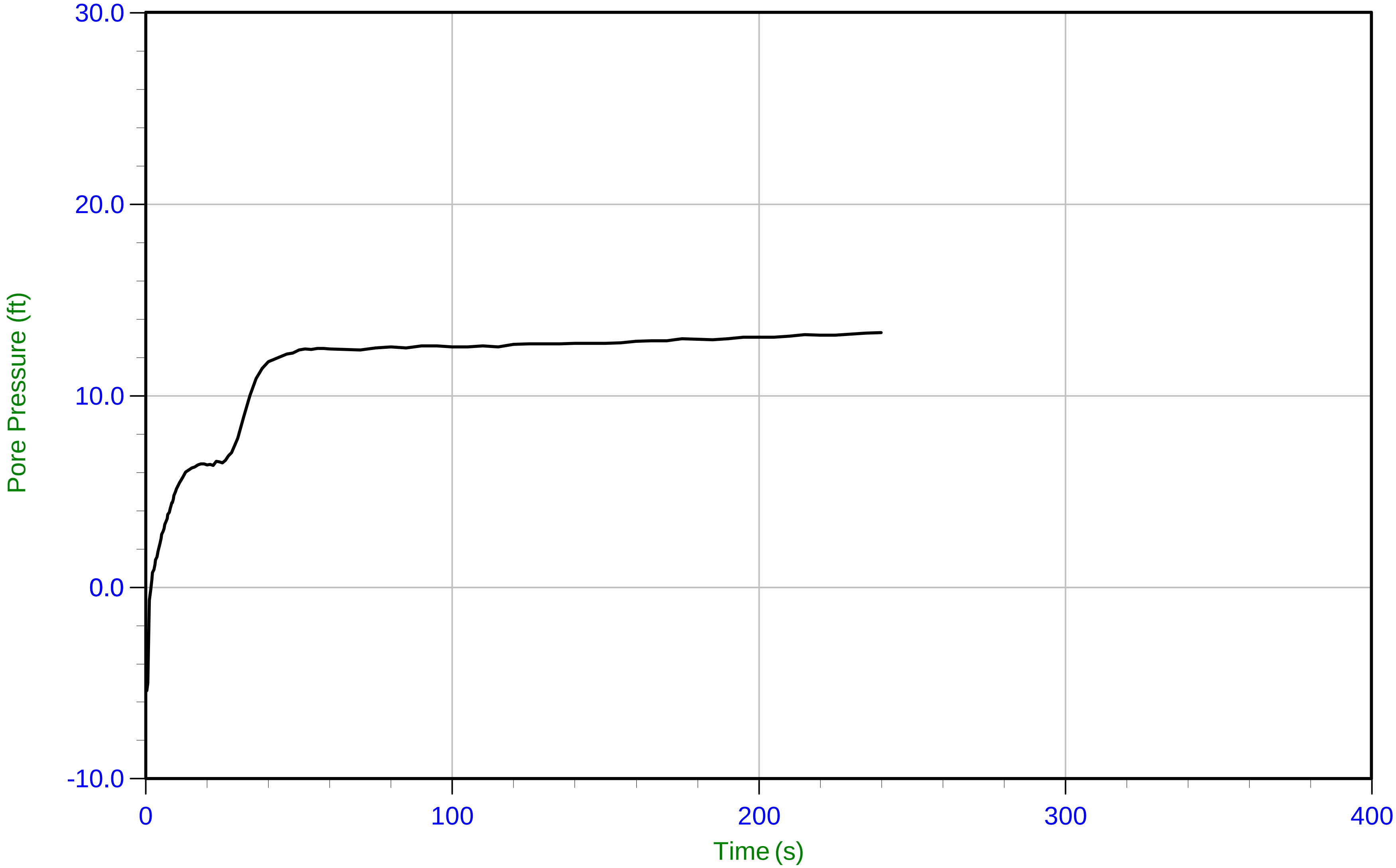
Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (ft)	Estimated Equilibrium Pore Pressure U_{eq} (ft)	Calculated Phreatic Surface (ft)
CPT-B01	21-59-23130_SP01	15.0	240.0	19.9	13.3	6.7
CPT-B02	21-59-23130_CP02	15.0	780.0	14.9	10.3	4.6
Total Duration			17.0 min			

CONETEC

Terracon

Job No: 21-59-23130
Date: 10/15/2021 08:45
Site: SAIA Freight Terminal

Sounding: CPT-B01
Cone: 730:T1500F15U35 Area=15 cm²



Trace Summary:

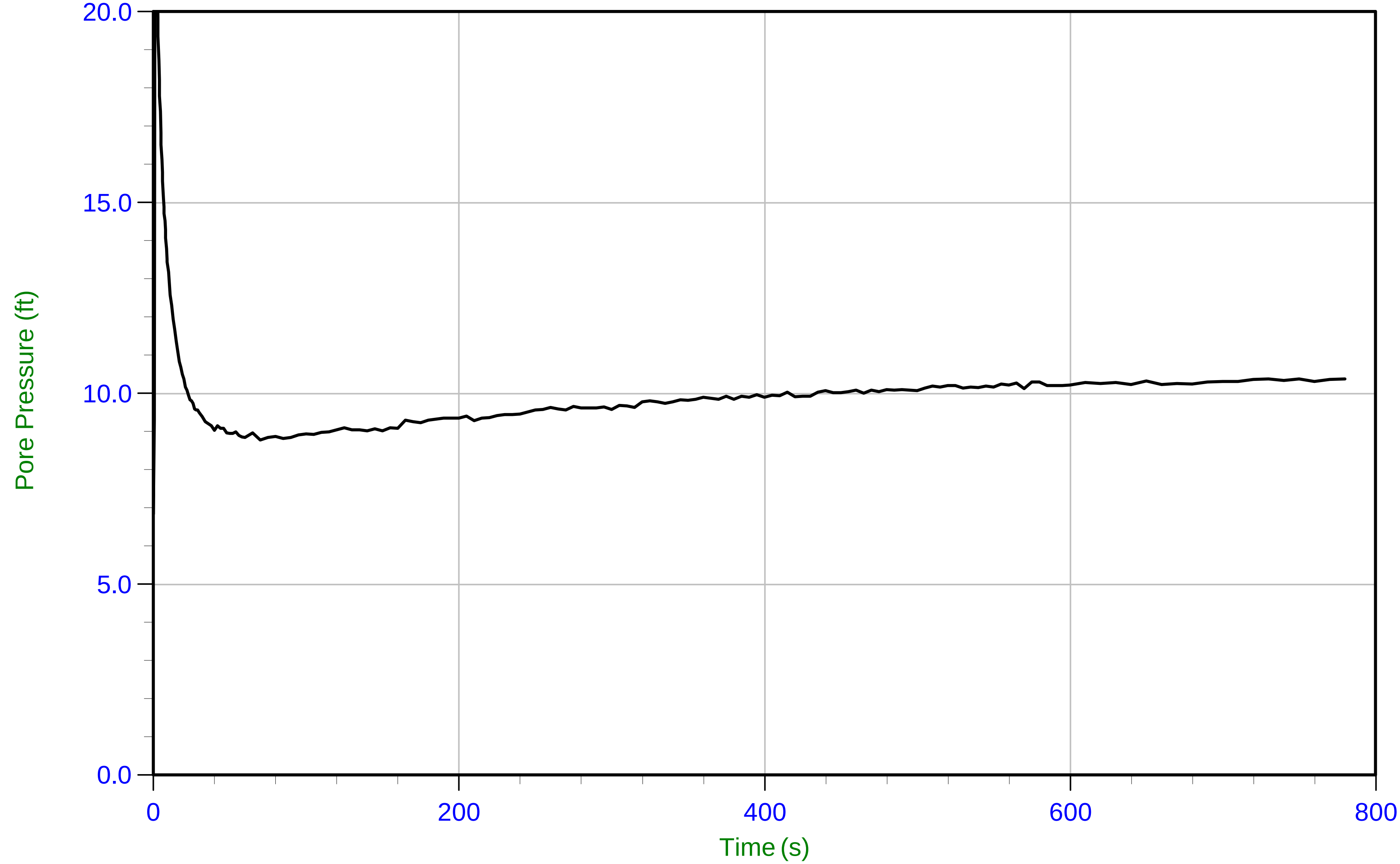
Filename: 21-59-23130_SP01.ppd2
Depth: 6.075 m / 19.931 ft
Duration: 240.0 s

