Technical Memorandum

TO: Jim Rioux, Project Manager

FROM: Annabel Warnell
Calvin McCaughan, PE

DATE: April 2, 2018

RE: **Summary of Groundwater Monitoring Services**
Water Street Tide Gate
Olympia, Washington
Project No. 0258054.010.011

Introduction

Landau Associates, Inc. (LAI) is pleased to present this technical memorandum summarizing the results of groundwater monitoring services in support of the City of Olympia's (City's) proposed Water Street Tide Gate project, located at 220 Water Street NW in Olympia, Washington (site). Our services have been provided in accordance with the scope outlined in our professional services agreement, authorized by the City on February 16, 2018.

The general project location is shown on Figure 1. Figure 2 shows pertinent site features and the approximate location of our exploration. Figures 3 and 4 present a soil classification system and key and a summary log of the subsurface conditions observed during our field investigation. Figure 5 shows groundwater elevation data and predicted tidal fluctuations.

This technical memorandum has been prepared based on discussions with, and information provided by, representatives of the City, our familiarity with the project area, the results of our field investigation and groundwater study, and our experience with similar projects.

Project Understanding

The City plans to install a new valve at the existing Water Street pump station. The tidal fluctuations of nearby Puget Sound may influence groundwater levels at the site, thereby affecting the scope of dewatering necessary during future construction. We originally anticipated excavation for the proposed improvements to be 10 feet (ft) below ground surface (bgs) or less; however, we understand the means and methods of installing the new valve have changed and will not require open excavations. Geotechnical services for the proposed improvements are no longer necessary and this technical memorandum serves to document our work performed on the project to date.

Site Conditions and Geologic Setting

Located at 220 Water Street NW in Olympia, Washington, the site consists of the existing pump station and an access area enclosed by a chain-link fence. Commercial buildings and parking lots border the north, south, and east sides of the site, with Puget Sound to the west. Site topography is generally flat.

Geologic information for the project area was obtained from the *Geologic Map of the Tumwater 7.5-minute Quadrangle, Thurston County, Washington* (Walsh et al. 2003). The map indicates that surficial deposits in the vicinity of the site consist of fill (Qf). In our experience, this unit is highly variable and can consist of clay, silt, sand, and gravel deposits with organic matter, shells, and other debris.

The subsurface conditions observed in our exploration were generally consistent with the mapped geology.

Subsurface Conditions

We explored subsurface conditions on February 9, 2018 by advancing one boring (MW-1) 20 ft bgs and installing a monitoring well at 15 ft bgs. Holocene Drilling, Inc. of Puyallup, Washington, subcontracted by LAI, operated the track-mounted push-probe drill rig.

The field investigation was coordinated and monitored by LAI personnel, who also maintained a detailed record of observed subsurface soil and groundwater conditions and described the soil observed by visual and textural examination. Subsurface soil conditions were described using the soil classification system shown on Figure 3 and in general accordance with ASTM International (ASTM) standard D2488, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures).* A summary log of our exploration is presented on Figure 4 and represents our interpretation of subsurface conditions observed during the field investigation. The stratigraphic contacts shown on the log represent approximate boundaries between soil types; actual transitions may be more gradual.

We categorize the soil observed underlying existing surface conditions (i.e., beauty bark and topsoil) into one general unit.

- **Dredge Fill:** This unit was observed underlying existing surface conditions and typically consists of sand with varying silt and gravel content or very sandy silt. Shell fragments and trace organics were observed in this unit. The dredge fill was generally in a loose to medium dense/medium stiff condition. Our exploration terminated in this unit.

Fill is highly variable and may contain organic matter, oversized material, and other debris. Although too large to have been observed in our exploration, cobbles, boulders, and debris may be present at the site. The contractor should be prepared to handle such oversized material.

During our February 2018 field investigation, groundwater was observed at an approximate elevation of 8 ft in boring MW-1. Subsequent groundwater readings were recorded in the monitoring well using a pressure transducer. Groundwater fluctuations measuring approximately ½ ft across tidal cycles were recorded during the 7-day monitoring period. A graph comparing groundwater readings from the pressure transducer with predicted tidal fluctuations is presented on Figure 5.

