Hedges D – Fleet Parking Lot

11507 SW 115th Avenue (private street), Tualatin, OR 97062

3. Public Notice

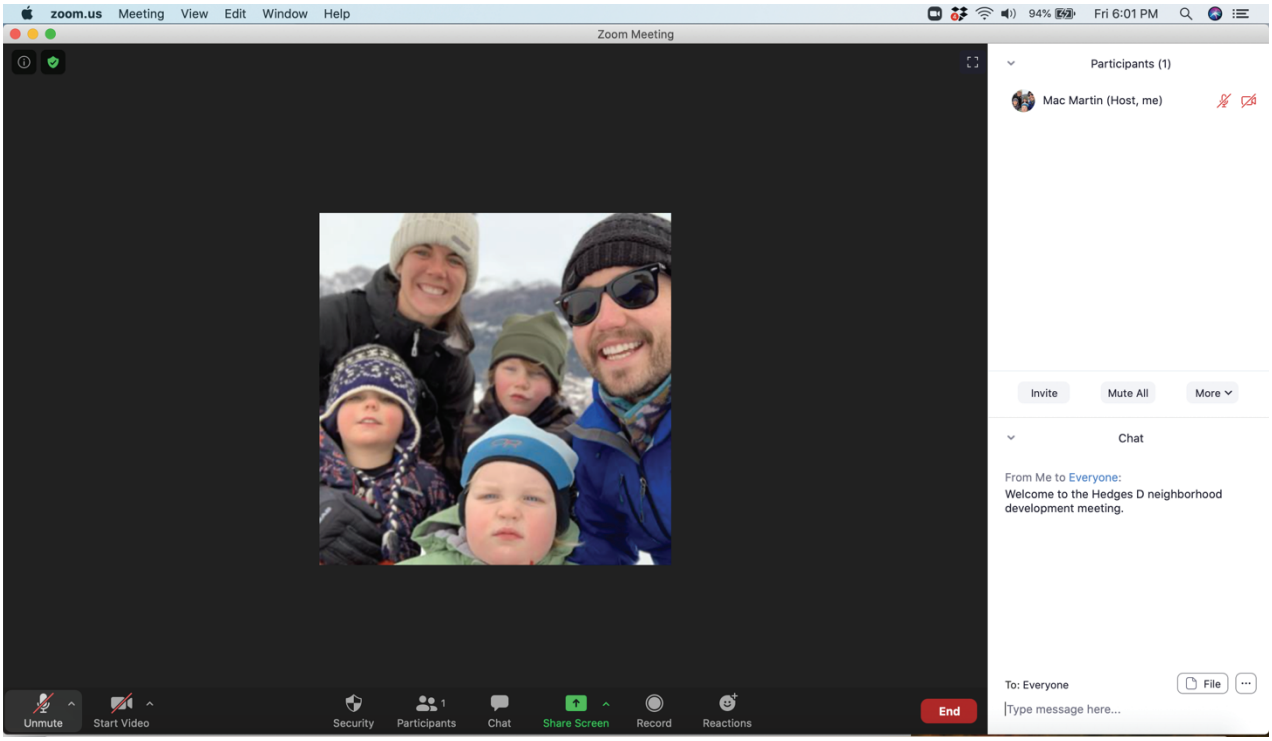
a. Documentation for Neighborhood Development Meeting

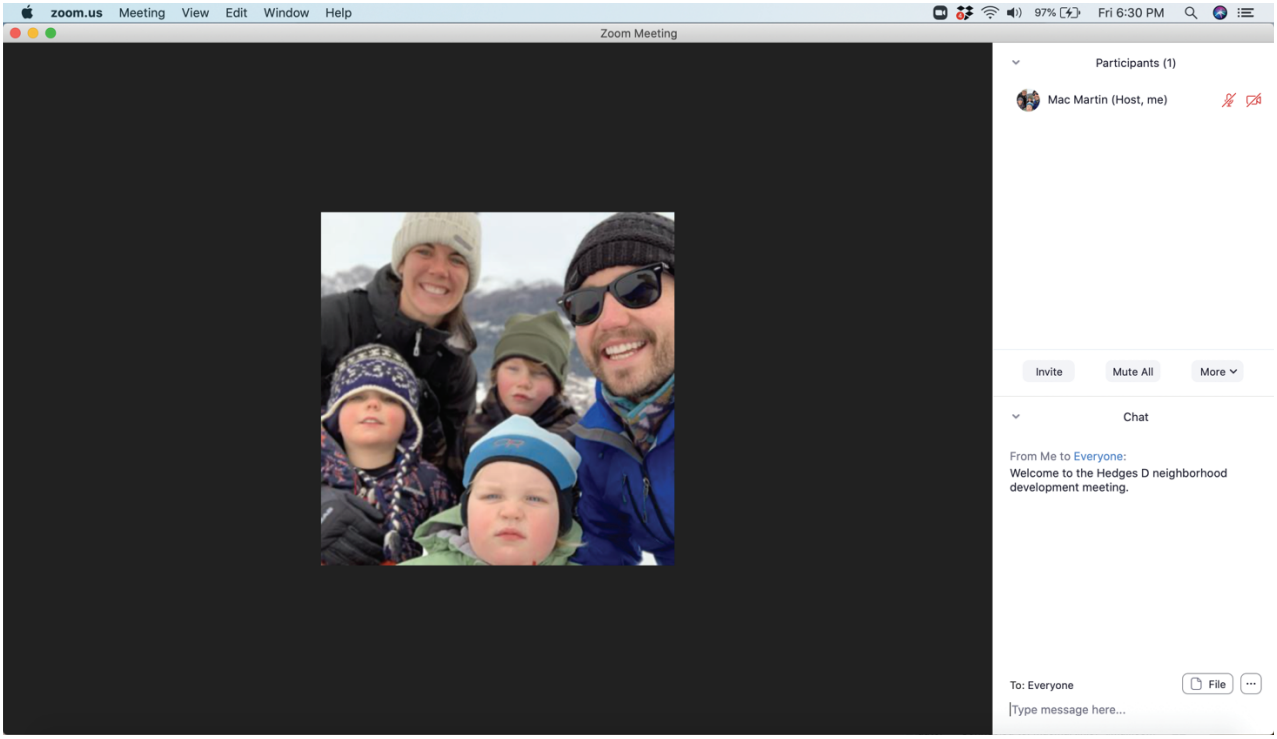
b. Certification of Sign Posting (Installation after AR is accepted & I.D. provided)

Hedges D: Neighborhood Meeting Packet: Parking Lot

Meeting Minutes

The meeting was held on 8/7/2020 @ 6:00 PM via Zoom. There were no people who showed up for the meeting or participated. I have screenshot below from the meeting to show that the meeting was held for 30 minutes without any other participants.





NOTICE OF NEIGHBORHOOD DEVELOPER MEETING

July 22nd, 2020

Hedges D, an LLC
PO Box 15523
Seattle WA 98115

RE: Hedges D, located at the end of SW 115th St.

Dear Property Owner:

You are cordially invited to attend a neighborhood meeting on **8/7/2020 @ 6:00 PM via Zoom, log in for free with Meeting ID: 759 2066 8950, Passcode: 9Hcen6.** This meeting shall be held to discuss a proposed project located at the end of SW 115th St. The proposal is to build a vehicle storage parking lot. This parking lot will conform to all Tualatin city standards and will have 4.5 acres of buffer and plantings around it for screening and environmental benefits. This site is zoned General Manufacturing ("MG") and is controlled by Chapter 61 of the Tualatin Development Code. Per Table 61-1, Vehicle Storage is a permitted use in the MG zone. We have already received land use approval for this site in the past, but we have changed the site plan enough to require another land use approval.

This is an informational meeting to share the development proposal with interested neighbors. You will have the opportunity to review preliminary plans and identify topics of interest for consideration. If you have any questions or comments ahead of time, please email them to me at the email provided below.

Regards,

Mac Martin
Martin Development
MartinDevelopment@outlook.com

cc: lsanford@tualatin.gov ; Tualatin Community Development Department

Hedges D: Neighborhood Meeting Packet: Parking Lot

Neighborhood Developer Meetings
Community Development Department - Planning Division

CERTIFICATION OF SIGN POSTING

NOTICE

NEIGHBORHOOD / DEVELOPER MEETING

__/__/2010 _:__ _.m.

_____ SW _____

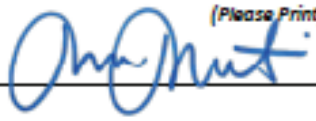
503-___-____

In addition to the requirements of TDC 31.064(2), the 18" x 24" sign must display the meeting date, time, and address as well as a contact phone number. The block around the word "NOTICE" must remain orange composed of the RGB color values Red 254, Green 127, and Blue 0. Staff has a Microsoft PowerPoint 2007 template of this sign design available through the Planning Division homepage at:
https://www.tualatinoregon.gov/planning/land-use-application-sign-templates

---

As the applicant for the Hedges D, Parking Lot project, I hereby certify that on this day, July 24th, 2020 sign(s) was/were posted on the subject property in accordance with the requirements of the Tualatin Development Code and the Community Development Division.

Applicant's Name: Mac Martin, Managing Member
(Please Print)

Applicant's Signature: 

Date: September 2nd, 2020

Hedges D: Neighborhood Meeting Packet: Parking Lot

Hedges D: Neighborhood Meeting Packet: Parking Lot

Neighborhood Developer Meetings
Community Development Department - Planning Division

AFFIDAVIT OF MAILING NOTICE

STATE OF OREGON)
) SS
COUNTY OF WASHINGTON)

I, Mackenzie Martin being first duly sworn, depose and say:

That on the 2nd day of September, 20 20, I served upon the persons shown on Exhibit "A" (Mailing Area List), attached hereto and by this reference incorporated herein, a copy of the Notice of Neighborhood/Developer Meeting marked Exhibit "B," attached hereto and by this reference incorporated herein, by mailing to them a true and correct copy of the original hereof. I further certify that the addresses shown on said Exhibit "A" are their regular addresses as determined from the books and records of the Washington County and/or Clackamas County Departments of Assessment and Taxation Tax Rolls, and that said envelopes were placed in the United States Mail with postage fully prepared thereon.

Signature

SUBSCRIBED AND SWORN to before me this _____ day of _____, 20_____.

Due to COVID concerns,
I didn't want to go into an office
and get this notorized, but this
makes my statement no less true
or valuable. Thanks

_____
Notary Public for Oregon
My commission expires:

RE: _____

CERTIFICATION OF SIGN POSTING

The applicant must provide and post a sign pursuant to Tualatin Development Code (TDC 32.150). The block around the word "NOTICE" must remain yellow composed of the RGB color values Red 255, Green 255, and Blue 0. A template is available at:
https://www.tualatinoregon.gov/planning/land-use-application-sign-templates

NOTE: For larger projects, the Community Development Department may require the posting of additional signs in conspicuous locations.

As the applicant for the _____ project, I hereby certify that on this day, _____ sign(s) was/were posted on the subject property in accordance with the requirements of the Tualatin Development Code and the Community Development Division.

Applicant's Name: _____
(Please Print)

Applicant's Signature: _____

Date: _____

Hedges D – Fleet Parking Lot

11507 SW 115th Avenue (private street), Tualatin, OR 97062

4. Reports

a. Transportation Impact Study
b. Stormwater Management Report
c. Existing Bridge – Field Evaluation Report

KITTELSON & ASSOCIATES
851 SW 6th AVENUE, SUITE 600
PORTLAND, OR 97204
P 503.228.5230 F 503.273.8169

September 11, 2020 Project #: 23574

Mac Martin
Martin Development
P.O. Box 15523
Seattle, WA 98115

RE: Hedges D Development Trip Debiting Letter – September 2020 Update

Dear Mac:

This letter documents the anticipated site trip generation for Hedges D development within the Franklin Business Park in Tualatin. Kittelson & Associates, Inc. previously prepared a debiting letter for this site dated January 16, 2020 reflecting the anticipated construction of a 76,872 square foot manufacturing building. Based on evolving market conditions and tenant needs, a 349-space secure fleet surface parking facility is now proposed in lieu of the planned manufacturing building.

This letter provides trip generation estimates for the fleet parking use, documents trips associated with previously approved site development, and compares the total trip generation of the proposed and constructed uses with the vested overall site trip generation. As documented herein, the trip generation associated with the proposed Hedges D development is consistent with the previously analyzed full build-out of Franklin Business Park. Further, upon completion of Hedges D, additional vested trips will remain for other future site development. As such, no further traffic impact analysis is needed.

BACKGROUND

As documented in the 1999 traffic study for the Franklin Business Park, a total of 1,328 trips were vested for overall site development. To date, approved and constructed site development includes:

- 101,400 square foot warehousing building;
- 64,808 square foot building with 30,000 square feet of office space and 34,808 square feet of warehousing space; and,
- 72,255 square foot Hedges C manufacturing building (as constructed).

The proposed new secure surface parking lot will be used for overnight storage of a fleet of Sprinter delivery vans (the delivery vans will all be dispatched off-site during the daytime supporting a nearby distribution center). Typical use of the surface parking lot is anticipated as follows:

- The parking area will house Sprinter vans overnight and employee's personal vehicles during the daytime hours.

- The drivers (employees) will arrive at the site in the morning, pick-up their assigned Sprinter van and travel off-site for package loading at the distribution center and subsequent customer delivery.
    - Sprinter drivers will arrive at the parking lot and then depart in their assigned delivery van over the course of staggered start times to allow for appropriate pick-up staging at the delivery center.
    - Sprinter drivers are expected to arrive for their workday in nine groups of people spaced between 9:15 AM and 1:00 PM. The drivers will participate in a daily safety meeting lasting about 15 minutes and then depart for loading off-site. The designated start time for individual drivers reflects both operator efforts to avoid their fleet mixing with peak traffic loading on the transportation network and the delivery needs (timing) of customers.
- Drivers will return their assigned Sprinter van to the parking area in the evening after completing their 10-hour delivery shift.
    - Sprinter drivers are expected to return to the overnight parking lot between approximately 7:10 PM and 10:30 PM (many customer deliveries occur in the late afternoon/early evening hours). The return times reflect operator efforts to spread out the arrivals of inbound drivers with the departures of outbound personal vehicles and outside the evening commuter peak.
- Most of the drivers are expected to commute to and from the fleet parking facility in one of three ways:
    - By personal vehicle, in which case they will park their vehicle on-site upon arrival in the morning and depart with their personal vehicle in the evening;
    - By a company shuttle that provides transportation for drivers to an off-site parking location whether their personal vehicles are housed; or
    - By bicycle, in which case they will park their bicycle in the designated bike rack on-site.

A small number of drivers may be dropped off at the parking area by others, given the somewhat uncertain return end-of-day pickup time associated with variable delivery needs/scheduling for any given driver.

TRIP GENERATION ESTIMATE

To date, weekday daily, AM peak hour and PM peak hour vehicle trip generation estimates for Franklin Business Park site development have been prepared using trip rates from the *Trip Generation Manual*, *9th Edition*, as published by the Institute of Transportation Engineers. Our review of both the 9th and

10th Edition of the *Trip Generation Manual* revealed that there is no land use data available directly reflective of the proposed fleet parking use or the unique staffing hours proposed for the fleet drivers.[1] Lacking data from the *Trip Generation Manual*, a quantitative estimate of the site trip generation was developed predicated on the following assumptions:

- The adjacent street system morning commute peak is generally considered to occur between 7:00 and 9:00 AM whereas the fleet parking shift arrival is expected to occur between 9:15 AM and 1:00 PM, suggesting the vast majority (and possibly all) of the inbound driver movements in the morning should occur outside the traditional commuter peak hour.

- The adjacent street system evening commute peak is generally considered to occur between 4:00 and 6:00 PM whereas the fleet parking shift is expected to conclude between 7:10 and 10:30 PM, suggesting all of the evening site trips could occur well outside the traditional commuter peak hour.

- The owner anticipates the parking lot will be fully utilized overnight during the peak November-early January delivery period and about 50% utilized the remainder of the year[2].

- Trips can be tracked to individual Sprinter vehicles and employee vehicles as presented below by season.

Sprinter Vehicle Trips

- Each Sprinter vehicle will depart the site in the morning at the start of the delivery driver shift (one trip out) and will enter the site in the evening at the end of the shift (one trip in), resulting in two trips at the site per day per Sprinter van.

December-Early January Peak Season

  - Daily Sprinter van trips = (1 trip out + 1 trip in) × 349 Sprinter vans = 698 trips

[1] The Park-and-Ride Lot with Bus or Light Rail Service (Land Use Code 90) was noted as a potential proxy use in the *Trip Generation Manual, 10th Edition* and has an average trip rate of 0.43 trips per parking space. While available, the Park-and-Ride Lot trip data is not reflective of the bi-directional nature of site trips with employees arriving in one vehicle and departing in another within the same hour.

[2] Additional "surge fleet" vehicle use is anticipated on-site during the Christmas holiday shopping season when supplemental delivery vehicles are used to support peak holiday delivery volume. The operator expects the entire surface parking lot to be occupied overnight by delivery vehicles during peak delivery season (typically November through late December/early January) with the lot approximately 50 percent utilized the remainder of the year.

- 9:15-1:00 PM trips = 1 trip out × 349 Sprinter vans = 349 trips out
    - Recognizing that all outbound trips are anticipated to occur starting after the safety briefing that begins at 9:15 AM, one could reasonably conclude no outbound trips occur between 7:00 and 9:00 AM.
- 7:10-10:30 PM trips = 1 trip in × 349 Sprinter vans = 349 trips in
    - Recognizing that all of inbound trips are anticipated to occur starting at 7:10 PM, one could reasonably conclude no site trips occur between 4:00 and 6:00 PM.

Late January-October Season

- Daily Sprinter van trips = (1 trip out + 1 trip in) × 175 Sprinter vans = 350 trips
- 9:15 AM-1:00 PM trips = 1 trip out × 175 Sprinter vans = 175 trips out
    - Recognizing that all outbound trips are anticipated to occur starting after the safety briefing that begins at 9:15 AM, one could reasonably conclude no outbound trips occur between 7:00 and 9:00 AM.
- 7:10-10:30 PM trips = 1 trip in × 175 Sprinter vans = 175 trips in
    - Recognizing that all of inbound trips are anticipated to occur starting at 7:10 PM, one could reasonably conclude no site trips occur between 4:00 and 6:00 PM.

Sprinter Employee Trips

- Each Sprinter vehicle is operated by a single employee during the course of a typical workday.
- Each employee that commutes to the fleet parking facility in a single occupant personal vehicle will generate one trip in at the start of their shift and one trip out at the end of their shift, resulting in two trips per day per employee single occupant vehicle.

December-Early January Peak Season

- Daily employee trips = (1 trip out + 1 trip in) × 349 employees = 698 trips
    - 9:15 AM-1:00 PM trips = 1 trip in × 349 employees = 349 trips in
- Assume up to 10% of 349 trips occur between 8:00 and 9:00 AM associated with employees who arrive early = 35 trips in

- Therefore AM commuter peak hour trips = 35 in

- 7:10-10:30 PM trips = 1 trip in × 349 employees = 349 trips out
    - As noted above, no trips occur between 4:00 and 6:00 PM

Late January-October Season

- Daily employee trips = (1 trip out + 1 trip in) × 175 employees = 350 trips
    - 9:15 AM -1:00 PM trips = 1 trip in × 175 employees = 175 trips in
- Assume 10% of 175 trips occur between 8:00 and 9:00 AM = 18 trips in
    - Therefore AM commuter peak hour trips = 18 in
- 7:10-10:30 PM trips = 1 trip in × 175 employees = 175 trips out
    - As noted above, no trips occur between 4:00 and 6:00 PM

- Each employee commuting by bicycle to and from the site will result in one fewer entry and one fewer exit trip per day compared to commuting along in a private vehicle. For the purposes of the trip generation estimate, no reductions in vehicular trips were applied associated with employees arriving by bicycle.
- Each employee commuting by shuttle van has the potential to result in one fewer entry and one fewer exit trip per day compared to commuting along in a private vehicle, though any shuttle trips made for the exclusive transport of one employee will result in no net change to vehicle trips to and from the site. For the purposes of the trip generation estimate, no reductions in vehicular trips were applied associated with employees arriving via shuttle van.

Tables 1 and 2 summarize seasonal trip estimates for the site based on the assumptions above and conservatively assuming all employees commute by themselves in private vehicles.

Table 1. November-Early January Fleet Parking Site Trip Generation Estimate (349 delivery vehicles)

Trip Source	Daily Trips	7-9 AM Commuter Peak Hour			4-6 PM Commuter Peak Hour		
		Total	In	Out	Total	In	Out
Sprinter Vehicle	698	0	0	0	0	0	0
Employee Vehicle	698	35	35	0	0	0	0
Total	**1,396**	**35**	**35**	**0**	**0**	**0**	**0**

Table 2. Late January-October Fleet Parking Site Trip Generation Estimate (175 delivery vehicles)

Trip Source	Daily Trips	AM Commuter Peak Hour			PM Commuter Peak Hour		
		Total	In	Out	Total	In	Out
Sprinter Vehicle	350	0	0	0	0	0	0
Employee Vehicle	350	18	18	0	0	0	0
Total	**700**	**18**	**18**	**0**	**0**	**0**	**0**

The trip estimates shown in Tables 1 and 2 are considered conservatively high (over-estimating) because:

- The estimates assume 10% of site trips occur during the 7:00-9:00 AM commuter peak period even though the first group of the Sprinter van drivers are expected to arrive on site for a 9:15 AM delivery shift start.
- The trip estimates assume every employee commutes to and from the fleet parking site in their own personal vehicle.
    - No reduction was made for employee trips made by bicycle.
    - No reduction was made for employee trips made by carpool.
    - No reduction was made for employee trips made via the employer shuttle.