u Min: -5.4 ft
u Max: 13.3 ft
u Final: 13.3 ft

WT: 2.034 m / 6.673 ft
Ueq: 13.3 ft

CONETEC

Terracon	Job No: 21-59-23130 Date: 10/15/2021 10:19 Site: SAIA Freight Terminal	Sounding: CPT-B02 Cone: 730:T1500F15U35 Area=15 cm²



Trace Summary:

Filename: 21-59-23130_CP02.ppd2	u Min: 6.8 ft	WT: 1.398 m / 4.587 ft
Depth: 4.550 m / 14.928 ft	u Max: 24.0 ft	Ueq: 10.3 ft
Duration: 780.0 s	u Final: 10.4 ft	

WASHINGTON STATE DEPARTMENT OF ECOLOGY

March 2022

GENERAL USE LEVEL DESIGNATION FOR BASIC (TSS), DISSOLVED METALS (ENHANCED), AND PHOSPHORUS TREATMENT

For

Oldcastle Infrastructure, Inc.'s
The BioPod™ Biofilter
(Formerly the TreePod Biofilter)

Ecology's Decision

Based on Oldcastle Infrastructure, Inc. application submissions for The BioPod™ Biofilter (BioPod), Ecology hereby issues the following use level designation:

1) General Use Level Designation (GULD) for Basic, Enhanced, and Phosphorus Treatment:
   - Sized at a hydraulic loading rate of 1.6 gallons per minute (gpm) per square foot (sq ft) of media surface area.
   - Constructed with a minimum media thickness of 18-inches (1.5-feet)
2) Ecology approves the BioPod at the hydraulic loading rate listed above, to achieve the maximum water quality design flow rate. The water quality design flow rates are calculated using the following procedures:
   - Western Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using the latest version of the Western Washington Hydrology Model or other Ecology- approved continuous runoff model.
   - Eastern Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using one of the three methods described in Chapter 2.7.6 of the Stormwater Management Manual for Eastern Washington (SWMMEW) or local manual.
   - Entire State: For treatment installed downstream of detention, the water quality design flow rate is the full 2-year release rate of the detention facility.
3) For systems that have a drain down outlet, designers must increase the water quality design flow rate calculated in Item 2, above, to account for the water that will enter the initial bay but won't be treated by the engineered soil. Multiply the flow rate determined above by 1.05

to determine the required flowrate for the BioPod unit.

4) The GULD has no expiration date, but may be amended or revoked by Ecology.

Ecology's Conditions of Use

The BioPod shall comply with these conditions:

1) Applicants shall design, assemble, install, operate, and maintain the BioPod installations in accordance with Oldcastle Infrastructure Inc.'s applicable manuals and the Ecology Decision.
2) The minimum size filter surface-area for use in Washington is determined by using the design water quality flow rate (as determined in Ecology Decision, Item 3, above) and the hydraulic loading rate (as identified in Ecology Decision, Item 1, above). Calculate the required area by dividing the water quality design flow rate (cu-ft/sec) by the hydraulic loading rate (converted to ft/sec) to obtain the required surface area (sq ft) of the BioPod unit.
3) BioPod media shall conform to the specifications submitted to and approved by Ecology.
4) The applicant tested the BioPod without plants. This GULD applies to the BioPod Stormwater Treatment System whether plants are included in the final product or not.
5) Maintenance: The required inspection/maintenance interval for stormwater treatment devices is often dependent on the efficiency of the device and the degree of pollutant loading from a particular drainage basin. Therefore, Ecology does not endorse or recommend a "one size fits all" maintenance cycle for a particular model/size of manufactured filter treatment device.
    - The BioPod is designed for a target maintenance interval of 1 year. Maintenance includes replacing the mulch, assessing plant health, removal of trash, and raking the top few inches of engineered media.
    - The BioPod system initially tested at the Lake Union Ship Canal Test Facility in Seattle, WA required maintenance after 1.5 months, or 6.3% of a water year. Monitoring personnel observed similar maintenance issues with other systems evaluated at the Test Facility. Runoff from the Test Facility may be unusual and maintenance requirements of systems installed at the Test Facility may not be indicative of typical maintenance requirements. Because of this, the initial version of the GULD required Oldcastle to subsequently "conduct hydraulic testing to obtain information about maintenance requirements on a site with runoff that is more typical of the Pacific Northwest". Quarterly testing from a 15-month maintenance frequency assessment conducted on a BioPod system installed along a roadway in Des Moines, WA indicated the system was able to treat a full water year before requiring maintenance.
    - Test results provided to Ecology from a BioPod System evaluated in a lab following New Jersey Department of Environmental Protection Laboratory Protocol for Filtration MTDs have indicated the BioPod System is capable of longer maintenance intervals.
    - Owners/operators must inspect BioPod systems for a minimum of twelve months from the start of post-construction operation to determine site-specific inspection/maintenance schedules and requirements. Owners/operators must conduct inspections monthly during the wet season, and every other month during the dry season. (According to the SWMMWW, the wet season in western Washington is October 1 to April 30. According

to the SWMMEW, the wet season in eastern Washington is October 1 to June 30.) After the first year of operation, owners/operators must conduct inspections based on the findings during the first year of inspections.

