**Final**

August 2023

# Supplemental Remedial Investigation Report Site Characterization

## Operable Unit 1

## Naval Base Kitsap

Keyport, Washington

**Department of the Navy**
**Naval Facilities Engineering Command Northwest**
1101 Tautog Circle
Silverdale, WA  98315

# SUPPLEMENTAL REMEDIAL INVESTIGATION REPORT
# SITE RECHARACTERIZATION
# OPERABLE UNIT 1
# NAVAL BASE KITSAP, KEYPORT, WASHINGTON

**FINAL**

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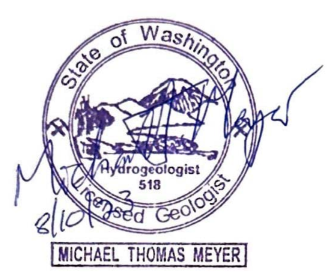

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| 2D | two dimensional |
| 3D | three-dimensional |
| µg/kg | microgram per kilogram |
| µg/L | microgram per liter |
| AGI | Advanced Geosciences, Inc. |
| ARAR | applicable or relevant and appropriate requirement |
| bgs | below ground surface |
| BOD | Biological Oxygen Demand |
| BP | before present |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| cm/s | centimeters per second |
| COC | contaminant of concern |
| COD | chemical oxygen demand |
| COI | contaminant of interest |
| COPC | contaminant of potential concern |
| CSM | conceptual site model |
| cVOC | chlorinated volatile organic compound |
| DAR | Data Assessment Report |
| DCA | dichloroethane |
| DCE | dichloroethene |
| DHC | Dehalococcoides |
| DNA | Deoxyribonucleic Acid |
| DNAPL | dense, nonaqueous phase liquid |
| DO | Dissolved Oxygen |
| DOC | dissolved organic carbon |
| DoD | Department of Defense |
| DU | decision unit |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| ERT | electrical resistivity tomography |
| ESS | environmental sequence stratigraphy |
| FS | Feasibility Study |
| ft | feet |
| g/cc | grams per cubic centimeter |
| HSU | hydrostratigraphic unit |
| HVDPE | high vacuum dual phase extraction |
| IAS | Initial Assessment Study |

| | |
|---|---|
| ISM | incremental sampling methodology |
| KCGWAC | Kitsap County Groundwater Advisory Committee |
| KCGWMP | Kitsap County Groundwater Management Plan |
| LNAPL | light nonaqueous phase liquid |
| LOD | limit of detection |
| LOQ | limit of quantitation (equivalent to PQL) |
| LTM | long-term monitoring |
| LUC | land use control |
| MBT | microbiology bench tool |
| mg/kg | milligram per kilogram |
| mg/L | milligram per liter |
| MIP | Membrane Interface Probe |
| MIS | marine isotope stage |
| MNA | monitored natural attenuation |
| mol/L | mole per liter |
| MTCA | State of Washington Model Toxics Control Act |
| NAPL | nonaqueous phase liquid |
| NBK | Naval Base Kitsap |
| OC | organic carbon |
| ORP | oxidation reduction potential |
| OU | operable unit |
| PAL | project action limit |
| PCB | polychlorinated biphenyl |
| PCE | tetrachloroethene |
| pg/L | picogram per liter |
| PID | Photoionization Detector |
| PFAS | perfluoroalkyl substances |
| QA | quality assurance |
| QC | quality control |
| RAO | remedial action objective |
| RG | remediation goal |
| RI | remedial investigation |
| ROD | Record of Decision |
| SAP | sampling and analysis plan |
| SCO | sediment cleanup objective |
| SCU | semi-confining unit |
| SMS | Sediment Management Standards |
| SVOC | semivolatile organic compound |
| TCA | trichloroethane |
| TCE | trichloroethene |

| | |
|---|---|
| TD | total depth |
| TEAP | terminal electron-accepting process |
| TOC | total organic carbon |
| TPH | total petroleum hydrocarbon |
| TRP | time-lapse electrical resistivity tomography |
| UCL | upper confidence limit |
| USCS | unified soil classification system |
| USGS | U.S. Geological Survey |
| VC | vinyl chloride |
| VOC | volatile organic compound |
| WAC | Washington Administrative Code |
| XSD | halogen specific detector |
| ya | years ago |

# 1.0 INTRODUCTION

This report synthesizes and interprets the results of investigations performed between 2014 and 2022 at the Area 1 former landfill comprising Operable Unit (OU) 1 of Naval Base Kitsap (NBK) Keyport in Keyport, Washington (Figures 1-1 and 1-2). This report supplements the remedial investigation (RI) for OU 1 finalized in 1993 (Navy, 1993a). The overall objective of these post-record of decision (ROD) investigations was to refine the conceptual site model (CSM) in support of potential remedy optimization to reduce the restoration timeframe. Additional elements of the supplemental RI are being conducted under separate contract and will be reported under separate cover. These include a revised risk assessment and an investigation of potential off-site transport of contaminants in groundwater beneath Dogfish Bay.

The activities documented in this report were conducted in accordance with project-specific sampling and analysis plans (SAPs) developed for each phase of investigation in consultation with the regulator/stakeholder team. This report was prepared under Navy Contract No. N39430-16-D-1802, CTO N3943018F4359 for Naval Facilities Engineering Systems Command Northwest by Battelle Memorial Institute, the prime contractor. As documented throughout this report, subcontractors to Battelle performed utility locating, land surveying, direct-push drilling, sonic drilling, well installation, laboratory analyses, data validation, and numerical groundwater modeling for investigation work led by Battelle. This report also integrates results of investigations led by other Navy contractors, and these results are identified as they are used.

Responses to regulatory agency and stakeholder comments received on the draft version of this report will be included in Appendix A once received.

## 1.1 REPORT ORGANIZATION

This subsection introduces the organization of this supplemental RI report, which is based on the original RI (Navy, 1993a) with consideration of the suggested RI report format in U.S. Environmental Protection Agency (EPA) guidance (EPA, 1988). This document minimizes reiteration of information that is unchanged from the original RI, instead referencing that previous document.

**Section 1** introduces the supplemental RI, explains the document organization, and provides the site description and history. Details of the site meteorology, demography and land use, and ecology were covered in the original RI and are not discussed in detail. Some of these elements are touched upon in the site description subsection.

**Section 2** documents the post-ROD investigations conducted in support of this supplemental RI. Previously reported investigations are cited, but not reproduced herein. Work performed between 2019 and 2022 not previously reported in a comprehensive document is described in Appendix B.

**Section 3** synthesizes and interprets the results of the post-ROD investigations conducted between 2014 and 2022. Subsections address key topic areas, while an updated CSM presents a concise description of the geology, hydrogeology, nature and extent of contamination, and fate and transport of contamination.

**Section 4** presents conclusions and recommendations for a focused feasibility study (FS).

## 1.2 SITE DESCRIPTION

NBK Keyport occupies 340 acres (including tidelands) adjacent to the town of Keyport in Kitsap County, Washington, on a small peninsula in the central portion of Puget Sound. The Keyport property was acquired by the Navy in 1913, with property acquisition continuing through World War II. The property was first used as a quiet-water range for torpedo testing. The first range facility was located in Port Orchard Inlet southeast of the site (Navy, 2015b).

During the early 1960s, Keyport's role was expanded to include manufacturing and fabrication, such as welding, metal plating, carpentry, and sheet metal work. Further expansion in 1966 consisted of a new torpedo shop, and, in 1978, the functions were broadened to include various undersea warfare weapons and systems engineering and development activities. Operations currently include engineering, fabrication, assembly, and testing of underwater weapons systems (Navy, 2015b).

Marine or brackish water bodies on and near the site consist of Liberty Bay to the east and north, Dogfish Bay to the northwest, tide flats and a marsh to the west, and a shallow lagoon (also known as the Keyport Lagoon) to the southeast (Figure 1-1). Freshwater bodies include two creeks draining into Marsh Pond and two creeks that discharge into the shallow lagoon. The topography of the site rises gently from the shoreline to an average of 25 to 30 feet (ft) above mean sea level and then rises steeply to approximately 130 ft above mean sea level at the southeast corner of the site (Navy, 2015b).

Area 1, the former base landfill, comprises approximately 9 acres in the western part of the base next to a wetland area and the tide flats that flow into Dogfish Bay (Figure 1-2). Most of the landfill area was formerly part of the wetland that now borders the landfill to the west and south. The former shoreline is shown on Figure 1-2. This wetland area drains northward into the tide flats of Dogfish Bay through a culvert under Keys Road. A tide gate has been installed at this culvert to control tidal inundation of the wetlands and landfill. The tide flats are connected to Dogfish Bay by a narrow channel through structural fill material that forms the foundation of the Highway 308 causeway and bridge. The landfill is unlined at the bottom, and the top is covered with areas of grass, trees, asphalt, and concrete. The remaining wetlands adjacent to the landfill include most of the area bounding the landfill to the west, northwest, southwest, and south (Figure 1-2) (Navy, 2015b). A small pond is located in the central part of the wetlands, west of the landfill. The pond is drained by a small creek that flows northward to the tide flats. The pond is fed by the remainder of the wetlands located south and southeast of the pond. The entire wetlands area is referred to as "the marsh," including the pond, the creek that drains the pond, and the wetland areas upstream and downstream of the pond.

Surface water discharges to Marsh Pond via two small freshwater creeks that enter the pond from the south end (U.S. Navy [Navy], EPA, and Washington State Department of Ecology [Ecology], 1998). The marsh also receives input from stormwater drainage systems (Figure 1-3) and shallow groundwater flowing toward the marsh from all sides in the shallow aquifer. Marsh Creek drains into the tide flats through the tide gate under Keys Road. This tide gate controls tidal flow into the marsh, regulating the marsh water level.

The surface water bodies near the former landfill constitute a complex, tidally influenced hydrologic system. Tidal fluctuations in Dogfish Bay influence the water levels in the tide flats northwest of the landfill, although the tide gate controls these effects on Marsh Creek and Marsh Pond. The typical range in tide level of the tide flats at a measuring point close to the southeast side of the Highway 308 bridge is about 10 ft from higher high to lower low tide (Navy, EPA, and Ecology, 1998).

Near-surface geology in the Keyport area generally consists of both glacial and non-glacial deposits. The former landfill at OU 1 is underlain by fine- to medium-grained sands interbedded with silt and clay to depths ranging from approximately 30 to 50 feet below ground surface (bgs). At this depth a coarse sand or gravel is commonly present overlying a peaty silt or clay that has been interpreted as a regionally significant aquitard. The surface of this aquitard is interpreted as erosional based on the varying depth at which the peaty silt/clay is logged, and sands found beneath the peaty silt/clay have been interpreted as mud-supported fluvial channels within this geologic formation.

The unconfined shallow water-bearing unit, interpreted in the ROD to include two distinct aquifers, but determined to be one aquifer through recent additional investigations, is the primary focus of this investigation and is present throughout the landfill area. The water table in this shallow water-bearing zone intersects the landfill waste material beneath much of the landfill. That is, roughly 5 ft of landfill material lies above the shallow groundwater surface in the unsaturated zone, and up to about 5 ft of material lies beneath the water table in the saturated zone (Navy, EPA, and Ecology, 1998).

Shallow groundwater flow has consistently been interpreted to flow through the landfill in a radial direction and discharge into the marsh northwest, west, southwest and south of the landfill. Deeper groundwater in this same water-bearing zone (historically considered the "intermediate aquifer") has been interpreted to flow toward the northwest. The depth to first groundwater is typically 4 to 5 ft bgs in the landfill.

Groundwater/surface water tidal interaction and groundwater salinity studies were performed historically, and the results included in the 1997 summary data assessment report (Navy, 1997b). Additional assessment of tidal influence was performed during phytoremediation monitoring. The 1997 focused FS concluded that groundwater levels at OU 1 are influenced by seasonal and tidal changes, but not enough to change the general groundwater flow patterns, and that tidal influence occurs in wells close to the shore, but rapidly attenuates with distance from the tide flats or Dogfish Bay, with a maximum tidal fluctuation in groundwater measured prior to 1997 of 2.5 feet (Navy, 1997a).

## 1.3 SITE BACKGROUND

### 1.3.1 Historical Operations

The landfill was the primary disposal area for domestic and industrial wastes generated by the base from the 1930s until 1973, when the landfill was closed. A burn pile for trash and demolition debris was located at the north end of the landfill from the 1930s to the 1960s. Unburned or partially burned materials from this pile were buried in the landfill or pushed into the marsh as it existed at the time, slowly expanding the landfill footprint. A trash incinerator was operated at the north end of the landfill from the 1930s to the 1960s, and incinerator ash was disposed of in the landfill. Burning continued at the landfill until the early 1970s. Soil excavated from elsewhere at NBK Keyport was stockpiled, at an unknown time prior to 1998, on top of the waste body in a portion of the landfill footprint just north of the current phytoremediation North Plantation. The origin and presence/level of contamination of this stockpiled soil is not documented; however, anecdotally it was generated from a construction project and was presumed to be "clean" at the time of placement. The original volume of this stockpile (based on estimates from LiDAR topography) was approximately 6,900 cubic yards. A portion of this pile was used in 1998 to create a soil layer for planting the two phytoremediation plantations, and the remaining stockpile volume is approximately 5,100 cubic yards.

From the 1930s until the 1970s, waste paint, thinners, and strippers from the paint and stripper shop were disposed of in the southwest area of the landfill (Navy, 1984). The Navy interviewed more than 50 former and current employees, eight of whom had been directly involved in landfill operations, to learn whether intact drums of liquid wastes were placed in the landfill. One person remembered that 12 to 14 pallets of 5-gallon cans of paint and some 55-gallon drums were buried whole. The remaining people believe that whole drums were not buried intact. Some said that drummed wastes were poured into the landfill or drums were crushed before burial. Overall, the interviews indicated that disposal of liquids in drums was not a common practice, and substantial amounts of drummed liquid wastes are unlikely to be in the landfill (Navy, EPA, and Ecology, 1998).

During various site investigation and assessment studies between 1984 and 1988, Area 1 was determined to have possible environmental contamination. In 1989, NBK Keyport was officially listed on the National Priorities List, becoming a Superfund site under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). Area 1 was included in a RI and FS that were conducted at NBK Keyport between 1988 and 1993 (Navy, 1993a, 1993b), and the RI included human health and ecological risk assessments (Navy, 1993c, 1993d). Based on the risk assessments, two subclasses of chemicals, chlorinated volatile organic compounds (cVOCs) and polychlorinated biphenyls (PCBs), were identified as contaminants of concern (COCs) at the site; cVOCs are COCs for soil, sediment, tissue, groundwater, and surface water throughout the landfill; and PCBs are COCs for a specific area of sediment and seep water at Area 1. The specific cVOCs established as COCs in the ROD include (Table 1-1): 1,1-dichloroethane (DCA), 1,2-DCA, 1,1-dichloroethylene (DCE), cis-1,2-DCE, trans-1,2-DCE, tetrachloroethylene (PCE), 1,1,1-trichloroethane (TCA), trichloroethylene (TCE), and vinyl chloride (VC). Although not designated as a COC in the ROD, chloroethane is typically quantified in groundwater at the site for the purposes of assessing degradation of the cVOC COCs.

The RI also identified indoor air risks to workers from vapor intrusion into modular units that were located on the landfill at the time. Shortly after the baseline risk assessment, the Navy removed the modular office buildings from the landfill surface to eliminate these potential risks. In addition, Navy personnel were no longer assigned to work full time in the buildings that remained in the southern portion of the landfill. The vapor intrusion studies did not indicate vapor intrusion as a pathway of concern outside the landfill boundary east of Bradley Road based on the soil gas action levels that were established at the time.

### 1.3.2 Remedial Action

After the RI was completed, the FS evaluated seven remedial alternatives for Area 1. The Navy, Ecology, and EPA selected a preferred remedial alternative for Area 1, which was described in the 1994 proposed plan (Navy, 1994). However, because public comment regarding the preferred remedial alternative was not favorable, the proposed plan was withdrawn, and Area 1 was separated from the remaining areas assessed during the RI to become OU 1.

To address the public's concerns, the Navy, Ecology, and EPA conducted further site characterization to collect data to supplement the RI. Beginning in 1995 and ending in September 1996, five quarterly rounds of sampling were conducted. The additional data were used to evaluate the potential risks from three key COC pathways at OU 1 (Navy, EPA, and Ecology, 1998):

- Drinking water pathway (human health risk)
- Seafood ingestion pathway (human health risk)
- Ecological pathway (risk to aquatic organisms)

The environmental media identified as those that could potentially result in future receptor exposures to contaminants were groundwater, surface water, and sediment downgradient of OU 1. The new data obtained from the site characterizations were discussed and evaluated in a summary data assessment report (Navy, 1997b), which supplemented the RI. Several additional alternatives were then evaluated in a supplemental focused FS (Navy, 1997a), from which a new preferred remedial alternative was selected and eventually accepted, based on public comment. The ROD for OU 1 was executed in September 1998 (Navy, EPA, and Ecology, 1998).

To achieve the remedial action objectives (RAOs), the remedial action components specified in the OU 1 ROD included the following:

- Treat volatile organic compound (VOC) hotspots in the landfill using phytoremediation by poplar trees in concert with natural attenuation.
- Remove PCB-contaminated sediments from around the seep area, which have the highest documented concentrations of PCBs.
- Upgrade the tide gate to protect the landfill from flooding and erosion during extreme tide events.
- Upgrade and maintain the landfill cover.
- Conduct long-term monitoring (LTM), including phytoremediation monitoring, intrinsic biodegradation monitoring, and risk and compliance monitoring.
- Take contingent actions for off-base domestic wells, if necessary.
- Implement institutional controls.

The OU 1 ROD also included a RAO to prevent human exposure to vapors from the landfill. As part of the selected remedy, all of the remaining occupied buildings were removed from the landfill, and institutional controls were established to prohibit construction of occupied structures on the landfill that could result in vapor exposure.

The Navy performed routine LTM of groundwater and surface water on an annual basis at OU 1 through 2016, when routine LTM was suspended by agreement between the Navy, Ecology, EPA, and the Suquamish Tribe (hereafter referred to as the "project team") until further characterization was completed and the LTM program could be updated based on the new data obtained. The LTM results have indicated no need for the implementation of contingent actions for off-base domestic wells. After routine LTM was suspended in 2016, the LTM program was used to collect targeted data in support of the investigations described in Section 2. These targeted data are incorporated into the interpretations within this supplemental RI and are identified when used (Figure 1-3).

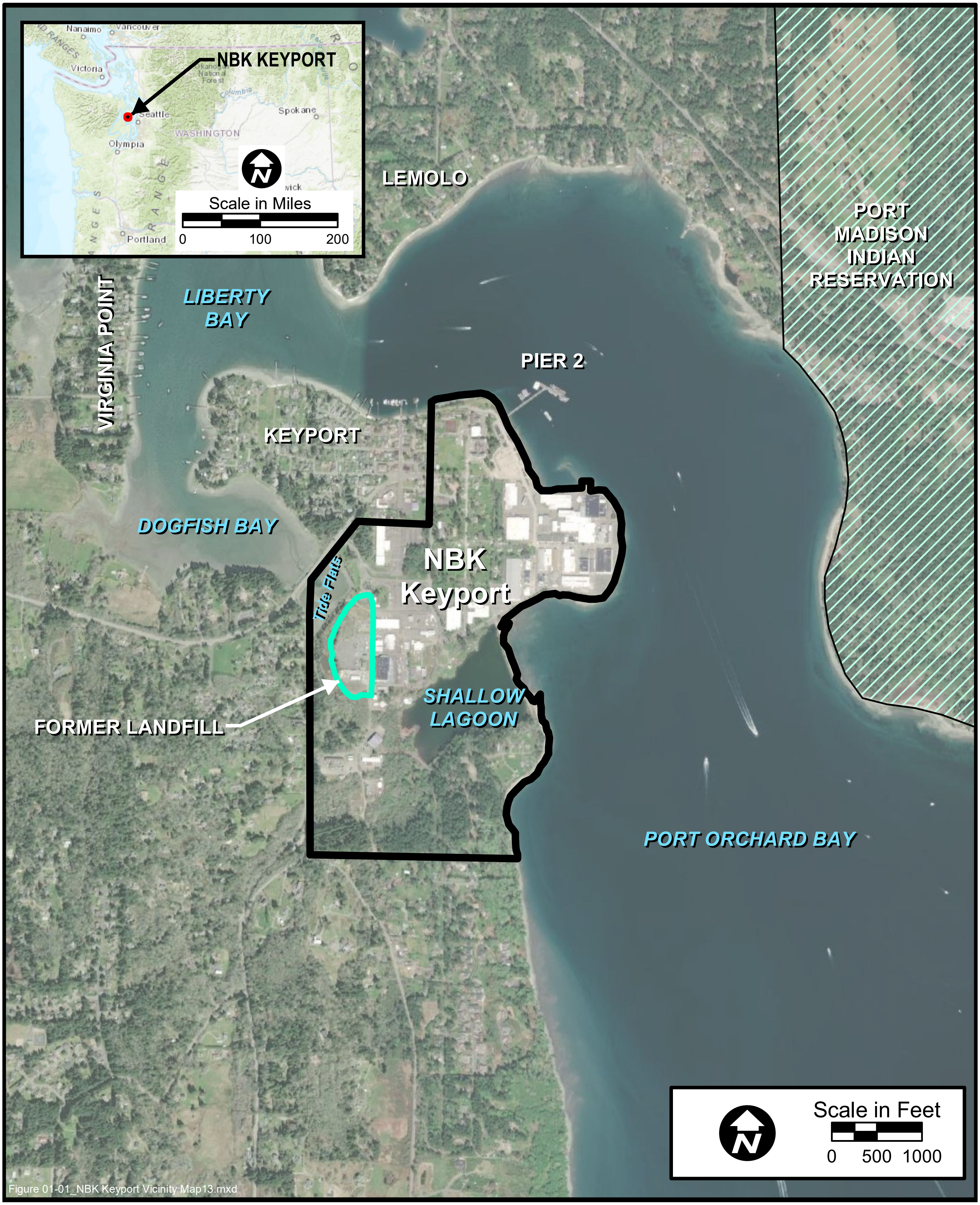
Through 2015 the United States Geological Survey (USGS) performed annual monitoring of natural biodegradation conditions beneath and near the former landfill. The results of these investigations indicated that natural reductive biodegradation processes were operating very effectively at the site.

All of the components of the selected remedy have been implemented, the most recent being the upgrade of the landfill cover completed in 2003. The upgrade included regrading of the landfill material and modification and construction of a stormwater conveyance system that includes catch basins and an oil/water separator that discharges to the marsh on the western edge of the landfill cover. The phytoremediation component of the remedy was implemented in 1999 and consisted of planting two plantations of hybrid poplar trees (referred to as the "North Plantation" and the "South Plantation") (Figure 1-3). The area between the North and South Plantations is referred to as the "Central Landfill."

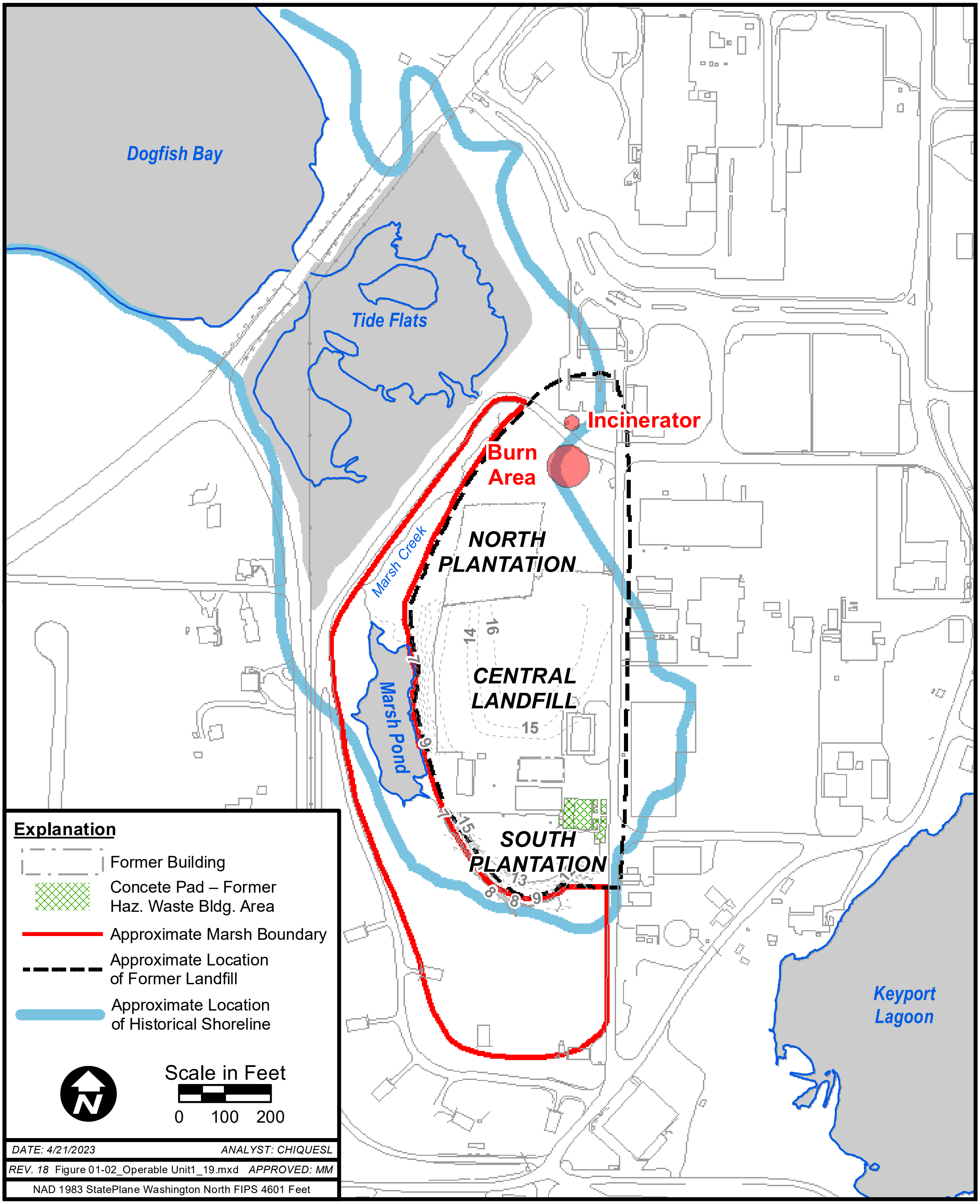
In spite of the high degree of biodegradation implied by the USGS data and the reductions in cVOC mass over time implied by the LTM results, the concentrations of cVOCs in groundwater from shallow monitoring wells located at the South Plantation remained very high (TCE concentrations up to 33,800 micrograms per liter [µg/L] and a cis-1,2-DCE concentration of 55,700 µg/L in 2014), and cVOC concentrations in surface water adjacent to the South Plantation have consistently exceeded the surface water remediation goals (RGs). TCE and VC were detected at concentrations as high as 2,580 µg/L and 4,330 µg/L, respectively, compared to RGs of 56 µg/L and 2.9 µg/L for these two cVOCs. These ROD RGs do not reflect the most current applicable or relevant and appropriate requirements (ARARs) for these COCs.

### 1.3.3 Evaluation of Natural Attenuation

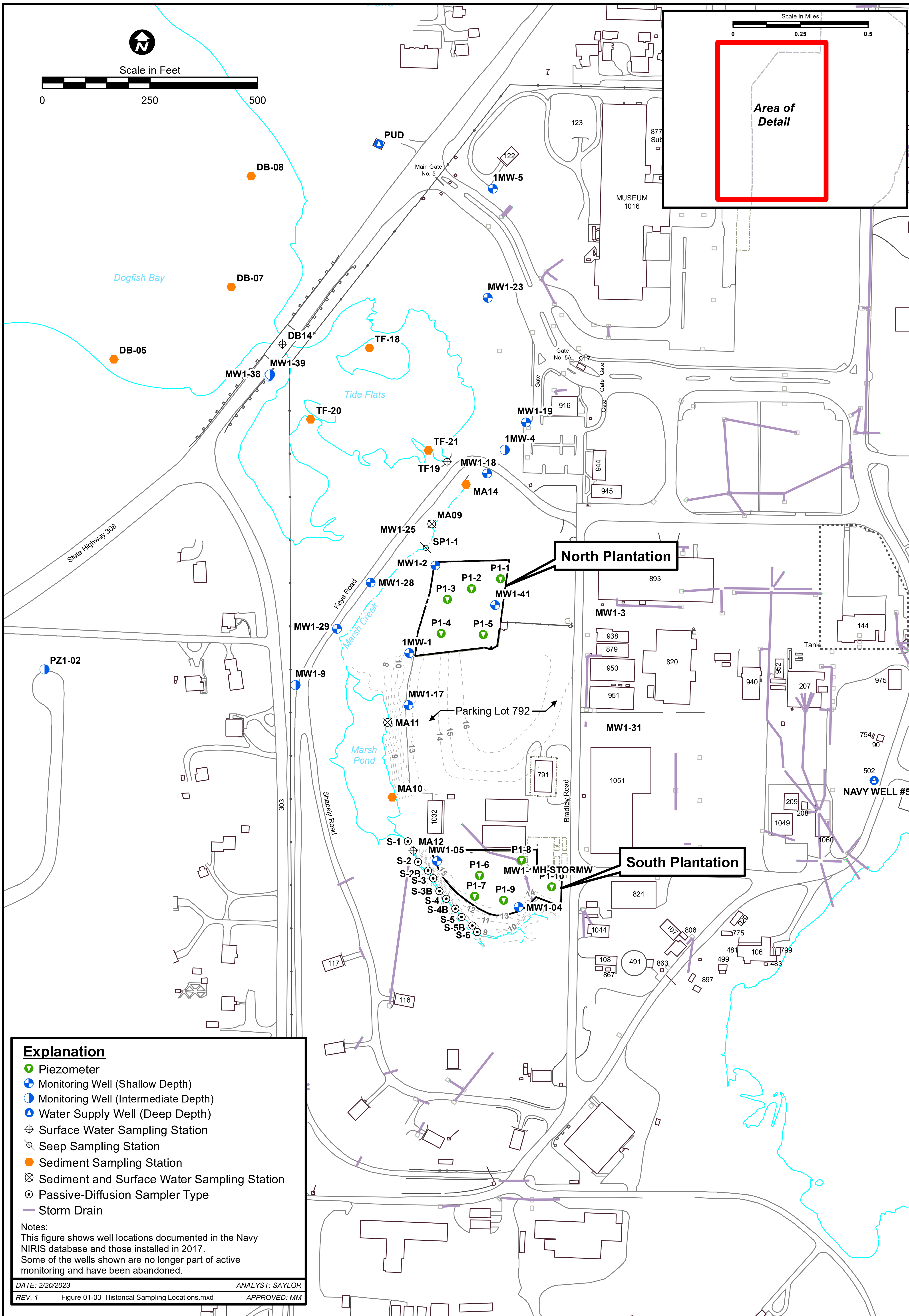
Based on concerns that the phytoremediation component of the selected remedy was not performing as expected in the South Plantation, the third five-year review (Navy, 2010) recommended that the Navy perform an evaluation of natural attenuation as a stand-alone remedy, as called for in the ROD. The Navy performed this evaluation in 2011 and 2012 (Navy, 2012) and concluded that the RG for discharge to surface water adjacent to the South Plantation would not be met within a reasonable restoration timeframe. The evaluation recommended that additional investigation of the South Plantation be performed to identify cVOC hotspots. In addition, trend analysis of the LTM results from well MW1-17, screened in the shallow groundwater and located on the western edge of the Central Landfill, indicated the potential presence of a source area upgradient of well MW1-17, between the two plantations. Although contaminant concentrations in MW1-17 remained less than the RGs, LTM data from 2009 through 2016 indicated increasing trends of three cVOCs that are TCE degradation products in this well (1,1-DCE. cis-1,2-DCE and VC). Section 2 summarizes the investigations conducted in response to the conclusions of the natural attenuation evaluation and the trend analysis findings for well MW1-17.




| U.S. NAVY | **Figure 1-1** **NBK Keyport Vicinity Map** | Naval Base Kitsap Keyport |
|---|---|---|




| | | |
|---|---|---|
| **U.S. NAVY** | **Figure 1-2**<br>**Operable Unit 1** | Naval Base Kitsap<br>Keyport |




| U.S. NAVY | Figure 1-3<br>Historical Sampling Locations | Naval Base Kitsap<br>Keyport |
|---|---|---|

## Table 1-1. Chemicals of Concern Established in OU 1 ROD

| Chemical of Concern | Remediation Goal |
|---|---|
| **Groundwater (µg/L)** | |
| Tetrachloroethene (PCE) | 5 |
| Trichloroethene (TCE) | 5 |
| 1,1-Dichloroethene | 0.5 |
| cis-1,2-Dichloroethene | 70 |
| trans-1,2-Dichloroethene | 100 |
| Vinyl chloride | 0.5 |
| 1,1,1-Trichloroethane | 200 |
| 1,1-Dichloroethane | 800 |
| 1,2-Dichloroethane | 5 |
| Total PCB Aroclors | 0.04 |
| **Surface Water (µg/L)** | |
| Tetrachloroethene (PCE) | 4.2 |
| Trichloroethene (TCE) | 56 |
| 1,1-Dichloroethene | 1.9 |
| cis-1,2-Dichloroethene | NE |
| trans-1,2-Dichloroethene | 33,000 |
| Vinyl chloride | 2.9 |
| 1,1,1-Trichloroethane | 41,700 |
| 1,1-Dichloroethane | NE |
| 1,2-Dichloroethane | 59 |
| Total PCB Aroclors | 0.04 |
| **Sediment (mg/kg)** | |
| Total PCB Aroclors | 12 |

Notes:
Values shown are the lowest for either the drinking water or protection of surface water pathways.
The OU 1 ROD did not establish numeric cleanup levels for soil or soil vapor beneath the landfill.
µg/L – microgram per liter
mg/kg – milligram per kilogram
NE – not established

# 2.0 POST-ROD INVESTIGATIONS

This section describes the post-ROD investigation activities performed between 2014 and 2022 that followed from the initial recommendation for additional investigation called out in the natural attenuation evaluation (Section 1.3.3). This section presents the investigations in chronological order and reiterates the findings of the investigations as they were reported at the time of the investigation. This presentation is meant to convey the history of the investigation decisions made by the project team.

## 2.1 PHASE I INVESTIGATIONS

Initially the project team agreed on a two-phased approach for a site recharacterization program designed to collect the data necessary to evaluate remedial alternatives for hotspot treatment to reduce the restoration timeframe. Phase I, which consisted of the collection of screening-level data, was completed in 2014 (Navy, 2015a). The Phase I investigation included the collection of tree core samples for analysis of cVOCs to identify potential contaminant hotspots in groundwater in the vicinity of the South Plantation and west, or downgradient, of the Central Landfill. Given the location (in the Central Landfill between the two plantations and at the western edge of the paved portion of the landfill), it was not possible to collect tree core samples upgradient of MW1-17. Geophysical surveys were also conducted in the South Plantation and a portion of the Central Landfill (Figure 2-1) to identify the presence or absence of subsurface anomalies that could represent potential contaminant sources and pose health risks for workers during future intrusive investigations. As described in the sections below, this initial investigation expanded into a more comprehensive investigation of residual sources, fate, and transport.

### 2.1.1 Phase I Results at the South Plantation

An evaluation of the tree core and geophysical data resulted in a refined understanding of COC distribution, which was then used to guide sampling for Phase II. The highest concentrations of cVOCs, especially TCE, appeared to be located south of the former hazardous waste building and along the southern edge of the landfill (area of wells MW1-56, MW1-57, and MW1-58 on Figure 2-2). In addition, the reported detections of 1,1,1-TCA in a tree adjacent to a stormwater outfall indicated a possible association with transport through damaged stormwater piping. Phase I concluded that identified geophysical anomalies were not collocated with high COC concentrations in tree cores or groundwater. Therefore, the contaminant source was not expected to be a buried primary source (such as a drum-containing product). Instead, the evidence suggested the presence of a residual source (contaminants adsorbed to soil).

### 2.1.2 Phase I Results in the Central Landfill

The area upgradient of well MW1-17 was included in the geophysical survey performed under Phase I to guide the Phase II investigation of this area. Within the Central Landfill area upgradient of well MW1-17, there was a significant variation in geophysical response. The northern portion of the area appeared to have more anomalies than the southern portion. The data suggested that areas of voids and metal debris exist within the Central Landfill (Figure 2-1 shows this general work area). The areas of geophysical anomalies were targeted for investigation under Phase II as potential source areas.

Tree core samples were collected from four native trees located downgradient of well MW1-17. PCE and TCE were detected in all four trees (see Figure 2-3 for the area of well MW1-17). However, daughter products of PCE and TCE were not reported in any of the tree core samples. In contrast, PCE and TCE were not reported in groundwater samples collected from well MW1-17 in 2014, while daughter products (1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, and VC) were reported in 2014 groundwater samples at concentrations greater than the RGs for all constituents except trans-1,2-DCE. Since 2006, a general upward trend of daughter product concentrations has been reported in samples from MW1-17. The groundwater data that show this trend are included in Appendix C of the fifth five-year review (Navy, 2020a).

## 2.2 RECOMMENDATIONS OF FOURTH FIVE-YEAR REVIEW

In the same timeframe that the Phase I investigation was finalized, the fourth five-year review was completed (Navy, 2015b). This review included two sampling recommendations that were incorporated into the Phase II investigation.

Based on the increasing trend of PCB concentrations in surface water at seep location SP1-1, the five-year review evaluated overall sampling trends as well as sampling trends since the previous five-year review (2004 to 2009) of total PCB concentrations at sediment sampling locations with historical detections above the PCB RG, including MA09, MA14, and TF-21, located between the North Plantation and the tide gate (Figure 2-4). Overall, the PCB trends at these three sediment sampling locations were found to have decreased from the initial sampling event in 1996 (MA09 and TF-21) and in 2000 (MA14). However, between 2004 and 2009, total PCB concentrations at MA09 decreased (from 2.68 milligrams per kilogram of organic carbon [mg/kg OC] to 1.36 mg/kg OC) while concentration changes at MA14 (from 0.6 to 3.45 mg/kg OC) and at TF-21 (from 1.16 to 6.2 mg/kg OC) implied a potential increasing trend. Although concentrations remained below the RG, the fourth five-year review recommended that PCB analysis of sediment be conducted at and around monitoring locations MA09, MA14, and TF-21 to establish current baseline conditions for future trend evaluations. In addition, collection of sediment samples at and around seep SP1-1 for PCB analysis was recommended to assess whether a correlation exists between the concentrations of PCBs in seep water and sediment and to evaluate if recontamination, as specified in the Sediment Management Standards (SMS) regulation (Ecology, 2013), is occurring.

This recommendation for sediment sampling and analysis was discussed and refined during the January 20, 2016 project team meeting. The project team agreed that the data from the planned sediment sampling should be adequate to support potential review of the ROD risk assumptions in light of the 2013 promulgation of Ecology's revised SMS, which is an ARAR in the ROD. This is captured in recommendation number 6 from the fourth five-year review, "Collect additional sediment samples at and in the vicinity of seep SP1-1 during the Phase II investigation and use the data to assess whether expanded, ongoing PCB monitoring should be initiated and risk assumptions reviewed."

The fourth five-year review also noted that the vapor intrusion evaluation performed east of Bradley Road running alongside the investigation area (this road is shown on Figure 2-2) during the RI did not meet current Ecology action levels. Although COCs were not detected in groundwater at the two wells east of Bradley Road (MW1-3 and MW1-11, Figure 2-3), a high soil gas concentration was historically found at soil gas location GM1-2 near a building on the east side of the road. Figure 2-5 of the RI report (Navy, 1993a) shows all soil gas sampling locations, including GM1-2, along with the analytical data. An evaluation of the vapor intrusion pathway was recommended based on limited current cVOC data for groundwater and soil gas east of the Bradley Road, cVOC detections in groundwater at the adjacent landfill, the lack of definition of the eastern extent of the TCE plume, and new EPA vapor intrusion regulations.

## 2.3 2016 PHASE II INVESTIGATION

Phase II of the additional investigation was designed to follow up on the findings of Phase I, and to address the recommendations of the fourth five-year review report. As part of scoping meetings, the project team developed the following investigation objectives:

1. Refine the understanding of contamination in groundwater in the upper aquifer beneath the central portion of the landfill and the South Plantation and in sediment and surface water present in watercourses immediately adjacent to the South Plantation and upstream of station MA12.

2. Refine the understanding of transport pathways for cVOC contamination from the South Plantation to the adjacent marsh.

3. Assess the presence or absence of a source or sources of cVOC contamination in groundwater in the upper aquifer beneath the central portion of the landfill, upgradient of monitoring well MW1-17.
4. If one or more sources of cVOCs are found, attempt to assess the lateral and vertical extent of the source(s).
5. Assess the presence or absence of the middle aquitard in the area of MW1-17.
6. Collect data necessary to allow screening of remedial technologies that could potentially be incorporated into hotspot cleanup alternatives for remedy optimization.
7. Identify any data gaps based on the Phase II investigation data, including the need for and location of additional monitoring wells, if warranted.
8. Establish current concentrations of PCBs in sediment (at seep SP1-1 and at downstream sampling stations).
9. Investigate the vapor intrusion pathway by collecting soil gas samples along the east side of Bradley Road.

The first part of the Phase II investigation was implemented in 2016, and consisted of a membrane interface probe (MIP) investigation and a soil vapor survey along Bradley Road (Navy, 2017a). During the field investigation, 62 MIP borings were completed in the South Plantation, and seven MIP borings were completed in the Central Landfill. The MIP borings were installed from ground surface to varying completion depths ranging from 15 feet bgs to 42.5 feet bgs. Throughout the investigation, the boring locations and completion depths were refined in the field based on MIP results obtained.

The MIP results were used to refine the CSM. A distinguishable aquitard between the upper aquifer and intermediate aquifer, as described in the ROD, was not evident based on the MIP responses in the South Plantation.

The MIP responses indicated that contamination extended to a minimum of 30 ft bgs in the eastern portion of the South Plantation, which is deeper than previously identified and deeper than the existing LTM well network at the time. The most significant source observed during the MIP investigation was located on the east side of the South Plantation, adjacent to Bradley Road and south of the former Hazardous Waste Building (Building 884). The distribution pattern exhibited characteristics consistent with dense, nonaqueous phase liquid (DNAPL) or residual DNAPL.

In the Central Landfill, the MIP responses were interpreted at the time to show a distinction between the upper and intermediate aquifers described in the ROD. The MIP responses indicated that contamination extended to approximately 32 ft bgs in the western portion of the Central Landfill, deeper than previously identified and deeper than the existing LTM well network at the time.

The following recommendations were made based on the results of the MIP investigation:

- Collect quantitative soil and groundwater data to verify the halogen-specific detector (XSD) results of the MIP investigation and to estimate the extent of hotspots in the South Plantation and the Central Landfill.
- Visually log soils and collect physical soil samples for geotechnical analysis to verify the results of the MIP investigation and to refine the hydrogeologic units at OU 1.
- Install a network of deeper monitoring wells and collect quantitative groundwater data to further assess the extent of groundwater contamination and confirm the groundwater flow patterns within the intermediate aquifer beneath the South Plantation and the Central Landfill.

Soil vapor sampling was also completed at nine of the planned 13 locations along Bradley Road during the initial part of the Phase II investigation. Because detected concentrations of TCE and VC in soil vapor exceeded the screening criteria at multiple sampling locations, further investigation of potential vapor intrusion at buildings east of Bradley Road was recommended.

## 2.4 2017 PHASE II INVESTIGATION

The elements of the Phase II additional investigation that were not completed in 2016 were completed in July-November 2017, and were adjusted based on the findings and recommendations of the 2016 investigation. The scope of the 2017 investigation consisted of the following, with sampling locations shown on Figures 2-2 through 2-4:

- Soil and groundwater samples were obtained from continuous-core, direct-push borings at 69 investigation locations (not counting step-out locations [e.g., SP-B01A] as unique sampling locations), with the samples analyzed for target cVOCs. Boring logs for these direct-push borings are included in Appendix D of the 2017 Site Recharacterization, Phase II Report (Navy, 2018b). Thirty-eight investigation locations were drilled in the Central Landfill area, including deeper exploratory borings near well MW1-15 to reassess the historical interpretation of an interconnection between the shallow and intermediate aquifers in this area (Figure 2-3). A total of 31investigation locations were drilled in the South Plantation area to target the hotspots identified by the MIP investigation (Figure 2-2). Additional analyses, beyond the list of target cVOCs, were performed on a small subset of samples from areas in both the Central Landfill and South Plantation based on field observations of oily residue. These additional analyses included the full list of VOCs by Method 8260, semivolatile organics (SVOCs), PCBs as Aroclors, petroleum hydrocarbons, and Otto fuel.

- cVOCs were analyzed in soil and groundwater samples collected from auger borings associated with 18 new groundwater monitoring wells: 10 in the South Plantation, seven in the Central Landfill area (Figures 2-2 and 2-3), and one located on the fence-line west-northwest of the South Plantation. Boring logs for these groundwater monitoring wells are included in Appendix D of the 2017 Site Recharacterization, Phase II Report (Navy, 2018b). In addition to installation, development, and sampling of these new wells, the existing irrigation well in the center of the South Plantation, well IW1-S, was sampled to provide another repeatable data point (Figure 2-2). All groundwater samples from the installed monitoring wells were analyzed for cVOCs, field parameters, conventional chemistry parameters, and oxygen demand. Wells located in apparent hotspots that were expected to be the focus of potential future remedial action were additionally analyzed for microbial population, perfluoroalkyl substances (PFAS), and 1,4-dioxane.
- Eleven soil samples from the screened interval of wells located in apparent hotspots were also analyzed for physical characteristics data (grain size, dry bulk density, hydraulic conductivity, effective porosity, and total organic carbon [TOC]).
- Six sediment samples and 10 passive samplers were analyzed for PCB congeners and PCB Aroclors.
- Two stormwater samples, 10 porewater samples (four porewater samples from south of the South Plantation and six porewater samples from west of the Central Landfill area) and 12 surface water samples in the waterways upstream of existing sampling station MA12 were analyzed for cVOCs.
- Horizontal locations and top of casing elevations for newly installed groundwater monitoring wells and peeper sampling tubes were surveyed by a licensed land surveyor. Depth to groundwater in newly installed groundwater monitoring wells, a subset of historical groundwater monitoring wells, and the USGS peeper tubes were then measured to allow preparation of a groundwater elevation contour map.

These data were used to update the CSM for the site and were evaluated against the decision rules established in the SAP (Navy, 2017b). The report of the 2017 results (Navy, 2018b) arrived at the findings and conclusions summarized in the subsections below.

### 2.4.1 2017 Findings Regarding Soil and Groundwater

At the conclusion of the 2017 investigation, the locations (horizontally and vertically) of the highest concentrations of cVOCs beneath the South Plantation and in the adjacent wetlands were summarized as follows:

1. The highest COC concentrations were observed beneath the eastern portion of the South Plantation, from Bradley Road on the east to approximately piezometer P1-10 (Figure 2-2) to a depth of at least 35 ft. Shallow nonaqueous phase liquid (NAPL) was also observed in this area.
2. Other areas of high COC concentrations (but lower than those described above) were evident in a small area around historical well MW1-16 and from east of piezometer P1-7 westward to the marsh. In contrast to the eastern portion of the South Plantation, the highest COC concentrations in these areas appeared to be shallower, typically extending vertically from 8 to 15 ft bgs.
3. Although the areas described in items 1 and 2 exhibited the highest COC concentrations, exceedances of the ROD RGs were found throughout the South Plantation, and at all surface water sampling locations adjacent to the South Plantation.

The likeliest discharge points along transport pathways from high concentration COC areas at the South Plantation to the adjacent wetlands were found to be:

1. From the eastern portion of the South Plantation discharging to the area of the marsh immediately south and adjacent to Bradley Road, east of the stormwater outfall.
2. From the vicinity of piezometer P1-7 discharging toward monitoring well MW1-49 and peeper sampling stations S-4 and S-4B.

In the Central Landfill, residual cVOC sources (including NAPL) were observed upgradient of well MW1-17 in the vicinity of monitoring wells MW1-46, MW1-47, and MW1-48. These sources appeared to represent more than one discrete residual source resulting in a commingled plume. The highest COC concentrations in this area were found in the depth range of 17 to 33 ft bgs, below the screened intervals of the existing LTM well network at the time.

Residual source(s) also appeared to exist in the area of direct-push borings CL-B03, CL-B04, CL-B35, and CL-B36. These residual sources appeared to be separated from those in the vicinity of MW1-46, MW1-47, and MW1-48 by an area of relatively lower concentrations. The highest COC concentrations in this area were found in the depth range 13 to 22 ft bgs, predominantly below the screened intervals of the existing LTM well network at the time.

Unexpected oily substances were observed in some direct-push borings, and the nature of these oily substances was assessed using additional laboratory analyses for fuels, PCBs, and a full list of VOCs and SVOCs in soil and groundwater samples from borings SP-B01, CL-B18, CL-B21, and SP-B62 (Figures 2-2 and 2-3). Because of the nature of historical operations at NBK Keyport, the on-base laboratory analyzed samples containing the oily substances for Otto fuel, which is used in submarine weapons propulsion. No Otto fuel was detected. These oily substances appear to be petroleum fuels, varying between gasoline-range and diesel/oil-range hydrocarbons depending on their location within the former landfill. PCBs were detected in association with some of these samples, but the concentrations were not indicative of PCB oil as the primary constituent. SVOC and full VOC results indicated that SVOCs and VOCs other than the cVOC COCs established in the ROD are present in residual source areas. Many of the SVOC and other VOC compounds detected are typically associated with petroleum.

PFAS compounds were analyzed in groundwater samples from 10 monitoring wells. Of the 10 monitoring wells, one or more PFAS compounds were detected in six monitoring wells (MW1-47, MW1-48, MW1-56, MW1-57, MW1-58, and MW1-60). However, none of the detected PFAS compound concentrations exceeded the project action limit (PAL), and all were much lower than the EPA lifetime health advisory in place at the time of the investigation. PFAS compounds were detected at concentrations exceeding the most recent EPA Residential Scenario Risk Screening Levels (RSLs) (DoD, 2022) in four monitoring wells (MW1-47, MW1-48, MW1-56, and MW1-57).

1,4-Dioxane was analyzed in groundwater samples from 10 monitoring wells and was detected in three monitoring wells (MW1-46, MW1-47, and MW1-48). The detected concentrations all exceeded the PAL of 0.44 µg/L by approximately an order of magnitude, with the highest concentration of 4.94 µg/L at MW1-48. These concentrations of 1,4-dioxane in the Central Landfill were in the same range as, but slightly higher than those detected in 2014 at the base boundary wells MW1-38 and MW1-39 (2.3 µg/L and 1.1 µg/L, respectively; Navy, 2015b). Wells MW1-38 and MW1-39 are downgradient of the Central Landfill, assuming a northwesterly groundwater flow direction.

### 2.4.2 2017 Findings Regarding Porewater

Based on the absence of detectable cVOCs in porewater samples collected in 2017 located due west of the Central Landfill, and the pattern of highest cVOC concentration observed in grab groundwater samples, cVOCs from the Central Landfill did not appear to be discharging to surface water in this area. Rather than the cVOC plume shape implied by the groundwater monitoring well data, contaminant transport beneath the Central Landfill appeared to be to the northwest along a more regional groundwater flow direction. Later, more extensive porewater sampling conducted in 2019 helped to reveal comparatively low concentrations of cVOCs discharging to surface water in a northwest flow direction in this area (see Appendix B).

### 2.4.3 2017 Findings Regarding Shallow and Intermediate Aquifers

Based on the continuous soil cores logged in 2017 and the 2016 MIP results, a laterally continuous aquitard was interpreted to not exist between the previously defined shallow and intermediate aquifers in the central portion of the landfill, upgradient of well MW1-17, or anywhere investigated in 2016 and 2017. This finding did not support the geologic interpretation presented in the ROD, but is consistent with that presented in the original RI/FS and resulted in a redefinition of the hydrogeology of the site to a single shallow aquifer underlain by the regional aquitard (previously interpreted as the Clover Park Unit).

### 2.4.4 2017 Findings Regarding PCBs in Sediment

In 2017, the highest concentrations of PCBs were detected in sediment at historical sampling location MA09, and in porewater at this same location. Total PCB concentrations in discrete sediment samples from downstream and upstream of MA09 (including near seep SP1-1) were two orders of magnitude lower than at MA09. Total PCB concentrations in sediment porewater samples collected upstream and downstream of MA09 were also lower than at MA09. For both sediment and porewater, PCB concentrations at locations upstream of MA09 (SP1-1 and MA19 on Figure 2-3) were lower than downstream of MA09 (MA14 on Figure 2-3). Only the PCB concentrations in the sediment sample from location MA09 exceeded the ROD RG, which implied at the time that the lateral extent of PCBs exceeding the RG was limited to the vicinity of this station. These findings are consistent with those of the ROD, which identified station MA09 as exhibiting the highest PCB concentrations, and the only concentrations exceeding the sediment quality standard at the time. The 2017 PCB concentrations at station MA09 are nearly identical to the pre-ROD concentrations at this station, prior to the sediment removal action. The 2017 report hypothesized that the PCB results could indicate a temporal increase in PCBs at location MA09, or a spatial variation in concentration in sediment in this area. Additional PCB sampling using both discrete sampling techniques and the incremental sampling methodology (ISM) technique have subsequently led to refined interpretations of PCB distribution (see Sections 2.5 and 3.5).

The 2017 report noted that elevated concentrations of PCBs in groundwater at well MW1-14, combined with the groundwater flow direction to the northwest and the location of the highest PCB concentrations in sediment and porewater at location MA09 (down gradient of MW1-14), could imply that recontamination may be occurring from an uncontrolled source within the landfill. The 2017 report recommended that the potential for an uncontrolled PCB source in the landfill should be assessed in accordance with the recontamination requirements of the SMS (Washington Administrative Code [WAC] 173-204-500[5][b][iii]).

### 2.4.5 2017 Conclusions Regarding the Conceptual Site Model

The 2017 investigation report concluded that a revised CSM was warranted and presented a revised contaminant transport pathway block diagram in support of the revised CSM. This block diagram has been superseded by later CSM depictions presented in this supplemental RI, and therefore the previous block diagram is not reproduced herein. The 2017 conclusions presented below remain valid, but have been further refined by additional investigations discussed throughout the remainder of this supplemental RI:

1. Two areas at the South Plantation exhibit the highest concentrations of cVOCs, however one or more COCs in groundwater exceed the ROD RGs at all locations sampled beneath the South Plantation.
2. Groundwater movement in the shallow portion of the aquifer is influenced by adjacent surface water bodies, resulting in cVOC transport from shallow groundwater to surface water at two primary locations adjacent to the South Plantation.
3. Surface water with high cVOC concentrations moves downstream from the first point of groundwater-to-surface discharge adjacent to Bradley Road and is diluted by flow from the stormwater outfall and Marsh Creek.
4. VOC concentrations in surface water increase at the second point of discharge on the western edge of the South Plantation, and then decrease downstream with dilution and degradation, with cVOC concentrations low or not detectable in surface water prior to passing through the tide gate.
5. Two areas in the Central Landfill exhibit the highest cVOC concentrations, with transport apparently to the northwest, following a more regional groundwater flow direction.
6. Based on the porewater samples collected in 2017, cVOC transport from the Central Landfill to adjacent surface water does not appear to be a primary pathway.
7. Groundwater present above the deep clayey aquitard occurs within interbedded fine sands and silts, with no laterally continuous aquitard separating an “upper aquifer” and “intermediate aquifer.” Overall flow within this water table aquifer is toward the northwest to the tide flats and Dogfish Bay.
8. A potential source of PCBs appears to be present in the landfill near the north edge of the North Plantation and may be resulting in discharge of groundwater containing PCBs to sediment and surface water near location MA09, downstream of seep SP1-1.

9. Shallow NAPL is present within the landfill and was directly observed as an oily substance during the 2017 investigation.
10. Matrix diffusion effects are likely to control the restoration timeframe at the site. Elevated cVOC concentrations in finer-grained materials indicate that cVOCs have diffused into these finer-grained materials and that treatment focused on coarser-grained materials will likely result in prolonged back diffusion.
11. Halorespiring bacteria are present at levels indicative of potential for active dechlorination, which supports past findings of on-going biodegradation at the site. However, at locations where high levels of cVOCs were detected, an apparent absence of halorespiring bacteria suggests that high levels of cVOCs may inhibit dechlorinating activity.

## 2.5 2019-2022 INVESTIGATIONS

### 2.5.1 Drivers and Rationale for 2019-2022 Investigations

Follow-on source investigations were conducted beginning in 2019 to meet the recommendations of the project team discussions subsequent to finalization of the 2017 investigation report (Navy, 2018b). The 2019 source investigations were designed to gather quantitative data to verify the migration path of VOCs and 1,4-dioxane from Central Landfill hotspots, the source of PCB contamination in site sediments, and better define the extent of contamination at the east side of the South Plantation, in the marsh area southeast of the South Plantation, and in Marsh Creek. Data from these 2019 investigations were intended to be used to update the existing CSM, map the regional aquitard contact within the site boundary, conduct fate and transport modeling, allow better evaluation of remedy effectiveness, and support a focused FS designed to evaluate alternatives for the treatment of identified hotspots to reduce the restoration timeframe at the site. Sampling locations from 2019 and 2022 are indicated on Figure 2-2 for the South Plantation and Central Landfill, and on Figure 2-3 for the North Plantation and Central Landfill.

***Driver and Rationale for the Geophysical Survey***

During initial work towards a numeric fate and transport model under the 2019 SAP (Navy, 2019b), it became clear that understanding the temporal variation in the freshwater/saltwater interface as it affects contaminant transport from groundwater to surface water would contribute substantially to the CSM. A more detailed understanding of the freshwater/saltwater interface within the wetland areas was also necessary to provide a comprehensive description of the environments for use in upcoming human health and ecological risk assessments being performed under separate contract. Therefore, a separate work plan was prepared covering a geophysical investigation to gather data regarding the freshwater/saltwater interface (Navy, 2020b) and this investigation was completed in January 2021. The geophysical investigation was also leveraged to collect stratigraphic information in support of an environmental sequence stratigraphy evaluation being performed as part of the geologic interpretation under the 2019 SAP (Navy, 2019b).

***Driver and Rationale for PCB and Upland Soil Investigations and Risk Assessment***

The 2019 investigation revealed an apparently localized area of the Northern Landfill with PCB concentrations in shallow soil up to 210 mg/kg, which is two orders of magnitude above the State of Washington Model Toxics Control Act (MTCA) Method A Soil Cleanup Level of 1 mg/kg. These PCB concentrations in shallow soil were found approximately 100 ft inland (east) of seep SP1-1, which has exhibited post-remedial action PCB concentrations in seep water in the range of not detected at 0.01 µg/L (summer 2017) to 0.57 µg/L (estimated; summer 2019) (Navy, 2020a) compared to an RG of 0.044 µg/L.

The RAO from the OU 1 ROD regarding PCBs is to "Prevent unacceptable risks to humans through ingestion of seafood and aquatic organisms because of sediment exposure by removing from the marsh sediment containing PCBs." The third and fourth five-year reviews documented that RGs had been met for PCBs in shellfish tissue, and therefore this RAO had been met. However, the fourth five-year review also acknowledged that the subsistence fisher exposure assumptions had changed since the RGs were developed, and that new risk-based screening levels should be developed. In addition, the fourth five-year review noted an apparent increasing trend in PCB concentrations in seep water at seep SP1-1 over the preceding five years. Because PCB results at location SP1-1 showed an increase in 2014 and sediment PCB trends at MA14 and TF-21 increased during the 2015 sampling round, the fourth five-year review recommended additional sampling of sediment around the seep, and more frequent monitoring of the seep water. These data were to be used to assess PCB concentration trends and to assess whether recontamination, as specified in the sediment management standards, was occurring. Decisions were to be made as to whether ongoing PCB monitoring should be initiated, and risk assumptions reviewed.

In response to the five-year review recommendations, the new hydrogeology and contaminant transport information revealed by the results of the 2017 investigation (Navy, 2018b), and the 2019 data, the Navy initiated an addendum to the baseline risk assessment for all of OU 1 to update exposure assumptions and assessment methods. This risk assessment, including comprehensive sampling, is being conducted under a separate contract, and the results will be reported in a separate installment of the supplemental RI. Some sampling was performed under the Battelle contract in support of the initial risk assessment planning. A stand-alone SAP was prepared to cover this supporting investigation, which included sampling for PCBs in sediment using ISM as well as shallow upland soil sampling. Fieldwork to support the risk assessment was completed in early summer 2021.

### 2.5.2 Elements and Findings of the 2019-2022 Investigations

The results of the 2019 investigation were initially reported to the project team during workshops and meetings, and through interim deliverables including tables, figures, boring logs, and three-dimensional plume model images. For some specific investigation work elements performed during this time period, stand-alone reports or technical memoranda were prepared to keep the project team informed while work progressed (see Table 2-1). Where such reports and memoranda were ultimately submitted as final documents, they are cited in the text of this supplemental RI and attached as appendices. For those memoranda not finalized, the content of the memoranda are incorporated into this supplemental RI, with revisions based on comments received from the project team.

Some of the investigation elements completed between 2019 and 2022 have not been previously documented in a comprehensive report outside of this supplemental RI. Therefore, Appendix B provides a detailed documentation of these investigations (Table 2-1).

**Table 2-1. Investigation Activities 2019-2022**

| Investigation Element | Report |
|---|---|
| *Source Investigation SAP* (Navy, 2019b) | |
| Direct-push drilling at 33 locations | Appendix B |
| Sonic drilling and well installation at 17 locations, well installation at 9 of these | Appendix B |
| Porewater sampling at 19 locations | Appendix B |
| Sediment at 7 locations | Appendix B |
| Surface water sampling at 8 locations | Appendix B |
| Numeric groundwater modeling | Stand-alone report (GSI, 2023; Appendix F) |
| *Geophysical Investigation WP* (Navy, 2020b) | |
| Intertidal geophysical investigation | Stand-alone report (Atlas, 2021; Appendix D) |
| *PCB and Upland Soils Investigation SAP* (Navy, 2021a) | |
| Upland shallow soil investigation, northern OU 1 | Stand-alone final technical memorandum (Navy, 2022c) |
| ISM sampling of PCBs in wetland sediment | Stand-alone final technical memorandum (Navy, 2022d; Appendix E) |
| *Vertical Extent Investigation and Aquifer Performance Testing SAP* (Navy, 2022a) | |
| Sonic drilling and well installation at 7 locations | Appendix B |
| Slug testing in 15 wells | Appendix B |

The subsections below introduce each of the investigation elements from the 2019-2022 timeframe, with detailed results, findings, and conclusions provided in Appendix B.

***2019 Direct Push and Sonic Drilling***

The direct-push and sonic drilling investigation element was planned under the 2019 SAP (Navy, 2019b), and the details of this investigation element are presented in Appendix B. The direct-push and sonic drilling investigation built upon the findings of the similar 2017 investigation (Section 2.4) and utilized a similar approach. Direct-push drilling was conducted first, to collect screening-level data. These data were then used during meetings with the project team to develop a consensus for location and screened intervals of permanent groundwater monitoring wells installed using sonic drilling. Sonic drilling was also used for screening-level at specific locations where drilling depth or obstructions precluded the use of direct-push drilling.

Direct-push drilling was performed at 33 locations, primarily within and around the Central Landfill and North Plantation (Figure 2-3) and continuous cores were obtained using a 5-ft-long, Macro-Core sampler at all locations. Screening-level data were obtained using a hand-held photoionization detector (PID) and by collection of grab soil and groundwater samples.

Sonic drilling was performed at 17 locations following direct-push sampling to allow for groundwater monitoring well installation, relatively undisturbed soil sampling, and grab groundwater sampling using temporary wellpoints. Locations for permanent monitoring wells, and design of the well screen intervals, were selected based on the data from the direct-push borings and in consultation with the project team. Sonic drilling locations (Figures 2-2 and 2-3) were distributed across OU 1, from the South Plantation up to the North Plantation to meet the data quality objectives, which were presented in Worksheet 11 of the 2019 SAP (Navy, 2019b). A total of nine permanent monitoring wells were installed in 2019, and groundwater samples were collected from these monitoring wells in addition to 20 existing monitoring wells across the north, central, and southern portions of the site.

The results of the soil and groundwater sampling conducted in 2019 demonstrated that the vertical extent of COCs had not yet been delimited (Appendix B). Also, the 2019 field investigation revealed geologic features that appear to represent preferential flow pathways for COCs, with grain sizes that imply different hydraulic conductivities than those estimated for site soils during investigations in the 1990s. These findings represent data gaps that were then addressed in the 2022 vertical extent and aquifer performance investigation, as described below.

In addition to soil and groundwater collected from direct-push and sonic borings and permanent monitoring wells, sediment porewater and surface water samples were collected from locations northwest of wells MW1-17 and MW1-43 to assess whether transport of cVOCs from groundwater to surface water is occurring to the northwest of these wells. Sediment porewater samples were also collected from locations further south and west of those collected in 2017 (i.e., PW1-02, PW1-03, PW1-04, and PW1-10) to assess the lateral extent of cVOCs in marsh porewater.

Results for PCB sampling in all media (i.e., soil, groundwater, porewater, surface water, and sediment) from 2017 through 2022 are described in detail below and in Section 3.5, as well as in the technical memoranda for upland shallow soil investigation and the ISM sampling of PCBs (Navy, 2022c; Navy, 2022d).

***Environmental Sequence Stratigraphy***

A technical memorandum covering environmental sequence stratigraphy (ESS) characterization of OU 1 was presented as a draft to the Project Team (Navy, 2022e). Details of this study and comments received are incorporated into the discussion in Section 3.2. For this ESS study, historical regional and site-specific literature, historical boring and well logs, and site contaminant data were utilized with principals of sequence stratigraphy and sedimentary facies models to characterize the geology, hydrogeology, and contaminant fate and transport at OU 1. Supplemental information for the ESS study, including figures, tables, plates, and background documentation, is presented in Appendix C.

The results of the ESS characterization at OU 1 were used to support the updated CSM (Section 3.1; Navy, 2022f). Four hydrostratigraphic units (HSUs), as defined by Schultz et al. (2017), were selected based on site and regional stratigraphy and validated based on site contaminant and groundwater elevation data.

***Biodegradation***

A technical memorandum covering biodegradation occurrence and potential beneath OU 1 was presented as a draft to the project team (Navy, 2021b). Details of this study and comments received are incorporated into the discussion in Section 3.4.

Sample results provided in the memorandum and in Section 3.4 were generated under the SAP covering 2017 sampling (Navy, 2017a), the SAP covering 2019 sampling (Navy, 2019b), and included historical data from a USGS report (USGS, 2015). The 2017 sample results were previously reported (Navy, 2018b).

Groundwater analytical data utilized in the biodegradation evaluation included cVOCs, nitrate, nitrite, sulfate, sulfite, biological oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen (DO), ferrous iron (iron II), oxidation/reduction potential (ORP), pH, conductivity, temperature, turbidity, dissolved organic carbon (DOC), methane, ethane, ethene, chloride, and microbial deoxyribonucleic acid (DNA).

The biodegradation evaluation for cVOCs concluded that groundwater conditions at OU 1 generally appear adequate to support biodegradation, but are not sufficient to result in robust, complete dechlorination of the site. Prevalent accumulation of intermediate daughter products (i.e., cis-1,2-DCE and VC) and relatively low concentrations of the innocuous end products (e.g., ethene) represent incomplete reductive dechlorination and suggest that biogeochemical conditions in groundwater are not optimal for complete dechlorination of PCE and TCE to ethene.

***2021 Intertidal Geophysics***

The intertidal geophysical survey element was planned under a task-specific SAP (Navy, 2020b). A detailed report covering the intertidal geophysics was presented as a draft to the project team and finalized based on comments received (Atlas, 2021). The final report is attached as Appendix D.

The objective of the intertidal geophysical survey was to complete a geophysical survey to evaluate the temporal change in position of the saltwater/freshwater interface over a 22-hour period that covers a wide tidal range, and to assess the shallow stratigraphy beneath the tide flats. Results of the geophysical survey were used to refine the CSM (Section 3.1) and inform the numeric modeling effort (Section 3.6).

The geophysical survey documented changes in relative resistivity in the subsurface over tidal cycles, corresponding to the flood and ebb tides. The changes in resistivity were mapped in plan view and in cross section and provide a line of evidence that the channelized subsurface geology documented beneath the landfill footprint (see Sections 3.1 and 3.2) extends to the northwest beneath the tide flats and Dogfish Bay. The resistivity changes also imply that channelized freshwater, potentially transporting COCs, flows as far as Dogfish Bay during the ebb tide.

***PCB Extent***

A technical memorandum covering results of environmental samples analyzed for PCBs in 2017 and 2019 was presented as a draft to the project team (Navy, 2022d). Details of this investigation element and comments received are incorporated into the discussion in Section 3.5.

Sample results provided in the memorandum and in Section 3.5 were generated under the SAP covering 2017 sampling (Navy, 2017a), and the SAP covering 2019 sampling (Navy, 2019b). The 2017 sample results were previously reported (Navy, 2018b).

Environmental samples analyzed for PCBs included sediment, surface water, porewater, groundwater, and soil. Based on the historical data regarding the occurrence of PCBs within the landfill footprint, sampling for PCBs was focused on the northern portion of OU 1.

The PCB evaluation concluded that total PCB concentrations in soil beneath the North Plantation at OU 1 exceed the PAL established for the investigation at depths ranging from 5 to 20 ft bgs, and total PCB concentrations have been detected below the PAL for all groundwater samples. The soil and groundwater sampling results imply that the area of elevated PCB concentrations in soil may be larger than assumed during planning of the 2019 investigation and may extend at least as far north as well MW1-18.

As discussed below, additional investigation was completed in 2021 to support more detailed risk assessment planning and evaluation. This additional investigation included upland shallow soil sampling and sediment sampling via ISM. The most recent risk assessments are described in Section 4.0.

***2021 Upland Shallow Soil***

The upland shallow soil investigation element was planned under a task-specific SAP (Navy, 2021a). A technical memorandum covering the upland shallow soil investigation was presented as a draft to the project team and finalized based on comments received (Navy, 2022c).

The upland shallow soil sampling was performed primarily to support risk assessment planning (see Section 4). The technical memorandum (Navy, 2022c) provided the results of soil samples collected from ground surface to 6 ft bgs in the northern portion of OU 1 and analyzed for a wide range of contaminants of interest (COIs).

***2021 ISM PCBs in Sediment***

The sampling of sediment for PCBs using ISM was planned under a task-specific SAP (Navy, 2021a). A technical memorandum covering the ISM sampling of sediment for PCBs was presented as a draft to the project team and finalized based on comments received (Navy, 2022d). The final memorandum is included as Appendix E.

ISM sampling for PCBs in sediment was performed in the reach of Marsh Creek from seep SP1-1, which consistently demonstrates measurable PCB concentrations in seep water, to the culvert discharge of the creek to the tide flats. The results were intended to serve as baseline 95 percent upper confidence limit of the arithmetic mean (95% UCL) concentrations in the reach of Marsh Creek downstream of seep SP1-1 and will be used for comparison to future results, to establish temporal concentration trends, or concentrations before and after any future removal or remedial actions in this area.

***2022 Vertical Extent and Aquifer Characteristics***

The investigation of vertical extent and aquifer characteristics was planned under a task-specific SAP (Navy, 2022a). Details of this investigation element are presented in Appendix B.

The interim data deliverables provided to the project team based on the 2019 data described above demonstrated that the vertical extent of COCs had not yet been delimited. Also, the 2019 field investigation revealed geologic features that appeared to represent preferential flow pathways for COCs, with grain sizes that implied different hydraulic conductivities than those estimated for site soils during investigations in the 1990s. As a result of these observations, additional investigation was conducted to address these two data gaps:

1. Vertical extent of contaminants
2. Hydraulic conductivity of geologic formations identified in 2019.

Seven additional wells were installed using sonic drilling methods, with well bores drilled as deep as 100 ft bgs to confirm the expected geology, allow for screening of continuous soil cores, and select optimal well screen intervals. Well screens were installed either to document COC concentrations in coarse-grained soils immediately above the regional aquitard, or to document the expected absence of COCs in coarse-grained soils within the otherwise low-permeability aquitard formation. Relatively undisturbed soil samples were collected from targeted geologic units for laboratory characterization of physical soil properties, and slug tests were performed in 15 wells representative of the key geologic units.

As presented in Appendix B, the last (vertically) documented concentrations of cVOCs in soil and groundwater samples imply that the vertical extent of cVOCs has been documented. Furthermore, based on depths and locations of new and existing data, and key assumptions, the lateral extent of contamination at depth has been defined. The hydraulic conductivity values across the site, as calculated by the laboratory soil samples and as calculated by slug testing, correspond to expected values from hydrogeology literature for the respective lithology types within the screened well intervals (i.e., silty sand, clean sand and gravel, etc.).

***2022 High Vacuum Dual Phase Extraction (HVDPE) Pilot Testing***

The HVDPE pilot testing at the South Plantation was conducted under a separate Navy contract task order, and a separate, project-specific SAP was prepared (Navy, 2022b). A detailed report covering the HVDPE pilot test was presented as a draft to the project team and finalized based on comments received (Navy, 2023).

As part of the HVDPE pilot study two shallow extractions wells (MW1-76 and MW1-77) were installed, along with one air sparge point (AS1-1). Several existing monitoring wells and surface water gauging stations were used as monitoring points during the pilot study.

The objective of the HVDPE pilot study was to assess HVDPE, both alone and in combination with air sparging, as a potential technology for inclusion in the planned OU 1 focused FS. The pilot study also generated data that can be used in the planned focused FS to evaluate a range of technologies. These data include information regarding:

- Radius of influence
- Aquifer characteristics
- COC concentrations in extracted groundwater and vapor
- Groundwater and vapor extraction flow rates
- Carbon usage rates

***Numeric Groundwater Modeling***

A planning-level source and plume remediation model, REMChlor-MD, was used to assess the potential long-term, plume-wide effects of targeted remediation of high-concentration residual source areas at OU 1. The full modeling report is attached as Appendix F.

One REMChlor-MD model was developed for each of four areas of interest at OU 1 and calibrated to actual site data. These models demonstrate the importance and impact of matrix diffusion on persistent plumes at these areas of interest by showing that many decades (or even centuries) might be required to achieve RGs even with complete high-concentration source removal.

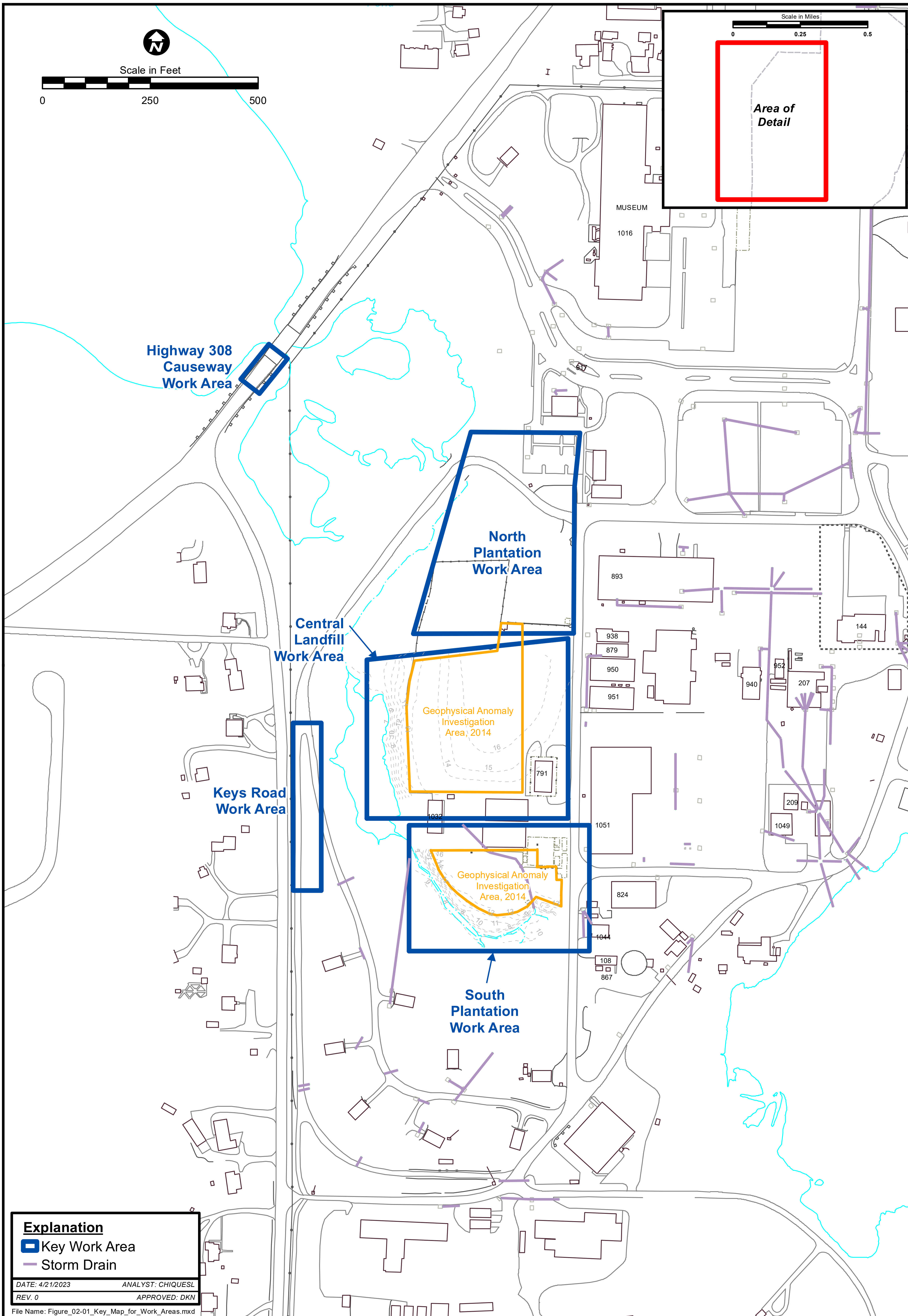
Planning-level REMChlor-MD modeling showed that the target cVOCs are likely to persist for many decades in the eastern portion of the South Plantation, and many centuries in the western portion of the South Plantation and in the Central Landfill. The modeling also indicated that the 1,4-dioxane plume is likely to persist for decades in the Central Landfill.

***Supporting Investigations under the LTM Program***

Within the timeframe of the investigations detailed in this report, various samples have been collected by Sealaska (prior to 2020) and EA Engineering, Science, and Technology, Inc. (EA) (2020 to present) under the LTM program. These include groundwater samples for PCBs and PFAS, and post-HVDPE groundwater and surface water sampling.

***Risk Assessment Investigation***

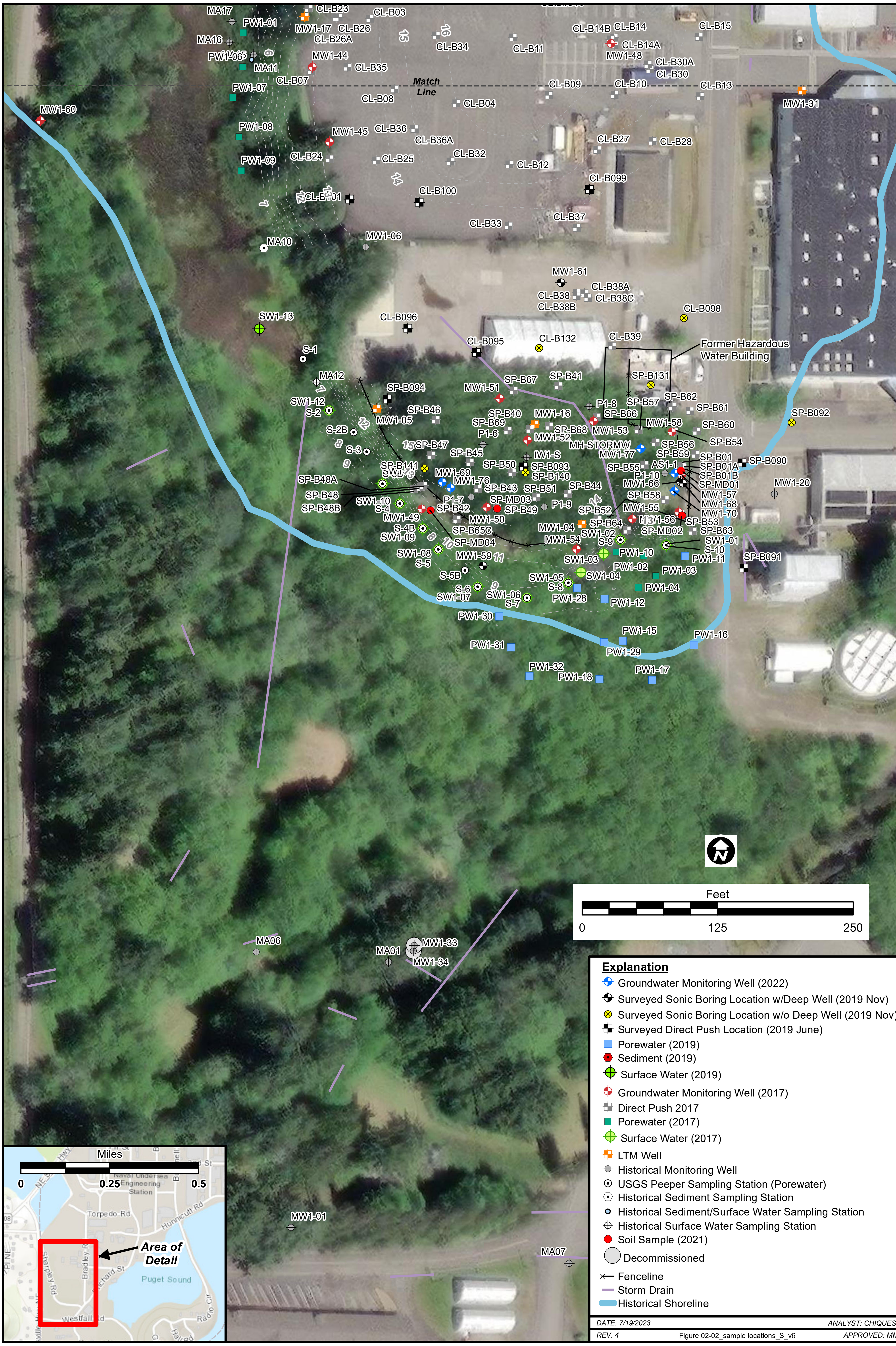
A risk assessment is not included in this volume of the Supplemental RI; however, both human health and ecological risk assessments are being performed under separate contract and will be submitted as a separate volume of the Supplemental RI.




U.S. NAVY

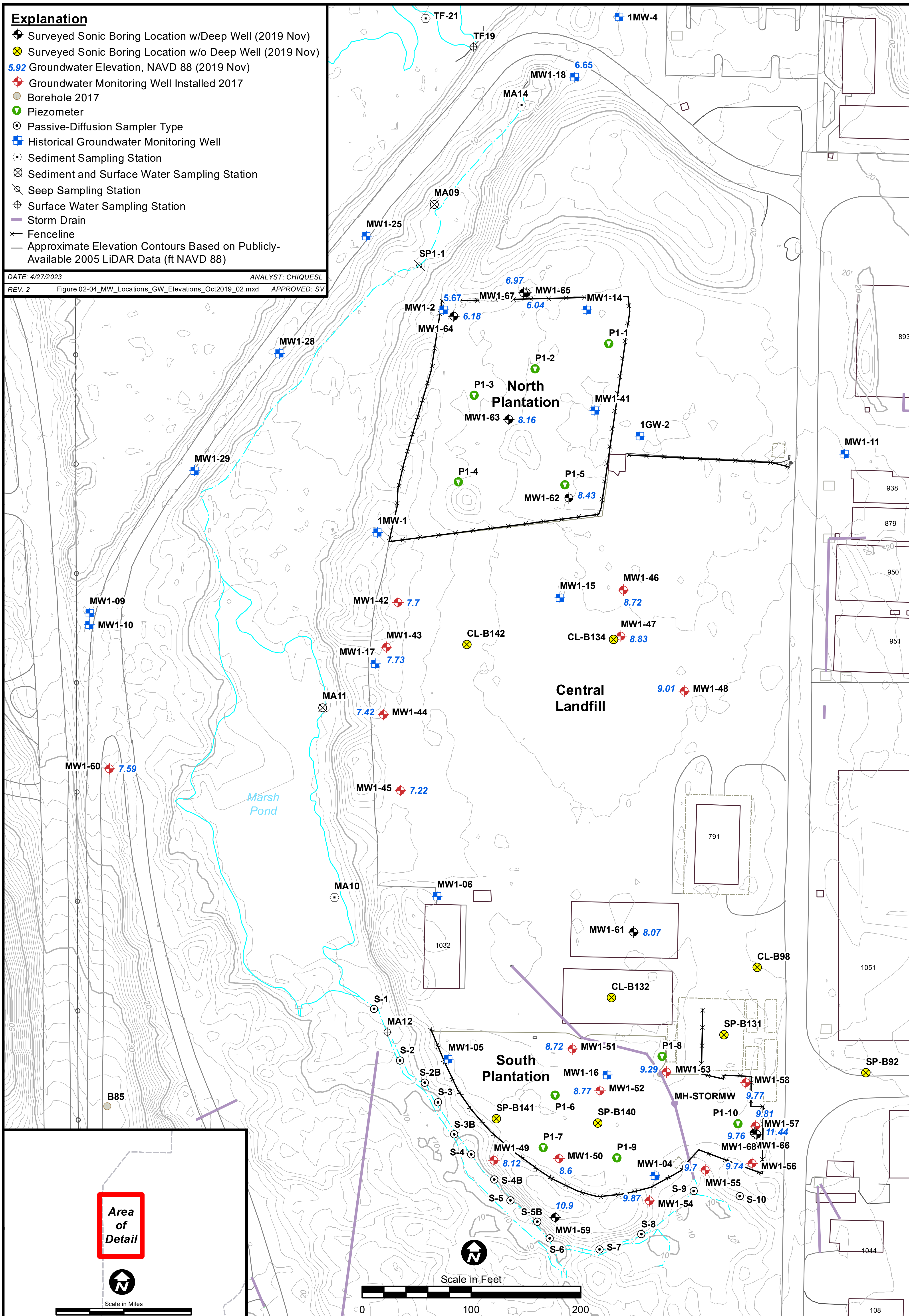
**Figure 2-1**
**Key Map for Work Areas**

Naval Base Kitsap
Keyport




| U.S. NAVY | **Figure 2-2**<br>**South Plantation and Central Landfill Sampling Locations** | Naval Base Kitsap Keyport |
|---|---|---|


| U.S. NAVY | **Figure 2-3**<br>**North Plantation and Central Landfill Sampling Locations** | Naval Base Kitsap Keyport |
|---|---|---|




| U.S. NAVY | Figure 2-4<br>Monitoring Well Locations and<br>Groundwater Elevations (October 2019) | Naval Base Kitsap<br>Keyport |
|---|---|---|

# 3.0 INTERPRETATION OF POST-ROD INVESTIGATION DATA

## 3.1 UPDATED CONCEPTUAL SITE MODEL

This section provides an updated CSM for OU 1 at NBK Keyport, based primarily on data collected in 2017, 2019, 2021, and 2022. This updated CSM is supported by the interpretations presented in the remaining subsections of Section 3 of this supplemental RI.

A CSM is an "iterative, living representation" of a site that summarizes and helps project teams visualize and understand available information. The CSM uses a concise combination of written and graphical work products to portray both known and hypothesized site information (U.S. EPA, 2011). The CSM is a tool used to assist in making decisions at a site and is updated throughout the life of a project as more information becomes available. Because a ROD is in place for OU 1 and remedy construction required by the ROD is complete, the CSM presented in this supplemental RI is considered a "post-remedy" CSM pursuant to U.S. EPA guidance (U.S. EPA, 2011). As of the date of this supplemental RI, additional site investigation work and risk assessment are underway and are expected to result in revisions to this CSM. This section presents the best interpretation of the CSM based on known information at the time of writing.

The pre-ROD investigation documents and the ROD from the 1990s did not present the site information in a synthesized CSM format as recommended by current EPA guidance (U.S. EPA, 2011). The CSM at the time of the ROD can be summarized as follows:

- cVOC contamination present primarily beneath the landfill footprint in a "shallow aquifer" present to approximately 15 feet bgs.
- The "shallow aquifer" was thought to be underlain by a laterally discontinuous aquitard, with sporadic detections of cVOCs in a deeper, "intermediate aquifer."
- Separation of the "intermediate aquifer" from deeper, regional groundwater by a clay aquitard several hundred feet thick.
- Discharge of cVOCs to Dogfish Bay along a groundwater to surface water pathway.
- Discharge of cVOCs to marsh surface water at a location upstream of station MA12 along a shallow groundwater flow pathway from the South Plantation.
- PCBs present in marsh sediment and discharging at seep SP1-1.

The updated, synthesized CSM was first presented to the project team in a draft memorandum (Navy, 2022f). No comments were received on that memorandum prior to preparation of this supplemental RI.

The site location and features are shown on Figures 1-1 and 1-2. Historical disposal areas at OU 1 (the former base landfill) are shown on Figure 3-1. Figures 3-2 through 3-5 illustrate contaminant distribution and transport pathways, and three-dimensional plume models are included in Appendix G (provided on CD only).

### 3.1.1 Known or Suspected Sources of Hazardous Substances

The known sources of hazardous substances at OU 1 are past disposal into the former landfill, which was constructed over the course of several decades in a tidal wetland within the historical intertidal zone of Dogfish Bay. These disposal practices were documented in the pre-ROD investigation documents and summarized in the ROD, and relatively little new information has been obtained regarding these practices since the ROD (see last paragraph of this section).

The extent of the landfill waste body is relatively clearly delimited on the west and south sides, where the waste body slopes down abruptly into what remains of the tidal wetland. The waste body extent to the north and east is less clear because of the presence of roadways, parking lots, and buildings on the apparent boundary. The northern boundary of the waste body has been commonly estimated as being within the parking lot of the Pass&ID Building, with the eastern boundary roughly beneath the adjacent north-south roadway. The most probable northern and eastern boundary of the waste body is the historical shoreline (Figure 2-3). This boundary is supported by the locations of PCB detections in shallow soil samples in this area (see Section 3.5.3). The eastern boundary of the waste body near the south end of the landfill appears to be confirmed by borings drilled in this area in 2017 and 2019, which did not identify waste. Additionally supporting this boundary is the historical shoreline in this area and the abrupt decline in cVOC concentrations moving from west to east from the area of highest concentrations on the east side of the South Plantation, to non-detectable concentrations east of Bradley Road in this area.

The landfill was the primary disposal area for domestic and industrial wastes generated by the base from the 1930s until 1973, when the landfill was closed. A burn pile for trash and demolition debris was located at the north end of the landfill from the 1930s to the 1960s. Unburned or partially burned materials from this pile were buried in the landfill or pushed into the marsh as it existed at the time, slowly expanding the landfill footprint. A trash incinerator was operated at the north end of the landfill from the 1930s to the 1960s, and incinerator ash was disposed of in the landfill. Burning continued at the landfill until the early 1970s.
Based on interviews of base personnel, the Initial Assessment Study (IAS) (Navy, 1984) identified the following types of industrial wastes that were likely disposed in the landfill:

- Paints, lacquers, thinners, ketones, enamel, and deflocculant from the paint shop;
- Paint residues and solvents such as TURCO, methyl ethyl ketone, TCE;
- TCE, alcohol, and toluene from the paint stripping shop;

- Residue from burning torpedo fuel (Otto fuel) and solids contaminated with torpedo fuel;
- Cutting oils, acids, caustics, and lead slag from metal shops;
- Dried bacterial sludge from the industrial wastewater treatment plant; and
- Pesticide rinsate from pest control shops.

The IAS also states that liquid plating bath wastes from the on-base plating shop (located on the eastern side of the base) were treated at the landfill from 1962 to 1984. From 1962 to 1972, the plating bath wastes were treated in tanks at former Building 439, which was located next to former Building 884 at OU 1 and where the building foundation remains. After treatment, the effluent was discharged to the marsh via a drain. Discharge of the treated effluent to the marsh was discontinued in 1972, at which time the base began sending the treated effluent to an off-site disposal facility. This was approximately the same time that the landfill was closed. In the 1980s, treatment was conducted in former Building 884. Treatment at the landfill was discontinued in 1984.

The IAS also identified general locations at the landfill where these aforementioned activities took place; these locations are noted in Figure 3-1, using the terminology of the IAS. The "acid treatment area" coincides with the location of former Building 439. The "waste paint disposal area" in the southern part of the landfill is a location where the IAS indicated painting-related wastes and solvents were disposed of from the 1930s until the 1970s. This location also coincides with some of the higher concentrations of solvent-type contaminants detected in groundwater at OU 1.

The IAS also describes management and disposal of drummed wastes at the base. It states that barrels of painting wastes and stripping solutions were disposed of at the landfill, and that "most of the waste was reportedly poured out of the barrels and the barrels were reused or recycled."

Empty barrels were stored, managed, and recycled at Area 2, the former drum storage area, (located in the southwestern part of the base) from the 1940s through the 1960s. The IAS states that drums that were not completely empty were reportedly drained onto the ground at the former drum storage area. Since February 1994, the Navy interviewed over 50 former and current employees to learn whether intact drums of liquid wastes were placed in the landfill. Eight of these people had been directly involved in landfill operations. One person remembered that 12 or 14 pallets of 5-gallon cans of paint and some 55-gallon drums were buried whole. The remaining people believe that whole drums were not buried intact. Some of them said that drums were emptied into the landfill or crushed before burial. Emptied drums were stored for reuse at Area 2. Overall, the interviews indicated that disposal of liquids in drums was not a common practice and substantial amounts of drummed liquid wastes are unlikely to be in the landfill.

Discussions in 2017 with one individual who worked in former hazardous waste building in the 1980s indicated that wastes were still being discharged in this timeframe to a trench oriented north-south along the west side of Bradly Road adjacent to the landfill and south of the former hazardous waste building. This location coincides with the highest concentrations of solvent-type contaminants detected in groundwater at OU 1.

### 3.1.2 Types and Concentrations of Hazardous Substances

Contaminants of interest and contaminants of potential concern (COPCs) were originally identified during the RI and risk assessments conducted in 1993 and assessed for risks to human health and the environment to develop the list of COCs carried into the ROD. The evolution of the risk assessment for this site did not result in a clear progression from COIs to COPCs, and therefore COIs and COPCs are combined in Tables 3-1 and 3-2. Tables 3-1 and 3-2 also show the list of COCs resulting from the 1993 risk assessment. As of the date of this supplemental RI, updated risk assessments are underway, and may result in revisions to the list of COIs, COPCs, and COCs, and a subsequent revision of the CSM described in the subsections that follow. The maximum concentrations of each COC identified to date in each environmental medium are shown in Table 3-3. Although not listed as a COC in the ROD, 1,4-dioxane was identified as a chemical of emerging concern during the five-year review process for the site and has been added to subsequent investigations and monitoring.

In 2021, the Navy performed a site-wide sampling of all available groundwater monitoring wells for the family of chemicals of emerging concern, PFAS. The results showed concentrations of PFAS were well below the documented screening levels at the time of sampling in all but one well sampled. However, comparing the results to the most recent EPA RSLs for PFAS, as documented in DoD policy guidance (DoD, 2022), shows that PFAS compounds were detected at levels exceeding the RSLs at 21 monitoring wells. A PFAS site investigation is underway for all of NBK Keyport and will provide a more rigorous assessment of these chemicals of emerging concern.

### 3.1.3 Contaminated Media

Contaminated environmental media are those media in which the OU 1 ROD concluded that COCs are present at concentrations representing an unacceptable risk to human health or the environment, as defined by the cleanup levels established in the ROD (Table 3-4). Contaminated environmental media consist of those media described in the subsections below. The COCs for the site, and therefore the contaminated media at the site, are currently being reevaluated. This section presents what is known regarding contaminated media based on the ROD and recent investigations, with some hypotheses presented regarding the potential outcome of the updated risk assessment, as recommended by U.S. EPA guidance (U.S. EPA, 2011).

***Soil***

Soil exhibiting COCs at concentrations exceeding the cleanup levels established in the ROD are present within the landfill footprint from near ground surface to at least 100 ft bgs (sample SP-B175-S-100-220426). The depth to groundwater beneath the site is very shallow (typically 2 to 8 feet bgs), and as a result many of the soil samples exhibiting COCs at concentrations exceeding the cleanup levels were collected from the saturated zone. These samples do not represent direct discharge of contaminants to soil, but rather provide information regarding contaminants partitioning between soil and groundwater.

No soil exhibiting COCs at concentrations exceeding the current cleanup levels has been identified outside the landfill footprint or off of Navy property.

Based on the nature of the COCs and their primary transport mechanism via groundwater, the extent of contaminated soil is unlikely to change substantially based on upcoming future investigation or risk assessment.

***Groundwater on Navy Property***

Groundwater exhibiting COCs at concentrations exceeding the cleanup levels established in the ROD are present throughout the landfill footprint and northwest of the landfill footprint, as measured in wells on Keys Road (MW1-25 and MW1-28, at mid-screen depths of approximately 42 to 43 ft bgs in each well). Groundwater exhibiting COCs at concentrations exceeding the cleanup levels is present beneath the landfill to a depth of at least 80 ft bgs (based on the screened interval of well MW1-70 [graphical summaries, including well construction diagrams, of MW1-69 through MW1-75 can be found in Figures 3-6 through 3-12]). Deep wells within the landfill footprint document groundwater COCs at concentrations below the cleanup levels in the upgradient well MW1-59, in Central Landfill well MW1-71 (Figure 3-8, and screened from 95 to 100 ft bgs), and North Plantation well MW1-73 (Figure 3-10, and screened from 90 to 100 ft bgs). As stated in Section 2.5 and presented in Appendix B, overall the set of deep wells installed in 2022 delimits the vertical extent of COCs in groundwater at concentrations exceeding cleanup levels. A graphical summary of COCs exceeding cleanup levels is presented on Figure 3-13 and Figure 3-14.

***Groundwater off Navy Property***

VC and the chemical of emerging concern 1,4-dioxane are consistently detected in monitoring wells on the Highway 308 causeway (the causeway), northwest of Navy property (Figure 3-13 and Appendix B). The VC concentration in well MW1-39 frequently exceeds the cleanup level established in the ROD in groundwater samples from 33 ft bgs. The 1,4-dioxane concentration in wells MW1-38 (46 ft bgs) and MW1-39 (33 ft bgs) frequently exceeds the groundwater cleanup level promulgated in the State of Washington's MTCA, which is an ARAR for the site under the ROD.

For the newly installed wells on the causeway, MW1-74 (drilled to 60 ft bgs) and adjacent well MW1-75 (drilled to 80 ft bgs), field PID readings and soil sample results imply no substantial cVOCs to the total depth drilled (Figure 3-11 and Figure 3-12). Key cVOCs were not detected in any soil samples from either well, and the three key cVOCs were not detected in the groundwater samples from either well. However, 1,4-dioxane was detected in the groundwater samples from both wells (Figure 3-13).

Beyond the causeway, no wells are present to establish the downgradient extent of COCs in groundwater, because groundwater flows to the northwest beneath Dogfish Bay. The wells on the causeway do not conclusively delimit the vertical extent of COCs in groundwater off of Navy property. The Navy is currently engaged in additional investigation to fill this data gap under separate contract.

***Indoor Air***

In 2018, the Navy performed a vapor intrusion study of buildings adjacent to the landfill, which concluded that there is no unacceptable risk from landfill COCs via the vapor intrusion pathway in these buildings (Navy, 2019a). The 1993 risk assessment did identify COCs in indoor air in temporary buildings present on the landfill as a risk to human health and these buildings were removed prior to selection of the remedy in the OU 1 ROD.

***Surface Water***

cVOCs and PCBs continue to be detected in surface water samples in the wetland adjacent to the landfill (Navy, 2018b; Navy, 2019c) and were historically detected in marine surface water in the tide flats and Dogfish Bay (Navy, 2019c). The measured concentrations of these COCs in surface water within the wetland are consistently above the cleanup levels established by the ROD or current ARAR values at sampling stations throughout these water bodies. COC concentrations in marine water in the tide flats and Dogfish Bay declined since initial sampling in 1995 and were not detected in the most recent sampling event in 2014 (with the exception of an estimated detection of cis-1,2-DCE at location DB14 in June of 2014) (Navy, 2019c).

Within the wetland, PCBs are consistently detected in seep water at seep SP1-1 located at the northwest corner of the North Plantation. Total PCB concentrations in the seep water measured as Aroclors between 1990 and 2019 range from not detected at 0.01 µg/L (summer 2017) to 1.8 µg/L (spring 1990) and represent transport of PCBs from shallow groundwater to surface water.

***Sediment***

The original RI concluded that VOCs, SVOCs, PCBs, and metals were COPCs in sediment within the marsh, tide flats, and Dogfish Bay, and sampling for this suite of chemicals was performed periodically beginning in 1996. One element of the selected remedy was removal of PCB-impacted sediment in the reach of Marsh Creek from seep SP1-1 to the tide gate. In 1999, 6 inches of surface sediments were removed from this reach of creek; however, confirmation sampling was not conducted following the removal. Sediments from the creek were removed in areas exhibiting PCBs below the ROD cleanup levels to prevent future movement into the tide flats and Dogfish Bay, based on analyses available at the time (Navy, 2010; Navy, 2015b).

Based on the post-remedy monitoring results, the list of analytes in sediment was adjusted to PCBs, pesticides, and metals in 2009, and to only metals after 2009 following the recommendations in the third five-year review (Navy, 2010). Additional assessment of PCBs in sediment was recommended by the fourth five-year review (Navy, 2015b), and this additional assessment (along with the overall findings of additional investigations within the landfill footprint), led to an expanded investigation of COIs in sediment and a revised risk assessment, which will be reported in a future volume of the supplemental RI report.

In June of 2021, sediment sampling in the reach of Marsh Creek from seep SP1-1 to the tide gate was conducted utilizing ISM techniques, with the reach of Marsh Creek divided into three decision units (DUs) spanning the width of the bank-full marks at high tide. This investigation concluded that total PCB concentrations in sediment in the distal reach of Marsh Creek at OU 1 exceed the marine sediment cleanup objective (SCO) of 12 mg/kg carbon normalized (OC) in all three DUs (Figure 3-5). The calculated PCB concentrations for sediment at DU 1, DU 2, and DU 3 were 23.3 mg/kg OC, 54.6 mg/kg OC, and 12.6 mg/kg, respectively. These results serve as baseline 95% UCL mean concentrations in the reach of Marsh Creek downstream of seep SP1-1 and will be used for comparison to future results, to establish temporal concentration trends, and to evaluate concentrations before and after any potential future additional removal or remedial actions in this area, as stated in the SAP for this work (Navy, 2021a).

***Marine Biota***

PCBs have been historically detected in marine biota at low levels, specifically in littleneck clam tissue. Concentrations, however, were not detected during 2004 and 2009 shellfish tissue sampling. Due to the detected concentrations remaining below the PCB RGs, it was recommended that monitoring tissue for PCBs be discontinued unless conditions at the landfill change (Navy, 2010). Based on this recommendation, marine biota has not been sampled since 2009.

Based on equivocal PCB trend data from historical sediment samples, the fourth five-year review (Navy, 2015b) recommended that additional sediment samples be collected from the vicinity of seep SP1-1, with the data used to assess whether expanded, ongoing PCB monitoring (including potentially in marine biota) should be initiated, and risk assumptions reviewed. Sediment samples were subsequently collected as part of investigations in 2017 and 2019, and the Navy has initiated additional sampling (including marine biota) in support of an updated risk assessment.

***Non-aqueous Phase Liquid (NAPL)***

The presence of NAPL within the landfill waste body was inferred during the pre-ROD investigations (Navy, USEPA, and Ecology, 1998), based on the measured dissolved concentrations of cVOCs in groundwater. Direct observation of NAPL was reported in borings drilled in the Central Landfill (CL-B18, CL-B21) and South Plantation (SP-B01, SP-B62). Reports of NAPL were from shallow depths (6 to 18 ft bgs) at the base of the waste body and consisted of oily substances in soil cores. Laboratory analysis of soil samples with these oily substances indicated that the NAPL consisted primarily of a mixture of petroleum fuels with cVOCs and PCBs, which is consistent with the disposal practices in the landfill (Navy, 2018b). This disposal history, in combination with the analytical results that show the presence of chlorinated solvents, fuel-range hydrocarbons, and PCBs indicate that the oily substances are likely “mixed NAPLs” (U.S. EPA, 2009). Prior to the HVDPE pilot test, conducted in spring/summer 2022, neither dense (heavier than water) nor light (lighter than water) NAPLs have been observed to accumulate in wells at the site, including wells installed where oily substances were observed in soil cores. However, during all three of the sampling events following the HVDPE pilot test, light NAPL (LNAPL) was observed floating on the water table in monitoring well MW1-77, which was likely caused by inducing drawdown in the well which allowed LNAPL to enter the well screen. This LNAPL was black, thick, and sticky, with a measured thickness of 0.5 feet.

### 3.1.4 Extent and Potential Migration of Hazardous Substances

cVOCs, a subset of which were identified as COCs in the ROD, are ubiquitous in groundwater within the landfill waste body and beneath the waste body to a depth of at least 80 ft bgs. Based on the sampling results from deeper wells installed in 2022, the vertical extent of cVOCs in groundwater has been delimited.

The landfill waste body is elevated relative to the wetland adjacent to the waste body on the south and west, and groundwater is very shallow within the waste body (roughly 4 ft bgs). This geometry leads to localized shallow groundwater flow and contaminant transport from the waste body to the south, west, and northwest into adjacent wetland surface water (Figures 3-2 through

3-5). cVOCs are detected in sediment porewater and surface water in the ephemeral creek and Marsh Creek and were historically detected in marine water in the tide flats (Navy, 2019c).

Regional groundwater flow drives contaminant transport to the northwest, along the long axis of the dogleg of Dogfish Bay. Erosional paleo topography in the surface of the Olympia Formation (as identified using ESS [see Section 3.2]) along with fluvial paleochannels within this formation, provide preferential flow pathways along this northwest flow direction. The interpreted outline of the subsurface paleochannels in plan view is shown on Figure C-14 in Appendix C. Transport of cVOCs in groundwater at a depth of 55 ft bgs is documented in well MW1-64, located at the northwest corner of the North Plantation, with cVOCs then detected in wells on the Highway 308 causeway to the northwest of MW1-64 (Figure 3-4).

Temporal geophysics data demonstrate that conductivity varies substantially within the paleochannels at depth over a tidal cycle. These data imply that freshwater flow and contaminant transport dominate in these paleochannels at low-low tides, allowing transport beneath the tide flats and beneath a portion of Dogfish Bay. Beyond the maximum low-low tide mark in Dogfish Bay, the paleochannels are expected to be flooded with saline water at all tide stages, with the less dense contaminated freshwater driven upward to daylight into the bay. This transport path is consistent with modeling performed in support of the ROD. The Navy is planning additional investigation to verify this transport pathway.

PCBs as Aroclors are listed as a COC in the ROD for groundwater, surface water, sediment, and shellfish tissue. Historical PCB data supplemented with data collected in 2017 and 2019, including both Aroclor and congener data, indicate that total PCB Aroclor concentrations at OU 1 in soil beneath the North Plantation at depths ranging from 5 to 13 ft below the landfill surface exceed the PALs established in SAPs. Total PCB concentrations (total Aroclors and total congeners) detected in groundwater were below the MTCA Method B Cleanup Level for drinking water (0.022 µg/L), with results from two wells exceeding the MTCA Method B Cleanup Level for surface water ($1x10^{-4}$ µg/L; Figure 3-5). The screening levels selected for comparison to site data are the subject of on-going discussions between the Navy and regulator/stakeholder groups as part of the updated risk assessment.

Soil and groundwater sample results imply that elevated PCB concentrations are widespread in soil within the landfill waste body from at least the middle of the North Plantation and northward (Figure 3-5; Navy, 2022c). Although in general PCBs exhibit a low solubility and do not transport readily in groundwater, the 2019 data indicate that PCB transport in groundwater at this site may be an important mechanism, with oil-range petroleum serving to facilitate PCB transport both laterally and vertically. The detection of PCBs in wells installed in 2022 to investigate the vertical extent of COCs at the site may indicate downward transport of PCBs at greater depth and over a wider portion of OU 1 than previously understood. However, as discussed in Section 3.5.4, these results from the deeper wells may be misleading and may not represent actual PCB concentrations in the aquifer at the depths explored.

Seep water sampling results, and the results of ISM of sediment in the reach of Marsh Creek downstream of the seep indicate that there is an ongoing contribution of PCBs to surface water from groundwater (Figure 3-5; Navy, 2022f).

### 3.1.5 Exposure Pathways and Receptors

PCB sampling results from 2017, 2019, and 2021 indicate that there is potential for adverse risk to human health and the environment from PCBs in sediment, surface water, and porewater, particularly in the reach of Marsh Creek from seep SP1-1 to the tide gate. An updated risk assessment to further quantify these potential adverse risks is ongoing, and additional sampling is planned. The updated risk assessment workplan provides a comprehensive analysis of gaps in the original site-wide risk assessment and the forthcoming risk assessment will address the identified gaps and needed updates.

The risks associated with human exposure to volatile COCs in air were established prior to the ROD and are controlled by LUCs established under the ROD, which prevent occupied structures from being located on the landfill surface. No risks associated with vapor intrusion into buildings adjacent to the landfill were identified prior to the ROD or during the indoor air sampling conducted within buildings adjacent to the landfill in 2018 (Navy, 2019a).

The LUCs established in the ROD also control human exposure to COCs in soil via direct contact, with restrictions on digging, construction, and site access.

Human exposure to cVOCs in groundwater directly beneath OU 1 is controlled by the LUCs established in the ROD. The ROD concluded that known off-site transport of cVOCs in groundwater would not result in human exposure because of daylighting of the cVOCs into a marine embayment. However, this conclusion is being verified with additional investigations in Dogfish Bay based on the more recent understanding of the geology and contaminant distribution and migration at depth beneath the landfill.

cVOCs in shallow groundwater discharge to wetland surface water immediately adjacent to the landfill and result in cVOC concentrations in surface water exceeding the ROD RGs and current ARAR values. Ecological receptors are exposed to cVOCs in this surface water and site workers could potentially be exposed. The surface water on site is not currently used for recreation or as a drinking water source.

## 3.2 ENVIRONMENTAL SEQUENCE STRATIGRAPHY

ESS is a novel approach to remedial site characterization, which utilizes principals of sequence stratigraphy and sedimentary facies models developed in the petroleum industry to better understand geologic complexity within the subsurface of remedial sites, resulting in more accurate CSMs and more cost-effective remedial strategies (Schultz et al., 2017). ESS techniques improve the ability to confidently interpret the lateral continuity of targeted geologic and hydrogeologic units (aquifers and aquitards) and assess contaminant transport pathways. A thorough review of ESS techniques, workflows, applications, and case studies is presented in Shultz et al. (2017).

ESS analysis of OU 1 has revealed the site to be underlain by the landfill waste body, Holocene-aged tidal flat deposits, and a Pleistocene-aged interglacial unit presumed to be deposited in a fluvial-floodplain environment during the Olympia interglacial interval. Four HSUs, as defined by Shultz et al. (2017), were selected based on site and regional stratigraphy and validated based on site contaminant and groundwater elevation data.

All figures, tables, and plates referenced in Section 3.2 are included in Appendix C.

### 3.2.1 Geologic and Geographic Setting

A detailed discussion of the geographic and geologic settings of NBK Keyport, including historical geology and geologic mechanisms most relevant to environmental investigations at OU 1, which are fundamental to the ESS characterization of OU 1, are included in Appendix C.

The NBK Keyport site is located within the Puget Lowland, a coastal province of western Washington State. The Puget Lowland is an elongate structural and topographic basin bordered to the east and west by the Cascade and Olympic Mountain ranges, respectively (Troost, 2016) (Figure C-1). The Puget Lowland is part of a greater topographic low within the region that is presently occupied by the Salish Sea, extending from the Strait of Georgia (British Columbia, Canada) into the Puget Sound of Washington State.

The shallow geologic framework of the Puget Lowland region has been significantly impacted by episodes of sea-level variation and glaciation and deglaciation within the Puget Lowland. Frequent glaciation-deglaciation events have resulted in a modern landscape which reflects repeated cycles of glacial and interglacial depositional settings (Booth et al., 2003; Troost and Booth, 2008). During interglacial periods (time periods when the region was free of ice), sedimentation across the Puget Lowland is generally dominated by relatively low-energy fluvial systems with localized lacustrine, marine, and volcaniclastic deposition.