OVERALL SITE TRIP DEBITING SUMMARY

Incorporating the trip data in Table 1 (peak season), trip generation estimates for the existing and proposed uses are summarized in Table 2.

Table 2 Trip Generation Estimates

Land Use	ITE Code	Size (square feet)	Daily Trips	AM Peak Hour Trips			PM Peak Hour Trips		
				Total	In	Out	Total	In	Out
Existing (Constructed) Uses									
Light Industrial	110	101,300	710	93	82	11	98	12	86
Warehousing	150	136,208	485	41	32	9	44	11	33
Office	710	30,000	331	47	41	6	45	8	37
Manufacturing (Hedges C)[1]	140	72,255	276	53	41	12	53	19	34
Subtotal Trips			**1,802**	**234**	**196**	**38**	**240**	**50**	**190**
Proposed Use									
Fleet Parking (Peak Season)		-	1,396	35	35	0	0	0	0
Existing + Proposed Uses									
Total Trips			**3,198**	**269**	**231**	**38**	**240**	**50**	**190**

[1] The December 6, 2019 Hedges C Trip Debiting Letter assumed a 72,970 square foot building whereas the actual constructed is slightly smaller.

Trip Accounting

Table 3 provides a trip summary of the existing and proposed uses at Franklin Business Park along with the corresponding trip debiting.

Table 3 Trip Debiting Summary

Use	Number of PM Peak Hour Trips	PM Peak Hour Vested Trips Remaining
1999 Traffic Study Vesting	1,328	1,328
Uses constructed to date	(240)	1,088
Proposed Hedges D	(0)	1,088

After accounting for the existing uses and the proposed Hedges D development, 1,088 weekday PM peak hour trips remain vested for future development of the site.

Please call us at (503) 535-7433 if additional information is needed regarding this evaluation or if you have questions.

Sincerely,
KITTELSON & ASSOCIATES, INC.

Chris Brehmer, PE
Senior Principal Engineer

MACKENZIE.

DESIGN DRIVEN | CLIENT FOCUSED

DRAINAGE REPORT

To
City of Tualatin

For
Hedges D Parking Lot

Submitted
September 1, 2020

Project Number
2200339.00

MACKENZIE
Since 1960

RiverEast Center | 1515 SE Water Avenue, Suite 100, Portland, OR 97214
T 503.224.9560 | F 503.228.1285 | www.mcknze.com

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FIGURES

TABLES

APPENDICES

1. INTRODUCTION

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

The 5-acre development includes surface parking for delivery vans and van driver personal vehicles, a concrete paved gathering area with a tent and portable restrooms, at-grade walking paths, 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.

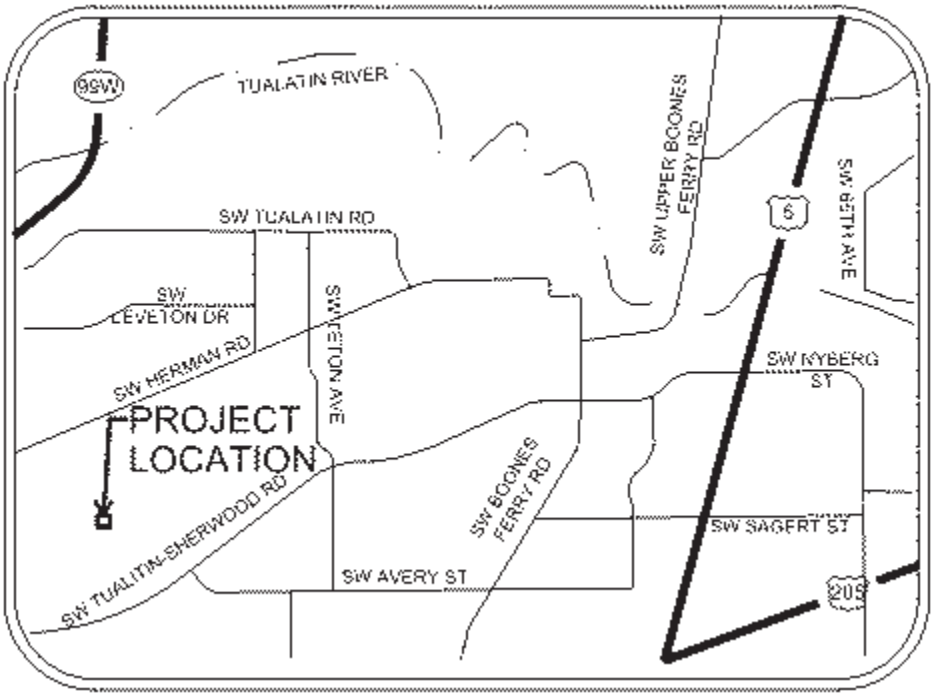


Figure 1: Vicinity Map

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 Contech StormFilter Catch Basins. 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 Contech's Phosphsorb Media Brochure, the Stormfilter Cartridges containing Phosphosorb Media have a TSS removal efficiency of 89% and phosphorous removal efficiency of 82%, and thus meet the requirements of CWS. Each filter is capable of providing this level of treatment for up to 15 gpm (18" tall cartridge) to 22 gpm (27" tall).

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

Table 2: Water Quality Summary

Drainage Basin	Impervious Area (ft^2)	Water Quality Flow (gpm)	Required # of Filters
NW	20,000	18.85	2 (27" Tall)
NE	63,800	59.70	4 (18" Tall)
SW	39,500	36.80	2 (27" Tall)
SE	80,900	75.85	4 (27" Tall)

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 parking lot 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 an ADS StormTech underground detention system with a flow control manhole. The facility will outfall directly to Hedges Creek with a rip rap pad 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>Category 3</td><td rowspan="3">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)**
(½) 2-year	0.133	0.132	43,550
5-year	0.562	0.184	
10-year	0.766	0.211	

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.

The peak 25-yr developed flow was prorated into each of the 4 major subareas to determine the design flow for conveyance. Per Hydraflow calculations in Appendix B, the peak 25-yr developed flow across the site is 4.31 cfs over 4.73 acres, thus the ratio is 0.91 cfs/ac. Prorations into each of the major subareas is shown in Table 7. Comparing the maximum capacities outlined in Table 6 with the sizes indicated on the project plans, it can be seen that the pipe sizes selected for the conveyance system will be adequate.

Table 6: General Pipe Sizing for Conveyance

Pipe Size/Slope	Capacity (ft^3/s)
8” @ 0.50%	0.85
12” @ 0.30%	1.94
12” @ 0.50%	2.50

Table 7: Subarea Peak Flows for Conveyance

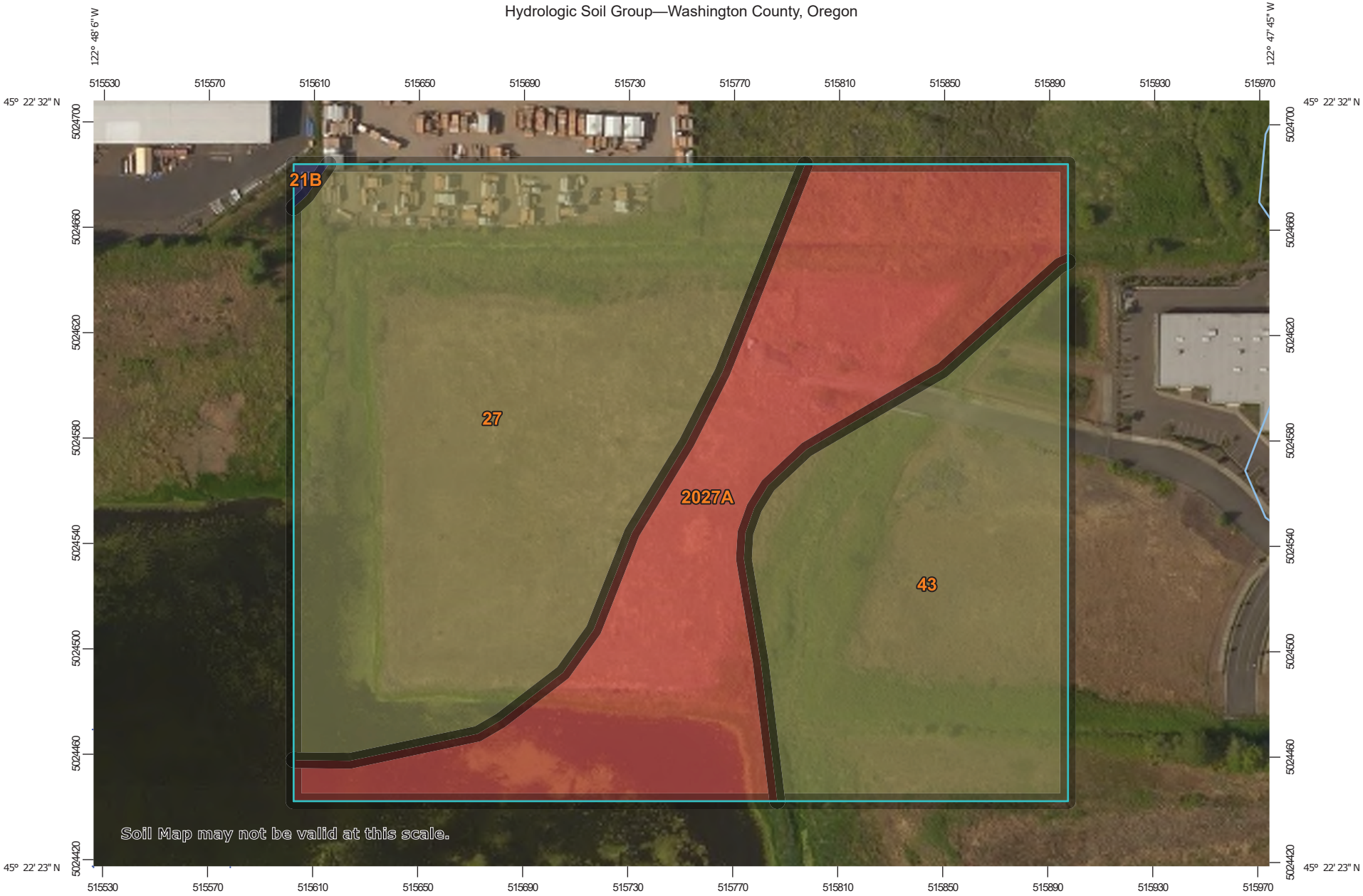
Subarea	Peak Flow
NW	0.42
NE	1.33
SW	0.83
SE	1.69

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

Hydraflow Table of Contents

339-Pond.gpw

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020 Thursday, 08 / 27 / 2020

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SBUH Runoff	------	-------	0.265	-------	0.562	0.766	1.054	-------	-------	Pre-Developed
2	SBUH Runoff	------	-------	2.607	-------	3.340	3.764	4.308	-------	-------	Developed
3	Reservoir	2	-------	0.104	-------	0.243	0.390	0.541	-------	-------	Route Through Pond

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

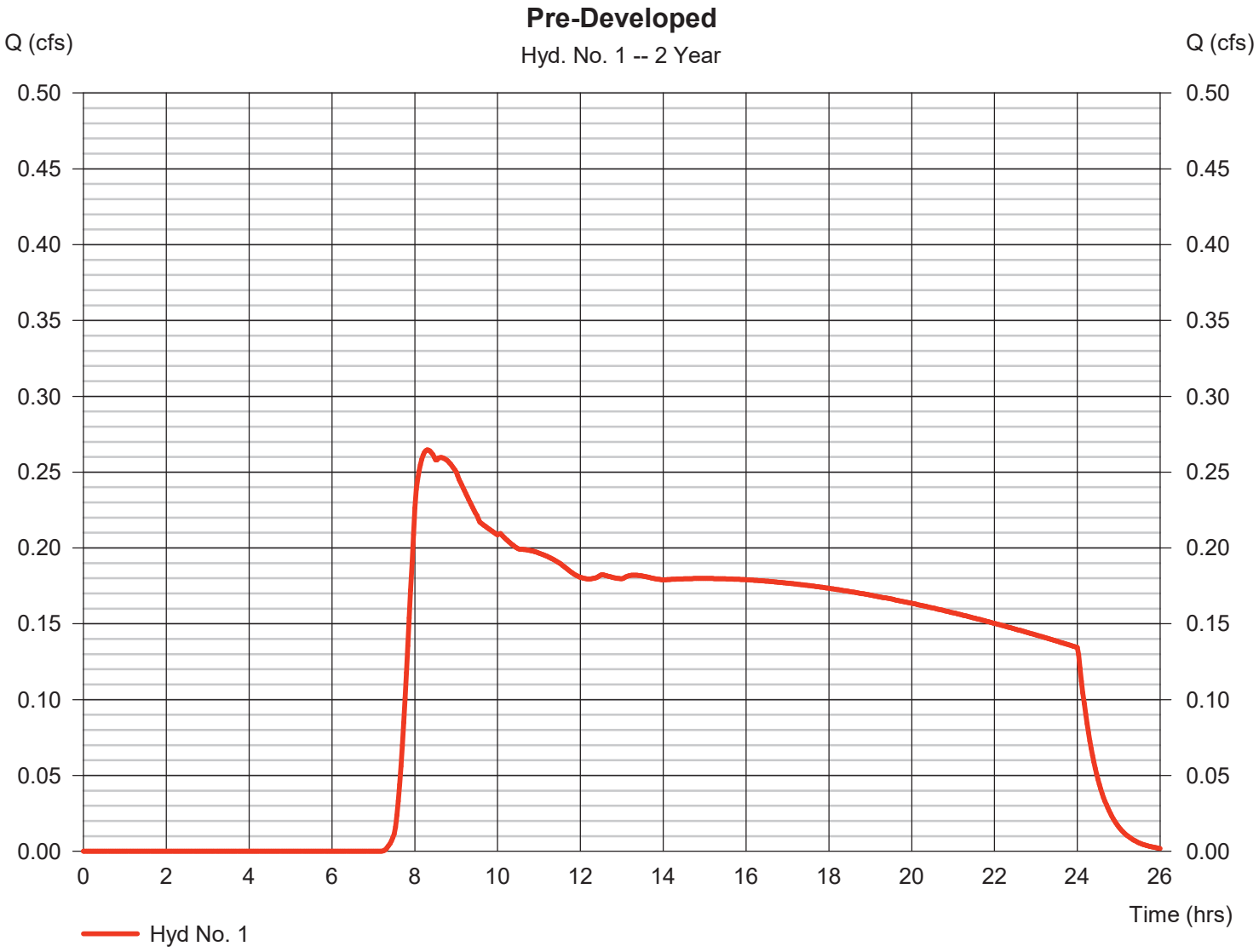
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SBUH Runoff	0.265	2	498	10,797	------	------	------	Pre-Developed
2	SBUH Runoff	2.607	2	474	36,589	------	------	------	Developed
3	Reservoir	0.104	2	1444	12,395	2	138.71	33,401	Route Through Pond

Hydrograph Report

Hyd. No. 1

Pre-Developed

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.265 cfs
Storm frequency	= 2 yrs	Time to peak	= 8.30 hrs
Time interval	= 2 min	Hyd. volume	= 10,797 cuft
Drainage area	= 4.890 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 27.80 min
Total precip.	= 2.50 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No. 1

Pre-Developed

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.150		0.011		0.011		
Flow length (ft)	= 300.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 2.50		0.00		0.00		
Land slope (%)	= 2.00		0.00		0.00		
Travel Time (min)	**= 26.70**	**+**	**0.00**	**+**	**0.00**	**=**	**26.70**
Shallow Concentrated Flow							
Flow length (ft)	= 150.00		0.00		0.00		
Watercourse slope (%)	= 2.00		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.28		0.00		0.00		
Travel Time (min)	**= 1.10**	**+**	**0.00**	**+**	**0.00**	**=**	**1.10**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00						
			0.00				
					0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 27.80 min

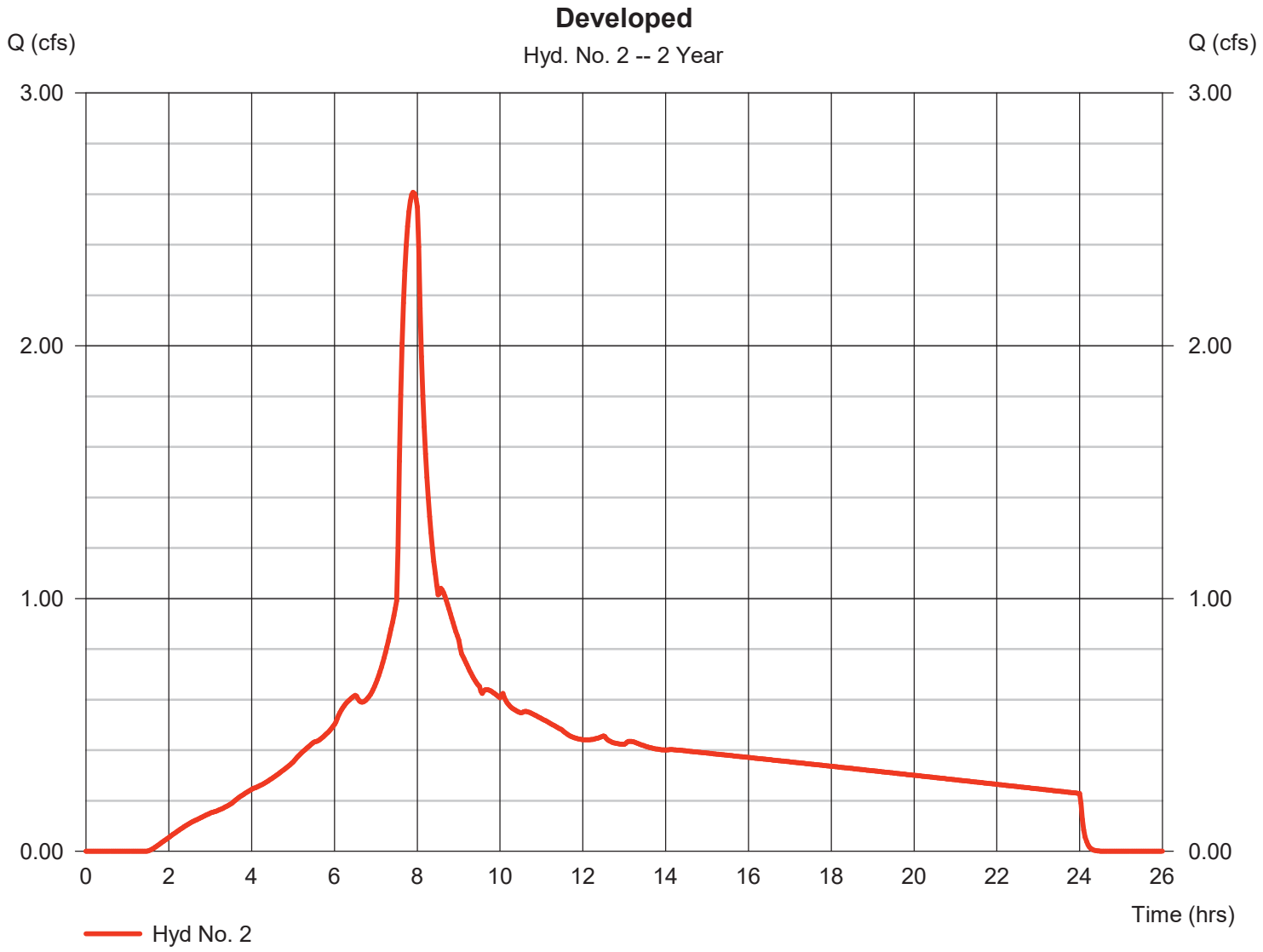
Hydrograph Report

Hyd. No. 2

Developed

Hydrograph type	= SBUH Runoff	Peak discharge	= 2.607 cfs
Storm frequency	= 2 yrs	Time to peak	= 7.90 hrs
Time interval	= 2 min	Hyd. volume	= 36,589 cuft
Drainage area	= 4.890 ac	Curve number	= 96*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 2.50 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(0.440 x 74) + (4.450 x 98)] / 4.890