An oil sheen was observed from 10 to 12.5 ft bgs and a petroleum odor was detected from 10 to 20 ft bgs. Soil and groundwater contamination from petroleum and petroleum-related constituents precluded soil

sample retention. Soil samples from our exploration were sealed in a drum and left on site within the pump station access area fence.

Conclusions and Recommendations

We understand the means and methods of installing the new valve at the Water Street pump station have changed since our services were retained and open excavations will no longer be required. Therefore, this technical memorandum simply documents geotechnical data collected to date. If the direction of the project reverts back to the original scope, we are available to provide geotechnical recommendations upon request.

Use of This Technical Memorandum

There may be some variation in subsurface soil and groundwater conditions, and the nature and extent of the variations may not become evident until construction. If variations in subsurface conditions are encountered during construction, LAI should be notified for review of this technical memorandum and revision of such if necessary. Accordingly, a contingency for unanticipated conditions should be included in the construction budget and schedule.

Closure

Landau Associates, Inc. prepared this technical memorandum for the exclusive use of the City of Olympia for the proposed Water Street Tide Gate project in Olympia, Washington. Use of this technical memorandum by others or for another project is at the user's sole risk. Within the limitations of scope, schedule, and budget, our services have been provided in accordance with generally accepted practices of the geotechnical engineering profession; no other warranty, express or implied, is made as to the professional advice included in this technical memorandum. We trust this technical memorandum provides you with sufficient information to proceed, and we appreciate the opportunity to provide geotechnical services on this project. If you have questions or comments, or if we may be of further service, please contact the undersigned at (360) 791-3178.

LANDAU ASSOCIATES, INC.

