Remedial Investigation and Feasibility Study

Gas Works Park Site
Seattle, Washington

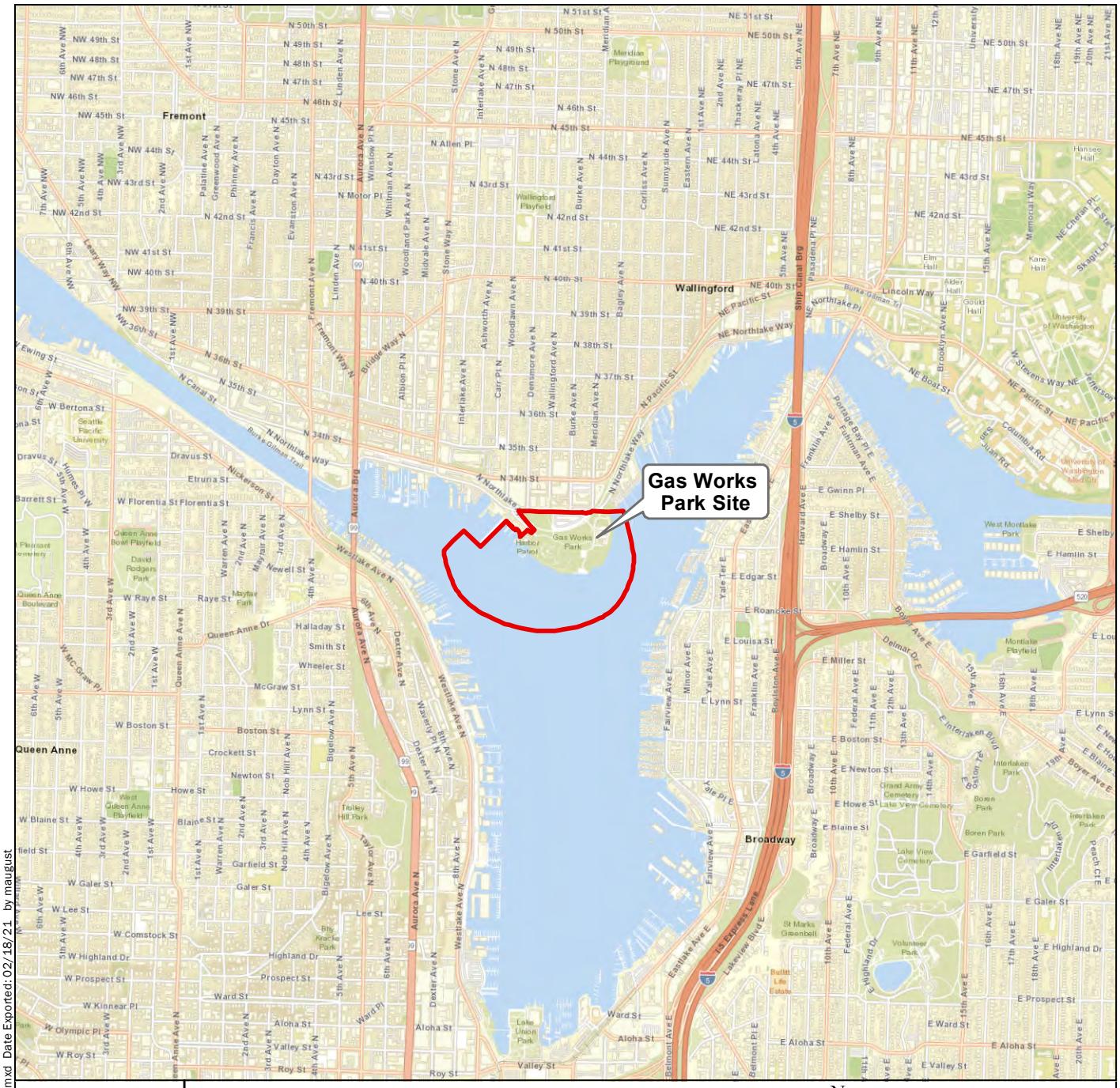
for
Puget Sound Energy and the City of Seattle

January 2023

GeoEngineers
Earth Science + Technology

FIGURES

GeoEngineers



Notes:

1. Gas Works Park Site boundary is the Area of Investigation.
2. Basemap - ESRI, 2021.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

Vicinity Map

Gas Works Park Site
Seattle, Washington

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Figure 1-1

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Legend

- Area of Investigation
- Shoreline (OHWM)
- Consent Decree
- Impervious (Paved or Structures)
- Gravel

Notes:

1. The AOI is documented in the 2013 Amendment of Agreed Order DE 2008 (Ecology 2013).
2. Basemap 2005 USGS aerial photograph. Does not show current conditions.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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Site Plan

Gas Works Park Site
Seattle, Washington

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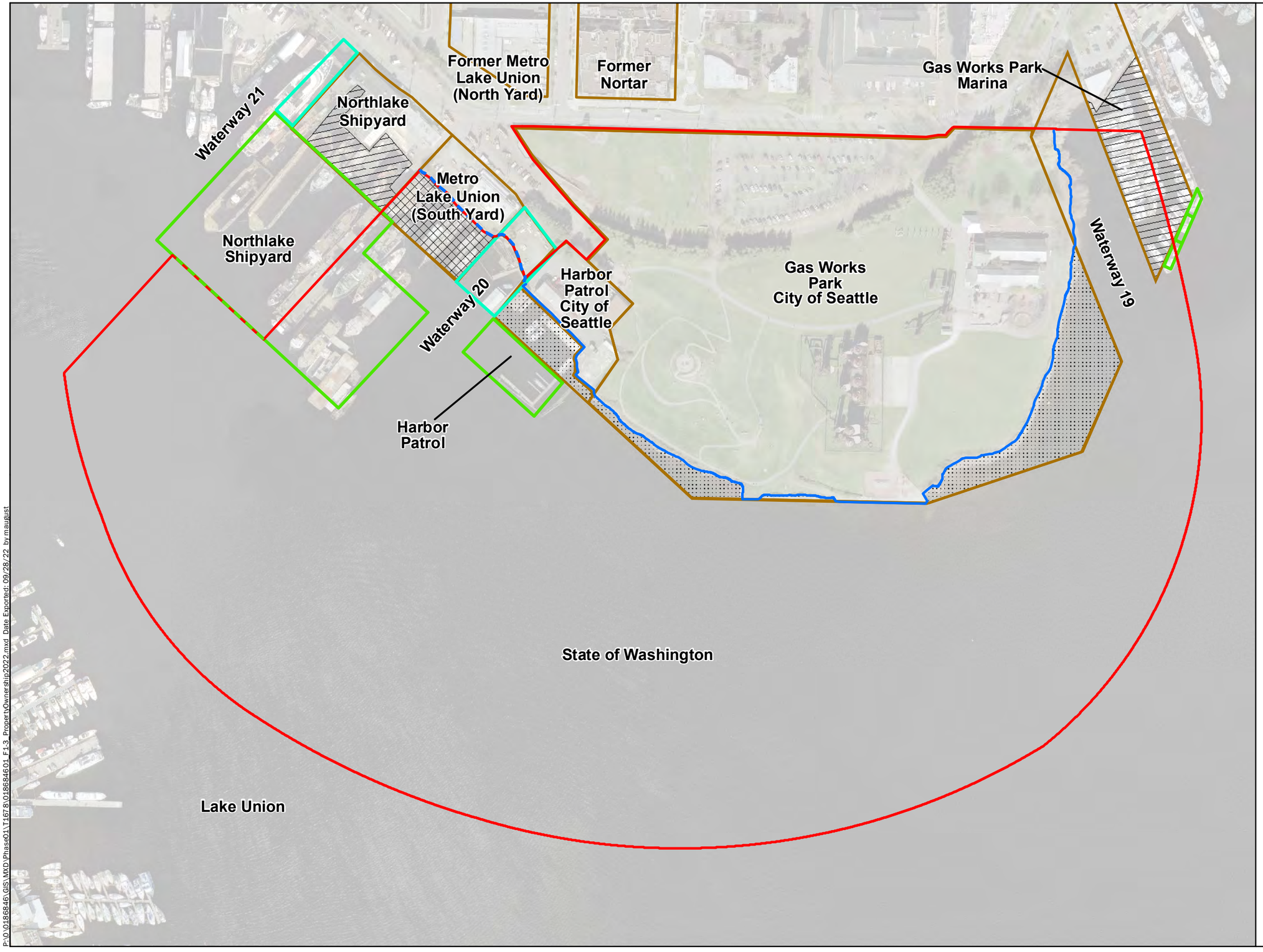
Figure 1-2

P:\0\0186846\GIS\MXD\Phase01\T1678\0186846_F1-2_SitePlan2021.mxd Date Exported: 02/26/21 by maugust



Legend

- Area of Investigation
- Shoreline (OHWM)

Properties

- City Owned Aquatic Property
- County Owned Aquatic Property
- Privately Owned Aquatic Property

Boundaries

- Property Boundary
- Aquatic Lease Boundary (State-Owned Aquatic Property)
- Waterway Use Permit Boundary (State-Owned Upland and and Aquatic Property)

Notes:

1. Reference: Department of Parks, Property Acquisition Map (1984). King County Parcel Viewer (2013). King County iMap (2013).
2. Record of Surveys: Northlake Shipyard - DNR Lease 20-A12992 and Waterway 21 DNR Aquatic Waterway User Permit [February 2008]; Waterway 20 DNR Aquatic Waterway User Permit No. 20-089981 [June 21, 2018]; Gas Works Park Marina DNR Lease 20-013648 [December 5, 2018), DNR Lease 20-A79485 [September 17, 2019], and DNR Lease 20-B12133 [September 17, 2019].
3. Basemap 2005 USGS aerial photograph. Does not show current conditions.
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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Property Ownership

Gas Works Park Site
Seattle, Washington

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Figure 1-3

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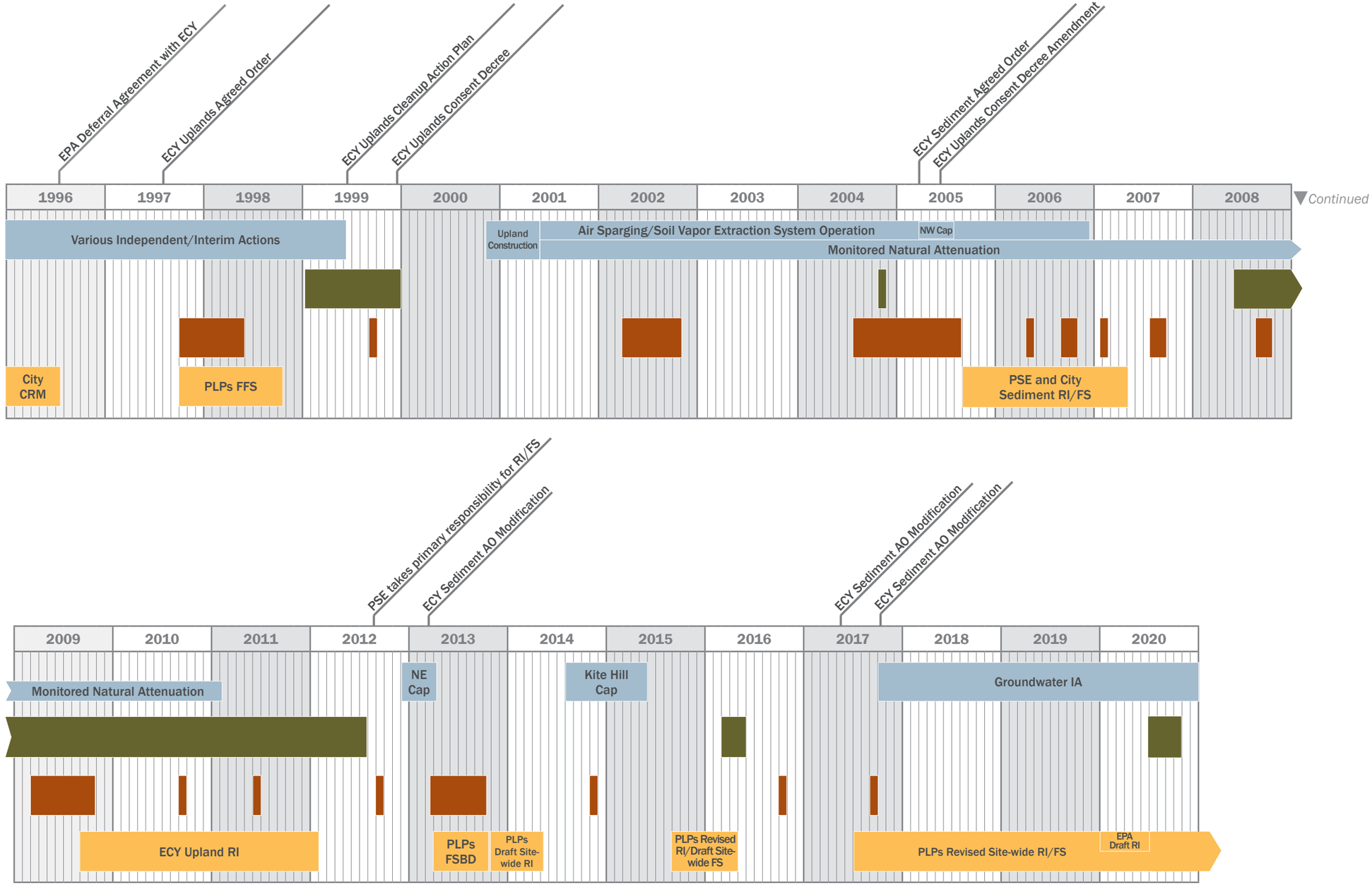

Legend

- Uplands Cleanup Activities
- EPA Comments
- Field Investigations Performed by PLPs
- RI/FS Reporting

Acronym Definitions

AO	Agreed Order
City	City of Seattle
CRM	Candidate Remedial Measures
ECY	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ESA	Eastern Sediment Area
FFS	Focused Feasibility Study
FSBD	Feasibility Study Bridging Document
IA	Interim Action
PLPs	Potentially Liable Persons (PSE and City)
PSE	Puget Sound Energy
RI/FS	Remedial Investigation/ Feasibility Study
WSA	Western Sediment Area

Key Events and Activities Timeline

Gas Works Park Site
Seattle, Washington

GeoEngineers | **Figure 1-4**

Path: P:\0\0186846\Graphics_Misc\Figure-1-4_Key-Events-Timeline.indd Revised: 30 April 2021 sbraicks

Legend

- Area of Investigation
- Shoreline (OHWM)
- Historical Railroad Features
- Former Tar Refinery Footprint
- Other Historical Non-MGP Operational Structures
- Former MGP Materials Storage (Lampblack)
- Former MGP Structures
- Thylox Process Facility
- Lampblack Use/Storage/Processing
- Western Overwater Docking
- Log Booming Area
- Historical Outfalls

Notes:

1. Site structures delineated as shown in the General Plan, Lake Station,Seattle Gas Company, April 1949, revised in June 1953. Historical railroad features shown as delineated in General Plan, Lake Station, Seattle Gas Co., June 1938. ATCO footprint as shown on 1919 Sanborn map. Sanborn Fire Insurance Map, 1950; Parametrix (1998) Focused Feasibility Study; 1946, 1956 aerial photo; Haag 1973a.
2. Basemap 2005 USGS aerial photograph. Does not show current conditions.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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Feet

Historical Operations

Gas Works Park Site
Seattle, Washington

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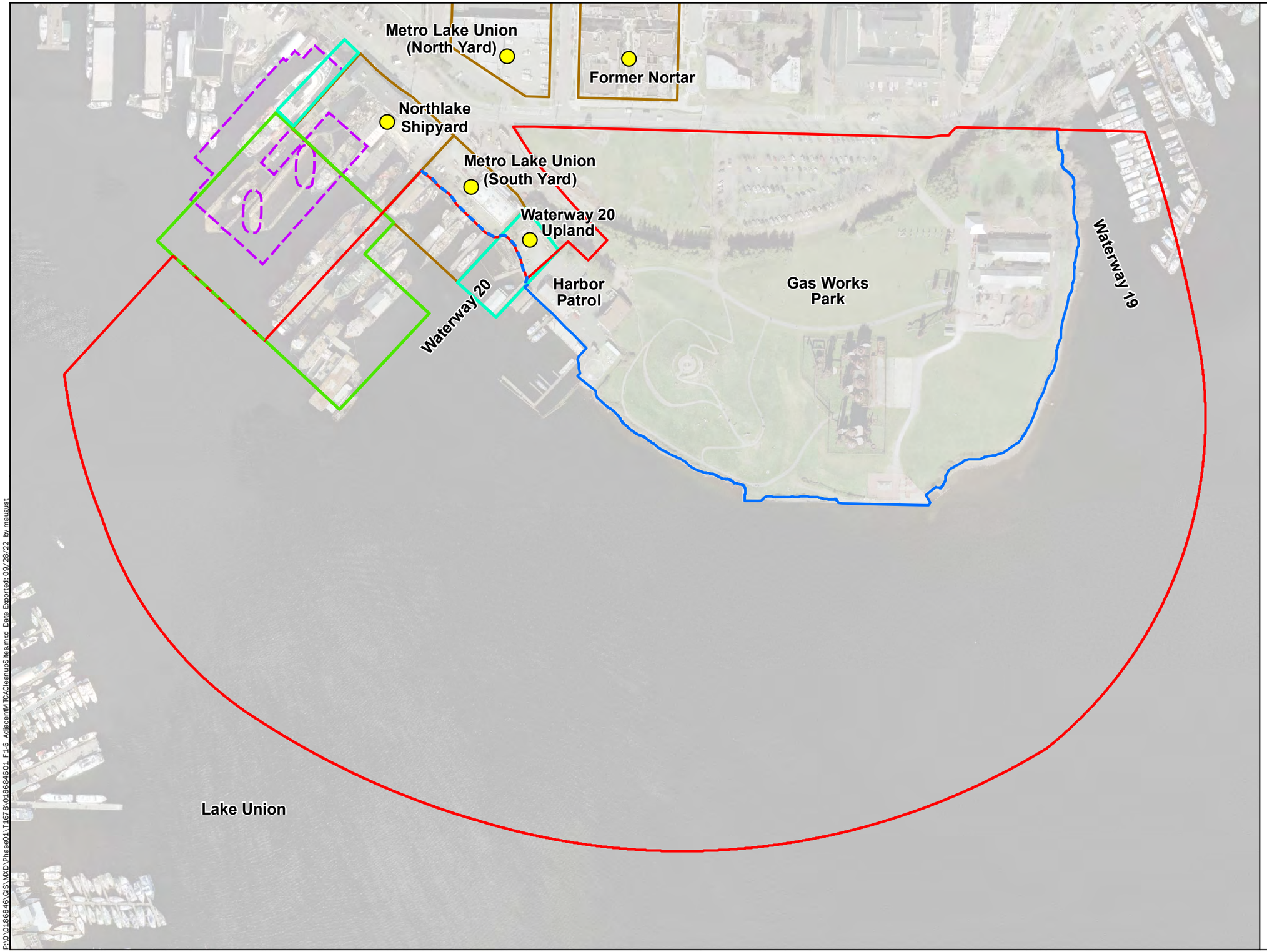
Figure 1-5

Path: P:\00186846\GIS\MXD\Phase01\T16780186846\01_F1-5_HistoricalStructures2021.mxd Map Revised: 03 December 2021 maugust



Legend

- Area of Investigation
- Shoreline (OHWM)
- MTCA Cleanup Site

Boundaries

- Property Boundary
- Aquatic Lease Boundary
- Waterway Use Permit Boundary
- Northlake Shipyard 2014 Interim Action Dredge Footprint

Notes:

1. Reference: Department of Parks, Property Acquisition Map (1984). King County Parcel Viewer (2013). King County iMap (2013).
2. Record of Surveys: Northlake Shipyard - DNR Lease 20-A12992 and Waterway 21 DNR Aquatic Waterway User Permit [February 2008]; Waterway 20 DNR Aquatic Waterway User Permit No. 20-089981 [June 21, 2018].
3. Basemap 2005 USGS aerial photograph. Does not show current conditions.
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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Feet

Adjacent MTCA Cleanup Sites

Gas Works Park Site
Seattle, Washington

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Figure 1-6

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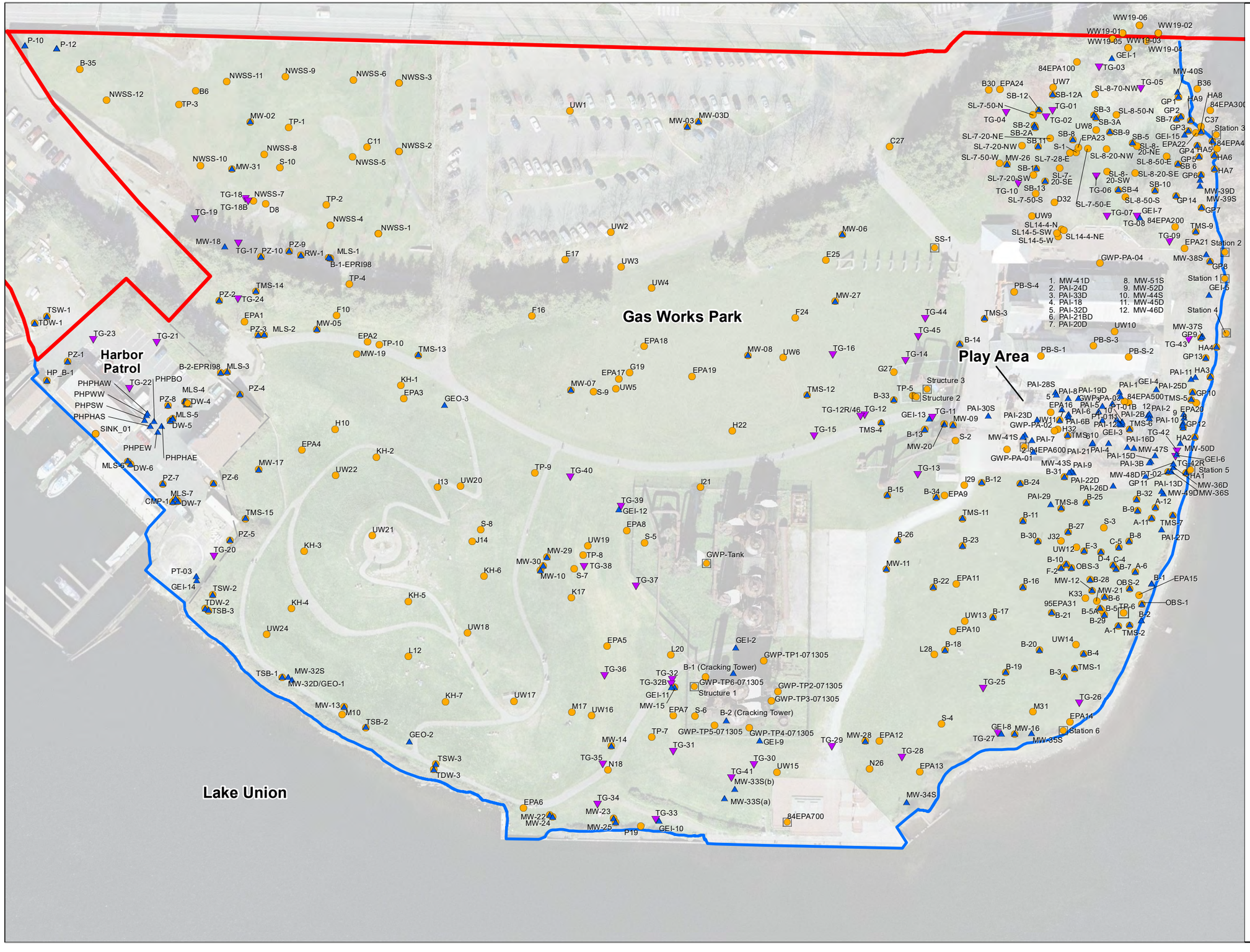

Notes:

1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection:NAD 1983 StatePlane Washington North FIPS 4601 Feet.