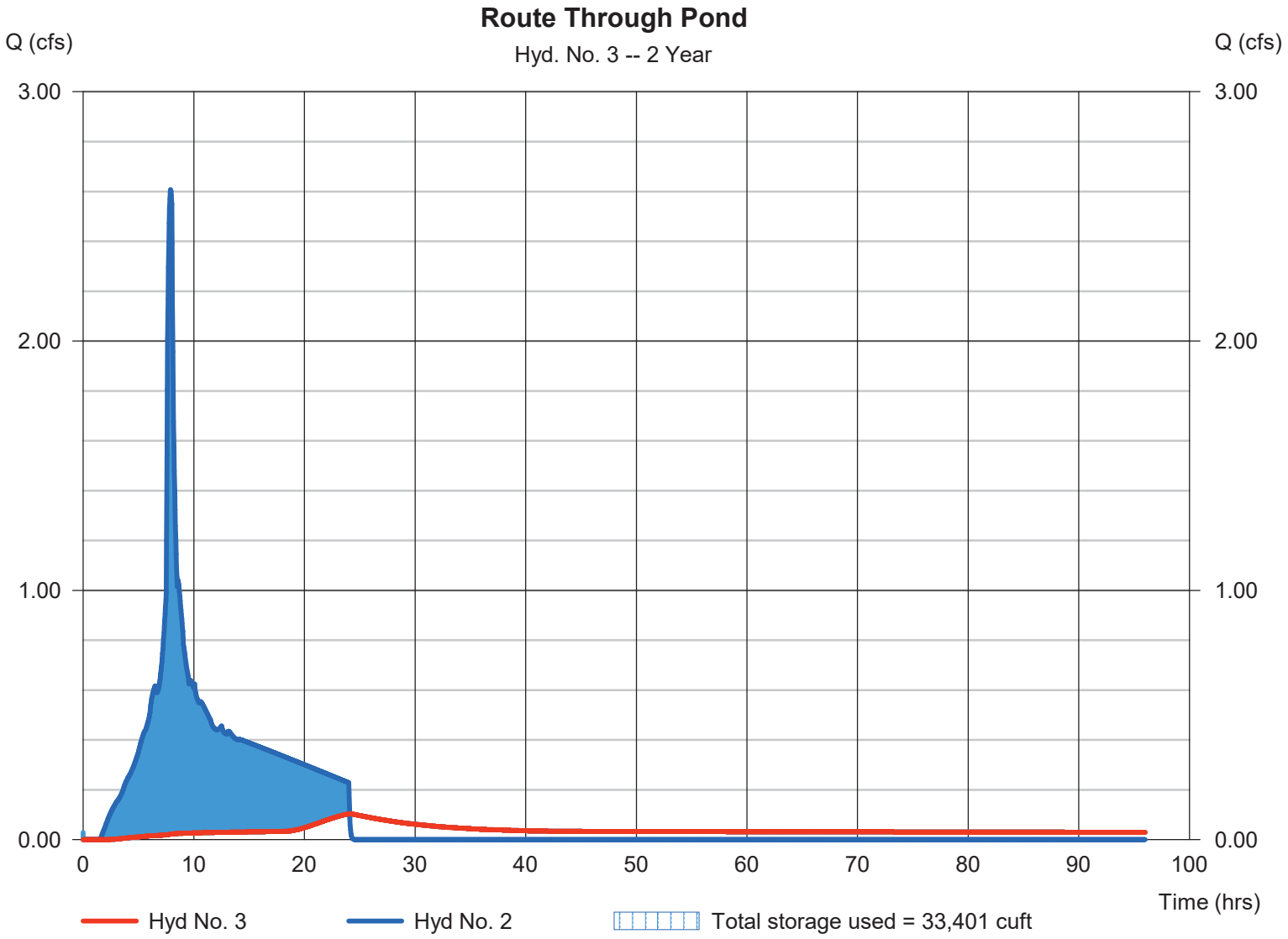
Hydrograph Report

Hyd. No. 3

Route Through Pond

Hydrograph type	= Reservoir	Peak discharge	= 0.104 cfs
Storm frequency	= 2 yrs	Time to peak	= 24.07 hrs
Time interval	= 2 min	Hyd. volume	= 12,395 cuft
Inflow hyd. No.	= 2 - Developed	Max. Elevation	= 138.71 ft
Reservoir name	= Pond	Max. Storage	= 33,401 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Pond No. 1 - Pond

Pond Data

UG Chambers -Invert elev. = 137.92 ft, Rise x Span = 2.50 x 4.25 ft, Barrel Len = 7.12 ft, No. Barrels = 370, Slope = 0.00%, Headers = Yes
Encasement -Invert elev. = 137.42 ft, Width = 4.75 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	137.42	n/a	0	0
0.35	137.77	n/a	4,090	4,090
0.70	138.12	n/a	7,223	11,312
1.05	138.47	n/a	9,512	20,824
1.40	138.82	n/a	9,337	30,162
1.75	139.17	n/a	9,039	39,201
2.10	139.52	n/a	8,592	47,792
2.45	139.87	n/a	7,942	55,734
2.80	140.22	n/a	6,949	62,683
3.15	140.57	n/a	4,916	67,599
3.50	140.92	n/a	4,090	71,689

Culvert / Orifice Structures

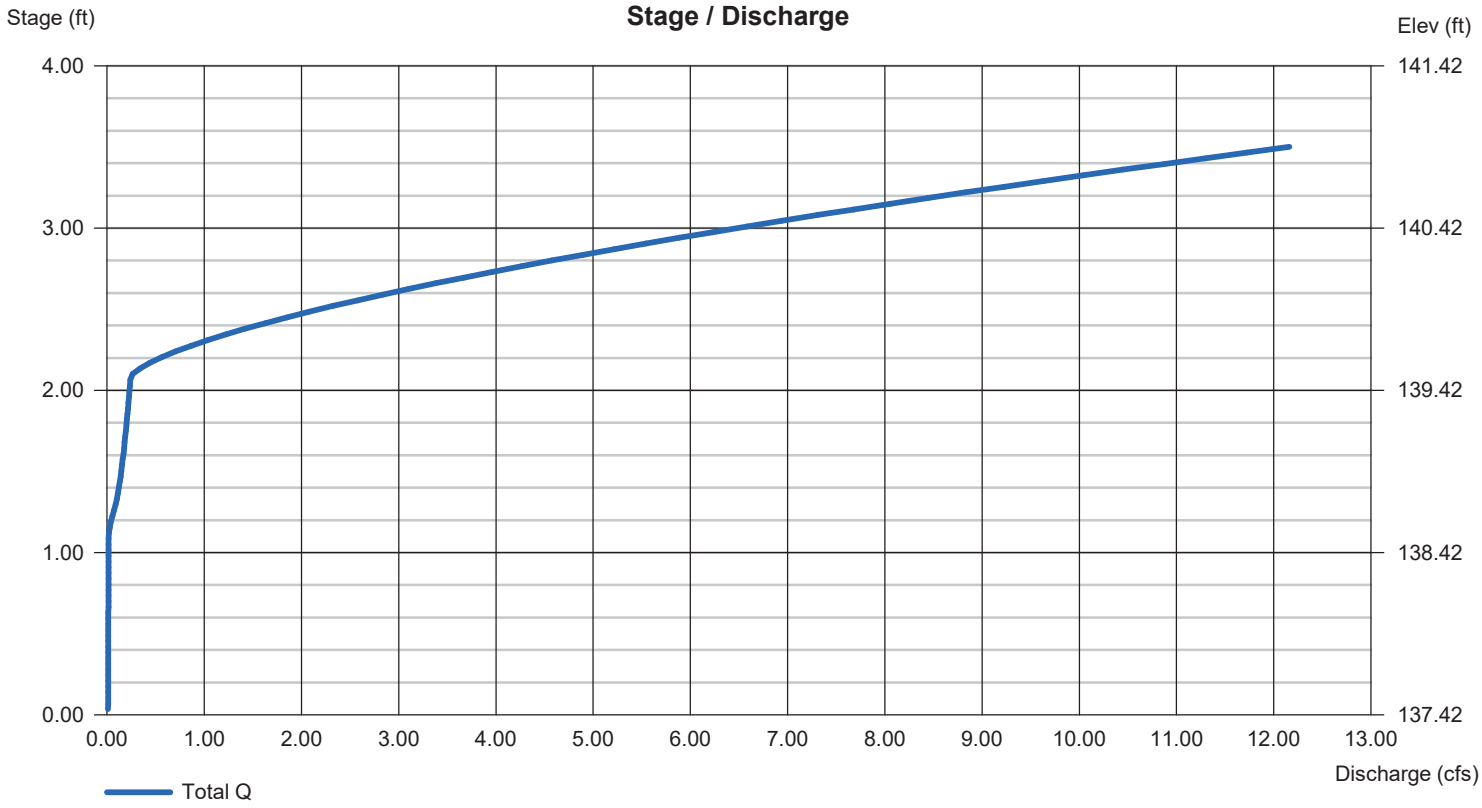
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.50	3.00	Inactive	Inactive
Span (in)	= 0.50	3.00	8.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 136.80	138.50	139.70	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 2.09	0.00	0.00	0.00
Crest El. (ft)	= 139.50	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.010 (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).



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

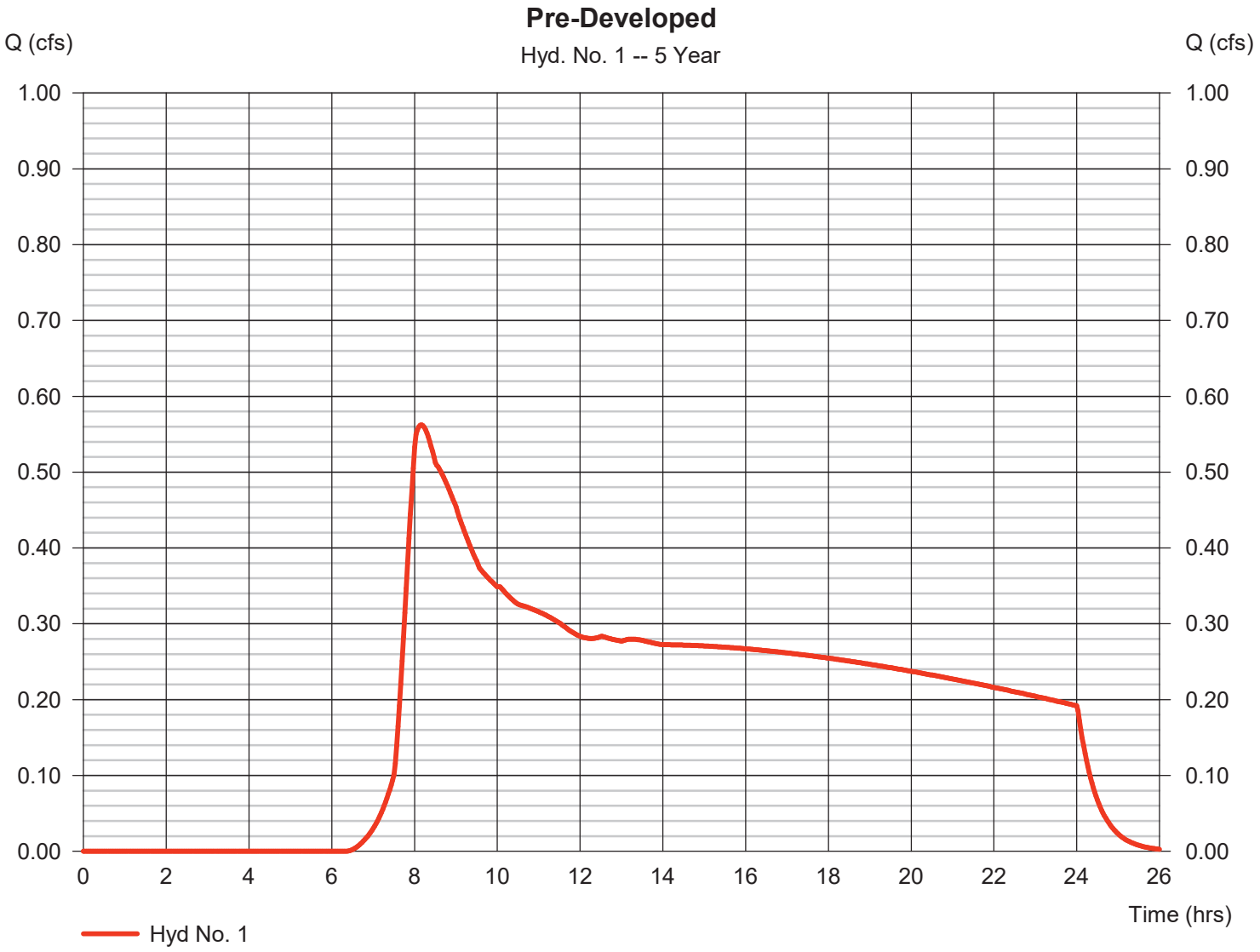
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SBUH Runoff	0.562	2	490	17,259	------	------	------	Pre-Developed
2	SBUH Runoff	3.340	2	474	47,049	------	------	------	Developed
3	Reservoir	0.243	2	1442	21,316	2	139.04	39,796	Route Through Pond

Hydrograph Report

Hyd. No. 1

Pre-Developed

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.562 cfs
Storm frequency	= 5 yrs	Time to peak	= 8.17 hrs
Time interval	= 2 min	Hyd. volume	= 17,259 cuft
Drainage area	= 4.890 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 27.80 min
Total precip.	= 3.10 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a



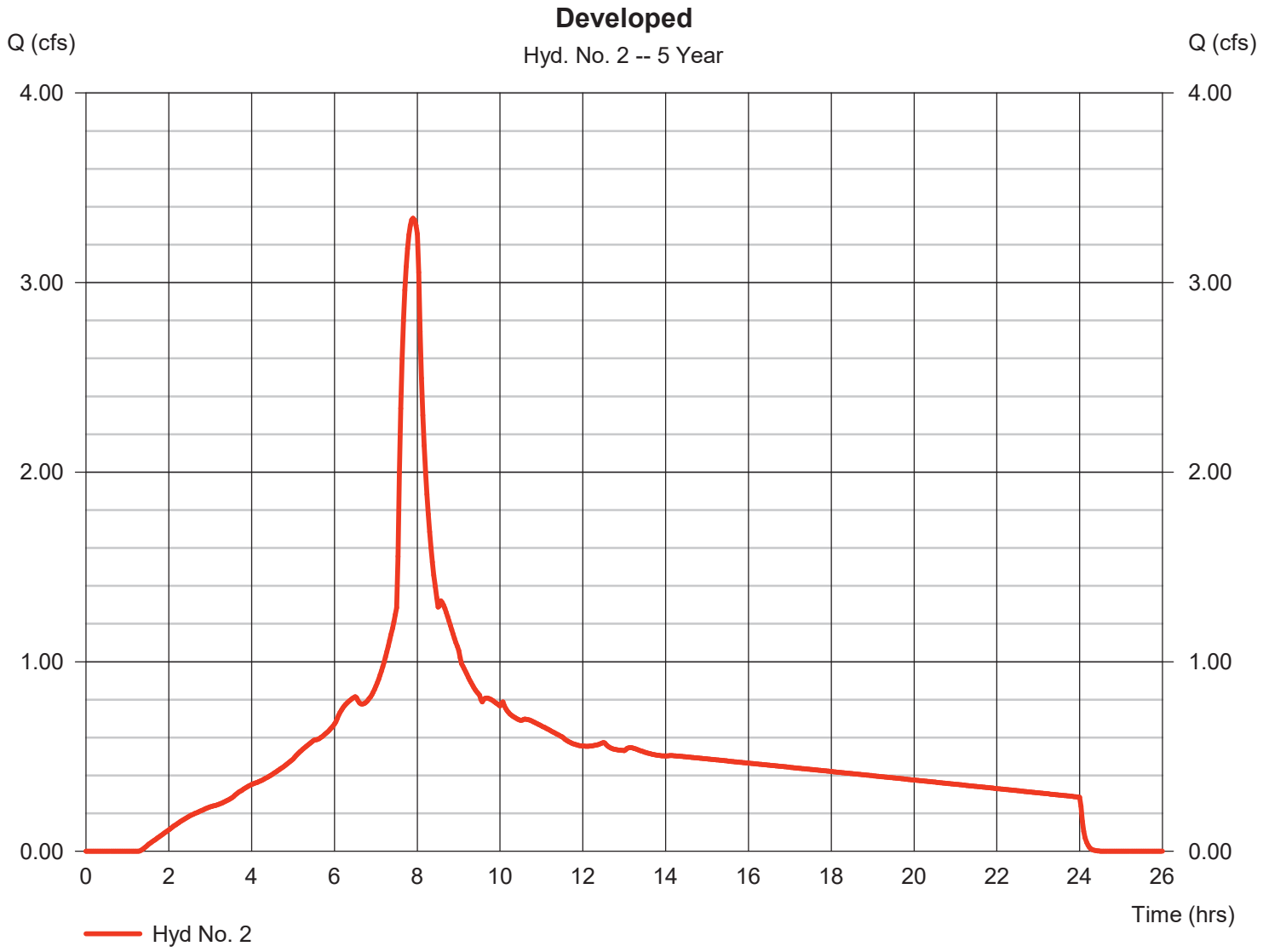
Hydrograph Report

Hyd. No. 2

Developed

Hydrograph type	= SBUH Runoff	Peak discharge	= 3.340 cfs
Storm frequency	= 5 yrs	Time to peak	= 7.90 hrs
Time interval	= 2 min	Hyd. volume	= 47,049 cuft
Drainage area	= 4.890 ac	Curve number	= 96*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.10 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(0.440 x 74) + (4.450 x 98)] / 4.890



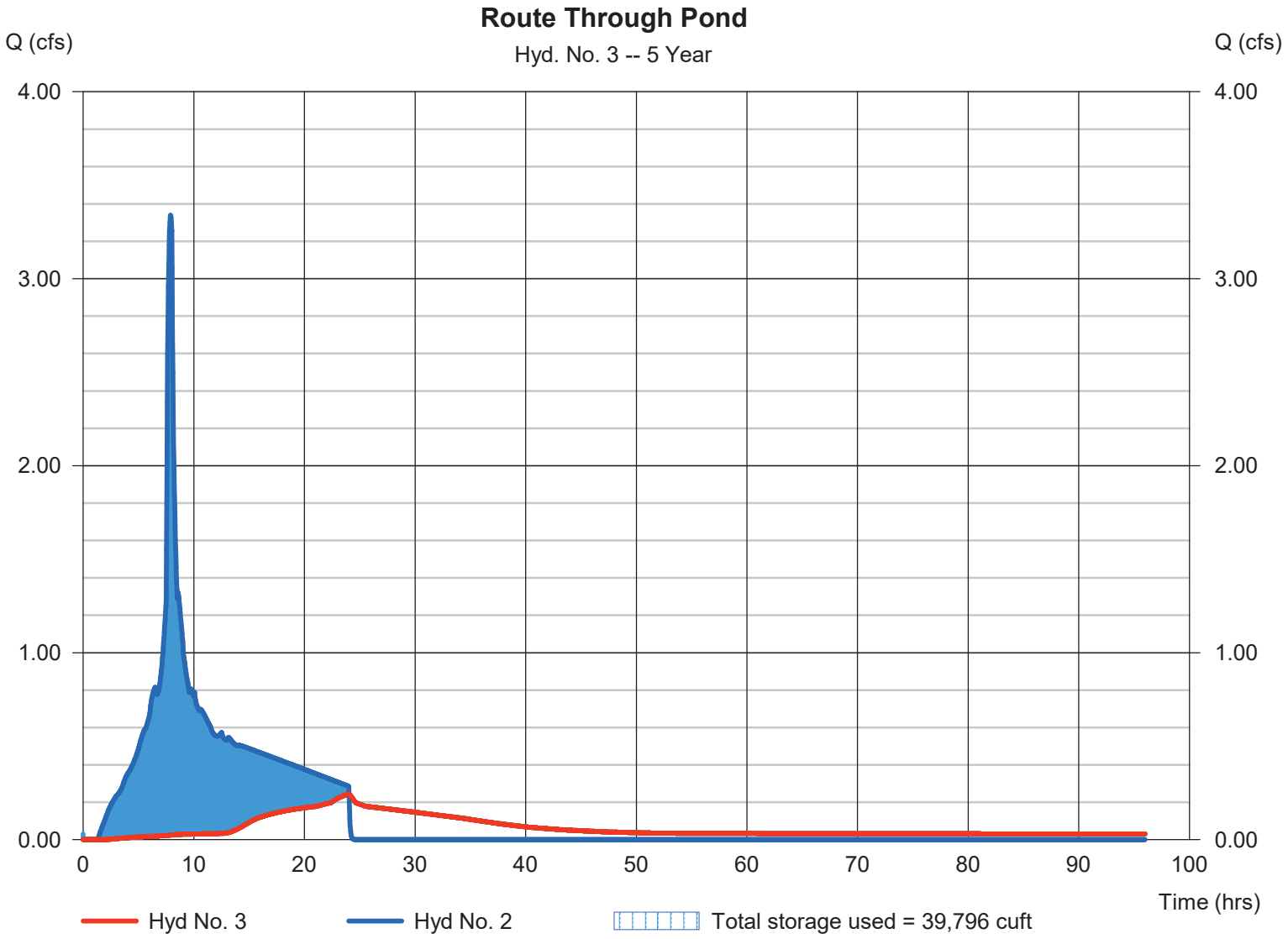
Hydrograph Report

Hyd. No. 3

Route Through Pond

Hydrograph type	= Reservoir	Peak discharge	= 0.243 cfs
Storm frequency	= 5 yrs	Time to peak	= 24.03 hrs
Time interval	= 2 min	Hyd. volume	= 21,316 cuft
Inflow hyd. No.	= 2 - Developed	Max. Elevation	= 139.04 ft
Reservoir name	= Pond	Max. Storage	= 39,796 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