### 3.2.2 Lithostratigraphy and Chronostratigraphy of the Puget Lowland

Further discussion of the recent history of interpretation, correlation, and construction of a chronologic framework for Quaternary-aged strata of the Puget Lowland is included in Appendix C and presented in Troost (2016). The study conducted by Troost (2016) utilized a chronostratigraphic mapping approach and yielded a simplified and correlative geologic framework for the Puget Lowland (shown in Table C-1). Because of the simplicity and correlatability of the stratigraphic framework provided by the work of Troost (2016), this study uses nomenclature consistent with that model; however, ESS characterization results were compared with pre-existing geologic models of OU 1 and the surrounding area and the lithostratigraphic terms used at the time. Units described and interpreted here are best considered preliminary until absolute dating methods are implemented to confirm the unit interpretations.

On a geologic scale, the depth of environmental investigations at OU 1 is shallow (less than 120 ft below modern sea level). As a result, this ESS study anticipates that geologic units encountered were likely deposited during the late Quaternary period. Only younger geologic units thought to be present beneath OU 1 are reviewed in the subsections below.

***Vashon-Stade Glacial Deposits***

The Fraser glaciation occurred from 25,000 to 16,800 years ago (ya), during marine isotope stage (MIS) 2 (Figure C-3). Time-transgressive advancement of glacial ice resulted in the deposition of the proglacial and periglacial deposits of units such as the Lawton Clay and Esperance Sand, while ice-contact deposition resulted in the Vashon Till along with unnamed ice-recessional and ice-contact deposits (kettle complexes, eskers, and kame terraces) (Troost, 2016). Due to limited exposures within the OU 1 area, coupled with the low availability of deep, high resolution boring logs, for this study these units will be referred to collectively and undifferentiated as the Vashon Drift (Figure C-2).

The Lawton Clay is a diachronous, discontinuous geologic unit interpreted to be deposited in glacial lacustrine settings. The unit is comprised of low-plasticity, massive-to-rhythmically bedded, light-to-dark grey, silt and clay with rare pollen, rare detrital wood fragments, and finely disseminated organics near its base. The Lawton Clay is known to be difficult to discern at outcrop/core scales, being best identified using absolute dating methods (Troost, 2016). The unit blankets depositional surface topography of the Olympia Interglacial deposits and is thought to be deposited as relatively continuous deposits in the Seattle area, reaching a maximum thickness of 164 ft (50 meters). This unit becomes more discontinuous south of Seattle, with the Lawton Clay deposits being more linear lacustrine deposits because of the southerly draining from the Puget Lowland.

The Esperance Sand (also referred to as simply Vashon advance outwash) is a stratigraphic unit comprised of fluvial deposits interpreted to be associated with advancement of the Puget Lobe into the Puget Lowland during MIS 2. The unit consists of predominately well sorted fine-to-medium sand which generally coarsens upward into gravel and has a gradational contact with the underlying Lawton Clay. The unit is relatively continuous in modern upland areas of the region and absent in areas of high paleo-relief (Pre-Fraser glaciation) and where eroded by subglacial channels (modern Puget Sound, Lake Washington, and the OU 1 area). The unit demonstrates a substantial variation in thickness, ranging from less than 3 ft to over 300 ft thick. Absolute age dating suggests the Esperance Sand accumulated between 17,750 to 17,000 ya (Troost, 2016).

The Vashon Till is described as a very dense, matrix supported gravelly sandy silt or gravelly silty sand with the matrix proportions of clay, silt, and sand being variable. The unit was deposited as ice covering the Puget Lowland and is interpreted to be mainly deposited as melt-out till; however, in some areas it may be homogenous basal till. The Vashon Till has been mapped as a near-continuous unit; however, as stated in the work of Troost (2016), the unit is much more discontinuous (even across local extents) than believed previously. The unit can range from less than a meter to several meters in thickness and exhibits a gradational to sharp contact with underlying advancement outwash. The unit is erosional in nature and the bottom contact of the Vashon Till is a mappable unconformity (disconformity), draping an irregular glacially scoured surface that can occur anywhere from 400 ft above sea level to well below sea level (Troost, 2016).

Recessional and ice-contact deposits associated with the Vashon ice sheet are semi-mappable unnamed units, which are locally deposited in areas across the Puget Lowland. These unnamed units were deposited during ice sheet melting and retreat across the region, beginning around 16,850 years before present (BP) (Troost, 2016), which generates large networks of meltwater streams (retreat outwash) in addition to proglacial lakes and localized kettle complexes, eskers, and kame terraces. These deposits reflect a complex time-transgressive nature of episodic and localized ice sheet recession across the region occurring most prominently in the south Puget Lowland (Troost, 2016).

***Olympia Interglacial Deposits (Discovery Nonglacial Unit)***

The Olympia interglacial unit consists of a nonglacial sedimentary package, which underlies the Lawton Clay or the Vashon Drift, and has been dated to have accumulated between 60,000 to 15,000 ya, between the limiting ages for MIS 3 and MIS 2 (Fraser glaciation) (Figure C-3 and Table C-1 in Appendix C). The unit was originally defined by Armstrong et al. (1965) as the climate episode immediately before the last major glaciation, represented by non-glacial strata beneath the Vashon Drift. The unit is an informal geologic unit, which Troost (2016) proposed to be a geologic formation because the Olympia interglacial interval resulted in deposition of extensive, mappable deposits across the Puget Lowland. The Olympia interglacial unit is correlative to the Qn2 formation of the Kitsap County Groundwater Management Plan

(KCGWMP) (Kitsap County Groundwater Advisory Committee [KCGWAC], 1991) and the Discovery nonglacial unit (Noble, 1990). The Olympia interglacial unit has commonly been misidentified to be the Kitsap Formation (Whidbey Formation, see below) in previous literature. However, the Kitsap Formation has been shown to pre-date the Olympia interglacial period (Noble, 1990).

As with any interglacial unit within the Puget Sound, there is no distinct type of deposit attributed to identify the Olympia interglacial unit, but rather the unit must be identified using absolute dating methods by either direct sampling within the unit, or indirectly via sampling units above or below. Deposits of the Olympia interglacial unit have sourced from several physical processes (terrestrial, volcanic, marine) and environments known to occur and shape the modern-day Puget Lowland such as: peat bogs, fluvial-floodplain, lakes, and estuaries. Deposition of the Olympia interglacial unit included widespread reworking and redistribution of sediments from underlying Possession glacial deposits. Diagnostic criteria for recognizing the Olympia Formation in outcrop varies with each location; however, in the central Puget Lowland the formation contains sand sourced from the central Cascades and typically includes peat, tephra, mudflows, and fluvial deposits. The unit may be absent in some deep valleys and troughs due to glacial scouring during the Vashon-Stade glaciation and may exhibit folding due to glaciotectonic and tectonic stress (Booth et al., 2003; Troost, 2016).

***Possession Glacial Deposits***

The Possession glacial drift underlies the Olympia interglacial unit and has been dated to have accumulated between 76,000 to 61,000 ya, during MIS 4 (Figure C-3, Table C-1 in Appendix C). Due to poor correlation across the region, historically investigators have interpreted that during the Possession glaciation, the Puget Lowland was either ice-free or the Possession glacier did not advance as far south as Seattle. However, using modern chronostratigraphic methods, Troost (2016) has correlated glacial tills of Possession-age as far south as the latitude of University Place, Washington (41°13’10”N).

Exposures of the Possession-age deposits often feature an incomplete, but typical succession of glacial facies from glaciolacustrine, glaciomarine, ice-advancement outwash, contact till, and ice-recessional sub environments (see Appendix C). The occurrence of preserved Possession-aged strata varies widely across the Puget Lowland. However, within the northern part of the Lowland, north of Beacon Hill in Seattle, glaciomarine drift, till, outwash, and glaciolacustrine deposits are prevalent. Possession-age glaciolacustrine deposits are apparently more continuous than the younger Vashon-stage Lawton Clay but exhibit a similar lithological texture and structure.

***Whidbey Formation (Clover Park Unit)***

The Whidbey Formation is a formal lithostratigraphic unit which underlies Possession glacial deposits and has been dated to be deposited between 125,000 to 80,000 ya and is correlative with MIS 5 (Figure C-3, Table C-1 Appendix C). The unit was first defined by Easterbrook (1968) as low-energy deltaic deposits from the ancestral Snohomish River; however, other age-correlative deposits have since been identified from varying but similar terrestrial depositional environments. Troost (2016) argued for inclusion of these age-correlative deposits outside of Whidbey Island as part of the Whidbey Formation, based on the recent use of the chronostratigraphic correlation techniques to improve and simplify the Quaternary record within the Puget Lowland. Therefore, the Whidbey Formation is time-correlative to the historically mapped Clover Park Unit (Noble, 1990), the Puyallup Formation (Luzier, 1969; Walters and Kimmel, 1968), and certain intervals mapped as the Kitsap Formation (Walters and Kimmel, 1968; Garling et al., 1965; Molenaar and Noble, 1970; Grimstad and Carson, 1981), in addition to other locally mapped units (Troost, 2016).

The Whidbey Formation deposits have been interpreted to be sourced from a climate and geomorphological landscape much similar to the modern Puget Sound area which featured terrestrial-to-coastal environments such as peaty bogs, fluvial-floodplain, lacustrine, and estuary environments. As with any interglacial period, deposition of the Whidbey Formation saw widespread erosional reworking and redistribution of the underlying Double Bluff glacial deposits (Troost, 2016). Sea-level reconstructions indicate that during the MIS 5, global sea level fluctuated to elevations below modern sea level and to upwards of 29.5 ft (9 meters) above modern sea level during specific stages (e.g., MIS 5e) (Figure C-3) (Lambeck et al., 2002; Muhs et al., 1994, 2006). The Whidbey Formation is observed to feature a wide range of sedimentary deposits including volcanic ash, diatomite, peat, and fluvial to deltaic sand and gravel. The unit can exhibit folding resulting from glaciotectonic and tectonic stress (Troost, 2016).

### 3.2.3 ESS Characterization Methodology

Within sedimentary geology the term lithofacies (or simply facies) is an observable body of rock or sediment defined on the basis of its distinctive lithological features (i.e., mineralogy, grain-size, bedding character, sedimentary structures) that are indicative of the physical process responsible for its deposition (Miall, 2010; Dalrymple, 2010). Facies are often grouped into facies associations or assemblages to display several physical processes which are characteristic or particular to a single depositional environment (e.g., river or tidal flats, etc.) (Miall, 2010). A facies model is a conceptual construct that describes the physical processes acting within a specific depositional environment which transport, deposit, and preserve sediment, and is usually presented as a three-dimensional block diagram illustrating the organization of sedimentary units in the stratigraphic record (Schultz et al., 2017). Sequence stratigraphy involves examining the vertical succession of genetically related sedimentary deposits in the context of changes in global, regional, and localized sea level, sediment supply, and capacity to store sediment (i.e., accommodation space) (Schultz et al., 2017). The practice of sequence stratigraphy is best utilized to examine, explain, and predict sedimentary packages as a function of the dynamic variations in depositional settings of a study area, as it relates to changes in sea level, sediment supply, and accommodation space, in accordance with Walther's Law.

The ESS characterization study at the NBK Keyport OU1 Former Landfill follows the standard ESS approach and methodology described by Shultz et al. (2017) and consists of a four-phased approach: 1) geologic reconnaissance of the site by leveraging regional and local geologic data, publications, reports, and maps; 2) construction of a robust geologic model and depositional framework by applying depositional facies models and sequence stratigraphic concepts to vertical grain-size data from soil boring logs; 3) generation of a hydrostratigraphic framework for the site by identifying and mapping candidate HSUs, interpreted to control hydraulic flow and transport; and, 4) integration of groundwater and chemistry data into the hydrostratigraphic framework to resolve stratigraphy-influenced contaminant migration pathways across the site and verify candidate HSUs.

To apply depositional facies models to geologic successions beneath the site, grain size and other geologic data are derived from unified soil classification system (USCS) soil boring descriptions, and vertical grain-size logs are created to identify vertical grain-size patterns that are indicative of depositional processes (Schultz et al., 2017). To accomplish this, a comprehensive geologic database was created by compiling all available well/boring data (well name, terminal depth, completion dates, drill method, elevation datums) sourced from Navy Installation Restoration Information Solution, the State, and Battelle archives. Borings were then selected for use in ESS analysis on the basis of terminal depth and availability of the original boring log document, with priority given to deeper borings and wells. A total of 93 soil borings/wells were selected for use in ESS analysis, all of which were located within or proximal to OU 1. USCS descriptions were then digitized and numerically coded in a spreadsheet to record vertical changes in grain size, lithology, and to note the presence of important sedimentary structures or markers on a foot-by-foot basis. Boring/well information and digitized grain-size logs were imported into GeoGraphix® software for quality assurance/quality control (QA/QC) review and interpretation. Graphic logs of grain size, lithology, and relative grain-size abundances (when available) were subsequently generated for each boring using a log display template in GeoGraphix® which was customized to illustrate the numerically coded grain-size data. Upon creation of the grain-size logs, depositional profiles, architectural units, and sedimentary packages/units were then interpreted and mapped across the area. Additional data from specific wells/borings located along cross sections were utilized to supplement grain-size data, including well screen intervals, groundwater levels, and field-derived PID readings, in addition to analytical results from soil, grab groundwater, and groundwater samples from permanent monitoring wells.

### 3.2.4 ESS Characterization Results

***Geologic Reconnaissance and Review of Previous Geologic Models***

To build a working geologic framework of OU 1 and identify the depositional facies, preexisting reports were compiled and reviewed. Additionally, historical and modern aerial satellite photographs (via Google Earth) depicting geomorphological landforms surrounding OU 1 were reviewed to identify adjacent depositional environments surrounding the site.

OU 1 is located adjacent to the tidelands of Dogfish Bay, part of the larger Liberty Bay system of the Port Orchard embayment (Figure C-4, Appendix C). The tidelands and beaches of Dogfish and Liberty Bays are generally fines-rich (>65%) and are protected from southerly wind-driven waves by the Keyport and Lemolo peninsulas. The primary sediment supply source which feeds the development of the Dogfish Bay and Liberty Bay tidelands is localized erosion of surrounding coastal bluffs composed of glacial sediment. During erosion at the bluff toe and after subsequent bluff collapse, transportable finer-grained sediment is entrained into longshore and cross-shore currents, while coarser-grained sediment too large for current transport generally remain as gravel lag along the toe of the bluff. A much smaller volume of sand, gravel, and fines is transported via the fluvial drainage systems into Dogfish and Liberty Bays, serving as a secondary sediment source (Takesue et al., 2011; Takesue and Dinicola, 2011; Downing, 1983).

Satellite imagery was used to identify the assemblage of modern depositional environments and processes occurring in and around OU 1 (Figure C-5, Appendix C). Figure C-5 displays a satellite image of exposed tidelands of Dogfish Bay taken during low-tide conditions in 2005. The tidal flats of Dogfish Bay are cross-cut by a complex network of sinusoidal tidal channels, creeks, and gullies which generally coalesce moving seaward towards subtidal conditions and the interpreted primary channel location. Several tidal bars are observed within some of the larger channels and generally the modern tidal flat is spatially dominated by overbank tidal flat deposits. Surrounding the Dogfish Bay tidal flats, coastal bluffs occupy the upland areas and are incised by vegetation-obscured fluvial streams which feed into the tidelands.

The first iteration of a geologic model for OU 1 was published in the RI report (Navy, 1993a), in which the RI identified six distinct geologic units present beneath OU 1 (summarized in Table C-2 and displayed in Figure C-6 in Appendix C). In the RI report, these units were correlated to regional geologic units found in Kitsap County, Washington using unit nomenclature published by KCGWAC (1991).

In 1997, an additional investigation (the Summary Data Assessment Report [DAR]) was conducted which expanded geologic mapping and interpretations for OU 1 to encompass the upland areas to the southwest and the remainder of NBK Keyport east of the former landfill (Figures C-7 and C-8 in Appendix C), while focusing on characterizing the site to a higher resolution and to a deeper zone of interest. Additional units and subunits were added including sub-members of the Vashon drift (Vashon Till, recessional and advanced outwash, Lawton Clay), the Discovery nonglacial unit (unverified beneath the site or surrounding area), the Possession Drift (unverified beneath the site or surrounding area), the Kitsap Formation, the Double Bluff Drift, and the Clover Park unit. A detailed breakdown of these units and the justification for their occurrence in and around OU 1 are available in the DAR (Navy, 1997b). The report identified the presence of discontinuous, lenticular, fining upward sand and gravel deposits, interpreted to be fluvial channels roughly oriented northwest-southeast within the Kitsap Formation in addition to the underlying Clover Park unit.

While the previous reports (KCGWAC, 1991) and previous investigations of OU 1 (Navy, 1993a; Navy, 1997b; Navy, 2017b) have interpreted OU 1 as underlain by the Kitsap Formation and the Clover Park unit (considered to form the basal aquitard for the site), it is important to note that in absence of absolute dating methods, the Olympia interglacial unit may be easily misidentified as the Whidbey Formation/Clover Park unit (or vice versa) as the depositional profiles and environments of interglacial deposits are similar (Troost, 2016; Noble 1990). Due to the misaligned variability of how the Kitsap Formation has been mapped historically (Noble, 1990), a mapped unit of the Kitsap Formation may be equivalent to either the Olympia interglacial unit (Discovery Unit) or the Whidbey Formation (Clover Park unit). Therefore, this ESS analysis will not recognize the Kitsap Formation stratigraphic nomenclature unless directly comparing study results to pre-existing site reports for OU 1. Additionally, as a result of the significant complexity in conducting stratigraphic correlations with the Quaternary section of the Puget Sound Region, coupled with the fact that the KCGWMP (KCGWAC, 1991), RI (Navy, 1993a), and DAR (Navy, 1997b) reports did not utilize any absolute dating methods to verify lithostratigraphic correlations, this ESS analysis disregards any previous interpretations of the age and classification of the nonglacial unit underlying OU 1. Until absolute dating methods are utilized to verify the age of the underlying interglacial unit, the unit will preliminarily be referred to as the Olympia interglacial unit in this ESS analysis due to its relative stratigraphic position.

The modern landscape surrounding OU 1 is observed to be comprised of sheltered tidal flats surrounded by coastal bluffs of glacial drift which are incised, and their sediment actively redistributed by fluvial streams and rivers. Using the fundamental principal of stratigraphy (Walther's Law), it can be assumed at varying points in the geologic past that this modern configuration of depositional environments was shifted laterally to some extent according to changes in sea level, sediment supply, or accommodation space. Additionally, geologic interpretations from the original RI and subsequent reports were also reviewed to provide a possible range in subsurface deposit types including tidal, peri-proglacial/glacial, and interglacial-alluvial deposits. Depositional facies models of these generalized environments were utilized for stratigraphic interpretations of strata beneath OU 1.

***ESS Geologic Model of OU 1***

Six ESS cross sections were strategically selected to best display geologic heterogeneity across the OU 1 study area for inclusion in this report (Plates C-1 through C-6). Five of the cross section alignments are oriented perpendicular to the long axis of the historical estuary (roughly southwest-northeast), and one cross section alignment is oriented parallel to the historical estuary (northwest-southeast). These ESS cross sections, A-A’, B-B’, D-D’, G-G’, I-I’, and N-N’, are shown on Figure C-9.

Geologic characterization was completed by first identifying and mapping the vertical and lateral extent of OU 1 (criteria for mapping the extent is discussed below). After identifying the landfill extent, grain-size patterns interpreted to be anthropogenic fill were separated from natural depositional patterns reflective of the stratigraphic record, and a detailed sedimentary facies analysis was then conducted. A total of eight ESS lithofacies were identified beneath or around OU 1 (Table C-3), each featuring vertical grain-size patterns or diagnostic sedimentary features (or a combination of both) indicative of its depositional origin. Four depositional packages have been interpreted (i.e., collection of genetically related facies), which should be treated as distinct geologic units/formations. The following subsections describe each depositional association, which unit/formation the depositional association is believed to be correlative to, and how each unit together fits into a sequence stratigraphic framework.

<u>Anthropogenic Landfill.</u> Anthropogenic landfill sediments were observed as discontinuous to semi-discontinuous, gravel, fine to coarse sand, clay, or silts containing waste debris (glass, wood, creosote, and various debris), which generally exhibited a lack of organized grain-size patterns and no natural depositional features/structures (Facies WB and AF, Table C-3). Facies AF has an excess of concrete and black top, while Facies WB has more variable landfill debris. The upper contact of the landfill stratigraphic zone was established just below the ground surface, and laterally correlated within the known footprint of the historic landfill. The lower contact of the landfill package was chosen based on the first occurrence of organic-rich fine sediment, indicative of marsh bottom sediments, which is reported in historical reports as the bottom of the landfill during excavation. If the organic-rich marker bed was absent, the lower contact was chosen from values from proximal borings/wells, with the absence of waste debris and occurrence of primary sedimentary features or bedforms being considered.

The OU 1 landfill waste body is observed at elevations ranging from just below the ground surface to a maximum subsea elevation of approximately 2 ft below sea-level (NAVD 88) and vary in vertical thickness between 2.4 and 19.54 ft thick (as shown in Figure C-10). Figure C-10 is an isopach map displaying the interpreted vertical thickness of the OU 1 landfill waste body. Generally, the OU 1 landfill waste body is observed to be thickest beneath the North Plantation, thins slightly and plateaus across the Central Landfill, and gradually thins beneath the South Plantation, suggesting the waste body is geometrically asymmetrical and lenticular. The former landfill waste body is observed to pinch out to the southeast (N-N', Plate C-6), consistent with the limits of the historical marsh shoreline. The isopach contours have been truncated to the east along the north-south road, because of the lack of data beneath the road. The limits of the historical shoreline imply that waste may be present beneath some portions of the roadway. While data are limited along the western side of the landfill, it is generally believed that the landfill waste body abruptly terminates at the toe of the slope along the southern and western edges at the contact with apparently native wetland features (i.e., Marsh Creek and Marsh Pond).

The landfill waste body is observed in cross sections D-D', G-G', I-I', and N-N' (Plates C-3 through C-6, respectively). The landfill waste body is observed to unconformably overlie tidal deposits (Facies FRH, SRH, CRB, OSG). Throughout most of OU 1, the waste body is underlain by fine-grained tidal marsh sediments (Facies FRH); however, moving towards the south-central portion of the site (see N-N', Plate C-6), stratigraphic thickening of sand-rich tidal deposits (Facies SRH) coupled with an apparent subsurface pinch out of Facies FRH strata near sea level (NAVD 88) suggests a sandy base may be present in localized areas. Facies FRH most likely correlates with the organic-rich fine-grained deposits that the historical records indicate are the base of OU 1.

Holocene-aged Tidal Deposits. Immediately underlying the waste body is the Tidal unit. This unit is a package of semi-continuous layers of coarse sand and gravel, fine-to-coarse sand with fines, and sandy silt and clay, all of which are crosscut by laterally discontinuous, well-graded, fining-upward packages of gravel and sand. These lithologies have been interpreted to be of a tidal origin and are comprised of the following facies: overbank muddy-tidalites (FRH), overbank sandy-tidalites (SRH), gravel-rich tidal flat deposits (CRB), and tidal channel/creek deposits (OSG) (Table C-3). A more detailed breakdown of each tidal facies along with justifications for sedimentological interpretations within the Tidal unit are available in Appendix C. Due to its stratigraphic position overlying interglacial deposits and cross-cutting relations with the adjacent Vashon Drift, the tidal package is interpreted to be Holocene in age.

Within OU 1, the Tidal unit consists of stratified belts of tidalite deposits that generally fine upwards, which is interpreted to represent a shift from intertidal to supratidal zones. The basal zone of the Tidal unit is comprised of permeable, semi-continuous gravel and sand-rich lithologies (Facies CRB) which infills erosional topography. CRB represents an early stage of tidal flat development within Dogfish Bay, corresponding to erosion and redistribution of gravel-rich topography created during the Vashon glaciation. Overlying the gravel-rich tidal flat deposits are one to two packages of heterogenous and heterolithic sand-rich tidalite deposits (Facies SRH) which form semi-continuous layers of permeable sand which is interbedded and interlaminated with fines throughout OU 1. Facies SRH is interpreted to be a sandy overbank tidalite, deposited within an intertidal sand flat-to-lower mixed flat setting. Sand-rich tidalites are observed to transition upwards into more mud and organic-rich tidalites (Facies FRH). Facies FRH is predominantly heterolithic silt and clay which is interbedded and interlaminated with fine sand. The sedimentary tidal packages of fine sand decrease in abundance moving upward. Facies FRH is interpreted to be overbank tidalites which were deposited within intertidal to supratidal mud-flat to marsh settings. This muddy, organic-rich heterolithic facies directly underlies the OU 1 landfill waste body. Cross-cutting CRB, SRH, and FRH are laterally discontinuous zones of normal-graded gravel and sand, which are interpreted to be high-to-mid order tidal channel/creek bar deposits (Facies OSG), which formed a complex drainage network for the ancestral tidal lands of Dogfish Bay.

The Tidal unit is observed in all included cross sections within this report (A-A’, B-B’, D-D’, G-G’, I-I’, and N-N’; Plates C-1 through C-6). The extent of the Tidal unit was mapped within OU 1 and adjacent areas based on lithological/sedimentological features in addition to information derived from historical records of the site. The upper contact of the Tidal unit was mapped within the former landfill footprint based on the shallowest occurrence of organic-rich silt/clay described in historical documents as the marsh bottom of the landfill during development. In areas surrounding the landfill footprint, the upper contact was mapped below anthropogenic fill or just below the ground surface within and around the footprint of the historical shoreline (Figure C-9), as geologic data were suggestive of a tidal origin. The upper contact of the tidal package is encountered between elevations -3 to 16.4 ft (NAVD 88). This upper contact is shallower in the central portion of the study area and generally deeper in the outer portions of the study area in all directions (Figure C-11). The bottom contact of the tidal package was mapped based on the first occurrence of dense/hard peat or organic rich clay or silt beneath the gravel-rich portion of the Tidal unit (Facies CRB).

The Tidal unit is extensive within the footprint of the historical shoreline (Figures C-11 and C-12); however, the unit laterally pinches out into the Vashon drift to the southwest and northeast of OU 1 (shown in B-B’, Plate C-2) and onlaps and drapes glacial drift deposits along the Highway 308 causeway. The unit is immediately overlain by the landfill waste body within OU 1 (D-D’, G-G’, I-I’, and N-N’; Plates C-3 through C-6) and underlies anthropogenic fill or is located just beneath the ground surface elsewhere throughout the remainder of the study area (B-B’ and N-N’; Plates C-2 and C-6) within or near the historical shoreline boundary. The Tidal unit directly overlies pre-Vashon-Stade interglacial deposits, draping and infilling the erosional topography of the underlying unit (B-B’, D-D’, G-G’, I-I’, and N-N’; Plates C-2 through C-6).

Figure C-12 displays the variation in gross vertical thickness of the tidal succession across the study area, where it varies from approximately 6 to 53 ft thick, averaging 26 ft thick across the study area. The unit abruptly thickens along the base perimeter road forming a northeast-southwest oriented thick ridge (B-B’), then gradually thins moving to the northwest (towards the Highway 308 causeway) and to the southeast moving into OU 1. Within OU 1, the unit generally exhibits a regular thickness throughout the Central Landfill, but abruptly thickens within discontinuous localized areas. The package progressively thickens moving into the South Plantation (and presumably thins with proximity to the historical shoreline), and abruptly thickens within the northwest section of the North Plantation. Localized abrupt thickening of the tidal package is interpreted to be largely due to the presence of erosional-scoured depressions infilled by tidal sediments.

The Tidal unit is interpreted to exhibit complex fine- to meso-scale geologic heterogeneity which affects groundwater and contaminant transport at OU 1. The lowermost gravel-rich zone (Facies CRB) is interpreted to be the most homogenous unit, comprised of predominately permeable gravel and medium to coarse sand, with few zones of fine sand. Sand-rich tidalite deposits (Facies SRH) are interpreted to be comprised of permeable sands complexly interlaminated with clay and silt, which generates micro- to meso-scale geologic heterogeneity, which may impact groundwater flow and contaminant transport. The mud-rich tidalites (Facies FRH) are comprised of predominantly low-permeability silt and clay interlaminated with high-permeability fine sand which likely adds significant geological complexity to hydraulic flow within the facies. Tidal channel/creek deposits (Facies OSG) are interpreted to serve as preferential pathways for fluid flow that are roughly oriented towards Dogfish Bay. Tidal drainage networks are known to be very complex systems with numerous interconnected tributaries stemming from main channel bodies. The effect of the tidal channels may be most pronounced during intervals of high tide when the water levels extend higher along the cutoff wall between the base perimeter road and the modern tidal flat, allowing communication of channel bodies within Facies FRH and SRH with the modern tidal flat.

Vashon Drift (Undifferentiated). Beyond the boundaries of the landfill, thick successions of gravel, sand, till, and fine sediments were observed (A-A’ and B-B’, Plates C-1 and C-2). Due to low resolution in historical boring log descriptions, coupled with its absence within the landfill footprint, Facies GD was mapped as one undifferentiated geologic unit interpreted to be of glacial origin. The glacial drift unit is observed to be a succession of stratified clay, silt, gravel, sand (fine to coarse), and matrix-supported gravel tills (Table C-3). Facies GD was mapped from historical boring log descriptions which specifically describe sedimentary characteristics indicative of a glacial origin (till callouts, proglacial lake, advance/retreat outwash, etc.). Facies GD is interpreted to feature geologic deposits which encompass all physical environments associated with episodic glaciation within the Puget Lowland area, including proglacial lacustrine, advancement outwash, glacial till, and retreat/meltwater outwash. Facies GD is rare across the OU 1 ESS study areas, mainly occurring in upland areas located adjacent to OU 1 (B-B’, Plate C-2), and along the Highway 308 causeway (A-A’, Plate C-1). Glacial drift deposits were observed to vertically overlie interglacial deposits within the periphery of the study area and exhibit drastic thickness variations infilling topography of the underlying interglacial unit. Due to its superposition above the underlying interglacial unit, shallow occurrence, and cross-cutting relations with adjacent modern tidal deposits of Dogfish Bay, this glacial drift unit is interpreted to likely be correlative to the Vashon-Stade glaciation. No subsurface maps were created for this zone because of the limited data and lack of boring completions revealing the entirety of the unit.

Pre-Vashon-aged interglacial Deposits (Olympia Formation). Underlying the tidal package within OU 1 and underlying the glacial till along the periphery of the study area is a sedimentary package containing discontinuous gravels and sand encased in semi-continuous, fine-grained, organic-rich sediment. These sediments have been interpreted to be likely of fluvial origin with anastomosing channel forms and are comprised of the following facies including fluvial floodplain or marsh fines (PRF), fluvial channel/creek sand and gravel (OSG), and crevasse splay/channel levee sand and gravel (TGS) (Table C- 3). A more detailed breakdown of each fluvial facies along with justifications for sedimentological interpretations within this unit are available in Appendix C. Due to the relative stratigraphic position of this interglacial unit with respect to the Holocene-aged tidal deposits and Vashon Drift, coupled with the indications of sustained overburden and consolidation, this unit is interpreted to be likely deposited during a pre-Vashon-Stade interglacial period such as the Olympia interglaciation (~60,000 to 23,000 ya) or the Whidbey interglaciation (~>100,000 to 80,000 ya). As a result, the unit is thought to be correlative to either the Olympia Formation (Discovery Unit) proposed in the work of Troost (2016) or the Whidbey/Kitsap Formations. While a definitive age of this interglacial unit is elusive without geochronology data, this unit is most likely correlative to the Olympia interglacial period and herein is referred to as the Olympia Formation. Regardless of its exact lithostratigraphic or chronostratigraphic designation, the unit is interpreted to be correlative to the Clover Park aquitard (unit Qn4) originally mapped during the RI (Navy, 1993a).

Within OU 1, the Olympia Formation consists predominantly of interbedded deposits of peat, peaty clay, and silt. The Olympia Formation is cross-cut by at least two channel bodies, oriented approximately northwest-southeast, and extends from the South Plantation through the North Plantation at OU 1. The unit is extensive across OU 1 and beyond, and it is observed in all cross sections (Plates C-1 through C-6). The upper contact of the unit was picked from the first occurrence of peat, silt, or clay beneath the coarse basal unit of the Tidal unit (Facies CRB, Table C-3) or below intervals designated as glacial drift. This upper contact is commonly identified by very stiff to hard, platy peat, but may also be clay or silt, and is largely correlative across the entire site. The upper contact generally is located 15 to 25 ft bgs (Figure C-13). Due to the limited depth of penetration of most borings available for this study, the basal contact of the Olympia Formation was not determined, apart from the boring log for the PUD-1 well, which suggested the package may extend down to a depth of 100 to 150 ft bgs to the uppermost contact of another glacial drift deposit, which may be the Possession glacial drift. The Olympia Formation is unconformably overlain by tidal deposits (specifically Facies CRB and SRH) within the extent of OU 1 and along the periphery of the study area (Highway 308) and is unconformably overlain by glacial drift in upland areas outside of the historical shoreline. The upper contact of the Olympia Formation is substantially eroded, characterized as a scoured irregular surface, with abrupt topographic depressions and localized erosional highs. The contact is observed to quickly deepen beneath the North Plantation moving northwest beneath the modern tidal flats, and also in the southwestern portion of the study area (Figure C-13), while apparently shallowing to the northeast and the southeast. Erosional topography of the upper contact controls thickness trends of the overlying tidal package, as it infills the erosional topography.

The Olympia Formation is interpreted to be mainly comprised of low-permeability sediments which will inhibit flow; however, preferential pathways for groundwater flow exist within permeable channel bodies, which are roughly oriented outwards towards Dogfish Bay and the PUD-1 well. It is unknown whether these channel forms are laterally connected; however, the prominence of preserved floodplain deposits, thick vertical extent of channel deposits, and their abrupt terminations is consistent with descriptions of fluvial systems with anastomosing forms where each channel likely existed within a single stable position, and therefore may not be connected as seen in braided or meandering fluvial channel forms. The permeable channel forms of the Olympia Formation are generally separated from overlying tidal deposits by less than 10 ft of low permeable floodplain fine-grained sediment. Figure C-14 is an interpreted map displaying the subsea depths to Olympia channel deposits and the interpreted connectivity between channel bodies. Two types of channel formation were interpreted: 1) anastomosing channels (primary at the site), which are sometimes observed as stacked channel zones, created via channel abandonment and continued sedimentation; and 2) eroded channels (secondary at the site) that were at one time likely present over the extent of the study area, but have mostly been eroded during the Vashon glaciation. Further detail regarding the fluvial channel bodies and the interpretations of their connectivity and orientation is provided in Appendix C.

***Hydrostratigraphy of OU 1***

This section presents the historical hydrostratigraphic interpretations and contrasts those with revised interpretations based on the ESS analysis.

<u>Historical Hydrostratigraphic Framework.</u> The hydrogeologic framework beneath the site was summarized in the RI (Navy, 1993a) and DAR (Navy, 1997b), which included both the site-wide, regional hydrogeologic setting, and the local setting beneath OU 1 and was based on both historical information compiled from previous investigations and studies, as well as findings from the RI and the DAR itself.

As presented in the RI, previous investigations had defined two main aquifers in the vicinity of NBK Keyport: an unconfined shallow aquifer and a confined deep aquifer. These two aquifers were considered to be separated by the Clover Park unit, also referred to as the Clover Park aquitard. The regional Clover Park unit, which is typically at least 100 ft thick in the vicinity of NBK Keyport, is composed of fine-grained sediments. The RI indicated that a more complex hydrogeologic setting existed beneath NBK Keyport, notably that multiple water-bearing zones, separated by aquitards, existed both above and below the Clover Park unit, including the regional deep aquifer beneath the Clover Park unit. The RI did state that, like any interglacial deposit, the Clover Park unit may have been eroded by local channels.

In the RI, two water-bearing zones were identified within the aquifer present above the uppermost clay of the Clover Park aquitard. The upper portion of this aquifer was considered the unconfined water table aquifer, with the deeper portion consisting of relatively coarse-grained material located immediately above the uppermost clay of the Clover Park aquitard. These two zones were interpreted to be separated by a middle aquitard; however, the RI stated that the two zones were likely laterally connected due to horizontal pinching out and/or the existence of coarser-grained and more permeable units within the middle aquitard. Nonetheless, the RI refers to the upper water table aquifer as the "shallow aquifer" and the deeper zone above the Clover Park unit as the "intermediate aquifer."

Data presented in the 2017 Site Recharacterization Report (Navy, 2018b) were used to conclude that the upper and lower zones of the shallow aquifer are hydraulically connected. Two distinct water-bearing zones were not identified – a conclusion which is generally consistent with the findings from the RI rather than the later DAR. Groundwater elevation measurements taken from wells screened at depths representative of both the "shallow aquifer" and "intermediate aquifer" resulted in a consistent contour map during the 2017 Site Recharacterization investigation (Navy, 2018b). Further evidence showing that these two zones are hydraulically connected was observed in the contaminant distribution in groundwater during the 2017 Site Recharacterization investigation.

During the RI, a sandy-gravelly zone was identified in a localized area of the upper portion of the Clover Park unit. It was stated that this zone was likely in hydraulic connection with the "intermediate aquifer," and thus was mapped as part of that aquifer. Other boring logs from OU 1 indicated that the majority of the Clover Park unit in and around OU 1 consisted of dense clay and silt, supporting the fact that this sandy-gravelly zone is localized (around well MW1-11). Multiple coarse-grained zones were identified in the Clover Park unit during the DAR (Navy, 1997b). It was not known at the time if these zones represented a continuous aquifer, or if they exist as isolated lenses, although the DAR speculated that they were lenses due to their sporadic occurrence.

It has been consistently stated in historical reports that any further downward migration of contaminants into the regional deep aquifer is being effectively prevented by the Clover Park aquitard.

Groundwater Flow Direction. As discussed in the RI and subsequent investigations and studies, shallow groundwater beneath the central and northern portions of the landfill flows to the west, discharging to the marsh and tidal flats. In the southern part of the landfill, shallow groundwater discharges to the south or southwest toward the marsh.

The RI, DAR, and 2017 Site Recharacterization all concluded that deeper groundwater flows in a north-northwesterly direction and discharges to the surface water of Dogfish Bay. Based on the evidence that groundwater flows toward and discharges into adjacent surface water bodies, a conclusion was made in the RI that this means groundwater does not flow off site to the west toward potential current or future drinking water wells. This conclusion was supported by the absence of VOCs in wells located along the western boundary of OU 1 (MW1-7, MW1-9, and MW1-10; which are screened at 39.5 to 44.5 ft bgs, 48.5 to 58.5 ft bgs, and 4 to 14 ft bgs, respectively).

In October 2019, groundwater elevation measurements were collected from 31 monitoring wells at OU 1 during source investigation activities. The soil descriptions taken during well installation and well screen depth intervals were cross-referenced with the preliminary ESS cross sections and site-wide stratigraphic interpretations. This analysis indicated that four wells installed in October 2019 (MW1-59, MW1-64, MW1-65, and MW1-68) were screened within the coarse-grained zones of the upper portion of the Olympia interglacial deposits (Facies OSG). An initial attempt at creating a groundwater elevation contour map (i.e., potentiometric surface map) including groundwater elevation measurements from all 31 wells indicated that all wells were not hydraulically connected. Therefore, one groundwater elevation contour map was created for wells screened above the contact of the Olympia interglacial deposits (Figure C-15) and a second groundwater elevation contour map was created for wells screened within the coarse-grained zones of the upper portion of the Olympia interglacial deposits (Figure C-16). For wells screened above the Olympia, the groundwater flow direction is to the west, discharging to the marsh and tidal flats in the northern part of the landfill. In the southern part of the landfill, groundwater discharges to the south or southwest toward the shore of the marsh. For wells screened within the coarse-grained zones of the upper portion of the Olympia, the groundwater flow direction is to the north-northwest across OU 1. The groundwater flow directions inferred from the 2019 groundwater elevation contour maps (Figures C-15 and C-16) are consistent with the historical conclusions and hypotheses regarding shallow groundwater flow to surface water and deeper regional groundwater flow.

These two contour maps demonstrate that the *shallow* zones and deeper coarse-grained zones of the upper portion of the *Olympia* are not hydraulically connected, and flow characteristics are different for the two zones. This analysis also confirms and expands upon the conclusion made in 2017 (Navy, 2018b) that the upper and lower zones of the shallow aquifer are hydraulically connected and groundwater elevations from all zones above the Olympia interglacial deposits can be contoured consistently.

<u>Candidate Hydrostratigraphic Unit Selection.</u> An HSU is defined by Schultz et al. (2017) as "a body of sediment saturated with groundwater with limited connectivity to adjacent sediments." HSUs represent defined stratigraphic layers that act as primary groundwater flow pathways. Unconsolidated aquifers are typically composed of multiple HSUs due to heterogeneous geology

(Shultz et al., 2017). Following the interpretation of lithology data and grain-size trends at a site, candidate HSUs are then chosen. The candidate HSUs can then be tested and validated by integrating hydrogeology and groundwater chemistry data, which provide further evidence for hydraulic continuity (Schultz et al., 2017). Candidate HSUs were chosen utilizing the same six ESS cross sections presented during discussion of the geologic model (cross sections A-A’, B-B’, D-D’, G-G’, I-I’, and N-N’; Plates C-7 through C-12).

Four HSUs have been defined in the six cross sections and are shown on Plates C-7 through C-12. The HSUs range from the shallow water-table aquifer to the coarse-grained channels within the Clover Park aquitard (Olympia interglacial deposits). The regional deep aquifer, present beneath the Clover Park aquitard, was not included in this study. The four candidate HSUs are presented below.

**HSU #1**

Candidate HSU #1 consists of sediments that comprise the anthropogenic landfill waste body. As described above, this anthropogenic unit ranges in vertical thickness from 2.4 to 19.54 ft and can be partly distinguished by the presence of landfill debris. The grain sizes in this unit range widely, with the majority of the unit being relatively coarse-grained (coarse sands and gravels), with some fine-grained deposits (silt and clay) observed throughout OU 1. The upper contact of HSU #1 is the water table surface (typically 5 to 10 ft bgs), and the lower contact of this HSU is the first occurrence of organic-rich fine sediment, which is historically considered the bottom of the landfill waste body. The vertical boundaries of HSU #1 correspond to the unconfined water table aquifer or “shallow aquifer” that is discussed in the historical literature.

Groundwater in HSU #1 flows from the landfill area in a westerly direction overall, with flow to the southwest and south beneath the South Plantation. This groundwater flow discharges to the surface waters of the marsh, Marsh Creek, and tidal flats. As a result of the discontinuous nature of the fine-grained layer that is below HSU #1 (hereafter identified as the semi-confining unit [SCU]), groundwater from HSU #1 is hydraulically connected with deeper zones of the shallow aquifer (see HSU #2), as evidenced by the results of contouring groundwater elevations in wells screened within HSU #1 and HSU #2.

As HSU #1 is situated within the landfill waste body, the majority of contaminant sources were likely deposited within this unit, followed by contaminant transport through dispersion and advective groundwater flow. HSU #1 likely serves as a primary horizontal migration pathway for contaminants to reach porewater and surface water of the marsh, Marsh Creek, and tidal flats, to the west and south of the OU 1 landfill. Additionally, vertical groundwater flow and contaminant transport are likely occurring from HSU #1 to deeper HSUs through more permeable areas of the SCU and through gaps in the SCU.

**HSU #2**

Facies SRH has been identified as a second candidate HSU (HSU #2) due to its relative permeability and saturated state. As described above, this unit consists of clayey and silty fine- to coarse-grained sand with trace amounts of gravel. HSU #2 interfingers with Facies FRH, which was historically interpreted as the "middle aquitard." Thus, at OU 1 this unit is overlain by the landfill waste body in some areas in the north and south (see cross sections B-B', I-I', and N-N'; Plates C-8, C-11, and C-12), and in some areas it is separated from the landfill waste body by the SCU/Facies FRH (D-D' and G-G'; Plates 9 and 10). HSU #2 generally overlies the coarser-grained Facies CRB, although HSU #2 directly overlies the Olympia interglacial deposits beneath Marsh Creek, the modern tidal flats, and in areas of the South Plantation (see cross sections B-B' and N-N'; Plates C-8 and C-12). This unit is designated HSU #2B in areas where the SCU isolates Facies SRH and separates it from lower lying HSUs (see cross sections B-B' and N-N'; Plates C-8 and C-12). The boundaries of HSU #2 correspond to the upper section of the "intermediate aquifer" that is discussed in the historical literature.

Groundwater in HSU #2 likely flows to the west, north, and northwest beneath the landfill area. Groundwater flow in this unit likely discharges to the tidal flats and potentially to Dogfish Bay. As described above, groundwater from the upper water table aquifer is able to flow vertically to this unit through gaps in the SCU and/or through more permeable areas of the SCU. Groundwater in this unit then can flow vertically to the deeper underlying section of the aquifer (i.e., the lower-lying HSU).

Contaminant mass could reach HSU #2 via direct downward migration from the upper water table aquifer (HSU #1), particularly in the North Plantation through coarse-grained Facies OSG and in southern areas of the Central Landfill where the landfill waste body directly overlies this unit. Additionally, contaminant mass could potentially reach HSU #2 via matrix diffusion from the finer-grained sediments of the SCU/Facies FRH. In the areas of the South Plantation where HSU #2 directly overlies the Olympia interglacial deposits, HSU #2 possibly represents a primary residual contaminant source area susceptible to back diffusion from the underlying Olympia interglacial deposits (Facies PRF) and the overlying Facies FRH, while also acting as a residual source to the underlying Olympia interglacial deposits (Facies PRF).

**HSU #3**

Facies CRB has been identified as a third candidate HSU (HSU #3) due to its relative permeability and saturated state. HSU #3 is differentiated from HSU #2 due to its relatively higher gravel content and less fine-grained material. As described above, this unit consists of poorly sorted sand with varying amounts of gravel. HSU #3 is laterally continuous beneath most of the OU 1 landfill but thins in the South Plantation and pinches out at the southeastern edge of the OU 1 landfill (see cross sections I-I' and N-N'; Plates C-11 and C-12, respectively) and to the south of the tidal flats (see cross section N-N'; Plate C-12). HSU #3 is directly overlain by

HSU #2 across much of the OU 1 landfill and in some areas it is overlain by the finer-grained material of Facies FRH (SCU). HSU #3 directly overlies the Olympia interglacial deposits, although HSU #2 directly overlies the Olympia interglacial deposits in areas of the South Plantation where HSU #3 is not present (see cross sections D-D', G-G', and N-N'; Plates C-9, C-10, and C-12, respectively). The boundaries of HSU #3 correspond to the lower zone of the "intermediate aquifer" that is discussed in the historical literature.

HSU #2 and HSU #3 occur juxtaposed to one another, and due to their relative permeability (based on grain size), groundwater likely flows vertically downward from one unit to the other. Both of these candidate HSUs have been historically defined as the "intermediate aquifer" (Navy, 1993a). HSU #3 appears to be a localized unit, as it pinches out to the south and terminates in the north, west, and east at contacts with the till-like deposits of the Vashon Drift. Groundwater in HSU #3 likely flows laterally to the west, north, and northwest beneath the landfill area and potentially discharges into the tide flats or Dogfish Bay. Groundwater from the upper water table aquifer can flow vertically downward to this unit through HSU #2. Downward vertical groundwater flow from HSU #3 is generally impeded by the peat-rich floodplain fines (Facies PRF) of the Olympia interglacial deposits. Groundwater will flow vertically downward into upper portions of the Olympia interglacial deposits in localized areas where coarse-grained channels (i.e., sands and gravels of Facies OSG) are present.

Contaminant mass may reach HSU #3 via direct downward migration from HSU #2. In places where the SCU/Facies FRH directly overlies HSU #3, contaminant mass is also likely to reach HSU #3 via matrix diffusion from these finer-grained sediments. Contaminants are likely to vertically migrate downwards and then be transported laterally along the base of HSU #3, along the contact with the Facies PRF of the Olympia interglacial deposits. Contaminants will also adsorb onto the underlying fine-grained sediments of Facies PRF. This sorbed material can then act as a secondary contamination source into HSU #3 via back diffusion. The relatively thin layers of fine-grained sediments of Facies PRF may impede downward vertical groundwater flow, but likely do not prevent vertical flow altogether; therefore, groundwater could flow into the underlying coarser-grained channels of Facies OSG, which is explained in further detail below.

**HSU #4**

Coarse-grained zones (Facies OSG) in the upper section of the Olympia interglacial deposits were identified as the fourth candidate HSU (HSU #4). Preliminary results from this ESS study indicate that these zones are more extensive than previously thought. These zones can more accurately be described as fluvial channel bodies, which extend and are aligned from the southern portion of OU 1 to the north in the general direction of Dogfish Bay (Figure C-14). The extent, orientation, and connectivity of these channels is not yet fully understood, and this could be analyzed further during processing of the remaining cross sections. These channels are separated from overlying HSUs (#2 or #3 based on location) by the uppermost fine-grained material of the Olympia interglacial deposits (Facies PRF). In the six cross sections included in this memorandum, the thickness of the upper fine-grained boundary ranges from approximately 1 to 7 ft. The bottom boundaries of the channels are indicated by the presence of the clay, peat, and silt of the Facies PRF, which is assumed to extend at least 100 ft down to the deep regional aquifer beneath the entire OU 1 area.

As suggested in the RI, DAR, and 2017 Site Recharacterization, groundwater in these deeper channels likely flows laterally to the north-northwest in a direction that mimics that of HSU #2 and HSU #3 of the "intermediate aquifer." Preliminary mapping of these channels suggests a channel orientation to the north and northwest, indicating that groundwater in this HSU could discharge to Dogfish Bay, but also potentially bypass the surface waters of Dogfish Bay and flow towards Liberty Bay to the north and beneath Virginia Point to the northwest. The evident orientation of these channels is consistent with the groundwater flow direction garnered from Figure C-16. Deeper lithological data would be needed to better characterize the features (i.e., orientation, continuity, connectivity, etc.) of these coarse-grained channels in the upper Olympia interglacial deposits. Collection of deeper lithologic data to map these channels to the northwest, through Dogfish Bay to Virginia Point, has been planned by the Navy for 2023, to be completed by others.

Contaminant mass could potentially reach HSU #4 via back diffusion from the thin overlying layer of organic-rich silts and clays of the Facies PRF, which receives contaminant flux from the overlying HSU #2 or HSU #3 candidates, depending on location. Contaminants could potentially be transported laterally along the base of these channels, along the contact with the underlying PRF Facies of the Olympia Formation. Contaminants would then be transported down-gradient, generally with the orientation of the channels, which is to the north and northwest. Based on preliminary findings, it is possible that these channels may provide a contaminant transport pathway into Dogfish Bay (as previously thought) or to the north of Dogfish Bay, to Liberty Bay, and beneath the adjacent landmasses, such as Virginia Point (depending on channel profile and orientation). Contaminants will also adsorb onto the uppermost fine-grained soil of the underlying silts and clays of Facies PRF; this sorbed material can then act as a secondary contamination source into HSU #4 via back diffusion. Existing data suggest the underlying Facies PRF acts as the confining aquitard, effectively preventing further vertical migration of contaminants to the deep regional aquifer, although additional isolated channel bodies may be present.

***Contaminant Stratigraphy and HSU Validation***

Soil, grab groundwater, and monitoring well analytical data, as well as groundwater elevations obtained during 2017, 2019, and 2022 site investigation efforts were integrated with hydrostratigraphic cross sections to assess subsurface distribution of COCs across the site with respect to working interpretations and selection of HSUs. The cross sections are also integrated with and evaluated against a series of two-dimensional (2D) vertical slices of the three-dimensional (3D) EarthVision kriged contaminant distribution model of OU 1. Each 2D slice shows approximated locations/orientation of the ESS cross sections D-D’, G-G’, I-I’, and N-N’ (Plates C-13 through C-16). The resultant contaminant stratigraphy cross sections were used to validate HSU candidacy in accordance with ESS methodology detailed by Schultz et al. (2017). Cross sections A-A’ and B-B’ are not included in this section as limited analytical data were available along these transects.

The findings presented in this section are limited to the completed cross sections, and no conclusions or discussion are included that involve data outside of these cross sections. The purpose of this section is to assess how contaminant distribution verifies, or refutes, HSU selection only. The ESS results have been used in conjunction with site-wide data, including the 3D data model, to document overall contaminant fate and transport trends, and to update the overall CSM.

The lithological and spatial descriptions of candidate HSUs are provided above. Distributions of COC concentrations in soil and groundwater samples collected in HSUs are graphically depicted in Plates C-13 through C-16. Analytical data from grab groundwater, monitoring well, and soil samples are summarized in Tables C-4 and C-5. Key findings and the verification process for each HSU are summarized in the subsections below.

<u>HSU #1 Properties, Contaminant Stratigraphy, and Validation.</u> Five soil samples were collected from HSU #1 and analyzed for physical parameters: effective porosity ranged from 19.2 to 34.63, with a median value of 25.1; TOC ranged from <500 to 19,000 mg/kg, with a median value of 956 mg/kg; dry bulk density ranged from 0.58 to 1.98 grams per cubic centimeter (g/cc), with a median value of 1.67 g/cc; and horizontal hydraulic conductivity ranged from 1.00 x $10^{-3}$ centimeters per second (cm/s) to 2.93 x $10^{-7}$ cm/s, with a median value of 6.79 x $10^{-4}$ cm/s. One slug test was performed at a monitoring well screened within HSU #1 (MW1-50), which yielded an average hydraulic conductivity value of 1.88 x $10^{-3}$ cm/s. These results are summarized in Table C-6, along with field descriptions and laboratory-measured mean grain size for each soil sample.

As depicted on the four cross sections analyzed, total VOCs were detected at elevated concentrations (greater than 100 µg/L) in grab groundwater samples collected at several locations within HSU #1. These include instances in which total VOC concentrations were *greater* in HSU #1 than at lower depths and instances in which total VOC concentrations were *less* in HSU #1 than at lower depths.

In the North Plantation, none of the target VOCs were detected in HSU #1 soil along the cross sections analyzed (Table C-5), including at the two locations at which VOCs were detected in grab groundwater. In the Central Landfill, total VOC concentrations in soil were relatively low in HSU #1 (less than 0.30 micrograms per kilograms [µg/kg] or non-detect). Total VOC concentrations in soil were much greater in the underlying fine-grained semi-confining unit (SCU #1; Facies FRH).

The instances that showed higher VOC concentrations at deeper locations in groundwater suggest that contaminants are being transported vertically downward through HSU #1 to deeper portions of the aquifer (in addition to horizontally into the adjacent marsh and surface water). These contaminants are then transported downgradient within deeper groundwater flow in lower HSUs. The absence of VOCs in shallow soil in the North Plantation and Central Landfill sampling locations supports this conclusion. Additionally, the difference in VOC concentrations in soil in HSU #1 as compared to the underlying fine-grained semi-confining unit supports the previous assumptions that contaminants are transported vertically downward through HSU #1 and are being adsorbed to the finer-grained material below.

<u>HSU #2 Properties, Contaminant Stratigraphy, and Validation.</u> Eleven soil samples were collected from HSU #2 and analyzed for physical parameters: effective porosity ranged from 18.8 to 35.9, with a median value of 29.76; TOC ranged from 110 to 7,600 mg/kg, with a median value of 950 mg/kg; dry bulk density ranged from 1.24 to 1.90 g/cc, with a median value of 1.68 g/cc; and horizontal hydraulic conductivity ranged from $7.18 \times 10^{-3}$ cm/s to $3.15 \times 10^{-6}$ cm/s, with a median value of $6.14 \times 10^{-4}$ cm/s. Two slug tests were performed at monitoring wells screened within HSU #2 (MW1-46 and MW1-47), which yielded average hydraulic conductivity values of $1.86 \times 10^{-3}$ cm/s and $1.47 \times 10^{-3}$ cm/s, respectively. These results are summarized in Table C-6, along with field descriptions and laboratory-measured mean grain size for each soil sample.

As depicted on the four cross sections analyzed, total VOCs were detected at elevated concentrations (greater than 100 µg/L) in grab groundwater samples collected at several locations within HSU #2. These include instances in which total VOC concentrations were *greater* in HSU #2 than at lower depths and in which total VOC concentrations were *less* in HSU #2 than at lower depths. At one location (SP-B131; Plate C-15), elevated concentrations of cis-1,2-DCE and VC were observed in grab groundwater within the transition zone from a discontinuous zone of fine-grained sediment (Facies FRH) to the sandy HSU #2.

Within and below HSU #2, soil chemistry sampling locations and results are variable. Concentrations of total VOCs in soil were observed to be both *less* at deeper HSUs (i.e., CL-B100, CL-B103, and NP-B114) and *greater* at deeper HSUs (i.e., NP-B117s).

The presence of VOC mass within deeper HSUs suggests that contaminant flux is downward through HSU #2 into underlying HSUs and then flows downgradient at depth.

<u>HSU #3 Properties, Contaminant Stratigraphy, and Validation.</u> Five soil samples were collected from HSU #3 and analyzed for physical parameters: two samples were analyzed for effective porosity, yielding values of 18.2 and 30.73; TOC ranged from 100 to 1,700 mg/kg, with a

median value of 540 mg/kg; dry bulk density ranged from 1.73 to 1.99 g/cc, with a median value of 1.95 g/cc; and horizontal hydraulic conductivity ranged from 5.33 x $10^{-3}$ cm/s to 5.56 x $10^{-4}$ cm/s, with a median value of 3.63 x $10^{-3}$ cm/s. One slug test was performed at a monitoring well screened within HSU #3 (MW1-74), which yielded an average hydraulic conductivity value of 2.08 x $10^{-2}$ cm/s. As expected, given the coarse-grained composition of HSU #3, hydraulic conductivity values from the laboratory and via slug tests are generally greater than values from HSU #1 and HSU #2. These results are summarized in Table C-6, along with field descriptions and laboratory-measured mean grain size for each soil sample.

As depicted on the four cross sections analyzed, total VOCs were detected at elevated concentrations (greater than 100 µg/L) in grab groundwater samples collected at several locations within HSU #3. Groundwater sampling locations in underlying units were sporadic; however, the results generally show total VOC concentrations in groundwater to be lower in units below HSU #3.

Within and below HSU #3, soil chemistry sampling locations and results are variable. Concentrations of total VOCs in soil exceeded 1,000 µg/kg in HSU #3 at four sampling locations (CL-B18a, CL-B98, NP-B117s, and NP-B177) and were low (<50 µg/kg) at five other sampling locations (NP-B114, NP-B136, CL-B105, CL-B134, and SP-B93).

Evaluation of chemistry data within HSU #3 suggests VOC mass reaches this unit from overlying HSUs, and is then transported downgradient at depth. VOC concentrations within HSU #3 are primarily in aqueous phase form, supporting the suggestion that VOC mass is largely sourced from downward migration from overlying SCU/HSU #2 and upgradient sources.

<u>HSU #4 Properties, Contaminant Stratigraphy, and Validation.</u> Two soil samples were collected from HSU #4 and analyzed for physical parameters: one sample was analyzed for effective porosity, yielding a value of 32.02; TOC ranged from 890 to 1,400 mg/kg, with a median value of 1,145 mg/kg; one sample was analyzed for dry bulk density, yielding a value of 1.80 g/cc; and one sample was analyzed for horizontal hydraulic conductivity, yielding a value of 6.78 x $10^{-4}$ cm/s. One slug test was performed at a monitoring well screened within HSU #4 (MW1-72), which yielded an average hydraulic conductivity value of 3.40 x $10^{-2}$ cm/s. These hydraulic conductivity values, measured from soil samples collected from the coarse-grained channel deposits within the Olympia (OSG), were several orders of magnitude greater than values measured from samples collected from the fine-grained deposits of the Olympia (Facies PRF), as discussed further below. These results are summarized in Table C-6, along with field descriptions and laboratory-measured mean grain size for each soil sample.

Within the four cross sections analyzed, groundwater sampling data within HSU #4 were limited to six locations (SP-B92, CL-B102, CL-B103, MW1-69, MW1-71, and MW1-72). MW1-69 VOC concentrations are found in Figure 3-6. VOC concentrations detected in groundwater at these locations within HSU #4 were relatively low; however, slightly elevated concentrations of cis-1,2-DCE (29 µg/L) and VC (11 µg/L) were encountered in grab groundwater collected from boring CL-B102. Additionally, seven monitoring wells MW1-59, MW1-64, MW1-65, MW1-68, MW1-70, MW1-73, and MW1-75) are screened within HSU #4 that were not part of the four cross sections analyzed. Elevated concentrations of VOCs were detected in four of these seven wells. VOCs were non-detect in upgradient well MW1-59 and downgradient well MW1-75, and total VOCs were less than 0.1 µg/L in MW1-73.

Within HSU #4, soil sampling data indicated total VOC concentrations were low, with the exception of soil collected from CL-B102 (1,397 µg/kg).

The presence of VOC mass in HSU #4 groundwater at location CL-B102 (Plate C-13), and four of the seven monitoring wells listed above, indicates that VOCs are being transported into the channel system below the top of the fine-grained Olympia interglacial deposits (i.e., through the fine-grained Facies PRF).

Based on the groundwater elevation contour map of the wells screened below the Olympia contact (Figure C-16), groundwater flow within the channels of HSU #4 is to the north-northwest. As described above, groundwater elevations and associated flow direction using wells screened above Olympia interglacial deposits (i.e., HSUs #1, #2, and #3) compared with wells screened within the coarse-grained zones of the upper portion of the Olympia interglacial deposits (i.e., HSU #4) helps to validate HSU #4 as a separate hydraulic unit with separate flow characteristics.

Fine-grained Olympia Interglacial Deposits. Seven soil samples were collected from within the fine-grained deposits of the Olympia, and analyzed for physical characteristics. Effective porosity ranged from 4.8 to 13.49, with a median value of 11.49; TOC ranged from 3,800 to 110,000 mg/kg, with a median value of 18,000 mg/kg; dry bulk density ranged from 0.85 to 1.63 g/cc, with a median value of 1.42 g/cc; and horizontal hydraulic conductivity ranged from 1.24 x $10^{-6}$ cm/s to 1.50 x $10^{-7}$ cm/s, with a median value of 3.18 x $10^{-7}$ cm/s. No slug tests were performed within the fine-grained deposits of the Olympia, as no monitoring wells were screened within this material. The relative low values of effective porosity and hydraulic conductivity, and relative high values of TOC are indicative of the fine-grained silt and clay soil samples that represent the Olympia interglacial deposits (Facies PRF). These values are within the expected ranges for the unit to act as an aquitard, as it has historically been characterized. These results are summarized in Table C-6, along with field descriptions and laboratory-measured mean grain size for each soil sample.

### 3.2.5 ESS Characterization Conclusions and Summary

ESS analysis of OU 1 has revealed the site is underlain by the landfill waste body, Holocene-aged tidal flat deposits, and a Pleistocene-aged interglacial unit presumed to be deposited in a fluvial-floodplain environment during the Olympia interglacial interval. A network of fluvial channel bodies was observed to exist just below the upper most contact of the interglacial unit and is apparently oriented roughly northwest-southeast. The hydrostratigraphy of the site is interpreted to be characterized by several mappable, hydrostratigraphic units including the landfill (HSU #1), a permeable tidal sand-rich heterolith (HSU #2), a permeable tidal coarse-rich basal zone (HSU #3), in addition to several fluvial channel body systems (HSU #4) located below the top of the fine-grained upper portion of the interglacial unit. The landfill waste body is observed to be underlain by a low permeability body of fine-grained tidal sediment which acts as a SCU. The coarse-rich basal zone and channel body systems are underlain by peaty fine-grained floodplain deposits of the interglacial unit which serves as a laterally continuous basal aquitard for the site.

ESS analysis support interpretations made during previous investigations that the contaminants from the landfill waste body can be and are transported downward in groundwater through the organic-rich marsh bottom (the semi-confining unit). The semi-confining unit also likely serves as a secondary source of contaminant mass to deeper intervals (HSUs #2 and #3) via matrix back-diffusion. The historically designated basal aquitard underlying contaminant-impacted tidal flat deposits is observed to be continuous across the entirety of OU 1; however, contaminants have reached the coarse-grained channel bodies within the upper-most portion of this unit from overlying aquifer units, and via back-diffusion from the uppermost organic-rich fine-grained sediment. The fate and transport of contaminant mass transported by the fluvial channels below the top of the aquitard is not well understood due to the relative lack of geologic and chemical data obtained within these deep channel bodies; however, the groundwater flow direction is likely to the north-northwest, comparable to the regional groundwater flow direction (Figure C-16). The planned effort to sample the channels across Dogfish Bay toward Virginia Point will provide more information regarding the fate and transport of this contaminant mass.

## 3.3 INTERTIDAL GEOPHYSICS

The results of intertidal geophysics performed in the Marsh Creek, tide flats, and Dogfish Bay imply that freshwater flow and contaminant transport dominate in paleochannels (Appendix C; Figure C-14) extending from the landfill footprint at low-low tides, allowing transport beneath the tide flats and beneath a portion of Dogfish Bay. Beyond the maximum low-low tide mark in Dogfish Bay, the paleochannels are expected to be flooded with saline water at all tide stages, with the less dense contaminated freshwater driven upward to daylight into the bay (though this hypothesis has not been verified with data). This transport path is consistent with modeling performed in support of the ROD. The remainder of this section summarizes key elements of the geophysical evaluation report included as Appendix D.

Between January 8 and 18, 2021, Atlas Technical Consultants, subcontracted to Battelle, performed a geophysical evaluation of the wetland and intertidal areas of OU 1. The investigation focused on assessing potential preferential migration pathways for groundwater (potentially containing COCs), obtaining information about the stratigraphy within the study area through the collection of land and marine high-resolution electrical resistivity data, and characterizing the movement of the saltwater wedge beneath the intertidal portions of the site.

The geophysical evaluation consisted of:

- Collection of six high-resolution, multi-electrode electrical resistivity tomography (ERT) traverses; ERT 1 through ERT 6. ERT 1 through ERT 5 utilized an Advanced Geosciences, Inc. (AGI) SuperSting R8 resistivity meter with an 84-electrode marine cable, and ERT 6 utilized an AGI SuperSting R8 resistivity meter with a 56-electrode marine cable.
- Collection of four high-resolution, multi-electrode time-lapse electrical resistivity tomography (TRP) traverses: TRP 1, TRP 1X, TRP 2, and TRP 3 using an AGI SuperSting R8 resistivity meter and a 56-electrode marine cable.

The results of the survey are illustrated by figures presenting resistivity/conductivity in color gradient form with warm (orange/red) colors representing higher recorded resistivity values and the cool colors (blue) representing higher conductivity values (Appendix D). Considering the heterogenous environment of the study area, the absolute resistivity values are not as indicative of features of interest as are relative changes. These relative changes are apparent by scrolling through the series of figures provided and noting the progression of resistivity changes over time.

The observed significant changes in resistivity values vertically and laterally support the interpretation of the presence of resistivity anomalies that are generally consistent with changes in several geologic characteristics including contrasts in fluid conductivity. In particular, the relative resistivity changes that correlate to tidal fluctuations appear indicative of more permeable zones in the subsurface. Responses with an observed delay or minimal change in resistivity contrast over a tide cycle are interpreted as features with relatively less permeability compared to anomaly features showing more rapid changes in resistivity contrast, especially when such rapid changes in the anomaly contrasts approximately correspond to, or lag just behind, known tidal fluctuations in time.

The resistivity of sea water is generally regarded as 0.3 Ohm-m (Appendix D). During the flood tide period, resistivity values seen at the surface (a saline environment) are similar to the responses seen at depth. Anomalies with increasingly higher resistivity values over an ebb tide may correlate with a lens of higher concentrations of freshwater. A distinct regional migration to higher resistivity values is observed from TRP 1X-1 through TRP 1X-5 (Appendix D). Comparing the changes in recorded subsurface resistivity observed along these transects to the timing of the ebb tide, the recorded response can be reasonably attributed to the influx of more resistive fluid across the alignment of the profile. The observed resistivity anomaly changes over time are consistent with imaging regressive migration of the saltwater wedge during the recorded time period within the tidal range. Similarly, TRP 1X-5 through TRP 1X-9 (Appendix D) depict a transgressive migration of relatively more conductive fluid.

## 3.4 BIODEGRADATION

This section provides an analysis of biodegradation occurrence and potential beneath OU 1 based primarily on data collected from wells that were installed in 2017 and 2019. Within the footprint of the former landfill, these wells were generally deeper than those installed prior to the ROD and provide laterally more extensive data regarding site conditions beneath the landfill footprint.

While this section provides analysis based on both 2017 and 2019 data, the 2019 results for natural attenuation parameters and microbial analysis in groundwater from monitoring wells is presented and summarized in Appendix B.

### 3.4.1 Summary of Biodegradation

The biodegradation evaluation for cVOCs concluded that groundwater conditions at OU 1 generally appear adequate to support biodegradation, but are not sufficient to result in robust, complete dechlorination of the site. Prevalent accumulation of intermediate daughter products (i.e., cis-1,2-DCE and VC) and relatively low concentrations of the innocuous end products (e.g., ethene) represent incomplete reductive dechlorination and suggest that biogeochemical conditions in groundwater are not optimal for complete dechlorination of PCE and TCE to ethene. The accumulation of cis-1,2-DCE and VC at OU 1 suggests that the degradation progress remains in a long transitional DCE and VC stage (often referred to as “DCE stall”). The remainder of this section details the data used to conclude that the site is in a DCE stall condition, especially considering that the geochemistry data presented in the past and from recently installed wells suggest groundwater conditions generally appear adequate for biodegradation.

### 3.4.2 Data Used in the Biodegradation Evaluation

Data included in the evaluation presented in this section consist of the following:

***2017 Data***

1. 23 groundwater samples from newly installed monitoring wells analyzed for cVOCs
2. 23 groundwater samples from monitoring wells analyzed for nitrate, nitrite, sulfate, sulfite, BOD, COD, DO, ferrous iron (iron II), ORP, pH, conductivity, temperature, and turbidity
3. 10 groundwater samples from monitoring wells in hotspots analyzed for microbial DNA

***2019 Data***

1. 32 groundwater samples from monitoring wells installed in 2017 and 2019 analyzed for cVOCs
2. 30 groundwater samples from monitoring wells analyzed for nitrate/nitrite, sulfate/sulfide, DOC, methane, ethane, ethene, chloride, DO, ORP, pH, conductivity, temperature, and turbidity
3. 14 groundwater samples from monitoring wells analyzed for microbial DNA.

***Historical Data***

1. cVOCs and geochemical results from a USGS 2015 report that were collected between 1996 and 2015.
2. Geochemistry data from 18 sampled points located upgradient and within the landfill footprint, and screened in the upper portion of the aquifer (5 to 17.5 ft bgs). Wells located downgradient and outside of the landfill footprint were screened in the intermediate portion of the aquifer (28 to 49 ft bgs) and excluded from this evaluation.
3. Analytical data include cVOCs, DOC, nitrate/nitrite, sulfate, methane, and chloride. Field measurements for DO, ORP, pH, sulfide and iron II were also available.

Nine of the groundwater monitoring wells used in this analysis were installed in 2019, and therefore, 2017 data from these locations are not available. This analysis primarily evaluates the 2019 data set and uses the 2017 data and historical data for comparison. Historical data sets consist of cVOCs and geochemical results that were assessed in the 2015 USGS report (USGS, 2015). Since the 2017 and 2019 data sets consist of samples from only the newly installed wells and only one to two data points per well are available, the robust historical data set of existing wells was included to frame the overall geochemical condition at the landfill. Additionally, the overall geochemical condition at the landfill was used to evaluate the microbial data, specifically at the northern and southern ends of the landfill.

Groundwater samples collected in 2017 and 2019 were analyzed for targeted cVOCs focused on the common parent compounds PCE and TCE and their associated breakdown compounds: 1,2-DCA, 1,1,1-TCA, chloroethane, 1,1-DCA, 1,1-DCE, cis-1,2-DCE, and VC. Groundwater samples collected in 2019 were additionally analyzed for dissolved gases (methane, ethane, and ethene), sulfide, chloride, DOC, and microbial population. Field geochemistry parameters were recorded at the time of sampling. The cVOC and dissolved gas concentrations, the geochemistry measurements, and the microbial analytical data were used to perform the cVOC biodegradation evaluation and are presented in Appendix H. The 2019 results are presented in graphs to visually aid and compare each parameter relative to other parameters.

Data used to evaluate biogeochemical conditions and draw conclusions are summarized below (Tables 3-5 through 3-8) and described in the following sections. Graphs of TCE and its degradation product (cis-1,2-DCE, trans-1,2-DCE, VC, and ethene) concentrations are plotted in molar concentrations for each well sampled (Appendix H) because the reductive dechlorination reaction is a one-to-one stoichiometric conversion (i.e., for each mole of TCE degraded, one mole of cis-1,2-DCE is produced). PCE is not included in these graphs because it is relatively rarely detected at the site, either because it was less commonly disposed of in the landfill or because it has largely degraded to TCE. The molar graphs were created as a visual aid to identify wells where considerable high concentrations were located, considerable concentration changes occurred between 2017 and 2019, and to help highlight where DCE stall is or is not occurring. The molar graphs present the TCE dechlorination pathway of TCE, DCE, VC, and ethene in the mole per liter (mol/L) unit. When available, both 2017 and 2019 data are presented in one graph for comparison. The graphs are presented on plan view maps of the site to allow a spatial comparison of degradation conditions at various areas of the site. Note that because the detected concentration ranges varied widely between analytes (2.1 µg/L to 260,000 µg/L for cis-1,2-DCE and 0.05 µg/L to 19,000 µg/L for VC), applying a similar concentration range or log axis was not practical for these graphs.

### 3.4.3 Biodegradation Evaluation

This section evaluates the data for cVOCs, indicators of natural attenuation and microbial populations.

***cVOCs***

The cVOCs most often detected in groundwater samples were TCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, and VC. In 2017, TCE, cis-1,2-DCE, and VC were identified as the key cVOCs at OU 1 because these three cVOCs frequently exceeded their PALs, and for every location where one of the other cVOCs exceeded its PAL, either TCE, cis-1,2-DCE, or VC also exceeded its PAL. In 2017, 23 monitoring wells were sampled and in 2019, 32 monitoring wells were sampled. Table 3-5 presents cVOC detection percentages for both the 2017 and 2019 sampling events. To account for limited data points available for North Plantation and Central Landfill areas, data evaluation is grouped into northern and southern portions of the landfill. Where northern portion consist of wells located within North Plantation and Central Landfill, and southern portion is the South Plantation. When comparing concentrations between 2017 and 2019, results from 16 South Plantation wells and seven Central Landfill wells were evaluated. Additional wells, three at South Plantation, one at Central Landfill, and five at North Plantation, were installed in 2019.

A general decrease in TCE and daughter products was observed in seven of the Central Landfill wells between 2017 and 2019 (an eighth well was installed in the Central Landfill in 2019). In the South Plantation, TCE, cis-1,2-DCE, and VC concentrations increased in three wells (MW1-56-12’, MW1-56-24’, and MW1-57-16’), and decreased in eight wells (MW1-49, MW1-50, MW1-54, MW1-55, MW1-57-32’, MW1-58-19’, MW1-58-35’, and MW1-60). Variability (both increase and decrease) in TCE and daughter product concentrations between 2017 and 2019 was observed in five out of the 16 South Plantation wells sampled in both 2017 and 2019 (MW1-57-10.5’, MW1-51, MW1-52, MW1-53, MW1-58-9’). In 2019, additional three monitoring wells were installed within South Plantation, where concentration comparison could not be performed.

At the Central Landfill, a general decrease in TCE and daughter product concentrations suggests that TCE degradation has been ongoing, and the groundwater biogeochemistry supported the degradation reactions. In the South Plantation, fluctuating cVOC concentrations between 2017 and 2019 are consistent with highly variable cVOC concentrations observed in the historical data set, which suggests that one or more fluctuating hydrogeologic or geochemical factors beneath the South Plantation are resulting in relatively rapid dissolved cVOC concentrations.

***Natural Attenuation Evaluation***

This section describes the analytes indicative of natural attenuation and biodegradation. Natural attenuation parameters measured in 2017 and/or 2019 were compared to historical concentration ranges when available. The 2017 and 2019 geochemistry results along with historical concentration ranges for each area from 1996 to 2015 are presented in Appendix H (USGS, 2015).

Samples collected in 2017 and 2019 were representative of newly installed wells within the landfill footprint at various depths within the aquifer, representing HSUs 1-4 described in Section 3.2. Historical samples collected from wells located within the landfill footprint were screened at shallow depths (5 to 17.5 ft bgs), and wells screened at deeper depths (28 to 49 ft bgs) were located downgradient from the landfill. Historical results from downgradient wells were not used because the data were not representative of conditions beneath the landfill.

Even though the wells sampled by the USGS were different from those sampled in 2017 and 2019, historical geochemistry results provided a concentration framework to evaluate whether the groundwater conditions of the new wells appear substantially different (within the same landfill area) and whether biodegradation activities are progressing towards complete dechlorination. USGS reported that concentrations of natural attenuation constituents in 2015 were consistent with concentrations reported since 1996, with DO levels all less than 1 milligrams per liter (mg/L); little to no detectable nitrate; commonly detected sulfide; abundant methane; and geochemistry concentrations in the South Plantation tending to vary from year to year. USGS suggested that groundwater conditions remained favorable for contaminant biodegradation. The 2017 and 2019 natural attenuation data were generally in line with USGS's historical concentration ranges, except sulfide, which was slightly higher in the new wells than in the existing wells. The USGS sulfide results were measured in the field rather than in the laboratory, which could contribute to lower concentrations reported. However, overall, sulfide concentrations were relatively low in the new wells (<0.6 to 2.2 mg/L) and also in the existing wells (<0.01 to 0.5 mg/L).

***Screening Indicators for Biodegradation***

Biodegradation potential was evaluated using monitored natural attenuation (MNA) parameters, such as DO, ORP, nitrate, nitrite, iron (II), sulfate, sulfide, methane, pH, DOC, and TCE daughter products, measured either in the field or the laboratory. The preliminary interpretation of the biodegradation potential of each well in the landfill area is summarized in Table H-2. The natural attenuation evaluation results were interpreted by comparing parameters against optimal ranges of values published in the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (U.S. EPA, 1998), which uses a weight of evidence approach in interpreting whether evidence of biodegradation is likely present at the time. Each field and analytical parameter is given points when certain criteria are met, and these points are tallied for each well. The tallied points are compared to specified ranges in order to interpret aquifer conditions as inadequate, limited, adequate, or strong evidence that biodegradation is occurring (U.S. EPA, 1998). Table 3-6 summarizes evidence of biodegradation for each well.

Based on Table 3-6, 21 of the 23 wells sampled in 2017 exhibited groundwater conditions that appeared less than adequate for active biodegradation to occur. However, the MNA parameters sulfide, ethene, methane, and DOC were not analyzed in 2017, contributing to biased low scores. In 2019, 30 wells were sampled for MNA parameters, groundwater conditions were generally adequate for biodegradation, with groundwater conditions in the Central Landfill and North Plantation apparently more conducive for biodegradation than the South Plantation. Note that more South Plantation data points were available for evaluation which highlighted data sets not within MNA parameter ranges and contributed to a perception that South Plantation is not as conducive to biodegradation. Chloride and DOC were analyzed in 2019, but these results did not contribute to the scoring; instead, the results were compared to the 2015 USGS concentrations to determine whether groundwater conditions have changed. Chloride detection is an indication of daughter products from organic chlorine and DOC indicates the presence of a carbon or energy source that drives dechlorination. Elevated chloride concentrations, when compared to a background concentration, are an indicator that chloride has been released from degraded chlorinated VOCs. The highest chloride concentration (150 mg/L) from the 2015 USGS data set was selected as the background benchmark. A greater than two times the background concentration (300 mg/L) is an indicator of an elevated concentration. The recent 2019 chloride concentrations in three northern and central landfill wells, MW1-43 (325 mg/L), MW1-44 (332 mg/L), and MW1-65 (380 mg/L), exceed two times the background value of 300 mg/L. The southern landfill wells were within the two times the selected "background" value. The DOC concentrations in three southern landfill wells, MW1-56-12' (37.5 mg/L), MW1-57-10.5' (25.7 mg/L), and MW1-58-9' (16.5 mg/L), exceeded the historical concentration range (0.7 to 10.5 mg/L). DOC was within the general historical range (5.3 to 23 mg/L) for all northern and central landfill wells.

***Metabolic Byproducts and Electron Acceptors***

Microbial mediated oxidation-reduction reactions consume available electron acceptors in the following natural order of progressive electron acceptor depletion:

1. DO
2. Nitrate
3. Iron (III) (non-dissolved)
4. Sulfate
5. Chlorinated solvents
6. Carbon dioxide

Through these biogeochemical processes, metabolic byproducts such as carbon dioxide, nitrite, iron (II) (which is soluble), hydrogen sulfide, and methane are produced. Evidence of byproducts suggests that the reductive state of the groundwater is conducive for the biodegradation process to further degrade chlorinated ethenes. The measurements of nitrate/nitrite, iron (II), sulfate, and methane offer insight into the primary terminal electron-accepting processes (TEAPs) related to microbial oxidative/reductive respiration (Parsons, 2004). Each sequential reaction drives the ORP of the groundwater downward into the range within which reductive dechlorination can occur.

For biological processes to dechlorinate DCE and VC, the ORP range is generally within -400 to -200 millivolts (mV) and is in sulfate-reducing and methanogenic conditions (methane production) (U.S. EPA, 1998). In 2019, ORP ranged from -241 to -31 mV in the North Plantation and Central Landfill wells and -230 to +253 mV in South Plantation wells. Sulfate-reducing conditions can be observed when sulfide is detected. A sulfide concentration greater than 1 mg/L is used as a screening criterion for evidence of biodegradation. Sulfide was reported at concentrations greater than 1 mg/L at all but three monitoring wells (MW1-50, MW1-57-16', MW1-65), with detected concentrations between 1 and 2.2 mg/L. The result from well MW1-44 was rejected and is not used in the analysis.

Methane was detected in all samples analyzed and exceeded the biodegradation screening criterion of 0.5 mg/L in 24 out of 30 samples analyzed for MNA parameters, suggesting that methanogenesis is occurring. Methane ranged from 0.39 to 19 mg/L in North Plantation and

Central Landfill wells and 0.0005 to 8.5 mg/L in South Plantation wells. It appears that a slight sulfate-reducing condition is present at the landfill, yet methanogenesis is occurring. When sulfide is produced as a result of sulfate reduction, but in the small quantity (between 1 to 2 mg/L) seen at OU 1, electron uptake competition between dechlorinating organisms and sulfate-reducing bacteria or methanogens can cause the dechlorination rate to be severely reduced, or to appear "stalled" (U.S. EPA, 1998).

Sulfate has been one of the often detected electron acceptors at OU 1, with sulfate concentrations fluctuating within a wide range both in the past and within the new wells. For example, at historical well MW1-41 (a North Plantation well), sulfate was reported from less than 0.300 mg/L to 30 mg/L between 2000 and 2001; at MW1-16 (a South Plantation well), sulfate ranged from 0.400 mg/L to 20 mg/L between 2005 and 2006 and from 88 to 8.6 mg/L between 2009 and 2010. At recently installed wells, sulfate concentrations fluctuated more widely in southern landfill wells than in northern landfill wells. South Plantation wells where sulfate fluctuated were MW1-58-35’ (from 1.25 to 44.8 mg/L), MW1-56-12’ (24.5 mg/L to 41.8 mg/L), and MW1-56-24’ (91 to 2.88 mg/L). In Central Landfill wells sulfate concentrations were similar between 2017 and 2019 in individual wells but varied between the wells (i.e., MW1-42 with sulfate ranging from <0.33 mg/L to 0.22 mg/L and MW1-46 with sulfate ranging from 52.5 mg/L to 65.5 mg/L). Fluctuating sulfate concentrations may disrupt the TEAP progress and create electron competition between dechlorinating microbes and sulfate-reducing bacteria. Microbial analyses were performed on select 2017 and 2019 groundwater samples, and these results are described below. Historically, sulfate concentrations fluctuated only in certain wells, while in other wells sulfate remained at consistently similar concentrations. Even though nitrate was detected in some 2017 and 2019 wells, concentrations have been mostly less than the screening criteria of 1 mg/L, indicating the presence of reductive dechlorination conditions.

***Microbial Analysis***

Fourteen groundwater samples collected in 2019 and 10 samples collected in 2017 were analyzed for microorganisms involved in the degradation of cVOCs using the QuantArray®-Chlor assay. Samples from the Central Landfill and the South Plantation were selected for microbial analysis. North Plantation samples were not analyzed for microorganisms. The QuantArray®-Chlor assay analysis quantifies specific genes that are important for cVOC degradation. Halorespiring bacteria known to use chloroethenes as electron acceptors to complete reductive dechlorination of PCE and TCE to ethene included: *Dehalobacter*, *Dehalococcoides (Dhc), Desulfitobacterium, Dehalogenimonas, Desulfuromonas,* and *Geobacter*. In addition, a suite of functional genes, such as VC reductase (*bvcA* and *vcrA*) and *Dehalogenimonas (Dhg)* chloroethene reductase gene (*cerA*) were examined. *Dhc* is the key genus to evaluate because of its ability to complete reductive dechlorination of TCE to ethene. Biodegradation literature suggests a concentration of $1 \times 10^4$ cells per milliliter (cells/mL) of *Dhc* could be used as a screening criterion to identify sites where active reductive dechlorination will yield a generally useful biodegradation rate (Lu et al., 2006). *Dhc* abundance exceeding 1 ×

$10^4$ cells/mL was reported only in four out of 14 samples in 2019 (Table 3-7; MW1-42, MW1-46, MW1-57-32', and MW1-58-9'), and no samples exceeded the *Dhc* screening criterion in 2017. The analytical results of targeted halorespiring bacteria (*Dehalobactor, Desulfitobacterium, Desulfuromonas,* and *Dhc*) and their functional genes (*vcrA*, *bvcA,* and *cerA)* are presented in Table 3-7.

Overall, the evaluation of microbial data indicated that bacterial counts were generally low at OU 1. Total *Eubacteria* counts ranged from $1.7 \times 10^3$ (MW1-51) to $1.6 \times 10^7$ cells/mL (MW1-48) in the groundwater samples and were used to gauge targeted halorespiring microbial abundance in comparison to the other microbial species often found in naturally attenuated chlorinated ethene plumes, such as sulfate-reducing bacteria and methanogens. Detections of *Dhc* and the functional genes *vcrA*, *bvcA,* and *cerA* suggest that microorganisms capable of dechlorinating TCE and PCE to ethene are currently present at the site. The percent composition of *Dhc*, sulfate-reducing bacteria and methanogens in the context of total Eubacteria are summarized in Table 3-7; the predominant microbe of the three consortiums is bolded. Because the presence of Dhc is minimal, limited dichlorination beyond cis-1,2-DCE is expected. The analytical data are consistent with this expectation.

Review of the percent abundance in Table 3-7 indicates that sulfate-reducing bacteria are more predominant in the Central Landfill than in the South Plantation, suggesting that groundwater conditions beneath the Central Landfill are slightly more sulfate-reducing. In the South Plantation area, dechlorinating microbes, including *Dhc*, sulfate-reducing bacteria, and methanogens, were predominant in different wells, suggesting that the fluctuating environmental conditions beneath the South Plantation are impacting the dechlorinating microbial process, impeding completion of the dechlorination progress. The most abundant microbial genus for each well were the same between 2017 and 2019, which confirms that natural attenuation at the site has remained similar and is unlikely to change in the future.

### *Biodegradation Summary and Conclusions*

At sites relying on MNA, performance assessment is typically conducted by measuring changes in contaminant concentration as a primary line of evidence. Geochemical and molecular biological analyses often supplement the assessment by serving as secondary and tertiary lines of evidence. Figures H-1 through H-3 presents comparative graphs of cVOC molar concentrations between 2017 and 2019, scoring graphs of the natural attenuation indicators (2019), and density graphs of the halorespiring microbes in relation to cVOC concentrations (2019). These graphs provide a visual indication of various lines of evidence used to evaluate the geochemical environment. The donut charts around each well show the relative proportion of the three key halorespiring microbes and the relative molar concentrations of the key chlorinated solvents TCE, cis-1,2-DCE, VC, and ethene. The radar plots illustrate the MNA scores for each MNA indicator, as extracted from the scoring criteria. Higher MNA scores are plotted closer to the perimeter of the graph, where lower MNA scores would indicate a dot in the middle of the graph (Appendix H).

Often conventional microbiology bench tools (MBTs), such as quantitative polymerase chain reaction or microarrays, are used to determine gene abundance and assess if specific microbial populations are present in the aquifer. However, conventional MBTs provide only a measure of targeted microorganisms and do not provide a holistic understanding of the microbial community. Evaluation of groundwater conditions for each landfill area using cVOC concentrations, geochemistry data, and microbial data is summarized below.

Overall, the MNA parameter concentrations, the limited dechlorinating microorganism populations, and cVOC molar concentrations of daughter products indicate that groundwater conditions at OU 1 are generally adequate for biodegradation to occur (Table 3-6) but are not optimal for completion of the dechlorination process from DCE and VC to ethene. Evidence supporting this apparent dechlorination stall at DCE/VC is summarized below:

- Decreased TCE, cis-1,2-DCE, and VC concentrations between 2017 and 2019 were observed in six of the seven Central Landfill wells sampled both years, and eight of the 16 South Plantation wells sampled both years, but an accumulation of cis-1,2-DCE and VC was found in 19 out of 23 wells sampled in 2017 and in 28 out of 32 wells sampled in 2019 (including the North Plantation wells).
- Evidence of biodegradation was observed across the landfill, based on the depletion of electron acceptors (DO, nitrate, sulfate, and chlorinated ethenes) in groundwater to below screening criteria. However, electron acceptors exceeding the screening criteria were observed in isolated areas of the site. Exceedances of the screening criteria occurred more frequently in the southern portion of the landfill than the northern portion.
- Evidence of reduced condition was observed in the wells where iron (II) and sulfide exceeded the screening criteria (i.e., sulfate-reducing conditions achieved). Again, southern wells were less reduced than northern wells. ORP results support the line of evidence that adequately reduced groundwater conditions exist at OU 1 with ORP measurements in 26 out of 32 wells having a value of less than -200 mV.
- Evidence of *Dhc* and their functioning genes (*vcrA*, *bvcA,* and *cerA)*, sulfate-reducing bacteria, and methanogens were only abundant in four out of 14 samples, and two of the four samples had *Dhc* that exceeded sulfate-reducing bacteria and methanogen population densities. This evidence suggests that sulfate-reducing bacteria and methanogens are competing with *Dhc* for electrons, which results in *Dhc* being dormant or less active in dechlorinating DCE and VC. Sulfate-reducing bacteria, iron-reducing bacteria, and methanogens have been documented to compete with *Dhc* for electron acceptors when sulfate, iron, and methane are present in the groundwater (Miao et al., 2012). This observation supports the tendency to accumulate cis-1,2-DCE and limit further dechlorination.

Based on lines of evidence, electron acceptors, specifically DO, iron and sulfate, need to be further reduced. From the well set sampled in both 2017 and 2019, only wells MW1-48 (Central), MW1-60 (Southern), and MW1-54 (Southern) were identified where TCE, cis-1,2-DCE, and VC either decreased to non-detect or was detected at less than 0.5 mg/L. Even though only two data points were available for evaluation, the framework for optimal biogeochemical conditions to meet or closely meet the PAL were identified. North Plantation wells were not evaluated because microbial and 2017 data were not available. At MW1-60 and MW1-54, targeted cVOCs decreased to non-detect, but these two wells are located outside of the landfill footprint where decreased contaminants may be due to migration rather than dechlorination. Based on the high ORP reading at MW1-54, suggesting non-reducing conditions, and a lack of microbial data to support a decrease in cVOC concentrations is due to bioactivity, MW1-54 data were not used for the evaluation. Data from MW1-60 were not used based on the well's location being further beyond the landfill and a lack of geochemical data. Instead, key biodegradation indicator data from two other wells, MW1-47 (Central) and MW1-58-19' (Southern), were selected for evaluation because TCE, cis-1,2-DCE, and VC decreased more than 80 percent between 2017 and 2019. On the contrary to when optimal conditions are observed, wells MW1-46 (Central) and MW1-58-9' (Southern) were selected to highlight when one of the key indicators do not meet the screening criterion, and an increase in TCE, cis-1,2-DCE, or VC was observed, suggesting a stalled condition. The key biodegradation indicators, DO, sulfate, sulfide (reduced sulfate), and iron (II) (reduced iron) concentrations are presented in Table 3-8 to highlight when screening criteria were met for optimal reduced conditions and how targeted cVOC concentrations are impacting OU 1.

Nitrate and nitrite were not included in the summary because no evident change in concentrations was noted. Electron acceptor concentrations have been shown to fluctuate more in the southern landfill than in the northern landfill area (see attached figures and the USGS historical data set in Table 3-8). The reducing conditions are not consistent over time or throughout the landfill and are not sufficiently reduced to support robust biodegradation activity to prevent accumulation of DCE and VC. Furthermore, potential sources in the vicinity of wells MW1-56, MW1-57, and MW1-66 are evident by high TCE concentrations (4,600 µg/L to 590,000 µg/L) and may continually be contributing TCE and daughter products into the groundwater.

The evidence of decreasing TCE and increasing daughter products at OU 1, along with evidence of reduced conditions and the presence of measurable halorespiring microbes , sulfate-reducing bacteria, and methanogen concentrations suggests that dechlorination reactions are ongoing. However, the limited presence of Dhc, the contributing source located in the eastern portion of the South Plantation, and the fluctuating DO, iron, and sulfate beneath the landfill, are contributing to the accumulation of DCE and VC. Additional data of key biogeochemical parameters from the existing and recently installed wells should be collected to further support this evaluation.

## 3.5 PCB EXTENT

This section describes the extent of PCBs at OU 1 based on data collected between 2017 and 2022 during the source investigation effort. Additional PCB investigation was performed in 2021 in support of a revised risk assessment and future LTM (Navy, 2022c; Navy 2022d). This additional investigation will be reported in detail as part of the revised risk assessment under separate cover.

This section first reiterates the PCB-related elements of the CSM (see Section 3.1), and then provides a more detailed analysis of the PCB data supporting the CSM. Much of the content of this section was previously provided to the project team in the 2021 draft PCB technical memorandum (Navy, 2021c). Comments received on that draft memorandum are incorporated into this section.

### 3.5.1 Summary of PCB Extent

PCBs as Aroclors are listed as a COC in the ROD for groundwater, surface water, sediment, and shellfish tissue. Historical PCB data supplemented with data collected in 2017 and 2019, including both Aroclor and congener data, indicate that total PCB Aroclor concentrations at OU 1 in soil beneath the North Plantation at depths ranging from 5 to 13 ft below the landfill surface exceed the PALs established in SAPs. Total PCB concentrations (total Aroclors and total congeners) detected in groundwater were below the MTCA Method B Cleanup Level for drinking water, with results from two wells exceeding the MTCA Method B Cleanup Level for surface water. The screening levels selected for comparison to site data are the subject of on-going discussions between the Navy and regulator/stakeholder groups as part of the updated risk assessment.

Soil and groundwater sample results imply that elevated PCB concentrations are widespread in soil within the landfill waste body from at least the middle of the North Plantation and northward (Figure 3-5; Navy, 2022c). Although in general PCBs exhibit a low solubility and do not transport readily in groundwater, the 2019 data indicate that PCB transport in groundwater at this site may be an important mechanism, with oil-range petroleum serving to facilitate PCB transport both laterally and vertically. The detection of PCBs in wells installed in 2022 to investigate the vertical extent of COCs at the site may indicate downward transport of PCBs at greater depth and over a wider portion of OU 1 than previously understood. However, as noted below, these results from the deeper wells may be misleading and may not represent actual PCB concentrations in the aquifer at the depths explored.

Seep water sampling results, and the results of ISM sampling of sediment in the reach of Marsh Creek downstream of the seep indicate that there is an ongoing contribution of PCBs to surface water from groundwater (Figure 3-5; Navy, 2022f).

### 3.5.2 Data Used in the PCB Extent Evaluation

Data included in the evaluation presented in this section consist of the following:

***2017 Data***

- Soil and grab groundwater samples collected in the North Plantation were analyzed for PCB Aroclors, with three of the soil samples also analyzed for PCB congeners.
- Sediment samples at four historical sampling locations and one new sampling location, all to the northwest of the North Plantation, were analyzed for PCB Aroclors and PCB congeners.
- Passive samplers were used to analyze PCB congeners in porewater and surface water to the northwest of the North Plantation and in groundwater in the northern portion of the North Plantation.

***2019 Data***

- Soil and grab groundwater samples collected in the North Plantation were analyzed for PCB Aroclors and PCB congeners.
- Groundwater samples collected from monitoring wells installed in 2019 and two existing monitoring wells in the North Plantation were analyzed for PCB congeners.
- Porewater and surface water samples from three new 2019 sampling locations to the northwest of the North Plantation were analyzed for PCB congeners.

Sediment samples at five historical sampling locations and two new 2019 sampling locations, all to the northwest of the North Plantation, were analyzed for PCB Aroclors and PCB congeners.

***2021 Data***

- Sediment sample results from the reach of Marsh Creek from seep SP1-1 to the tide gate collected and analyzed utilizing ISM techniques, with the reach of Marsh Creek divided into three DUs as established in the SAP (Navy, 2021a). These data were reported in a final technical memorandum following incorporation of comments from the project team (Navy, 2022d, and attached as Appendix E).
- Soil samples collected from the upper 6 ft of soil in the northern portion of the landfill in support of risk assessment planning. These data were reported in a final technical memorandum following incorporation of comments from the project team (Navy, 2022c).

***2022 Data***

- Soil samples collected in the North Plantation were analyzed for PCB Aroclors and PCB congeners.
- Groundwater samples collected from new monitoring wells in the North Plantation, Central Landfill, South Plantation, and on the Highway 308 causeway were analyzed for PCB Aroclors and PCB congeners.

Data summary tables for 2017 sampling data are provided in Appendix I and 2019 sampling data are provided in Appendix B. These tables are updated from the equivalent tables provided to the project team in the 2021 draft PCB technical memorandum (Navy, 2021c). This section also evaluates concentrations of total petroleum hydrocarbons (TPH) along with PCBs to test the hypothesis that the presence of TPH (“oil”) may be increasing the mobility of PCBs in groundwater. TPH data obtained in 2019 are included in Appendix B. All PCB sampling locations in the vicinity of the North Plantation are shown on Figure 3-15 along with a summary of the PCB results from 2017 and 2019. PCB results from the ISM sampling of Marsh Creek sediment are presented in the final technical memorandum covering this work (Navy, 2022d; Appendix E). PCB results from the shallow soil samples collected in and around the North Plantation in support of the risk assessment are presented in the final technical memorandum covering this work (Navy, 2022c ). PCB results in soil and groundwater samples from deep wells installed in 2022 are presented in Appendix B.

Sampling methodologies and approaches for each of the data sets used in this Section 3.5 are detailed in the following documents:

***2017 Data***

- Site recharacterization SAP (Navy, 2017a)
- Site recharacterization report (Navy, 2018b)

***2019 Data***

- Source investigation SAP (Navy, 2019b)
- Appendix B of this supplemental RI

***2021 Data***

- PCB and upland soils investigation SAP (Navy, 2021a)
- Final memorandum covering ISM sampling of PCBs in sediment (Navy, 2022d)

- Final memorandum covering upland shallow soil (Navy, 2022c)

*2022 Data*

- Vertical extent investigation and aquifer performance testing SAP (Navy, 2022a)
- Appendix B of this supplemental RI

### 3.5.3 Concentrations of 2019 and 2022 PCBs and TPH with Respect to Cleanup Levels

This section provides a narrative summary of the 2019 and 2022 results of PCB and TPH analysis in soil and groundwater samples compared to cleanup levels used as PALs in the most recent SAP approved by the project team (Navy, 2021a). Equivalent narrative summaries of data collected in 2017 and 2021 were included in previous reports (Navy, 2021c; Navy, 2022d) and are not repeated in the body of this supplemental RI report. PCB data collected in 2017 are presented in Appendix I and 2019 through 2022 are presented in Appendix B.

Overall, all PCB concentrations in groundwater were below the MTCA Method B Cleanup Level for drinking water, with results from two wells exceeding the MTCA Method B Cleanup Level for surface water. In soil, exceedances of the EPA residential regional screening level for PCBs in soil (230 µg/kg) were all in samples collected from within the waste body of the landfill, less than 13 ft from the landfill surface elevation (note that in some areas sampled, ground surface is above the landfill surface because of a pile of construction debris soil later placed on top of the landfill).

***Soil***

The 2019 results of PCB and TPH analysis of soil samples are compared on Figure 3-16 and can be summarized as follows:

- Total PCBs as Aroclors in soil exceeded the PAL established in the SAP in eight samples, from eight different boring locations, at depths ranging from 5 to 20 ft bgs.
- Total PCBs as congeners in soil exceeded the PAL established in the SAP in one sample, at a depth of 6 ft bgs.
- TPH in soil exceeded the PAL established in the SAP in one sample from NP-B119 at a depth of 12 ft bgs.
- When compared to the MTCA Method B cleanup level for saturated soil protective of groundwater (17 µg/kg), all of the detected PCB concentrations in shallow soil, and the typical reporting limit (25 µg/kg) for these samples, exceed this cleanup level (which is substantially lower than the soil PAL of 500 µg/kg established it the investigation SAP).

During drilling of deep well bores for investigation of vertical extent in 2022, soil samples collected from the two well bores drilled within the North Planation (MW1-72 and MW1-73) were analyzed for PCBs as Aroclors and as congeners and the results can be summarized as follows:

- Total PCBs as Aroclors and as congeners were detected only in the shallowest soil samples from each well bore, 7 ft bgs in both borings. PCBs were not detected as Aroclors or congeners above the limit of quantitation (LOQ) in the deeper soil samples from these borings, in the depth range of 30 to 100 ft bgs.
- In the well bore for well MW1-72, the PCB detection in the soil sample from 7 ft bgs was quantified as Aroclor 1254 and exceeded the PAL for both the MTCA Method B cleanup level and the cleanup level for total PCBs.
- In the well bore for well MW1-73, the PCB detection in the soil sample from 7 ft bgs was quantified as Aroclor 1248 and exceeded the PAL for the MTCA Method B cleanup level for total PCBs (there is no specific MTCA Method B cleanup level for Aroclor 1248).
- When quantified as PCB congeners, total PCBs in the soil samples from 7 ft bgs in both of these well bores exceeded the MTCA Method B cleanup level for saturated soil protective of groundwater (note that this standard is based on total Aroclor analysis).

***Groundwater***

The 2019 results of PCB and TPH analysis of groundwater samples are compared on Figure 3-16 and can be summarized as follows:

- PCBs as Aroclors were not detected in any groundwater sample above the limit of detection (LOD) of 0.008 μg/L.
- Total PCBs (congeners) were detected in the groundwater samples from all four wells sampled. The result in shallow well MW1-67 exceeded the MTCA Method B cleanup level for surface water (7 picograms per liter [pg/L]).
- TPH in groundwater exceeded the PAL in two grab groundwater samples at screened intervals of 28 to 32 ft bgs and 10 to 15 ft bgs.
- TPH in groundwater exceeded the PAL in three monitoring well groundwater samples; two wells with screened intervals of 15 to 25 ft bgs and one well with a screened interval of 5 to 15 ft bgs.

The installation and sampling of deep wells for investigation of vertical extent in 2022 included the analysis of groundwater samples from all seven wells installed for PCBs as Aroclors and as congeners and the results can be summarized as follows:

- PCBs as Aroclors were detected in the groundwater sample from one well, MW1-71, at a concentration exceeding the MTCA Method B Cleanup Level for the protection of surface water. PCBs as Aroclors were not detected above the LOD in the remaining six deep wells.
- PCBs as congeners were detected above the LOD in the groundwater samples from all seven deep wells installed in 2022. Total PCBs as congeners in all of these samples exceeded the MTCA Method B cleanup level for protection of surface water. However, only the concentration in well MW1-71 exceeded the MTCA Method B cleanup level for drinking water.

### 3.5.4 PCB Data Evaluation

This section evaluates the PCB data with regard to nature and extent and fate and transport.

***Nature and Extent***

The focus of PCB investigations at OU 1 have been in the vicinity of seep SP1-1 (Figure 3-5), which has consistently exhibited PCBs in seep water discharging to Marsh Creek. Investigations have assessed PCB concentrations in wetland media, as well as in soil and groundwater upgradient of the seep (generally the vicinity of the northern portion of the North Planation). As investigations evolved, PCB results for more southerly portions of OU 1 led to an interpretation of limited PCB sources in these southerly areas.

The 2019 soil and groundwater investigations assessed the potential for PCB hotspots within the landfill footprint upgradient of the seep, and supplemented historical data documenting PCBs in marsh porewater, surface water, and sediment. Much of the nature and extent and fate and transport assessments rely on these 2019 data, supplemented by 2017 data and historical data.

Supplementary information regarding the nature, extent, fate, and transport of PCBs at OU 1 include the ISM sampling of PCBs in the reach of Marsh Creek from seep SP1-1 to the tide gate (Navy, 2022d), and upland shallow soil sampling performed in support of risk assessment planning (Navy, 2022c).

General Observations:

- The co-located presence of relatively high TPH concentrations and high PCB concentrations in soil generally does not result in detectable PCB concentrations as Aroclors in groundwater (i.e., NP-B120-S-12.5-190624, NP-B121-S-05-190620, NP-B122-S-09-190620, NP-B124-S-14-190620, NP-B125-S-20-190619, and NP-B1244-S-10-190620). PCBs as Aroclors were not detected in groundwater, other than the sample from deep well MW1-71 in 2022 (this detection is discussed further below).

- PCBs as congeners were detected in groundwater in co-located shallow and deep well pairs MW1-2/MW1-64 (total depths [TDs] of 17.5 ft and 55 ft bgs) and MW1-67/MW1-65 (TDs of 15 ft and 63 ft bgs).
- PCBs as congeners were also detected in well MW1-18 (44 pg/L; 0.000044 µg/L) at a higher concentration than measured in shallow well MW1-2, but lower than that measured in deep wells MW1-64 and MW1-65. MW1-18 is located approximately 100 ft north of boring NP-B125 (Figure 3-5) and is screened at a depth of 12 to 17 ft bgs, similar to wells MW1-2 and MW1-67. This detection of PCBs in well MW1-18 and the elevated concentration of PCBs in shallow soil at location NP-B125 installed cross-gradient between MW1-67/MW1-65 and MW1-18 implies that the area of elevated PCB concentrations in soil may be larger than assumed during planning of the 2019 investigation and may extend at least as far north as well MW1-18. The upland shallow soil investigation performed in 2021 (Navy, 2022c) further supports the more widespread presence of PCBs in shallow soil, although these shallow data (no deeper than 6 feet bgs) do not provide a comprehensive assessment of the distribution of PCBs. In this 2021 data set, PCBs were detected at concentrations greater than the PAL of 230,000 pg/g in shallow soil near MW1-18 at locations NP-B154, NP-B166, NP-B167, NP-B169, and NP-B172.
- PCBs as congeners were also detected in all seven deep wells installed in 2022, with total well depths ranging from 52 to 100 ft bgs. These detections are discussed further below.
- The highest PCB concentrations in soil are co-located with nearly the highest TPH concentrations in soil (NP-B121, Figure 3-5), which are also co-located with the highest PCB congener concentrations in shallow groundwater, and nearly the highest TPH concentrations in shallow groundwater (MW1-67).
- With one exception (NP-B125), TPH does not appear to have migrated from shallow soil to deep soil. However, TPH was detected in deeper groundwater samples collected from NP-B119 (28 to 32 ft bgs), NP-B120 (46 to 50 ft bgs), NP-B121 (31 to 35 ft bgs), MW1-64 (45 to 55 ft bgs), and MW1-65 (53 to 63 ft bgs). TPH in soil generally does not migrate tens of ft downward below first water; therefore, concentrations of TPH in groundwater in the deep well supports the hypothesis that TPH and PCBs are being transported laterally from upgradient areas at depth (as opposed to vertically at the locations listed in this bullet).
- TPH results are used in this evaluation as an indicator of the presence of oils that could enhance the migration of PCBs. The TPH LOD is high relative to the LOD for PCB congeners, and concentrations of oily substances below the TPH LOD might still enhance PCB transport.

- The ISM sampling of sediment for PCBs in the reach of Marsh Creek from seep SP1-1 to the tide gate (Navy, 2022d) documents that PCBs are present throughout this reach of creek at concentrations that exceed the RGs established in the ROD.
- The upland shallow soil sampling performed in support of risk assessment planning (Navy, 2022c) documented the presence of PCBs in soil throughout the northern portion of OU 1. In these shallow samples (0 to 6 ft bgs), exceedances of the EPA residential regional screening level for PCBs in soil (230 µg/kg) were nearly all in samples collected from within the waste body of the landfill. Exceedances were all from locations west of the approximate former shoreline (Figure 1-2) where waste is more likely to have been placed. Except for one location (NP-B154) exceedances were at locations drilled on the landfill surface, rather than on the hill formed of construction debris soil later placed on top of the landfill.

Table 3-9 shows soil and groundwater data for PCBs and TPH in the shallow and deep well pairs described below. Table 3-10 shows soil and grab groundwater data for PCBs and TPH collected from borings in the North Plantation. A graphical comparison of PCB and TPH concentrations in soil and groundwater organized by geographic area and depth below ground surface is provided in Figure 3-17.

<u>MW1-67 / MW1-65 Well Pair.</u> Co-located with shallow well MW1-67, deep well MW1-65 exhibits a moderate PCB congener concentration in groundwater (263 pg/L), and a relatively low TPH concentration in groundwater (48 J pg/L), but MW1-65 also exhibits relatively low PCB concentrations in soil and no detectable TPH in soil. This result seems to more likely indicate local downward transport of PCBs and TPH in groundwater at this location, rather than dissolution of PCBs from soil at depth.

An intermediate, 2-ft thick silt layer (relatively thin) was observed at this location from 33 to 35 ft bgs, and the well pair implies a downward vertical gradient of 0.019. Both of these conditions are conducive for downward transport of contaminants in groundwater.

<u>MW1-2 / MW1-64 Well Pair.</u> At well pair MW1-2 (shallow) and MW1-64 (deep), PCBs as congeners were detected at higher concentrations in deep groundwater than in shallow groundwater. Similar concentrations of TPH were detected in both deep groundwater (270 µg/L) and shallow groundwater (320 µg/L) at this location (TPH was not analyzed for in the shallow monitoring well; however the TPH concentrations were detected in shallow grab groundwater from boring NP-B120, 11 to 15 ft bgs in this area). This could indicate either lateral migration of PCBs in groundwater from upgradient areas, or a depleted shallow source after vertical migration to deeper groundwater at the MW1-2/MW1-64 location.

An intermediate, 1-ft thick silt layer was observed at this location from 45 to 46 ft bgs, which was not observed at NP-B120 to a completion depth of 49.5 ft bgs. This well pair implies an upward vertical gradient of 0.015.

***Analysis of Total PCB Detections by Homolog.***

Total PCB congener detections in soil and groundwater were differentiated by homolog (i.e., total number of chlorine atoms) and are shown in Tables 3-11 and 3-12. Note that more highly chlorinated PCBs are less soluble in water than less chlorinated PCBs.

Observations and conclusions taken from this analysis are provided below:

- The overall distribution of PCB detections versus homologs generally mirrors the distribution of chlorine in all PCB congeners/homologs.
- From MW1-2 (shallow) to MW1-64 (deep), lowest-chlorine PCBs are detected in deep groundwater that were not detected in shallow groundwater, and highest-chlorine PCBs detected in shallow groundwater were not detected in deep groundwater. TPH concentrations in soil decrease to non-detect with depth but stay relatively constant in groundwater. In shallow soil collected from the MW1-2 location (NP-B120), a high concentration of Aroclor-1016 was detected (16,000 µg/kg), which is largely made up of lower-chlorine congeners. This evidence supports the idea that the presence of PCBs at depth are from dissolution at upgradient areas followed by lateral migration, rather than shallow dissolution and vertical migration from above at the MW1-2/MW1-64 location.
- Deep soil samples collected from the MW1-65 and MW1-64 locations have similar mid-range congener assemblages. This could possibly indicate lateral transport in groundwater from MW1-65 to MW1-64 at depth, with sorption onto soil.
    - Some lower-chlorine PCBs in deep groundwater at MW1-64 were not detected in deep soil at this location (NP-B137). This, along with the fact that TPH was not detected in deep soil, supports the idea of transport of contaminants in groundwater versus dissolution from a local source in soil.
    - Certain PCBs (both low-chlorine and high-chlorine PCBs) present in deep groundwater at MW1-65 were not detected in deep soil at this location (NP-B138). This, along with the fact that TPH was not detected in deep soil, supports the idea of transport of PCB in groundwater.
- From MW1-67 (shallow) to MW1-65 (deep), there is generally a similar distribution of congeners from shallow to deep, with a decrease in detections of every homolog type. TPH was detected at a high concentration in shallow soil, then decreases to non-detect with depth. TPH was detected at a high concentration in shallow groundwater, then decreases, but is still present, in deep groundwater. This evidence supports the

interpretation that TPH and PCBs are moving together in groundwater; however, it should be noted that concentrations of PCBs detected in deeper groundwater samples were below the PAL and below the Aroclor detection limit.

