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DRAINAGE REPORT

To
City of Tualatin

For
Hedges D

Submitted
December 9, 2019

Project Number
2190365.00

EXPIRES: 12/31/20

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1. INTRODUCTION

The following storm drainage calculations are intended to support the water quality and hydromodification systems for the Hedges D Development. This report demonstrates the proposed stormwater system's compliance with Clean Water Services Design and Construction Standards (April 2019).

The 5-acre industrial development includes a single building, surface parking, proprietary treatment devices, and underground storage on currently undeveloped fallow land in the City of Tualatin. The project is tributary to Hedges Creek of the Tualatin River Watershed. The property is surrounded by a vegetated corridor and storm surface drainage easements. The project is subject to the 2019 Clean Water Services Design and Construction Standards, including water quality and hydromodification requirements.

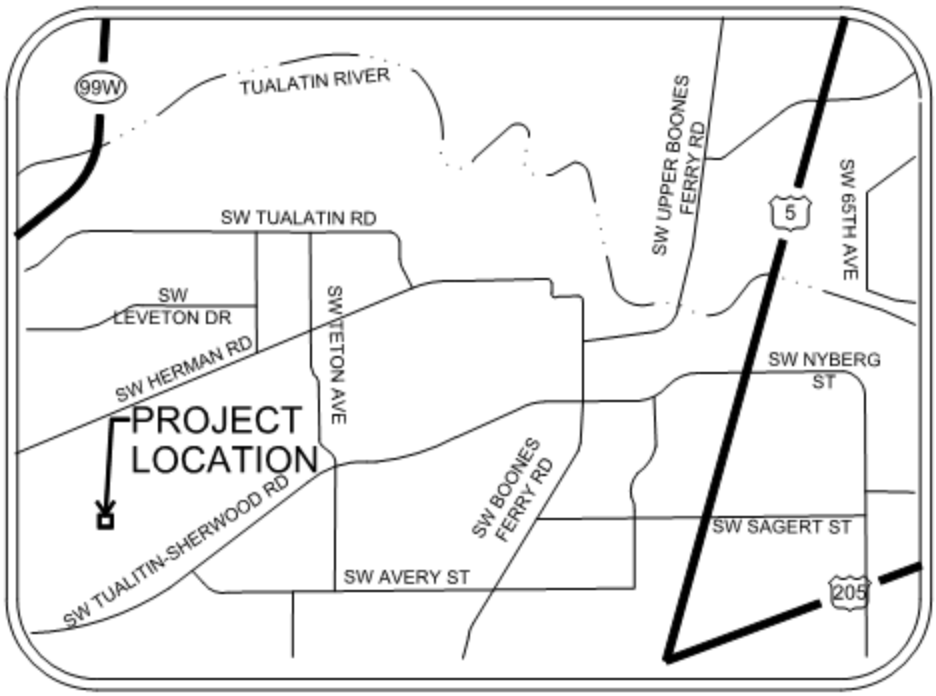


Figure 1: Vicinity Map

2. BASIS OF DESIGN AND ASSUMPTIONS

BASIS OF DESIGN

This project is subject to the design requirements of the 2019 Clean Water Services Design and Construction Standards.

- Hydrologic calculations are computed using TR-55, the Santa Barbara Urban Hydrograph (SBUH), and Autodesk Hydraflow Hydrographs Extension, Version 2020.
- Impervious area used in design of water quality, conveyance capacity, and hydromodification
    - Quality: Area = New Impervious + 3(Modified Impervious)
    - Quantity: All new and modified impervious area created by the development
- The project creates more than 1,000 square feet of impervious surfaces and so is subject to implement water quality components mitigate impacts of hydromodification
    - Conveyance facilities will be sized from the 25-year storm
    - Water Quality: A dry weather storm event totaling 0.36 inches of precipitation falling in 4 hours with an average storm return period of 96 hours.
    - To address Hydromodification requirements, the project follows Category 2, option 2 Peak-Flow Matching design to address Hydromodification requirements: attenuate the 2-year post-development peak flow to ½ the 2-year pre-developed peak flow, the 5-year-post-developed peak to the 5-year pre-developed peak, and the 10-year post-developed peak to the 10-year pre-developed peak.

Table 1: Storm Events to be Used in CWS Design (CWS Table 4-4)

Recurrence Interval	Total 24-Hour Precipitation Depth (water equivalent inches)
2-year	2.5
5-year	3.10
10-year	3.45
25-year	3.90

ASSUMPTIONS

- Groundwater does not interact with the system for the scope of this analysis
- Infiltration rates are negligible
- Hedges Creek has sufficient capacity for project flows and downstream analysis is not required
- Backwater from Hedges creek will be negligible at worst within the scope of this analysis

3. WATER QUALITY

This project creates more than 1,000 square feet of impervious surface and is thus required to implement techniques to reduce impacts to the downstream receiving water body. Water quality will be provided using Oldcastle Perkfilter manholes. Per section 4.07.8 of the CWS manual, proprietary devices meeting the removal efficiency requirements (designed to remove 65 percent of the total phosphorus from the runoff from the impervious area that is tributary to the facility) in section 4.04.3(a) are allowed for single commercial, industrial, multi-family, or condominium parcels. Per Oldcastle Field Monitoring Performance Summary, the Perkfilter containing ZPC media has an average TSS removal efficiency of 82.4%, and thus meets the requirements of CWS.

The impervious area and resultant number of required filters for each of the four drainage basins (shown in the attached Basin Map) are summarized in Table 2. See Appendix D for operations and maintenance procedures for the Oldcastle Perkfilters.

Table 2: Water Quality Summary

Drainage Basin	Impervious Area (ft^2)	Water Quality Flow (cfs)	Required # of Filters
NW	53,561	0.11	4
NE	49,729	0.10	4
SW	50,910	0.11	4
SE	35,328	0.07	2

CWS standards for water quality is to design for a storm event totaling 0.36 inches or precipitation over 4 hours, and is calculated as follows:

$$\text{Water Quality Volume } (ft^3) = \frac{0.36 \text{ (in.)} \times \text{Area (sq. ft.)}}{12 \text{ (in/ft)}}$$

$$\text{Water Quality Flow } (ft^3/s) = \frac{\text{Water Quality Volume } (ft^3)}{14{,}400 \text{ seconds}}$$

Pollutants of concern in the truck dock maneuvering area include zinc from brake pads and copper from wheels, which are addressed with the proprietary media.

4. HYDROMODIFICATION

This project creates more than 1,000 square feet of impervious surface and is thus required to implement techniques to reduce impacts to the downstream receiving water body. Impacts for this project will be mitigated by implementing two ADS StormTech underground detention systems with flow control manholes. The facilities will outfall directly to Hedges Creek with rip rap pads for energy dissipation.

CWS requires a Hydromodification Assessment (per section 4.03.3 of the CWS Design and Construction Standards) to determine the method that must be used to meet flow control standards. Using the CWS Hydromodification Map Web Tool, the project is determined to be low risk and exists in a developed area. Because the project is over 80,000 ft^2, the project falls under Approach Category 2 per Table 3.

Table 3: Hydromodification Approach Project Category Table (CWS Table 4-2)

<table>
<tr><th>Development Class/ Risk Level</th><th>Small Project 1,000 – 12,000 SF</th><th>Medium Project >12,000 – 80,000 SF</th><th>Large Project > 80,000 SF</th></tr>
<tr><td>Expansion/High</td><td rowspan="6">Category 1</td><td rowspan="2">Category 3</td><td rowspan="4">Category 3</td></tr>
<tr><td>Expansion/ Moderate</td></tr>
<tr><td>Expansion/ Low</td><td>Category 2</td></tr>
<tr><td>Developed/ High</td><td>Category 3</td></tr>
<tr><td>Developed/ Moderate</td><td rowspan="2">Category 2</td><td rowspan="2">Category 2</td></tr>
<tr><td>Developed/ Low</td></tr>
</table>

Under Category 2, the following options may be used to address hydromodification:

1. Infiltration Low Impact Development Approach (LIDA), using the Standard LIDA Sizing, described in Section 4.08.5; or
2. Peak-Flow Matching Detention, using design criteria described in Section 4.08.6; or
3. Combination of Infiltration LIDA and Peak-Flow Matching Detention, using criteria described in Section 4.08.5 and 4.08.6; or
4. Any option listed in Category 3

The Peak-Flow Matching Detention design criteria was chosen to be pursued for this project. Per section 4.08.6 of the 2019 CWS Design and Construction Standards, approaches shall be designed such that the post-development runoff rates from the site do not exceed the pre-development runoff rates shown in Table 4.

Table 4: Pre-Development Peak Runoff Rate Targets (CWS Table 4-7)

Post-Development Peak Runoff Rate	Pre-Development Peak Runoff Rate Target
2-year, 24-hour	50% of 2-year, 24-hour
5-year, 24-hour	5-year, 24 hour
10-year, 24-hour	10-year, 24-hour

Peak flow matching flows for each of the detention systems are summarized in Table 5. See Appendix B for supporting calculations and Appendix D for operations and maintenance procedures for the underground detention system.

Table 5: Hydromodification Summary			
Storm Event	**Pre-Development Flow (ft^3/s)**	**Post-Development Flow (ft^3/s)**	**Required Storage Volume (ft^3)**
North Basin			
(½) 2-year	0.077	0.063	21,011
5-year	0.325	0.199	
10-year	0.443	0.249	
South Basin			
(½) 2-year	0.057	0.055	15,684
5-year	0.240	0.124	
10-year	0.327	0.175	

5. CONVEYANCE DESIGN

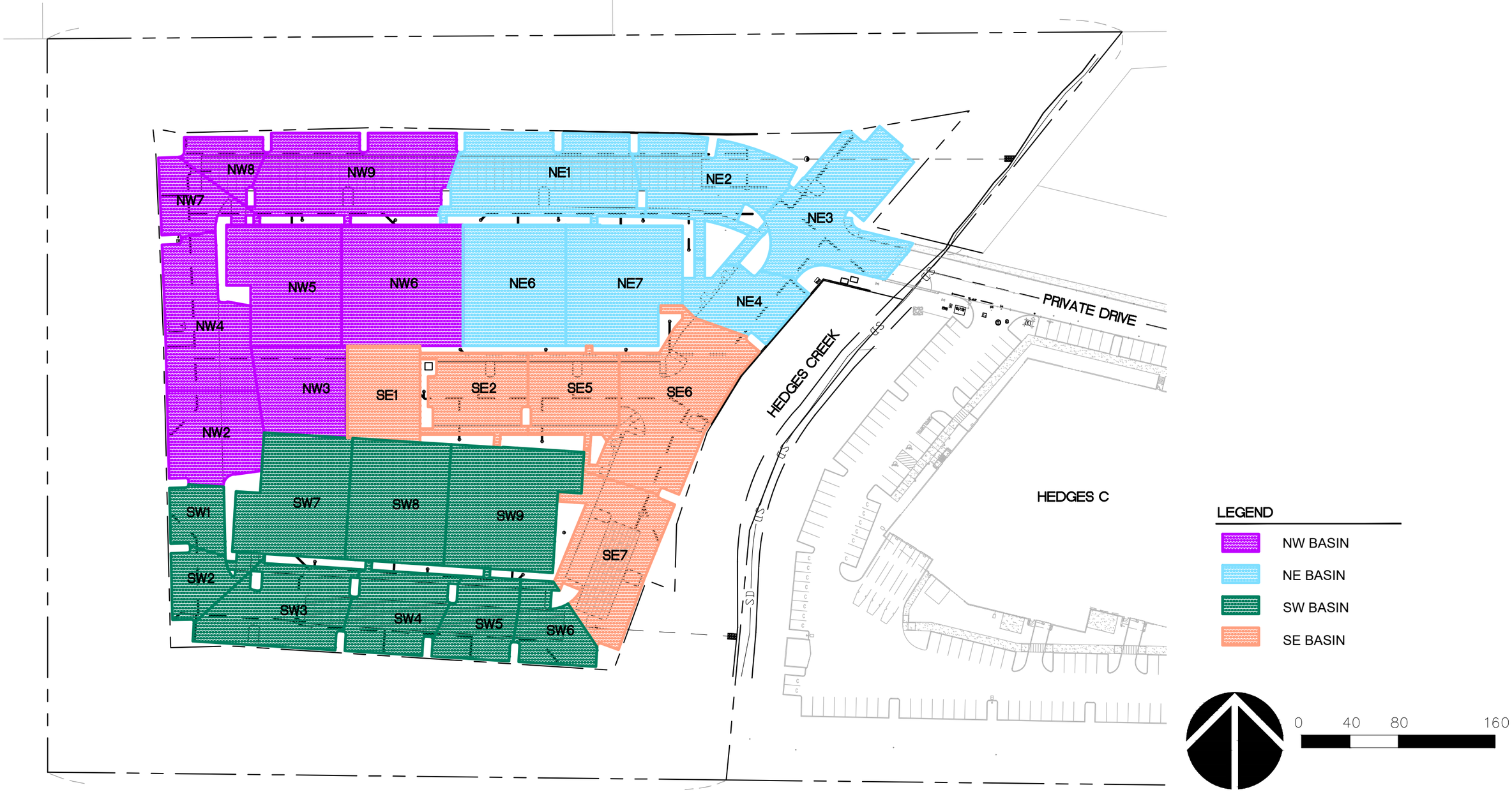
The conveyance design was determined using TR-55 and the Santa Barbara Urban Hydrograph. The 25-year design storm was applied over the entire site to determine a peak flow value. This peak flow value was prorated over each area tributary to catch basins, area drains, and roof drains (see attached Basin Map). Critical points along the system were identified and these prorated flow values were balanced against the capacity at each critical point. The Table 6 was used for design of the conveyance system.

Table 6: General Pipe Sizing for Conveyance

Pipe Size/Slope	Capacity (ft^3/s)
4” @ 0.35%	0.13
6” @ 0.35%	0.40
8” @ 0.35%	0.85
12” @ 0.35%	2.50

6. CONCLUSION

The on-site private stormwater management approach for the Hedges D project includes the implementation of an underground detention system and proprietary treatment devices, which meets the water quality and hydromodification criteria of the 2019 CWS Design and Construction Standards.



APPENDIX A

NRCS WEB SOIL SURVEY SUMMARY

Map Scale: 1:2,050 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 30 60 120 180

Feet
0 50 100 200 300

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 1:20,000.

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: Washington County, Oregon
Survey Area Data: Version 17, Sep 10, 2019

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

Date(s) aerial images were photographed: Aug 3, 2014—Aug 23, 2014

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
21B	Hillsboro loam, 3 to 7 percent slopes	B	0.0	0.2%
27	Labish mucky clay	C/D	7.9	44.5%
43	Wapato silty clay loam	C/D	4.7	26.3%
2027A	Verboort silty clay loam, 0 to 3 percent slopes	D	5.1	29.1%
Totals for Area of Interest			**17.7**	**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

WATER QUANTITY SIZING CALCULATIONS

Pond Report

Pond No. 1 - SC-740 Chambers NORTH

Pond Data

UG Chambers -Invert elev. = 137.50 ft, Rise x Span = 2.50 x 4.25 ft, Barrel Len = 2477.00 ft, No. Barrels = 1, Slope = 0.00%, Headers = No
Encasement -Invert elev. = 137.50 ft, Width = 5.25 ft, Height = 3.50 ft, Voids = 40.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	137.50	n/a	0	0
0.35	137.85	n/a	4,025	4,025
0.70	138.20	n/a	3,981	8,006
1.05	138.55	n/a	3,890	11,896
1.40	138.90	n/a	3,746	15,642
1.75	139.25	n/a	3,534	19,176
2.10	139.60	n/a	3,225	22,401
2.45	139.95	n/a	2,709	25,109
2.80	140.30	n/a	1,863	26,972
3.15	140.65	n/a	1,821	28,793
3.50	141.00	n/a	1,821	30,614

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.50	1.50	4.00	0.00
Span (in)	= 0.50	1.50	4.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 137.50	138.00	139.10	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 3.14	0.00	0.00	0.00
Crest El. (ft)	= 140.20	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	137.50	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.04	402	137.54	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.07	805	137.57	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.10	1,207	137.60	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.14	1,610	137.64	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.17	2,012	137.68	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.21	2,415	137.71	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.25	2,817	137.74	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.28	3,220	137.78	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.31	3,622	137.82	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.35	4,025	137.85	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.38	4,423	137.88	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.42	4,821	137.92	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.46	5,219	137.96	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.49	5,617	137.99	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.52	6,015	138.02	0.00	0.00 ic	0.00	---	0.00	---	---	---	---	---	0.001
0.56	6,413	138.06	0.00	0.00 ic	0.00	---	0.00	---	---	---	---	---	0.005
0.60	6,811	138.10	0.00	0.01 ic	0.00	---	0.00	---	---	---	---	---	0.011
0.63	7,210	138.13	0.00	0.02 ic	0.00	---	0.00	---	---	---	---	---	0.015
0.67	7,608	138.16	0.00	0.02 ic	0.00	---	0.00	---	---	---	---	---	0.019
0.70	8,006	138.20	0.00	0.02 ic	0.00	---	0.00	---	---	---	---	---	0.022
0.74	8,395	138.24	0.00	0.02 ic	0.00	---	0.00	---	---	---	---	---	0.025
0.77	8,784	138.27	0.00	0.03 ic	0.00	---	0.00	---	---	---	---	---	0.027
0.80	9,173	138.30	0.00	0.03 ic	0.00	---	0.00	---	---	---	---	---	0.029
0.84	9,562	138.34	0.00	0.03 ic	0.00	---	0.00	---	---	---	---	---	0.031
0.87	9,951	138.38	0.00	0.03 ic	0.00	---	0.00	---	---	---	---	---	0.033
0.91	10,340	138.41	0.00	0.03 ic	0.00	---	0.00	---	---	---	---	---	0.035
0.94	10,729	138.45	0.00	0.04 ic	0.00	---	0.00	---	---	---	---	---	0.037
0.98	11,118	138.48	0.00	0.04 ic	0.00	---	0.00	---	---	---	---	---	0.038
1.01	11,507	138.51	0.00	0.04 ic	0.00	---	0.00	---	---	---	---	---	0.040
1.05	11,896	138.55	0.00	0.04 ic	0.00	---	0.00	---	---	---	---	---	0.041
1.09	12,270	138.59	0.00	0.04 ic	0.00	---	0.00	---	---	---	---	---	0.043

Continues on next page...

SC-740 Chambers NORTH

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
1.12	12,645	138.62	0.00	0.04 ic	0.00	---	0.00	---	---	---	---	---	0.044
1.15	13,020	138.65	0.00	0.05 ic	0.00	---	0.00	---	---	---	---	---	0.045
1.19	13,394	138.69	0.00	0.05 ic	0.00	---	0.00	---	---	---	---	---	0.047
1.23	13,769	138.73	0.00	0.05 ic	0.00	---	0.00	---	---	---	---	---	0.048
1.26	14,143	138.76	0.00	0.05 ic	0.00	---	0.00	---	---	---	---	---	0.049
1.29	14,518	138.79	0.00	0.05 ic	0.00	---	0.00	---	---	---	---	---	0.051
1.33	14,892	138.83	0.00	0.05 ic	0.00	---	0.00	---	---	---	---	---	0.052
1.37	15,267	138.87	0.00	0.05 ic	0.00	---	0.00	---	---	---	---	---	0.053
1.40	15,642	138.90	0.00	0.05 ic	0.00	---	0.00	---	---	---	---	---	0.054
1.43	15,995	138.93	0.00	0.06 ic	0.00	---	0.00	---	---	---	---	---	0.055
1.47	16,348	138.97	0.00	0.06 ic	0.00	---	0.00	---	---	---	---	---	0.056
1.50	16,702	139.01	0.00	0.06 ic	0.00	---	0.00	---	---	---	---	---	0.057
1.54	17,055	139.04	0.00	0.06 ic	0.00	---	0.00	---	---	---	---	---	0.058
1.58	17,409	139.07	0.00	0.06 ic	0.00	---	0.00	---	---	---	---	---	0.059
1.61	17,762	139.11	0.00	0.06 ic	0.00 ic	---	0.00	---	---	---	---	---	0.061
1.64	18,116	139.15	0.00	0.06 ic	0.01 ic	---	0.00	---	---	---	---	---	0.067
1.68	18,469	139.18	0.00	0.06 ic	0.02 ic	---	0.00	---	---	---	---	---	0.078
1.72	18,822	139.21	0.00	0.06 ic	0.03 ic	---	0.00	---	---	---	---	---	0.094
1.75	19,176	139.25	0.00	0.06 ic	0.05 ic	---	0.00	---	---	---	---	---	0.115
1.78	19,498	139.29	0.00	0.07 ic	0.07 ic	---	0.00	---	---	---	---	---	0.138
1.82	19,821	139.32	0.00	0.07 ic	0.10 ic	---	0.00	---	---	---	---	---	0.164
1.86	20,143	139.35	0.00	0.07 ic	0.12 ic	---	0.00	---	---	---	---	---	0.190
1.89	20,466	139.39	0.00	0.07 ic	0.15 ic	---	0.00	---	---	---	---	---	0.216
1.92	20,788	139.43	0.00	0.07 ic	0.17 ic	---	0.00	---	---	---	---	---	0.237
1.96	21,111	139.46	0.00	0.07 ic	0.18 ic	---	0.00	---	---	---	---	---	0.255
2.00	21,433	139.49	0.00	0.07 ic	0.20 ic	---	0.00	---	---	---	---	---	0.271
2.03	21,756	139.53	0.00	0.07 ic	0.22 ic	---	0.00	---	---	---	---	---	0.287
2.07	22,078	139.57	0.00	0.07 ic	0.23 ic	---	0.00	---	---	---	---	---	0.302
2.10	22,401	139.60	0.00	0.07 ic	0.24 ic	---	0.00	---	---	---	---	---	0.316
2.13	22,671	139.63	0.00	0.07 ic	0.25 ic	---	0.00	---	---	---	---	---	0.329
2.17	22,942	139.67	0.00	0.07 ic	0.27 ic	---	0.00	---	---	---	---	---	0.342
2.20	23,213	139.71	0.00	0.08 ic	0.28 ic	---	0.00	---	---	---	---	---	0.354
2.24	23,484	139.74	0.00	0.08 ic	0.29 ic	---	0.00	---	---	---	---	---	0.366
2.28	23,755	139.77	0.00	0.08 ic	0.30 ic	---	0.00	---	---	---	---	---	0.377
2.31	24,026	139.81	0.00	0.08 ic	0.31 ic	---	0.00	---	---	---	---	---	0.388
2.35	24,297	139.85	0.00	0.08 ic	0.32 ic	---	0.00	---	---	---	---	---	0.398
2.38	24,568	139.88	0.00	0.08 ic	0.33 ic	---	0.00	---	---	---	---	---	0.409
2.42	24,838	139.91	0.00	0.08 ic	0.34 ic	---	0.00	---	---	---	---	---	0.419
2.45	25,109	139.95	0.00	0.08 ic	0.35 ic	---	0.00	---	---	---	---	---	0.428
2.48	25,296	139.99	0.00	0.08 ic	0.36 ic	---	0.00	---	---	---	---	---	0.438
2.52	25,482	140.02	0.00	0.08 ic	0.36 ic	---	0.00	---	---	---	---	---	0.447
2.56	25,668	140.05	0.00	0.08 ic	0.37 ic	---	0.00	---	---	---	---	---	0.456
2.59	25,855	140.09	0.00	0.08 ic	0.38 ic	---	0.00	---	---	---	---	---	0.465
2.63	26,041	140.13	0.00	0.08 ic	0.39 ic	---	0.00	---	---	---	---	---	0.474
2.66	26,227	140.16	0.00	0.09 ic	0.40 ic	---	0.00	---	---	---	---	---	0.483
2.69	26,413	140.20	0.00	0.09 ic	0.40 ic	---	0.00	---	---	---	---	---	0.491
2.73	26,600	140.23	0.01 ic	0.09 ic	0.41 ic	---	0.01 s	---	---	---	---	---	0.509
2.77	26,786	140.26	0.01 ic	0.09 ic	0.42 ic	---	0.01 s	---	---	---	---	---	0.517
2.80	26,972	140.30	0.01 ic	0.09 ic	0.43 ic	---	0.00 s	---	---	---	---	---	0.526
2.84	27,154	140.34	0.01 ic	0.09 ic	0.43 ic	---	0.00	---	---	---	---	---	0.534
2.87	27,336	140.37	0.01 ic	0.09 ic	0.44 ic	---	0.00	---	---	---	---	---	0.542
2.90	27,519	140.40	0.01 ic	0.09 ic	0.45 ic	---	0.00	---	---	---	---	---	0.550
2.94	27,701	140.44	0.01 ic	0.09 ic	0.46 ic	---	0.00	---	---	---	---	---	0.557
2.97	27,883	140.48	0.01 ic	0.09 ic	0.46 ic	---	0.00	---	---	---	---	---	0.565
3.01	28,065	140.51	0.01 ic	0.09 ic	0.47 ic	---	0.00	---	---	---	---	---	0.572
3.05	28,247	140.54	0.01 ic	0.09 ic	0.48 ic	---	0.00	---	---	---	---	---	0.580
3.08	28,429	140.58	0.01 ic	0.09 ic	0.48 ic	---	0.00	---	---	---	---	---	0.587
3.12	28,611	140.62	0.01 ic	0.09 ic	0.49 ic	---	0.00	---	---	---	---	---	0.594
3.15	28,793	140.65	0.01 ic	0.10 ic	0.49 ic	---	0.00	---	---	---	---	---	0.601
3.18	28,975	140.68	0.01 ic	0.10 ic	0.50 ic	---	0.00	---	---	---	---	---	0.608
3.22	29,157	140.72	0.01 ic	0.10 ic	0.51 ic	---	0.00	---	---	---	---	---	0.615
3.26	29,340	140.76	0.01 ic	0.10 ic	0.51 ic	---	0.00	---	---	---	---	---	0.621
3.29	29,522	140.79	0.01 ic	0.10 ic	0.52 ic	---	0.00	---	---	---	---	---	0.628
3.33	29,704	140.82	0.01 ic	0.10 ic	0.52 ic	---	0.00	---	---	---	---	---	0.635
3.36	29,886	140.86	0.01 ic	0.10 ic	0.53 ic	---	0.00	---	---	---	---	---	0.641
3.39	30,068	140.90	0.01 ic	0.10 ic	0.54 ic	---	0.00	---	---	---	---	---	0.648
3.43	30,250	140.93	0.01 ic	0.10 ic	0.54 ic	---	0.00	---	---	---	---	---	0.654
3.46	30,432	140.96	0.01 ic	0.10 ic	0.55 ic	---	0.00	---	---	---	---	---	0.660
3.50	30,614	141.00	0.01 ic	0.10 ic	0.55 ic	---	0.00	---	---	---	---	---	0.667