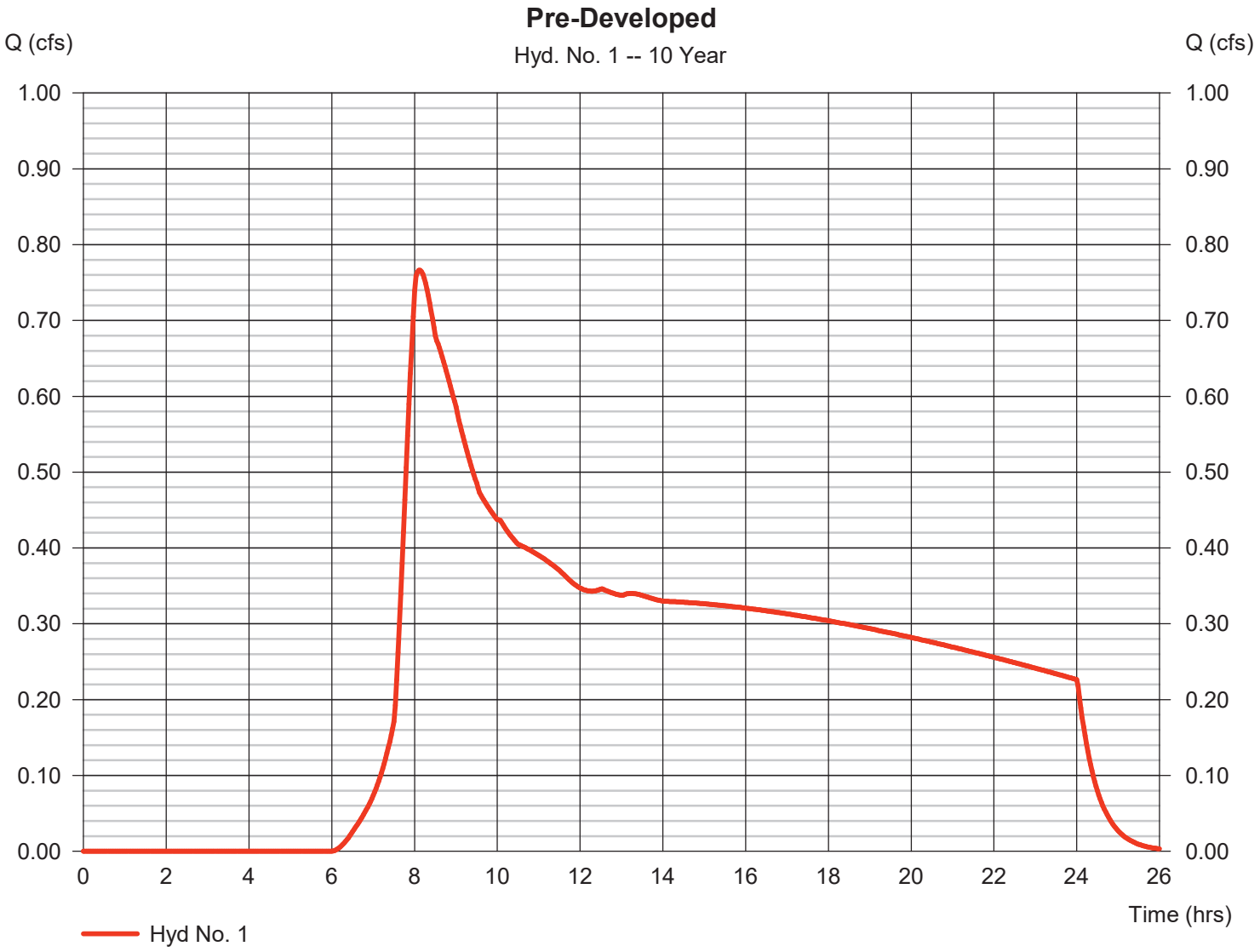
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SBUH Runoff	0.766	2	488	21,399	------	------	------	Pre-Developed
2	SBUH Runoff	3.764	2	474	53,179	------	------	------	Developed
3	Reservoir	0.390	2	1252	27,337	2	139.09	40,782	Route Through Pond

Hydrograph Report

Hyd. No. 1

Pre-Developed

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.766 cfs
Storm frequency	= 10 yrs	Time to peak	= 8.13 hrs
Time interval	= 2 min	Hyd. volume	= 21,399 cuft
Drainage area	= 4.890 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 27.80 min
Total precip.	= 3.45 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a



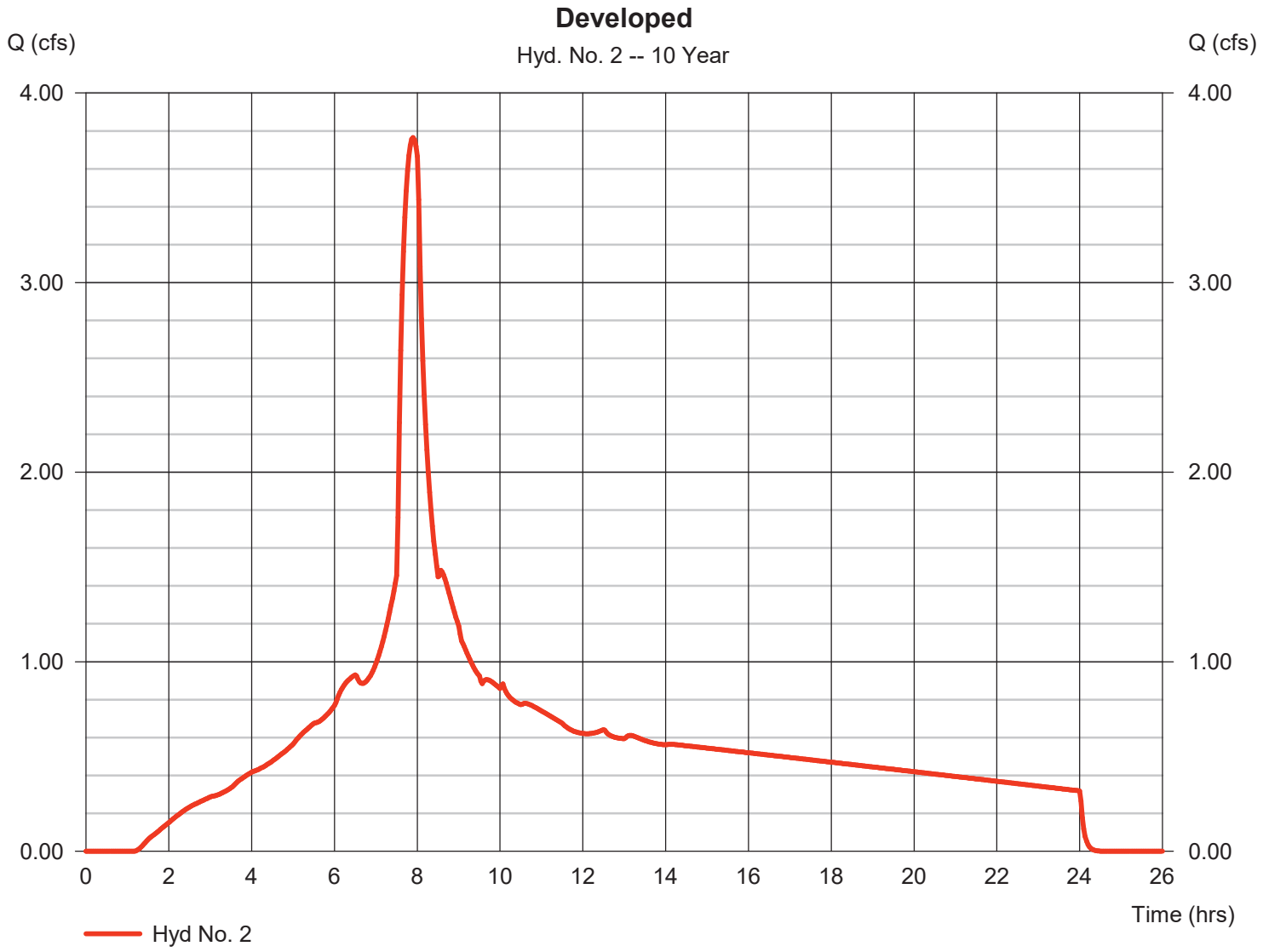
Hydrograph Report

Hyd. No. 2

Developed

Hydrograph type	=	SBUH Runoff	Peak discharge	=	3.764 cfs
Storm frequency	=	10 yrs	Time to peak	=	7.90 hrs
Time interval	=	2 min	Hyd. volume	=	53,179 cuft
Drainage area	=	4.890 ac	Curve number	=	96*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	3.45 in	Distribution	=	Type IA
Storm duration	=	24 hrs	Shape factor	=	n/a

* Composite (Area/CN) = [(0.440 x 74) + (4.450 x 98)] / 4.890



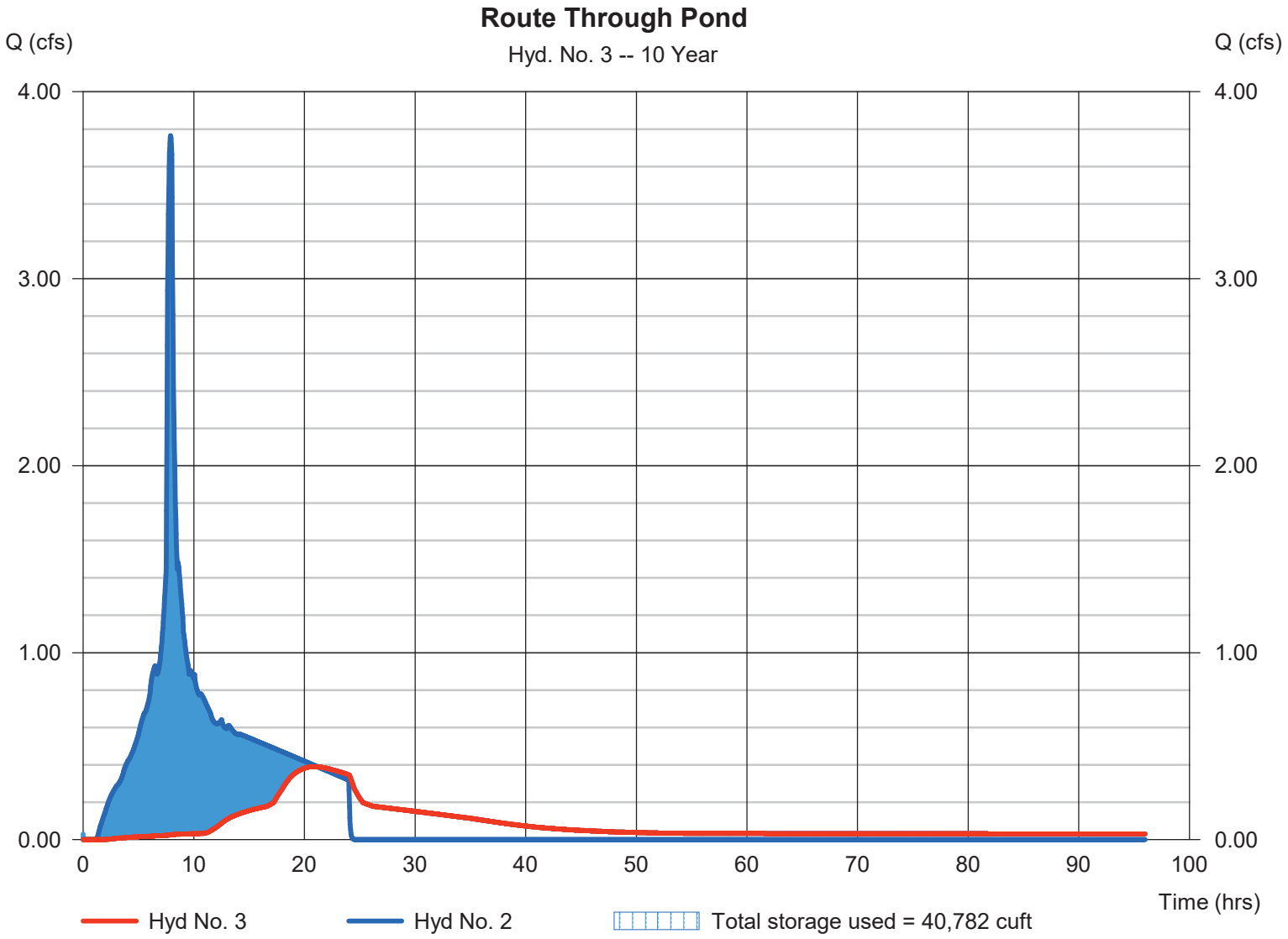
Hydrograph Report

Hyd. No. 3

Route Through Pond

Hydrograph type	= Reservoir	Peak discharge	= 0.390 cfs
Storm frequency	= 10 yrs	Time to peak	= 20.87 hrs
Time interval	= 2 min	Hyd. volume	= 27,337 cuft
Inflow hyd. No.	= 2 - Developed	Max. Elevation	= 139.09 ft
Reservoir name	= Pond	Max. Storage	= 40,782 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

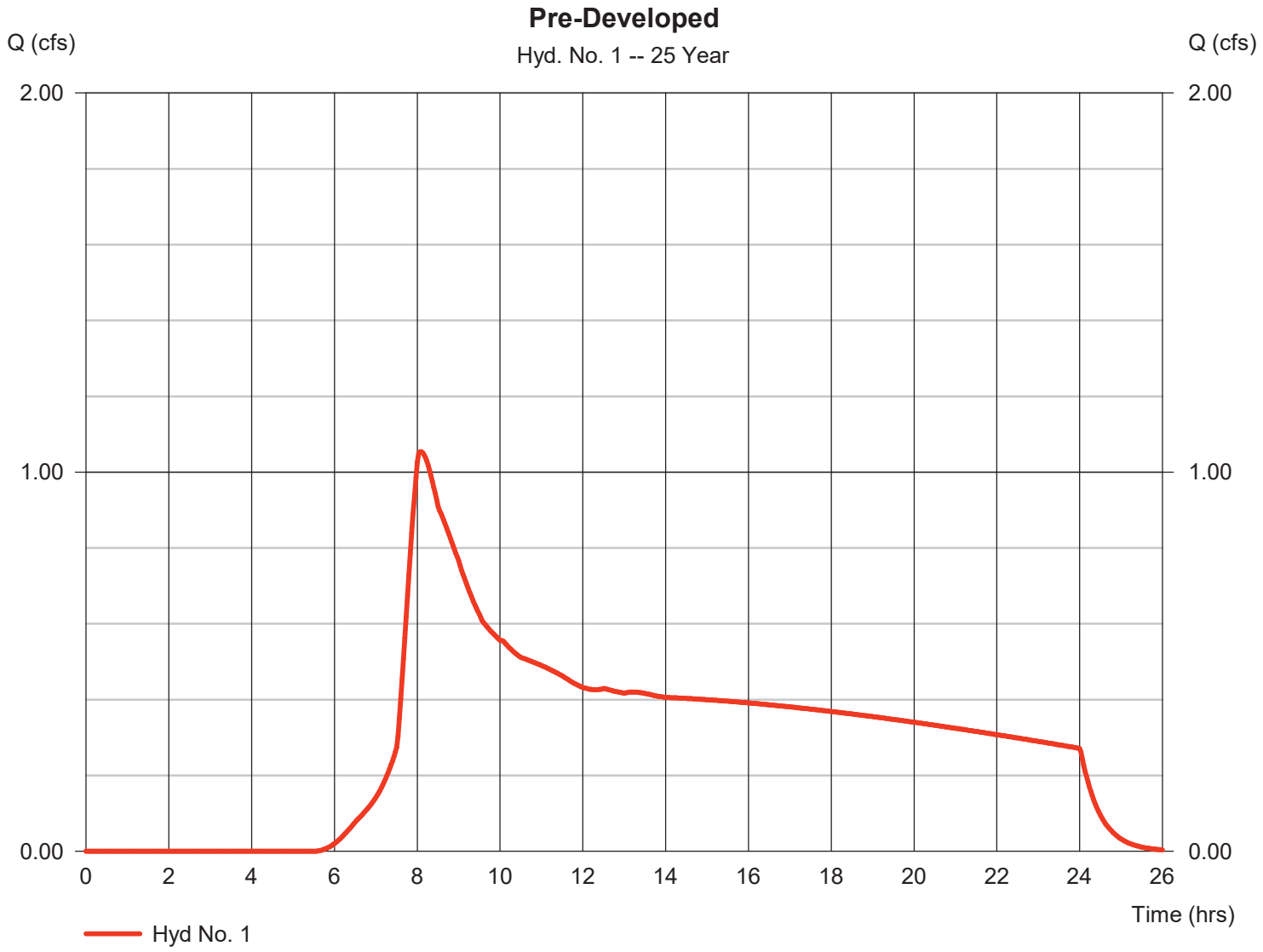
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SBUH Runoff	1.054	2	486	27,040	------	------	------	Pre-Developed
2	SBUH Runoff	4.308	2	474	61,080	------	------	------	Developed
3	Reservoir	0.541	2	1046	35,193	2	139.13	41,537	Route Through Pond

Hydrograph Report

Hyd. No. 1

Pre-Developed

Hydrograph type	= SBUH Runoff	Peak discharge	= 1.054 cfs
Storm frequency	= 25 yrs	Time to peak	= 8.10 hrs
Time interval	= 2 min	Hyd. volume	= 27,040 cuft
Drainage area	= 4.890 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 27.80 min
Total precip.	= 3.90 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a



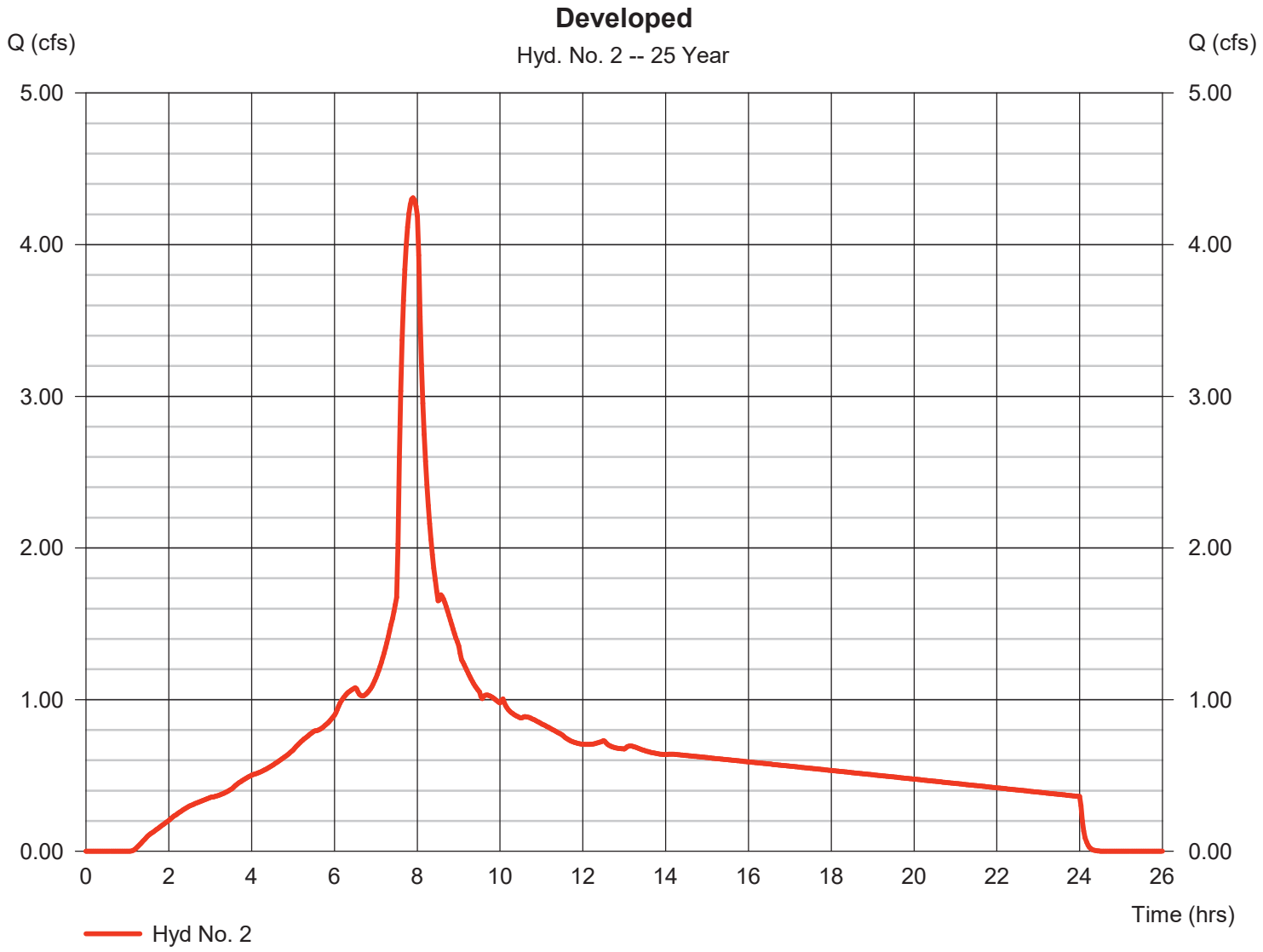
Hydrograph Report

Hyd. No. 2

Developed

Hydrograph type	= SBUH Runoff	Peak discharge	= 4.308 cfs
Storm frequency	= 25 yrs	Time to peak	= 7.90 hrs
Time interval	= 2 min	Hyd. volume	= 61,080 cuft
Drainage area	= 4.890 ac	Curve number	= 96*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.90 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(0.440 x 74) + (4.450 x 98)] / 4.890