- Conduct inspections by qualified personnel, follow manufacturer's guidelines, and use methods capable of determining either a decrease in treated effluent flow rate and/or a decrease in pollutant removal ability.

6) Install the BioPod in such a manner that you bypass flows exceeding the maximum operating rate and you will not resuspend captured sediment.
7) Discharges from the BioPod shall not cause or contribute to water quality standard violations in receiving waters.

Approved Alternate Configurations

BioPod Internal Bypass

1) The BioPod Internal Bypass configuration may be combined with a Curb Inlet, Grated Inlet, and Piped-In Inlet. Water quality flows and peak flows are directed from the curb, overhead grate, or piped inlet to a contoured inlet rack. The inlet rack disperses water quality flows over the top surface of the biofiltration chamber. Excess flows are diverted over a curved bypass weir to the outlet area without passing through the treatment area. Both water quality flows and bypass flows are combined in the outlet area prior to being discharged out of the system.
2) To select a BioPod Internal Bypass unit, the designer must determine the size of the standard unit using the sizing guidance described above. Systems that have an internal bypass may use the off-line water quality design flow rate.
3) The internal bypass configuration has a maximum flow rate of 900 gallons per minute. Sites where the anticipated flow rate at the treatment device is larger than 900 gpm must use an external bypass, or size the treatment device for the on-line water quality design flow rate.

Applicant:	Oldcastle Infrastructure, Inc.
Applicant's Address:	7100 Longe St, Suite 100 Stockton, CA 95206

Application Documents:

BioPod™ Stormwater Filter Maintenance Frequency Assessment, Prepared for Oldcastle Infrastructure, Inc., Prepared by Herrera Environmental Consultants, Inc. February 2022

Technical Evaluation Report TreePod™ BioFilter System Performance Certification Project, Prepared for Oldcastle, Inc., Prepared by Herrera Environmental Consultants, Inc. February 2018

Technical Memorandum: Response to Board of External Reviewers' Comments on the Technical Evaluation Report for the TreePod™ Biofilter System Performance Certification Project, Oldcastle, Inc. and Herrera Environmental Consultants, Inc., February 2018

Technical Memorandum: Response to Board of External Reviewers' Comments on the Technical Evaluation Report for the TreePod™ Biofilter System Performance Certification Project, Oldcastle, Inc. and Herrera Environmental Consultants, Inc., January 2018

Application for Pilot Use Level Designation, TreePod™ Biofilter – Stormwater Treatment System, Oldcastle Stormwater Solutions, May 2016

Emerging Stormwater Treatment Technologies Application for Certification: The TreePod™ Biofilter, Oldcastle Stormwater Solutions, April 2016

Applicant's Use Level Request:

- General Use Level Designation as a Basic, Enhanced, and Phosphorus Treatment device in accordance with Ecology's *Stormwater Management Manual for Western Washington*

Applicant's Performance Claims:

Based on results from laboratory and field-testing, the applicant claims the BioPod™ Biofilter operating at a hydraulic loading rate of 153 inches per hour is able to remove:

- 80% of Total Suspended Solids (TSS) for influent concentrations greater than 100 mg/L and achieve a 20 mg/L effluent for influent concentrations less than 100 mg/L.
- 60% dissolved zinc for influent concentrations 0.02 to 0.3 mg/L.
- 30% dissolved copper for influent concentrations 0.005 to 0.02 mg/L.
- 50% or greater total phosphorus for influent concentrations 0.1 to 0.5 mg/L.

Ecology's Recommendations:

Ecology finds that:

- Oldcastle Infrastructure, Inc. has shown Ecology, through laboratory and field testing, that the BioPod™ Biofilter is capable of attaining Ecology's Basic, Total Phosphorus, and Enhanced treatment goals.

Findings of Fact:

Field Testing

- Herrera Environmental Consultants, Inc. conducted monitoring of the BioPod™ Biofilter at the Lake Union Ship Canal Test Facility in Seattle Washington between November 2016 and April 2018. Herrera collected flow-weight composite samples during 14 separate storm events and peak flow grab samples during 3 separate storm events. The system was sized at an infiltration rate of 153 inches per hour or a hydraulic loading rate of 1.6 gpm/ft^2.

  - The D_{50} of the influent PSD ranged from 3 to 292 microns, with an average D_{50} of 28 microns.
  - Influent TSS concentrations ranged from 17 mg/L to 666 mg/L, with a mean concentration of 98 mg/L. For all samples (influent concentrations above and below 100 mg/L) the bootstrap estimate of the lower 95 percent confidence limit (LCL 95) of the mean TSS reduction was 84% and the bootstrap estimate of the upper 95 percent confidence limit (UCL95) of the mean TSS effluent concentration was 8.2 mg/L.
  - Dissolved copper influent concentrations from the 17 events ranged from 9.0 µg/L to 21.1 µg/L. The 21.1 µg/L data point was reduced to 20.0 µg/L, the upper limit to the TAPE allowed influent concentration range, prior to calculating the pollutant removal. A bootstrap estimate of the LCL95 of the mean dissolved copper reduction was 35%.
  - Dissolved zinc influent concentrations from the 17 events ranged from 26.1 µg/L to 43.3 µg/L. A bootstrap estimate of the LCL95 of the mean dissolved zinc reduction was 71%.
  - Total phosphorus influent concentrations from the 17 events ranged from 0.064 mg/L to 1.56 mg/L. All influent data greater than 0.5 mg/L were reduced to 0.5 mg/L, the upper limit to the TAPE allowed influent concentration range, prior to calculating the pollutant removal. A bootstrap estimate of the LCL95 of the mean total phosphorus reduction was 64%.
  - The system experienced rapid sediment loading and needed to be maintained after 1.5 months. Monitoring personnel observed similar sediment loading issues with other systems evaluated at the Test Facility. The runoff from the Test Facility may not be indicative of maintenance requirements for all sites.
- Herrera Environmental Consultants, Inc. conducted a maintenance frequency assessment of the BioPod™ installed along a roadway in Des Moines, WA between September 2020 and January 2022.
  - Herrera collected influent grab samples during 10 storm events and paired effluent samples during 5 storm events. Influent concentrations ranged from 1 mg/L to 164 mg/L, with a median concentration of 23 mg/L. Effluent concentrations ranged from 1 mg/L to 19 mg/L, with a median of 5 mg/L.
  - Herrera collected influent PSD samples during 3 storm events. The D_{50} for the samples were 42, 1306, and 57 microns. The 1306 micron value was collected during an event with an influent TSS concentration of 1 mg/L. It is assumed this sample was atypical and that it contained a few grains of very coarse sand and almost no other particles.
  - Herrera used a water truck to conduct flow testing 7 times to assess how long the system could filter at the design flow rate without bypass. Results show the system was able to treat up to a full water year before the system needed maintenance.