...End

Hydrograph Report

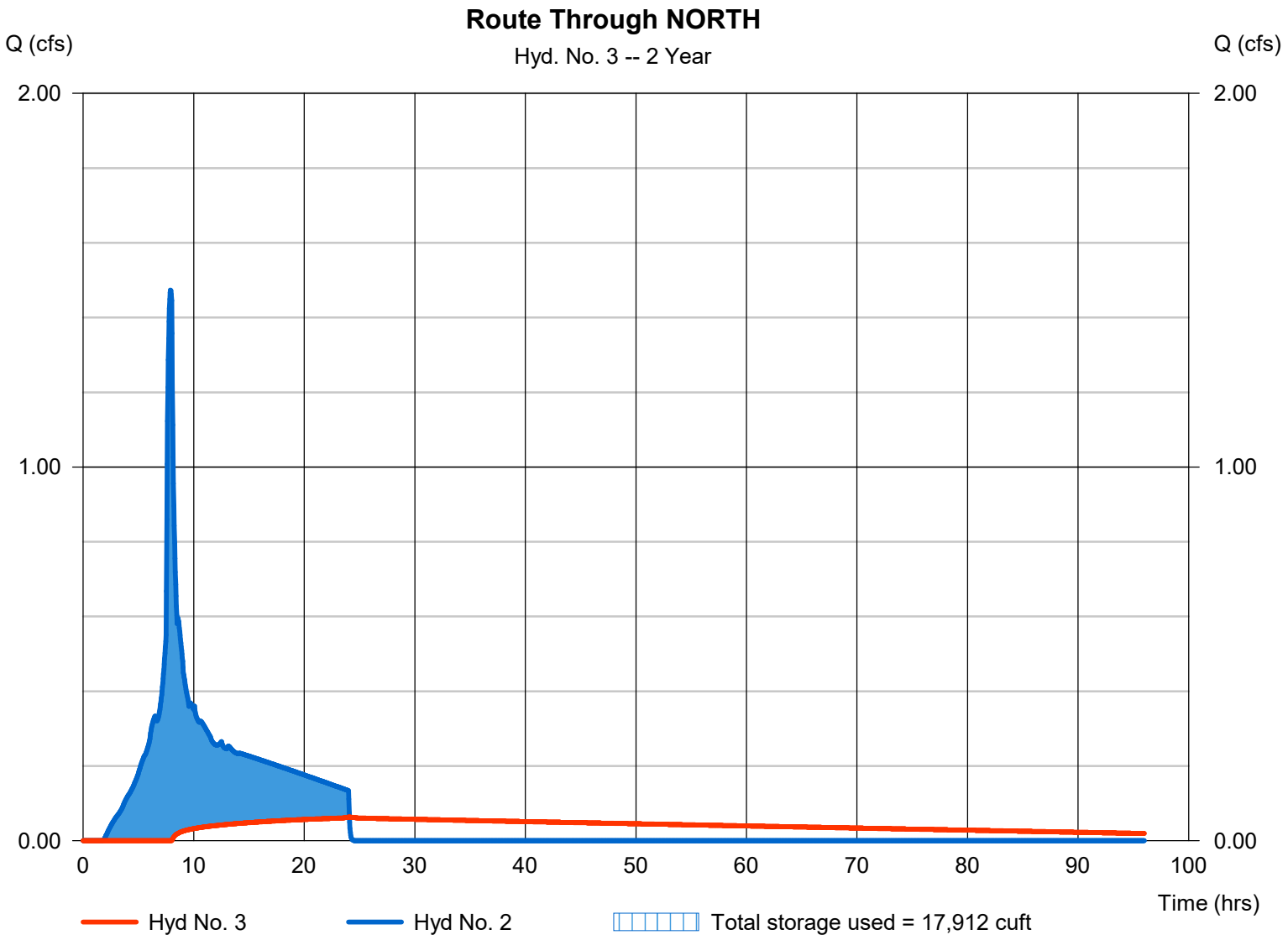
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 12 / 9 / 2019

Hyd. No. 3

Route Through NORTH

Hydrograph type	= Reservoir	Peak discharge	= 0.063 cfs
Storm frequency	= 2 yrs	Time to peak	= 24.07 hrs
Time interval	= 2 min	Hyd. volume	= 13,019 cuft
Inflow hyd. No.	= 2 - North Developed	Max. Elevation	= 139.12 ft
Reservoir name	= SC-740 Chambers NORTH	Max. Storage	= 17,912 cuft

Storage Indication method used.



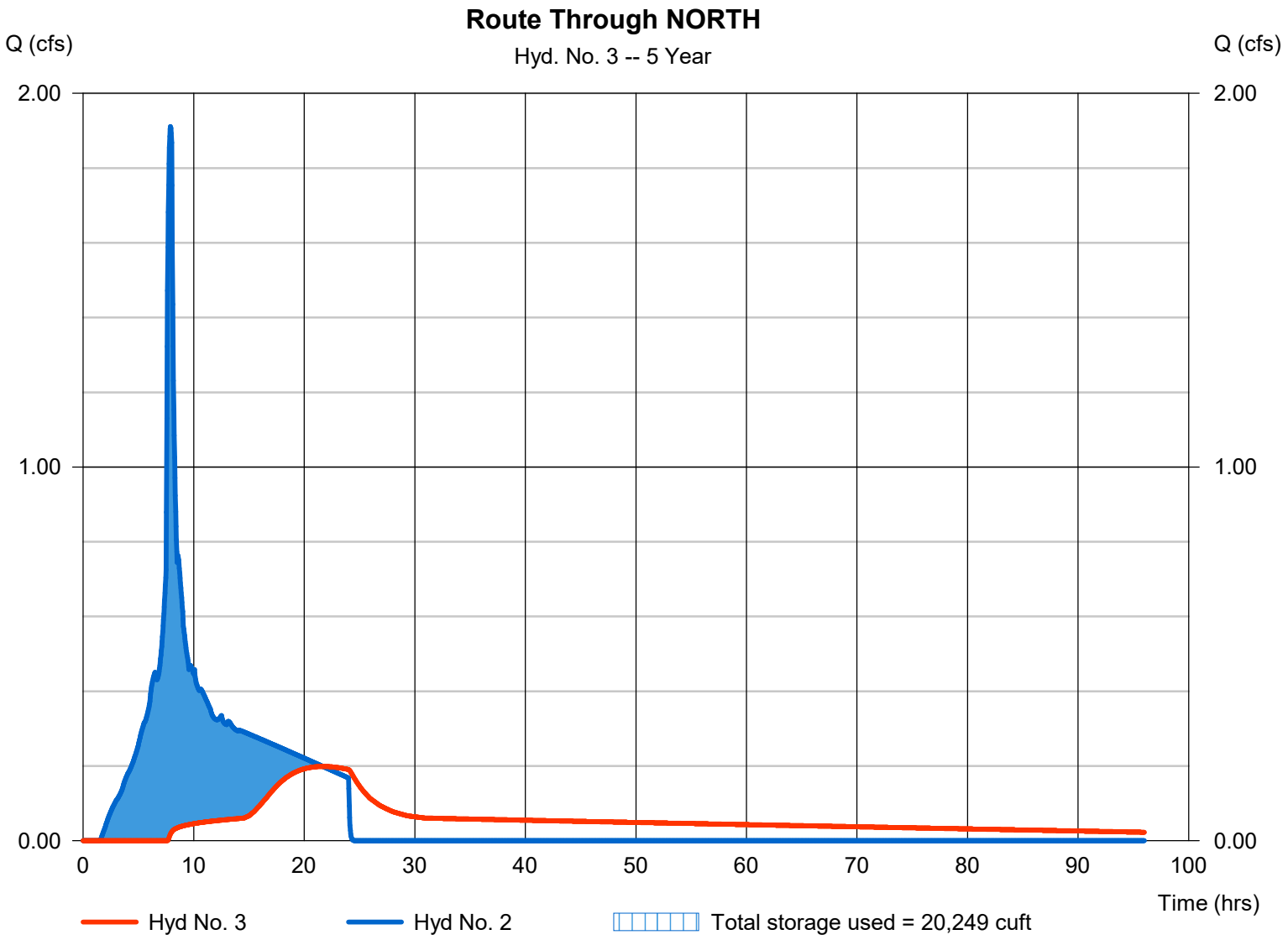
Hydrograph Report

Hyd. No. 3

Route Through NORTH

Hydrograph type	=	Reservoir	Peak discharge	=	0.199 cfs
Storm frequency	=	5 yrs	Time to peak	=	21.70 hrs
Time interval	=	2 min	Hyd. volume	=	18,710 cuft
Inflow hyd. No.	=	2 - North Developed	Max. Elevation	=	139.37 ft
Reservoir name	=	SC-740 Chambers NORTH	Max. Storage	=	20,249 cuft

Storage Indication method used.



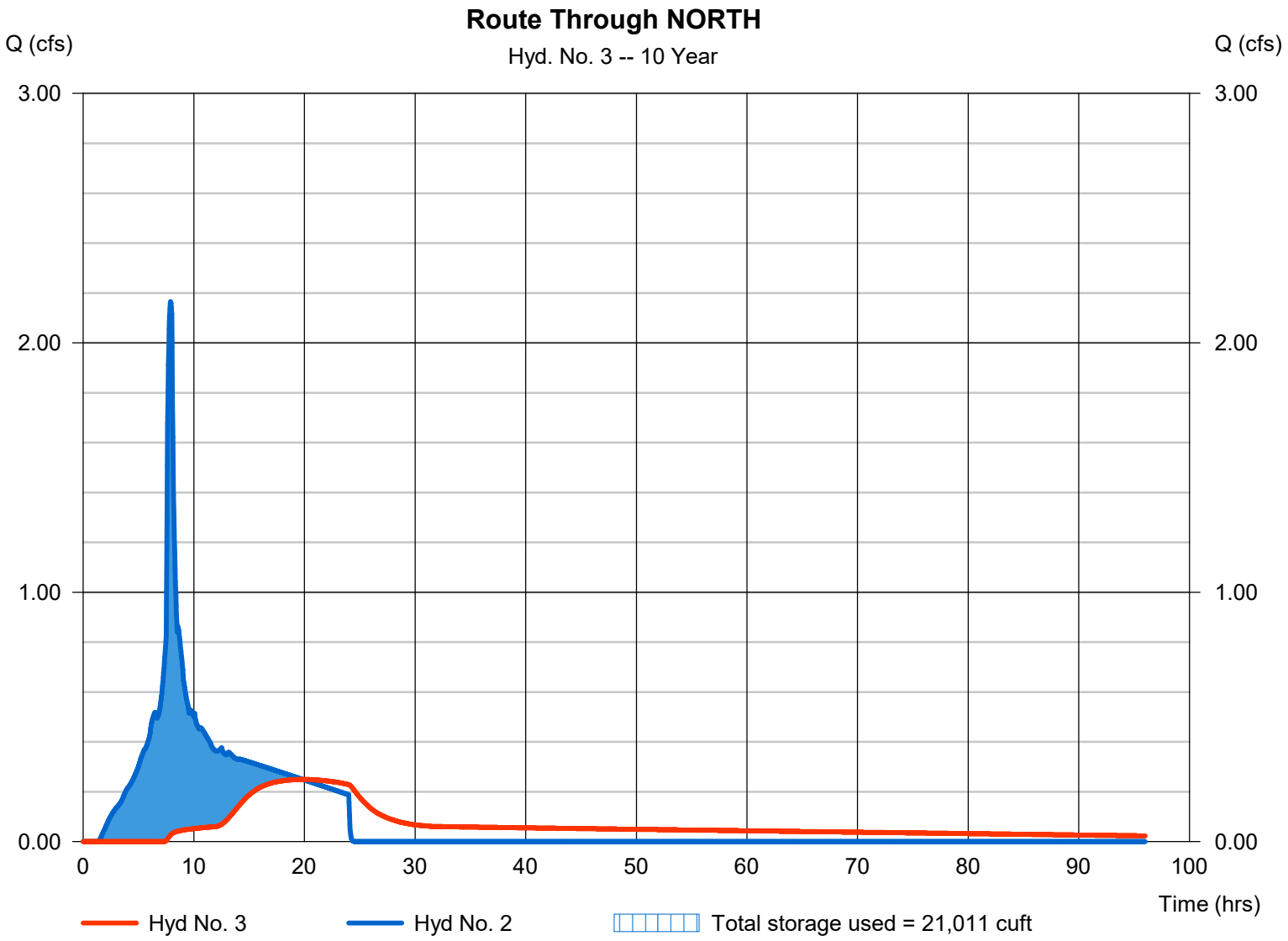
Hydrograph Report

Hyd. No. 3

Route Through NORTH

Hydrograph type	=	Reservoir	Peak discharge	=	0.249 cfs
Storm frequency	=	10 yrs	Time to peak	=	19.87 hrs
Time interval	=	2 min	Hyd. volume	=	22,264 cuft
Inflow hyd. No.	=	2 - North Developed	Max. Elevation	=	139.45 ft
Reservoir name	=	SC-740 Chambers NORTH	Max. Storage	=	21,011 cuft

Storage Indication method used.



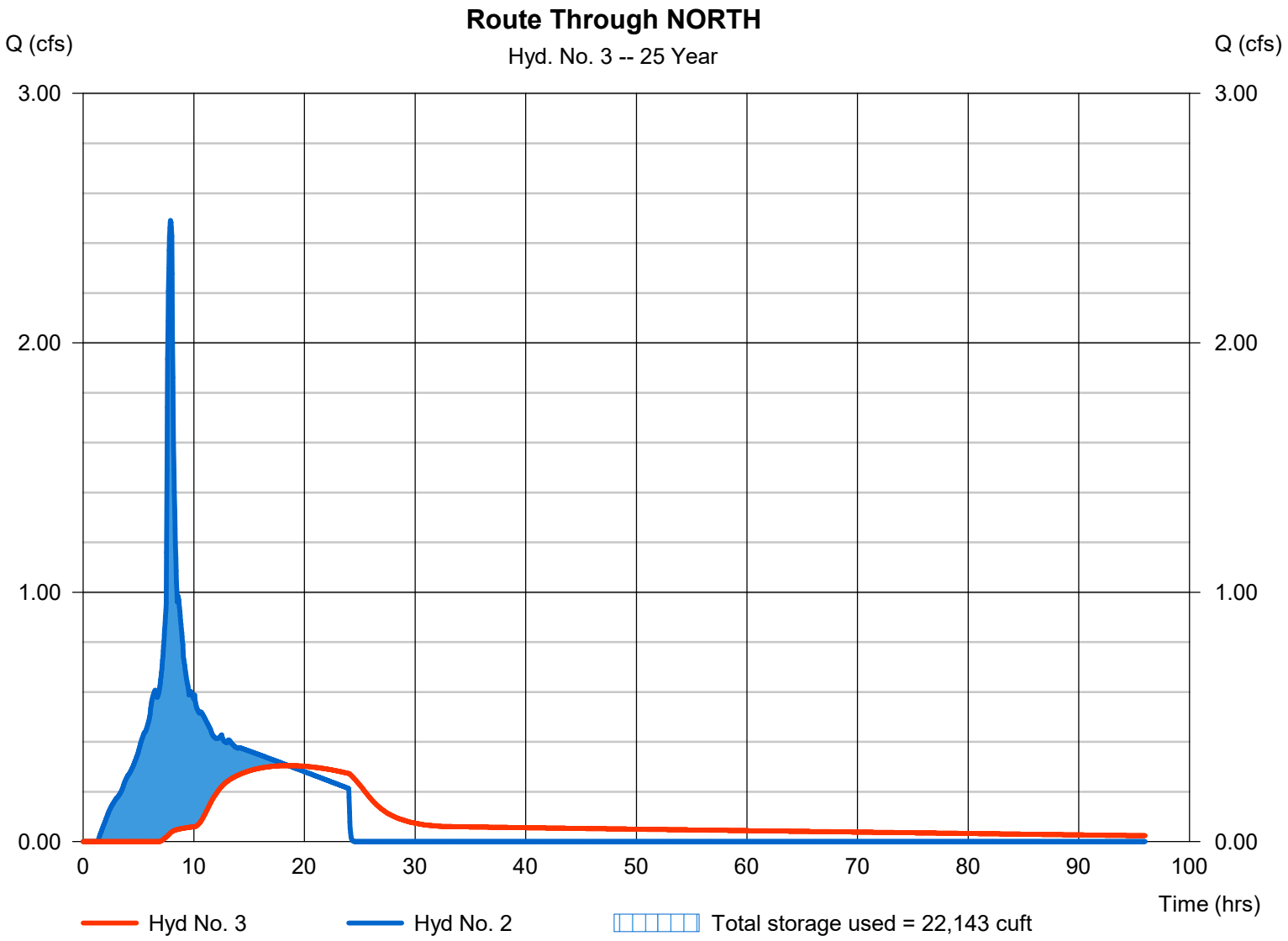
Hydrograph Report

Hyd. No. 3

Route Through NORTH

Hydrograph type	=	Reservoir	Peak discharge	=	0.305 cfs
Storm frequency	=	25 yrs	Time to peak	=	18.57 hrs
Time interval	=	2 min	Hyd. volume	=	26,849 cuft
Inflow hyd. No.	=	2 - North Developed	Max. Elevation	=	139.57 ft
Reservoir name	=	SC-740 Chambers NORTH	Max. Storage	=	22,143 cuft

Storage Indication method used.



Pond Report

Pond No. 3 - SC-740 Chambers SOUTH

Pond Data

UG Chambers -Invert elev. = 139.20 ft, Rise x Span = 2.50 x 4.25 ft, Barrel Len = 2120.00 ft, No. Barrels = 1, Slope = 0.00%, Headers = No
Encasement -Invert elev. = 139.20 ft, Width = 5.25 ft, Height = 3.50 ft, Voids = 40.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	139.20	n/a	0	0
0.35	139.55	n/a	3,445	3,445
0.70	139.90	n/a	3,407	6,852
1.05	140.25	n/a	3,329	10,181
1.40	140.60	n/a	3,206	13,387
1.75	140.95	n/a	3,025	16,412
2.10	141.30	n/a	2,760	19,172
2.45	141.65	n/a	2,318	21,490
2.80	142.00	n/a	1,594	23,085
3.15	142.35	n/a	1,559	24,643
3.50	142.70	n/a	1,559	26,202

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.50	1.60	6.00	0.00
Span (in)	= 0.50	1.60	6.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 139.20	139.70	140.60	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 3.14	0.00	0.00	0.00
Crest El. (ft)	= 142.20	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	139.20	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.04	344	139.24	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.07	689	139.27	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.11	1,033	139.31	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.14	1,378	139.34	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.17	1,722	139.38	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.21	2,067	139.41	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.24	2,411	139.45	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.28	2,756	139.48	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.31	3,100	139.52	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.35	3,445	139.55	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.38	3,786	139.59	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.42	4,126	139.62	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.45	4,467	139.66	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.49	4,808	139.69	0.00	0.00	0.00	---	0.00	---	---	---	---	---	0.000
0.52	5,148	139.73	0.00	0.00 ic	0.00	---	0.00	---	---	---	---	---	0.001
0.56	5,489	139.76	0.00	0.01 ic	0.00	---	0.00	---	---	---	---	---	0.005
0.60	5,830	139.80	0.00	0.01 ic	0.00	---	0.00	---	---	---	---	---	0.011
0.63	6,170	139.83	0.00	0.02 ic	0.00	---	0.00	---	---	---	---	---	0.017
0.67	6,511	139.87	0.00	0.02 ic	0.00	---	0.00	---	---	---	---	---	0.021
0.70	6,852	139.90	0.00	0.02 ic	0.00	---	0.00	---	---	---	---	---	0.025
0.74	7,185	139.93	0.00	0.03 ic	0.00	---	0.00	---	---	---	---	---	0.028
0.77	7,518	139.97	0.00	0.03 ic	0.00	---	0.00	---	---	---	---	---	0.030
0.80	7,851	140.01	0.00	0.03 ic	0.00	---	0.00	---	---	---	---	---	0.033
0.84	8,184	140.04	0.00	0.04 ic	0.00	---	0.00	---	---	---	---	---	0.035
0.87	8,517	140.08	0.00	0.04 ic	0.00	---	0.00	---	---	---	---	---	0.037
0.91	8,850	140.11	0.00	0.04 ic	0.00	---	0.00	---	---	---	---	---	0.039
0.94	9,183	140.15	0.00	0.04 ic	0.00	---	0.00	---	---	---	---	---	0.041
0.98	9,515	140.18	0.00	0.04 ic	0.00	---	0.00	---	---	---	---	---	0.043
1.01	9,848	140.22	0.00	0.05 ic	0.00	---	0.00	---	---	---	---	---	0.045
1.05	10,181	140.25	0.00	0.05 ic	0.00	---	0.00	---	---	---	---	---	0.047
1.08	10,502	140.29	0.00	0.05 ic	0.00	---	0.00	---	---	---	---	---	0.048

Continues on next page...