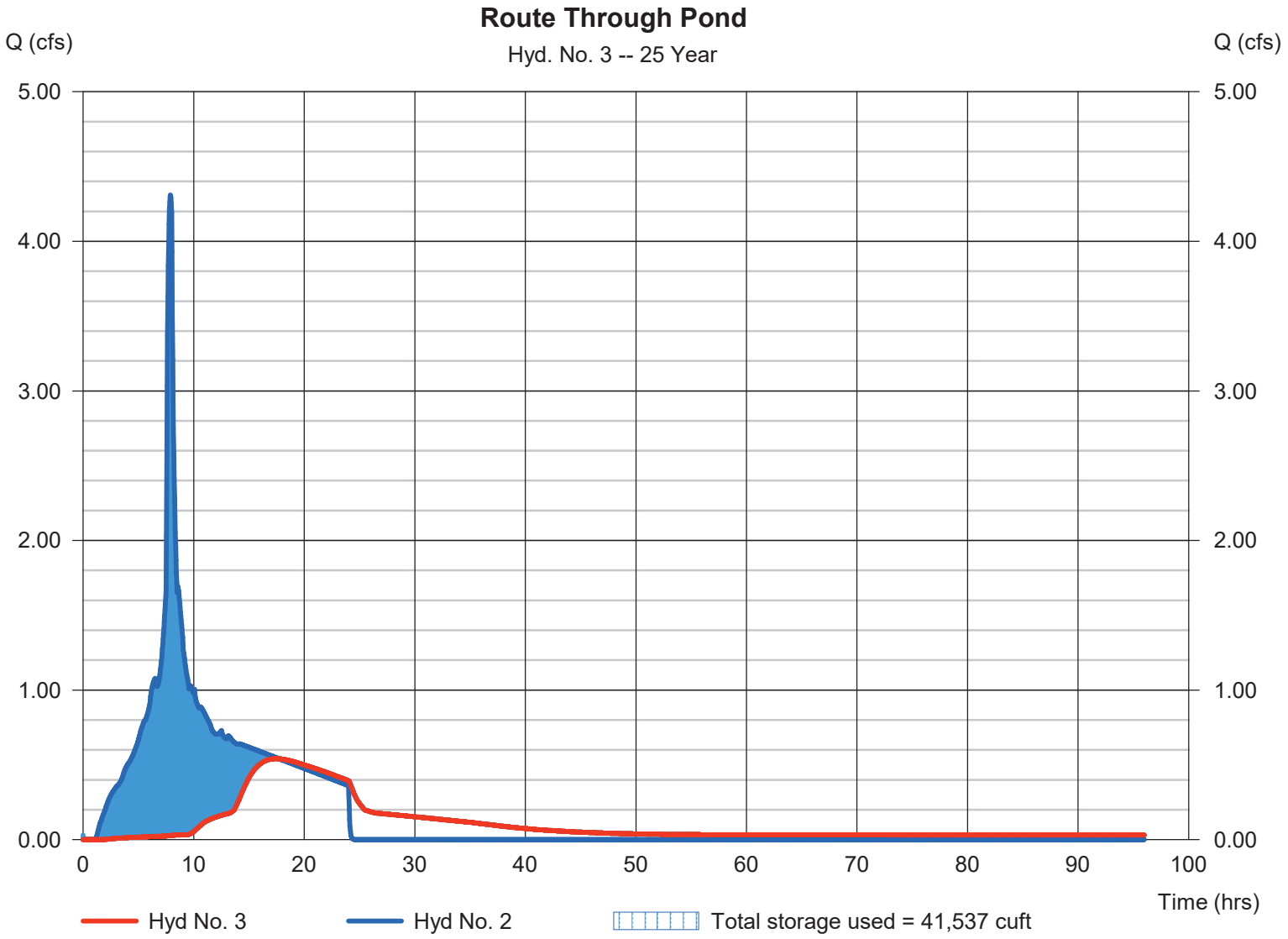
Hydrograph Report

Hyd. No. 3

Route Through Pond

Hydrograph type	= Reservoir	Peak discharge	= 0.541 cfs
Storm frequency	= 25 yrs	Time to peak	= 17.43 hrs
Time interval	= 2 min	Hyd. volume	= 35,193 cuft
Inflow hyd. No.	= 2 - Developed	Max. Elevation	= 139.13 ft
Reservoir name	= Pond	Max. Storage	= 41,537 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	69.8703	13.1000	0.8658	--------
3	0.0000	0.0000	0.0000	--------
5	79.2597	14.6000	0.8369	--------
10	88.2351	15.5000	0.8279	--------
25	102.6072	16.5000	0.8217	--------
50	114.8193	17.2000	0.8199	--------
100	127.1596	17.8000	0.8186	--------

File name: SampleFHA.idf

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	5.69	4.61	3.89	3.38	2.99	2.69	2.44	2.24	2.07	1.93	1.81	1.70
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.57	5.43	4.65	4.08	3.65	3.30	3.02	2.79	2.59	2.42	2.27	2.15
10	7.24	6.04	5.21	4.59	4.12	3.74	3.43	3.17	2.95	2.77	2.60	2.46
25	8.25	6.95	6.03	5.34	4.80	4.38	4.02	3.73	3.48	3.26	3.07	2.91
50	9.04	7.65	6.66	5.92	5.34	4.87	4.49	4.16	3.88	3.65	3.44	3.25
100	9.83	8.36	7.30	6.50	5.87	5.36	4.94	4.59	4.29	4.03	3.80	3.60

Tc = time in minutes. Values may exceed 60.

Reports & Calc Templates\Calc Templates\Stormwater\Hydraflow Stormwater Precipitation Data\CWS precipitation.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	0.00	2.50	0.00	3.10	3.45	3.90	4.20	4.50
SCS 6-Hr	0.00	1.05	0.00	1.25	1.55	1.70	1.80	1.90
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX C

O&M MANUAL

Stormwater Operations & Maintenance Manual

For:

Hedges D Parking Lot
Tualatin, Oregon

September 2020

Prepared by:

Mackenzie
1515 SE Water Avenue
Suite 100
Portland, OR 97214
2200339.00

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 parking lot project located in Tualatin, Oregon. Construction of the Hedges D project includes a delivery van parking lot, landscape, supporting utilities, water quality filter catch basins, and underground detention chambers.

Runoff from the site sheets flows to various filter or standard catch basins and is detained in underground chamber systems prior to outfall to the creek.

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.

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 elements

Operations and Maintenance Contact

Hedges D – Facilities Manager

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

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 O&M Facility Map shows 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 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 are plastic with associated fittings. 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.

Maintenance Schedule

Summer: Make structural repairs; clean gutters and downspouts; remove any build-up of weeds or organic debris.

Fall: Replant exposed soil and replace dead plants. Remove sediment and plant debris.

Winter: Clear gutters and downspouts.

Spring: Remove sediment and plant debris. Replant exposed soil and replace dead plants.

All season: Weed as necessary.

Maintenance Record

All facility operators are required to keep an inspection and maintenance log. Record date, description, and contractor (if applicable) for all repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the City inspector.

Access

Maintain ingress/egress per design standards.

Vector (Mosquitoes and Rats)

Facilities must not harbor mosquito larvae or rodents. Record the time/date, weather, and site conditions when vector activity is observed. Record when vector abatement started and ended.

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

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.

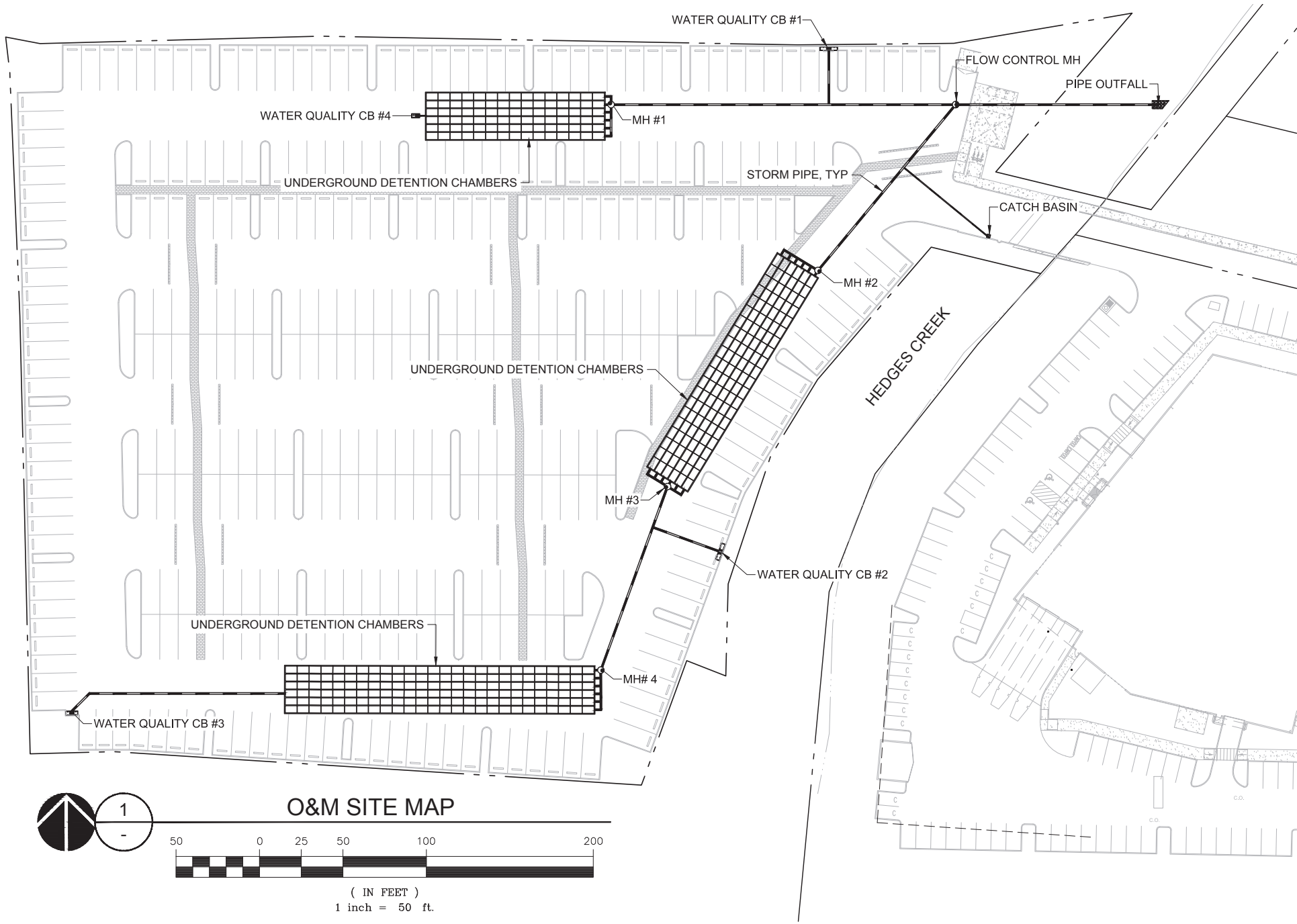
1. During the initial 3-year establishment period, remove undesired vegetation using minimal (or preferably no) use of toxic herbicides and pesticides at least 3 times a year. Replace plants that die during this period.

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



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O&M SITE MAP

50 0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

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

Date:_____________ Initials:___________
Work performed by:____
Work performed:____
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Work area or specific stormwater facility area: ____
Details:____
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Date:_____________ Initials:___________
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Date:_____________ Initials:___________
Work performed by:____
Work performed:____
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Work area or specific stormwater facility area: ____
Details:____
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Maintenance Guidelines

The primary purpose of the Stormwater Management StormFilter® is to filter and prevent pollutants from entering our waterways. Like any effective filtration system, periodically these pollutants must be removed to restore the StormFilter to its full efficiency and effectiveness.

Maintenance requirements and frequency are dependent on the pollutant load characteristics of each site. Maintenance activities may be required in the event of a chemical spill or due to excessive sediment loading from site erosion or extreme storms. It is a good practice to inspect the system after major storm events.

Maintenance Procedures

Although there are many effective maintenance options, we believe the following procedure to be efficient, using common equipment and existing maintenance protocols. The following two-step procedure is recommended::

1. **Inspection**
   - Inspection of the vault interior to determine the need for maintenance.
2. **Maintenance**
   - Cartridge replacement
   - Sediment removal

Inspection and Maintenance Timing

At least one scheduled inspection should take place per year with maintenance following as warranted.

First, an inspection should be done before the winter season. During the inspection the need for maintenance should be determined and, if disposal during maintenance will be required, samples of the accumulated sediments and media should be obtained.

Second, if warranted, a maintenance (replacement of the filter cartridges and removal of accumulated sediments) should be performed during periods of dry weather.

In addition to these two activities, it is important to check the condition of the StormFilter unit after major storms for potential damage caused by high flows and for high sediment accumulation that may be caused by localized erosion in the drainage area. It may be necessary to adjust the inspection/ maintenance schedule depending on the actual operating conditions encountered by the system. In general, inspection activities can be conducted at any time, and maintenance should occur, if warranted, during dryer months in late summer to early fall.

Maintenance Frequency

The primary factor for determining frequency of maintenance for the StormFilter is sediment loading.

A properly functioning system will remove solids from water by trapping particulates in the porous structure of the filter media inside the cartridges. The flow through the system will naturally decrease as more and more particulates are trapped. Eventually the flow through the cartridges will be low enough to require replacement. It may be possible to extend the usable span of the cartridges by removing sediment from upstream trapping devices on a routine as-needed basis, in order to prevent material from being re-suspended and discharged to the StormFilter treatment system.

The average maintenance lifecycle is approximately 1-5 years. Site conditions greatly influence maintenance requirements. StormFilter units located in areas with erosion or active construction may need to be inspected and maintained more often than those with fully stabilized surface conditions.

Regulatory requirements or a chemical spill can shift maintenance timing as well. The maintenance frequency may be adjusted as additional monitoring information becomes available during the inspection program. Areas that develop known problems should be inspected more frequently than areas that demonstrate no problems, particularly after major storms. Ultimately, inspection and maintenance activities should be scheduled based on the historic records and characteristics of an individual StormFilter system or site. It is recommended that the site owner develop a database to properly manage StormFilter inspection and maintenance programs..

Inspection Procedures

The primary goal of an inspection is to assess the condition of the cartridges relative to the level of visual sediment loading as it relates to decreased treatment capacity. It may be desirable to conduct this inspection during a storm to observe the relative flow through the filter cartridges. If the submerged cartridges are severely plugged, then typically large amounts of sediments will be present and very little flow will be discharged from the drainage pipes. If this is the case, then maintenance is warranted and the cartridges need to be replaced.

Warning: In the case of a spill, the worker should abort inspection activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

To conduct an inspection:

Important: Inspection should be performed by a person who is familiar with the operation and configuration of the StormFilter treatment unit and the unit's role, relative to detention or retention facilities onsite.

1. If applicable, set up safety equipment to protect and notify surrounding vehicle and pedestrian traffic.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the access portals to the vault and allow the system vent.
4. Without entering the vault, visually inspect the inside of the unit, and note accumulations of liquids and solids.
5. Be sure to record the level of sediment build-up on the floor of the vault, in the forebay, and on top of the cartridges. If flow is occurring, note the flow of water per drainage pipe. Record all observations. Digital pictures are valuable for historical documentation.
6. Close and fasten the access portals.
7. Remove safety equipment.
8. If appropriate, make notes about the local drainage area relative to ongoing construction, erosion problems, or high loading of other materials to the system.
9. Discuss conditions that suggest maintenance and make decision as to whether or not maintenance is needed.

Maintenance Decision Tree

The need for maintenance is typically based on results of the inspection. The following Maintenance Decision Tree should be used as a general guide. (Other factors, such as Regulatory Requirements, may need to be considered).

Please note Stormwater Management StormFilter devices installed downstream of, or integrated within, a stormwater storage facility typically have different operational parameters (i.e. draindown time). In these cases, the inspector must understand the relationship between the retention/detention facility and the treatment system by evaluating site specific civil engineering plans, or contacting the engineer of record, and make adjustments to the below guidance as necessary. Sediment deposition depths and patterns within the StormFilter are likely to be quite different compared to systems without upstream storage and therefore shouldn't be used exclusively to evaluate a need for maintenance.

1. Sediment loading on the vault floor.
   a. If >4" of accumulated sediment, maintenance is required.
2. Sediment loading on top of the cartridge.
   a. If >1/4" of accumulation, maintenance is required.
3. Submerged cartridges.
   a. If >4" of static water above cartridge bottom for more than 24 hours after end of rain event, maintenance is required. (Catch basins have standing water in the cartridge bay.)
4. Plugged media.
   a. While not required in all cases, inspection of the media within the cartridge may provide valuable additional information.
   b. If pore space between media granules is absent, maintenance is required.
5. Bypass condition.
   a. If inspection is conducted during an average rain fall event and StormFilter remains in bypass condition (water over the internal outlet baffle wall or submerged cartridges), maintenance is required.
6. Hazardous material release.
   a. If hazardous material release (automotive fluids or other) is reported, maintenance is required.
7. Pronounced scum line.
   a. If pronounced scum line (say ≥ 1/4" thick) is present above top cap, maintenance is required.

Maintenance

Depending on the configuration of the particular system, maintenance personnel will be required to enter the vault to perform the maintenance.

Important: If vault entry is required, OSHA rules for confined space entry must be followed.

Filter cartridge replacement should occur during dry weather. It may be necessary to plug the filter inlet pipe if base flows is occurring.

Replacement cartridges can be delivered to the site or customers facility. Information concerning how to obtain the replacement cartridges is available from Contech Engineered Solutions.

Warning: In the case of a spill, the maintenance personnel should abort maintenance activities until the proper guidance is obtained. Notify the local hazard control agency and Contech Engineered Solutions immediately.

To conduct cartridge replacement and sediment removal maintenance:

1. If applicable, set up safety equipment to protect maintenance personnel and pedestrians from site hazards.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the doors (access portals) to the vault and allow the system to vent.
4. Without entering the vault, give the inside of the unit, including components, a general condition inspection.
5. Make notes about the external and internal condition of the vault. Give particular attention to recording the level of sediment build-up on the floor of the vault, in the forebay, and on top of the internal components.
6. Using appropriate equipment offload the replacement cartridges (up to 150 lbs. each) and set aside.
7. Remove used cartridges from the vault using one of the following methods:

Method 1:

A. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.

   Using appropriate hoisting equipment, attach a cable from the boom, crane, or tripod to the loose cartridge. Contact Contech Engineered Solutions for suggested attachment devices.

B. Remove the used cartridges (up to 250 lbs. each) from the vault.

Important: Care must be used to avoid damaging the cartridges during removal and installation. The cost of repairing components damaged during maintenance will be the responsibility of the owner.

C. Set the used cartridge aside or load onto the hauling truck.

D. Continue steps a through c until all cartridges have been removed.

Method 2:

A. This activity will require that maintenance personnel enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Disconnect each filter cartridge from the underdrain connector by rotating counterclockwise 1/4 of a turn. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.

B. Unscrew the cartridge cap.

C. Remove the cartridge hood and float.

D. At location under structure access, tip the cartridge on its side.

E. Empty the cartridge onto the vault floor. Reassemble the empty cartridge.

F. Set the empty, used cartridge aside or load onto the hauling truck.

G. Continue steps a through e until all cartridges have been removed.

8. Remove accumulated sediment from the floor of the vault and from the forebay. This can most effectively be accomplished by use of a vacuum truck.
9. Once the sediments are removed, assess the condition of the vault and the condition of the connectors.
10. Using the vacuum truck boom, crane, or tripod, lower and install the new cartridges. Once again, take care not to damage connections.
11. Close and fasten the door.
12. Remove safety equipment.
13. Finally, dispose of the accumulated materials in accordance with applicable regulations. Make arrangements to return the used **empty** cartridges to Contech Engineered Solutions.

Material Disposal

The accumulated sediment found in stormwater treatment and conveyance systems must be handled and disposed of in accordance with regulatory protocols. It is possible for sediments to contain measurable concentrations of heavy metals and organic chemicals (such as pesticides and petroleum products). Areas with the greatest potential for high pollutant loading include industrial areas and heavily traveled roads.

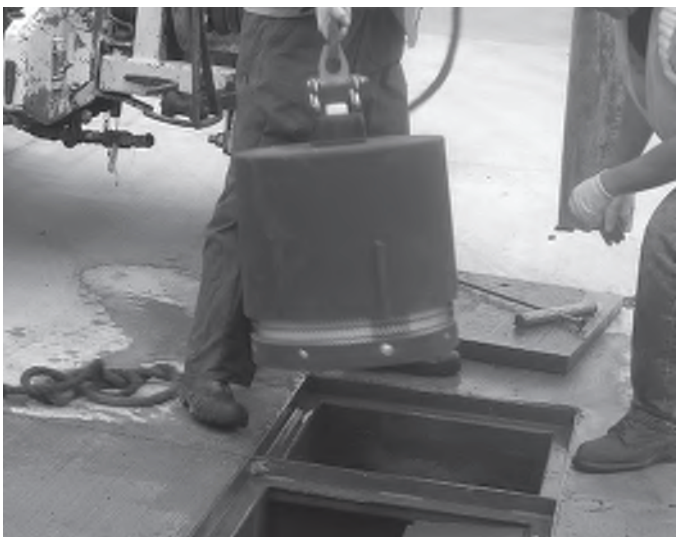
Sediments and water must be disposed of in accordance with all applicable waste disposal regulations. When scheduling maintenance, consideration must be made for the disposal of solid and liquid wastes. This typically requires coordination with a local landfill for solid waste disposal. For liquid waste disposal a number of options are available including a municipal vacuum truck decant facility, local waste water treatment plant or on-site treatment and discharge.

Related Maintenance Activities - Performed on an as-needed basis

StormFilter units are often just one of many structures in a more comprehensive stormwater drainage and treatment system.

In order for maintenance of the StormFilter to be successful, it is imperative that all other components be properly maintained. The maintenance/repair of upstream facilities should be carried out prior to StormFilter maintenance activities.

In addition to considering upstream facilities, it is also important to correct any problems identified in the drainage area. Drainage area concerns may include: erosion problems, heavy oil loading, and discharges of inappropriate materials.



Inspection Report

Date: _____ Personnel: _____

Location: _____ System Size: _____ Months in Service: _____

System Type: Vault ☐ Cast-In-Place ☐ Linear Catch Basin ☐ Manhole ☐ Other: _____

Sediment Thickness in Forebay: _____ Date: _____

Sediment Depth on Vault Floor: _____

Sediment Depth on Cartridge Top(s): _____

Structural Damage: _____

Estimated Flow from Drainage Pipes (if available): _____

Cartridges Submerged: Yes ☐ No ☐ Depth of Standing Water: _____

StormFilter Maintenance Activities (check off if done and give description)

☐ Trash and Debris Removal: _____

☐ Minor Structural Repairs: _____

☐ Drainage Area Report _____

Excessive Oil Loading: Yes ☐ No ☐ Source: _____

Sediment Accumulation on Pavement: Yes ☐ No ☐ Source: _____

Erosion of Landscaped Areas: Yes ☐ No ☐ Source: _____

Items Needing Further Work: _____

Owners should contact the local public works department and inquire about how the department disposes of their street waste residuals.