Soil Explorations

Gas Works Park Site
Seattle, Washington

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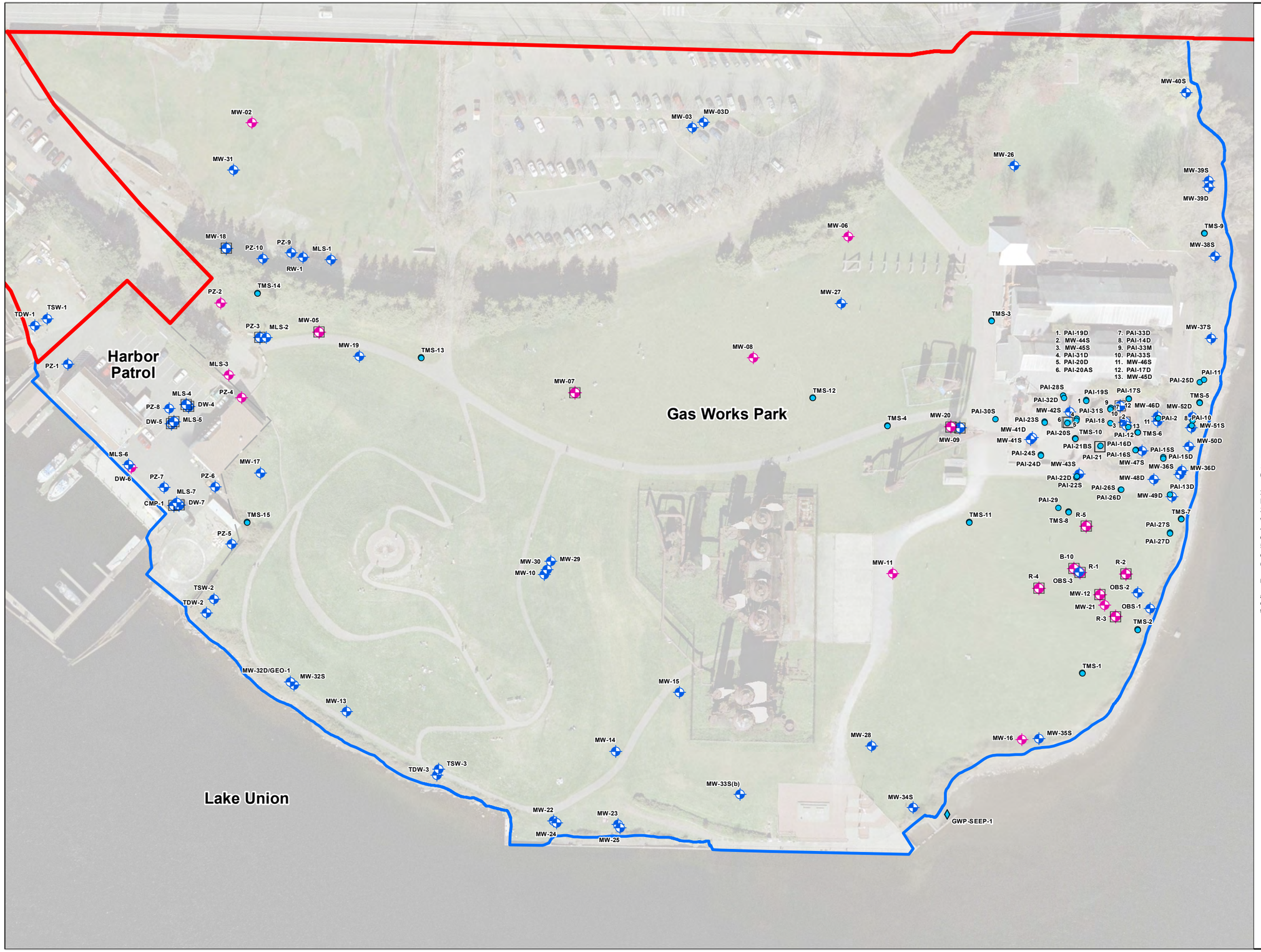
Figure 2-1

Path: P:\0\0186846\GIS\MXD\Phase01\T1678018684601_F2-1_ExplorationsUpland2021.mxd Map Revised: 18 February 2021 maugust



Legend

- Area of Investigation
- Shoreline (OHWM)
- Grab Groundwater Well
- Current Groundwater Monitoring Well
- Historical Groundwater Monitoring Well
- Tar or NAPL Detected in Well
- Groundwater Seep

Notes:

1. As of last well gauging event (December 2020), confirmed NAPL (i.e., >0.01 foot) was detected in wells DW-4, DW-5, DW-7, MW-9, MW-18, and PZ-3.
2. R1 through R4 records lost and NAPL detection not indicated. However, some/all of these wells contained NAPL.
3. The groundwater seep was observed in the fall of 2000 and winter of 2001. The location is approximate.
4. NAPL not shown as detected if only 0.01 foot detected once and not confirmed or if only a trace detected (see Table 3J-2).
5. Basemap 2005 USGS aerial photograph. Does not show current conditions.
6. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N
W E
S

100 0 100
Feet

Groundwater Explorations

Gas Works Park Site
Seattle, Washington

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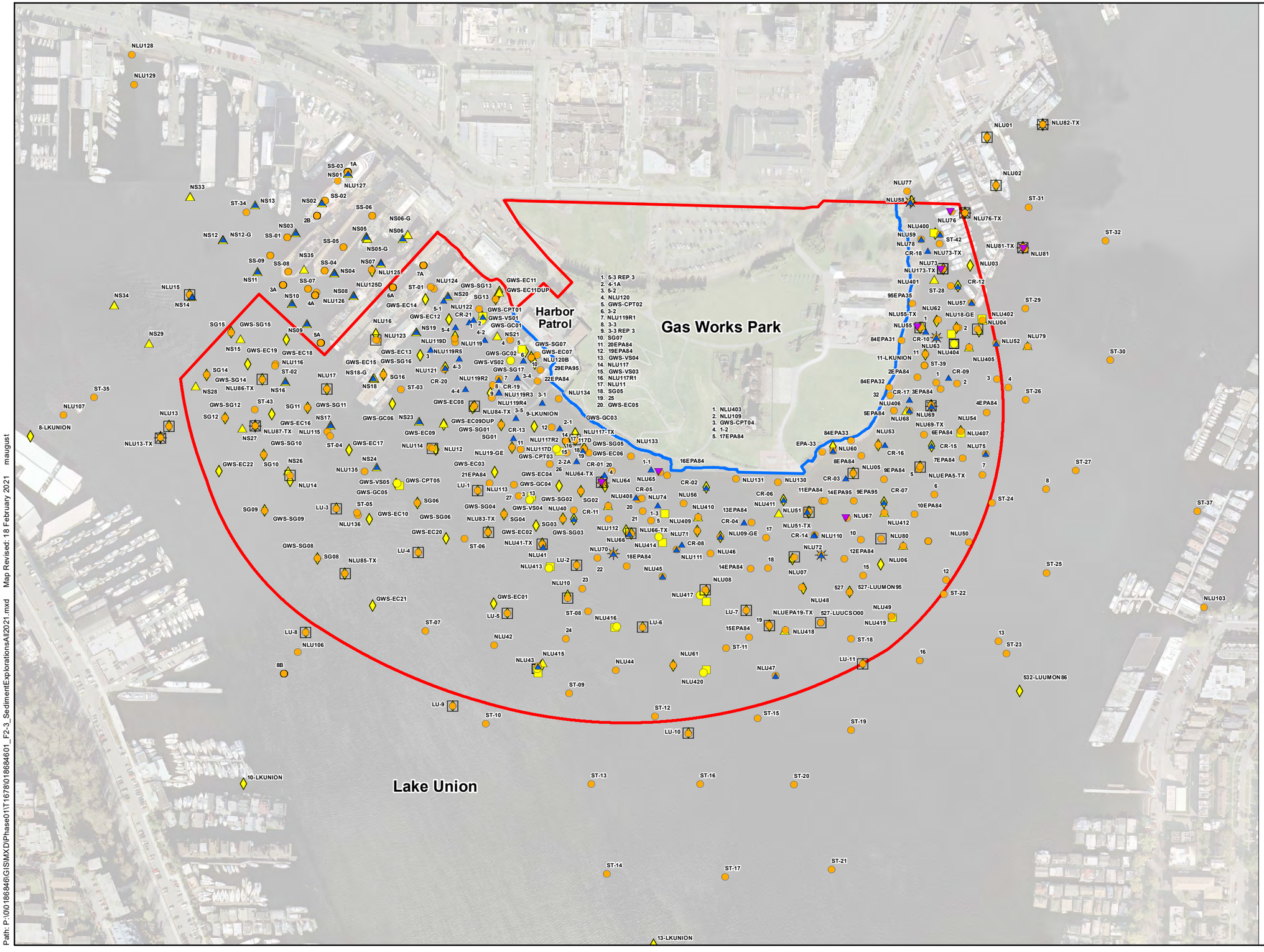
Figure 2-2

Path: P:\00186846\GIS\MXD\Phase01\T1678\01868601_F2-2_GWExplorations2021.mxd Map Revised: 28 April 2021 maugust



Legend

- Area of Investigation
- Shoreline (OHWM)

Chemical

- Grab
- Core
- Diver Collected
- Bioassay
- Porewater\Offshore Groundwater

Geotechnical

- Cone Penetrometer Test
- Standard Penetration Test
- Vane Shear
- Other Geotechnical
- Sediment Bearing Plate

Notes:

1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

300 0 300

Feet

All Sediment Explorations

Gas Works Park Site
Seattle, Washington

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Figure 2-3

Path: P:\0\0186846\GIS\MXD\Phase01\T167801\8684601_F2-3_SedimentExplorationsAll2021.mxd Map Revised: 18 February 2021 maugust

Notes:
1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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Legend

- Area of Investigation
- Shoreline (OHWM)

Chemical
- Grab
- Core
- Diver Collected
- Bioassay
- Porewater\Offshore Groundwater

N W E S

150 0 150
Feet

Chemical Sediment Explorations

Gas Works Park Site
Seattle, Washington

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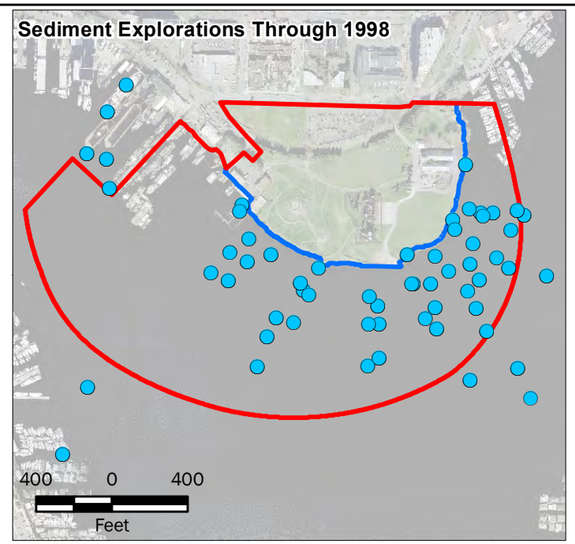

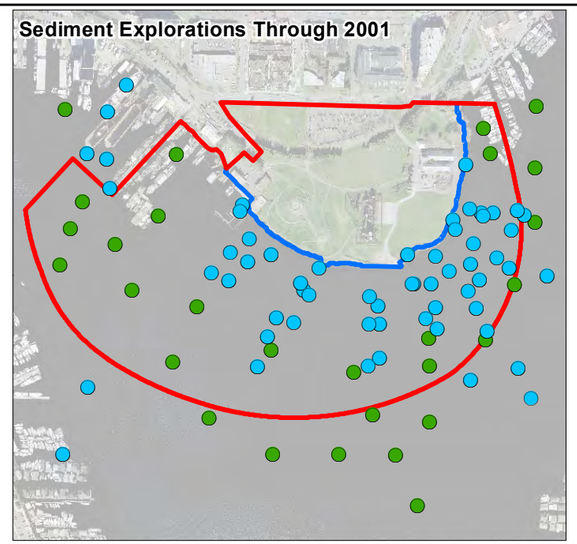

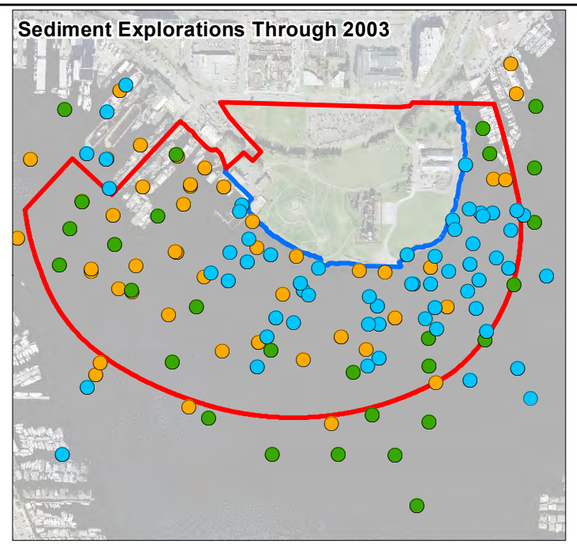

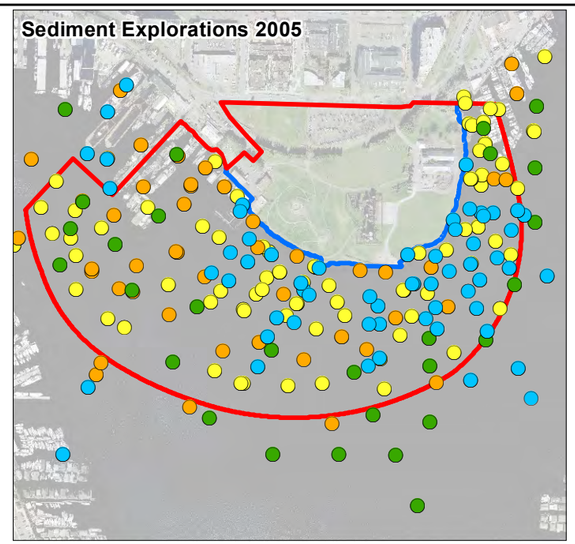

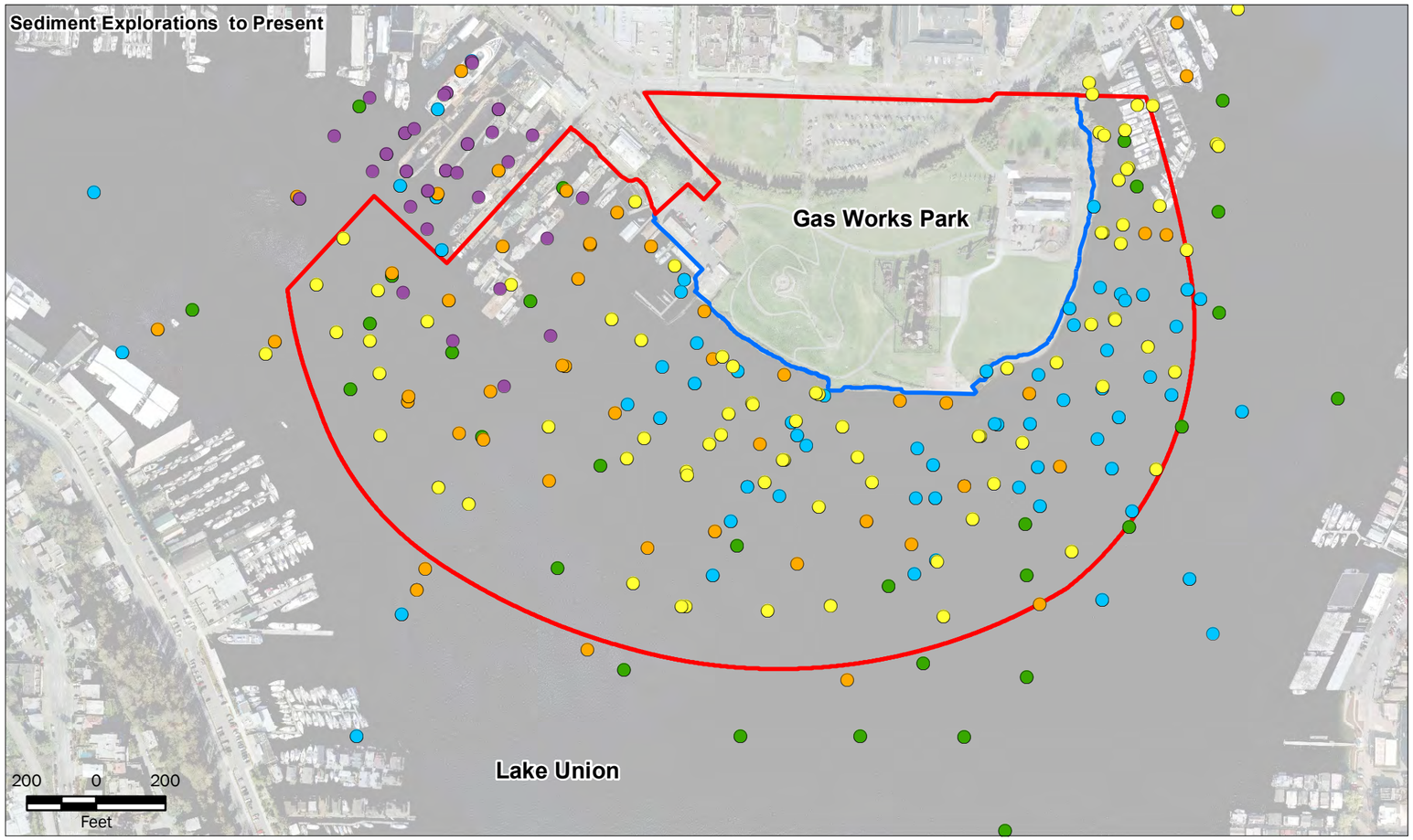

Legend

- Area of Investigation
- Shoreline (OHWM)
- Explorations through 1998
- Explorations from 1999 through 2001
- Explorations from 2002 through 2003
- Explorations from 2004 through 2005
- Explorations from 2006 to Present

Notes:

1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

Chemical Sediment Explorations By Date

Gas Works Park Site
Seattle, Washington

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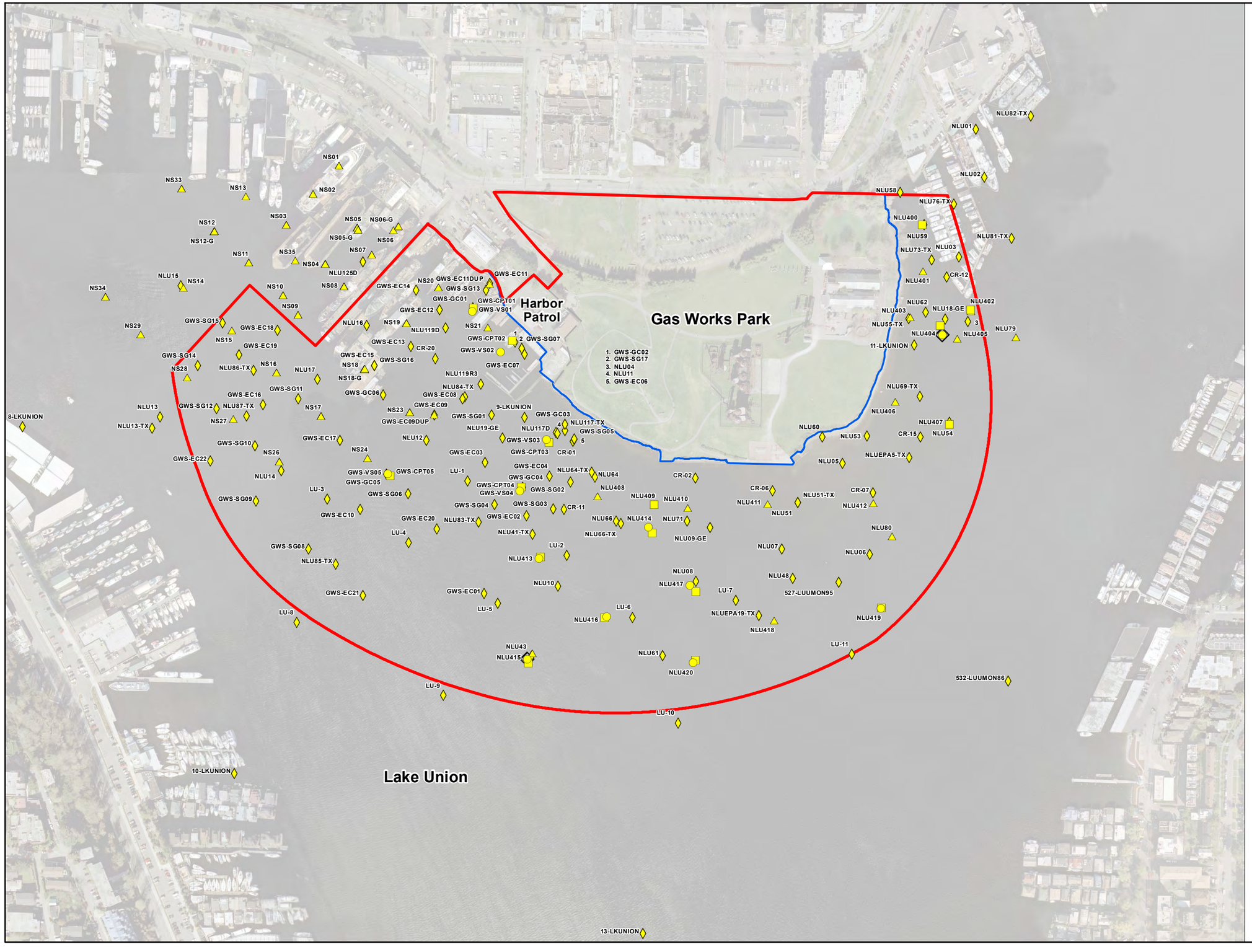
Figure 2-5

Path: P:\00186846\GIS\MXD\Phase01\T1678\018684601_F2-5_SedSampleTimeSeries2021.mxd Map Revised: 18 February 2021 maugust



Legend

- Area of Investigation
- Shoreline (OHWM)

Geotechnical

- Cone Penetrometer Test
- Standard Penetration Test
- Vane Shear
- Other Geotechnical
- Bearing Plate

Notes:

1. Reference Appendix 3D Table 3D-2 for other sediment geotechnical tests.
2. Basemap 2005 USGS aerial photograph. Does not show current conditions.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

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N
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300 0 300

Feet

Geotechnical Sediment Explorations

Gas Works Park Site
Seattle, Washington

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Figure 2-6

Path: P:\0\0186846\GIS\MXD\Phase01\T1678018684601_F2-6_GeotechnicalSedimentExplorations2021.mxd Map Revised: 18 February 2021 maugust

Legend

Area of Investigation

Shoreline (OHWM)

Remedial Actions

Independent Remedial Actions

1984: Approximate Area of 1-Foot-Thick Soil Cover

1999: Decommissioned UST

1999 Consent Decree Cleanup Actions

1997: Approximate Location of Tar Removal

1998-1999 NAPL Recovery Wells

2000-2010: Monitored Natural Attenuation

2001: Vegetative Soil Cap

2001-2006: Air Sparging Area

2005: Vegetative Soil Cap

2007-2008: Approximate Location of Minor Tar Removal

2010: Shoreline Maintenance

2012: Vegetative Soil Cap

2014: Vegetated Soil Cap

Security Fence

1997 and 2005 Agreed Order Actions

1998: Tank Cleanout and Decommissioning

2017-2020 Play Area Interim Action Treatment Area

Injection Well - Fill

Injection Well - Outwash

2007: Minor Tar Removal

Notes:

1. Play Area Interim Action Construction Completion Report by GeoEngineers 2021 (in development). References: Construction Completion Report by RETEC 2001. As-Built Set of Drawings by Seattle Parks and Recreation 2005. NE Corner Capping Project by Hart Crowser 2012c, adjusted for existing structures. Kite Hill Construction Completion Report 2015.
2. Basemap 2005 USGS aerial photograph. Does not show current conditions.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

100 0 100

Feet

Previous Remedial Actions

Gas Works Park Site
Seattle, Washington

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Figure 2-7

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Lake Union

Legend

- Area of Investigation
- Shoreline (OHWM)
- Security Fence

Surface Cover Preventing Exposure

- Vegetated Soil Cap
- Impervious (Paved or Structures)
- Gravel

Soil Exposure Areas (Uncapped)

Shoreline/Bank Areas

- Northeast Corner (0.35 acres)
- Southeast and Southwest (0.24 acres)

Upland Areas

- Northeast Corner - Meadow (0.67 acres)
- Limited Use Areas (1.5 acres)
- Cracking Tower Area (0.52 acres)

Notes:

1. References: Construction Completion Report by RETEC 2001. As-Built Set of Drawings by Seattle Parks and Recreation 2005. NE Corner Capping Project by Hart Crowser 2012, adjusted for existing structures. Kite Hill Construction Completion Report by GeoEngineers 2015 .
2. Basemap - 2005 USGS aerial photograph. Does not show current conditions.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

100 0 100

Feet

Upland Areas with Surface Covers (Soil Caps, Paving, Buildings, and Gravel)

Gas Works Park Site
Seattle, Washington

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Figure 2-8

P:\0\0186846\GIS\MXD\Phase01\T1678\0186846001_F2-8_PotentialUplandHH2021.mxd Date Exported: 04/28/21 by maukust

Legend

- Area of Investigation
- Shoreline (OHWM)
- Historical Railroad Features
- Former MGP Structure
- Approximate Excavation Areas and Depths (2 FT)

Notes:

1. Reference for soil excavation areas:
Layout Plan Excavation and Demolition by
Richard Haag Associates Inc. February 8, 1973b. Demolition Section 3
pages 1-9 by Richard Haag Associates Inc. 1973a. Concrete and
Demolition Work Plan by Richard Haag Associates Inc. March 15 1973.
2. Site structures delineated as shown in the General Plan,
Lake Station,Seattle Gas Company, April 1949, revised in June 1953.
Historical railroad features shown as delineated in General Plan,
Lake Station, Seattle Gas Co., June 1938. Sanborn Fire Insurance
Map, 1950; Parametrix (1998) FFS; 1946, 1956 aerial photo;
Haag 1973.
3. Basemap 2005 USGS aerial photograph. Does not show
current conditions.
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

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Feet

Park Redevelopment
Soil Excavation Areas

Gas Works Park Site
Seattle, Washington

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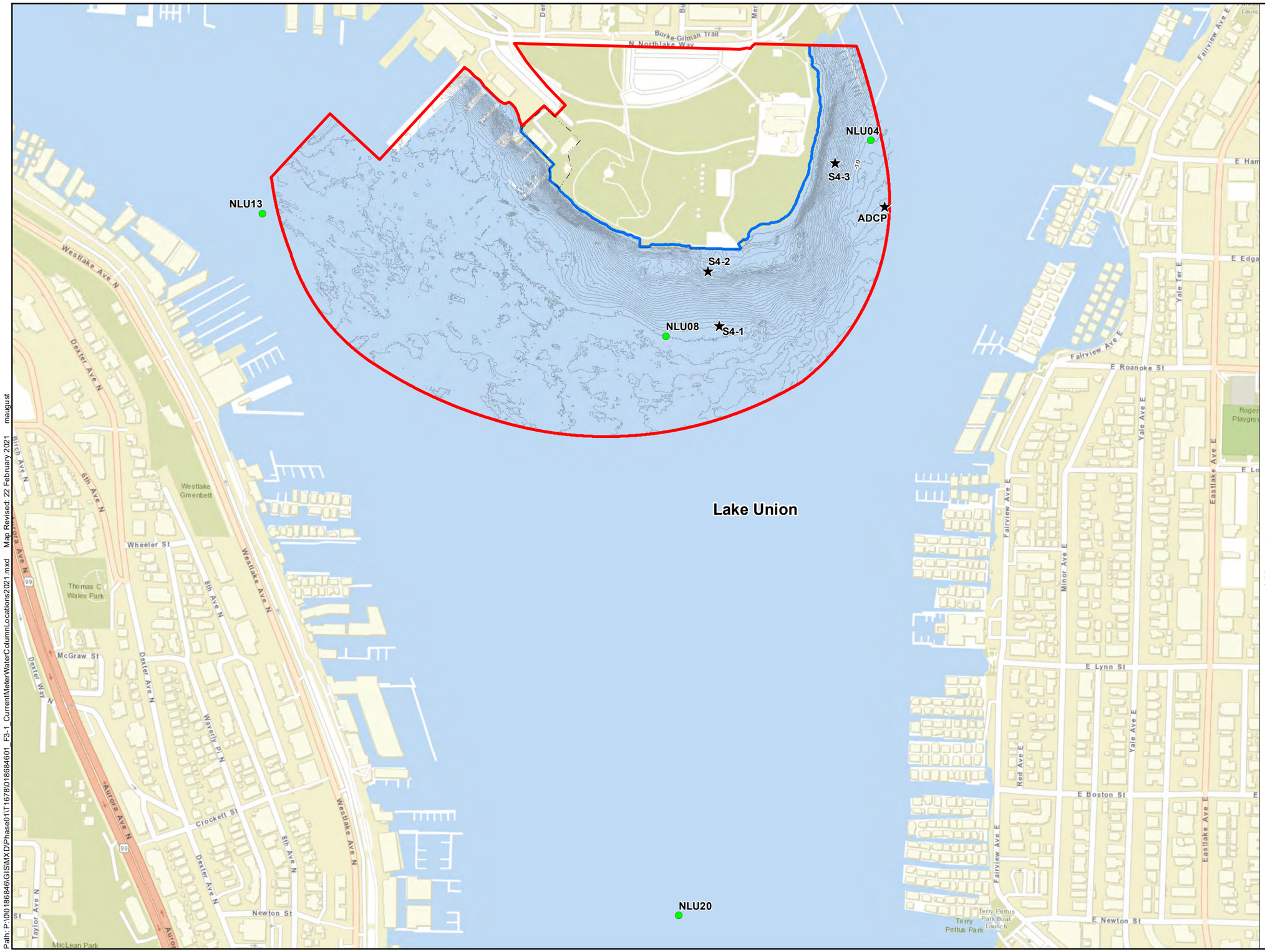
Figure 2-9

Path: P:\00\186846\GIS\MXD\Phase01\T1678\018684601_F2-9_ParkRedevelopmentExcAreas2021.mxd Map Revised: 22 February 2021 maugust



Legend

- Area of Investigation
- Shoreline (OHWM)
- Current Meter
- Water Column Profile

Notes:

1. Basemap - ESRI, 2021.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

400 0 400

Feet

Current Meter and Water Column Profiling Locations

Gas Works Park Site
Seattle, Washington

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Figure 3-1

Path: P:\0\0186846\GIS\MXD\Phase01\T1678\0186846_01_F3-1_CurrentMeterWaterColumnLocations2021.mxd Map Revised: 22 February 2021 maugust

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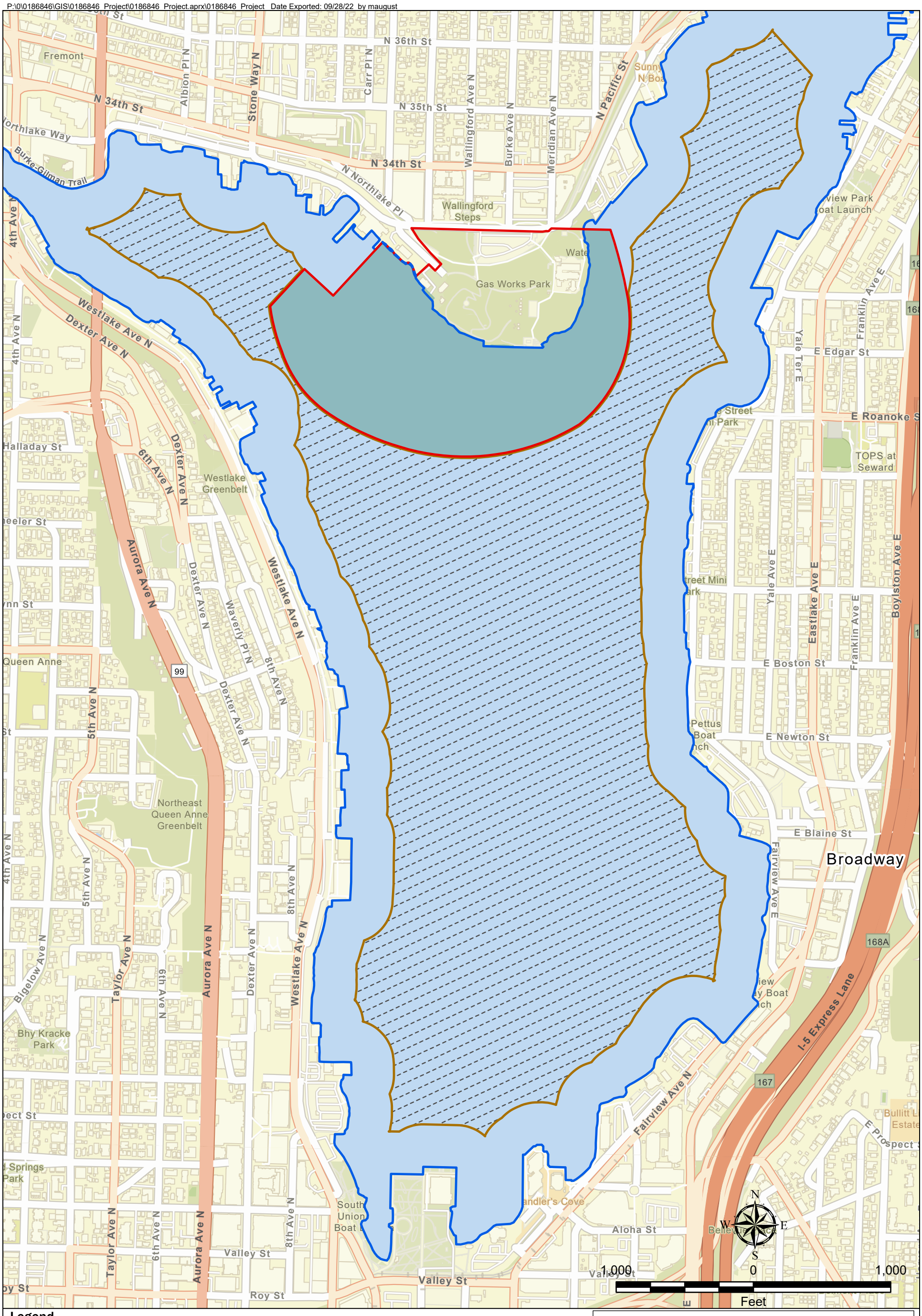

Legend

- Area of Investigation (AOI)
- Shoreline (OHWM)
- Ambient Lake Union (ALU) Area
- Sediment Portion of the AOI

Notes:
1. Basemap - ESRI, 2021.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

Ambient Lake Union Area

Gas Works Park Site
Seattle, Washington

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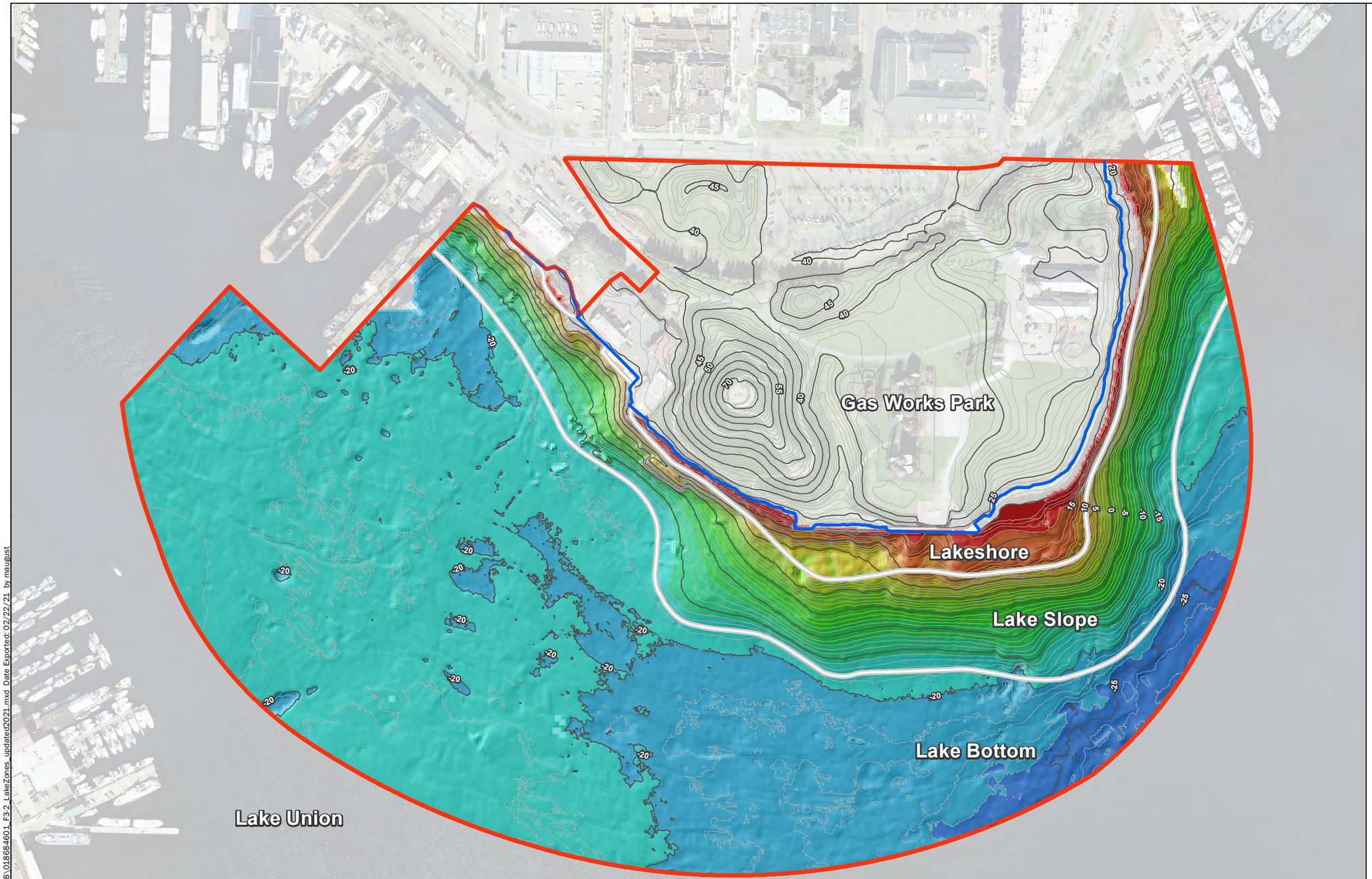
Figure 3-2



Legend

Area of Investigation

Shoreline (OHWM)

Topographic/Bathymetric Contour in Feet (USACE Locks Datum)

1' Contour Interval

5' Contour Interval

Mudline Elevation in Feet (USACE Locks Datum)

- -28.6 to -24
- -24 to -20
- -20 to -16
- -16 to -12
- -12 to -8
- -8 to -4
- -4 to 0
- 0 - 4
- 4 to 8
- 8 to 12
- 12 to 16
- 16 to 20

Notes:

1. Data Source: Upland topography is based on AECOM 2010 topographic base map supplemented with True North Land Surveying, Inc., Gas Works Park, Kite Hill Soil Cover Project, drawing J14-80.00, August 20, 2015; and Northwest Corner topography from City of Seattle (2005). Northeast Corner topography does not reflect 2012 capping. Bathymetry generated from side-scan sonar surveys (RETEC, September 1999; City of Seattle November 2002), nearshore singlebeam bathymetry survey (RETEC, October 2002), multibeam bathymetry surveys (Parametrix, December 2002; Tetra Tech, October 2006), leadline survey (RETEC, 2005).
2. Basemap 2005 USGS aerial photograph. Does not show current conditions.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