Annabel Warnell
Senior Staff EIT

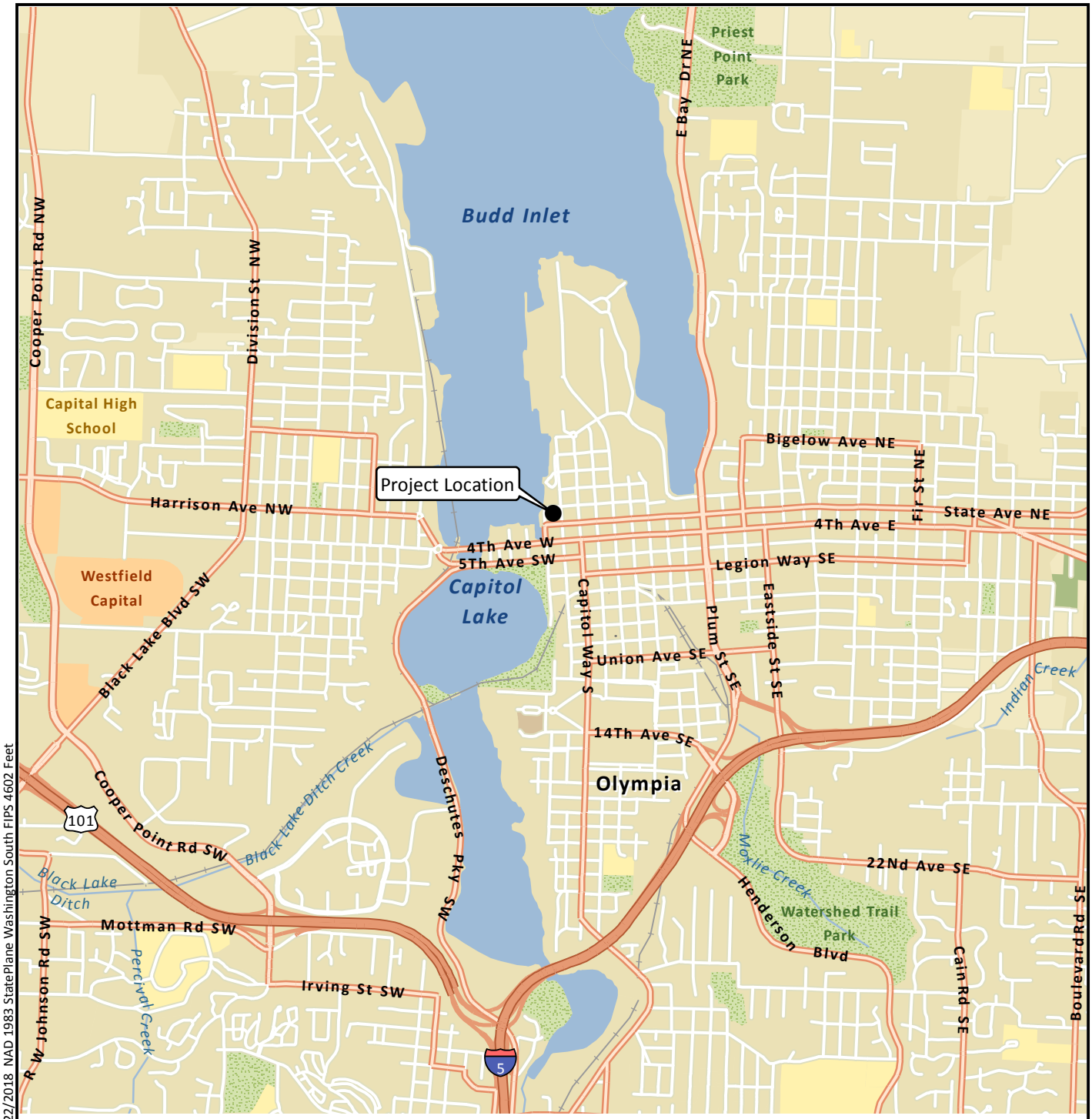
Calvin McCaughan, PE
Principal

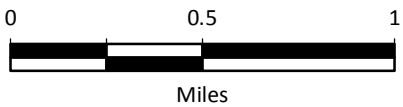
AMW/CAM/mcs
[Y:\0258\054.010\R\WATER STREET TIDE GATE SUMMARY OF GROUNDWATER MONITORING SERVICES TECHNICAL MEMORANDUM.DOCX]

References

Walsh, T.J., R.L. Logan, H.W. Schasse, and M. Polenz. 2003. *Geologic Map of the Tumwater 7.5-minute Quadrangle, Thurston County, Washington.* Washington Division of Geology and Earth Resources Open File Report 2003-25.

Attachments: Figure 1. Vicinity Map
Figure 2. Site and Exploration Location Plan
Figure 3. Soil Classification System and Key
Figure 4. Log of MW-1
Figure 5. Groundwater Data vs. Tidal Fluctuations





Data Source: Esri 2012

G:\Projects\258\054\010\011\F01VicMap.mxd 2/22/2018 NAD 1983 StatePlane Washington South FIPS 4602 Feet

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City of Olympia Water Street Tide Gate Olympia, Washington	**Vicinity Map**	Figure 1

Source: Google Earth Pro, 2018

City of Olympia Water Street Tide Gate Olympia, Washington	**Site and Exploration Location Plan**	Figure 2

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Soil Classification System

MAJOR DIVISIONS			GRAPHIC SYMBOL	USCS LETTER SYMBOL[1]	TYPICAL DESCRIPTIONS [2][3]
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)		GW	Well-graded gravel; gravel/sand mixture(s); little or no fines
				GP	Poorly graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)		GM	Silty gravel; gravel/sand/silt mixture(s)
				GC	Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)		SW	Well-graded sand; gravelly sand; little or no fines
				SP	Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)		SM	Silty sand; sand/silt mixture(s)
				SC	Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)			ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
				CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
				OL	Organic silt; organic, silty clay of low plasticity
	SILT AND CLAY (Liquid limit greater than 50)			MH	Inorganic silt; micaceous or diatomaceous fine sand
				CH	Inorganic clay of high plasticity; fat clay
				OH	Organic clay of medium to high plasticity; organic silt
	HIGHLY ORGANIC SOIL			PT	Peat; humus; swamp soil with high organic content

OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT		AC or PC	Asphalt concrete pavement or Portland cement pavement
ROCK		RK	Rock (See Rock Classification)
WOOD		WD	Wood, lumber, wood chips
DEBRIS		DB	Construction debris, garbage

Notes:
1. USCS letter symbols correspond to symbols used by the Unified Soil Classification System and ASTM classification methods. Dual letter symbols (e.g., SP-SM for sand or gravel) indicate soil with an estimated 5-15% fines. Multiple letter symbols (e.g., ML/CL) indicate borderline or multiple soil classifications.
2. Soil descriptions are based on the general approach presented in the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the Standard Test Method for Classification of Soils for Engineering Purposes, as outlined in ASTM D 2487.
3. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:

Primary Constituent:	> 50% - "GRAVEL," "SAND," "SILT," "CLAY," etc.
Secondary Constituents:	> 30% and ≤ 50% - "very gravelly," "very sandy," "very silty," etc.
	> 15% and ≤ 30% - "gravelly," "sandy," "silty," etc.
Additional Constituents:	> 5% and ≤ 15% - "with gravel," "with sand," "with silt," etc.
	≤ 5% - "with trace gravel," "with trace sand," "with trace silt," etc., or not noted.