***Fate and Transport***

Although in general PCBs exhibit a low solubility and do not transport readily in groundwater, a groundwater to surface water transport pathway is clearly demonstrated by the consistent detection of PCBs in groundwater seep samples from SP1-1 as it discharges to Marsh Creek. The results of ISM sampling of Marsh Creek sediment for PCBs in the reach from seep SP1-1 to the tide gate (Navy, 2022d) implies that this transport pathway is on-going, considering that cleanup of this reach of creek was previously remediated in the 1990s. The investigation of shallow upland soil near the seep (Navy, 2022c) demonstrated the relatively widespread occurrence of PCBs in shallow soil in the vicinity of the seep, which could also result in overland flow transport of PCBs in runoff to Marsh Creek. This overland flow pathway is hypothetical and has not been verified with testing.

The analysis of PCB and TPH concentrations in paired deep and shallow wells in the *nature and extent* section above also indicate that PCB transport in groundwater at this site may be an important mechanism, with oil-range petroleum serving to facilitate PCB transport both laterally and vertically. The subsections below assess evidence for and against two possible transport pathways:

1. Shallow dissolution of PCBs then vertical migration to deeper groundwater
2. Lateral migration of PCBs in deep groundwater from upgradient areas

Both of these transport pathways are likely present at the site. For lateral transport in deeper groundwater (e.g., HSUs 2 and 3), vertical transport of PCBs must first occur from a shallow source within HSU 1 within the landfill footprint.

The detection of PCBs in wells installed in 2022 to investigate the vertical extent of COCs at the site may indicate downward transport of PCBs at greater depth and over a wider portion of OU 1 than previously understood. An evaluation of these results is also presented below.

Evidence for Shallow Dissolution of PCBs then Vertical Migration to Deeper Groundwater.
1. Occurrences observed at MW1-67/MW1-65 location, including:

    - MW1-65 (deep well) exhibits the a moderate PCB congener concentration in groundwater, and a relatively low TPH concentration in groundwater, but no detectable TPH in soil and relatively low PCB concentrations in soil.

- The silt layer observed at this location was relatively thin (2 ft thick) and the well pair implies a downward vertical gradient of 0.019. Both of these conditions are conducive for downward transport of contaminants in groundwater.
- Similar distribution of PCB congeners/homologs from shallow to deep (soil and groundwater).
- Certain PCBs (both low-chlorine and high-chlorine PCBs) present in MW1-65 groundwater (deep) were not present in deep soil.

2. TPH is present in both shallow and deep groundwater.

Evidence for Presence of PCBs in Deep Groundwater due to Lateral Migration from Upgradient Areas.

1. TPH detected in shallow soil and shallow and deep groundwater, but not detected in deep soil: TPH in soil generally does not migrate tens of feet downward below first water; therefore, concentrations of TPH in groundwater in the deep well supports the idea that TPH and PCBs are being transported laterally at depth (as opposed to vertically), perhaps following the plunging paleochannel (Appendix C; Figure C-14) observed to influence the migration of cVOCs.
2. Occurrences observed at MW1-2/MW1-64 location, including:
    - PCBs as congeners were detected at higher concentrations in deep groundwater than in shallow groundwater. Similar concentrations of TPH were detected in both deep groundwater (270 µg/L) and shallow groundwater (320 µg/L) at this location (TPH was not analyzed for in the shallow monitoring well; however, the TPH concentrations were detected in shallow grab groundwater from boring NP-B120, at 11 to 15 ft bgs in this area). Conversely, this could also signify a depleted shallow source after local vertical migration to deeper groundwater.
    - Lowest-chlorine PCBs detected in deep groundwater are not detected in shallow groundwater, and highest-chlorine PCBs detected in shallow groundwater are not detected in deep groundwater. TPH concentrations in soil decrease to non-detect with depth but stay relatively constant in groundwater. In shallow soil collected from the MW1-2 location (NP-B120), a high concentration of Aroclor-1016 was detected (16,000 µg/kg), which is largely made up of lower-chlorine congeners.
3. Deep soil samples collected from the MW1-65 and MW1-64 locations have similar mid-range congener assemblages.

**PCB Fate and Transport Implications of 2022 Deep Well Results.** As described in detail in Appendix B, PCBs as congeners were detected in all of the seven wells installed in 2022 to assess the vertical extent of COCs beneath OU 1. PCBs as Aroclor 1254 were also detected in well MW1-71 but were not detected above the LOD in the other six wells (the analysis for PCBs as Aroclors has an elevated LOD compared to the congener analysis). These results are not consistent with the expected fate and transport of PCBs at the site, and this supplemental RI recommends verification of these detections through additional sampling prior to drawing conclusions based on these results (Section 4). One interpretation of these results is that PCBs have been transported downward vertically from shallow sources in the landfill waste body into deep groundwater within native geologic formations. However, several lines of evidence indicate that this interpretation might not be correct and that the results may not represent actual PCB concentrations in the aquifer at the depths explored.

- Analysis for PCBs as congeners and as Aroclors were included for soil samples from the well bores for the two wells installed in the North Plantation, where PCBs were known to be present in the landfill waste body. Consistent with historical results, PCBs were detected in the soil samples from 7 ft bgs (within the waste body). However, PCBs were not detected in any of the remaining nine to 10 samples per boring down to the TD explored. This includes soil samples from within the screened intervals of these two wells (MW1-72 and MW1-73). If PCBs are present in the groundwater at these locations, it is reasonable to expect some detectable PCB concentrations in soil samples from the same depth, since PCBs tend to sorb to soil.
- The groundwater sample from well MW1-71 in the Central Landfill exhibited the highest concentrations of PCBs in groundwater, though past investigations have not indicated substantial PCB concentrations in the waste body in this area. In contrast, cVOCs were not detected in the groundwater sample from this well, but are known to be present in shallower groundwater and this location at high concentrations, and are typically much more mobile than PCBs.
- During sampling of the two wells on the Highway 308 causeway (MW1-74 and MW1-75), where PCBs have not previously been reported, PCB concentrations were reported in a field equipment blank generated by pumping laboratory-grade distilled water through new sampling tubing using a peristaltic pump. The PCB concentrations in this equipment blank were reported as higher than those in the groundwater samples from the causeway wells.

Other than transport from the waste body, other possible explanations for PCBs in the groundwater samples from deep wells include:

- Carry down of contaminants during drilling
- Laboratory cross-contamination
- Field sampling cross-contamination or introduction from sampling supplies (e.g., distilled water, tubing)

Each of these potential explanations was evaluated and each appeared to have a low probability of occurrence and to lack supporting evidence. The Navy plans future additional well development and resampling of these wells to verify or refute the results.

## 3.6 NUMERIC GROUNDWATER MODELING

A planning-level source and plume remediation model, REMChlor-MD, was used to assess the potential long-term, plume-wide effects of targeted remediation of high-concentration residual source areas at OU 1. The full modeling report is attached as Appendix F.

REMChlor-MD uses several simplifying assumptions, such as one-dimensional groundwater flow, but accounts for key groundwater fate and transport processes such as advection, dispersion, sorption, matrix diffusion, and the impact of remediation measures to the source and/or the plume. One REMChlor-MD model was developed for each of four areas of interest at OU 1 and calibrated to actual site data. The matrix diffusion modeling runs (all runs except Run 1 at each model location) included matrix diffusion in both the source and the plume downgradient of the source, i.e., matrix diffusion processes were considered present within the entire modeling domain. Run 1 at each site assumes there is no matrix diffusion in the plume. These models demonstrate the importance and impact of matrix diffusion on persistent plumes at these areas of interest by showing that many decades (or even centuries) might be required to achieve RGs even with complete high-concentration source removal.

The high-concentration source areas where modeling was performed are termed “hotspots” for ease of reference and consist of the following (see figures in Appendix F):

- South Plantation Eastern Hotspot – located along the eastern edge of the South Plantation adjacent to Bradley Road
- South Plantation Western Hotspot – located near the western edge of the landfill near the point of historical high concentrations of cVOCs in wetland surface water
- Central Landfill Hotspot – Located in roughly the center of the paved portion of the landfill, approximately midway between Bradley Road on the east and the western edge of the landfill

The modeling results for each of these areas are reiterated below, with a full description included in the figures included in Appendix F.

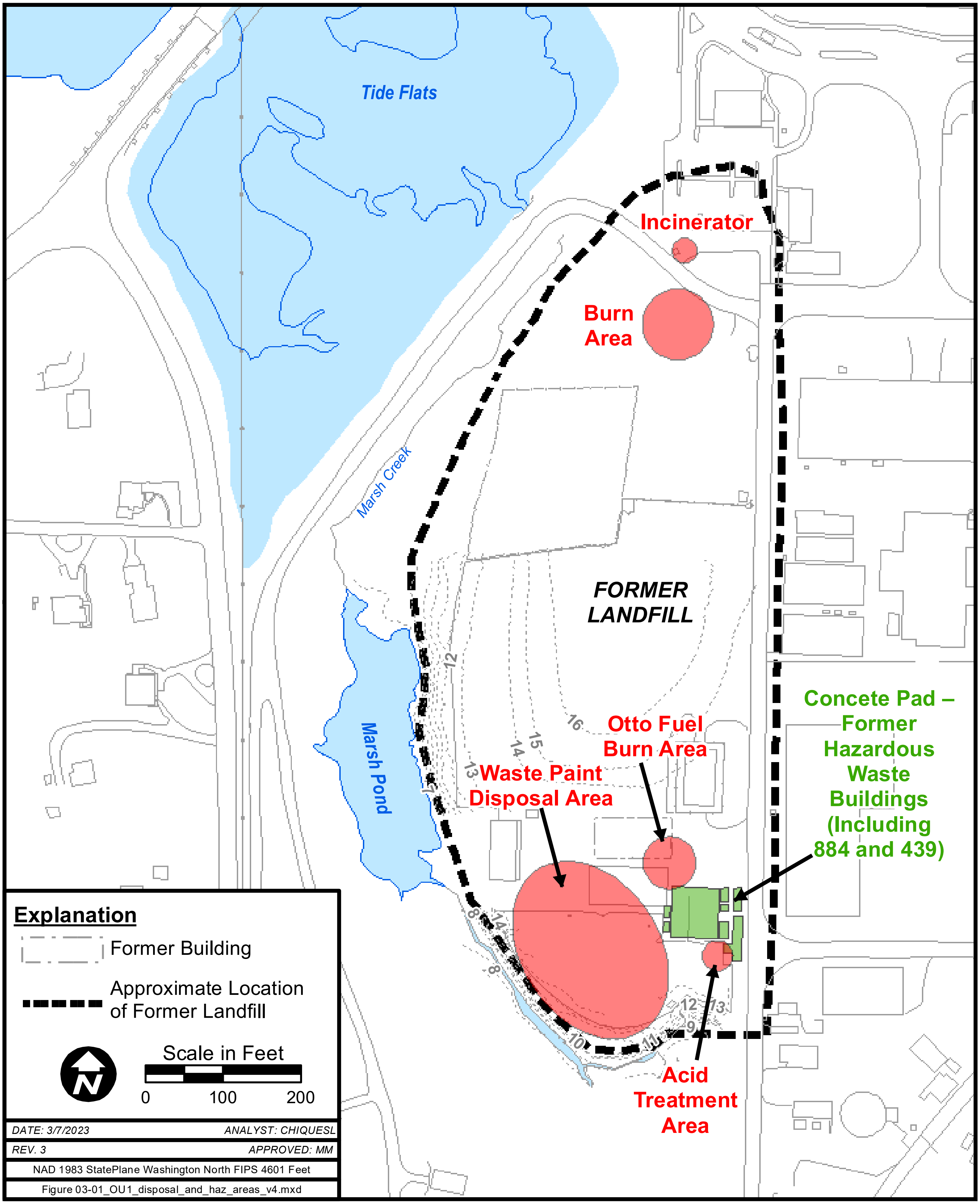
Overall, the impacts of matrix diffusion effects make the contaminant mass remaining in low-k zones difficult to treat because remediation amendments (e.g., for chemical oxidation or bioremediation) cannot be easily delivered to and distributed throughout lower permeability soils such as silts and clays. These planning-level model runs suggest that matrix diffusion processes reduce the effectiveness of even complete source remediation for the cleanup of downgradient plumes. Even if the hotspots are thoroughly remediated (e.g., with an in-situ treatment or excavation), the same reduction in concentration is not observed in the plume downgradient of the hotspots (i.e., a 90% reduction in source concentrations does not result in a 90% reduction in the downgradient plume concentrations). It is possible that the concentrations of plumes like the ones at NBK Keyport may "hover" just above the RGs at single-digit, part-per-billion concentrations for many decades due the effects of on-going matrix diffusion processes.

South Plantation Eastern Hotspot. Planning-level REMChlor-MD computer modeling of the South Plantation eastern hotspot showed that the target cVOCs (TCE, cDCE, and VC) are likely to persist for many decades. Modeling runs suggested that even with complete isolation of the identified source zone with a passive reactive barrier (PRB) in 2025, an additional **~150 year**s from the year 2025 would be required to permanently reach the VC (the most conservative cVOC of interest) RG at the plume boundary at the marsh as a result of matrix diffusion effects. At the stream bank downgradient of the eastern hotspot, an additional **~140 years** from the year 2025 might be needed to permanently reach sub-RG concentrations for VC in groundwater.

South Plantation Western Hotspot – Modeling Results. At the South Plantation western hotspot, planning-level modeling showed that the target cVOCs (TCE, cDCE, and VC) may persist for centuries. The modeling runs suggested that even with complete isolation of the source with a PRB in 2025, an additional **~400 years** from the year 2025 might be required to permanently reach the VC (the most conservative cVOC of interest) RG at the plume boundary due to matrix diffusion effects.

Central Landfill cVOC Plume – Modeling Results. REMChlor-MD models of the Central Landfill cVOC plume showed that the target cVOCs (TCE, cDCE, and VC) may persist for centuries. The modeling runs suggested that even with complete isolation of the source with a PRB in 2025, an additional **~200 years** from the year 2025 might be required to permanently reach the VC (the most conservative CVOC of interest) RG at MW1-25 due to matrix diffusion effects.

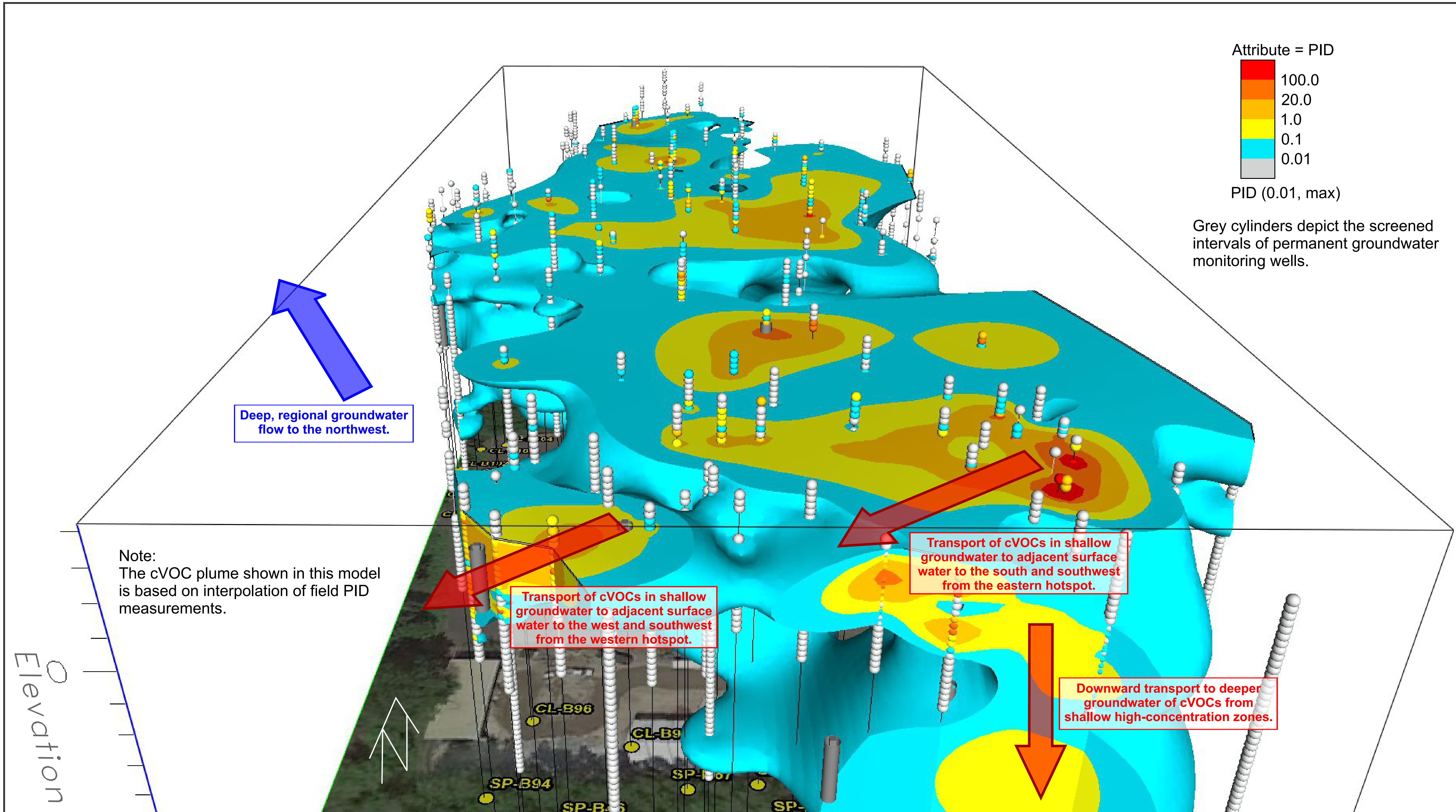
Central Landfill 1,4-Dioxane Plume – Modeling Results. At the Central Landfill, REMChlor-MD modeling of the 1,4-dioxane plume showed that the plume is likely to persist for decades. The modeling runs suggested that even with complete isolation of the source with a PRB in 2025, an additional **~36 years** from the year 2025 might be required to permanently reach the RG at MW1-25 due to matrix diffusion effects.




**U.S. NAVY**

**Figure 3-1**
**Historical Waste Management Activities at the Former Landfill**

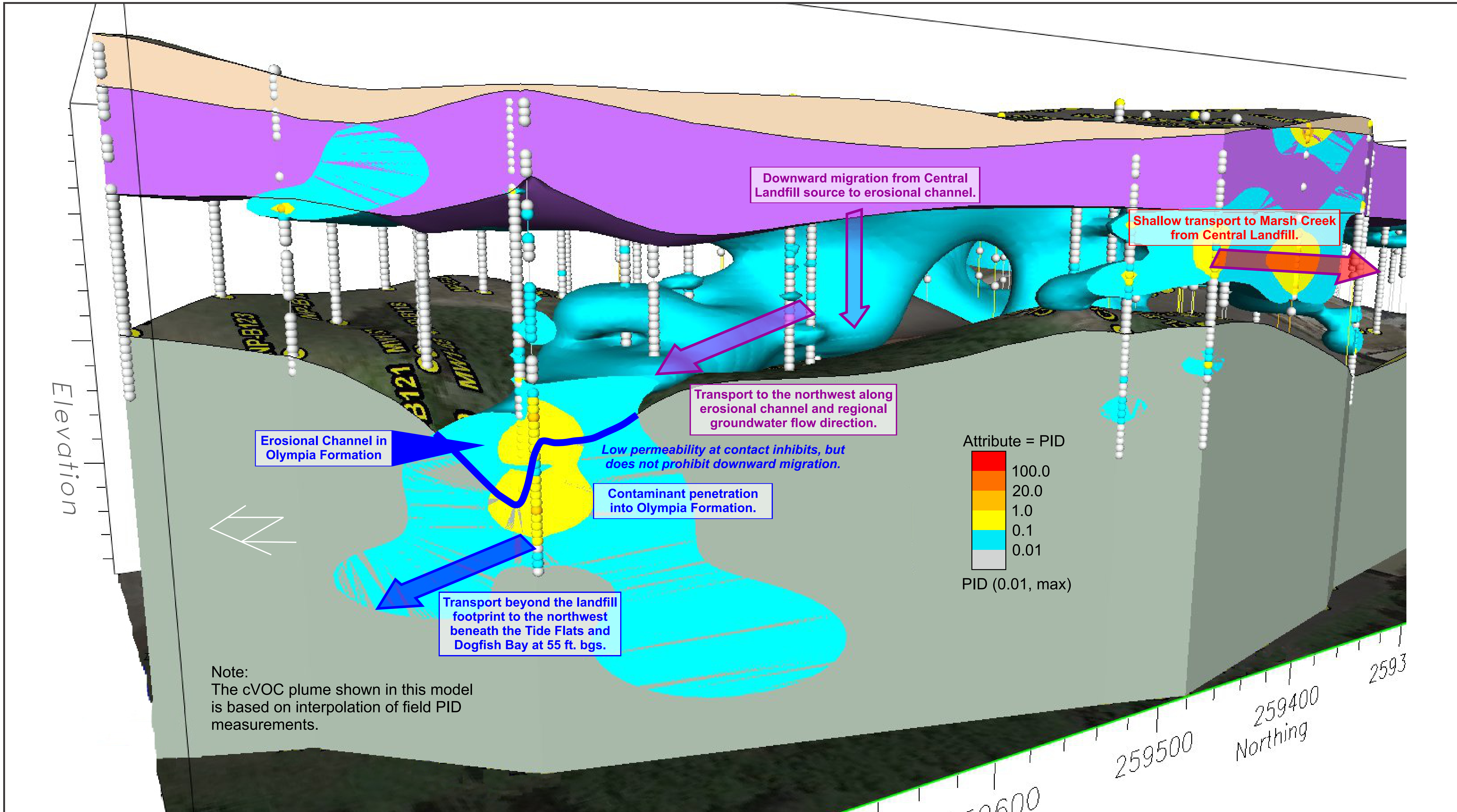
Naval Base Kitsap Keyport




U.S. NAVY

Figure 3-2
Shallow Transport Pathways from the Southern Landfill

Naval Base Kitsap
Keyport




| U.S. NAVY | **Figure 3-3**<br>**Transport Pathways from the Central Landfill** | Naval Base Kitsap<br>Keyport |
|---|---|---|

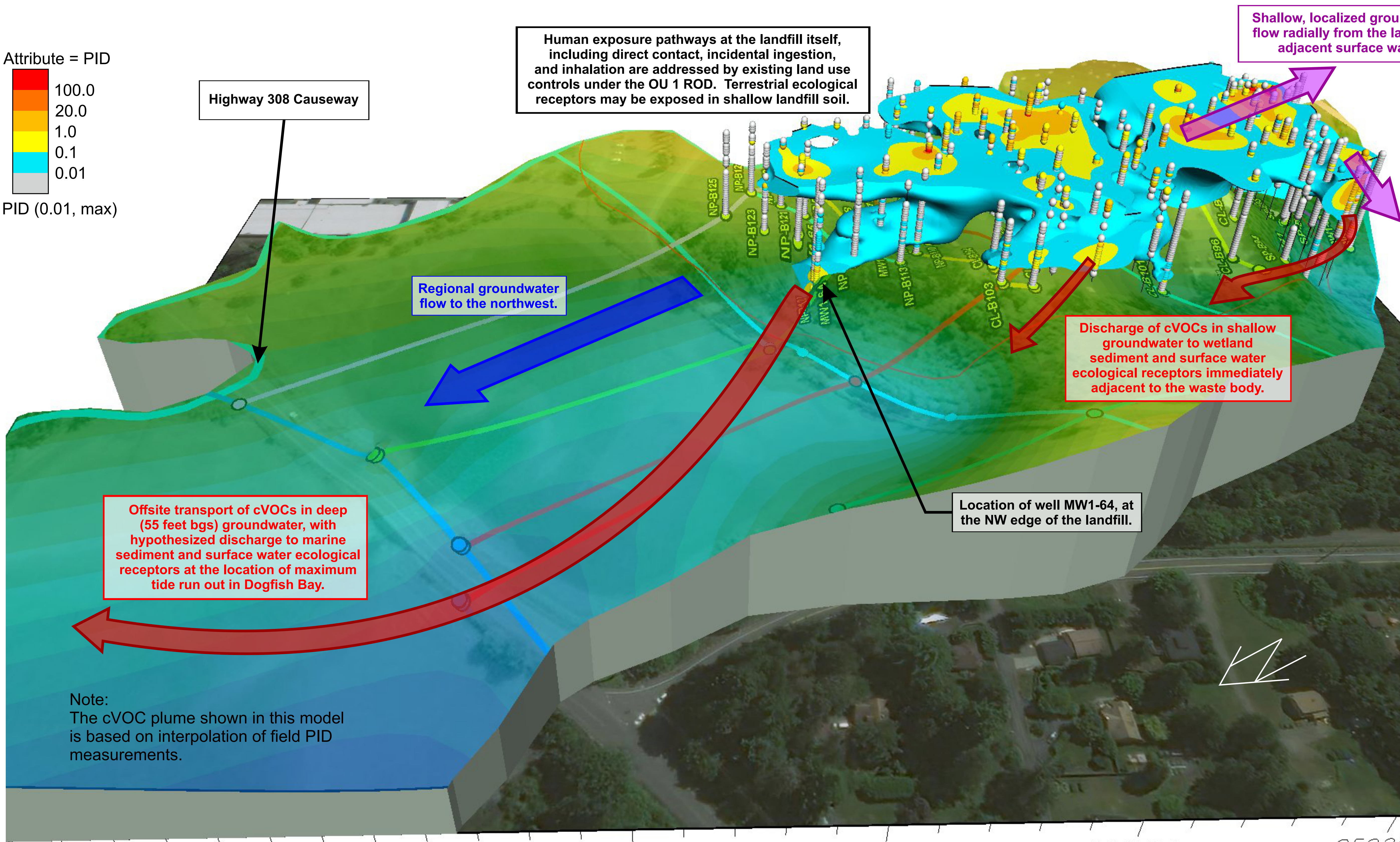
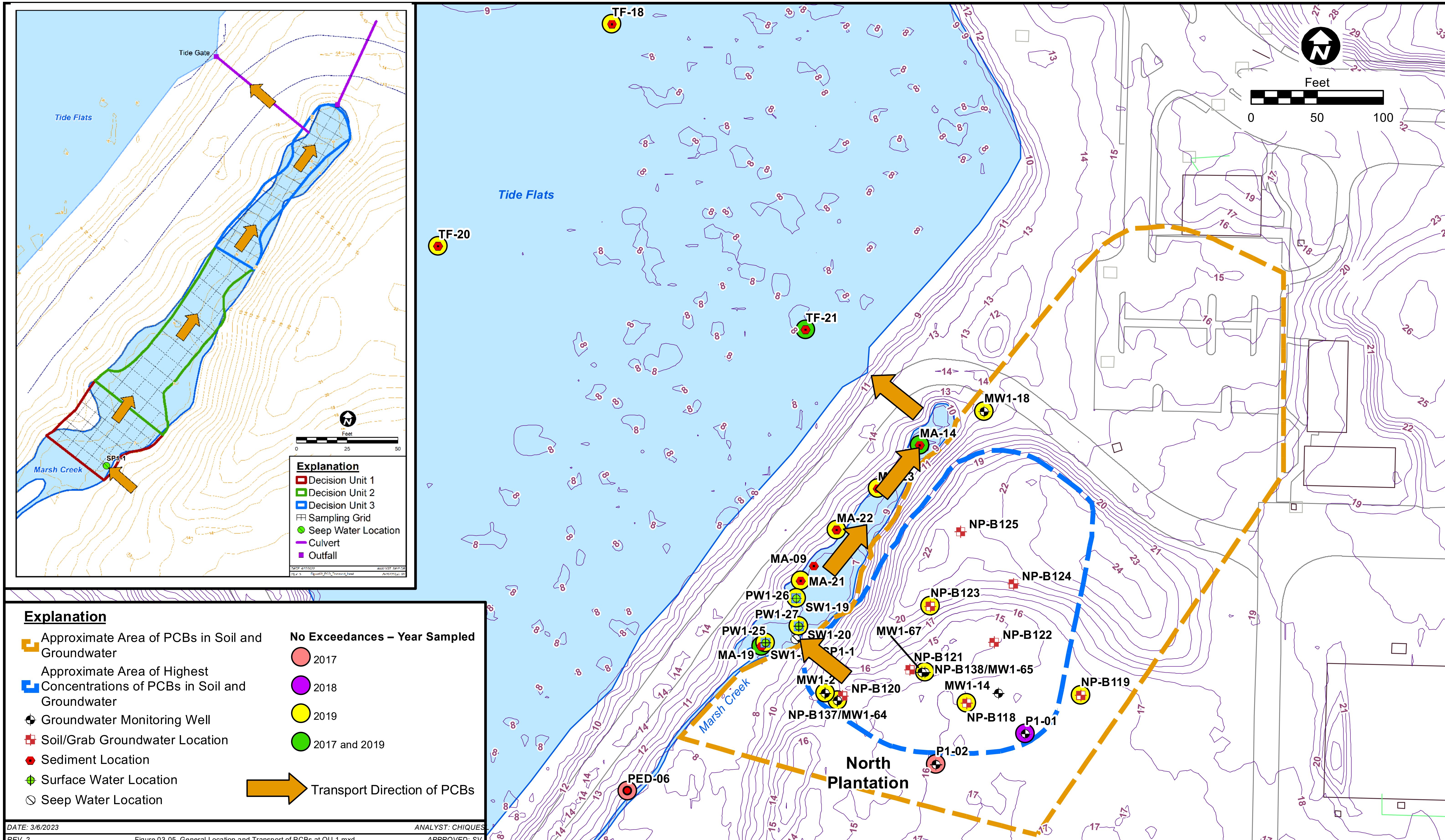



FIGURE06_TRANSPORT_TO_SURFACE_WATER.CDR

**U.S. NAVY**

**Figure 3-4**
**Transport Pathways to Surface Water**

Naval Base Kitsap
Keyport




**U.S. NAVY**

**Figure 3-5**
**General Location and Transport of PCBs at OU 1**

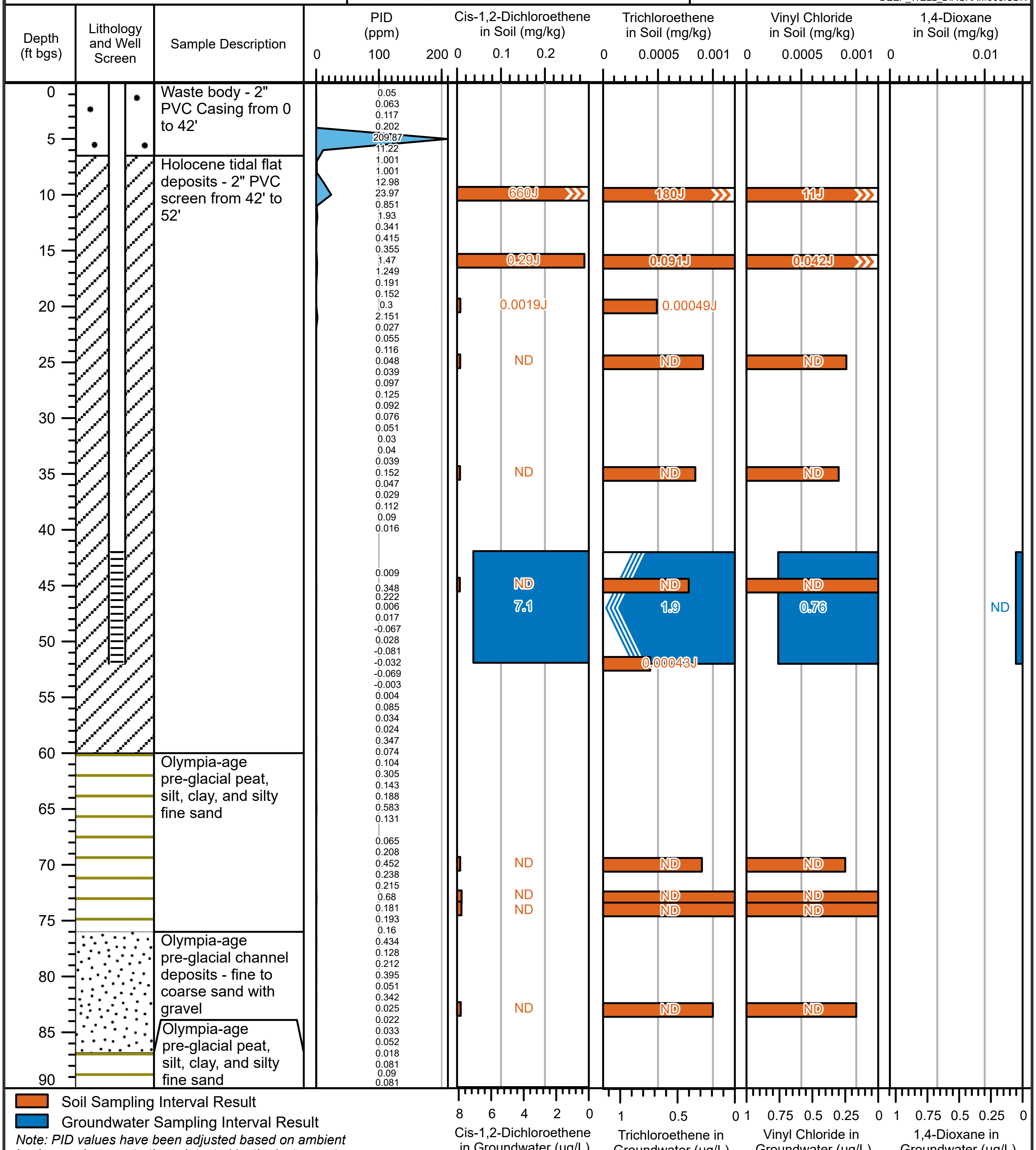
Naval Base Kitsap
Keyport

Permit Number: 22-EP058
Project Number: G24790.30
Date Logged: 4/27/2021
Geologist: Hunter Butler
Total Depth (ft bgs): 90
Reviewer: Michael Meyer

Drilling Contractor: Holt Services, Inc
Driller: J Johnson
Drilling Equipment: Terra Sonic Compact Crawler
Drilling Method: Rotosonic
Boring Diameter: 6-inch
Sampler Type: CA Split Spoon
Hammer Type: 140-lb. Auto hammer

Northing (NAD 83): 259011.7
Easting (NAD 83): 1198926
Surface Elevation (NAVD 88): 14.86 ft
Borehole Abandoned: No
Backfill Method: N/A
Device Type: 2-inch PVC monitoring well

DEEP_WELL_DIAGRAMS08.CDR




Soil Sampling Interval Result
Groundwater Sampling Interval Result

*Note: PID values have been adjusted based on ambient background concentrations detected by the instrument.*

**U.S. NAVY**

## Figure 3-6
## Graphical Summary of PID and Laboratory Analytical Results in MW1-69

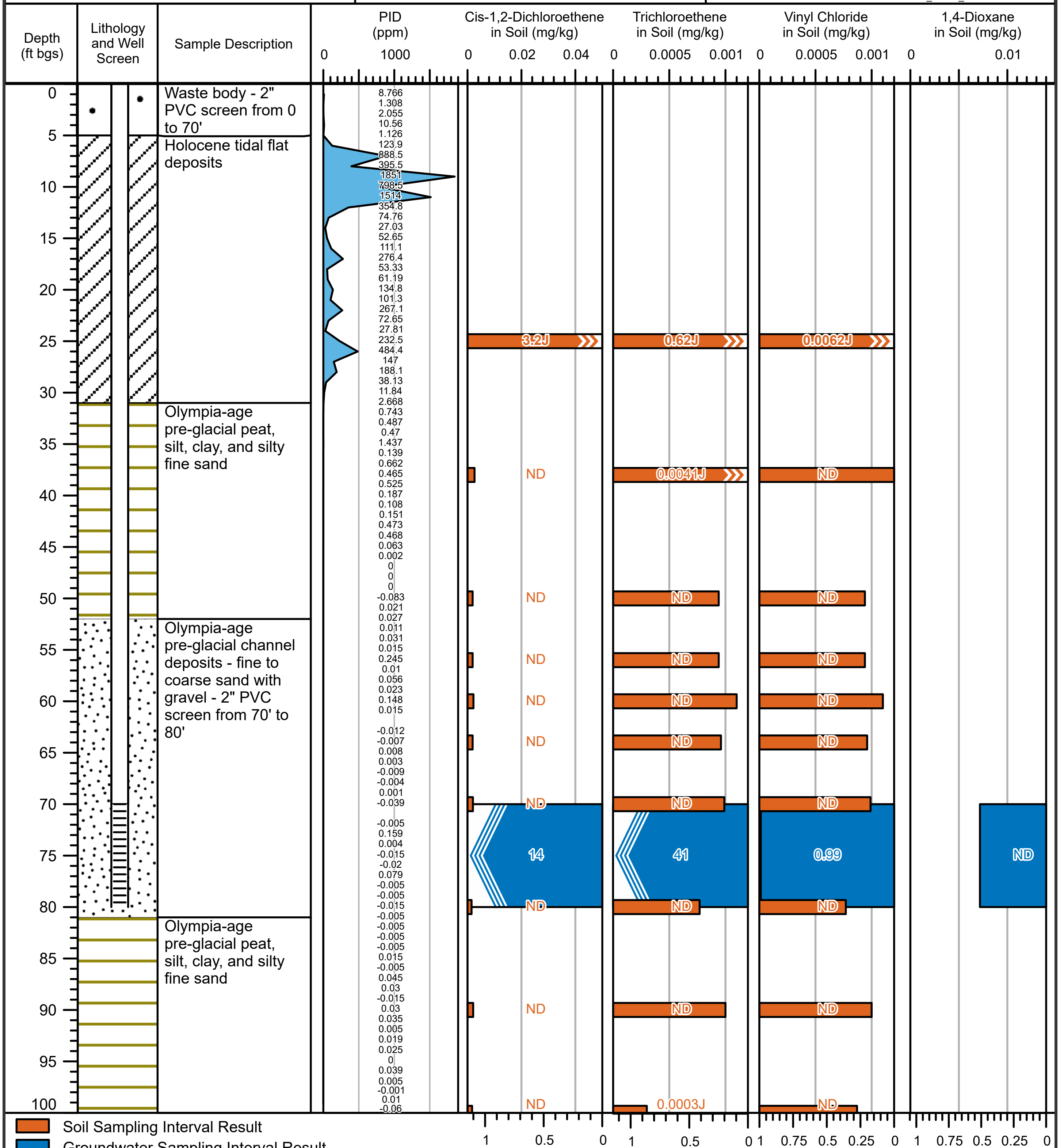
Naval Base Kitsap Keyport

Permit Number: 22-EP058
Project Number: G24790.30
Date Logged: 4/25/2022
Geologist: Hunter Butler
Total Depth (ft bgs): 100
Reviewer: Michael Meyer

Drilling Contractor: Holt Services, Inc
Driller: J Johnson
Drilling Equipment: Terra Sonic Compact Crawler
Drilling Method: Rotosonic
Boring Diameter: 6-inch
Sampler Type: CA Split Spoon
Hammer Type: 140-lb. Auto hammer

Northing (NAD 83): 259003.5
Easting (NAD 83): 1199140
Surface Elevation (NAVD 88): 13.71 ft
Borehole Abandoned: No
Backfill Method: N/A
Device Type: 2-inch PVC monitoring well

DEEP_WELL_DIAGRAMS08.CDR



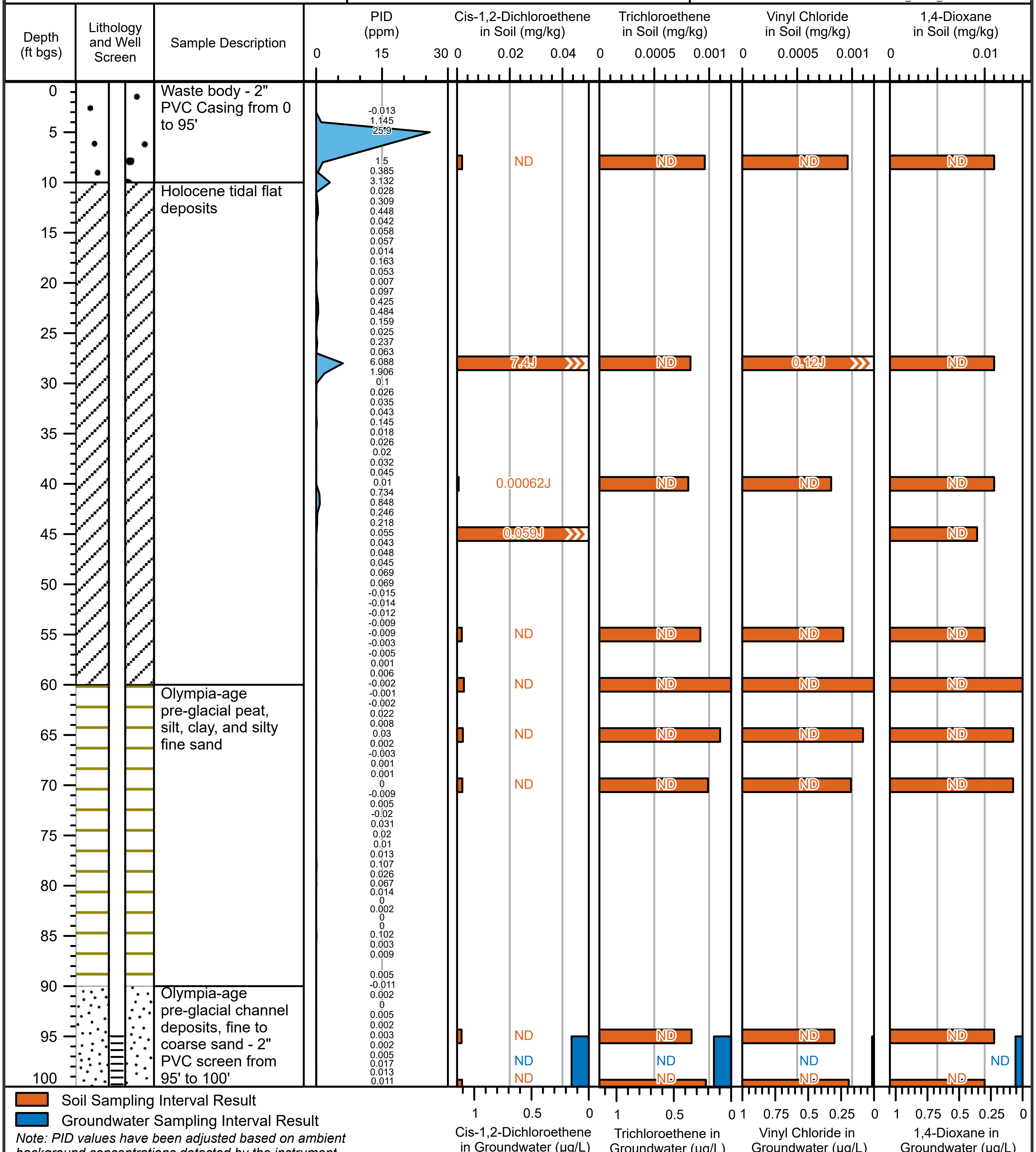

*Note: PID values have been adjusted based on ambient background concentrations detected by the instrument.*

**U.S. NAVY**

## Figure 3-7
## Graphical Summary of PID and Laboratory Analytical Results in MW1-70

Naval Base Kitsap Keyport

| | | |
|---|---|---|
| Permit Number: 22-EP058<br>Project Number: G24790.30<br>Date Logged: 5/2/2022<br>Geologist: Hunter Butler<br>Total Depth (ft bgs): 100<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc<br>Driller: J Johnson<br>Drilling Equipment: Terra Sonic Compact Crawler<br>Drilling Method: Rotosonic<br>Boring Diameter: 6-inch<br>Sampler Type: CA Split Spoon<br>Hammer Type: 140-lb. Auto hammer | Northing (NAD 83): 259491.3<br>Easting (NAD 83): 1199038<br>Surface Elevation (NAVD 88): 16.96 ft<br>Borehole Abandoned: No<br>Backfill Method: N/A<br>Device Type: 2-inch PVC monitoring well<br>DEEP_WELL_DIAGRAMS08.CDR |




*Note: PID values have been adjusted based on ambient background concentrations detected by the instrument.*

**U.S. NAVY**

## Figure 3-8
## Graphical Summary of PID and Laboratory Analytical Results in MW1-71

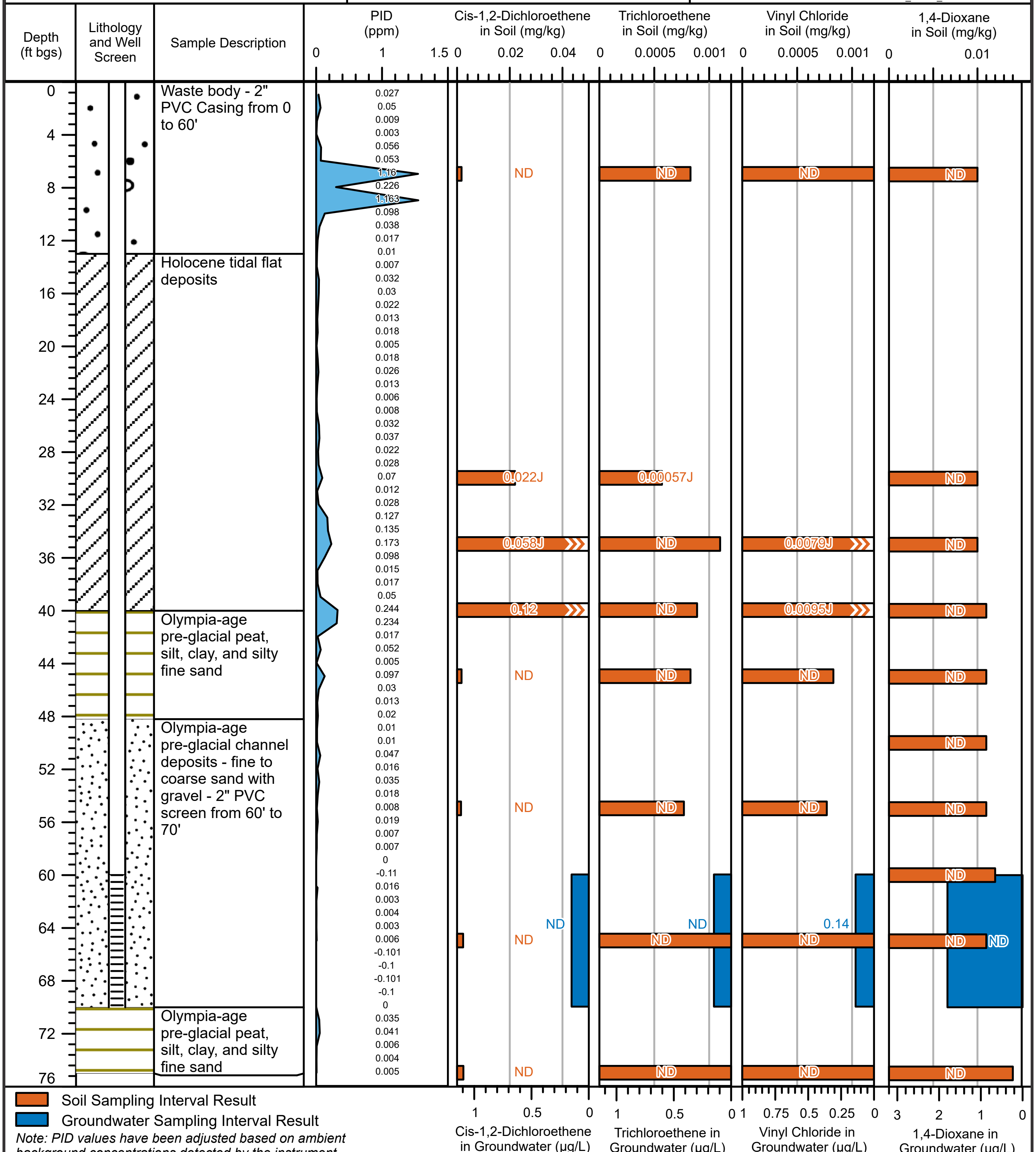
Naval Base Kitsap Keyport

Permit Number: 22-EP058
Project Number: G24790.30
Date Logged: 5/5/2022
Geologist: Hunter Butler
Total Depth (ft bgs): 75
Reviewer: Michael Meyer

Drilling Contractor: Holt Services, Inc
Driller: J Johnson
Drilling Equipment: Terra Sonic Compact Crawler
Drilling Method: Rotosonic
Boring Diameter: 6-inch
Sampler Type: CA Split Spoon
Hammer Type: 140-lb. Auto hammer

Northing (NAD 83): 259642.4
Easting (NAD 83): 1198935
Surface Elevation (NAVD 88): 16.11 ft
Borehole Abandoned: No
Backfill Method: N/A
Device Type: 2-inch PVC monitoring well

DEEP_WELL_DIAGRAMS08.CDR




*Note: PID values have been adjusted based on ambient background concentrations detected by the instrument.*

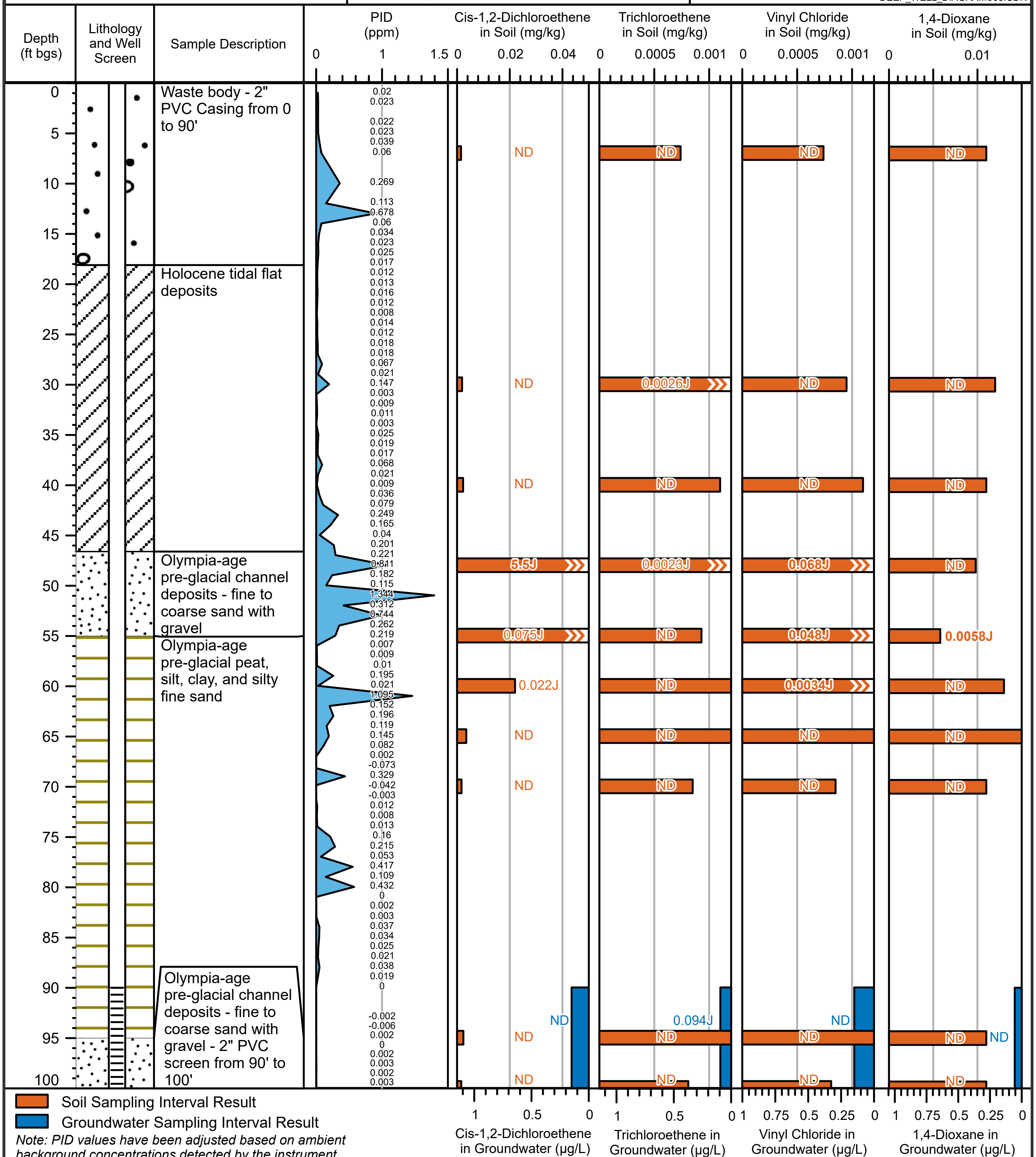
**U.S. NAVY**

**Figure 3-9**
**Graphical Summary of PID and Laboratory Analytical Results in MW1-72**

Naval Base Kitsap Keyport

| | | |
|---|---|---|
| Permit Number: 22-EP058<br>Project Number: G24790.30<br>Date Logged: 5/9/2022<br>Geologist: Hunter Butler<br>Total Depth (ft bgs): 100<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc<br>Driller: J Johnson<br>Drilling Equipment: Terra Sonic Compact Crawler<br>Drilling Method: Rotosonic<br>Boring Diameter: 6-inch<br>Sampler Type: CA Split Spoon<br>Hammer Type: 140-lb. Auto hammer | Northing (NAD 83): 259763.3<br>Easting (NAD 83): 1198893<br>Surface Elevation (NAVD 88): 13.32 ft<br>Borehole Abandoned: No<br>Backfill Method: N/A<br>Device Type: 2-inch PVC monitoring well |

DEEP_WELL_DIAGRAMS08.CDR



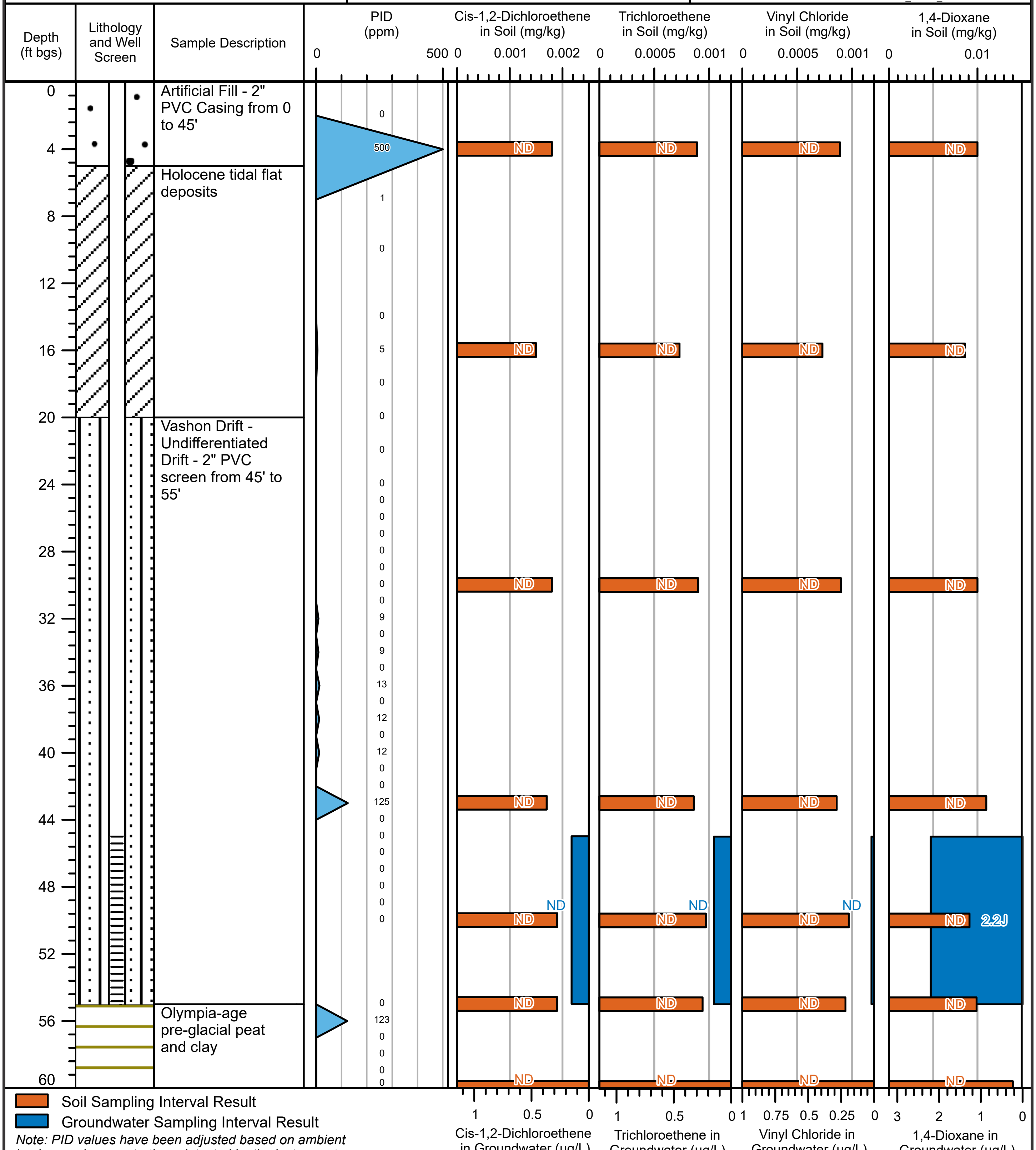

**U.S. NAVY**

## Figure 3-10
## Graphical Summary of PID and Laboratory Analytical Results in MW1-73

Naval Base Kitsap Keyport

| | | |
|---|---|---|
| Permit Number: 22-EP058<br>Project Number: G24790.30<br>Date Logged: 7/12/2022<br>Geologist: Michael Meyer<br>Total Depth (ft bgs): 60<br>Reviewer: Steven Verdibello | Drilling Contractor: Holt Services, Inc<br>Driller: J Johnson<br>Drilling Equipment: Terra Sonic Compact Crawler<br>Drilling Method: Rotosonic<br>Boring Diameter: 6-inch<br>Sampler Type: CA Split Spoon<br>Hammer Type: 140-lb. Auto hammer | Northing (NAD 83): 260210.6<br>Easting (NAD 83): 1198481<br>Surface Elevation (NAVD 88): 13.69 ft<br>Borehole Abandoned: No<br>Backfill Method: N/A<br>Device Type: 2-inch PVC monitoring well |

DEEP_WELL_DIAGRAMS08.CDR




Soil Sampling Interval Result

Groundwater Sampling Interval Result

*Note: PID values have been adjusted based on ambient background concentrations detected by the instrument.*

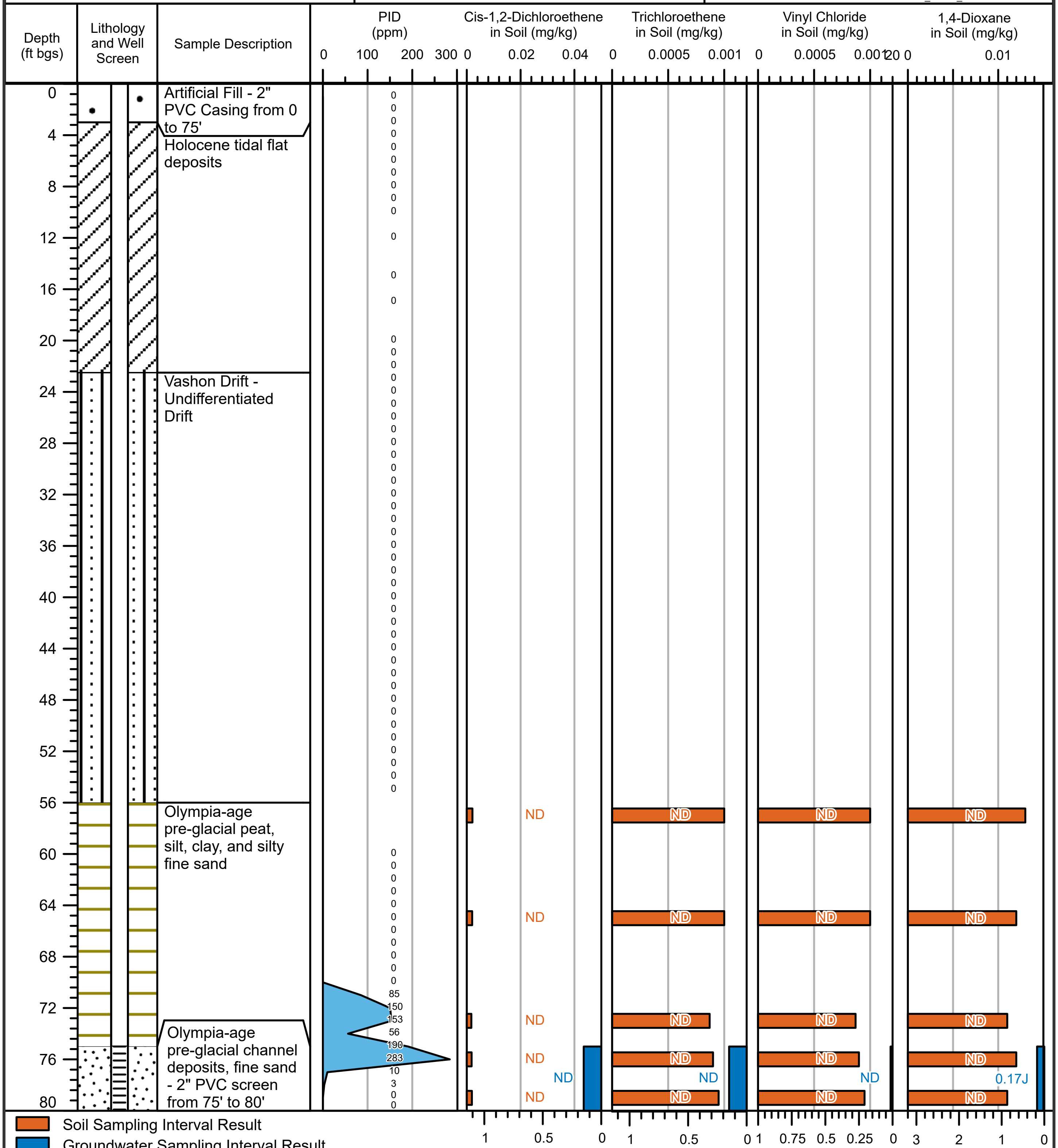
| | | |
|---|---|---|
| **U.S. NAVY** | **Figure 3-11**<br>**Graphical Summary of PID and Laboratory Analytical Results in MW1-74** | Naval Base Kitsap Keyport |

Permit Number: 22-EP058
Project Number: G24790.30
Date Logged: 7/11/2022
Geologist: Michael Meyer
Total Depth (ft bgs): 80
Reviewer: Steven Verdibello

Drilling Contractor: Holt Services, Inc
Driller: J Johnson
Drilling Equipment: Terra Sonic Compact Crawler
Drilling Method: Rotosonic
Boring Diameter: 6-inch
Sampler Type: CA Split Spoon
Hammer Type: 140-lb. Auto hammer

Northing (NAD 83): 260200.5
Easting (NAD 83): 1198474
Surface Elevation (NAVD 88): 13.66 ft
Borehole Abandoned: No
Backfill Method: N/A
Device Type: 2-inch PVC monitoring well

DEEP_WELL_DIAGRAMS08.CDR

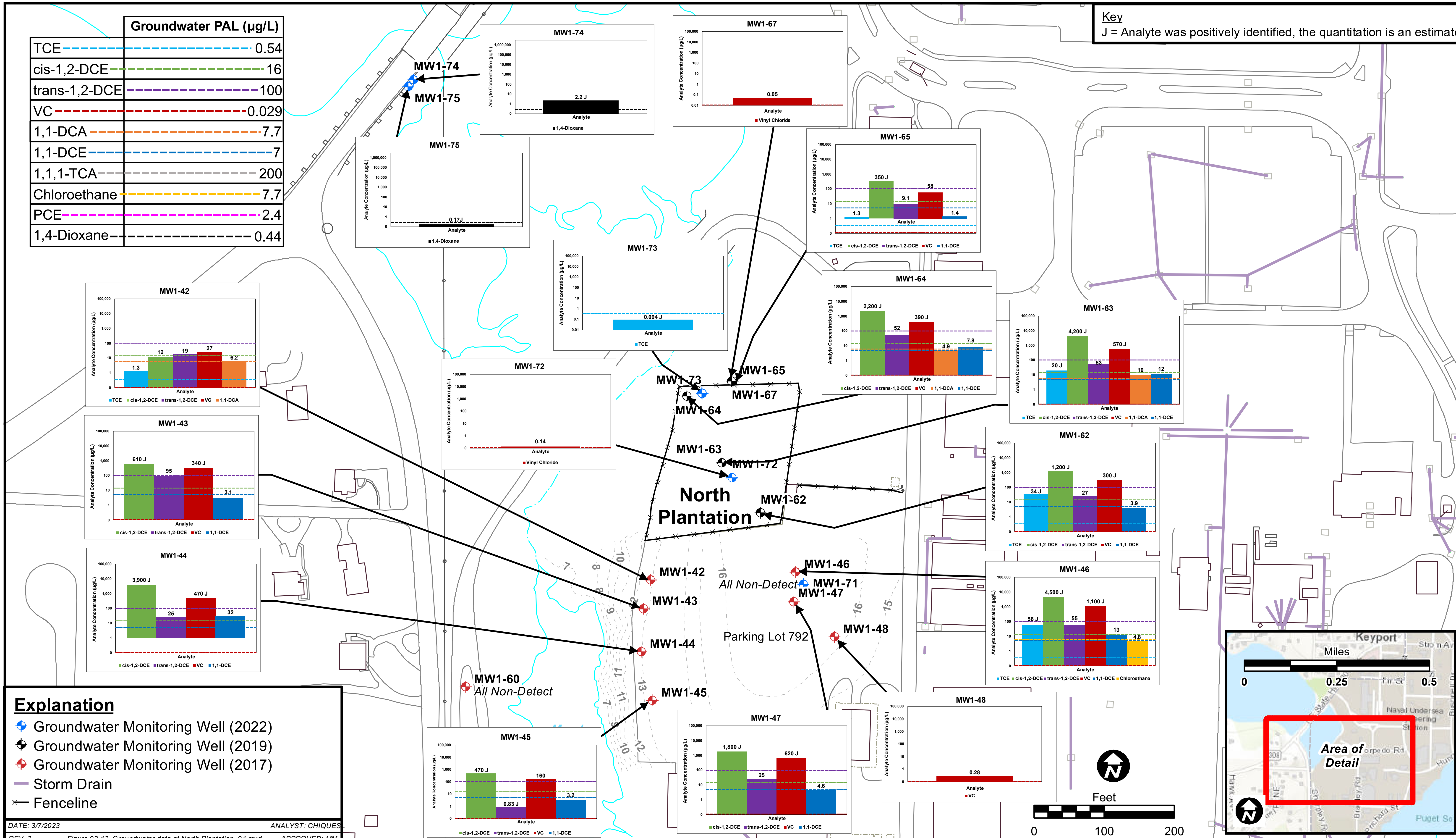



*Note: PID values have been adjusted based on ambient background concentrations detected by the instrument.*

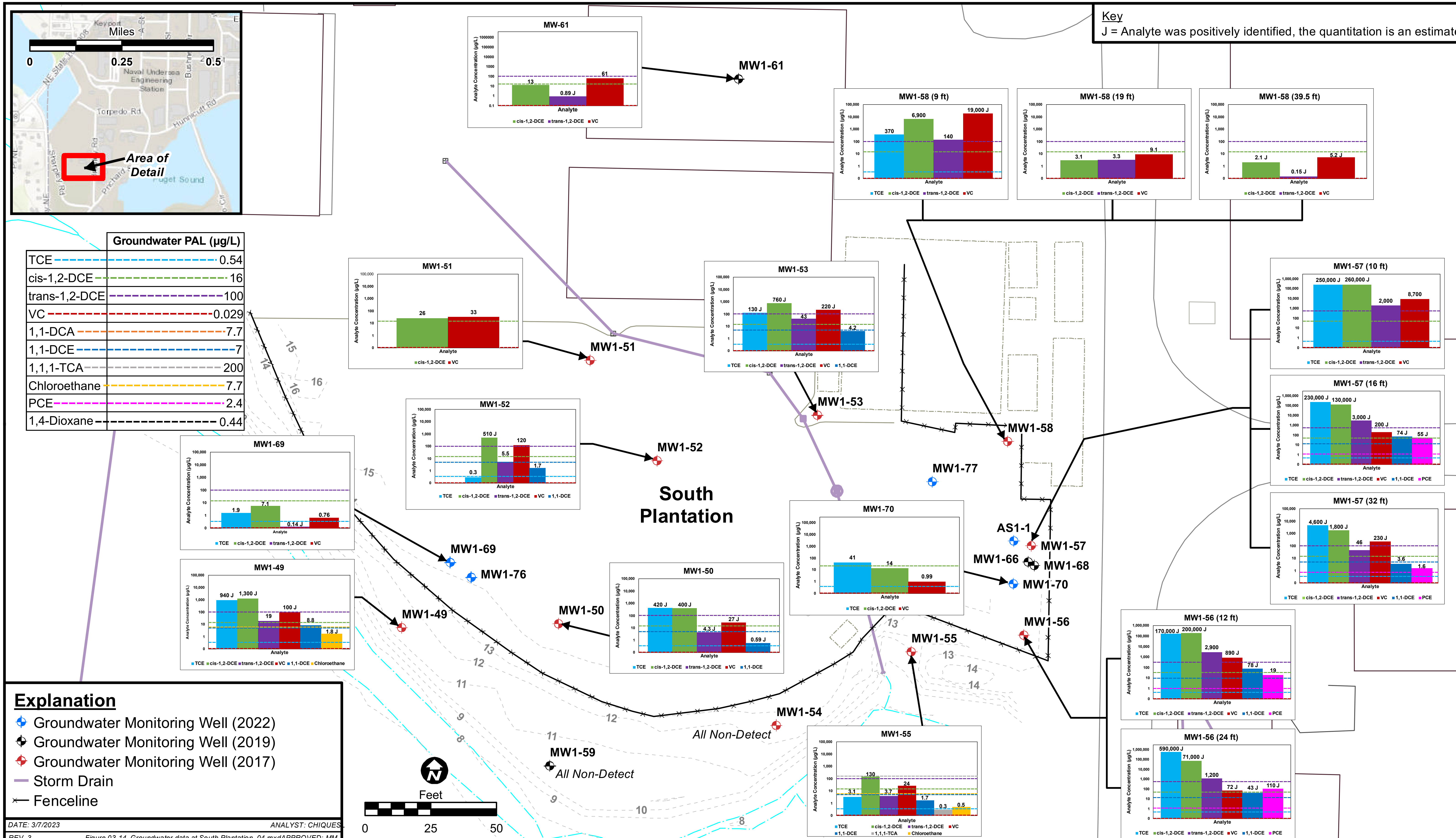
**U.S. NAVY**

## Figure 3-12
## Graphical Summary of PID and Laboratory Analytical Results in MW1-75

Naval Base Kitsap
Keyport




| U.S. NAVY | Figure 3-13<br>Groundwater Data at North Plantation | Naval Base Kitsap<br>Keyport |
|---|---|---|




**U.S. NAVY**

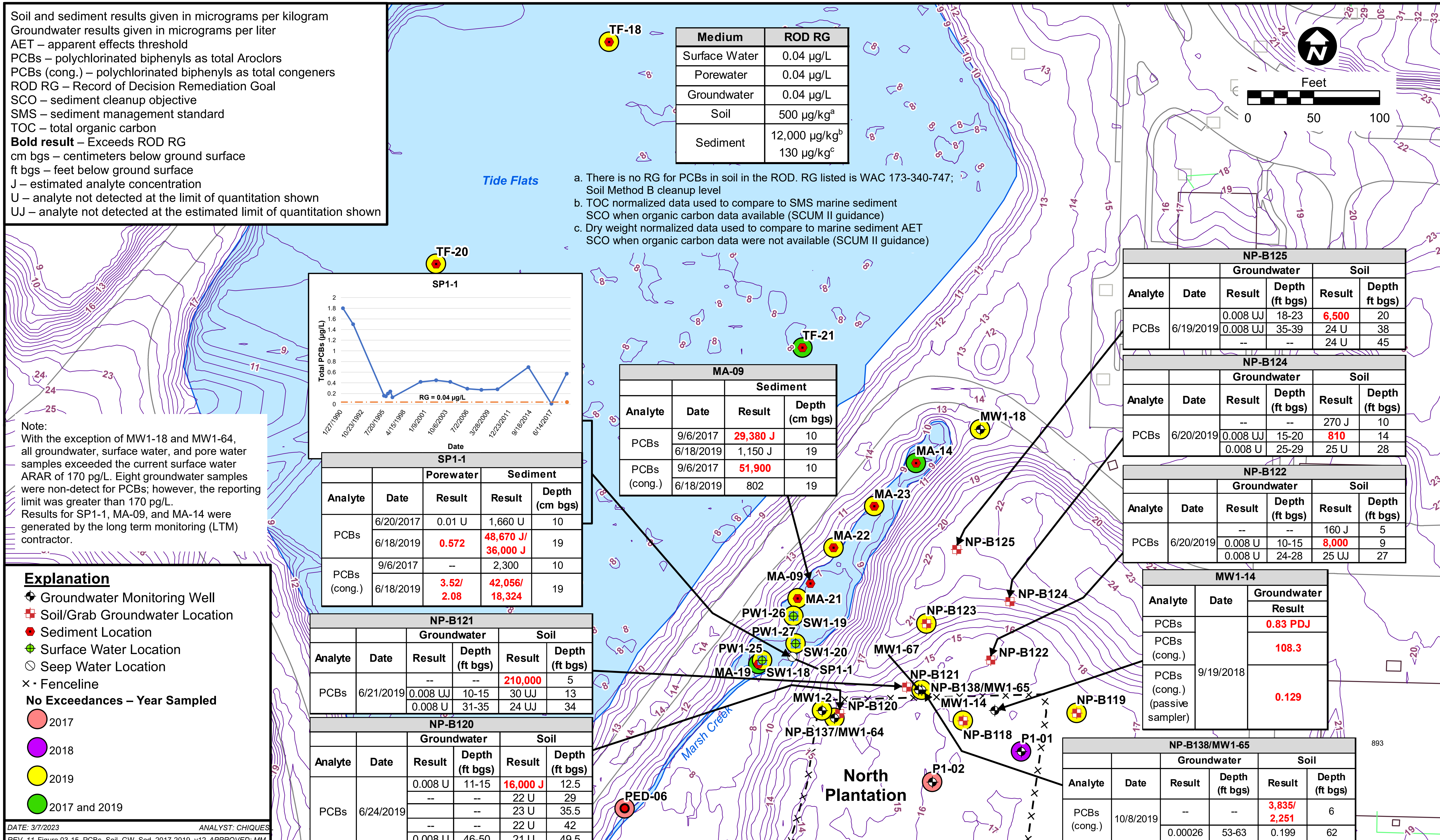
**Figure 3-14**
**Groundwater Data at South Plantation**

Naval Base Kitsap
Keyport

Soil and sediment results given in micrograms per kilogram
Groundwater results given in micrograms per liter
AET – apparent effects threshold
PCBs – polychlorinated biphenyls as total Aroclors
PCBs (cong.) – polychlorinated biphenyls as total congeners
ROD RG – Record of Decision Remediation Goal
SCO – sediment cleanup objective
SMS – sediment management standard
TOC – total organic carbon
**Bold result** – Exceeds ROD RG
cm bgs – centimeters below ground surface
ft bgs – feet below ground surface
J – estimated analyte concentration
U – analyte not detected at the limit of quantitation shown
UJ – analyte not detected at the estimated limit of quantitation shown

| Medium | ROD RG |
|---|---|
| Surface Water | 0.04 µg/L |
| Porewater | 0.04 µg/L |
| Groundwater | 0.04 µg/L |
| Soil | 500 µg/kg[a] |
| Sediment | 12,000 µg/kg[b] 130 µg/kg[c] |

a. There is no RG for PCBs in soil in the ROD. RG listed is WAC 173-340-747; Soil Method B cleanup level
b. TOC normalized data used to compare to SMS marine sediment SCO when organic carbon data available (SCUM II guidance)
c. Dry weight normalized data used to compare to marine sediment AET SCO when organic carbon data were not available (SCUM II guidance)




Note:
With the exception of MW1-18 and MW1-64, all groundwater, surface water, and pore water samples exceeded the current surface water ARAR of 170 pg/L. Eight groundwater samples were non-detect for PCBs; however, the reporting limit was greater than 170 pg/L.
Results for SP1-1, MA-09, and MA-14 were generated by the long term monitoring (LTM) contractor.

## Explanation

- Groundwater Monitoring Well
- Soil/Grab Groundwater Location
- Sediment Location
- Surface Water Location
- Seep Water Location
- Fenceline

**No Exceedances – Year Sampled**

- 2017
- 2018
- 2019
- 2017 and 2019

**SP1-1**

| Analyte | Date | Porewater Result | Sediment Result | Sediment Depth (cm bgs) |
|---|---|---|---|---|
| PCBs | 6/20/2017 | 0.01 U | 1,660 U | 10 |
| PCBs | 6/18/2019 | **0.572** | **48,670 J/ 36,000 J** | 19 |
| PCBs (cong.) | 9/6/2017 | -- | 2,300 | 10 |
| PCBs (cong.) | 6/18/2019 | **3.52/ 2.08** | **42,056/ 18,324** | 19 |

**MA-09**

| Analyte | Date | Sediment Result | Sediment Depth (cm bgs) |
|---|---|---|---|
| PCBs | 9/6/2017 | **29,380 J** | 10 |
| PCBs | 6/18/2019 | 1,150 J | 19 |
| PCBs (cong.) | 9/6/2017 | **51,900** | 10 |
| PCBs (cong.) | 6/18/2019 | 802 | 19 |

**NP-B125**

| Analyte | Date | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|---|
| PCBs | 6/19/2019 | 0.008 UJ | 18-23 | **6,500** | 20 |
| | | 0.008 UJ | 35-39 | 24 U | 38 |
| | | -- | -- | 24 U | 45 |

**NP-B124**

| Analyte | Date | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|---|
| PCBs | 6/20/2019 | -- | -- | 270 J | 10 |
| | | 0.008 UJ | 15-20 | **810** | 14 |
| | | 0.008 U | 25-29 | 25 U | 28 |

**NP-B122**

| Analyte | Date | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|---|
| PCBs | 6/20/2019 | -- | -- | 160 J | 5 |
| | | 0.008 U | 10-15 | **8,000** | 9 |
| | | 0.008 U | 24-28 | 25 UJ | 27 |

**MW1-14**

| Analyte | Date | Groundwater Result |
|---|---|---|
| PCBs | 9/19/2018 | **0.83 PDJ** |
| PCBs (cong.) | 9/19/2018 | **108.3** |
| PCBs (cong.) (passive sampler) | 9/19/2018 | **0.129** |

**NP-B121**

| Analyte | Date | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|---|
| PCBs | 6/21/2019 | -- | -- | **210,000** | 5 |
| | | 0.008 UJ | 10-15 | 30 UJ | 13 |
| | | 0.008 U | 31-35 | 24 UJ | 34 |

**NP-B120**

| Analyte | Date | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|---|
| PCBs | 6/24/2019 | 0.008 U | 11-15 | **16,000 J** | 12.5 |
| | | -- | -- | 22 U | 29 |
| | | | -- | 23 U | 35.5 |
| | | -- | -- | 22 U | 42 |
| | | 0.008 U | 46-50 | 21 U | 49.5 |

**NP-B138/MW1-65**

| Analyte | Date | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|---|
| PCBs (cong.) | 10/8/2019 | -- | -- | **3,835/ 2,251** | 6 |
| | | 0.00026 | 53-63 | 0.199 | 62 |

DATE: 3/7/2023 ANALYST: CHIQUES
REV. 11 Figure 03-15_PCBs_Soil_GW_Sed_2017-2019_v12 APPROVED: MM

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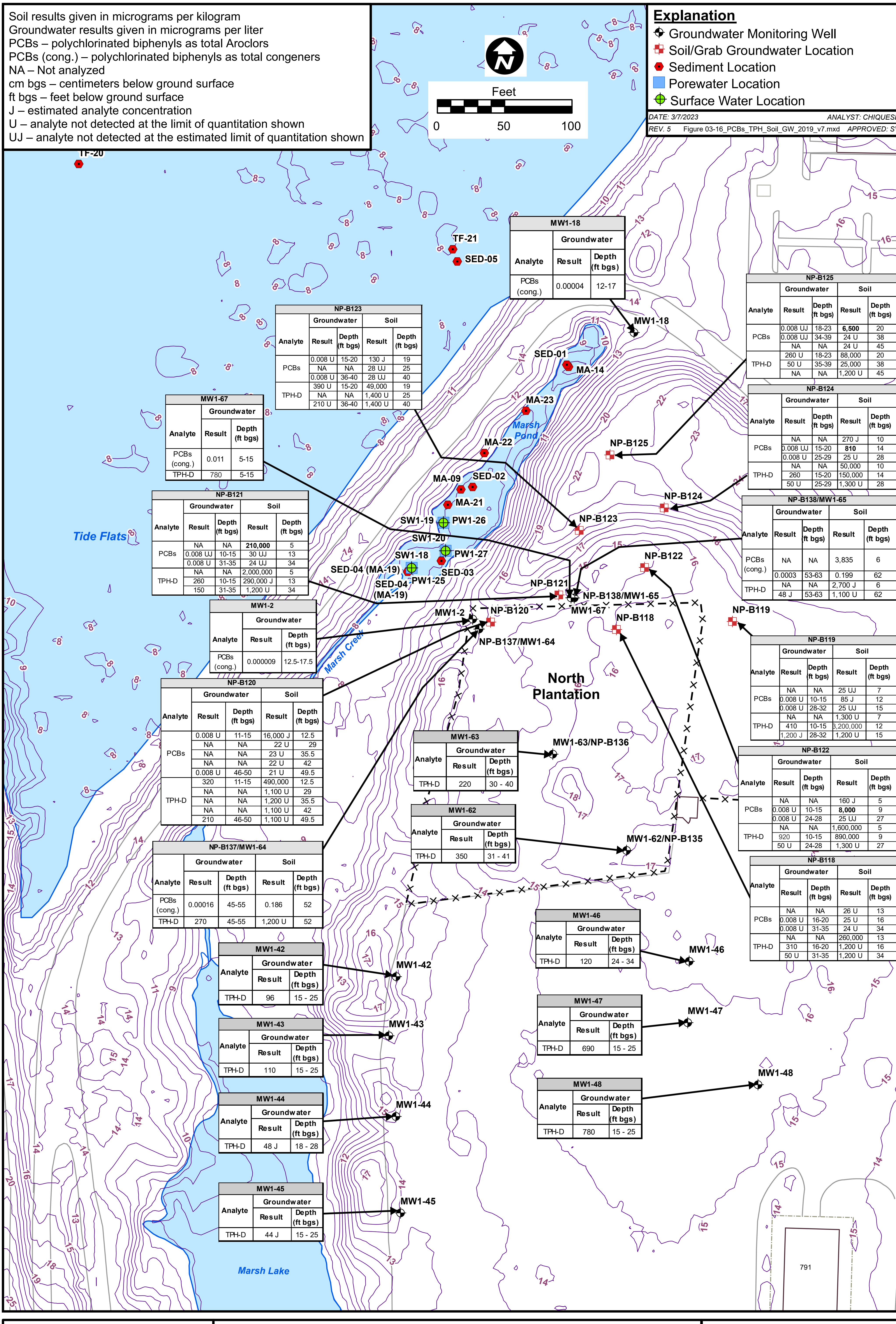
**Figure 3-15**
**PCBs in Soil, Groundwater, and Sediment (2017–2019)**

Naval Base Kitsap
Keyport

Soil results given in micrograms per kilogram
Groundwater results given in micrograms per liter
PCBs – polychlorinated biphenyls as total Aroclors
PCBs (cong.) – polychlorinated biphenyls as total congeners
NA – Not analyzed
cm bgs – centimeters below ground surface
ft bgs – feet below ground surface
J – estimated analyte concentration
U – analyte not detected at the limit of quantitation shown
UJ – analyte not detected at the estimated limit of quantitation shown

**Explanation**
- Groundwater Monitoring Well
- Soil/Grab Groundwater Location
- Sediment Location
- Porewater Location
- Surface Water Location

DATE: 3/7/2023 ANALYST: CHIQUESL
REV. 5 Figure 03-16_PCBs_TPH_Soil_GW_2019_v7.mxd APPROVED: SV




**MW1-18**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) |
| --- | --- | --- |
| PCBs (cong.) | 0.00004 | 12-17 |

**NP-B125**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
| --- | --- | --- | --- | --- |
| PCBs | 0.008 UJ | 18-23 | **6,500** | 20 |
| | 0.008 UJ | 34-39 | 24 U | 38 |
| | NA | NA | 24 U | 45 |
| TPH-D | 260 U | 18-23 | 88,000 | 20 |
| | 50 U | 35-39 | 25,000 | 38 |
| | NA | NA | 1,200 U | 45 |

**NP-B123**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
| --- | --- | --- | --- | --- |
| PCBs | 0.008 U | 15-20 | 130 J | 19 |
| | NA | NA | 28 UJ | 25 |
| | 0.008 U | 36-40 | 28 UJ | 40 |
| TPH-D | 390 U | 15-20 | 49,000 | 19 |
| | NA | NA | 1,400 U | 25 |
| | 210 U | 36-40 | 1,400 U | 40 |

**MW1-67**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) |
| --- | --- | --- |
| PCBs (cong.) | 0.011 | 5-15 |
| TPH-D | 780 | 5-15 |

**NP-B124**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
| --- | --- | --- | --- | --- |
| PCBs | NA | NA | 270 J | 10 |
| | 0.008 UJ | 15-20 | **810** | 14 |
| | 0.008 U | 25-29 | 25 U | 28 |
| TPH-D | NA | NA | 50,000 | 10 |
| | 260 | 15-20 | 150,000 | 14 |
| | 50 U | 25-29 | 1,300 U | 28 |

**NP-B121**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
| --- | --- | --- | --- | --- |
| PCBs | NA | NA | **210,000** | 5 |
| | 0.008 UJ | 10-15 | 30 UJ | 13 |
| | 0.008 U | 31-35 | 24 UJ | 34 |
| TPH-D | NA | NA | 2,000,000 | 5 |
| | 260 | 10-15 | 290,000 J | 13 |
| | 150 | 31-35 | 1,200 U | 34 |

**NP-B138/MW1-65**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
| --- | --- | --- | --- | --- |
| PCBs (cong.) | NA | NA | 3,835 | 6 |
| | 0.0003 | 53-63 | 0.199 | 62 |
| TPH-D | NA | NA | 2,700 J | 6 |
| | 48 J | 53-63 | 1,100 U | 62 |

**MW1-2**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) |
| --- | --- | --- |
| PCBs (cong.) | 0.000009 | 12.5-17.5 |

**NP-B119**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
| --- | --- | --- | --- | --- |
| PCBs | NA | NA | 25 UJ | 7 |
| | 0.008 U | 10-15 | 85 J | 12 |
| | 0.008 U | 28-32 | 25 UJ | 15 |
| TPH-D | NA | NA | 1,300 U | 7 |
| | 410 | 10-15 | 3,200,000 | 12 |
| | 1,200 J | 28-32 | 1,200 U | 15 |

**NP-B120**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
| --- | --- | --- | --- | --- |
| PCBs | 0.008 U | 11-15 | 16,000 J | 12.5 |
| | NA | NA | 22 U | 29 |
| | NA | NA | 23 U | 35.5 |
| | NA | NA | 22 U | 42 |
| | 0.008 U | 46-50 | 21 U | 49.5 |
| TPH-D | 320 | 11-15 | 490,000 | 12.5 |
| | NA | NA | 1,100 U | 29 |
| | NA | NA | 1,200 U | 35.5 |
| | NA | NA | 1,100 U | 42 |
| | 210 | 46-50 | 1,100 U | 49.5 |

**MW1-63**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) |
| --- | --- | --- |
| TPH-D | 220 | 30 - 40 |

**NP-B122**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
| --- | --- | --- | --- | --- |
| PCBs | NA | NA | 160 J | 5 |
| | 0.008 U | 10-15 | **8,000** | 9 |
| | 0.008 U | 24-28 | 25 UJ | 27 |
| TPH-D | NA | NA | 1,600,000 | 5 |
| | 920 | 10-15 | 890,000 | 9 |
| | 50 U | 24-28 | 1,300 U | 27 |

**MW1-62**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) |
| --- | --- | --- |
| TPH-D | 350 | 31 - 41 |

**NP-B137/MW1-64**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
| --- | --- | --- | --- | --- |
| PCBs (cong.) | 0.00016 | 45-55 | 0.186 | 52 |
| TPH-D | 270 | 45-55 | 1,200 U | 52 |

**NP-B118**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
| --- | --- | --- | --- | --- |
| PCBs | NA | NA | 26 U | 13 |
| | 0.008 U | 16-20 | 25 U | 16 |
| | 0.008 U | 31-35 | 24 U | 34 |
| TPH-D | NA | NA | 260,000 | 13 |
| | 310 | 16-20 | 1,200 U | 16 |
| | 50 U | 31-35 | 1,200 U | 34 |

**MW1-46**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) |
| --- | --- | --- |
| TPH-D | 120 | 24 - 34 |

**MW1-42**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) |
| --- | --- | --- |
| TPH-D | 96 | 15 - 25 |

**MW1-47**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) |
| --- | --- | --- |
| TPH-D | 690 | 15 - 25 |

**MW1-43**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) |
| --- | --- | --- |
| TPH-D | 110 | 15 - 25 |

**MW1-48**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) |
| --- | --- | --- |
| TPH-D | 780 | 15 - 25 |

**MW1-44**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) |
| --- | --- | --- |
| TPH-D | 48 J | 18 - 28 |

**MW1-45**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) |
| --- | --- | --- |
| TPH-D | 44 J | 15 - 25 |

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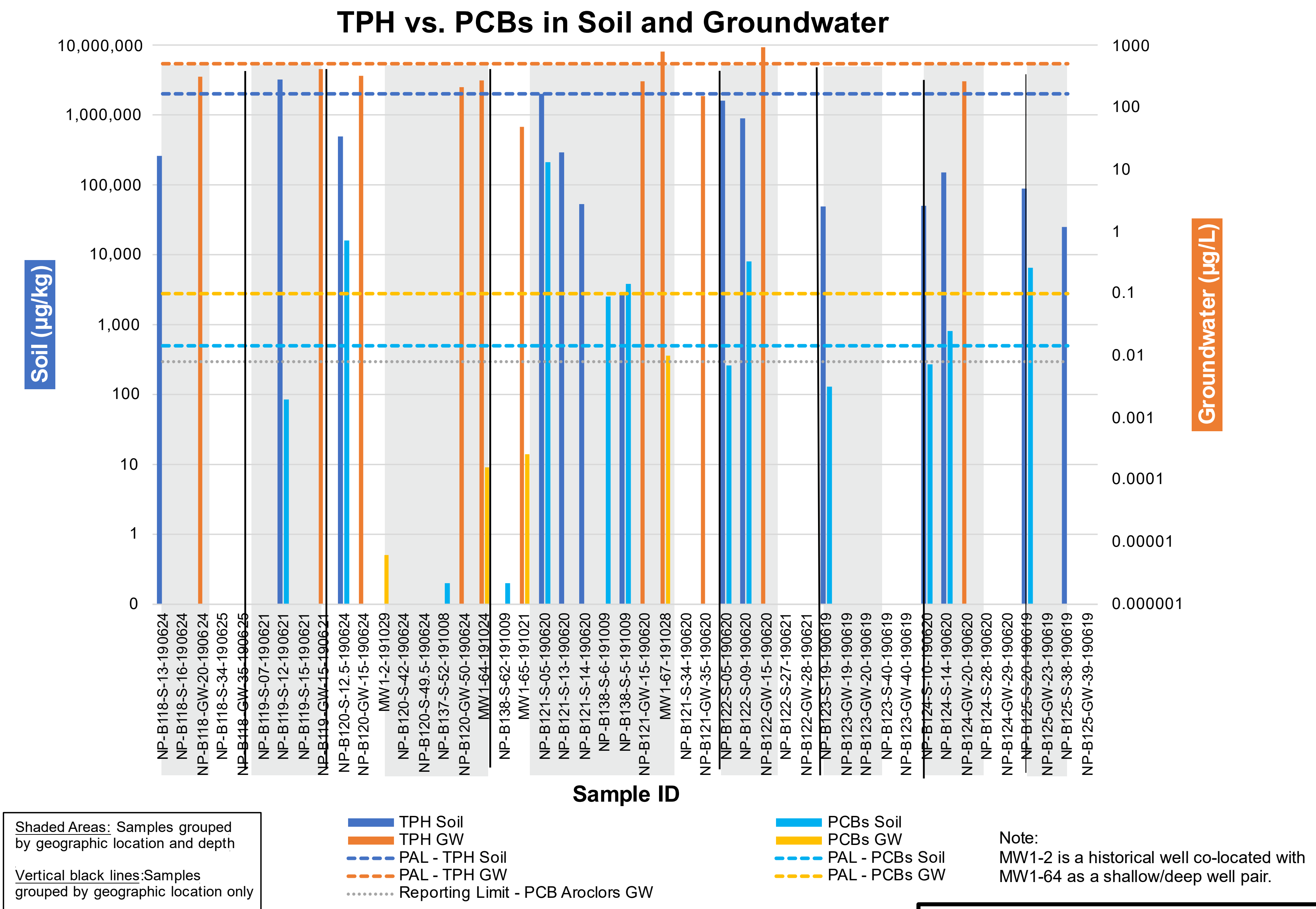
**Figure 3-16**
**PCBs and TPH in Soil and Groundwater (2019)**

Naval Base Kitsap
Keyport




| DATE: 3/7/2023 | ANALYST: CHIQUESL |
|---|---|
| REV. 2 Figure 03-17_TPH_vs_PCBs_Soil_GW 2019_v3.mxd | APPROVED: MM |

| U.S. NAVY | Figure 3-17<br>TPH vs. PCBs in Soil and Groundwater (2019) | Naval Base Kitsap<br>Keyport |
|---|---|---|

## Table 3-1. COIs, COPCs, and COCs Based on Human Health Risk Assessment

| | Soil | | | | Groundwater | | Air | | | | Sediment | | | | | | Surface Water | | | | | | Tissue | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Surface Soil | | Root-Zone Soil | | Groundwater and Seeps | | Indoor Air | | Outdoor Air | | Marsh Sediment | | Tide Flats Sediment | | Dogfish Bay Sediment | | Marsh Surface Water | | Tide Flats Surface Water | | Dogfish Bay Surface Water | | Tide Flats Shellfish Tissue | | Dogfish Bay Shellfish Tissue (Depurated) | | Dogfish Bay Shellfish Tissue (Nondepurated) | |
| Phase | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC |
| Inorganics | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Antimony | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Arsenic | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Beryllium | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cadmium | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chromium | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cobalt | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Copper | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lead | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Manganese | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mercury | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Silver | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Thallium | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VOCs | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Acetone | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Benzene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bromodichloromethane | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,3-Butadiene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2-Butanone | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Carbon tetrachloride | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chlorobenzene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chloroform | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chloromethane | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cyclohexane | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,4-Dichlorobenzene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,1-Dichloroethane | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,1-Dichloroethene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,2-Dichloroethenes | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,3-Dichloropropene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ethylbenzene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Freon 11 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Freon 12 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

## Table 3-1. COIs, COPCs, and COCs Based on Human Health Risk Assessment (continued)

| | Soil | | | | Groundwater | | Air | | | | Sediment | | | | | | Surface Water | | | | | | Tissue | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Surface Soil | | Root-Zone Soil | | Groundwater and Seeps | | Indoor Air | | Outdoor Air | | Marsh Sediment | | Tide Flats Sediment | | Dogfish Bay Sediment | | Marsh Surface Water | | Tide Flats Surface Water | | Dogfish Bay Surface Water | | Tide Flats Shellfish Tissue | | Dogfish Bay Shellfish Tissue (Depurated) | | Dogfish Bay Shellfish Tissue (Nondepurated) | |
| Phase | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC |
| Freon 114 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Methylene chloride | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Octane | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Propylene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Styrene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tetrachloroethene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Toluene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,2,4-Trichlorobenzene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,1,1-Trichloroethene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Trichloroethene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,2,4-Trimethylbenzene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,3,5-Trimethylbenzene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Vinyl Chloride | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Xylenes | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,1,1-Trichloroethane | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| trans-1,2-dichloroethene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| cis-1,2-dichloroethene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,2-dichloroethane | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SVOCs | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Benzo(a)anthracene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Benzo(a)pyrene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chrysene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| bis(2-ethylhexyl)phthalate | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fluoranthene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Phenantherene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Propyleneglycol dinitrate | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chloronated Pesticides/PCBs | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Arochlors | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Endosulfan sulfate | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Aldrin | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chlordane | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Diedrin | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**Table 3-1. COIs, COPCs, and COCs Based on Human Health Risk Assessment (continued)**

| | Soil | | | | Groundwater | | Air | | | | Sediment | | | | | | Surface Water | | | | | | Tissue | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Surface Soil | | Root-Zone Soil | | Groundwater and Seeps | | Indoor Air | | Outdoor Air | | Marsh Sediment | | Tide Flats Sediment | | Dogfish Bay Sediment | | Marsh Surface Water | | Tide Flats Surface Water | | Dogfish Bay Surface Water | | Tide Flats Shellfish Tissue | | Dogfish Bay Shellfish Tissue (Depurated) | | Dogfish Bay Shellfish Tissue (Nondepurated) | |
| Phase | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC |
| Heptachlor | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Heptachlor epoxide | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

## Table 3-2. COIs, COPCs, and COCs Based on Ecological Risk Assessment

| | Soil | | | | Groundwater | | Air | | | | Sediment | | | | | | Surface Water | | | | | | Tissue | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Surface Soil | | Root-Zone Soil | | Groundwater and Seeps | | Indoor Air | | Outdoor Air | | Marsh Sediment | | Tide Flats Sediment | | Dogfish Bay Sediment | | Marsh Surface Water | | Tide Flats Surface Water | | Dogfish Bay Surface Water | | Tide Flats Shellfish Tissue | | Dogfish Bay Shellfish Tissue (Depurated) | | Dogfish Bay Shellfish Tissue (Nondepurated) | |
| Phase | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC |
| Inorganics | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Aluminum | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Antimony | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Arsenic | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cadmium | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chromium | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Copper | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Iron | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lead | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Manganese | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mercury | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nickel | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Selenium | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Silver | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Zinc | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VOCs | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1,1-Dichloroethane | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Vinyl Chloride | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Xylenes | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SVOCs | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Anthracene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Acenaphthene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Benzoic acid | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Butylbenzylphthalate | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chrysene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Diethylphthalate | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Di-n-butylphthalate | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| bis(2-ethylhexyl)phthalate | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fluoranthene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Phenantherene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Phenol | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pyrene | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

## Table 3-2. COIs, COPCs, and COCs Based on Ecological Risk Assessment (continued)

| | Soil | | | | Groundwater | | Air | | | | Sediment | | | | | | Surface Water | | | | | | Tissue | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chemical | Surface Soil | | Root-Zone Soil | | Groundwater and Seeps | | Indoor Air | | Outdoor Air | | Marsh Sediment | | Tide Flats Sediment | | Dogfish Bay Sediment | | Marsh Surface Water | | Tide Flats Surface Water | | Dogfish Bay Surface Water | | Tide Flats Shellfish Tissue | | Dogfish Bay Shellfish Tissue (Depurated) | | Dogfish Bay Shellfish Tissue (Nondepurated) | |
| Phase | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC | COPC/COI | COC |
| Propyleneglycol dinitrate | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4-Nitrophenol | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chloronated Pesticides/PCBs | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Arochlors | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2,4-D | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4,4'-DDD | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4-4'-DDE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4,4'-DDT | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Endosulfan | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Endrin | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Methoxychlor | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Aldrin | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chlordane | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Methoxychlor | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Organophosphorus Pesticides | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Methyl parathion | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chlorinated Herbicides | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dicamba | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

## Table 3-3. Maximum Concentrations of COCs Detected in Environmental Media

| Chemical | Groundwater, Porewater and Seeps (µg/L) | Sediment (mg/kg) | Surface Water (µg/L) | Shellfish Tissue (mg/kg) |
|---|---|---|---|---|
| 1,1-Dichloroethane | 30,000[c] | NA | 11[c] | NA |
| 1,1-Dichloroethene | 305 | NA | 13.3 | NA |
| Tetrachloroethene | 110 | NA | ND | NA |
| Trichloroethene | 590,000 | NA | 2,580 | NA |
| Vinyl Chloride | 32,000 | NA | 4,330 | NA |
| 1,1,1-Trichloroethane | 5,810 | NA | ND | NA |
| trans-1,2-dichloroethene | 4,100 | NA | 53.7 | NA |
| cis-1,2-dichloroethene | 350,000 | NA | 10,600 | NA |
| 1,2-dichloroethane | 53 | NA | ND | NA |
| Aroclors | 1.8[b] | 48.67[a] | 0.13[c] | 0.013[c] |

[a] - carbon-normalized value from station SP1-1, June 2019
[b] - data from seep water, SP1-1, spring 1990
[c] - maximum value from ROD, all others from 2017 and 2019 data.
µg/L – microgram per liter
mg/kg – milligram per liter
NA - not analyzed
ND - not detected above laboratory reporting limit (varies)

## Table 3-4. Groundwater and Surface Water RGs for OU 1 (µg/L)

| | ROD Drinking Water RG[a] | Basis of ROD Drinking Water RG | ROD RG Based on MTCA Method B Surface Water[a] |
|---|---|---|---|
| 1,1-DCA | 800 | MTCA B | NA |
| 1,2-DCA | 5 | MCL | 59 |
| 1,1-DCE | 0.5 | PQL | 1.9 |
| cis-1,2-DCE | 70 | MCL | NE |
| trans-1,2-DCE | 100 | MCL | 33,000 |
| PCE[g] | 5 | MCL | 4.2 |
| 1,1,1-TCA | 200 | MCL | 41,700 |
| TCE | 5 | MCL | 56 |
| Vinyl chloride | 0.5 | PQL: 0.02 | 2.9 |
| PCBs | 0.04 | PQL: 0.01-0.005 | PQL: 0.04 |
| 1,4-Dioxane[b] | 0.44[b] | MTCA B | NE |

a. Source: ROD Table 11-4 for groundwater and Table 11-5 for surface water (U.S. Navy, EPA, and Ecology, 1998). Many of these RGs frozen at the time of the ROD would be different if established based on current ARARs and are being re-evaluated based on a revised risk assessment.
b. The chemical was identified as a potential chemical of concern in the second FYR; therefore, no ROD RG was established.

Notes:
µg/L – microgram per liter
DCA – dichloroethane
DCE – dichloroethene
MCL – maximum contaminant level
MTCA – Model Toxics Control Act
MTCA B – MTCA Method B Cleanup Levels
NE – not established
PCBs – polychlorinated biphenyls
PCE – tetrachloroethene
PQL – practical quantitation limit
RG – remedial goal
ROD – Record of Decision
TCA – trichloroethane
TCE – trichloroethene
WQC – water quality criteria

## Table 3-5. Sample Detection Frequency

| **2019 Frequency of Detection in Groundwater Samples from Monitoring Wells** | | | | | | |
|---|---|---|---|---|---|---|
| **Analyte** | **Number of Groundwater Samples Collected from Monitoring Wells** | **Number of Detections in Monitoring Wells** | **Percent Detection** | **Minimum Detected Concentration (µg/L)** | **Maximum Detected Concentration (µg/L)** | **PAL (µg/L)** |
| cis-1,2-DCE | 32 | 27 | 84% | 2.1 | 260,000 | 16 |
| 1,1-DCA | 32 | 3 | 9% | 4.9 | 10 | 7.7 |
| 1,1-DCE | 32 | 19 | 59% | 0.59 | 78 | 7 |
| trans-1,2-DCE | 32 | 25 | 78% | 0.15 | 3,000 | 100 |
| TCE | 32 | 16 | 50% | 1.3 | 590,000 | 0.54 |
| VC | 32 | 29 | 91% | 0.05 | 19,000 | 0.029 |
| PCE | 32 | 5 | 16% | 1.6 | 110 | 5 |
| **2017 Frequency of Detection in Groundwater Samples from Monitoring Wells** | | | | | | |
| **Analyte** | **Number of Groundwater Samples Collected from Monitoring Wells** | **Number of Detections in Monitoring Wells** | **Percent Detection** | **Minimum Detected Concentration (µg/L)** | **Maximum Detected Concentration (µg/L)** | **PAL (µg/L)** |
| cis-1,2-DCE | 23 | 22 | 96% | 1.76 | 94,300 | 16 |
| 1,1-DCA | 23 | 2 | 9% | 0.357 | 5.09 | 7.7 |
| 1,1-DCE | 23 | 6 | 26% | 0.613 JD | 26.5 JD | 7 |
| trans-1,2-DCE | 23 | 16 | 70% | 0.64 | 938 | 100 |
| TCE | 23 | 18 | 78% | 1.18 | 361,000 | 0.54 |
| VC | 23 | 19 | 83% | 0.464 | 9,570 | 0.029 |
| PCE | 23 | 0* | 0% | NA | NA | 5 |

*Due to dilution, PCE results in 2017 were reported with high detection limits of greater than 500 µg/L. Concentrations below 500 µg/L were not reportable.

µg/L – microgram per liter
DCA – dichloroethane
DCE – dichloroethene
NA – not applicable because zero values cannot be used for this calculation
PAL –- project action limit
PCE – tetrachloroethene
TCA – trichloroethane
TCE – trichloroethene
VC – vinyl chloride

## Table 3-6. Evidence of Biodegradation Potential

| Landfill Area | Well ID | Screen Intervals (ft bgs) | 2017 Evidence of Biodegradation | 2019 Evidence of Biodegradation |
|---|---|---|---|---|
| South Plantation | MW1-49 | 5 to 15 | Limited | Limited |
| South Plantation | MW1-50 | 5 to 15 | Limited | Limited |
| South Plantation | MW1-51 | 10 to 20 | Limited | Limited |
| South Plantation | MW1-52 | 7 to 17 | Limited | Adequate |
| South Plantation | MW1-53 | 5 to 15 | Limited | Adequate |
| South Plantation | MW1-54 | 29 to 39 | Limited | Limited |
| South Plantation | MW1-55 | 26.5 to 36.5 | Limited | Adequate |
| South Plantation | MW1-56-12' | 8 to 12 | Limited | Adequate |
| South Plantation | MW1-56-24' | 20 to 24 | Limited | Adequate |
| South Plantation | MW1-57-10.5' | 6 to 10.5 | Adequate | Adequate |
| South Plantation | MW1-57-16' | 12 to 16 | Limited | Adequate |
| South Plantation | MW1-57-32' | 27 to 32 | Limited | Adequate |
| South Plantation | MW1-58-9' | 5 to 9 | Limited | Adequate |
| South Plantation | MW1-58-19' | 15 to 19 | Limited | Adequate |
| South Plantation | MW1-58-35' | 31 to 35 | Limited | Adequate |
| South Plantation | MW1-59 | 60 to 70 | -- | Adequate |
| South Plantation | MW1-60* | 15 to 25 | Limited | Inadequate |
| South Plantation | MW1-66 | 5 to 20 | -- | Limited |
| South Plantation | MW1-68* | 37 to 47 | -- | Adequate |
| Central Landfill | MW1-42 | 15 to 25 | Limited | Adequate |
| Central Landfill | MW1-43 | 15 to 25 | Limited | Adequate |
| Central Landfill | MW1-44 | 18 to 28 | Limited | Adequate |
| Central Landfill | MW1-45 | 15 to 25 | Limited | Adequate |
| Central Landfill | MW1-46 | 24 to 34 | Limited | Adequate |
| Central Landfill | MW1-47 | 15 to 25 | Adequate | Adequate |
| Central Landfill | MW1-48 | 15 to 25 | Limited | Limited |
| Central Landfill | MW1-61 | 3 to 13 | -- | Adequate |
| North Plantation | MW1-62 | 31 to 41 | -- | Adequate |
| North Plantation | MW1-63 | 30 to 40 | -- | Adequate |
| North Plantation | MW1-64 | 45 to 55 | -- | Adequate |
| North Plantation | MW1-65 | 53 to 63 | -- | Adequate |
| North Plantation | MW1-67 | 5 to 15 | -- | Adequate |

---- Well installed in 2019

* Sample from well was not analyzed for natural attenuation parameters.

## Table 3-7. Predominance of Halorespiring Bacteria, Sulfate Reducing Bacteria, and Methanogenic Microbes

| Well ID | Dhc % | Sulfate Reducing Bacterial % | Methanogen % | Total Eubacteria (cells/L) |
|---|---|---|---|---|
| **2019 Central Landfill** | | | | |
| MW1-42 | **0.96%** | 0.32% | 0.08% | 2.15E+06 |
| MW1-45 | 0.46% | **1.71%** | 0.08% | 1.56E+04 |
| MW1-46 | 1.45% | **9.57%** | 0.01% | 7.38E+05 |
| MW1-47 | 0.57% | **2.89%** | 0.01% | 1.57E+06 |
| MW1-48 | 0.04% | **0.69%** | 0.08% | 1.57E+07 |
| **2017 Central Landfill** | | | | |
| MW1-46 | 0.14% | **6.10%** | 0.05% | 3.59E+05 |
| MW1-47 | 0.15% | **3.45%** | 0.59% | 7.92E+05 |
| MW1-48 | 0.02% | **1.30%** | 0.20% | 7.31E+06 |
| **2019 South Plantation** | | | | |
| MW1-50 | 0.00% | **3.49%** | 0.01% | 9.11E+04 |
| MW1-51 | **1.45%** | 0.00% | 0.55% | 1.76E+03 |
| MW1-52 | 0.36% | **4.04%** | 0.01% | 1.65E+05 |
| MW1-57-10' | 0.04% | 0.00% | **0.08%** | 3.41E+04 |
| MW1-57-16' | 0.01% | 0.07% | **0.29%** | 5.62E+06 |
| MW1-57-32' | 0.69% | **2.25%** | 0.59% | 1.47E+06 |
| MW1-58-9' | **27.95%** | 2.47% | 0.10% | 6.69E+05 |
| MW1-59 | 0.05% | 0.00% | **0.39%** | 2.76E+03 |
| MW1-68 | 0.00%* | 0.00% | 0.00% | 4.84E+06 |
| **2017 South Plantation** | | | | |
| MW1-50 | 0.00% | **4.15%** | 0.00% | 5.25E+04 |
| MW1-52 | 0.02% | **0.60%** | 0.11% | 4.27E+05 |
| MW1-56-12' | 0.00% | 0.00% | **0.14%** | 3.58E+02 |
| MW1-56-24' | 0.00% | 0.00% | **1.18%** | 7.64E+01 |
| MW1-57-10' | 0.00% | 0.00% | **0.63%** | 2.39E+02 |
| MW1-57-16' | 0.02% | 0.81% | **4.53%** | 4.64E+05 |
| MW1-57-32' | 0.29% | **0.93%** | 0.60% | 1.77E+06 |

**Bold:** Highest percentage composition between target halorespiring bacteria, sulfate reducing bacteria, and methanogens.
* Majority of the microbes were identified as *Dehalobacter* (DHBt) with 0.09%.