SC-740 Chambers SOUTH

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
1.12	10,823	140.32	0.00	0.05 ic	0.00	---	0.00	---	---	---	---	---	0.050
1.15	11,143	140.36	0.00	0.05 ic	0.00	---	0.00	---	---	---	---	---	0.052
1.19	11,464	140.39	0.00	0.05 ic	0.00	---	0.00	---	---	---	---	---	0.053
1.22	11,784	140.43	0.00	0.05 ic	0.00	---	0.00	---	---	---	---	---	0.055
1.26	12,105	140.46	0.00	0.06 ic	0.00	---	0.00	---	---	---	---	---	0.056
1.29	12,425	140.50	0.00	0.06 ic	0.00	---	0.00	---	---	---	---	---	0.057
1.33	12,746	140.53	0.00	0.06 ic	0.00	---	0.00	---	---	---	---	---	0.059
1.36	13,067	140.57	0.00	0.06 ic	0.00	---	0.00	---	---	---	---	---	0.060
1.40	13,387	140.60	0.00	0.06 ic	0.00	---	0.00	---	---	---	---	---	0.061
1.43	13,690	140.63	0.00	0.06 ic	0.00 ic	---	0.00	---	---	---	---	---	0.066
1.47	13,992	140.67	0.00	0.06 ic	0.02 ic	---	0.00	---	---	---	---	---	0.079
1.50	14,295	140.71	0.00	0.07 ic	0.03 ic	---	0.00	---	---	---	---	---	0.098
1.54	14,597	140.74	0.00	0.07 ic	0.06 ic	---	0.00	---	---	---	---	---	0.124
1.57	14,900	140.78	0.00	0.07 ic	0.09 ic	---	0.00	---	---	---	---	---	0.155
1.61	15,202	140.81	0.00	0.07 ic	0.12 ic	---	0.00	---	---	---	---	---	0.191
1.64	15,505	140.85	0.00	0.07 ic	0.16 ic	---	0.00	---	---	---	---	---	0.231
1.68	15,807	140.88	0.00	0.07 ic	0.20 ic	---	0.00	---	---	---	---	---	0.275
1.71	16,110	140.92	0.00	0.07 ic	0.25 ic	---	0.00	---	---	---	---	---	0.321
1.75	16,412	140.95	0.00	0.07 ic	0.30 ic	---	0.00	---	---	---	---	---	0.369
1.78	16,688	140.99	0.00	0.07 ic	0.34 ic	---	0.00	---	---	---	---	---	0.417
1.82	16,964	141.02	0.00	0.08 ic	0.39 ic	---	0.00	---	---	---	---	---	0.464
1.85	17,240	141.06	0.00	0.08 ic	0.43 ic	---	0.00	---	---	---	---	---	0.507
1.89	17,516	141.09	0.00	0.08 ic	0.47 ic	---	0.00	---	---	---	---	---	0.543
1.92	17,792	141.13	0.00	0.08 ic	0.50 ic	---	0.00	---	---	---	---	---	0.574
1.96	18,068	141.16	0.00	0.08 ic	0.53 ic	---	0.00	---	---	---	---	---	0.606
1.99	18,344	141.20	0.00	0.08 ic	0.56 ic	---	0.00	---	---	---	---	---	0.636
2.03	18,620	141.23	0.00	0.08 ic	0.58 ic	---	0.00	---	---	---	---	---	0.664
2.06	18,896	141.27	0.00	0.08 ic	0.61 ic	---	0.00	---	---	---	---	---	0.691
2.10	19,172	141.30	0.00	0.08 ic	0.63 ic	---	0.00	---	---	---	---	---	0.717
2.13	19,404	141.34	0.00	0.08 ic	0.66 ic	---	0.00	---	---	---	---	---	0.743
2.17	19,636	141.37	0.00	0.09 ic	0.68 ic	---	0.00	---	---	---	---	---	0.767
2.21	19,868	141.41	0.00	0.09 ic	0.70 ic	---	0.00	---	---	---	---	---	0.790
2.24	20,099	141.44	0.00	0.09 ic	0.73 ic	---	0.00	---	---	---	---	---	0.813
2.28	20,331	141.48	0.00	0.09 ic	0.75 ic	---	0.00	---	---	---	---	---	0.835
2.31	20,563	141.51	0.00	0.09 ic	0.77 ic	---	0.00	---	---	---	---	---	0.857
2.35	20,795	141.55	0.00	0.09 ic	0.79 ic	---	0.00	---	---	---	---	---	0.878
2.38	21,027	141.58	0.00	0.09 ic	0.81 ic	---	0.00	---	---	---	---	---	0.898
2.42	21,259	141.62	0.00	0.09 ic	0.83 ic	---	0.00	---	---	---	---	---	0.918
2.45	21,490	141.65	0.00	0.09 ic	0.85 ic	---	0.00	---	---	---	---	---	0.938
2.48	21,650	141.68	0.00	0.09 ic	0.86 ic	---	0.00	---	---	---	---	---	0.957
2.52	21,809	141.72	0.00	0.09 ic	0.88 ic	---	0.00	---	---	---	---	---	0.976
2.56	21,969	141.76	0.00	0.09 ic	0.90 ic	---	0.00	---	---	---	---	---	0.994
2.59	22,128	141.79	0.00	0.10 ic	0.92 ic	---	0.00	---	---	---	---	---	1.012
2.63	22,288	141.83	0.00	0.10 ic	0.93 ic	---	0.00	---	---	---	---	---	1.030
2.66	22,447	141.86	0.00	0.10 ic	0.95 ic	---	0.00	---	---	---	---	---	1.047
2.70	22,607	141.90	0.00	0.10 ic	0.97 ic	---	0.00	---	---	---	---	---	1.064
2.73	22,766	141.93	0.00	0.10 ic	0.98 ic	---	0.00	---	---	---	---	---	1.081
2.77	22,925	141.97	0.00	0.10 ic	1.00 ic	---	0.00	---	---	---	---	---	1.098
2.80	23,085	142.00	0.00	0.10 ic	1.01 ic	---	0.00	---	---	---	---	---	1.114
2.83	23,241	142.04	0.00	0.10 ic	1.03 ic	---	0.00	---	---	---	---	---	1.130
2.87	23,397	142.07	0.00	0.10 ic	1.04 ic	---	0.00	---	---	---	---	---	1.146
2.90	23,552	142.11	0.00	0.10 ic	1.06 ic	---	0.00	---	---	---	---	---	1.162
2.94	23,708	142.14	0.00	0.10 ic	1.07 ic	---	0.00	---	---	---	---	---	1.177
2.98	23,864	142.18	0.00	0.10 ic	1.09 ic	---	0.00	---	---	---	---	---	1.192
3.01	24,020	142.21	0.01 ic	0.11 ic	1.10 ic	---	0.01	---	---	---	---	---	1.218
3.05	24,176	142.25	0.01 ic	0.11 ic	1.12 ic	---	0.01 s	---	---	---	---	---	1.229
3.08	24,332	142.28	0.01 ic	0.11 ic	1.13 ic	---	0.00 s	---	---	---	---	---	1.248
3.12	24,488	142.32	0.01 ic	0.11 ic	1.14 ic	---	0.00	---	---	---	---	---	1.263
3.15	24,643	142.35	0.01 ic	0.11 ic	1.16 ic	---	0.00	---	---	---	---	---	1.277
3.18	24,799	142.38	0.01 ic	0.11 ic	1.17 ic	---	0.00	---	---	---	---	---	1.292
3.22	24,955	142.42	0.01 ic	0.11 ic	1.18 ic	---	0.00	---	---	---	---	---	1.306
3.25	25,111	142.46	0.01 ic	0.11 ic	1.20 ic	---	0.00	---	---	---	---	---	1.320
3.29	25,267	142.49	0.01 ic	0.11 ic	1.21 ic	---	0.00	---	---	---	---	---	1.333
3.33	25,423	142.53	0.01 ic	0.11 ic	1.22 ic	---	0.00	---	---	---	---	---	1.347
3.36	25,578	142.56	0.01 ic	0.11 ic	1.24 ic	---	0.00	---	---	---	---	---	1.360
3.40	25,734	142.60	0.01 ic	0.11 ic	1.25 ic	---	0.00	---	---	---	---	---	1.374
3.43	25,890	142.63	0.01 ic	0.11 ic	1.26 ic	---	0.00	---	---	---	---	---	1.387
3.47	26,046	142.67	0.01 ic	0.11 ic	1.27 ic	---	0.00	---	---	---	---	---	1.400
3.50	26,202	142.70	0.01 ic	0.12 ic	1.29 ic	---	0.00	---	---	---	---	---	1.413

...End

Hydrograph Report

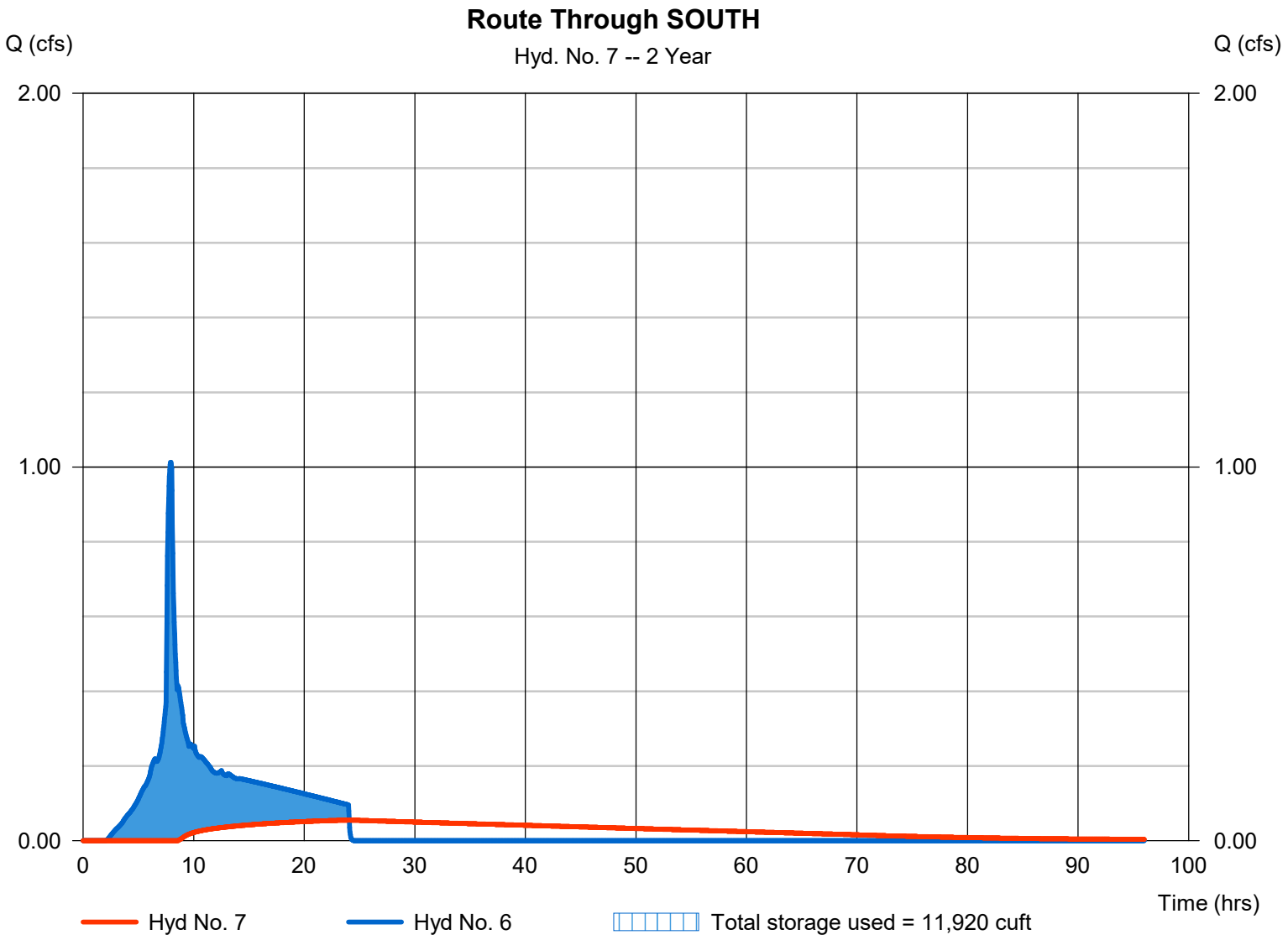
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Monday, 12 / 9 / 2019

Hyd. No. 7

Route Through SOUTH

Hydrograph type	=	Reservoir	Peak discharge	=	0.055 cfs
Storm frequency	=	2 yrs	Time to peak	=	24.07 hrs
Time interval	=	2 min	Hyd. volume	=	8,888 cuft
Inflow hyd. No.	=	6 - South Developed	Max. Elevation	=	140.44 ft
Reservoir name	=	SC-740 Chambers SOUTH	Max. Storage	=	11,920 cuft

Storage Indication method used.



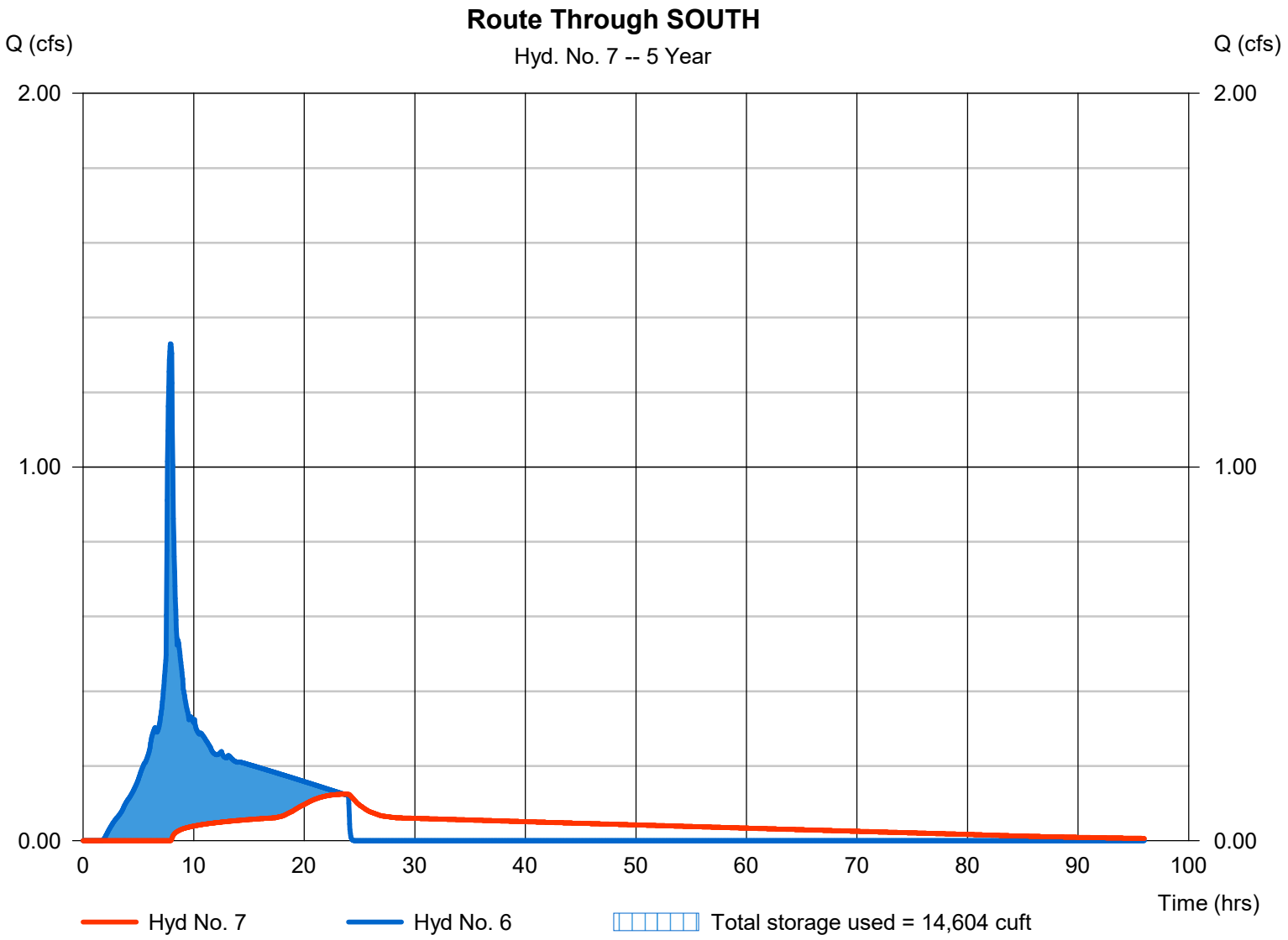
Hydrograph Report

Hyd. No. 7

Route Through SOUTH

Hydrograph type	=	Reservoir	Peak discharge	=	0.124 cfs
Storm frequency	=	5 yrs	Time to peak	=	23.60 hrs
Time interval	=	2 min	Hyd. volume	=	13,105 cuft
Inflow hyd. No.	=	6 - South Developed	Max. Elevation	=	140.74 ft
Reservoir name	=	SC-740 Chambers SOUTH	Max. Storage	=	14,604 cuft

Storage Indication method used.



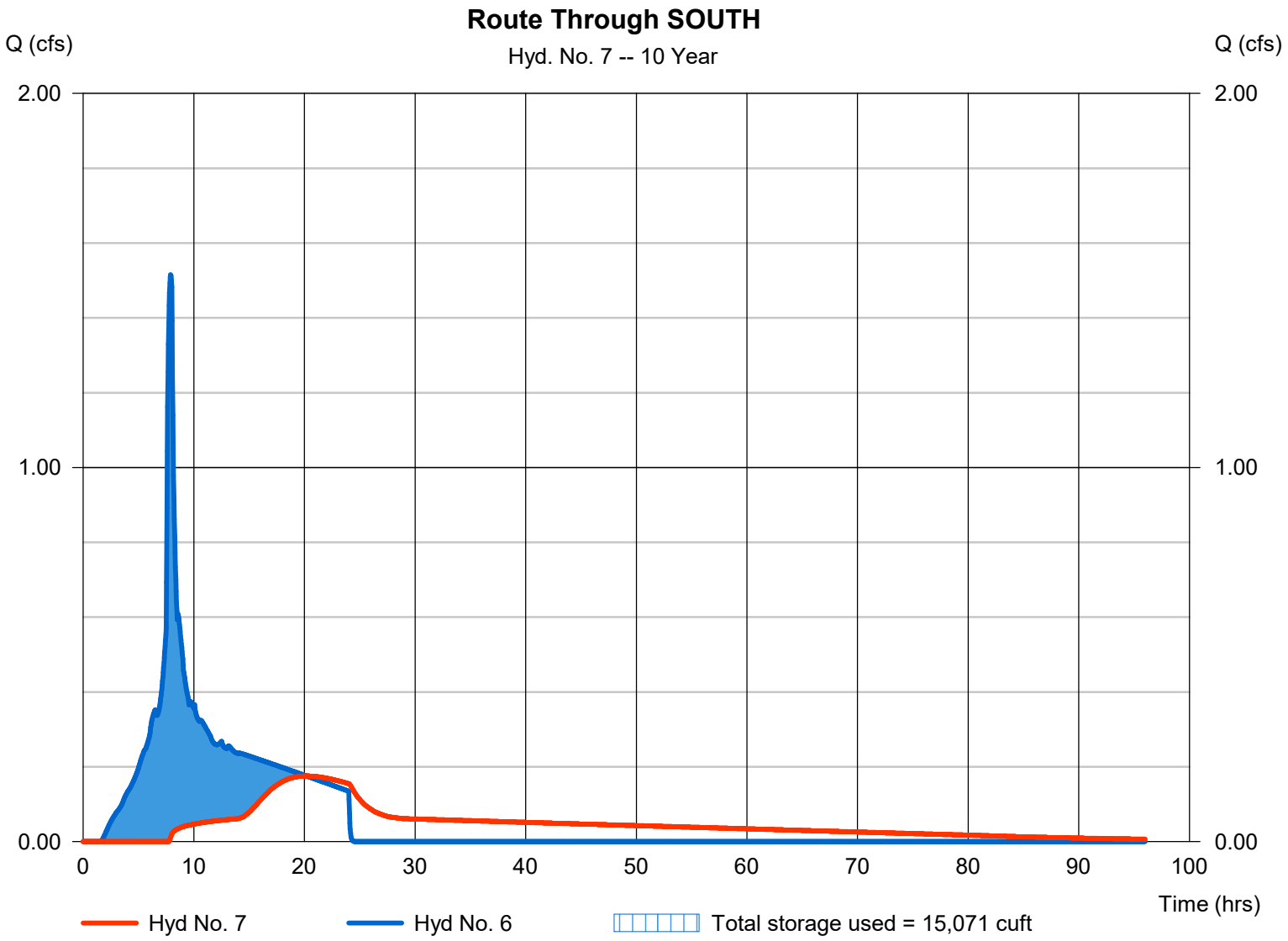
Hydrograph Report

Hyd. No. 7

Route Through SOUTH

Hydrograph type	=	Reservoir	Peak discharge	=	0.175 cfs
Storm frequency	=	10 yrs	Time to peak	=	20.20 hrs
Time interval	=	2 min	Hyd. volume	=	15,684 cuft
Inflow hyd. No.	=	6 - South Developed	Max. Elevation	=	140.79 ft
Reservoir name	=	SC-740 Chambers SOUTH	Max. Storage	=	15,071 cuft

Storage Indication method used.



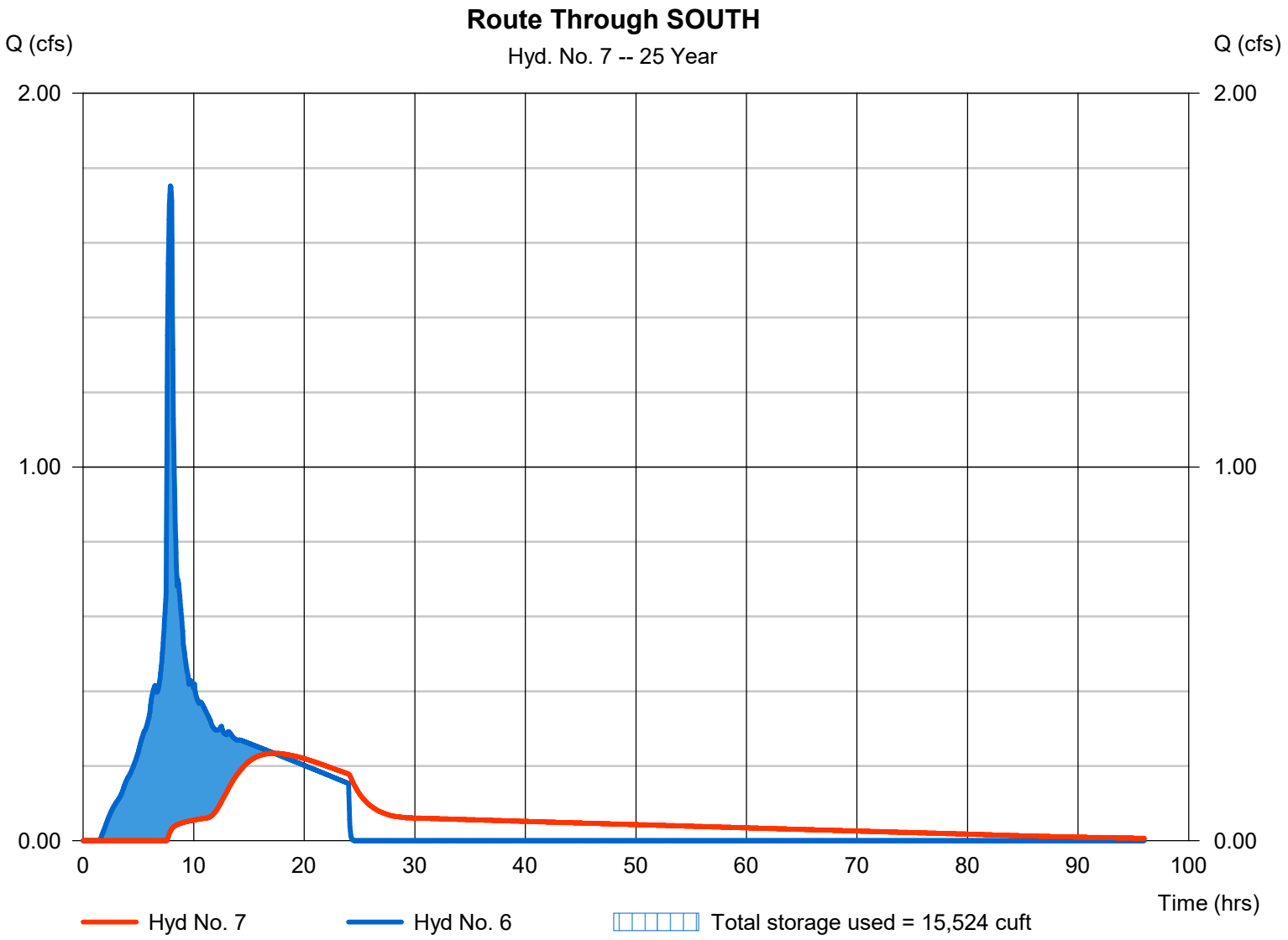
Hydrograph Report

Hyd. No. 7

Route Through SOUTH

Hydrograph type	=	Reservoir	Peak discharge	=	0.234 cfs
Storm frequency	=	25 yrs	Time to peak	=	17.27 hrs
Time interval	=	2 min	Hyd. volume	=	19,027 cuft
Inflow hyd. No.	=	6 - South Developed	Max. Elevation	=	140.85 ft
Reservoir name	=	SC-740 Chambers SOUTH	Max. Storage	=	15,524 cuft

Storage Indication method used.