Laboratory Testing

- Good Harbour Laboratories (GHL) conducted laboratory testing at their site in Mississauga, Ontario in October 2017 following the New Jersey Department of Environmental Protection Laboratory Protocol for Filtration MTDs. The testing evaluated a 4-foot by 6-foot standard biofiltration chamber and inlet contour rack with bypass weir. The test sediment used during the testing was custom blended by GHL using various commercially available silica sands, which had an average d_{50} of 69 µm. Based on the lab test results:

  - GHL evaluated removal efficiency over 15 events at a Maximum Treatment Flow Rate (MTFR) of 37.6 gpm, which corresponds to a MTFR to effective filtration treatment area ratio of 1.80 gpm/ft^2. The system, operating at 100% of the MTFR with an average influent concentration of 201.3 mg/L, had an average removal efficiency of 99 percent.
  - GHL evaluated sediment mass loading capacity over an additional 16 events using an influent SSC concentration of 400 mg/L. The first 11 runs were evaluated at 100% of the MTFR. The BioPod began to bypass, so the remaining 5 runs were evaluated at 90% of the MTFR. The total mass of the sediment captured was 245.0 lbs and the cumulative mass removal efficiency was 96.3%.

- Herrera Environmental Consultants Inc. conducted laboratory testing in September 2014 at the Seattle University Engineering Laboratory. The testing evaluated the flushing characteristics, hydraulic conductivity, and pollutant removal ability of twelve different media blends. Based on this testing, Oldcastle Infrastructure, Inc. selected one media blend, Mix 8, for inclusion in their TAPE evaluation of the BioPod™ Biofilter.
  - Herrera evaluated Mix 8 in an 8-inch diameter by 36-inch tall polyvinyl chloride (PVC) column. The column contained 18-inches of Mix 8 on top of 6-inches of pea gravel. The BioPod will normally include a 3-inch mulch layer on top of the media layer; however, this was not included in the laboratory testing.
  - Mix 8 has a hydraulic conductivity of 218 inches per hour; however, evaluation of the pollutant removal ability of the media was based on an infiltration rate of 115 inches per hour. The media was tested at 75%, 100%, and 125% of the infiltration rate. Based on the lab test results:
    - The system was evaluated using natural stormwater. The dissolved copper and dissolved zinc concentrations in the natural stormwater were lower than the TAPE influent standards; therefore, the stormwater was spiked with 66.4 mL of 100 mg/L Cu solution and 113.6 mL of 1,000 mg/L Zn solution.
    - The BioPod removed an average of 81% of TSS, with a mean influent concentration of 48.4 mg/L and a mean effluent concentration of 9.8 mg/L.
    - The BioPod removed an average of 94% of dissolved copper, with a mean influent concentration of 10.6 µg/L and a mean effluent concentration of 0.6 µg/L.
    - The BioPod removed an average of 97% of dissolved zinc, with a mean influent concentration of 117 µg/L and a mean effluent concentration of 4 µg/L.
    - The BioPod removed an average of 97% of total phosphorus, with a mean influent concentration of 2.52 mg/L and a mean effluent concentration of 0.066 mg/L. When total phosphorus influent concentrations were capped at the TAPE upper limit of 0.5 mg/L, calculations showed an average removal of 87%.

Other BioPod Related Issues to be Addressed by the Company:

1. None identified at this time.

Technology Description: Download at https://oldcastleprecast.com/stormwater/bioretention-biofiltration-applications/bioretention-biofiltration-solutions/

Contact Information:

Applicant: Chris Demarest
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Chris.demarest@oldcastle.com

Applicant website: https://oldcastleprecast.com/stormwater/

Ecology web link: https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies

Ecology: Douglas C. Howie, P.E.
Department of Ecology
Water Quality Program
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douglas.howie@ecy.wa.gov

Revision History

Date	Revision
March 2018	GULD granted for Basic Treatment
March 2018	Provisional GULD granted for Enhanced and Phosphorus Treatment
June 2016	PULD Granted
April 2018	GULD for Basic and Provisional GULD for Enhanced and Phosphorus granted, changed name to BioPod from TreePod
July 2018	GULD for Enhanced and Phosphorus granted
September 2018	Changed Address for Oldcastle
December 2018	Added minimum media thickness requirement
May 2019	Changed language on who must Install and maintain the device from Oldcastle to Applicants
August 2019	Added text on sizing using infiltration rate and water quality design flow rate
October 2019	Added text describing ability to use off-line design water quality flow rate for sizing due to internal bypass
December 2021	Extended approval to installations without plants, added sizing adjustment when using facilities with a drawdown outlet
March 2022	Added results from the maintenance frequency assessment to the Ecology's Conditions of Use and the Findings of Fact sections

APPENDIX D: OPERATIONS & MAINTENANCE

APPENDIX E: WWHM2012 MODEL OUTPUT

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	Stormwater Detention Pond
Site Name:	
Site Address:	128th ave ne
City:	
Report Date:	6/23/2022
Gage:	Everett
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.200
Version Date:	2021/08/18
Version:	4.2.18

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year

Landuse Basin Data
Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Flat	11.011
Pervious Total	11.011
Impervious Land Use	acre
Impervious Total	0
Basin Total	11.011

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Flat	2.27
Pervious Total	2.27
Impervious Land Use	acre
PARKING FLAT	7.561
POND	1.18
Impervious Total	8.741
Basin Total	11.011

Element Flows To:

Surface	Interflow	Groundwater
Detention Pond	Detention Pond	

Routing Elements
Predeveloped Routing

Mitigated Routing

Detention Pond

Bottom Length:	186.62 ft.
Bottom Width:	186.62 ft.
Depth:	6 ft.
Volume at riser head:	4.6747 acre-feet.
Side slope 1:	3 To 1
Side slope 2:	3 To 1
Side slope 3:	3 To 1
Side slope 4:	3 To 1
Discharge Structure	
Riser Height:	5 ft.
Riser Diameter:	18 in.
Notch Type:	Rectangular
Notch Width:	0.058 ft.
Notch Height:	2.444 ft.
Orifice 1 Diameter:	2.085 in. Elevation:0 ft.
Element Flows To:	
Outlet 1	Outlet 2