200 0 200

Feet

Lake Zones

Gas Works Park Site
Seattle, Washington

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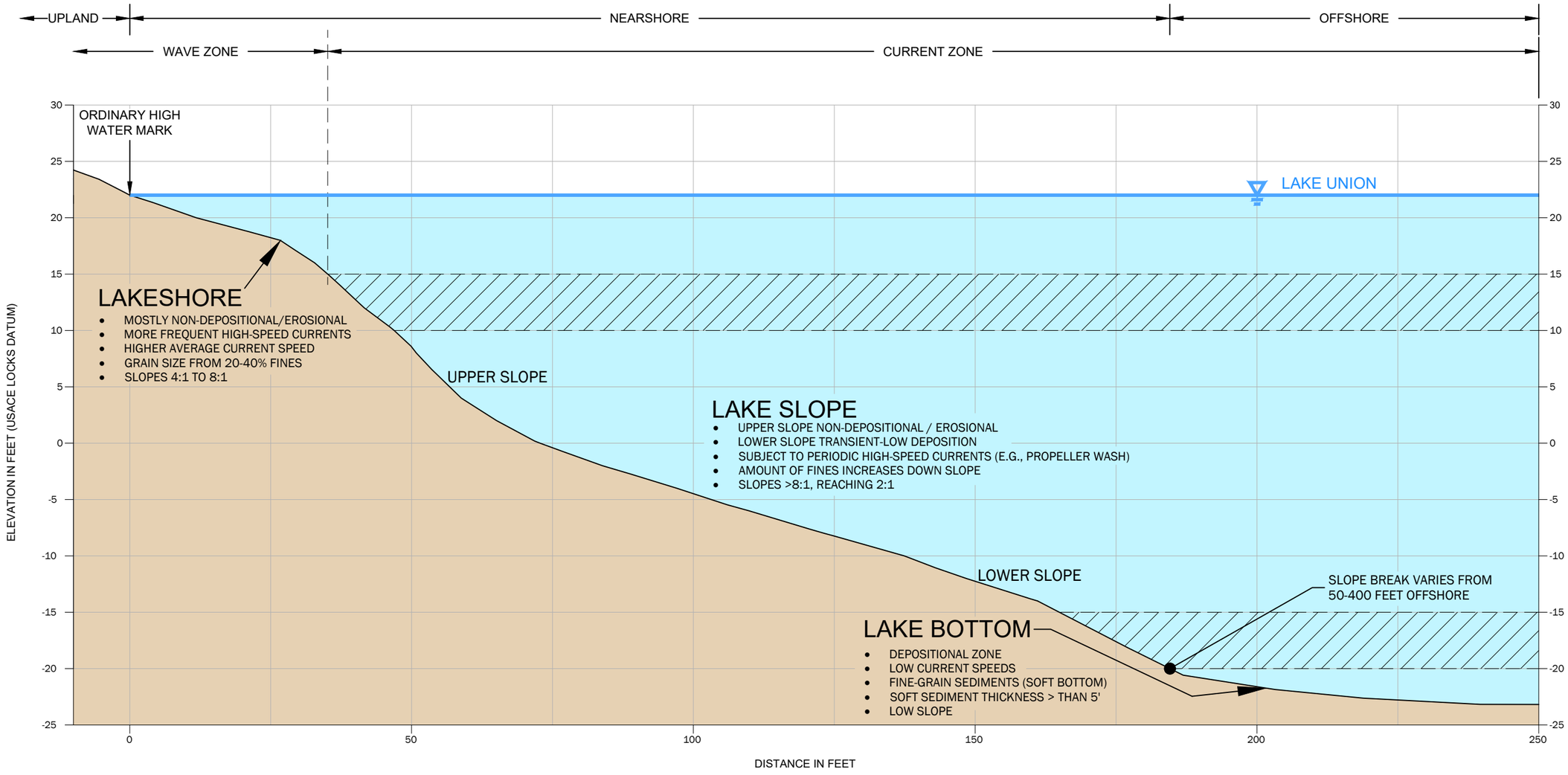
Figure 3-3

P:\0\0186846\GIS\MXD\Phase01\T1678\0186846_F3-2_LakeZones_updated2021.mxd Date Exported: 02/22/21 by maugust



Legend

Lake zone elevations vary from the western part to the eastern part of the AOI.

10 0 20

SCALE IN FEET

Vertical Exaggeration: 2

Notes:

1. Lakeshore zone characteristics not applicable to western area northwest and southeast of Waterway 20.

Lake Zone Schematic

Gas Works Park Site
Seattle, Washington

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Figure 3-4

Harbor Patrol

Gas Works Park

Gas Works Park Marina

Lake Union

Legend

- Area of Investigation
- Shoreline (OHWM)

Offshore Debris

- Fill (Debris Prevalent)
- Gas Works Park Marina (Debris Prevalent)
- Sunken Boat/Vessel
- Boat/Boat Debris
- Wooden Structure
- Wood Debris
- Large Wood Debris (e.g. Piling)
- Milled Wood/Lumber
- Metal Drum
- Tire
- Miscellaneous Trash
- Possible Debris Identified by Multi-beam Bathymetry Survey
- Boulder
- Log or Beam, Structure

Notes:

1. Data Sources: Side-scan sonar survey (RETEC, September 1999), towed underwater video survey (RETEC/SAIC, November 1999), nearshore bathymetry survey (RETEC, October 2002), side-scan sonar survey (City of Seattle, November, 2002), detailed multi-beam bathymetric survey (Parametrix, December 2002), underwater diving and video (Grette & Associates, February 2005), and multi-beam bathymetry survey (Tetra Tech, October 2006).
2. Basemap 2005 USGS aerial photograph. Does not show current conditions.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

200 0 200

Feet

Offshore Debris

Gas Works Park Site
Seattle, Washington

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Figure 3-5

Path: P:\0018684\6\GIS\MXD\Phase01\T1678\0186846\01_F3-4_OffshoreDebris2021.mxd Map Revised: 25 August 2022 maugust

Generalized Geologic Stratigraphic Section

	Geologic Unit Name	Unit Description	Graphic Symbol
Post Development (1890-present)	Fill **(Af)** (0 to 35' thick)	**Fill:** Loose to medium dense brown to black, poorly graded sand with silt, clay, gravel and debris (ash, soot, cinders, reddish-brown smooth fused and platy agglomerate, black vesicular low-density gravel, wood, brick fragments, and other anthropogenic debris).	
Pleistocene Glacial deposits — Vashon Stade (12,000 to 18,000 years old)	Vashon Recessional Outwash[1] **(Qvr)** (0 to 25' thick)	**SP/GP, SM:** Loose to dense brown to gray sand and gravel, to sand and gravel mixtures with variable amounts of silt.	
	Vashon Advance Outwash **(Qva)** (0 to 20' thick)	**SP/GP:** Dense to very dense gray to brown poorly graded slightly silty sand (predominantly fine and medium grained) with interbeds of clean coarser sand, thin silt beds, or sand and gravel mixtures.	
Pleistocene Glacial deposits — Pre-Fraser (70,000 to 250,000 years old)	Pre-Fraser Till **(Qpgt)**	**SM:** Medium dense to very dense diamicts with clayey to silty fine sand matrix with variable gravel content and scattered cobbles and boulders.	

Notes:

1. Recent Beach and Shallow Shelf Deposits (Qb) are present stratigraphically between fill and Qvr. The Qb is a localized deposit and is absent in most areas. For this reason, Qb was grouped with Qvr in the cross-sections and lateral extent maps. See Appendix 3B for more information.
2. Vashon Recessional Glaciolacustrine Deposits (Qvrl) are present locally at or near the top of the Qvr. Qvrl is a localized deposit and is absent in most areas. Qvrl is shown on Cross-section A-A' (Figure 3-8) but is grouped with Qvr on the lateral extent map (Appendix 3B). See Figure 3-5B for description of Qvrl.
3. This figure includes generalized descriptions of the main geologic units at GWPS encountered in uplands. For additional detail or for sub-units or other minor geologic units please refer to the Geologic CSM Package (GWSA, 2011a).
4. Graphic Symbols color-coded based on CSM Package (GWSA, 2011a). Ages of deposits are from Seattle Geologic map (Troost et. al., 2005)

Generalized Upland Geologic Stratigraphic Section

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 3-6A

Generalized Geologic Stratigraphic Section

	Geologic Unit Name	Unit Description	Graphic Symbol
Post Development (1890-present)	Fill **(Af)** (0 to 35' thick)	**Fill:** Loose to medium dense black, poorly graded sand with silt, clay, gravel and debris (ash, soot, cinders, reddish-brown smooth fused and platy agglomerate, black vesicular low-density gravel, wood, brick fragments, and other anthropogenic debris).	
Holocene Postglacial Deposits (0 to 12,000 years old)	Recent Lacustrine Deposits **(Ql)** (0 to 50' feet thick)	**ML/OL:** Very soft reddish-brown to black organic silt and clay with fibrous organic matter and minor component of sand. The unit is separated into upper and lower Ql. The upper Ql also includes varying amounts of woody material and/or anthropogenic debris and is often separated from the lower Ql by a thin gray silt layer.	
Pleistocene Glacial deposits — Vashon Stade (12,000 to 18,000 years old)	Vashon Recessional Glaciolacustrine Deposits **(Qvrl)** (0 to 20' thick)	**ML/CL:** Gray, firm to stiff silt and clay with thin interbeds of fine sand, occasional sandy or gravelly layers, scattered dropstones, and trace amounts of organic matter.	
	Vashon Recessional Outwash **(Qvr)** (0 to 25' thick)	**SP/GP, SM:** Loose to dense brown to gray sand and gravel, to sand and gravel mixtures with variable amounts of silt.	
	Vashon Advance Outwash **(Qva)** (0 to 20' thick)	**SP/GP:** Dense to very dense gray to brown poorly graded slightly silty sand (predominantly fine and medium grained) with interbeds of clean coarser sand, thin silt beds, or sand and gravel mixtures.	
Pleistocene Glacial deposits — Pre-Fraser (70,000 to 250,000 years old)	Pre-Fraser Till **(Qpgt)**	**SM:** Medium dense to very dense diamicts with clayey to silty fine sand matrix with variable gravel content and scattered cobbles and boulders.	

Notes:

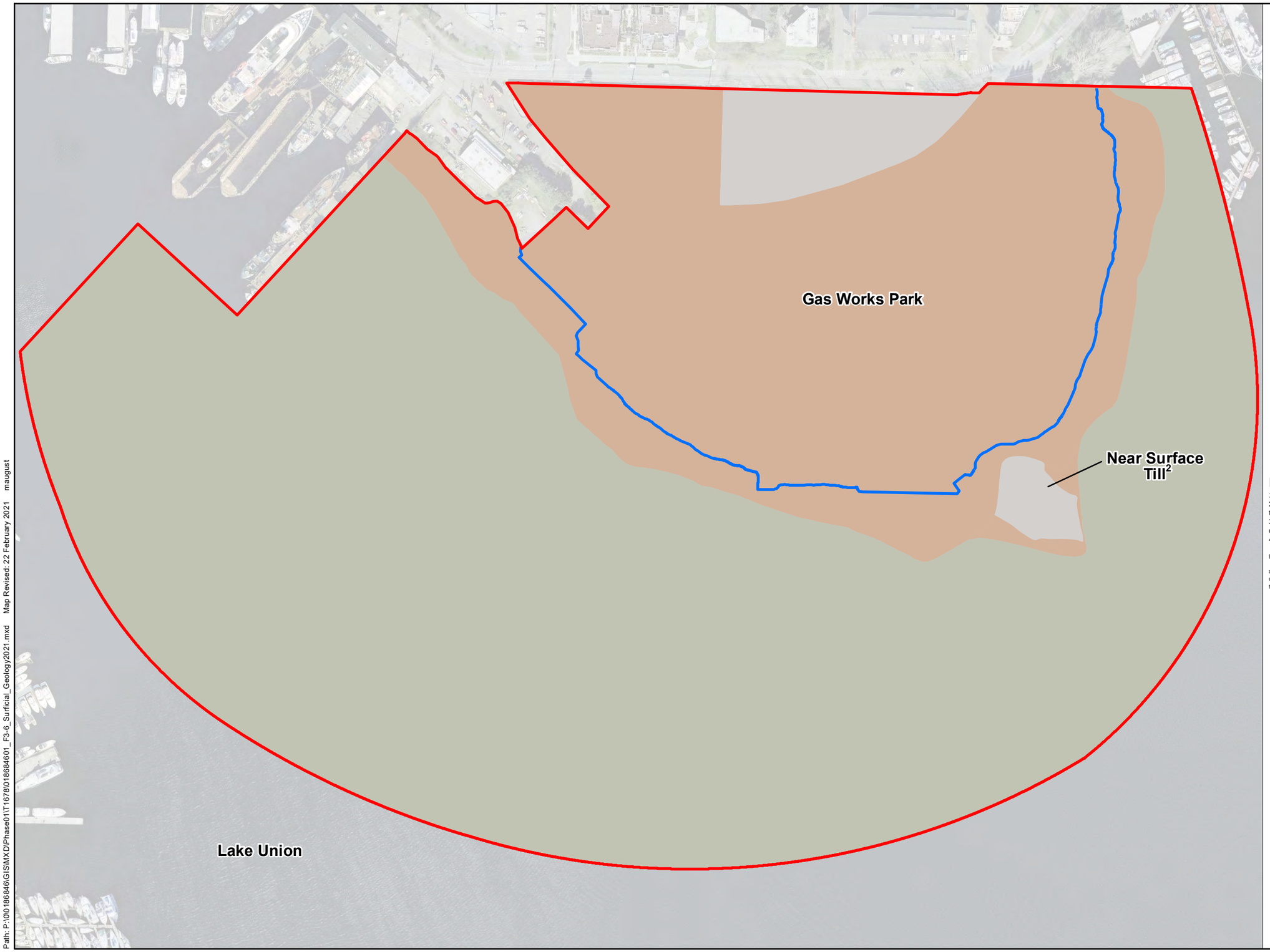
1. This figure includes generalized descriptions of the main geologic units encountered in AOI sediment. For additional detail or for sub-units or other minor geologic units please refer to the Geologic CSM Package (GWSA, 2011a).
2. Graphic Symbols color-coded based on CSM Package (GWSA, 2011a). Ages of deposits are from Seattle Geologic Map (Troost et. al., 2005)

Generalized Offshore Geologic Stratigraphic Section

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 3-6B



Legend

- Area of Investigation
- Shoreline (OHWM)

Geologic Unit

- Fill
- Lake Sediment
- Till

Notes:

1. Till outcrop locally covered by fill in planters.
2. Till crops out (near surface) offshore southeast of upland - thin layer of fill interpreted.
3. Basemap 2005 USGS aerial photograph. Does not show current conditions.
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

200 0 200

Feet

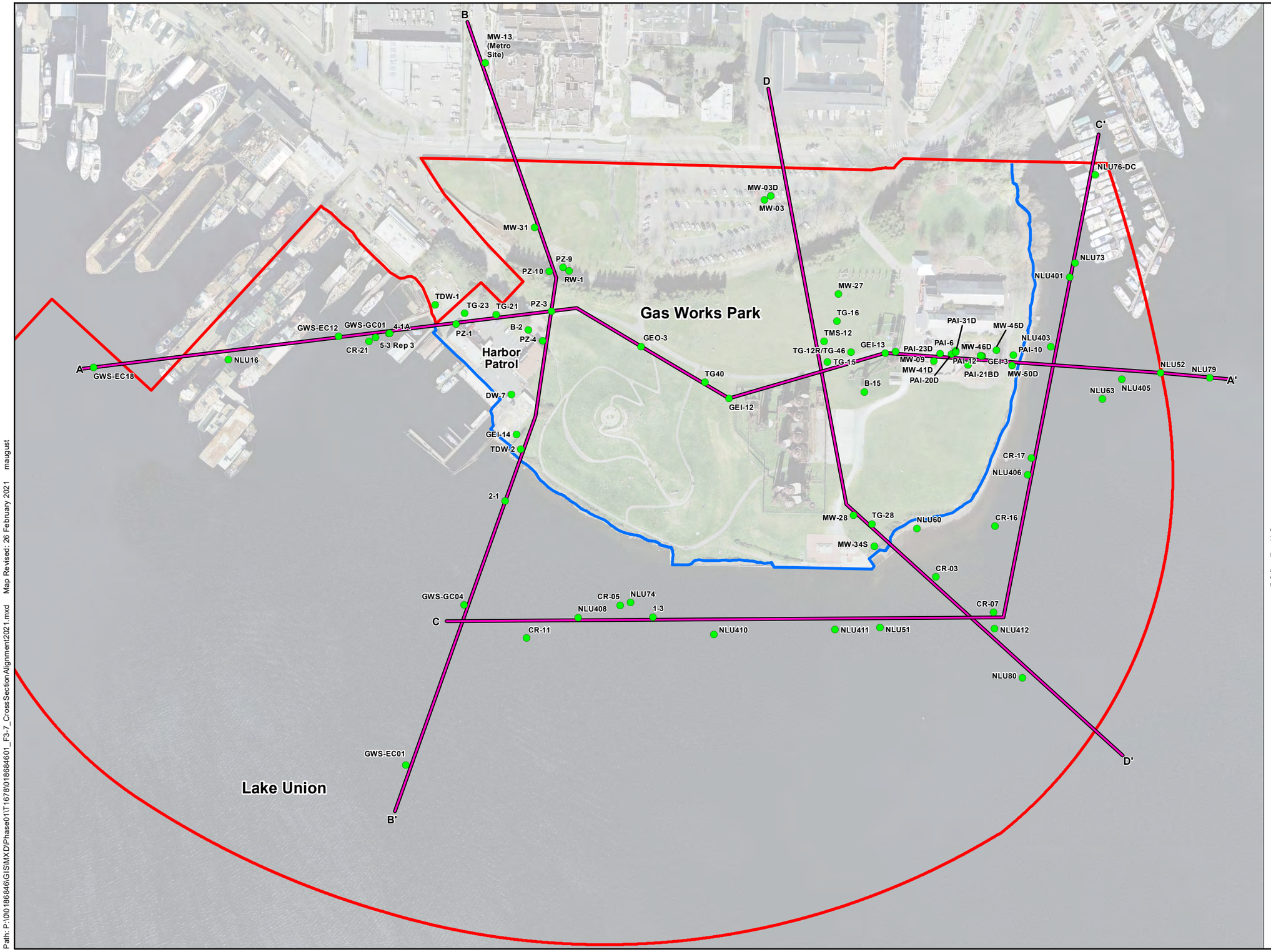
Surficial Geology

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 3-7

Path: P:\00\186846\GIS\MXD\Phase01\T16780\186846l01_F3-6_Surficial_Geology2021.mxd Map Revised: 22 February 2021 maugust



Path: P:\00\186846\GIS\MXD\Phase01\T16780\18684601_F3-7_CrossSectionAlignment2021.mxd Map Revised: 26 February 2021 maugust21

Legend

- Area of Investigation
- Shoreline (OHWM)
- A A' Cross Section
- Cross Section Control Point

Notes:

1. Basemap 2005 USGS aerial photograph. Does not show current conditions.
2. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