APPENDIX C

O&M MANUAL

Operations & Maintenance Manual

For:

Hedges D
Tualatin, Oregon

December 2019

Prepared by:

Mackenzie
1515 SE Water Avenue
Suite 100
Portland, OR 97214
2190365.00

TABLE OF CONTENTS

ATTACHMENTS

I. GENERAL- SITE DESCRIPTION, ASSUMPTIONS AND GENEREAL SYSTEM DESCRIPTION

This plan was developed to provide a basis for maintenance of stormwater facilities for the Hedges D project located in Tualatin, Oregon. Construction of the Hedges D project includes a single building, parking and truck maneuvering space, landscape, supporting utilities, water quality filter manholes and two underground detention facilities.

The on-site stormwater system consists of the collection system (catch basins, area drains, and pipes) and treatment facilities (filter manholes). Runoff from the site sheets flows to various catch basins and is routed to one of four proposed filter manholes, then through one of two proposed underground detention systems. A copy of the site's stormwater plan is included with this maintenance plan.

This Operations and Maintenance Plan generally provides maintenance requirements of the stormwater collection and treatment system. Best Management Practices (BMPs) related to maintenance of the facilities shall include regular maintenance and upkeep of the parking and landscape areas. All business operations (other than car and truck parking) are expected to be confined to areas within the building and not to impact stormwater collection, treatment or operation of the drainage system.

II. GENERAL MAINTENANCE AND FACILITY-SPECIFIC MAINTENANCE REQUIREMENTS

The Hedges D Facilities Manager shall be responsible for regular inspections and maintenance of the storm drainage system and related facilities. Inspections shall include observations of the landscaping, parking areas, catch basin grates and basins for debris, loose soil or sediment that may enter the system. Inspection of the collection system includes observation of the catch basins, and conveyance lines. General maintenance requirements of those facilities include removal of sediment and debris, repair of damaged components and general maintenance of mechanical systems.

Facility-specific maintenance requirements shall also be the responsibility of the Hedges D Facilities Manager. Inspections shall include documentation of observations and maintenance or repairs of each of the drainage system facilities. This would include:

- Landscape areas
- Parking areas
- Catch basins
- Cleanouts
- Conveyance pipes
- Treatment devices
- Detention chamber elements

Operations and Maintenance Contact

Hedges D – Facilities Manager

##########
##########
##########

III. GENERAL MAINTENANCE ACTIVITIES

Maintenance of stormwater system components is the key to a successful stormwater plan. Most stormwater systems can fail in the first few years due to lack of adequate maintenance. The following guidelines will be used for general maintenance of the stormwater system.

1. Dry sweeping of the parking area to reduce accumulation of sediments and debris in the catch basins will be conducted regularly. Clogging the catch basin with sediments will result in its failure.

2. Quarterly visual inspection of the catch basins for debris and obstructions. All catch basins or other structures shall be kept clear of sediment, debris or other obstructions that may affect the flow or treatment of stormwater.

3. Visually inspect the stormwater system after all major storm events for evidence of system problems. Look for ponded water, debris, erosion, or any other signs of system problems.

4. Annually inspect the spill kit to ensure all supplies are available and have not deteriorated or expired (Note: each tenant shall have a separate spill kit or access to a shared spill kit). Check with city staff to stay aware of newly available products or spill containment procedures. Become familiar with the spill control plan (included with this O&M Plan) and ensure that at least one employee during each work shift is familiar with the plan (always have someone on-site who is aware of the spill containment kit and procedures).

5. Biannually or quarterly inspect the catch basin sumps. Sediments need to be removed along with any oils before the deposits reach one foot in depth and before the outlet is obstructed. Materials removed from the catch basin inlet shall be disposed of in accordance with applicable state law. Records of debris disposal shall be kept on file at the main office in accordance with the state law and shall be available for review by regulating agencies.

IV. SITE PLAN SHOWING LOCATION OF FACILITY COMPONENTS

The attached Utility Plan show the general location of the facility components. The site utility “As-built” drawings should be consulted for further information regarding facility locations, sizes or details.

V. INSPECTION PROGRAM – PERFORMANCE MEASURES FOR MAINTENANCE ACTIVITIES

Objective

The objective of this manual is to help the property owner to maintain the storm sewer system for Hedges D so it can continue to operate as designed.

Requirements

Conduct inspections with the as-built plans in hand. Inspect the facility on a quarterly basis for the first 3 years from construction, and a minimum or semi-annually thereafter. Additional inspections will be necessary after long dry periods, large storms or spills. Immediately remove spilled material, taking the appropriate safety and disposal precautions.

Keep inspection records to track the progressive development of the system over time. The inspection records shall include:

1. Sediment condition and depth in sumps
2. Water elevation/observations (sheen, smell, etc.)
3. Conditions of the inlet and outlet pipes, and remaining storage capacity
4. Unscheduled maintenance needs
5. Components that do not meet performance criteria and require immediate maintenance
6. Common problem areas, solutions, and general observations
7. Aesthetic conditions

Collection System

The collection system consists of several curb breaks, underground pipes, and catch basins.

Catch Basins

The catch basins are metal basins with steel grates. The catch basins have a trapped outlet and sump and need to be inspected and maintained (if necessary) on a quarterly basis and following major storm events. Maintenance includes inspection of the structure itself and removal of any oils, debris or sediment as described in the maintenance table. Check to see if sediment has built up on the bottom of the catch basin by measuring down from the outlet pipe. If it is less than 12-inches then the catch basin needs to be cleaned out.

Storm Sewer Pipes

The storm sewer pipes connect ditch inlets to the downstream system. The pipes need to be inspected and cleaned quarterly (in necessary) following major storm events. Cleanouts and manholes are provided for access to the pipe system. The pipes need to be inspected for sediment buildup and cleaned out, if necessary, using a vactor truck so that sediment is removed.

Filter System

Refer to attached manufacturer recommendations.

Detention System

Refer to attached manufacturer recommendations.

VI. O&M INSPECTION SCHEDULE

- Quarterly inspection of the catch basins and drainage system for accumulation of sediments or oils

- Annual inspection of the emergency spill kit to ensure that all supplies are available and have not deteriorated or expired

- Quarterly inspection of the swale for proper landscape maintenance, removal of trash or sediment and repair of erosion

- Materials removed from the catch basin or pipes shall be disposed of in accordance with state law

Employee and Public Education

Employees with be trained upon hiring and thereafter annually, when new requirements are published or when there are any changes to the system equipment. Employee training will include:

- Reading this Stormwater Management Plan
- Familiarity of all components and locations for materials indicated in the SWMP
- Spill response and Personal Protective Equipment (PPE)
- Documentation requirements

VII. MAINTENANCE EQUIPMENT

Hand tools or other specialized equipment may be necessary to maintain the facilities. Suggested maintenance equipment is listed in the Inspection Checklist. The Facility Manager shall be responsible to maintain on-site, or be able to make available, all required equipment.

Suggested Maintenance Equipment and Materials

- Push broom
- Rake
- Shovel
- Spill kit
- Manhole lid puller
- General landscape tools (weed cutters, pruning clippers, leak rake, etc.)
- Vactor Truck

VIII. SEDIMENT STORAGE, TESTING, AND DISPOSAL

Maintenance of the storm drainage facilities (manholes and catch basins) may include removal of oils, sediments or debris that requires specialized testing or disposal. All removed oils, sediments or other debris shall be disposed of in accordance with applicable regulations. The Facility Manager shall be responsible to retain a qualified company to dispose of this material or otherwise comply with the applicable regulations. The Facility Manager should contact the City of Tualatin Public Works to verify current regulations or requirements. Local companies providing testing, storage and disposal services:

Evergreen Pacific: (503) 835-5028
Loy Clark: (503) 849-4560
All Vac: (503) 289-4063

IX. EMERGENCY CONTACTS

Emergency Contacts

##################
##################
##################

Maintenance Responsibilities

The Facility Manager shall be responsible to inspect, maintain or otherwise repair the stormwater facilities. Regular inspections shall occur, and documentation of the inspections, maintenance or repairs kept on-site for a minimum of three years from the date of the activity.

X. SPILL PREVENTION AND CONTROL PLAN

Spill prevention is an important factor in the successful operation of a stormwater management system. All employees will be trained to this plan so that they are certain of the location of materials, who to notify in case of a spill, and how to initially contain the spill of hazardous materials. Employees shall never dump water materials into the stormwater collection/treatment system. Employees shall be observant of other potential contamination occurrences. All employees will review the following page regarding detailed spill response steps.

This data will be posted in an accessible area.

WHAT TO DO IN CASE OF A SPILL

1. The spill kit is located #######
2. Get the spill kit (and spill kit instructions when provided)
    a. If possible, determine visually what type of fluids have been spilled
    b. Put on gloves and glasses or any other necessary Personal Protective Equipment (PPE)
    c. Get the absorbent material provided in the kit and drain block cover (pig)
    d. Place the absorbent material in the path of the spill
    e. Remove any debris from the vicinity of the catch basin inlets in the parking lot
    f. Unroll the drain blocker, and place is snugly over the catch basin inlet
    g. Verify the cover has full contact with the rim of the catch basin inlet
    h. Use snakes, pillow or pigs to completely contain the areas
    i. If the spill cannot be contained locally, shut off the storm drain pumps so any spilled material does not leave the site
3. Notify the following personnel immediately:

City of Tualatin Public Works:	(503) 629-3091
After Hours:	(503) 629-0111
Department of Environmental Quality:	(800) 452-0311
	(800) 452-4011
	(503) 229-5263
4. Other emergency contact numbers:	(###) ###-####
	(###)###-####

Note: Only dry cleanup methods may be employed to clean up spills (i.e. no use of water to wash spilled materials from pavement will be conducted).

XI. ADDITIONAL MAINTENANCE REQUIREMENTS FOR INITIAL ESTABLISHMENT PERIOD

Initial maintenance of landscape vegetation may require additional attention to ensure that landscaping, groundcover and erosion control measures are established or maintained as intended. Proper landscaping and groundcover are an important feature of a successful storm drainage system.

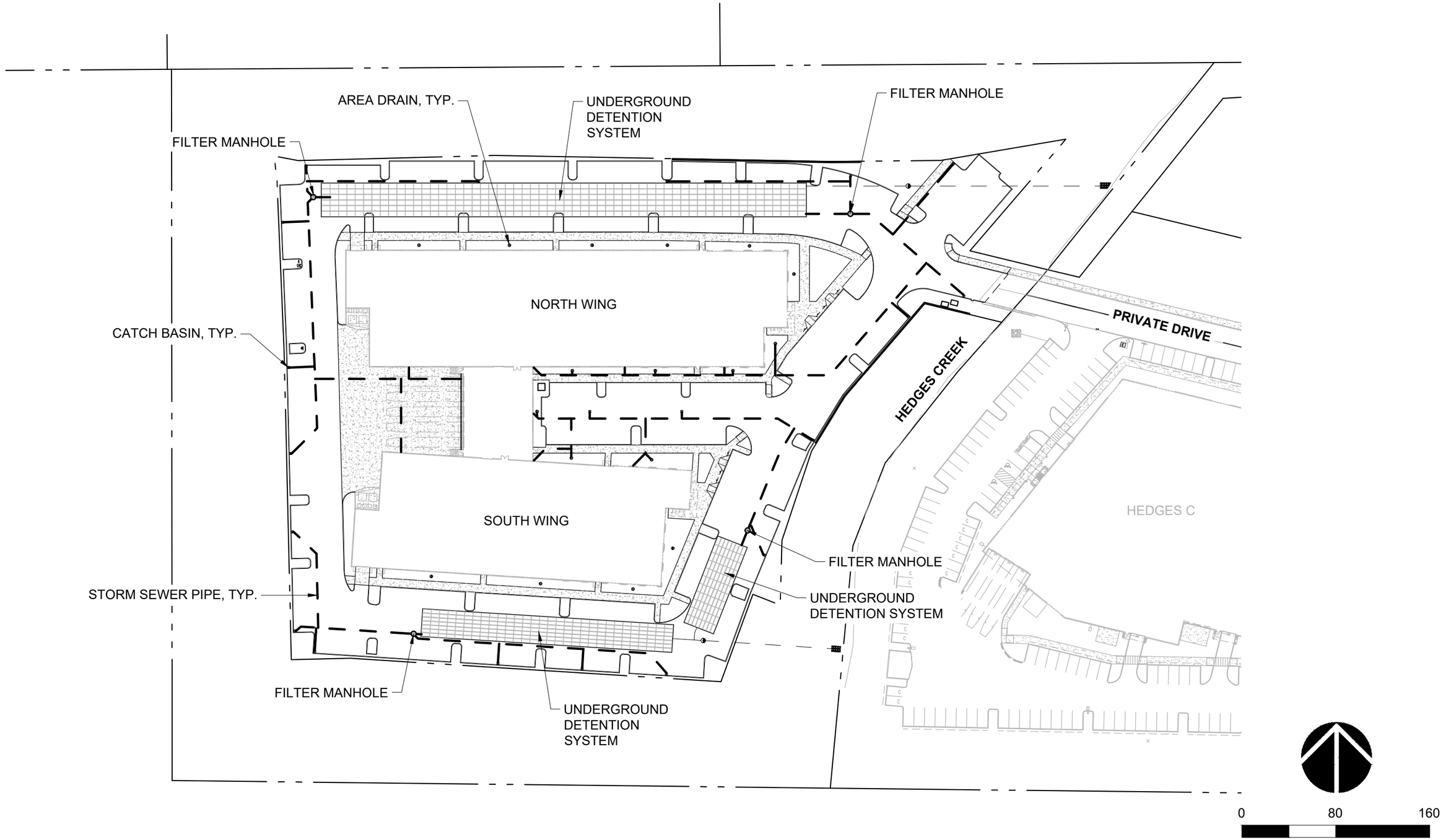
1. During the initial 3-year establishment period, remove undesired vegetation using minimal (or preferably no) use of toxic herbicides and pesticides at least 3 times a year. Replace plants that die during this period.

2. Irrigate as necessary to establish site landscaping

3. Replenish mulch at least annually. Make sure that all exposed soil is covered with mulch or other groundcover

4. Do not use excessive fertilizers, herbicides or pesticides for vegetation maintenance

5. Use replacement plants that conform to the initial planting list



Date:____________ Initials:___________
Work performed by:____
Work performed:____

Work area or specific stormwater facility area: ________________________
Details:____

Date:____________ Initials:___________
Work performed by:____
Work performed:____

Work area or specific stormwater facility area: ________________________
Details:____

Date:____________ Initials:___________
Work performed by:____
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Work area or specific stormwater facility area: ________________________
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Details:____

Date:____________ Initials:___________
Work performed by:____
Work performed:____

Work area or specific stormwater facility area: ________________________
Details:____

Oldcastle Infrastructure™
A CRH COMPANY

PERKFILTER™

Inspection and Maintenance Guide

Water

PerkFilter™ Media Filtration System

Description

The PerkFilter is a stormwater treatment device used to remove pollutants from urban runoff. Impervious surfaces and other urban and suburban landscapes generate a variety of contaminants that can enter stormwater and pollute downstream receiving waters. The PerkFilter is a media-filled cartridge filtration device designed to capture and retain sediment, gross solids, metals, nutrients, hydrocarbons, and trash and debris. As with any stormwater treatment system, the PerkFilter requires periodic maintenance to sustain optimum system performance.

Function

The PerkFilter is a water quality treatment system consisting of three chambers: an inlet chamber, a filter cartridge treatment chamber, and an outlet chamber (Figure 1). Stormwater runoff enters the inlet chamber through an inlet pipe, curb opening, or grated inlet. Gross solids are settled out, and floating trash and debris are trapped in the inlet chamber. Pretreated flow is then directed to the treatment chamber through an opening in the baffle wall between the inlet chamber and treatment chamber. The treatment chamber contains media-filled filter cartridges (Figure 2) that use physical and chemical processes to remove pollutants. During a storm event, runoff pools in the treatment chamber before passing radially through the cylindrical cartridges from the outside surface, through the media for treatment, and into the center of the cartridge. At the center of the cartridge is a center tube assembly designed to distribute the hydraulic load evenly across the surface of the filter cartridge and control the treatment flow rate. The center tube assembly discharges treated flow through the false floor and into the outlet chamber. A draindown feature built into each cartridge allows the treatment chamber to dewater between storm events.

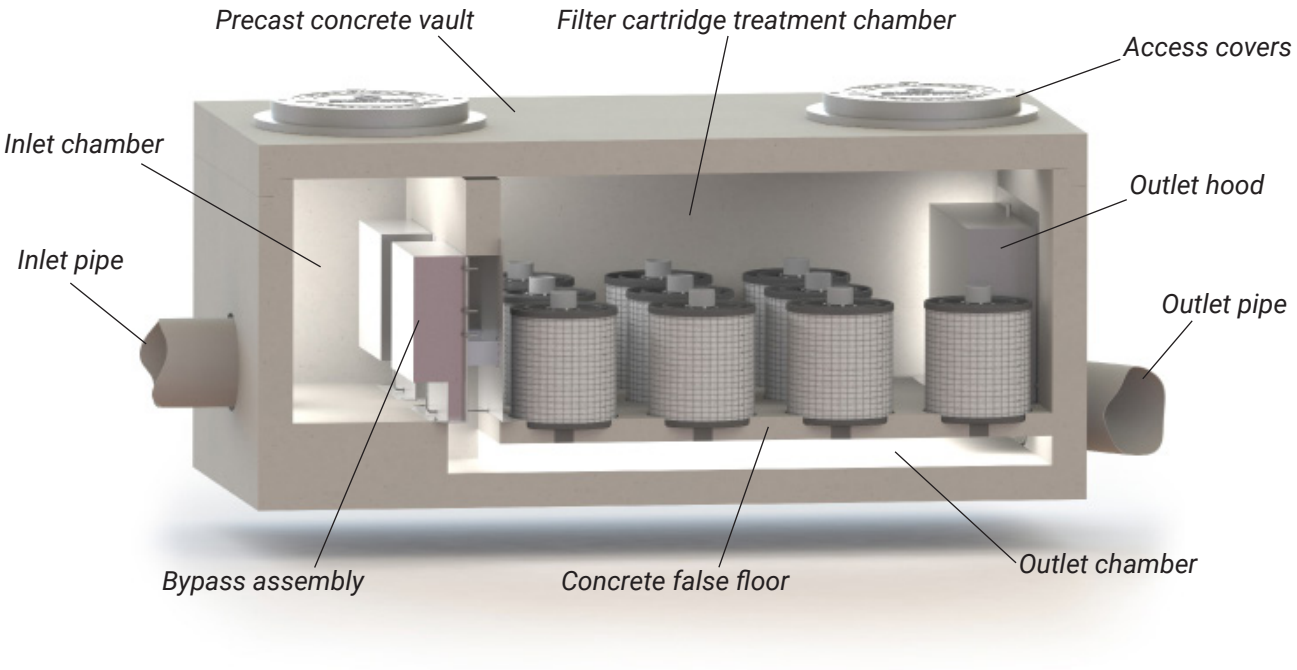


Figure 1. Schematic of the PerkFilter system.

All PerkFilter systems include a high-flow bypass assembly to divert flow exceeding the treatment capacity of the filter cartridges around the treatment chamber. The bypass assembly routes peak flow from the inlet chamber directly to the outlet chamber, bypassing the treatment chamber to prevent sediment and other captured pollutants from being scoured and re-entrained by high flow. Treated flow and bypass flow merge in the outlet chamber for discharge by a single outlet pipe.

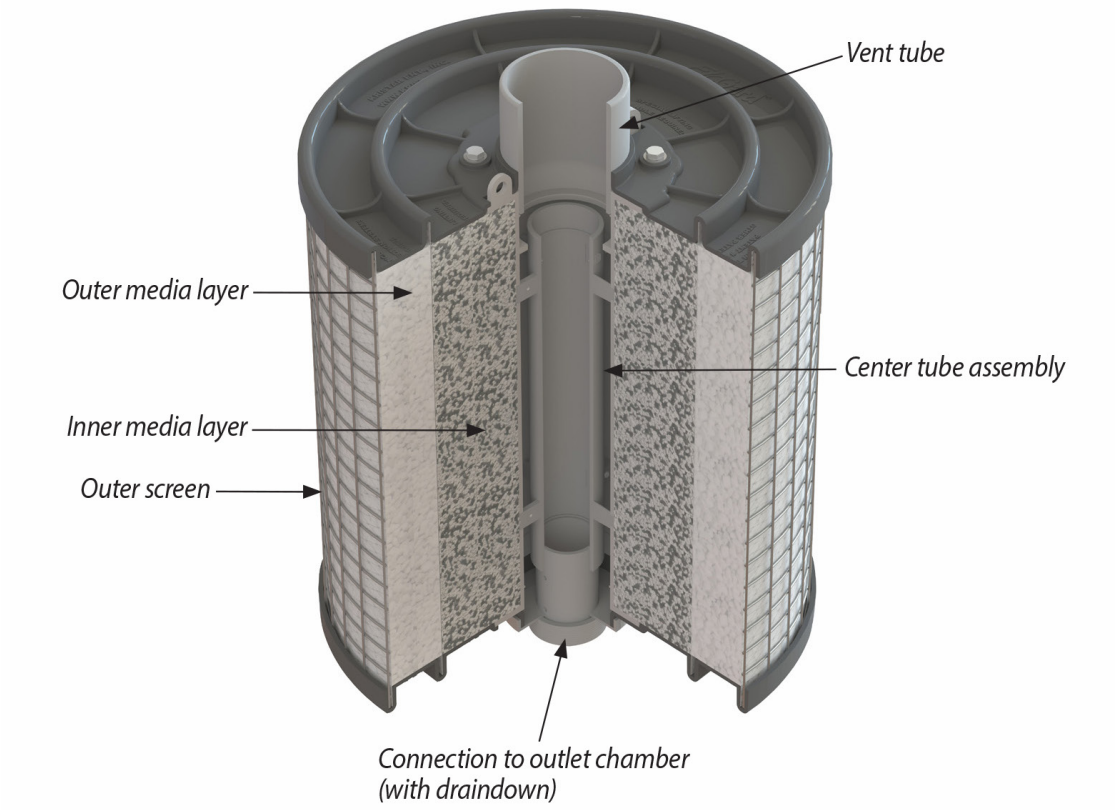


Figure 2. Schematic of PerkFilter cartridge.