**Bottom Length, Bottom Width, and Slopes do not reflect the proposed design dimensions. The proposed design features the Depth, Outlet Structure and Volume dimensions specified in this report.*

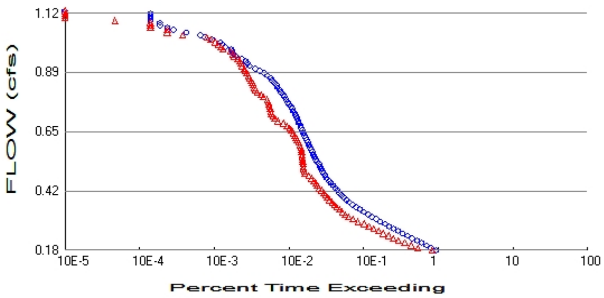
Pond Hydraulic Table

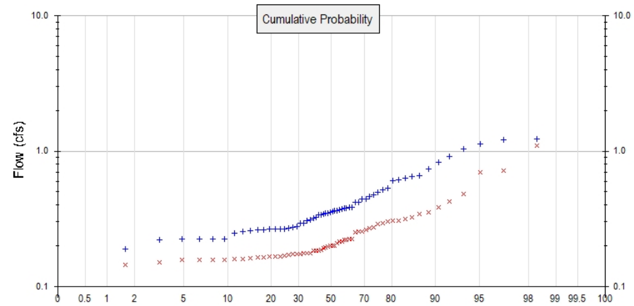
Stage(feet)	**Area(ac.)**	**Volume(ac-ft.)**	**Discharge(cfs)**	**Infilt(cfs)**
0.0000	0.799	0.000	0.000	0.000
0.0667	0.803	0.053	0.030	0.000
0.1333	0.806	0.107	0.043	0.000
0.2000	0.809	0.160	0.052	0.000
0.2667	0.813	0.215	0.060	0.000
0.3333	0.816	0.269	0.068	0.000
0.4000	0.820	0.323	0.074	0.000
0.4667	0.823	0.378	0.080	0.000
0.5333	0.827	0.433	0.086	0.000
0.6000	0.830	0.489	0.091	0.000
0.6667	0.834	0.544	0.096	0.000
0.7333	0.837	0.600	0.101	0.000
0.8000	0.841	0.656	0.105	0.000
0.8667	0.844	0.712	0.109	0.000
0.9333	0.848	0.768	0.114	0.000
1.0000	0.851	0.825	0.118	0.000
1.0667	0.855	0.882	0.121	0.000
1.1333	0.858	0.939	0.125	0.000
1.2000	0.862	0.996	0.129	0.000
1.2667	0.866	1.054	0.132	0.000
1.3333	0.869	1.112	0.136	0.000
1.4000	0.873	1.170	0.139	0.000
1.4667	0.876	1.228	0.142	0.000
1.5333	0.880	1.287	0.146	0.000
1.6000	0.883	1.346	0.149	0.000
1.6667	0.887	1.405	0.152	0.000
1.7333	0.891	1.464	0.155	0.000
1.8000	0.894	1.524	0.158	0.000
1.8667	0.898	1.583	0.161	0.000
1.9333	0.902	1.643	0.164	0.000
2.0000	0.905	1.704	0.166	0.000
2.0667	0.909	1.764	0.169	0.000

2.1333	0.913	1.825	0.172	0.000
2.2000	0.916	1.886	0.175	0.000
2.2667	0.920	1.947	0.177	0.000
2.3333	0.924	2.009	0.180	0.000
2.4000	0.927	2.070	0.182	0.000
2.4667	0.931	2.132	0.185	0.000
2.5333	0.935	2.194	0.187	0.000
2.6000	0.938	2.257	0.192	0.000
2.6667	0.942	2.320	0.199	0.000
2.7333	0.946	2.383	0.209	0.000
2.8000	0.950	2.446	0.219	0.000
2.8667	0.953	2.509	0.231	0.000
2.9333	0.957	2.573	0.243	0.000
3.0000	0.961	2.637	0.256	0.000
3.0667	0.965	2.701	0.269	0.000
3.1333	0.968	2.766	0.283	0.000
3.2000	0.972	2.830	0.297	0.000
3.2667	0.976	2.895	0.312	0.000
3.3333	0.980	2.960	0.327	0.000
3.4000	0.983	3.026	0.341	0.000
3.4667	0.987	3.092	0.356	0.000
3.5333	0.991	3.158	0.371	0.000
3.6000	0.995	3.224	0.388	0.000
3.6667	0.999	3.290	0.406	0.000
3.7333	1.003	3.357	0.425	0.000
3.8000	1.006	3.424	0.444	0.000
3.8667	1.010	3.491	0.463	0.000
3.9333	1.014	3.559	0.483	0.000
4.0000	1.018	3.627	0.589	0.000
4.0667	1.022	3.695	0.616	0.000
4.1333	1.026	3.763	0.643	0.000
4.2000	1.030	3.831	0.671	0.000
4.2667	1.033	3.900	0.699	0.000
4.3333	1.037	3.969	0.728	0.000
4.4000	1.041	4.039	0.757	0.000
4.4667	1.045	4.108	0.787	0.000
4.5333	1.049	4.178	0.817	0.000
4.6000	1.053	4.248	0.848	0.000
4.6667	1.057	4.318	0.879	0.000
4.7333	1.061	4.389	0.911	0.000
4.8000	1.065	4.460	0.943	0.000
4.8667	1.069	4.531	0.975	0.000
4.9333	1.073	4.603	1.008	0.000
5.0000	1.077	4.674	1.042	0.000
5.0667	1.081	4.746	1.317	0.000
5.1333	1.085	4.818	1.817	0.000
5.2000	1.089	4.891	2.451	0.000
5.2667	1.093	4.964	3.172	0.000
5.3333	1.097	5.037	3.933	0.000
5.4000	1.101	5.110	4.684	0.000
5.4667	1.105	5.183	5.380	0.000
5.5333	1.109	5.257	5.980	0.000
5.6000	1.113	5.331	6.458	0.000
5.6667	1.117	5.406	6.813	0.000
5.7333	1.121	5.480	7.074	0.000
5.8000	1.125	5.555	7.400	0.000
5.8667	1.129	5.630	7.661	0.000
5.9333	1.133	5.706	7.912	0.000