200 0 200

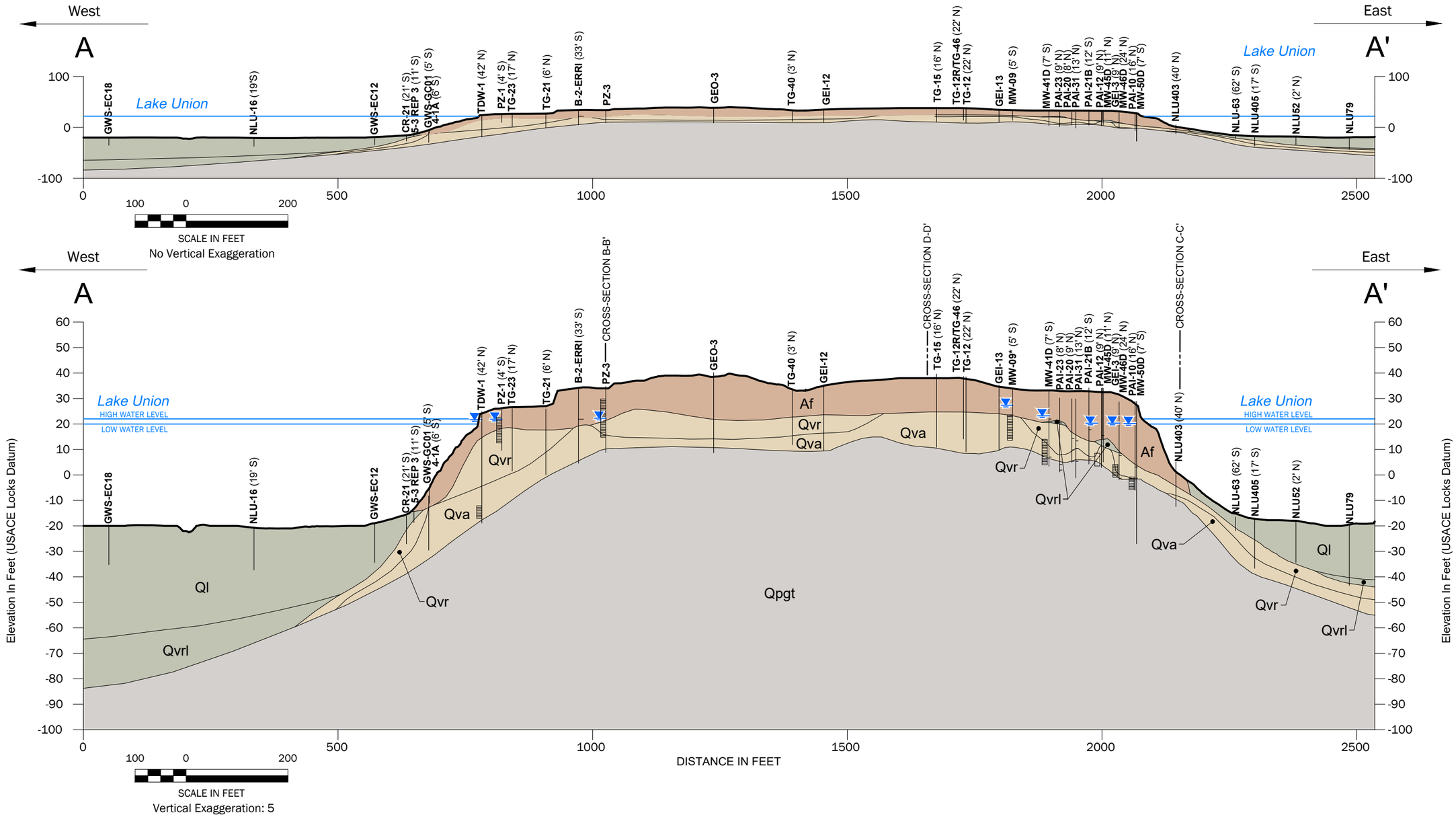
Feet

Geologic Cross Section Alignment

Gas Works Park Site
Seattle, Washington

GeoEngineers

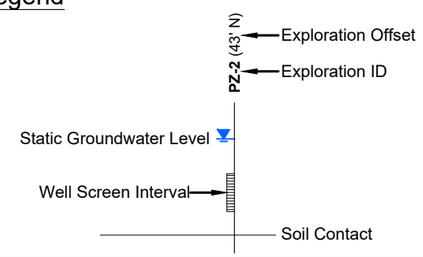
Figure 3-8



Legend

Geologic Units

- Fill (Af)
- Lake Sediment (Ql, Qvrl)
- Outwash (Qvr, Qva)
- Till (Qpgt)



Notes:

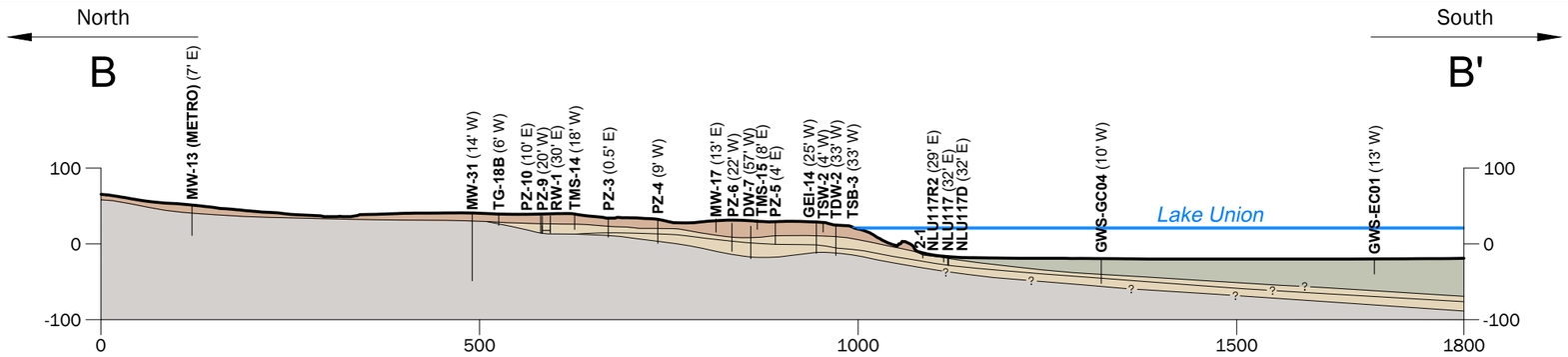
1. Groundwater level measured on April 22, 2013 in monitoring wells TDW-1, PZ-1, PZ-3, and MW-9 and February 2018 in monitoring wells MW-41D, MW-45D, MW-46D, and MW-50D.

Geologic Cross Section A-A'

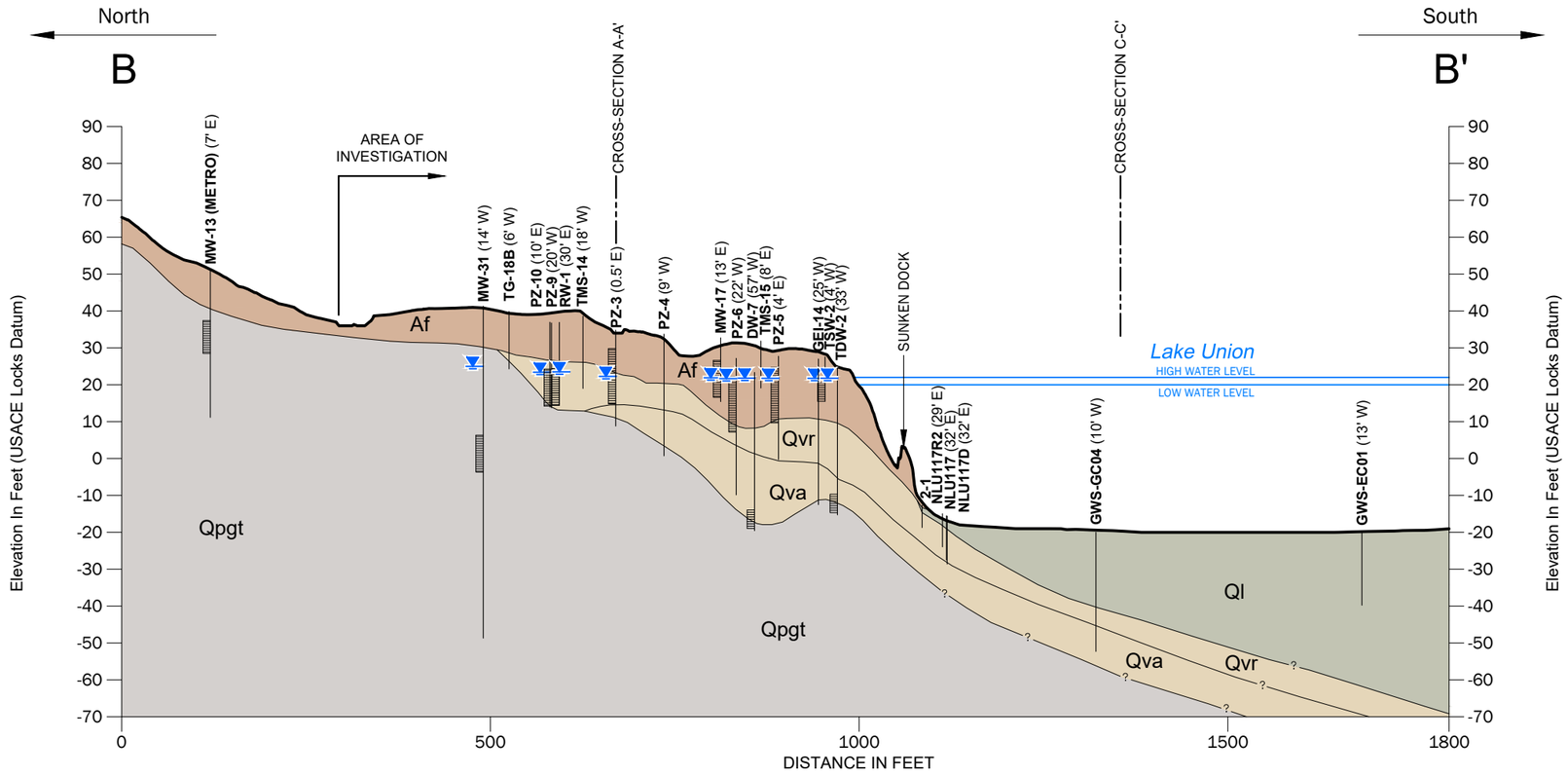
Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 3-9



100 0 200
SCALE IN FEET
No Vertical Exaggeration



100 0 200
SCALE IN FEET
Vertical Exaggeration: 5

Legend

Geologic Units
- Fill (Af)
- Lake Sediment (Ql, Qvrl)
- Outwash (Qvr, Qva)
- Till (Qpgt)

MW-26 (2' N) — Exploration Offset, Exploration ID
Static Groundwater Level
Well Screen Interval
Soil Contact

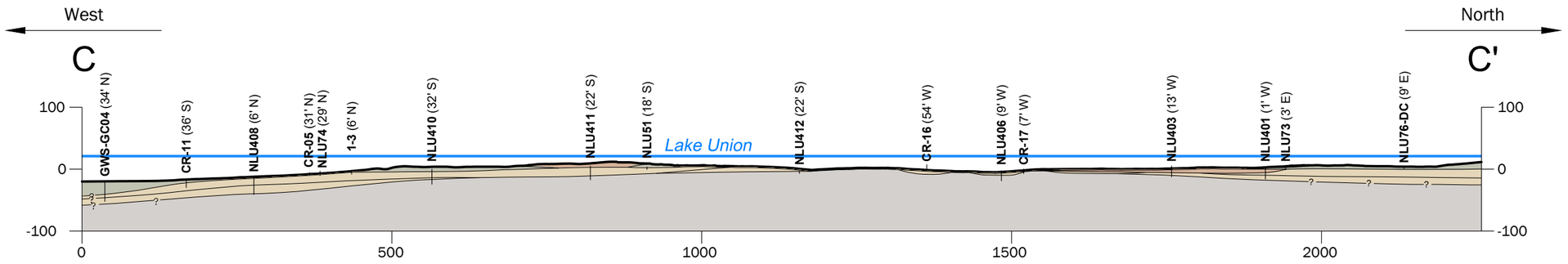
Notes:

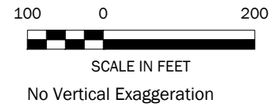
1. Groundwater level measured on April 14, 2016. Groundwater level data not available for MW-13 (METRO).

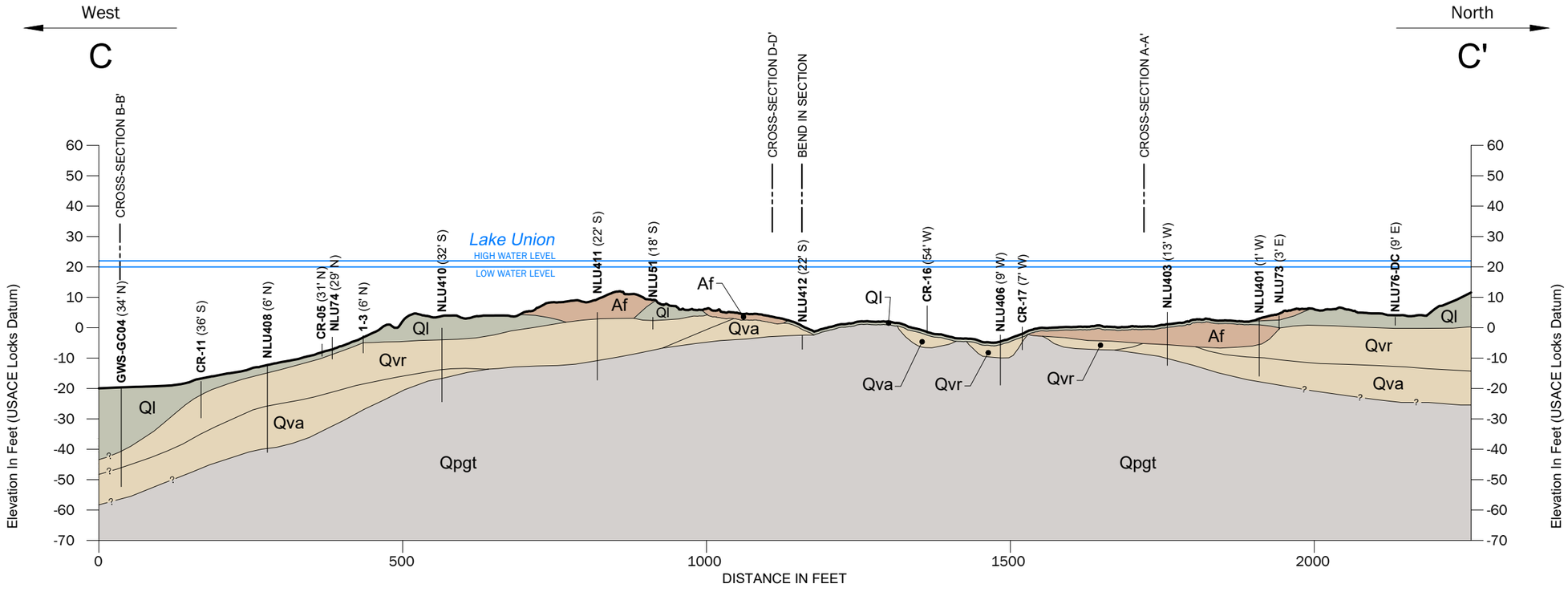
Geologic Cross Section B-B'

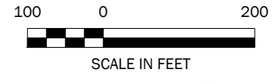
Gas Works Park Site
Seattle, Washington

GeoEngineers — Figure 3-10









Legend

Geologic Units

- Fill (Af)
- Lake Sediment (Ql, Qvrl)
- Outwash (Qvr, Qva)
- Till (Qpgt)

NLU-410 (32' S) — Exploration Offset / Exploration ID

Soil Contact

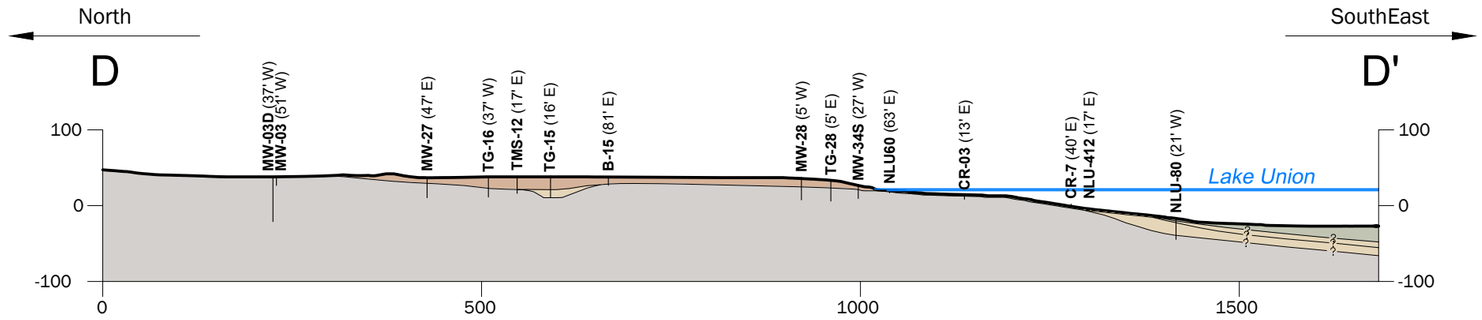
DISCLAIMER: This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. The locations of all features are approximate. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers,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

Geologic Cross Section C-C'

Gas Works Park Site
Seattle, Washington

GeoEngineers

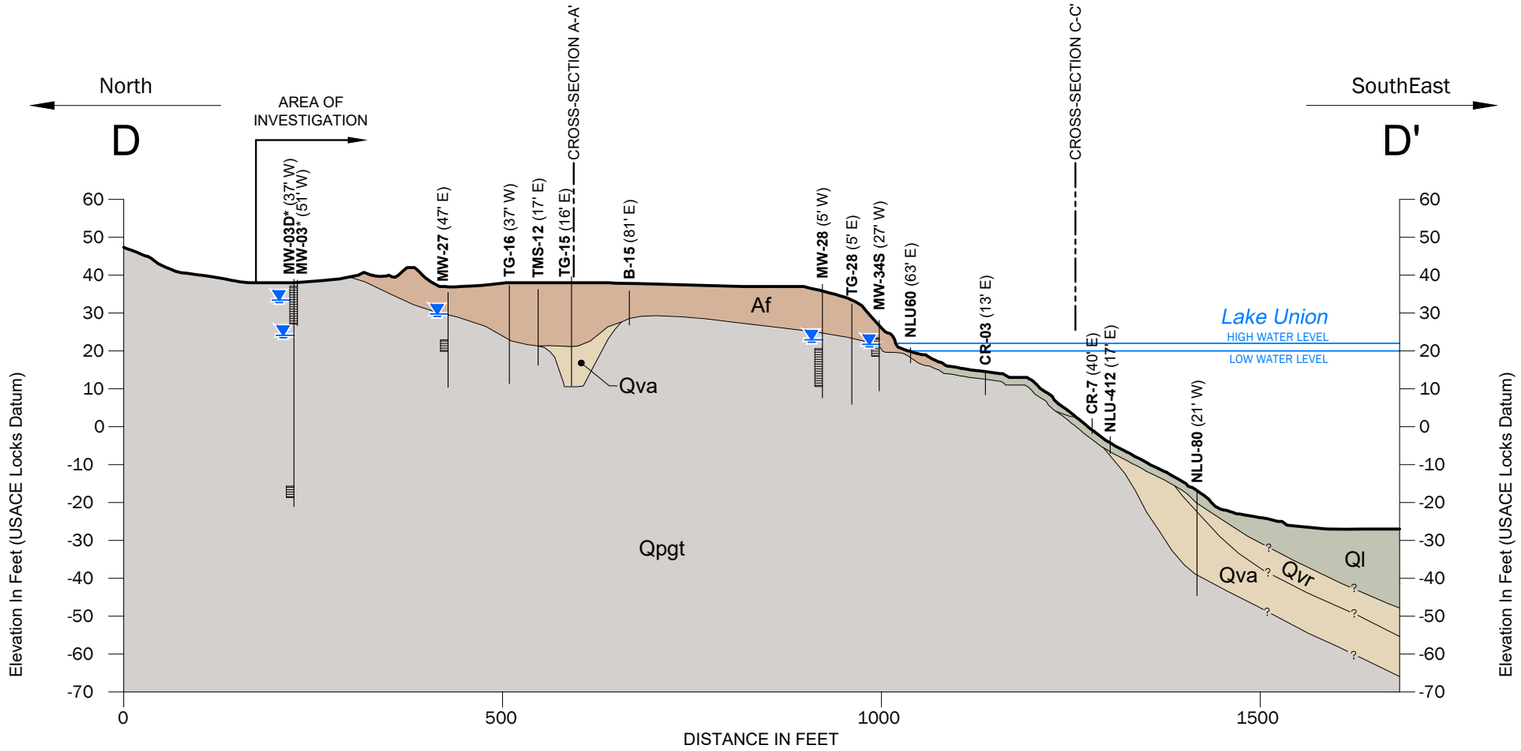
Figure 3-11



100 0 200

SCALE IN FEET

No Vertical Exaggeration



100 0 200

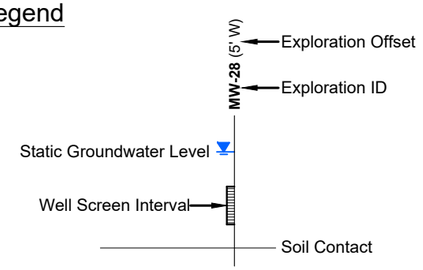
SCALE IN FEET

Vertical Exaggeration: 5

Legend

Geologic Units

- Fill (Af)
- Lake Sediment (Ql, Qvrl)
- Outwash (Qvr, Qva)
- Till (Qpgt)



Notes:

1. Groundwater level measured on April 22, 2013.

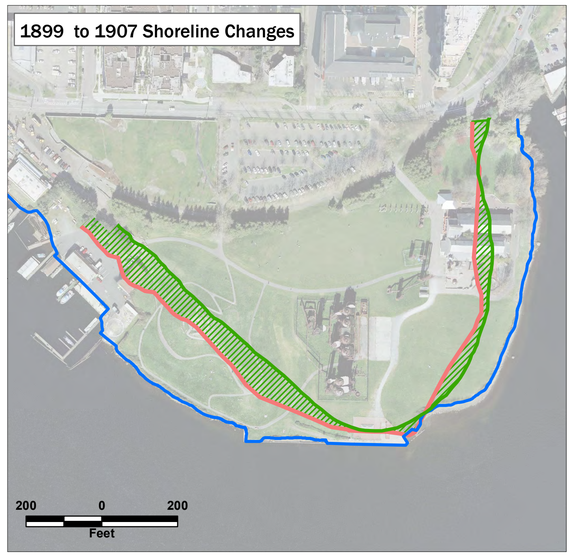
DISCLAIMER: This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. The locations of all features are approximate. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers,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

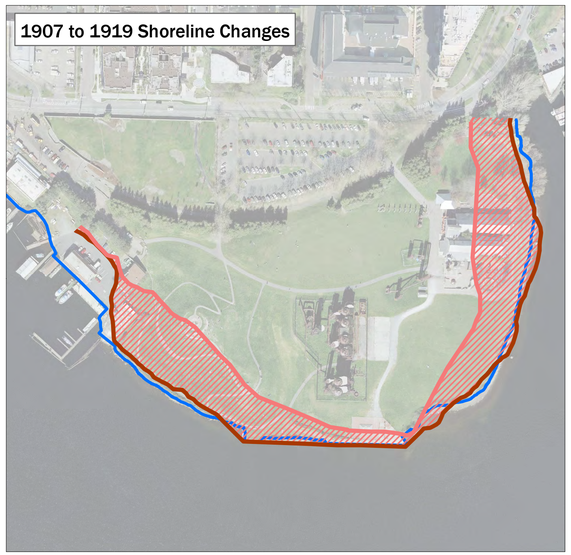
Geologic Cross Section D-D'

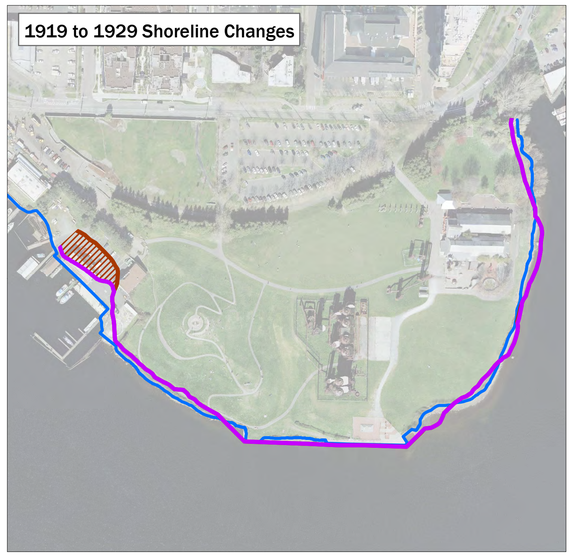
Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 3-12







Notes:

1. Source: Current shoreline shown as observed in a 2011 aerial photo. The 1973 shoreline shown as in Gas Works Park Grading Plan by Haag (1973) a or b. The 1929 shoreline shown as delineated in USACE bathymetric map, drafted in 1927 revised in 1929. The 1919 shoreline shown as delineated in 1919 Sanborn Maps. The 1907 shoreline shown as delineated in the Lake Union Shore Lands, 1907. The 1899 shoreline shown as delineated in US Coast and Geodetic Survey (1899).
2. Shoreline depictions are approximate and do not take into account seasonal fluctuations of lake level.
3. Basemap 2005 USGS aerial photograph. Does not show current conditions.