## Table 3-8. Effect on cVOC Concentrations from DO, Iron, Sulfate, and Sulfide

| Well | TCE µg/L | | Cis-1,2-DCE µg/L | | VC µg/L | | DO mg/L | | Ferrous Iron mg/L | Sulfate mg/L | | Sulfide mg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.5 | | 16 | | 0.029 | | < 1 | | > 1 | < 20 | | > 1 |
| | **2017** | **2019** | **2017** | **2019** | **2017** | **2019** | **2017** | **2019** | **2017** | **2017** | **2019** | **2019** |
| Met all key biodegradation indicator criterion | | | | | | | | | | | | |
| MW1-47 | 86.4 | < 3 | 20900 | 1800 | 3400 | 620 | 0.23 | 0 | 1.91 | 1.97 | 1.59 | 1.16 |
| MW1-48 | 111 | < 0.15 | 438 | < 0.15 | 98.2 | 0.28 | 3.95 | 0.75 | 1.07 | < 0.66 | 0.363 | 1.39 |
| MW1-58-19' | 27.6 | < 0.15 | 1110 | 3.1 | 106 | 9.1 | 0.07 | 0.26 | 2.18 | 1.9 | < 0.09 | 1.35 |
| Not all key biodegradation indicator criterion were met | | | | | | | | | | | | |
| MW1-46 | < 25 | < 7.5 | 8500 | 4700 | 2050 | 1100 | 0.12 | 0 | 2.4 | 52.5 | 65.5 | 1.35 |
| MW1-58-9’ | 66.6 | 370 | 23600 | 6900 | 9570 | 19000 | 0.56 | 6.87 | 1.53 | 36.2 | 0.352 | 1.95 |

**Note:**
< = indicates less than
DCE – dichloroethene
DO – dissolved oxygen
mg/L – milligram per liter
TCE – trichloroethene
VC – vinyl chloride
µg/L – microgram per liter

## Table 3-9. TPH versus Total PCBs in Soil and Groundwater (Monitoring Wells)

| Location Name | Sample Name | Sampling Media | Sample Type | Sampling Depth/Screen Interval (ft bgs) | TPH-Diesel Range C12-C24[a] | Total PCBs (Congeners)[b] |
|---|---|---|---|---|---|---|
| MW1-64/NP-B137 | NP-B137-S-52-191008 | S | N | 52 | 1,200 U | 0.000186 |
| | MW1-64-191024 | GW | N | 45 - 55 | 270 | 0.00016 |
| MW1-2 | MW1-2-191029 | GW | N | 12.5 - 17.5 | NS | 0.0000006 (FD) |
| MW1-65/NP-B138 | NP-B138-S-62-191009 | S | N | 62 | 1,100 U | 0.199 |
| | MW1-65-191021 | GW | N | 53 - 63 | 48 J | 0.00026 |
| MW1-67/NP-B138[c] | NP-B138-S-6-191009 | S | P | 6 | 1,100 UJ | **2,521** |
| | NP-B138-S-5-191009 | S | FD | 5 | 2,700 J | **3,835** |
| | MW1-67-191028[c] | GW | N | 5 - 15 | **780** | 0.011 |
| **Soil PAL (µg/kg)** | | | | | 2,000,000 | 500 |
| **Soil ROD RG (µg/kg)** | | | | | NA[d] | NA[d] |
| **Groundwater PAL (µg/L)** | | | | | 500 | 0.1 |
| **Groundwater ROD RG (µg/L)** | | | | | NA[d] | 0.04[e] |

Notes:
[a] Soil TPH units = µg/kg; GW TPH units = µg/L
[b] Soil PCB units = µg/kg; GW PCB units = µg/L
[c] MW-67 installed in NP-B143 borehole, which was part of nested pair with NP-B138.
[d] There is no RG for PCBs in soil or TPH-D in soil or groundwater in the ROD.
[e] WAC 173-340-700(6) states that in cases where cleanup levels are below the practical quantitation limit (PQL), compliance with cleanup standards will be based on the PQL. For this chemical, the PQL is higher than the cleanup level. In accordance with WAC 173-340-700(6) and Ecology's Implementation Memorandum No. 3 (PQLs as Cleanup Standards, dated November 24, 1993) the PQL was selected as the remediation goal for this chemical.

## Table 3-9 (continued). TPH versus Total PCBs in Soil and Groundwater (Monitoring Wells)

FD – field duplicate
ft bgs – feet below ground surface
GW – groundwater
J – The reported value is an estimated concentration.
N – normal
NA – not applicable
NS – not sampled
P – parent sample
PAL – project action limit
PCB – polychlorinated biphenyl
RG – remedial goal
S – soil
TPH – total petroleum hydrocarbons
U – The analyte was analyzed but not detected at or above the stated limit of detection
µg/kg – microgram per kilogram
µg/L – microgram per liter
**Bolded** values indicate that the reported concentration exceeds the PAL.

**Table 3-10. TPH versus PCB Aroclors in Soil and Grab Groundwater Samples**

| Location Name | Sample Name | Sampling Media | Sampling Depth/Screen Interval (ft bgs) | TPH-Diesel Range C12-C24[a] | Total PCB Aroclors[b] |
|---|---|---|---|---|---|
| NP-B118 | NP-B118-S-13-190624 | S | 13 | 260,000 | 26 U |
| | NP-B118-S-16-190624 | S | 16 | 1,200 U | 25 U |
| | NP-B118-GW-20-190624 | GW | 16 - 20 | 310 | 0.008 U |
| | NP-B118-S-34-190625 | S | 34 | 1,200 U | 24 U |
| | NP-B118-GW-35-190625 | GW | 31 - 35 | 50 U | 0.008 U |
| NP-B119 | NP-B119-S-07-190621 | S | 7 | 1,300 U | 25 UJ |
| | NP-B119-S-12-190621 | S | 12 | **3,200,000** | 85 J |
| | NP-B119-S-15-190621 | S | 15 | 1,200 U | 25 UJ |
| | NP-B119-GW-15-190621 | GW | 10 - 15 | 410 | 0.008 U |
| | NP-B119-GW-32-190621 | GW | 28 - 32 | 1,200 J | 0.008 U |
| NP-B120 | NP-B120-S-12.5-190624 | S | 12.5 | 490,000 | **16,000 J** |
| | NP-B120-GW-15-190624 | GW | 11 - 15 | 320 | 0.008 U |
| | NP-B120-S-35.5-190624 | S | 35.5 | 1,200 U | 0.008 U |
| | NP-B120-S-42-190624 | S | 42 | 1,100 U | 22 U |
| | NP-B120-S-49.5-190624 | S | 49.5 | 1,100 U | 21 U |
| | NP-B120-GW-50-190624 | GW | 46 - 50 | 210 | 0.008 U |
| NP-B121 | NP-B121-S-05-190620 | S | 5 | 2,000,000 | **210,000** |
| | NP-B121-S-13-190620 | S | 13 | 290,000 J | 29 UJ |
| | NP-B121-S-14-190620 | S | 13 (FD) | 53,000 J | 30 UJ |
| | NP-B121-GW-15-190620 | GW | 10 - 15 | 260 | 0.008 UJ |
| | NP-B121-S-34-190620 | S | 34 | 1,200 U | 24 UJ |
| | NP-B121-GW-35-190620 | GW | 31 - 35 | 150 | 0.008 U |
| NP-B122 | NP-B122-S-05-190620 | S | 5 | 1,600,000 | 160 J |
| | NP-B122-S-09-190620 | S | 9 | 890,000 | **8,000 J** |
| | NP-B122-GW-15-190620 | GW | 10 - 15 | **920** | 0.008 U |
| | NP-B122-S-27-190621 | S | 27 | 1,300 U | 25 UJ |
| | NP-B122-GW-28-190621 | GW | 24 - 28 | 50 U | 0.008 U |
| NP-B123 | NP-B123-S-19-190619 | S | 19 | 49,000 | 130 J |
| | NP-B123-S-25-190619 | S | 25 | 1,400 U | 28 UJ |
| | NP-B123-GW-19-190619 | GW | 15 - 20 | 300 U | 0.008 UJ |
| | NP-B123-GW-20-190619 | GW | 15 - 20 | 390 U | 0.008 UJ |
| | NP-B123-S-40-190619 | S | 40 | 1,400 U | 28 UJ |
| | NP-B123-GW-40-190619 | GW | 36 - 40 | 210 U | 0.008 U |
| NP-B124 | NP-B124-S-10-190620 | S | 10 | 50,000 | 270 J |
| | NP-B124-S-14-190620 | S | 14 | 150,000 | **810 J** |
| | NP-B124-GW-20-190620 | GW | 15 - 20 | 260 | 0.008 UJ |
| | NP-B124-S-28-190620 | S | 28 | 1,300 U | 25 U |
| | NP-B124-GW-29-190620 | GW | 25 - 29 | 50 U | 0.008 U |
| NP-B125 | NP-B125-S-20-190619 | S | 20 | 88,000 | **6,500 J** |
| | NP-B125-GW-23-190619 | GW | 18 - 23 | 260 U | 0.008 UJ |
| | NP-B125-S-38-190619 | S | 38 | 25,000 | 24 U |
| | NP-B125-GW-39-190619 | GW | 35 - 39 | 50 U | 0.008 U |
| | NP-B125-S-45-190619 | S | 45 | 1,200 U | 24 U |
| | | | **Soil PAL (µg/kg)** | 2,000,000 | 500 |
| | | | **Soil ROD RG (µg/kg)** | NA[c] | NA[c] |
| | | | **Groundwater PAL (µg/L)** | 500 | 0.1 |
| | | | **Groundwater ROD RG (µg/L** | NA[c] | 0.04[d] |

Notes:
[a] Soil TPH units = µg/kg; GW TPH units = µg/L
[b] Soil PCBs units = µg/kg; GW PCBs units = µg/L
[c] There is no RG for PCBs in soil or TPH-D in soil or groundwater in the ROD.
[d] WAC 173-340-700(6) states that in cases where cleanup levels are below the practical quantitation limit (PQL), compliance with cleanup standards will be based on the PQL. For this chemical, the PQL is higher than the cleanup level. In accordance with WAC 173-340-700(6) and Ecology's Implementation Memorandum No. 3 (PQLs as Cleanup Standards, dated November 24, 1993) the PQL was selected as the remediation goal for this chemical.
FD – field duplicate
ft bgs – feet below ground surface
GW – groundwater
J – The reported value is an estimated concentration.
NA – not applicable
PAL – project action limit PCB – polychlorinated biphenyl

**Table 3-10. TPH versus PCB Aroclors in Soil and Grab Groundwater Samples (continued)**

RG – remedial goal
ROD – record of decision
S – soil
U – The analyte was analyzed but not detected at or above the stated limit of detection.
μg/kg – microgram per kilogram
μg/L – microgram per liter
**Bolded** values indicate that the reported concentration exceeds the PAL

## Table 3-11. Total PCB Detections by Homolog – Soil

| Total Chlorine Atoms (total congeners in this category) | NP-B137 (52') | NP-B138 (5') | NP-B138 (62') |
|---|---|---|---|
| | *Deep (MW1-64)* | *Shallow (MW1-67)* | *Deep (MW1-65)* |
| **1** (3) highest solubility | -- | 3 | -- |
| **2** (12) | -- | 4 | -- |
| **3** (24) | 3 | 18 | 3 |
| **4** (42) | 12 | 32 | 16 |
| **5** (46) | 20 | 36 | 20 |
| **6** (42) | 20 | 32 | 13 |
| **7** (24) | -- | 21 | 1 |
| **8** (12) | -- | 10 | -- |
| **9** (3) | -- | 2 | -- |
| **10** (1) lowest solubility | -- | 1 | -- |
| **Total Detections** | 55 | 159 | 53 |
| **TPH GW (µg/L)** | 270 | 780 | 48 J |
| **TPH S (µg/kg)** | 1,200 U | 2,700 J - 2,000,000 [a] | 1,100 U |

[a] These TPH results are from grab samples collected at location NP-B121 at 5 ft bgs, adjacent to NP-B138/MW1-67.
ft bgs – feet below ground surface
GW – groundwater
J – The reported value is an estimated concentration.
PCB – polychlorinated biphenyl
S – soil
TPH – total petroleum hydrocarbons
U – The analyte was analyzed but not detected at or above the stated limit of detection.
µg/kg – microgram per kilogram
µg/L – microgram per liter

## Table 3-12. Total PCB Detections by Homolog – Groundwater

| Total Chlorine Atoms (total congeners in this category) | MW1-2 | MW1-2 FD | MW1-64 | MW1-67 | MW1-65 | MW1-18 |
|---|---|---|---|---|---|---|
| | *Shallow* | | *Deep* | *Shallow* | *Deep* | *Shallow* |
| **1** (3) highest solubility | -- | -- | 1 | 3 | 2 | 2 |
| **2** (12) | -- | -- | 2 | 10 | -- | -- |
| **3** (24) | -- | -- | 13 | 18 | 14 | 4 |
| **4** (42) | -- | 1 | 11 | 34 | 18 | 9 |
| **5** (46) | 2 | 1 | 7 | 28 | 14 | 4 |
| **6** (42) | 2 | 2 | 1 | 24 | 11 | 11 |
| **7** (24) | -- | 4 | -- | 12 | 2 | 5 |
| **8** (12) | -- | 1 | -- | 8 | 3 | 3 |
| **9** (3) | -- | -- | -- | 1 | -- | -- |
| **10** (1) lowest solubility | -- | -- | -- | -- | -- | -- |
| **Total Detections** | 4 | 9 | 35 | 138 | 64 | 38 |
| **TPH GW (µg/L)** | 320[a] | | 270 | 780 | 48 J | -- |
| **TPH S (µg/kg)** | 490,000 [a] | | 1,200 U | 2,700 - 2,000,000 [b] | 1,100 U | -- |

[a] – These TPH results are from grab samples collected at location NP-B120, adjacent to existing well MW1-2.
[b] – These TPH results are from grab samples collected at location NP-B121 at 5 ft bgs, adjacent to NP-B138/MW1-67.
GW – groundwater
J – The reported value is an estimated concentration.
PCB – polychlorinated biphenyl
S – soil
TPH – total petroleum hydrocarbons
U – The analyte was analyzed but not detected at or above the stated limit of detection.
µg/kg – microgram per kilogram
µg/L – microgram per liter

# 4.0 CONCLUSIONS AND RECOMMENDATIONS

This section presents the conclusions of the site recharacterization elements of the supplemental RI and recommendations for next steps.

## 4.1 CONCLUSIONS

The overall objective of the investigations reported in this document was to refine the CSM in support of potential remedy optimization to reduce the restoration timeframe. Given this objective, the refined CSM presented in Section 3.1 and supported by the remainder of Section 3 constitutes the detailed conclusions of this report. The remainder of this section summarizes the findings presented in Section 3.

The updated CSM depicts a hydrogeologic regime and cVOC and 1,4-dioxane plumes in groundwater that are different in important ways from the understanding underlying the selected remedy in the OU 1 ROD. The updated CSM calls into question the adequacy of the remedy in place and an update of the existing remedy is warranted. The hydrogeologic setting has been reinterpreted from a distinct contaminated “shallow aquifer” and relatively uncontaminated “intermediate aquifer” to a complex assemblage of paleochannels, with cVOC contamination extending to approximately 100 ft bgs. These paleochannels are now understood to extend beneath Dogfish Bay and likely provide preferential flow pathways for cVOC transport further beneath the bay than understood based on a simple saltwater wedge model. A second, higher concentration point of discharge from shallow South Plantation groundwater to adjacent wetland surface water is now known, and PCBs have been shown to remain within wetland sediment above the cleanup criteria in the area previously subject to remediation. Although conditions are favorable for biodegradation, these conditions do not support full reductive dechlorination to nontoxic end products, but rather result in “DCE stall.” Higher concentration source areas within the landfill are now identified, with the transport from these areas characterized, providing a focus for future focused FS efforts.

The key observations of the supplemental RI are:

- The hydrogeologic regime is characterized by shallow Holocene-age tidal channel deposits that result in a complex assemblage of fine sands, silts, and clays that vary in their depth of occurrence over short distances between exploratory borings. These deposits are underlain by Olympia-age strata identifiable by a peat-rich silt and clay found overlain by a coarse sand/fine gravel. The Olympia-age strata exhibit a channelized surface that appears to provide preferential migration pathways for cVOCs along the regional groundwater flow direction to the northwest.

- The landfill waste body itself was placed in a tidal wetland atop the Holocene-age deposits, and the former wetland sediment layer is observable in many exploratory borings. The shallow depth to groundwater (as shallow as 2 ft bgs in some areas and seasons) and the elevated landfill waste body compared to the elevation of the adjacent remaining wetland results in local groundwater to surface transport of cVOCs from the waste body to the wetland. These shallow, local groundwater flows are driven by the hyper-local topography and thus can be to the south, southwest, west or northwest, in contrast to the deeper northwesterly regional groundwater flow direction; in other words, the landfill creates localized radial flow of contaminated shallow groundwater.
- The paleochannel features appear to extend beyond the landfill footprint and beyond Navy property to the subsurface of Dogfish Bay, as evidence by subsurface conductivity changes during tidal cycles mapped using geophysics.
- The cVOC plume in groundwater (as defined by exceedance of a regulatory standard by any of the cVOC COCs identified in the ROD) is present beneath the majority of the landfill footprint, extending to a maximum depth of approximately 100 ft bgs. This plume originates primarily from three identified higher concentration source areas within the landfill. But based on the typical nature of ad-hoc landfill construction, the plume probably also emanates from a larger number of sources distributed throughout the footprint. cVOCs have sorbed to fine-grained soils throughout the plume area, and long-term, slow back-diffusion from these fine matrices will impact the efficacy of many potential remedial technologies.
- The biodegradation evaluation for cVOCs concluded that groundwater conditions generally appear adequate to support biodegradation, but are not sufficient to result in robust, complete dechlorination of the site. Prevalent accumulation of intermediate daughter products (i.e., cis-1,2-DCE and VC) and relatively low concentrations of the innocuous end products (e.g., ethene) represent incomplete reductive dechlorination and suggest that biogeochemical conditions in groundwater are not optimal for complete dechlorination of PCE and TCE to ethene. The accumulation of cis-1,2-DCE and VC at OU 1 suggests that the degradation progress remains in a long transitional DCE and VC stage (often referred to as "DCE stall").
- The solvent-stabilizer compound 1,4-dioxane is present in the higher concentration area identified in the Central Landfill, and in the downgradient plume to the northwest, but is not found in the southern portion of the landfill (see Appendix B for more detail on this distribution of 1,4-dioxane). This may reflect the variation in material types disposed over time in different portions of the landfill. 1,4-Dioxane is found along with low concentrations of VC in wells located within the apparent preferential flow pathway offsite on the Highway 308 causeway. The presence of these more mobile compounds at this location may indicate that the Highway 308 causeway is near the leading edge of the plume.

- Elevated PCB concentrations appear to be widespread in soil within the landfill waste body from at least the middle of the North Plantation and northward. Although in general PCBs exhibit a low solubility and do not transport readily in groundwater, the 2019 data indicate that PCB transport in groundwater at this site may be an important mechanism, with oil-range petroleum serving to facilitate PCB transport both laterally and vertically. The detection of PCBs in wells installed in 2022 to investigate the vertical extent of COCs at the site may indicate downward transport of PCBs at greater depth and over a wider portion of OU 1 than previously understood. However, these results from the deeper wells may be misleading and may not represent actual PCB concentrations in the aquifer at the depths explored (Section 3.5.4). Seep water sampling results, and the results of ISM sampling of sediment in the reach of Marsh Creek downstream of the seep indicate that there is an ongoing contribution of PCBs to surface water from groundwater.

## 4.2 RECOMMENDATIONS AND NEXT STEPS

Additional elements of the supplemental RI are being conducted under separate contract and will be reported under separate cover. These include a revised risk assessment and an investigation of potential off-site transport of contaminants beneath Dogfish Bay. These elements will further inform the CSM for OU 1. Remaining data gaps in the site CSM include the following:

- The updated risk assessment workplan provides a comprehensive analysis of gaps in the original site-wide risk assessment and the forthcoming risk assessment will address the identified gaps and needed updates.
- It is uncertain whether cVOCs are being transported from shallow groundwater to surface water (Marsh Creek) in the northwestern area of OU 1. Additional shallow groundwater samples and/or sediment porewater samples may be needed along transects between MW1-17/MW1-43 to Marsh Creek.
- The detection of PCBs in wells installed in 2022 to investigate the vertical extent of COCs at the site may indicate downward transport of PCBs at greater depth and over a wider portion of OU 1 than previously understood. However, as discussed in Section 3.5.4, these results from the deeper wells may be misleading and may not represent actual PCB concentrations in the aquifer at the depths explored. Additional sampling and development of the wells installed in 2022 is needed to assess the representativeness of the data collected to date.
- Off-site transport of cVOCs and 1,4-dioxane within the coarse-grained paleochannels to the northwest, beneath Dogfish Bay, is possible; however, environmental sampling has not occurred further northwest (i.e., downgradient) of the Highway 308 causeway. Sampling beneath Dogfish Bay is currently in the planning process under separate contract.

Following completion of these additional supplemental RI elements, a focused FS is recommended to optimize the existing remedy. A comprehensive focused FS is recommended with the following specific considerations highlighted:

- A comprehensive FS was completed in the 1990s that relied on a robust "tiger team" approach and community input. Although dated and based on the older CSM, the findings of this previous FS should be considered during preparation of the upcoming focused FS. Many of the conclusions regarding potential remedial alternative impacts to the wetland may still be valid.
- The remedial alternative evaluation in the upcoming focused FS would be more robust if informed by analytical results of groundwater samples from wells installed in 2017, 2019, and 2022 that demonstrate concentration trends over time and provide representative mean concentrations in each well. A set of seasonal synoptic depth to water measurements keyed to tide stages would also better inform the focused FS evaluations compared to the relatively limited data set available based on this supplemental RI. Also during these recommended sampling events, clear bailers and oil/water interface probes should be used to assess the presence or absence of accumulated LNAPL or DNAPL in wells, especially in the South Plantation.
- The findings of the groundwater modeling performed as part of this supplemental RI (Appendix F) should be carefully considered when evaluating remedial alternatives. The modeled matrix diffusion is likely to strongly affect the efficacy of many remedial technologies and should be one of the factors considered when evaluating remedial technologies.
- The results of the 2022 HVDPE pilot study (Navy, 2023) should be considered, not only for evaluation of this particular technology, but to support the evaluation of other technologies. Much of the data generated during this pilot study are relevant to evaluation of a range of other technologies.
- The 3D depiction of the cVOC plume should be leveraged to estimate the approximate total contaminant mass present within the plume using a three-phase or four-phase portioning model and the volume of each interpolated 3-D concentration "shell." This approximate total mass will provide a useful baseline to compare to potential mass removals estimated for various remedial technologies.

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# Appendix A

## Responses to Agency and Stakeholder Comments on the Draft Report

| **Document Title:**<br>Draft Supplemental Remedial Investigation Report Site Recharacterization Operable Unit 1, Naval Base Kitsap, Keyport, Washington |
|---|
| **Document dated:** June 30, 2023 |

**Comments from: Binod Chaudhary, Washington State Department of Ecology**
**Comments dated: June 28, 2023**

| # | Page No./ Line No. | Comment | Proposed Response | Response Accepted? |
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| **1** | General | Ecology believes that a complete delineation of nature and extent of contamination is not complete in this version of supplemental RI report pending with the ongoing investigations. Therefore, Ecology thinks that this report may need to be updated based on the findings of ongoing investigations.<br>• Include references for Table 3-1 and 3-2 in the body of the report. Are COIs, COPCs and COCs determinations based on ongoing human health and ecological risk assessment or from the past respective risk assessments?<br>• Include a table showing investigation levels for various media that are used for supplemental RI.<br>• What are current cleanup levels or current ARAR cleanup levels that are used in the supplemental RI?<br>• Please include a rationale for not investigating north plantation area during phase I and II investigations. But this area is included during 2019-2022 investigations.<br>• Include plan view of plume maps of various COCs after Figure 3-16 and reference those figures in the report. | As noted in the introduction, Section 1.0, ongoing investigations will be documented in Volumes 1 and 2 of the supplemental RI.<br>• The source of Tables 3-1 and 3-2 is called out in Section 3.1.2. These tables document the information from past risk assessments.<br>• As noted in the response to the next bullet in this comment, the screening levels used in this Volume 1 supplemental RI are the ROD cleanup levels as revised by more recent ARAR values identified during preparation of the sampling and analysis workplans for each work element. Project Action Levels (screening levels) were agreed upon for each work plan, and were often the most conservative ARAR value for a chemical of interest in order to maximize the future utility of the data. Because of the variations in the screening levels used for comparison throughout the various investigations that support this supplemental RI, we feel that a single comprehensive table would not be helpful. The screening levels used for comparison are shown in the tables and figures presented | Yes |

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| | | • Can you please explain why plume beneath south plantation is not migrating with the direction of regional groundwater flow?<br><br>• Provide tentative mass of contaminant at least in four hotspots or source areas that will be helpful for future study. | throughout this supplemental RI. Note that the Volume 2 risk assessment will evaluate the appropriate risk-based cleanup levels and will identify any additional analytes that should be carried forward that are not already designated as COCs in the ROD.<br>• The screening levels used in this Volume 1 supplemental RI are the ROD cleanup levels as revised by more recent ARAR values identified during preparation of the sampling and analysis workplans for each work element.<br>• The rationale for the initial investigations is described first at the end of Section 1.3.3, then in the early portions of Section 2. The investigations were not initially intended as a site-wide supplemental RI, but rather to investigate potential hotspots that were expected to be present in the South Plantation.<br>• Because of the complex vertical architecture of the plume, plan view maps are not a very informative method of data depiction at this site. The 3-dimensional plume maps in Appendix G provide many views of the plume, including plan views at various depths in the plume. | |

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| | | | • The radial direction of shallow groundwater flow and contaminant migration at the South Plantation is discussed in Section 3.1.4.<br>• Estimating contaminant mass is a future work recommendation of this volume 1 supplemental RI, in Section 4.2. Therefore, no tentative calculations have been made at this time. | |
| **2** | Sec. 1.2 & pg. 1-3 | "The marsh also receives input from stormwater drainage systems at two outfalls and shallow groundwater flowing toward the marsh from all sides in the shallow aquifer."<br><br>Please include reference of figure that shows the location of stormwater outfalls. | We will reference Figure 1-3. We will also remove the phrase "at two outfalls," because there is some uncertainty regarding the presence or absence of some of the stormdrains shown on Figure 1-3 (from the facility base map), which are hidden under dense vegetation. | Yes |
| **3** | Sec. 2.1 & pg. 2-1 | Change number sequencing for Phase I and subsequent Phases of investigations as currently it seems that Phase II is a part of Phase I investigations. | Yes, thank you. We will correct the heading levels in Section 2. | Yes |
| **4** | Sec. 2.1 & pg. 2-1 | "Given the location (in the Central Landfill between the two plantations and at the western edge of the paved portion of the landfill), it was not possible to collect tree core samples upgradient of MW1-17."<br><br>Were there any trees at upgradient of MW1-17 during sampling? It looks like areas upstream of MW1-17 is paved. | Yes, that is correct, the area upgradient of MW1-17 is paved and there are/were no trees. | Yes |

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| **5** | Sec. 2.1.4 & Figure 2-2 | There are 69 direct-push borings as per the first bullet in section 2.1.4. But, on Figure 2-2, Legend indicates Geoprobe. Are direct-push borings and Geoprobe same? If so, include Geoprobe within a bracket of direct-push borings. Also, reference the report that has boring logs information of 69 direct-push borings. The phase II investigation report does not have boring logs information besides the location of borings in one of the maps. | Yes, direct-push drilling is the technique and Geoprobe is the brand name of a manufacturer of direct-push equipment. We recommend not using this brand name to refer to the technique. To be consistent, we will change "Geoprobe" in Figures 2-2 and 2-3 to "Direct Push." The boring logs from the Phase II investigation are included as Appendix D of the Phase II Site Recharacterization Report. We will add a statement to this effect. | Yes, thank you. |
| **6** | Sec. 2.2.1& pg. 2-1 | "Phase I concluded that identified geophysical anomalies were not collocated with high COC concentrations in tree cores or groundwater."<br><br>Was groundwater sampled during Phase I investigation? If not, how were geophysical anomalies compared with high COC concentrations in groundwater? | The geophysical results were compared to the groundwater sample data generated during many years of long-term monitoring data collection from shallow groundwater monitoring wells. The most relevant groundwater sample results are shown in Table 4-1 of the Phase I report, with isoconcentration contours included on the plan view figures in Appendix C. | Yes |
| **7** | Sec. 2.1.1 & pg. 2-2 | "Since 2006, a general upward trend of daughter product concentrations has been reported in samples from MW1-17."<br><br>Include a refence for a table that shows upward trend of daughter products in MW1-17 samples. | We will add a reference to Appendix C of the fifth five-year review, which includes all of the groundwater monitoring data for this well. | Yes |
| **8** | Sec. 2.1.2 & pg. 2-3 | "Although COCs were not detected in groundwater at the two wells east of Bradley Road (MW1-3 and MW1-11, Figure 2-3), a high soil gas concentration was historically found at | Rather than show only GM1-2 on the figures in the supplemental RI, we will add a reference to Figure 2-5 of the 1993 remedial investigation report, which shows all of the soil gas sampling location and the analytical data. | Yes |

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| | | soil gas location GM1-2 near a building on the east side of the road. "<br><br>Please show the location of GM1-2 on Figure 2-3. Also, include COCs (such as total cVOCs or any cVOC) in soil gas that was found high at location GM1-2 instead of just mentioning a high soil gas concentration. | | |
| **9** | Sec. 2.1.3 & pg. 2-4 | "62 MIP borings were completed in the South Plantation, and seven MIP borings were completed in the Central Landfill."<br><br>As per Phase II investigation report, there are 61 MIP locations in south plantation and 8 MIP locations in Central landfill areas. Please make correction on the cited sentence accordingly. Also, please include depth ranges of borings of MIPs both in south plantation and central landfill areas. | Page 1-10 of the Phase II investigation report documents 62 MIP locations in the South Plantation and the 7 in the Central Landfill, so it appears that there is no discrepancy. We will add the depth ranges as requested. | Yes |
| **10** | Sec. 2.1.4 & pg. 2-5 | "Soil and groundwater samples were obtained from continuous-core, direct-push borings at 69 investigation locations (not counting step-out locations [e.g., SP-B01A] as unique sampling locations), with the samples analyzed for target cVOCs."<br><br>Please provide reference for 69 direct-push boring logs information and include the reference document in the appendix. | We will cite the report covering the 2017 work however, this report is large and would add another 28 Mb to the already large electronic file for the supplemental RI. It seems inconsistent to attach the report covering 2017 and not attach the report covering the MIP probe and soil vapor investigation conducted in 2016 and the Phase I investigation conducted in 2014. All of these investigations are discussed in Section 2 of this supplemental RI. We believe that it is best to reference, but not attach, these | Yes |

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| | | | large previous reports given the already very large file size for the supplemental RI. | |
| **11** | Sec. 2.1.4 & pg. 2-5 | "Additional analyses, beyond the list of target cVOCs, were performed on a small subset of samples based on field observations of oily residue."<br><br>Include a list of additional analyses within a bracket. Were additional analyses performed only in south plantation or both in south plantation and central landfill? | We will revise this sentence to read, "Additional analyses, beyond the list of target cVOCs, were performed on a small subset of samples from areas in both the Central Landfill and South Plantation based on field observations of oily residue. These additional analyses included the full list of VOCs by Method 8260, semivolatile organics (SVOCs), PCBs as Aroclors, petroleum hydrocarbons, and Otto fuel." | Yes |
| **12** | Sec. 2.1.4 & pg. 2-6 | "Wells located in apparent hotspots that were expected to be the focus of potential future remedial action were additionally analyzed for microbial population, perfluoroalkyl substances (PFAS), and 1,4-dioxane. "<br><br>Since 1,4-dioxane is analyzed in hotspot areas of south plantation, why is 1,4-dioxane not modelled in Appendix G2? | 1,4-dioxane has not been detected in the South Plantation so no plume is depicted on the figures in Appendix G2. | Yes |
| **13** | Sec. 2.1.4 & pg. 2-7 | "In the Central Landfill, residual cVOC sources (including NAPL) were observed upgradient of well MW1-17 in the vicinity of monitoring wells MW1-46, MW1-47, and MW1-48."<br><br>Did Navy observe NAPL or oily substances in any monitoring wells in central landfill and south plantation? | Only as reported in Section 3.1.3, following HVDPE testing. We will add a statement to Section 3.1.3 that LNAPL was only observed in monitoring wells following HVDPE testing, when drawdown was induced in the well, allowing LNAPL to enter the well screen. | Yes |

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| **14** | Sec. 2.1.4 & pg. 2-7 | "Unexpected oily substances were observed in some direct-push borings, and the nature of these oily substances was assessed using additional laboratory analyses for fuels, PCBs, and a full list of VOCs and semivolatile organic compounds (SVOCs) in soil and groundwater samples from borings SP-B01, SP-B18, SP-B21, and SP-B62. "<br><br>Please include a reference for figure that shows location of highlighted borings. | We will call out Figures 2-2 and 2-3 at this location. We will also correct "SP-B18" and "SP-B21" to "CL-B18" and "CL-B21" because these two locations are in the Central Landfill area. | Yes |
| **15** | Sec. 2.1.4 & pg. 2-8 | "Of the 10 monitoring wells, one or more PFAS compounds were detected in five monitoring wells (MW1-47, MW1-48, MW1-56, MW1-57, MW1-58, and MW1-60)"<br><br>There are six wells in the bracket. Please make correction.<br><br>Were PFAS compounds and 1,4-dioxane sampled from same 10 monitoring wells? Also, is a delineation for nature and extent of these compounds complete in this RI or need additional investigations to fully delineate these COCs? | Thank you for catching this. We will change "five" to "six."<br><br>Yes, during the 2017 investigation samples from the same 10 monitoring wells were sampled for PFAS and 1,4-dioxane, as shown in Table 2-3 of the report covering the 2017 investigation. A more comprehensive investigation of the extent of these two analytes was conducted as part of later investigations described in this volume 1 supplemental RI. 1,4-dioxane extent on site is fully characterized, with offsite extent to be further investigated in later volumes of the supplemental RI. A separate RI will be completed in the future for PFAS. | Yes |
| **16** | Sec. 2.1.5 & pg. 2-15 | "Sample results provided in the memorandum and in Section 3.4 were generated under the SAP covering 2017 sampling (Navy, 2017a), the SAP covering 2019 sampling (Navy, 2019b), and | The report covering 2017 work is large and would add another 28 Mb to the already large electronic file for the supplemental RI. It seems inconsistent to attach the report covering 2017 and not attach the report covering the MIP | Yes |

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| | | included historical data from a USGS report (USGS, 2015). The 2017 sample results were previously reported (Navy, 2018b).”<br><br>Please include the report for 2017 sample results as appendix in this report. | probe and soil vapor investigation conducted in 2016 and the Phase I investigation conducted in 2014. All of these investigations are discussed in Section 2 of this supplemental RI. We believe that it is best to reference, but not attach, these large previous reports given the already very large file size for the supplemental RI. | |
| **17** | Sec. 2.1.5 & pg. 2-18 | “Sonic drilling locations (Figures 2-2 and 2-3) were distributed across OU 1, from the South Plantation up to the North Plantation to meet the data quality objectives. “<br><br>Please include DQOs that are related to distribution of samplings locations throughout the landfill. | We will add a reference to Worksheet 11 of the SAP covering this work, which established the DQOs. | Yes |
| **18** | Sec. 3.1.1 & pg. 3-2 | “The most probable northern and eastern boundary of the waste body is the historical shoreline (Figure 2-3).”<br><br>Figure 2-3 does not have a shoreline. Please include the shoreline in this figure. Also, is the historical shoreline a boundary of the waste body? | We will add the historical shoreline to Figures 2-2 and 2-3. The landfill was created by filling the tidal wetland that existed adjacent to the historical shoreline, so the shoreline has been hypothesized as the boundary of the waste body. Results of soil, groundwater, and porewater samples have supported this hypothesis. | Yes |
| **19** | Sec. 3.1.3 & pg. 3-5 | “No soil exhibiting COCs at concentrations exceeding the current cleanup levels has been identified outside the landfill footprint or off of Navy property.”<br><br>The landfill footprint and Navy property line is different to each other. Please confirm | Confirming that both parts of these statement are true. No soil exhibiting COCs exceeding CULs has been identified outside of the landfill footprint. No soil exhibiting COCs exceeding CULs has been identified off of Navy property. | Yes |

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| | | whether COCs in soils exceeding cleanup levels are only within the landfill footprint or also outside the footprint and make correction if needed. | | |
| **20** | Sec. 3.1.3 & pg. 3-7 | "Additional assessment of PCBs in sediment was recommended by the fourth five-year review (Navy, 2015b), and this additional assessment (along with the overall findings of additional investigations within the landfill footprint), led to an expanded investigation of COIs in sediment and a revised risk assessment, which is ongoing by others."<br><br>Please change highlight to "which is reported in volume 2 of the supplemental RI report." | We will change the highlighted text to "...which will be reported in a future volume of the supplemental RI report." We expect that this will be volume 2, but feel it is best to not constrain the volume number itself. | Yes |
| **21** | Sec. 3.1.3 & pg. 3-7 | "These results serve as baseline 95% UCL mean concentrations in the reach of Marsh Creek downstream of seep SP1-1 and will be used for comparison to future results, to establish temporal concentration trends, and to evaluate concentrations before and after any potential future additional removal or remedial actions in this area."<br><br>Please include 95% UCL mean concentration value in the cited sentence that will be easier to compare with SCO value. Also, please include reference of determination that 95% UCL mean concentration will be used for any potential future remedial actions. | We will add the 95% UCL mean concentrations for the three decision units as requested. We will add a reference to the SAP for this work. The DQOs for this sampling establish that the 95% UCL mean concentration of PCBs in this area will be used as a baseline for comparison to future results. | Yes |

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| **22** | Sec. 3.1.4 & pg. 3-9 | "Total PCB concentrations (total Aroclors and total congeners) detected in groundwater were below the MTCA Method B Cleanup Level for drinking water, with results from two wells exceeding the MTCA Method B Cleanup Level for surface water (Figure 3-5)."<br>Please include MTCA Method B cleanup levels for drinking water and surface water. | We will add the numeric values for these cleanups levels in parentheses. | Yes |
| **23** | Sec. 3.2 & pg. 3-10 | Please include few figures (such as a typical cross section(s)) from ESS tech memo within the body of supplemental RI report. | We are concerned that it would be confusing to add the plan view figure showing the cross section locations and only one or two cross sections to the body of the supplemental RI report. Therefore no changes have been made in response to this comment. | Yes<br>But, Ecology believes that it would be good to include typical cross-sections in the main body of the SI report to get a broader idea of the geological conditions of the site. |
| **24** | Appendix C | Please show the location of DPT soil borings completed in 2021 in Figures 2-2 or other figures. The locations are SP-MD01, SP-MD02, SP-MD03, SP-MD04. | We will add these four locations to Figure 2-2 as requested. | Yes, thank you. |
| **25** | Sec. 3.6 & pg. 3-59 | "Modeling runs suggested that even with complete isolation of the identified source zone with a passive reactive barrier (PRB) in 2025, an additional ~**150 years** from the year 2025 would be required to permanently reach the VC (the most conservative cVOC of interest) RG at the plume boundary at the marsh as a result of matrix diffusion effects." – | Great question. REMChlor-MD allows for incorporating matrix diffusion in any combination of the source and plume (e.g., matrix diffusion in the source but no matrix diffusion in the plume, matrix diffusion in both the source and plume, etc.). For NBK Keyport, the matrix diffusion modeling runs (all runs except Run 1 at each site) included matrix diffusion in both the source and the plume | Yes, thank you. |

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| | | Is the matrix diffusion considering in modeling from outside of the identified source zone, from the identified source zone isolated with a PRB or throughout the landfill areas? | downgradient of the source, i.e., matrix diffusion processes were considered present within the entire modeling domain. Run 1 at each site assumes there is no matrix diffusion in the plume.<br><br>Note that in the case of complete (100%) source removal/isolation (e.g., Run 2), the matrix diffusion in the source no longer impacts the downgradient plume after the source has been isolated. For example, in Run 2, the source was completely isolated in 2025. Therefore, REMChlor-MD includes matrix diffusion impacts in the source from 1970 through 2025, then from 2026 onwards, the matrix diffusion in the source no longer has any impact on the downgradient plume.<br><br>We will add explanatory text to both the body of the supplemental RI report and the modeling report in the appendix. | |

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**Comments from: Benjamin Leake, PMP, U.S. Environmental Protection Agency**
**Comments dated: June 29, 2023**

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| **1** | Section 1.0 | This section briefly describes the additional elements of the Supplemental RI that are being conducted under separate contract. Some of these additional elements will further inform the site CSM. It would be beneficial to include a table in this section, or another, that clearly shows remaining data gaps in the CSM. See related comments about conclusions and additional data needs in Appendix B. | We will add a bullet list or a table as suggested, listing additional data needs. We will add this to Section 4.2. | Yes |
| **2** | Section 1.3.1 | Is anything else known about the "soil excavated from elsewhere" referenced in this section? Was it clean fill, or is there information to suggest that it could be a potential source of contaminants? | Unfortunately, nothing else is known about this soil. Anecdotally it was generated from elsewhere on the base as part of a construction project. Nothing is known about its potential to contain contaminants, though, anecdotally it was presumed to be "clean" at the time of placement. We will add this information to the text. | Yes |
| **3** | Figure 2-3 | Recommend showing the approximate location of the historical shoreline. | We will add the historical shoreline to Figures 2-2 and 2-3. | Yes |
| **4** | Figure 2-4 | The depth to groundwater information shown on this figure is helpful. Adding a potentiometric surface map, measured seasonally and uniformly with tidal stages, to this figure, or to a new figure, would be a meaningful addition to the CSM. | Potentiometric surface maps are included in Appendix C, as part of the ESS study, because it is necessary to consider hydrostratigraphic units when preparing these contour maps. Many years of data were collected from the LTM program in the past and the potentiometric surface maps have been very similar over time. | Yes |

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| | | | We will add a statement regarding this to the text. | |
| **5** | Section 3.1.4 | Lines 1000 – 1004 state that PCB results from the deeper wells may not be representative, “as discussed below”. Include a specific reference to report section that discusses this reasoning. The discussion about why this data could be misleading is an important part of the site CSM and should be clearly linked to this statement. | We will add a reference to the discussion in Section 3.5.4, page 3-57. | Yes |
| **6** | Appendix B, Section 2.6 | The final sentence of this section states that the slug test from MW1-64 “yielded results that were unable to be processed”. Include an additional sentence or two to explain why the results from this well could not be processed to compute hydraulic conductivity. | We will add sentence to end of this paragraph that explains that the data was unsuitable for analytical processing/curve matching due to sporadic data points. | Yes |
| **7** | Appendix B, Table B2-1 | The 10th row of this table discusses using 1-liter amber jars to collect microbial samples. Recommend including a statement indicating whether any of the impacted sample jars actually did break. | We will add a note that no breakage occurred. | Yes |
| **8** | Appendix B, Table B2-2 | The first note after the Table on Page 2-27 is confusing. Recommend revising to more clearly explain the meaning of the gray shading in the table. | We will consider other methods of presentation to show the list of soil sample and groundwater samples at each location such that we can eliminate the gray shading. | Yes |

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| **9** | Appendix B, Table B2-8 | Include in the notes, or possibly in Section 2.7, the reason why MW1-74 was not tested in duplicate or triplicate like the other wells. | We will add a note to explain that duplicate and triplicate sampling was not originally planned but was performed at most wells because the fast response of the wells to testing allowed rapid collection of a larger data set. Duplicate/triplicate testing was not performed at MW1-74 to minimize the time of staff presence alongside Highway 308. | Yes |
| **10** | Appendix B, Section 4.1.2 | This section does not make a conclusion, rather it presents two plausible explanations for cVOC contamination in surface water. Recommend presenting a conclusion or statement about what additional data is needed, if any, to make a conclusion about this pathway. | Thank you for pointing out. We gave these data additional consideration. We will add the following to the first paragraph, "This plume model shows a lobe of the cVOC plume from the Central Landfill elongated along the shallow east-to-west groundwater flow direction in the area of wells MW1-17 and MW1-43." Then at the end of this section we will add, "To conclude whether cVOC transport in shallow groundwater to surface water is occurring in this area, shallow groundwater samples and/or sediment porewater samples would be needed along transects between MW1-17/MW1-43 to Marsh Creek. A broad marshy area, heavily vegetated, is present along these transects. Hand collection of data might be required." | Yes |
| **11** | Appendix B, Section 4.1.6 | Recommend including a statement about what additional actions, if any, are needed to determine if unidentified PCB source do exist. | We will add, "Because PCBs have been identified throughout the area upgradient of the seep, it is not a productive use of resources to continue attempting to link a particular PCB source within the landfill waste body to the seep. A more efficient use of resources is addressing the ongoing discharge of PCBs at the seep." | Yes |

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| **12** | General | Have dioxins/furans ever been analyzed as a COPC at the site? As noted in the personnel interviews, waste from the southern end of the operable unit was taken to the northern incinerator/burn pile area. If chlorinated solvents were burned, there is a possibility that dioxins/furans could have been created. | As shown in Tables 3-1 and 3-2, dioxins and furans were not included as COPCs during the original RI. However, the upland soil sampling near the incinerator/burn pile did include sampling for dioxins/furans as a data input for the revised risk assessment currently underway. | Yes |
| **13** | General | Has methylmercury ever been analyzed as a site COPC? Table 3-1 shows inorganic mercury as a COPC. The presence of organic mercury, along with the anoxic conditions and sulfate reducing bacteria shown on Table 3-7, has the possibility of creating methylmercury. | From the available records, it does not appear that methylmercury was analyzed during the original RI or risk assessment. However, methylmercury in shellfish tissue has been analyzed under separate contract in support of the revised risk assessment currently underway. | Yes |
| **14** | General | A subsurface figure with the generalized paleochannels mapped out would be helpful. | This figure is Figure C-14 in Appendix C, and we will reference this figure in the main text in Sections 3.1.4, 3.3, and 3.5.3. | Yes |
| **15** | General | Review and as necessary, correct the number of sections and sub-sections within the report. EPA noted several cases where headings were out of order or appeared to be missing, including in Section 2 and line “Natural Attenuation Evaluation” in line 2202. | Thank you. We will correct the header numbering. | Yes |

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**Comments from: Andrew Schmeising, The Suquamish Tribe**
**Comments dated: June 29, 2023**

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| **1** | General | The Supplemental RI is a large document, with a tremendous amount of information summarized and discussed within. Much of the site history and summaries of previous work, along with many of the new data sections were previously reviewed by Team members as individual technical memos (TMs) (e.g. upland soil sampling for PCBs, or the first round of geophysical characterization in Dogfish Bay). This was done as an effort to make the overall SRI easier to process and comment upon for the reviewers. As a result, the Tribe has no comments on the first two sections of the report, which include Section 1: Introduction and Section 2: Post-ROD (Record of Decision) Investigations. Suquamish comments begin with Section 3: Interpretation of Post-ROD Investigation Data. | Thank you. We're glad that the approach helped with your review. | Yes |
| **2** | Section 3, Lines 950-952 | "…during all three of the sampling events following the HVDPE pilot test, light NAPL (LNAPL) was observed floating on the water table in monitoring well MW1-77."<br>Comment:<br>a) What are the LNAPL thickness measurements? | We will add that the LNAPL was black, thick, and sticky, with a measured thickness of 0.5 feet.<br><br>The FS should certainly include an evaluation of source removal. However, it is important to consider the results of the groundwater modeling, which indicates that even aggressive source removal is unlikely to make substantive changes to concentrations at the receptors (i.e., | Thank you.<br><br>Thank you for committing to evaluating source removal as a viable option. In the interests of keeping all options open: The presence of LNAPL |

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**Document dated:** June 30, 2023

| # | Page No./ Line No. | Comment | Proposed Response | Response Accepted? |
|---|---|---|---|---|
| | | b) What type of NAPL?<br>c) Would source removal be appropriate here? | surface water) for more than 100 years. On this basis the FS might conclude that containment, or treatment at the point of release to the receptor, is more effective in a shorter timeframe. | indicates the source is shallow, at the water table or near it. Even if it is necessary to include the original marsh deposits beneath the fill, it should be possible to excavate the landfill itself and any finer-grained layers near the original water table, i.e. that represent the sources of the modeled matrix diffusion affecting surface water receptors. While the cost pros and cons can be debated for removal vs containment & treatment followed by 100+ years of O&M and program oversight, it is important to note that excavation costs and their relative effectiveness become much more viable vs capital costs of containment and extended time periods when separate phase contaminants are present. |
| **3** | Section 3, Lines 978-982 | "Beyond the maximum low-low tide mark in Dogfish Bay, the paleochannels are expected to | We agree that it is worth considering during DQO development for the Dogfish Bay studies what those studies can reasonably accomplish. | Yes |

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| | | be flooded with saline water at all tide stages, with the less dense contaminated freshwater driven upward to daylight into the bay. This transport path is consistent with modeling performed in support of the ROD. The Navy is planning additional investigation to verify this transport pathway."<br><br>Comment:<br><br>Geophysical investigation showed paleochannels very clearly. Not sure it proves freshwater is driven upwards into the bay. Will the new studies be able to determine if there is actual freshwater upwelling vs attenuation/dilution/mixing within the paleochannels? | The statement in this volume of the supplemental RI is just meant to convey a hypothesis based on the simplified standard model of the saline wedge. At some point the preferential flow of freshwater should encounter salt water that is always present in the paleochannels and that should have a strong effect on freshwater and contaminant transport. | |
| **4** | Section 3, Lines 1017-1018 | "The on-going risk assessment update will identify areas with potential risks associated with human and ecological direct contact with soil in the upper 6 ft of soil at the landfill."<br><br>Comment: While human ingestion of soil seems unlikely, what about other routes of ecological exposure such as bio uptake and accumulation in the north and south plantations? | Originally this statement was meant to speak directly to the shallow soil data collected in one part of the northern landfill to support the revised risk assessment, but we agree that it isn't clear. To be more comprehensive we will delete this sentence and instead add a sentence to the preceding paragraph to say, "The updated risk assessment workplan provides a comprehensive analysis of gaps in the original site-wide risk assessment and the forthcoming risk assessment will address the identified gaps and needed updates." | Yes |
| **5** | Section 3, Line 1067, Figure C-1 | This refers to Figure 1 of the freestanding figures and tables after the body text in | Good point, thank you. We will revise this figure numbering scheme for clarity. | Yes |

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| | | Appendix C. There are also five figures (Figures 1 through 5) embedded within the Appendix C text. Recommend renumbering one or the other for clarity. | | |
| **6** | Section 3, Line 1137 | "anywhere from 400 ft bgs to well below sea level"<br><br>Comment:<br><br>Is this intended to say "...400 ft elevation to well below sea level"? | Yes, thank you. This should say 400 feet above sea level to well below sea level. | Yes |
| **7** | Section 3, Lines 1666-1671 | "These two contour maps demonstrate that the shallow zones and deeper coarse-grained zones of the upper portion of the Olympia are not hydraulically connected, and flow characteristics are different for the two zones. This analysis also confirms and expands upon the conclusion made in 2017 (Navy, 2018b) that the upper and lower zones of the shallow aquifer are hydraulically connected and groundwater elevations from all zones above the Olympia interglacial deposits can be contoured consistently."<br><br>Comment:<br><br>Found this text confusing at first. Suggest using *italics* to emphasize the distinctions being made here between *Olympia* and *Shallow Aquifer.* | We'll consider either rewording this paragraph or using italics as you suggest. | Yes, thank you. |

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| **8** | Section 4, Lines 2951-2953 | "The updated CSM depicts a hydrogeologic regime and cVOC and 1,4-dioxane plumes in groundwater that are different in important ways from the understanding underlying the selected remedy in the OU 1 ROD."<br><br>Comment:<br><br>This is an understatement. Suggest making a direct statement emphasizing the conclusion that the OU 1 ROD remedy is no longer supported by the new data, and needs to be amended. Please note that Tribal concurrence will be required for the ROD Amendment. | We will add as the second sentence in this paragraph, "The updated CSM calls into question the adequacy of the remedy in place and an update of the existing remedy is warranted." | Yes, thank you |
| **9** | Section 4, Lines 2979-2981 | "These shallow, local groundwater flows are driven by the hyper-local topography and thus can be to the south, southwest, west or northwest, in contrast to the deeper northwesterly regional groundwater flow direction."<br><br>Comment:<br><br>Suggest simplifying with: "in other words, the landfill creates localized radial flow of contaminated shallow GW." | We will add the suggested additional text. | Thank you |
| **10** | Section 4, Lines 2988-2989 | "This plume originates from three identified higher concentration source areas within the landfill." | Good point. We will make this change. | Yes, thank you |

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| | | Suggest "primarily from" to allow for other minor sources. | | |
| **11** | Section 4, Lines 3019-3021 | "However, these results from the deeper wells may be misleading and may not represent actual PCB concentrations in the aquifer at the depths explored."<br>Comment:<br>Why? Please add supporting statement. | We will add a reference to the discussion in Section 3.5.4, because the lines of evidence discussion is fairly lengthy. | Yes, thank you |
| **12** | Section 4, Lines 3046-3048 | "The modeled matrix diffusion is likely to strongly affect the efficacy of many remedial technologies."<br>Comment:<br>However, it should not be the sole variable considered, depending on the targeted reduction methods considered in source areas. (e.g. source removal could still effectively remove the vast majority of the contaminant mass directly impacting surface water and marine habitats). | The modeled matrix diffusion is likely to strongly affect the efficacy of many remedial technologies, and should be one of the factors considered when evaluating remedial technologies. The text will be updated accordingly. | Yes, thank you. |
| **13** | Section 4, Last Bullet | "The 3D depiction of the cVOC plume should be leveraged to estimate the total contaminant mass present within the plume using a three-phase or four-phase portioning model and the volume of each interpolated 3-D concentration "shell." This total mass will provide a useful baseline to compare to potential mass | Thank you. We will add qualifiers to this statement to note that this would be a "rough" mass estimate. | Yes, thank you. |

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| | | removals estimated for various remedial technologies."<br><br>Comment:<br><br>While informative, these types of models should not be overly relied upon for absolute numerical mass estimates. Agree that the model is a useful basis of comparison, all things being equal, for evaluating potential remedial approaches. | | |

# Appendix B

## Summary of 2019-2022 Investigations

# SUPPLEMENTAL REMEDIAL INVESTIGATION REPORT
# OPERABLE UNIT 1
# NAVAL BASE KITSAP, KEYPORT, WASHINGTON

## APPENDIX B – SUMMARY OF 2019-2022 INVESTIGATIONS

**Prepared by**
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**Prepared for**
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**Silverdale, Washington**

**U.S. Navy Contract No. N39430-16-D-1802**
**Contract Task Order N3943018F4359**

**August 2023**

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### TABLES

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| 3D | three dimensional |
| µg/kg | microgram per kilogram |
| µg/L | microgram per liter |
| %D | percent difference |
| %R | percent recovery |
| bgs | below ground surface |
| BOD | biological oxygen demand |
| CCV | continuing calibration verification |
| cm/s | centimter per second |
| COC | contaminant of concern |
| COD | chemical oxygen demand |
| CSL | contaminant screening level |
| CSM | conceptual site model |
| CTO | contract task order |
| cVOC | chlorinated volatile organic compound |
| DCA | dichloroethane |
| DCE | dichloroethene |
| DNA | Deoxyribonucleic Acid |
| DO | dissolved oxygen |
| DOC | dissolved organic carbon |
| DoD | Department of Defense |
| DQO | data quality objective |
| ELAP | Environmental Laboratory Accreditation Program |
| EPA | U.S. Environmental Protection Agency |
| FCR | Field Change Request |
| ft | feet |
| g/cc | gram per cubic centimeter |
| GPS | global positioning system |
| HVDPE | high vacuum dual phase extraction |
| ICV | initial calibration verification |
| ID | identification |
| IS | internal standard |
| ISM | incremental sampling methodology |
| LCS | laboratory control standard |
| LOD | limit of detection |
| LOQ | limit of quantitation (equivalent to PQL) |
| LTM | long-term monitoring |
| mg/kg | milligram per kilogram |
| mg/L | milligram per liter |

| | |
|---|---|
| MIP | membrane interface probe |
| MNA | monitored natural attenuation |
| mS/cm | millisiemens per centimeter |
| MS/MSD | matrix spike/matrix spike duplicate |
| NAVD | North American Vertical Datum |
| NAVFAC | Naval Facilities Engineering Systems Command |
| NBK | Naval Base Kitsap |
| NTU | nephelometric turbidity unit |
| ORP | oxidation reduction potential |
| OU | operable unit |
| PAL | project action limit |
| PCB | polychlorinated biphenyl |
| PCE | tetrachloroethene |
| PFAS | perfluoroalkyl substances |
| pg/g | picogram per gram |
| pg/L | picogram per liter |
| PID | photoionization detector |
| ppb | part per billion |
| PQL | practical quantitation limit (equivalent to LOQ) |
| PVC | polyvinyl chloride |
| QA | quality assurance |
| QC | quality control |
| RG | remediation goal |
| RI | remedial investigation |
| ROD | Record of Decision |
| RPD | relative percent difference |
| RSD | relative standard deviation |
| SAP | sampling and analysis plan |
| SCO | sediment cleanup objective |
| SCUM | Sediment Cleanup User's Manual |
| SDG | sample delivery group |
| SIM | selective ion monitoring |
| SMS | Sediment Management Standards |
| SOP | standard operating procedure |
| SQS | sediment quality standard |
| TCA | trichloroethane |
| TCE | trichloroethene |
| TOC | total organic carbon |
| TPH | total petroleum hydrocarbon |
| USCS | unified soil classification system |
| USGS | U.S. Geological Survey |

| | |
|---|---|
| VC | vinyl chloride |
| VOC | volatile organic compound |
| WAC | Washington Administrative Code |

# 1.0 INTRODUCTION

This appendix documents the additional site characterization work performed between 2019 and 2022 in support of the supplemental remedial investigation (RI) for the Area 1 former landfill comprising Operable Unit (OU) 1 of Naval Base Kitsap (NBK) Keyport in Keyport, Washington (Figures 11 and 12). The overall objective of this phase of the investigation was to collect the data necessary to further define the vertical and lateral extent of remaining contamination in the subsurface at OU 1 and assess migration of this contamination. Areas of the site where work was conducted in 2019 and 2022 are shown on Figure 1-2, and historical sampling locations are shown on Figure 1-3.

The activities documented in this appendix were conducted in accordance with three project-specific OU 1 sampling and analysis plans (SAPs) (U.S. Navy, 2019; U.S. Navy, 2022a; U.S. Navy, 2022b). These activities were conducted under Navy Contract No. N39430-16-D-1802, Contract Task Order (CTO) N3943018F4359 for Naval Facilities Engineering Systems Command (NAVFAC) Northwest. As the prime contractor, Battelle performed the field data collection and data usability evaluation/interpretation described herein and prepared this data appendix. Subcontractors to Battelle performed utility locating, traffic control, land surveying, direct-push drilling, sonic drilling, well installation, laboratory analyses, data validation, and numerical modeling.

The site description and background for OU 1, as well as figures referenced in this appendix, are provided in the main body text of the supplemental RI report.

## 1.1 INVESTIGATION ACTIVITIES 2019-2022

This section summarizes the investigation activities conducted in the timeframe 2019-2022 under the CTO listed above. This phase of the investigation was developed based on the results of the investigations conducted between 2014 and 2017, which were reported separately (as described in the main body text of the supplemental RI report). These investigations are listed in Table 1-1. Other investigations during this time period were performed under a separate Battelle CTO (e.g., the high vacuum dual phase extraction (HVDPE) pilot study [U.S. Navy, 2023]), or by other Navy contractors (e.g., risk assessment investigations and long-term monitoring [LTM] investigations). These other investigations are incorporated into the supplemental RI report, but are not described in this Appendix B.

**Table B1-1. Investigation Activities 2019-2022**

| Investigation Element | Report |
|---|---|
| *Source Investigation SAP* (U.S. Navy, 2019) | |
| Direct-push drilling at 33 locations | This Appendix B |
| Sonic drilling at 17 locations, well installation at 9 of these | This Appendix B |
| Porewater sampling at 19 locations | This Appendix B |
| Sediment at 7 locations | This Appendix B |
| Surface water sampling at 8 locations | This Appendix B |
| Numeric groundwater modeling | Stand-alone report (GSI, 2023; Appendix F) |
| *Geophysical Investigation Work Plan* (U.S. Navy, 2020) | |
| Intertidal geophysical investigation | Stand-alone report (Atlas, 2021; Appendix D) |
| *PCB and Upland Soils Investigation SAP* (U.S. Navy, 2021a) | |
| Upland shallow soil investigation, northern OU 1 | Stand-alone final technical memorandum (U.S. Navy, 2022c) |
| ISM sampling of PCBs in wetland sediment | Stand-alone final technical memorandum (U.S. Navy, 2022d; Appendix E) |
| *Vertical Extent Investigation and Aquifer Performance Testing SAP* (U.S. Navy, 2022a) | |
| Sonic drilling and well installation at 7 locations | This Appendix B |
| Slug testing in 15 wells | This Appendix B |

## 1.2 SCOPE OF INVESTIGATIONS

This section presents the scope of the investigations noted in Table B1-1 as being documented in this Appendix B. The drivers and rationale for the 2019-2022 investigations are provided in Section 2.1.5 of the supplemental RI report.

The scope of the investigations conducted under the 2019 SAP (see Table B1-1) and reported in this Appendix B consisted of:

- Soil and groundwater samples were obtained from 33 continuous-core, direct-push borings, with the samples analyzed for some combination of target volatile organic compounds (VOCs), 1,4-dioxane, polychlorinated biphenyls (PCBs), total organic carbon (TOC), and total petroleum hydrocarbons for diesel range organics (TPH-Dx). Thirteen borings were located in the Central Landfill area and a total of four soil borings were advanced in the South Plantation area to reassess the lateral and vertical extent of VOCs surrounding the known hotspots in these areas, and to better define the aquitard depth. Select borings located in the Central Landfill area were also used to assess the extent of 1,4-dioxane surrounding known hotspots in this area. Sixteen borings were located in the North Plantation area to assess the potential migration of VOCs and 1,4-dioxane from the Central Landfill hotspots, and to assess a possible PCB source.

- Soil and groundwater samples were obtained from 17 sonic borings: five located in the South Plantation, five located in the Central Landfill area, five located in the North Plantation, one located along 5th Street, near the intersection with Bradley Road, and one boring was installed through a concrete pad directly to the northeast of the South Plantation. New groundwater wells were installed at nine of the 17 soil boring locations. In addition to installation, development, and sampling of these new wells, sampling was conducted at 20 existing monitoring wells, including 18 wells that were installed in 2017. All groundwater samples from the monitoring wells were analyzed for VOCs, field parameters, conventional chemistry parameters, and oxygen demand (see Section 2 for the details of these analyses). Wells located in apparent hotspots that were expected to be the focus of potential future remedial action were additionally analyzed for microbial population, perfluoroalkyl substances (PFAS), PCBs, TPH-Dx, 1,4-dioxane, and biodegradation parameters (i.e. methane, ethane, nitrate, nitrite, sulfate, chloride, dissolved organic carbon [DOC], and sulfide). All soil samples collected from the sonic borings were sampled for VOCs; two samples included analyses for TOC; and two samples included analyses for PCB congeners and TPH-Dx.
- Seven sediment samples were collected along the streambed and from the tide flats and were analyzed for PCB congeners.
- Nineteen porewater samples were collected (three samples from the streambed nearby SP1-1, five samples from the streambed downstream of Marsh Pond, eight samples from south of the South Plantation, and three samples from west/southwest of the South Plantation) and eight surface water samples were collected (seven samples at downstream locations from the Marsh Pond and one sample from immediately upstream from the Marsh Pond). The porewater and surface water samples collected from upstream, downstream, and nearby SP1-1 were analyzed for PCB congeners, and the samples collected from upstream and downstream of Marsh Pond were analyzed for target VOCs and field parameters (i.e., dissolved oxygen [DO], oxidation reduction potential [ORP]/Redox, pH, turbidity, specific conductance, temperature).
- Horizontal locations and top of casing elevations for newly installed groundwater monitoring wells were surveyed by a licensed land surveyor. Horizontal location and ground surface elevations at direct-push boring locations were also surveyed by a licensed land surveyor. Depth to groundwater in newly installed groundwater monitoring wells, a subset of historical groundwater monitoring wells, and the United States Geological Survey (USGS) peeper tubes were measured to allow preparation of a groundwater elevation contour map.

The scope of the investigations conducted under the 2022 SAP (see Table B1-1) and reported in this Appendix B consisted of:

- Both grab and undisturbed soil samples were obtained from seven sonic borings: two located in the South Plantation, one located in the Central Landfill area, two located in the North Plantation, and two located along the Highway 308 causeway. New groundwater wells were installed at all seven of these locations. All groundwater samples from the monitoring wells were analyzed for VOCs, 1,4-dioxane, PCBs as Aroclors and congeners, and PFAS. All grab soil samples collected from the sonic borings were sampled for VOCs and TOC. Grab soil samples from the Central Landfill and Highway 308 causeway were additionally sampled for 1,4-dioxane. Grab soil samples from within the North Plantation were sampled for 1,4-dioxane and PCBs as Aroclors and congeners. Relatively undisturbed soil samples were analyzed for grain size, hydraulic conductivity (horizontal and vertical), bulk density, and porosity (total and effective).
- Falling head and rising head slug tests were performed in the 15 wells selected in the SAP. These wells were selected based on their distribution throughout OU 1 and the screened intervals relative to key soil types.
- Horizontal locations and top of casing elevations for the seven newly installed groundwater monitoring wells were surveyed by a licensed land surveyor.

# 2.0 INVESTIGATION ACTIVITIES

This section describes the investigation activities performed during the 2019 source investigation and the 2022 vertical extent investigation and aquifer performance testing. Deviations from the SAPs are described by work element in the subsections below, and listed in Table B2-1. Approved Field Change Request (FCR) forms are included in Attachment 1. Daily reports of the field work performed are included in Attachment 2.

## 2.1 DIRECT-PUSH SOIL AND GROUNDWATER SAMPLING

### 2.1.1 Direct-Push Sampling Approach

In June 2019, direct-push drilling was used to collect grab soil and groundwater samples primarily in and around the North Planation, with additional locations in the South Plantation and Central Landfill. Locations were selected in the SAP to build upon the understanding of chlorinated volatile organic compound (cVOC) migration pathways developed based on the 2017 data set, and to assess the potential for a continuous plume of 1,4-dioxane from the Central Landfill to the northwest corner of the North Plantation (and potentially further to the northwest offsite). The locations for direct-push drilling were selected based on the 2017 investigation results. Continuous soil cores were retrieved at each direct-push drilling location, the soil lithology was logged to identify the regional aquitard at key locations, and the cores were screened using a hand-held photoionization detector (PID) in an attempt to identify the areas of highest cVOC concentrations along the length of each core. Based on these findings, grab soil and groundwater samples were preferentially collected at the locations and depths exhibiting the highest readings on the hand-held PID. Samples were also collected at locations and depths expected to be representative of low cVOC concentrations to enable assessment of the lateral and vertical extent of cVOCs exceeding the project action limits (PALs).

### 2.1.2 Direct-Push Sampling Activities

Direct-push soil and groundwater sampling was performed in accordance with the approved SAP, except where deviations from the SAP are identified in this section and Table B2-1.

Utility locating was performed in advance of direct-push drilling on May 20, 2019, and the Navy issued excavation permit 19-EP111 on June 5, 2019. Direct-push drilling was performed between June 10 and June 28, 2019. Holt Services, of Puyallup, Washington provided a Geoprobe Model 7822DT track-mounted direct-push drilling rig operated by a driller licensed in Washington State.

Direct-push drilling was performed at 33 locations and continuous cores were obtained using a 5-foot-long, Macro-Core sampler at all locations (see Attachment 3 for boring logs). Shallow refusal was met during the initial attempt at one boring, and one other step-out (within 2 feet [ft]) was necessary to avoid buried obstructions (electrical).

Soil from the macro-cores was visually examined for contamination and classified in accordance with the Unified Soil Classification System (USCS). Soils were field screened, at 1-foot intervals, with a PID equipped with a part per billion (ppb) detector. The following procedures were adhered to during PID screening activities:

- Screening took place as soon as possible after each macro-core liner was opened. If screening could not take place immediately after the core was retrieved, the liner was left unopened until screening could be conducted.
- At each screening interval (every foot or more frequent), a Terra Core sampling device (or equivalent thin-walled sample tube) was temporarily pressed into the soil core to isolate a known volume of soil and create a small headspace above the soil volume.
- Tubing from the PID was inserted into the headspace above the soil core.
- The highest value measured on the PID for each measurement interval was recorded.
- A new Terra Core sampler was used for each interval, with samplers decontaminated and re-used between soil cores.

Grab soil and groundwater sample depths were selected based on these hand-held PID readings and comparison to nearby membrane interface probe (MIP) results (when available). Grab soil samples were collected by subsampling the soil cores using single-use Terra Core samplers to transfer soil to laboratory-supplied vials. Grab groundwater samples were collected using one of two methods depending on the depth of the sample. The Geoprobe Screen Point 22 sampler (which has a 4-foot screened interval) was generally used for deeper sample collection when the direct-push rig was needed to advance the sampler to the target depth. For shallower samples, a 5-foot section of polyvinyl chloride (PVC) well screen attached to blank PVC casing was hand installed to the target depth. Using this method, a peristaltic pump was used to purge groundwater at the target depth until the water visibly cleared, at which time a sample was pumped directly into the laboratory-supplied vials.

Table B2-2 summarizes the grab soil and grab groundwater samples collected from each direct-push boring, along with the laboratory analyses performed on each sample. At a minimum, all samples were analyzed for the target VOCs listed in the SAP, consisting of the nine cVOC contaminants of concern (COCs) identified in the Record of Decision (ROD) and chloroethane as a final breakdown product of 1,1,1-trichloroethane (TCA). Subsets of samples were analyzed for 1,4-dioxane (Central Landfill and North Plantation), TOC (Central Landfill), PCB Aroclors (North Plantation), and TPH-Dx (North Plantation).

***South Plantation***

Direct-push soil borings were drilled at four locations in the South Plantation to investigate the lateral extent of cVOC COCs to the east, southeast, and northeast of the South Plantation, to confirm the apparently lower concentrations between the South Plantation and Central Landfill, and better define the depth to the regional aquitard in the center and western edge of the South Plantation (Figure 2-1). Boring SP-B91 was the first direct-push boring drilled in this area, which was located to the east of South Plantation, along Bradley Road. Boring SP-B090 was also placed along Bradley Road, to the north of SP-B91. Borings SP-B93 and SP-B94 were drilled in the center and western edge of the South Plantation, respectively. These locations were placed generally following the locations planned in the SAP.

The hand-held PID readings indicated that elevated PID readings were not observed at any depth in borings SP-B090, SP-B91, and SP-B94. The highest PID readings were observed in boring SP-B93 between 12 and 13 ft below ground surface (bgs; 1,989 ppb and 1,901 ppb) and at 17 ft bgs (1,605 ppb).

Two to three grab soil samples and one to two grab groundwater samples were collected from each boring, based on field observations, including PID screening results.

***Central Landfill***

Direct-push soil borings were drilled and sampled at 13 locations in the Central Landfill (Figures 2-2 and 2-3) to investigate the lateral extent of cVOC COCs and 1,4-dixoane from the Central Landfill hotspots, to assess TOC concentrations in soil from areas with relatively low concentration of VOCs, and to assess the depth to the regional aquitard along the western and eastern side of the Central Landfill.

The initial boring locations (CL-B105, CL-B106, CL-B107, CL-B108, and CL-B109) were placed to the north and northeast of the Central Landfill hotspots. Then, borings CL-B102, CL-B103, and CL-B104 were placed to the northwest of the Central Landfill hotspots. The purpose of these borings included investigating potential transport of cVOC COCs towards surface water to the northwest. Borings CL-B101, CL-B99, CL-B100, CL-B95, and CL-B96 (in that order) were placed to the south-southwest of the Central Landfill hotspots.

The hand-held PID readings indicated that PID readings were detected at various depths in all Central Landfill borings (CL-B95, CL-B96, CL-B99, CL-B100, CL-B101, CL-B102, CL-B103, CL-B104, CL-B105, CL-B106, CL-B107, CL-B108, and CL-B109). The highest PID readings were observed in borings CL-B99 (2,057 ppb at 12 ft bgs), CL-B105 (20,250 ppb at 10 ft bgs; 2,856 ppb at 13 ft bgs), and CL-B108 (2,036 at 8 ft bgs).

Between two and four grab soil samples and two grab groundwater samples were collected from each boring, based on field observations, including PID screening results.

***North Plantation***

Direct-push soil borings were drilled and sampled at 16 locations in the North Plantation to investigate the distribution of VOCs beneath the North Plantation (assuming groundwater transport to the northwest from Central Landfill hotspots), to assess the migration of 1,4-dioxane from the Central Landfill hotspots beneath the North Plantation, to investigate a potential PCB source area, to assess TOC concentrations in soil from areas with relatively low concentration of VOCs, and to assess the depth to the regional aquitard along the eastern side of the Central Landfill (Figure 2-2).

The initial boring locations (NP-B110, NP-B111, NP-B112, NP-B113, NP-B114, NP-B115, and NP-B117s) were placed to the northwest of the Central Landfill hotspots. Then, borings NP-B116, NP-B118, NP-B119, NP-B120, NP-B121, NP-B122, NP-B123, NP-B124, and NP-B125 were placed further to the northwest of the previous borings and Central Landfill hotspots. The purpose of these borings included investigating a possible PCB source in this area.

The hand-held PID readings indicated that PID readings were detected at various depths in 15 of the 16 North Plantation borings. The highest PID readings were observed in borings NP-B110 (21,350 ppb at 8 ft bgs; 8,375 ppb at 9 ft bgs; 2,204 ppb at 11 ft bgs), NP-B114 (1,881 ppb at 8 ft bgs), NP-B117 (1,826 ppb at 10 ft bgs; 1,125 ppb at 13 ft bgs; 1,825 ppb ft bgs), NP-B122 (1,112 ppb at 5 ft bgs), and NP-B123 (1,889 at 19 ft bgs).

Between two and five grab soil samples and one to two grab groundwater samples were collected from each boring, based on field observations, including PID screening results. At one location in the North Plantation (NP-B113), only one groundwater sample was collected due to a clogged well screen.

## 2.2 SONIC DRILLING SOIL SAMPLING AND WELL INSTALLATION

### 2.2.1 Sonic Drilling Approach

***2019 Sonic Drilling***

Following laboratory analysis of the grab soil and groundwater samples collected during the direct-push drilling program completed in June 2019, draft isoconcentration contour maps were prepared for the maximum concentrations of three key cVOCs, regardless of depth. These maps, along with exhibits showing tabulated analytical results for each location sampled, were used during a project team meeting on September 18, 2019, to discuss the ramifications and initial interpretations of the data and agree on the locations and screened intervals for additional permanent groundwater monitoring wells. Following this meeting, sonic drilling and monitoring well installation began on September 30, 2019.

Soil samples were collected during sonic drilling within the screened intervals of each well, to provide cVOC concentrations in soil at the time of well installation. Soil samples were also collected at select intervals where elevated PID readings were observed. Once the new wells had been developed to ensure connectivity with the aquifer and had been allowed to rest, groundwater samples were collected from October 21, 2019 to October 28, 2019.

***2022 Sonic Drilling***

Following laboratory analysis of the soil and groundwater samples collected during the 2019 sonic drilling program, three-dimensional (3D) data interpretations were prepared and shared with the project team during a workshop on February 4, 2021. The data interpretations showed, in part, that the vertical extent of COCs beneath OU 1 had not been clearly delimited. The project team met again on July 8, 2021 to discuss the scope of additional sonic drilling to assess vertical extent. The result of that meeting was a SAP covering a vertical extent investigation and aquifer performance testing (U.S. Navy, 2022a). Drilling locations were selected at key locations throughout OU 1 based on the known vertical distribution of COCs. Sonic drilling and monitoring well installation under this SAP began on April 20, 2022.

Soil samples were collected during sonic drilling within the screened intervals of each well, to provide cVOC concentrations in soil at the time of well installation. Soil samples were also collected at zones of known and/or suspected contamination, and deeper at regular intervals to document expected declining COC concentrations with depth. Once the new wells had been developed to ensure connectivity with the aquifer and had been allowed to rest, groundwater samples were collected from May 2, 2022 to May 13, 2022 and on July 18, 2022.

### 2.2.2 Sonic Drilling Activities

Sonic drilling, groundwater monitoring well installation, and monitoring well development were performed in accordance with the approved SAPs, except where deviations from the SAPs are identified in this section and Table B2-1.

Utility locating was performed in advance of 2019 sonic drilling on September 12, 2019, and the Navy issued excavation permit 19-EP140 on September 23, 2019. Sonic drilling was performed from September 30 through October 17, 2019. Holt provided a Terra Sonic International 150C crawler-mounted sonic drill rig operated by a driller licensed in Washington State.

Utility locating was again performed in advance of 2022 sonic drilling on April 4, 2022, and the Navy issued excavation permit 22-EP058 on April 18, 2022. Sonic drilling was performed from

April 20 through July 14, 2022. Holt provided a Terra Sonic International 150C crawler-mounted sonic drill rig operated by a driller licensed in Washington State.

***Sonic Drilling***

Sonic drilling was performed to allow for groundwater monitoring well installation, relatively undisturbed soil sampling, and grab groundwater sampling using temporary wellpoints (during 2019 investigation). The rotosonic drilling method, also known as vibratory drilling or sonic drilling, uses an eccentrically oscillating drill head to produce high-frequency vibratory energy that is then transmitted down a drill string to a core barrel to quickly advance through the subsurface. Water was utilized during drilling to control heave. Additionally, conductor casing was driven in conjunction with the sampling rods to prevent cross contamination of deeper lithologic layers from shallow contamination.

In 2019, the locations of sonic drilling, grab sampling (soil and groundwater), and groundwater monitoring well installation were selected based on the results of the direct-push sampling in collaboration with the project team as well as on real-time observations made in the field. In 2022, the locations of sonic drilling, soil sampling, and groundwater monitoring well installation were selected based on historical contaminant data in collaboration with the project team as well as on real-time observations made in the field. Figures 2-2 and 2-3 show all 2019 and 2022 sonic boring locations in the south, central, and north areas of the site.

During the 2019 investigation, five sonic borings were installed in the South Plantation, five borings were installed in the Central Landfill, and five borings were installed in the North Plantation. Additionally, one sonic boring was installed along 5$^{th}$ Street, near the intersection with Bradley Road, and one boring was installed through a concrete pad directly to the northeast of the South Plantation.

During the 2022 investigation, two sonic borings were installed in the South Plantation, one boring was installed in the Central Landfill, and two borings were installed in the North Plantation. Additionally, two borings were installed on the Highway 308 causeway adjacent to existing wells MW1-38 and MW1-39.

***Soil Sampling***

Continuous soil cores were collected during sonic drilling and immediately logged upon retrieval using the following procedure. A tubular plastic sleeve with a sealed bottom was placed beneath the core barrel. The core barrel was then vibrated, causing the soil sample to be extruded into the plastic sleeve. Each plastic sleeve was filled with no more than 3 ft of soil core. The plastic sleeve was then marked with the sample interval using indelible ink. The majority of cores were approximately 4 inches in diameter, with the exception of one 2019 boring (MW1-66/SP-B139) that was drilled with a 6-inch diameter core to accommodate a 4-inch well casing.

Soil from the sonic cores was visually examined for contamination and classified in accordance with the USCS. Soils were field screened, at 1-foot intervals, with a PID equipped with a ppb detector. PID screening, and subsequent sampling, was conducted at the middle of the rotosonic core to minimize soil disturbance and temperature effects of the rotosonic drilling. The following procedures were adhered to during PID screening activities:

- Screening took place as soon as possible after each core tube was opened. If screening could not take place immediately after the core was retrieved, the plastic sleeve was left unopened until screening could be conducted.
- At each screening interval (every foot or more frequent), a Terra Core sampling device (or equivalent thin-walled sample tube) was temporarily pressed into the soil core to isolate a known volume of soil and create a small headspace above the soil volume.
- Tubing from the PID was inserted into the headspace above the soil core.
- The highest value measured on the PID for each measurement interval was recorded.
- A new Terra Core sampler was used for each interval, with samplers decontaminated and re-used between soil cores.

Relatively undisturbed soil samples were collected from the sonic borings at intervals based on PID field screening results and within the planned screened interval for each monitoring well. During the 2022 investigation soil samples were collected at zones of known and/or suspected contamination, and deeper at regular intervals to document expected declining COC concentrations with depth. Table B2-3 summarizes the grab soil samples collected from each sonic boring, along with the laboratory analyses performed on each sample. At a minimum, all soil samples were analyzed for the target VOCs listed in the SAP and chloroethane. Additionally, soil samples collected from particular borings were analyzed for TOC (South Plantation and Central Landfill), PCB congeners (North Plantation), TPH-Dx (North Plantation), and 1,4-dioxane (Central Landfill, North Plantation, and Highway 308 causeway).

In addition to the parameters listed above, soil samples were also collected and analyzed for physical characteristics. These samples were collected by driving a 3-inch diameter by 6-inch long modified California split-spoon sampler fitted with brass rings through the outer sonic casing. These samples were analyzed for soil physical characteristics, including horizontal and vertical permeability, effective porosity, density, grain size, and TOC.

***Grab Groundwater Sampling***

In 2019, grab groundwater samples were collected during direct-push and sonic drilling. Grab groundwater sample depths were selected based on the PID field screening results. Each grab groundwater sample was collected by installing, by hand, a 5-foot section of PVC well screen attached to blank PVC casing to the target depth. Using this method, a plastic Typhoon® submersible pump was used to purge groundwater at the target depth until the water visibly cleared, at which time a sample was pumped directly into the laboratory-supplied vials.

Tables B2-2 and B2-3 summarize the grab groundwater samples collected from each direct-push and sonic boring, respectively, along with the laboratory analyses performed on each sample. At a minimum, all grab groundwater samples were analyzed for the target VOCs listed in the SAP and chloroethane. Additionally, one grab groundwater sample was also analyzed for 1,4-dioxane (CL-B134).

Grab groundwater sampling was not performed during the 2022 vertical extent investigation.

***Groundwater Monitoring Well Installation***

In 2019, a total of nine monitoring wells were installed at the site: three at the South Plantation, one in the Central Landfill, and five at the North Plantation. Wells installed in 2019 continued the historical naming conventions for OU 1 wells, beginning with the next well number in series (MW1-59). "MW1-60" was installed previously, in 2017.

In 2022, a total of seven monitoring wells were installed at the site: two at the South Plantation, one in the Central Landfill, two at the North Plantation, and two along the Highway 308 causeway. Wells installed in 2022 continued the historical naming conventions for OU 1 wells, beginning with the next well number in series (MW1-69).

Figures 2-2 and 2-3 show the locations of all groundwater monitoring wells installed at the site in 2017, 2019, and 2022, as well as the locations of historical groundwater monitoring wells.

The locations and screened intervals for new groundwater monitoring wells were selected in consultation with the project team. In 2019, screened intervals were selected based on the soil and grab groundwater sampling results of the direct-push investigation, real-time observations made in the field (i.e., lithology, PID screening results, etc.), and in consultation with the Navy. In 2022, the anticipated screened intervals were initially presented in the SAP (U.S. Navy, 2022a), and were based on the known vertical distribution of COCs at the time, and in consultation with the project team. Actual screened intervals were selected based on real-time observations in the field (i.e., lithology, PID screening results, etc.), and in consultation with the Navy. The well screen information for new and existing wells is presented in Table B2-4.

The wells were constructed of flush-threaded Schedule 40 PVC with a sand trap on the bottom, 5 to 15 ft of 0.010 slot screened well casing, blank well casing to the ground surface and sealed with a lockable compression cap. The filter pack around the screen consisted of #12/20 grade silica sand, and the well seal consisted of hydrated bentonite chips.

Wells were completed with above-ground steel "stick-up" protective casings surrounded by three bollards in unpaved portions of the site, and with traffic-rated flush mount monuments in paved portions of the site. Table B2-4 summarizes the well screen details and survey information for wells installed in 2019 and 2022, as well as pre-existing wells at OU 1.

All 16 newly installed wells were found to produce sufficient groundwater flow for purging and sampling.

Boring logs and well construction diagrams were completed that included the driller's license number and are signed by the licensed driller. The driller will upload these logs to Ecology's database, as required. The Washington State Well identification (ID) for each installed well was provided by the well drilling contractor and attached to each well as required by Ecology's *Minimum Standards for Construction and Maintenance of Wells* (Chapter 173-160 Washington Administrative Code [WAC]).

***Monitoring Well Development***

Newly installed wells were allowed to rest a minimum of 24 hours following installation. In 2019, well development was conducted from October 10 to October 23, 2019. In 2022, well development was conducted April 28 through May 13, 2022 and on July 14, 2022 (MW1-74 and MW1-75).

Well development was performed in accordance with the SAP using surging and bailing, followed by high flow pumping while monitoring water quality parameters. As expected, water quality parameters (especially turbidity) did not fully stabilize during development of most wells because of the fine-grained nature of the formation. However, development achieved substantial reductions in turbidity at most wells.

## 2.3 GROUNDWATER SAMPLING FROM MONITORING WELLS

In 2019 and 2022, groundwater sampling was performed at least 72 hours after well development of newly installed wells (except for MW1-59 and MW1-66, and MW1-73), using low-flow techniques in accordance with the SAP and NAVFAC NW Standard Operating Procedure (SOP) I-C-5 (U.S. Navy, 2017). Samples for PFAS from the wells selected for this analysis were collected according to the procedures listed in the SAPs (U.S. Navy, 2019; U.S. Navy, 2022a).

<u>2019</u>

In 2019, groundwater samples were collected from newly installed wells, as well as wells installed in 2017, along with existing wells MW1-2 and MW1-18. A total of 34 groundwater samples were collected from 29 wells (groundwater samples were collected from multiple depths at three wells: MW1-56, MW1-57, and MW1-58). Table B2-3 summarizes the groundwater samples collected and the analyses performed.

Of the 34 groundwater sampling locations in 2019, 32 groundwater samples were analyzed for the nine target VOCs. Samples from 12 of the 34 sampling locations were collected and analyzed for 1,4-dioxane to support remedial technology screening (Table B2-3); samples from 14 of the 34 sampling locations were collected for microbial analysis; samples from 30 of the 34 sampling locations were collected and analyzed for biodegradation parameters, including DOC, nitrate/nitrite, sulfate/sulfide, methane, ethane, ethene, and chloride; samples from 12 of the 34 sampling locations were collected and analyzed for TPH-Dx; samples from five of the 34 sampling locations were collected and analyzed for PCB congeners; and samples from four of the 34 sampling locations were collected for PFAS analysis. Field parameters, including DO, ORP, pH, specific conductivity, temperature, and turbidity were collected during well purging, and immediately prior to sampling of all wells.

On October 29, 2019, depth to groundwater measurements were collected from all wells installed in 2017 and 2019 (Table B2-4). Groundwater elevations, calculated from depth to groundwater measurements and survey data (Table B2-4), are shown on Figure 2-4 for October 2019 measurements. Potentiometric surface maps are included in Appendix C of the supplemental RI report, as part of the ESS study, because it is necessary to consider hydrostratigraphic units when preparing these contour maps. Many years of data have been collected from the LTM program in the past and the potentiometric surface maps have been very similar over time.

<u>2022</u>

In 2022, groundwater samples were collected from the newly installed wells. A total of seven groundwater samples were collected from seven wells. Table B2-3 summarizes the groundwater samples collected and the analyses performed.

At the seven groundwater sampling locations in 2022, groundwater samples were analyzed for the nine target VOCs, 1,4-dioxane, PCB congeners, PCB Aroclors, and PFAS. Field parameters, including DO, ORP, pH, specific conductivity, temperature, and turbidity were collected during well purging, and immediately prior to sampling of all wells.

From May 2 through 13, 2022, and July 18, 2022 (MW1-74 and MW1-75), groundwater measurements were collected from the newly installed wells prior to purging and sampling. Groundwater elevations, calculated from depth to groundwater measurements and survey data are shown in Table B2-4.

## 2.4 POREWATER AND SURFACE WATER SAMPLING

### 2.4.1 Porewater and Surface Water Sampling Approach

In 2019, porewater samples south of the South Plantation were collected to assess the lateral extent of cVOC COCs as “step out” locations further south of the 2017 porewater locations, which exhibited elevated cVOC concentrations. Porewater and surface water samples were collected along Marsh Creek, downstream of Marsh Pond, to assess a possible groundwater to surface water pathway from the Central Landfill. In 2019, one surface water sample was collected at the upstream end of Marsh Pond to compare to 2017 data from upstream locations in Marsh Creek.

Lastly, porewater and surface water samples were collected upstream, downstream, and near the seep (SP1-1) to assess possible groundwater to surface water transport of PCBs.

Sampling of surface water and porewater was performed following sufficient seasonal precipitation to ensure typical flow conditions in the marsh area.

### 2.4.2 Porewater Sampling Activities

A total of eight porewater samples were collected to the south of the South Plantation, five porewater samples were collected to the northwest of the Central Landfill, downstream of Marsh Pond, and three porewater samples were collected in Marsh Creek (around the seep, SP1-1) on September 4, 5, and 6, 2019. Additionally, three porewater samples were collected from west/southwest of the South Plantation on October 18, 2019. All porewater samples were collected using a PushPoint sampler as planned in the SAP, and 16 samples were analyzed for the nine cVOC COCs and chloroethane, and three samples (PW1-25, PW1-26, and PW1-27) were analyzed for PCB congeners.

Porewater samples collected are summarized in Table B2-5 and the sampling locations are shown on Figures 2-1 and 2-2. Sampling of porewater was performed following sufficient seasonal precipitation to ensure typical flow conditions in the marsh area. Porewater sampling was not performed during the 2022 vertical extent investigation.

Data from porewater samples are used in Section 4 to assess the lateral extent of cVOCs in groundwater prior to water daylighting to surface water at the edge of the marsh (South Plantation) and downstream of Marsh Pond (northwest of Central Landfill). The data from the porewater samples nearby the seep, SP1-1, were analyzed to assess the potential groundwater transport of PCBs.

### 2.4.3 Surface Water Sampling Activities

In June 2019, one surface water sample was collected in the waterways immediately upstream of Marsh Pond, within Marsh Creek, northwest of the South Plantation. Additionally, seven surface water samples were collected from downstream of Marsh Pond, where a groundwater to surface water migration pathway may exist. Five of the surface water samples were analyzed for the target VOCs. Three of the surface water samples (from SW1-18, SW1-19, and SW1-20) were analyzed for PCB congeners. Field water quality parameters were collected for all surface water samples, including DO, ORP/Redox, pH, turbidity, specific conductance, and temperature. Surface water samples collected are summarized in Table B2-6, and sampling locations are shown on Figures 2-1 and 2-2. Surface water sampling was not performed during the 2022 vertical extent investigation.

## 2.5 SEDIMENT SAMPLING

### 2.5.1 Sediment Sampling Approach

As planned in the SAP, sediment samples were collected in 2019 at the same locations sampled in 2017, with the addition of two historical locations within the tide flats to allow calculation of area weighted averages for tide flats. Additional sediment samples were collected in 2021 using the incremental sampling methodology (ISM) protocol. These 2021 samples were collected under a separate SAP (U.S. Navy, 2021a) and were reported under separate cover (U.S. Navy, 2022d); therefore, 2019 sampling only is discussed here in detail.

### 2.5.2 Sediment Sampling Activities

Seven sediment samples were collected on June 4 and 5, 2019 to assess PCB concentrations at, or in the vicinity of, historical sediment sample locations. Samples were collected from MA-19, MA-21, MA-22, MA-23, TF-18, TF-20, and TF-21. New stations MA-21, MA-22, and MA-23 were added as part of this investigation to refine the understanding of PCB distribution in Marsh Creek. The 2017 investigation found the highest PCB concentrations in sediment at location MA09, which is in the vicinity of these 2019 sediment sampling locations. Sediment samples were collected in accordance with the SAP and NAVFAC NW SOP I-B-8 (U.S. Navy, 2017) and analyzed for PCB as Aroclors and total congeners in accordance with the SAP.

Sediment samples collected in 2019 are summarized in Table B2-7, and sampling locations are shown on Figure 2-2. Sediment samples in 2021 are presented under separate cover (U.S. Navy, 2022d). Sediment sampling was not performed during the 2022 vertical extent investigation.

## 2.6 SLUG TESTING

During SAP development and scoping, the Navy considered several methods for characterizing the aquifer beneath OU 1. Methods considered included pumping tests, slug tests, laboratory analysis of soil cores, and tracer testing. As part of assessing these methods, slug tests were conducted in three wells in June 2021 to provided initial hydraulic conductivity values for key soil types beneath OU 1. Based on these initial values, the project team agreed that the best approach for characterizing the aquifer was combining the results of additional slug tests with laboratory analysis of soil cores from key soil types.

Slug testing was conducted between June 2021 and July 2022 and consisted of at least one rising head and one falling head test in each of the 15 wells selected in the SAP (U.S. Navy, 2022a). At some wells multiple tests were performed to achieve the cleanest response curve. The slug testing wells, along with well screen intervals and general location, are shown in Table B2-8.

Slug tests were performed using a solid slug constructed on site using PVC pipe partially filled with sand, with the well response recorded using a Solinst-brand Levelogger pressure transducer and datalogger. In some wells screened within high transmissivity soil types, the aquifer response was rapid enough that the fastest available data collection interval on the datalogger resulted in few data points collected before equilibrium conditions were reached. The slug test conducted from monitoring well MW1-64 yielded data that were unsuitable for analytical processing/curve matching due to sporadic data points; therefore, hydraulic conductivity values could not be computed from this well.

## 2.7 LAND SURVEY

<u>2019</u>

The SAP for the 2019 investigation (U.S. Navy, 2019) anticipated that boring locations would be documented using a global positioning system (GPS) unit. However, based on the difficulty in getting satellite coverage within tree plantations, traditional survey techniques were utilized to document the locations. Surveys of all soil borings installed in June, September, and October 2019 and the nine new groundwater monitoring wells were conducted on July 10 and October 29, 2019 by a State of Washington-licensed surveyor under the supervision of Battelle. The locations were tied into the existing base map developed for the site. The ground elevation and the elevation of the top of the PVC casing for each well was surveyed to a reference point determined in the field and reported to within 0.01 foot. All elevations were referenced to the North American Vertical Datum (NAVD) 1988. The horizontal locations of each point were documented in North American Datum (1983/91) Washington State Plane North Zone with an accuracy of up to 0.1 foot. The survey report is included in Attachment 4.

2022

Surveys of the seven groundwater monitoring wells installed in April, May, and July 2022 were conducted in July 2022, by a State of Washington-licensed surveyor under the supervision of Battelle. The locations were tied into the existing base map developed for the site. The ground elevation and the elevation of the top of the PVC casing for each well was surveyed to a reference point determined in the field and reported to within 0.01 foot. All elevations were referenced to the NAVD88. The horizontal locations of each point were documented in North American Datum (1983/91) Washington State Plane North Zone with an accuracy of up to 0.1 foot. The survey report is included in Attachment 4.

## *Figures Included in Supplemental RI*

**Table B2-1. Deviations from the Sampling and Analysis Plan - 2019 and 2022**

| Deviation | Description | Rationale | Effective Date | Samples Affected | FCR No. | SAP Section(s) Affected |
|---|---|---|---|---|---|---|
| **2019 Investigation** | | | | | | |
| Addition of Field Site Manager and Alternate SSHO for second mobilization (September 2019) | Steven Verdibello added as Field Site Manager and Alternate SSHO for second mobilization (September 2019). | Due to relatively long duration of field work, this provided additional staffing flexibility. | 9/30/2019 | None | 1 | N/A |
| Addition of tree felling AHA | Tree felling was performed by a professional tree removal subcontractor to Battelle to access boring/well locations in the north and south plantations. | Based on the final position of wells to be drilled during mobilization 2, trees needed to be felled to allow drill rig access. | 9/30/2019 | None | 1 | SAP Worksheet #s14,15-8,18,19,20, and #23-6 |
| No traffic control plan or road lane closures | No Traffic Control Plan was developed for the site, as closure of Bradley Road was not necessary. | Borings SP-B91, SP-B91, and SP-B92 were placed to the side of Bradley Road or Gadberry Street, and the locations were deemed safe enough to not implement a traffic control plan or road lane closures | 6/3/2019 | None | None | Worksheet #s12-1, 14, 15-1, 18, 19, 20, 23-5, 24, 25, 28-1, and 30 |
| Modification of sediment sampling locations | Sampled TF-21 instead of TF-22. The TF-18 sample was collected at farthest point of longest spit jutting out from northwest corner of tide flats, approximately 25 meters "short" of the historical location. | TF-22 was not accessible by foot at low tide. The sampling team instead collected a sample at the nearest accessible location to TF-22; however, this location better coincided with location TF-21. TF-21 was therefore selected as the sample ID to be more representative of the actual location of the sample. Historical TF-18 sampling location was not accessible, even at lowest tide level; therefore, sample was moved to closest area possible | 6/04/2019 & 6/5/2019 | TF-18, TF-21, and TF-22 | None | Worksheet #s14, 17, 18, 19, and 20 |
| Planned locations of soil boring and monitoring wells shifted | Slight shifts of several boring locations from proposed locations presented in SAP. | Shifts were necessary based on utility survey and pre-drilling site walkthrough | 9/30/2019 | None | None | Worksheet #17; Figure 3 |
| Additional borings added to delineate vertical and lateral extent of clay aquitard | SP-B140, SP-B141, and CL-B142 added to identify depth to clay aquitard | Additional information regarding the clay aquitard was desirable to add information to the conceptual site model | 9/30/2019 | None | None | Worksheet #17-2.7, 17-4.7; Figure 3, Figure 4 |

**Table B2-1. Deviations from the Sampling and Analysis Plan (continued)**

| Deviation | Description | Rationale | Effective Date | Samples Affected | FCR No. | SAP Section(s) Affected |
|---|---|---|---|---|---|---|
| Additional wells installed at planned locations MW1-65 and MW1-66 | MW1-67 (NP-B143) was added in the MW1-65 location and MW1-68 (SP-B144) was added in the MW1-66 location. | MW1-67 was added to have a shallow and deep well pair in this location to better delineate documented contamination. MW1-68 was added for the same reason. | 9/30/2019 | Additional soil and groundwater samples collected | None | Worksheet #17, Figure 3, Figure 4 |
| Microbial sampling locations for groundwater | Due to labeling error, a groundwater sample was collected for microbial analysis at MW1-58 (shallow; MW1-58-9) instead of MW1-56, as intended. | Monitoring wells MW1-58 and MW1-56 were confused during sample collection. Error was noticed the following day, but microbial sample was still run for MW1-58 instead of MW1-56. | 10/23/2019 | MW1-58-9; MW1-56 | None | Worksheet #18.2 |
| No sample collected from deep interval of MW1-56 | Groundwater sample was not able to be collected from the deep interval of MW1-56. | Could not collect any volume or detect groundwater with an interface probe from this interval. Same issue was encountered during sampling in 2017. | 10/24/2019 | MW1-56-36 | None | Worksheet #18.2, 20 |
| Microbial sample collection method | Microbial samples were collected using 1-liter glass amber jars instead of Bio-Flo filters | 1 L amber glass containers were used to collect 1 L of sample volume for some samples intended for microbial analysis due to a shortage of filters onsite. More filters were used per sample than expected due to elevated total suspended solids at some locations. Per the method, amber glass bottles can be used but are not recommended simply due to the likelihood of breakage during shipment (no breakage occurred in this instance). Samples affected include the following: MW1-46, FD-191025-01, MW1-47, MW1-48, and MW1-68. | 10/21/2019 | MW1-46, FD-191025-01, MW1-47, MW1-48, and MW1-68 | None | Worksheet #s14, 17, 19, and 21 |

**Table B2-1. Deviations from the Sampling and Analysis Plan (continued)**

| Deviation | Description | Rationale | Effective Date | Samples Affected | FCR No. | SAP Section(s) Affected |
|---|---|---|---|---|---|---|
| MNA parameters sample collection method | MNA parameters—including sulfide and DOC—at MW1-48, MW1-61, and MW1-68 were collected into unpreserved 1 L amber glass containers for the laboratory to subsample and preserved as necessary. These samples were shipped overnight at the end of 10/28/2019 for arrival at the laboratory on the morning of 10/29/2019. | Unpreserved 1 L amber glass containers were used due to a shortage of pre-preserved bottles onsite. Samples were sub-sampled and preserved upon receipt at the analytical laboratory. Samples affected include the following: MW1-48, MW1-61, and MW1-68 | 10/21/2019 | MW1-48, MW1-61, and MW1-68 | None | Worksheet #19 |
| Some field MNA parameters were not measured | Field samples were not collected for iron (Fe2) or sulfite during sampling. The SAP states that titration kits would be used to sample iron and sulfite, as in 2017. | Error by sampler. | 10/21/2019 | All groundwater samples collected from monitoring wells | None | Worksheet #17 |
| Number and locations of porewater samples | 17 porewater samples were proposed in the SAP and 19 porewater samples were collected. PW1-28 and PW1-29 were new locations that replaced PW1-13 and PW1-14, respectively (did not produce porewater). No sample collected from PW-19 (no water). PW1-30, PW1-31, PW1-32 samples not discussed in SAP (southwest of south plantation hotspot) | PW1-13, PW1-14, and PW1-19 did not produce porewater, new locations were selected. PW1-30, PW1-31, and PW1-32 were new locations added to explore area southwest of south plantation hotspot. | 6/06/2019 & 10/18/2019 | None | None | Worksheet #17-2.8, Figure 3 |
| Plastic submersible centrifugal pump used to collect grab groundwater samples | Rather than using a peristaltic pump as stated in the SAP, a plastic submersible pump was used to collect grab groundwater samples. | The submersible pump was successful because pumping at higher flow rates (than the peristaltic) allowed water to visibly clear quickly during sampling. | 9/30/2019 | Grab groundwater samples | None | Worksheet #17. |
| No source blanks or field reagent blanks collected | Field quality control samples included Trip Blanks, Equipment Blanks, and Field Duplicates. Despite being shown in Worksheet #12 and Worksheet #17, source and reagent blanks not indicated in Worksheet #20. | Quality control samples, including trip blanks, equipment blanks, field duplicates, and MS/MSD followed Worksheet #20, and was deemed sufficient by Battelle staff. | 6/3/2017 | Quality control samples | None | Worksheet #s 12, 17, 20. |
| No equipment blanks for soil sampling collected | No equipment blanks were collected for soil sampling equipment. | Re-usable equipment was not used during soil sampling, thus equipment blanks were not necessary | 9/30/2019 | Soil samples | None | Worksheet #20 |

**Table B2-1. Deviations from the Sampling and Analysis Plan (continued)**

| Deviation | Description | Rationale | Effective Date | Samples Affected | FCR No. | SAP Section(s) Affected |
|---|---|---|---|---|---|---|
| Less than 72-hour wait time between well development and sampling | MW1-66 sample was collected 28 hours following well development and MW1-59 sample was collected 17 hours following well development rather than the full 72 hours. | Groundwater visibly cleared during development, and water level returned to static prior to purging for sampling | 10/23/2019 | None | None | Worksheet #17 |
| Water quality parameters not measured during development of MW1-61 and MW1-66 | Water quality parameters were not measured during development of MW1-61 and MW1-66; however, these wells were developed in the same manner as the previous wells: surging for ten minutes followed by pumping for approximately 55 gallons of recovered volume. | The effluent was visibly inspected to determine whether turbidity met requirements for successful development. | 10/23/2019 | None | None | Worksheet #17 |
| **2022 Investigation** | | | | | | |
| Planned locations of soil boring and monitoring wells shifted | Slight shifts of several boring locations from proposed locations presented in SAP. | Shifts were necessary based on utility survey and pre-drilling site walkthrough | 4/4/2022 | None | None | Worksheet #17 |
| Less than 72-hour wait time between well development and sampling | MW1-73 sample was collected 43 hours following well development rather than the full 72 hours. | Groundwater visibly cleared during development, and water level returned to static prior to purging for sampling | 5/13/2022 | None | None | Worksheet #17 |
| Deviation of planned Well Screening Interval at: MW1-69/SP-B174 | Proposed well screen interval was identified as 70-80 ft bgs. The actual recorded screened interval is at 42-52 ft bgs. | Actual screened intervals chosen based on observed lithology and PID screening. | 4/27/2022 | None | None | Worksheet #17 Table 17.1 |
| Deviation of planned Well Screening Interval at: MW1-70/SP-B175 | Proposed well screen interval was identified as 100-110 ft bgs. The actual recorded screened interval is at 70-80 ft bgs. | Actual screened intervals chosen based on observed lithology and PID screening. | 4/25/2022 | None | None | Worksheet #17 Table 17.1 |
| Deviation of planned Well Screening Interval at: MW1-71/CL-B176 | Proposed well screen interval was identified as 70-80 ft bgs. The actual recorded screened interval is at 95-100 ft bgs. | Actual screened intervals chosen based on observed lithology and PID screening. | 5/2/2022 | None | None | Worksheet #17 Table 17.1 |
| Deviation of planned Well Screening Interval at: MW1-73/NP-B178 | Proposed well screen interval was identified as 70-80 ft bgs. The actual recorded screened interval is at 90-100 ft bgs. | Actual screened intervals chosen based on observed lithology and PID screening. | 5/9/2022 | None | None | Worksheet #17 Table 17.1 |
| Deviation of planned Well Screening Interval at: MW1-74/DG-B179 | Proposed well screen interval was identified as 64-74 ft bgs. The actual recorded screened interval is at 45-55 ft bgs. | Actual screened intervals chosen based on observed lithology and PID screening. | 7/12/2022 | None | None | Worksheet #17 Table 17.1 |

**Table B2-1. Deviations from the Sampling and Analysis Plan (continued)**

| Deviation | Description | Rationale | Effective Date | Samples Affected | FCR No. | SAP Section(s) Affected |
|---|---|---|---|---|---|---|
| Deviation of planned Well Screening Interval at: MW1-75/DG-B180 | Proposed well screen interval was identified as 94-104 ft bgs. The actual recorded screened interval is at 75-80 ft bgs. | Actual screened intervals chosen based on observed lithology and PID screening. | 7/11/2022 | None | None | Worksheet #17 Table 17.1 |

Notes:
AHA – activity hazard analysis
FCR – field change request
ft bgs – feet below ground surface
MNA – monitored natural attenuation
MS – matrix spike
MSD – matrix spike duplicate
N/A – not applicable
SAP – sampling and analysis plan
SSHO – Site Safety and Health Officer

## Table B2-2. Sampling Performed during Direct-Push Drilling - 2019

| Location ID | Soil Sample ID | Soil Analyses | GW Sample ID | GW Sample Analyses |
|---|---|---|---|---|
| **South Plantation** | | | | |
| **SP-B090** | SP-B090-S-08-190628 | Target VOCs | SP-B090-GW-15-190628 | Target VOCs |
| | SP-B090-S-14-190628 | Target VOCs | SP-B090-GW-14-190628 | Target VOCs |
| | SP-B090-S-15-190628 | Target VOCs | SP-B090-GW-27-190628 | Target VOCs |
| | SP-B090-S-27-190628 | Target VOCs | -- | -- |
| **SP-B91** | SP-B91-S-8-190626 | Target VOCs | SP-B91-GW-9-190626 | Target VOCs |
| | SP-B91-S-30-190626 | Target VOCs | -- | -- |
| **SP-B93** | SP-B93-S-12-190626 | Target VOCs | SP-B93-GW-12.5-190626 | Target VOCs |
| | SP-B93-S-17-190626 | Target VOCs | SP-B93-GW-40-190626 | Target VOCs |
| | SP-B93-S-40-190626 | Target VOCs | -- | -- |
| **SP-B94** | SP-B94-S-15-190626 | Target VOCs | SP-B94-GW-20-190626 | Target VOCs |
| | SP-B94-S-39-190626 | Target VOCs | SP-B94-GW-39-190626 | Target VOCs |
| **CL-B95** | CL-B95-S-7-190627 | Target VOCs | CL-B95-GW-13-190627 | Target VOCs |
| | CL-B95-S-13-190627 | Target VOCs | CL-B95-GW-33-190627 | Target VOCs |
| | CL-B95-S-33-190627 | Target VOCs | -- | -- |
| **CL-B96** | CL-B96-S-5-190627 | Target VOCs | CL-B96-GW-15-190627 | Target VOCs |
| | CL-B96-S-13-190627 | Target VOCs | CL-B96-GW-40-190627 | Target VOCs |
| | CL-B96-S-39-190627 | Target VOCs | -- | -- |
| **CL-B99** | CL-B99-S-12-190625 | Target VOCs | CL-B99-GW-15-190625 | Target VOCs |
| | CL-B99-S-17-190625 | Target VOCs | CL-B99-GW-26-190625 | Target VOCs |
| | CL-B99-S-26-190625 | Target VOCs | -- | -- |
| **CL-B100** | CL-B100-S-5-190625 | Target VOCs | CL-B100-GW-15-190625 | Target VOCs |
| | CL-B100-S-13-190625 | Target VOCs | CL-B100-GW-39-190625 | Target VOCs |
| | CL-B100-S-22-190625 | Target VOCs | -- | -- |

## Table B2-2. Sampling Performed during Direct-Push Drilling (continued)

| Location ID | Soil Sample ID | Soil Analyses | GW Sample ID | GW Sample Analyses |
|---|---|---|---|---|
| | CL-B100-S-37-190625 | Target VOCs | -- | -- |
| CL-B101 | CL-B101-S-09-190618 | Target VOCs | CL-B101-GW-10-190618 | Target VOCs |
| | CL-B101-S-32-190618 | Target VOCs | CL-B101-GW-35-190618 | Target VOCs |
| | CL-B101-S-40-190618 | Target VOCs | -- | -- |
| CL-B102 | CL-B102-S-14-190617 | Target VOCs, 1,4-dioxane | CL-B102-GW-13-190617 | Target VOCs, 1,4-dioxane |
| | CL-B102-S-19-190617 | Target VOCs, 1,4-dioxane | CL-B102-GW-35-190617 | Target VOCs, 1,4-dioxane |
| | CL-B102-S-33-190617 | Target VOCs, 1,4-dioxane | -- | -- |
| CL-B103 | CL-B103-S-09-190617 | Target VOCs, 1,4-dioxane | CL-B103-GW-09-190617 | Target VOCs, 1,4-dioxane |
| | CL-B103-S-12-190617 | Target VOCs, 1,4-dioxane | CL-B103-GW-40-190617 | Target VOCs, 1,4-dioxane |
| | CL-B103-S-19-190617 | Target VOCs, 1,4-dioxane | -- | -- |
| | CL-B103-S-39-190617 | Target VOCs, 1,4-dioxane | -- | -- |
| CL-B104 | CL-B104-S-09-190618 | Target VOCs | CL-B104-GW-14-190618 | Target VOCs |
| | CL-B104-S-28-190618 | Target VOCs | CL-B104-GW-28-190618 | Target VOCs |
| | CL-B104-S-32-190618 | Target VOCs | -- | -- |
| CL-B105 | CL-B105-S-10-190612 | Target VOCs, 1,4-dioxane | CL-B105-GW-15-190612 | Target VOCs, 1,4-dioxane |
| | CL-B105-S-13-190612 | Target VOCs, 1,4-dioxane | CL-B105-GW-40-190612 | Target VOCs, 1,4-dioxane |
| | CL-B105-S-39-190612 | Target VOCs, 1,4-dioxane | -- | -- |
| CL-B106 | CL-B106-S-20-190610 | Target VOCs, 1,4-dioxane | CL-B106-GW-20-190610 | Target VOCs, 1,4-dioxane |
| | CL-B106-S-27-190610 | Target VOCs, 1,4-dioxane | CL-B106-GW-32-190610 | Target VOCs, 1,4-dioxane |
| | CL-B106-S-33-190610 | Target VOCs, 1,4-dioxane | -- | -- |

## Table B2-2. Sampling Performed during Direct-Push Drilling (continued)

| Location ID | Soil Sample ID | Soil Analyses | GW Sample ID | GW Sample Analyses |
|---|---|---|---|---|
| **CL-B107** | CL-B107-S-07-190611 | Target VOCs, 1,4-dioxane, TOC | CL-B107-GW-10-190611 | Target VOCs, 1,4-dioxane |
| | CL-B107-S-22-190611 | Target VOCs, 1,4-dioxane, TOC | CL-B107-GW-32-190611 | Target VOCs, 1,4-dioxane |
| | CL-B107-S-33-190611 | Target VOCs, 1,4-dioxane, TOC | -- | -- |
| **CL-B108** | CL-B108-S-08-190611 | Target VOCs, 1,4-dioxane | CL-B108-GW-12-190611 | Target VOCs, 1,4-dioxane |
| | CL-B108-S-22-190611 | Target VOCs, 1,4-dioxane | CL-B108-GW-25-190611 | Target VOCs, 1,4-dioxane |
| **CL-B109** | CL-B109-S-03-190611 | Target VOCs, 1,4-dioxane | CL-B109-GW-15-190611 | Target VOCs, 1,4-dioxane |
| | CL-B109-S-18-190611 | Target VOCs, 1,4-dioxane | CL-B109-GW-37-190611 | Target VOCs, 1,4-dioxane |
| | CL-B109-S-37-190611 | Target VOCs, 1,4-dioxane | -- | -- |
| **NP-B110** | NP-B110-S-08-190612 | Target VOCs, 1,4-dioxane | NP-B110-GW-15-190612 | Target VOCs, 1,4-dioxane |
| | NP-B110-S-14-190612 | Target VOCs, 1,4-dioxane | NP-B110-GW-40-190612 | Target VOCs, 1,4-dioxane |
| | NP-B110-S-16-190612 | Target VOCs, 1,4-dioxane | QC-190612-01 | Target VOCs, 1,4-dioxane |
| **NP-B111** | NP-B111-S-10-190612 | Target VOCs, 1,4-dioxane | NP-B111-GW-17-190612 | Target VOCs, 1,4-dioxane |
| | NP-B111-S-19-190612 | Target VOCs, 1,4-dioxane | NP-B111-GW-40-190612 | Target VOCs, 1,4-dioxane |
| | NP-B111-S-39-190612 | Target VOCs, 1,4-dioxane | -- | -- |
| **NP-B112** | NP-B112-S-08-190614 | Target VOCs, 1,4-dioxane | NP-B112-GW-15-190614 | Target VOCs, 1,4-dioxane |
| | NP-B112-S-27-190614 | Target VOCs, 1,4-dioxane | NP-B112-GW-31-190614 | Target VOCs, 1,4-dioxane |
| | NP-B112-S-32-190614 | Target VOCs, 1,4-dioxane | -- | -- |

## Table B2-2. Sampling Performed during Direct-Push Drilling (continued)

| Location ID | Soil Sample ID | Soil Analyses | GW Sample ID | GW Sample Analyses |
|---|---|---|---|---|
| **NP-B113** | NP-B113-S-13-190613 | Target VOCs, 1,4-dioxane | NP-B113-GW-15-190613 | Target VOCs, 1,4-dioxane |
| | NP-B113-S-20-190613 | Target VOCs, 1,4-dioxane | -- | -- |
| | NP-B113-S-27-190613 | Target VOCs, 1,4-dioxane | -- | -- |
| **NP-B114** | NP-B114-S-08-190613 | Target VOCs, 1,4-dioxane | NP-B114-GW-15-190613 | Target VOCs, 1,4-dioxane |
| | NP-B114-S-15-190613 | Target VOCs, 1,4-dioxane | NP-B114-GW-40-190613 | Target VOCs, 1,4-dioxane |
| | NP-B114-S-23-190613 | Target VOCs, 1,4-dioxane | -- | -- |
| | NP-B114-S-33-190613 | Target VOCs, 1,4-dioxane | -- | -- |
| **NP-B115** | NP-B115-S-04-190614` | Target VOCs, 1,4-dioxane | NP-B115-GW-15-190614 | Target VOCs, 1,4-dioxane |
| | NP-B115-S-09-190614 | Target VOCs, 1,4-dioxane | NP-B115-GW-27-190614 | Target VOCs, 1,4-dioxane |
| | NP-B115-S-27-190614 | Target VOCs, 1,4-dioxane | -- | -- |
| **NP-B116** | NP-B116-S-13-190621 | Target VOCs, 1,4-dioxane | NP-B116-GW-15-190621 | Target VOCs, 1,4-dioxane |
| | NP-B116-S-22-190624 | Target VOCs, 1,4-dioxane | NP-B116-GW-14-190621 | Target VOCs, 1,4-dioxane |
| | NP-B116-S-34-190624 | Target VOCs, 1,4-dioxane | NP-B116-GW-36-190624 | Target VOCs, 1,4-dioxane |
| **NP-B117** | NP-B117-S-10-190613 | Target VOCs, 1,4-dioxane | -- | -- |
| **NP-B117s** [1] | NP-B117s-S-10-190613 | Target VOCs, 1,4-dioxane | NP-B117s-GW-15-190613 | Target VOCs, 1,4-dioxane |
| | NP-B117s-S-28-190613 | Target VOCs, 1,4-dioxane | NP-B117s-GW-40-190613 | Target VOCs, 1,4-dioxane |
| | NP-B117s-S-39-190613 | Target VOCs, 1,4-dioxane | -- | -- |
| **NP-B118** | NP-B118-S-13-190624 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | NP-B118-GW-20-190624 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx |

## Table B2-2. Sampling Performed during Direct-Push Drilling (continued)

| Location ID | Soil Sample ID | Soil Analyses | GW Sample ID | GW Sample Analyses |
|---|---|---|---|---|
| | NP-B118-S-16-190624 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | NP-B118-GW-35-190625 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx |
| | NP-B118-S-34-190625 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | -- | -- |
| **NP-B119** | NP-B119-S-07-190621 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | NP-B119-GW-15-190621 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx |
| | NP-B119-S-12-190621 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | NP-B119-GW-32-190621 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx |
| | NP-B119-S-15-190621 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | -- | -- |
| **NP-B120** | NP-B120-S-12.5-190624 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | NP-B120-GW-15-190624 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx |
| | NP-B120-S-29-190624 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | NP-B120-GW-50-190624 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx |
| | NP-B120-S-35.5-190624 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | -- | -- |
| | NP-B120-S-42-190624 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | -- | -- |

## Table B2-2. Sampling Performed during Direct-Push Drilling (continued)

| Location ID | Soil Sample ID | Soil Analyses | GW Sample ID | GW Sample Analyses |
|---|---|---|---|---|
| | NP-B120-S-49.5-190624 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | -- | -- |
| NP-B121 | NP-B121-S-05-190620 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | NP-B121-GW-15-190620 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx |
| | NP-B121-S-13-190620 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | NP-B121-GW-35-190620 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx |
| | NP-B121-S-14-190620 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | -- | -- |
| | NP-B121-S-34-190620 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | -- | -- |
| NP-B122 | NP-B122-S-05-190620 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | NP-B122-GW-15-190620 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx |
| | NP-B122-S-09-190620 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | NP-B122-GW-28-190621 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx |
| | NP-B122-S-27-190621 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | -- | -- |
| NP-B123 | NP-B123-S-19-190619 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | NP-B123-GW-19-190619 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx |

## Table B2-2. Sampling Performed during Direct-Push Drilling (continued)

| Location ID | Soil Sample ID | Soil Analyses | GW Sample ID | GW Sample Analyses |
|---|---|---|---|---|
| | NP-B123-S-25-190619 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | NP-B123-GW-20-190619 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx |
| | NP-B123-S-40-190619 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | NP-B123-GW-40-190619 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx |
| **NP-B124** | NP-B124-S-10-190620 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | NP-B124-GW-20-190620 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx |
| | NP-B124-S-14-190620 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | NP-B124-GW-29-190620 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx |
| | NP-B124-S-28-190620 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | -- | -- |
| **NP-B125** | NP-B125-S-20-190619 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | NP-B125-GW-23-190619 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx |
| | NP-B125-S-38-190619 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | NP-B125-GW-39-190619 (2019) | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx |
| | NP-B125-S-45-190619 | Target VOCs, 1,4-dioxane, PCB Aroclors, TPH-Dx | -- | -- |

**Notes:**
PCB Aroclors - Samples analyzed for PCBs using EPA Method 8082A

## Table B2-2. Sampling Performed during Direct-Push Drilling (continued)

Target VOCs - Samples analyzed using EPA Method 8260C for the 9 VOC COCs: 1,2-dichloroethane, tetrachloroethylene (PCE), cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, 1,1,1-trichloroethane, vinyl chloride, 1,1-dichloroethane, 1,1-dichloroethylene, and trichloroethylene (TCE) plus the degradation compound chloroethane.
TPH-Dx – Samples analyzed for TPH-diesel using the NWTPH-DX method
1,4-Dioxane - Samples analyzed for 1,4-Dioxane using EPA Method 8270D.
*Direct-push drilling and soil sampling also performed as part of Upland Soils and PCB investigation (U.S. Navy, 2023)
[1] NP-B117s was 2-ft lateral step-out boring drilled due to refusal in the original boring (NP-B117) at 11 ft bgs.