6.0000	1.137	5.782	8.154	0.000
6.0667	1.141	5.858	8.388	0.000

Analysis Results
POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1

Total Pervious Area:	11.011
Total Impervious Area:	0

Mitigated Landuse Totals for POC #1

Total Pervious Area:	2.27
Total Impervious Area:	8.741

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.369974
5 year	0.567552
10 year	0.719928
25 year	0.937938
50 year	1.119505
100 year	1.318073

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.214488
5 year	0.313142
10 year	0.394497
25 year	0.518084
50 year	0.627018
100 year	0.752011

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.370	0.176
1950	0.378	0.200
1951	0.338	0.164
1952	0.267	0.158
1953	0.223	0.160
1954	1.209	0.184
1955	0.476	0.306
1956	0.420	0.344
1957	0.521	0.249
1958	0.376	0.177

1959	0.373	0.185
1960	0.348	0.208
1961	0.657	0.301
1962	0.324	0.163
1963	0.535	0.174
1964	0.385	0.145
1965	0.321	0.201
1966	0.188	0.165
1967	0.381	0.167
1968	0.464	0.214
1969	1.128	0.177
1970	0.266	0.173
1971	0.420	0.386
1972	0.310	0.182
1973	0.293	0.215
1974	0.634	0.193
1975	0.258	0.158
1976	0.266	0.185
1977	0.224	0.173
1978	0.266	0.159
1979	0.740	0.172
1980	0.347	0.157
1981	0.272	0.161
1982	0.353	0.291
1983	0.601	0.169
1984	0.363	0.424
1985	0.439	0.293
1986	1.033	0.714
1987	0.493	0.483
1988	0.255	0.305
1989	0.260	0.158
1990	0.345	0.254
1991	0.355	0.199
1992	0.271	0.222
1993	0.224	0.150
1994	0.246	0.220
1995	0.361	0.315
1996	0.616	0.272
1997	1.226	1.096
1998	0.226	0.167
1999	0.295	0.225
2000	0.221	0.351
2001	0.089	0.132
2002	0.336	0.254
2003	0.263	0.196
2004	0.443	0.326
2005	0.308	0.191
2006	0.820	0.269
2007	0.649	0.260
2008	0.911	0.694
2009	0.278	0.225

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	1.2256	1.0958
2	1.2086	0.7137
3	1.1276	0.6941

4	1.0333	0.4831
5	0.9110	0.4236
6	0.8203	0.3865
7	0.7401	0.3506
8	0.6572	0.3437
9	0.6490	0.3257
10	0.6344	0.3149
11	0.6163	0.3065
12	0.6010	0.3052
13	0.5346	0.3009
14	0.5208	0.2928
15	0.4930	0.2908
16	0.4762	0.2722
17	0.4638	0.2694
18	0.4426	0.2603
19	0.4394	0.2540
20	0.4204	0.2536
21	0.4200	0.2493
22	0.3846	0.2253
23	0.3814	0.2246
24	0.3779	0.2218
25	0.3764	0.2203
26	0.3732	0.2146
27	0.3697	0.2143
28	0.3628	0.2083
29	0.3611	0.2012
30	0.3552	0.2003
31	0.3525	0.1990
32	0.3476	0.1962
33	0.3468	0.1934
34	0.3450	0.1914
35	0.3379	0.1854
36	0.3358	0.1849
37	0.3244	0.1836
38	0.3212	0.1824
39	0.3098	0.1771
40	0.3081	0.1770
41	0.2945	0.1761
42	0.2931	0.1745
43	0.2776	0.1734
44	0.2717	0.1728
45	0.2707	0.1718
46	0.2666	0.1693
47	0.2660	0.1675
48	0.2660	0.1672
49	0.2656	0.1654
50	0.2631	0.1640
51	0.2600	0.1630
52	0.2582	0.1613
53	0.2554	0.1605
54	0.2464	0.1586
55	0.2256	0.1579
56	0.2242	0.1577
57	0.2240	0.1576
58	0.2233	0.1573
59	0.2212	0.1497
60	0.1880	0.1447
61	0.0887	0.1318

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1850	19885	17543	88	Pass
0.1944	17105	11293	66	Pass
0.2039	14861	9300	62	Pass
0.2133	12778	7597	59	Pass
0.2227	11052	6271	56	Pass
0.2322	9456	5292	55	Pass
0.2416	8243	4652	56	Pass
0.2511	7078	3959	55	Pass
0.2605	6173	3407	55	Pass
0.2699	5375	2917	54	Pass
0.2794	4682	2502	53	Pass
0.2888	4105	2188	53	Pass
0.2983	3563	1809	50	Pass
0.3077	3153	1535	48	Pass
0.3171	2761	1336	48	Pass
0.3266	2466	1209	49	Pass
0.3360	2145	1111	51	Pass
0.3455	1900	1014	53	Pass
0.3549	1675	937	55	Pass
0.3643	1512	872	57	Pass
0.3738	1379	812	58	Pass
0.3832	1253	750	59	Pass
0.3927	1159	704	60	Pass
0.4021	1069	664	62	Pass
0.4115	1010	627	62	Pass
0.4210	955	581	60	Pass
0.4304	892	540	60	Pass
0.4399	830	516	62	Pass
0.4493	779	490	62	Pass
0.4587	737	465	63	Pass
0.4682	687	428	62	Pass
0.4776	651	392	60	Pass
0.4871	622	348	55	Pass
0.4965	603	342	56	Pass
0.5059	585	337	57	Pass
0.5154	562	333	59	Pass
0.5248	539	330	61	Pass
0.5343	508	328	64	Pass
0.5437	489	324	66	Pass
0.5531	473	320	67	Pass
0.5626	457	319	69	Pass
0.5720	440	316	71	Pass
0.5814	424	313	73	Pass
0.5909	414	309	74	Pass
0.6003	394	299	75	Pass
0.6098	380	287	75	Pass
0.6192	368	275	74	Pass
0.6286	354	266	75	Pass
0.6381	341	253	74	Pass
0.6475	334	243	72	Pass
0.6570	323	232	71	Pass
0.6664	313	218	69	Pass
0.6758	305	200	65	Pass