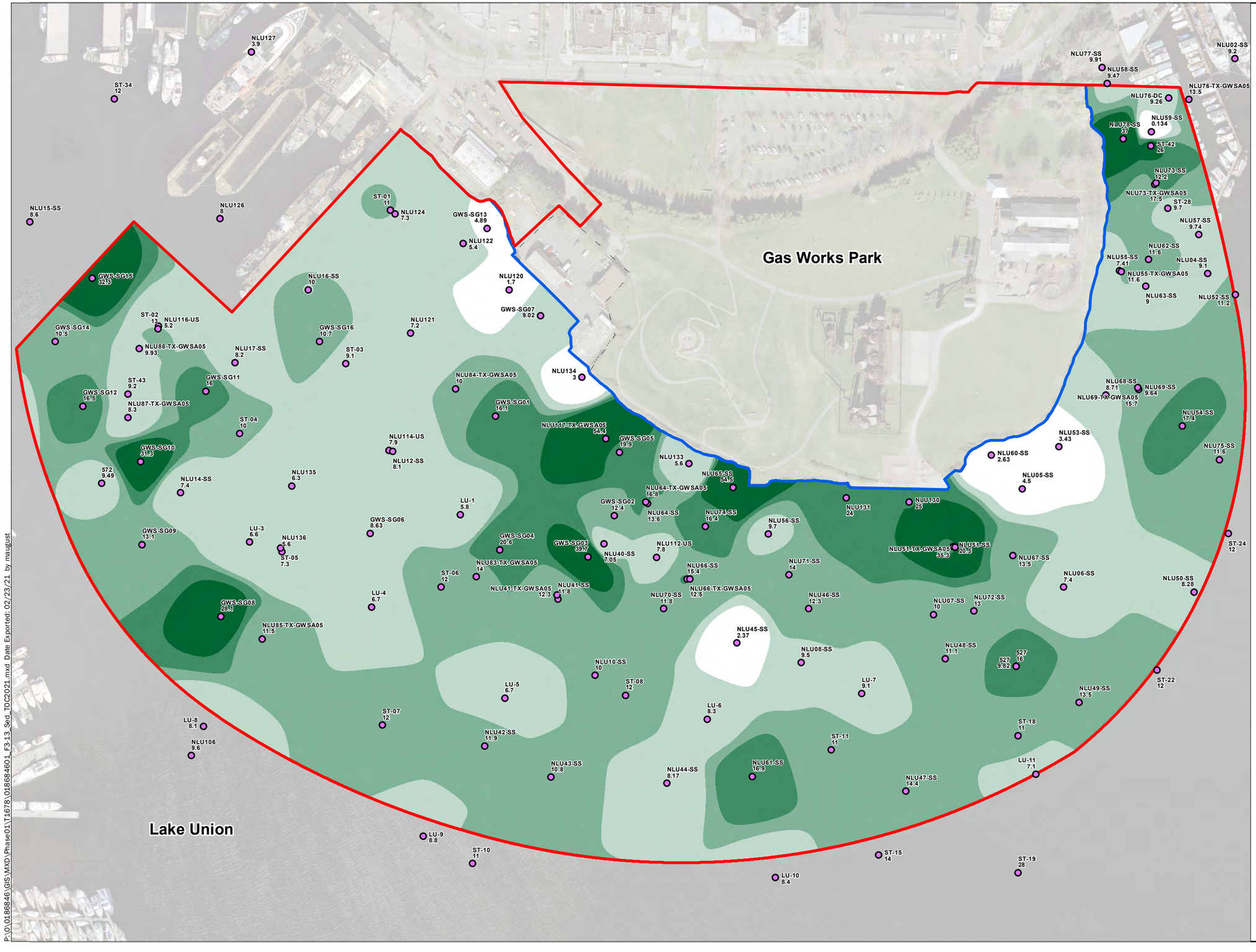
Shoreline Changes and Fill History

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 3-13

Path: P:\0\0186846\GIS\MXD\Phase01\T167801868460 1_F3-12_ShorelineProgression2021.mxd Map Revised: 23 February 2021 maugust 2021



Legend

- Area of Investigation
- Shoreline (OHWM)
- Surface Sample

Interpolated Total Organic Carbon (TOC) Content (% dry weight)

- <5
- 5-10
- 10-15
- 15-25
- >25

Notes:

1. Surface Sediment is defined as the top 6 inches of sediment.
2. TOC content showed a large variation between labs (roughly 2.5 times in split samples) due to differences in sample preparation and testing method. The values posted are minimum values.
3. Some labs screened sediment samples to remove large organic debris and plant material prior to analyses; other labs included all material submitted for analysis resulting in widely varying estimates of sediment organic carbon.
4. Concentration contour map generated through interpolation using an Inverse Distance Weighted (IDW) scheme (power=6). Maximum reach from each sampling location is equal to 500 feet. Contoured interval may differ from actual data shown due to influence by neighboring values.
5. Where the sample was below detection limit, 1/2 the detection limit was used in the interpolation.
6. Basemap 2005 USGS aerial photograph. Does not show current conditions.
7. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

200 0 200

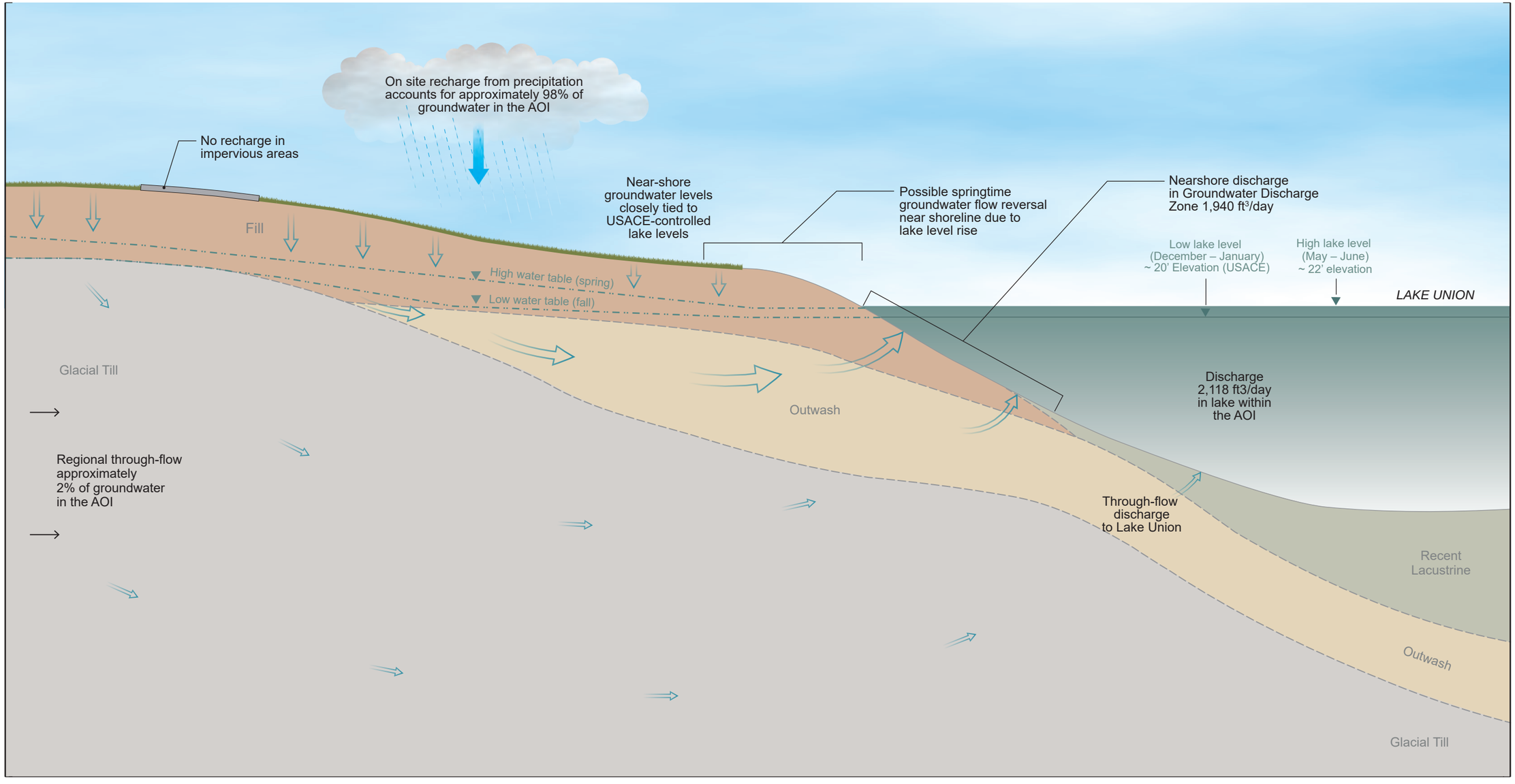
Feet

Surface Sediment Total Organic Carbon

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 3-14



Notes:

1. An estimated 37 ft³/day flows from the AOI into the larger model domain.
2. The location of all features shown are approximate.

Legend

- Groundwater flow
- Recharge from precipitation
- Regional through-flow

Not to Scale

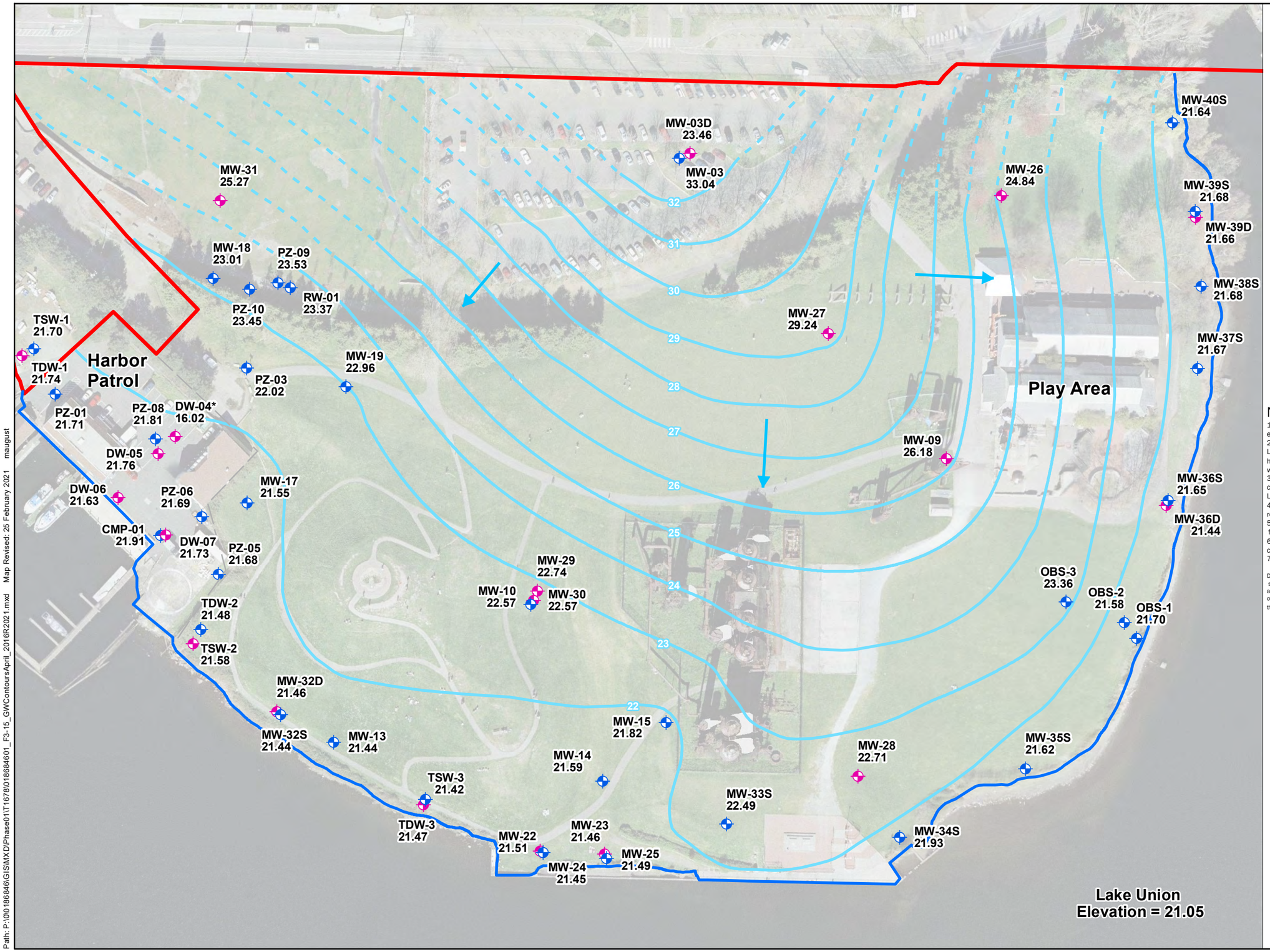
Hydrogeologic Conceptual Site Model

Gas Works Park Site
Seattle, WA

GeoEngineers

Figure 3-15

P:\0\0186846\Graphics_Misc\Figure 3-14 - Hydrogeologic Conceptual Site Model.ai Exported 3/22/21 by spride



Legend

- Area of Investigation
- Shoreline (OHWM)
- Water Table Monitoring Well
- Deeper Monitoring Well (Not Used for Contouring)
- 22 — Approximated Groundwater Elevation Contour (USACE) (Dashed Where Inferred)
- Inferred Groundwater Flow Direction
- MW-40S 21.05 — Monitoring Well Identifier, Measured Water Level Elevation (USACE)

Notes:

1. Groundwater elevations measured on 4/14/2016, except TSW-2, MW-34S and CMP-01 measured on 5/13/2016.
2. Lake Union elevation taken from Lake Washington Ship Canal at Locks, 08:00 a.m.on 5/13/2016. http://www.nwd-wc.usace.army.mil/dd/common/dataquery/www/?k=lake%20washington
3. Monitoring wells TSW-1, TDW-1, DW-05, DW-07, MW-18 and MW-09 contained NAPL; groundwater elevations have been corrected for LNAPL density if detected beyond trace.
4. *DW-04 well screen may be fouled by product; measurements not representative of groundwater conditions, excluded from contouring.
5. MW-09, MW-27 and MW-26 deeper monitoring wells used for contouring.
6. Basemap 2005 USGS aerial photograph. Does not show current conditions.
7. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N
W E
S

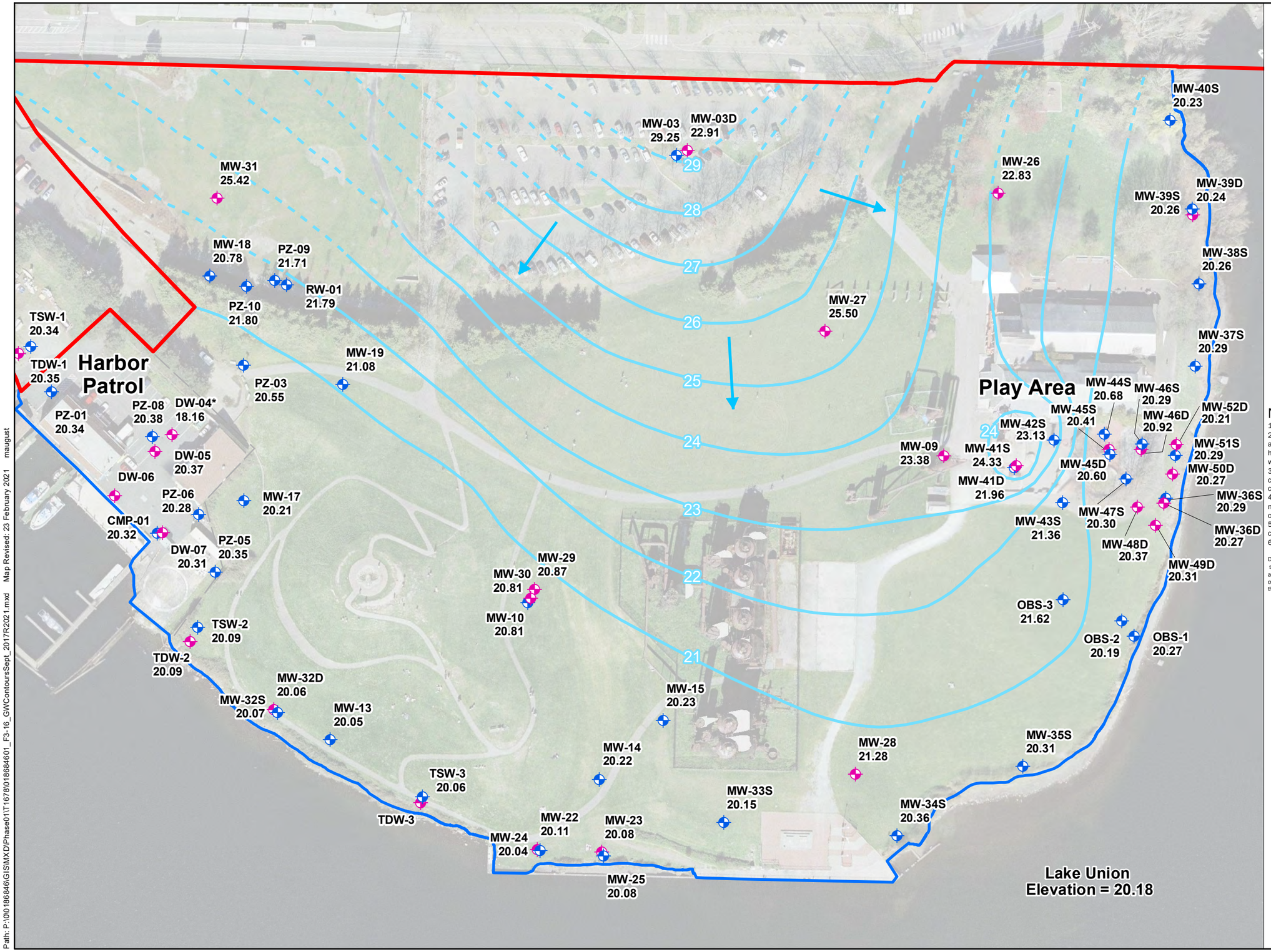
100 0 100
Feet

Groundwater Elevations and Water Table Contours (April 14, 2016)

Gas Works Park Site
Seattle, Washington

GeoEngineers | Figure 3-16

Path: P:\0018684\6\GIS\MXD\Phase01\T1678\01868401_F3-15_GWContoursApril_2016R2021.mxd Map Revised: 25 February 2021 maugust