## Table B2-3. Sampling Performed during Sonic Drilling and from Groundwater Monitoring Wells - 2019 and 2022

| Location ID | Soil Sample ID | Soil Analyses | GW Sample ID | GW Sample Analyses |
|---|---|---|---|---|
| **2019 Investigation** | | | | |
| **SP-B92** | SP-B92-S-13-191016 | Target VOCs, TOC | SP-B92-GW-15-191016 | Target VOCs |
| | SP-B92-S-12-191016 | TOC | SP-B92-GW-30-191016 | Target VOCs |
| | SP-B92-S-28-191016 | Target VOCs, TOC | -- | -- |
| **MW1-59/SP-B130** | SP-B130-S-65-191002 | Target VOCs | MW1-59-191023 | Target VOCs, PFAS, Microbial DNA, biodegradation |
| **SP-B131** | SP-B131-S-6-191015 | Target VOCs, TOC | SP-B131-GW-15-191015 | Target VOCs |
| | SP-B131-S-23-191015 | Target VOCs, TOC | SP-B131-GW-40-191015 | Target VOCs |
| **MW1-66/SP-B139** | SP-B139-S-9-191017 | Target VOCs | MW1-66-191024 | Target VOCs |
| | SP-B139-S-10-191017 | Target VOCs | | |
| **SP-B140** | *No samples collected for laboratory analytical testing* | | | |
| **SP-B141** | *No samples collected for laboratory analytical testing* | | | |
| **MW1-68/SP-B144** | SP-B144-S-50-191016 | Target VOCs | MW1-68-191028 | Target VOCs, Microbial DNA, biodegradation |
| **CL-B98** | CL-B98-S-2-191014 | Target VOCs | CL-B98-GW-15-191014 | Target VOCs |
| | CL-B98-S-30-191014 | Target VOCs | CL-B98-GW-37-191014 | Target VOCs |
| **CL-B132** | CL-B132-S-07-190930 | Target VOCs, TOC | CL-B132-GW-15-190930 | Target VOCs |
| | CL-B132-S-27-190930 | Target VOCs, TOC | CL-B132-GW-45-190930 | Target VOCs |
| **MW1-61/CL-B133** | CL-B133-S-6-191011 | Target VOCs | MW1-61-191028 | Target VOCs, PFAS (FD), biodegradation |
| | CL-B133-S-13-191011 | Target VOCs | | |
| | CL-B133-S-29-191011 | Target VOCs | | |
| | CL-B133-S-38-191011 | Target VOCs | | |
| **CL-B134** | CL-B134-S-49-191003 | Target VOCs | CL-B134-GW-49-191003 | Target VOCs, 1,4-dioxane |
| | CL-B134-S-50-191003 | Target VOCs | CL-B134-GW-50-191003 | Target VOCs, 1,4-dioxane |

## Table B2-3. Sampling Performed during Sonic Drilling and from Groundwater Monitoring Wells - 2019 and 2022 (continued)

| Location ID | Soil Sample ID | Soil Analyses | GW Sample ID | GW Sample Analyses |
|---|---|---|---|---|
| **CL-B142** | *No samples collected for laboratory analytical testing* | | | |
| **MW1-62/NP-B135** | NP-B135-S-38-191004 | Target VOCs | MW1-62-191024 | Target VOCs, 1,4-dioxane, PFAS, biodegradation, TPH-Dx |
| | NP-B135-S-78-191004 | Target VOCs | -- | -- |
| **MW1-63/NP-B136** | NP-B136-S-36-191007 | Target VOCs | MW1-63-191025 | Target VOCs, 1,4-dioxane, biodegradation, TPH-Dx |
| | NP-B136-S-66-191007 | Target VOCs | -- | -- |
| **MW1-64/NP-B137** | NP-B137-S-52-191008 | Target VOCs, PCB congeners, TPH-Dx | MW1-64-191024 | Target VOCs, 1,4-dioxane, PCB congeners, TPH-Dx, PFAS, biodegradation |
| **MW1-65/NP-B138** | NP-B138-S-5-191009 | PCB Congeners, TPH-Dx | MW1-65-191021 | Target VOCs, 1,4-dioxane, PCB congeners, TPH-Dx, biodegradation |
| | NP-B138-S-6-191009 | Target VOCs, PCB Congeners, TPH-Dx | | |
| | NP-B138-S-62-191009 | Target VOCs, PCB Congeners, TPH-Dx | | |
| **MW1-67/NP-B143** | | | MW1-67-191028 | Target VOCs, 1,4-dioxane, PCB congeners, TPH-Dx, biodegradation |
| **MW1-2** | -- | -- | MW1-2-191029 | PCB congeners (FD) |
| **MW1-18** | -- | -- | MW1-18-191021 | PCB congeners |
| **MW1-42** | -- | -- | MW1-42-191022 | Target VOCs, 1,4-dioxane, Microbial DNA, biodegradation, TPH-Dx |

**Table B2-3. Sampling Performed during Sonic Drilling and from Groundwater Monitoring Wells - 2019 and 2022 (continued)**

| Location ID | Soil Sample ID | Soil Analyses | GW Sample ID | GW Sample Analyses |
|---|---|---|---|---|
| **MW1-43** | -- | -- | MW1-43-191022 | Target VOCs, 1,4-dioxane, biodegradation, TPH-Dx |
| **MW1-44** | -- | -- | MW1-44-191024 | Target VOCs, 1,4-dioxane, biodegradation, TPH-Dx |
| **MW1-45** | -- | -- | MW1-45-191022 | Target VOCs, 1,4-dioxane, Microbial DNA, biodegradation, TPH-Dx |
| **MW1-46** | -- | -- | MW1-46-191025 | Target VOCs, 1,4-dioxane, Microbial DNA, biodegradation, TPH-Dx (FD for all) |
| **MW1-47** | -- | -- | MW1-47-191025 | Target VOCs, 1,4-dioxane, Microbial DNA, biodegradation, TPH-Dx |
| **MW1-48** | -- | -- | MW1-48-191028 | Target VOCs, 1,4-dioxane, Microbial DNA, biodegradation, TPH-Dx |
| **MW1-49** | -- | -- | MW1-49-191022 | Target VOCs, biodegradation (FD for all) |
| **MW1-50** | -- | -- | MW1-50-191023 | Target VOCs, Microbial DNA (FD), biodegradation |
| **MW1-51** | -- | -- | MW1-51-191021 | Target VOCs, Microbial DNA, biodegradation |
| **MW1-52** | -- | -- | MW1-52-191021 | Target VOCs, Microbial DNA, biodegradation |
| **MW1-53** | -- | -- | MW1-53-191023 | Target VOCs, biodegradation |
| **MW1-54** | -- | -- | MW1-54-191021 | Target VOCs, biodegradation |
| **MW1-55** | -- | -- | MW1-55-191024 | Target VOCs, biodegradation |

## Table B2-3. Sampling Performed during Sonic Drilling and from Groundwater Monitoring Wells - 2019 and 2022 (continued)

| Location ID | Soil Sample ID | Soil Analyses | GW Sample ID | GW Sample Analyses |
|---|---|---|---|---|
| **MW1-56** | -- | -- | MW1-56-12-191023 | Target VOCs, biodegradation |
| | -- | -- | MW1-56-24-191023 | Target VOCs, biodegradation |
| **MW1-57** | -- | -- | MW1-57-10-191022 | Target VOCs, Microbial DNA, biodegradation |
| | -- | -- | MW1-57-16-191022 | Target VOCs, Microbial DNA, biodegradation |
| | -- | -- | MW1-57-32-191022 | Target VOCs, Microbial DNA, biodegradation |
| **MW1-58** | | | MW1-58-9-191023 | Target VOCs, Microbial DNA, biodegradation |
| | | | MW1-58-19-191024 | Target VOCs, biodegradation |
| | | | MW1-58-39.5-191024 | Target VOCs, biodegradation |
| **MW1-60** | | | MW1-60-191023 | Target VOCs |
| **2022 Investigation** | | | | |
| **MW1-69/SP-B174** | SP-B174-S-10-220427 | Target VOCs, TOC, Physical Characteristics | MW1-69-220511 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors, PFAS |
| | SP-B174-S-16-220427 | Target VOCs | | |
| | SP-B174-S-20-220427 | Target VOCs | | |
| | SP-B174-S-25-220427 | Target VOCs | | |
| | SP-B174-S-35-220427 | Target VOCs | | |
| | SP-B174-S-45-220427 | Target VOCs | | |
| | SP-B174-S-48-220427 | TOC, Physical Characteristics | | |
| | SP-B174-S-52-220428 | Target VOCs | | |

**Table B2-3. Sampling Performed during Sonic Drilling and from Groundwater Monitoring Wells - 2019 and 2022 (continued)**

| Location ID | Soil Sample ID | Soil Analyses | GW Sample ID | GW Sample Analyses |
|---|---|---|---|---|
| | SP-B174-S-58-220428 | TOC, Physical Characteristics | | |
| | SP-B174-S-70-220428 | Target VOCs | | |
| | SP-B174-S-73-220428 | Target VOCs | | |
| | SP-B174-S-83-220428 | Target VOCs | | |
| **MW1-70/SP-B175** | SP-B175-S-15-220425 | TOC, Physical Characteristics | MW1-70-220502 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors, PFAS |
| | SP-B175-S-25-220425 | Target VOCs, TOC, Physical Characteristics | | |
| | SP-B175-S-38-220425 | Target VOCs, TOC, Physical Characteristics | | |
| | SP-B175-S-50-220425 | Target VOCs | | |
| | SP-B175-S-56-220426 | Target VOCs | | |
| | SP-B175-S-60-220426 | Target VOCs | | |
| | SP-B175-S-64-220426 | Target VOCs | | |
| | SP-B175-S-70-220426 | Target VOCs | | |
| | SP-B175-S-80-220426 | Target VOCs | | |
| | SP-B175-S-90-220426 | Target VOCs | | |
| | SP-B175-S-100-220426 | Target VOCs | | |
| **MW1-71/CL-B176** | CL-B176-S-08-220502 | Target VOCs, 1,4-dioxane | MW1-71-220512 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors, PFAS |
| | CL-B176-S-25-220502 | TOC, Physical Characteristics | | |
| | CL-B176-S-28-220502 | Target VOCs, 1,4-dioxane | | |
| | CL-B176-S-40-220502 | Target VOCs, 1,4-dioxane | | |

## Table B2-3. Sampling Performed during Sonic Drilling and from Groundwater Monitoring Wells - 2019 and 2022 (continued)

| Location ID | Soil Sample ID | Soil Analyses | GW Sample ID | GW Sample Analyses |
|---|---|---|---|---|
| | CL-B176-S-45-220502 | Target VOCs, 1,4-dioxane, TOC, Physical Characteristics | | |
| | CL-B176-S-55-220503 | Target VOCs, 1,4-dioxane, TOC, Physical Characteristics | | |
| | CL-B176-S-65-220503 | Target VOCs, 1,4-dioxane | | |
| | CL-B176-S-70-220503 | Target VOCs, 1,4-dioxane | | |
| | CL-B176-S-95-220503 | Target VOCs, 1,4-dioxane | | |
| | CL-B176-S-100-220503 | Target VOCs, 1,4-dioxane | | |
| **MW1-72/NP-B177** | NP-B177-S-07-220505 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors | MW1-72-220512 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors, PFAS (FD for all) |
| | NP-B177-S-30-220505 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors | | |
| | NP-B177-S-35-220505 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors | | |
| | NP-B177-S-40-220505 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors, TOC, Physical Characteristics | | |
| | NP-B177-S-45-220505 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors | | |
| | NP-B177-S-50-220505 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors | | |

## Table B2-3. Sampling Performed during Sonic Drilling and from Groundwater Monitoring Wells - 2019 and 2022 (continued)

| Location ID | Soil Sample ID | Soil Analyses | GW Sample ID | GW Sample Analyses |
|---|---|---|---|---|
| | NP-B177-S-55-220505 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors | | |
| | NP-B177-S-60-220505 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors | | |
| | NP-B177-S-65-220505 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors, TOC, Physical Characteristics (grain size only) | | |
| | NP-B177-S-75-220505 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors, TOC, Physical Characteristics | | |
| **MW1-73/NP-B178** | NP-B178-S-07-220509 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors | MW1-73-220513 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors, PFAS |
| | NP-B178-S-30-220509 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors, TOC, Physical Characteristics | | |
| | NP-B178-S-40-220509 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors | | |
| | NP-B178-S-48-220509 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors | | |
| | NP-B178-S-50-220509 | TOC, Physical Characteristics | | |

**Table B2-3. Sampling Performed during Sonic Drilling and from Groundwater Monitoring Wells - 2019 and 2022 (continued)**

| Location ID | Soil Sample ID | Soil Analyses | GW Sample ID | GW Sample Analyses |
|---|---|---|---|---|
| | NP-B178-S-55-220509 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors | | |
| | NP-B178-S-58-220509 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors, TOC, Physical Characteristics | | |
| | NP-B178-S-60-220509 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors | | |
| | NP-B178-S-65-220509 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors | | |
| | NP-B178-S-70-220509 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors | | |
| | NP-B178-S-95-220510 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors | | |
| | NP-B178-S-100-220510 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors | | |
| **MW1-74/DG-B179** | DG-B179-S-4-220712 | Target VOCs, 1,4-dioxane | MW1-74-220718 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors, PFAS |
| | DG-B179-S-16-220712 | Target VOCs, 1,4-dioxane | | |
| | DG-B179-S-30-220712 | Target VOCs, 1,4-dioxane, TOC, Physical Characteristics | | |
| | DG-B179-S-43-220712 | Target VOCs, 1,4-dioxane | | |

## Table B2-3. Sampling Performed during Sonic Drilling and from Groundwater Monitoring Wells - 2019 and 2022 (continued)

| Location ID | Soil Sample ID | Soil Analyses | GW Sample ID | GW Sample Analyses |
|---|---|---|---|---|
| | DG-B179-S-45-220712 | TOC, Physical Characteristics | | |
| | DG-B179-S-50-220713 | Target VOCs, 1,4-dioxane | | |
| | DG-B179-S-55-220713 | Target VOCs, 1,4-dioxane, TOC, Physical Characteristics | | |
| | DG-B179-S-60-220713 | Target VOCs, 1,4-dioxane | | |
| **MW1-75/DG-B180** | DG-B180-S-57-220711 | Target VOCs, 1,4-dioxane | MW1-75-220718 | Target VOCs, 1,4-dioxane, PCB Congeners, PCB Aroclors, PFAS (FD for all) |
| | DG-B180-S-65-220711 | Target VOCs, 1,4-dioxane | | |
| | DG-B180-S-70-220712 | Target VOCs, 1,4-dioxane, TOC, Physical Characteristics | | |
| | DG-B180-S-73-220712 | Target VOCs, 1,4-dioxane | | |
| | DG-B180-S-76-220712 | Target VOCs, 1,4-dioxane | | |
| | DG-B180-S-79-220712 | Target VOCs, 1,4-dioxane | | |

**Notes:**
Biodegradation – Samples analyzed for: chloride/nitrate/nitrite/sulfate (EPA method 9056A), sulfide (SM4500-S2-F), dissolved organic carbon (SW846 9060), and methane/ethane/ethene (RSK 175)
Target VOCs - Samples analyzed using EPA Method 8260C for the 9 VOC COCs: 1,2-dichloroethane, tetrachloroethylene (PCE), cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, 1,1,1-trichloroethane, vinyl chloride, 1,1-dichloroethane, 1,1-dichloroethylene, and trichloroethylene (TCE) plus the degradation compound chloroethane.
FD – field duplicate
Microbial - Samples analyzed for microbes using the QuantArray®-Chlor approach (Microbial Insights).
PCBs – Samples analyzed for PCB congeners using EPA Method 1668C and PCB Aroclors using EPA Method 8082A
PFAS - Samples analyzed for PFAS using DoD QSM Table B-15.
TOC – Samples analyzed for total organic carbon using EPA Method 9060A
TPH-Dx – Samples analyzed for TPH-diesel using the NWTPH-DX method
1,4-Dioxane - Samples analyzed for 1,4-Dioxane using EPA Method 8270E.

**Table B2-4. Keyport OU 1 Monitoring Well Construction Details and Groundwater Elevation Data Collected in 2019 and 2022**

| Well Name | Ground Elevation (ft, NAVD 88) | TOC Elevation (ft, NAVD 88) | Easting | Northing | Well Screen Information | | | | Static Depth to Water 2019 (ft BTOC) | Static Depth to Water 2022 (ft BTOC) | Groundwater Elevation 2019 | Groundwater Elevation 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Top (ft bgs) | Bottom (ft bgs) | Top (ft BTOC) | Bottom (ft BTOC) | | | | |
| P1-1 | 16.37 | 17.62 | 1199012.96 | 259733.83 | 10 | 15 | 11.25 | 16.25 | -- | -- | -- | -- |
| P1-2 | 15.04 | 17.03 | 1198945.48 | 259710.8 | 10 | 15 | 11.99 | 16.99 | -- | -- | -- | -- |
| P1-3 | 14.26 | 15.99 | 1198889.91 | 259686.42 | 10 | 15 | 11.73 | 16.73 | -- | -- | -- | -- |
| P1-4 | 14.27 | 15.82 | 1198875.25 | 259607.06 | 10 | 15 | 11.55 | 16.55 | -- | -- | -- | -- |
| P1-5 | 16.38 | 18.35 | 1198972.74 | 259604.63 | 10 | 15 | 11.97 | 16.97 | -- | -- | -- | -- |
| P1-6 | 14.57 | 15.98 | 1198964.04 | 259046.24 | 10 | 15 | 11.41 | 16.41 | -- | 7.20 | -- | 8.78 |
| P1-7 | 13.9 | 15.33 | 1198953 | 258997.98 | 10 | 15 | 11.43 | 16.43 | -- | 6.68 | -- | 8.65 |
| P1-8 | 13.52 | 15.31 | 1199061.91 | 259081.7 | 10 | 15 | 11.79 | 16.79 | -- | -- | -- | -- |
| P1-9 | 13.83 | 15.15 | 1199020.4 | 258988.87 | 10 | 15 | 11.32 | 16.32 | -- | -- | -- | -- |
| P1-10 | 13.45 | 15.16 | 1559011.7 | 259078.6 | 10 | 15 | 11.71 | 16.71 | -- | 5.00 | -- | 10.16 |
| 1MW-1 | 11.59 | 13.35 | 1198801.27 | 259561.29 | 7.5 | 17.5 | 9.26 | 19.26 | -- | -- | -- | -- |
| 1MW-4 | 14.27 | 15.71 | 1558902.6 | 260091.7 | 15 | 25 | 16.44 | 26.44 | -- | -- | -- | -- |
| MW1-2 | 13.19 | 15.156 | 1558741.90 | 259823.50 | 12.5 | 17.5 | 14.47 | 19.47 | 9.49 | -- | 5.67 | -- |
| MW1-03 | 17.03 | 16.78 | 1199228.4 | 259637.1 | 5.5 | 10.5 | 5.25 | 10.25 | -- | -- | -- | -- |
| MW1-04 | 13.46 | 15.56 | 1558935.2 | 259031.7 | 7 | 12 | 9.10 | 14.10 | -- | 6.43 | -- | 9.13 |
| MW1-05 | 14.99 | 16.36 | 1198865.79 | 259079.40 | 6 | 11 | 7.37 | 12.37 | -- | -- | -- | -- |
| MW1-06 | 14.35 | 16.51 | 1558736.1 | 259287.2 | 8 | 13 | 10.16 | 15.16 | -- | -- | -- | -- |
| MW1-09 | 13.29 | 15.34 | 1198537.66 | 259487.59 | 48.5 | 58.5 | 50.55 | 60.55 | -- | -- | -- | -- |
| MW1-10 | 13.29 | 15.31 | 1558417.7 | 259535.6 | 4 | 14 | 6.02 | 16.02 | -- | -- | -- | -- |
| MW1-11 | 16.82 | 16.69 | 1559108.9 | 259691.6 | 54.5 | 59.5 | 54.37 | 59.37 | -- | -- | -- | -- |
| MW1-14 | 15.95 | 17.88 | 1558873.0 | 259823.6 | 9 | 14 | 10.93 | 15.93 | -- | -- | -- | -- |
| MW1-15 | 16.87 | 16.58 | 1198968.25 | 259501.66 | 6 | 11 | 5.71 | 10.71 | -- | -- | -- | -- |
| MW1-16 | 14.24 | 16.15 | 1558891.9 | 259123.6 | 6 | 11 | 7.91 | 12.91 | -- | -- | -- | -- |
| MW1-17 | 12.95 | 12.73 | 1198799.35 | 259440.86 | 7.5 | 12.5 | 7.28 | 12.28 | -- | -- | -- | -- |
| MW1-18 | 12.47 | 15.36 | 1558861.90 | 260036.50 | 12 | 17 | 14.89 | 19.89 | 8.71 | -- | 6.65 | -- |
| MW1-19 | 14.67 | 17.13 | 1558952.3 | 260155.2 | 7.5 | 12.5 | 9.96 | 14.96 | -- | -- | -- | -- |
| MW1-20 | 14.13 | 13.75 | 1199232.57 | 259000.97 | 10 | 15 | 9.62 | 14.62 | -- | 3.06 | -- | 10.69 |
| MW1-23 | 16.46 | 19.31 | 1558863.2 | 260443.5 | 21 | 26 | 23.85 | 28.85 | -- | -- | -- | -- |
| MW1-24 | 17.51 | 16.93 | 1559041.4 | 260259.3 | 23 | 28 | 22.42 | 27.42 | -- | -- | -- | -- |
| MW1-25 | 13.16 | 15.27 | 1198791.14 | 259832.42 | 38 | 48 | 40.11 | 50.11 | -- | -- | -- | -- |
| MW1-27 | 16.66 | 16.45 | 1559104.23 | 259691.38 | 24 | 29 | 23.79 | 28.79 | -- | -- | -- | -- |
| MW1-28 | 13.73 | 16.52 | 1198711.54 | 259725.19 | 39 | 44 | 41.79 | 46.79 | -- | -- | -- | -- |
| MW1-29 | 13.44 | 16.05 | 1198633.88 | 259617.76 | 31.5 | 36.5 | 34.11 | 39.11 | -- | -- | -- | -- |

**Table B2-4. Keyport OU 1 Monitoring Well Construction Details and Groundwater Elevation Data Collected in 2019 and 2022 (continued)**

| Well Name | Ground Elevation (ft, NAVD 88) | TOC Elevation (ft, NAVD 88) | Easting | Northing | Well Screen Information | | | | Static Depth to Water 2019 (ft BTOC) | Static Depth to Water 2022 (ft BTOC) | Groundwater Elevation 2019 | Groundwater Elevation 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Top (ft bgs) | Bottom (ft bgs) | Top (ft BTOC) | Bottom (ft BTOC) | | | | |
| MW1-31 | 16.44 | 16 | 1559138.4 | 259431.5 | 17 | 22 | 16.56 | 21.56 | -- | -- | -- | -- |
| MW1-38 | 13.47 | 13.23 | 1558354.67 | 260261.87 | 44 | 49 | 43.76 | 48.76 | -- | -- | -- | -- |
| MW1-39 | 13.51 | 13.22 | 1558358.03 | 260266.5 | 27.5 | 32.5 | 27.21 | 32.21 | -- | 8.76 | -- | 4.46 |
| MW1-41 | 16.54 | 18.51 | 1199000.27 | 259672.81 | 5 | 15 | 6.97 | 16.97 | -- | -- | -- | -- |
| MW1-42 | 13.62 | 12.77 | 1198819.77 | 259497.02 | 15 | 25 | 14.15 | 24.15 | 5.07 | -- | 7.7 | -- |
| MW1-43 | 13.05 | 12.69 | 1198809.41 | 259456.23 | 15 | 25 | 14.64 | 24.64 | 4.96 | 4.12 | 7.73 | 8.57 |
| MW1-44 | 12.89 | 12.24 | 1198806.50 | 259394.52 | 18 | 28 | 17.35 | 27.35 | 4.82 | 3.39 | 7.42 | 8.85 |
| MW1-45 | 13.34 | 12.99 | 1198822.32 | 259325.26 | 15 | 25 | 14.65 | 24.65 | 5.77 | -- | 7.22 | -- |
| MW1-46 | 17.07 | 16.71 | 1199026.27 | 259508.60 | 24 | 34 | 23.64 | 33.64 | 7.99 | -- | 8.72 | -- |
| MW1-47 | 16.78 | 16.44 | 1199023.85 | 259466.25 | 15 | 25 | 14.66 | 24.66 | 7.61 | -- | 8.83 | -- |
| MW1-48 | 16.09 | 15.8 | 1199082.01 | 259416.03 | 15 | 25 | 14.71 | 24.71 | 6.79 | -- | 9.01 | -- |
| MW1-49 | 10.88 | 14.17 | 1198907.63 | 258986.91 | 5 | 15 | 8.29 | 18.29 | 6.05 | 6.02 | 8.12 | 8.15 |
| MW1-50 | 14.21 | 16.75 | 1198967.28 | 258988.47 | 5 | 15 | 7.54 | 17.54 | 8.15 | 8.05 | 8.6 | 8.7 |
| MW1-51 | 14.44 | 17.23 | 1198979.37 | 259088.54 | 10 | 20 | 12.79 | 22.79 | 8.51 | -- | 8.72 | -- |
| MW1-52 | 14.13 | 17.11 | 1199004.93 | 259050.35 | 7 | 17 | 9.98 | 19.98 | 8.34 | -- | 8.77 | -- |
| MW1-53 | 13.33 | 13.4 | 1199065.84 | 259067.70 | 5 | 15 | 5.07 | 15.07 | 4.11 | 3.92 | 9.29 | 9.48 |
| MW1-54 | 12.69 | 15.57 | 1199050.16 | 258949.79 | 29 | 39 | 31.88 | 41.88 | 5.70 | -- | 9.87 | -- |
| MW1-55 | 12.18 | 15.6 | 1199101.47 | 258977.68 | 26.5 | 36.5 | 29.92 | 39.92 | 5.90 | 5.49 | 9.7 | 10.11 |
| MW1-56 | 13.16 | 15.82 | 1199144.30 | 258984.05 | 8 | 12 | 10.66 | 14.66 | 6.08 | -- | 9.74 | -- |
| | | | | | 20 | 24 | 20.00 | 24.00 | 6.05 | -- | 9.77 | -- |
| | | | | | 32 | 36 | 32.00 | 36.00 | N/A | -- | N/A | -- |
| MW1-57 | 12.96 | 15.62 | 1199147.17 | 259018.14 | 6 | 10.5 | 8.66 | 13.16 | 5.81 | -- | 9.81 | -- |
| | | | | | 12 | 16 | 12.00 | 16.00 | 5.83 | -- | 9.79 | -- |
| | | | | | 26 | 31 | 26.00 | 31.00 | 5.84 | -- | 9.78 | -- |
| MW1-58 | 14.03 | 16.84 | 1199138.21 | 259057.79 | 5 | 9 | 7.81 | 11.81 | 7.07 | -- | 9.77 | -- |
| | | | | | 15 | 19 | 15.00 | 19.00 | 7.08 | -- | 9.76 | -- |
| | | | | | 31 | 35 | 31.00 | 35.00 | 6.83 | -- | 10.01 | -- |
| MW1-59 | 10.88 | 12.68 | 1198963.99 | 258934.36 | 60 | 70 | 61.80 | 71.80 | 1.78 | -- | 10.9 | -- |
| MW1-60 | 14.85 | 18.01 | 1198555.91 | 259345.11 | 15 | 25 | 18.16 | 28.16 | 10.42 | -- | 7.59 | -- |
| MW1-61 | 13.83 | 13.47 | 1199035.84 | 259195.56 | 3 | 13 | 2.64 | 12.64 | 5.40 | 5.17 | 8.07 | 8.3 |
| MW1-62 | 16.86 | 19.46 | 1198976.33 | 259592.91 | 31 | 41 | 33.60 | 43.60 | 11.03 | 10.10 | 8.43 | 9.36 |
| MW1-63 | 15.46 | 18.17 | 1198921.44 | 259664.43 | 30 | 40 | 32.71 | 42.71 | 10.01 | -- | 8.16 | -- |
| MW1-64 | 14.25 | 17.13 | 1198871.21 | 259759.23 | 45 | 55 | 47.88 | 57.88 | 10.95 | 10.69 | 6.18 | 6.44 |

## Table B2-4. Keyport OU 1 Monitoring Well Construction Details and Groundwater Elevation Data Collected in 2019 and 2022 (continued)

| Well Name | Ground Elevation (ft, NAVD 88) | TOC Elevation (ft, NAVD 88) | Easting | Northing | Well Screen Information | | | | Static Depth to Water 2019 (ft BTOC) | Static Depth to Water 2022 (ft BTOC) | Groundwater Elevation 2019 | Groundwater Elevation 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Top (ft bgs) | Bottom (ft bgs) | Top (ft BTOC) | Bottom (ft BTOC) | | | | |
| MW1-65 | 13.89 | 16.77 | 1198937.41 | 259780.55 | 53 | 63 | 55.88 | 65.88 | 10.73 | -- | 6.04 | -- |
| MW1-66 | 12.99 | 14.95 | 1199146.03 | 259011.91 | 5 | 15 | 7.85 | 17.85 | 5.19 | -- | 6.97 | -- |
| MW1-67 | 13.75 | 16.6 | 1198935.04 | 259780.68 | 5 | 20 | 6.96 | 21.96 | 9.63 | 6.44 | 9.76 | 10.16 |
| MW1-68 | 13.04 | 14.99 | 1199148.31 | 259010.62 | 37 | 47 | 38.95 | 48.95 | 3.55 | 2.70 | 11.44 | 12.29 |
| MW1-69 | 14.86 | 16.71 | 1198926.24 | 259011.72 | 42 | 52 | 43.85 | 53.85 | -- | 7.79 | -- | 8.92 |
| MW1-70 | 13.71 | 15.81 | 1199140.22 | 259003.48 | 70 | 80 | 72.10 | 82.10 | -- | 3.37 | -- | 12.44 |
| MW1-71 | 16.96 | 16.6 | 1199038.05 | 259491.30 | 95 | 100 | 94.64 | 99.64 | -- | 4.70 | -- | 11.9 |
| MW1-72 | 16.11 | 18.45 | 1198934.51 | 259642.45 | 60 | 70 | 62.34 | 72.34 | -- | 9.84 | -- | 8.61 |
| MW1-73 | 13.32 | 17.51 | 1198893.02 | 259763.26 | 90 | 100 | 94.19 | 104.19 | -- | 5.70 | -- | 11.81 |
| MW1-74 | 13.69 | 13.29 | 1198481.49 | 260210.62 | 45 | 55 | 44.60 | 54.60 | -- | 8.85 | -- | 4.44 |
| MW1-75 | 13.66 | 13.38 | 1198473.75 | 260200.52 | 75 | 80 | 74.72 | 79.72 | -- | 4.06 | -- | 9.32 |
| MW1-76 | 16.57 | 14.5 | 1198934.17 | 259006.03 | 5 | 20 | 2.93 | 17.93 | -- | 9.00 | -- | 5.5 |
| MW1-77 | 15.21 | 17.36 | 1199109.48 | 259042.47 | 5 | 20 | 7.15 | 22.15 | -- | 5.20 | -- | 12.16 |

**Notes:**
2019 Depth to groundwater measurements collected on October 29, 2019.
2022 Depth to groundwater measurements collected in the timeframe of April to July 2022.
Northing and easting coordinates based on Washington State Plan Coordinate System, North Zone, US Survey feet.
bgs - below ground surface
BTOC - below top of casing
ft - feet
ID - inside diameter
in - inches
NAVD 88 - North American Vertical Datum of 1988
OD - outside diameter
TOC - top of casing

## Table B2-5. Porewater Sampling - 2019

| Location ID | Location at Site | Porewater Sample ID | Porewater Analyses |
|---|---|---|---|
| PW1-11 | South of South Plantation | PW1-11-190606 | Target VOCs |
| PW1-12 | South of South Plantation | PW1-12-190606 | Target VOCs |
| PW1-15 | South of South Plantation | PW1-15-190606 | Target VOCs |
| PW1-16 | South of South Plantation | PW1-16-190606 | Target VOCs |
| PW1-17 | South of South Plantation | PW1-17-190606 | Target VOCs |
| PW1-18 | South of South Plantation | PW1-18-190606 | Target VOCs |
| PW1-20 | Downstream of Marsh Pond | PW1-20-190605 | Target VOCs |
| PW1-21 | Downstream of Marsh Pond | PW1-21-190605 | Target VOCs |
| PW1-22 | Downstream of Marsh Pond | PW1-22-190605 | Target VOCs |
| PW1-23 | Downstream of Marsh Pond | PW1-23-190605 | Target VOCs |
| PW1-24 | Downstream of Marsh Pond | PW1-24-190605 | Target VOCs (FD) |
| PW1-25 | Marsh Creek (near SP1-1) | PW1-25-190604 | PCB Congeners |
| PW1-26 | Marsh Creek (near SP1-1) | PW1-26-190604 | PCB Congeners |
| PW1-27 | Marsh Creek (near SP1-1) | PW1-27-190604 | PCB Congeners (FD) |
| PW1-28 | South of South Plantation | PW1-28-190606 | Target VOCs |
| PW1-29 | South of South Plantation | PW1-29-190606 | Target VOCs |
| PW1-30 | Marsh to Southwest of South Plantation Hotspot | PW1-30-191018 | Target VOCs |
| PW1-31 | Marsh to Southwest of South Plantation Hotspot | PW1-31-191018 | Target VOCs |
| PW1-32 | Marsh to Southwest of South Plantation Hotspot | PW1-32-191018 | Target VOCs (FD) |

**Notes:**
FD - field duplicate
PCB Congeners - Samples analyzed for PCBs using EPA Method 1668C
Target VOCs - Samples analyzed using EPA Method 8260C for the 9 VOC COCs: 1,2-dichloroethane, tetrachloroethylene (PCE), cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, 1,1,1-trichloroethane, vinyl chloride, 1,1-dichloroethane, 1,1-dichloroethylene, and trichloroethylene (TCE) plus the degradation compound chloroethane.

## Table B2-6. Surface Water Sampling – 2019

| Location ID | Location at Site | Surface Water Sample ID | Surface Water Sample Analyses |
|---|---|---|---|
| SW1-13 | Upstream of Marsh Pond | SW1-13-190604 | Target VOCs |
| SW1-14 | Downstream of Marsh Pond | SW1-14-190603 | Target VOCs |
| SW1-15 | Downstream of Marsh Pond | SW1-15-190603 | Target VOCs |
| SW1-16 | Downstream of Marsh Pond | SW1-16-190603 | Target VOCs |
| SW1-17 | Downstream of Marsh Pond | SW1-17-190603 | Target VOCs (FD) |
| SW1-18 | Downstream of Marsh Pond | SW1-18-190603 | PCB Congeners (FD) |
| SW1-19 | Downstream of Marsh Pond | SW1-19-190603 | PCB Congeners |
| SW1-20 | Downstream of Marsh Pond | SW1-20-190603 | PCB Congeners |

**Notes:**
FD - field duplicate
PCB Congeners - Samples analyzed for PCBs using EPA Method 1668C
Target VOCs - Samples analyzed using EPA Method 8260C for the 9 VOC COCs: 1,2-dichloroethane, tetrachloroethylene (PCE), cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, 1,1,1-trichloroethane, vinyl chloride, 1,1-dichloroethane, 1,1-dichloroethylene, and trichloroethylene (TCE) plus the degradation compound chloroethane.

## Table B2-7. Sediment Sampling - 2019

| Nearest Historical Location ID | Sediment Sample ID | Sediment Analyses |
|---|---|---|
| MA-19 | SED-MA19-190604 | PCB Congeners & Aroclors |
| MA-21 | SED-MA21-190604 | PCB Congeners & Aroclors |
| MA-22 | SED-MA22-190604 | PCB Congeners & Aroclors |
| MA-23 | SED-MA23-190604 | PCB Congeners & Aroclors (FD) |
| TF-18 | SED-TF18-190605 | PCB Congeners & Aroclors |
| TF-20 | SED-TF20-190604 | PCB Congeners & Aroclors |
| TF-21 | SED-TF21-190604 | PCB Congeners & Aroclors |

**Notes:**
FD - field duplicate
PCB Congeners - Samples analyzed for PCBs using EPA Method 1668C
PCB Aroclors - Samples analyzed for PCBs using EPA Method 8082A
* Sediment samples also collected as part of PCB ISM investigation in 2021 (U.S. Navy, 2022d)

## Table B2-8. Slug Testing

| Well ID | Well Screen Interval | Date of Test | General Location |
|---|---|---|---|
| MW1-39 | 27.5 - 32.5 | 5/4/2022 | Hwy 308 Causeway |
| MW1-43 | 15 - 25 | 5/3/2022 | Western Edge of Central Landfill |
| MW1-44 | 18 - 28 | 5/3/2022 | Western Edge of Central Landfill |
| MW1-46 | 24 - 34 | 7/15/2022 | Central Landfill hot spot |
| MW1-47 | 15 - 25 | 6/24/2021 | Central Landfill hot spot |
| MW1-49 | 5 - 15 | 4/29/2022 | Western Plume in South Plantation |
| MW1-50 | 5 - 15 | 7/15/2022 | Western Plume in South Plantation |
| MW1-62 | 31 - 41 | 5/4/2022 & 7/15/2022 | Center of North Plantation |
| MW1-63 | 30 - 40 | 6/24/2021 | Center of North Plantation |
| MW1-64 [1] | 45 - 55 | 5/4/2022 | Northwest Corner of North Plantation |
| MW1-65 | 53 - 63 | 6/24/2021 | Northern Edge of North Plantation |
| MW1-66 | 5 - 20 | 4/29/2022 | Eastern hot spot in South Plantation |
| MW1-68 | 37 - 47 | 4/29/2022 | Eastern hot spot in South Plantation |
| MW1-72 | 60 - 70 | 5/11/2022 | Center of North Plantation |
| MW1-74 | 64 - 74 | 7/15/2022 | Hwy 308 Causeway |

**Notes:**
Rising head and falling head tests were run at each well
Slug was solid 1-inch diameter x 6-feet long PVC pipe
Solinst Leveloggers used for groundwater level measurements, recorded every 2 seconds
Tests run in duplicate or triplicate as the fast groundwater response during the test allowed for rapid collection of a larger data set. Duplicate/triplicate testing was not performed at MW1-74 to minimize the time of staff presence alongside Highway 308.
[1] Unable to process; results not conducive for curve matching

# 3.0 LABORATORY AND FIELD ANALYTICAL RESULTS

This section summarizes the overall quality assurance (QA) program planning and execution and results of laboratory analytical results and quality control (QC) sample results and data validation of laboratory results and the final data quality assessment.

## 3.1 QUALITY ASSURANCE/QUALITY CONTROL – 2019 SAMPLING

All samples collected in 2019 were collected and analyzed in accordance with Environmental Protection Agency (EPA) methods stated in the *Final Sampling and Analysis Plan (SAP) for Keyport OU 1 Source Investigations, Naval Base Kitsap, Keyport, Washington* (U.S. Navy, 2019). Table B3-1 lists differences from Worksheet #18 in the SAP that were planned sampling points and parameters versus what was collected. The overall sample collection was higher than what was planned because of various reasons described in Table B2-1.

Samples were shipped via overnight courier under chain-of-custody documentation to the designated analytical laboratories for analysis. TestAmerica, Inc., located in West Sacramento, California, performed PCB congener analysis on sediment, groundwater, porewater, and surface water samples, and PCB Aroclors analysis on sediment samples. Microbial Insights, located in Knoxville, Tennessee, performed QuantArray®-Chlor analysis (microbial deoxyribonucleic acid [DNA] analysis) in groundwater samples. Battelle's Norwell, Massachusetts laboratory performed PFAS analysis on groundwater samples. All other analyses (cVOCs, vinyl chloride [VC] by selective ion monitoring [SIM], 1,4-dioxane, PCB Aroclors on soils and groundwater, TPH-diesel, TOC and DOC, anions, sulfide, and dissolved gases) were performed by APPL, Inc., located in Clovis, California. The analytical laboratories were required to maintain certification from Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) for the analytical methods performed on the samples, where applicable.

Laboratory QA oversight involved the performance of a first-level screening of the data and an indication of any deviations from their precision, accuracy, detection limit, or laboratory QA/QC criteria. A representative from each laboratory signed the data sheets, ensuring that the screening described above had been completed. Subsequently, Battelle completed a completeness review of the data by comparing the analyses requested for each sample on the chain-of-custody form with the database results for that sample. Additionally, the analytical data, along with the associated laboratory QC information, were forwarded to an independent, third-party data validation service, Laboratory Data Consultants. A Stage II data validation was performed on TPH-diesel, dissolved gases, sulfide, and anions analyses. A Stage III data validation was performed on TOC and DOC analyses. A Stage I (completeness) review was performed on the

QuantArray®-Chlor analysis. All other parameters and samples were subject to a Stage IV data validation process.

Results from the sampling event indicated that the data generally met analytical criteria. However, there were exceptions to the analytical criteria noted in the laboratory data validation reports. Exceptions to the analytical criteria are detailed in the sections below by matrix (e.g. soil, groundwater) and analytical group.

Exceptions to the analytical criteria resulted in the assignment of "J" or "R" qualifiers to the data. The "J" qualifier indicates that the result is considered an estimated value, while the "R" qualifier indicates that the result is rejected due to serious deficiencies in meeting QC criteria, and the data are unusable.

During sampling, field duplicate QC samples were collected for all parameters in sediment, soil, groundwater, porewater, and surface water samples to evaluate reproducibility and ensure that a meaningful and representative dataset was generated for the Keyport OU 1 source investigation. Per the SAP, the goal was to collect field duplicate samples at a rate of 5% (1 per 20) of sample locations per matrix and parameter. Table B3-2a summarizes the numbers of samples, the number of field duplicates, and percentages of field duplicates collected by parameter and matrix. All parameters and matrices achieved 5% or greater rate of field duplicate collection except for cVOCs, 1,4-dioxane, and PCB Aroclors in soils at 4%, 3%, and 4%, respectively. The overall average rate of field duplicate collection was 7% for the project, surpassing the 5% goal.

Field duplicate relative percent difference (RPD) criteria for solid samples is less than or equal to (≤) 100% and for aqueous samples is ≤50%. Table B3-3a lists all field duplicate pairs analyzed during 2019 sampling. Where RPDs exceeded SAP criteria, the RPD is bolded in Table B3-3a. All field duplicates for all matrices and for all parameters met these criteria except for:

***Soil***

- SP-B139 for cVOCs: 1,1-dichloroethene (DCE), tetrachloroethene (PCE), and trans-1,2-DCE
- NP-B121 for TPH-diesel
- NP-B138 for PCB congeners: PCB-25, PCB-26/29, PCB-42, PCB-57, PCB-59/62/75, PCB-63, PCB-66, PCB-68, PCB-69/49, and PCB-72.

***Porewater***

- PW1-27 for PCB congeners: PCB-206

***Groundwater***

- MW1-46 for dissolved gases: ethane
- MW1-46 for microbial DNA analyses: trans-1,2-DCE Reductase
- MW1-49 for cVOCs: chloroethane
- MW1-50 for microbial DNA analyses: sulfate reducing bacteria, *Dehalococcoides*, *Desulfuromonas* spp., and *Desulfitobacterium* spp.

These analytes in the sample and field duplicate were qualified as estimated (J), reflecting the imprecision of the results.

Review of the laboratory data and data validation confirmed that the measurement quality objectives were achieved, and data are acceptable for use with the exception of a few instances where results not detected above the laboratory limit of detection (LOD) were qualified as rejected (R qualified) by the data validator. Project decision making is focused on areas of high concentrations, rather than concentrations near the LOD, and therefore these R-qualified values where contaminants were not detected do not materially impact project decisions made based on the overall data set. Data validation qualifiers used in the data set are:

- J – Estimated: The analyte was analyzed for and positively identified by the laboratory; however, the reported concentration is estimated due to non-conformance discovered during data validation.
- U – Non-detected: The analyte was analyzed for and positively identified by the laboratory; however, the analyte should be considered non-detected at the reported concentration due to the presence of contaminants detected in the associated blank(s).
- UJ – Non-detected estimated: The analyte was reported as not detected by the laboratory; however, the reported quantitation/detection limit is estimated due to non-conformances discovered during data validation.
- R – Sample results rejected: The sample results were affected by serious deficiencies during analysis, resulting in the rejection of the data for the purposes of this project by the project team.

Except where otherwise stated, the data associated with all of the issues identified below were qualified as estimated using either the qualifier “J” where the analyte was detected above the laboratory limit of quantitation (LOQ), which is equivalent to the practical quantitation limit (PQL), or “UJ” where the analyte was not detected above the laboratory LOD.

### 3.1.1 Sediment

***PCB Congeners***

- Laboratory control sample (LCS) percent recovery (%R) for PCB-104 was outside of the acceptable range affecting five sediment samples (Sed-MA22-190604, Sed-MA23-190604, FD-190604-01, Sed-TF21-190604, and Sed-TF20-190604).
- PCB congeners were detected in one sediment laboratory blank at trace levels (less than the reporting limits). Sample concentrations were compared to concentrations detected in the laboratory blanks. If sample concentrations were not significantly greater than five times (>5X) the blank concentrations, the sample concentrations were considered to be non-detect. Four PCB congeners were identified in the laboratory blank which resulted in reporting results as non-detect at the reported concentrations of four sediment samples (Sed-MA19-190604, Sed-MA21-190604, Sed-TF20-190604, and Sed-TF18-190605).

***PCB Aroclors***

- All data met criteria.

### 3.1.2 Soil

***Chlorinated VOCs***

- The holding time requirement of 14 days for cVOCs analysis was exceeded for three soil samples (CL-B98-S-30-191014 for cis-DCE, trans-1,2-DCE, VC, and trichloroethene [TCE]; CL-B139-S-10-191017 and CL-B139-S-9-191017 for cis-1,2-DCE and TCE). The original analyses were run within holding time but because of high concentrations, reanalyses with dilution were run outside of holding time by 22 to 25 days.
- The initial calibration percent relative standard deviation (%RSD) criteria was exceeded for PCE affecting two samples (CL-B95-S-13-190627 and CL-B95-S-7-190627).
- The initial calibration verification (ICV) standard percent difference (%D) criteria was exceeded for VC affecting five samples in two sample delivery groups (SDGs; CL-B132-S-07-190930, CL-B132-S-27-190930, CL-B134-S-49-191003, SP-B130-S-65-191002, and NP-B135-S-38-191004).
- The continuing calibration verification (CCV) standard %D criteria was exceeded for VC affecting two samples (CL-B103-S-19-190617 and CL-B102-S-33-190617). The CCV standard %D criteria was exceeded for PCE affecting six samples in two different batches (NP-B116-S-22-190624, NP-B116-S-34-190624, NP-B120-S-35.5-190624, NP-B120-S-42-190624, NP-B120-S-49.5-190624, and NP-B118-D-16-190624).

- Matrix spike/matrix spike duplicate %R for nine out of 10 cVOCs were outside of the acceptable range for NP-B138-S-6-191009.
- Matrix spike/matrix spike duplicate %R for cis-1,2-DCE and TCE were outside of the acceptable range for SP-B139-S-9-191017.
- Internal standard (IS) area responses were outside acceptance criteria in 10 soil samples out of 129 total soil samples (6%). Two of these samples (1.6%) had all analytes rejected (R) except for cis-1,2-DCE because the area response was <20% of the CCV area and the result was non-detect.
- Surrogate spike %R was outside of the acceptable range in 18 soil samples out of 129 total soil samples (14%).
- VC exceeded the calibration range in two samples (SP-B93-S-12-190626 and SP-B93-S-17-190626), resulting in qualification of the data.

***1,4-Dioxane***

- The CCV standard %D criteria was exceeded for 1,4-dioxane affecting three samples (NP-B118-S-13-190624, NP-B118-S-16-190624, and NP-B118-S-34-190625).

***PCB Aroclors***

- The CCV standard %D criteria was exceeded for PCB-1242, 1248, 1254, 1260, 1262, and 1268 in two SDGs affecting seven samples (NP-B124-S-28-190620, NP-B125-S-38-190619, NP-B125-S-45-190619, NP-B124-S-14-190620, NP-B121-S-05-190620, NP-B125-S-20-190619, and NP-B122-S-09-190620).
- The CCV standard %D criteria was exceeded for all Aroclors in two SDGs affecting two samples (NP-B121-S-34-190620 and NP-B120-S-12.5-190624).
- Surrogate spike %R was outside of the acceptable range in one soil sample (NP-B120-S-12.5-190624) out of 27 total soil samples (3.7%).
- PCB compound quantitation criteria are evaluated during validation and where the quantitation of detected compounds differs between two gas chromatographic columns by more than 40 RPD, the results are considered estimated. PCB-1254 detected in two samples (NP-B120-S-12.5-190624 and NP-B119-S-12-190621) were qualified due to compound quantitation criteria not being met.

***TPH-Diesel***

- Matrix spike/matrix spike duplicate %R for TPH-diesel was outside of the acceptable range in two samples (NP-B138-S-6-191004 and NP-B138-S-5-191009).

- The surrogate spike %R for TPH-diesel was outside of the acceptable range affecting one soil sample (NP-B119-S-12-190621) out of 31 total soil samples (3.2%).

***Total Organic Carbon (TOC)***

- All data met criteria.

### 3.1.3 Groundwater

***Chlorinated VOCs***

- The holding time requirement of 14 days for cVOCs analysis was exceeded for six groundwater samples (MW-1-57-10-191022, MW1-57-16-191022, MW1-56-24-191023, and MW1-66-191024 for cis-1,2-DCE and TCE; MW1-58-9-191024 for VC; and MW1-56-12-191023 for 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, VC, and TCE). The original analyses were run within holding time but because of high concentrations, reanalyses with dilution were run outside of holding time by 1 to 3 days.
- Because the sample was missed on the chain-of-custody documentation, sample MW1-50-191023 was logged into the laboratory for analysis after the holding time of 14 days expired. The original analysis was therefore outside of the holding time and all detected analytes were qualified J and non-detects R. Analytes qualified as rejected were: 1,2-dichloroethane (DCA), PCE, 1,1,1-TCA, chloroethane, and 1,1-DCA.
- The ICV standard %D criteria was exceeded for VC affecting three samples in three SDGs (MW1-57-16-191022, MW1-56-24-191023, and MW1-66-191024).
- LCS/LCS duplicate RPD for VC was outside of the acceptable range affecting one groundwater sample (CL-B107-GW-10-190611).
- The CCV standard %D criteria was exceeded for chloroethane in one SDG affecting one sample (CL-B132-GW-15-190930). The CCV standard %D criteria was exceeded for cis-1,2-DCE and/or TCE in two SDGs affecting six samples (MW1-65-191021, MW1-52-191021, MW1-45-191022, MW1-54-191021, MW1-60-191023, MW1-43-191023).
- Matrix spike/matrix spike duplicate %R for cis-1,2-DCE and TCE was outside of the acceptable range for MW1-53-191023.
- IS area responses were outside acceptance criteria in one groundwater sample out of 109 total soil samples (0.9%). Four analytes were qualified (chloroethane, 1,1-DCA, 1,2-DCA, and 1,1,1-TCA).
- Surrogate spike %R were outside of the acceptable range in 25 groundwater samples out of 109 total groundwater samples (23%).

***VC by SIM***

- The holding time requirement of 14 days was exceeded for one groundwater sample (NP-B112-GW-15-190614). The original analysis was run within holding time but because of no detection with the full scan run, reanalysis with the SIM method was run outside of holding time by 4 days.
- Surrogate spike %R were outside of the acceptable range in six groundwater samples out of 56 total groundwater samples (11%).

***1,4-Dioxane***

- All data met criteria.

***Per- and Polyfluoroalkyl Substances***

- All data met criteria.

***PCB Congeners***

- PCB congeners were detected in three groundwater laboratory blanks at trace levels (less than the reporting limits). Sample concentrations were compared to concentrations detected in the laboratory blanks. If sample concentrations were not significantly greater than five times (>5X) the blank concentrations, the sample concentrations were considered to be non-detect. From four to 39 out of 169 reported PCB congeners were identified in the laboratory blanks which resulted in reporting results as non-detect at the LOD of six groundwater samples (MW1-67-191028, MW1-2-191029, FD-191029-01, MW1-18-191021, MW1-65-191021, and MW1-64-191024).
- PCB congeners were detected in two groundwater field blanks (EB-191028-01 and EB-19102802) at trace levels (less than the reporting limits). Sample concentrations were compared to concentrations detected in the field blanks. If sample concentrations were not significantly greater than five times (>5X) the blank concentrations, the sample concentrations were considered to be non-detect. PCB congeners identified in the field blanks resulted in reporting results as non-detect at the LOD in two groundwater samples (MW1-67-191028 for seven congeners and MW1-2-191029 for 35 congeners).
- PCB congeners that are flagged by the laboratory as estimated maximum possible concentration are changed to a “J” qualifier by the validator to indicate an estimated value. This qualification occurred for five groundwater samples (MW1-67-191028, MW1-2-191029, FD-191029-01, MW1-18-191021, and MW1-65-191021).

***PCB Aroclors***

- All data met criteria.

***TPH-Diesel***

- The holding time requirement of 7 days for extraction was exceeded for one groundwater sample (MW1-65-191021) by one day.
- TPH-diesel was detected in one groundwater field blank (EB-190619-01) above the LOQ. Sample concentrations were compared to concentrations detected in the field blanks. If sample concentrations were not significantly greater than five times (>5X) the blank concentration, the sample concentrations were considered to be non-detect. TPH-diesel identified in the field blank resulted in reporting results as non-detect at the reported concentration in four groundwater samples (NP-B125-GW-23-190619, NP-B123-GW-19-190619, NP-B123-GW-20-190619, and NP-B123-GW-40-190619).

***Dissolved Gases***

- Matrix spike/matrix spike duplicate %R for ethene was outside of the acceptable range affecting one sample (MW1-62-101024).

***Anions***

- The holding time requirement of 48 hours was exceeded for 23 groundwater samples for nitrate and/or nitrite out of 30 groundwater samples (77%). The holding times were exceeded from 1 to 33 hours with detections and non-detections and from 51 to 104 hours with detections. These sample results were qualified as estimated (J).
- The holding time requirement of 48 hours was exceeded for five groundwater samples for nitrate and/or nitrite out of 30 groundwater samples (17%) where the holding time was greater than 48 hours beyond the holding time (51-104 hours) and the results were non-detect, therefore the data were rejected (R). Samples MW1-64-191024, MW1-62-191024, and MW1-58-39.5-191024 for nitrate; sample MW1-58-19-191024 for nitrite; and sample MW1-55-19-191024 for nitrate and nitrite were qualified R.
- Matrix spike/matrix spike duplicate %R for chloride and nitrate were outside of the acceptable range affecting one sample (MW1-62-191024).

***Sulfide***

- The holding time requirement of 7 days was exceeded for five groundwater samples out of 30 groundwater samples (17%). Four samples exceeded the hold time by 1 day; one sample exceeded it by 22 days and had a detection. These sample results were qualified as estimated (J).
- The holding time requirement of 7 days was exceeded for one groundwater sample (MW1-44-191024) where the holding time was greater than 7 days beyond the holding time (46 days) and the result was non-detect, therefore the data were rejected (R).

- Matrix spike/matrix spike duplicate %R for sulfide was outside of the acceptable range affecting one sample (MW1-62-191024).
- Matrix spike/matrix spike duplicate %RPD for sulfide was outside of the acceptable range affecting one sample (MW1-53-191023).

***Dissolved Organic Carbon (DOC)***

- Matrix spike/matrix spike duplicate %R was outside of the acceptable range affecting one sample (MW1-53-191023).

### 3.1.4 Porewater

***Chlorinated VOCs***

- The CCV standard %D criteria was exceeded for cis-1,2-DCE and/or TCE affecting one sample (PW1-32-191018).

***PCB Congeners***

- PCB congeners were detected in two laboratory blanks at trace levels (less than the reporting limits). Sample concentrations were compared to concentrations detected in the laboratory blanks. If sample concentrations were not significantly greater than five times (>5X) the blank concentrations, the sample concentrations were considered to be non-detect. Eleven PCB congeners were identified in the laboratory blanks which resulted in reporting results as non-detect at the reported concentrations in one porewater sample (PW1-25-190604).
- PCB congeners were detected in three field blanks ((EB-190604-01, EB-1906-02, and EB-190605-01) at trace levels (less than the reporting limits). Sample concentrations were compared to concentrations detected in the field blanks. If sample concentrations were not significantly greater than five times (>5X) the blank concentrations, the sample concentrations were considered to be non-detect. One PCB congener (PCB-209) was identified in the blanks which resulted in reporting results as non-detect at the reported concentrations in three porewater samples (PW1-25-190604, PW1-26-190604, and FD-190604-02).

### 3.1.5 Surface Water

***Chlorinated VOCs***

- Matrix spike/matrix spike duplicate %R for cis-1,2-DCE was outside of the acceptable range for SW1-17-190603.

***PCB Congeners***

- PCB congeners were detected in two laboratory blanks at trace levels (less than the reporting limits). Sample concentrations were compared to concentrations detected in the laboratory blanks. If sample concentrations were not significantly greater than five times (>5X) the blank concentrations, the sample concentrations were considered to be non-detect. One PCB congener (PCB-68) was identified in the laboratory blanks which resulted in reporting results as non-detect at the reported concentration in two surface water samples (SW1-19-190603 and FD-190603-01).
- PCB congeners were detected in three field blanks at trace levels (less than the reporting limits). Sample concentrations were compared to concentrations detected in the field blanks. If sample concentrations were not significantly greater than five times (>5X) the blank concentrations, the sample concentrations were considered to be non-detect. Five PCB congeners were identified in the blanks which resulted in reporting results as non-detect at the reported concentration in four surface water samples (SW1-19-190603, SW1-20-190603, SW1-18-190603 and FD-190603-01).

Table B3-4a summarizes the percentage of valid data by matrix and parameter. As indicated above, data were rejected for cVOCs in soil and groundwater and for sulfide, nitrate, and nitrite in groundwater. All other data were acceptable and meet data quality objectives (DQOs) for this project. The overall percentage of usable data is 99.6%.

## 3.2 QUALITY ASSURANCE/QUALITY CONTROL – 2022 SAMPLING

All samples were collected and analyzed in accordance with EPA methods stated in the *Final Project-Specific Sampling and Analysis Plan (SAP) for Keyport OU 1 Vertical Extent Investigation and Aquifer Performance Testing, Naval Base Kitsap, Keyport, Washington* (U.S. Navy, 2022a).

Samples were shipped via overnight courier under chain-of-custody documentation to the designated analytical laboratories for analysis. Eurofins TestAmerica, located in West Sacramento, California, performed analysis of soil and groundwater samples for PCB congeners. Soil and groundwater samples were analyzed for cVOCs, 1,4-dioxane, and PCB Aroclors by Eurofins TestAmerica located in Seattle, Washington. Soil samples were also analyzed for TOC by Eurofins, Seattle and groundwater samples were analyzed for PFAS by Battelle's Norwell, Massachusetts laboratory. Physical testing for permeability, porosity, density, and grain size was performed by Integrated Geosciences Laboratories, LLC located in Houston, Texas on select soil samples.

The analytical laboratories were required to maintain certification from the DoD ELAP for the analytical methods performed on the samples, where applicable.

Laboratory QA oversight involved the performance of a first-level screening of the data and an indication of any deviations from their precision, accuracy, detection limit, or laboratory QA/QC criteria. A representative from each laboratory signed the data sheets, ensuring that the screening described above had been completed. Subsequently, Battelle completed a completeness review of the data by comparing the analyses requested for each sample on the chain-of-custody form with the database results for that sample. Additionally, the analytical data, along with the associated laboratory QC information, were forwarded to an independent, third-party data validation service, Laboratory Data Consultants. A Stage 4 data validation was performed on all chemical analyses. A completeness check was performed on the geochemical tests.

Results from the sampling event indicated that the data generally met analytical criteria with one percent (%) data being rejected (R). There were exceptions to the analytical criteria noted in the laboratory data validation reports. Exceptions to the analytical criteria are detailed in the sections below by matrix (e.g., soil and groundwater) and analytical group.

Exceptions to the analytical criteria resulted in the assignment of “J”, “R”, or “U” qualifiers to the data. The “J” qualifier indicates that the result is considered an estimated value. The “R” qualifier indicates the result is considered rejected and should not be used for the study. The “U” qualifier indicates that the result is not detected at the LOD.

During soil sampling, field duplicate QC samples were collected for cVOCs, 1,4-dioxane, PCB congeners, and PCB Aroclors (all parameters except for TOC) to evaluate reproducibility and ensure that a meaningful and representative dataset was generated for the Keyport OU 1 vertical extent investigation. Field duplicates were also collected for all parameters for groundwater samples. Per the SAP, the goal was to collect field duplicate samples at a rate of 5% (1 per 20) of sample locations per matrix and parameter. The number of samples collected per parameter and matrix varied, and therefore, the number of field duplicates varied as well. The field duplicates for 2022 sampling are summarized in Table B3-2b by matrix and method.

The field duplicate rate exceeded the 5% requirement for groundwater and nearly met the requirement for soil for all parameters. Field duplicates were collected at MW1-72 for all parameters and for MW1-75 and MW1-77 for PFAS in groundwater and at NP-B177-S-35 (labeled as NP-B177-S-36) for all parameters for soil. Additionally, NP-B178-S-30 (labeled as NP-B178-S-32) was collected as a field duplicate for cVOCs and 1,4-dioxane, and SP-B174-S-73 (labeled as SP-B174-S-74) for cVOCs.

Field duplicate RPD criteria for soil samples is ≤100% and the RPD criteria for groundwater is ≤50%. Table B3-3b lists all field duplicate pairs analyzed during 2022 sampling. Where RPDs exceeded SAP criteria, the RPD is bolded in Table B3-3b. All field duplicates for all parameters met these criteria except for cis-1,2-DCE in the duplicate pair NP-B177-S-35/NP-B177-S-36. The results for this analyte were estimated (J).

Review of the laboratory data and data validation confirmed that the measurement quality objectives were achieved, and data are acceptable for use except where data were rejected (R). Data validation qualifiers used in the data set are:

- J – Estimated: The analyte was analyzed for and positively identified by the laboratory; however, the reported concentration is estimated due to non-conformance discovered during data validation.
- U – Non-detected: The analyte was analyzed for and positively identified by the laboratory; however, the analyte should be considered non-detected at the reported concentration due to the presence of contaminants detected in the associated blank(s).
- UJ – Non-detected estimated: The analyte was reported as not detected by the laboratory; however, the reported quantitation/detection limit is estimated due to non-conformances discovered during data validation.
- R – Sample results rejected: The sample results were affected by serious deficiencies during analysis, resulting in the rejection of the data for the purposes of this project by the project team.

Except where otherwise stated, the data associated with all the issues identified below were qualified as estimated using either the qualifier "J" where the analyte was positively detected above the laboratory detection limit, or "UJ" where the analyte was not detected and reported as less than the LOD.

### 3.2.1 Soil

***Chlorinated VOCs***

- The holding time requirement of 14 days for cVOCs analysis was exceeded for 10 soil samples by 1 to 31 days. In some cases, samples were run multiple times due to required dilutions or failed QC. The best quality analytical results were chosen to report. Most sample VOC results were estimated (J/UJ), however, there were some results that were rejected (R) as follows: CL-B176-S-45 all analytes except for cis-1,2-DCE; NP-B177-S-50, all analytes; NP-B178-S-07, PCE; and NP-B177-S-36, 1,1,1-TCA, 1,1-DCA, 1,1-DCE, 1,2-DCA, chloroethane, and PCE.
- The ICV %D criteria were exceeded for chloroethane, 1,1-DCE, and/or VC affecting eight samples. Samples were qualified as estimated (J/UJ).

- Failures in the CCV criteria %D for one to all analytes (when a CCV was not analyzed at the end of the analytical run) affected 57 of 64 samples, resulting in estimating (J/UJ) sample results.
- The concentration of TCE in SP-B175-S-25 exceeded the calibration range, therefore, the result was estimated (J).
- The LCS %R or percent RPD were exceeded in 18 and five samples, respectively, for 1-9 analytes. Affected sample results were estimated (J/UJ).
- The matrix spike/matrix spike duplicate %R or RPD were exceeded in four and one samples, respectively, for one to 10 analytes. Affected sample results were estimated (J/UJ).
- Surrogate %R exceedances occurred in 16 samples. Affected sample results were estimated (J/UJ), except for non-detects for sample NP-B177-S-30, which were rejected (R) due to extremely low (<10%) surrogate recoveries.
- Internal area responses exceeded criteria in eight samples. Affected sample results were estimated (J/UJ); however, four samples with extremely low (<20%) area responses had rejected (R) data for non-detect results. These sample results are as follows: NP-B177-S-60, all analytes; NP-B178-S-07, PCE; SP-B174-S-20, 1,1,1-TCA, 1,1-DCA, 1,1-DCE, chloroethene, and trans-1,2-DCE; and SP-B174-S-52, 1,1,1-TCA, 1,1-DCA, 1,1-DCE, 1,2-DCA, chloroethene, trans-1,2-DCE, and VC.
- Because of labels being added to the sample vials in the field, sample weights could be affected and possibly bias the final results low. This sample result bias affected 24 samples for all analytes, where results were estimated (J/UJ).

***1,4-Dioxane***

- The LCS %R was exceeded affecting 24 samples. Affected sample results were estimated (UJ).
- The matrix spike/matrix spike duplicate %R was exceeded in three samples. Affected sample results were estimated (UJ).
- The internal area response exceeded criteria in four samples. Sample results were estimated (UJ), however, samples DG-B179-S-4 and NP-B178-S-07 exhibited extremely low responses (<20%), therefore, 1,4-dioxane results were rejected (R).

***PCB Congeners***

- Failures in the CCV criteria %D for three PCB congeners affected NP-B178-S-07, leading to sample results being estimated (J/UJ).

***PCB Aroclors***

- All data met criteria.

***Total Organic Carbon***

- TOC was detected in the laboratory blank below the LOQ. A result in sample SP-B174-S-10 was qualified as non-detect (U) at the reported concentration.

### 3.2.2 Groundwater

***Chlorinated VOCs***

- All data met criteria.

***1,4-Dioxane***

- The surrogate %R was exceeded in sample MW1-74. The affected sample result was estimated (J).
- The internal area response exceeded criteria in five samples. Sample results were estimated (UJ).

***PCB Congeners***

- The LCS %R was exceeded for six congeners affecting sample MW1-70. Affected sample results were estimated (J).
- The matrix spike/matrix spike duplicate %R was exceeded for two PCB congeners in sample MW1-71. Affected sample results were estimated (J).
- Total tetrachlorobiphenyls were detected in the equipment blank below the LOQ. They were also detected in sample MW1-75 above the LOQ, therefore, the result was estimated (J).

***PCB Aroclors***

- Failures in the CCV criteria %D for one to all analytes affected three samples (MW1-70, MW1-74, and MW1-75), resulting in estimated (UJ) sample results.

***Per- and Polyfluoroalkyl Substances***

- The cooler temperature for samples MW1-69, MW1-71, MW1-72, FD-220512-02, and MW1-73 was exceeded (14°C versus SAP temperature of 4°C ±2°C). All sample results were estimated (J/UJ).

- The holding time requirement for extraction of 14 days for PFAS analysis was exceeded for MW1-70 for perfluorotridecanoic acid (PFTrDA) by 37 days. The result was estimated (UJ).
- The labeled compound %R exceeded criteria in seven samples for PFTrDA and perfluorotetradecanoic acid (PFTeDA) in six of the seven samples and for PFTeDA and perfluorodecanoic acid (PFDoA) in the seventh. Sample results were estimated (UJ), except for sample MW1-70 for PFTeDA, which had extremely low recovery. This sample result was rejected (R).
- Target analyte identification ion ratio criteria were not met for perfluorohexanesulfonic acid (PFHxS) in three samples and for perfluorooctanoic acid (PFOA) in sample MW1-74. Sample results were estimated (J).

cVOC data were rejected for technical holding time exceedances (4 soils), surrogate recovery exceedance (1 soil), and internal standard area response exceedances (4 soils). Two soil samples for 1,4-dioxane were rejected for internal area response. One PFAS compound was rejected for labeled compound %R exceedance.

Estimations of data were made for cooler temperature elevation, holding time exceedances, blank contamination, calibration uncertainty, LCS %R and RPD exceedances, matrix spike/matrix spike duplicate (MS/MSD) %R and RPD exceedances, labeled compound and/or surrogate recovery exceedances, field duplicate imprecision, ion ratio exceedance, and other matrix related failures. All other data were acceptable and met DQOs for this project. With the exception of the rejected data which account for less than 1% of the data, all other data are acceptable (see Table B3-4b).

## 3.3 SOIL ANALYTICAL RESULTS

This subsection presents the results of field and laboratory analysis of grab soil samples collected both from direct push sampling in 2019 and from sonic well bores in 2019 and 2022.

### 3.3.1 Field Analysis of Soil Samples

Field analysis of soil consisted of hand-held PID screening and headspace analysis of grab soil samples of continuous soil cores collected from direct-push borings and sonic borings. Hand-held PID readings are shown on the boring logs in Attachment 3.

### 3.3.2 cVOCs in Soil Samples

Similar to the findings of the 2017 investigation, the most frequently detected cVOCs in soil samples in 2019 and 2022 were TCE, cis-1,2-DCE, and VC. TCE, cis-1,2-DCE, and VC were also the cVOCs that most frequently exceeded their PAL in soil samples, with samples exhibiting these cVOCs exceeding their PAL in 37, 42, and 50 of the samples collected, respectively.

A frequency of detection analysis was completed in 2017, which showed that cVOCs other than TCE, cis-1,2-DCE, and VC are collocated with TCE, cis-1,2-DCE, and VC. That is, for every location where one of the other cVOCs were detected and/or exceeded its PAL in 2017, either TCE, cis-1,2-DCE, and/or VC also were detected and/or exceeded its PAL. This finding was likewise observed in the 2019 and 2022 soil sampling data, with two exceptions in the 2019 data: chloroethane (3.1 J micrograms per kilogram [µg/kg]) was detected in a sample collected from boring CL-B95 and 1,2-DCA (10 µg/kg) and 1,1-DCA (1.5 J µg/kg) were detected in a sample collected from NP-B110; and one exception in 2022 data: chloroethane (0.99 J µg/kg) was detected in a sample from boring CL-B176.

The results of the nine cVOC COCs (plus chloroethane) analyzed in the 124 soil samples collected in 2019 are summarized in Tables B3-5 (direct-push drilling) and B3-6 (sonic drilling). The highest concentrations measured at each boring location of the key analytes, TCE, cis-1,2-DCE, and VC, are shown on Figures B3-1 through B3-6.

The results of the nine cVOC COCs (plus chloroethane) analyzed in the 64 soil samples collected in 2022 are summarized in Table B3-6. The highest concentrations measured at each boring location of the key analytes, TCE, cis-1,2-DCE, and VC, are shown on Figures B3-1 through B3-6.

For 2019 and 2022 soil sampling, concentrations of TCE were detected above PALs in 37 total soil samples (23 boring locations); concentrations of cis-1,2-DCE were detected above PALs in 42 total samples (23 boring locations); and concentrations of VC were detected above PALs in 50 total samples (32 boring locations). Chloroethane was detected in four total samples (4 boring locations), with two concentrations (CL-B95 and CL-B101) exceeding its PAL of 2.6 µg/kg. The highest cVOC concentrations in soil samples were from borings located in the South Plantation, with TCE and cis-1,2-DCE detected at concentrations of 3,2000,000 J µg/kg and 47,000 J µg/kg, respectively, at SP-B139 (eastern portion of the South Plantation) and 180,000 J µg/kg and 660,000 J µg/kg, respectively, at SP-B174 (western portion of the South Plantation).

Although TCE is a chemical daughter product of PCE, both TCE and PCE can be "parent" compounds released to the environment from industrial operations, and these parent compounds biodegrade to form other "daughter" products with fewer chlorine atoms (see the chlorinated solvent degradation chemistry graph in Attachment 5). In soil samples collected in 2019, TCE was detected more frequently than PCE (TCE in 20 percent of samples compared to PCE in 1.6 percent of samples). The maximum concentration of TCE detected in soil samples was also substantially higher compared to PCE (3,200,000 J µg/kg compared to 11,000 J µg/kg). This trend was also found in the 2017 investigation and indicates that the PCE released historically has substantially degraded to TCE, or that TCE was more commonly released at the site.

### 3.3.3 PCBs and TPH in Soil Samples

***PCBs in Soil***

Concentrations of PCB Aroclor-1016 were detected in soil samples collected from borings NP-B120 and NP-B122, at depths of 12.5 ft bgs and 5 ft bgs, respectively. PCB Aroclor-1254 was detected in soil samples collected from NP-B119 (12 ft bgs), NP-B121 (5 ft bgs), NP-B122 (9 ft bgs), NP-B123 (19 ft bgs), NP-B124 (10 and 14 ft bgs), NP-B125 (20 ft bgs), and NP-B177 (7 ft bgs). PCB Aroclor-1248 was detected in a soil sample collected from NP-B178 (7 ft bgs). The results of PCB soil sampling (Aroclors only) conducted during direct-push and sonic drilling in 2019 and 2022 are shown in Table B3-7.

For 2019 and 2022 soil sampling, concentrations of total PCBs as Aroclors were detected above the PAL of 17 µg/kg in 11 total soil samples (9 boring locations). No PCB Aroclors were detected above the laboratory LOD at depths greater than 20 ft bgs.

Total PCBs (as congeners) were detected in the shallow soil samples collected from NP-B138 (6 ft bgs), NP-B177 (7 ft bgs), and NP-B178 (7 ft bgs) at concentrations exceeding the PAL of 17,000 picograms per gram (pg/g). The highest concentration of total PCBs (as congeners) was detected in the NP-B138 (field duplicate) sample, at a concentration of 3,834,944 pg/g. In the deeper samples, total PCBs (as congeners) were detected at NP-B137 (52 ft bgs) and NP-B138 (62 ft bgs) at concentrations of 186 pg/g and 199 pg/g, respectively. PCBs (as congeners) were not detected above the laboratory LOD for any of the deeper samples (greater than 7 ft bgs) collected from NP-B177 or NP-B178. The results of PCB soil sampling (total congeners) conducted during sonic drilling in 2019 and 2022 are shown in Table B3-8 and the total PCB concentrations per sample collected, along with the total number of PCB detections per sample collected, are summarized in Table B3-9.

***TPH in Soil***

TPH-Dx was detected above the laboratory LOD in 13 samples collected from boring locations NP-B118 (13 ft bgs), NP-B119 (12 ft bgs), NP-B120 (12.5 ft bgs), NP-B121 (5 and 13 ft bgs), NP-B122 (5 and 9 ft bgs), NP-B123 (19 ft bgs), NP-B124 (10 and 14 ft bgs), NP-B125 (20 and 38 ft bgs), and NP-B138 (6 ft bgs). The TPH-Dx concentrations detected in each of these samples exceeded the PAL of 2,000 µg/kg. Concentrations of TPH-Dx ranged from 25,000 µg/kg (NP-B138; 6 ft bgs) to 3,200,000 µg/kg (NP-B119; 12 ft bgs).

The depth of samples collected that indicated TPH detections/exceedances ranged from 5 ft bgs to 20 ft bgs for 12 of the 13 samples exhibiting exceedance of the PAL. The sample designated

NP-B125-S-38-190619 (25,000 µg/kg) was collected at a depth of 38 ft bgs and was located north of the north-central boundary of the North Plantation (Figure 2-2). The results of TPH-Dx sampling conducted during direct-push and sonic drilling are summarized in Table B3-10.

### 3.3.4 1,4-Dioxane in Soil Samples

Concentrations of 1,4-dioxane were detected above the laboratory LOD in one soil sample, at boring location NP-B178 (55 ft bgs; estimated concentration of 0.0058 milligrams per kilogram [mg/kg]), which exceeded the PAL of 0.00013 mg/kg. Soil samples were also collected from this location at depths from 7 to 48 ft bgs and from 60 to 100 ft bgs. The results of soil sampling for 1,4-dioxane conducted during direct-push and sonic drilling are shown on Figure B3-7 and summarized in Table B3-11.

### 3.3.5 TOC and Moisture Content in Soil Samples

***Total Organic Carbon***

Soil samples were collected in both 2019 and 2022 for TOC analysis in native soil from areas with relatively low concentration of VOCs, for use in fate and transport modeling. TOC was measured in soil samples from boring locations SP-B92 (12, 13, and 28 ft bgs), SP-B131 (6 and 23 ft bgs), CL-B107 (7, 22, and 33 ft bgs), Cl-B132 (7 and 27 ft bgs), SP-B174 (48 and 58 ft bgs), SP-B175 (15, 25, and 38 ft bgs), CL-B176 (25, 45, and 55 ft bgs), NP-B177 (40, 65, and 75 ft bgs), NP-B178 (30, 50, and 58 ft bgs), DG-B179 (30, 45, and 55 ft bgs), and DG-B180 (70 ft bgs). TOC measured in the soil samples collected in both 2019 and 2022 ranged from 100 mg/kg to 110,000 mg/kg, with a median value of 4,700 mg/kg and geometric mean value of 5,830 mg/kg.

***Total Moisture Content***

The majority of soil samples were collected from below the water table. The moisture content in soil samples ranged from 3.1% weight to 68.4% weight. Of the 199 total soil samples collected (including field duplicates), 154 samples indicated moisture content between 10 and 30%. The TOC results and correlated total moisture content in soil are summarized in Table B3-12.

### 3.3.6 Physical Characteristics of Soil

During investigation work performed in 2019, soil types were identified through field observations and classifications only; no laboratory analysis for soil type was conducted in 2019. The field descriptions completed in 2019 matched closely with the field descriptions and laboratory analysis from 2017, with the predominant soil type being fine sand, with varying amounts of clay, silt, medium to coarse sand, and gravel.

The soil descriptions are provided in the boring logs in Attachment 3. A thorough explanation of site geology, including the interpretation of the regional aquitard, is provided in the main body of the supplemental RI report, in the section covering environmental sequence stratigraphy.

2022 Investigation

In 2022, soil samples were collected from target intervals at each of the seven sonic well bores and analyzed for physical characteristics, as described in Section 2.2.2. Soil sampling depths were chosen based on a combination of the proposed sampling depths as documented in the SAP (U.S. Navy, 2022a) and lithologies observed by the field geologist. The results of the physical characteristics analyses are summarized in Table B3-13, and key parameters are described in the subsections below. Additionally, a discussion of these key parameters within the context of separate hydrostratigraphic units is provided in the environmental sequence stratigraphy section (Section 3.2) of the supplemental RI report.

***Soil Type***

The soil types identified through laboratory analysis ranged from silt to gravel, with the predominant soil type according to the USCS being fine sand. The laboratory classification of soil types generally matched well with the field descriptions, with a slight variation in description of sand grain size (i.e., fine versus medium versus coarse) and silt content in some descriptions. For example, the sample from the soil boring NP-B178 (MW1-73) at 58 ft bgs was classified in the field as a peat to sandy clay, but by the laboratory as a gravelly sand, with a mean grain size of coarse sand, with little (<2%) silty/clay. The variations in description can be attributed to the heterogeneity of the materials on a fine scale. The field geologist described the overall soil core observed, whereas the laboratory analyzed a subsample of the discrete brass core tubes provided.

***Total Organic Carbon***

TOC measured in the 2022 soil samples (excluding the 2019 samples discussed in Section 3.3.5) ranged from 100 mg/kg to 110,000 mg/kg, with a median value of 1,400 mg/kg and geometric mean value of 2,227 mg/kg. The TOC results from samples collected from NP-B177 at 75 ft bgs (110,000 mg/kg) and NP-B178 at 58 ft bgs (99,000 mg/kg) were the only instances in which TOC concentrations were greater than 26,000 mg/kg. The majority of TOC concentrations (14 of the 19 samples) were below 10,000 mg/kg. TOC results within the context of samples analyzed in both 2019 and 2022 are discussed above in Section 3.3.5.

***Dry Bulk Density***

Dry bulk density of the soils ranged from 0.85 grams per cubic centimeter (g/cc) to 1.99 g/cc, with a median value of 1.64 g/cc and a geometric mean value of 1.54g/cc.

***Effective Porosity***

Effective porosity (porosity consisting of interconnected pore space), of the soil samples ranged from 8.08% by bulk volume (Vb) to 34.63%Vb, with a median value of 23.43%Vb and a geometric mean value of 20.25%Vb. The soil samples collected from borings DG-B179 and DG-B180 were not analyzed for effective porosity (see Table B2-1).

***Laboratory Hydraulic Conductivity***

Horizontal hydraulic conductivity ranged from $3.03 \times 10^{-7}$ centimeters per second (cm/s) to $5.33 \times 10^{-3}$ cm/s, with a median value of $6.05 \times 10^{-4}$ cm/s and a geometric mean value of $6.08 \times 10^{-5}$ cm/s. Values in the range of $1 \times 10^{-5}$ cm/s are typical of the silty fine sand observed at the site. The lowest values, within the range of $1 \text{ x } 10^{-6}$ to $1 \text{ x } 10^{-7}$, were assigned silt and clay USCS designations (i.e., MH, CH, or CL) . These values are typical of glacial till and silt, and on the higher end for marine clays (Freeze and Cherry, 1979).

Vertical hydraulic conductivity ranged from $1.50 \times 10^{-7}$ cm/s to $5.13 \times 10^{-3}$ cm/s, with a median value of $5.52 \times 10^{-4}$ cm/s and a geometric mean value of $4.56 \times 10^{-5}$ cm/s. The anisotropy ratio, calculated as vertical hydraulic conductivity divided by horizontal hydraulic conductivity, was between 0.85 and 1.00 for 15 of the 18 samples. These values represent groundwater flow that is nearly isotropic. In the remaining three samples, the anisotropy ratio was between 0.07 and 0.50. These values represent a slightly greater horizontal flow component as compared to vertical, which is typical of unconsolidated alluvial material (Todd, 1980).

## 3.4 GROUNDWATER ANALYTICAL RESULTS

This section summarizes the results of field and laboratory analysis of groundwater samples collected during both direct-push and sonic drilling. The concentration magnitude of each COC was substantially different between grab groundwater samples collected from direct-push borings and samples collected from monitoring wells. The results from these two sample types are therefore discussed first in separate subsections and then compared in Section 3.4.3.

### 3.4.1 Grab Groundwater Samples

***cVOCs***

The most frequently detected cVOCs in grab groundwater samples were TCE, cis-1,2-DCE, VC, and trans-1,2-DCE. TCE, cis-1,2-DCE, and VC were the cVOCs that most frequently exceeded their PAL in grab groundwater samples, with samples exhibiting these cVOCs exceeding their PAL in 16, 17, and 61 of the samples collected, respectively.

A frequency of detection analysis was completed in 2017, which indicated that the key cVOCs in groundwater are TCE, cis-1,2-DCE, and VC. This analysis demonstrated that cVOCs other than TCE, cis-1,2-DCE, and VC are collocated with TCE, cis-1,2-DCE, and VC, as described in Section 3.2.2. The results from the 2019 grab groundwater sampling event corroborate this conclusion, as all samples in which "other" cVOCs were detected, either TCE, cis-1,2, DCE, or VC were also detected.

The results of the nine cVOC COCs (plus chloroethane) analyzed in the 72 grab groundwater samples collected in 2019 are shown in Table B3-14. The highest concentrations measured at each boring location of the key analytes TCE, cis-1,2-DCE, and VC are shown on Figures B3-1 through B3-6.

Concentrations of TCE were detected above PALs in 16 total grab groundwater samples (14 boring locations); concentrations of cis-1,2-DCE were detected above PALs in 17 total samples (14 boring locations); and concentrations of VC were detected above PALs in 61 total samples (35 boring locations). Chloroethane was detected in one sample, but the concentration did not exceed its PAL. The highest concentration of total cVOCs in grab groundwater samples was detected in the samples collected from boring SP-B93 at a screened interval of 7.5 to 12.5 ft bgs, in the central portion of the South Plantation.

Although both chlorinated ethene compounds (e.g., TCE, cis-1,2-DCE) and chlorinated ethane compounds (e.g., 1,1-DCA, 1,2-DCA) were detected in grab groundwater samples, maximum concentrations of chlorinated ethenes were detected at much higher levels than maximum concentrations of chlorinated ethanes.

PCE was not detected in any grab groundwater samples collected in 2019. During the 2017 groundwater sampling event, TCE was detected much more frequently than PCE in grab groundwater samples (TCE in 75 percent of samples compared to PCE in 30 percent of samples), and the maximum concentration of TCE detected in grab groundwater samples was also substantially higher compared to PCE (540,000 micrograms per liter [μg/L] compared to 43 μg/L). These findings indicate that PCE has substantially degraded to TCE, or TCE was more commonly released at the site.

The breakdown compound chloroethane, which is not a COC at the site but represents a final breakdown product of the chlorinated ethane pathway (see Attachment 5), was only detected in one grab groundwater sample. During the 2017 groundwater sampling event, chloroethane was detected in 26% of grab groundwater samples, and was the highest concentration analyte detected in five of the 87 samples. The presence of measurable chloroethane at the site implies that degradation of the chlorinated ethanes is occurring in at least some areas.

***TPH and PCBs***

Concentrations of TPH-Dx were detected above the laboratory LOD in nine of the 16 grab groundwater samples collected from six of the North Plantation borings. Concentrations of TPH-Dx were detected above the PAL of 500 µg/L in two samples. TPH-Dx was detected at a concentration of 1,200 J µg/L at boring NP-B119 at a screened interval of 28 to 32 ft bgs, and a concentration of 920 µg/L at boring NP-B122 at a screened interval of 10 to 15 ft bgs. The results of TPH-Dx in grab groundwater samples collected during direct-push drilling are shown in Table B3-15.

PCBs as Aroclors were not detected above the laboratory LOD (0.008 µg/L) in any of the 17 grab groundwater samples collected from eight of the North Plantation borings. For total PCB Aroclors in groundwater, the laboratory LOD (0.008 µg/L) was three orders of magnitude greater than the PAL of $7 \times 10^{-6}$ µg/L. The results of PCBs in grab groundwater samples collected during direct-push drilling are shown in Table B3-16.

***1,4-Dioxane***

The results of 1,4-dioxane sampling in grab groundwater indicated that the laboratory LOD (0.60 µg/L) was greater than the PAL for 1,4-dioxane (0.44 µg/L); therefore, all detections of 1,4-dioxane in grab groundwater were also above the PAL. Concentrations of 1,4-dioxane were detected above the PAL in 17 total grab groundwater samples (12 boring locations), five of which were collected from four Central Landfill borings, and 12 of which were collected from eight of the North Plantation borings. The screened intervals of 1,4-dioxane detections in grab groundwater ranged from 4 to 9 ft bgs to 46 to 50 ft bgs. The results of 1,4-dioxane in grab groundwater samples collected during direct-push and sonic drilling (one sample) are shown on Figure B3-7 and summarized in Table B3-17.

### 3.4.2 Groundwater Samples from Monitoring Wells

***cVOCs***

In 2019 and 2022, the most frequently detected cVOCs in groundwater samples from monitoring wells were TCE, cis-1,2-DCE, VC, trans-1,2-DCE, and 1,1-DCE. TCE, cis-1,2-DCE, and VC were the cVOCs that most frequently exceeded their PAL in monitoring well groundwater samples, with samples exhibiting these cVOCs exceeding their PAL in 20, 22, and 32 of the samples collected, respectively.

Similar to the results of both 2017 and 2019 grab groundwater sampling, the 2019 and 2022 monitoring well groundwater sampling confirmed that all cVOCs other than TCE, cis-1,2-DCE, and VC are collocated with TCE, cis-1,2-DCE, and VC. All samples in which "other" cVOCs were detected, either TCE, cis-1,2, DCE, or VC were also detected.

The results of the analysis of the nine cVOC COCs (plus chloroethane) analyzed in the 39 monitoring well groundwater samples collected in 2019 and 2022 are shown in Table B3-18. Groundwater samples were collected from multiple screened intervals at monitoring wells MW1-56, MW1-57, and MW1-58. The concentrations of detected cVOCs measured at each monitoring well location are shown on Figures 3-13 and 3-14.

Concentrations of TCE were detected above PALs in 20 total groundwater samples; concentrations of cis-1,2-DCE were detected above PALs in 22 total samples; and concentrations of VC were detected above PALs in 32 total samples. Other cVOCs that were detected above PALs included PCE (4 samples), 1,1-DCE (9 samples), trans-1,2-DCE (6 samples), and 1,1-DCA (1 sample). Chloroethane was detected in four samples, but the concentrations did not exceed the PAL. The presence of measurable chloroethane at the site implies that degradation of the chlorinated ethanes is occurring in at least some areas.

The maximum detected concentrations of cVOCs were very high in a few samples at the site, with the measured concentration of TCE in one groundwater sample detected at 590,000 µg/L. The highest cVOC concentrations in groundwater monitoring well samples were from wells located in the eastern portion of the South Plantation. The highest TCE concentration was observed in MW1-56 at the 20 to 24 ft bgs screen interval, the highest cis-1,2-DCE concentration was observed in MW1-57 at the 6 to 10.5 ft bgs screen interval, and the highest VC concentration was observed in MW1-58 at the 5 to 9 ft bgs screen interval.

Although both chlorinated ethene compounds (e.g., TCE, cis-1,2-DCE) and chlorinated ethane compounds (e.g., 1,1-DCA, 1,1,1-TCA) were detected in groundwater samples, maximum concentrations of chlorinated ethenes were detected at concentrations several magnitudes higher than maximum concentrations of chlorinated ethanes.

In monitoring well groundwater samples, TCE was detected in 69 percent of samples, whereas PCE was only detected in 16 percent of samples. Furthermore, the maximum concentration of TCE detected in groundwater samples was substantially higher compared to PCE (590,000 J µg/L compared to 110 µg/L). These findings indicate that PCE has substantially degraded to TCE, or TCE was more commonly released at the site.

***TPH and PCBs***

Concentrations of TPH-Dx were detected above the laboratory LOD in groundwater at all 12 of the monitoring wells in which TPH-Dx was sampled. Concentrations of TPH were detected above the PAL of 500 µg/L in three samples. TPH-Dx was detected at concentrations of 690 μg/L at MW1-47, 780 μg/L at MW1-48, and 780 μg/L at MW1-67. The results of TPH-Dx sampling in monitoring wells are shown in Table B3-19.

PCBs (as congeners) were detected above laboratory LOD in groundwater at all 12 of the monitoring wells in which PCBs were sampled. The sum of total PCBs (as congeners) exceeded the PAL of 7 picograms per liter (pg/L) in 11 of the 12 monitoring wells sampling. The maximum concentration of total PCBs (as congeners) was detected at MW1-71 (180,000 J pg/L) at a screened interval of 95 to 100 ft bgs. The results of PCB groundwater sampling collected from monitoring wells are shown in Table B3-20 and the total PCB concentrations per sample collected, along with the total number of PCB detections per sample collected, are summarized in Table B3-21.

A detailed analysis of the extent and relationship of TPH and PCBs in groundwater is provided in Section 3.5 of the supplemental RI report.

***1,4-Dioxane***

Concentrations of 1,4-dioxane were detected above the PAL in 10 groundwater samples collected from monitoring wells. 1,4-Dioxane was detected above the PAL in both shallow groundwater (i.e., MW1-43, MW1-45, MW1-46, MW1-47, and MW1-48) and deep groundwater (i.e., MW1-62, MW1-63, MW1-64, MW1-65, and MW1-74) in the central and northern areas of the site (including MW1-74, located on the Highway 308 causeway). The results of 1,4-dioxane in groundwater collected from monitoring wells are shown on Figure B3-7 and summarized in Table B3-22.

***PFAS***

PFAS compounds were analyzed in groundwater samples from four of the newly installed monitoring wells in 2019 and seven of the newly installed monitoring wells in 2022, as shown in Table B3-23. PFAS compounds were detected in five monitoring wells (MW1-61, MW1-62, MW1-64, MW1-69, and MW1-74), with one compound (PFOS in MW1-61) exceeding PALs. No PFAS compounds were detected above laboratory LODs in the groundwater sample collected from MW1-59, located in the southern edge of the South Plantation. PALs were updated based on the July 6, 2022 update to the DoD memorandum, *Investigating Per- and Polyfluoroalkyl Substances within the Department of Defense Cleanup Program* (DoD, 2022). For applicable PFAS compounds, the PAL values were set to the residential scenario screening levels for tap water with a hazard quotient of 0.1.

***Natural Attenuation Parameters***

Monitoring well samples were analyzed for laboratory (2019 only) and field parameters indicative of natural attenuation. The results of laboratory analyses for nitrate, nitrite, sulfide, sulfate, chloride, DOC, ethane, ethene, and methane are summarized in Table B3-24. Chemical oxygen demand (COD) and biological oxygen demand (BOD) were measured in 2017 to support remedy evaluation (U.S. Navy, 2018).

Field measured monitored natural attenuation (MNA) parameters were collected immediately prior to sampling and are summarized in Table B3-25. DO concentrations were less than 1 milligram per liter (mg/L) in all groundwater samples, with the exceptions of MW1-50, MW1-57 (10 ft interval), MW1-58 (9 ft interval), and MW1-70 with DO concentrations of 2.25 mg/L, 8.96 mg/L, 6.87 mg/L, and 6.98 mg/L, respectively. ORP ranged from -425 to 253 mV with the average ORP value equal to -112 mV; specific conductivity ranged from 0.194 to 2.26 millisiemens per centimeter (mS/cm); and pH of the groundwater averaged 7.2, with anomalously low pH values of 3.21 and 2.62 at MW1-74 and MW1-75, respectively. Turbidity ranged from 0 to 236 nephelometric turbidity units (NTUs) for all groundwater samples, with the exception of MW1-71 (995 NTUs). Overall, these parameters indicate the reducing environment necessary to support biodegradation of the cVOCs via reductive dechlorination is prevalent in both the Central Landfill and South Planation.

***Microbial Analysis***

In 2019, 14 groundwater samples, collected from 12 monitoring wells, were analyzed for the presence of microorganisms involved in degradation of cVOCs using the QuantArray®-Chlor assay. The analysis allows quantification of specific gene targets important for the cVOC degradation. *Dehalococcoides* are the only known bacterial group capable of complete reductive dechlorination of PCE and TCE to ethene. However, other microorganisms such as *Dehalobacter* and *Dehalogenimonas* are also assessed in this assay due to their ability for reductive dechlorination of chloroethenes, chloroethanes, chlorobenzenes, chlorophenols and chloroforms. Thus, a suite of functional genes involved in aerobic (co)metabolic pathways for biodegradation of chlorinated solvents were examined.

Overall, the abundance of total Eubacteria at all monitoring wells was low and ranged from $1 \times 10^3$ to $1 \times 10^6$ cells per liter (cells/L) of groundwater. The presence of cVOC degrading *Dehalococcoides* species was generally low with average abundance of $1.3 \times 10^1$ to $1.87 \times 10^5$ cells/L. Per previous reports biomarkers associated with *Dehalococcoides* cell densities relevant to MNA sites should be in the $< 10^6$ cells per milliliter (cells/mL) range, and up to $> 10^8$ cells/mL range, which is relevant to biostimulated and bioaugmented sites. Detailed results are listed in Table B3-26.

In the Central Landfill, the highest concentrations of *Dehalococcoides* cells were found in MW1-47 and MW1-48, where not only Eubacteria ($1.57 \times 10^6$ cells/mL and $1.57 \times 10^7$ cells/mL, respectively) but also halorespiring bacteria (*Dehalococcoides* $8.92 \times 10^3$ cells/mL and $5.78 \times 10^3$ cells/mL) were found. *Dehalococcoides* genes responsible for complete dechlorination of cVOCs, namely vinyl chloride reductase (*vcrA* and *bvcA*) and *Dehalogenimonas* chloroethene reductase gene (*cerA*) were also found. Interestingly, high concentration of sulfate reducing bacteria ($1.57 \times 10^6$ to $1.57 \times 10^7$) was found in these two wells. Results from the other monitoring wells in the Central Landfill, specifically MW1-46 and MW1-45, showed low and negligible abundance of *Dehalococcoides* cells below the threshold for active dechlorination (Table B3-26).

In the wells of the South Plantation west of the storm drain, MW1-50, MW 1-51 and MW 1-52 abundance of *Dehalococcoides* cells was low and ranged from $4.5 \times 10^0$ cells/mL to $5.94 \times 10^2$ cells/mL with Eubacteria abundance in the range of $1.65 \times 10^5$ cells/mL to $2.15 \times 10^6$ cells/mL. The abundance of functional genes was equally low and in the range of $2.1 \times 10^0$ to $2.55 \times 10^1$ which does not support active degradation of cVOCs. The only well with higher abundance of sulfate reducing bacteria was MW 1-52 with $3.18 \times 10^3$.

Results from the South Plantation east of the storm drain showed a similar trend. For both depths (12 and 24 ft bgs) at MW1-56 and the 10 ft bgs depth at MW1-57, the abundance of both microbial cells and genes were either low ($10^4$ cells/mL) or negligible.

Additional discussion regarding biodegradation at OU 1, including microbial analysis and natural attenuation, is presented in the Section 3.4 of the supplemental RI report.

### 3.4.3 Comparison of Groundwater Sample Results

In 2017, an analysis was performed that compared TCE, cis-1,2-DCE, and VC concentrations in samples from groundwater monitoring wells to concentrations in the nearest representative grab groundwater sample from the direct-push borings (U.S. Navy, 2018). This comparison shows that concentrations in grab groundwater samples were generally substantially higher than those in monitoring wells. The 2017 report stated that this finding was common at chlorinated solvent sites generally due to the two primary factors of screen length and turbidity (U.S. Navy, 2018). The results from the 2019 sampling of cVOCs in grab groundwater and monitoring well groundwater, specifically from collocated samples in the vicinity of MW1-51 and MW1-61, further confirmed this conclusion.

## 3.5 POREWATER ANALYTICAL RESULTS

This subsection presents the results of laboratory analysis of porewater samples collected from locations south of the South Plantation and downstream of Marsh Pond for cVOCs and from locations northwest of the North Plantation, along Marsh Creek, for PCBs. Detailed analyses regarding the relationship of VOCs and PCBs in groundwater, porewater, surface water, and sediment, are provided in Section 3.5 of the supplemental RI report. The PALs for cVOCs were updated and are based on EPA Human Health Surface Water Criteria (40 CFR 131.45). Additionally, surrogates were selected for compounds with no values (i.e., cis-1,2-DCE) based on structural similarity.

***cVOCs***

In the porewater samples collected from downstream of Marsh Pond (west of North Plantation), VC was the only cVOC detected that exceeded its PAL (0.02 µg/L) in four of the five samples. No cVOCs were detected above the laboratory LOD in PW1-22.

In the porewater samples collected from the South Plantation, concentrations of VC were detected above its PAL in the samples collected from PW1-11, PW1-12, PW1-28, and PW1-29. Concentrations of cis-1,2-DCE were also detected at these sampling locations, at concentrations below its PAL. Additionally, concentrations of TCE were detected above its PAL in the samples collected from PW1-12, PW1-28, and PW1-29. Concentrations of cVOCs were not detected above laboratory LOD in porewater samples collected from locations farthest from the South Plantation hotspot to the southwest (PW1-30, PW1-31, and PW1-32) and south (PW1-15, PW1-16, PW1-17, and PW1-18). The results of 2019 porewater sampling for cVOCs are shown on Figure B3-1 through Figure B3-6 and summarized in Table B3-27.

***PCBs***

PCBs as congeners were detected above laboratory LOD in all three porewater samples collected from locations to the northwest of the North Plantation. Total PCB concentrations of 960 pg/L (69 total detections), 10,945 pg/L (129 total detections), and 4,480 pg/L (124 total detections) were detected at PW1-25, PW1-26, and PW1-27, respectively. The results for the summation of the PCB congeners assumed the non-detect values to be zero. The results of 2019 porewater sampling for PCBs are shown on Figure 3-15 and summarized in Table B3-28, and the total PCB concentrations per sample collected, along with the total number of PCB detections per sample collected, are summarized in Table B3-29.

## 3.6 SURFACE WATER ANALYTICAL RESULTS

This subsection presents the 2019 results of laboratory analysis of surface water samples collected from one location to the northwest of the South Plantation, and four locations downstream of Marsh Pond for cVOCs, and from three locations northwest of the North Plantation, downstream of Marsh Pond, for PCBs. One surface water sample was collected in the waterways immediately upstream of Marsh Pond, within Marsh Creek, northwest of the

South Plantation. Additionally, seven surface water samples were collected from downstream of Marsh Pond. Detailed analyses regarding the relationship of VOCs and PCBs in groundwater, porewater, surface water, and sediment, are provided in Section 3.5 of the supplemental RI report. Similar to porewater, the PALs for cVOCs were updated and are based on EPA Human Health Surface Water Criteria (40 CFR 131.45). Additionally, surrogates were selected for compounds with no values (i.e., cis-1,2-DCE) based on structural similarity, and the State of Washington surface water criteria was used for VC.

***cVOCs***

In all surface water samples collected for cVOCs, concentrations of cis-1,2-DCE and VC were detected above laboratory LOD, and concentrations of TCE and trans-1,2-DCE were detected above the laboratory LOD in the sample collected at SW1-13. No other cVOCs were detected above the laboratory LOD in any of the other surface water samples. Concentrations of VC exceeded its PAL (0.02 µg/L) in all surface water samples, and the concentration of TCE exceeded its PAL (0.38 µg/L) at SW1-13. The results of 2019 surface water sampling for cVOCs are shown on Figures B3-1 through B3-6 and summarized in Table B3-30.

***PCBs***

PCBs as congeners were detected above the laboratory LOD in all three surface water samples. Total PCB concentrations of 1,752 pg/L (110 total detections), 19,376 pg/L (146 total detections), and 1,850 pg/L (128 total detection) were detected at SW1-18, SW1-19, and SW1-20, respectively. The results for the summation of the PCB congeners assumed the non-detect values to be zero. The results of 2019 surface water sampling for PCBs are shown on Figure 3-15 and summarized in Table B3-31, and the total PCB concentrations per sample collected, along with the total number of PCB detections per sample collected, are summarized in Table B3-32.

## 3.7 SEDIMENT ANALYTICAL RESULTS

This subsection presents the results of laboratory analysis of sediment samples collected from sampling stations located to the northwest of the North Plantation, in the vicinity of Marsh Creek and in the tidal flats. The sediment samples were analyzed for PCBs as Aroclors and total congeners. Detailed analyses regarding the relationship of PCBs in groundwater, porewater, surface water, and sediment, are provided in Section 3.5 of the supplemental RI report.

Aroclor 1254 was detected in two of the three new sampling stations, MA-22 and MA-23, at estimated concentrations of 55 J µg/kg and 70 J µg/kg, respectively. These concentrations were well below the PAL of 12,000 µg/kg, which is based on the State of Washington Sediment Cleanup User's Manual (SCUM) sediment quality standard (SQS). No other Aroclors were detected above the laboratory LOD in any of the sediment samples. The results of 2019 sediment sampling for PCBs as Aroclors are shown on Figure 3-15 and summarized in Table B3-33.

Analysis of PCB congeners indicates that PCBs were detected in all seven sediment samples, at total concentrations of 3,398 pg/g (MA-19), 5,357 pg/g (MA-21), 40,595 pg/g (MA-22), 38,605 pg/g, 4,005 pg/g (TF-18), 889 pg/g (TF-20), and 10,541 pg/g (TF-21). The results for the summation of the PCB congeners assumed the non-detect values to be zero. Concentrations of total PCBs (as congeners) were detected below the SMS sediment cleanup objective (SCO) and cleanup screening level (CSL). The results of 2019 sediment sampling for PCB congeners are shown on Figure 3-15 and summarized in Table B3-34, and the total PCB concentrations per sample collected, along with the total number of PCB detections per sample collected, are summarized in Table B3-35.

Additional discussion regarding PCB extent in all media at OU 1, including sediment, is presented in the Section 3.5 of the supplemental RI report.

## 3.8 AQUIFER CHARACTERISTICS

This section describes the slug test data analysis and integrates those results with the results of laboratory analysis of soil physical characteristics (Section 3.3.6) to draw conclusions regarding the characteristics of the aquifer beneath OU 1.

### 3.8.1 Slug Test Data Analysis

Reduction of slug test data was performed using the standard hydrogeologic data analysis procedures encoded in the commercially available software AQTESOLV® version 4.5. The results of the slug tests, including well details (i.e., screened intervals and USCS soil type), initial water displacement, and calculated hydraulic conductivity and groundwater velocity values, are included in Table B3-36.

Slug test data sets were analyzed following the Bouwer and Rice method (Bouwer and Rice, 1976) to estimate hydraulic conductivity. The Bouwer and Rice solution can account for partial penetration of a well in an aquifer, which is the case for most of the wells tested.

Assumptions of the Bower and Rice solution include the following:

- The aquifer is unconfined, homogeneous, continuous, uniform thickness;
- The water table is horizontal over the area influenced by the test;
- The lower boundary is an impermeable layer;
- The flow to the well is quasi-steady state by disregarding the compressibility of the aquifer; and

- The instantaneous change in water level was due to withdrawal or addition of a slug in the well.

The bottom of aquifer depth interpreted for each well tested is shown in the slug test reports (Attachment 6) and based on the log of the well bore, adjacent wells and borings, and cross sections. This bottom of aquifer depth and the depth to groundwater at the time of testing was used to calculate the saturated aquifer thickness at each well tested.

The Bouwer and Rice method used to evaluate the slug test data relies on graphical curve matching to estimate the hydraulic conductivity of the formation adjacent to the well. Visual curve matching was used to match the straight solution line through the target range that meets the assumptions of the solution.

As stated in Section 2.6, at least one rising head and one falling head test was conducted at each of the wells selected for slug testing. Overall, the results of multiple runs were more repeatable for rising head tests than falling head tests. Therefore, the rising head test results are used in further discussions and comparisons regarding hydraulic conductivity and groundwater velocity values calculated at each well location. Average hydraulic conductivity per well ranged from 2.16 ft/day (7.61 x $10^{-4}$ cm/s), screened in a silty sand, to 237.9 ft/day (8.39 x $10^{-2}$ cm/s), screened in well graded sand and gravel. Likewise, average groundwater velocity ranged from 0.05 ft/day (1.76 x $10^{-5}$ cm/s) to 5.49 ft/day (1.94 x $10^{-3}$ cm/s). These values correlate with expected values from hydrogeology literature (Freeze and Cherry, 1979).