Other Comments:

_____

_____

_____

_____

_____

_____

_____

_____

Review the condition reports from the previous inspection visits.

StormFilter Maintenance Report

Date: _____ Personnel: _____

Location: _____ System Size: _____

System Type: Vault ☐ Cast-In-Place ☐ Linear Catch Basin ☐ Manhole ☐ Other: _____

List Safety Procedures and Equipment Used: _____

_____

_____

System Observations

Months in Service: _____

Oil in Forebay (if present): Yes ☐ No ☐

Sediment Depth in Forebay (if present): _____

Sediment Depth on Vault Floor: _____

Sediment Depth on Cartridge Top(s): _____

Structural Damage: _____

Drainage Area Report

Excessive Oil Loading: Yes ☐ No ☐ Source: _____

Sediment Accumulation on Pavement: Yes ☐ No ☐ Source: _____

Erosion of Landscaped Areas: Yes ☐ No ☐ Source: _____

StormFilter Cartridge Replacement Maintenance Activities

Remove Trash and Debris: Yes ☐ No ☐ Details: _____

Replace Cartridges: Yes ☐ No ☐ Details: _____

Sediment Removed: Yes ☐ No ☐ Details: _____

Quantity of Sediment Removed (estimate?):

Minor Structural Repairs: Yes ☐ No ☐ Details: _____

Residuals (debris, sediment) Disposal Methods: _____

Notes:

_____

_____

_____

_____

_____

_____

_____

12.1 ISOLATOR ROW INSPECTION

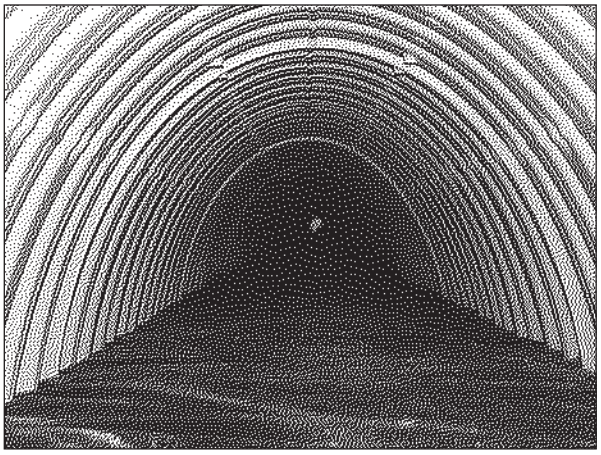
Regular inspection and maintenance are essential to assure a properly functioning stormwater system. Inspection is easily accomplished through the manhole or optional inspection ports of an Isolator Row. Please follow local and OSHA rules for a confined space entry.

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.

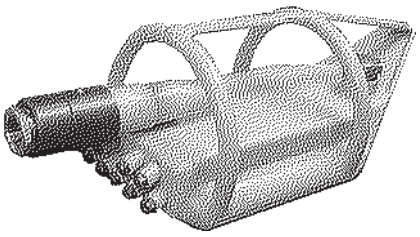
12.2 ISOLATOR ROW MAINTENANCE

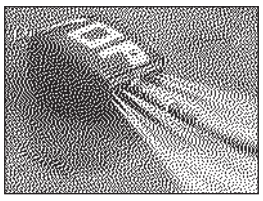
JetVac maintenance is recommended if sediment has been collected to an average depth of 3" (76 mm) inside the Isolator Row. More frequent maintenance may be required to maintain minimum flow rates through the Isolator Row. The JetVac process utilizes a high pressure water nozzle to propel itself down 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).

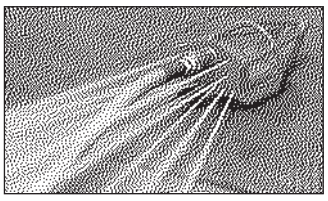


Looking down the Isolator Row

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

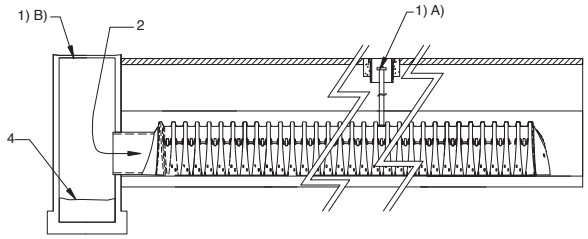
B) Apply multiple passes of JetVac until backflush water is clean

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.

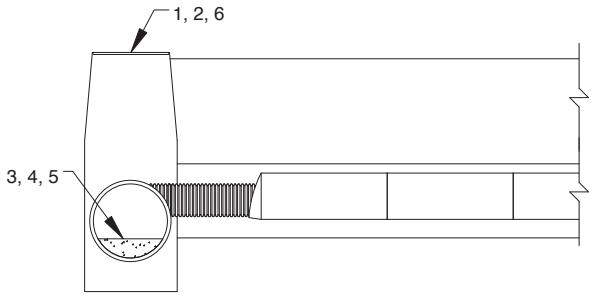
12.4 ECCENTRIC PIPE MANIFOLD MAINTENANCE

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

Prepared by:

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Tyler A. Pierce, PE
Project Engineer

Greg A. Landau, PE, GE

REGISTERED PROFESSIONAL ENGINEER
OREGON
NOVEMBER 08, 2013
GREG ALAN LANDAU

Digitally signed by Greg A. Landau, PE, GE
Date: 2019.07.10 15:31:42 -07'00'

Greg A. Landau, PE, GE
Associate Geotechnical Engineer

EXPIRES: 12/31/20

TAP:GAL:cje

Disclaimer: Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

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.

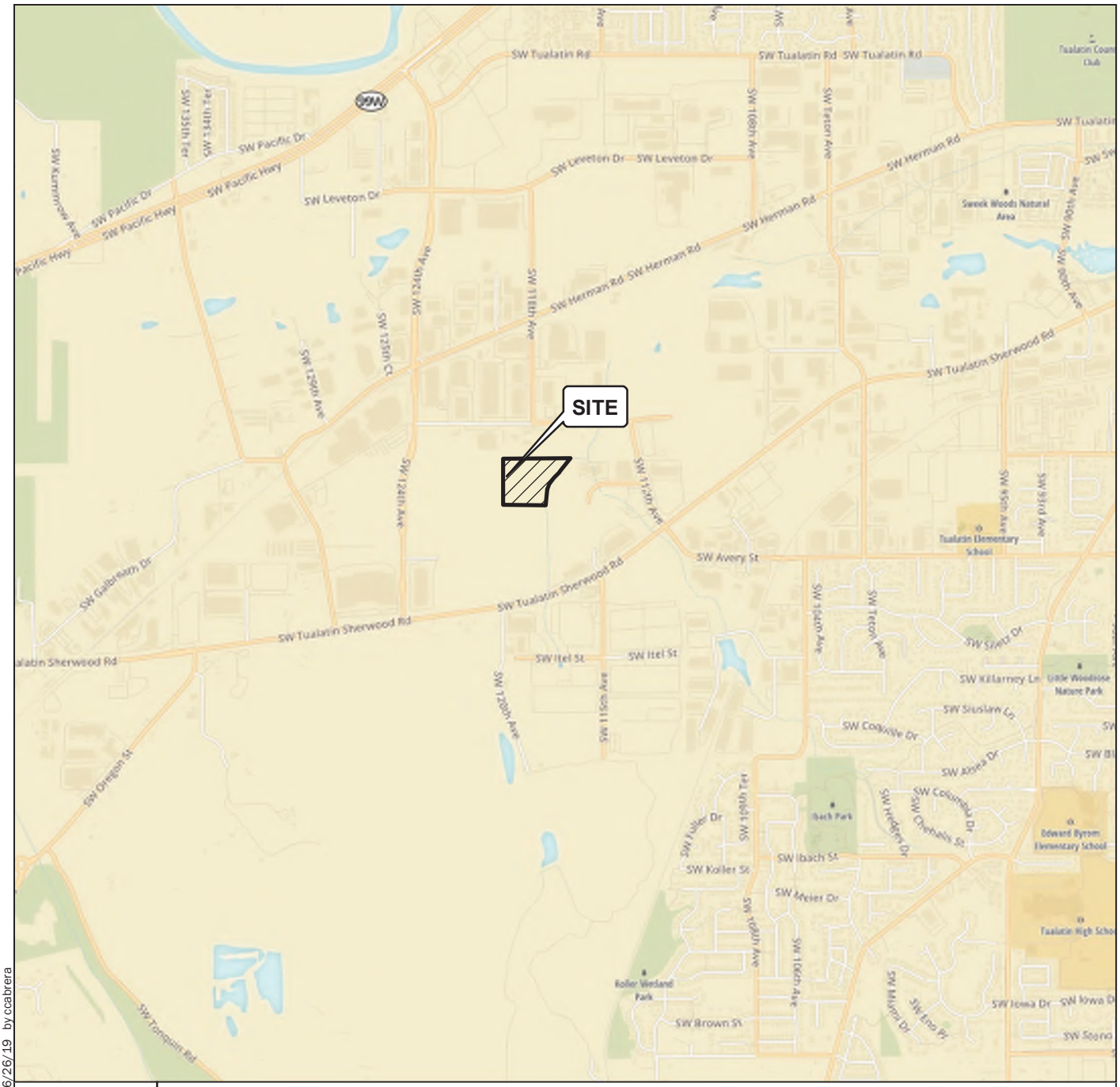
Please refer to Appendix B titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.

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

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

Vicinity Map

Hedges D
Tualatin, Oregon

GeoEngineers

Figure 1

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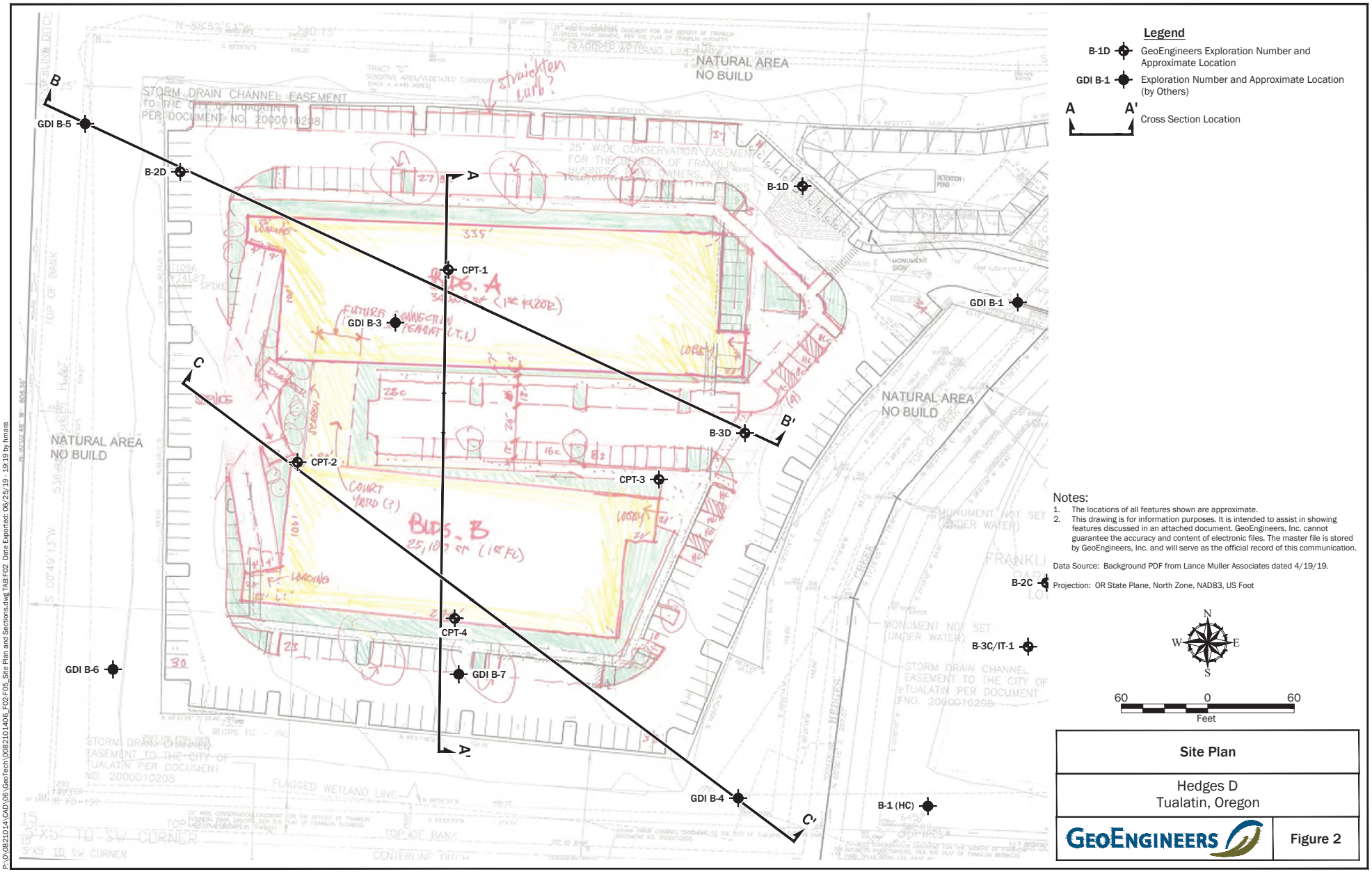


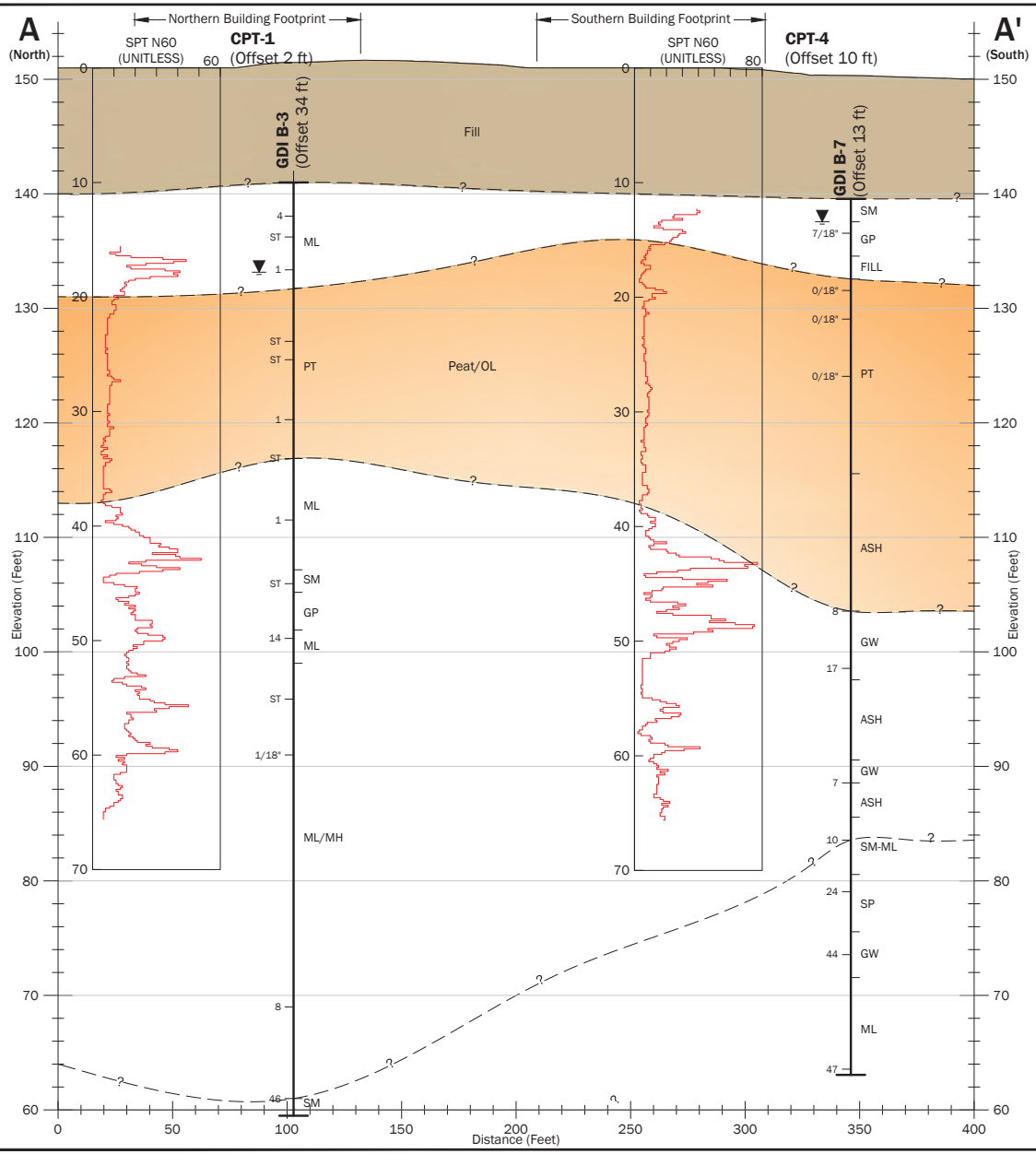
Site Plan

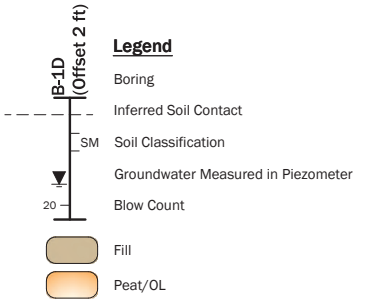
Hedges D
Tualatin, Oregon

GeoEngineers

Figure 2

P:\0\0821014\CAD\06\GeoTech\0082101406_F02-F05_Site Plan and Sections.dwg TAB:F02 Date Exported: 06/25/19 - 19:19 by hmara

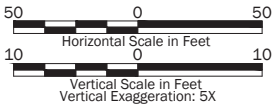




Notes:

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.



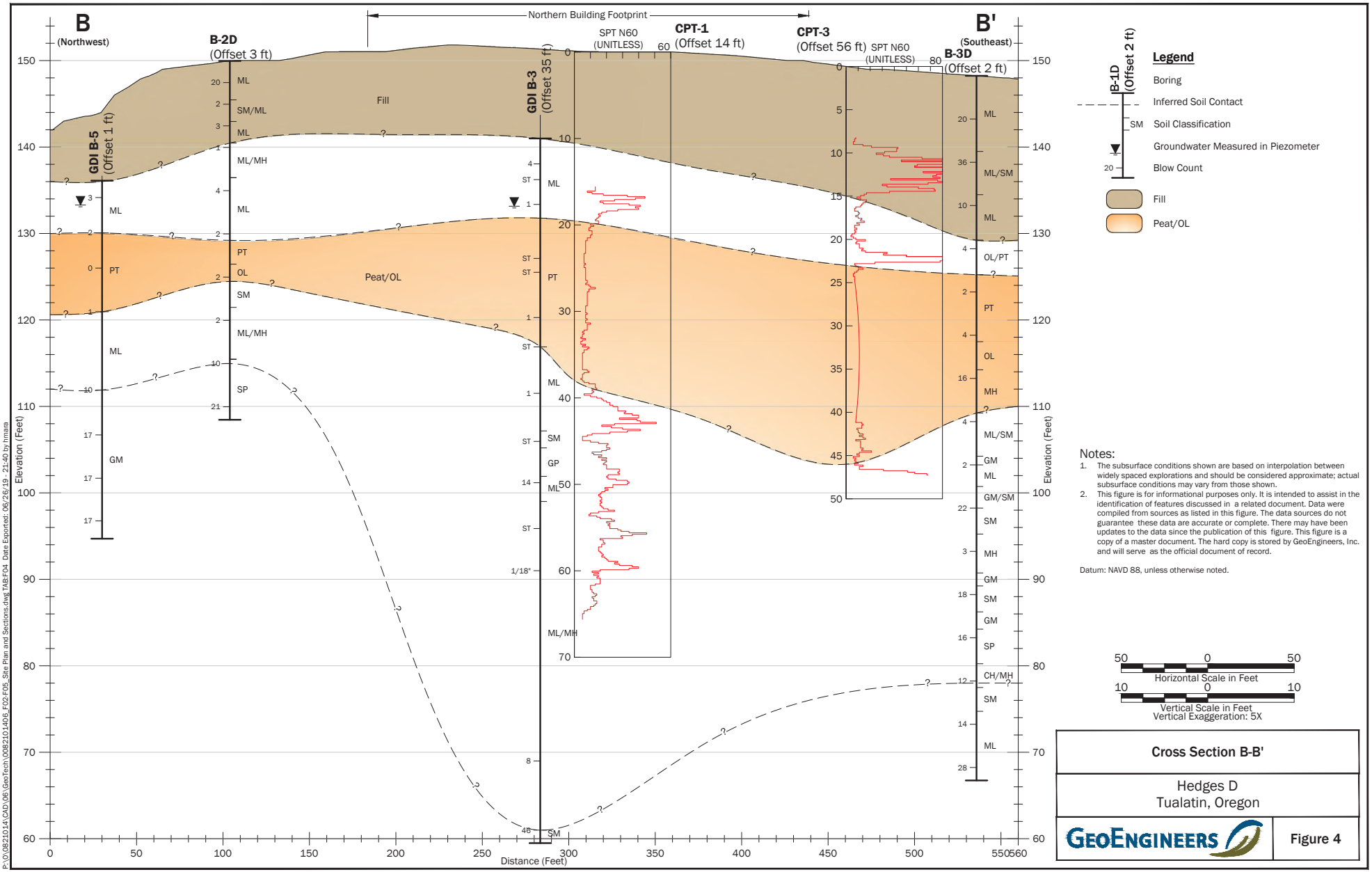
Cross Section A-A'

Hedges D
Tualatin, Oregon

GeoEngineers

Figure 3

P:\0\0821014\CAD\06\GeoTech\0082101406_F02-F05_Site Plan and Sections.dwg TAB:F03 Date Exported: 06/26/19 - 21:39 by hmara



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.