Legend

- Area of Investigation
- Shoreline (OHWM)
- Water Table Monitoring Well
- Deeper Monitoring Well (Not Used for Contouring)
- 21 — Approximated Groundwater Elevation Contour (USACE) (Dashed Where Inferred)
- Inferred Groundwater Flow Direction
- MW-40S / 20.35 — Monitoring Well Identifier / Measured Water Level Elevation (USACE)

Notes:

1. Groundwater elevations measured on 9/18/2017.
2. Lake Union elevation taken from Lake Washington Ship Canal at Locks, 08:00 a.m. on 9/18/2017. http://www.nwd-wc.usace.army.mil/dd/common/dataquery/www/?k=lake%20washington
3. Moinitoring wells MW-09, MW-44S, and MW-45S contained greater than a trace of LNAPL and groundwater elevations corrected for LNAPL.
4. *DW-04 well screen may be fouled by product; measurements not representative of groundwater conditions, excluded from contouring.
5. Basemap 2005 USGS aerial photograph. Does not show current conditions.
6. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N
W E
S

100 0 100
Feet

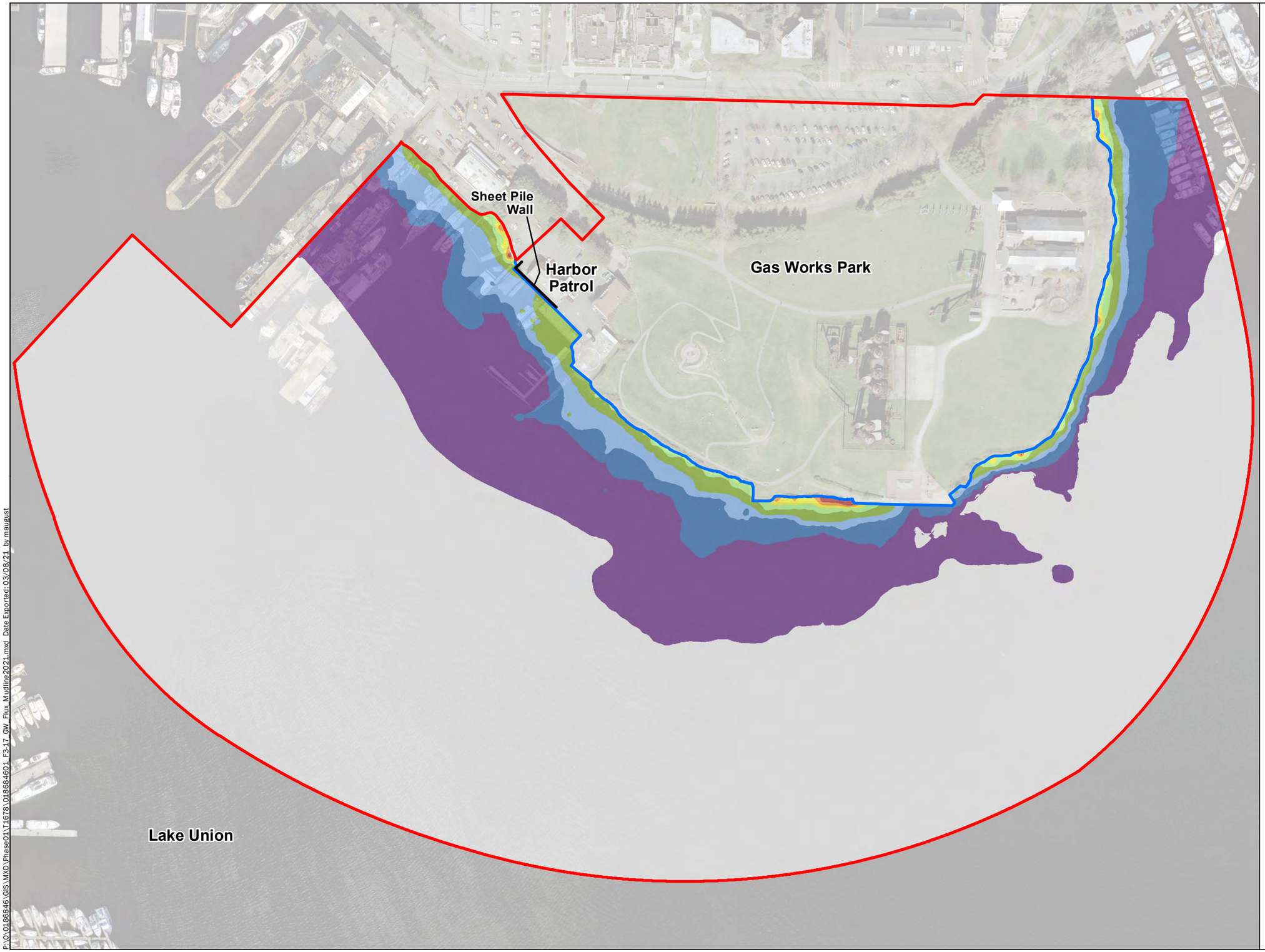
Groundwater Elevations and Water Table Contours (September 18, 2017)

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 3-17

Path: P:\00186846\GIS\MXD\Phase01\T1678\0186846_01_F3-16_GWContoursSept_2017R2021.mxd Map Revised: 23 February 2021 maugust



Legend

Area of Investigation

Shoreline (OHWM)

Mudline Discharge (feet/day)	% Total Discharge	% Cumulative Discharge
>0.05	3%	3%
0.05 - 0.04	5%	8%
0.04 - 0.03	9%	17%
0.03 - 0.02	18%	35%
0.02 - 0.01	29%	64%
0.01 - 0.005	17%	81%
0.005 - 0.001	11%	92%
0.001 - 0.0001	6%	98%
<0.0001	2%	100%

Notes:

1. Calculated discharge through the fill and outwash at the shoreline within the AOI is 1,660 cfd. Shoreline fill and outwash groundwater discharges to Lake Union nearshore in the area where mudline discharge is greater than 0.001 ft/day (i.e., Groundwater Discharge Zone).
2. Mudline discharge data from Anchor QEA 2018.
3. Basemap 2005 USGS aerial photograph. Does not show current conditions.
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

200 0 200

Feet

Estimated Groundwater Discharge at Mudline

Gas Works Park Site
Seattle, Washington

GeoEngineers

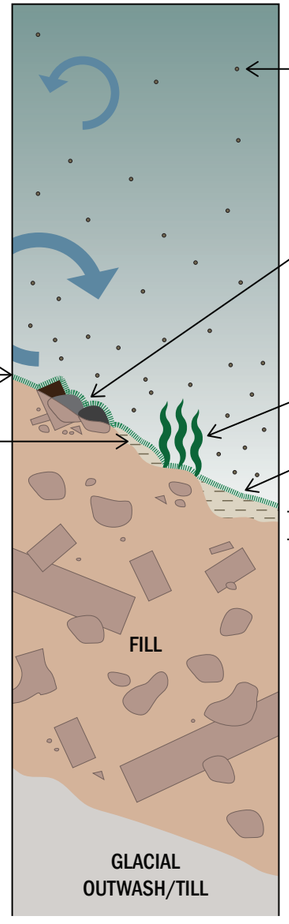
Figure 3-18

P:\0186846\GIS\MXD\Phase01\T1678\0186846_F3-17_GW_Flux_Mudline2021.mxd Date Exported: 03/08/21 by maugust

LAKESHORE/ UPPER LAKE SLOPE

HIGHER ENERGY ENVIRONMENT

- More frequent high speed currents
- Waves and prop wash erode or resuspend sediment and transports it to the lake bottom
- Prevents accumulation of flocculant



LAKE BOTTOM

QUIESCENT DEPOSITIONAL ENVIRONMENT

- Low current speeds

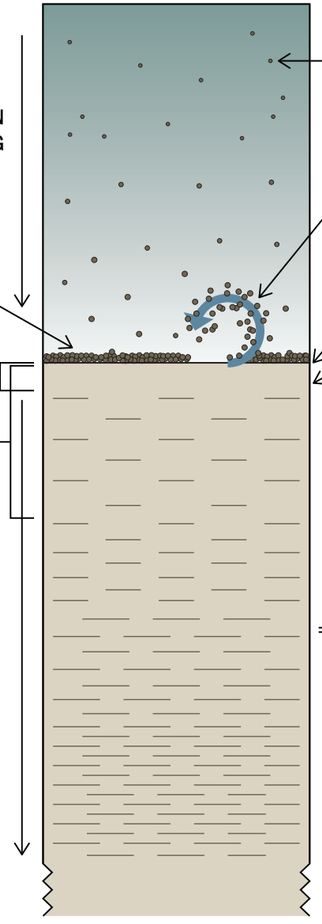
FLOCCULATION AND SETTLING

SETTLED FLOCCULANT (~1 INCH OR "DUSTING")
- Readily resuspended
- Typically not included in surface grab samples

BIOLOGICALLY ACTIVE ZONE (10 CM) (SURFACE GRAB SAMPLES)

AGE DATING FOR DEPOSITION RATES (CORES)

ONGOING DEPOSITION/BURIAL
- Sediment undergoing compaction/consolidation
- Decreasing water content
- Increasing strength



Sediment Characteristics and Biologically Active Zone

Gas Works Park Site
Seattle, Washington

GeoEngineers | Figure 3-19

P:\0\0186846\Graphics_Misc\Sediment Characteristics and Biologically Active Zone.ai Exported 4/29/21 by spride

Gas Works Park

Mowed Grass

Area of Overhanging Vegetation

Invasive Species
- Himalayan Blackberry
- Butterfly Bush

Emergent Wetland Vegetation

Native Red Alder & Sitka Willows

Mowed Grass

Mowed Grass

Himalayan Blackberry

Himalayan Blackberry

Lake Union

Legend

- Area of Investigation
- Shoreline (OHWM)
- Approximate Low-Water Shoreline

Shoreline Vegetation

- Forested
- Invasive Species
- Native Shrub
- Wetland Fringe

Notes:

1. Shoreline vegetation collected during low water on February 4, 2005 and during high water on July 6, 2005, may not be consistent with current conditions.
2. Bathymetry generated from side-scan sonar surveys (RETEC, September 1999; City of Seattle November 2002), nearshore singlebeam bathymetry survey (RETEC, October 2002), multibeam bathymetry surveys (Parametrix, December 2002; Tetra Tech, October 2006), leadline survey (RETEC, 2005).
3. Basemap 2005 USGS aerial photograph. Does not show current conditions.
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

100 0 100

Feet

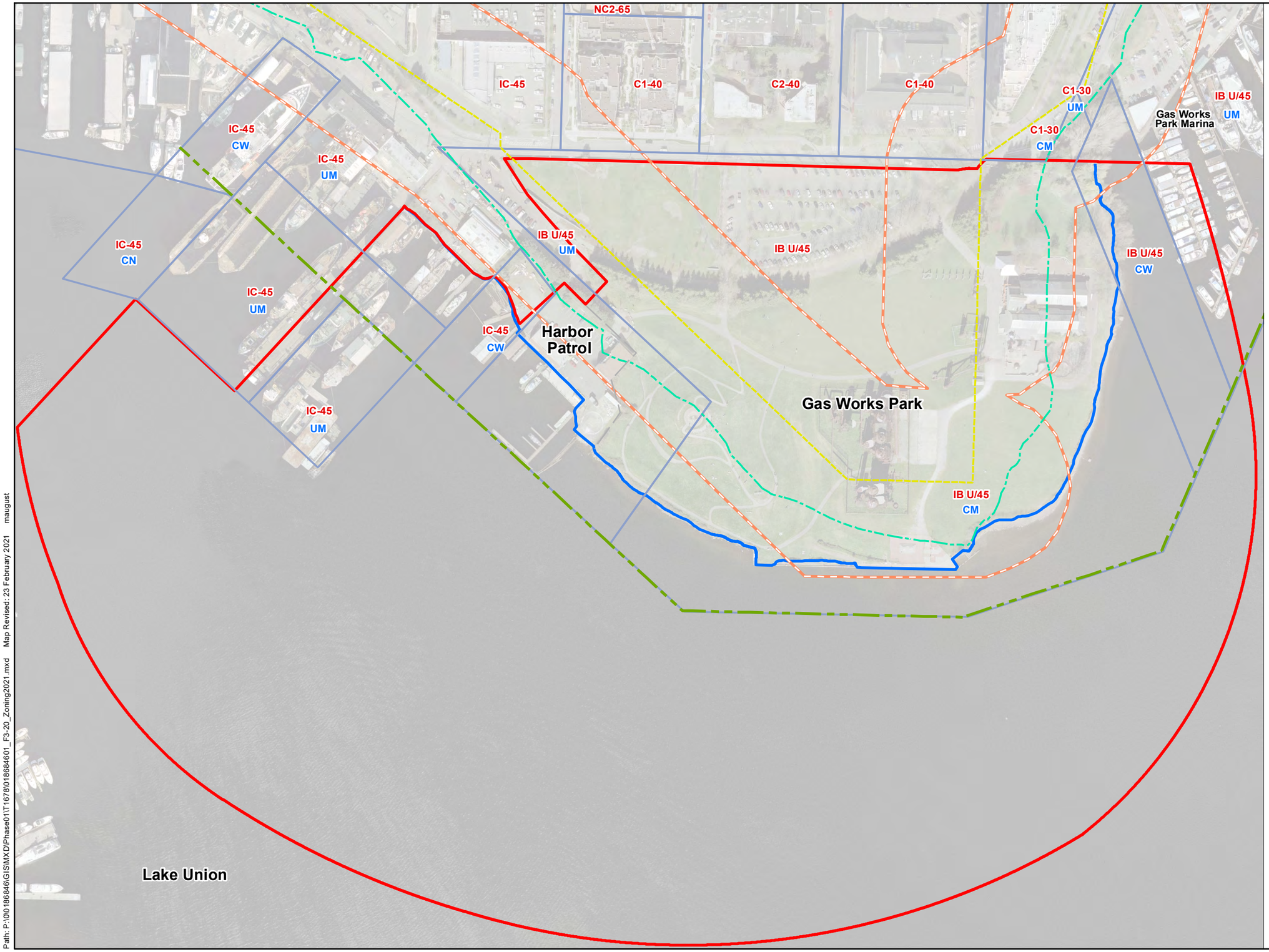
Shoreline Vegetation

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 3-20

Path: P:\0\0186846\GIS\MXD\Phase01\T1678\0186846 01_F3-19_ShorelineVegetation2021.mxd Map Revised: 23 February 2021 maugust



Legend

- Area of Investigation
- Shoreline (OHWM)
- Seattle Construction Limit Line
- Historical Outer Harbor Line (1907 Shoreline)
- Government Meander Line
- Archaeological Buffer Line

Zoning

IC-45 — 1C - Industrial Commercial
1B - Industrial Buffer
C1 - Commercial
C2 - Commercial

Shoreline Designations

UM — CN - Conservancy Navigation
CM - Conservancy Management
CW - Conservancy Waterway
UM - Urban Maritime

Notes:

1. Reference: King County Parcel Viewer (2013). King County iMap (2013).
2. Basemap 2005 USGS aerial photograph. Does not show current conditions.
3. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

N W E S

200 0 200

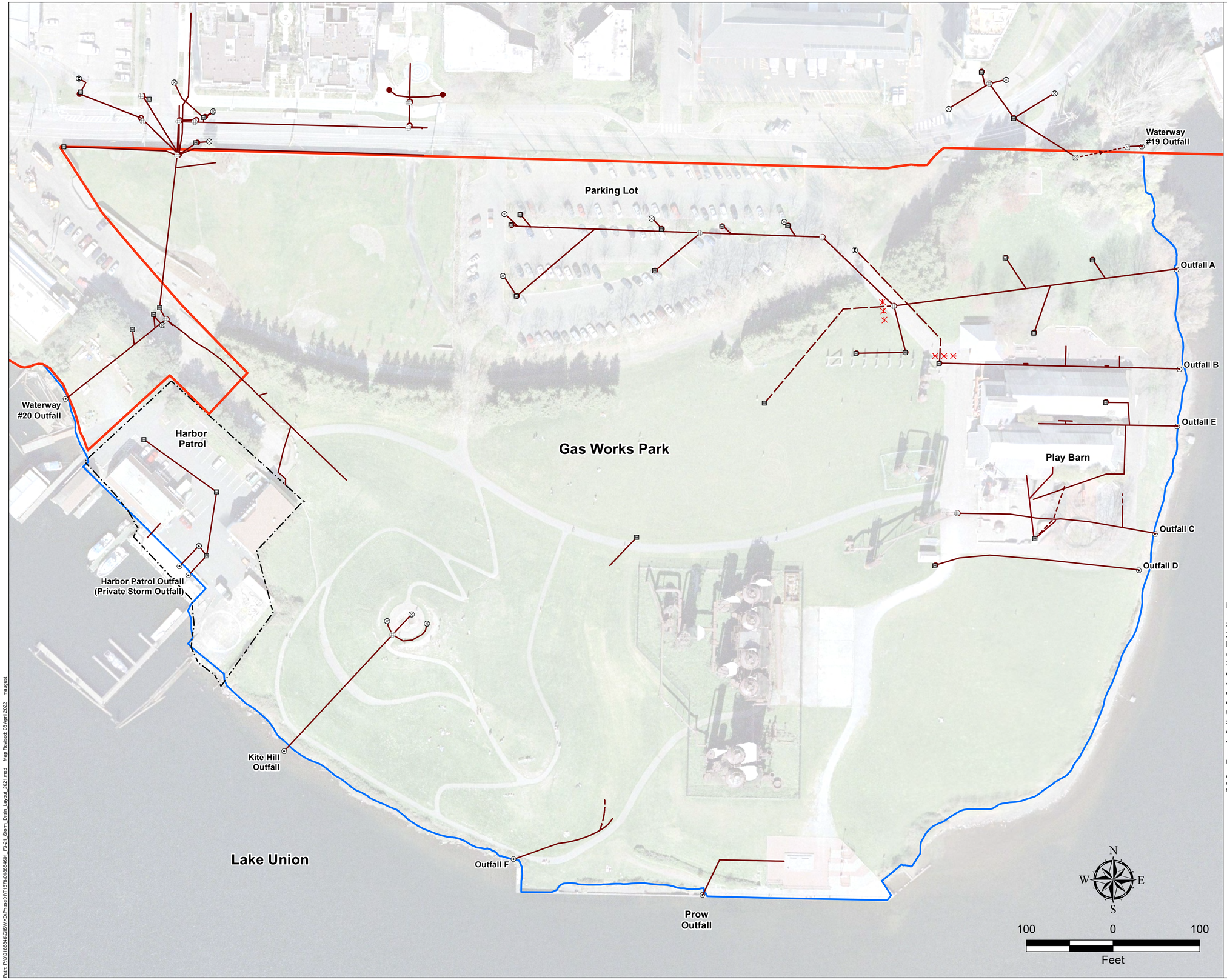
Feet

Zoning

Gas Works Park Site
Seattle, Washington

GeoEngineers **Figure 3-21**

Path: P:\0018684\6\GIS\MXD\Phase01\T1678\018684601_F3-20_Zoning2021.mxd Map Revised: 23 February 2021 maugust



Legend

- Area of Investigation
- Shoreline (OHWM)
- Storm Drain
- Perforated Storm Drain
- Drainage Ditch
- Oil/Water Separator
- Drain
- Catch Basin
- Inlet
- Maintenance Hole or Manhole
- Unknown Sewer/Lateral Point
- Storm Drain Outfall Location
- Plugged Pipe

Notes:
1. Reference: Attachments 6B-1 through attachments 6B-8, and Seattle Parks & Recreation As-Builts from November 2018.
2. Former outfall C perforated laterals not shown. Perforated laterals were lined during the Play Area 2018 renovation (Seattle Parks & Recreation As-Builts, November 16, 2018).
3. No flow was observed from Outfall F, Prow Outfall, or Kite Hill Outfall during several storm events.
4. Perforated underdrain pipes connected to Outfall C were installed during the Play Area renovation. These pipes were installed in a layer of clean material above a vapor barrier and do not come in contact with underlying, potentially contaminated soils.
5. Basemap 2005 USGS aerial photograph. Does not show current conditions.
4. Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet.