### 3.8.2 Integration of Slug Test Data and Physical Soil Characteristics

This section presents a comparison of the results of the slug test data analysis along with the laboratory results of the physical characteristics of soil samples (see Section 3.3.6). Laboratory analysis of hydraulic conductivity in soil samples collected in 2017 are included in this discussion. Further discussion of physical characteristics of soil within the context of separate hydrostratigraphic units is provided in the environmental sequence stratigraphy section (Section 3.2) of the supplemental RI report.

Results for soil samples analyzed for physical characteristics, including hydraulic conductivity, within well screen intervals of monitoring wells, are presented in Table B3-37. Results for slug tests completed in 2021 and 2022 are also presented in Table B3-37, to facilitate the comparison between laboratory analysis and slug test analysis of hydraulic conductivity. For comparison purposes, horizontal hydraulic conductivity values as measured by the laboratory are used.

Laboratory measured hydraulic conductivity for soil samples collected within monitoring well screened intervals ranged from $2.93 \times 10^{-7}$ cm/s to $7.18 \times 10^{-3}$ cm/s, and average hydraulic conductivity measured from slug tests ranged from $7.61 \times 10^{-4}$ cm/s to $8.39 \times 10^{-2}$. As noted in Sections 3.3.6 and 3.8.1, measured hydraulic conductivity generally fit within expected value ranges for the lithology, as published in literature. For direct comparisons, four monitoring wells, MW1-46, MW1-47, MW1-50, and MW1-74, included hydraulic conductivity values deduced from both laboratory measurements and slug tests. Comparison of these values indicates RPDs of 118%, 193%, 61%, and 129%, respectively, and three out of four instances indicate that the hydraulic conductivity measured from slug tests was greater than the hydraulic conductivity measured by the laboratory. Hydraulic conductivity as measured by the laboratory is based on the 3-inch diameter soil core that was collected and analyzed; however, slug testing is based on a localized area of the in situ aquifer formation immediately surrounding the monitoring well. The differences in hydraulic conductivity values reflect these differences in the scale and method of measurement and should be given careful consideration when selecting hydraulic conductivity values to use during evaluation of potential remediation strategies.


Figure B3-1
Maximum TCE Concentrations (North)

U.S. NAVY

Figure B3-2
Maximum cis-1,2-DCE Concentrations (North)

Naval Base Kitsap Keyport


Figure B3-3
Maximum VC Concentrations (North)


U.S. NAVY

**Figure B3-4**
**Maximum TCE Concentrations (South)**

Naval Base Kitsap Keyport


**Explanation**

- Surveyed Sonic Boring Location w/Deep Well (2019 Nov)
- Surveyed Sonic Boring Location w/o Deep Well (2019 Nov)
- Surveyed Direct Push Location (2019 June)
- Porewater (2019)
- Sediment (2019)
- Surface Water (2019)
- Groundwater Monitoring Well (2017)
- Porewater (2017)
- Surface Water (2017)
- LTM Well
- Historical Monitoring Well
- USGS Peeper Sampling Station (Porewater)
- Historical Sediment Sampling Station
- Historical Sediment/Surface Water Sampling Station
- Historical Surface Water Sampling Station
- 2017 cis-1,2-DCE Groundwater Concentration Contour (µg/L)
- Storm Drain

Red = Maximum cis-1,2-DCE in Soil (µg/kg)
Blue = Maximum cis-1,2-DCE in Groundwater (µg/L)
Green = Maximum cis-1,2-DCE in Surface Water (µg/L)
Purple = Maximum cis-1,2-DCE in Porewater (µg/L)
15 = Soil or Porewater Sample Depth (ft bgs)
5-10 = Groundwater Sample Depth (ft bgs)

Notes:
Ft bgs – below ground surface
TCE – trichloroethene
VC – vinyl chloride
cis-1,2-DCE – cis-1,2-dichloroethene
PCBs – polychlorinated biphenyls as total Aroclors
TPH-D – total petroleum hydrocarbons as diesel
U – not detected above the laboratory reporting limit
J – estimated concentration
UJ – The analyte was not detected at or above the stated sample quantitation limit, which is an estimated value

Groundwater results shown in micrograms per liter
Soil results shown in micrograms per kilogram
Maximum concentration shown at each location, regardless of depth

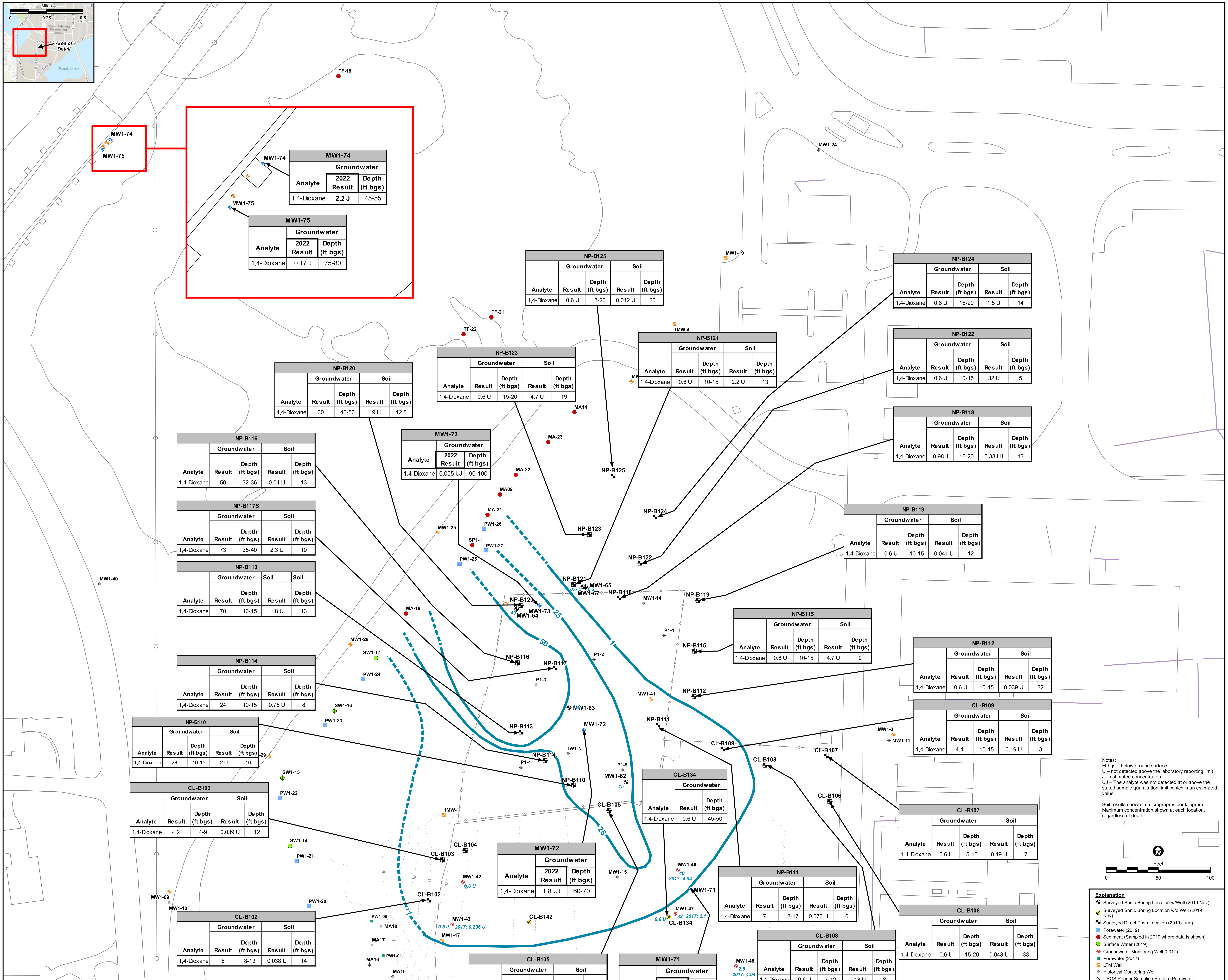
DATE: 3/8/2023 ANALYST: CHIQUESL
REV: 2 Figure B3-05_Max cis-1,2-DCE in Grab GW-Soil_South APPROVED: MM

U.S. NAVY

**Figure B3-5**
**Maximum cis-1,2-DCE Concentrations (South)**

Naval Base Kitsap Keyport


Figure B3-6
Maximum VC Concentrations (South)




**MW1-74**

| Analyte | Groundwater 2022 Result | Depth (ft bgs) |
|---|---|---|
| 1,4-Dioxane | 2.2 J | 45-55 |

**MW1-75**

| Analyte | Groundwater 2022 Result | Depth (ft bgs) |
|---|---|---|
| 1,4-Dioxane | 0.17 J | 75-80 |

**NP-B125**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 0.6 U | 18-23 | 0.042 U | 20 |

**NP-B124**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 0.6 U | 15-20 | 1.5 U | 14 |

**NP-B121**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 0.6 U | 10-15 | 2.2 U | 13 |

**NP-B123**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 0.6 U | 15-20 | 4.7 U | 19 |

**NP-B120**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 30 | 46-50 | 19 U | 12.5 |

**NP-B122**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 0.6 U | 10-15 | 32 U | 5 |

**NP-B118**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 0.98 J | 16-20 | 0.38 UJ | 13 |

**MW1-73**

| Analyte | Groundwater 2022 Result | Depth (ft bgs) |
|---|---|---|
| 1,4-Dioxane | 0.055 UJ | 90-100 |

**NP-B116**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 50 | 32-36 | 0.04 U | 13 |

**NP-B117S**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 73 | 35-40 | 2.3 U | 10 |

**NP-B113**

| Analyte | Groundwater Result | Soil Depth (ft bgs) | Soil Result | Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 70 | 10-15 | 1.8 U | 13 |

**NP-B119**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 0.6 U | 10-15 | 0.041 U | 12 |

**NP-B115**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 0.6 U | 10-15 | 4.7 U | 9 |

**NP-B114**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 24 | 10-15 | 0.75 U | 8 |

**NP-B112**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 0.6 U | 10-15 | 0.039 U | 32 |

**NP-B110**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 28 | 10-15 | 2 U | 16 |

**CL-B109**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 4.4 | 10-15 | 0.19 U | 3 |

**CL-B103**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 4.2 | 4-9 | 0.039 U | 12 |

**CL-B134**

| Analyte | Groundwater Result | Depth (ft bgs) |
|---|---|---|
| 1,4-Dioxane | 0.6 U | 45-50 |

**CL-B107**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 0.6 U | 5-10 | 0.19 U | 7 |

**MW1-72**

| Analyte | Groundwater 2022 Result | Depth (ft bgs) |
|---|---|---|
| 1,4-Dioxane | 1.8 UJ | 60-70 |

**NP-B111**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 7 | 12-17 | 0.073 U | 10 |

**CL-B106**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 0.6 U | 15-20 | 0.043 U | 33 |

**CL-B102**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 5 | 8-13 | 0.038 U | 14 |

**CL-B108**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 0.6 U | 7-12 | 0.18 U | 8 |

**CL-B105**

| Analyte | Groundwater Result | Groundwater Depth (ft bgs) | Soil Result | Soil Depth (ft bgs) |
|---|---|---|---|---|
| 1,4-Dioxane | 42 | 10-15 | 0.99 U | 10 |

**MW1-71**

| Analyte | Groundwater 2022 Result | Depth (ft bgs) |
|---|---|---|
| 1,4-Dioxane | 0.056 UJ | 95-100 |

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Figure B3-7
1,4-Dioxane Concentrations in Soil and Grab Groundwater

Naval Base Kitsap Keyport

## Table B3-1. Changes to Sample Collection Plans

| Sample Location | Parameter | Number of Samples | |
|---|---|---|---|
| | | Planned | Collected |
| **2019 SAP (U.S. Navy, 2019)** | | | |
| CL-B100-GWx | cVOCs | 3 | 4 |
| CL-B100-Sx | cVOCs | 3 | 4 |
| CL-B102-GWx | 1,4-Dioxane | 0 | 2 |
| CL-B102-Sx | 1,4-Dioxane | 0 | 3 |
| CL-B103-GWx | 1,4-Dioxane | 0 | 2 |
| CL-B103-Sx | 1,4-Dioxane | 0 | 4 |
| CL-B103-Sx | cVOCs | 3 | 4 |
| CL-B108-Sx | cVOCs, 1,4-Dioxane | 3 | 2 |
| CL-B133-Sx | cVOCs | 2 | 4 |
| CL-B97-GWx | cVOCs | 2 | 0 |
| CL-B97-Sx | cVOCs | 3 | 0 |
| MW1-43 | Anions, Dissolved Gases, Sulfide, DOC | 0 | 1 |
| MW1-49 | Microbes | 1 | 0 |
| MW1-56-12 | Microbes | 1 | 0 |
| MW1-58-9 | Microbes | 0 | 1 |
| MW1-67 | cVOCs, 1,4-dioxane, PCB congeners, TPH-Diesel, Anions, Dissolved Gases, Sulfide, DOC | 0 | 1 |
| MW1-68 | cVOCs, Anions, Dissolved Gases, Sulfide, DOC, Microbes | 0 | 1 |
| NP-B113-GWx | cVOCs, 1,4-Dioxane | 2 | 1 |
| NP-B114-Sx | cVOCs, 1,4-Dioxane | 3 | 4 |
| NP-B116-GWx | cVOCs, 1,4-Dioxane | 2 | 3 |
| NP-B117S-GWx | Replaces NP-B117-GWx | 0 | 1 |
| NP-B117S-Sx | Replaces NP-B117-Sx | 0 | 1 |
| NP-B120-Sx | cVOCs, 1,4-Dioxane, PCB Aroclors, TPH-Diesel | 3 | 5 |
| NP-B121-Sx | cVOCs, 1,4-Dioxane, PCB Aroclors, TPH-Diesel | 3 | 4 |
| NP-B123-GWx | cVOCs, 1,4-Dioxane, PCB Aroclors, TPH-Diesel | 2 | 3 |
| NP-B135-Sx | cVOCs | 1 | 2 |
| NP-B136-Sx | cVOCs | 1 | 2 |
| NP-B138-Sx | cVOCs | 1 | 2 |
| NP-B138-Sx | PCB Congeners, TPH-Diesel | 1 | 3 |
| PW1-28 | cVOCs | 0 | 1 |
| PW1-29 | cVOCs | 0 | 1 |
| SP-B139-Sx | cVOCs | 1 | 2 |

**Table B3-1. Changes to Sample Collection Plans (continued)**

| Sample Location | Parameter | Number of Samples | |
|---|---|---|---|
| | | **Planned** | **Collected** |
| SP-B144-Sx | cVOCs | 0 | 1 |
| SP-B90-GWx | cVOCs | 2 | 3 |
| SP-B90-Sx | cVOCs | 3 | 4 |
| SP-B91-GWx | cVOCs | 2 | 1 |
| SP-B91-Sx | cVOCs | 3 | 2 |
| SP-B92-Sx | TOC | 2 | 3 |
| SP-B94-Sx | cVOCs | 3 | 2 |
| | **2019 Totals** | **56** | **84** |
| **2022 SAP (U.S. Navy, 2022)** | | | |
| SP-B174-Sx | Physical parameters[c] | 4 | 3 |
| SP-B175-Sx | Physical parameters[c] | 4 | 3 |
| NP-B177-Sx | Physical parameters[c] | 3 | 3[d] |
| DG-B179-Sx | cVOCs, 1,4-Dioxane | 10 | 7 |
| DG-B179-Sx | Physical parameters[c] | 5 | 3 |
| DG-B180-Sx | cVOCs, 1,4-Dioxane | 9 | 5 |
| DG-B180-Sx | Physical parameters[c] | 3 | 1 |
| | **2022 Totals** | **38** | **25** |

**Notes:**
* Only sample locations with differences between planned in the SAP vs. actual collection included in table
cVOCs- chlorinated volatile organic compounds
DOC - dissolved organic carbon
PCB - polychlorinated biphenyls
PFAS - per- and polyfluoroalkyl substances
SIM - selective ion monitoring
TOC - total organic carbon
TPH - total petroleum hydrocarbons
[a] - Duplicate collected for all analytes
[b] - Duplicate collected for PFAS analysis only
[c] - includes total organic carbon (TOC)

## Table B3-2a. Field Duplicate Compliance Rates - 2019

| Parameter | Soil | | | Sediment | | | GW | | | SW | | | PW | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | # Samp | # Fdup | % Fdup | # Samp | # Fdup | % Fdup | # Samp | # Fdup | % Fdup | # Samp | # Fdup | % Fdup | # Samp | # Fdup | % Fdup |
| cVOCs | 124 | 5 | **4%** | - | - | - | 105 | 7 | 7% | 5 | 1 | 20% | 16 | 2 | 13% |
| Vinyl Chloride by SIM | - | - | - | - | - | - | 56 | 4 | 7% | 4 | 1 | 25% | 10 | 1 | 10% |
| 1,4-Dioxane | 72 | 2 | **3%** | - | - | - | 58 | 5 | 9% | - | - | - | - | - | - |
| PCB Aroclors | 26 | 1 | **4%** | 7 | 1 | 14% | 16 | 1 | 6% | - | - | - | - | - | - |
| PCB Congeners | 3 | 1 | 33% | 7 | 1 | 14% | 5 | 1 | 20% | 3 | 1 | 33% | 3 | 1 | 33% |
| TPH-Diesel | 29 | 2 | 7% | - | - | - | 28 | 2 | 7% | - | - | - | - | - | - |
| Organic Carbon (Total or Dissolved) | 9 | 1 | 11% | - | - | - | 30 | 2 | 7% | - | - | - | - | - | - |
| Sulfide | - | - | - | - | - | - | 30 | 2 | 7% | - | - | - | - | - | - |
| Anions | - | - | - | - | - | - | 30 | 2 | 7% | - | - | - | - | - | - |
| Dissolved Gases | - | - | - | - | - | - | 30 | 2 | 7% | - | - | - | - | - | - |
| PFAS | - | - | - | - | - | - | 4 | 1 | 25% | - | - | - | - | - | - |
| Microbes | - | - | - | - | - | - | 14 | 2 | 14% | - | - | - | - | - | - |
| **Totals** | **263** | **12** | **5%** | **14** | **2** | **14%** | **406** | **31** | **8%** | **12** | **3** | **25%** | **29** | **4** | **14%** |

| | |
|---|---|
| **Total # Samp** | **724** |
| **Total # Fdup** | **52** |
| **Total %Fdup** | **7%** |

**Notes:**
**<5%; goal for Fdup percent**
cVOCs- chlorinated volatile organic compounds
GW - groundwater
PCB - polychlorinated biphenyls
PFAS - per- and polyfluoroalkyl substances
PW - porewater
SIM - selective ion monitoring
SW - surface water
TPH - total petroleum hydrocarbons
"-" indicates no data available

## Table B3-2b. Field Duplicate Compliance Rates – 2019

| Parameter | Soil | | | GW | | |
|---|---|---|---|---|---|---|
| | # Samp | # Fdup | % Fdup | # Samp | # Fdup | % Fdup |
| cVOCs | 64 | 3 | 4.69% | 7 | 1 | 14.29% |
| 1,4-Dioxane | 44 | 3 | 6.82% | 7 | 1 | 14.29% |
| PCB Aroclors | 21 | 2 | 9.52% | 7 | 1 | 14.29% |
| PCB Congeners | 21 | 2 | 9.52% | 7 | 1 | 14.29% |
| PFAS | | | | 9 | 3 | 33.33% |
| **Totals** | **150** | **10** | 6.67% | **37** | **7** | 18.92% |
| **Total # Samp** | **187** | | | | | |
| **Total # Fdup** | **17** | | | | | |
| **Total %Fdup** | **9.09%** | | | | | |

**Notes:**
**<5%; goal for Fdup percent**
cVOCs- chlorinated volatile organic compounds
GW - groundwater
PCB - polychlorinated biphenyls
PFAS - per- and polyfluoroalkyl substances

## Table B3-3a. Field Duplicate Analyses Summary - 2019

| SOILS | | | |
|---|---|---|---|
| **Compound** | **Concentration (µg/kg)** | | **RPD (Limits)** |
| | **SP-B090-S-15-190628** | **SP-B090-S-14-190628** | |
| VOCs | *No results detected | *No results detected | N/A |
| **Compound** | **Concentration (µg/kg)** | | **RPD (Limits)** |
| | **NP-B110-S-14-190612** | **NP-B110-S-16-190612** | |
| Vinyl chloride | 2.5 U | 1.6 J | Not calculable |
| 1,4-dioxane | *No results detected | *No results detected | N/A |
| **Compound** | **Concentration (µg/kg)** | | **RPD (Limits)** |
| | **NP-B121-S-13-190620** | **NP-B121-S-14-190620** | |
| VOCs | *No results detected | *No results detected | N/A |
| 1,4-dioxane | *No results detected | *No results detected | N/A |
| PCB Aroclors | *No results detected | *No results detected | N/A |
| TPH-Dx | 290,000 J | 53,000 J | **138 (≤100)** |
| **Compound** | **Concentration (µg/kg)** | | **RPD (Limits)** |
| | **SP-B139-S-9-191017** | **SP-B139-S-10-191017** | |
| 1, 1-Dichloroethene | 1,000 J | 150 J | **148 (≤100)** |
| cis-1,2-Dichloroethene | 47,000 J | 24,000 J | 65 (≤100) |
| Tetrachloroethene | 11,000 J | 1,500 J | **152 (≤100)** |
| Trichloroethene | 3,200,000 J | 1,800,000 J | 56 (≤100) |
| trans-1,2-Dichloroethene | 8,400 J | 1,100 J | **154 (≤100)** |
| Vinyl chloride | 230 J | 79 J | 98 (≤100) |
| **Compound** | **Concentration (µg/kg)** | | **RPD (Limits)** |
| | **CL-B134-S-49-191003** | **CL-B134-S-50-191003** | |
| VOCs | *No results detected | *No results detected | N/A |
| **Compound** | **Concentration (mg/kg)** | | **RPD (Limits)** |
| | **SP-B92-S13-191016** | **SP-B92-S12-191016** | |
| TOC | 2,000 | 2,300 | 14 (≤100) |
| **Compound** | **Concentration (µg/kg)** | | **RPD (Limits)** |
| | **NP-B138-S-6-191009** | **NP-B138-S-5-191009** | |
| TPH-Dx | 1,100 UJ | 27000 J | Not calculable |
| **Compound** | **Concentration (pg/g)** | | **RPD (Limits)** |
| | **NP-B138-S-6-191008** | **NP-B138-S-5-191008** | |
| PCB-1 | 540 | 800 J | 39 (≤100) |

## Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)

| Compound | Concentration (pg/g) | | RPD (Limits) |
|---|---|---|---|
| | NP-B138-S-6-191008 | NP-B138-S-5-191008 | |
| PCB-2 | 38 J | 82 J | 73 (≤100) |
| PCB-3 | 140 J | 420 J | **100 (≤100)** |
| PCB-4 | 940 | 1,200 J | 24 (≤100) |
| PCB-6 | 330 | 430 J | 26 (≤100) |
| PCB-8 | 1,700 | 2,500 | 38 (≤100) |
| PCB-15 | 1,400 J | 1,800 J | 25 (≤100) |
| PCB-16 | 3,500 | 3,000 | 15 (≤100) |
| PCB-17 | 4,200 | 4,400 | 5 (≤100) |
| PCB-19 | 810 J | 850 J | 5 (≤100) |
| PCB-21/33 | 4,800 | 3,500 J | 31 (≤100) |
| PCB-22 | 2,500 | 2,000 | 22 (≤100) |
| PCB-24 | 84 J | 100 J | 17 (≤100) |
| PCB-25 | 580 J | 6,700 J | **168 (≤100)** |
| PCB-26/29 | 1,500 J | 19,000 J | **171 (≤100)** |
| PCB-27 | 590 | 610 J | 3 (≤100) |
| PCB-28/20 | 8,500 | 12,000 | 34 (≤100) |
| PCB-30/18 | 7,000 | 6,900 | 1 (≤100) |
| PCB-31 | 9,800 | 12,000 | 20 (≤100) |
| PCB-32 | 2,500 | 2,400 | 4 (≤100) |
| PCB-37 | 2,000 J | 2,700 | 30 (≤100) |
| PCB-40/71 | 5,700 | 8,400 | 38 (≤100) |
| PCB-42 | 4,200 J | 18,000 J | **124 (≤100)** |
| PCB-44/47/65 | 45,000 | 100,000 | 76 (≤100) |
| PCB-48 | 1,600 | 2,100 | 27 (≤100) |
| PCB-50/53 | 2,700 | 2,900 J | 7 (≤100) |
| PCB-52 | 120,000 | 190,000 | 45 (≤100) |
| PCB-56 | 5,600 | 8,800 | 44 (≤100) |
| PCB-57 | 3,400 J | 1,100 J | **102 (≤100)** |
| PCB-59/62/75 | 940 J | 4,900 J | **136 (≤100)** |
| PCB-60 | 2,100 | 1,100 J | 63 (≤100) |
| PCB-61/70/74/76 | 67,000 | 120,000 | 57 (≤100) |
| PCB-63 | 850 J | 3,700 J | **125 (≤100)** |
| PCB-64 | 12,000 | 20,000 | 50 (≤100) |
| PCB-66 | 20,000 J | 79,000 J | **119 (≤100)** |
| PCB-68 | 350 J | 4,300 J | **170 (≤100)** |

## Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)

| Compound | Concentration (pg/g) | | RPD (Limits) |
|---|---|---|---|
| | NP-B138-S-6-191008 | NP-B138-S-5-191008 | |
| PCB-69/49 | 28,000 J | 110,000 J | **119 (≤100)** |
| PCB-72 | 470 J | 5,800 J | **170 (≤100)** |
| PCB-77 | 640 | 1,300 | 68 (≤100) |
| PCB-79 | 1,200 | 2,000 | 50 (≤100) |
| PCB-82 | 18,000 | 13,000 | 32 (≤100) |
| PCB-83 | 17,000 | 34,000 | 67 (≤100) |
| PCB-84 | 69,000 | 75,000 | 8 (≤100) |
| PCB-88/91 | 23,000 | 36,000 | 44 (≤100) |
| PCB-92 | 43,000 | 79,000 | 59 (≤100) |
| PCB-95 | 210,000 | 290,000 | 32 (≤100) |
| PCB-96 | 990 | 1,000 J | 1 (≤100) |
| PCB-98/102 | 3,400 | 5,900 | 54 (≤100) |
| PCB-99 | 72,000 | 190,000 | 90 (≤100) |
| PCB-104 | 5 J | 12 J | 76 (≤100) |
| PCB-105 | 71,000 | 53,000 | 29 (≤100) |
| PCB-107/124 | 5,000 | 4,500 | 11 (≤100) |
| PCB-108/119/86/97/125/87 | 140,000 | 150,000 | 7 (≤100) |
| PCB-109 | 11,000 J | 38,000 J | 110 (≤100) |
| PCB-110/115 | 220,000 | 330,000 | 40 (≤100) |
| PCB-113/90/101 | 230,000 | 360,000 | 44 (≤100) |
| PCB-114 | 3,900 J | 3,100 | 23 (≤100) |
| PCB-117/116/85 | 21,000 | 22,000 | 5 (≤100) |
| PCB-118 | 200,000 | 450,000 | 77 (≤100) |
| PCB-128/166 | 32,000 | 30,000 | 6 (≤100) |
| PCB-130 | 13,000 | 15,000 | 14 (≤100) |
| PCB-131 | 2,900 | 2,500 | 15 (≤100) |
| PCB-132 | 62,000 | 84,000 | 30 (≤100) |
| PCB-133 | 1,700 | 2,900 | 52 (≤100) |
| PCB-134/143 | 9,900 | 13,000 | 27 (≤100) |
| PCB-136 | 20,000 | 23,000 | 14 (≤100) |
| PCB-137 | 11,000 | 11,000 | 0 (≤100) |
| PCB-138/163/129 | 190,000 | 190,000 | 0 (≤100) |
| PCB-139/140 | 3,100 | 4,100 | 28 (≤100) |
| PCB-141 | 23,000 | 18,000 | 24 (≤100) |
| PCB-144 | 5,700 | 4,800 | 17 (≤100) |

## Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)

| Compound | Concentration (pg/g) | | RPD (Limits) |
|---|---|---|---|
| | NP-B138-S-6-191008 | NP-B138-S-5-191008 | |
| PCB-146 | 18,000 | 32,000 | 56 (≤100) |
| PCB-147/149 | 100,000 | 140,000 | 33 (≤100) |
| PCB-151/135 | 35,000 | 49,000 | 33 (≤100) |
| PCB-153/168 | 110,000 | 160,000 | 37 (≤100) |
| PCB-154 | 1,100 | 2,900 | 90 (≤100) |
| PCB-156/157 | 26,000 | 24,000 | 8 (≤100) |
| PCB-158 | 20,000 | 18,000 | 11 (≤100) |
| PCB-159 | 190 J | 170 J | 11 (≤100) |
| PCB-162 | 540 | 470 J | 14 (≤100) |
| PCB-164 | 10,000 | 13,000 | 26 (≤100) |
| PCB-167 | 7,600 J | 7,200 | 5 (≤100) |
| PCB-170 | 16,000 | 12,000 | 29 (≤100) |
| PCB-171/173 | 4,600 | 3,700 J | 22 (≤100) |
| PCB-172 | 1,800 | 1,300 J | 32 (≤100) |
| PCB-174 | 8,400 | 7,100 | 17 (≤100) |
| PCB-175 | 570 | 470 J | 19 (≤100) |
| PCB-176 | 1,600 | 1,600 J | 0 (≤100) |
| PCB-177 | 5,900 | 5,700 | 3 (≤100) |
| PCB-178 | 1,800 | 1,800 J | 0 (≤100) |
| PCB-179 | 3,100 | 3,100 | 0 (≤100) |
| PCB-180/193 | 18,000 | 14,000 | 25 (≤100) |
| PCB-181 | 120 J | 100 J | 18 (≤100) |
| PCB-182 | 110 J | 93 J | 17 (≤100) |
| PCB-183 | 5,800 | 4,700 | 21 (≤100) |
| PCB-184 | 12 J | 15 J | 22 (≤100) |
| PCB-187 | 8,500 | 8,300 | 2 (≤100) |
| PCB-188 | 17 J | 20 J | 16 (≤100) |
| PCB-189 | 610 J | 490 | 22 (≤100) |
| PCB-190 | 1,400 | 1,200 J | 15 (≤100) |
| PCB-191 | 600 | 490 J | 20 (≤100) |
| PCB-194 | 420 | 340 J | 21 (≤100) |
| PCB-195 | 50 J | 63 J | 23 (≤100) |
| PCB-196 | 360 | 290 J | 22 (≤100) |
| PCB-197 | 30 J | 28 J | 7 (≤100) |
| PCB-198/199 | 600 | 550 J | 9 (≤100) |

## Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)

| **Compound** | **Concentration (pg/g)** | | **RPD (Limits)** |
|---|---|---|---|
| | **NP-B138-S-6-191008** | **NP-B138-S-5-191008** | |
| PCB-200 | 8 J | 17 J | 74 (≤100) |
| PCB-201 | 98 J | 89 J | 10 (≤100) |
| PCB-202 | 130 J | 130 J | 0 (≤100) |
| PCB-203 | 52 J | 87 J | 50 (≤100) |
| PCB-206 | 140 J | 95J | 38 (≤100) |
| PCB-208 | 65 J | 43 J | 41 (≤100) |
| PCB-209 | 180 J | 130 J | 32 (≤100) |
| **SEDIMENT** | | | |
| **Compound** | **Concentration (µg/kg)** | | **RPD (Limits)** |
| | **Sed-MA23-190604** | **FD-190604-01** | |
| PCB-1254 | 70 | 52 | 30 (≤100) |
| **Compound** | **Concentration (pg/g)** | | **RPD (Limits)** |
| | **Sed-MA23-190604** | **FD-190604-01** | |
| PCB-1 | 19 J | 21 | 10 (≤100) |
| PCB-2 | 68 | 80 | 16 (≤100) |
| PCB-3 | 19 J | 16 J | 17(≤100) |
| PCB-4 | 110 | 140 | 24 (≤100) |
| PCB-6 | 100 | 140 | 33 (≤100) |
| PCB-8 | 170 | 200 | 16 (≤100) |
| PCB-10 | 6 J | 7.1 J | 17 (≤100) |
| PCB-11 | 27 | 31 | 14(≤100) |
| PCB-12/13 | 37 J | 42 | 13(≤100) |
| PCB-15 | 250 | 300 | 18 (≤100) |
| PCB-16 | 94 | 120 | 24 (≤100) |
| PCB-17 | 150 | 180 | 18 (≤100) |
| PCB-19 | 51 | 64 | 23 (≤100) |
| PCB-21/33 | 89 | 94 | 5 (≤100) |
| PCB-22 | 75 | 88 | 16 (≤100) |
| PCB-25 | 140 | 160 | 13 (≤100) |
| PCB-26/29 | 320 | 360 | 12 (≤100) |
| PCB-27 | 84 | 100 | 17 (≤100) |
| PCB-28/20 | 450 | 520 | 14 (≤100) |
| PCB-30/18 | 270 | 370 | 31 (≤100) |
| PCB-31 | 390 | 430 | 10 (≤100) |
| PCB-32 | 110 | 130 | 17 (≤100) |

## Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)

| Compound | Concentration (pg/g) | | RPD (Limits) |
|---|---|---|---|
| | Sed-MA23-190604 | FD-190604-01 | |
| PCB-37 | 83 | 100 | 19 (≤100) |
| PCB-40/71 | 240 | 270 | 12 (≤100) |
| PCB-42 | 100 | 120 | 18 (≤100) |
| PCB-43 | 13 J | 19 J | 38 (≤100) |
| PCB-44/47/65 | 570 | 630 | 10 (≤100) |
| PCB-45 | 46 | 51 | 10 (≤100) |
| PCB-46 | 26 | 32 | 21 (≤100) |
| PCB-48 | 37 | 42 | 13 (≤100) |
| PCB-50/53 | 140 | 160 | 13 (≤100) |
| PCB-51 | 22 | 26 | 17(≤100) |
| PCB-52 | 1,200 | 1,400 | 15 (≤100) |
| PCB-54 | 2.5 J | 3.2 J | 25 (≤100) |
| PCB-56 | 92 | 100 | 8 (≤100) |
| PCB-58 | 22 | 24 | 9 (≤100) |
| PCB-59/62/75 | 62 | 69 | 11 (≤100) |
| PCB-60 | 36 | 43 | 18 (≤100) |
| PCB-61170/74/76 | 370 | 540 | 37 (≤100) |
| PCB-63 | 7.6 J | 9.5 J | 22 (≤100) |
| PCB-64 | 120 | 140 | 15 (≤100) |
| PCB-66 | 360 | 440 | 20 (≤100) |
| PCB-67 | 7.4 J | 8.9 J | 18 (≤100) |
| PCB-68 | 11 J | 11 J | 0 (≤100) |
| PCB-69/49 | 690 | 710 | 3 (≤100) |
| PCB-72 | 19 J | 18 J | 5 (≤100) |
| PCB-77 | 71 | 74 | 4 (≤100) |
| PCB-79 | 19 J | 22 | 15 (≤100) |
| PCB-80 | 13 J | 13 J | 0 (≤100) |
| PCB-82 | 200 | 210 | 5 (≤100) |
| PCB-83 | 89 | 96 | 8 (≤100) |
| PCB-84 | 220 | 460 | 71 (≤100) |
| PCB-88/91 | 2.0U | 240 | Not calculable |
| PCB-92 | 470 | 500 | 6 (≤100) |
| PCB-95 | 850 | 980 | 14(≤100) |
| PCB-96 | 11 J | 12 J | 9 (≤100) |
| PCB-98/102 | 28 J | 38 J | 30 (≤100) |

**Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)**

| Compound | Concentration (pg/g) | | RPD (Limits) |
|---|---|---|---|
| | Sed-MA23-190604 | FD-190604-01 | |
| PCB-99 | 1,400 | 1,400 | 0 (≤100) |
| PCB-104 | 0.54 J | 0.53 J | 2 (≤100) |
| PCB-105 | 830 | 930 | 11 (≤100) |
| PCB-107/124 | 47 | 59 | 23 (≤100) |
| PCB-108/119/86/97/125/87 | 1,300 | 1,400 | 7 (≤100) |
| PCB-109 | 160 | 160 | 0 (≤100) |
| PCB-110/115 | 2,900 | 3,000 | 3 (≤100) |
| PCB-113/90/101 | 2,300 | 2,500 | 8 (≤100) |
| PCB-114 | 27 | 38 | 34 (≤100) |
| PCB-117/116/85 | 420 | 430 | 2 (≤100) |
| PCB-118 | 2,400 | 2,700 | 12 (≤100) |
| PCB-122 | 29 | 36 | 22 (≤100) |
| PCB-123 | 31 | 43 | 32 (≤100) |
| PCB-128/166 | 710 | 690 | 3 (≤100) |
| PCB-130 | 280 | 280 | 0 (≤100) |
| PCB-131 | 46 | 47 | 2 (≤100) |
| PCB-132 | 1,000 | 1,000 | 0 (≤100) |
| PCB-133 | 41 | 40 | 2 (≤100) |
| PCB-134/143 | 170 | 190 | 11 (≤100) |
| PCB-136 | 290 | 300 | 3 (≤100) |
| PCB-137 | 240 | 230 | 4 (≤100) |
| PCB-138/163/129 | 3,900 | 3,900 | 0 (≤100) |
| PCB-139/140 | 73 | 74 | 1 (≤100) |
| PCB-141 | 430 | 410 | 5 (≤100) |
| PCB-144 | 110 | 110 | 0 (≤100) |
| PCB-146 | 420 | 410 | 2 (≤100) |
| PCB-147/149 | 2,000 | 2,000 | 0 (≤100) |
| PCB-151/135 | 670 | 670 | 0 (≤100) |
| PCB-153/168 | 2,500 | 2,500 | 0 (≤100) |
| PCB-154 | 39 | 37 | 5 (≤100) |
| PCB-156/157 | 450 | 470 | 4 (≤100) |
| PCB-158 | 400 | 410 | 2 (≤100) |
| PCB-159 | 7 J | 6.2 J | 12(≤100) |
| PCB-162 | 15 J | 15 J | 0 (≤100) |
| PCB-164 | 210 | 200 | 5 (≤100) |

## Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)

| Compound | Concentration (pg/g) | | RPD (Limits) |
|---|---|---|---|
| | Sed-MA23-190604 | FD-190604-01 | |
| PCB-167 | 180 | 180 | 0 (≤100) |
| PCB-170 | 450 | 430 | 5 (≤100) |
| PCB-171/173 | 130 | 130 | 0 (≤100) |
| PCB-172 | 62 | 59 | 5 (≤100) |
| PCB-174 | 260 | 250 | 4 (≤100) |
| PCB-175 | 16 J | 16 J | 0 (≤100) |
| PCB-176 | 44 | 44 | 0 (≤100) |
| PCB-177 | 180 | 180 | 0 (≤100) |
| PCB-178 | 62 | 63 | 2 (≤100) |
| PCB-179 | 110 | 100 | 10 (≤100) |
| PCB-180/193 | 680 | 640 | 6 (≤100) |
| PCB-181 | 6.7 J | 6 J | 11 (≤100) |
| PCB-182 | 3.5 J | 3.9 J | 11 (≤100) |
| PCB-183 | 210 | 200 | 5 (≤100) |
| PCB-184 | 0.88 J | 0.77 J | 13 (≤100) |
| PCB-185 | 23 | 21 | 9 (≤100) |
| PCB-186 | 0.27 J | 0.99U | Not calculable |
| PCB-187 | 350 | 340 | 3 (≤100) |
| PCB-188 | 1.5 J | 1.6 J | 6 (≤100) |
| PCB-189 | 21 | 19 | 10(≤100) |
| PCB-190 | 76 | 70 | 8 (≤100) |
| PCB-191 | 17 J | 17 J | 0 (≤100) |
| PCB-194 | 86 | 82 | 5 (≤100) |
| PCB-195 | 31 | 29 | 7 (≤100) |
| PCB-196 | 63 | 59 | 7 (≤100) |
| PCB-197 | 4.1 J | 3.9 J | 5 (≤100) |
| PCB-198/199 | 120 | 110 | 9 (≤100) |
| PCB-200 | 15 J | 14 J | 7 (≤100) |
| PCB-201 | 19 J | 19 J | 0 (≤100) |
| PCB-202 | 28 | 27 | 4 (≤100) |
| PCB-203 | 70 | 65 | 7 (≤100) |
| PCB-204 | 0.15 J | 0.99U | Not calculable |
| PCB-205 | 5.4 J | 5.2 J | 4 (≤100) |
| PCB-206 | 6.4 J | 5.2 | 21 (≤100) |

## Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)

| Compound | Concentration (pg/g) | | RPD (Limits) |
|---|---|---|---|
| | **Sed-MA23-190604** | **FD-190604-01** | |
| PCB-207 | 11 J | 9.1 J | 19 (≤100) |
| PCB-208 | 40 | 24 | 50 (≤100) |
| PCB-209 | 100 | 66 | 41 (≤100) |
| **POREWATER** | | | |
| **Compound** | **Concentration (µg/L)** | | **RPD (Limits)** |
| | **PW1-24-190605** | **FD-190605-01** | |
| cis-1,2-Dichloroethene | 0.71 J | 0.78 J | 9 (≤50) |
| Vinyl chloride | 1.5 | 1.5 | 0 (≤50) |
| **Compound** | **Concentration (µg/L)** | | **RPD (Limits)** |
| | **PW1-32-191018** | **FD-191018-01** | |
| VOCs | *No results detected | *No results detected | N/A |
| **Compound** | **Concentration (pg/L)** | | **RPD (Limits)** |
| | **PW1-27-190604** | **FD-190604-02** | |
| PCB-1 | 150 J | 140 J | 7 (≤50) |
| PCB-3 | 2.6 J | 2 J | 26 (≤50) |
| PCB-4 | 220 | 210 | 5 (≤50) |
| PCB-6 | 91 J | 91 J | 0 (≤50) |
| PCB-8 | 100 J | 98 J | 2 (≤50) |
| PCB-16 | 130 J | 120 J | 8 (≤50) |
| PCB-17 | 120 J | 130 J | 8 (≤50) |
| PCB-19 | 70 J | 72 J | 3 (≤50) |
| PCB-21/33 | 38 J | 39 J | 3 (≤50) |
| PCB-22 | 37 J | 41 J | 10 (≤50) |
| PCB-24 | 4.6 J | 4 J | 14 (≤50) |
| PCB-25 | 47 J | 52 J | 10 (≤50) |
| PCB-26/29 | 160 J | 170 J | 6 (≤50) |
| PCB-27 | 21 J | 24 J | 13 (≤50) |
| PCB-28/20 | 120 J | 130 J | 8 (≤50) |
| PCB-30/18 | 230 J | 230 J | 0 (≤50) |
| PCB-31 | 110 J | 120 J | 9 (≤50) |
| PCB-32 | 63 J | 63 J | 0 (≤50) |
| PCB-37 | 5.3 J | 7.1 J | 29 (≤50) |
| PCB-40/71 | 49 J | 49 J | 0 (≤50) |
| PCB-42 | 40 J | 43 J | 7 (≤50) |
| PCB-44/47/65 | 250 J | 290 J | 15(≤50) |

## Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)

| Compound | Concentration (pg/g) | | RPD (Limits) |
|---|---|---|---|
| | PW1-27-190604 | FD-190604-02 | |
| PCB-45 | 29 J | 31 J | 7 (≤50) |
| PCB-46 | 13 J | 12 J | 8 (≤50) |
| PCB-48 | 8.5 J | 8.8 J | 3 (≤50) |
| PCB-50/53 | 27 J | 31 J | 14(≤50) |
| PCB-51 | 67 J | 72 J | 7 (≤50) |
| PCB-52 | 380 | 410 | 8 (≤50) |
| PCB-55 | 9.6 U | 1.5 | Not calculable |
| PCB-56 | 15 J | 15 J | 0 (≤50) |
| PCB-57 | 2.4 J | 2.4 J | 0 (≤50) |
| PCB-58 | 7 J | 5.8 J | 19 (≤50) |
| PCB-59/62/75 | 16 J | 15 J | 6 (≤50) |
| PCB-61/70/74/76 | 86 J | 82 J | 5 (≤50) |
| PCB-63 | 2.1 J | 2.2 J | 5 (≤50) |
| PCB-64 | 39 J | 38 J | 3 (≤50) |
| PCB-66 | 52 J | 50 J | 4 (≤50) |
| PCB-67 | 6.5 J | 7.2 J | 10 (≤50) |
| PCB-68 | 45 J | 53 J | 16 (≤50) |
| PCB-69/49 | 200 J | 210 J | 5 (≤50) |
| PCB-72 | 4.6 J | 4.7 J | 2 (≤50) |
| PCB-77 | 2.2 J | 2.2 J | 0 (≤50) |
| PCB-82 | 11 J | 11 J | 0 (≤50) |
| PCB-83 | 8.7 J | 7 J | 22 (≤50) |
| PCB-84 | 88 J | 92 J | 4 (≤50) |
| PCB-88/91 | 44 J | 44 J | 0 (≤50) |
| PCB-92 | 47 J | 43 J | 9 (≤50) |
| PCB-93/100 | 19 U | 4.1 J | Not calculable |
| PCB-95 | 280 | 280 | 0 (≤50) |
| PCB-96 | 2.1 J | 19 U | Not calculable |
| PCB-98/102 | 6.6 J | 6.7 J | 2 (≤50) |
| PCB-99 | 72 J | 74 J | 3 (≤50) |
| PCB-103 | 3.8 J | 9.6 U | Not calculable |
| PCB-105 | 20 | 17 J | 16 (≤50) |
| PCB-108/119/86/97/125/87 | 89 J | 85 J | 5 (≤50) |

## Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)

| Compound | Concentration (pg/g) | | RPD (Limits) |
|---|---|---|---|
| | PW1-27-190604 | FD-190604-02 | |
| PCB-109 | 7.4 J | 6.1 J | 19 (≤50) |
| PCB-110/115 | 190 J | 190 J | 0 (≤50) |
| PCB-113/90/1 01 | 160 J | 160 J | 0 (≤50) |
| PCB-117/116/85 | 20 J | 20 J | 0 (≤50) |
| PCB-118 | 75 | 68 | 10 (≤50) |
| PCB-128/166 | 8.5 J | 7.3 J | 15(≤50) |
| PCB-130 | 4.8 J | 4.5 J | 6 (≤50) |
| PCB-132 | 24 J | 21 J | 13(≤50) |
| PCB-134/143 | 4.7 J | 4.8 J | 2 (≤50) |
| PCB-136 | 12 J | 12 J | 0 (≤50) |
| PCB-137 | 2.1 J | 19 U | Not calculable |
| PCB-138/163/129 | 57 J | 48 J | 17(≤50) |
| PCB-139/140 | 1.2 J | 1.3 J | 8 (≤50) |
| PCB-141 | 5.4 J | 6.2 J | 14 (≤50) |
| PCB-144 | 2.2 J | 2 J | 10(≤50) |
| PCB-146 | 7.8 J | 7.5 J | 4 (≤50) |
| PCB-147/149 | 51 J | 48 J | 6 (≤50) |
| PCB-151/135 | 20 J | 18 J | 11 (≤50) |
| PCB-153/168 | 42 J | 36 J | 15(≤50) |
| PCB-154 | 1.4 J | 9.6 U | Not calculable |
| PCB-156/157 | 5.7 J | 3.7 J | 43 (≤50) |
| PCB-158 | 5.8 J | 3.9 J | 39 (≤50) |
| PCB-164 | 3.8 J | 3.1 J | 20 (≤50) |
| PCB-167 | 2.2 J | 1.5 J | 38 (≤50) |
| PCB-170 | 19 U | 2 J | Not calculable |
| PCB-174 | 1.9 J | 3.1 J | 48 (≤50) |
| PCB-177 | 1.7 J | 1.2 J | 34 (≤50) |
| PCB-178 | 1.7 J | 9.6 U | Not calculable |
| PCB-179 | 1.6 J | 19 U | Not calculable |
| PCB-180/193 | 7.1 J | 5.8 J | 20 (≤50) |
| PCB-183 | 2.1 J | 1.9 J | 10 (≤50) |

**Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)**

| Compound | Concentration (pg/g) | | RPD (Limits) |
|---|---|---|---|
| | **PW1-27-190604** | **FD-190604-02** | |
| PCB-187 | 6.3 J | 19 U | Not calculable |
| PCB-194 | 1.4 J | 19 U | Not calculable |
| PCB-196 | 1.1 J | 19 U | Not calculable |
| PCB-198/199 | 0.98 J | 0.87 J | 12 (≤50) |
| PCB-203 | 0.76 J | 1.1 J | 37 (≤50) |
| PCB-206 | 2.5 J | 0.91 J | **93 (≤50)** |
| PCB-207 | 0.29 J | 9.6 U | Not calculable |
| PCB-208 | 0.39 J | 9.6 U | Not calculable |
| PCB-209 | 2.7 J | 0.92 U | Not calculable |
| **SURFACE WATER** | | | |
| **Compound** | **Concentration (µg/L)** | | **RPD (Limits)** |
| | **SW1-17-190603** | **FD-190603-02** | |
| cis-1,2-Dichloroethene | 2.2 J | 2.4 | 9 (≤50) |
| Vinyl chloride | 0.093 | 0.13 | 33 (≤50) |
| **Compound** | **Concentration (pg/L)** | | **RPD (Limits)** |
| | **SW1-18-190603** | **FD-190603-01** | |
| PCB-1 | 14 J | 12 J | 15 (≤50) |
| PCB-3 | 1.9 J | 1.5 J | 24 (≤50) |
| PCB-4 | 120 J | 130 J | 8 (≤50) |
| PCB-6 | 49 J | 46 J | 6 (≤50) |
| PCB-8 | 88 J | 78 J | 12(≤50) |
| PCB-15 | 30 J | 29 J | 3 (≤50) |
| PCB-16 | 38 J | 40 J | 5 (≤50) |
| PCB-17 | 56 J | 51 J | 9 (≤50) |
| PCB-19 | 24 J | 24 J | 0 (≤50) |
| PCB-21/33 | 40 J | 38 J | 5 (≤50) |
| PCB-22 | 21 J | 17 J | 21 (≤50) |
| PCB-24 | 19 U | 2.6 J | Not calculable |
| PCB-25 | 19 J | 15 J | 24 (≤50) |

## Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)

| Compound | Concentration (pg/L) | | RPD (Limits) |
|---|---|---|---|
| | SW1-18-190603 | FD-190603-01 | |
| PCB-26/29 | 46 J | 39 J | 16 (≤50) |
| PCB-27 | 19 J | 17 J | 11 (≤50) |
| PCB-28/20 | 100 J | 97 J | 3 (≤50) |
| PCB-30/18 | 110 J | 100 J | 10 (≤50) |
| PCB-31 | 80 J | 76 J | 5 (≤50) |
| PCB-32 | 23 J | 22 J | 4 (≤50) |
| PCB-37 | 8.7 J | 8 J | 8 (≤50) |
| PCB-40/71 | 18 J | 19 J | 5 (≤50) |
| PCB-42 | 10 J | 11 J | 10 (≤50) |
| PCB-43 | 1.1 J | 9.9 U | Not calculable |
| PCB-44/47/65 | 52 J | 53 J | 2 (≤50) |
| PCB-45 | 11 J | 9.6 J | 14(≤50) |
| PCB-46 | 4.9 J | 3.9 J | 23 (≤50) |
| PCB-48 | 10 J | 11 J | 10 (≤50) |
| PCB-50/53 | 15 J | 17 J | 13 (≤50) |
| PCB-51 | 3 J | 3.7 J | 21 (≤50) |
| PCB-52 | 94 J | 97 J | 3 (≤50) |
| PCB-56 | 6.3 J | 5.9 J | 7 (≤50) |
| PCB-57 | 9.5 U | 1.9 J | Not calculable |
| PCB-59/62/75 | 6.3 J | 6.1 J | 3 (≤50) |
| PCB-60 | 3.2 J | 3.2 J | 0 (≤50) |
| PCB-61/70/74/76 | 39 J | 41 J | 5 (≤50) |
| PCB-63 | 1.6 J | 20 U | Not calculable |
| PCB-64 | 14 J | 15 J | 7 (≤50) |
| PCB-66 | 28 J | 30 J | 7 (≤50) |
| PCB-67 | 19 U | 1.3 J | Not calculable |
| PCB-69/49 | 43 J | 44 J | 2 (≤50) |
| PCB-72 | 19 U | 1.3 J | Not calculable |
| PCB-73 | 19 U | 1.1 J | Not calculable |
| PCB-77 | 2.7 J | 2.1 J | 25 (≤50) |
| PCB-79 | 9.5 U | 1.1 J | Not calculable |

## Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)

| Compound | Concentration (pg/L) | | RPD (Limits) |
|---|---|---|---|
| | SW1-18-190603 | FD-190603-01 | |
| PCB-82 | 3.7 J | 4 J | 8 (≤50) |
| PCB-83 | 1.8 J | 20 U | Not calculable |
| PCB-84 | 14 J | 14 J | 0 (≤50) |
| PCB-88/91 | 8.5 J | 9.5 J | 11 (≤50) |
| PCB-92 | 10 J | 8.7 J | 14(≤15) |
| PCB-95 | 50 J | 59 J | 17(≤50) |
| PCB-98/102 | 1.5 J | 20 U | Not calculable |
| PCB-99 | 29 J | 34 J | 16 (≤50) |
| PCB-105 | 16 J | 20 | 22 (≤50) |
| PCB-108/119/86/97/125/87 | 29 J | 32 J | 10 (≤50) |
| PCB-109 | 2.3 J | 3.5 J | 41 (≤50) |
| PCB-110/115 | 53 J | 60 J | 12 (≤50) |
| PCB-113/90/101 | 53 J | 61 J | 14 (≤50) |
| PCB-118 | 46 J | 55 | 18 (≤50) |
| PCB-128/166 | 7.6 J | 8.5 J | 11 (≤50) |
| PCB-130 | 3.4 | 3.6 J | 6 (≤50) |
| PCB-131 | 19 U | 1 J | Not calculable |
| PCB-132 | 10 J | 15 J | 40 (≤50) |
| PCB-134/143 | 2.2 J | 2 J | 10 (≤50) |
| PCB-136 | 2.8 J | 5 J | 56 (≤50) |
| PCB-137 | 1.9 J | 2.1 J | 10 (≤50) |
| PCB-138/163/129 | 47 J | 57 J | 19 (≤50) |
| PCB-139/140 | 19 U | 1 J | Not calculable |
| PCB-141 | 4.6 J | 4.9 J | 6 (≤50) |
| PCB-144 | 9.5 U | 1.3 J | Not calculable |
| PCB-146 | 5.4 J | 5.8 J | 7 (≤50) |
| PCB-147/149 | 23 J | 27 J | 16 (≤50) |
| PCB-151/135 | 7.9 J | 8.5 J | 7 (≤50) |
| PCB-153/168 | 31 J | 35 J | 12 (≤50) |
| PCB-154 | 9.5 U | 1.1 J | Not calculable |
| PCB-156/157 | 6.3 J | 7.8 J | 21 (≤50) |

**Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)**

| Compound | Concentration (pg/L) | | RPD (Limits) |
|---|---|---|---|
| | SW1-18-190603 | FD-190603-01 | |
| PCB-158 | 4.5 J | 5.8 J | 25 (≤50) |
| PCB-164 | 2.5 J | 2.6 J | 4 (≤50) |
| PCB-167 | 2.3 J | 2.5 J | 8 (≤50) |
| PCB-170 | 4.2 J | 5.5 J | 27 (≤50) |
| PCB-171/173 | 19 U | 2 J | Not calculable |
| PCB-174 | 2.2 J | 1.9 J | 15(≤50) |
| PCB-177 | 2 J | 1.2 J | 50 (≤50) |
| PCB-179 | 1.2 J | 1.5 J | 22 (≤50) |
| PCB-180/193 | 5.3 J | 6.2 J | 16 (≤50) |
| PCB-183 | 2.9 U | 3.3 U | 13 (≤50) |
| PCB-187 | 4.1 J | 3 J | 31 (≤50) |
| PCB-190 | 19 U | 0.87 J | Not calculable |
| PCB-194 | 19 U | 0.99 J | Not calculable |
| PCB-195 | 19 U | 1.3 J | Not calculable |
| PCB-196 | 0.52 J | 20 U | Not calculable |
| PCB-198/199 | 0.71 U | 1 U | 34 (≤50) |
| PCB-200 | 19 U | 0.21 J | Not calculable |
| PCB-203 | 0.71 J | 0.47 J | 41 (≤50) |
| PCB-206 | 1.2 | 1.1 J | 9 (≤50) |
| **GROUNDWATER** | | | |
| **Compound** | **Concentration (µg/L)** | | **RPD (Limits)** |
| | **SP-B090-GW-15-190628** | **SP-B090-GW-14-190628** | |
| Vinyl chloride | 0.14 | 0.14 | 0 (≤50) |
| **Compound** | **Concentration (µg/L)** | | **RPD (Limits)** |
| | **CL-B134-GW-50-191003** | **CL-B134-GW-49-191003** | |
| cis-1,2-Dichloroethene | 7.5 | 7.1 | 5 (≤50) |
| Vinyl chloride | 0.34 | 0.33 | 3 (≤50) |
| 1,4-dioxane | *No results detected | *No results detected | N/A |

## Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)

| **Compound** | **Concentration (µg/L)** | | **RPD (Limits)** |
|---|---|---|---|
| | **NP-B110-GW-15-190612** | **QC-190612-02** | |
| cis-1,2-Dichloroethene | 0.30 U | 0.73 J | Not calculable |
| Vinyl chloride | 0.93 | 0.89 | 4 (≤50) |
| 1,4-dioxane | 28 | 27 | 4 (≤50) |
| **Compound** | **Concentration (µg/L)** | | **RPD (Limits)** |
| | **NP-B116-GW-15-190621** | **NP-B116-GW-14-190621** | |
| Vinyl chloride | 0.12 J | 0.1 J | 18 (≤50) |
| 1,4-dioxane | 3.5 | 3.2 | 9 (≤50) |
| **Compound** | **Concentration (µg/L)** | | **RPD (Limits)** |
| | **NP-B123-GW-19-190619** | **NP-B123-GW-20-190619** | |
| Vinyl chloride | 0.052 | 0.066 | 24 (≤50) |
| TPH-Dx | 300 U | 390 U | 26 (≤100) |
| 1,4-dioxane | *No results detected | *No results detected | N/A |
| PCB Aroclors | *No results detected | *No results detected | N/A |
| **Compound** | **Concentration (µg/L)** | | **RPD (Limits)** |
| | **MW1-46-191025** | **FD-191025-01** | |
| 1,1-Dichloroethene | 11 | 13 | 17 (≤50) |
| Chloroethane | 0.5 U | 4.8 | Not calculable |
| trans-1,2-Dichloroethene | 55 | 61 | 10 (≤50) |
| cis-1,2-Dichloroethene | 4,700 | 4,500 J | 4 (≤50) |
| Trichloroethene | 15 U | 56 J | Not calculable |
| Vinyl chloride | 1,100 J | 1,100 J | 0 (≤50) |
| 1,4-dioxane | 40 | 46 | 14 (≤50) |
| TPH-Dx | 110 | 120 | 9 (≤50) |
| Ethane | 39 | 91 | **80 (≤50)** |
| Ethene | 79 | 75 | 5 (≤50) |
| Methane | 6,300 | 4,100 | 42 (≤50) |
| **Compound** | **Concentration (µg/L)** | | **RPD (Limits)** |
| | **MW1-46-191025** | **FD-191025-01** | |
| Chloride | 210,000 | 210,000 | 0 (≤50) |
| Dissolved organic carbon | 9,150 | 9,150 | 0 (≤50) |
| Nitrite as N | 1,050 | 1,100 | 5 (≤50) |
| Sulfate | 65,500 | 71,200 | 8 (≤50) |
| Sulfide | 1,350 | 1,410 | 4 (≤50) |

# Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)

| Compound | Concentration (µg/L) | | RPD (Limits) |
|---|---|---|---|
| | MW1-49-191022 | FD-191022-01 | |
| 1,1-Dichloroethene | 8.8 | 9.1 | 3 (≤50) |
| Chloroethane | 1.8 | 0.59 J | **101 (≤50)** |
| trans-1,2-Dichloroethene | 19 | 21 | 10 (≤50) |
| cis-1,2-Dichloroethene | 1,300 J | 1,300 J | 0 (≤50) |
| Trichloroethene | 940 J | 990 J | 5 (≤50) |
| Vinyl chloride | 100 J | 84 J | 17 (≤50) |
| Ethane | 0.88 J | 0.79 J | 11 (≤50) |
| Ethane | 4 J | 4.1 J | 2 (≤50) |
| Methane | 46 | 40 | 14 (≤50) |
| **Compound** | **Concentration (µg/L)** | | **RPD (Limits)** |
| | **MW1-49-191022** | **FD-191022-01** | |
| Chloride | 5,850 | 6,990 | 18 (≤50) |
| Dissolved organic carbon | 1,040 | 1,070 | 3 (≤50) |
| Nitrite as N | 34.9 J | 35 J | 0 (≤50) |
| Sulfate | 10,800 | 11,000 | 2 (≤50) |
| Sulfide | 2,100 | 1,640 J | 25 (≤50) |
| **Compound** | **Concentration (pg/L)** | | **RPD (Limits)** |
| | **MW1-2-191029** | **FD-191029-01** | |
| PCB-51 | 19 U | 0.76 J | Not calculable |
| PCB-84 | 3.3 J | 3.5 J | 6 (≤50) |
| PCB-109 | 1 J | 9.5 U | Not calculable |
| PCB-128/166 | 1.9 J | 2.1 J | 10 (≤50) |
| PCB-171/173 | 19 U | 0.69 J | Not calculable |
| PCB-177 | 19 U | 0.72 J | Not calculable |
| PCB-179 | 19 U | 0.52 J | Not calculable |
| PCB-203 | 19U | 0.28 J | Not calculable |
| **Compound** | **Concentration (ng/L)** | | **RPD (Limits)** |
| | **MW1-61-191028** | **FD-191028-01** | |
| Perfluorohexanoic acid (PFHxA) | 2.72 J | 2.69 J | 1 (≤50) |
| Perfluoroheptanoic acid (PFHpA) | 1.74 J | 1.63 J | 7 (≤50) |

## Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)

| Compound | Concentration (ng/L) | | RPD (Limits) |
|---|---|---|---|
| | MW1-61-191028 | FD-191028-01 | |
| Perfluorooctanoic acid (PFOA) | 4.36 J | 4.46 J | 2 (≤50) |
| Perfluorononanoic acid (PFNA) | 0.87 J | 0.89 J | 2 (≤50) |
| Perfluorodecanoic acid (PFDA) | 0.44 J | 0.4 J | 10 (≤50) |
| Perfluorobutanesulfonic acid (PFBS) | 2.34 J | 2.12 J | 10 (≤50) |
| Perfluorohexanesulfonic acid (PFHxS) | 1.74 J | 1.61 J | 8 (≤50) |
| Perfluorooctane sulfonate (PFOS) | 4.21 J | 3.92 J | 7 (≤50) |
| **Compound** | **Concentration (cells/mL)** | | **RPD (Limits)** |
| | **MW1-50-191023** | **FD-191023-01** | |
| Phenol Hydroxylase (PHE) | 5.0 U | 18 | Not calculable |
| Desulfitobacterium spp. (DSB) | 1,170 | 4,760 | **121 (≤50)** |
| Desulfuromonas spp. (DSM) | 294 | 4.5 | **194 (≤50)** |
| Total Eubacteria (EBAC) | 91,100 | 127,000 | 33 (≤50) |
| Sulfate Reducing Bacteria (APS) | 3,180 | 1,850 | **53 (≤50)** |
| Dehalobium chlorocoercia (DECO) | 5.0U | 101 | Not calculable |
| Dehalococcoides (DHC) | 4.5 | 16 | **110 (≤50)** |
| Dehalogenimonas spp. (DHG) | 5.0U | 246 | Not calculable |
| Epoxyalkane Transferase (EtnE) | 53 | 5.0 U | Not calculable |
| Toluene Monooxygenase 2 (RDEG) | 20 | 5.0 U | Not calculable |
| Toluene Monooxygenase (RMO) | 274 | 5.0 U | Not calculable |
| **Compound** | **Concentration (cells/mL)** | | **RPD (Limits)** |
| | **MW1-46-191025** | **FD-191025-01** | |
| Vinyl Chloride Reductase (VCR) | 956 | 861 | 10 (≤50) |
| Phenol Hydroxylase (PHE) | 264 | 289 | 9 (≤50) |
| BAV1 Vinyl Chloride Reductase (BVC) | 753 | 666 | 12 (≤50) |
| Dehalobacter spp. (DHBt) | 1,860 | 1,670 | 11 (≤50) |
| Desulfitobacterium spp. (DSB) | 1,880 | 2,890 | 42 (≤50) |
| Desulfuromonas spp. (DSM) | 19 | 19 | 2 (≤50) |
| Total Eubacteria (EBAC) | 738,000 | 894,000 | 19 (≤50) |
| Methanogens (MGN) | 63 | 51 | 21 (≤50) |
| Sulfate Reducing Bacteria (APS) | 70,600 | 72,900 | 3 (≤50) |
| Dehalobium chlorocoercia (DECO) | 5,940 | 5,780 | 3 (≤50) |

## Table B3-3a. Field Duplicate Analyses Summary – 2019 (continued)

| Compound | Concentration (cells/mL) | | RPD (Limits) |
|---|---|---|---|
| | MW1-46-191025 | FD-191025-01 | |
| Dehalococcoides (DHC) | 10,700 | 9,400 | 13 (≤50) |
| Dehalogenimonas spp. (DHG) | 52,500 | 42,500 | 21 (≤50) |
| Ethene Monooxygenase (EtnC) | 865 | 968 | 11 (≤50) |
| Epoxyalkane Transferase (EtnE) | 5,130 | 7,090 | 32 (≤50) |
| Toluene Monooxygenase 2 (RDEG) | 105 | 109 | 4 (≤50) |
| Toluene Monooxygenase (RMO) | 4,150 | 3,220 | 25 (≤50) |
| trans-1,2-DCE Reductase (TDR) | 23,400 | 12,200 | **63 (≤50)** |

**Notes:**
Field duplicates exceeding RPDs are bolded.
Only analytes showing detections are shown.
J qualifiers have been omitted.

## Table B3-3b. Field Duplicate Analyses Summary - 2022

| SOILS | | | |
|---|---|---|---|
| **Compound** | **Concentration (µg/kg)** | | **RPD (Limits)** |
| | **SP-B174-S-73-220428** | **SP-B174-S-74-220428** | |
| VOCs | *No results detected | *No results detected | N/A |
| **Compound** | **Concentration (µg/kg)** | | **RPD (Limits)** |
| | **SP-B178-S-30-220509** | **SP-B178-S-32-220509** | |
| Trichloroethene | 0.0026 J | Not analyzed by lab | Not Calculable |
| 1,4-dioxane | *No results detected | *No results detected | N/A |
| PCB Aroclors | *No results detected | *No results detected | N/A |
| PCB Congeners | *No results detected | *No results detected | N/A |
| **Compound** | **Concentration (µg/kg)** | | **RPD (Limits)** |
| | **NP-B177-S-35-220505** | **NP-B177-S-36-220505** | |
| cis-1,2-Dichloroethene | 0.058 J | 1.3 J | **183% (≤100)** |
| trans-1,2-Dichloroethene | 0.0009 J | 0.0039 J | <LOQ |
| Trichloroethene | 0.0011 U | 0.13 J | Not Calculable |
| Vinyl chloride | 0.0079 J | 0.075 J | <LOQ |
| 1,4-dioxane | *No results detected | *No results detected | N/A |
| PCB Aroclors | *No results detected | *No results detected | N/A |
| PCB Congeners | *No results detected | *No results detected | N/A |
| **Compound** | **Concentration (µg/kg)** | | **RPD (Limits)** |
| | **DG-B179-S-50-220713** | **DG-B179-S-50-220713[a]** | |
| VOCs | *No results detected | *No results detected | N/A |
| 1,4-dioxane | *No results detected | *No results detected | N/A |
| **GROUNDWATER** | | | |
| **Compound** | **Concentration (µg/L)** | | **RPD (Limits)** |
| | **MW1-72-220512** | **FD-220512-02** | |
| cis-1,2-Dichloroethene | 0.15 U | 0.47 | Not Calculable |
| Vinyl chloride | 0.14 | 0.015 U | Not Calculable |
| 1,4-dioxane | *No results detected | *No results detected | N/A |
| PCB Aroclors | *No results detected | *No results detected | N/A |
| PFAS | *No results detected | *No results detected | N/A |

## Table B3-3b. Field Duplicate Analyses Summary – 2022 (continued)

| Compound | Concentration (pg/L) | | RPD (Limits) |
|---|---|---|---|
| | **MW1-72-220512** | **FD-220512-02** | |
| PCB-044/047/065 | 44 J | 49 J | 11 (≤50%) |
| PCB-051 | 25 J | 25 J | 0 (≤50%) |
| PCB-052 | 13 J | 13 J | 0 (≤50%) |
| PCB-068 | 37 J | 41 J | 10 (≤50%) |
| Total PCBs | 130 J | 130 J | 0 (≤50%) |
| Pentachlorbiphenyl | 12 J | 19 U | Not Calculable |
| Tetrachlorobiphenyl | 120 J | 130 J | 8 (≤50%) |
| **Compound** | **Concentration (ng/L)** | | **RPD (Limits)** |
| | **MW1-75-220718** | **MW1-75-220718[a]** | |
| PFAS | *No results detected | *No results detected | N/A |
| **Compound** | **Concentration (µg/L)** | | **RPD (Limits)** |
| | **MW1-77-220429[b]** | **FD-220429-01[b]** | |
| 1,1-Dichloroethene | 6.07 | 6.51 | 7 (≤50%) |
| Chloroethane | 0.64 J | 1.45 J | <LOQ |
| cis-1,2-Dichloroethene | 581 | 571 | 7 (≤50%) |
| trans-1,2-Dichloroethene | 42.3 | 43.7 | 3 (≤50%) |
| Trichloroethene | 42.5 | 47.4 | 10 (≤50%) |
| Vinyl chloride | 130 | 136 | 4 (≤50%) |
| **Compound** | **Concentration (ng/L)** | | **RPD (Limits)** |
| | **MW1-77-220429** | **FD-220429-01** | |
| Perfluorohexansulfonic Acid (PFHxS) | 5.02 J | 5.61 J | 11 (≤50%) |
| Perfluorononanoic Acid (PFNA) | 1.67 J | 2.68 U | Not Calculable |
| Perfluoroocatanesulfonic Acid (PFOS) | 9.95 | 9.38 | 6 (≤50%) |
| Perfluorooctanoic Acid (PFOA) | 9.67 | 10.4 | 7 (≤50%) |

**Notes:**
Field duplicates exceeding RPDs are bolded.
Only analytes showing detections are shown.
[a] - Analyzed as a laboratory duplicate
[b] - Duplicates not included in count on Table 3-3a as these were collected for different phase of project.
<LOQ - results less than the LOQ are not calculable

## Table B3-4a. Summary of Valid Data – 2019

| Parameter | # Analytes Per Parameter | Soil | | | | Sediment | | | | GW | | | | SW | | | | PW | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | # Samp | # Total Analytes Possible | # Total Valid Analytes[a] | % Valid Data | # Samp | # Total Analytes Possible | # Total Valid Analytes[a] | % Valid Data | # Samp | # Total Analytes Possible | # Total Valid Analytes[a] | % Valid Data | # Samp | # Total Analytes Possible | # Total Valid Analytes[a] | % Valid Data | # Samp | # Total Analytes Possible | # Total Valid Analytes[a] | % Valid Data |
| cVOCs | 10 | 124 | 1240 | 1222 | 98.5% | - | - | - | - | 105 | 1050 | 1045 | 99.5% | 5 | 50 | 50 | 100% | 16 | 160 | 160 | 100% |
| Vinyl Chloride by SIM | 1 | - | - | - | - | - | - | - | - | 56 | 56 | 56 | 100% | 4 | 4 | 4 | 100% | 10 | 10 | 10 | 100% |
| 1,4-Dioxane | 1 | 72 | 72 | 72 | 100% | - | - | - | - | 58 | 58 | 58 | 100% | - | - | - | - | - | - | - | - |
| PCB Aroclors | 10 | 26 | 260 | 260 | 100% | 7 | 70 | 70 | 100% | 16 | 160 | 160 | 100% | - | - | - | - | - | - | - | - |
| PCB Congeners | 168 | 3 | 504 | 504 | 100% | 7 | 1176 | 1176 | 100% | 5 | 840 | 840 | 100% | 3 | 504 | 504 | 100% | 3 | 504 | 504 | 100% |
| TPH-Diesel | 1 | 29 | 29 | 29 | 100% | - | - | - | - | 28 | 28 | 28 | 100% | - | - | - | - | - | - | - | - |
| Organic Carbon (Total or Dissolved) | 1 | 9 | 9 | 9 | 100% | - | - | - | - | 30 | 30 | 30 | 100% | - | - | - | - | - | - | - | - |
| Sulfide | 1 | - | - | - | - | - | - | - | - | 30 | 30 | 29 | 97% | - | - | - | - | - | - | - | - |
| Anions | 4 | - | - | - | - | - | - | - | - | 30 | 120 | 114 | 95% | - | - | - | - | - | - | - | - |
| Dissolved Gases | 3 | - | - | - | - | - | - | - | - | 30 | 90 | 90 | 100% | - | - | - | - | -- | - | - | - |
| PFAS | 14 | - | - | - | -- | - | - | - | - | 4 | 56 | 56 | 100% | - | - | - | - | - | - | - | - |
| Microbes | 29 | - | - | - | - | - | - | - | | 14 | 406 | 406 | 100% | - | - | - | - | - | - | - | - |
| **Totals** | | **263** | **2114** | **2096** | **99.1%** | **14** | **1246** | **1246** | **100 %** | **406** | **2924** | **2912** | **99.6 %** | **12** | **558** | **558** | **100 %** | **29** | **674** | **674** | **100 %** |

| | |
|---|---|
| **Total # Analytes Possible** | **7516** |
| **Total # Valid Analytes[a]** | **7486** |
| **Total % Valid Data[b]** | **99.6 %** |

**Notes:**
[a] - # Total Valid Analytes is the number of non-rejected data points.
[b] - Overall Total % Valid Data is completeness.
cVOCs- chlorinated volatile organic compounds
GW - groundwater
PCB - polychlorinated biphenyls
PFAS - per- and polyfluoroalkyl substances
PW - porewater
SIM - selective ion monitoring
SW - surface water
TPH - total petroleum hydrocarbons

## Table B3-4b. Summary of Valid Data – 2022

| Parameter | # Analytes Per Parameter | Soil | | | | GW | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | # Samp | # Total Analytes Possible | # Total Valid Analytes[a] | % Valid Data | # Samp | # Total Analytes Possible | # Total Valid Analytes[a] | % Valid Data |
| cVOCs | 10 | 64 | 640 | 583 | 91.1% | 7 | 70 | 70 | 100% |
| 1,4-Dioxane | 1 | 44 | 44 | 44 | 100% | 7 | 7 | 7 | 100% |
| PCB Aroclors | 9 | 21 | 189 | 189 | 100% | 7 | 63 | 63 | 100% |
| PCB Congeners | 168 | 21 | 3528 | 3528 | 100% | 7 | 1176 | 1176 | 100% |
| Organic Carbon Total | 1 | 19 | 19 | 19 | 100% | - | - | - | - |
| PFAS | 14 | - | - | - | - | 9 | 126 | 125 | 99% |
| **Totals** | | **169** | **4420** | **4363** | **98.7%** | **37** | **1442** | **1441** | **99.9%** |

| | |
|---|---|
| **Total # Analytes Possible** | **5862** |
| **Total # Valid Analytes[a]** | **5804** |
| **Total % Valid Data[b]** | **99.0%** |

**Notes:**
[a] - # Total Valid Analytes is the number of non-rejected data points.
[b] - Overall Total % Valid Data is completeness.
cVOCs- chlorinated volatile organic compounds
GW - groundwater
PCB - polychlorinated biphenyls
PFAS - per- and polyfluoroalkyl substances

**Table B3-5. Target VOCs in Direct Push Boring Soil Samples - 2019**

| | | **Location Name** | SP-B090 | SP-B090 | SP-B090 | SP-B090 | SP-B91 | SP-B91 | SP-B93 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SP-B090-S-08-190628 | SP-B090-S-14-190628 | SP-B090-S-15-190628 | SP-B090-S-27-190628 | SP-B91-S-8-190626 | SP-B91-S-30-190626 | SP-B93-S-12-190626 |
| | | **Sample Collection Date** | 6/28/2019 | 6/28/2019 | 6/28/2019 | 6/28/2019 | 6/26/2019 | 6/26/2019 | 6/26/2019 |
| | | **Sample Depth (ft bgs)** | 8 | 14 | 14 | 27 | 8 | 30 | 12 |
| | | **Sample Type** | N | FD | P | N | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/kg | 1.6 | 2.8 U | 2.4 U | 4.9 U | 2.8 UJ | 2.9 U | 2.5 U | 2.5 UJ |
| Tetrachloroethene | µg/kg | 1.3 | 2.8 U | 2.4 U | 4.9 U | 2.8 UJ | 2.9 U | 2.5 U | 2.5 UJ |
| Trans-1,2-Dichloroethene | µg/kg | 32 | 2.8 U | 2.4 U | 4.9 U | 2.8 UJ | 2.9 U | 2.5 U | **33 J** |
| 1,1,1-Trichloroethane | µg/kg | 84 | 2.8 U | 2.4 U | 4.9 U | 2.8 UJ | 2.9 U | 2.5 U | 2.5 UJ |
| Chloroethane | µg/kg | 2.6 | 2.8 U | 2.4 U | 4.9 U | 2.8 UJ | 2.9 U | 2.5 U | 2.5 UJ |
| 1,1-Dichloroethane | µg/kg | 2.6 | 2.8 U | 2.4 U | 4.9 U | 2.8 UJ | 2.9 U | 2.5 U | 2.5 UJ |
| 1,1-Dichloroethene | µg/kg | 2.5 | 2.8 U | 2.4 U | 4.9 U | 2.8 UJ | 2.9 U | 2.5 U | **8.4 J** |

| | | **Location Name** | SP-B93 | | SP-B93 | | SP-B94 | | SP-B94 | | CL-B95 | | CL-B95 | | CL-B95 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SP-B93-S-17-190626 | | SP-B93-S-40-190626 | | SP-B94-S-15-190626 | | SP-B93-S-39-190626 | | CL-B95-S-7-190627 | | CL-B95-S-13-190627 | | CL-B95-S-33-190627 | |
| | | **Sample Collection Date** | 6/26/2019 | | 6/26/2019 | | 6/26/2019 | | 6/26/2019 | | 6/27/2019 | | 6/27/2019 | | 6/27/2019 | |
| | | **Sample Depth (ft bgs)** | 17 | | 40 | | 15 | | 39 | | 7 | | 13 | | 33 | |
| | | **Sample Type** | N | | N | | N | | N | | N | | N | | N | |
| **Analyte Name** | **Result** | **Result** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | | | | |
| 1,2-Dichloroethane | 2.4 | U | 2.4 | U | 2.3 | U | 2.4 | U | 2.4 | U | 2.1 | U | 2.6 | U | 2.5 | U |
| Tetrachloroethene | 2.4 | U | 2.4 | U | 2.3 | U | 2.4 | U | 2.4 | U | 2.1 | UJ | 2.6 | UJ | 2.5 | U |
| Trans-1,2-Dichloroethene | 18 | | 18 | | 2.3 | U | 2.4 | U | 2.4 | U | 2.1 | U | 1.6 | J | 2.5 | U |
| 1,1,1-Trichloroethane | 2.4 | U | 2.4 | U | 2.3 | U | 2.4 | U | 2.4 | U | 2.1 | U | 2.6 | U | 2.5 | U |
| Chloroethane | 2.4 | U | 2.4 | U | 2.3 | U | 2.4 | U | 2.4 | U | **3.1** | **J** | 2.6 | U | 2.5 | U |
| 1,1-Dichloroethane | 2.4 | U | 2.4 | U | 2.3 | U | 2.4 | U | 2.4 | U | 2.1 | U | 2.6 | U | 2.5 | U |
| 1,1-Dichloroethene | **6.5** | | **6.5** | | 2.3 | U | 2.4 | U | 2.4 | U | 2.1 | U | 2.6 | U | 2.5 | U |

**Notes:**
Samples analyzed using EPA Method 8260C
FD - Field Duplicate; PAL - Project Action Limit
J - The reported value is an estimated concentration.
N – Sample is not part of a duplicate pair. P – Parent sample of field duplicate
R - The sample results were rejected due to gross non-conformances discovered during data validation. Data qualified as rejected is not usable
U - The analyte was not detected at or above the stated limit. (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
UJ - The analyte was not detected at or above the stated sample quantitation limit, which is an estimated value.
µg/kg – micrograms per kilogram
Underlined values represent analytes not detected at or above the stated limit, which exceeds the PAL
**Bolded** values indicate that the reported concentration exceeds the PAL.

## Table B3-6. Target VOCs in Sonic Soil Samples – 2019 and 2022

| | | **Location Name** | SP-B92 | SP-B92 | SP-B130 | CL-B98 | CL-B98 | SP-B131 | SP-B131 | CL-B132 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SP-B92-S-13-191016 | SP-B92-S-28-191016 | SP-B130-S-65-191002 | CL-B98-S-2-191014 | CL-B98-S-30-191014 | SP-B131-S-6-191015 | SP-B131-S-23-191015 | CL-B132-S-07-190930 |
| | | **Sample Collection Date** | 10/16/2019 | 10/16/2019 | 10/2/2019 | 10/14/2019 | 10/14/2019 | 10/15/2019 | 10/15/2019 | 9/30/2019 |
| | | **Sample Depth (ft bgs)** | 13 | 28 | 65 | 2 | 30 | 6 | 23 | 7 |
| | | **Sample Type** | N | N | N | N | N | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/kg | 1.6 | 2.2 U | 2.3 U | 2.4 U | 2.2 U | 2.5 U | 2.5 U | 2.2 U | 2.8 U |
| Tetrachloroethene | µg/kg | 1.3 | 2.2 U | 2.3 U | 2.4 U | 0.7 J | 2.5 U | 2.5 U | 2.2 U | 2.8 U |
| Cis-1,2-Dichloroethene | µg/kg | 5.2 | 2.2 U | 2.3 U | 2.4 U | 2.2 U | **430 J** | 2.5 U | **24** | 2.8 U |
| Trans-1,2-Dichloroethene | µg/kg | 32 | 2.2 U | 2.3 U | 2.4 U | 2.2 U | **280 J** | 2.5 U | 4.1 J | 2.8 U |
| 1,1,1-Trichloroethane | µg/kg | 84 | 2.2 U | 2.3 U | 2.4 U | 2.2 U | 2.5 U | 2.5 U | 2.2 U | 2.8 U |
| Chloroethane | µg/kg | 2.6 | 2.2 U | 2.3 U | 2.4 U | 2.2 U | 2.5 U | 2.5 U | 2.2 U | 2.8 U |
| Vinyl Chloride | µg/kg | 0.0062 | 2.2 U | 2.3 U | 2.4 UJ | 2.2 U | **43 J** | 2.5 U | **12** | 2.8 UJ |
| 1,1-Dichloroethane | µg/kg | 2.6 | 2.2 U | 2.3 U | 2.4 U | 2.2 U | 2.5 U | 2.5 U | 2.2 U | 2.8 U |
| 1,1-Dichloroethene | µg/kg | 2.5 | 2.2 U | 2.3 U | 2.4 U | 2.2 U | **23** | 2.5 U | 2.2 U | 2.8 U |
| Trichloroethene | µg/kg | 0.11 | 2.2 U | 2.2 J | 2.4 U | **3.6 J** | **410 J** | **3 J** | **6.1** | **3.4 J** |

| | | **Location Name** | CL-B132 | CL-B133 | CL-B133 | CL-B133 | CL-B133 | CL-B134 | CL-B134 | NP-B135 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | CL-B132-S-27-190930 | CL-B133-S-6-191011 | CL-B133-S-13-191011 | CL-B133-S-29-191011 | CL-B133-S-38-191011 | CL-B134-S-49-191003 | CL-B134-S-50-191003 | NP-B135-S-38-191004 |
| | | **Sample Collection Date** | 9/30/2019 | 10/11/2019 | 10/11/2019 | 10/11/2019 | 10/11/2019 | 10/3/2019 | 10/3/2019 | 10/4/2019 |
| | | **Sample Depth (ft bgs)** | 27 | 6 | 13 | 29 | 38 | 50 | 50 | 38 |
| | | **Sample Type** | N | N | N | N | N | FD | P | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/kg | 1.6 | 2.7 U | 2.7 U | 2.5 U | 2.7 U | 2.4 UJ | 2.5 U | 2.5 U | 2.3 U |
| Tetrachloroethene | µg/kg | 1.3 | 2.7 U | 2.7 U | 2.5 U | 2.7 U | 2.4 UJ | 2.5 U | 2.5 U | 2.3 U |
| Cis-1,2-Dichloroethene | µg/kg | 5.2 | 2.7 U | 2.7 U | 2.5 U | **9.4** | 2.4 UJ | 2.5 U | 2.5 U | 0.8 |
| Trans-1,2-Dichloroethene | µg/kg | 32 | 2.7 U | 2.7 U | 2.5 U | 2.7 U | 2.4 UJ | 2.5 U | 2.5 U | 6.9 |
| 1,1,1-Trichloroethane | µg/kg | 84 | 2.7 U | 2.7 U | 2.5 U | 2.7 U | 2.4 UJ | 2.5 U | 2.5 U | 2.3 U |
| Chloroethane | µg/kg | 2.6 | 2.7 U | 2.7 U | 2.5 U | 2.7 U | 2.4 UJ | 2.5 U | 2.5 U | 2.3 U |
| Vinyl Chloride | µg/kg | 0.0062 | 2.7 UJ | 2.7 U | 2.5 U | **17** | 2.4 UJ | 2.5 UJ | 2.5 U | **63 J** |
| 1,1-Dichloroethane | µg/kg | 2.6 | 2.7 U | 2.7 U | 2.5 U | 2.7 U | 2.4 UJ | 2.5 U | 2.5 U | 2.3 U |
| 1,1-Dichloroethene | µg/kg | 2.5 | 2.7 U | 2.7 U | 2.5 U | 2.7 U | 2.4 UJ | 2.5 U | 2.5 U | 2.3 U |
| Trichloroethene | µg/kg | 0.11 | 2.7 U | **4.6 J** | **5 J** | **2.5 J** | 2.4 UJ | 2.5 U | 2.5 U | **3.5 J** |

| | | **Location Name** | NP-B135 | NP-B136 | NP-B136 | NP-B137 | NP-B138 | NP-B138 | SP-B139 | SP-B139 |
|---|---|---|---|---|---|---|---|---|---|---|

**Table B3-6. Target VOCs in Sonic Soil Samples – 2019 and 2022 (continued)**

| | | Sample Name | NP-B135-S-78-191004 | NP-B136-S-36-191007 | NP-B136-S-66-191007 | NP-B137-S-52-191008 | NP-B138-S-6-191009 | NP-B138-S-62-191009 | SP-B139-S-9-191017 | SP-B139-S-10-191017 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Collection Date** | 10/4/2019 | 10/7/2019 | 10/7/2019 | 10/8/2019 | 10/9/2019 | 10/9/2019 | 10/17/2019 | 10/17/2019 |
| | | **Sample Depth (ft bgs)** | 78 | 36 | 66 | 52 | 6 | 62 | 9 | 9 |
| | | **Sample Type** | N | N | N | N | N | N | P | FD |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/kg | 1.6 | 3.7 UJ | 2.1 U | 4.5 U | 2.3 U | 2.2 UJ | 2.2 U | 2.4 UJ | 2.3 UJ |
| Tetrachloroethene | µg/kg | 1.3 | 3.7 UJ | 2.1 U | 4.5 U | 2.3 U | 2.2 UJ | 2.2 U | **11,000 J** | **1,500 J** |
| Cis-1,2-Dichloroethene | µg/kg | 5.2 | 3.7 UJ | 0.46 | 4.5 U | 2.2 J | 2.2 UJ | **12** | **47,000 J** | **24,000 J** |
| Trans-1,2-Dichloroethene | µg/kg | 32 | 3.7 UJ | 4.8 J | 4.5 U | 24 | 2.2 UJ | 2.2 U | **8,400 J** | **1,100 J** |
| 1,1,1-Trichloroethane | µg/kg | 84 | 3.7 UJ | 2.1 U | 4.5 U | 2.3 U | 2.2 UJ | 2.2 U | 2.4 UJ | 2.3 UJ |
| Chloroethane | µg/kg | 2.6 | 3.7 UJ | 2.1 U | 4.5 U | 2.3 U | 2.2 UJ | 2.2 U | 2.4 UJ | 2.3 UJ |
| Vinyl Chloride | µg/kg | 0.0062 | 3.7 UJ | **17 J** | 4.5 UJ | **60 J** | 2.2 UJ | **17 J** | **230 J** | **79 J** |
| 1,1-Dichloroethane | µg/kg | 2.6 | 3.7 UJ | 2.1 U | 4.5 U | 2.3 U | 2.2 UJ | 2.2 U | 2.4 UJ | 2.3 UJ |
| 1,1-Dichloroethene | µg/kg | 2.5 | 3.7 UJ | 2.1 U | 4.5 U | 2.1 J | 2.2 UJ | 2.2 U | **1,000 J** | **150 J** |
| Trichloroethene | µg/kg | 0.11 | 3.7 UJ | **3.2 J** | 4.5 U | **7.3** | 2.2 UJ | 2.2 U | **3,200,000 J** | **1,800,000 J** |

| | | Location Name | SP-B144 | SP-B174 | SP-B174 | SP-B174 | SP-B174 | SP-B174 | SP-B174 | SP-B174 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SP-B144-S-50-191016 | SP-B174-S-10-220427 | SP-B174-S-16-220427 | SP-B174-S-20-220427 | SP-B174-S-25-220427 | SP-B174-S-35-220427 | SP-B174-S-45-220427 | SP-B174-S-52-220428 |
| | | **Sample Collection Date** | 10/16/2019 | 4/27/2022 | 4/27/2022 | 4/27/2022 | 4/27/2022 | 4/27/2022 | 4/27/2022 | 4/28/2022 |
| | | **Sample Depth (ft bgs)** | 50 | 10 | 16 | 20 | 25 | 35 | 45 | 52 |
| | | **Sample Type** | N | N | N | N | N | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/kg | 1.6 | 2.3 UJ | 0.48 UJ | 4.8 UJ | 0.55 J | 0.48 UJ | 0.42 UJ | 0.39 UJ | 0.35 R |
| Tetrachloroethene | µg/kg | 1.3 | 2.3 UJ | 0.96 UJ | 0.95 UJ | 1.1 UJ | 0.91 UJ | 0.84 UJ | 0.78 UJ | 0.69 UJ |
| Cis-1,2-Dichloroethene | µg/kg | 5.2 | 2.3 UJ | **660,000 J** | **290 J** | 1.9 J | 1.8 UJ | 1.7 UJ | 1.6 UJ | 1.4 R |
| Trans-1,2-Dichloroethene | µg/kg | 32 | 2.3 UJ | **38 J** | 3.2 J | 1.1 R | 0.91 UJ | 0.84 UJ | 0.78 UJ | 0.69 R |
| 1,1,1-Trichloroethane | µg/kg | 84 | 2.3 UJ | 0.96 UJ | 0.95 UJ | 1.1 R | 0.91 UJ | 0.84 UJ | 0.78 UJ | 0.69 R |
| Chloroethane | µg/kg | 2.6 | 2.3 UJ | 1.9 UJ | 1.9 UJ | 2.3 R | 1.8 UJ | 1.7 UJ | 1.6 UJ | 1.4 R |
| Vinyl Chloride | µg/kg | 0.0062 | 2.3 UJ | **11,000 J** | **42 J** | 1.1 R | 0.91 UJ | 0.84 UJ | 7.8 UJ | 0.69 R |
| 1,1-Dichloroethane | µg/kg | 2.6 | 2.3 UJ | 0.61 J | 0.48 UJ | 0.57 R | 0.45 UJ | 0.42 UJ | 0.39 UJ | 0.35 R |
| 1,1-Dichloroethene | µg/kg | 2.5 | 2.3 UJ | **4 J** | 2.9 UJ | 3.4 R | 2.7 UJ | 2.5 UJ | 2.3 UJ | 2.1 R |
| Trichloroethene | µg/kg | 0.11 | **53 J** | **180,000 J** | **91 J** | **0.49 J** | 0.91 UJ | 0.84 UJ | 0.78 UJ | **0.43 J** |

**Table B3-6. Target VOCs in Sonic Soil Samples – 2019 and 2022 (continued)**

| | | **Location Name** | SP-B174 | SP-B174 | SP-B174 | SP-B174 | SP-B175 | SP-B175 | SP-B175 | SP-B175 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SP-B174-S-70-220428 | SP-B174-S-73-220428 | SP-B174-S-74-220428 | SP-B174-S-83-220428 | SP-B175-S-25-220425 | SP-B175-S-38-220425 | SP-B175-S-50-220425 | SP-B175-S-56-220426 |
| | | **Sample Collection Date** | 4/28/2022 | 4/28/2022 | 4/28/2022 | 4/28/2022 | 4/25/2022 | 4/25/2022 | 4/25/2022 | 4/26/2022 |
| | | **Sample Depth (ft bgs)** | 70 | 73 | 73 | 83 | 25 | 38 | 50 | 56 |
| | | **Sample Type** | N | P | FD | N | N | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/kg | 1.6 | 0.45 UJ | 0.65 UJ | 0.62 UJ | 0.52 UJ | 0.46 UJ | 0.64 UJ | 0.47 UJ | 0.47 UJ |
| Tetrachloroethene | µg/kg | 1.3 | 0.9 UJ | 1.3 UJ | 1.2 UJ | 1 UJ | **3.3 J** | 1.3 UJ | 0.94 UJ | 0.94 UJ |
| Cis-1,2-Dichloroethene | µg/kg | 5.2 | 1.8 UJ | 2.6 UJ | 2.5 UJ | 2.1 UJ | **3,200 J** | 2.6 UJ | 1.9 UJ | 1.9 UJ |
| Trans-1,2-Dichloroethene | µg/kg | 32 | 0.9 UJ | 1.3 UJ | 1.2 UJ | 1 UJ | 1.3 J | 1.3 UJ | 0.94 UJ | 0.94 UJ |
| 1,1,1-Trichloroethane | µg/kg | 84 | 0.9 UJ | 1.3 UJ | 1.2 UJ | 1 UJ | 0.93 UJ | 1.3 UJ | 0.94 UJ | 0.94 UJ |
| Chloroethane | µg/kg | 2.6 | 1.8 UJ | 2.6 UJ | 2.5 UJ | 2.1 UJ | 1.9 UJ | 2.6 UJ | 1.9 UJ | 1.9 UJ |
| Vinyl Chloride | µg/kg | 0.0062 | 0.9 UJ | 1.3 UJ | 1.2 UJ | 1 UJ | **6.2 J** | 1.3 UJ | 0.94 UJ | 0.94 UJ |
| 1,1-Dichloroethane | µg/kg | 2.6 | 0.45 UJ | 0.65 UJ | 0.62 UJ | 0.52 UJ | 0.46 UJ | 0.64 UJ | 0.47 UJ | 0.47 UJ |
| 1,1-Dichloroethene | µg/kg | 2.5 | 2.7 UJ | 3.9 UJ | 3.7 UJ | 3.1 UJ | 2.8 UJ | 3.9 UJ | 2.8 UJ | 2.8 UJ |
| Trichloroethene | µg/kg | 0.11 | 0.9 UJ | 1.3 UJ | 1.2 UJ | 1 UJ | **620 J** | **4.1 J** | 0.94 UJ | 0.94 UJ |

| | | **Location Name** | SP-B175 | SP-B175 | SP-B175 | SP-B175 | SP-B175 | SP-B175 | CL-B176 | CL-B176 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SP-B175-S-60-220426 | SP-B175-S-64-220426 | SP-B175-S-70-220426 | SP-B175-S-80-220426 | SP-B175-S-90-220426 | SP-B175-S-100-220426 | CL-B176-S-08-220502 | CL-B176-S-28-220502 |
| | | **Sample Collection Date** | 4/26/2022 | 4/26/2022 | 4/26/2022 | 4/26/2022 | 4/26/2022 | 4/26/2022 | 5/2/2022 | 5/2/2022 |
| | | **Sample Depth (ft bgs)** | 60 | 64 | 70 | 80 | 90 | 100 | 8 | 28 |
| | | **Sample Type** | N | N | N | N | N | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/kg | 1.6 | 0.56 UJ | 0.48 UJ | 0.49 UJ | 0.39 UJ | 0.52 UJ | 0.44 UJ | 0.48 UJ | 0.42 UJ |
| Tetrachloroethene | µg/kg | 1.3 | 1.1 UJ | 0.96 UJ | 0.99 UJ | 0.77 UJ | 1 UJ | 0.87 UJ | 0.96 UJ | 0.83 UJ |
| Cis-1,2-Dichloroethene | µg/kg | 5.2 | 2.2 UJ | 1.9 UJ | 2 UJ | 1.5 UJ | 2.1 UJ | 1.7 UJ | 1.9 UJ | **7400 J** |
| Trans-1,2-Dichloroethene | µg/kg | 32 | 1.1 UJ | 0.96 UJ | 0.99 UJ | 0.77 UJ | 1 UJ | 0.87 UJ | 0.96 UJ | **33 J** |
| 1,1,1-Trichloroethane | µg/kg | 84 | 1.1 UJ | 0.96 UJ | 0.99 UJ | 0.77 UJ | 1 UJ | 0.87 UJ | 0.96 UJ | 0.83 UJ |
| Chloroethane | µg/kg | 2.6 | 2.2 UJ | 1.9 UJ | 2 UJ | 1.5 UJ | 2.1 UJ | 1.7 UJ | 0.99 J | 1.7 UJ |
| Vinyl Chloride | µg/kg | 0.0062 | 1.1 UJ | 0.96 UJ | 0.99 UJ | 0.77 UJ | 1 UJ | 0.87 UJ | 0.96 UJ | **120 J** |
| 1,1-Dichloroethane | µg/kg | 2.6 | 0.56 UJ | 0.48 UJ | 0.49 UJ | 0.39 UJ | 5.2 UJ | 0.44 UJ | 0.48 UJ | 0.42 UJ |
| 1,1-Dichloroethene | µg/kg | 2.5 | 3.3 UJ | 2.9 UJ | 3 UJ | 2.3 UJ | 3.1 UJ | 2.6 UJ | 2.9 UJ | **6.1 J** |
| Trichloroethene | µg/kg | 0.11 | 1.1 UJ | 0.96 UJ | 0.99 UJ | 0.77 UJ | 1 UJ | **0.3 J** | 0.96 UJ | 0.83 UJ |

## Table B3-6. Target VOCs in Sonic Soil Samples – 2019 and 2022 (continued)

**Notes:**
Samples analyzed using EPA Method 8260C
FD - Field Duplicate
J - The reported value is an estimated concentration.
N – Sample is not part of a duplicate pair.
P – Parent sample of field duplicate
PAL - Project Action Limit
R - The sample results were rejected due to gross non-conformances discovered during data validation. Data qualified as rejected is not usable
U - The analyte was not detected at or above the stated limit. (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
UJ - The analyte was not detected at or above the stated sample quantitation limit, which is an estimated value.
µg/kg – micrograms per kilogram
Underlined values represent analytes not detected at or above the stated limit, which exceeds the PAL
**Bolded** values indicate that the reported concentration exceeds the PAL.