0.6853	293	179	61	Pass
0.6947	284	151	53	Pass
0.7042	276	138	50	Pass
0.7136	267	130	48	Pass
0.7230	257	125	48	Pass
0.7325	242	122	50	Pass
0.7419	234	120	51	Pass
0.7514	226	118	52	Pass
0.7608	213	115	53	Pass
0.7702	205	113	55	Pass
0.7797	195	110	56	Pass
0.7891	187	97	51	Pass
0.7986	177	90	50	Pass
0.8080	166	80	48	Pass
0.8174	160	77	48	Pass
0.8269	152	74	48	Pass
0.8363	146	71	48	Pass
0.8458	135	69	51	Pass
0.8552	128	66	51	Pass
0.8646	121	63	52	Pass
0.8741	111	61	54	Pass
0.8835	100	58	58	Pass
0.8930	86	55	63	Pass
0.9024	75	54	72	Pass
0.9118	63	51	80	Pass
0.9213	59	49	83	Pass
0.9307	56	47	83	Pass
0.9402	50	44	88	Pass
0.9496	42	40	95	Pass
0.9590	39	38	97	Pass
0.9685	37	35	94	Pass
0.9779	36	28	77	Pass
0.9874	30	26	86	Pass
0.9968	28	24	85	Pass
1.0062	26	22	84	Pass
1.0157	20	19	95	Pass
1.0251	16	17	106	Pass
1.0345	14	8	57	Pass
1.0440	9	5	55	Pass
1.0534	6	5	83	Pass
1.0629	5	3	60	Pass
1.0723	4	3	75	Pass
1.0817	4	3	75	Pass
1.0912	3	1	33	Pass
1.1006	3	0	0	Pass
1.1101	3	0	0	Pass
1.1195	3	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	1.1209 acre-feet
On-line facility target flow:	1.6554 cfs.
Adjusted for 15 min:	1.6554 cfs.
Off-line facility target flow:	0.9366 cfs.
Adjusted for 15 min:	0.9366 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Detention Pond POC	☐	1763.93			☐	0.00			
Total Volume Infiltrated		1763.93	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

POC 2

POC #2 was not reported because POC must exist in both scenarios and both scenarios must have been run.

POC 3

POC #3 was not reported because POC must exist in both scenarios and both scenarios must have been run.

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

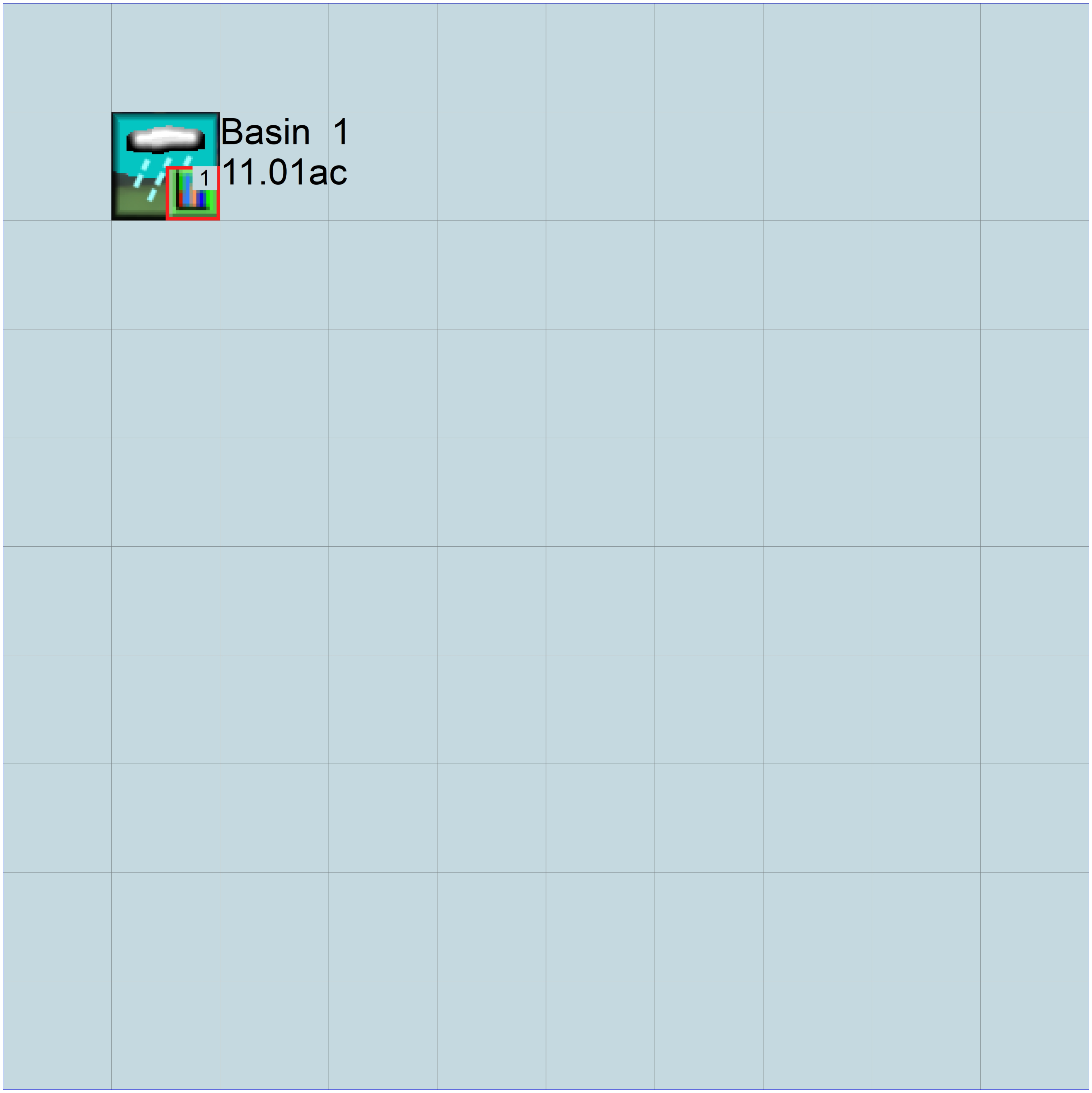
No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix

Predeveloped Schematic



Mitigated Schematic

Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   Stormwater Detention Pond.wdm
MESSU      25   PreStormwater Detention Pond.MES
           27   PreStormwater Detention Pond.L61
           28   PreStormwater Detention Pond.L62
           30   POCStormwater Detention Pond1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      10
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                   MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                            User  t-series Engl Metr ***
                                             in  out           ***
   10     C, Forest, Flat         1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   10         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   10         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   10         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   10              0       4.5      0.08       400      0.05       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   10              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   10            0.2       0.5      0.35         6       0.5       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   10              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                      in  out           ***
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
  END IWAT-STATE1
```

```
END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  10                      11.011     COPY   501     12
PERLND  10                      11.011     COPY   501     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.2            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.2            IMPLND   1 999 EXTNL  PREC
```