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Horizontal Scale in Feet

Vertical Scale in Feet
Vertical Exaggeration: 5X

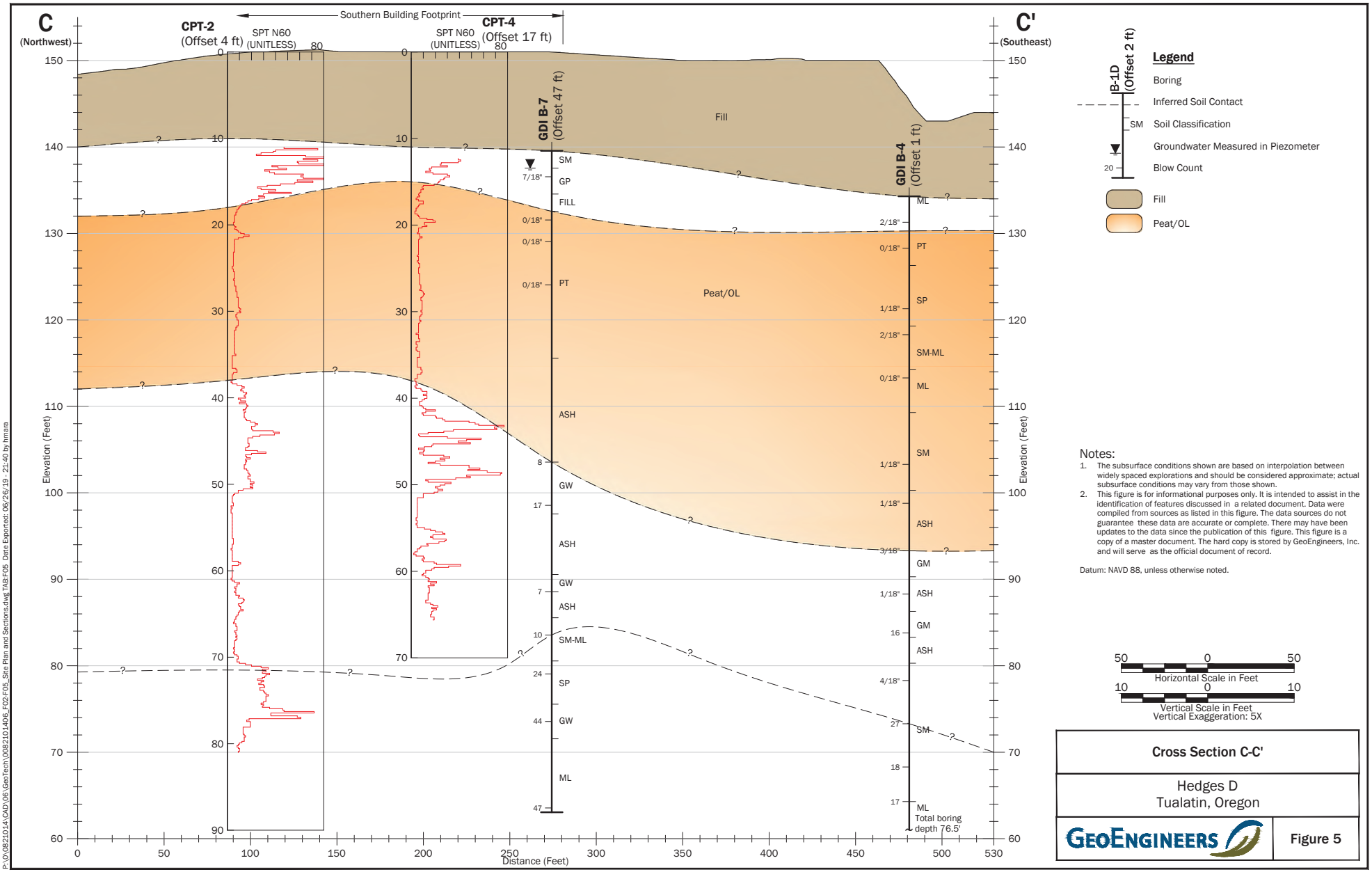
Cross Section B-B'

Hedges D
Tualatin, Oregon

GeoEngineers

Figure 4

P:\0\0821014\CAD\06\GeoTech\0082101406_F02-F05_Site Plan and Sections.dwg TAB:F04 Date Exported: 06/26/19 - 21:40 by hmara



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.

Horizontal Scale in Feet

Vertical Scale in Feet
Vertical Exaggeration: 5X

Cross Section C-C'

Hedges D
Tualatin, Oregon

GeoEngineers

Figure 5

P:\0\0821014\CAD\06\GeoTech\0082101406_F02-F05_Site Plan and Sections.dwg TAB:F05 Date Exported: 06/26/19 - 21:40 by hmara

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)			
		0	8		3						
140											
	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											
	20	10	6		6 MD		ML	Dark gray silt, moderate plasticity, trace to occasional roots and organic fibers, trace fine sand (medium stiff, wet) (alluvium)	31		DD = 86 pcf
125							OL/PT	Dark gray to black organic silt with fine sand, occasional interbeds of brown peat, much fibrous organic matter (soft, wet)			
	25	12	3		7 OC				276		OC = 40 percent
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.

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-01D

GeoEngineers

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

Figure A-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

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

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.

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-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			

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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
125								Occasional wood fragments, wet			
	25	18	2		5 MD				304		DD = 17 pcf
120											
	30	18	4		6 OC				329		OC = 42 percent
115							OL	Brown organic silt, much organic fibers, low plasticity, fine horizontal layers (soft, moist)			
	35						MH	Gray elastic silt, trace organic matter, moderate			

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

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

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

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	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)			
							GM				Driller reports very loose to loose gravel
85	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

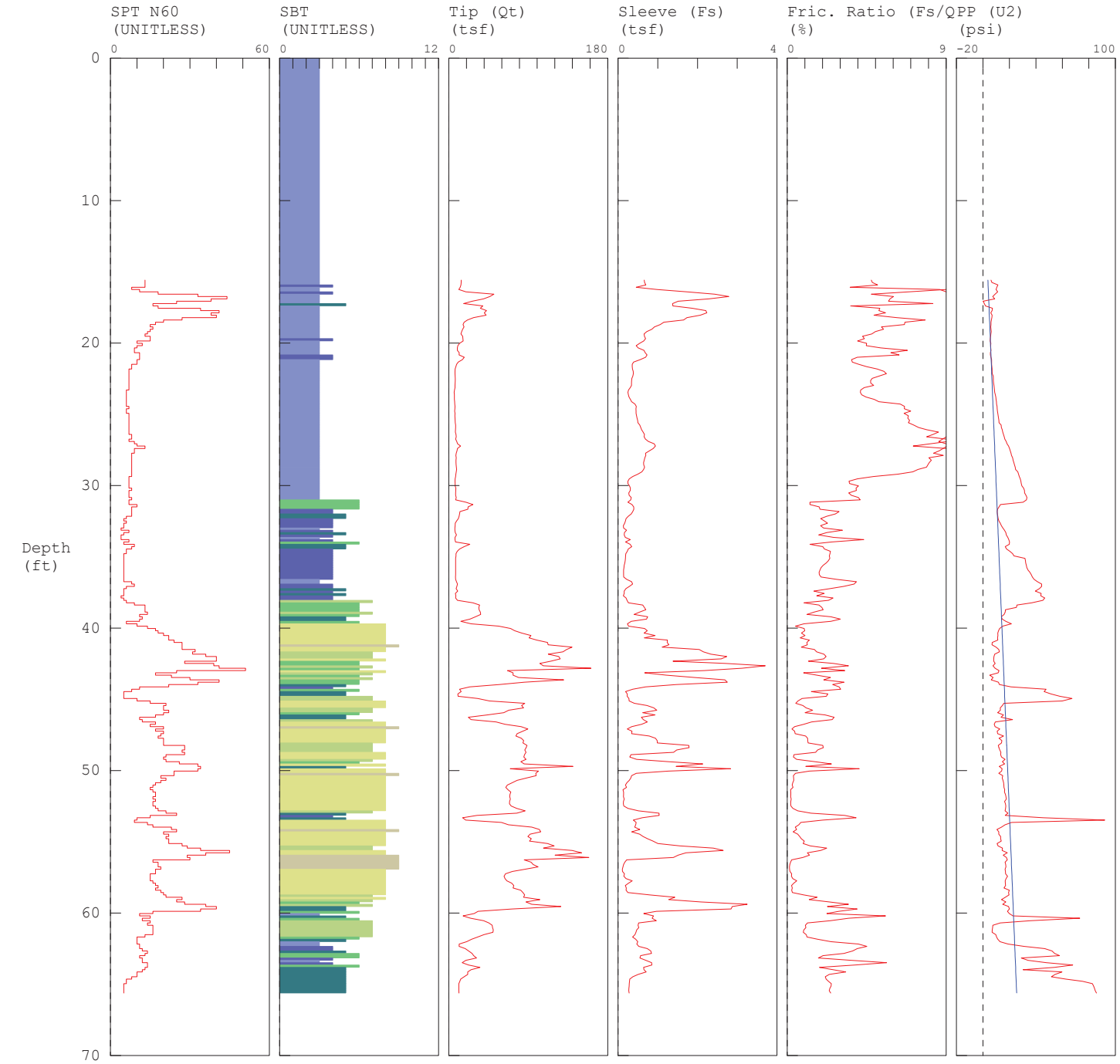
Project: The Hedges - Building C and D
Project Location: Tualatin, Oregon
Project Number: 0821-014-02

Figure A-4
Sheet 3 of 3

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

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



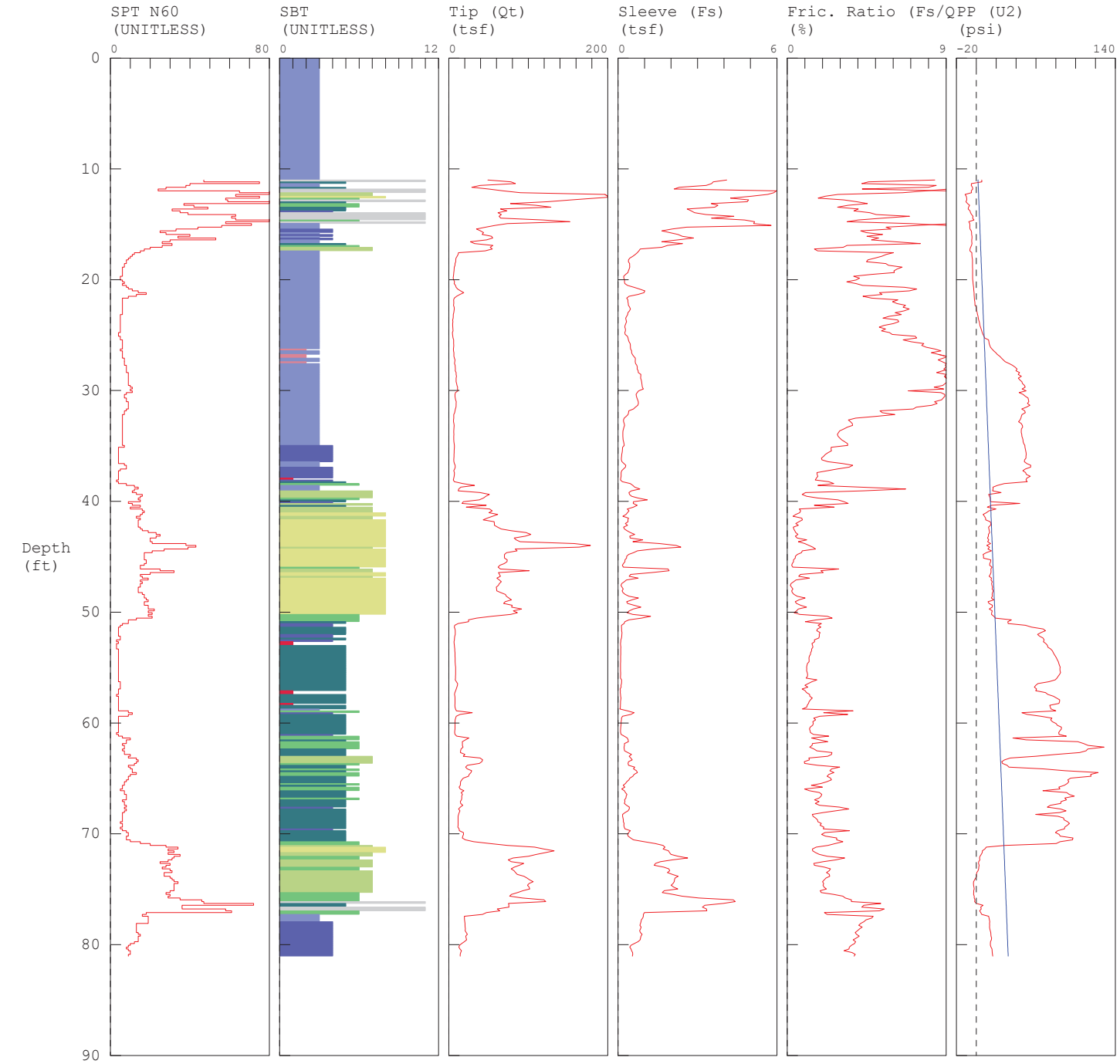
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty cl
6 sandy silt to clayey si
7 silty sand to sandy si
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*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



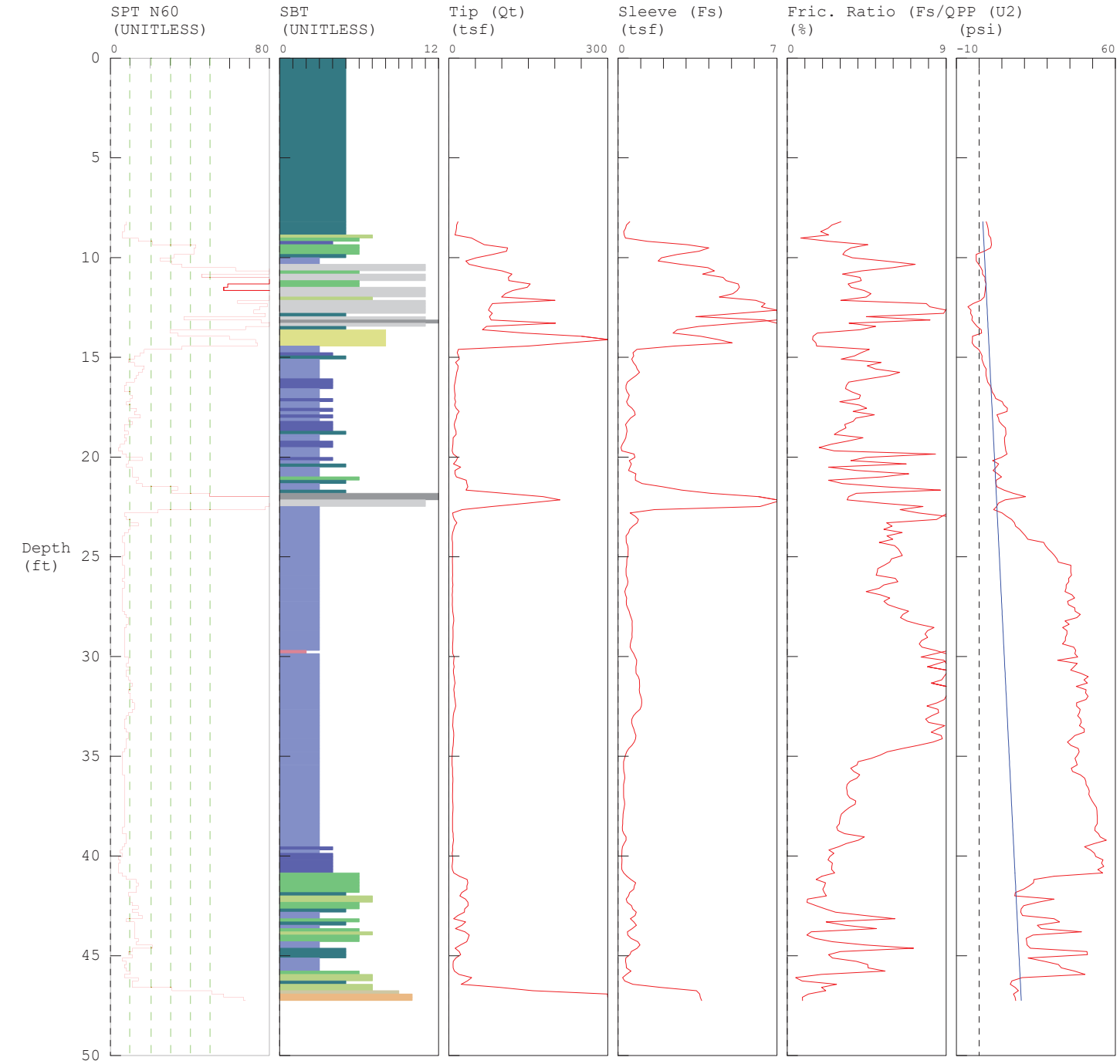
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty cl
6 sandy silt to clayey si
7 silty sand to sandy si
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*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

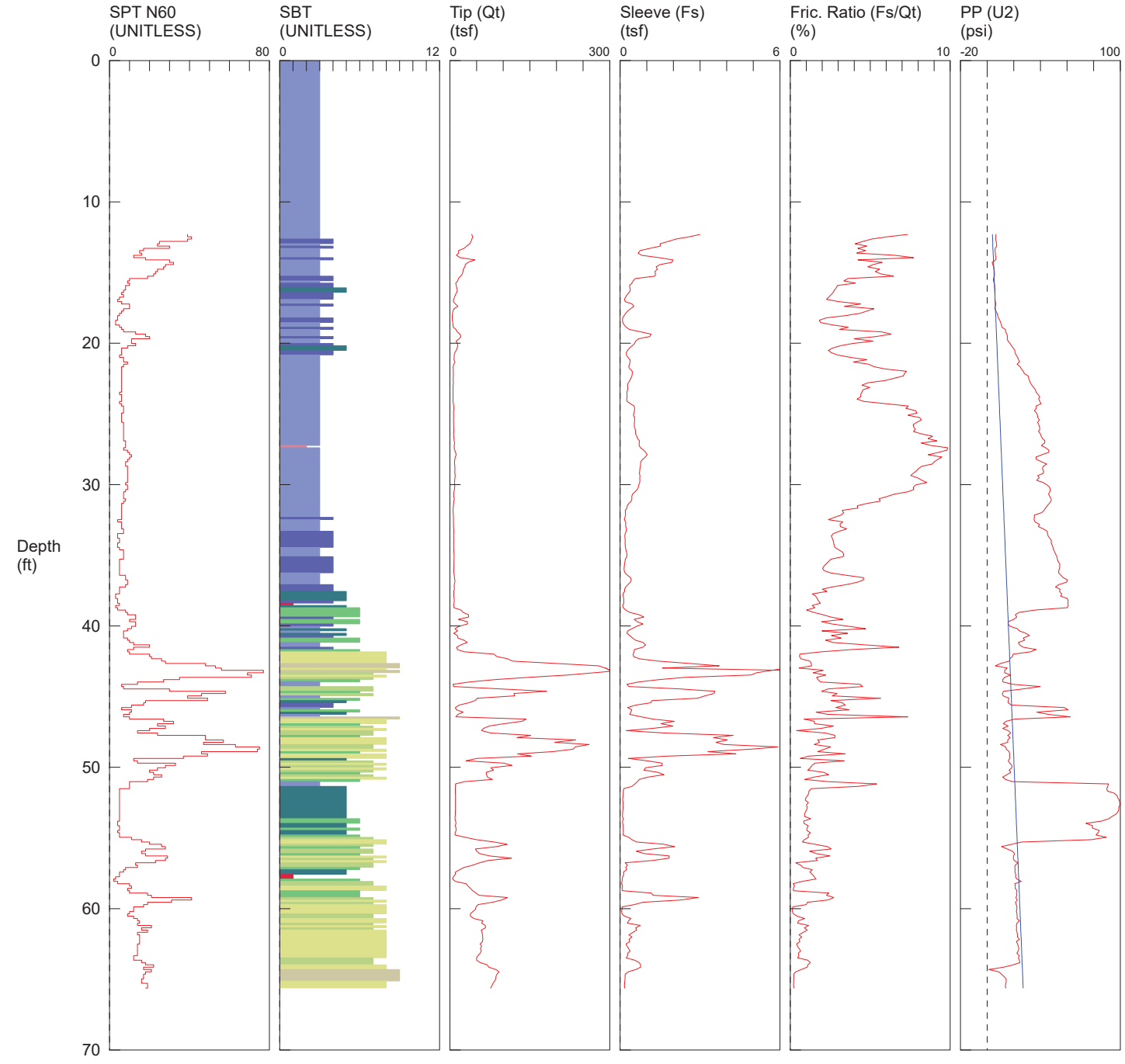


*SBT/SPT CORRELATION: UBC-1983

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.

---

[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.