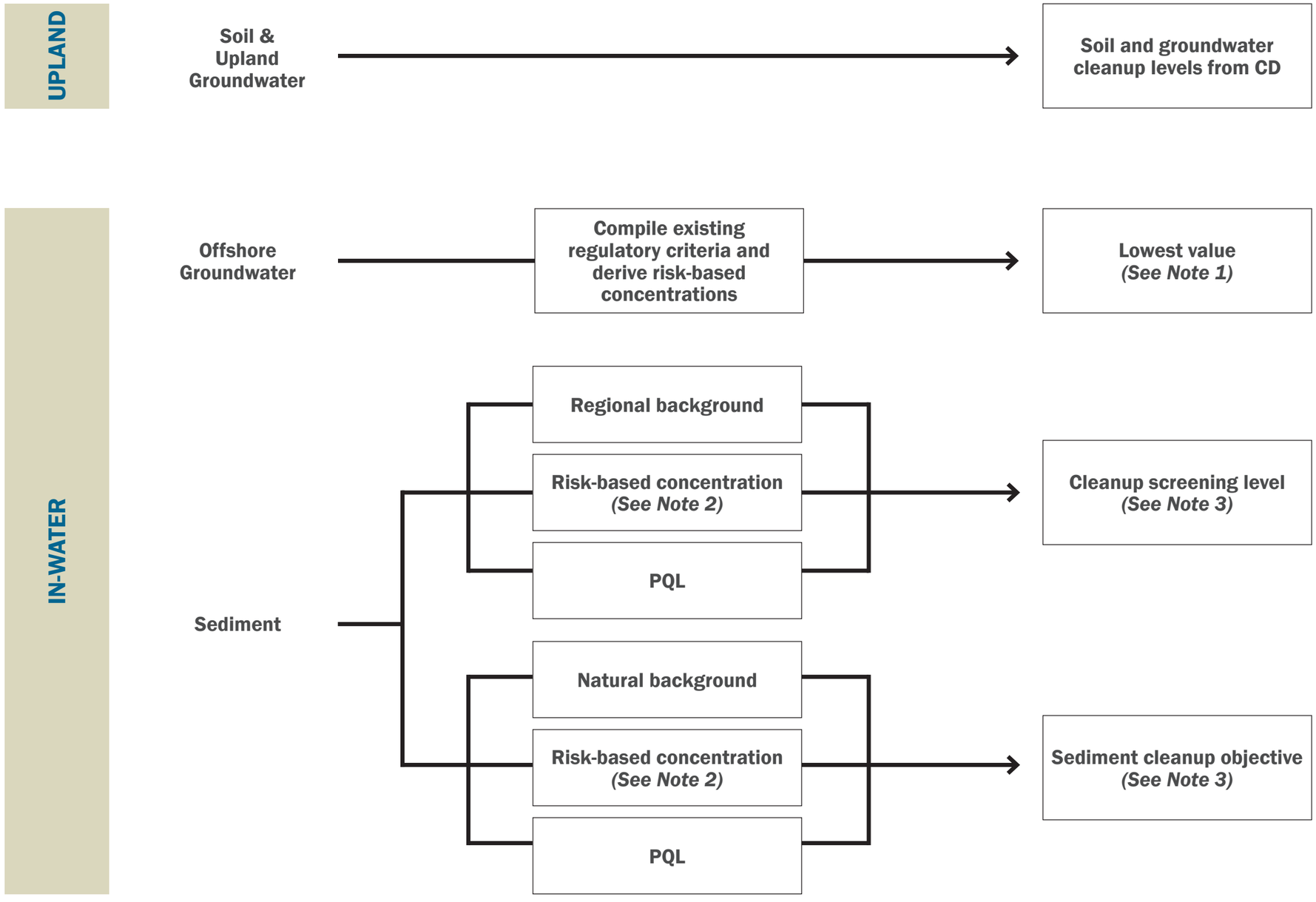
Catch Basin, Storm Drain, and Outfall Locations

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 3-22

Path: P:\0\0186846\GIS\MXD\Phase01\T1678\0186846001_F3-21_Storm_Drain_Layout_2021.mxd Map Revised: 08 April 2022 maugust



Acronym Definitions

CD	Consent Decree (1999)
MTCA	Model Toxics Control Act
PQL	Practical Quantitation Limit

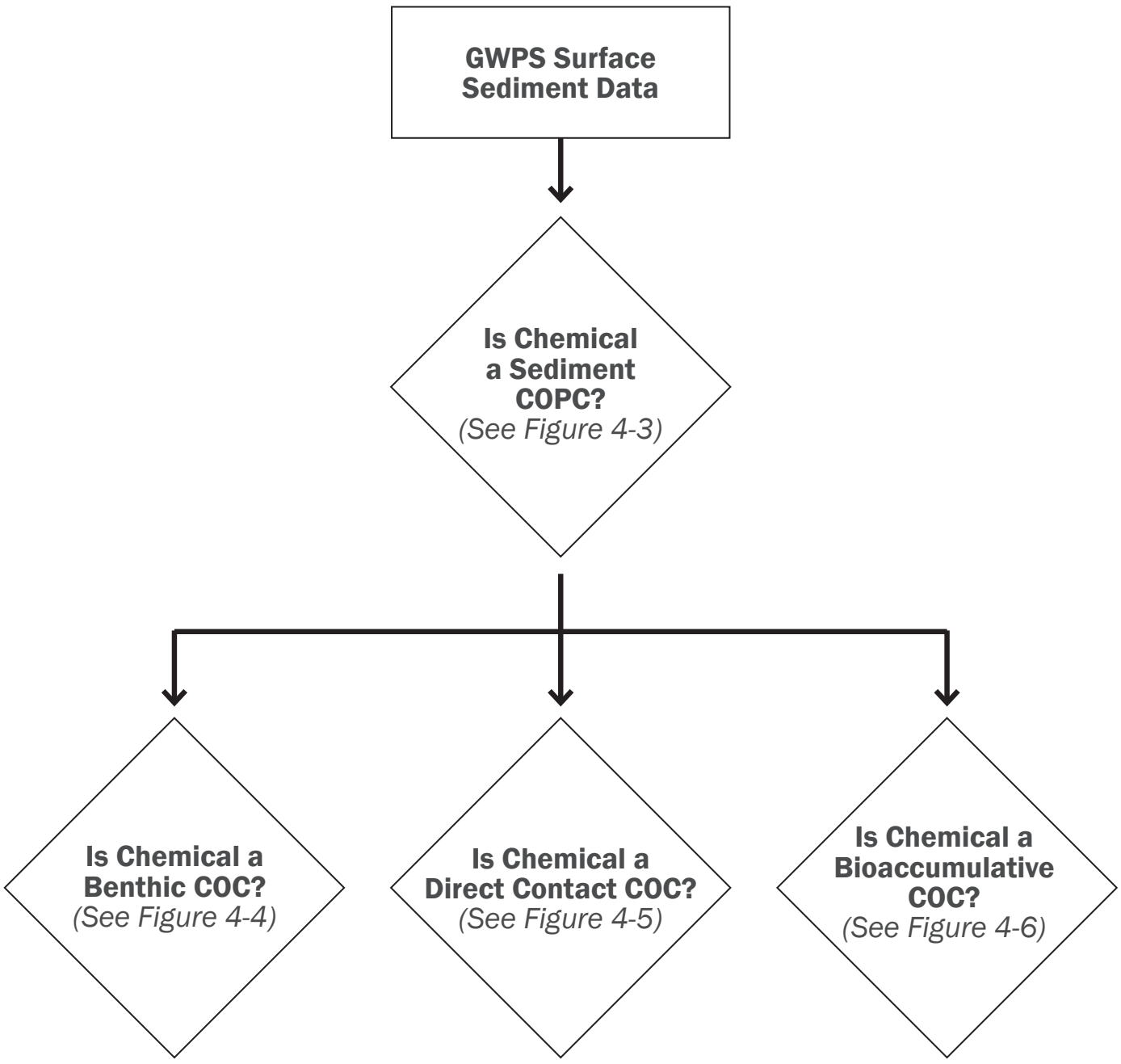
Notes

1. Per MTCA process, lowest value is adjusted upward, as necessary, to analytical PQL or background, whichever is higher.
2. Lowest of benthic, human health, higher trophic level and existing regulatory criteria.
3. Highest of background, risk-based concentration and PQL.

Selection of Screening Levels

Gas Works Park Site
Seattle, Washington

GeoEngineers | Figure 4-1



Acronym Definitions

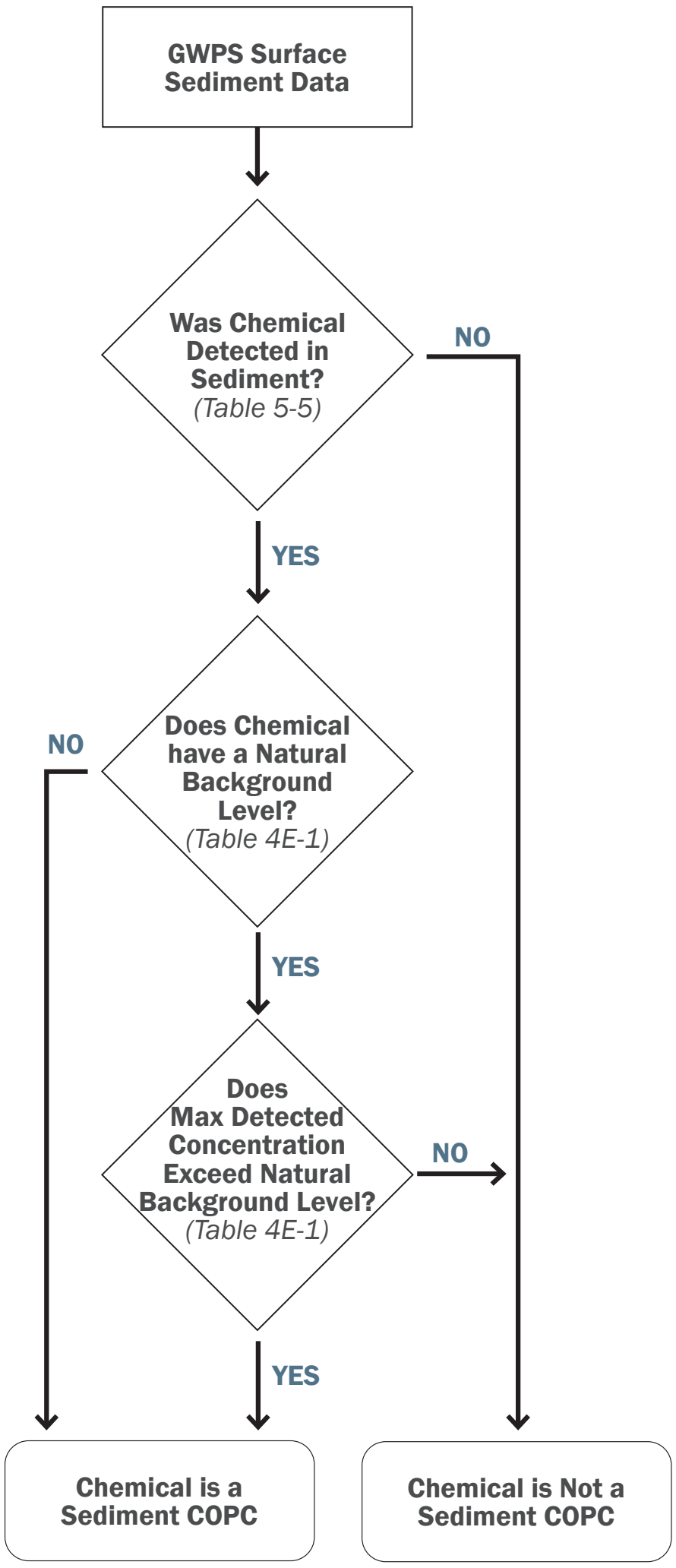
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
GWPS	Gas Works Park Site

Process for Identifying Sediment COCs

Gas Works Park Site
Seattle, Washington

GeoEngineers

Figure 4-2



Note

The answers to the questions above can be found in Table 5-5 or Appendix 4E.

Acronym Definitions

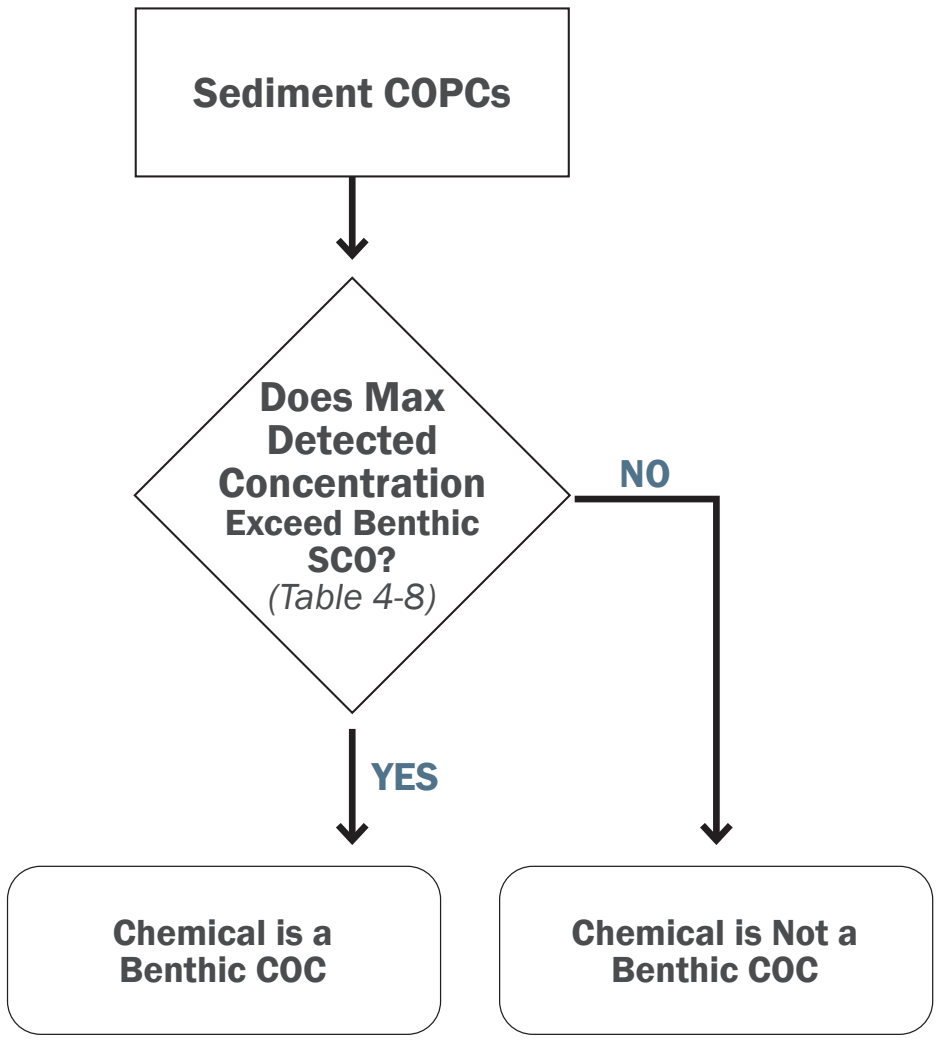
COPC	Contaminant of Potential Concern
GWPS	Gas Works Park Site

Decision Flowchart for Identifying Sediment COPCs

Gas Works Park Site
Seattle, Washington

GeoEngineers | **Figure 4-3**

Path: P:\0\0186846\Graphics_Misc\Decision-Flowcharts-for-Identifying-Sediment-COCs.indd Revised: 26 February, 2020 mherzel



Note

The answers to the section above can be found in Table 4-10.

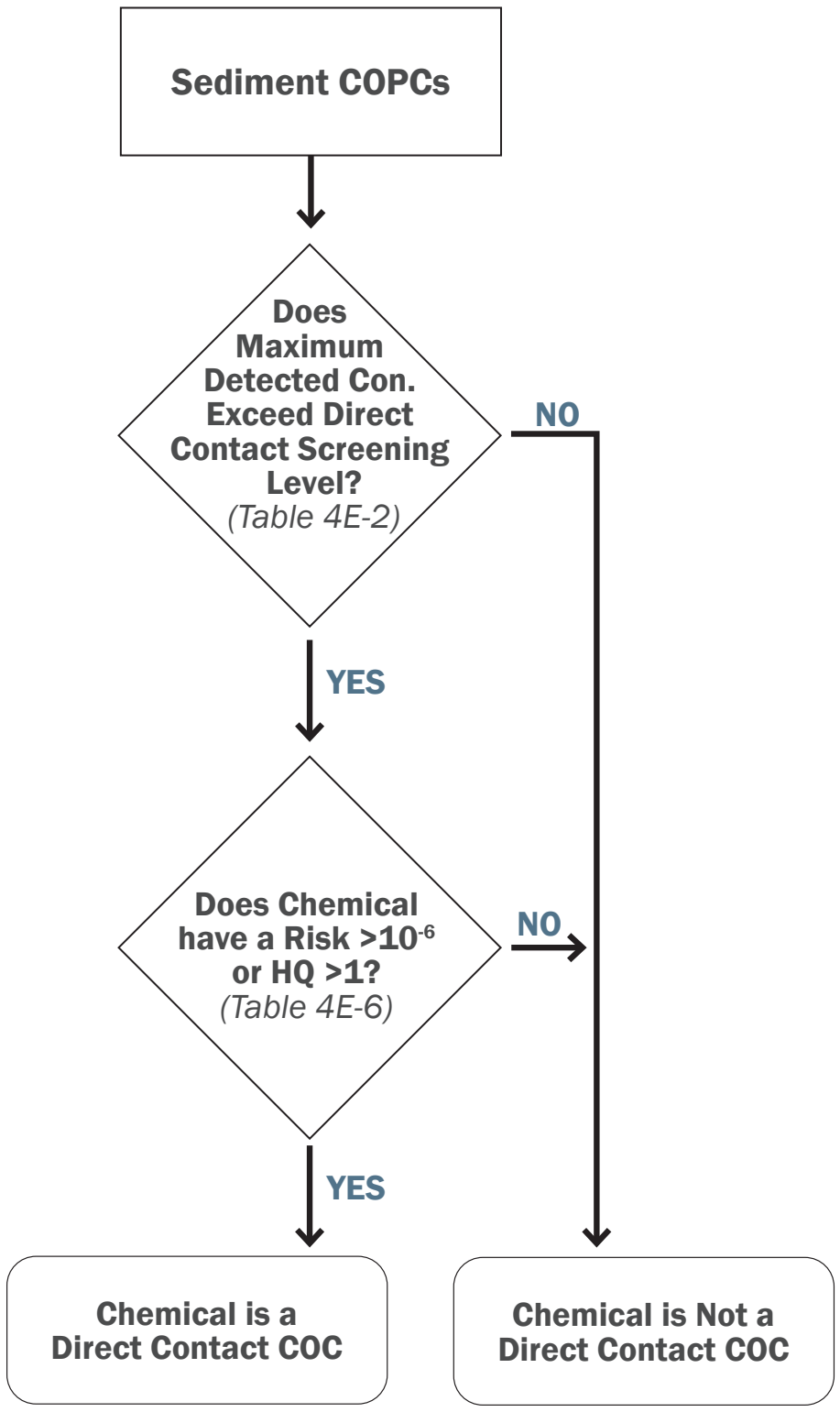
Acronym Definitions

COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
SCO	Sediment Cleanup Objective

Decision Flowchart for Identifying Benthic Sediment COCs

Gas Works Park Site
Seattle, Washington

GeoEngineers | **Figure 4-4**



Note

The answers to the questions above can be found in Appendix 4E.

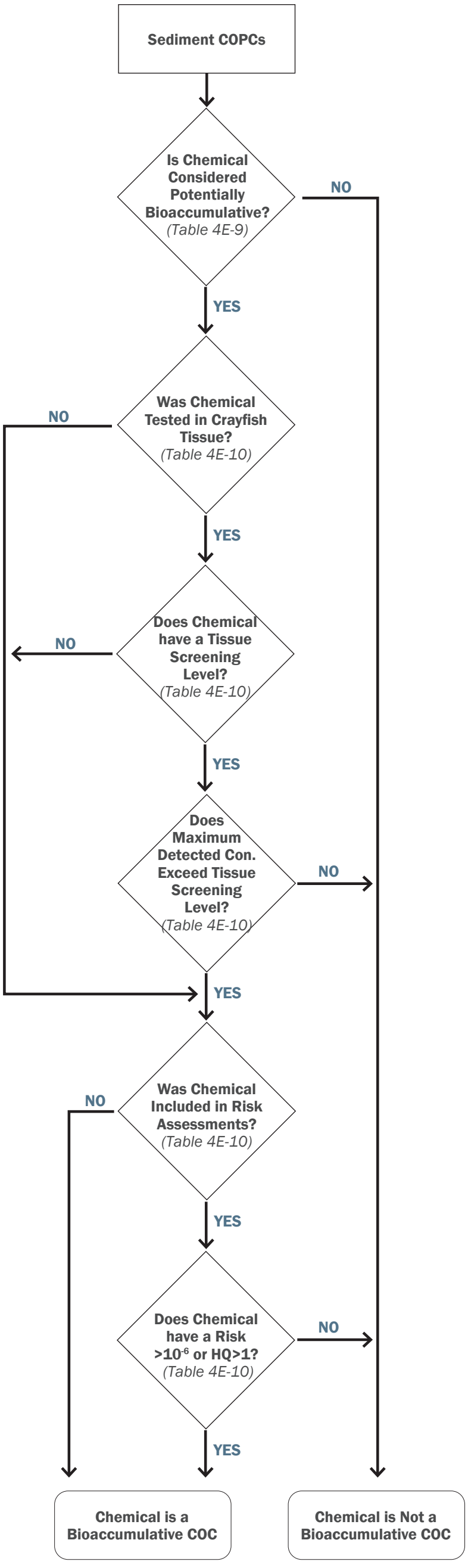
Acronym Definitions

COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
HQ	Hazard Quotient

Decision Flowchart for Identifying Direct Contact Sediment COCs

Gas Works Park Site
Seattle, Washington

GeoEngineers | **Figure 4-5**



Note

The answers to the questions above can be found in Appendix 4E.

Acronym Definitions

COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
HQ	Hazard Quotient

Decision Flowchart for Identifying Bioaccumulative Sediment COCs

Gas Works Park Site
Seattle, Washington

GeoEngineers | Figure 4-6