Configuration

The PerkFilter structure may consist of a vault, manhole, or catch basin configuration. Catch basin units may be fabricated from concrete or steel. Internal components including the PerkFilter cartridges are manufactured from durable plastic and stainless steel components and hardware. All cartridges are 18 inches in diameter and are available in two heights: 12-inch and 18-inch. Cartridges may be used alone or may be stacked (Figure 3) to provide 24-inch and 30-inch combinations. The capacity of each cartridge or cartridge combination is dictated by the allowable operating rate of the media and the outer surface area of the cartridge. Thus, taller cartridges have greater treatment capacity than shorter cartridges, but they also require more hydraulic drop across the system. Cartridges may be filled with a wide variety of media but the standard mix is composed of zeolite, perlite and carbon (ZPC).

Access to an installed PerkFilter system is typically provided by ductile iron castings or hatch covers. The location and number of access appurtenances is dependent on the size and configuration of the system.

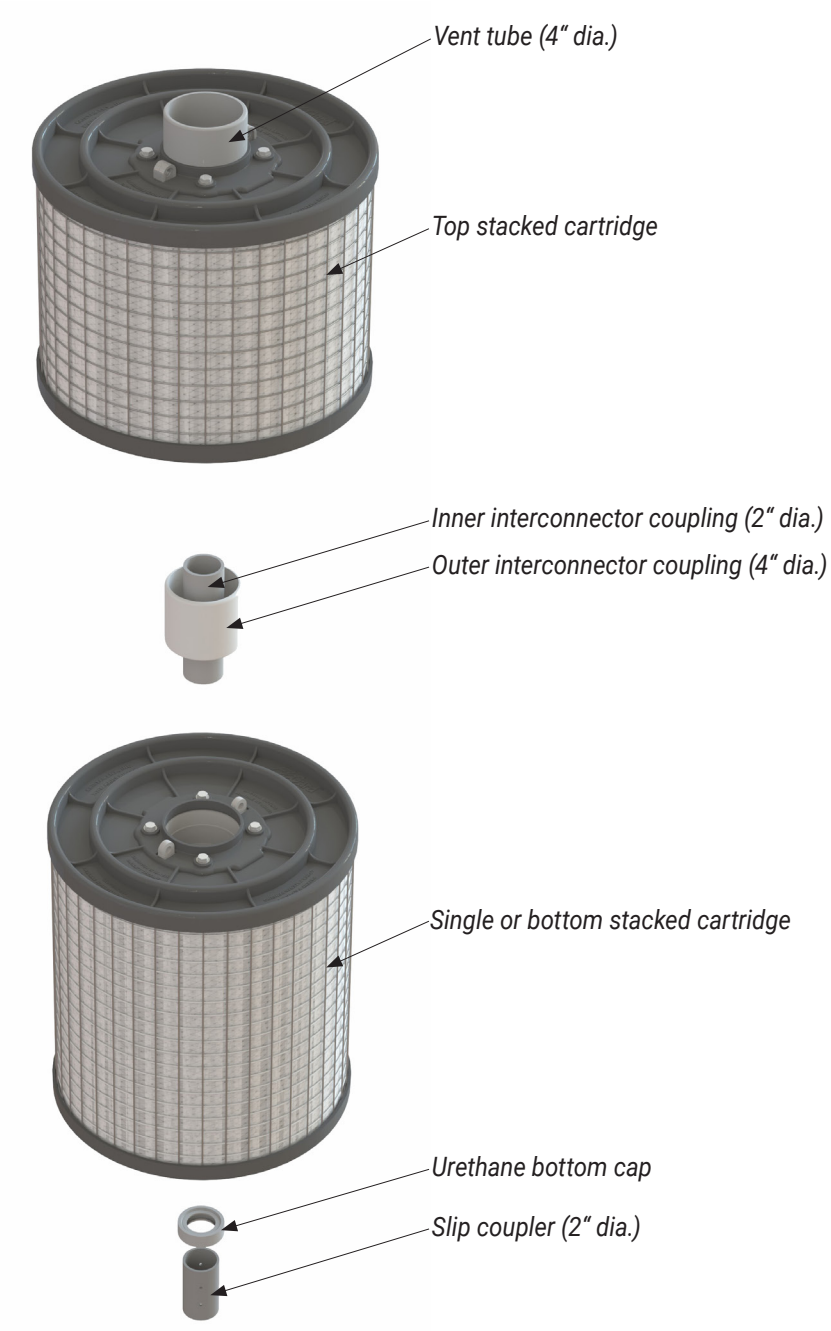


Figure 3. Schematic of stacked cartridges and connector components.

Maintenance Overview

State and local regulations require all stormwater management systems to be inspected on a periodic basis and maintained as necessary to ensure performance and protect downstream receiving waters. Maintenance prevents excessive pollutant buildup that can limit system performance by reducing the operating capacity and increasing the potential for scouring of pollutants during periods of high flow.

Inspection and Maintenance Frequency

The PerkFilter should be inspected on a periodic basis, typically twice per year, and maintained as required. Initially, inspections of a new system should be conducted more frequently to help establish an appropriate site-specific inspection frequency. The maintenance frequency will be driven by the amount of runoff and pollutant loading encountered by a given system. In most cases, the optimum maintenance interval will be one to three years. Inspection and maintenance activities should be performed only during dry weather periods.

Inspection Equipment

The following equipment is helpful when conducting PerkFilter inspections:

- Recording device (pen and paper form, voice recorder, iPad, etc.)
- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
- Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Socket and wrench for bolt-down access covers
- Manhole hook or pry bar
- Flashlight
- Tape measure
- Measuring stick or sludge sampler
- Long-handled net (optional)

Inspection Procedures

PerkFilter inspections are visual and may be conducted from the ground surface without entering the unit. To complete an inspection, safety measures including traffic control should be deployed before the access covers are removed. Once the covers have been removed, the following items should be checked and recorded (see form provided at the end of this document) to determine whether maintenance is required:

- Inspect the internal components and note whether there are any broken or missing parts. In the unlikely event that internal parts are broken or missing, contact Oldcastle Infrastructure at (800) 579-8819 to determine appropriate corrective action.
- Note whether the inlet pipe is blocked or obstructed. The outlet pipe is covered by a removable outlet hood and cannot be observed without entering the unit.
- Observe, quantify and record the accumulation of floating trash and debris in the inlet chamber. The significance of accumulated floating trash and debris is a matter of judgment. A long-handled net may be used to retrieve the bulk of trash and debris at the time of inspection if full maintenance due to accumulation of floating oils or settled sediment is not yet warranted.

- Observe, quantify and record the accumulation of oils in the inlet chamber. The significance of accumulated floating oils is a matter of judgment. However, if there is evidence of an oil or fuel spill, immediate maintenance by appropriate certified personnel is warranted.
- Observe, quantify and record the average accumulation of sediment in the inlet chamber and treatment chamber. A calibrated dipstick, tape measure, or sludge sampler may be used to determine the amount of accumulated sediment in each chamber. The depth of sediment may be determined by calculating the difference between the measurement from the rim of the PerkFilter to the top of the accumulated sediment, and the measurement from the rim of the PerkFilter to the bottom of the PerkFilter structure. Finding the top of the accumulated sediment below standing water takes some practice and a light touch, but increased resistance as the measuring device is lowered toward the bottom of the unit indicates the top of the accumulated sediment.
- Finally, observe, quantify and record the amount of standing water in the treatment chamber around the cartridges. If standing water is present, do not include the depth of sediment that may have settled out below the standing water in the measurement.

Maintenance Triggers

Maintenance should be scheduled if any of the following conditions are identified during the inspection:

- Internal components are broken or missing.
- Inlet piping is obstructed.
- The accumulation of floating trash and debris that cannot be retrieved with a net and/or oil in the inlet chamber is significant.
- There is more than 6” of accumulated sediment in the inlet chamber.
- There is more than 4” of accumulated sediment in the treatment chamber.
- There is more than 4” of standing water in the treatment chamber more than 24 hours after end of rain event.
- A hazardous material release (e.g. automotive fluids) is observed or reported.
- The system has not been maintained for 3 years (wet climates) to 5 years (dry climates).

Maintenance Equipment

The following equipment is helpful when conducting PerkFilter maintenance:

- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
- Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Socket and wrench for bolt-down access covers
- Manhole hook or pry bar
- Confined space entry equipment, if needed
- Flashlight
- Tape measure
- 9/16” socket and wrench to remove hold-down struts and filter cartridge tops
- Replacement filter cartridges
- Vacuum truck with water supply and water jet

Contact Oldcastle Infrastructure at (800) 579-8819 for replacement filter cartridges. A lead time of four weeks is recommended.

Maintenance Procedures

Maintenance should be conducted during dry weather when no flow is entering the system. Confined space entry is necessary to maintain vault and manhole PerkFilter configurations. Only personnel that are OSHA Confined Space Entry trained and certified may enter underground structures. Confined space entry is not required for catch basin PerkFilter configurations. Once safety measures such as traffic control are deployed, the access covers may be removed and the following activities may be conducted to complete maintenance:

- Remove floating trash, debris and oils from the water surface in the inlet chamber using the extension nozzle on the end of the boom hose of the vacuum truck. Continue using the vacuum truck to completely dewater the inlet chamber and evacuate all accumulated sediment from the inlet chamber. Some jetting may be required to fully remove sediment. The inlet chamber does not need to be refilled with water after maintenance is complete. The system will fill with water when the next storm event occurs.
- Remove the hold-down strut from each row of filter cartridges and then remove the top of each cartridge (the top is held on by four 9/16" bolts) and use the vacuum truck to evacuate the spent media. When empty, the spent cartridges may be easily lifted off their slip couplers and removed from the vault. The couplers may be left inserted into couplings cast into the false floor to prevent sediment and debris from being washed into the outlet chamber during washdown.
- Once all the spent cartridges have been removed from the structure, the vacuum truck may be used to evacuate all accumulated sediment from the treatment chamber. Some jetting may be required to fully remove sediment. Take care not to wash sediment and debris through the openings in the false floor and into the outlet chamber. All material removed from the PerkFilter during maintenance including the spent media must be disposed of in accordance with local, state, and/or federal regulations. In most cases, the material may be handled in the same manner as disposal of material removed from sumped catch basins or manholes.
- Place a fresh cartridge in each cartridge position using the existing slip couplers and urethane bottom caps. If the vault is equipped with stacked cartridges, the existing outer and inner interconnector couplers must be used between the stacked cartridges to provide hydraulic connection. Transfer the existing vent tubes from the spent cartridges to the fresh cartridges. Finally, refit the struts to hold the fresh cartridges in place.
- Securely replace access covers, as appropriate.
- Make arrangements to return the empty spent cartridges to Oldcastle Infrastructure.

PerkFilter
Inspection and Maintenance Log

Location_____

Structure Configuration and Size:

Inspection Date_____

☐ Vault _____feet x _____feet
☐ Manhole _____feet diameter
☐ Catch Basin _____feet x _____feet

Number and Height of Cartridge Stacks:

Count____each ☐12" ☐ 18" ☐ 24" ☐ 30"

Media Type:

☐ ZPC ☐ Perlite ☐ Other_____

Condition of Internal Components ☐ Good ☐ Damaged ☐ Missing	Notes:
Inlet or Outlet Blockage or Obstruction ☐ Yes ☐ No	Notes:
Floating Trash and Debris ☐ Significant ☐ Not Significant	Notes:
Floating Oils ☐ Significant ☐ Not Significant ☐ Spill	Notes:
Sediment Depth in Inlet Chamber ☐ Inches of Sediment:_____	Notes:
Sediment Depth in Treatment Chamber ☐ Inches of Sediment:_____	Notes:
Standing Water in Treatment Chamber ☐ Inches of Standing Water:_____	Notes:

Maintenance Required

☐ **Yes - Schedule Maintenance** ☐ **No - Inspect Again in _____ Months**

PERKFILTER™

OUR MARKETS

BUILDING STRUCTURES

COMMUNICATIONS

WATER

ENERGY

TRANSPORTATION

12.0 Inspection and Maintenance

12.1 ISOLATOR ROW INSPECTION

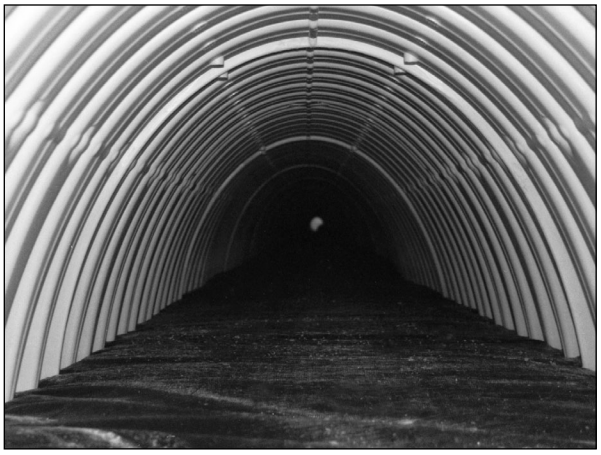
Regular inspection and maintenance are essential to assure a properly functioning stormwater system. Inspection is easily accomplished through the manhole or optional inspection ports of an Isolator Row. Please follow local and OSHA rules for a confined space entry.

Inspection ports can allow inspection to be accomplished completely from the surface without the need for a confined space entry. Inspection ports provide visual access to the system with the use of a flashlight. A stadia rod may be inserted to determine the depth of sediment. If upon visual inspection it is found that sediment has accumulated to an average depth exceeding 3" (76 mm), cleanout is required.

A StormTech Isolator Row should initially be inspected immediately after completion of the site's construction. While every effort should be made to prevent sediment from entering the system during construction, it is during this time that excess amounts of sediments are most likely to enter any stormwater system. Inspection and maintenance, if necessary, should be performed prior to passing responsibility over to the site's owner. Once in normal service, a StormTech Isolator Row should be inspected bi-annually until an understanding of the sites characteristics is developed. The site's maintenance manager can then revise the inspection schedule based on experience or local requirements.

12.2 ISOLATOR ROW MAINTENANCE

JetVac maintenance is recommended if sediment has been collected to an average depth of 3" (76 mm) inside the Isolator Row. More frequent maintenance may be required to maintain minimum flow rates through the Isolator Row. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, a wave of suspended sediments is flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/ JetVac combination vehicles. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45" (1143 mm) are best. The JetVac process shall only be performed on StormTech Rows that have AASHTO class 1 woven geotextile over the foundation stone (ADS 315ST or equal).



Looking down the Isolator Row

A typical JetVac truck (This is not a StormTech product.)

Examples of culvert cleaning nozzles appropriate for Isolator Row maintenance. (These are not StormTech products).

12.0 Inspection & Maintenance

STORMTECH ISOLATOR™ ROW - STEP-BY-STEP MAINTENANCE PROCEDURES

Step 1) Inspect Isolator Row for sediment

A) Inspection ports (if present)

i. Remove lid from floor box frame

ii. Remove cap from inspection riser

iii. Using a flashlight and stadia rod, measure depth of sediment

iv. If sediment is at, or above, 3” (76 mm) depth proceed to Step 2. If not proceed to Step 3.

B) All Isolator Rows

i. Remove cover from manhole at upstream end of Isolator Row

ii. Using a flashlight, inspect down Isolator Row through outlet pipe

1. Follow OSHA regulations for confined space entry if entering manhole

2. Mirrors on poles or cameras may be used to avoid a confined space entry

iii. If sediment is at or above the lower row of sidewall holes [approximately 3” (76 mm)] proceed to Step 2. If not proceed to Step 3.

Step 2) Clean out Isolator Row using the JetVac process

A) A fixed floor cleaning nozzle with rear facing nozzle spread of 45” (1143 mm) or more is preferable

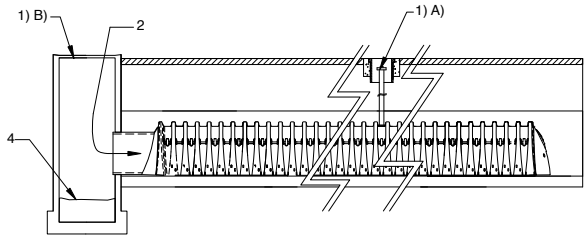
B) Apply multiple passes of JetVac until backflush water is clean

C) Vacuum manhole sump as required during jetting

Step 3) Replace all caps, lids and covers

Step 4) Inspect and clean catch basins and manholes upstream of the StormTech system following local guidelines.

Figure 20 – StormTech Isolator Row (not to scale)



12.3 ECCENTRIC PIPE HEADER INSPECTION

Theses guidelines do not supercede a pipe manufacturer’s recommended I&M procedures. Consult with the manufacturer of the pipe header system for specific I&M procedures. Inspection of the header system should be carried out quarterly. On sites which generate higher levels of sediment more frequent inspections may be necessary. Headers may be accessed through risers, access ports or manholes. Measurement of sediment may be taken with a stadia rod or similar device. Cleanout of sediment should occur when the sediment volume has reduced the storage area by 25% or the depth of sediment has reached approximately 25% of the diameter of the structure.

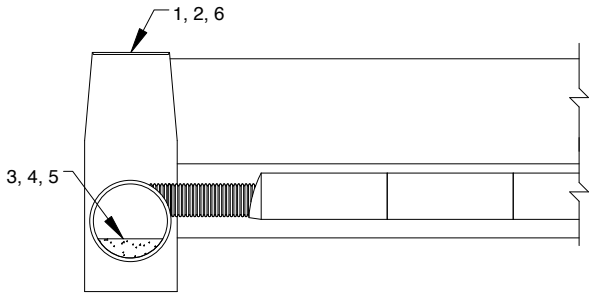
12.4 ECCENTRIC PIPE MANIFOLD MAINTENANCE

Cleanout of accumulated material should be accomplished by vacuum pumping the material from the header. Cleanout should be accomplished during dry weather. Care should be taken to avoid flushing sediments out through the outlet pipes and into the chamber rows.

Eccentric Header Step-by-Step Maintenance Procedures

1. Locate manholes connected to the manifold system
2. Remove grates or covers
3. Using a stadia rod, measure the depth of sediment
4. If sediment is at a depth of about 25% pipe volume or 25% pipe diameter proceed to step 5. If not proceed to step 6.
5. Vacuum pump the sediment. Do not flush sediment out inlet pipes.
6. Replace grates and covers
7. Record depth and date and schedule next inspection

Figure 21 – Eccentric Manifold Maintenance



Please contact StormTech’s Technical Services Department at 888-892-2894 for a spreadsheet to estimate cleaning intervals.

APPENDIX D

GEOTECHNICAL REPORT

Report of Additional Geotechnical Engineering Services

The Hedges Development—Building D
Tualatin, Oregon

for
Martin Development

July 10, 2019

GeoEngineers
Earth Science + Technology

Report of Additional Geotechnical Engineering Services

The Hedges Development—Building D
Tualatin, Oregon

for
Martin Development

July 10, 2019

GeoEngineers

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Report of Additional Geotechnical Engineering Services

The Hedges Development—Building D
Tualatin, Oregon

File No. 0821-014-06

July 10, 2019

Prepared for:

Martin Development
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Attention: Mac Martin

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Tyler A. Pierce, PE
Project Engineer

REGISTERED PROFESSIONAL ENGINEER
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GREG ALAN LANDAU

Greg A. Landau, PE, GE

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Date: 2019.07.10 15:31:42 -07'00'

Greg A. Landau, PE, GE
Associate Geotechnical Engineer

EXPIRES: 12/31/20

TAP:GAL:cje

GeoEngineers

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APPENDICES

1.0 INTRODUCTION

This report presents the results of GeoEngineers' additional geotechnical engineering services for the proposed Hedges D site at the Hedges Development in Tualatin, Oregon. The site is located at the west end of SW 115th Street and is bounded by private properties, or undeveloped riparian wetlands, to the north, west and south, and by the Hedges Creek channel on the east. The location of the site is shown in the Vicinity Map, Figure 1.

GeoEngineers completed a Due Diligence and Preliminary Geotechnical Engineering Services Report for Hedges C & D, dated September 6, 2018 (Preliminary Report). Since the Preliminary Report was finalized, the proposed Hedges D development has been modified from a single 64,500-square-foot (sf) building to two buildings—a northern 34,600-sf building and a southern 25,000-sf building. Building loads have not been developed at the time this report was prepared, but we understand the proposed buildings will be a single-story, concrete tilt panel construction with the possibility of 50 percent mezzanine.

Subsurface conditions encountered during the due diligence phase encountered a variable thickness of human placed fill material over alluvium, including a variable layer of very soft elastic silt, very loose silty sand and peat.

2.0 SCOPE OF SERVICES

The purpose of this report is to better define the subsurface conditions beneath the proposed buildings and update our recommendations from the Preliminary Report, as appropriate. Our proposed scope of services included the following:

1. Reviewed previous explorations completed at the site.
2. Coordinated utility locating prior to our explorations by contacting the public "One Call" locating service.
3. Explored subsurface soil and groundwater conditions at the site by completing up to four cone penetrometer tests (CPT), to depths between 47 and 81 feet below ground surface (bgs). The CPTs were located within the proposed building footprints and completed in a single day.
4. Prepared this report that summarizes our findings and provides our recommendations for aggregate piers, including layout, estimated depths, and whether grouted aggregate piers are appropriate. Our report includes a description of surface and subsurface conditions and a Site Plan showing explorations locations and other pertinent features. Results of the CPTs, as well as updated subsurface cross sections are included.

3.0 FIELD EXPLORATIONS AND LABORATORY TESTING

3.1. Field Explorations

The subsurface conditions at the proposed building locations were evaluated by performing four CPTs to depths between 47 and 81 feet below ground surface (bgs), in addition to the three geotechnical borings to depths ranging from 41½ to 81½ feet bgs, performed for the Preliminary Report. We also reviewed logs of borings performed during earlier explorations of the site by others (GeoDesign, Inc. 1997).

The approximate locations of the explorations, including those performed by others, are shown in Figure 2. The results of our explorations are presented in Appendix A.

3.2. Laboratory Testing

Soil samples are not collected when performing CPT's, so laboratory testing was not completed for this phase of the project. Laboratory tests completed for Hedges D during the due diligence phase are presented in Appendix A.

4.0 SITE CONDITIONS

4.1. Surface Conditions

The site is an approximately 5-acre parcel located west of the Hedges Creek canal. Similar drainage canals have been excavated along the north and much of the west side of the parcel. The site is currently vacant and is covered with rough field grass and small trees. The site surface is flat to very gently undulating, with elevations across the site ranging from approximately 150 feet above mean sea level (MSL) to 153 feet MSL.

4.2. Subsurface Conditions

The project site is located within the Tualatin River valley, once dominated by the active floodplains and alluvial terraces of the Tualatin River and its tributaries such as Hedges Creek.

During agricultural development and later urbanization of Tualatin-Sherwood metropolitan area, these lowlands were altered, largely by channelization of the tributary streams as well as raising the grade of the original riparian lowlands by placing a variety of fill materials ranging from ditch channel spoil, silt, sand, gravel, and construction and demolition debris. The original topography of Hedges Creek as well as the surrounding agricultural areas were never documented or, if so, was not preserved, so the thickness, extent, and location of these fills are not well defined. The project site is mantled with these man-made fills.

Two types of soil were encountered underlying the site within the depth of exploration—fill and alluvial sediments. The latter are further divided into Holocene-age alluvial silt, fine sand, and clay overlying Pleistocene-age silts and sand to gravel alluvium deposited by the catastrophic Missoula Floods. Records of site grading indicate that silty and sandy man-made fill was placed across the bulk of the site in the late 1990s, raising the site grades between 8 and 19 feet.