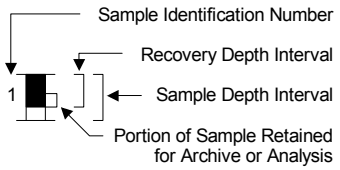
4. Soil density or consistency descriptions are based on judgement using a combination of sampler penetration blow counts, drilling or excavating conditions, field tests, and laboratory tests, as appropriate.

Drilling and Sampling Key

SAMPLER TYPE

Code	Description
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon
c	Shelby Tube
d	Grab Sample
e	Single-Tube Core Barrel
f	Double-Tube Core Barrel
g	2.50-inch O.D., 2.00-inch I.D. WSDOT
h	3.00-inch O.D., 2.375-inch I.D. Mod. California
i	Other - See text if applicable
1	300-lb Hammer, 30-inch Drop
2	140-lb Hammer, 30-inch Drop
3	Pushed
4	Vibrocore (Rotosonic/Geoprobe)
5	Other - See text if applicable

SAMPLE NUMBER & INTERVAL



Field and Lab Test Data

Code	Description
PP = 1.0	Pocket Penetrometer, tsf
TV = 0.5	Torvane, tsf
PID = 100	Photoionization Detector VOC screening, ppm
W = 10	Moisture Content, %
D = 120	Dry Density, pcf
-200 = 60	Material smaller than No. 200 sieve, %
GS	Grain Size - See separate figure for data
AL	Atterberg Limits - See separate figure for data
GT	Other Geotechnical Testing
CA	Chemical Analysis

Groundwater

▽ Approximate water level at time of drilling (ATD)

▼ Approximate water level at time other than ATD

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Water Street Tide Gate
Olympia, Washington

Soil Classification System and Key

Figure 3

MW-1

SAMPLE DATA | **SOIL PROFILE** | **GROUNDWATER**

Drilling Method: Geoprobe™
Ground Elevation (ft): 15.3 (NAVD 88)
Drilled By: Holocene Drilling Inc.

Detail
(DOE#: BKC 438)

Depth (ft)	Sample Number & Interval	Sampler Type	Blows/Foot	Test Data	Graphic Symbol	USCS Symbol	Soil Description
0						SM	Beauty bark over 4 inches of dark brown,
						SM	very silty, fine to coarse SAND with organics (loose, moist)
							(TOPSOIL)
2							Brown, silty, fine to coarse SAND with gravel (loose, moist)
							(DREDGE FILL)
						SP	-Used hand tools to dig first 2 ft
							Gray-brown, fine to coarse SAND with gravel (medium dense, moist)
4							
6							-Grades to brown, mottled, and with trace shell fragments
							-Very silty sand layer about 3 inches thick
8							-Grades to gray and without shell fragments
10							-Observed oil sheen from 10-12.5 ft. Detected gas odor from 10-20 ft
12							-Grades to with trace straw for about 2 inches
14						SM	Gray, silty, fine to medium SAND (medium dense, wet)
						SP	Gray, fine to coarse SAND with gravel (medium dense, wet)
16						ML	Gray, very sandy SILT with shell fragments and trace straw (medium stiff, moist to wet)
18							
20							

Water Level: Groundwater at 7.44 ft bgs

Well construction:
- Flush-mounted monument with locking cap
- Concrete Seal
- Bentonite chips
- 2-inch-diameter, Schedule 40 PVC well casing
- 10/20 Colorado sand pack
- 2-inch-diameter, Schedule 40 PVC screen (0.020-inch slot size)

Boring Completed 02/09/18
Total Depth of Boring = 20.0 ft.

Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

258054.01 4/2/18 Y:\0258\054.010\T\0258054.010.GPJ WELL LOG

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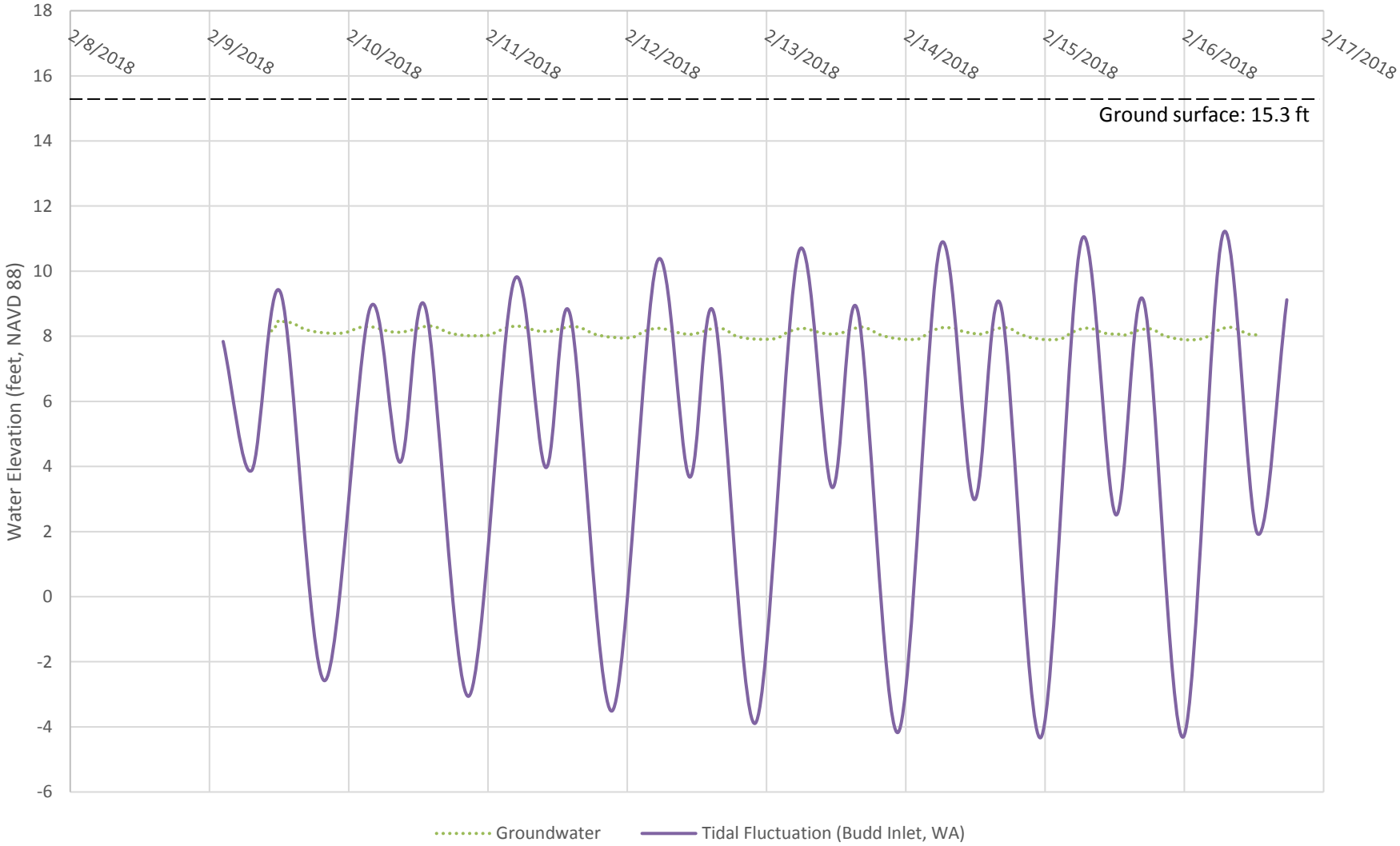
Log of MW-1

Figure
4



Notes

1. Tidal data source: National Oceanic and Atmospheric Administration (NOAA) Tides and Currents Station 9446969, Budd Inlet, Puget Sound, Washington.
2. Tidal fluctuation data, converted to North American Vertical Datum of 1988 (NAVD 88) as presented above, are based on predicted, not observed, tidal water elevations.

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Groundwater Data vs. Tidal Fluctuations

Figure
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