## Table B3-7. PCB Aroclors in Soil Samples - 2019 and 2022

| | | **Location Name** | NP-B118 | NP-B118 | NP-B118 | NP-B119 | NP-B119 | NP-B119 | NP-B120 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | NP-B118-S-13-190624 | NP-B118-S-16-190624 | NP-B118-S-34-190625 | NP-B119-S-07-190621 | NP-B119-S-12-190621 | NP-B119-S-15-190621 | NP-B120-S-12.5-190624 |
| | | **Sample Collection Date** | 6/24/2019 | 6/24/2019 | 6/25/2019 | 6/21/2019 | 6/21/2019 | 6/21/2019 | 6/24/2019 |
| | | **Sample Depth (ft bgs)** | 13 | 16 | 34 | 7 | 12 | 15 | 12.5 |
| | | **Sample type** | N | N | N | N | N | N | N |
| **Analyte** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| AROCLOR-1016 | µg/kg | 60 | 26 U | 25 U | 24 U | 25 UJ | 27 UJ | 25 UJ | **16,000 J** |
| AROCLOR-1221 | µg/kg | NE | 26 U | 25 U | 24 U | 25 UJ | 27 UJ | 25 UJ | 5,100 UJ |
| AROCLOR-1232 | µg/kg | NE | 13 U | 12 U | 12 U | 13 UJ | 14 UJ | 12 UJ | 2,600 UJ |
| AROCLOR-1242 | µg/kg | NE | 13 U | 12 U | 12 U | 13 UJ | 14 UJ | 12 UJ | 2,600 UJ |
| AROCLOR-1248 | µg/kg | NE | 13 U | 12 U | 12 U | 13 UJ | 14 UJ | 12 UJ | 2,600 UJ |
| AROCLOR-1254 | µg/kg | 2.9 | 13 U | 12 U | 12 U | 13 UJ | **85 J** | 12 UJ | 2,600 UJ |
| AROCLOR-1260 | µg/kg | 18 | 13 U | 12 U | 12 U | 13 UJ | 14 UJ | 12 UJ | 2,600 UJ |
| AROCLOR-1262 | µg/kg | NE | 15 U | 15 U | 15 U | 15 UJ | 16 UJ | 15 UJ | 3,100 UJ |
| AROCLOR-1268 | µg/kg | NE | 15 U | 15 U | 15 U | 15 UJ | 16 UJ | 15 UJ | 3,100 UJ |
| Total PCB Aroclors | µg/kg | 17 | 26 U | 25 U | 24 U | 25 UJ | **85 J** | 25 UJ | **16,000 J** |

| | | **Location Name** | NP-B120 | NP-B120 | NP-B120 | NP-B120 | NP-B121 | NP-B121 | NP-B121 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | NP-B120-S-29-190624 | NP-B120-S-35.5-190624 | NP-B120-S-42-190624 | NP-B120-S-49.5-190624 | NP-B121-S-05-190620 | NP-B121-S-13-190620 | NP-B121-S-14-190620 |
| | | **Sample Collection Date** | 6/24/2019 | 6/24/2019 | 6/24/2019 | 6/24/2019 | 6/20/2019 | 6/20/2019 | 6/20/2019 |
| | | **Sample Depth (ft bgs)** | 29 | 35.5 | 42 | 49.5 | 5 | 13 | 13 |
| | | **Sample type** | N | N | N | N | N | P | FD |
| **Analyte** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| AROCLOR-1016 | µg/kg | 60 | 22 U | 23 U | 22 U | 21 U | 48,000 U | 29 UJ | 15 UJ |
| AROCLOR-1221 | µg/kg | NE | 22 U | 23 U | 22 U | 21 U | 48,000 U | 29 UJ | 30 UJ |
| AROCLOR-1232 | µg/kg | NE | 11 U | 12 U | 11 U | 11 U | 24,000 U | 15 UJ | 15 UJ |
| AROCLOR-1242 | µg/kg | NE | 11 U | 12 U | 11 U | 11 U | 24,000 UJ | 15 UJ | 16 UJ |
| AROCLOR-1248 | µg/kg | NE | 11 U | 12 U | 11 U | 11 U | 24,000 UJ | 15 UJ | 15 UJ |
| AROCLOR-1254 | µg/kg | 2.9 | 11 U | 12 U | 11 U | 11 U | **210,000 J** | 15 UJ | 15 UJ |
| AROCLOR-1260 | µg/kg | 18 | 11 U | 12 U | 11 U | 11 U | 24,000 UJ | 15 UJ | 15 UJ |
| AROCLOR-1262 | µg/kg | NE | 13 U | 14 U | 13 U | 13 U | 29,000 UJ | 18 UJ | 18 UJ |
| AROCLOR-1268 | µg/kg | NE | 13 U | 14 U | 13 U | 13 U | 29,000 UJ | 18 UJ | 18 UJ |
| Total PCB Aroclors | µg/kg | 17 | 22 U | 23 U | 22 U | 21 U | **210,000** | 29 UJ | 30 UJ |

**Table B3-7. PCB Aroclors in Soil Samples - 2019 and 2022 (continued)**

| | | **Location Name** | NP-B121 | NP-B122 | NP-B122 | NP-B122 | NP-B123 | NP-B123 | NP-B123 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | NP-B121-S-34-190620 | NP-B122-S-05-190620 | NP-B122-S-09-190620 | NP-B122-S-27-190621 | NP-B123-S-19-190619 | NP-B123-S-25-190619 | NP-B123-S-40-190619 |
| | | **Sample Collection Date** | 6/20/2019 | 6/20/2019 | 6/20/2019 | 6/21/2019 | 6/19/2019 | 6/19/2019 | 6/19/2019 |
| | | **Sample Depth (ft bgs)** | 34 | 5 | 9 | 27 | 19 | 25 | 40 |
| | | **Sample type** | N | N | N | N | N | N | N |
| **Analyte** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| AROCLOR-1016 | µg/kg | 60 | 24 UJ | **160 J** | 2,300 U | 25 UJ | 31 UJ | 28 UJ | 28 UJ |
| AROCLOR-1221 | µg/kg | NE | 24 UJ | 21 UJ | 2,300 U | 25 UJ | 31 UJ | 28 UJ | 28 UJ |
| AROCLOR-1232 | µg/kg | NE | 12 UJ | 11 UJ | 1,200 U | 13 UJ | 16 UJ | 14 UJ | 14 UJ |
| AROCLOR-1242 | µg/kg | NE | 12 UJ | 11 UJ | 1,200 UJ | 13 UJ | 16 UJ | 14 UJ | 14 UJ |
| AROCLOR-1248 | µg/kg | NE | 12 UJ | 11 UJ | 1,200 UJ | 13 UJ | 16 UJ | 14 UJ | 14 UJ |
| AROCLOR-1254 | µg/kg | 2.9 | 12 UJ | 11 UJ | **8,000 J** | 13 UJ | **130 J** | 14 UJ | 14 UJ |
| AROCLOR-1260 | µg/kg | 18 | 12 UJ | 11 UJ | 1,200 UJ | 13 UJ | 16 UJ | 14 UJ | 14 UJ |
| AROCLOR-1262 | µg/kg | NE | 14 UJ | 13 UJ | 1,400 UJ | 15 UJ | 19 UJ | 17 UJ | 17 UJ |
| AROCLOR-1268 | µg/kg | NE | 14 UJ | 13 UJ | 1,400 UJ | 15 UJ | 19 UJ | 17 UJ | 17 UJ |
| Total PCB Aroclors | µg/kg | 17 | 24 UJ | **160 J** | **8,000** | 25 UJ | **130 J** | 28 UJ | 28 UJ |

**Notes:**
Samples analyzed using EPA Method 8082 A
FD - Field Duplicate
J - The result is an estimated concentration that is less than the LOQ, but greater than or equal to the DL.
N – Sample is not part of a duplicate pair.
P – Parent sample of field duplicate
PAL - Project Action Limit
U - The compound was analyzed for, but was not detected ("nondetect") at or above the LOD.
UJ - The analyte was not detected at the stated sample quantitation limit, which is an estimated value
Underlined values represent analytes not detected at or above the stated xlimit, which exceeds the PAL
**Bolded** values indicate that the reported concentration exceeds the PAL.
µg/kg - microgram per kilogram

**Table 3.8** - PCB Congeners in Soil Samples - 2019 and 2022

| Location Name | | NP-B137 | NP-B138 | NP-B138 | NP-B138 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | | NP-B137-S-52-191008 | NP-B138-S-5-191008 | NP-B138-S-6-191008 | NP-B138-S-62-191008 | NP-B177-S-07-220505 | NP-B177-S-30-220505 | NP-B177-S-35-220505 | NP-B177-S-36-220505 | NP-B177-S-40-220505 | NP-B177-S-45-220505 | NP-B177-S-50-220505 | NP-B177-S-55-220505 | NP-B177-S-60-220505 | NP-B177-S-65-220505 | NP-B177-S-75-220505 | NP-B178-S-07-220509 | NP-B178-S-30-220509 | NP-B178-S-40-220509 | NP-B178-S-48-220509 | NP-B178-S-55-220509 | NP-B178-S-60-220509 | NP-B178-S-65-220509 | NP-B178-S-70-220509 | NP-B178-S-95-220510 | NP-B178-S-100-220510 |
| Sample Collection Date | | 10/8/2019 | 10/8/2019 | 10/8/2019 | 10/8/2019 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/10/2022 | 5/10/2022 |
| Sample Depth (ft bgs) | | 52 | 5 | 6 | 62 | 7 | 30 | 35 | 36 | 40 | 45 | 50 | 55 | 60 | 65 | 75 | 7 | 30 | 40 | 48 | 55 | 60 | 65 | 70 | 95 | 100 |
| Sample Type | | N | FD | P | N | N | N | P | FD | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| **Analyte** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| PCB-001 | NA | 11 U | 800 J | 540 | 11 U | 16 J | 29 U | 31 U | 31 U | 32 U | 32 U | 32 U | 35 U | 33 U | 34 U | 39 U | 250 | 35 U | 31 U | 31 U | 33 U | 39 U | 43 U | 32 U | 31 U | 30 U |
| PCB-002 | NA | 11 U | 82 J | 38 J | 11 U | 32 U | 29 U | 31 U | 31 U | 32 U | 32 U | 32 U | 35 U | 33 U | 34 U | 39 U | 220 U | 35 U | 31 U | 31 U | 33 U | 39 U | 43 U | 32 U | 31 U | 30 U |
| PCB-003 | NA | 28 U | 420 J | 140 J | 28 U | 45 U | 41 U | 44 U | 44 U | 46 U | 46 U | 46 U | 50 U | 48 U | 48 U | 56 U | 320 U | 50 U | 45 U | 44 U | 48 U | 56 U | 62 U | 46 U | 44 U | 42 U |
| PCB-004 | NA | 28 U | 1,200 J | 940 | 28 U | 60 | 37 U | 40 U | 40 U | 41 U | 41 U | 41 U | 45 U | 43 U | 43 U | 50 U | 1600 | 45 U | 40 U | 40 U | 43 U | 51 U | 56 U | 41 U | 40 U | 38 U |
| PCB-005 | NA | 28 U | 510 U | 52 U | 28 U | 41 U | 37 U | 40 U | 40 U | 41 U | 41 U | 41 U | 45 U | 43 U | 43 U | 50 U | 290 U | 45 U | 40 U | 40 U | 43 U | 51 U | 56 U | 41 U | 40 U | 38 U |
| PCB-006 | NA | 28 U | 430 J | 330 | 28 U | 11 J | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 340 | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-007 | NA | 28 U | 510 U | 52 U | 28 U | 23 U | 21 U | 22 U | 22 U | 23 U | 23 U | 23 U | 25 U | 24 U | 24 U | 28 U | 160 UJ | 25 U | 22 U | 22 U | 24 U | 28 U | 31 U | 23 U | 22 U | 21 U |
| PCB-008 | NA | 28 U | 2,500 | 1,700 | 28 U | 55 | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 2400 | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-009 | NA | 28 U | 510 U | 52 U | 28 U | 18 U | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 110 J | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-010 | NA | 28 U | 510 U | 52 U | 28 U | 32 U | 29 U | 31 U | 31 U | 32 U | 32 U | 32 U | 35 U | 33 U | 34 U | 39 U | 220 U | 35 U | 31 U | 31 U | 33 U | 39 U | 43 U | 32 U | 31 U | 30 U |
| PCB-011 | NA | 110 U | 2,000 U | 210 U | 110 U | 150 U | 140 U | 150 U | 150 U | 150 U | 150 U | 150 U | 160 U | 160 U | 160 U | 180 U | 1100 U | 160 U | 150 U | 140 U | 160 U | 190 U | 200 U | 150 U | 150 U | 140 U |
| PCB-012 AND 013 | NA | 56 U | 1,000 U | 100 U | 57 U | 32 U | 29 U | 31 U | 31 U | 32 U | 32 U | 32 U | 35 U | 33 U | 34 U | 39 U | 180 J | 35 U | 31 U | 31 U | 33 U | 39 U | 43 U | 32 U | 31 U | 30 U |
| PCB-014 | NA | 28 U | 510 U | 52 U | 28 U | 18 U | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 130 U | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-015 | NA | 28 U | 1,800 J | 1,400 J | 28 U | 30 | 21 U | 22 U | 22 U | 23 U | 23 U | 23 U | 25 U | 24 U | 24 U | 28 U | 1100 | 25 U | 22 U | 22 U | 24 U | 28 U | 31 U | 23 U | 22 U | 21 U |
| PCB-016 | NA | 11 U | 3,000 | 3,500 | 11 U | 62 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 1200 | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-017 | NA | 11 U | 4,400 | 4,200 | 11 U | 54 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 1200 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-019 | NA | 11 U | 850 J | 810 J | 11 U | 20 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 1200 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-021 AND 033 | NA | 11 U | 3,500 J | 4,800 | 11 U | 100 | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 2600 | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-022 | NA | 11 U | 2,000 | 2,500 | 11 U | 61 | 25 U | 26 U | 27 U | 27 U | 28 U | 27 U | 30 U | 29 U | 29 U | 33 U | 1300 | 30 U | 27 U | 26 U | 29 U | 34 U | 37 U | 28 U | 26 U | 25 U |
| PCB-023 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 9 U | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-024 | NA | 5.6 U | 100 J | 84 J | 5.7 U | 9 U | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 39 J | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-025 | NA | 5.6 U | 6,700 J | 580 J | 5.7 U | 14 J | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 290 | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-026 AND 029 | NA | 11 U | 19,000 J | 1,500 J | 11 U | 50 U | 45 U | 49 U | 49 U | 50 U | 51 U | 50 U | 55 U | 52 U | 53 U | 61 U | 640 | 55 U | 49 U | 48 U | 52 U | 62 U | 68 U | 51 U | 49 U | 46 U |
| PCB-027 | NA | 5.6 U | 610 J | 590 | 5.7 U | 12 J | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 260 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-028 AND 020 | NA | 5.4 J | 12,000 | 8,500 | 5.1 J | 210 | 29 U | 31 U | 31 U | 32 U | 32 U | 32 U | 35 U | 33 U | 34 U | 39 U | 4500 | 35 U | 31 U | 31 U | 33 U | 39 U | 43 U | 32 U | 31 U | 30 U |
| PCB-030 AND 018 | NA | 23 U | 6,900 | 7,000 | 23 U | 120 | 21 U | 22 U | 22 U | 23 U | 23 U | 23 U | 25 U | 24 U | 24 U | 28 U | 2100 | 25 U | 22 U | 22 U | 24 U | 28 U | 31 U | 23 U | 22 U | 21 U |
| PCB-031 | NA | 5.6 J | 12,000 | 9,800 | 5.3 J | 290 | 21 U | 22 U | 22 U | 23 U | 23 U | 23 U | 25 U | 24 U | 24 U | 28 U | 3500 | 25 U | 22 U | 22 U | 24 U | 28 U | 31 U | 23 U | 22 U | 21 U |
| PCB-032 | NA | 11 U | 2,400 | 2,500 | 11 U | 58 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 1400 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-034 | NA | 5.6 U | 100 U | 58 J | 5.7 U | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-035 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 18 U | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 130 U | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-036 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 9 U | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-037 | NA | 5.6 U | 2,700 | 2,000 J | 5.7 U | 66 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 1400 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-038 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 9 U | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-039 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-040 AND 071 | NA | 1.4 U | 8,400 | 5,700 | 1.9 J | 510 | 21 U | 22 U | 22 U | 23 U | 23 U | 23 U | 25 U | 24 U | 24 U | 28 U | 1200 | 25 U | 22 U | 22 U | 24 U | 28 U | 31 U | 23 U | 22 U | 21 U |
| PCB-041 | NA | 11 U | 200 U | 21 U | 11 U | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 330 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-042 | NA | 5.6 U | 18,000 J | 4,200 J | 1.8 J | 250 | 33 U | 35 U | 35 U | 37 U | 37 U | 37 U | 40 U | 38 U | 38 U | 44 U | 770 | 40 U | 36 U | 35 U | 38 U | 45 U | 49 U | 37 U | 35 U | 34 U |
| PCB-043 | NA | 5.6 U | 1,700 J | 10 U | 5.7 U | 27 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 100 J | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-044 AND 047 AND 065 | NA | 9.3 J | 100,000 | 45,000 | 11 J | 1700 | 37 U | 40 U | 40 U | 41 U | 41 U | 41 U | 45 U | 43 U | 43 U | 50 U | 2700 | 45 U | 40 U | 40 U | 43 U | 51 U | 56 U | 41 U | 40 U | 38 U |
| PCB-045 | NA | 5.6 U | 100 U | 1,700 | 5.7 U | 150 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 660 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-046 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 58 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 290 | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-048 | NA | 5.6 U | 2,100 | 1,600 | 5.7 U | 140 | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 560 | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-050 AND 053 | NA | 11 U | 2,900 J | 2,700 | 11 U | 200 | 54 U | 57 U | 57 U | 59 U | 60 U | 59 U | 65 U | 62 U | 62 U | 72 U | 580 | 65 U | 58 U | 57 U | 62 U | 73 U | 80 U | 60 U | 57 U | 55 U |
| PCB-051 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 18 U | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 140 | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-052 | NA | 15 J | 190,000 | 120,000 | 17 J | 3700 | 29 U | 31 U | 31 U | 32 U | 32 U | 32 U | 35 U | 33 U | 34 U | 39 U | 3600 | 35 U | 31 U | 31 U | 33 U | 39 U | 43 U | 32 U | 31 U | 30 U |
| PCB-054 | NA | 5.6 U | 100 U | 20 J | 5.7 U | 9 U | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-055 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 9 U | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 65 J | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-056 | NA | 5.6 U | 8,800 | 5,600 | 1.2 J | 550 | 62 U | 66 U | 66 U | 69 U | 69 U | 69 U | 75 U | 71 U | 72 U | 83 U | 1100 | 74 U | 67 U | 66 U | 71 U | 84 U | 93 U | 69 U | 66 U | 63 U |
| PCB-057 | NA | 5.6 U | 1,100 J | 3,400 J | 5.7 U | 9 U | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-058 | NA | 5.6 U | 860 J | 10 U | 5.7 U | 150 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-059 AND 062 AND 075 | NA | 17 U | 4,900 J | 940 J | 17 U | 71 | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 310 J | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-060 | NA | 5.6 U | 1,100 J | 2,100 | 5.7 U | 250 | 54 U | 57 U | 57 U | 59 U | 60 U | 59 U | 65 U | 62 U | 62 U | 72 U | 610 | 65 U | 58 U | 57 U | 62 U | 73 U | 80 U | 60 U | 57 U | 55 U |
| PCB-061 AND 070 AND 074 AND 076 | NA | 8 J | 120,000 | 67,000 | 8.8 J | 4000 | 58 U | 62 U | 62 U | 64 U | 64 U | 64 U | 70 U | 67 U | 67 U | 78 U | 4900 | 69 U | 63 U | 61 U | 67 U | 79 U | 86 U | 64 U | 62 U | 59 U |
| PCB-063 | NA | 5.6 U | 3,700 J | 850 J | 5.7 U | 38 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 97 J | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-064 | NA | 2.7 J | 20,000 | 12,000 | 2.7 J | 810 | 66 U | 71 U | 71 U | 73 U | 74 U | 73 U | 80 U | 76 U | 77 U | 89 U | 1200 | 79 U | 72 U | 70 U | 76 U | 90 U | 99 U | 74 U | 71 U | 67 U |

**Table 3.8** - PCB Congeners in Soil Samples - 2019 and 2022

| | Location Name | NP-B137 | NP-B138 | NP-B138 | NP-B138 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sample Name | NP-B137-S-52-191008 | NP-B138-S-5-191008 | NP-B138-S-6-191008 | NP-B138-S-62-191008 | NP-B177-S-07-220505 | NP-B177-S-30-220505 | NP-B177-S-35-220505 | NP-B177-S-36-220505 | NP-B177-S-40-220505 | NP-B177-S-45-220505 | NP-B177-S-50-220505 | NP-B177-S-55-220505 | NP-B177-S-60-220505 | NP-B177-S-65-220505 | NP-B177-S-75-220505 | NP-B178-S-07-220509 | NP-B178-S-30-220509 | NP-B178-S-40-220509 | NP-B178-S-48-220509 | NP-B178-S-55-220509 | NP-B178-S-60-220509 | NP-B178-S-65-220509 | NP-B178-S-70-220509 | NP-B178-S-95-220510 | NP-B178-S-100-220510 |
| | Sample Collection Date | 10/8/2019 | 10/8/2019 | 10/8/2019 | 10/8/2019 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/10/2022 | 5/10/2022 |
| | Sample Depth (ft bgs) | 52 | 5 | 6 | 62 | 7 | 30 | 35 | 36 | 40 | 45 | 50 | 55 | 60 | 65 | 75 | 7 | 30 | 40 | 48 | 55 | 60 | 65 | 70 | 95 | 100 |
| | Sample Type | N | FD | P | N | N | N | P | FD | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| **Analyte** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| PCB-066 | NA | 3.5 J | 79,000 J | 20,000 J | 4.3 J | 1400 | 58 U | 62 U | 62 U | 64 U | 64 U | 64 U | 70 U | 67 U | 67 U | 78 U | 2500 | 69 U | 63 U | 61 U | 67 U | 79 U | 86 U | 64 U | 62 U | 59 U |
| PCB-067 | NA | 5.6 U | 6,500 | 10 U | 5.7 U | 12 J | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 100 J | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-068 | NA | 5.6 U | 4,300 J | 350 J | 5.7 U | 9 U | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-069 AND 049 | NA | 4.9 J | 110,000 J | 28,000 J | 7.7 J | 950 | 21 U | 22 U | 22 U | 23 U | 23 U | 23 U | 25 U | 24 U | 24 U | 28 U | 1500 | 25 U | 22 U | 22 U | 24 U | 28 U | 31 U | 23 U | 22 U | 21 U |
| PCB-072 | NA | 5.6 U | 5,800 J | 470 J | 5.7 U | 20 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-073 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-077 | NA | 5.6 U | 1,300 | 640 | 5.7 U | 77 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 280 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-078 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 9 U | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-079 | NA | 5.6 U | 2,000 | 1,200 | 5.7 U | 57 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-080 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 16 J | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-081 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 100 | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 130 U | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-082 | NA | 5.6 U | 13,000 | 18,000 | 5.7 U | 1000 | 33 U | 35 U | 35 U | 37 U | 37 U | 37 U | 40 U | 38 U | 38 U | 44 U | 900 | 40 U | 36 U | 35 U | 38 U | 45 U | 49 U | 37 U | 35 U | 34 U |
| PCB-083 | NA | 5.6 U | 34,000 | 17,000 | 1.8 J | 540 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 500 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-084 | NA | 5.7 J | 75,000 | 69,000 | 5.3 J | 2700 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 2500 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-086 AND 087 AND 097 AND 109 AND 119 AND 125 | NA | -- -- | -- -- | -- -- | -- -- | 5900 | 78 U | 84 U | 84 U | 87 U | 87 U | 87 U | 95 U | 91 U | 91 U | 110 U | 4800 | 94 U | 85 U | 83 U | 90 U | 110 U | 120 U | 87 U | 84 U | 80 U |
| PCB-088 | NA | -- -- | -- -- | -- -- | -- -- | 1200 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 1100 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-088 AND 091 | NA | 2.1 J | 36,000 | 23,000 | 2.4 J | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-089 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 70 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 97 J | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-091 | | -- -- | -- -- | -- -- | -- -- | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-092 | NA | 3.6 J | 79,000 | 43,000 | 4.6 J | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 1400 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-093 AND 100 | NA | 11 U | 3,100 J | 21 U | 11 U | 18 U | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 130 U | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-094 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-095 | NA | 17 J | 290,000 | 210,000 | 17 J | 7500 | 25 U | 26 U | 27 U | 27 U | 28 U | 27 U | 30 U | 29 U | 29 U | 33 U | 7300 | 30 U | 27 U | 26 U | 29 U | 34 U | 37 U | 28 U | 26 U | 25 U |
| PCB-096 | NA | 5.6 U | 1,000 J | 990 | 5.7 U | 48 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 36 J | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-098 AND 102 | NA | 11 U | 5,900 | 3,400 | 11 U | 230 | 25 U | 26 U | 27 U | 27 U | 28 U | 27 U | 30 U | 29 U | 29 U | 33 U | 240 J | 30 U | 27 U | 26 U | 29 U | 34 U | 37 U | 28 U | 26 U | 25 U |
| PCB-099 | NA | 5.2 J | 190,000 | 72,000 | 9.7 J | 3300 | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 2600 | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-103 | NA | 5.6 U | 4,800 | 10 U | 5.7 U | 9 U | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-104 | NA | 5.6 U | 12 J | 5 J | 5.7 U | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-105 | NA | 4.8 J | 53,000 | 71,000 | 2.8 J | 2900 | 25 U | 26 U | 27 U | 27 U | 28 U | 27 U | 30 U | 29 U | 29 U | 33 U | 1600 | 30 U | 27 U | 26 U | 29 U | 34 U | 37 U | 28 U | 26 U | 25 U |
| PCB-106 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 130 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-107 | | -- -- | -- -- | -- -- | -- -- | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 220 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-107 AND 124 | NA | 11 U | 4,500 | 5,000 | 11 U | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-108 AND 119 AND 086 AND 097 AND 125 AND 087 | NA | 9.8 J | 150,000 | 140,000 | 9.1 J | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-108 AND 124 | | -- -- | -- -- | -- -- | -- -- | 350 | 25 U | 26 U | 27 U | 27 U | 28 U | 27 U | 30 U | 29 U | 29 U | 33 U | 170 J | 30 U | 27 U | 26 U | 29 U | 34 U | 37 U | 28 U | 26 U | 25 U |
| PCB-109 | NA | 1 J | 38,000 J | 11,000 J | 5.7 U | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-110 AND 115 | NA | 15 J | 330,000 | 220,000 | 18 J | 10000 | 33 U | 35 U | 35 U | 37 U | 37 U | 37 U | 40 U | 38 U | 38 U | 44 U | 8900 | 40 U | 36 U | 35 U | 38 U | 45 U | 49 U | 37 U | 35 U | 34 U |
| PCB-111 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 18 U | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 130 U | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-112 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 9 U | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-113 AND 090 AND 101 | NA | 15 J | 360,000 | 230,000 | 18 J | 9300 | 25 U | 26 U | 27 U | 27 U | 28 U | 27 U | 30 U | 29 U | 29 U | 33 U | 6900 | 30 U | 27 U | 26 U | 29 U | 34 U | 37 U | 28 U | 26 U | 25 U |
| PCB-114 | NA | 5.6 U | 3,100 | 3,900 J | 5.7 U | 190 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 85 J | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-117 AND 116 AND 085 | NA | 17 U | 22,000 | 21,000 | 17 U | 1500 | 29 U | 31 U | 31 U | 32 U | 32 U | 32 U | 35 U | 33 U | 34 U | 39 U | 1200 | 35 U | 31 U | 31 U | 33 U | 39 U | 43 U | 32 U | 31 U | 30 U |
| PCB-118 | NA | 13 | 450,000 | 200,000 | 15 | 7000 | 37 U | 40 U | 40 U | 41 U | 41 U | 41 U | 45 U | 43 U | 43 U | 50 U | 4000 | 45 U | 40 U | 40 U | 43 U | 51 U | 56 U | 41 U | 40 U | 38 U |
| PCB-120 | NA | 5.6 U | 3,600 | 10 U | 5.7 U | 18 U | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 130 U | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-121 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 9 U | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-122 | NA | 5.6 U | 100 U | 2,100 | 5.7 U | 110 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 66 J | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-123 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 520 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 84 J | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-126 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 77 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-127 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-128 AND 166 | NA | 1.3 J | 30,000 | 32,000 | 11 U | 1500 | 21 U | 22 U | 22 U | 23 U | 23 U | 23 U | 25 U | 24 U | 24 U | 28 U | 1300 | 25 U | 22 U | 22 U | 24 U | 28 U | 31 U | 23 U | 22 U | 21 U |
| PCB-130 | NA | 1.2 J | 15,000 | 13,000 | 5.7 U | 660 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 540 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-131 | NA | 5.6 U | 2,500 | 2,900 | 5.7 U | 160 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 110 J | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-132 | NA | 3.7 J | 84,000 | 62,000 | 4.2 J | 3800 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 2700 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-133 | NA | 5.6 U | 2,900 | 1,700 | 5.7 U | 98 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 53 J | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-134 | | -- -- | -- -- | -- -- | -- -- | 590 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 440 | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-134 AND 143 | NA | 11 U | 13,000 | 9,900 | 11 U | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-136 | NA | 1.9 J | 23,000 | 20,000 | 1.2 J | 1300 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 720 | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-137 | NA | 5.6 U | 11,000 | 11,000 | 5.7 U | 530 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 390 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-138 AND 163 AND 129 | NA | 9.3 J | 190,000 | 190,000 | 6.5 J | 10000 | 29 U | 31 U | 31 U | 32 U | 32 U | 32 U | 35 U | 33 U | 34 U | 39 U | 7500 | 35 U | 31 U | 31 U | 33 U | 39 U | 43 U | 32 U | 31 U | 30 U |
| PCB-139 AND 140 | NA | 11 U | 4,100 | 3,100 | 11 U | 180 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 130 J | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-141 | NA | 1.2 J | 18,000 | 23,000 | 5.7 U | 1700 | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 960 | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |

**Table 3.8** - PCB Congeners in Soil Samples - 2019 and 2022

| | Location Name | NP-B137 | NP-B138 | NP-B138 | NP-B138 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B177 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 | NP-B178 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sample Name | NP-B137-S-52-191008 | NP-B138-S-5-191008 | NP-B138-S-6-191008 | NP-B138-S-62-191008 | NP-B177-S-07-220505 | NP-B177-S-30-220505 | NP-B177-S-35-220505 | NP-B177-S-36-220505 | NP-B177-S-40-220505 | NP-B177-S-45-220505 | NP-B177-S-50-220505 | NP-B177-S-55-220505 | NP-B177-S-60-220505 | NP-B177-S-65-220505 | NP-B177-S-75-220505 | NP-B178-S-07-220509 | NP-B178-S-30-220509 | NP-B178-S-40-220509 | NP-B178-S-48-220509 | NP-B178-S-55-220509 | NP-B178-S-60-220509 | NP-B178-S-65-220509 | NP-B178-S-70-220509 | NP-B178-S-95-220510 | NP-B178-S-100-220510 |
| | Sample Collection Date | 10/8/2019 | 10/8/2019 | 10/8/2019 | 10/8/2019 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 5/10/2022 | 5/10/2022 |
| | Sample Depth (ft bgs) | 52 | 5 | 6 | 62 | 7 | 30 | 35 | 36 | 40 | 45 | 50 | 55 | 60 | 65 | 75 | 7 | 30 | 40 | 48 | 55 | 60 | 65 | 70 | 95 | 100 |
| | Sample Type | N | FD | P | N | N | N | P | FD | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| **Analyte** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| PCB-142 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 9 U | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| | | -- -- | -- -- | -- -- | -- -- | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-144 | NA | 5.6 U | 4,800 | 5,700 | 5.7 U | 450 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 250 | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-145 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 9 U | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-146 | NA | 0.85 J | 32,000 | 18,000 | 0.91 J | 1100 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 790 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-147 AND 149 | NA | 7.1 J | 140,000 | 100,000 | 7.2 J | 7500 | 21 U | 22 U | 22 U | 23 U | 23 U | 23 U | 25 U | 24 U | 24 U | 28 U | 4700 | 25 U | 22 U | 22 U | 24 U | 28 U | 31 U | 23 U | 22 U | 21 U |
| PCB-148 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-150 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 6.8 J | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-151 AND 135 | NA | 2.7 J | 49,000 | 35,000 | 11 U | 2600 | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 1500 | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-152 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 9.2 J | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-153 AND 168 | NA | 6.2 J | 160,000 | 110,000 | 5.8 J | 6600 | 21 U | 22 U | 22 U | 23 U | 23 U | 23 U | 25 U | 24 U | 24 U | 28 U | 4600 | 25 U | 22 U | 22 U | 24 U | 28 U | 31 U | 23 U | 22 U | 21 U |
| PCB-154 | NA | 5.6 U | 2,900 | 1,100 | 5.7 U | 62 J | 82 U | 88 U | 88 U | 91 U | 92 U | 91 U | 100 U | 95 U | 96 U | 110 U | 640 U | 99 U | 90 U | 88 U | 95 U | 110 U | 120 U | 92 U | 88 U | 84 U |
| PCB-155 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 18 U | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 130 U | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-156 AND 157 | NA | 1.8 J | 24,000 | 26,000 | 0.81 J | 1100 | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 600 | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-158 | NA | 1.3 J | 18,000 | 20,000 | 5.7 U | 970 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 680 | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-159 | NA | 5.6 U | 170 J | 190 J | 5.7 U | 60 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-160 | NA | 11 U | 200 U | 21 U | 11 U | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-161 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-162 | NA | 5.6 U | 470 J | 540 | 5.7 U | 71 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-164 | NA | 5.6 U | 13,000 | 10,000 | 5.7 U | 680 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 500 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-165 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 9 U | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-167 | NA | 0.71 J | 7,200 | 7,600 J | 0.34 J | 370 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 260 | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-169 | NA | 0.63 U | 100 U | 10 U | 5.7 U | 12 J | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-170 | NA | 5.6 U | 12,000 | 16,000 | 5.7 U | 1400 | 21 U | 22 U | 22 U | 23 U | 23 U | 23 U | 25 U | 24 U | 24 U | 28 U | 850 | 25 U | 22 U | 22 U | 24 U | 28 U | 31 U | 23 U | 22 U | 21 U |
| PCB-171 AND 173 | NA | 11 U | 3,700 J | 4,600 | 11 U | 470 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 300 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-172 | NA | 5.6 U | 1,300 J | 1,800 | 5.7 U | 240 | 29 U | 31 U | 31 U | 32 U | 32 U | 32 U | 35 U | 33 U | 34 U | 39 U | 160 J | 35 U | 31 U | 31 U | 33 U | 39 U | 43 U | 32 U | 31 U | 30 U |
| PCB-174 | NA | 0.7 U | 7,100 | 8,400 | 11 U | 1600 | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 860 | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-175 | NA | 5.6 U | 470 J | 570 | 5.7 U | 70 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-176 | NA | 5.6 U | 1,600 J | 1,600 | 5.7 U | 270 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 140 | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-177 | NA | 5.6 U | 5,700 | 5,900 | 5.7 U | 800 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 470 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-178 | NA | 5.6 U | 1,800 J | 1,800 | 5.7 U | 320 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 180 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-179 | NA | 5.6 U | 3,100 | 3,100 | 5.7 U | 720 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 360 | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-180 AND 193 | NA | 1.4 U | 14,000 | 18,000 | 1.3 U | 2700 | 21 U | 22 U | 22 U | 23 U | 23 U | 23 U | 25 U | 24 U | 24 U | 28 U | 1700 | 25 U | 22 U | 22 U | 24 U | 28 U | 31 U | 23 U | 22 U | 21 U |
| PCB-181 | NA | 5.6 U | 100 J | 120 J | 5.7 U | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-182 | NA | 5.6 U | 93 J | 110 J | 5.7 U | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-183 | NA | 5.6 U | 4,700 | 5,800 | 1.3 J | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-183 AND 185 | | -- -- | -- -- | -- -- | -- -- | 1200 | 21 U | 22 U | 22 U | 23 U | 23 U | 23 U | 25 U | 24 U | 24 U | 28 U | 700 | 25 U | 22 U | 22 U | 24 U | 28 U | 31 U | 23 U | 22 U | 21 U |
| PCB-184 | NA | 5.6 U | 15 J | 12 J | 5.7 U | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-185 | NA | 5.6 U | 100 U | 10 U | 5.7 U | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-186 | NA | 5.6 U | 100 U | 3 J | 5.7 U | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-187 | NA | 5.6 U | 8,300 | 8,500 | 5.7 U | 1700 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 980 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-188 | NA | 5.6 U | 20 J | 17 J | 5.7 U | 110 U | 99 U | 110 U | 110 U | 110 U | 110 U | 110 U | 120 U | 110 U | 110 U | 130 U | 770 U | 120 U | 110 U | 110 U | 110 U | 130 U | 150 U | 110 U | 110 U | 100 U |
| PCB-189 | NA | 5.6 U | 490 | 610 J | 5.7 U | 58 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 33 J | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-190 | NA | 5.6 U | 1,200 J | 1,400 | 5.7 U | 240 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 140 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-191 | NA | 5.6 U | 490 J | 600 | 5.7 U | 49 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-192 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 14 U | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-194 | NA | 5.6 U | 340 J | 420 | 5.7 U | 510 | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 320 | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-195 | NA | 5.6 U | 63 J | 50 J | 5.7 U | 220 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 120 J | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-196 | NA | 5.6 U | 290 J | 360 | 5.7 U | 310 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 220 | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-197 | NA | 5.6 U | 28 J | 30 J | 5.7 U | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-197 AND 200 | | -- -- | -- -- | -- -- | -- -- | 90 | 21 U | 22 U | 22 U | 23 U | 23 U | 23 U | 25 U | 24 U | 24 U | 28 U | 160 U | 25 U | 22 U | 22 U | 24 U | 28 U | 31 U | 23 U | 22 U | 21 U |
| PCB-198 AND 199 | NA | 11 U | 550 J | 600 | 11 U | 590 | 16 U | 18 U | 18 U | 18 U | 18 U | 18 U | 20 U | 19 U | 19 U | 22 U | 430 | 20 U | 18 U | 18 U | 19 U | 22 U | 25 U | 18 U | 18 U | 17 U |
| PCB-200 | NA | 5.6 U | 17 J | 8 J | 5.7 U | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-201 | NA | 5.6 U | 89 J | 98 J | 5.7 U | 93 J | 91 U | 97 U | 97 U | 100 U | 100 U | 100 U | 110 U | 100 U | 110 U | 120 U | 700 U | 110 U | 99 U | 97 U | 100 U | 120 U | 140 U | 100 U | 97 U | 93 U |
| PCB-202 | NA | 5.6 U | 130 J | 130 J | 5.7 U | 130 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 110 J | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-203 | NA | 5.6 U | 87 J | 52 J | 5.7 U | 350 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 230 | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-204 | NA | 5.6 U | 100 U | 10 U | 5.7 U | 9 U | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 64 U | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-205 | NA | 5.6 U | 100 U | 11 J | 5.7 U | 27 | 12 U | 13 U | 13 U | 14 U | 14 U | 14 U | 15 U | 14 U | 14 U | 17 U | 96 U | 15 U | 13 U | 13 U | 14 U | 17 U | 19 U | 14 U | 13 U | 13 U |
| PCB-206 | NA | 5.6 U | 95 J | 140 J | 5.7 U | 160 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 330 | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-207 | NA | 5.6 U | 100 U | 8 J | 5.7 U | 26 | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | 44 J | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |
| PCB-208 | NA | 5.6 U | 43 J | 65 J | 5.7 U | 53 | 41 U | 44 U | 44 U | 46 U | 46 U | 46 U | 50 U | 48 U | 48 U | 56 U | 320 U | 50 U | 45 U | 44 U | 48 U | 56 U | 62 U | 46 U | 44 U | 42 U |
| PCB-209 | NA | 3.1 U | 130 J | 180 J | 2 U | 74 J | 120 U | 130 U | 130 U | 130 U | 130 U | 130 U | 140 U | 140 U | 140 U | 160 U | 560 J | 140 U | 130 U | 130 U | 140 U | 160 U | 180 U | 130 U | 130 U | 120 U |
| TOTAL PCBs | 17,000 | 186 | **3,834,944** | **2,521,200** | 199 | **127,619** | 8.2 U | 8.8 U | 8.8 U | 9.1 U | 9.2 U | 9.1 U | 10 U | 9.5 U | 9.6 U | 11 U | **133,859** | 9.9 U | 9 U | 8.8 U | 9.5 U | 11 U | 12 U | 9.2 U | 8.8 U | 8.4 U |

**Notes:**
FD – Field duplicate
J - The reported value is an estimated concentration.
N – Sample is not part of a field duplicate pair
NA - Not applicable
NE - Not established
P – Parent sample of field duplicate
PCB - polychlorinated biphenyls
U - The analyte was not detected at or above the limit of detection (LOD). (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
**Bolded** values indicate that the reported concentration exceeds the PAL.
pg/g - picograms per gram

## Table B3-9. Total PCBs (Congeners) in Soil - 2019 and 2022

| Location Name | Sample Name | Sample type | Total PCBs (Sum of analyte value with ND as null) Result (pg/g) | Total number of PCBs detections |
|---|---|---|---|---|
| | | **Soil Cleanup Level** | **17,000** | |
| NP-B137 | NP-B137-S-52-191008 | N | 186 | 52 |
| NP-B138 | NP-B138-S-5-191008 | FD | **3,834,944** | 159 |
| NP-B138 | NP-B138-S-6-191008 | P | **2,521,200** | 159 |
| NP-B138 | NP-B138-S-62-191008 | N | 199 | 53 |
| NP-B177 | NP-B177-S-07-220505 | N | **127,619** | 116 |
| NP-B177 | NP-B177-S-30-220505 | N | 8.2 U | 0 |
| NP-B177 | NP-B177-S-35-220505 | P | 8.8 U | 0 |
| NP-B177 | NP-B177-S-36-220505 | FD | 8.8 U | 0 |
| NP-B177 | NP-B177-S-40-220505 | N | 9.1 U | 0 |
| NP-B177 | NP-B177-S-45-220505 | N | 9.2 U | 0 |
| NP-B177 | NP-B177-S-50-220505 | N | 9.1 U | 0 |
| NP-B177 | NP-B177-S-55-220505 | N | 10 U | 0 |
| NP-B177 | NP-B177-S-60-220505 | N | 9.5 U | 0 |
| NP-B177 | NP-B177-S-65-220505 | N | 9.6 U | 0 |
| NP-B177 | NP-B177-S-75-220505 | N | 11 U | 0 |
| NP-B178 | NP-B178-S-07-220509 | N | **133,859** | 106 |
| NP-B178 | NP-B178-S-30-220509 | N | 9.9 U | 0 |
| NP-B178 | NP-B178-S-40-220509 | N | 9 U | 0 |
| NP-B178 | NP-B178-S-48-220509 | N | 8.8 U | 0 |

## Table B3-9. Total PCBs (Congeners) in Soil - 2019 and 2022 (continued)

| Location Name | Sample Name | Sample type | Total PCBs (Sum of analyte value with ND as null) Result (pg/g) | Total number of PCBs detections |
|---|---|---|---|---|
| NP-B178 | NP-B178-S-55-220509 | N | 9.5 U | 0 |
| NP-B178 | NP-B178-S-60-220509 | N | 11 U | 0 |
| NP-B178 | NP-B178-S-65-220509 | N | 12 U | 0 |
| NP-B178 | NP-B178-S-70-220509 | N | 9.2 U | 0 |
| NP-B178 | NP-B178-S-95-220510 | N | 8.8 U | 0 |
| NP-B178 | NP-B178-S-100-220510 | N | 8.4 U | 0 |

**Notes:**
FD – Field duplicate
N – Sample is not part of a field duplicate pair
P – Parent sample of field duplicate
PCB - polychlorinated biphenyls
U - The analyte was not detected at or above the limit of detection (LOD). (sometimes validators will elevate the limit due
to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
**Bolded** values indicate that the reported concentration exceeds the PAL.
pg/g - picograms per gram

## Table B3-10. TPH in Soil Samples – 2019

| Location Name | Sample Name | Sample Collection Date | Sample Depth (ft bgs) | Sample Type | PAL (µg/kg) | TPH-Diesel range C12-C24 (µg/kg) |
|---|---|---|---|---|---|---|
| NP-B118 | NP-B118-S-13-190624 | 6/24/2019 | 13 | N | 2,000 | **260,000** |
| | NP-B118-S-16-190624 | 6/24/2019 | 16 | N | 2,000 | 1,200 U |
| | NP-B118-S-34-190625 | 6/25/2019 | 34 | N | 2,000 | 1,200 U |
| NP-B119 | NP-B119-S-07-190621 | 6/21/2019 | 7 | N | 2,000 | 1,300 U |
| | NP-B119-S-12-190621 | 6/21/2019 | 12 | N | 2,000 | **3,200,000** |
| | NP-B119-S-15-190621 | 6/21/2019 | 15 | N | 2,000 | 1,200 U |
| NP-B120 | NP-B120-S-12.5-190624 | 6/24/2019 | 12.5 | N | 2,000 | **490,000** |
| | NP-B120-S-29-190624 | 6/24/2019 | 29 | N | 2,000 | 1,100 U |
| | NP-B120-S-35.5-190624 | 6/24/2019 | 35.5 | N | 2,000 | 1,200 U |
| | NP-B120-S-42-190624 | 6/24/2019 | 42 | N | 2,000 | 1,100 U |
| | NP-B120-S-49.5-190624 | 6/24/2019 | 49.5 | N | 2,000 | 1,100 U |
| NP-B121 | NP-B121-S-05-190620 | 6/20/2019 | 5 | N | 2,000 | **2,000,000** |
| | NP-B121-S-13-190620 | 6/20/2019 | 13 | P | 2,000 | **290,000 J** |
| | NP-B121-S-14-190620 | 6/20/2019 | 13 | FD | 2,000 | **53,000 J** |
| | NP-B121-S-34-190620 | 6/20/2019 | 34 | N | 2,000 | 1,200 U |
| NP-B122 | NP-B122-S-05-190620 | 6/20/2019 | 5 | N | 2,000 | **1,600,000** |
| | NP-B122-S-09-190620 | 6/20/2019 | 9 | N | 2,000 | **890,000** |
| | NP-B122-S-27-190621 | 6/21/2019 | 27 | N | 2,000 | 1,300 U |
| NP-B123 | NP-B123-S-19-190619 | 6/19/2019 | 19 | N | 2,000 | **49,000** |
| | NP-B123-S-25-190619 | 6/19/2019 | 25 | N | 2,000 | 1,400 U |
| | NP-B123-S-40-190619 | 6/19/2019 | 40 | N | 2,000 | 1,400 U |

## Table B3-10. TPH in Soil Samples – 2019 (continued)

| Location Name | Sample Name | Sample Collection Date | Sample Depth (ft bgs) | Sample Type | PAL (µg/kg) | TPH-Diesel range C12-C24 (µg/kg) |
|---|---|---|---|---|---|---|
| NP-B124 | NP-B124-S-10-190620 | 6/20/2019 | 10 | N | 2,000 | **50,000** |
| | NP-B124-S-14-190620 | 6/20/2019 | 14 | N | 2,000 | **150,000** |
| | NP-B124-S-28-190620 | 6/20/2019 | 28 | N | 2,000 | 1,300 U |
| NP-B125 | NP-B125-S-20-190619 | 6/19/2019 | 20 | N | 2,000 | **88,000** |
| | NP-B125-S-38-190619 | 6/19/2019 | 38 | N | 2,000 | **25,000** |
| | NP-B125-S-45-190619 | 6/19/2019 | 45 | N | 2,000 | 1,200 U |
| NP-B137 | NP-B137-S-52-191008 | 10/8/2019 | 52 | N | 2,000 | 1,200 U |
| NP-B138 | NP-B138-S-5-191009 | 10/9/2019 | 6 | FD | 2,000 | **2,700 J** |
| | NP-B138-S-6-191009 | 10/9/2019 | 6 | P | 2,000 | 1,100 UJ |
| | NP-B138-S-62-191009 | 10/9/2019 | 62 | N | 2,000 | 1,100 U |

**Notes:**
Samples analyzed using EPA Method NWTPH-Dx
FD - Field Duplicate
J - The reported value is an estimated concentration.
P – Parent sample of field duplicate
PAL - Project Action Limit
N – Sample is not part of a duplicate pair.
U - The analyte was analyzed but not detected at or above the stated limit. (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
UJ - The analyte was analyzed but not detected. the sample quantitation limit is an estimated value.
**Bolded** values indicate that the reported concentration exceeds the PAL.
µg/kg - micrograms per kilogram

## Table B3-11. 1,4-Dioxane in Soil Samples - 2019 and 2022

| Location Name | Sample Name | Sample Collection Date | Sample Depth (ft bgs) | Sample Type | PAL (mg/kg) | 1,4-Dioxane (mg/kg) |
|---|---|---|---|---|---|---|
| CL-B102 | CL-B102-S-14-190617 | 6/17/2019 | 14 | N | 0.00013 | 0.038 U |
| | CL-B102-S-19-190617 | 6/17/2019 | 19 | N | 0.00013 | 0.038 U |
| | CL-B102-S-33-190617 | 6/17/2019 | 33 | N | 0.00013 | 0.033 U |
| CL-B103 | CL-B103-S-09-190617 | 6/17/2019 | 9 | N | 0.00013 | 0.036 U |
| | CL-B103-S-12-190617 | 6/17/2019 | 12 | N | 0.00013 | 0.039 U |
| | CL-B103-S-19-190617 | 6/17/2019 | 19 | N | 0.00013 | 0.037 U |
| | CL-B103-S-39-190617 | 6/17/2019 | 39 | N | 0.00013 | 0.033 U |
| CL-B105 | CL-B105-S-10-190612 | 6/12/2019 | 10 | N | 0.00013 | 0.99 U |
| | CL-B105-S-13-190612 | 6/12/2019 | 13 | N | 0.00013 | 0.80 U |
| | CL-B105-S-39-190612 | 6/12/2019 | 39 | N | 0.00013 | 0.032 U |
| CL-B106 | CL-B106-S-20-190610 | 6/10/2019 | 20 | N | 0.00013 | 0.038 U |
| | CL-B106-S-27-190610 | 6/10/2019 | 27 | N | 0.00013 | 0.037 U |
| | CL-B106-S-33-190610 | 6/10/2019 | 33 | N | 0.00013 | 0.043 U |
| CL-B107 | CL-B107-S-07-190611 | 6/11/2019 | 7 | N | 0.00013 | 0.19 U |
| | CL-B107-S-22-190611 | 6/11/2019 | 22 | N | 0.00013 | 0.036 U |
| | CL-B107-S-33-190611 | 6/11/2019 | 33 | N | 0.00013 | 0.047 U |
| CL-B108 | CL-B108-S-08-190611 | 6/11/2019 | 8 | N | 0.00013 | 0.18 U |
| | CL-B108-S-22-190611 | 6/11/2019 | 22 | N | 0.00013 | 0.036 U |
| CL-B109 | CL-B109-S-03-190611 | 6/11/2019 | 3 | N | 0.00013 | 0.19 U |
| | CL-B109-S-18-190611 | 6/11/2019 | 18 | N | 0.00013 | 0.039 U |
| | CL-B109-S-37-190611 | 6/11/2019 | 37 | N | 0.00013 | 0.042 U |

## Table B3-11. 1,4-Dioxane in Soil Samples - 2019 and 2022 (continued)

| Location Name | Sample Name | Sample Collection Date | Sample Depth (ft bgs) | Sample Type | PAL (mg/kg) | 1,4-Dioxane (mg/kg) |
|---|---|---|---|---|---|---|
| NP-B110 | NP-B110-S-08-190612 | 6/12/2019 | 8 | N | 0.00013 | 0.037 U |
| | NP-B110-S-14-190612 | 6/12/2019 | 14 | P | 0.00013 | 1.9 U |
| | NP-B110-S-16-190612 | 6/12/2019 | 14 | FD | 0.00013 | 2.0 U |
| NP-B111 | NP-B111-S-10-190612 | 6/12/2019 | 10 | N | 0.00013 | 0.073 U |
| | NP-B111-S-19-190612 | 6/12/2019 | 19 | N | 0.00013 | 0.044 U |
| | NP-B111-S-39-190612 | 6/12/2019 | 39 | N | 0.00013 | 0.04 U |
| NP-B112 | NP-B112-S-08-190614 | 6/14/2019 | 8 | N | 0.00013 | 0.037 U |
| | NP-B112-S-27-190614 | 6/14/2019 | 27 | N | 0.00013 | 0.037 U |
| | NP-B112-S-32-190614 | 6/14/2019 | 32 | N | 0.00013 | 0.039 U |
| NP-B113 | NP-B113-S-13-190613 | 6/13/2019 | 13 | N | 0.00013 | 1.8 U |
| | NP-B113-S-20-190613 | 6/13/2019 | 20 | N | 0.00013 | 0.036 U |
| | NP-B113-S-27-190613 | 6/13/2019 | 27 | N | 0.00013 | 0.036 U |
| NP-B114 | NP-B114-S-08-190613 | 6/13/2019 | 8 | N | 0.00013 | 0.75 U |
| | NP-B114-S-15-190613 | 6/13/2019 | 15 | N | 0.00013 | 0.04 U |
| | NP-B114-S-23-190613 | 6/13/2019 | 23 | N | 0.00013 | 0.038 U |
| | NP-B114-S-33-190613 | 6/13/2019 | 33 | N | 0.00013 | 0.033 U |
| NP-B115 | NP-B115-S-04-190614 | 6/14/2019 | 4 | N | 0.00013 | 1.8 U |
| | NP-B115-S-09-190614 | 6/14/2019 | 9 | N | 0.00013 | 4.7 U |
| | NP-B115-S-27-190614 | 6/14/2019 | 27 | N | 0.00013 | 0.035 U |
| NP-B116 | NP-B116-S-13-190621 | 6/21/2019 | 13 | N | 0.00013 | 0.04 U |
| | NP-B116-S-22-190624 | 6/24/2019 | 22 | N | 0.00013 | 0.033 U |

## Table B3-11. 1,4-Dioxane in Soil Samples - 2019 and 2022 (continued)

| Location Name | Sample Name | Sample Collection Date | Sample Depth (ft bgs) | Sample Type | PAL (mg/kg) | 1,4-Dioxane (mg/kg) |
|---|---|---|---|---|---|---|
| | NP-B116-S-34-190624 | 6/24/2019 | 34 | N | 0.00013 | 0.035 U |
| NP-B117 | NP-B117-S-10-190613 | 6/13/2019 | 10 | N | 0.00013 | 0.034 U |
| NP-B117s | NP-B117S-S-10-190613 | 6/13/2019 | 10 | N | 0.00013 | 2.3 U |
| | NP-B117S-S-28-190613 | 6/13/2019 | 28 | N | 0.00013 | 0.034 U |
| | NP-B117S-S-39-190613 | 6/13/2019 | 39 | N | 0.00013 | 0.49 U |
| NP-B118 | NP-B118-S-13-190624 | 6/24/2019 | 13 | N | 0.00013 | 0.38 UJ |
| | NP-B118-S-16-190624 | 6/24/2019 | 16 | N | 0.00013 | 0.37 U |
| | NP-B118-S-34-190625 | 6/25/2019 | 34 | N | 0.00013 | 0.036 U |
| NP-B119 | NP-B119-S-07-190621 | 6/21/2019 | 7 | N | 0.00013 | 0.038 U |
| | NP-B119-S-12-190621 | 6/21/2019 | 12 | N | 0.00013 | 0.041 U |
| | NP-B119-S-15-190621 | 6/21/2019 | 15 | N | 0.00013 | 0.037 U |
| NP-B120 | NP-B120-S-12.5-190624 | 6/24/2019 | 12.5 | N | 0.00013 | 19 U |
| | NP-B120-S-29-190624 | 6/24/2019 | 29 | N | 0.00013 | 0.033 U |
| | NP-B120-S-35.5-190624 | 6/24/2019 | 35.5 | N | 0.00013 | 0.035 U |
| | NP-B120-S-42-190624 | 6/24/2019 | 42 | N | 0.00013 | 0.033 U |
| | NP-B120-S-49.5-190624 | 6/24/2019 | 49.5 | N | 0.00013 | 0.032 U |
| NP-B121 | NP-B121-S-05-190620 | 6/20/2019 | 5 | N | 0.00013 | 1.8 U |
| | NP-B121-S-13-190620 | 6/20/2019 | 13 | P | 0.00013 | 2.2 U |
| | NP-B121-S-14-190620 | 6/20/2019 | 13 | FD | 0.00013 | 1.8 U |
| | NP-B121-S-34-190620 | 6/20/2019 | 34 | N | 0.00013 | 0.035 U |
| NP-B122 | NP-B122-S-05-190620 | 6/20/2019 | 5 | N | 0.00013 | 32 U |

## Table B3-11. 1,4-Dioxane in Soil Samples - 2019 and 2022 (continued)

| Location Name | Sample Name | Sample Collection Date | Sample Depth (ft bgs) | Sample Type | PAL (mg/kg) | 1,4-Dioxane (mg/kg) |
|---|---|---|---|---|---|---|
| | NP-B122-S-09-190620 | 6/20/2019 | 9 | N | 0.00013 | 1.8 U |
| | NP-B122-S-27-190621 | 6/21/2019 | 27 | N | 0.00013 | 0.038 U |
| NP-B123 | NP-B123-S-19-190619 | 6/19/2019 | 19 | N | 0.00013 | 4.7 U |
| | NP-B123-S-25-190619 | 6/19/2019 | 25 | N | 0.00013 | 0.041 U |
| | NP-B123-S-40-190619 | 6/19/2019 | 40 | N | 0.00013 | 0.041 U |
| NP-B124 | NP-B124-S-10-190620 | 6/20/2019 | 10 | N | 0.00013 | 1.4 U |
| | NP-B124-S-14-190620 | 6/20/2019 | 14 | N | 0.00013 | 1.5 U |
| | NP-B124-S-28-190620 | 6/20/2019 | 28 | N | 0.00013 | 0.038 U |
| NP-B125 | NP-B125-S-20-190619 | 6/19/2019 | 20 | N | 0.00013 | 0.042 U |
| | NP-B125-S-38-190619 | 6/19/2019 | 38 | N | 0.00013 | 0.036 U |
| | NP-B125-S-45-190619 | 6/19/2019 | 45 | N | 0.00013 | 0.036 U |
| CL-B176 | CL-B176-S-08-220502 | 5/2/2022 | 8 | N | 0.00013 | 0.011 U |
| | CL-B176-S-28-220502 | 5/2/2022 | 28 | N | 0.00013 | 0.011 U |
| | CL-B176-S-40-220502 | 5/2/2022 | 40 | N | 0.00013 | 0.011 U |
| | CL-B176-S-45-220502 | 5/2/2022 | 45 | N | 0.00013 | 0.0092 U |
| | CL-B176-S-55-220503 | 5/3/2022 | 55 | N | 0.00013 | 0.01 U |
| | CL-B176-S-60-220503 | 5/3/2022 | 60 | N | 0.00013 | 0.014 U |
| | CL-B176-S-65-220503 | 5/3/2022 | 65 | N | 0.00013 | 0.013 U |
| | CL-B176-S-70-220503 | 5/3/2022 | 70 | N | 0.00013 | 0.013 U |
| | CL-B176-S-95-220503 | 5/3/2022 | 95 | N | 0.00013 | 0.011 U |
| | CL-B176-S-100-220503 | 5/3/2022 | 100 | N | 0.00013 | 0.01 U |

## Table B3-11. 1,4-Dioxane in Soil Samples - 2019 and 2022 (continued)

| Location Name | Sample Name | Sample Collection Date | Sample Depth (ft bgs) | Sample Type | PAL (mg/kg) | 1,4-Dioxane (mg/kg) |
|---|---|---|---|---|---|---|
| NP-B177 | NP-B177-S-07-220505 | 5/5/2019 | 7 | N | 0.00013 | 0.01 UJ |
| | NP-B177-S-30-220505 | 5/5/2019 | 30 | N | 0.00013 | 0.01 UJ |
| | NP-B177-S-35-220505 | 5/5/2019 | 35 | P | 0.00013 | 0.01 UJ |
| | NP-B177-S-36-220505 | 5/5/2019 | 35 | FD | 0.00013 | 0.011 UJ |
| | NP-B177-S-40-220505 | 5/5/2019 | 40 | N | 0.00013 | 0.011 UJ |
| | NP-B177-S-45-220505 | 5/5/2019 | 45 | N | 0.00013 | 0.011 U |
| | NP-B177-S-50-220505 | 5/5/2019 | 50 | N | 0.00013 | 0.011 UJ |
| | NP-B177-S-55-220505 | 5/5/2019 | 55 | N | 0.00013 | 0.011 UJ |
| | NP-B177-S-60-220505 | 5/5/2019 | 60 | N | 0.00013 | 0.012 UJ |
| | NP-B177-S-65-220505 | 5/5/2019 | 65 | N | 0.00013 | 0.011 UJ |
| | NP-B177-S-75-220505 | 5/5/2019 | 75 | N | 0.00013 | 0.014 UJ |
| NP-B178 | NP-B178-S-07-220509 | 5/9/2019 | 7 | N | 0.00013 | 0.011 R |
| | NP-B178-S-30-220509 | 5/9/2019 | 30 | P | 0.00013 | 0.012 U |
| | NP-B178-S-32-220509 | 5/9/2019 | 30 | FD | 0.00013 | 0.011 U |
| | NP-B178-S-40-220509 | 5/9/2019 | 40 | N | 0.00013 | 0.011 U |
| | NP-B178-S-48-220509 | 5/9/2019 | 48 | N | 0.00013 | 0.0098 UJ |
| | NP-B178-S-55-220509 | 5/9/2019 | 55 | N | 0.00013 | **0.0058 J** |
| | NP-B178-S-60-220509 | 5/9/2019 | 60 | N | 0.00013 | 0.013 U |
| | NP-B178-S-65-220509 | 5/9/2019 | 65 | N | 0.00013 | 0.015 U |
| | NP-B178-S-70-220509 | 5/9/2019 | 70 | N | 0.00013 | 0.011 U |
| | NP-B178-S-95-220510 | 5/10/2019 | 95 | N | 0.00013 | 0.011 UJ |

## Table B3-11. 1,4-Dioxane in Soil Samples - 2019 and 2022 (continued)

| Location Name | Sample Name | Sample Collection Date | Sample Depth (ft bgs) | Sample Type | PAL (mg/kg) | 1,4-Dioxane (mg/kg) |
|---|---|---|---|---|---|---|
| | NP-B178-S-100-220510 | 5/10/2019 | 100 | N | 0.00013 | 0.011 UJ |
| DG-B179 | DG-B179-S-4-220712 | 7/12/2022 | 4 | N | 0.00013 | 0.01 R |
| | DG-B179-S-16-220712 | 7/12/2022 | 16 | N | 0.00013 | 0.0086 UJ |
| | DG-B179-S-30-220712 | 7/12/2022 | 30 | N | 0.00013 | 0.01 UJ |
| | DG-B179-S-43-220712 | 7/12/2022 | 43 | N | 0.00013 | 0.011 UJ |
| | DG-B179-S-50-220713 | 7/13/2022 | 50 | P | 0.00013 | 0.0091 UJ |
| | DG-B179-S-50-220713 (FD) | 7/13/2022 | 50 | FD | 0.00013 | 0.011 U |
| | DG-B179-S-55-220713 | 7/13/2022 | 55 | N | 0.00013 | 0.0099 UJ |
| | DG-B179-S-60-220713 | 7/13/2022 | 60 | N | 0.00013 | 0.014 UJ |
| DG-B180 | DG-B180-S-57-220711 | 7/11/2022 | 57 | N | 0.00013 | 0.013 UJ |
| | DG-B180-S-65-220711 | 7/11/2022 | 65 | N | 0.00013 | 0.012 UJ |
| | DG-B180-S-73-220712 | 7/12/2022 | 73 | N | 0.00013 | 0.011 UJ |
| | DG-B180-S-76-220712 | 7/12/2022 | 76 | N | 0.00013 | 0.012 UJ |
| | DG-B180-S-79-220712 | 7/12/2022 | 79 | N | 0.00013 | 0.011 UJ |

**Notes:**
Samples analyzed using EPA Method 8270D.
FD - Field Duplicate; PAL - Project Action Limit; mg/kg - milligrams per kilogram
J - The reported value is an estimated concentration. P – Parent sample of field duplicate. N – Sample is not part of a field duplicate pair
U - The analyte was not detected at or above the stated limit. (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
UJ - The analyte was analyzed but not detected. the sample quantitation limit is an estimated value.
Underlined values represent analytes not detected at or above the stated limit, which exceeds the PAL.
**Bolded** values indicate that the reported concentration exceeds the PAL.

## Table B3-12. Total Organic Carbon and Moisture Content in Soil - 2019 and 2022

| Location Name | Sample Name | Sample Collection Date | Sample Depth (ft bgs) | Sample Type | Moisture Content (%wt) | TOC (mg/kg) |
|---|---|---|---|---|---|---|
| SP-B92 | SP-B92-S-12-191016 | 10/16/2019 | 13 | FD | 10.6 | 2,300 |
| | SP-B92-S-13-191016 | 10/16/2019 | 13 | P | 9.7 | 2,000 |
| | SP-B92-S-28-191016 | 10/16/2019 | 28 | N | 11.4 | 790 |
| SP-B131 | SP-B131-S-6-191015 | 10/15/2019 | 6 | N | 18.9 | 3,900 |
| | SP-B131-S-23-191015 | 10/15/2019 | 23 | N | 8.1 | 380 |
| CL-B107 | CL-B107-S-07-190611 | 6/11/2019 | 7 | N | 22.3 | 18,000 |
| | CL-B107-S-22-190611 | 6/11/2019 | 22 | N | 15.8 | 280 |
| | CL-B107-S-33-190611 | 6/11/2019 | 33 | N | 36.1 | 26,000 |
| CL-B132 | CL-B132-S-07-190930 | 9/30/2019 | 7 | N | 27.9 | 5,600 |
| | CL-B132-S-27-190930 | 9/30/2019 | 27 | N | 26.1 | 4,700 |
| SP-B174 | SP-B174-S-10-220427 | 4/27/2022 | 10 | N | 21.7 | 500 U |
| | SP-B174-S-48-220427 | 4/27/2022 | 48 | N | NA | 890 J |
| | SP-B174-S-58-220428 | 4/28/2022 | 58 | N | NA | 3,800 |
| SP-B175 | SP-B175-S-15-220425 | 4/25/2022 | 15 | N | NA | 1,400 J |
| | SP-B175-S-25-220425 | 4/25/2022 | 25 | N | 14 | 7,600 |
| | SP-B175-S-38-220425 | 4/25/2022 | 38 | N | 30.9 | 3,800 |
| CL-B176 | CL-B176-S-25-220502 | 5/2/2022 | 25 | N | NA | 1,000 J |
| | CL-B176-S-45-220502 | 5/2/2022 | 45 | N | 3.1 | 670 J |
| | CL-B176-S-55-220503 | 5/3/2022 | 55 | N | 23.3 | 18,000 |
| NP-B177 | NP-B177-S-40-220505 | 5/5/2022 | 40 | N | 14 | 100 J |
| | NP-B177-S-65-220505 | 5/5/2022 | 65 | N | 17.4 | 1,400 J |

## Table B3-12. Total Organic Carbon and Moisture Content in Soil - 2019 and 2022 (continued)

| Location Name | Sample Name | Sample Collection Date | Sample Depth (ft bgs) | Sample Type | Moisture Content (%wt) | TOC (mg/kg) |
|---|---|---|---|---|---|---|
| | NP-B177-S-75-220505 | 5/5/2022 | 75 | N | 29.2 | 110,000 |
| NP-B178 | NP-B178-S-30-220509 | 5/9/2022 | 30 | N | 19.6 | 110 J |
| | NP-B178-S-50-220509 | 5/9/2022 | 50 | N | NA | 540 J |
| | NP-B178-S-58-220509 | 5/9/2022 | 58 | N | NA | 99,000 |
| DG-B179 | DG-B179-S-30-220712 | 7/12/2022 | 30 | N | 17 | 250 J |
| | DG-B179-S-45-220712 | 7/12/2022 | 45 | N | NA | 1,700 J |
| | DG-B179-S-55-220712 | 7/12/2022 | 55 | N | 14.3 | 1,100 J |
| DG-B180 | DG-B180-S-70-220712 | 7/12/2022 | 70 | N | NA | 26,000 |

**Notes:**
TOC - Total Organic Carbon; No PAL designated for TOC
TOC analyzed by Walkley-Black Method (2019) or EPA 9060A (2022)
FD - Field Duplicate
P – Parent sample of field duplicate
N – Sample is not part of a duplicate pair.
NA - Not Analyzed
mg/kg – milligrams per kilogram

**Table B3-13. Physical Properties of Soil – 2022**

| | **Location Name** | SP-B174 | | | SP-B175 | | | CL-B176 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Sample Name** | SP-B174-S-10-220427 | SP-B174-S-48-220427 | SP-B174-S-58-220428 | SP-B175-S-15-220425 | SP-B175-S-25-220425 | SP-B175-S-38-220425 | CL-B176-S-25-220502 | CL-B176-S-45-220502 | CL-B176-S-55-220503 |
| | **Sample Collection Date** | 4/27/2022 | 4/27/2022 | 4/28/2022 | 4/25/2022 | 4/25/2022 | 4/25/2022 | 5/2/2022 | 5/2/2022 | 5/3/2022 |
| | **Sample Depth (ft bgs)** | 10 | 48 | 58 | 15 | 25 | 38 | 25 | 45 | 55 |
| | **Sample Type** | N | N | N | N | N | N | N | N | N |
| **Description** | **Units** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| Mean Grain Size Description USCS/ASTM | NA | Fine Sand | Medium Sand | Fine Sand | Fine Sand | Fine Sand | Fine Sand | Fine Sand | Fine Sand | Fine Sand |
| Gravel | wt. percent | 0 | 29.75 | 5.85 | 0.33 | 0 | 0 | 0.12 | 0 | 1.52 |
| Coarse Sand Size | wt. percent | 0.81 | 19.34 | 0.68 | 0.43 | 0.39 | 0 | 0.18 | 0 | 1.52 |
| Medium Sand Size | wt. percent | 7.09 | 20.58 | 16.1 | 1.98 | 1.89 | 38.75 | 3.19 | 24.12 | 40.22 |
| Fine Sand Size | wt. percent | 89.64 | 27.83 | 61.52 | 92.23 | 93.2 | 60.65 | 79.25 | 71.44 | 57.42 |
| Clay | wt. percent | 0.71 | 1.06 | 0.1 | 1.67 | 1.08 | 0.13 | 1.62 | 0.66 | 0.01 |
| Silt/Clay | wt. percent | 2.46 | 2.5 | 15.85 | 5.03 | 4.52 | 0.6 | 17.26 | 4.43 | 0.66 |
| Silt | wt. percent | 1.75 | 1.44 | 15.75 | 3.36 | 3.44 | 0.47 | 15.63 | 3.77 | 0.65 |
| Median Grain Size | mm | 0.280 | 1.901 | 0.233 | 0.238 | 0.207 | 0.360 | 0.153 | 0.284 | 0.382 |
| TOC | mg/kg | 500 U | 890 J | 3,800 | 1,400 J | 7,600 | 3,800 | 1,000 J | 670 J | 18,000 |
| Dry Bulk Density | g/cc | 1.62 | 1.80 | 1.6 | 1.65 | 1.68 | 1.42 | 1.24 | 1.71 | 0.85 |
| Horizontal Effective Permeability to Water | millidarcy | 632 | 641 | 1.35 | 581 | 591 | 0.519 | 3.52 | 655 | 0.363 |
| Vertical Effective Permeability to Water | millidarcy | 611 | 602 | 1.18 | 536 | 588 | 0.231 | 3.28 | 47.8 | 0.306 |
| Horizontal Intrinsic Permeability to Water | $cm^2$ | 6.24E-09 | 6.33E-09 | 1.33E-11 | 5.74E-09 | 5.83E-09 | 5.12E-12 | 3.48E-11 | 6.47E-09 | 3.58E-12 |
| Vertical Intrinsic Permeability to Water | $cm^2$ | 6.03E-09 | 5.94E-09 | 1.17E-11 | 5.29E-09 | 5.80E-09 | 2.28E-12 | 3.23E-11 | 4.72E-10 | 3.02E-12 |
| Effective Porosity | %Vb | 34.63 | 32.02 | 13.49 | 29.76 | 31.81 | 8.08 | 19.03 | 27.83 | 11.16 |
| Total Porosity | %Vb | 36.7 | 35.4 | 56.0 | 35.4 | 37.0 | 43.8 | 77.6 | 32.9 | 52.9 |
| Horizontal Hydraulic Conductivity | cm/s | 6.79E-04 | 6.76E-04 | 1.42E-06 | 6.18E-04 | 6.32E-04 | 5.49E-07 | 3.70E-06 | 6.89E-04 | 3.81E-07 |
| Vertical Hydraulic Conductivity | cm/s | 6.43E-04 | 6.35E-04 | 1.24E-06 | 5.69E-04 | 6.19E-04 | 2.45E-07 | 3.45E-06 | 5.03E-05 | 3.22E-07 |
| Moisture Content | % wt | 19.2 | 17.6 | 30.7 | 14 | 18.4 | 27.1 | 58.4 | 17.1 | 39.7 |
| Volumetric Water Content | fraction Vb | 0.347 | 0.261 | 0.387 | 0.238 | 0.317 | 0.457 | 0.215 | 0.31 | 0.35 |
| Total Sample Volume | cc | 141.07 | 141.07 | 246.07 | 141.07 | 224.86 | 141.07 | 212.15 | 141.07 | 212.15 |
| USCS (field) | -- | SP | SW | MH | SP | SP | MH/CH | MH/SP | SW | MH |
| Field Description | | Fine to very fine sand | Fine to coarse sand | Sandy silt | Very fine to medium sand | Very fine sand | Silt to silty clay | Sandy silt to very fine sand | Medium to coarse sand | Sandy silt |

**Table B3-13. Physical Properties of Soil – 2022 (continued)**

| Location Name | | NP-B177 | | | NP-B178 | | | DG-B179 | | | DB-B180 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | | NP-B177-S-40-220505 | NP-B177-S-65-220505 | NP-B177-S-75-220505 | NP-B178-S-30-220509 | NP-B178-S-50-220509 | NP-B178-S-58-220509 | DG-B179-S-30-220712 | DG-B179-S-45-220712 | DG-B179-S-55-220712 | DG-B180-S-70-220712 |
| Sample Collection Date | | 5/5/2022 | 5/5/2022 | 5/5/2022 | 5/9/2022 | 5/9/2022 | 5/9/2022 | 7/12/2022 | 7/12/2022 | 7/12/2022 | 7/12/2022 |
| Sample Depth (ft bgs) | | 40 | 65 | 75 | 30 | 50 | 58 | 30 | 45 | 55 | 70 |
| Sample Type | | N | N | N | N | N | N | N | N | N | N |
| **Description** | **Units** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| Mean Grain Size Description USCS/ASTM | NA | Fine Sand | Fine Sand | Fine Sand | Fine Sand | Fine Sand | Coarse Sand | Gravel | Medium Sand | Medium Sand | Silt |
| Gravel | wt. percent | 0 | 0 | 0 | 0 | 0 | 16.67 | 89.62 | 15.02 | 0.19 | 0 |
| Coarse Sand Size | wt. percent | 0.46 | 0.48 | 0.33 | 0.1 | 0.1 | 46.27 | 7.31 | 17.37 | 7.35 | 0 |
| Medium Sand Size | wt. percent | 26.44 | 8.28 | 37.96 | 1.26 | 1.26 | 31.19 | 0.85 | 32.93 | 55.23 | 0.16 |
| Fine Sand Size | wt. percent | 72.15 | 84.31 | 59.07 | 94.51 | 94.45 | 4.56 | 1.79 | 27.98 | 32.63 | 40.97 |
| Clay | wt. percent | 0.19 | 0.56 | 0.23 | 0.75 | 0.75 | 0.16 | 0.07 | 2.62 | 1.44 | 15.61 |
| Silt/Clay | wt. percent | 0.95 | 6.93 | 2.64 | 4.13 | 4.18 | 1.32 | 0.43 | 6.7 | 4.6 | 58.87 |
| Silt | wt. percent | 0.77 | 6.37 | 2.41 | 3.38 | 3.43 | 1.15 | 0.36 | 4.08 | 3.16 | 43.26 |
| Median Grain Size | mm | 0.316 | 0.212 | 0.38 | 0.196 | 0.196 | 2.495 | 11.525 | 0.796 | 0.541 | 0.060 |
| TOC | mg/kg | 100 J | 1,400 J | 110,000 | 110 J | 540 J | 99,000 | 250 J | 1,700 J | 1,100 J | 26,000 |
| Dry Bulk Density | g/cc | 1.73 | NA | 1.03 | 1.61 | 1.95 | 1.17 | 1.99 | 1.98 | 1.78 | 1.63 |
| Horizontal Effective Permeability to Water | millidarcy | 564 | NA | 0.451 | 614 | 524 | 0.331 | 4875 | 3876 | 5493 | 0.322 |
| Vertical Effective Permeability to Water | millidarcy | 554 | NA | 0.416 | 566 | 505 | 0.296 | 4587 | 3654 | 5379 | 0.157 |
| Horizontal Intrinsic Permeability to Water | $cm^2$ | 5.91E-04 | NA | 4.76E-07 | 6.58E-04 | 5.56E-04 | 3.48E-07 | 4.81E-08 | 3.83E-08 | 5.42E-08 | 3.18E-12 |
| Vertical Intrinsic Permeability to Water | $cm^2$ | 5.90E-04 | NA | 4.41E-07 | 6.00E-04 | 5.35E-04 | 3.14E-07 | 4.53E-08 | 3.61E-08 | 5.31E-08 | 1.55E-12 |
| Effective Porosity | %Vb | 30.73 | NA | 13.42 | 32.43 | 18.2 | 11.82 | N/A | N/A | N/A | N/A |
| Total Porosity | %Vb | 33.5 | NA | 60.2 | 36.0 | 24.6 | 59.9 | 43.7 | 48.3 | 44.2 | 39.7 |
| Horizontal Hydraulic Conductivity | cm/s | 5.91E-04 | NA | 4.76E-07 | 6.58E-04 | 5.56E-04 | 3.48E-07 | 4.49E-03 | 3.63E-03 | 5.33E-03 | 3.03E-07 |
| Vertical Hydraulic Conductivity | cm/s | 5.90E-04 | NA | 4.41E-07 | 6.00E-04 | 5.35E-04 | 3.14E-07 | 4.23E-03 | 3.51E-03 | 5.13E-03 | 1.50E-07 |
| Moisture Content | % wt | 15.6 | NA | 55 | 19.3 | 7.7 | 44.5 | 2.4 | 9.9 | 13.6 | 22.3 |
| Volumetric Water Content | fraction Vb | 0.27 | NA | 0.568 | 0.312 | 0.15 | 0.519 | 0.048 | 0.196 | 0.242 | 0.365 |
| Total Sample Volume | cc | 141.9 | NA | 205.92 | 141.9 | 141.9 | 214.82 | 61.27 | 139.32 | 139.83 | 140.51 |
| USCS (field) | -- | MH | SP | MH | SP | SW | Pt/CL | GW | SP | SP/CL | CL |
| Field Description | | Sandy silt | Very fine to medium sand | Sandy silt | Very fine to medium sand | Gravelly fine to very coarse sand | Peat to sandy clay | Silty sandy gravel | Fine sand | Fine sand/clay interface | Silty clay |

## Table B3-13. Physical Properties of Soil – 2022 (continued)

**Notes:**
J - The reported value is an estimated concentration.
N – Sample is not part of a field duplicate pair
NA = not analyzed
U - The analyte was not detected at or above the limit of detection (LOD). (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
cc = cubic centimeter
$cm^2$ = squared centimeter
cm/s = centimeter per second
g/cc = grams per cubic centimeter
g/g = grams per gram
mg/kg = milligrams per kilogram
mm = millimeters
USCS - Unified Soil Classification System
Vb = bulk volume
wt. percent = percentage by weight
% wt = water percentage

**Table B3-14. Target VOCs in Grab Groundwater Samples – 2019**

| | | **Location Name** | SP-B90 | SP-B90 | SP-B90 | SP-B91 | SP-B92 | SP-B92 | SP-B93 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SP-B090-GW-14-190628 | SP-B090-GW-15-190628 | SP-B090-GW-27-190628 | SP-B91-GW-9-190626 | SP-B92-GW-15-191016 | SP-B92-GW-30-191016 | SP-B93-GW-12.5-190626 |
| | | **Sample Collection Date** | 6/28/2019 | 6/28/2019 | 6/28/2019 | 6/26/2019 | 10/16/2019 | 10/16/2019 | 6/26/2019 |
| | | **Screen Interval (ft bgs)** | 10 - 15 | 10 - 15 | 23 - 27 | 5 - 9 | 10 - 15 | 25 - 30 | 7.5 - 12.5 |
| | | **Sample Type** | FD | P | N | N | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | μg/L | 0.48 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 UJ | 0.3 UJ | 0.3 U |
| Tetrachloroethene | μg/L | 2.4 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 UJ | 0.3 UJ | 0.3 U |
| Cis-1,2-Dichloroethene | μg/L | 16 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 UJ | 0.3 UJ | **19,000** |
| Trans-1,2-Dichloroethene | μg/L | 100 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 UJ | 0.3 UJ | **240 J** |
| 1,1,1-Trichloroethane | μg/L | 200 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 UJ | 0.3 UJ | 0.3 U |
| Chloroethane | μg/L | 7.7 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 UJ | 0.5 UJ | 0.3 U |
| Vinyl Chloride | μg/L | 0.02 | **0.14** | **0.14** | 0.015 U | 0.015 U | **0.15** | **0.071** | **1,900** |
| 1,1-Dichloroethane | μg/L | 7.7 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 UJ | 0.3 UJ | 0.3 U |
| 1,1-Dichloroethene | μg/L | 7 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 UJ | 0.5 UJ | **53** |
| Trichloroethene | μg/L | 0.3 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 UJ | 0.3 UJ | **1,600** |

| | | **Location Name** | SP-B93 | SP-B94 | SP-B94 | SP-B131 | SP-B131 | CL-B95 | CL-B95 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SP-B93-GW-40-190626 | SP-B94-GW-20-190626 | SP-B94-GW-39-190626 | SP-B131-GW-15-191015 | SP-B131-GW-40-191015 | CL-B95-GW-13-190627 | CL-B95-GW-33-190627 |
| | | **Sample Collection Date** | 6/26/2019 | 6/26/2019 | 6/26/2019 | 10/15/2019 | 10/15/2019 | 6/27/2019 | 6/27/2019 |
| | | **Screen Interval (ft bgs)** | 36 - 40 | 16 - 20 | 35 - 39 | 10 - 15 | 35 - 40 | 8 - 13 | 29 - 33 |
| | | **Sample Type** | N | N | N | N | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | μg/L | 0.48 | 0.3 U | 0.3 U | 0.3 U | 0.3 UJ | 0.3 UJ | 0.3 U | 0.3 U |
| Tetrachloroethene | μg/L | 2.4 | 0.3 U | 0.3 U | 0.3 U | 0.3 UJ | 0.3 UJ | 0.3 U | 0.3 U |
| Cis-1,2-Dichloroethene | μg/L | 16 | **22** | **39** | 1.1 | **69 J** | 3.6 J | **65 J** | 1.3 |
| Trans-1,2-Dichloroethene | μg/L | 100 | 0.34 J | 2.3 | 0.3 U | 3.3 J | 0.3 UJ | 18 J | 0.3 U |
| 1,1,1-Trichloroethane | μg/L | 200 | 0.3 U | 0.3 U | 0.3 U | 0.3 UJ | 0.3 UJ | 0.3 U | 0.3 U |
| Chloroethane | μg/L | 7.7 | 0.5 U | 0.5 U | 0.5 U | 0.5 UJ | 0.5 UJ | 4.1 J | 0.5 U |
| Vinyl Chloride | μg/L | 0.02 | **1** | **130** | **0.42** | **120** | **29 J** | **4,700 J** | **22** |
| 1,1-Dichloroethane | μg/L | 7.7 | 0.3 U | 3.8 | 0.3 U | 0.3 UJ | 0.3 UJ | 7 J | 0.3 U |
| 1,1-Dichloroethene | μg/L | 7 | 0.5 U | 0.5 U | 0.5 U | 0.5 UJ | 0.5 UJ | 0.5 U | 0.5 U |
| Trichloroethene | μg/L | 0.3 | **1.7** | **3.6** | **0.41 J** | 0.3 UJ | 0.3 UJ | 0.3 U | 0.3 U |

**Table B3-14. Target VOCs in Grab Groundwater Samples – 2019 (continued)**

| | | **Location Name** | CL-B96 | | CL-B96 | | CL-B98 | | CL-B98 | | CL-B99 | | CL-B99 | | CL-B100 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | CL-B96-GW-15-190627 | | CL-B96-GW-40-190627 | | CL-B98-GW-15-191014 | | CL-B98-GW-37-191014 | | CL-B99-GW-15-190625 | | CL-B99-GW-26-190625 | | CL-B100-GW-15-190625 | |
| | | **Sample Collection Date** | 6/27/2019 | | 6/27/2019 | | 10/14/2019 | | 10/14/2019 | | 6/25/2019 | | 6/25/2019 | | 6/25/2019 | |
| | | **Screen Interval (ft bgs)** | 11 - 15 | | 36 - 40 | | 10 - 15 | | 32 - 37 | | 11 - 15 | | 22 - 26 | | 11 - 15 | |
| | | **Sample Type** | N | | N | | N | | N | | N | | N | | N | |
| **Analyte Name** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| 1,2-Dichloroethane | µg/L | 0.48 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | UJ | 0.3 | U | 0.3 | U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | UJ | 0.3 | U | 0.3 | U |
| Cis-1,2-Dichloroethene | µg/L | 16 | 6.9 | | 0.3 | U | 0.3 | U | **310** | | 3.5 | J | 16 | | 0.3 | U |
| Trans-1,2-Dichloroethene | µg/L | 100 | 1.2 | | 0.3 | U | 0.3 | U | 100 | | 0.3 | UJ | 3.2 | | 0.3 | U |
| 1,1,1-Trichloroethane | µg/L | 200 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | UJ | 0.3 | U | 0.3 | U |
| Chloroethane | µg/L | 7.7 | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | UJ | 0.5 | U | 0.5 | U |
| Vinyl Chloride | µg/L | 0.02 | **20** | | **0.03** | | **0.31** | | **250** | | **3.3** | **J** | **17** | | **0.22** | **J** |
| 1,1-Dichloroethane | µg/L | 7.7 | 0.92 | J | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | UJ | 0.3 | U | 0.3 | U |
| 1,1-Dichloroethene | µg/L | 7 | 0.5 | U | 0.5 | U | 0.5 | U | 6.4 | | 0.5 | UJ | 0.5 | U | 0.5 | U |
| Trichloroethene | µg/L | 0.3 | **0.72** | **J** | 0.3 | U | 0.3 | U | **8** | | 0.3 | UJ | **1.2** | | 0.3 | U |

| | | **Location Name** | CL-B100 | | CL-B101 | | CL-B101 | | CL-B102 | | CL-B102 | | CL-B103 | | CL-B103 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | CL-B100-GW-39-190625 | | CL-B101-GW-10-190618 | | CL-B101-GW-35-190618 | | CL-B102-GW-13-190617 | | CL-B102-GW-35-190617 | | CL-B103-GW-09-190617 | | CL-B103-GW-40-190617 | |
| | | **Sample Collection Date** | 6/25/2019 | | 6/18/2019 | | 6/18/2019 | | 6/17/2019 | | 6/17/2019 | | 6/17/2019 | | 6/17/2019 | |
| | | **Screen Interval (ft bgs)** | 35 - 39 | | 5 - 10 | | 31 - 35 | | 8 - 13 | | 31 - 35 | | 4 - 9 | | 36 - 40 | |
| | | **Sample Type** | N | | N | | N | | N | | N | | N | | N | |
| **Analyte Name** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| 1,2-Dichloroethane | µg/L | 0.48 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| Cis-1,2-Dichloroethene | µg/L | 16 | 2.6 | | 0.3 | U | **650** | **J** | **340** | **J** | **29** | | 12 | J | 0.3 | U |
| Trans-1,2-Dichloroethene | µg/L | 100 | 1.6 | | 0.3 | U | 14 | J | 20 | | 2 | | 1 | J | 0.3 | U |
| 1,1,1-Trichloroethane | µg/L | 200 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| Chloroethane | µg/L | 7.7 | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U |
| Vinyl Chloride | µg/L | 0.02 | **16** | | **0.11** | | **690** | **J** | **230** | **J** | **11** | | **140** | **J** | **0.34** | |
| 1,1-Dichloroethane | µg/L | 7.7 | 0.3 | U | 0.3 | U | 0.3 | U | 0.48 | J | 0.3 | U | 0.65 | J | 0.3 | U |
| 1,1-Dichloroethene | µg/L | 7 | 0.5 | U | 0.5 | U | 5.4 | J | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U |
| Trichloroethene | µg/L | 0.3 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |

**Table B3-14. Target VOCs in Grab Groundwater Samples – 2019 (continued)**

| | | **Location Name** | CL-B104 | CL-B104 | CL-B105 | CL-B105 | CL-B106 | CL-B106 | CL-B107 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | CL-B104-GW-14-190618 | CL-B104-GW-28-190618 | CL-B105-GW-15-190612 | CL-B105-GW-40-190612 | CL-B106-GW-20-190610 | CL-B106-GW-32-190610 | CL-B107-GW-10-190611 |
| | | **Sample Collection Date** | 6/18/2019 | 6/18/2019 | 6/12/2019 | 6/12/2019 | 6/10/2019 | 6/10/2019 | 6/11/2019 |
| | | **Screen Interval (ft bgs)** | 9 - 14 | 24 - 28 | 10 - 15 | 36 - 40 | 15 - 20 | 28 - 32 | 5 - 10 |
| | | **Sample Type** | N | N | N | N | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/L | 0.48 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Cis-1,2-Dichloroethene | µg/L | 16 | **310** | **97 J** | 0.3 U | **370** | 0.3 U | 0.3 U | 0.3 U |
| Trans-1,2-Dichloroethene | µg/L | 100 | 9.3 J | 64 J | 1.2 J | 3.1 | 0.3 U | 0.3 U | 0.3 U |
| 1,1,1-Trichloroethane | µg/L | 200 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Chloroethane | µg/L | 7.7 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Vinyl Chloride | µg/L | 0.02 | **790** | **570 J** | **14 J** | **64** | 0.015 U | 0.015 U | **0.69 J** |
| 1,1-Dichloroethane | µg/L | 7.7 | 0.42 J | 2.2 J | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| 1,1-Dichloroethene | µg/L | 7 | 1.1 J | 0.5 U | 0.5 U | 0.66 J | 0.5 U | 0.5 U | 0.5 U |
| Trichloroethene | µg/L | 0.3 | 0.3 U | **1.7 J** | 0.3 U | **2.9** | 0.3 U | 0.3 U | 0.3 U |

| | | **Location Name** | CL-B107 | CL-B108 | CL-B108 | CL-B109 | CL-B109 | CL-B132 | CL-B132 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | CL-B107-GW-32-190611 | CL-B108-GW-12-190611 | CL-B108-GW-25-190611 | CL-B109-GW-15-190611 | CL-B109-GW-37-190611 | CL-B132-GW-15-190930 | CL-B132-GW-45-190930 |
| | | **Sample Collection Date** | 6/11/2019 | 6/11/2019 | 6/11/2019 | 6/11/2019 | 6/11/2019 | 9/30/2019 | 9/30/2019 |
| | | **Screen Interval (ft bgs)** | 28 - 32 | 7 - 12 | 21 - 25 | 10 - 15 | 33 - 37 | 10 - 15 | 40 - 45 |
| | | **Sample Type** | N | N | N | N | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/L | 0.48 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Cis-1,2-Dichloroethene | µg/L | 16 | 0.3 U | 0.3 U | 0.3 U | 2.4 | 0.3 U | **76** | 0.3 U |
| Trans-1,2-Dichloroethene | µg/L | 100 | 0.3 U | 0.3 U | 0.3 U | 1 | 0.3 U | 14 | 0.3 U |
| 1,1,1-Trichloroethane | µg/L | 200 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Chloroethane | µg/L | 7.7 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U |
| Vinyl Chloride | µg/L | 0.02 | 0.015 U | 0.015 U | 0.015 U | **0.26** | 0.015 U | **3,700** | **0.45** |
| 1,1-Dichloroethane | µg/L | 7.7 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| 1,1-Dichloroethene | µg/L | 7 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Trichloroethene | µg/L | 0.3 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |

## Table B3-14. Target VOCs in Grab Groundwater Samples – 2019 (continued)

| | | **Location Name** | CL-B134 | CL-B134 | NP-B110 | | NP-B110 | NP-B111 | NP-B111 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | CL-B134-GW-49-191003 | CL-B134-GW-50-191003 | NP-B110-GW-15-190612 | QC-190612-02 | NP-B110-GW-40-190612 | NP-B111-GW-17-190612 | NP-B111-GW-40-190612 |
| | | **Sample Collection Date** | 10/3/2019 | 10/3/2019 | 6/12/2019 | 6/12/2019 | 6/12/2019 | 6/12/2019 | 6/12/2019 |
| | | **Screen Interval (ft bgs)** | 45 - 50 | 45 - 50 | 10 - 15 | 10 - 15 | 36 - 40 | 12 - 17 | 36 - 40 |
| | | **Sample Type** | FD | P | P | FD | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/L | 0.48 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Cis-1,2-Dichloroethene | µg/L | 16 | 7.1 | 7.5 | 0.3 U | 0.73 J | **190** | 0.3 U | 0.3 U |
| Trans-1,2-Dichloroethene | µg/L | 100 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 3.6 | 0.76 J | 0.3 U |
| 1,1,1-Trichloroethane | µg/L | 200 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Chloroethane | µg/L | 7.7 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Vinyl Chloride | µg/L | 0.02 | **0.33** | **0.34** | **0.93** | **0.89** | **21** | **0.28** | 0.015 U |
| 1,1-Dichloroethane | µg/L | 7.7 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| 1,1-Dichloroethene | µg/L | 7 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Trichloroethene | µg/L | 0.3 | 0.3 U | **0.51 J** | 0.3 U | 0.3 U | **9.4** | 0.3 U | 0.3 U |

| | | **Location Name** | NP-B112 | NP-B112 | NP-B113 | NP-B114 | NP-B114 | NP-B115 | NP-B115 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | NP-B112-GW-15-190614 | NP-B112-GW-31-190614 | NP-B113-GW-15-190613 | NP-B114-GW-15-190613 | NP-B114-GW-40-190613 | NP-B115-GW-15-190614 | NP-B115-GW-27-190614 |
| | | **Sample Collection Date** | 6/14/2019 | 6/14/2019 | 6/13/2019 | 6/13/2019 | 6/13/2019 | 6/14/2019 | 6/14/2019 |
| | | **Screen Interval (ft bgs)** | 10 - 15 | 27 - 31 | 10 - 15 | 10 - 15 | 35 - 40 | 10 - 15 | 23 - 27 |
| | | **Sample Type** | N | N | N | N | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/L | 0.48 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Cis-1,2-Dichloroethene | µg/L | 16 | 0.3 U | 0.3 U | 2.8 | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Trans-1,2-Dichloroethene | µg/L | 100 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| 1,1,1-Trichloroethane | µg/L | 200 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Chloroethane | µg/L | 7.7 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Vinyl Chloride | µg/L | 0.02 | **0.036 J** | **0.17** | **0.089 J** | **0.64** | **0.27** | 0.015 J | **0.17** |
| 1,1-Dichloroethane | µg/L | 7.7 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| 1,1-Dichloroethene | µg/L | 7 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Trichloroethene | µg/L | 0.3 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | **2** |

**Table B3-14. Target VOCs in Grab Groundwater Samples – 2019 (continued)**

| | | **Location Name** | NP-B116 | NP-B116 | NP-B116 | NP-B117s | NP-B117s | NP-B118 | NP-B118 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | NP-B116-GW-14-190621 | NP-B116-GW-15-190621 | NP-B116-GW-36-190624 | NP-B117s-GW-15-190613 | NP-B117s-GW-40-190613 | NP-B118-GW-20-190624 | NP-B118-GW-35-190625 |
| | | **Sample Collection Date** | 6/21/2019 | 6/21/2019 | 6/24/2019 | 6/13/2019 | 6/13/2019 | 6/24/2019 | 6/25/2019 |
| | | **Screen Interval (ft bgs)** | 10 - 15 | 10 - 15 | 32 - 36 | 10 - 15 | 35 - 40 | 16 - 20 | 31 - 35 |
| | | **Sample Type** | FD | P | N | N | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/L | 0.48 | 0.3 UJ | 0.3 U | **0.76 J** | 0.3 U | 0.3 UJ | 0.3 U | 0.3 U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 UJ | 0.3 U | 0.3 U | 0.3 U | 0.3 UJ | 0.3 U | 0.3 U |
| Cis-1,2-Dichloroethene | µg/L | 16 | 0.3 UJ | 0.3 U | **2,000** | 0.3 U | **4,300** | 3.7 | 0.3 U |
| Trans-1,2-Dichloroethene | µg/L | 100 | 0.3 UJ | 0.3 U | 27 | 0.3 U | 45 J | 0.3 U | 0.3 U |
| 1,1,1-Trichloroethane | µg/L | 200 | 0.3 UJ | 0.3 U | 0.3 U | 0.3 U | 0.3 UJ | 0.3 U | 0.3 U |
| Chloroethane | µg/L | 7.7 | 0.5 UJ | 0.5 U | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 U |
| Vinyl Chloride | µg/L | 0.02 | **0.1 J** | **0.12 J** | **280** | **0.034 J** | **830** | **0.61** | **0.033** |
| 1,1-Dichloroethane | µg/L | 7.7 | 0.3 UJ | 0.3 U | **8.7** | 0.3 U | 7.3 J | 0.3 U | 0.3 U |
| 1,1-Dichloroethene | µg/L | 7 | 0.5 UJ | 0.5 U | 5.2 | 0.5 U | **9.3 J** | 0.5 U | 0.5 U |
| Trichloroethene | µg/L | 0.3 | 0.3 UJ | 0.3 U | **2** | 0.3 U | **1.5 J** | 0.3 U | 0.3 U |

| | | **Location Name** | NP-B119 | NP-B119 | NP-B120 | NP-B120 | NP-B121 | NP-B121 | NP-B122 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | NP-B119-GW-15-190621 | NP-B119-GW-32-190621 | NP-B120-GW-15-190624 | NP-B120-GW-50-190624 | NP-B121-GW-15-190620 | NP-B121-GW-35-190620 | NP-B122-GW-15-190620 |
| | | **Sample Collection Date** | 6/21/2019 | 6/21/2019 | 6/24/2019 | 6/24/2019 | 6/20/2019 | 6/20/2019 | 6/20/2019 |
| | | **Screen Interval (ft bgs)** | 10 - 15 | 28 - 32 | 11 - 15 | 46 - 50 | 10 - 15 | 31 - 35 | 10 - 15 |
| | | **Sample Type** | N | N | N | N | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/L | 0.48 | 0.3 U | 0.3 U | 0.3 U | **0.6 J** | 0.3 U | 0.3 U | 0.3 U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Cis-1,2-Dichloroethene | µg/L | 16 | 0.3 U | 0.3 U | 1 | **1,400 J** | 0.3 U | 0.41 J | 0.57 J |
| Trans-1,2-Dichloroethene | µg/L | 100 | 0.3 U | 0.3 U | 0.3 U | 46 | 0.3 U | 0.3 U | 0.3 U |
| 1,1,1-Trichloroethane | µg/L | 200 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Chloroethane | µg/L | 7.7 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Vinyl Chloride | µg/L | 0.02 | 0.015 U | **0.024** | **0.43** | **240 J** | **0.087** | **0.24** | **0.12** |
| 1,1-Dichloroethane | µg/L | 7.7 | 0.3 U | 0.3 U | 0.3 U | 3.6 | 0.3 U | 0.3 U | 0.3 U |
| 1,1-Dichloroethene | µg/L | 7 | 0.5 U | 0.5 U | 0.5 U | 4.4 | 0.5 U | 0.5 U | 0.5 U |
| Trichloroethene | µg/L | 0.3 | 0.3 U | 0.3 U | 0.3 U | **0.9 J** | 0.3 U | **0.8 J** | 0.3 U |

**Table B3-14. Target VOCs in Grab Groundwater Samples – 2019 (continued)**

| | | **Location Name** | NP-B122 | NP-B123 | NP-B123 | NP-B123 | NP-B124 | NP-B124 |
|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | NP-B122-GW-28-190621 | NP-B123-GW-19-190619 | NP-B123-GW-20-190619 | NP-B123-GW-40-190619 | NP-B124-GW-20-190620 | NP-B124-GW-29-190620 |
| | | **Sample Collection Date** | 6/21/2019 | 6/19/2019 | 6/19/2019 | 6/19/2019 | 6/20/2019 | 6/20/2019 |
| | | **Screen Interval (ft bgs)** | 24 - 28 | 15 - 20 | 15 - 20 | 36 - 40 | 15 - 20 | 25 - 29 |
| | | **Sample Type** | N | P | FD | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/L | 0.48 | 0.3 U | 0.3 U | 0.3 UJ | 0.3 U | 0.3 U | 0.3 U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 U | 0.3 U | 0.3 UJ | 0.3 U | 0.3 U | 0.3 U |
| Cis-1,2-Dichloroethene | µg/L | 16 | 0.3 U | 0.3 U | 0.3 UJ | 0.3 U | 0.3 U | 0.3 U |
| Trans-1,2-Dichloroethene | µg/L | 100 | 0.3 U | 0.3 U | 0.3 UJ | 0.3 U | 0.3 U | 0.3 U |
| 1,1,1-Trichloroethane | µg/L | 200 | 0.3 U | 0.3 U | 0.3 UJ | 0.3 U | 0.3 U | 0.3 U |
| Chloroethane | µg/L | 7.7 | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 U | 0.5 U |
| Vinyl Chloride | µg/L | 0.02 | **0.13** | **0.052** | **0.066** | **0.14** | **0.14** | **0.12** |
| 1,1-Dichloroethane | µg/L | 7.7 | 0.3 U | 0.3 U | 0.3 UJ | 0.3 U | 0.3 U | 0.3 U |
| 1,1-Dichloroethene | µg/L | 7 | 0.5 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 U | 0.5 U |
| Trichloroethene | µg/L | 0.3 | 0.3 U | 0.3 U | 0.3 UJ | 0.3 U | 0.3 U | 0.3 U |

| | | **Location Name** | NP-B125 | NP-B125 |
|---|---|---|---|---|
| | | **Sample Name** | NP-B125-GW-23-190619 | NP-B125-GW-39-190619 |
| | | **Sample Collection Date** | 6/19/2019 | 6/19/2019 |
| | | **Screen Interval (ft bgs)** | 18 - 23 | 35 - 39 |
| | | **Sample Type** | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/L | 0.48 | 0.3 U | 0.3 U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 U | 0.3 U |
| Cis-1,2-Dichloroethene | µg/L | 16 | 0.3 U | 0.3 U |
| Trans-1,2-Dichloroethene | µg/L | 100 | 0.3 U | 0.3 U |
| 1,1,1-Trichloroethane | µg/L | 200 | 0.3 U | 0.3 U |
| Chloroethane | µg/L | 7.7 | 0.5 U | 0.5 U |
| Vinyl Chloride | µg/L | 0.02 | **0.023** | **0.1** |
| 1,1-Dichloroethane | µg/L | 7.7 | 0.3 U | 0.3 U |
| 1,1-Dichloroethene | µg/L | 7 | 0.5 U | 0.5 U |
| Trichloroethene | µg/L | 0.3 | 0.3 U | 0.3 U |

## Table B3-14. Target VOCs in Grab Groundwater Samples – 2019 (continued)

**Notes:**
Samples analyzed using EPA Method 8260C
FD - Field Duplicate
J - The reported value is an estimated concentration.
N – Sample is not part pof a field duplicate pair
P – Parent sample of field duplicate
PAL - Project Action Limit
U - The analyte was not detected at or above the stated limit. (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
UJ - The analyte was not detected at or above the sample quantitation limit, which is an estimated value.
Underlined values represent analytes not detected at or above the stated limit, which exceeds the PAL.
**Bolded** values indicate that the reported concentration exceeds the PAL.
µg/L - micrograms per liter

## Table B3-15. TPH in Grab Groundwater Samples - 2019

| Location Name | Sample Name | Sample Collection Date | Screened Interval (ft bgs) | Sample Type | PAL (µg/L) | TPH-Diesel range C12-C24 (µg/L) |
|---|---|---|---|---|---|---|
| NP-B118 | NP-B118-GW-20-190624 | 6/24/2019 | 16 - 20 | N | 500 | 310 |
| | NP-B118-GW-35-190625 | 6/25/2019 | 31 - 35 | N | 500 | 50 U |
| NP-B119 | NP-B119-GW-15-190621 | 6/21/2019 | 10 - 15 | N | 500 | 410 |
| | NP-B119-GW-32-190621 | 6/21/2019 | 28 - 32 | N | 500 | **1,200 J** |
| NP-B120 | NP-B120-GW-15-190624 | 6/24/2019 | 11 - 15 | N | 500 | 320 |
| | NP-B120-GW-50-190624 | 6/24/2019 | 46 - 50 | N | 500 | 210 |
| NP-B121 | NP-B121-GW-15-190620 | 6/20/2019 | 10 - 15 | N | 500 | 260 |
| | NP-B121-GW-35-190620 | 6/20/2019 | 31 - 35 | N | 500 | 150 |
| NP-B122 | NP-B122-GW-15-190620 | 6/20/2019 | 10 - 15 | N | 500 | **920** |
| | NP-B122-GW-28-190621 | 6/21/2019 | 24 - 28 | N | 500 | 50 U |
| NP-B123 | NP-B123-GW-19-190619 | 6/19/2019 | 15 - 19 | P | 500 | 300 U |
| | NP-B123-GW-20-190619 | 6/19/2019 | 15 - 19 | FD | 500 | 390 U |
| | NP-B123-GW-40-190619 | 6/19/2019 | 36 - 40 | N | 500 | 210 U |
| NP-B124 | NP-B124-GW-20-190620 | 6/20/2019 | 15 - 20 | N | 500 | 260 |
| | NP-B124-GW-29-190620 | 6/20/2019 | 25 - 29 | N | 500 | 50 U |
| NP-B125 | NP-B125-GW-23-190619 | 6/19/2019 | 18 - 23 | N | 500 | 260 U |
| | NP-B125-GW-39-190619 | 6/19/2019 | 35 - 39 | N | 500 | 50 U |

**Notes:**
Samples analyzed using EPA Method NWTPH-Dx
FD - Field Duplicate
J - The reported value is an estimated concentration.
N – Sample is not part of a duplicate pair.
P – Parent sample of field duplicate
PAL - Project Action Limit
U - The analyte was analyzed but not detected at or above the stated limit. (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
**Bolded** values indicate that the reported concentration exceeds the PAL.
µg/L - micrograms per liter

**Table B3-16. PCB Aroclors in Grab Groundwater Samples - 2019**

| | | **Location Name** | NP-B118 | NP-B118 | NP-B119 | NP-B119 | NP-B120 | NP-B120 | NP-B121 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | NP-B118-GW-20-190624 | NP-B118-GW-35-190625 | NP-B119-GW-15-190621 | NP-B119-GW-32-190621 | NP-B120-GW-15-190624 | NP-B120-GW-50-190624 | NP-B121-GW-15-190620 |
| | | **Sample Collection Date** | 6/24/2019 | 6/25/2019 | 6/21/2019 | 6/21/2019 | 6/24/2019 | 6/24/2019 | 6/20/2019 |
| | | **Screened Interval (ft bgs)** | 16 - 20 | 31 - 35 | 10 - 15 | 28 - 32 | 11 - 15 | 46 - 50 | 10 - 15 |
| | | **Sample type** | N | N | N | N | N | N | N |
| **Analyte Name** | **Units** | **PAL (µg/L)** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| AROCLOR-1016 | µg/L | 0.003 | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| AROCLOR-1221 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| AROCLOR-1232 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| AROCLOR-1242 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| AROCLOR-1248 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| AROCLOR-1254 | µg/L | 0.0001 | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| AROCLOR-1260 | µg/L | 0.0001 | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| AROCLOR-1262 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| AROCLOR-1268 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| Total PCB Aroclors | µg/L | 0.000007 | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |

| | | **Location Name** | NP-B121 | NP-B122 | NP-B122 | NP-B123 | NP-B123 | NP-B123 | NP-B124 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | NP-B121-GW-35-190620 | NP-B122-GW-15-190620 | NP-B122-GW-28-190621 | NP-B123-GW-19-190619 | NP-B123-GW-20-190619 | NP-B123-GW-40-190619 | NP-B124-GW-20-190620 |
| | | **Sample Collection Date** | 6/20/2019 | 6/20/2019 | 6/21/2019 | 6/19/2019 | 6/19/2019 | 6/19/2019 | 6/20/2019 |
| | | **Screened Interval (ft bgs)** | 31 - 35 | 10 - 15 | 24 - 28 | 15 - 19 | 15 - 19 | 36 - 40 | 15 - 20 |
| | | **Sample type** | N | N | N | P | FD | N | N |
| **Analyte Name** | **Units** | **PAL (µg/L)** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| AROCLOR-1016 | µg/L | 0.003 | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| AROCLOR-1221 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| AROCLOR-1232 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| AROCLOR-1242 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| AROCLOR-1248 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| AROCLOR-1254 | µg/L | 0.0001 | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| AROCLOR-1260 | µg/L | 0.0001 | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| AROCLOR-1262 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| AROCLOR-1268 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| Total PCB Aroclors | µg/L | 0.000007 | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |

## Table B3-16. PCB Aroclors in Grab Groundwater Samples – 2019 (continued)

| | | **Location Name** | NP-B124 | NP-B125 | NP-B125 |
|---|---|---|---|---|---|
| | | **Sample Name** | NP-B124-GW-29-190620 | NP-B125-GW-23-190619 | NP-B125-GW-39-190619 |
| | | **Sample Collection Date** | 6/20/2019 | 6/19/2019 | 6/19/2019 |
| | | **Screened Interval (ft bgs)** | 25 - 29 | 18 - 23 | 35 - 39 |
| | | **Sample type** | N | N | N |
| **Analyte Name** | **Units** | **PAL (µg/L)** | **Result** | **Result** | **Result** |
| AROCLOR-1016 | µg/L | 0.003 | <u>0.008 U</u> | <u>0.008 UJ</u> | <u>0.008 UJ</u> |
| AROCLOR-1221 | µg/L | NE | 0.008 U | 0.008 UJ | 0.008 UJ |
| AROCLOR-1232 | µg/L | NE | 0.008 U | 0.008 UJ | 0.008 UJ |
| AROCLOR-1242 | µg/L | NE | 0.008 U | 0.008 UJ | 0.008 UJ |
| AROCLOR-1248 | µg/L | NE | 0.008 U | 0.008 UJ | 0.008 UJ |
| AROCLOR-1254 | µg/L | 0.0001 | <u>0.008 U</u> | <u>0.008 UJ</u> | <u>0.008 UJ</u> |
| AROCLOR-1260 | µg/L | 0.0001 | <u>0.008 U</u> | <u>0.008 UJ</u> | <u>0.008 UJ</u> |
| AROCLOR-1262 | µg/L | NE | 0.008 U | 0.008 UJ | 0.008 UJ |
| AROCLOR-1268 | µg/L | NE | 0.008 U | 0.008 UJ | 0.008 UJ |
| Total PCB Aroclors | µg/L | 0.000007 | <u>0.008 U</u> | <u>0.008 UJ</u> | <u>0.008 UJ</u> |

**Notes:**
Samples analyzed using EPA Method 8082 A
FD - Field Duplicate
J - The result is an estimated concentration that is less than the LOQ, but greater than or equal to the DL.
N – Sample is not part of a duplicate pair.
P – Parent sample of field duplicate
PAL - Project Action Limit
U - The compound was analyzed for, but was not detected ("nondetect") at or above the LOD.
UJ - The analyte was not detected at the stated sample quantitation limit, which is an estimated value
<u>Underlined</u> values represent analytes not detected at or above the stated limit, which exceeds the PAL.
**Bolded** values indicate that the reported concentration exceeds the PAL.
µg/L -micrograms per liter

## Table B3-17. 1,4-Dioxane in Grab Groundwater Samples - 2019

| Location Name | Sample Name | Sample Collection Date | Screened Interval (ft bgs) | Sample Type | PAL (µg/L) | 1,4-Dioxane (µg/L) |
|---|---|---|---|---|---|---|
| CL-B102 | CL-B102-GW-13-190617 | 6/17/2019 | 8 - 13 | N | 0.44 | **5** |
| | CL-B102-GW-35-190617 | 6/17/2019 | 31 - 35 | N | 0.44 | 0.6U |
| CL-B103 | CL-B103-GW-09-190617 | 6/17/2019 | 4 - 9 | N | 0.44 | **4.2** |
| | CL-B103-GW-40-190617 | 6/17/2019 | 36 - 40 | N | 0.44 | 0.6U |
| CL-B105 | CL-B105-GW-15-190612 | 6/12/2019 | 10 - 15 | N | 0.44 | **42** |
| | CL-B105-GW-40-190612 | 6/12/2019 | 36 - 40 | N | 0.44 | **3.6** |
| CL-B106 | CL-B106-GW-20-190610 | 6/10/2019 | 15 - 20 | N | 0.44 | 0.6U |
| | CL-B106-GW-32-190610 | 6/10/2019 | 28 - 32 | N | 0.44 | 0.6U |
| CL-B107 | CL-B107-GW-10-190611 | 6/11/2019 | 5 - 10 | N | 0.44 | 0.6U |
| | CL-B107-GW-32-190611 | 6/11/2019 | 28 - 32 | N | 0.44 | 0.6U |
| CL-B108 | CL-B108-GW-12-190611 | 6/11/2019 | 7 - 12 | N | 0.44 | 0.6U |
| | CL-B108-GW-25-190611 | 6/11/2019 | 21 - 25 | N | 0.44 | 0.6U |
| CL-B109 | CL-B109-GW-15-190611 | 6/11/2019 | 10 - 15 | N | 0.44 | **4.4** |
| | CL-B109-GW-37-190611 | 6/11/2019 | 33 - 37 | N | 0.44 | 0.6U |
| CL-B134 | CL-B134-GW-49-191003 | 10/3/2019 | 45 - 50 | FD | 0.44 | 0.6U |
| | CL-B134-GW-50-191003 | 10/3/2019 | 45 - 50 | P | 0.44 | 0.6U |
| NP-B110 | NP-B110-GW-15-190612 | 6/12/2019 | 10 - 15 | P | 0.44 | **28** |
| | QC-190612-02 | 6/12/2019 | 10 - 15 | FD | 0.44 | **27** |
| | NP-B110-GW-40-190612 | 6/12/2019 | 36 - 40 | N | 0.44 | 0.6U |
| NP-B111 | NP-B111-GW-17-190612 | 6/12/2019 | 12 - 17 | N | 0.44 | **7** |
| | NP-B111-GW-40-190612 | 6/12/2019 | 36 - 40 | N | 0.44 | 0.6U |
| NP-B112 | NP-B112-GW-15-190614 | 6/14/2019 | 10 - 15 | N | 0.44 | 0.6U |
| | NP-B112-GW-31-190614 | 6/14/2019 | 27 - 31 | N | 0.44 | 0.6U |
| NP-B113 | NP-B113-GW-15-190613 | 6/13/2019 | 10 - 15 | N | 0.44 | **70** |
| NP-B114 | NP-B114-GW-15-190613 | 6/13/2019 | 10 - 15 | N | 0.44 | **24** |
| | NP-B114-GW-40-190613 | 6/13/2019 | 35 - 40 | N | 0.44 | **1.4** |
| NP-B115 | NP-B115-GW-15-190614 | 6/14/2019 | 10 - 15 | N | 0.44 | 0.6U |
| | NP-B115-GW-27-190614 | 6/14/2019 | 23 - 27 | N | 0.44 | 0.6U |
| NP-B116 | NP-B116-GW-14-190621 | 6/21/2019 | 10 - 15 | FD | 0.44 | **3.2** |
| | NP-B116-GW-15-190621 | 6/21/2019 | 10 - 15 | P | 0.44 | **3.5** |
| | NP-B116-GW-36-190624 | 6/24/2019 | 32 - 36 | N | 0.44 | **50** |
| NP-B117s | NP-B117S-GW-15-190613 | 6/13/2019 | 10 - 15 | N | 0.44 | **10** |
| | NP-B117S-GW-40-190613 | 6/13/2019 | 35 - 40 | N | 0.44 | **73** |

## Table B3-17. 1,4-Dioxane in Grab Groundwater Samples – 2019 (continued)

| Location Name | Sample Name | Sample Collection Date | Screened Interval (ft bgs) | Sample Type | PAL (µg/L) | 1,4-Dioxane (µg/L) |
|---|---|---|---|---|---|---|
| NP-B118 | NP-B118-GW-20-190624 | 6/24/2019 | 16 - 20 | N | 0.44 | **0.98**J |
| | NP-B118-GW-35-190625 | 6/25/2019 | 31 - 35 | N | 0.44 | 0.6U |
| NP-B119 | NP-B119-GW-15-190621 | 6/21/2019 | 10 - 15 | N | 0.44 | 0.6U |
| | NP-B119-GW-32-190621 | 6/21/2019 | 28 - 32 | N | 0.44 | 0.6U |
| NP-B120 | NP-B120-GW-15-190624 | 6/24/2019 | 11 - 15 | N | 0.44 | **16** |
| | NP-B120-GW-50-190624 | 6/24/2019 | 46 - 50 | N | 0.44 | **30** |
| NP-B121 | NP-B121-GW-15-190620 | 6/20/2019 | 10 - 15 | N | 0.44 | 0.6U |
| | NP-B121-GW-35-190620 | 6/20/2019 | 31 - 35 | N | 0.44 | 0.6U |
| NP-B122 | NP-B122-GW-15-190620 | 6/20/2019 | 10 - 15 | N | 0.44 | 0.6U |
| | NP-B122-GW-28-190621 | 6/21/2019 | 24 - 28 | N | 0.44 | 0.6U |
| NP-B123 | NP-B123-GW-19-190619 | 6/19/2019 | 15 - 19 | P | 0.44 | 0.6U |
| | NP-B123-GW-20-190619 | 6/19/2019 | 15 - 19 | FD | 0.44 | 0.6U |
| | NP-B123-GW-40-190619 | 6/19/2019 | 36 - 40 | N | 0.44 | 0.6U |
| NP-B124 | NP-B124-GW-20-190620 | 6/20/2019 | 15 - 20 | N | 0.44 | 0.6U |
| | NP-B124-GW-29-190620 | 6/20/2019 | 25 - 29 | N | 0.44 | 0.6U |
| NP-B125 | NP-B125-GW-23-190619 | 6/19/2019 | 18 - 23 | N | 0.44 | 0.6U |
| | NP-B125-GW-39-190619 | 6/19/2019 | 35 - 39 | N | 0.44 | 0.6U |

**Notes:**
Samples analyzed using EPA Method 8270D.
FD - Field Duplicate
J - The reported value is an estimated concentration.
N – Sample is not part of a field duplicate pair
P – Parent sample of field duplicate
PAL - Project Action Limit
U - The analyte was not detected at or above the stated limit. (sometimes validators will elevate the limit due to the "B" qualifier
using the 5x/10x rule so this definition is different than the lab description).
Underlined values represent analytes not detected at or above the stated limit, which exceeds the PAL.
**Bolded** values indicate that the reported concentration exceeds the PAL.
µg/L – micrograms per liter

**Table B3-18. Table B3-18. Target VOCs in Groundwater Monitoring Wells - 2019 and 2022**

| | | **Location Name** | MW1-42 | MW1-43 | MW1-44 | MW1-45 | MW1-46 | | MW1-47 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | MW1-42-191022 | MW1-43-191023 | MW1-44-191024 | MW1-45-191022 | MW1-46-191025 | FD-191025-01 | MW1-47-191025 |
| | | **Sample Collection Date** | 10/22/2019 | 10/23/2019 | 10/24/2019 | 10/22/2019 | 10/25/2019 | 10/25/2019 | 10/25/2019 |
| | | **Screened Interval (ft bgs)** | 15 - 25 | 15 - 25 | 18 - 28 | 15 - 25 | 24 - 34 | 24 - 34 | 15 - 25 |
| | | **Sample Type** | N | N | N | N | P | FD | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/L | 0.48 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Cis-1,2-Dichloroethene | µg/L | 16 | 12 | **610 J** | **3,900 J** | **470 J** | **4,700 J** | **4,500 J** | **1,800 J** |
| Trans-1,2-Dichloroethene | µg/L | 100 | 19 | 95 | 25 | 0.83 J | 55 | 61 | 25 |
| 1,1,1-Trichloroethane | µg/L | 200 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Chloroethane | µg/L | 7.7 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 4.8 | 0.5 U |
| Vinyl Chloride | µg/L | 0.02 | **27** | **340 J** | **470 J** | **160** | **1,100 J** | **1,100 J** | **620 J** |
| 1,1-Dichloroethane | µg/L | 7.7 | 6.2 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| 1,1-Dichloroethene | µg/L | 7 | 0.5 U | 3.1 | **32** | 3.2 | **11** | **13** | 4.6 |
| Trichloroethene | µg/L | 0.3 | **1.3** | 6 UJ | 15 UJ | 0.3 UJ | 15 UJ | **56 J** | 6 UJ |

| | | **Location Name** | MW1-48 | MW1-49 | | MW1-50 | MW1-51 | MW1-52 | MW1-53 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | MW1-48-191028 | MW1-49-191022 | FD-191022-01 | MW1-50-191023 | MW1-51-191021 | MW1-52-191021 | MW1-53-191023 |
| | | **Sample Collection Date** | 10/28/2019 | 10/22/2019 | 10/22/2019 | 10/23/2019 | 10/21/2019 | 10/21/2019 | 10/23/2019 |
| | | **Screened Interval (ft bgs)** | 15 - 25 | 5 - 15 | 5 - 15 | 5 - 15 | 10 - 20 | 7 - 17 | 5 - 15 |
| | | **Sample Type** | N | P | FD | N | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/L | 0.48 | 0.3 U | 0.3 U | 0.3 U | 0.3 R | 0.3 U | 0.3 U | 0.3 U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 U | 0.3 U | 0.3 U | 0.3 R | 0.3 U | 0.3 U | 0.3 U |
| Cis-1,2-Dichloroethene | µg/L | 16 | 0.3 U | **1,300 J** | **1,300 J** | **400 J** | **26** | **510 J** | **760 J** |
| Trans-1,2-Dichloroethene | µg/L | 100 | 0.3 U | 19 | 21 | 4.3 J | 0.3 U | 5.5 | 43 |
| 1,1,1-Trichloroethane | µg/L | 200 | 0.3 U | 0.3 U | 0.3 U | 0.3 R | 0.3 U | 0.3 U | 0.3 U |
| Chloroethane | µg/L | 7.7 | 0.5 U | 1.8 J | 0.59 J | 0.5 R | 0.5 U | 0.5 U | 0.5 U |
| Vinyl Chloride | µg/L | 0.02 | **0.28 J** | **100 J** | **84 J** | **27 J** | **33** | **120** | **220 J** |
| 1,1-Dichloroethane | µg/L | 7.7 | 0.3 U | 0.3 U | 0.3 U | 0.3 R | 0.3 U | 0.3 U | 0.3 U |
| 1,1-Dichloroethene | µg/L | 7 | 0.5 U | **8.8** | **9.1** | 0.59 J | 0.5 U | 1.7 | 4.2 |
| Trichloroethene | µg/L | 0.3 | 0.3 U | **940 J** | **990 J** | **420 J** | 0.3 U | 0.3 U | **130 J** |