Subsurface conditions beneath each building are described below.

4.2.1. Northern Building (Building A)

The fill extends between 10 and 18 feet bgs across the northern building footprint. The composition of the fill is likely variable across the building footprint, varying between stiff to very stiff silt and dense silty sand to soft silt or loose silty fine sand. The CPTs were predrilled through the fill, so information pertaining to the consistency of the fill is limited to the borings conducted for the Preliminary Report.

Very soft to medium stiff silt, sandy silt or elastic silt and loose silty sand or silty gravel was encountered below the fill to depths ranging between 70 and 89 feet. A layer of highly organic peat ranging between 8 and 22 feet thick was encountered underlying the building footprint, at depths between 20 and 24 feet bgs. Beneath the very soft/loose alluvial deposits, very stiff silt with sand and dense to very dense silty

gravels and sands were encountered. Dense gravels were encountered in B-02D at 40 feet bgs and in GeoDesign, Inc. (GDI) B-3 at a depth of 89 feet bgs.

4.2.2. Southern Building (Building B)

Beneath the southern building footprint, the fill extends between 9 and 10 feet bgs. No borings or CPTs were conducted within the fill beneath the southern building, but based on our explorations and surface observations, we anticipate the fill conditions are like those encountered below the northern building.

Very soft to medium stiff silt, sandy silt, elastic silt or organic silt, and very loose to loose silty gravel and sand was encountered to depths between 65 and 70 feet bgs. Similar to the northern building, a layer of highly organic peat or organic silt ranging between 19 and 28 feet thick was encountered at depths between 15 and 18 feet bgs. Beneath the very soft/very loose alluvial deposits, very stiff to hard silt or dense to very dense silty gravels and sands were encountered. The dense gravels were observed at a depth of 66 feet bgs in GDI B-7 and at 80 feet bgs in CPT-2.

4.2.3. Groundwater

During our drilling program completed in February 2018, groundwater was encountered within ½ foot to 4 feet bgs in B-01D and B-02D, respectively. Pore water dissipation tests performed during the CPT soundings estimate static groundwater between 7 and 15 feet bgs.

Groundwater conditions are expected to vary seasonally due to rainfall events and other factors.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary

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

- An 8 to 28-foot-thick layer of organic silt and peat was encountered under the proposed building footprints. This organic material is highly compressible and will likely continue to settle with additional loading, although the majority of settlement under the weight of the existing fill has likely occurred.
- Based on pore pressure readings, groundwater was estimated between approximately 7 to 15 feet bgs during CPT soundings completed in June 2019. Based on drilled borings completed in February 2018, groundwater was encountered at or near the surface.
- The buildings can be supported on aggregate piers under the building footings or the entire building footprint. Grouted aggregate piers will likely be required to mitigate for the organic soils encountered.

Our specific geotechnical recommendations are presented in the following sections of this report.

6.0 EARTHWORK RECOMMENDATIONS

6.1. Site Preparation

Initial site preparation and earthwork operations will include stripping and grading the site, and excavating for utilities and foundations.

Depending on the final layout of the buildings, stripping of grass rootzone and removal and grubbing of shrubs/trees surrounding the structures may be required. Existing shrubs/trees should be removed from the site in all proposed building pad and pavement areas and for a 5-foot margin around such areas. Typically, the depth of stripping is approximately 6 to 8 inches, although thicker stripping depths may be required. The actual stripping depth should be based on field observations at the time of construction. Stripped material should be transported off site for disposal or used in landscaped areas.

Trees and their root balls should be grubbed to the depth of the roots, which could exceed 3 feet bgs. Depending on the methods used to remove the preceding material, considerable disturbance and loosening of the subgrade could occur. We recommend that disturbed soil be removed to expose medium stiff or stiffer native soil. The resulting excavations should be backfilled with structural fill.

6.2. Subgrade Preparation and Evaluation

Upon completion of site preparation activities, the exposed subgrade should be proof-rolled with a fully-loaded dump truck or similar heavy rubber-tired construction equipment to identify soft, loose or unsuitable areas. Proof-rolling should be conducted prior to placing fill, and should be observed by a representative of GeoEngineers who will evaluate the suitability of the subgrade and identify areas of yielding that are indicative of soft or loose soil. If soft or loose zones are identified during proof-rolling, these areas should be excavated to the extent indicated by our representative and replaced with Imported Select Structural Fill as defined in this report.

During wet weather, or when the exposed subgrade is wet or unsuitable for proof-rolling, the prepared subgrade should be evaluated by observing excavation activity and probing with a steel foundation probe. Observations, probing and compaction testing should be performed by a member of our staff. Wet soil that has been disturbed due to site preparation activities or soft or loose zones identified during probing, should be removed and replaced with Imported Select Structural Fill as defined in this report.

6.3. Wet Weather Construction

The fine-grained soils at the site are highly susceptible to moisture. Wet weather construction practices will be necessary if work is performed during periods of wet weather. If site grading will occur during wet weather conditions, it will be necessary to use track-mounted equipment, use gravel working pads and employ other methods to reduce ground disturbance. The contractor should be responsible to protect the subgrade during construction.

During wet weather we recommend that:

- The ground surface in and around the work area should be sloped so that surface water is directed to a sump or discharge location. The ground surface should be graded such that areas of ponded water do not develop.
- The site soils should not be left uncompacted and exposed to moisture. Sealing the surficial soils by rolling with a smooth-drum roller prior to periods of precipitation will reduce the extent to which these soils become wet or unstable.
- Construction activities should be scheduled so that the length of time that soils are left exposed to moisture is reduced to the extent practicable.

- During periods of wet weather, concrete should be placed as soon as practical after preparing foundation excavations. Foundation bearing surfaces should not be exposed to standing water. Should water infiltrate and pool in the excavation, the water should be removed, and the foundation subgrade should be re-evaluated before placing reinforcing steel or concrete. Foundation subgrade protection, such as a 3- to 4-inch-thickness of crushed rock, may be necessary if footing excavations are exposed to extended wet weather conditions.

6.4. Excavation

It is our opinion that conventional earthmoving equipment in proper working condition should be capable of making necessary general excavations. The earthwork contractor should be responsible for reviewing this report, including the exploration logs, providing their own assessments, and providing equipment and methods needed to excavate the site soils while protecting subgrades.

6.5. Dewatering

As discussed in Section 4.2.3 of this report, depending on the time of year construction is completed, groundwater may be encountered at or near the ground surface. If groundwater is encountered, saturated/wet soils should be dewatered. Sump pumps are expected to adequately address groundwater encountered in shallow excavations.

6.6. Shoring

All trench excavations should be made in accordance with applicable Occupational Safety and Health Administration (OSHA) and state regulations. Site soils within expected excavation depths consist of a variable human placed fill, classified as OSHA Soil Type C, provided there is no seepage and excavations occur during periods of dry weather. Excavations deeper than 4 feet should be shored or laid back at an inclination of 1.5H:1V (horizontal to vertical) for Type C soils. Flatter slopes may be necessary if workers are required to enter. Excavations made to construct footings or other structural elements should be laid back or shored at the surface as necessary to prevent soil from falling into excavations.

Shoring for trenches less than 6 feet deep that are above the effects of groundwater should be possible with a conventional box system. Moderate sloughing should be expected outside the box. Shoring deeper than 6 feet or below the groundwater table should be designed by a registered engineer before installation. Further, the shoring design engineer should be provided with a copy of this report.

In our opinion, the contractor will be in the best position to observe subsurface conditions continuously throughout the construction process and to respond to the soil and groundwater conditions. Construction site safety is generally the sole responsibility of the contractor, who also is solely responsible for the means, methods and sequencing of the construction operations and choices regarding excavations and shoring. Under no circumstances should the information provided by GeoEngineers be interpreted to mean that GeoEngineers is assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

6.7. Structural Fill and Backfill

6.7.1. General

Materials used to support building foundations, floor slabs, hardscape, pavements and any other areas intended to support structures or within the influence zone of structures are classified as structural fill for the purposes of this report.

All structural fill should be free of debris, clay balls, roots, organic matter, frozen soil, man-made contaminants, particles with greatest dimension exceeding 4 inches and other deleterious materials. The suitability of soil for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines in the soil matrix increases, the soil becomes increasingly more sensitive to small changes in moisture content and achieving the required degree of compaction becomes more difficult or impossible. Recommendations for suitable fill material are provided in the following sections.

6.7.2. Use of On-site Soil

As described in Section 4.2, the on-site near surface soil consists of variable silty fill. On-site soils can be used as structural fill, provided the material meets the above requirements, although due to moisture sensitivity, this material will likely be unsuitable as structural fill during most of the year. If the soil is too wet to achieve satisfactory compaction, moisture conditioning by drying back the material will be required. If the material cannot be properly moisture conditioned, we recommend using imported material for structural fill.

An experienced geotechnical engineer from GeoEngineers should determine the suitability of on-site soil encountered during earthwork activities for reuse as structural fill.

6.7.3. Imported Select Structural Fill

Imported select granular material may be used as structural fill. Imported Select Structural Fill should consist of pit or quarry run rock, crushed rock, or crushed gravel and sand that is fairly well-graded between coarse and fine sizes, with approximately 25 to 65 percent passing the U.S. No. 4 sieve. It should have less than 5 percent passing the U.S. No. 200 sieve and have a minimum of two mechanically fractured faces. During dry weather, the fines content can be increased to a maximum of 12 percent.

6.7.4. Aggregate Base

Aggregate base material located under floor slabs and pavements, and crushed rock used in footing overexcavations, should consist of imported clean, durable, crushed angular rock. Aggregate base material should be well-graded, have a maximum particle size of 1 inch and have less than 5 percent passing the U.S. No. 200 sieve. In addition, aggregate base shall have a minimum of 75 percent fractured particles according to American Association of State Highway and Transportation Officials (AASHTO) TP-61 and a sand equivalent of not less than 30 percent based on AASHTO T-176.

6.7.5. Trench Backfill

Backfill for pipe bedding and in the pipe zone should consist of well-graded granular material with a maximum particle size of ¾ inch and less than 5 percent passing the U.S. No. 200 sieve. Trench backfill material should be free of organic matter and other deleterious materials. Further, the backfill should meet

the pipe manufacturer's recommendations. Above the pipe zone, Imported Select Structural Fill may be used as described above.

6.7.6. Fill Placement and Compaction

Structural fill should be compacted to a minimum of 95 percent of the maximum dry density (MDD) at moisture contents that are within 3 percent of the optimum moisture content as determined by ASTM International (ASTM) Standard Practices Test Method D 1557 (Modified Proctor). The optimum moisture content varies with gradation and should be evaluated during construction. Fill material that is not near the optimum moisture content should be moisture conditioned prior to compaction.

Fill and backfill material should be placed in uniform, horizontal lifts and compacted with appropriate equipment. The appropriate lift thickness will vary depending on the material and compaction equipment used. It is the contractor's responsibility to select appropriate compaction equipment and place the material in lifts that are thin enough to meet these criteria. However, in no case should the loose lift thickness exceed 18 inches.

A representative from GeoEngineers should evaluate compaction of each lift of fill. Compaction should be evaluated by compaction testing, unless other methods are proposed for oversized materials and are approved by GeoEngineers prior to fill placement. These other methods typically involve procedural placement and compaction specifications together with verifying requirements such as proof-rolling.

6.8. Temporary Cut Slopes

Earthwork activities are expected to occur at grade, we do not expect significant cut slopes at the site.

7.0 STRUCTURAL DESIGN RECOMMENDATIONS

The foundation support recommendations provided below are based on our analysis and collaborative discussion considering required performance and cost for the project. We have carefully evaluated foundation support and subgrade preparation to provide efficient foundation design and adequate performance for the proposed building, while still considering the project schedule, soil conditions and cost of earthwork.

7.1. Foundation Support Recommendations

7.1.1. Aggregate Piers

Shallow spread footings supported on aggregate piers would provide relatively high bearing capacity and reduced settlement by creating a stiff soil subgrade. Ground improvement methods can consist of the Rammed Aggregate Pier® (RAP) System constructed by GeoPier Foundation Company, Vibro Piers™ constructed by Hayward Baker, or alternate systems if approved in advance by GeoEngineers. Aggregate pier systems are typically designed and constructed by the specialty contractor to a performance specification. They should submit a ground improvement design that has been completed and stamped by a registered professional engineer with experience in such projects. We recommend that GeoEngineers review the design on behalf of the Owner, although the specialty contractor will retain responsibility for the design and construction of the ground improvements to the specified performance criteria.

The inclusion of grout to the aggregate pier system provides additional structural rigidity within the pier element that extends through the soft compressible peat material. We anticipate that the aggregate piers would extend from footing subgrade to approximately 45 feet bgs, although the grout-improved zone would likely not extend the full depth.

We anticipate aggregate piers will extend one row outside the building footprint. They should be designed to meet the final bearing capacity and settlement tolerances provided by the structural engineer. The specialty contractor would provide final design and in-house quality control for the piers. We recommend that GeoEngineers provide construction quality assurance for the Owner during the construction process.

7.1.2. Bearing Capacity

The bearing capacity of the aggregate pier-improved subgrade would be determined by the specialty contractor and will be dependent on actual building loads and acceptable settlement magnitudes. Based on conversations with GeoPier, their aggregate piers typically can achieve bearing capacity of approximately 4,000 to 6,000 pounds per square foot (psf) in soils similar to those at the site that have been improved with aggregate piers. This value may be increased by one third when considering earthquake or wind loads.

We recommend footings have a minimum width of 24 inches and the bottom of the exterior footings be founded at least 18 inches below the lowest adjacent grade, or as needed to meet the design loads. The recommended minimum footing depth is greater than the anticipated frost depth.

7.1.3. Foundation Settlement

Settlement for shallow foundations supported on an aggregate pier improved subgrade, as described above, would depend on the specialty contractor's design. Typically, the systems are designed to a performance specification that is normally on the order of approximately 1 inch.

7.1.4. Lateral Resistance

Lateral foundation loads may be resisted by passive resistance on the sides of footings and by friction on the base of the shallow foundations. For shallow foundations supported on subgrade soils prepared as described above, the allowable frictional resistance may be computed using a coefficient of friction of 0.4 applied to vertical dead-load forces.

The allowable passive resistance may be computed using an equivalent fluid density of 280 pounds per cubic foot (pcf) (triangular distribution). These values are appropriate for foundation elements that are poured directly against undisturbed soils or surrounded by structural fill.

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

7.2. Drainage Considerations

We recommend the ground surface be sloped away from the buildings at least 2 percent. All downspouts should be tightlined away from the building foundation areas and should also be discharged into a stormwater disposal system. Downspouts should not be connected to footing drains.

We recommend that perimeter footing drains be installed around the proposed buildings at the base of the exterior footings. The perimeter footing drains should be provided with cleanouts and should consist of at least 4-inch-diameter perforated pipe placed on a 3-inch bed of, and surrounded by, 6 inches of drainage material enclosed in a non-woven geotextile such as Mirafi 140N (or approved alternate) to prevent fine soil from migrating into the drain material. We recommend against using flexible tubing for footing drainpipes. The perimeter drains should be sloped to drain by gravity to a suitable discharge point, preferably a storm drain. We recommend that the cleanouts be covered and placed in flush-mounted utility boxes. Water collected in roof downspout lines must not be routed to the footing drain lines.

7.3. Slab-on-Grade Floors

The exposed subgrade should be evaluated after site grading is complete. Proof-rolling with heavy, rubber-tired construction equipment should be used for this purpose during dry weather. Probing should be used to evaluate the subgrade during periods of wet weather. The exposed soil should be firm and unyielding, and without significant groundwater. Loose and disturbed areas should be removed and replaced with compacted structural fill.

We recommend that GeoEngineers observe the condition of all subgrade areas to evaluate whether the work is completed in accordance with our recommendations.

Conventional slabs may be supported on-grade, provided the subgrade soils are prepared as recommended above. For slabs designed as a beam on an elastic foundation, a modulus of subgrade reaction of 150 pounds per cubic inch (pci) may be used for subgrade soils prepared as recommended over the capillary break. It should be noted that this minimum thickness of capillary break will not provide adequate support of construction traffic.

We recommend that the slab-on-grade floors be underlain by a 6-inch-thick capillary break consisting of clean (less than 5 percent passing the No. 200 sieve) ¾-inch crushed gravel. We recommend that the capillary break be compacted to at least 95 percent of the MDD in accordance with ASTM Test Method D 1557. We also recommend that an appropriate vapor retarder be installed below the floor slab to further reduce the risk of moisture migration through the on-grade floor slabs if they are inhabited spaces.

Slab-on-grade settlements will be estimated by the ground improvement subcontractor.

8.0 RECOMMENDED ADDITIONAL GEOTECHNICAL SERVICES

During construction, GeoEngineers should observe the installation of the ground improvements, evaluate the suitability of the foundation subgrades, evaluate structural backfill, and provide a summary letter of our construction observation services. The purposes of GeoEngineers construction phase services are to confirm that the subsurface conditions are consistent with those observed in the explorations and other reasons described in Appendix B, Report Limitations and Guidelines for Use.

9.0 LIMITATIONS

We have prepared this report for the exclusive use of Martin Development and their authorized agents for The Hedges Development—Building D Project in Tualatin, Oregon.

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

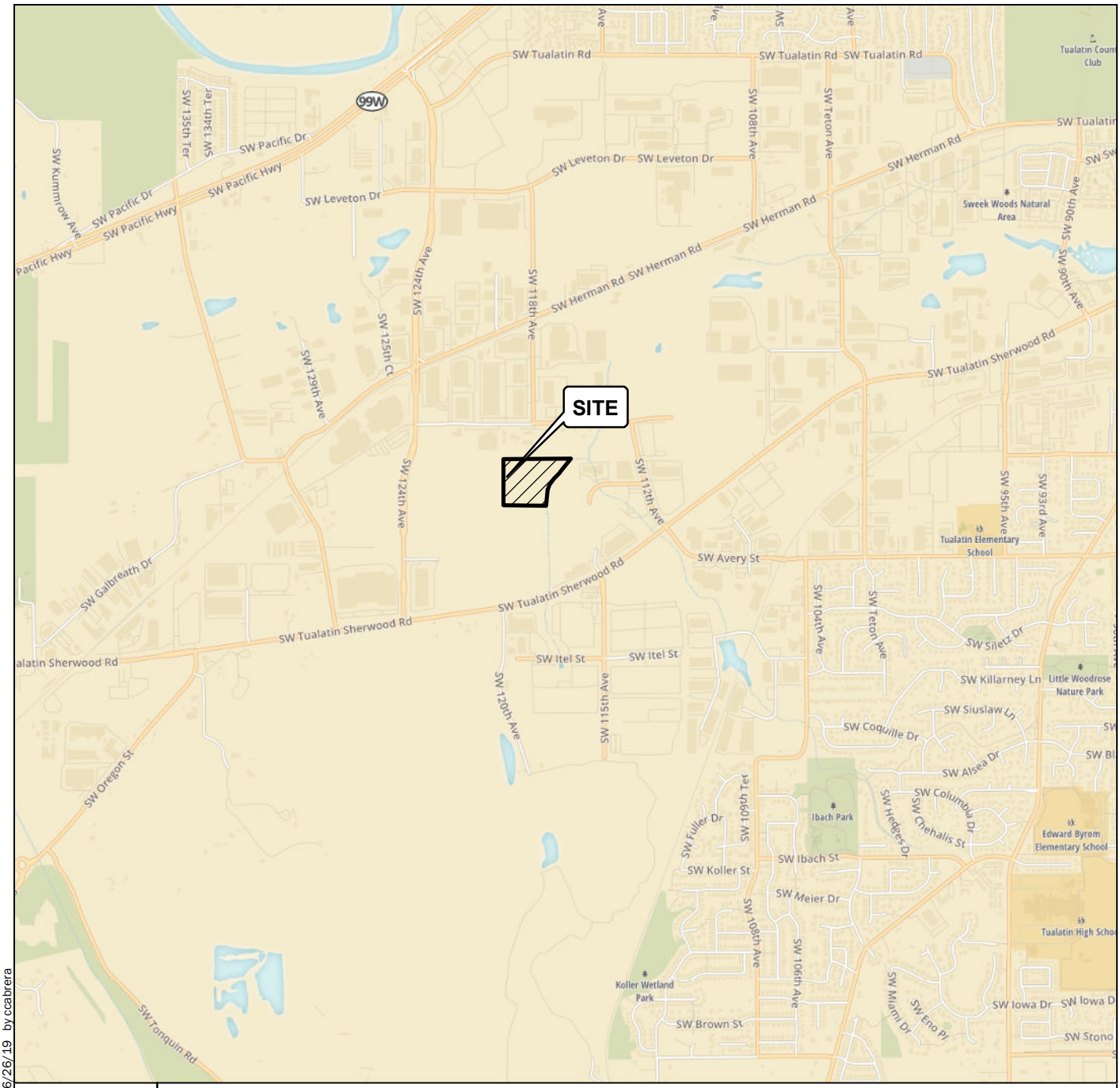
Please refer to Appendix B titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.

10.0 REFERENCES

GeoDesign, Inc. 1997. Report of Geotechnical Engineering Services, Lots 11 and 12, Franklin Business Park, Southwest Avery Street and Tualatin-Sherwood Road, Tualatin, Oregon, GDI Project: Drake-3, prepared for Drake Management Company, dated June 6, 1997.

FIGURES

GeoEngineers



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Feet

Vicinity Map

Hedges D
Tualatin, Oregon

GeoEngineers

Figure 1

Notes:

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

Data Source: Mapbox Open Street Map, 2016

Projection: NAD 1983 UTM Zone 10N

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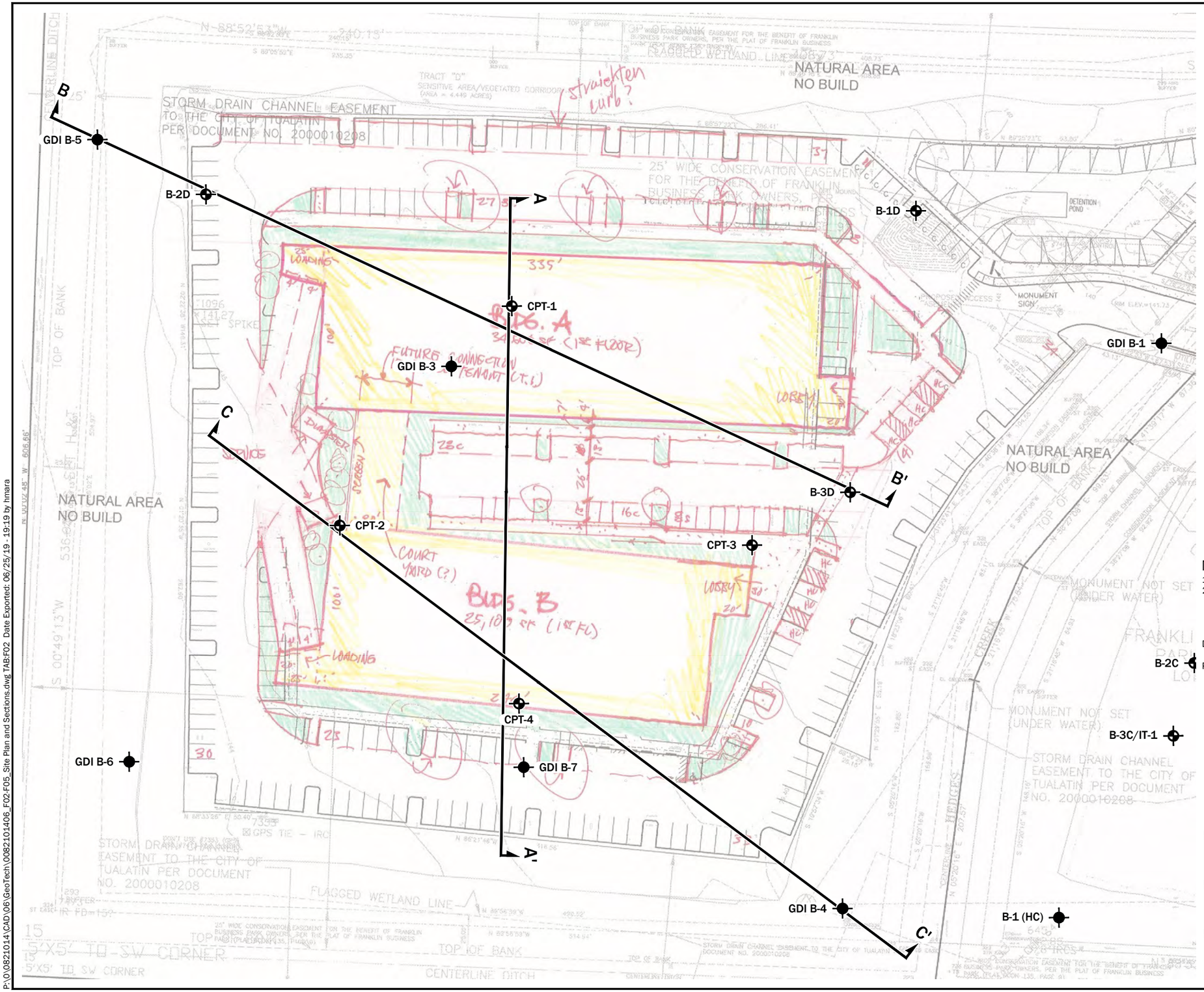

Legend

- B-1D — GeoEngineers Exploration Number and Approximate Location
- GDI B-1 — Exploration Number and Approximate Location (by Others)
- A — A' — Cross Section Location

Notes:

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

Data Source: Background PDF from Lance Muller Associates dated 4/19/19.