```
WDM      1 EVAP     ENGL    0.76            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76            IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2009 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   Stormwater Detention Pond.wdm
MESSU      25   MitStormwater Detention Pond.MES
           27   MitStormwater Detention Pond.L61
           28   MitStormwater Detention Pond.L62
           30   POCStormwater Detention Pond1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      16
      IMPLND      11
      IMPLND      14
      RCHRES       1
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Detention Pond             MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   16      C, Lawn, Flat           1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   16         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
```

```
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   16         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   16         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   16              0       4.5      0.03       400      0.05       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   16              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   16            0.1      0.25      0.25         6       0.5      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   16              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out            ***
   11      PARKING/FLAT           1    1    1   27    0
   14      POND                   1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
   11         0    0    1    0    0    0
   14         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
   11         0    0    4    0    0    0    1    9
   14         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI    ***
   11         0    0    0    0    0
   14         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
```

```
  11            400      0.01       0.1       0.1
  14            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
  11              0         0
  14              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
  11              0         0
  14              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin***
PERLND  16                        2.27     RCHRES   1      2
PERLND  16                        2.27     RCHRES   1      3
IMPLND  11                       7.561     RCHRES   1      5
IMPLND  14                        1.18     RCHRES   1      5

******Routing******
PERLND  16                        2.27     COPY     1     12
IMPLND  11                       7.561     COPY     1     15
IMPLND  14                        1.18     COPY     1     15
PERLND  16                        2.27     COPY     1     13
RCHRES   1                           1     COPY   501     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                            in  out                          ***
    1     Detention Pond          1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
```

```
    RCHRES  Flags for each HYDR Section                                          ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
    1        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1              1      0.04       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1           0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   91    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.799524  0.000000  0.000000
  0.066667  0.802955  0.053416  0.030460
  0.133333  0.806393  0.107061  0.043076
  0.200000  0.809839  0.160935  0.052758
  0.266667  0.813292  0.215040  0.060919
  0.333333  0.816752  0.269374  0.068110
  0.400000  0.820220  0.323940  0.074611
  0.466667  0.823695  0.378737  0.080589
  0.533333  0.827178  0.433767  0.086153
  0.600000  0.830668  0.489028  0.091379
  0.666667  0.834165  0.544522  0.096322
  0.733333  0.837669  0.600250  0.101023
  0.800000  0.841181  0.656212  0.105515
  0.866667  0.844700  0.712408  0.109824
  0.933333  0.848227  0.768839  0.113970
  1.000000  0.851761  0.825505  0.117970
  1.066667  0.855302  0.882407  0.121839
  1.133333  0.858851  0.939546  0.125588
  1.200000  0.862407  0.996921  0.129229
  1.266667  0.865970  1.054533  0.132771
  1.333333  0.869541  1.112384  0.136220
  1.400000  0.873118  1.170472  0.139584
  1.466667  0.876704  1.228800  0.142869
  1.533333  0.880296  1.287367  0.146079
  1.600000  0.883896  1.346173  0.149221
  1.666667  0.887504  1.405220  0.152298
  1.733333  0.891119  1.464507  0.155314
  1.800000  0.894741  1.524036  0.158273
  1.866667  0.898370  1.583806  0.161177
  1.933333  0.902007  1.643819  0.164030
  2.000000  0.905651  1.704074  0.166834
  2.066667  0.909302  1.764572  0.169592
  2.133333  0.912961  1.825314  0.172306
  2.200000  0.916627  1.886301  0.174977
  2.266667  0.920301  1.947532  0.177609
  2.333333  0.923981  2.009008  0.180202
  2.400000  0.927670  2.070729  0.182758
  2.466667  0.931365  2.132697  0.185279
  2.533333  0.935068  2.194912  0.187766
  2.600000  0.938778  2.257373  0.191999
  2.666667  0.942496  2.320082  0.199608
  2.733333  0.946221  2.383040  0.208954
```

```
  2.800000  0.949953  2.446245  0.219541
  2.866667  0.953692  2.509700  0.231089
  2.933333  0.957439  2.573405  0.243408
  3.000000  0.961194  2.637359  0.256355
  3.066667  0.964955  2.701564  0.269814
  3.133333  0.968724  2.766020  0.283690
  3.200000  0.972501  2.830727  0.297900
  3.266667  0.976284  2.895687  0.312373
  3.333333  0.980075  2.960899  0.327045
  3.400000  0.983874  3.026364  0.341857
  3.466667  0.987679  3.092082  0.356758
  3.533333  0.991492  3.158055  0.371699
  3.600000  0.995313  3.224282  0.388456
  3.666667  0.999141  3.290763  0.406533
  3.733333  1.002976  3.357501  0.425080
  3.800000  1.006818  3.424494  0.444082
  3.866667  1.010668  3.491743  0.463527
  3.933333  1.014525  3.559250  0.483405
  4.000000  1.018389  3.627013  0.589451
  4.066667  1.022261  3.695035  0.616167
  4.133333  1.026140  3.763315  0.643419
  4.200000  1.030027  3.831854  0.671196
  4.266667  1.033921  3.900652  0.699488
  4.333333  1.037822  3.969710  0.728284
  4.400000  1.041731  4.039029  0.757574
  4.466667  1.045646  4.108608  0.787350
  4.533333  1.049570  4.178449  0.817604
  4.600000  1.053500  4.248551  0.848327
  4.666667  1.057438  4.318916  0.879511
  4.733333  1.061384  4.389543  0.911150
  4.800000  1.065336  4.460434  0.943236
  4.866667  1.069296  4.531588  0.975763
  4.933333  1.073263  4.603007  1.008724
  5.000000  1.077238  4.674690  1.042114
  5.066667  1.081220  4.746639  1.317562
  5.133333  1.085209  4.818853  1.817073
  5.200000  1.089206  4.891333  2.451802
  5.266667  1.093210  4.964081  3.172881
  5.333333  1.097222  5.037095  3.933284
  5.400000  1.101240  5.110377  4.684664
  5.466667  1.105266  5.183927  5.380176
  5.533333  1.109300  5.257746  5.980023
  5.600000  1.113341  5.331834  6.458714
  5.666667  1.117389  5.406192  6.813644
  5.733333  1.121444  5.480820  7.074786
  5.800000  1.125507  5.555718  7.400943
  5.866667  1.129577  5.630888  7.661391
  5.933333  1.133655  5.706329  7.912053
  6.000000  1.137740  5.782042  8.153959
  END FTABLE  1
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.2            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.2            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   1 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1001 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS
```

```
MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       16
RCHRES     ROFLOW                          COPY           INPUT  MEAN
  END MASS-LINK   16

END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

Disclaimer

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