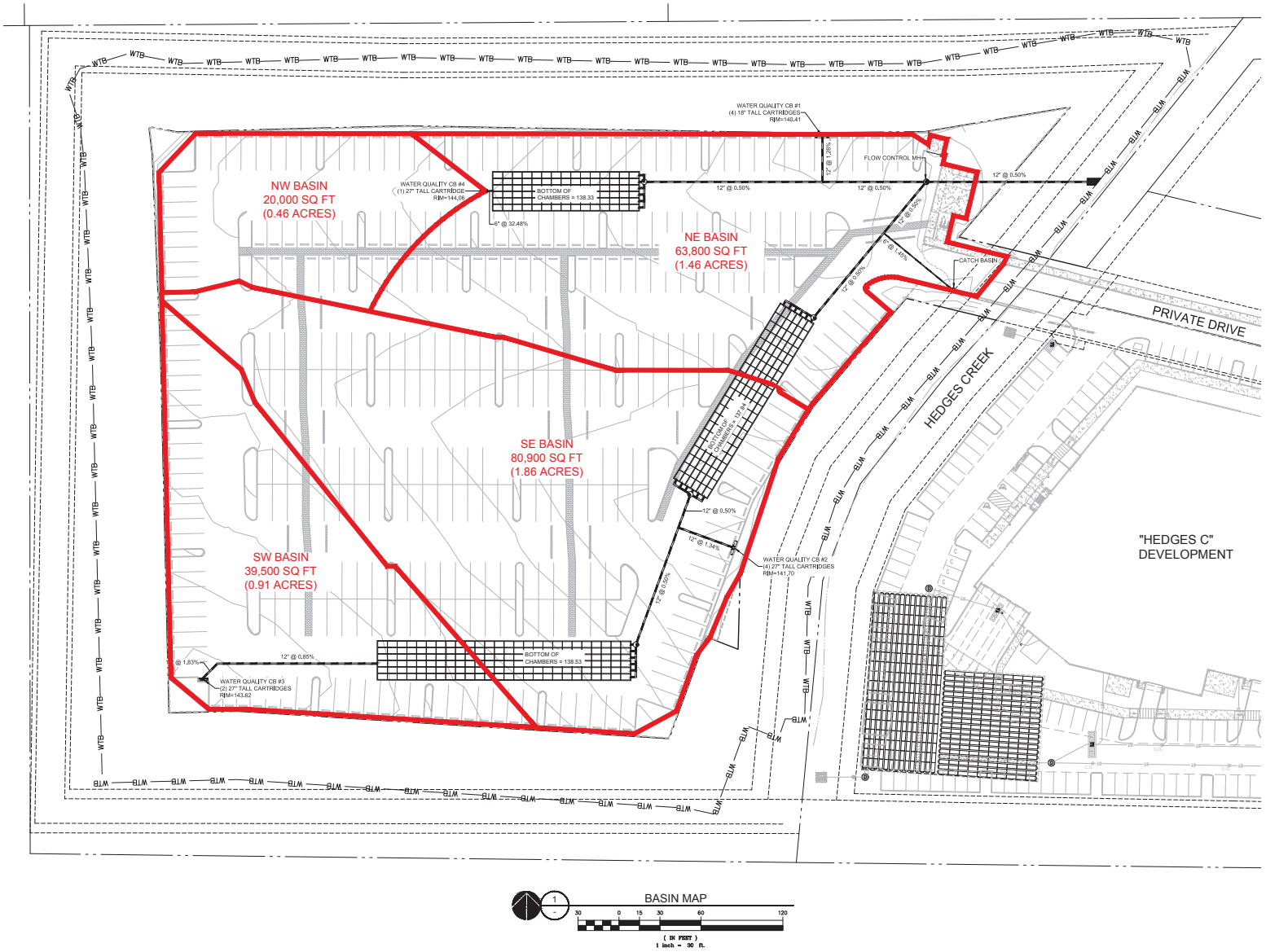
Biological Pollutants

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.

APPENDIX E

BASIN MAP



1 BASIN MAP

30 0 15 30 60 120

(IN FEET)
1 inch = 30 ft.

Architecture · Interiors
Planning · Engineering

Portland, OR
Vancouver, WA
Seattle, WA
www.mackenzie.com

MACKENZIE

Client

MARTIN DEVELOPMENT NW
PO BOX 15523
SEATTLE, WA 98115

Project

HEDGES D PARKING LOT
11507 SW AMU STREET
TUALATIN, OREGON

REGISTERED PROFESSIONAL ENGINEER
91897
OREGON
JAN. 10, 2003
GREGORY I. MINK
EXPIRES: 12/31/20

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THESE DRAWINGS ARE THE PROPERTY OF MACKENZIE AND ARE NOT TO BE USED OR REPRODUCED IN ANY MANNER, WITHOUT PRIOR WRITTEN PERMISSION

REVISION SCHEDULE

Delta	Issued As	Issue Date

SHEET TITLE:
BASIN MAP

DRAWN BY: BTC

CHECKED BY: GIM

SHEET

-

JOB NO. **2200339.00**

THE SURVEY INFORMATION SHOWN AS A BACKGROUND SCREEN ON THIS SHEET IS SHOWN FOR REFERENCE ONLY AND IS BASED ON A SURVEY BY: WEDDLE SURVEYING DATE: 10/21/2019

PERMIT SUBMITTAL 08/10/20

2200339000\DRAWINGS\CIVIL\EXHIBITS\339-BASIN MAP.DWG GIM 08/27/20 10:36 1:30

VLMK
ENGINEERING + DESIGN

FIELD INVESTIGATION

To:	Martin Real Estate	*Report Date:*	September 9, 2020
Project:	Hedges Lot D	*Site Visit:*	September 3, 2020
Location:	SW 115th Street Tualatin, Oregon	*VLMK Project Number:*	20180292
Weather:	Sunny	*Temperature:*	Approx. 90 deg. F
File Path:	G:\ACAD2018\20180292\Correspondence\Hedges D Bridge _Field Evaluation Report.docx		

PRESENT AT SITE

Trent Nagele, P.E., S.E., VLMK Engineering + Design

PURPOSE

As requested, a site visit was made to review the general condition of the bridge that crosses Hedges Creek at the end of SW 115th Street and provides access to Lot D in the Franklin Industrial Park.

Specifically, this report addresses item #13 in Tualatin Valley Fire & Rescue's review notes dated January 17, 2020 for proposed development of Tax Lot I.D.: 2S127BA0800.

> *"Please provide an engineers report regarding the private bridge that indicates the weight limit and the soundness of the bridge. Please indicate who is responsible for the maintenance of the bridge. Vehicle load limits signs shall be posted at both entrances to the bridge."*

OBSERVATIONS

Original design drawings for the bridge were obtained from Conlee Engineers, Inc. of Portland, Oregon. These drawings have two structural sheets – S1 and S2 – and are dated 10-15-01, with revision dates on sheet S2 of 4-15-02 and 4-27-04.

Structural Notes on sheet S1 indicate the bridge is designed to, "Highway Loads – AASHTO HS20". A copy of these drawings is attached, and the notes indicate additional criteria for sidewalks, railings and piping support.

The bridge is a single span concrete structure supported by abutments and piles on either side of the creek. The main deck utilizes precast concrete planks, 4-feet wide and 18-inches thick with a span of 39-feet measured from centerline of the abutments. Railings on either side of the bridge are

galvanized steel tubes. Utility piping is supported underneath the bridge and along the south side. A 6-foot sidewalk is present along the north side.

Based on visual observations of the structure at the site, the bridge is in good and sound condition. There were no observed signs of deterioration or other conditions that would reduce the capacity of the structure to support the design load.

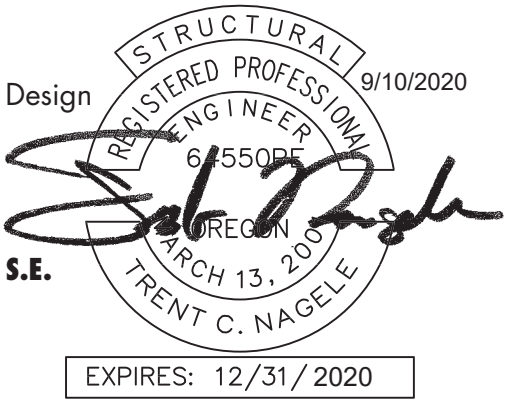
RECOMMENDATIONS

1. Future maintenance and/or evaluations of the structure are the responsibility of the owner, Martin Real Estate, and will be coordinated by them.

2. The bridge was designed for the AASHTO HS20 design criteria which is consistent with typical highway bridge standards for over-the-road vehicles. Commonly, unless a bridge has a reduced load capacity that is less than the HS20 standard, it should not be necessary to post a load rating. Please confirm if posting is required for this bridge? Note that the HS20 criteria does not correspond to a single weight limit, but rather considers a number of factors, including quantity, spacing and weight distribution to the vehicle axles, which makes posting any specific weights difficult and not wholly accurate.

Should you have questions or need additional information, please contact us.

Submitted by,
VLMK Engineering + Design



TRENT NAGELE, P.E., S.E.
Principal

Attachments: Figures (1)
Photographs (6)
Original Drawings (2 pp.)

Distribution:

Mac Martin, Martin Real Estate	macmartinis@gmail.com
Bob Wells, LMA Architects	bwells@lmueller.com

Figure 1 – Aerial of Bridge Location

Photo 1

Bridge, looking generally west.

Photo 2
Bridge, looking west.

Photo 3
South side of bridge.

Photo 4
North side of bridge.

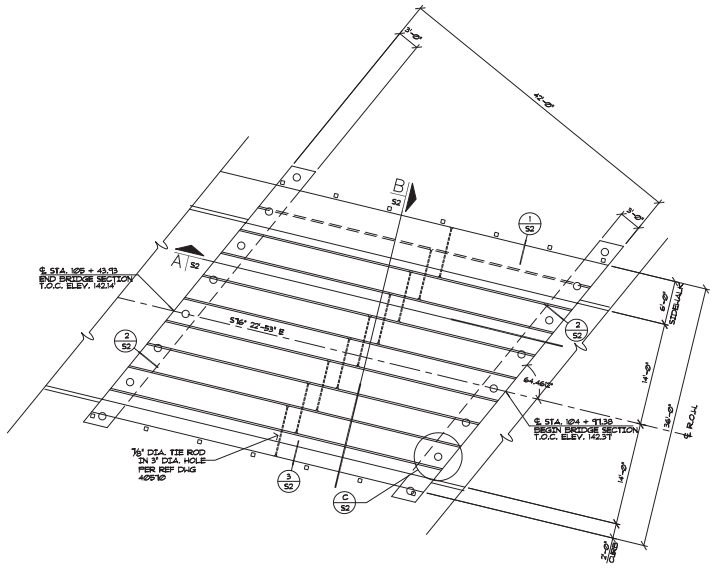
Photo 5
Bridge railing.

Photo 6

Underside of bridge (looking toward east abutment).

Photo 7

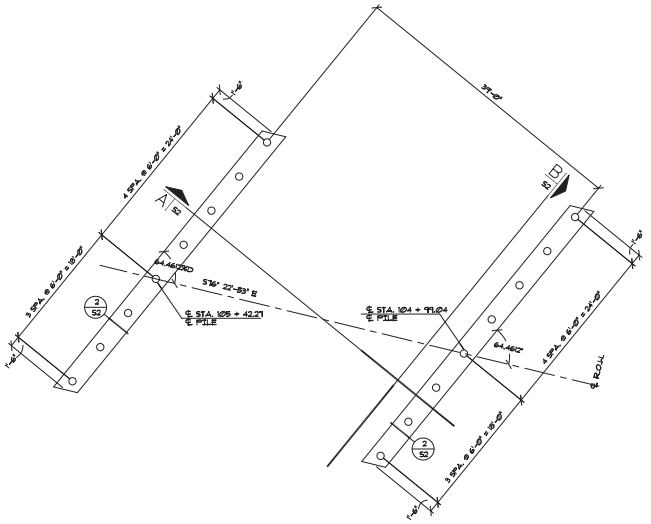
Underside of bridge (looking toward west abutment).



NORTH

BRIDGE DECK PLAN

SCALE: 1/8" = 1'-0"



NORTH

FOUNDATION PLAN

SCALE: 1/8" = 1'-0"

STRUCTURAL NOTES

CODE: STANDARD SPECIFICATIONS FOR BRIDGES (AASHTO LATEST EDITION)

DESIGN: DEAD LOADS - AS REQUIRED
HIGHWAY LOADS - AASHTO HS20
SIDEWALKS - 85 PSF OR HS20
RAILING - PER AASHTO ART. 1.1.8
PIPING - 60#/F³ PER ES2
FILLING - 60 TCN PER GEOTECHNICAL REPORT (4-13-00) PREPARED BY GEODESIGN.

CONCRETE: PLANT MIXED PER ASTM C 94. REFERENCE SPECIFICATIONS ACI 301.
1. STRENGTH - F'C = 3,000 PSI AT 28 DAYS. MINIMUM CEMENT CONTENT 5½ SACKS/CU YD., 5% + 1% ENTRAINED AIR.
2. REINFORCING - ASTM A615, GRADE 60. LAP BARS AS SHOWN ON PLANS WITH MINIMUM LAP OF 36 BAR DIAMETERS.
3. COVER - AS FOLLOWS UNLESS SHOWN OTHERWISE ON PLANS.
   A. CONCRETE PLACED AGAINST EARTH - 3"
   B. FORMED CONCRETE AGAINST EARTH - 2"
   C. SLABS-ON-GRADE - 2" TOP
4. FINISH -
   A. PILE CAPS - SMOOTH FORM FINISH. FILL TIE HOLES WITH NON-SHRINK GROUT AND GRIND SMOOTH. TOP OF CAP TO HAVE HARD TROWELED FINISH.
5. SUBMITTALS
   A. MIX DESIGN - 4 COPIES.
   B. REINFORCING SHOP DRAWINGS - 4 COPIES
6. INSPECTION - ENGINEER SHALL INSPECT REINFORCING IN PLACE PRIOR TO PLACING CONCRETE.
7. SAMPLING AND TESTING - TESTING LABORATORY TO SAMPLE AND TEST CONCRETE PER AASHTO, ART. 42.4.1.

PRECAST, PRESTRESSED VOIDED SLAB SYSTEM
1. REFERENCE STANDARDS - AASHTO SECTION 1.6 AND OSHD STANDARD PLANS (DWG. 402563 & 402570) FOR 18" STD. P/C, P/S SLAB.
2. DESIGN - FABRICATOR SHALL DESIGN AND DETAIL PRECAST PRESTRESSED MEMBERS. CALCULATIONS AND SHOP DRAWINGS SHALL BE STAMPED BY AN ENGINEER REGISTERED IN OREGON.
3. BEARING PADS - ELASTOMERIC CONFORMING TO DIVISION 2, SECTION 25 OF AASHTO SPECIFICATIONS FOR HIGHWAY BRIDGES.
4. SUBMITTALS
   A. MIX DESIGN - 4 COPIES.
   B. CALCULATIONS - 3 COPIES.
   C. SHOP DRAWINGS - 4 COPIES.
   D. TEST REPORTS - 4 COPIES.

STRUCTURAL AND MISCELLANEOUS STEEL
1. MATERIALS -
   A. SHAPES AND PLATES - ASTM A36
   B. STRUCTURAL TUBING - ASTM A500, GRADE B
   C. PIPE - ASTM A53
2. WELDING - BY CERTIFIED WELDERS PER AWS RECOMMENDATIONS. E 70 XX ELECTRODES.
3. BOLTS - ASTM A307
4. FABRICATION AND ERECTION - PER AASHTO SECTION 2.10
5. FINISH - HOT DIP GALVANIZE AFTER FABRICATION PER AASHTO M111 (ASTM A123)
6. SUBMITTALS
   A. SHOP DRAWINGS - 4 COPIES.

REVISIONS

CONLEE ENGINEERS, INC.
1308 S.W. Berths Blvd.
Portland, Oregon 97219 (503) 244-0579

PRIVATE HAUL ROAD / HEDGES CREEK BRIDGE

FRANKLIN INDUSTRIAL PARK
TUALATIN, OREGON

BRIDGE PLANS & STRUCTURAL NOTES

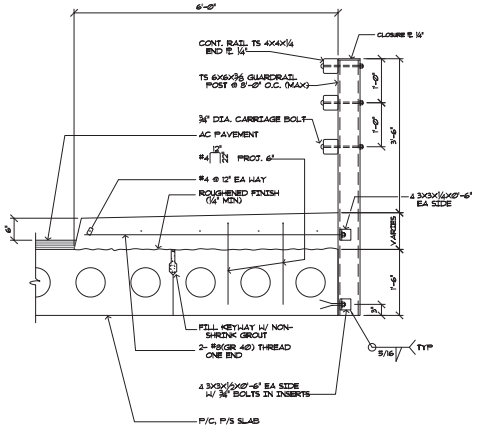
DATE: 10-15-01

PROJECT NO: DMC01

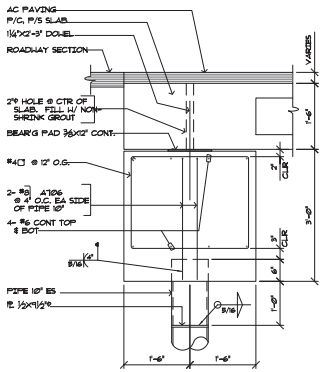
SHEET NO

S1

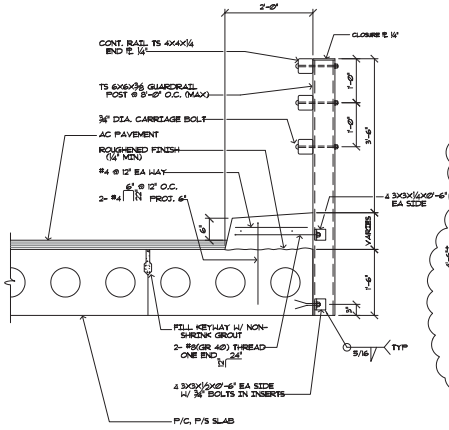
OF



1 S2 SECTION AT SIDEWALK AND GUARDRAIL
SCALE: ¾" = 1'-0"



2 S2 BRIDGE DECK / ABUTMENT
SCALE: ¾" = 1'-0"



3 S2 SECTION @ CURB AND GUARDRAIL
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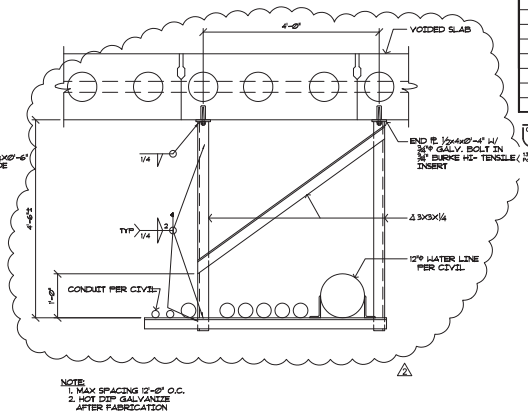
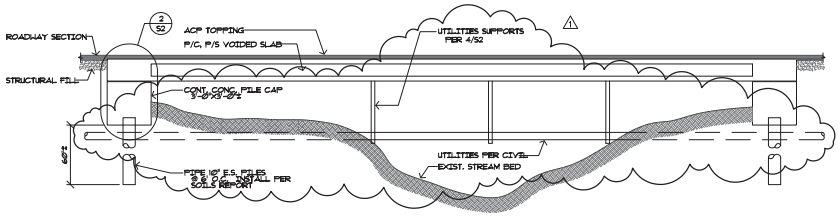
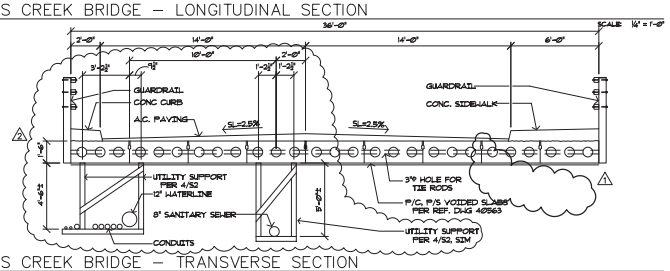


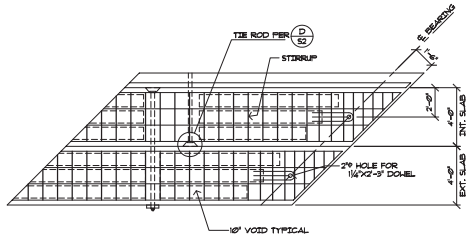
4 S2 UTILITY SUPPORT
SCALE: ¾" = 1'-0"



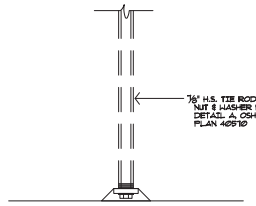
A S2 HEDGES CREEK BRIDGE – LONGITUDINAL SECTION



B S2 HEDGES CREEK BRIDGE – TRANSVERSE SECTION
SCALE: ¼" = 1'-0"



C S2 PRECAST PRESTRESSED SLAB PLAN
SCALE: N.T.S.



D S2 TIE ROD DETAIL
SCALE: ½" = 1'-0"

REVISIONS	
1	4-15-02
2	4-27-04

CONLEE ENGINEERS, INC.
1308 S.W. Berths Ave.
Portland, Oregon 97219 (503) 244-0579

PRIVATE HAUL ROAD / HEDGES CREEK BRIDGE

FRANKLIN INDUSTRIAL PARK
TUALATIN, OREGON

BRIDGE SECTIONS & DETAILS

DATE: 10-15-01
PROJECT NO: DMC01
SHEET NO
S2
OF

Hedges D – Fleet Parking Lot

11507 SW 115th Avenue (private street), Tualatin, OR 97062

End