Projection: OR State Plane, North Zone, NAD83, US Foot

N W E S

60 0 60
Feet

Site Plan

Hedges D
Tualatin, Oregon

GeoEngineers

Figure 2

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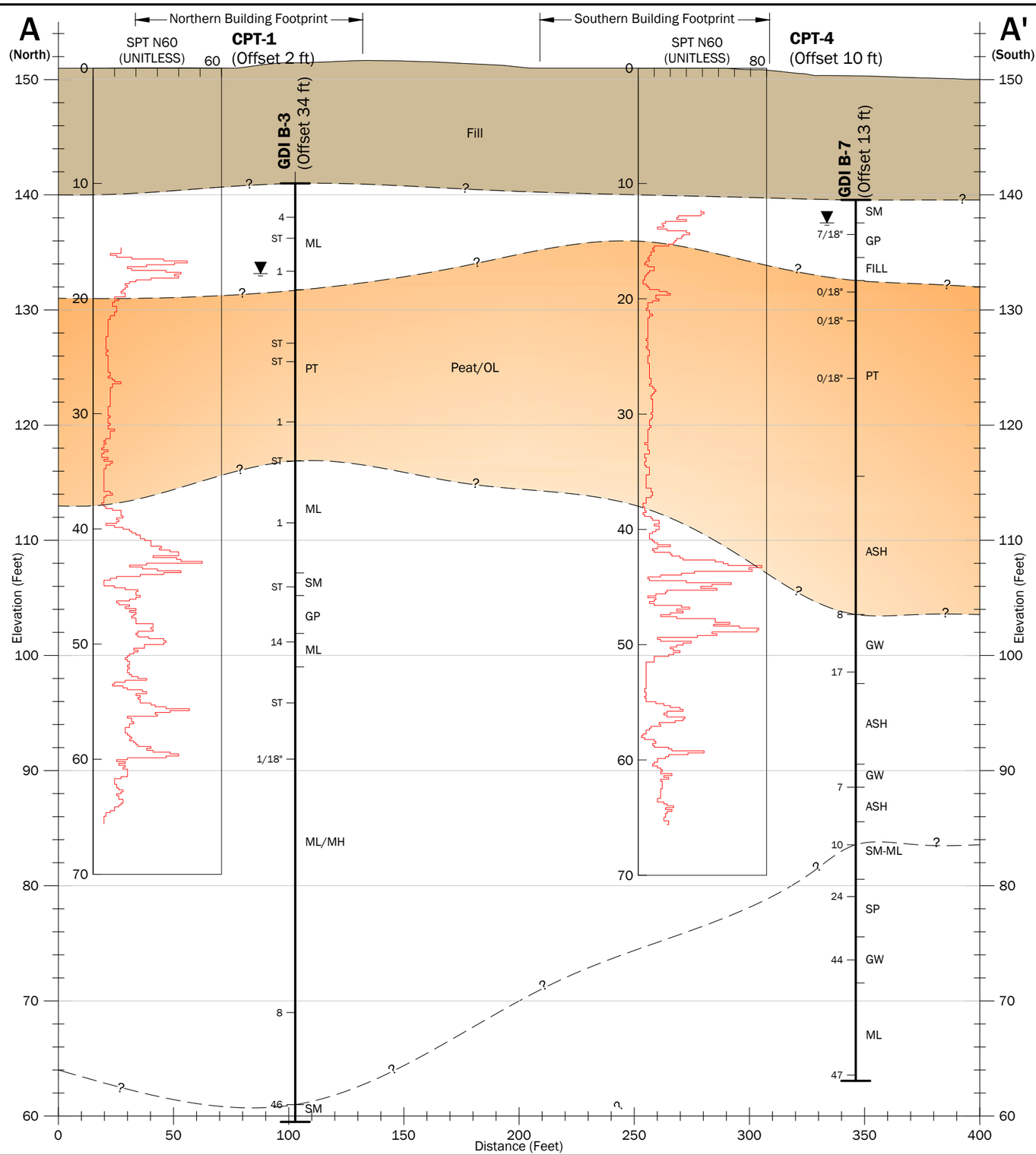
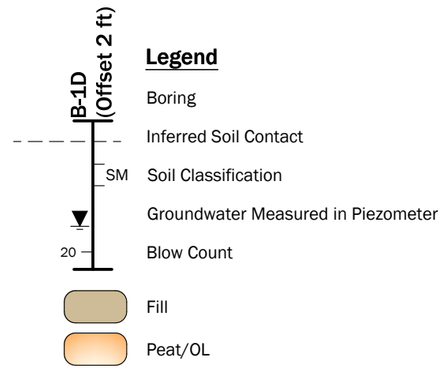




Notes:

1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Datum: NAVD 88, unless otherwise noted.

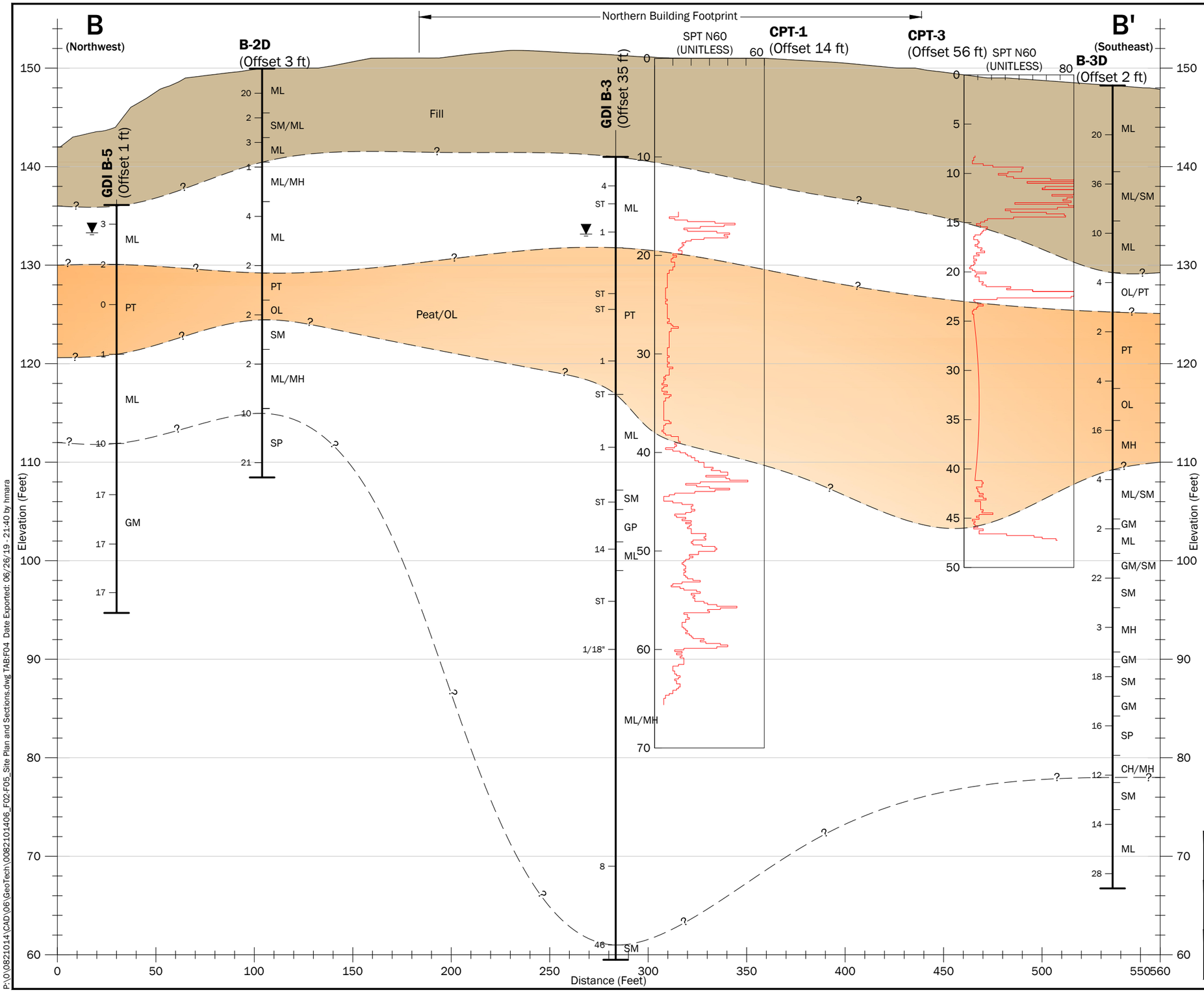
50 0 50
Horizontal Scale in Feet
10 0 10
Vertical Scale in Feet
Vertical Exaggeration: 5X

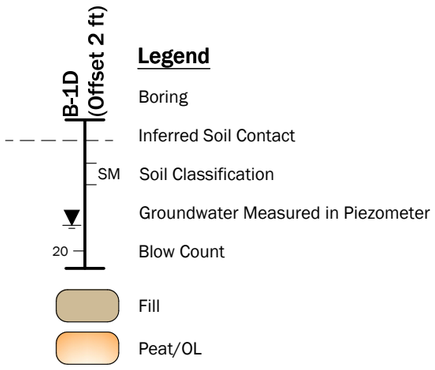
Cross Section A-A'

Hedges D
Tualatin, Oregon

GeoEngineers

Figure 3

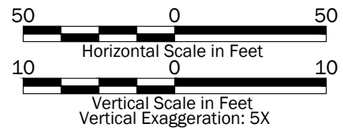




Notes:

1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Datum: NAVD 88, unless otherwise noted.

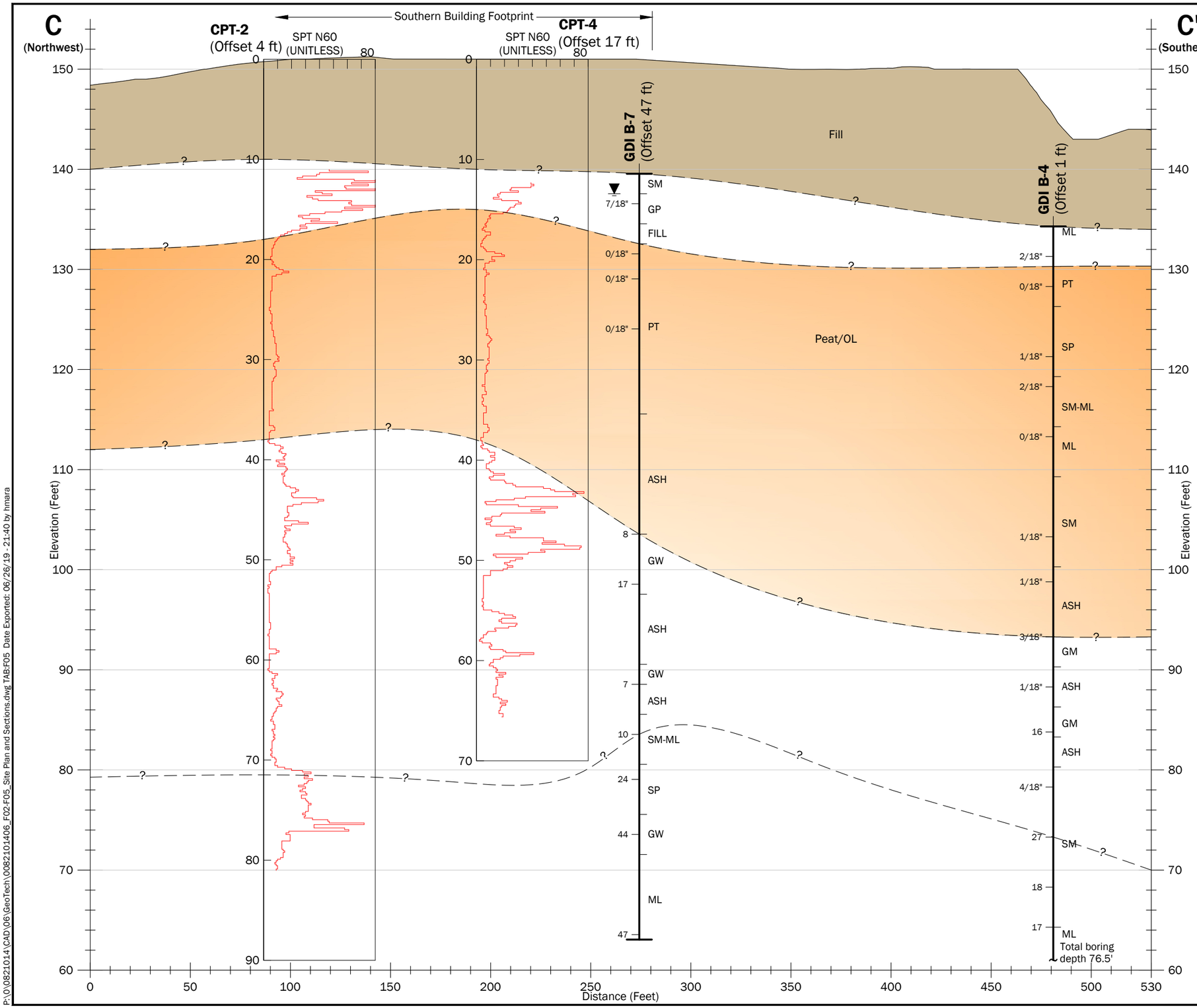


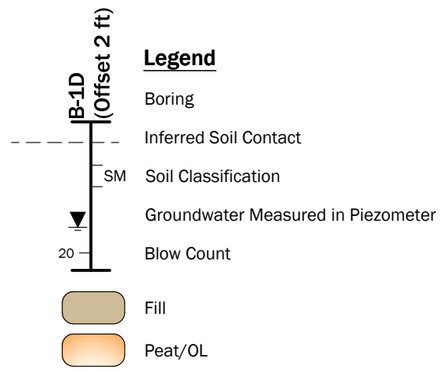
Cross Section B-B'

Hedges D
Tualatin, Oregon

GeoEngineers

Figure 4

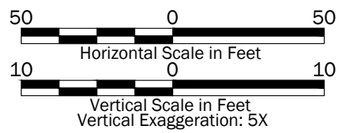




Notes:

1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Datum: NAVD 88, unless otherwise noted.



Cross Section C-C'

Hedges D
Tualatin, Oregon

GeoEngineers

Figure 5

APPENDICES

GeoEngineers

APPENDIX A
Field Exploration and Laboratory Testing

APPENDIX A
FIELD EXPLORATIONS AND LABORATORY TESTING

Subsurface conditions were explored by drilling two borings with a trailer-mounted drill rig employing solid-stem auger techniques provided by Dan Fisher Drilling on February 15, 2018, one boring with a tracked rig and mud-rotary techniques provided by Western States Drilling on February 21, 2018, and four cone CPT soundings on June 10, 2019, with a truck rig owned and operated by Oregon Geotechnical Explorations. The locations of the explorations were estimated by taping/pacing from existing site features. The approximate exploration locations are shown in the Site Plan, Figure 2.

Borings (Completed during Due Diligence Phase)

The drilling was continuously monitored by an engineering geologist from our office who maintained a detailed log of subsurface explorations, visually classified the soil encountered and obtained representative soil samples from the borings.

Representative soil samples were obtained from each boring at approximate 2½- to 10-foot-depth intervals using either: (1) a 1-inch, inside-diameter, standard split spoon sampler; or (2) a 2.4-inch, inside-diameter, split-barrel ring sampler (Dames & Moore [D&M]). The samplers were driven into the soil using a 140-pound hammer free-falling 30 inches on each blow; the trailer-mounted (Fisher) rig using rope-and-cathead methods, the track (Western States) using an autohammer.

The number of blows required to drive the sampler each of three, 6-inch increments of penetration were recorded in the field. The sum of the blow counts for the last two, 6-inch increments of penetration is reported on the boring logs as the ASTM International (ASTM) Standard Practices Test Method D 1556 standard penetration test (SPT) N-value. The N-value for D&M samples have been reduced by approximately 50 percent from the field readings to roughly correlate with the SPT N-values.

Recovered soil samples were visually classified in the field in general accordance with ASTM D 2488 and the classification chart listed in Key to Exploration Logs, Figure A-1. Logs of the borings are presented in Figures A-2 through A-4. The logs are based on interpretation of the field and laboratory data and indicate the depth at which subsurface materials or their characteristics change, although these changes might actually be gradual.

Cone Penetration Tests (CPT)

The CPT is a subsurface exploration technique in which a small-diameter steel tip with adjacent sleeve is continuously advanced with hydraulically operated equipment. Measurements of tip and sleeve resistance allow interpretation of the soil profile and the consistency of the strata penetrated. The tip, sleeve resistance and pore water pressure are recorded on the CPT logs. The logs of the CPT probes are presented in Figures A-5 through A-8.

Laboratory Testing (completed during Due Diligence Phase)

Soil samples obtained from the explorations were transported to GeoEngineers' laboratory and evaluated to confirm or modify field classifications, as well as to evaluate engineering properties of the soil samples. Representative samples were selected for laboratory testing to determine the moisture content, moisture-density, percent fines (material passing the U.S. No. 200 sieve), and organic content. The tests were performed in general accordance with ASTM standard practices or other applicable procedures.

The results of the moisture content and percent fines determinations are presented at the respective sample depths in the exploration logs in Appendix A.

Moisture Content

Moisture content tests were completed in general accordance with ASTM D 2216 for representative samples obtained from the explorations. The results of these tests are presented in the exploration logs in Appendix A at the depths at which the samples were obtained.

Moisture-Density

We completed moisture density (dry density) testing on selected D&M samples in general accordance with the ASTM D 2937 test method. The results are presented on the boring logs.

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

Selected samples were "washed" through the U.S. No. 200 mesh sieve to estimate the relative percentages of coarse- and fine-grained particles in the soil. The percent passing value represents the percentage by weight of the sample finer than the U.S. No. 200 sieve. These tests were conducted to verify field descriptions and to estimate the fines content for analysis purposes. The tests were conducted in accordance with ASTM D 1140, and the results are shown in the exploration logs in Appendix A at the respective sample depths.

Organic Content

Organic content tests were performed to determine the amount of organic material present in selected samples in general accordance with ASTM D 2974, Method C. The results of the organic content tests are presented in the exploration logs in Appendix A.

SOIL CLASSIFICATION CHART

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

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

ADDITIONAL MATERIAL SYMBOLS

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

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Sampler Symbol Descriptions

2.4-inch I.D. split barrel

Standard Penetration Test (SPT)

Shelby tube

Piston

Direct-Push

Bulk or grab

Continuous Coring

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

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

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

Laboratory / Field Tests

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

Sheen Classification

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

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

Key to Exploration Logs

GeoEngineers

Figure A-1

Drilled Start 2/15/2018 End 2/15/2018	Total Depth (ft) 41.5	Logged By JLL Checked By GL	Driller Dan Fischer Drilling	Drilling Method Solid-stem Auger	
Surface Elevation (ft) 149 Vertical Datum NAVD88		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment Paul Bunyan Trailer	
Easting (X) 7611554 Northing (Y) 631175		System Datum OR State Plane North NAD83 (feet)		See "Remarks" section for groundwater observed	

Notes: D&M N-value reduced by 50 percent to approximate SPT N-value

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0						ML	Brown silt, low to medium plasticity, grass roots to 6 to 8 inches, trace to occasional sand (very stiff, moist) (fill)			Groundwater observed at approximately 6 inches below ground surface during drilling
145		10	22		1						
	5	14	9		2		SM	Brown silty fine to medium sand, fine gravel (loose, moist to wet)			
140		0	8		3						
	10	12	8		4		ML	Light gray-brown fine sandy silt, low plasticity, trace brick fragments and gravel (medium stiff, moist to wet)			
								Drill action indicates cobble or debris 12½ to 14½ feet			
135	15	0	12		5			Dark gray fine to medium sandy silt with gravel, angular basalt gravel to 4 inches (stiff, wet)			
130							ML	Dark gray silt, moderate plasticity, trace to occasional roots and organic fibers, trace fine sand (medium stiff, wet) (alluvium)	31		DD = 86 pcf
	20	10	6		6 MD						
125							OL/PT	Dark gray to black organic silt with fine sand, occasional interbeds of brown peat, much fibrous organic matter (soft, wet)	276		OC = 40 percent
	25	12	3		7 OC						
120											
	30	1	4		8 OC			Gray sandy silt with organic silt (soft to medium stiff, wet)	95		OC = 10 percent
115							ML/MH	Dark gray silt, moderate plasticity, trace fine sand (medium stiff, wet)			
	35										

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

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Log of Boring B-01D

GeoEngineers

Project: The Hedges - Building C and D
Project Location: Tualatin, Oregon
Project Number: 0821-014-02

Figure A-2
Sheet 1 of 2

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	FIELD DATA: Blows/foot	FIELD DATA: Collected Sample	FIELD DATA: Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	35	1	5		9						
110							SM	Dark gray silty medium to coarse sand, occasional gravel (dense, wet)			
	40	12	38		10		GM	Dark gray silty gravel with coarse sand, angular basalt gravel to 1-inch (dense, wet)			

Log of Boring B-01D (continued)

GeoEngineers

Project: The Hedges - Building C and D
Project Location: Tualatin, Oregon
Project Number: 0821-014-02

Figure A-2
Sheet 2 of 2

Drilled Start 2/15/2018 End 2/15/2018	Total Depth (ft) 41.5	Logged By JLL Checked By GL	Driller Dan Fischer Drilling	Drilling Method Solid-stem Auger	
Surface Elevation (ft) 150 Vertical Datum NAVD88		Hammer Data Rope & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment Paul Bunyan Trailer	
Easting (X) 7611117 Northing (Y) 631187		System Datum OR State Plane North NAD83 (feet)		See "Remarks" section for groundwater observed	

Notes: D&M N-value reduced by 50 percent to approximate SPT N-value

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0						ML	Dark brown silt, trace sand and debris (roots to 6 to 8 inches) (stiff, moist) (fill)			
		12	20		1			Mixed gray and brown silt with fine to medium sand, occasional gravel, low plasticity (very stiff, moist)			
145	5	14	2		2 %F		SM	Brown silty fine sand with occasional interbeds of sandy silt, occasional gravel to ¾-inch, low plasticity to non-plastic (loose and soft, wet)	26	37	Groundwater observed at approximately 4 feet below ground surface during drilling
		14	3		3 MD		ML	Dark gray to occasional brown mottling silt, trace fine sand, low to moderate plasticity (soft, wet)	30		DD = 95 pcf
140	10	12	1		4		ML/MH	Gray-brown silt to elastic silt, trace fine sand, occasional gravel, moderate plasticity (very soft, wet) (alluvium)			
135	15	16	4		5 MD		ML	Dark gray silt, low to moderate plasticity, occasional organic fragments including fibers, roots and stems, occasional 3- to 4-inch-thick organic silt layers with much organic matter (soft, wet)	31		DD = 88 pcf
130	20	0	2		6 MD				212		DD = 33 pcf
							OL	Brown organic silt, trace peat, fibrous organic matter, trace fine sand (soft, wet)			
125	25	4	2		7			Becomes yellow-brown with red-brown mottling, moderate plasticity, stems and grass blades			
							SM	Dark gray silty fine sand, massive (very loose, wet)			
120	30	8	2		8		ML/MH	Mixed light gray and brown elastic silt with gray-brown silt, trace organic matter, low to medium plasticity (soft, wet)			
115	35										

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

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Log of Boring B-02D

GeoEngineers

Project: The Hedges - Building C and D
Project Location: Tualatin, Oregon
Project Number: 0821-014-02

Figure A-3
Sheet 1 of 2

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
110	35		12	10		9		SP	Dark gray poorly-graded coarse sand, massive (loose, wet)			
	40		6	21		10			Becomes medium dense			

Log of Boring B-02D (continued)

GeoEngineers

Project: The Hedges - Building C and D
Project Location: Tualatin, Oregon
Project Number: 0821-014-02

Figure A-3
Sheet 2 of 2

Drilled Start 2/21/2018 End 2/21/2018	Total Depth (ft) 81.5	Logged By JLL Checked By GL	Driller Western States Soil Conservation, Inc.	Drilling Method Mud Rotary	
Surface Elevation (ft) 149 Vertical Datum NAVD88		Hammer Data Roper & Cathead 140 (lbs) / 30 (in) Drop		Drilling Equipment CME-850 Truck	
Easting (X) 7611497 Northing (Y) 630994		System Datum OR State Plane North NAD83 (feet)		Groundwater not observed at time of exploration	

Notes: D&M N-value reduced by 50 percent to approximate SPT N-value

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0						ML	Dark brown silt, roots and organic matter to 6 to 8 inches, low to moderate plasticity (soft, wet) (fill)			
								Drill action and cuttings indicate occasional cobbles, cobble-sized brick, concrete debris 2 to 4 feet			
145	5	12	20		1			Becomes dark gray, trace fine sand, occasional fine sandy silt, low plasticity to non-plastic (very stiff, moist)			
								Large debris/cobble fragments 7½ to 9 feet			
140							ML/SM	Dark gray, occasional brown silt with fine to medium sand and gravel to silty medium to coarse sand with gravel, round to angular basalt gravels (dense and hard, moist)			
	10	14	36		2 %F				18	36	
135							ML	Dark gray, green, occasional medium silt, low plasticity, trace fine sand, occasional sand, trace angular gravel, brick fragments (stiff, moist)			
	15	14	10		3						
130							PT	Black, occasional brown peat, low plasticity, fibrous organic matter (soft, moist) (alluvium)			
	20	18	4		4 OC				404		OC = 56 percent
								Occasional wood fragments, wet			
125	25	18	2		5 MD				304		DD = 17 pcf
120											
	30	18	4		6 OC				329		OC = 42 percent
							OL	Brown organic silt, much organic fibers, low plasticity, fine horizontal layers (soft, moist)			
115							MH	Gray elastic silt, trace organic matter, moderate			
	35										

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

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Log of Boring B-03D

GeoEngineers

Project: The Hedges - Building C and D
Project Location: Tualatin, Oregon
Project Number: 0821-014-02

Figure A-4
Sheet 1 of 3

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	35	16	P		7			plasticity (very soft, moist)			
110							ML/SM	Interbedded gray silt, low plasticity, trace fine sand and silty fine sand, occasional 1-inch layers of coarse sand (soft and loose, wet)	57		DD = 67 pcf
	40	18	4		8 MD						
105							GM	Drill action indicates gravel 44 to 45 feet			
	45	12	2		9		ML	Gray silt, low to moderate plasticity, trace fine sand (soft, wet)			Lost circulation at 45 feet
100							GM/SM				Drill action indicates gravel, occasional cobble 47½ to 50 feet, coarse sand and gravel in cuttings Lost circulation at 48 feet
	50	0	22		10		SM	Dark gray silty coarse sand with gravel to silty gravel with coarse sand (medium dense, wet)			
95							MH	Gray elastic silt, massive (soft, wet)			
	55	16	3		11						
90							GM				Drill action indicates gravel at 57½ Lost circulation at 58 feet
	60	6	18		12		SM	Dark gray silty coarse sand with gravel, angular basalt gravel to 1½ inches (medium dense, wet)			
85							GM				Driller reports very loose to loose gravel
	65	10	16		13		SP	Dark gray poorly-graded coarse sand with gravel (medium dense, wet)			
80					AL		ML	Light gray silt, moderate to high plasticity (very soft, wet)	61		AL (LL = 40, PL = 29, PI = 17)
	70	16	12		14		SM	Gray-green silty fine sand, massive to horizontal layers (medium dense, wet)			
75							ML	Gray-green silt, low plasticity, trace fine sand, massive (stiff, moist)			
	75	18	14		15						

Date:3/6/18 Path:P:\0\0821014\GINT\082101402.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_STANDARD_%F_NO_GW

Log of Boring B-03D (continued)

GeoEngineers

Project: The Hedges - Building C and D
Project Location: Tualatin, Oregon
Project Number: 0821-014-02

Figure A-4
Sheet 2 of 3

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	FIELD DATA: Blows/foot	FIELD DATA: Collected Sample / Sample Name Testing	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
70										
	80	0	28	16			Becomes gray-green with brown mottling, very stiff			

Log of Boring B-03D (continued)

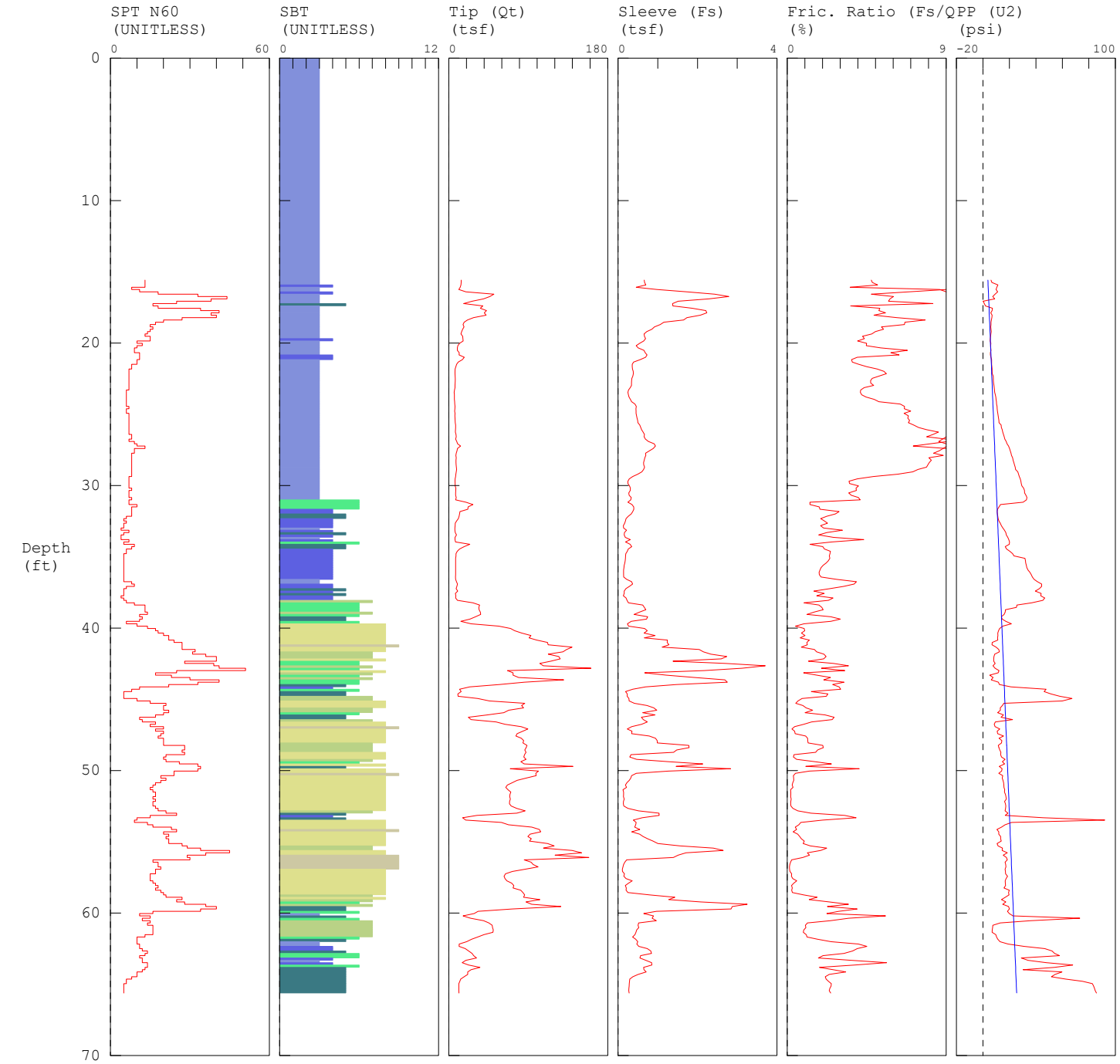
GeoEngineers

Project: The Hedges - Building C and D
Project Location: Tualatin, Oregon
Project Number: 0821-014-02

Figure A-4
Sheet 3 of 3

GeoEngineers / CPT-1 / Hedges SW 115th Street Tualatin

OPERATOR: OGE TAJ
CONE ID: DPG1386
HOLE NUMBER: CPT-1
TEST DATE: 6/10/2019 1:10:12 PM
TOTAL DEPTH: 65.617 ft



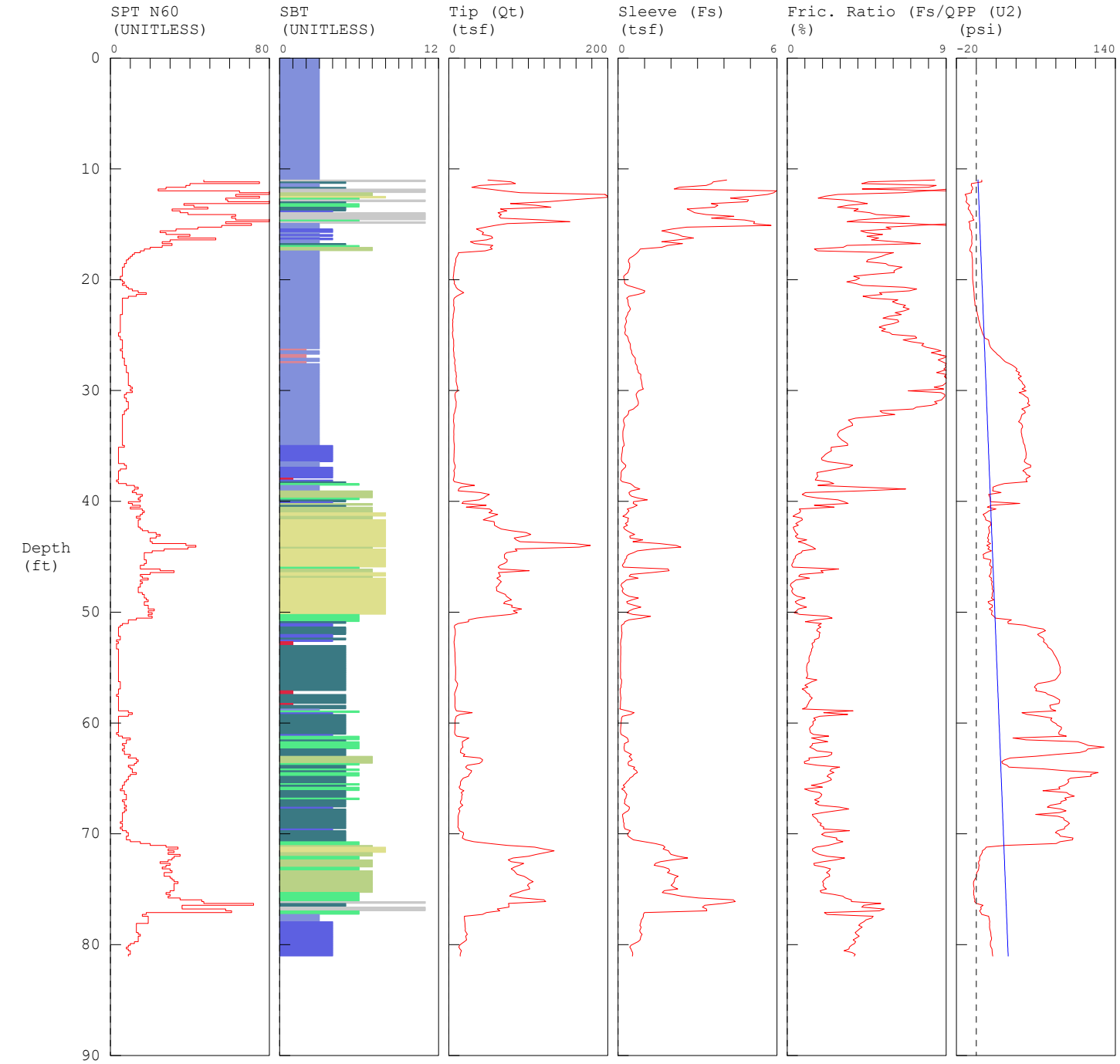
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty cl
6 sandy silt to clayey si
7 silty sand to sandy si
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

Figure A-5

GeoEngineers / CPT-2 / Hedges SW 115th Street Tualatin

OPERATOR: OGE TAJ
CONE ID: DPG1386
HOLE NUMBER: CPT-2
TEST DATE: 6/10/2019 11:38:23 AM
TOTAL DEPTH: 81.037 ft



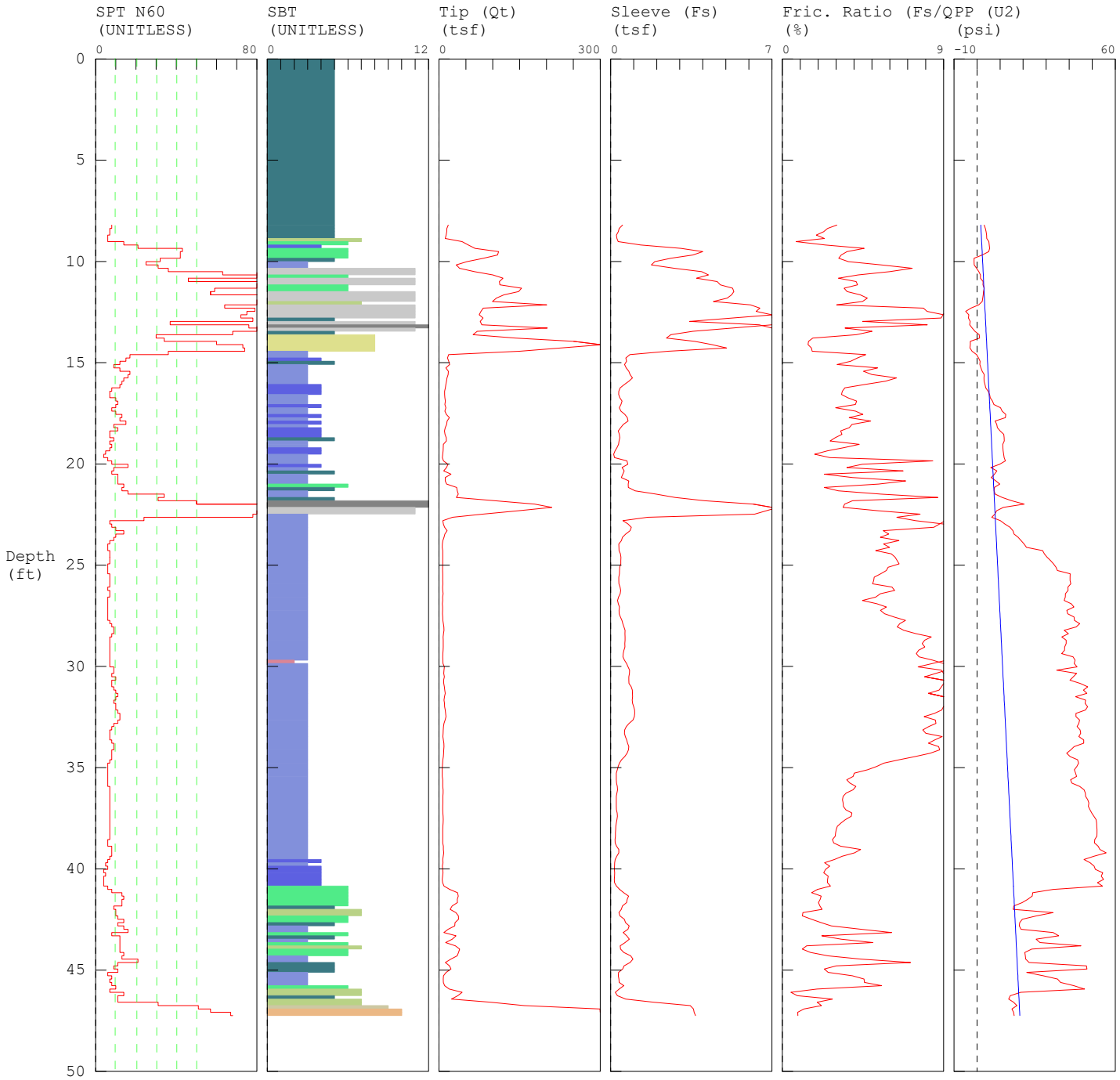
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty cl
6 sandy silt to clayey si
7 silty sand to sandy si
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

Figure A-6

GeoEngineers / CPT-3 / Hedges SW 115th Street Tualatin

OPERATOR: OGE TAJ
CONE ID: DPG1386
HOLE NUMBER: CPT-3
TEST DATE: 6/10/2019 9:48:19 AM
TOTAL DEPTH: 47.244 ft

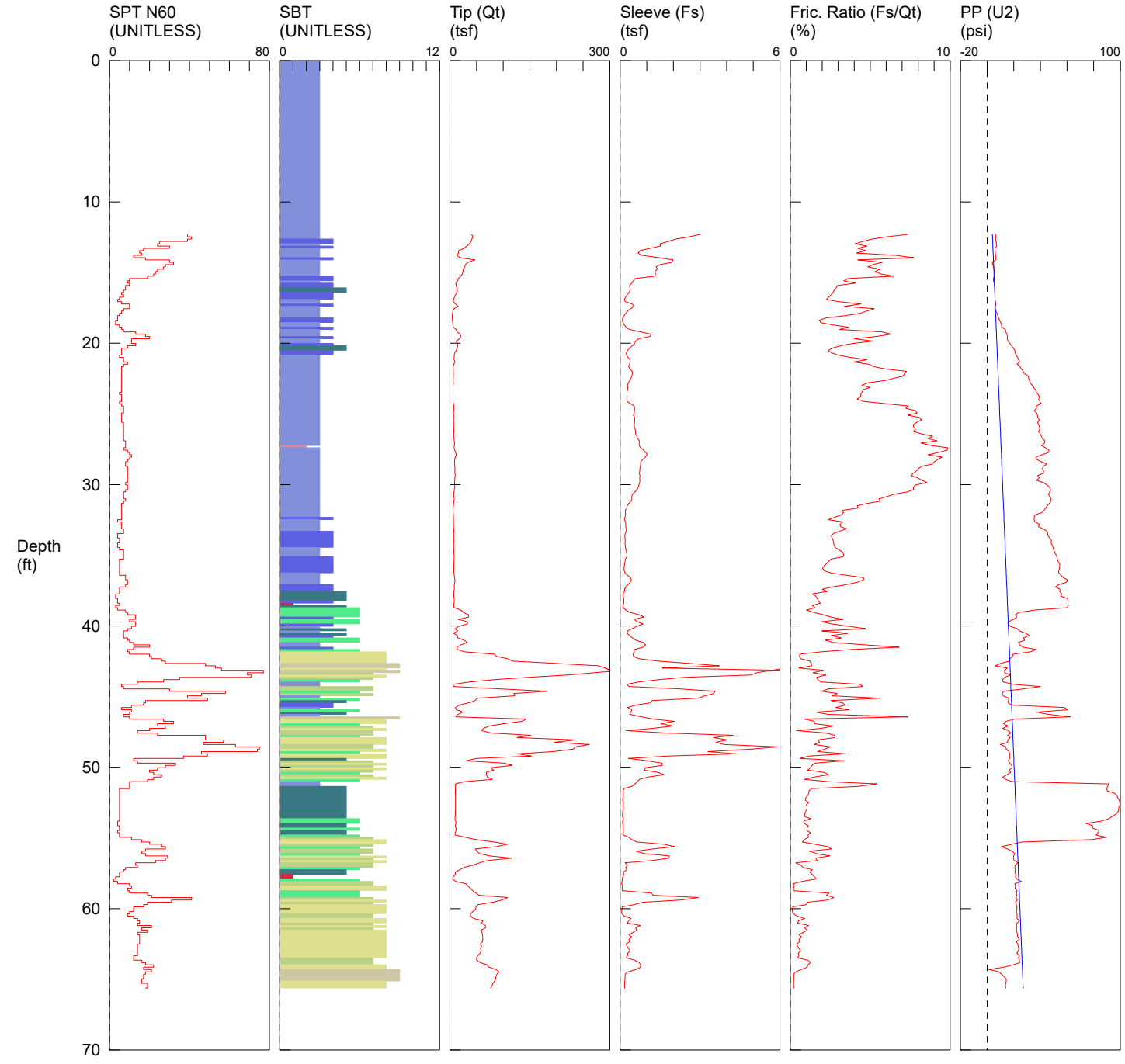


*SBT/SPT CORRELATION: UBC-1983

Figure A-7

GeoEngineers / CPT-4 / Hedges SW 115th Street Tualatin

OPERATOR: OGE TAJ
CONE ID: DPG1386
HOLE NUMBER: CPT-4
TEST DATE: 6/10/2019 2:19:25 PM
TOTAL DEPTH: 65.617 ft



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

Figure A-8

APPENDIX B
Report Limitations and Guidelines for Use

APPENDIX B
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

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

Geotechnical Services Are Performed for Specific Purposes, Persons and Projects

This report has been prepared for the exclusive use of the Martin Development and for the Project specifically identified in the report. The information contained herein is not applicable to other sites or projects.

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

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

This report has been prepared for The Hedges Development—Building D Project in Tualatin, Oregon. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, do not rely on this report if it was:

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

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

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

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

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

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

Most Geotechnical and Geologic Findings Are Professional Opinions

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

Geotechnical Engineering Report Recommendations Are Not Final

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

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

A Geotechnical Engineering or Geologic Report Could Be Subject to Misinterpretation

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having GeoEngineers confer with appropriate members of the design team after submitting the report. Also retain GeoEngineers to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having GeoEngineers participate in pre-bid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable but recognize that separating logs from the report can elevate risk.

Give Contractors a Complete Report and Guidance

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

Contractors Are Responsible for Site Safety on Their Own Construction Projects

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

Read These Provisions Closely

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

Geotechnical, Geologic and Environmental Reports Should Not Be Interchanged

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

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings, or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants and no conclusions or inferences should be drawn regarding Biological Pollutants, as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.

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

GeoEngineers