**Table B3-18. Table B3-18. Target VOCs in Groundwater Monitoring Wells - 2019 and 2022 (continued)**

| | | **Location Name** | MW1-54 | MW1-55 | MW1-56 | MW1-56 | MW1-57 | MW1-57 | MW1-57 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | MW1-54-191021 | MW1-55-191024 | MW1-56-12-191023 | MW1-56-24-191023 | MW1-57-10-191022 | MW1-57-16-191022 | MW1-57-32-191022 |
| | | **Sample Collection Date** | 10/21/2019 | 10/24/2019 | 10/23/2019 | 10/23/2019 | 10/22/2019 | 10/22/2019 | 10/22/2019 |
| | | **Screened Interval (ft bgs)** | 29 - 39 | 26.5 - 36.5 | 8 - 12 | 20 - 24 | 6 - 10.5 | 12 - 16 | 26 - 31 |
| | | **Sample Type** | N | N | N | N | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/L | 0.48 | 0.3 U | 0.3 U | 0.3 U | 0.3 UJ | 150 U | 0.3 U | 0.3 U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 U | 0.3 U | **19** | **110 J** | 150 U | **55 J** | 1.6 |
| Cis-1,2-Dichloroethene | µg/L | 16 | 0.3 UJ | **130 J** | **200,000 J** | **71,000 J** | **260,000 J** | **130,000 J** | **1,800 J** |
| Trans-1,2-Dichloroethene | µg/L | 100 | 0.3 U | 3.7 | **2,900** | **1,200** | **2,000** | **3,000 J** | 46 |
| 1,1,1-Trichloroethane | µg/L | 200 | 0.3 U | 0.3 | 0.3 U | 0.3 UJ | 150 U | 0 U | 0 U |
| Chloroethane | µg/L | 7.7 | 0.5 U | 0.5 | 0.5 U | 0.5 UJ | 250 U | 0.5 U | 0.5 U |
| Vinyl Chloride | µg/L | 0.02 | 0.015 U | **24 J** | **890 J** | **72 J** | **8,700** | **200 J** | **230 J** |
| 1,1-Dichloroethane | µg/L | 7.7 | 0.3 U | 0.3 U | 0.3 U | 0.3 UJ | 150 U | 0.3 U | 0.3 U |
| 1,1-Dichloroethene | µg/L | 7 | 0.5 U | 1.7 | **78 J** | **43 J** | 250 U | **74 J** | 3.6 |
| Trichloroethene | µg/L | 0.3 | 0.3 UJ | **3.1** | **170,000 J** | **590,000 J** | **250,000 J** | **230,000 J** | **4,600 J** |

| | | **Location Name** | MW1-58 | MW1-58 | MW1-58 | MW1-59 | MW1-60 | MW1-61 | MW1-62 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | MW1-58-9-191024 | MW1-58-19-191024 | MW1-58-39.5-191024 | MW1-59-191023 | MW1-60-191023 | MW1-61-191028 | MW1-62-191024 |
| | | **Sample Collection Date** | 10/24/2019 | 10/24/2019 | 10/24/2019 | 10/23/2019 | 10/23/2019 | 10/28/2019 | 10/24/2019 |
| | | **Screened Interval (ft bgs)** | 5 - 9 | 15 - 19 | 31 - 35 | 60 - 70 | 15 - 25 | 3 - 13 | 31 - 41 |
| | | **Sample Type** | N | N | N | N | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/L | 0.48 | 30 U | 0.3 U | 0.3 UJ | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Tetrachloroethene | µg/L | 2.4 | 30 U | 0.3 U | 0.3 UJ | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Cis-1,2-Dichloroethene | µg/L | 16 | **6,900** | 3.1 | 2.1 J | 0.3 U | 0.3 UJ | 13 | **1,200 J** |
| Trans-1,2-Dichloroethene | µg/L | 100 | **140** | 3.3 | 0.15 J | 0.3 U | 0.3 U | 0.89 J | 27 |
| 1,1,1-Trichloroethane | µg/L | 200 | 30 U | 0.3 U | 0.3 UJ | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Chloroethane | µg/L | 7.7 | 50 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Vinyl Chloride | µg/L | 0.02 | **19,000 J** | **9.1** | **5.2 J** | 0.015 U | 0.015 U | **61** | **300 J** |
| 1,1-Dichloroethane | µg/L | 7.7 | 30 U | 0.3 U | 0.3 UJ | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| 1,1-Dichloroethene | µg/L | 7 | 50 U | 0.5 U | 0.5 UJ | 0.5 U | 0.5 U | 0.5 U | 3.9 |
| Trichloroethene | µg/L | 0.3 | **370** | 0.3 U | 0.3 UJ | 0.3 U | 0.3 UJ | 0.3 U | **34 J** |

**Table B3-18. Table B3-18. Target VOCs in Groundwater Monitoring Wells - 2019 and 2022 (continued)**

| | | **Location Name** | MW1-63 | MW1-64 | MW1-65 | MW1-66 | MW1-67 | MW1-68 | MW1-69 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | MW1-63-191025 | MW1-64-191024 | MW1-65-191021 | MW1-66-191024 | MW1-67-191028 | MW1-68-191028 | MW1-69-220511 |
| | | **Sample Collection Date** | 10/25/2019 | 10/24/2019 | 10/21/2019 | 10/24/2019 | 10/28/2019 | 10/28/2019 | 5/11/2022 |
| | | **Screened Interval (ft bgs)** | 30 - 40 | 45 - 55 | 53 - 63 | 5 - 20 | 5 - 15 | 37 - 47 | 42 - 52 |
| | | **Sample Type** | N | N | N | N | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/L | 0.48 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.15 U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 U | 0.3 U | 0.3 U | **42 J** | 0.3 U | 0.3 U | 0.25 U |
| Cis-1,2-Dichloroethene | µg/L | 16 | **4,200 J** | **2,200 J** | **350 J** | **96,000 J** | 0.3 U | 3.4 | 7.1 |
| Trans-1,2-Dichloroethene | µg/L | 100 | 53 | 52 | 9.1 | **1,500 J** | 0.3 U | 0.3 U | 0.14 J |
| 1,1,1-Trichloroethane | µg/L | 200 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.07 U |
| Chloroethane | µg/L | 7.7 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.25 U |
| Vinyl Chloride | µg/L | 0.02 | **570 J** | **390 J** | **58** | **2,200 J** | **0.05** | **0.062** | **0.76** |
| 1,1-Dichloroethane | µg/L | 7.7 | **10** | 4.9 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.07 U |
| 1,1-Dichloroethene | µg/L | 7 | **12** | **7.8** | 1.4 | **73 J** | 0.5 U | 0.5 U | 0.07 U |
| Trichloroethene | µg/L | 0.3 | **20 J** | <u>15 UJ</u> | **1.3** | **280,000 J** | **35** | **35** | **1.9** |

| | | **Location Name** | MW1-70 | MW1-71 | MW1-72 | | MW1-73 | MW1-74 | MW1-75 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | MW1-70-220502 | MW1-71-220512 | MW1-72-220512 | FD-220512-02 | MW1-73-220513 | MW1-74-220718 | MW1-75-220718 |
| | | **Sample Collection Date** | 5/2/2022 | 5/12/2022 | 5/12/2022 | 5/12/2022 | 5/13/2022 | 7/18/2022 | 7/18/2022 |
| | | **Screened Interval (ft bgs)** | 70 - 80 | 95 - 100 | 60 - 70 | 60 - 70 | 90 - 100 | 45 - 55 | 75 - 80 |
| | | **Sample Type** | N | N | P | FD | N | N | N |
| **Analyte Name** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/L | 0.48 | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U | 0.15 U |
| Tetrachloroethene | µg/L | 2.4 | 0.25 U | 0.25 U | 0.25 U | 0.25 U | 0.25 U | 0.25 U | 0.25 U |
| Cis-1,2-Dichloroethene | µg/L | 16 | 14 | 0.15 U | 0.15 U | 0.47 | 0.15 U | 0.15 U | 0.15 U |
| Trans-1,2-Dichloroethene | µg/L | 100 | 0.07 U | 0.07 U | 0.07 U | 0.07 U | 0.07 U | 0.07 U | 0.07 U |
| 1,1,1-Trichloroethane | µg/L | 200 | 0.07 U | 0.07 U | 0.07 U | 0.07 U | 0.07 U | 0.07 U | 0.07 U |
| Chloroethane | µg/L | 7.7 | 0.25 U | 0.25 U | 0.25 U | 0.25 U | 0.25 U | 0.25 U | 0.25 U |
| Vinyl Chloride | µg/L | 0.02 | **0.99** | 0.015 U | **0.14** | 0.015 U | 0.015 U | 0.015 U | 0.015 U |
| 1,1-Dichloroethane | µg/L | 7.7 | 0.07 U | 0.07 U | 0.07 U | 0.07 U | 0.07 U | 0.07 U | 0.07 U |
| 1,1-Dichloroethene | µg/L | 7 | 0.07 U | 0.07 U | 0.07 U | 0.07 U | 0.07 U | 0.07 U | 0.07 U |
| Trichloroethene | µg/L | 0.3 | **41** | 0.15 U | 0.15 U | 0.15 U | 0.094 J | 0.15 U | 0.15 U |

## Table B3-18. Table B3-18. Target VOCs in Groundwater Monitoring Wells - 2019 and 2022 (continued)

**Notes:**
Samples analyzed using EPA Method 8260C
FD - Field Duplicate
J - The reported value is an estimated concentration.
N – Sample is not part pof a field duplicate pair
P – Parent sample of field duplicate
PAL - Project Action Limit
R - The reported value is unusable, rejected.
U - The analyte was not detected at or above the stated limit. (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
UJ - The analyte was not detected at or above the sample quantitation limit, which is an estimated value.
Underlined values represent analytes not detected at or above the stated limit, which exceeds the PAL.
**Bolded** values indicate that the reported concentration exceeds the PAL.
µg/L - micrograms per liter

## Table B3-19. TPH in Groundwater Monitoring Wells - 2019

| Location Name | Sample Name | Sample Collection Date | Screened Interval (ft bgs) | Sample Type | PAL (µg/L) | TPH-Diesel range C12-C24 (µg/L) |
|---|---|---|---|---|---|---|
| MW1-42 | MW1-42-191022 | 10/22/2019 | 15 - 25 | N | 500 | 96 |
| MW1-43 | MW1-43-191023 | 10/23/2019 | 15 - 25 | N | 500 | 110 |
| MW1-44 | MW1-44-191024 | 10/24/2019 | 18 - 28 | N | 500 | 48 J |
| MW1-45 | MW1-45-191022 | 10/22/2019 | 15 - 25 | N | 500 | 44 J |
| MW1-46 | MW1-46-191025 | 10/25/2019 | 24 - 34 | P | 500 | 110 |
| | FD-191025-01 | 10/25/2019 | 24 - 34 | FD | 500 | 120 |
| MW1-47 | MW1-47-191025 | 10/25/2019 | 15 - 25 | N | 500 | **690** |
| MW1-48 | MW1-48-191028 | 10/28/2019 | 15 - 25 | N | 500 | **780** |
| MW1-62 | MW1-62-191024 | 10/24/2019 | 31 - 41 | N | 500 | 350 |
| MW1-63 | MW1-63-191025 | 10/25/2019 | 30 - 40 | N | 500 | 220 |
| MW1-64 | MW1-64-191024 | 10/24/2019 | 45 - 55 | N | 500 | 270 |
| MW1-65 | MW1-65-191021 | 10/21/2019 | 53 - 63 | N | 500 | 48 J |
| MW1-67 | MW1-67-191028 | 10/28/2019 | 5 - 15 | N | 500 | **780** |

**Notes:**
Samples analyzed using EPA Method NWTPH-Dx
FD - Field Duplicate
J - The reported value is an estimated concentration.
N – Sample is not part of a duplicate pair.
P – Parent sample of field duplicate
PAL - Project Action Limit
**Bolded** values indicate that the reported concentration exceeds the PAL.
µg/L - micrograms per liter

**Table B3-20**. PCB Congeners in Groundwater Monitoring Wells - 2019 and 2022

| **Location Name** | | | MW1-2 | | MW1-18 | MW1-64 | MW1-65 | MW1-67 | MW1-69 | MW1-70 | MW1-71 | MW1-72 | | MW1-73 | MW1-74 | MW1-75 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Name** | | | MW1-2-191029 | FD-191029-01 | MW1-18-191021 | MW1-64-191024 | MW1-65-191021 | MW1-67-191028 | MW1-69-220511 | MW1-70-220502 | MW1-71-220512 | MW1-72-220512 | FD-220512-02 | MW1-73-220513 | MW1-74-2200718 | MW1-75-220718 |
| **Sample Collection Date** | | | 10/29/2019 | 10/29/2019 | 10/21/2019 | 10/24/2019 | 10/21/2019 | 10/28/2019 | 5/11/2022 | 5/2/2022 | 5/12/2022 | 5/12/2022 | 5/12/2022 | 5/13/2022 | 7/18/2022 | 7/18/2022 |
| **Screened Interval (ft bgs)** | | | 12.5 - 17.5 | 12.5 - 17.5 | 12 - 17 | 45 - 55 | 53 - 63 | 5 - 15 | 42 - 52 | 70 - 80 | 95 - 100 | 60 - 70 | 60 - 70 | 90 - 100 | 45 - 55 | 75 - 80 |
| **Sample Type** | | | P | FD | N | N | N | N | N | N | N | P | FD | N | N | N |
| **Analyte** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| PCB-001 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 8.1 J | 11 J | 520 | 69 U | **4.8 J** | 700 U | 68 U | 68 U | 68 U | 67 U | 69 U |
| PCB-002 | pg/L | NA | 19 U | 19 U | 1.8 J | 19 U | 19 U | 38 J | 49 U | **1.6 J** | 500 U | 49 U | 48 U | 49 U | 48 U | 49 U |
| PCB-003 | pg/L | NA | 9.5 U | 9.5 U | 0.9 J | 9.5 U | 1.7 J | 77 J | 39 U | **5 J** | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-004 | pg/L | NA | 24 U | 24 U | 24 U | 26 J | 24 U | 1,900 | **130** | 48 U | **300 J** | 43 U | 43 U | 43 U | 42 U | 43 U |
| PCB-005 | pg/L | NA | 24 U | 24 U | 24 U | 24 U | 24 U | 49 J | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-006 | pg/L | NA | 24 U | 24 U | 24 U | 24 U | 24 U | 410 | **21 J** | 19 U | **550** | 35 U | 35 U | 35 U | 34 U | 35 U |
| PCB-007 | pg/L | NA | 24 U | 24 U | 24 U | 24 U | 24 U | 51 J | 34 U | 19 U | 350 U | 34 U | 34 U | 34 U | 33 U | 34 U |
| PCB-008 | pg/L | NA | 24 U | 24 U | 24 U | 11 J | 24 U | 710 | **61** | **61 J** | **200 J** | 32 U | 32 U | 32 U | 32 U | 32 U |
| PCB-009 | pg/L | NA | 47 U | 48 U | 47 U | 48 U | 48 U | 81 J | 34 U | 29 U | 350 U | 34 U | 34 U | 34 U | 33 U | 34 U |
| PCB-010 | pg/L | NA | 47 U | 48 U | 47 U | 48 U | 48 U | 110 J | 43 U | 29 U | 440 U | 43 U | 43 U | 43 U | 42 U | 43 U |
| PCB-011 | pg/L | NA | 24 U | 24 U | 24 U | 16 U | 24 U | 24 U | 270 U | **110 J** | 2,800 U | 270 U | 270 U | 270 U | 260 U | 270 U |
| PCB-012 AND 013 | pg/L | NA | 38 U | 38 U | 38 U | 38 U | 39 U | 37 J | 69 U | 96 U | 700 U | 68 U | 68 U | 68 U | 67 U | 69 U |
| PCB-014 | pg/L | NA | 24 U | 24 U | 24 U | 24 U | 24 U | 24 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-015 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 110 J | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-016 | pg/L | NA | 47 U | 48 U | 47 U | 9.3 J | 5.7 J | 230 | **44** | **38 J** | **240 J** | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-017 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 11 J | 5.1 J | 270 | **38 J** | **38 J** | **420** | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-018 AND 030 | pg/L | | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | **76 J** | **71 J** | **5,400** | 49 U | 48 U | 49 U | 48 U | 49 U |
| PCB-019 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 6.8 J | 3.5 J | 200 | **34 J** | **11 J** | **310 J** | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-020 AND 028 | pg/L | | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | **43 J** | **110 J** | **470 J** | 58 U | 58 U | 58 U | 57 U | 59 U |
| PCB-021 AND 033 | pg/L | NA | 38 U | 38 U | 38 U | 5.3 J | 3.7 J | 90 J | 59 U | **73 J** | 600 U | 58 U | 58 U | 58 U | 57 U | 59 U |
| PCB-022 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 3.4 J | 1.6 J | 76 J | **14 J** | **39 J** | 300 U | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-023 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 30 U | 19 U | 300 U | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-024 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 7.5 J | 34 U | 19 U | 350 U | 34 U | 34 U | 34 U | 33 U | 34 U |
| PCB-025 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 90 J | 30 U | **8.1 J** | **760** | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-026 AND 029 | pg/L | NA | 38 U | 38 U | 38 U | 3.5 J | 1.8 J | 230 J | 71 U | **20 J** | **3,200** | 70 U | 70 U | 70 U | 69 U | 71 U |
| PCB-027 | pg/L | NA | 19 U | 19 U | 19 U | 2.6 J | 19 U | 64 J | 25 U | **6.7 J** | **380 J** | 24 U | 24 U | 24 U | 24 U | 25 U |
| PCB-028 AND 020 | pg/L | NA | 38 U | 38 U | 3 J | 12 U | 7 J | 280 J | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-030 AND 018 | pg/L | NA | 47 U | 48 U | 2.2 J | 20 J | 11 J | 530 | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-031 | pg/L | NA | 19 U | 19 U | 19 U | 12 U | 19 U | 310 | **43** | **150 J** | **770** | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-032 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 5.9 J | 3.3 J | 130 J | **33 J** | **25 J** | **330 J** | 19 U | 19 U | 19 U | 19 U | 20 U |
| PCB-034 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 34 U | 19 U | 350 U | 34 U | 34 U | 34 U | 33 U | 34 U |
| PCB-035 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 38 U | **3.1 J** | 390 U | 38 U | 38 U | 38 U | 37 U | 38 U |
| PCB-036 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 30 U | 19 U | 300 U | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-037 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 2.4 J | 1.4 J | 23 J | 20 U | **29 J** | 200 U | 19 U | 19 U | 19 U | 19 U | 20 U |
| PCB-038 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 34 U | 19 U | 350 U | 34 U | 34 U | 34 U | 33 U | 34 U |
| PCB-039 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 35 U | 29 U | 360 U | 35 U | 35 U | 35 U | 34 U | 35 U |
| PCB-040 AND 071 | pg/L | NA | 19 U | 19 U | 19 U | 3.1 J | 2.8 J | 84 J | 59 U | **61 J** | **2,000** | 58 U | 58 U | 58 U | 57 U | 59 U |
| PCB-041 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | **12 J** | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-042 | pg/L | NA | 19 U | 19 U | 19 U | 2.5 J | 3.7 J | 77 J | 39 U | **34 J** | **910** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-043 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.9 J | 39 U | **5.4 J** | **210 J** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-044 AND 047 AND 065 | pg/L | NA | 71 U | 71 U | 71 U | 14 U | 72 U | 370 J | **54 J** | **290 J** | **4,100** | **44 J** | **49 J** | **97 J** | **67 J** | **37 J** |
| PCB-045 | pg/L | NA | 19 U | 19 U | 19 U | 2 J | 1.2 J | 61 J | 39 U | **22 J** | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-046 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 31 J | 39 U | **8.6 J** | **710 J** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-048 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 1.1 J | 25 J | 30 U | **26 J** | **150 J** | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-049 AND 069 | pg/L | | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 69 U | **110 J** | **4,000** | 68 U | 68 U | 68 U | 67 U | 69 U |
| PCB-050 AND 053 | pg/L | NA | 38 U | 38 U | 0.69 J | 1.9 J | 1.3 J | 66 J | 200 U | **27 J** | **2,900 J** | 190 U | 190 U | 190 U | 190 U | 200 U |
| PCB-051 | pg/L | NA | 19 U | 0.76 J | 1.6 J | 2.3 J | 1 J | 18 J | **17 J** | **67 J** | **350 J** | **25 J** | **25 J** | **55 J** | **63 J** | **28 J** |
| PCB-052 | pg/L | NA | 19 U | 19 U | 19 U | 13 J | 39 J | 700 | **33 J** | **420** | **9,500** | **13 J** | **13 J** | 39 U | 38 U | 39 U |
| PCB-054 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 2.8 J | 39 U | 29 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-055 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-056 | pg/L | NA | 19 U | 19 U | 0.54 J | 1.3 J | 2 J | 30 J | 39 U | **65 J** | **570 J** | 39 U | 39 U | 39 U | 38 U | 39 U |

**Table B3-20**. PCB Congeners in Groundwater Monitoring Wells - 2019 and 2022

| | | Location Name | MW1-2 | | MW1-18 | MW1-64 | MW1-65 | MW1-67 | MW1-69 | MW1-70 | MW1-71 | MW1-72 | | MW1-73 | MW1-74 | MW1-75 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | MW1-2-191029 | FD-191029-01 | MW1-18-191021 | MW1-64-191024 | MW1-65-191021 | MW1-67-191028 | MW1-69-220511 | MW1-70-220502 | MW1-71-220512 | MW1-72-220512 | FD-220512-02 | MW1-73-220513 | MW1-74-2200718 | MW1-75-220718 |
| | | **Sample Collection Date** | 10/29/2019 | 10/29/2019 | 10/21/2019 | 10/24/2019 | 10/21/2019 | 10/28/2019 | 5/11/2022 | 5/2/2022 | 5/12/2022 | 5/12/2022 | 5/12/2022 | 5/13/2022 | 7/18/2022 | 7/18/2022 |
| | | **Screened Interval (ft bgs)** | 12.5 - 17.5 | 12.5 - 17.5 | 12 - 17 | 45 - 55 | 53 - 63 | 5 - 15 | 42 - 52 | 70 - 80 | 95 - 100 | 60 - 70 | 60 - 70 | 90 - 100 | 45 - 55 | 75 - 80 |
| | | **Sample Type** | P | FD | N | N | N | N | N | N | N | P | FD | N | N | N |
| **Analyte** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| PCB-057 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 2.3 J | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-058 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-059 AND 062 AND 075 | pg/L | NA | 57 U | 57 U | 57 U | 57 U | 58 U | 27 J | 99 U | **11 J** | 1,000 U | 97 U | 97 U | 97 U | 96 U | 98 U |
| PCB-060 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 9.8 J | 30 U | **37 J** | **120 J** | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-061 AND 070 AND 074 AND 076 | pg/L | NA | 38 U | 38 U | 38 U | 7.2 U | 15 J | 220 J | 120 U | **400 J** | **6,200** | 120 U | 120 U | 120 U | 110 U | 120 U |
| PCB-063 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 7.4 J | 39 U | **5.2 J** | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-064 | pg/L | NA | 19 U | 19 U | 0.78 J | 3.3 U | 3.7 J | 82 J | **13 J** | **83 J** | **1,200** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-066 | pg/L | NA | 9.5 U | 9.5 U | 1.5 J | 3.1 U | 9 J | 120 J | **15 J** | **130 J** | **2,900** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-067 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 6.3 J | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-068 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 4 J | **29 J** | **46 J** | **180 J** | **37 J** | **41 J** | **63 J** | **66 J** | **27 J** |
| PCB-069 AND 049 | pg/L | NA | 38 U | 38 U | 1.9 J | 5.8 J | 18 J | 310 J | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-072 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 5.5 J | 30 U | 19 U | **210 J** | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-073 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-077 | pg/L | NA | 9.5 U | 9.5 U | 1.2 J | 9.5 U | 9.6 U | 3.3 J | 39 U | **13 J** | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-078 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-079 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | **13 J** | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-080 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 29 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-081 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-082 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 1.4 J | 15 J | 39 U | **52 J** | **1,100 J** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-083 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 3.3 J | 22 J | 39 U | **25 J** | **840** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-084 | pg/L | NA | 3.3 J | 3.5 J | 19 U | 3.4 J | 7.5 J | 120 J | 59 U | **150 J** | **3,600** | 58 U | 58 U | 58 U | 57 U | 59 U |
| PCB-085 AND 116 AND 117 | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 130 U | **77 J** | **1,900 J** | 130 U | 130 U | 130 U | 120 U | 130 U |
| PCB-086 AND 087 AND 097 AND 109 AND 119 AND 125 | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 300 U | **340 J** | **7,600** | 290 U | 290 U | 290 U | 290 U | 300 U |
| PCB-088 | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 39 U | -- -- | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-088 AND 091 | pg/L | NA | 19 U | 19 UJ | 1.2 J | 1.2 J | 3 J | 61 J | -- -- | **68 J** | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-089 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 29 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-090 AND 101 AND 113 | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 120 U | **470 J** | **13,000** | 120 U | 120 U | 120 U | 110 U | 120 U |
| PCB-091 | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 39 U | -- -- | **1,800** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-092 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 1.8 J | 5.1 J | 66 J | 39 U | **78 J** | **2,600** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-093 AND 100 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 79 U | 38 U | 800 U | 78 U | 78 U | 78 U | 77 U | 79 U |
| PCB-094 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 39 U | 29 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-095 | pg/L | NA | 19 U | 19 U | 5.2 J | 9.6 U | 23 J | 390 | **15 J** | **400** | **10,000** | **12 J** | 39 U | 39 U | 38 U | 39 U |
| PCB-096 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 2.9 J | 39 U | **2.5 J** | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-098 AND 102 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 9.8 J | 99 U | **8.8 J** | **430 J** | 97 U | 97 U | 97 U | 96 U | 98 U |
| PCB-099 | pg/L | NA | 19 U | 19 U | 19 U | 3.9 U | 10 J | 110 J | 39 U | **170 J** | **6,800** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-103 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 29 U | **140 J** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-104 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 29 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-105 | pg/L | NA | 19 U | 19 U | 19 U | 1.6 U | 19 U | 35 | 39 U | **160** | **3,300 J** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-106 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-107 | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 39 U | -- -- | **1,000** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-107 AND 124 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | -- -- | **16 J** | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-108 AND 119 AND 086 AND 097 AND 125 AND 087 | pg/L | NA | 57 U | 57 U | 57 U | 5.9 U | 58 U | 140 J | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-108 AND 124 | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 79 U | -- -- | **330 J** | 78 U | 78 U | 78 U | 77 U | 79 U |
| PCB-109 | pg/L | NA | 1 J | 9.5 U | 9.5 U | 9.5 U | 1.5 J | 13 J | -- -- | **24 J** | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-110 AND 115 | pg/L | NA | 19 U | 19 U | 19 U | 9.3 U | 20 J | 270 J | 99 U | **520** | **16,000** | 97 U | 97 U | 97 U | 96 U | 98 U |
| PCB-111 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-112 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-113 AND 090 AND 101 | pg/L | NA | 28 U | 29 U | 28 U | 8.1 U | 22 J | 270 J | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-114 | pg/L | NA | 9.5 U | 9.5 U | 1 J | 9.5 U | 9.6 U | 9.5 U | 39 U | **9.1 J** | **260 J** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-117 AND 116 AND 085 | pg/L | NA | 57 U | 57 U | 57 U | 1.2 J | 58 U | 24 J | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |

**Table B3-20**. PCB Congeners in Groundwater Monitoring Wells - 2019 and 2022

| | | **Location Name** | MW1-2 | | MW1-18 | MW1-64 | MW1-65 | MW1-67 | MW1-69 | MW1-70 | MW1-71 | MW1-72 | | MW1-73 | MW1-74 | MW1-75 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | MW1-2-191029 | FD-191029-01 | MW1-18-191021 | MW1-64-191024 | MW1-65-191021 | MW1-67-191028 | MW1-69-220511 | MW1-70-220502 | MW1-71-220512 | MW1-72-220512 | FD-220512-02 | MW1-73-220513 | MW1-74-2200718 | MW1-75-220718 |
| | | **Sample Collection Date** | 10/29/2019 | 10/29/2019 | 10/21/2019 | 10/24/2019 | 10/21/2019 | 10/28/2019 | 5/11/2022 | 5/2/2022 | 5/12/2022 | 5/12/2022 | 5/12/2022 | 5/13/2022 | 7/18/2022 | 7/18/2022 |
| | | **Screened Interval (ft bgs)** | 12.5 - 17.5 | 12.5 - 17.5 | 12 - 17 | 45 - 55 | 53 - 63 | 5 - 15 | 42 - 52 | 70 - 80 | 95 - 100 | 60 - 70 | 60 - 70 | 90 - 100 | 45 - 55 | 75 - 80 |
| | | **Sample Type** | P | FD | N | N | N | N | N | N | N | P | FD | N | N | N |
| **Analyte** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| PCB-118 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 8.4 U | 17 U | 170 | 39 U | **350** | **11,000 J** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-120 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-121 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-122 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 19 U | **150 J** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-123 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 69 U | **4.9 J** | 700 U | 68 U | 68 U | 68 U | 67 U | 69 U |
| PCB-126 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 69 U | 19 U | 700 U | 68 U | 68 U | 68 U | 67 U | 69 U |
| PCB-127 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 20 U | 19 U | 200 U | 19 U | 19 U | 19 U | 19 U | 20 U |
| PCB-128 AND 166 | pg/L | NA | 1.9 J | 2.1 J | 2.4 J | 1.4 U | 0.96 J | 15 J | 69 U | **45 J** | **1,900** | 68 U | 68 U | 68 U | 67 U | 69 U |
| PCB-129 AND 138 AND 163 | pg/L | | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 110 U | **260 J** | **9,900** | 110 U | 110 U | 110 U | 110 U | 110 U |
| PCB-130 | pg/L | NA | 9.5 U | 9.5 U | 1.1 J | 9.5 U | 9.6 U | 5.3 J | 39 U | **18 J** | **770 J** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-131 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 39 U | **4.3 J** | **160 J** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-132 | pg/L | NA | 19 U | 19 U | 3.4 J | 2 U | 3.5 J | 35 J | 39 U | **92 J** | **4,100** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-133 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | **2.5 J** | **140 J** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-134 | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 39 U | -- -- | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-134 AND 143 | pg/L | NA | 38 U | 38 U | 38 U | 38 U | 0.64 J | 7.4 J | -- -- | 38 U | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-135 AND 151 | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 99 U | **59 J** | **2,100** | 97 U | 97 U | 97 U | 96 U | 98 U |
| PCB-136 | pg/L | NA | 9.5 U | 9.5 U | 0.6 J | 1.2 J | 1.1 J | 18 J | 39 U | **29 J** | **1,100** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-137 | pg/L | NA | 19 U | 19 U | 0.5 J | 19 U | 19 U | 4.6 J | 39 U | **16 J** | **720 J** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-138 AND 163 AND 129 | pg/L | NA | 57 U | 57 U | 57 U | 7.8 U | 7.7 U | 87 J | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-139 AND 140 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 2 J | 69 U | **4.7 J** | **240 J** | 68 U | 68 U | 68 U | 67 U | 69 U |
| PCB-141 | pg/L | NA | 9.5 U | 9.5 U | 1.4 J | 1.3 U | 0.72 J | 11 J | 20 U | **45 J** | **1,400** | 19 U | 19 U | 19 U | 19 U | 20 U |
| PCB-142 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 30 U | 19 U | 300 U | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-143 | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 39 U | -- -- | **600 J** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-144 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 4.3 J | 49 U | **9.1 J** | **280 J** | 49 U | 48 U | 49 U | 48 U | 49 U |
| PCB-145 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 49 U | 9.6 U | 500 U | 49 U | 48 U | 49 U | 48 U | 49 U |
| PCB-146 | pg/L | NA | 19 U | 19 UJ | 1.6 J | 0.72 U | 1 J | 13 J | 39 U | **23 J** | **1,200** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-147 AND 149 | pg/L | NA | 38 U | 38 U | 38 U | 4.7 U | 39 U | 79 J | 79 U | **160 J** | **6,600** | 78 U | 78 U | 78 U | 77 U | 79 U |
| PCB-148 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-150 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-151 AND 135 | pg/L | NA | 38 U | 38 UJ | 38 U | 1.8 U | 39 U | 31 J | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-152 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 9.6 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-153 AND 168 | pg/L | NA | 38 U | 38 U | 38 U | 5.3 U | 39 U | 68 J | 79 U | **150 J** | **6,400** | 78 U | 78 U | 78 U | 77 U | 79 U |
| PCB-154 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 99 U | 19 U | 1,000 U | 97 U | 97 U | 97 U | 96 U | 98 U |
| PCB-155 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 29 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-156 AND 157 | pg/L | NA | 19 U | 19 UJ | 19 U | 1.2 U | 19 U | 19 U | 79 U | **53 J** | **1,500 J** | 78 U | 78 U | 78 U | 77 U | 79 U |
| PCB-158 | pg/L | NA | 19 U | 19 U | 1 J | 0.72 U | 0.88 J | 8.7 J | 39 U | **29 J** | **930** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-159 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 49 U | **1.2 J** | 500 U | 49 U | 48 U | 49 U | 48 U | 49 U |
| PCB-160 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-161 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-162 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 30 U | **1.1 J** | 300 U | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-164 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 5.6 J | 20 U | **19 J** | **700 J** | 19 U | 19 U | 19 U | 19 U | 20 U |
| PCB-165 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-167 | pg/L | NA | 9.5 U | 9.5 U | 1.3 J | 0.44 U | 0.7 J | 4.1 J | 39 U | **16 J** | **430 J** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-169 | pg/L | NA | 9.5 U | 9.5 U | 1.4 J | 9.5 U | 0.42 J | 9.5 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-170 | pg/L | NA | 19 U | 19 U | 19 U | 1.7 U | 19 UJ | 8.2 J | 39 U | **53 J** | **910** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-171 AND 173 | pg/L | NA | 19 U | 0.69 J | 19 U | 19 U | 19 U | 2.2 J | 49 U | **15 J** | **280 J** | 49 U | 48 U | 49 U | 48 U | 49 U |
| PCB-172 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 30 U | **7.6 J** | **130 J** | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-174 | pg/L | NA | 19 U | 19 U | 19 U | 1.2 U | 19 U | 7.1 J | 39 U | **48 J** | **540 J** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-175 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 39 U | **0.77 J** | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-176 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 1.1 J | 20 U | **4.4 J** | **99 J** | 19 U | 19 U | 19 U | 19 U | 20 U |

**Table B3-20**. PCB Congeners in Groundwater Monitoring Wells - 2019 and 2022

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location Name** | | | MW1-2 | | MW1-18 | MW1-64 | MW1-65 | MW1-67 | MW1-69 | MW1-70 | MW1-71 | MW1-72 | | MW1-73 | MW1-74 | MW1-75 |
| **Sample Name** | | | MW1-2-191029 | FD-191029-01 | MW1-18-191021 | MW1-64-191024 | MW1-65-191021 | MW1-67-191028 | MW1-69-220511 | MW1-70-220502 | MW1-71-220512 | MW1-72-220512 | FD-220512-02 | MW1-73-220513 | MW1-74-2200718 | MW1-75-220718 |
| **Sample Collection Date** | | | 10/29/2019 | 10/29/2019 | 10/21/2019 | 10/24/2019 | 10/21/2019 | 10/28/2019 | 5/11/2022 | 5/2/2022 | 5/12/2022 | 5/12/2022 | 5/12/2022 | 5/13/2022 | 7/18/2022 | 7/18/2022 |
| **Screened Interval (ft bgs)** | | | 12.5 - 17.5 | 12.5 - 17.5 | 12 - 17 | 45 - 55 | 53 - 63 | 5 - 15 | 42 - 52 | 70 - 80 | 95 - 100 | 60 - 70 | 60 - 70 | 90 - 100 | 45 - 55 | 75 - 80 |
| **Sample Type** | | | P | FD | N | N | N | N | N | N | N | P | FD | N | N | N |
| **Analyte** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| PCB-177 | pg/L | NA | 19 U | 0.72 J | 1.1 J | 19 U | 19 U | 4 J | 30 U | **23 J** | **370 J** | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-178 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 0.39 U | 9.6 U | 9.5 U | 59 U | **5.2 J** | 600 U | 58 U | 58 U | 58 U | 57 U | 59 U |
| PCB-179 | pg/L | NA | 19 U | 0.52 J | 0.57 J | 0.25 U | 19 U | 2.8 J | 30 U | **12 J** | **170 J** | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-180 AND 193 | pg/L | NA | 38 U | 38 U | 38 U | 2.9 U | 39 U | 14 J | 69 U | **100 J** | **1,200 J** | 68 U | 68 U | 68 U | 67 U | 69 U |
| PCB-181 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 30 U | 19 U | 300 U | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-182 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-183 | pg/L | NA | 19 U | 19 U | 19 U | 1.5 U | 19 U | 19 U | -- -- | **23 J** | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-183 AND 185 | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 79 U | -- -- | **400 J** | 78 U | 78 U | 78 U | 77 U | 79 U |
| PCB-184 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-185 | pg/L | NA | 19 U | 19 U | 0.31 J | 0.32 U | 19 U | 0.67 J | -- -- | **4.9 J** | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-186 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-187 | pg/L | NA | 19 U | 19 U | 1.4 J | 1.1 U | 1.1 J | 7.5 J | 39 U | **28 J** | **470 J** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-188 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 180 U | 29 U | 1,800 U | 180 U | 170 U | 180 U | 170 U | 180 U |
| PCB-189 | pg/L | NA | 9.5 U | 9.5 U | 1.1 J | 9.5 U | 9.6 U | 9.5 U | 39 U | **2.6 J** | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-190 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 1.3 J | 39 U | **7.9 J** | **160 J** | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-191 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 30 U | **2.1 J** | 300 U | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-192 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 30 U | 9.6 U | 300 U | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-194 | pg/L | NA | 19 U | 19 U | 19 U | 1.5 U | 19 U | 2.7 J | 39 U | **22 J** | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-195 | pg/L | NA | 19 U | 19 U | 0.29 J | 19 U | 0.3 J | 0.73 J | 49 U | **7.1 J** | 500 U | 49 U | 49 U | 49 U | 48 U | 49 U |
| PCB-196 | pg/L | NA | 19 U | 19 U | 0.4 J | 0.59 U | 19 U | 1.7 J | 39 U | **9.5 J** | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-197 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | -- -- | **0.43 J** | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-197 AND 200 | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 49 U | -- -- | 500 U | 49 U | 48 U | 49 U | 48 U | 49 U |
| PCB-198 AND 199 | pg/L | NA | 19 U | 19 U | 19 U | 1.5 U | 0.42 J | 3 J | 49 U | **18 J** | 500 U | 49 U | 48 U | 49 U | 48 U | 49 U |
| PCB-200 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 0.64 J | -- -- | **2.4 J** | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- |
| PCB-201 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 0.72 J | 190 U | **3 J** | 1,900 U | 190 U | 180 U | 180 U | 180 U | 190 U |
| PCB-202 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 30 U | **5 J** | 300 U | 29 U | 29 U | 29 U | 29 U | 30 U |
| PCB-203 | pg/L | NA | 19 U | 0.28 J | 0.59 J | 0.82 U | 19 U | 1.6 J | 49 U | **12 J** | 500 U | 49 U | 48 U | 49 U | 48 U | 49 U |
| PCB-204 | pg/L | NA | 19 U | 19 U | 19 U | 19 U | 19 U | 19 U | 39 U | 19 U | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-205 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 20 U | **0.87 J** | 200 U | 19 U | 19 U | 19 U | 19 U | 20 U |
| PCB-206 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 4.3 U | 9.6 U | 2.3 J | 20 U | **8.8 J** | 200 U | 19 U | 19 U | 19 U | 19 U | 20 U |
| PCB-207 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 39 U | **5.6 J** | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| PCB-208 | pg/L | NA | 9.5 U | 9.5 U | 9.5 U | 9.5 U | 9.6 U | 9.5 U | 110 U | **2.4 J** | 1,100 U | 110 U | 110 U | 110 U | 110 U | 110 U |
| PCB-209 | pg/L | NA | 19 UJ | 19 U | 19 U | 5.7 U | 19 U | 19 U | 740 U | **2.5 J** | 7,500 U | 730 U | 730 U | 730 U | 720 U | 740 U |
| Total Monochlorobiphenyls | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 39 U | -- -- | 400 U | 39 U | 39 U | 39 U | 38 U | 39 U |
| Total Dichlorobiphenyls | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | **210 J** | -- -- | **1,100 J** | 31 U | 31 U | 31 U | 31 U | 31 U |
| Total Trichlorobiphenyls | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | **330 J** | -- -- | **12,000 J** | 19 U | 19 U | 19 U | 19 U | 20 U |
| Total Tetrachlorobiphenyls | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | **160 J** | -- -- | **36,000 J** | **120 J** | **130 J** | **220 J** | **200 J** | **92 J** |
| Total Pentachlorobiphenyls | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | **15 J** | -- -- | **82,000 J** | **12 J** | 19 U | 19 U | 19 U | 20 U |
| Total Hexachlorobiphenyls | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 20 U | -- -- | **41,000 J** | 19 U | 19 U | 19 U | 19 U | 20 U |
| Total Heptachlorobiphenyls | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 20 U | -- -- | **4,700 J** | 19 U | 19 U | 19 U | 19 U | 20 U |
| Total Nonachlorobiphenyls | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 30 U | -- -- | 200 U | 19 U | 19 U | 19 U | 19 U | 20 U |
| Total Octachlorobiphenyls | pg/L | NA | -- -- | -- -- | -- -- | -- -- | -- -- | -- -- | 20 U | -- -- | 200 U | 19 U | 19 U | 19 U | 19 U | 20 U |
| TOTAL PCBs | pg/L | 7 | 6.2 | **8.6** | **44** | **156** | **263** | **11,076** | **710 J** | **7,100 J** | **180,000 J** | **130 J** | **130 J** | **220 J** | **200 J** | **92 J** |

**Notes:**
FD – Field duplicate
J - The reported value is an estimated concentration.
N – Sample is not part of a field duplicate pair
NA - Not applicable
P – Parent sample of field duplicate
PCB - polychlorinated biphenyls
U - The analyte was not detected at or above the limit of detection (LOD). (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
**Bolded** values indicate that the reported concentration exceeds the PAL.

## Table B3-21. Total PCBs (Congeners) in Groundwater - 2019 and 2022

| Location Name | Sample Name | Sample type | Total PCBs (Sum of congeners with ND as null) Result (pg/L) | Total number of PCB congeners detected |
|---|---|---|---|---|
| | | **PAL** | 7 | |
| MW1-2 | MW1-2-191029 | P | 6.2 | 4 |
| MW1-2 | FD-191029-01 | FD | **8.6** | 9 |
| MW1-18 | MW1-18-191021 | N | **44** | 38 |
| MW1-64 | MW1-64-191024 | N | **156** | 35 |
| MW1-65 | MW1-65-191021 | N | **263** | 62 |
| MW1-67 | MW1-67-191028 | N | **11,076** | 114 |
| MW1-69 | MW1-69-220511 | N | **713** | 18 |
| MW1-70 | MW1-70-220502 | N | **7,090** | 111 |
| MW1-71 | MW1-71-220512 | N | **177,289** | 80 |
| MW1-72 | MW1-72-220512 | N | **131** | 5 |
| MW1-73 | MW1-73-220513 | N | **215** | 3 |
| MW1-74 | MW1-74-220718 | N | **196** | 3 |
| MW1-75 | MW1-75-220718 | N | **92** | 3 |

**Notes:**
FD – Field duplicate
N – Sample is not part of a field duplicate pair
P – Parent sample of field duplicate
U - The analyte was not detected at or above the limit of detection (LOD). (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
PCB - polychlorinated biphenyls
**Bolded** values indicate that the reported concentration exceeds the PAL.
pg/L - picograms per liter

## Table B3-22. 1,4-Dioxane in Groundwater Monitoring Wells - 2019 and 2022

| Location Name | Sample Name | Sample Collection Date | Screened Interval (ft bgs) | Sample Type | PAL (µg/L) | 1,4-Dioxane (µg/L) |
|---|---|---|---|---|---|---|
| MW1-42 | MW1-42-191022 | 10/22/2019 | 15 - 25 | N | 0.44 | <u>0.6 U</u> |
| MW1-43 | MW1-43-191023 | 10/23/2019 | 15 - 25 | N | 0.44 | **0.6 J** |
| MW1-44 | MW1-44-191024 | 10/24/2019 | 18 - 28 | N | 0.44 | <u>0.6 U</u> |
| MW1-45 | MW1-45-191022 | 10/22/2019 | 15 - 25 | N | 0.44 | **1.1** |
| MW1-46 | MW1-46-191025 | 10/25/2019 | 24 - 34 | P | 0.44 | **40** |
| | FD-191025-01 | 10/25/2019 | 24 - 34 | FD | 0.44 | **46** |
| MW1-47 | MW1-47-191025 | 10/25/2019 | 15 - 25 | N | 0.44 | **32** |
| MW1-48 | MW1-48-191028 | 10/28/2019 | 15 - 25 | N | 0.44 | **2.5** |
| MW1-62 | MW1-62-191024 | 10/24/2019 | 31 - 41 | N | 0.44 | **15** |
| MW1-63 | MW1-63-191025 | 10/25/2019 | 30 - 40 | N | 0.44 | **110** |
| MW1-64 | MW1-64-191024 | 10/24/2019 | 45 - 55 | N | 0.44 | **43** |
| MW1-65 | MW1-65-191021 | 10/21/2019 | 53 - 63 | N | 0.44 | **6.3** |
| MW1-67 | MW1-67-191028 | 10/28/2019 | 5 - 15 | N | 0.44 | <u>0.6 U</u> |
| MW1-69 | MW1-69-220511 | 5/11/2022 | 42 - 52 | N | 0.44 | 0.053 UJ |
| MW1-70 | MW1-70-220502 | 5/2/2022 | 70 - 80 | N | 0.44 | <u>0.51 U</u> |
| MW1-71 | MW1-71-220512 | 5/12/2022 | 95 - 100 | N | 0.44 | 0.056 UJ |
| MW1-72 | MW1-72-220512 | 5/12/2022 | 60 - 70 | P | 0.44 | <u>1.8 UJ</u> |
| | FD-220512-02 | 5/12/2022 | 60 - 70 | FD | 0.44 | <u>1.8 UJ</u> |
| MW1-73 | MW1-73-220513 | 5/13/2022 | 90 - 100 | N | 0.44 | 0.055 UJ |
| MW1-74 | MW1-74-220718 | 7/18/2022 | 45 - 55 | N | 0.44 | **2.2 J** |
| MW1-75 | MW1-75-220718 | 7/18/2022 | 75 - 80 | N | 0.44 | 0.17 J |

**Notes:**
Samples analyzed using EPA Method 8270D.
FD - Field Duplicate
J - The reported value is an estimated concentration.
N – Sample is not part of a field duplicate pair
P – Parent sample of field duplicate
PAL - Project Action Limit
U - The analyte was not detected at or above the stated limit. (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
<u>Underlined</u> values represent analytes not detected at or above the stated limit, which exceeds the PAL.
**Bolded** values indicate that the reported concentration exceeds the PAL.
µg/L – micrograms per liter

**Table B3-23. PFAS Compounds in Groundwater Monitoring Wells - 2019 and 2022**

| | | **Location Name** | MW1-59 | MW1-61 | | MW1-62 | MW1-64 | MW1-69 |
|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | MW1-59-191023 | MW1-61-191028 | FD-191028-01 | MW1-62-191024 | MW1-64-191024 | MW1-69-220511 |
| | | **Sample Collection Date** | 10/23/2019 | 10/28/2019 | 10/28/2019 | 10/24/2019 | 10/24/2019 | 5/11/2022 |
| | | **Screened Interval (ft bgs)** | 60 - 70 | 3 - 13 | 3 - 13 | 31 - 41 | 45 - 55 | 42 - 52 |
| | | **Sample Type** | N | P | FD | N | N | N |
| **Analyte Name** | **Units** | **PAL [a]** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| Perfluorooctane sulfonate (PFOS) | ng/L | 4 | 0.86U | **4.21J** | 3.92J | 1.32J | 1.32J | 2.3UJ |
| N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA) | ng/L | NE | 0.86U | 1.04U | 1.04U | 0.86U | 0.83U | 2.3UJ |
| N-methylperfluorooctane sulfonamidoacetic acid (NMeFOSAA) | ng/L | NE | 0.86U | 1.04U | 1.04U | 0.86U | 0.83U | 2.3UJ |
| Perfluorobutanesulfonic acid (PFBS) | ng/L | 601 | 0.43U | 2.34J | 2.12J | 1.99J | 3.27J | 2.3UJ |
| Perfluorodecanoic acid (PFDA) | ng/L | NE | 0.43U | 0.44J | 0.40J | 0.43U | 0.42U | 2.3UJ |
| Perfluoroheptanoic acid (PFHpA) | ng/L | NE | 0.86U | 1.74J | 1.63J | 0.57J | 2.01J | 2.3UJ |
| Perfluorohexanesulfonic acid (PFHxS) | ng/L | 39 | 0.34U | 1.74J | 1.61J | 1.95J | 2.46J | 2.3UJ |
| Perfluorononanoic acid (PFNA) | ng/L | 6 | 0.86U | 0.87J | 0.89J | 0.86U | 0.32J | 2.3UJ |
| Perfluorooctanoic acid (PFOA) | ng/L | 6 | 1.29U | 4.36J | 4.46J | 1.93J | 4.70 | 2.3UJ |
| Perfluorotetradecanoic acid (PFTeDA) | ng/L | NE | 1.72U | 2.08U | 2.08U | 1.72U | 1.67U | 2.3UJ |
| Perfluorotridecanoic acid (PFTrDA) | ng/L | NE | 0.43U | 0.52U | 0.52U | 0.43U | 0.42U | 2.3UJ |
| Perfluoroundecanoic acid (PFUnA) | ng/L | NE | 0.43U | 0.52U | 0.52U | 0.43U | 0.42U | 4.32J |
| Perfluorododecanoic acid (PFDoA) | ng/L | NE | 0.43U | 0.52U | 0.52U | 0.43U | 0.42U | 2.3UJ |
| Perfluorohexanoic acid (PFHxA) | ng/L | NE | 1.29U | 2.72J | 2.69J | 1.61J | 4.33 | 2.3UJ |
| | | | | | | | | |

**Table B3-23. PFAS Compounds in Groundwater Monitoring Wells - 2019 and 2022 (continued)**

| | | **Location Name** | MW1-70 | MW1-71 | MW1-72 | | MW1-73 | MW1-74 |
|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | MW1-70-220502 | MW1-71-220512 | MW1-72-220512 | FD-220512-02 | MW1-73-220513 | MW1-74-220718 |
| | | **Sample Collection Date** | 5/2/2022 | 5/12/2022 | 5/12/2022 | 5/12/2022 | 5/13/2022 | 7/18/2022 |
| | | **Screened Interval (ft bgs)** | 70 - 80 | 95 - 100 | 60 - 70 | 60 - 70 | 90 - 100 | 45 - 55 |
| | | **Sample Type** | N | N | P | FD | N | N |
| **Analyte Name** | **Units** | **PAL [a]** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| Perfluorooctane sulfonate (PFOS) | ng/L | 4 | 2.25 U | 2.56 UJ | 2.45 UJ | 2.39 UJ | 2.36 UJ | 2.25 U |
| N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA) | ng/L | NE | 2.25 U | 2.56 UJ | 2.45 UJ | 2.39 UJ | 2.36 UJ | 2.25 U |
| N-methylperfluorooctane sulfonamidoacetic acid (NMeFOSAA) | ng/L | NE | 2.25 U | 2.56 UJ | 2.45 UJ | 2.39 UJ | 2.36 UJ | 1.18 J |
| Perfluorobutanesulfonic acid (PFBS) | ng/L | 601 | 2.25 U | 2.56 UJ | 2.45 UJ | 2.39 UJ | 2.36 UJ | 2.25 U |
| Perfluorodecanoic acid (PFDA) | ng/L | NE | 2.25 U | 2.56 UJ | 2.45 UJ | 2.39 UJ | 2.36 UJ | 2.25 U |
| Perfluoroheptanoic acid (PFHpA) | ng/L | NE | 2.25 U | 2.56 UJ | 2.45 UJ | 2.39 UJ | 2.36 UJ | 2.25 U |
| Perfluorohexanesulfonic acid (PFHxS) | ng/L | 39 | 2.25 UJ | 2.56 UJ | 2.45 UJ | 2.39 UJ | 2.36 UJ | 2.25 U |
| Perfluorononanoic acid (PFNA) | ng/L | 6 | 2.32 UJ | 2.56 UJ | 2.45 UJ | 2.39 UJ | 2.36 UJ | 2.25 U |
| Perfluorooctanoic acid (PFOA) | ng/L | 6 | 2.25 R | 2.56 UJ | 2.45 UJ | 2.39 UJ | 2.36 UJ | 2.25 U |
| Perfluorotetradecanoic acid (PFTeDA) | ng/L | NE | 2.25 U | 2.56 UJ | 2.45 UJ | 2.39 UJ | 2.36 UJ | 2.25 U |
| Perfluorotridecanoic acid (PFTrDA) | ng/L | NE | 2.25 U | 2.56 UJ | 2.45 UJ | 2.39 UJ | 2.36 UJ | 2.25 U |
| Perfluoroundecanoic acid (PFUnA) | ng/L | NE | 2.25 U | 2.56 UJ | 2.45 UJ | 2.39 UJ | 2.36 UJ | 1.38 J |
| Perfluorododecanoic acid (PFDoA) | ng/L | NE | 2.25 U | 2.56 UJ | 2.45 UJ | 2.39 UJ | 2.36 UJ | 1.31 J |
| Perfluorohexanoic acid (PFHxA) | ng/L | NE | 2.25 U | 2.56 UJ | 2.45 UJ | 2.39 UJ | 2.36 UJ | 2.25 U |

**Table B3-23. PFAS Compounds in Groundwater Monitoring Wells - 2019 and 2022 (continued)**

| | | **Location Name** | MW1-75 | |
|---|---|---|---|---|
| | | **Sample Name** | MW1-75-220718 | MW1-75-220718 |
| | | **Sample Collection Date** | 7/18/2022 | 7/18/2022 |
| | | **Screened Interval (ft bgs)** | 45 - 55 | 75 - 80 |
| | | **Sample Type** | P | FD |
| **Analyte Name** | **Units** | **PAL [a]** | **Result** | **Result** |
| Perfluorooctane sulfonate (PFOS) | ng/L | 4 | 2.21 U | 2.22 U |
| N-ethyl perfluorooctanesulfonamidoacetic acid (NEtFOSAA) | ng/L | NE | 2.21 U | 2.22 U |
| N-methylperfluorooctane sulfonamidoacetic acid (NMeFOSAA) | ng/L | NE | 2.21 U | 2.22 U |
| Perfluorobutanesulfonic acid (PFBS) | ng/L | 601 | 2.21 U | 2.22 U |
| Perfluorodecanoic acid (PFDA) | ng/L | NE | 2.21 U | 2.22 U |
| Perfluoroheptanoic acid (PFHpA) | ng/L | NE | 2.21 U | 2.22 U |
| Perfluorohexanesulfonic acid (PFHxS) | ng/L | 39 | 2.21 U | 2.22 U |
| Perfluorononanoic acid (PFNA) | ng/L | 6 | 2.21 U | 2.22 U |
| Perfluorooctanoic acid (PFOA) | ng/L | 6 | 2.21 U | 2.22 U |
| Perfluorotetradecanoic acid (PFTeDA) | ng/L | NE | 2.21 U | 2.22 U |
| Perfluorotridecanoic acid (PFTrDA) | ng/L | NE | 2.21 U | 2.22 U |
| Perfluoroundecanoic acid (PFUnA) | ng/L | NE | 2.21 U | 2.22 U |
| Perfluorododecanoic acid (PFDoA) | ng/L | NE | 2.21 U | 2.22 U |
| Perfluorohexanoic acid (PFHxA) | ng/L | NE | 2.21 U | 2.22 U |

**Notes:**
PFAS compounds analyzed by DoD QSM 5.1
FD - Field Duplicate
J - The reported value is an estimated concentration.
N – Sample is not part of a field duplicate pair
NE - Not established.
P – Parent sample of field duplicate.
PAL - Project action limit as established in the sampling and analysis plan.
R - The reported value is unusable, rejected.
U - The analyte was not detected at or above the stated limit. (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
UJ - The analyte was not detected at the stated sample quantitation limit, which is an estimated value.
**Bold** text indicates that the result or the LOD exceeds the PAL.
ng/L - nanograms per liter
[a] PALs updated based on July 6, 2022 update to DoD memorandum (DoD, 2022). PAL values set to residential scenario screening levels for tap water with a hazard quotient of 0.1.

# Table B3-24. Laboratory MNA Parameters - 2019

| Location Name | | MW1-42 | MW1-43 | MW1-44 | MW1-45 | MW1-46 | | MW1-47 |
|---|---|---|---|---|---|---|---|---|
| Sample Name | | MW1-42-191022 | MW1-43-191023 | MW1-44-191024 | MW1-45-191022 | MW1-46-191025 | FD-191025-01 | MW1-47-191025 |
| Sample Collection Date | | 10/22/2019 | 10/23/2019 | 10/24/2019 | 10/22/2019 | 10/25/2019 | 10/25/2019 | 10/25/2019 |
| Screened Interval (ft bgs) | | 15 - 25 | 15 - 25 | 18 - 28 | 15 - 25 | 24 - 34 | 24 - 34 | 15 - 25 |
| Sample Type | | N | N | N | N | P | FD | N |
| **Analyte Name** | **Units** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| Sulfide | µg/L | 1,600 J | 1,060 J | 2,000 R | 1,330 J | 1,350 J | 1,410 J | 1,160 J |
| Nitrite | µg/L | 53 J | 481 | 623 | 40 U | 1,050 J | 1,100 J | 130 UJ |
| Sulfate | µg/L | 220 J | 27,800 | 15,800 | 21,500 | 65,500 | 71,200 | 1,590 |
| Nitrate | µg/L | 40 | 40 U | 40 U | 40 U | 180 UJ | 180 UJ | 180 UJ |
| Chloride | µg/L | 28,100 | 325,000 | 332,000 | 108,000 | 210,000 | 210,000 | 24,100 |
| Dissolved Organic Carbon (DOC) | µg/L | 5,750 | 6,500 | 5,740 | 9,640 | 9,150 | 9,150 | 25,100 |
| Ethane | µg/L | 23 | 25 | 1.4 J | 28 | 39 J | 91 J | 170 |
| Ethene | µg/L | 21 | 82 | 3.4 J | 1.8 U | 79 | 75 | 57 |
| Methane | µg/L | 3,600 | 7,300 | 2,500 | 6,300 | 6,300 | 4,100 | 17,000 |

| Location Name | | MW1-48 | MW1-49 | | MW1-50 | MW1-51 | MW1-52 | MW1-53 |
|---|---|---|---|---|---|---|---|---|
| Sample Name | | MW1-48-191028 | MW1-49-191022 | FD-191022-01 | MW1-50-191023 | MW1-51-191021 | MW1-52-191021 | MW1-53-191023 |
| Sample Collection Date | | 10/28/2019 | 10/22/2019 | 10/22/2019 | 10/23/2019 | 10/21/2019 | 10/21/2019 | 10/23/2019 |
| Screened Interval (ft bgs) | | 15 - 25 | 5 - 15 | 5 - 15 | 5 - 15 | 10 - 20 | 7 - 17 | 5 - 15 |
| Sample Type | | N | P | FD | N | N | N | N |
| **Analyte Name** | **Units** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| Sulfide | µg/L | 1,390 J | 2,100 | 1,640 J | 607 J | 1,620 J | 1,390 J | 1,600 J |
| Nitrite | µg/L | 40 UJ | 40 UJ | 40 UJ | 40 UJ | 40 UJ | 40 U | 40 U |
| Sulfate | µg/L | 363 J | 10,800 | 11,000 | 8,470 | 3,390 | 713 J | 210 J |
| Nitrate | µg/L | 40 UJ | 35 J | 35 J | 225 UJ | 40 UJ | 40 U | 38 J |
| Chloride | µg/L | 21,700 | 5,850 | 6,990 | 4,710 | 3,220 | 3,760 | 5,170 |
| Dissolved Organic Carbon (DOC) | µg/L | 17,400 | 1,040 | 1,070 | 578 J | 1,300 | 1,760 | 3,500 J |
| Ethane | µg/L | 130 | 0.88 J | 0.79 J | 1.7 UJ | 0.73 J | 4.5 J | 6.0 |
| Ethene | µg/L | 1.8 U | 4.0 J | 4.1 J | 1.8 UJ | 7.0 | 15 | 18 |
| Methane | µg/L | 15,000 | 46 | 40 | 28 J | 340 | 3,000 | 7,500 |

**Table B3-24. Laboratory MNA Parameters – 2019 (continued)**

| | Location Name | MW1-54 | MW1-55 | MW1-56 | MW1-56 | MW1-57 | MW1-57 | MW1-57 |
|---|---|---|---|---|---|---|---|---|
| | Sample Name | MW1-54-191021 | MW1-55-191024 | MW1-56-12-191023 | MW1-56-24-191023 | MW1-57-10-191022 | MW1-57-16-191022 | MW1-57-32-191022 |
| | Sample Collection Date | 10/21/2019 | 10/24/2019 | 10/23/2019 | 10/23/2019 | 10/22/2019 | 10/22/2019 | 10/22/2019 |
| | Screened Interval (ft bgs) | 29 - 39 | 26.5 - 36.5 | 8 - 12 | 20 - 24 | 6 - 10.5 | 12 - 16 | 26 - 31 |
| | Sample Type | N | N | N | N | N | N | N |
| **Analyte Name** | **Units** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| Sulfide | µg/L | 1,540 J | 1,060 J | 1,000 J | 1,250 J | 1,160 J | 906 J | 1,480 J |
| Nitrite | µg/L | 40 UJ | 130 R | 112 J | 100 J | 40 U | 82 J | 40 UJ |
| Sulfate | µg/L | 5,050 | 332 J | 41,800 | 2,880 | 5,620 | 306 J | 234 J |
| Nitrate | µg/L | 1,010 J | 180 R | 40 U | 39 J | 40 U | 40 UJ | 40 UJ |
| Chloride | µg/L | 4,250 | 3,250 | 58,700 | 34,400 | 182,000 | 43,300 | 5,880 |
| Dissolved Organic Carbon (DOC) | µg/L | 834 | 1,270 | 37,500 | 6,790 | 25,700 | 9,950 | 3,970 |
| Ethane | µg/L | 1.7 U | 1.1 J | 12 | 3.6 J | 48 | 5.1 | 3.8 J |
| Ethene | µg/L | 1.8 U | 1.1 J | 71 | 1.4 J | 120 | 5.6 | 27 |
| Methane | µg/L | 0.5 J | 160 | 8,400 | 7,000 | 2,200 | 7,700 | 3,800 |

| | Location Name | MW1-58 | MW1-58 | MW1-58 | MW1-59 | MW1-61 | MW1-62 | MW1-63 |
|---|---|---|---|---|---|---|---|---|
| | Sample Name | MW1-58-9-191024 | MW1-58-19-191024 | MW1-58-39.5-191024 | MW1-59-191023 | MW1-61-191028 | MW1-62-191024 | MW1-63-191025 |
| | Sample Collection Date | 10/24/2019 | 10/24/2019 | 10/24/2019 | 10/23/2019 | 10/28/2019 | 10/24/2019 | 10/25/2019 |
| | Screened Interval (ft bgs) | 5 - 9 | 15 - 19 | 31 - 35 | 60 - 70 | 3 - 13 | 31 - 41 | 30 - 40 |
| | Sample Type | N | N | N | N | N | N | N |
| **Analyte Name** | **Units** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| Sulfide | µg/L | 1,950 J | 1,350 J | 1,430 J | 1,370 J | 1,450 J | 1,450 J | 1,640 J |
| Nitrite | µg/L | 242 | 130 R | 224 J | 40 UJ | 40 UJ | 355 J | 475 J |
| Sulfate | µg/L | 352 J | 198 U | 44,800 | 620 J | 697 J | 11,900 | 8,670 |
| Nitrate | µg/L | 40 U | 250 J | 180 R | 35 J | 36 J | 180 R | 180 UJ |
| Chloride | µg/L | 99,500 | 4,580 | 31,000 | 1,790 | 4,320 | 67,200 J | 84,500 |
| Dissolved Organic Carbon (DOC) | µg/L | 16,500 | 6,590 | 2,580 | 2,210 | 5,840 | 7,100 | 12,100 |
| Ethane | µg/L | 190 | 24 | 4.2 J | 1.2 J | 8.8 | 5.6 | 67 |
| Ethene | µg/L | 830 | 0.91 J | 1.1 J | 0.47 J | 8.8 | 11 J | 40 |
| Methane | µg/L | 6,700 | 7,500 | 8,500 | 5,700 | 10,000 | 390 | 8,100 |

## Table B3-24. Laboratory MNA Parameters – 2019 (continued)

| | **Location Name** | MW1-64 | MW1-65 | MW1-67 | MW1-68 |
|---|---|---|---|---|---|
| | **Sample Name** | MW1-64-191024 | MW1-65-191021 | MW1-67-191028 | MW1-68-191028 |
| | **Sample Collection Date** | 10/24/2019 | 10/21/2019 | 10/28/2019 | 10/28/2019 |
| | **Screened Interval (ft bgs)** | 45 - 55 | 53 - 63 | 5 - 15 | 37 - 47 |
| | **Sample Type** | N | N | N | N |
| **Analyte Name** | **Units** | **Result** | **Result** | **Result** | **Result** |
| Sulfide | µg/L | 2,180 | 983 J | 1,160 J | 1,480 J |
| Nitrite | µg/L | 114 J | 40 UJ | 40 UJ | 40 UJ |
| Sulfate | µg/L | 14,200 | 37,200 | 624 J | 430 J |
| Nitrate | µg/L | 40 R | 40 UJ | 40 UJ | 39 J |
| Chloride | µg/L | 63,600 | 380,000 | 20,900 | 1,890 |
| Dissolved Organic Carbon (DOC) | µg/L | 11,100 | 5,920 | 11,600 | 2,850 |
| Ethane | µg/L | 22 | 4.3 J | 6.5 | 6.5 |
| Ethene | µg/L | 21 | 8.2 | 1.8 U | 7.3 |
| Methane | µg/L | 3,700 | 2,200 | 19,000 | 7,600 |

**Notes:**
*No PALs designated for these compounds
FD - Field Duplicate
J - The reported value is an estimated concentration.
P – Parent sample of field duplicate
MNA - Monitored Natural Attenuation
N – Sample is not part of a field duplicate pair
R - The reported value is unusable, rejected.
U - The analyte was not detected at or above the stated limit. (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
UJ - The analyte was not detected at the stated sample quantitation limit, which is an estimated value

## Table B3-25. Field MNA Parameters - 2019 and 2022

| Location Name | | MW1-2 | MW1-18 | MW1-42 | MW1-43 | MW1-44 | MW1-45 | MW1-46 | MW1-47 | MW1-48 | MW1-49 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Name** | | MW1-2-191029 | MW1-18-191021 | MW1-42-191022 | MW1-43-191023 | MW1-44-191024 | MW1-45-191022 | MW1-46-191025 | MW1-47-191025 | MW1-48-191028 | MW1-49-191022 |
| **Sample Collection Date** | | 10/29/2019 | 10/21/2019 | 10/22/2019 | 10/23/2019 | 10/24/2019 | 10/22/2019 | 10/25/2019 | 10/25/2019 | 10/28/2019 | 10/22/2019 |
| **Screened Interval (ft bgs)** | | 12.5 - 17.5 | 12 - 17 | 15 - 25 | 15 - 25 | 18 - 28 | 15 - 25 | 24 - 34 | 15 - 25 | 15 - 25 | 5 - 15 |
| **Analyte** | **Units** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| Dissolved oxygen | mg/L | 0 | 0 | 0.20 | 0.06 | 0 | 0 | 0 | 0 | 0.75 | 0.08 |
| Oxidation Reduction Potential | mV | -30 | -115 | -126 | -134 | -210 | -221 | -133 | -54 | -31 | -87 |
| pH | pH | 6.73 | 7.05 | 7.38 | 7.66 | 8.80 | 8.84 | 7.23 | 6.37 | 6.35 | 7.51 |
| Conductivity | mS/cm | 0.787 | 0.709 | 0.586 | 1.91 | 1.69 | 1.35 | 2.11 | 1.06 | 0.683 | 0.247 |
| Temperature | Deg_C | 11.04 | 13.45 | 15.09 | 13.19 | 14.17 | 15.11 | 15.28 | 15.09 | 12.21 | 11.77 |
| Turbidity | NTU | 4.0 | 14.3 | 0 | 9.8 | 5.9 | 94.7 | 71.0 | 47.8 | 26.3 | 3.3 |

| Location Name | | MW1-50 | MW1-51 | MW1-52 | MW1-53 | MW1-54 | MW1-55 | MW1-56 | MW1-56 | MW1-57 | MW1-57 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Name** | | MW1-50-191023 | MW1-51-191021 | MW1-52-191021 | MW1-53-191023 | MW1-54-191021 | MW1-55-191024 | MW1-56-12-191023 | MW1-56-24-191023 | MW1-57-10-191022 | MW1-57-16-191022 |
| **Sample Collection Date** | | 10/23/2019 | 10/21/2019 | 10/21/2019 | 10/23/2019 | 10/21/2019 | 10/24/2019 | 10/23/2019 | 10/23/2019 | 10/22/2019 | 10/22/2019 |
| **Screened Interval (ft bgs)** | | 5 - 15 | 10 - 20 | 7 - 17 | 5 - 15 | 29 - 39 | 26.5 - 36.5 | 8 - 12 | 20 - 24 | 6 - 10.5 | 12 - 16 |
| **Analyte** | **Units** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| Dissolved oxygen | mg/L | 2.25 | 0 | 0 | 0 | 0.69 | 0 | 0.01 | 0 | 8.96 | 0 |
| Oxidation Reduction Potential | mV | 36 | -171 | -181 | -131 | 253 | 4 | -23 | 215 | -2 | -3 |
| pH | pH | 7.45 | 8.68 | 8.75 | 8.23 | 6.93 | 7.15 | 6.63 | 6.79 | 6.56 | 6.36 |
| Conductivity | mS/cm | 0.235 | 0.334 | 0.347 | 0.378 | 0.194 | 0.263 | 0.852 | 0.467 | 1.09 | 0.445 |
| Temperature | Deg_C | 11.59 | 12.28 | 12.47 | 13.00 | 12.55 | 14.00 | 11.87 | 14.04 | 14.15 | 15.4 |
| Turbidity | NTU | 1.1 | 9.8 | 9.6 | 9.6 | 194 | 59.8 | 9.1 | 26.0 | 170 | 20.8 |

**Table B3-25. Field MNA Parameters - 2019 and 2022 (continued)**

| **Location Name** | | MW1-57 | MW1-58 | MW1-58 | MW1-58 | MW1-59 | MW1-60 | MW1-61 | MW1-62 | MW1-63 | MW1-64 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Name** | | MW1-57-32-191022 | MW1-58-9-191024 | MW1-58-19-191024 | MW1-58-39.5-191024 | MW1-59-191023 | MW1-60-191023 | MW1-61-191028 | MW1-62-191024 | MW1-63-191025 | MW1-64-191024 |
| **Sample Collection Date** | | 10/22/2019 | 10/24/2019 | 10/24/2019 | 10/24/2019 | 10/23/2019 | 10/23/2019 | 10/28/2019 | 10/24/2019 | 10/25/2019 | 10/24/2019 |
| **Screened Interval (ft bgs)** | | 26 - 31 | 5 - 9 | 15 - 19 | 31 - 35 | 60 - 70 | 15 - 25 | 3 - 13 | 31 - 41 | 30 - 40 | 45 - 55 |
| **Analyte** | **Units** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| Dissolved oxygen | mg/L | 0.32 | 6.87 | 0.26 | 0.03 | 0 | 0 | 0 | 0 | 0 | 0.05 |
| Oxidation Reduction Potential | mV | -46 | -47 | -82 | -151 | -230 | -158 | -92 | -136 | -61 | -78 |
| pH | pH | 7.01 | 6.52 | 6.94 | 7.60 | 8.62 | 8.08 | 7.40 | 7.31 | 6.77 | 6.81 |
| Conductivity | mS/cm | 0.381 | 0.880 | 0.395 | 0.382 | 0.268 | 0.333 | 0.438 | 0.899 | 1.20 | 1.09 |
| Temperature | Deg_C | 14.66 | 14.86 | 14.33 | 13.57 | 11.14 | 11.82 | 13.94 | 15.53 | 11.85 | 11.29 |
| Turbidity | NTU | 5.1 | 49.1 | 7.8 | 19.7 | 233 | 124 | 42.2 | 10.0 | 73.9 | 145 |

| **Location Name** | | MW1-65 | MW1-66 | MW1-67 | MW1-68 | MW1-69 | MW1-70 | MW1-71 | MW1-72 | MW1-73 | MW1-74 | MW1-75 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Name** | | MW1-65-191021 | MW1-66-191024 | MW1-67-191028 | MW1-68-191028 | MW1-69-220511 | MW1-70-220502 | MW1-71-220512 | MW1-72-220512 | MW1-73-220513 | MW1-74-220718 | MW1-75-220718 |
| **Sample Collection Date** | | 10/21/2019 | 10/24/2019 | 10/28/2019 | 10/28/2019 | 5/11/2022 | 5/2/2022 | 5/12/2022 | 5/12/2022 | 5/13/2022 | 7/18/2022 | 7/18/2022 |
| **Screened Interval (ft bgs)** | | 53 - 63 | 5 - 20 | 5 - 15 | 37 - 47 | 42 - 52 | 70 - 80 | 95 - 100 | 60 - 70 | 90 - 100 | 45 - 55 | 75 - 80 |
| **Analyte** | **Units** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| Dissolved oxygen | mg/L | 0 | 0 | 0.02 | 0 | 0 | 6.98 | 0 | 0 | 0 | 0.73 | 0.71 |
| Oxidation Reduction Potential | mV | -247 | -105 | -203 | -212 | -389 | -425 | -142 | -376 | -291 | 0 | 10 |
| pH | pH | 7.53 | 6.25 | 8.55 | 8.41 | 7.4 | 8.05 | 7.49 | 7.43 | 7.78 | 3.21 | 2.62 |
| Conductivity | mS/cm | 2.26 | 0.434 | 1.29 | 0.289 | 0.275 | 0.315 | 0.319 | 2.00 | 1.21 | 0.895 | 1.60 |
| Temperature | Deg_C | 12.29 | 15.17 | 9.10 | 11.75 | 11.98 | 11.79 | 13.1 | 12.48 | 11.55 | 16.38 | 16.61 |
| Turbidity | NTU | 57.0 | 148 | 5.0 | 75.6 | 9.7 | 0 | 995 | 3.2 | 7.9 | 34.2 | 236 |

**Notes:**
Deg_C - degrees celsius
mg/L - milligrams per liter
MNA - Monitored Natural Attenuation
mS/cm - millisiemens per centimeter
mV - millivolts
NTU - nephelometric turbidity units
*$Fe^2$ and sulfite not analyzed during field activities

**Table B3-26. Microbial Data for Groundwater Monitoring Wells - 2019**

| | | **Location Name** | MW1-42 | | MW1-45 | | MW1-46 | | | | MW1-47 | | MW1-48 | | MW1-50 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | MW1-42-191022 | | MW1-45-191022 | | MW1-46-191025 | | FD-191025-01 | | MW1-47-191025 | | MW1-48-191028 | | MW1-50-191023 | | FD-191023-01 | |
| | | **Sample Collection Date** | 10/22/2019 | | 10/22/2019 | | 10/25/2019 | | 10/25/2019 | | 10/25/2019 | | 10/28/2019 | | 10/23/2019 | | 10/23/2019 | |
| | | **Screened Interval (ft bgs)** | 15 - 25 | | 15 - 25 | | 24 - 34 | | 24 - 34 | | 15 - 25 | | 15 - 25 | | 5 - 15 | | 5 - 15 | |
| | | **Sample Type** | N | | N | | P | | FD | | N | | N | | P | | FD | |
| **Analyte Name** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| Vinyl Chloride Reductase (VCR) | cells/mL | NA | 3,700 | | 35.5 | | 956 | | 861 | | 178 | | 560 | | 0.5 | U | 0.5 | U |
| Phenol Hydroxylase (PHE) | cells/mL | NA | 1,230 | | 12.3 | U | 264 | | 289 | | 10 | | 110 | | 5.0 | U | 18 | |
| Toluene Dioxygenase (TOD) | cells/mL | NA | 27 | | 12.3 | U | 4.8 | U | 4.7 | U | 5.0 | U | 4.7 | U | 5.0 | U | 5.0 | U |
| BAV1 Vinyl Chloride Reductase (BVC) | cells/mL | NA | 666 | | 0.3 | J | 753 | | 666 | | 537 | | 15 | | 0.5 | U | 0.2 | J |
| Dehalobacter spp. (DHBt) | cells/mL | NA | 4,520 | | 79.3 | | 1,860 | | 1,670 | | 2,220 | | 4.7 | U | 5.0 | U | 5.0 | U |
| Desulfitobacterium spp. (DSB) | cells/mL | NA | 723 | | 12.3 | U | 1,880 | | 2,890 | | 2,060 | | 2,020 | | 1,170 | J | 4,760 | J |
| Desulfuromonas spp. (DSM) | cells/mL | NA | 38 | | 12.3 | U | 19 | | 19 | | 5.0 | U | 2.5 | J | 294 | J | 4.5 | J |
| Total Eubacteria (EBAC) | cells/mL | NA | 2,150,000 | | 15,600 | | 738,000 | | 894,000 | | 1,570,000 | | 15,700,000 | | 91,100 | | 127,000 | |
| Methanogens (MGN) | cells/mL | NA | 1,690 | | 12.3 | U | 63 | | 51 | | 180 | | 12,200 | | 5.0 | U | 5.0 | U |
| Soluble Methane Monooxygenase (SMMO) | cells/mL | NA | 2,830 | | 12.3 | U | 4.8 | U | 4.7 | U | 5.0 | U | 4.7 | U | 5.0 | U | 5.0 | U |
| tceA Reductase (TCE) | cells/mL | NA | 36 | | 1.2 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U |
| Sulfate Reducing Bacteria (APS) | cells/mL | NA | 6,810 | | 266 | | 70,600 | | 72,900 | | 45,300 | | 109,000 | | 3,180 | J | 1,850 | J |
| cerA Reductase (CER) | cells/mL | NA | 17 | | 12.3 | U | 11 | | 1.0 | J | 5.0 | U | 4.7 | U | 5.0 | U | 5.0 | U |
| Chloroform Reductase (CFR) | cells/mL | NA | 5.0 | U | 12.3 | U | 4.8 | U | 4.7 | U | 5.0 | U | 4.7 | U | 5.0 | U | 5.0 | U |
| 1,1 DCA Reductase (DCA) | cells/mL | NA | 5.0 | U | 12.3 | U | 4.8 | U | 4.7 | U | 5.0 | U | 4.7 | U | 5.0 | U | 5.0 | U |
| 1,2 DCA Reductase (DCAR) | cells/mL | NA | 5.0 | U | 12.3 | U | 4.8 | U | 4.7 | U | 5.0 | U | 4.7 | U | 5.0 | U | 5.0 | U |
| Dehalobacter DCM (DCM) | cells/mL | NA | 5.0 | U | 12.3 | U | 4.8 | U | 4.7 | U | 5.0 | U | 4.7 | U | 5.0 | U | 5.0 | U |
| Dichloromethane Dehalogenase (DCMA) | cells/mL | NA | 5.0 | U | 12.3 | U | 4.8 | U | 4.7 | U | 5.0 | U | 4.7 | U | 5.0 | U | 5.0 | U |
| Dehalobium chlorocoercia (DECO) | cells/mL | NA | 5,010 | | 12.3 | U | 5,940 | | 5,780 | | 4,910 | | 28,500 | | 5.0 | U | 101 | |
| Dehalococcoides (DHC) | cells/mL | NA | 20,600 | | 72.2 | | 10,700 | | 9,400 | | 8,920 | | 5,780 | | 4.5 | J | 16 | J |
| Dehalogenimonas spp. (DHG) | cells/mL | NA | 14,000 | | 590 | | 52,500 | | 42,500 | | 4,200 | | 4.7 | U | 5.0 | U | 246 | |
| Ethene Monooxygenase (EtnC) | cells/mL | NA | 21 | | 12.3 | U | 865 | | 968 | | 5 | U | 62 | | 5.0 | U | 5.0 | U |
| Epoxyalkane Transferase (EtnE) | cells/mL | NA | 62 | | 12.3 | U | 5,130 | | 7,090 | | 111 | | 4.7 | U | 53 | | 5.0 | U |
| PCE Reductase (PCE-1) | cells/mL | NA | 17 | | 12.3 | U | 4.8 | U | 4.7 | U | 5.0 | U | 4.7 | U | 5.0 | U | 5.0 | U |
| PCE Reductase (PCE-2) | cells/mL | NA | 5.0 | U | 12.3 | U | 4.8 | U | 4.7 | U | 5.0 | U | 4.7 | U | 5.0 | U | 5.0 | U |
| Toluene Monooxygenase 2 (RDEG) | cells/mL | NA | 5.0 | U | 12.3 | U | 105 | | 109 | | 5.0 | U | 305 | | 20 | | 5.0 | U |
| Toluene Monooxygenase (RMO) | cells/mL | NA | 7,170 | | 12.3 | U | 4,150 | | 3,220 | | 5.0 | U | 1,850 | | 274 | | 5.0 | U |
| Trichlorobenzene Dioxygenase (TCBO) | cells/mL | NA | 5.0 | U | 12.3 | U | 4.8 | U | 4.7 | U | 5.0 | U | 4.7 | U | 5.0 | U | 5.0 | U |
| trans-1,2-DCE Reductase (TDR) | cells/mL | NA | 29,400 | | 12.3 | U | 23,400 | J | 12,200 | J | 5.0 | U | 4.7 | U | 5.0 | U | 5.0 | U |

**Table B3-26. Microbial Data for Groundwater Monitoring Wells – 2019 (continued)**

| | | **Location Name** | MW1-51 | | MW1-52 | | MW1-57 | | MW1-57 | | MW1-57 | | MW1-58 | | MW1-59 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | MW1-51-191022 | | MW1-52-191021 | | MW1-57-10-191022 | | MW1-57-16-191022 | | MW1-57-32-191022 | | MW1-58-9-191024 | | MW1-59-191023 | |
| | | **Sample Collection Date** | 10/22/2019 | | 10/21/2019 | | 10/22/2019 | | 10/22/2019 | | 10/22/2019 | | 10/24/2019 | | 10/23/2019 | |
| | | **Screened Interval (ft bgs)** | 10 - 20 | | 7 - 17 | | 6 - 10.5 | | 12 - 16 | | 26 - 31 | | 5 - 9 | | 60 - 70 | |
| | | **Sample Type** | N | | N | | N | | N | | N | | N | | N | |
| **Analyte Name** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| Vinyl Chloride Reductase (VCR) | cells/mL | NA | 2.1 | | 26 | | 1.3 | | 11 | | 730 | | 445 | | 1.1 | U |
| Phenol Hydroxylase (PHE) | cells/mL | NA | 10 | U | 4.2 | | 7.2 | U | 1,170 | | 5,120 | | 27 | | 11 | U |
| Toluene Dioxygenase (TOD) | cells/mL | NA | 0.2 | J | 3.5 | U | 7.2 | U | 5.0 | U | 4.5 | U | 5.0 | U | 11 | U |
| BAV1 Vinyl Chloride Reductase (BVC) | cells/mL | NA | 1.0 | U | 11 | | 0.5 | J | 27 | | 200 | | 4,180 | | 1.1 | U |
| Dehalobacter spp. (DHBt) | cells/mL | NA | 10 | U | 79 | | 182 | | 2,010 | | 6,960 | | 1,190 | | 11 | U |
| Desulfitobacterium spp. (DSB) | cells/mL | NA | 10 | U | 35 | | 178 | | 2,690 | | 5,500 | | 1,390 | | 11 | U |
| Desulfuromonas spp. (DSM) | cells/mL | NA | 10 | U | 118 | | 7.2 | U | 1,060 | | 39,800 | | 13 | | 11 | U |
| Total Eubacteria (EBAC) | cells/mL | NA | 1,760 | | 165,000 | | 34,100 | | 5,620,000 | | 1,470,000 | | 669,000 | | 2,760 | |
| Methanogens (MGN) | cells/mL | NA | 10 | U | 20 | | 28 | | 16,400 | | 8,730 | | 662 | | 11 | U |
| Soluble Methane Monooxygenase (SMMO) | cells/mL | NA | 10 | U | 101 | | 7.2 | U | 5.0 | U | 4.5 | U | 5.0 | U | 11 | U |
| tceA Reductase (TCE) | cells/mL | NA | 1.0 | U | 5.0 | | 0.7 | U | 0.5 | U | 0.5 | U | 0.5 | U | 1.1 | U |
| Sulfate Reducing Bacteria (APS) | cells/mL | NA | 10 | U | 6,660 | | 7.2 | U | 4,070 | | 33,100 | | 16,500 | | 11 | U |
| cerA Reductase (CER) | cells/mL | NA | 10 | U | 3.5 | U | 7.2 | U | 5.0 | U | 4.5 | U | 0 | J | 11 | U |
| Chloroform Reductase (CFR) | cells/mL | NA | 10 | U | 3.5 | U | 7.2 | U | 5.0 | U | 4.5 | U | 5.0 | U | 11 | U |
| 1,1 DCA Reductase (DCA) | cells/mL | NA | 10 | U | 3.5 | U | 7.2 | U | 5.0 | U | 4.5 | U | 5.0 | U | 11 | U |
| 1,2 DCA Reductase (DCAR) | cells/mL | NA | 10 | U | 3.5 | U | 7.2 | U | 5.0 | U | 4.5 | U | 5.0 | U | 11 | U |
| Dehalobacter DCM (DCM) | cells/mL | NA | 10 | U | 3.5 | U | 7.2 | U | 5.0 | U | 4.5 | U | 5.0 | U | 11 | U |
| Dichloromethane Dehalogenase (DCMA) | cells/mL | NA | 10 | U | 3.5 | U | 7.2 | U | 5.0 | U | 4.5 | U | 5.0 | U | 11 | U |
| Dehalobium chlorocoercia (DECO) | cells/mL | NA | 10 | U | 749 | | 64 | | 939 | | 9,750 | | 2,970 | | 11 | U |
| Dehalococcoides (DHC) | cells/mL | NA | 26 | | 594 | | 14 | | 428 | | 10,200 | | 187,000 | | 1.3 | |
| Dehalogenimonas spp. (DHG) | cells/mL | NA | 10 | U | 11,800 | | 7.2 | U | 5.0 | U | 199 | | 2,510 | | 11 | U |
| Ethene Monooxygenase (EtnC) | cells/mL | NA | 10 | U | 28 | | 7.2 | U | 5.0 | U | 519 | | 5.0 | U | 11 | U |
| Epoxyalkane Transferase (EtnE) | cells/mL | NA | 10 | U | 30 | | 7.2 | U | 5.0 | U | 3,490 | | 5.0 | U | 11 | U |
| PCE Reductase (PCE-1) | cells/mL | NA | 10 | U | 3.5 | U | 238 | | 124,000 | | 378 | | 5.0 | U | 11 | U |
| PCE Reductase (PCE-2) | cells/mL | NA | 10 | U | 3.5 | U | 7.2 | U | 5.0 | U | 86 | | 5.0 | U | 11 | U |
| Toluene Monooxygenase 2 (RDEG) | cells/mL | NA | 10 | U | 79 | | 7.2 | U | 272 | | 2,050 | | 61 | | 11 | U |
| Toluene Monooxygenase (RMO) | cells/mL | NA | 10 | U | 3.5 | U | 7.2 | U | 21 | | 7,300 | | 5.0 | U | 11 | U |
| Trichlorobenzene Dioxygenase (TCBO) | cells/mL | NA | 10 | U | 3.5 | U | 7.2 | U | 5.0 | U | 4.5 | U | 5.0 | U | 11 | U |
| trans-1,2-DCE Reductase (TDR) | cells/mL | NA | 10 | U | 3.5 | U | 7.2 | U | 5.0 | U | 4.5 | U | 2,320 | | 11 | U |

**Table B3-26. Microbial Data for Groundwater Monitoring Wells – 2019 (continued)**

| | | Location Name | MW1-68 | |
|---|---|---|---|---|
| | | Sample Name | MW1-68-191028 | |
| | | Sample Collection Date | 10/28/2019 | |
| | | Screened Interval (ft bgs) | 37 - 47 | |
| | | Sample Type | N | |
| **Analyte Name** | **Units** | **PAL** | **Result** | |
| Vinyl Chloride Reductase (VCR) | cells/mL | NA | 0.1 | J |
| Phenol Hydroxylase (PHE) | cells/mL | NA | 3,970 | |
| Toluene Dioxygenase (TOD) | cells/mL | NA | 24 | |
| BAV1 Vinyl Chloride Reductase (BVC) | cells/mL | NA | 0.5 | U |
| Dehalobacter spp. (DHBt) | cells/mL | NA | 4,360 | |
| Desulfitobacterium spp. (DSB) | cells/mL | NA | 933 | |
| Desulfuromonas spp. (DSM) | cells/mL | NA | 2.5 | J |
| Total Eubacteria (EBAC) | cells/mL | NA | 4,840,000 | |
| Methanogens (MGN) | cells/mL | NA | 4.6 | U |
| Soluble Methane Monooxygenase (SMMO) | cells/mL | NA | 4.6 | U |
| tceA Reductase (TCE) | cells/mL | NA | 0.5 | U |
| Sulfate Reducing Bacteria (APS) | cells/mL | NA | 4.6 | U |
| cerA Reductase (CER) | cells/mL | NA | 4.6 | U |
| Chloroform Reductase (CFR) | cells/mL | NA | 4.6 | U |
| 1,1 DCA Reductase (DCA) | cells/mL | NA | 4.6 | U |
| 1,2 DCA Reductase (DCAR) | cells/mL | NA | 4.6 | U |
| Dehalobacter DCM (DCM) | cells/mL | NA | 4.6 | U |
| Dichloromethane Dehalogenase (DCMA) | cells/mL | NA | 4.6 | U |
| Dehalobium chlorocoercia (DECO) | cells/mL | NA | 1,220 | |
| Dehalococcoides (DHC) | cells/mL | NA | 28 | |
| Dehalogenimonas spp. (DHG) | cells/mL | NA | 4.6 | U |
| Ethene Monooxygenase (EtnC) | cells/mL | NA | 4.6 | U |
| Epoxyalkane Transferase (EtnE) | cells/mL | NA | 117 | |
| PCE Reductase (PCE-1) | cells/mL | NA | 4.6 | U |
| PCE Reductase (PCE-2) | cells/mL | NA | 4.6 | U |
| Toluene Monooxygenase 2 (RDEG) | cells/mL | NA | 2,550 | |
| Toluene Monooxygenase (RMO) | cells/mL | NA | 468 | |
| Trichlorobenzene Dioxygenase (TCBO) | cells/mL | NA | 4.6 | U |
| trans-1,2-DCE Reductase (TDR) | cells/mL | NA | 4.6 | U |

**Table B3-26. Microbial Data for Groundwater Monitoring Wells – 2019 (continued)**

**Notes:**
*Samples analyzed using Microbial Insights QuantArray®-Chlor
FD - Field Duplicate
J - The reported value is an estimated concentration.
P – Parent sample of field duplicate
PAL - Project Action Limit
N – Sample is not part of the field duplicate pair
NA - Not Applicable
U - Not detected above the associated LOQ shown

# Table B3-27. Target VOCs in Porewater – 2019

| | | **Location Name** | PW1-11 | | PW1-12 | | PW1-15 | | PW1-16 | | PW1-17 | | PW1-18 | | PW1-20 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | PW1-11-190606 | | PW1-12-190606 | | PW1-15-190606 | | PW1-16-190606 | | PW1-17-190606 | | PW1-18-190606 | | PW1-20-190605 | |
| | | **Sample Collection Date** | 6/6/2019 | | 6/6/2019 | | 6/6/2019 | | 6/6/2019 | | 6/6/2019 | | 6/6/2019 | | 6/5/2019 | |
| | | **Sample Type** | N | | N | | N | | N | | N | | N | | N | |
| **Analyte Name** | **Units** | **PAL [a]** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| 1,2-Dichloroethane | µg/L | 8.9 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| cis-1,2-Dichloroethene | µg/L | 200 | 64 | | 160 | | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| trans-1,2-Dichloroethene | µg/L | 200 | 0.51 | J | 0.97 | J | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| 1,1,1-Trichloroethane | µg/L | 20,000 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| Chloroethane | µg/L | 700 | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U |
| Vinyl Chloride | µg/L | 0.02 | **26** | | **110** | | 0.015 | U | 0.015 | U | 0.015 | U | 0.015 | U | **0.23** | |
| 1,1-Dichloroethane | µg/L | 700 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| 1,1-Dichloroethene | µg/L | 700 | 0.5 | U | 0.82 | J | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U |
| Trichloroethene | µg/L | 0.3 | 0.3 | U | **2.5** | | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |

| | | **Location Name** | PW1-21 | | PW1-22 | | PW1-23 | | PW1-24 | | | | PW1-28 | | PW1-29 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | PW1-21-190605 | | PW1-22-190605 | | PW1-23-190605 | | PW1-24-190605 | | FD-190605-01 | | PW1-28-190606 | | PW1-29-190606 | |
| | | **Sample Collection Date** | 6/5/2019 | | 6/5/2019 | | 6/5/2019 | | 6/5/2019 | | 6/5/2019 | | 6/6/2019 | | 6/6/2019 | |
| | | **Sample Type** | N | | N | | N | | P | | FD | | N | | N | |
| **Analyte Name** | **Units** | **PAL [a]** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| 1,2-Dichloroethane | µg/L | 8.9 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| cis-1,2-Dichloroethene | µg/L | 200 | 1.4 | | 0.3 | U | 2.3 | | 0.71 | J | 0.78 | J | 27 | | 52 | |
| trans-1,2-Dichloroethene | µg/L | 200 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| 1,1,1-Trichloroethane | µg/L | 20,000 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| Chloroethane | µg/L | 700 | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U |
| Vinyl Chloride | µg/L | 0.02 | **0.14** | | 0.015 | U | **0.92** | | **1.5** | | **1.5** | | **7.5** | | **11** | |
| 1,1-Dichloroethane | µg/L | 700 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| 1,1-Dichloroethene | µg/L | 700 | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U |
| Trichloroethene | µg/L | 0.3 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U | **0.39** | **J** | **2** | |

**Table B3-27. Target VOCs in Porewater – 2019 (continued)**

| | | **Location Name** | PW1-30 | | PW1-31 | | PW1-32 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | PW1-30-191018 | | PW1-31-191018 | | PW1-32-191018 | | FD-191018-01 | |
| | | **Sample Collection Date** | 10/18/2019 | | 10/18/2019 | | 10/18/2019 | | 10/18/2019 | |
| | | **Sample Type** | N | | N | | P | | FD | |
| **Analyte Name** | **Units** | **PAL [a]** | **Result** | | **Result** | | **Result** | | **Result** | |
| 1,2-Dichloroethane | µg/L | 8.9 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| cis-1,2-Dichloroethene | µg/L | 200 | 0.3 | U | 0.3 | U | 0.3 | UJ | 0.3 | U |
| trans-1,2-Dichloroethene | µg/L | 200 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| 1,1,1-Trichloroethane | µg/L | 20,000 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| Chloroethane | µg/L | 700 | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U |
| Vinyl Chloride | µg/L | 0.02 | 0.015 | U | 0.015 | U | 0.015 | U | 0.015 | U |
| 1,1-Dichloroethane | µg/L | 700 | 0.3 | U | 0.3 | U | 0.3 | U | 0.3 | U |
| 1,1-Dichloroethene | µg/L | 700 | 0.5 | U | 0.5 | U | 0.5 | U | 0.5 | U |
| Trichloroethene | µg/L | 0.3 | 0.3 | U | 0.3 | U | 0.3 | UJ | 0.3 | U |

**Notes**
[a] PALs updated from 2018 SAP (U.S. Navy, 2018) and are based on EPA Human Health Surface Water Criteria (40 CFR 131.45). Surrogates were used for cis-1,2-dichloroethene, chloroethane, 1,1-dichloroethane. State of Washington surface water criteria was used for vinyl chloride.
FD - Field Duplicate
J - The reported value is an estimated concentration.
N – Sample is not part of a field duplicate pair
P – Parent sample of field duplicate
PAL - Project Action Limit
U - The analyte was not detected at or above the stated limit. (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
Underlined values represent analytes not detected at or above the stated limit, which exceeds the PAL.
**Bolded** values indicate that the reported concentration exceeds the PAL.
µg/L - micrograms per liter

## Table B3-28. PCB Congeners in Porewater - 2019

| | | **Location Name** | PW1-25 | | PW1-26 | | PW1-27 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | PW1-25-190604 | | PW1-26-190604 | | PW1-27-190604 | | FD-190604-02 | |
| | | **Sample Collection Date** | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | |
| | | **Sample Type** | N | | N | | P | | FD | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-001 | pg/L | NA | 23 | J | 40 | J | 150 | J | 140 | J |
| PCB-002 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-003 | pg/L | NA | 2.6 | J | 2.4 | J | 2.6 | J | 2 | J |
| PCB-004 | pg/L | NA | 92 | J | 420 | | 220 | | 210 | |
| PCB-005 | pg/L | NA | 24 | U | 24 | U | 24 | U | 24 | U |
| PCB-006 | pg/L | NA | 24 | U | 69 | J | 91 | J | 91 | J |
| PCB-007 | pg/L | NA | 24 | U | 24 | U | 24 | U | 24 | U |
| PCB-008 | pg/L | NA | 24 | U | 100 | J | 100 | J | 98 | J |
| PCB-009 | pg/L | NA | 48 | U | 48 | U | 48 | U | 48 | U |
| PCB-010 | pg/L | NA | 48 | U | 48 | U | 48 | U | 48 | U |
| PCB-011 | pg/L | NA | 24 | U | 24 | U | 24 | U | 24 | U |
| PCB-012 AND 013 | pg/L | NA | 38 | U | 39 | U | 38 | U | 38 | U |
| PCB-014 | pg/L | NA | 24 | U | 24 | U | 24 | U | 24 | U |
| PCB-015 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-016 | pg/L | NA | 18 | J | 150 | J | 130 | J | 120 | J |
| PCB-017 | pg/L | NA | 20 | J | 220 | | 120 | J | 130 | J |
| PCB-019 | pg/L | NA | 21 | J | 120 | J | 70 | J | 72 | J |
| PCB-021 AND 033 | pg/L | NA | 7.4 | J | 76 | J | 38 | J | 39 | J |

## Table B3-28. PCB Congeners in Porewater – 2019 (continued)

| | | **Location Name** | PW1-25 | | PW1-26 | | PW1-27 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | PW1-25-190604 | | PW1-26-190604 | | PW1-27-190604 | | FD-190604-02 | |
| | | **Sample Collection Date** | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | |
| | | **Sample Type** | N | | N | | P | | FD | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-022 | pg/L | NA | 5.1 | J | 56 | J | 37 | J | 41 | J |
| PCB-023 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-024 | pg/L | NA | 19 | U | 19 | U | 4.6 | J | 4 | J |
| PCB-025 | pg/L | NA | 8.1 | J | 91 | J | 47 | J | 52 | J |
| PCB-026 AND 029 | pg/L | NA | 24 | J | 350 | J | 160 | J | 170 | J |
| PCB-027 | pg/L | NA | 12 | J | 70 | J | 21 | J | 24 | J |
| PCB-028 AND 020 | pg/L | NA | 27 | J | 200 | J | 120 | J | 130 | J |
| PCB-030 AND 018 | pg/L | NA | 51 | J | 350 | J | 230 | J | 230 | J |
| PCB-031 | pg/L | NA | 28 | J | 180 | J | 110 | J | 120 | J |
| PCB-032 | pg/L | NA | 12 | J | 100 | J | 63 | J | 63 | J |
| PCB-034 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-035 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-036 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-037 | pg/L | NA | 9.6 | U | 12 | J | 5.3 | J | 7.1 | J |
| PCB-038 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-039 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-040 AND 071 | pg/L | NA | 13 | U | 190 | J | 49 | J | 49 | J |
| PCB-041 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |

## Table B3-28. PCB Congeners in Porewater – 2019 (continued)

| | | Location Name | PW1-25 | | PW1-26 | | PW1-27 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | PW1-25-190604 | | PW1-26-190604 | | PW1-27-190604 | | FD-190604-02 | |
| | | **Sample Collection Date** | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | |
| | | **Sample Type** | N | | N | | P | | FD | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-042 | pg/L | NA | 5.8 | J | 160 | J | 40 | J | 43 | J |
| PCB-043 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-044 AND 047 AND 065 | pg/L | NA | 110 | J | 820 | | 250 | J | 290 | J |
| PCB-045 | pg/L | NA | 5.3 | J | 46 | J | 29 | J | 31 | J |
| PCB-046 | pg/L | NA | 3.8 | J | 48 | J | 13 | J | 12 | J |
| PCB-048 | pg/L | NA | 2.8 | J | 35 | J | 8.5 | J | 8.8 | J |
| PCB-050 AND 053 | pg/L | NA | 15 | J | 110 | J | 27 | J | 31 | J |
| PCB-051 | pg/L | NA | 51 | J | 190 | | 67 | J | 72 | J |
| PCB-052 | pg/L | NA | 79 | J | 1200 | | 380 | | 410 | |
| PCB-054 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-055 | pg/L | NA | 9.6 | U | 2.9 | J | 9.6 | U | 1.5 | J |
| PCB-056 | pg/L | NA | 2.4 | U | 41 | J | 15 | J | 15 | J |
| PCB-057 | pg/L | NA | 9.6 | U | 9.7 | U | 2.4 | J | 2.4 | J |
| PCB-058 | pg/L | NA | 19 | U | 18 | J | 7 | J | 5.8 | J |
| PCB-059 AND 062 AND 075 | pg/L | NA | 3.2 | J | 79 | J | 16 | J | 15 | J |
| PCB-060 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-061 AND 070 AND 074 AND 076 | pg/L | NA | 19 | U | 280 | J | 86 | J | 82 | J |
| PCB-063 | pg/L | NA | 19 | U | 10 | J | 2.1 | J | 2.2 | J |

## Table B3-28. PCB Congeners in Porewater – 2019 (continued)

| | | **Location Name** | PW1-25 | | PW1-26 | | PW1-27 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | PW1-25-190604 | | PW1-26-190604 | | PW1-27-190604 | | FD-190604-02 | |
| | | **Sample Collection Date** | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | |
| | | **Sample Type** | N | | N | | P | | FD | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-064 | pg/L | NA | 6.7 | U | 130 | J | 39 | J | 38 | J |
| PCB-066 | pg/L | NA | 13 | U | 200 | | 52 | J | 50 | J |
| PCB-067 | pg/L | NA | 19 | U | 11 | J | 6.5 | J | 7.2 | J |
| PCB-068 | pg/L | NA | 34 | J | 170 | J | 45 | J | 53 | J |
| PCB-069 AND 049 | pg/L | NA | 32 | J | 810 | | 200 | J | 210 | J |
| PCB-072 | pg/L | NA | 19 | U | 14 | J | 4.6 | J | 4.7 | J |
| PCB-073 | pg/L | NA | 19 | U | 11 | J | 19 | U | 19 | U |
| PCB-077 | pg/L | NA | 9.6 | U | 6.5 | J | 2.2 | J | 2.2 | J |
| PCB-078 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-079 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-080 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-081 | pg/L | NA | 9.6 | U | 4.5 | J | 9.6 | U | 9.6 | U |
| PCB-082 | pg/L | NA | 2.9 | J | 9.7 | U | 11 | J | 11 | J |
| PCB-083 | pg/L | NA | 19 | U | 15 | J | 8.7 | J | 7 | J |
| PCB-084 | pg/L | NA | 12 | J | 210 | | 88 | J | 92 | J |
| PCB-088 AND 091 | pg/L | NA | 7.2 | J | 200 | J | 44 | J | 44 | J |
| PCB-089 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-092 | pg/L | NA | 7.3 | J | 95 | J | 47 | J | 43 | J |

## Table B3-28. PCB Congeners in Porewater – 2019 (continued)

| Location Name | | | PW1-25 | | PW1-26 | | PW1-27 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | | | PW1-25-190604 | | PW1-26-190604 | | PW1-27-190604 | | FD-190604-02 | |
| Sample Collection Date | | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | |
| Sample Type | | | N | | N | | P | | FD | |
| Analyte | Units | PAL | Result | | Result | | Result | | Result | |
| PCB-093 AND 100 | pg/L | NA | 19 | U | 12 | J | 19 | U | 4.1 | J |
| PCB-094 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-095 | pg/L | NA | 46 | J | 670 | | 280 | | 280 | |
| PCB-096 | pg/L | NA | 19 | U | 5.5 | J | 2.1 | J | 19 | U |
| PCB-098 AND 102 | pg/L | NA | 19 | U | 35 | J | 6.6 | J | 6.7 | J |
| PCB-099 | pg/L | NA | 18 | J | 310 | | 72 | J | 74 | J |
| PCB-103 | pg/L | NA | 9.6 | U | 19 | J | 3.8 | J | 9.6 | U |
| PCB-104 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-105 | pg/L | NA | 8.3 | J | 37 | | 20 | | 17 | J |
| PCB-106 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-107 AND 124 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-108 AND 119 AND 086 AND 097 AND 125 AND 087 | pg/L | NA | 18 | J | 190 | J | 89 | J | 85 | J |
| PCB-109 | pg/L | NA | 9.6 | U | 20 | J | 7.4 | J | 6.1 | J |
| PCB-110 AND 115 | pg/L | NA | 37 | J | 490 | | 190 | J | 190 | J |
| PCB-111 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-112 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-113 AND 090 AND 101 | pg/L | NA | 35 | J | 490 | J | 160 | J | 160 | J |
| PCB-114 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |

## Table B3-28. PCB Congeners in Porewater – 2019 (continued)

| | | Location Name | PW1-25 | | PW1-26 | | PW1-27 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Sample Name | PW1-25-190604 | | PW1-26-190604 | | PW1-27-190604 | | FD-190604-02 | |
| | | Sample Collection Date | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | |
| | | Sample Type | N | | N | | P | | FD | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-117 AND 116 AND 085 | pg/L | NA | 5.3 | J | 24 | J | 20 | J | 20 | J |
| PCB-118 | pg/L | NA | 23 | | 250 | | 75 | | 68 | |
| PCB-120 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-121 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-122 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-123 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-126 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-127 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-128 AND 166 | pg/L | NA | 2.6 | U | 20 | J | 8.5 | J | 7.3 | J |
| PCB-130 | pg/L | NA | 9.6 | U | 6.2 | J | 4.8 | J | 4.5 | J |
| PCB-131 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-132 | pg/L | NA | 5.6 | J | 36 | J | 24 | J | 21 | J |
| PCB-133 | pg/L | NA | 9.6 | U | 3 | J | 9.6 | U | 9.6 | U |
| PCB-134 AND 143 | pg/L | NA | 1.1 | J | 8.1 | J | 4.7 | J | 4.8 | J |
| PCB-136 | pg/L | NA | 2.2 | U | 32 | J | 12 | J | 12 | J |
| PCB-137 | pg/L | NA | 19 | U | 3.8 | J | 2.1 | J | 19 | U |
| PCB-138 AND 163 AND 129 | pg/L | NA | 17 | J | 120 | J | 57 | J | 48 | J |
| PCB-139 AND 140 | pg/L | NA | 19 | U | 2.3 | J | 1.2 | J | 1.3 | J |

## Table B3-28. PCB Congeners in Porewater – 2019 (continued)

| | | **Location Name** | PW1-25 | | PW1-26 | | PW1-27 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | PW1-25-190604 | | PW1-26-190604 | | PW1-27-190604 | | FD-190604-02 | |
| | | **Sample Collection Date** | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | |
| | | **Sample Type** | N | | N | | P | | FD | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-141 | pg/L | NA | 9.6 | U | 11 | J | 5.4 | J | 6.2 | J |
| PCB-142 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-144 | pg/L | NA | 9.6 | U | 2.5 | J | 2.2 | J | 2 | J |
| PCB-145 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-146 | pg/L | NA | 2.3 | J | 22 | J | 7.8 | J | 7.5 | J |
| PCB-147 AND 149 | pg/L | NA | 13 | J | 150 | J | 51 | J | 48 | J |
| PCB-148 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-150 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-151 AND 135 | pg/L | NA | 3.9 | U | 41 | J | 20 | J | 18 | J |
| PCB-152 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-153 AND 168 | pg/L | NA | 14 | U | 120 | J | 42 | J | 36 | J |
| PCB-154 | pg/L | NA | 9.6 | U | 4.7 | J | 1.4 | J | 9.6 | U |
| PCB-155 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-156 AND 157 | pg/L | NA | 2.6 | J | 11 | J | 5.7 | J | 3.7 | J |
| PCB-158 | pg/L | NA | 2 | J | 11 | J | 5.8 | J | 3.9 | J |
| PCB-159 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-160 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-161 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |

## Table B3-28. PCB Congeners in Porewater – 2019 (continued)

| | | Location Name | PW1-25 | | PW1-26 | | PW1-27 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Sample Name | PW1-25-190604 | | PW1-26-190604 | | PW1-27-190604 | | FD-190604-02 | |
| | | Sample Collection Date | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | |
| | | Sample Type | N | | N | | P | | FD | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-162 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-164 | pg/L | NA | 0.72 | J | 7.8 | J | 3.8 | J | 3.1 | J |
| PCB-165 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-167 | pg/L | NA | 1.4 | J | 5.2 | J | 2.2 | J | 1.5 | J |
| PCB-169 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-170 | pg/L | NA | 19 | U | 8.1 | J | 19 | U | 2 | J |
| PCB-171 AND 173 | pg/L | NA | 19 | U | 2.2 | J | 19 | U | 19 | U |
| PCB-172 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-174 | pg/L | NA | 0.96 | J | 4.7 | J | 1.9 | J | 3.1 | J |
| PCB-175 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-176 | pg/L | NA | 9.6 | U | 1 | J | 9.6 | U | 9.6 | U |
| PCB-177 | pg/L | NA | 19 | U | 4.9 | J | 1.7 | J | 1.2 | J |
| PCB-178 | pg/L | NA | 9.6 | U | 9.7 | U | 1.7 | J | 9.6 | U |
| PCB-179 | pg/L | NA | 19 | U | 3.1 | J | 1.6 | J | 19 | U |
| PCB-180 AND 193 | pg/L | NA | 38 | U | 14 | J | 7.1 | J | 5.8 | J |
| PCB-181 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-182 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-183 | pg/L | NA | 1.6 | U | 5.5 | J | 2.1 | J | 1.9 | J |

# Table B3-28. PCB Congeners in Porewater – 2019 (continued)

| | | Location Name | PW1-25 | | PW1-26 | | PW1-27 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | PW1-25-190604 | | PW1-26-190604 | | PW1-27-190604 | | FD-190604-02 | |
| | | **Sample Collection Date** | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | |
| | | **Sample Type** | N | | N | | P | | FD | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-184 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-185 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-186 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-187 | pg/L | NA | 19 | U | 9.3 | J | 6.3 | J | 19 | U |
| PCB-188 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-189 | pg/L | NA | 9.6 | U | 0.78 | J | 9.6 | U | 9.6 | U |
| PCB-190 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-191 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-192 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-194 | pg/L | NA | 19 | U | 2.6 | J | 1.4 | J | 19 | U |
| PCB-195 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-196 | pg/L | NA | 19 | U | 0.91 | J | 1.1 | J | 19 | U |
| PCB-197 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-198 AND 199 | pg/L | NA | 19 | U | 1.6 | J | 0.98 | J | 0.87 | J |
| PCB-200 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-201 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-202 | pg/L | NA | 9.6 | U | 0.55 | J | 9.6 | U | 9.6 | U |
| PCB-203 | pg/L | NA | 19 | U | 1.6 | J | 0.76 | J | 1.1 | J |

# Table B3-28. PCB Congeners in Porewater – 2019 (continued)

| | | **Location Name** | PW1-25 | | PW1-26 | | PW1-27 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | PW1-25-190604 | | PW1-26-190604 | | PW1-27-190604 | | FD-190604-02 | |
| | | **Sample Collection Date** | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | |
| | | **Sample Type** | N | | N | | P | | FD | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-204 | pg/L | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-205 | pg/L | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-206 | pg/L | NA | 9.6 | U | 1 | J | 2.5 | J | 0.91 | J |
| PCB-207 | pg/L | NA | 9.6 | U | 9.7 | U | 0.29 | J | 9.6 | U |
| PCB-208 | pg/L | NA | 9.6 | U | 9.7 | U | 0.39 | J | 9.6 | U |
| PCB-209 | pg/L | NA | 0.61 | U | 1.1 | U | 2.7 | J | 0.92 | U |
| TOTAL PCBs | pg/L | 7 | **960** | | **10,945** | | **4,480** | | **4,532** | |

**Notes:**
*PAL not established in SAP (U.S. Navy, 2018); PAL used is EPA Human Health Surface Water Criteria (40 CFR 131.45)
FD – Field duplicate
J - The reported value is an estimated concentration.
N – Sample is not part of a field duplicate pair
NA - Not applicable
P – Parent sample of field duplicate
PAL - Project Action Limit
PCB - polychlorinated biphenyls
U - The analyte was not detected at or above the limit of detection (LOD). (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
**Bolded** values indicate that the reported concentration exceeds the PAL.
pg/L - picograms per liter

## Table B3-29. Total PCBs (Congeners) in Porewater - 2019

| Location Name | Sample Name | Sample type | Total PCBs (Sum of congeners with ND as null) Result (pg/L) | Total number of PCB congeners detected |
|---|---|---|---|---|
| | | **Surface Water Criterion[1]** | **7** | **--** |
| PW1-25 | PW1-25-190604 | N | **960** | 69 |
| PW1-26 | PW1-26-190604 | N | **10,945** | 129 |
| PW1-27 | PW1-27-190604 | N | **4,480** | 124 |

Notes:
[1] EPA Human Health Surface Water Criteria (40 CFR 131.45)
All samples analyzed using analytical method 1668C.
N – Sample is not part of a field duplicate pair
PCB - polychlorinated biphenyl
**Bolded** values indicate that the reported concentration exceeds the PAL.
pg/L - picograms per liter

# Table B3-30. Target VOCs in Surface Water - 2019

| | | **Location Name** | SW1-13 | SW1-14 | SW1-15 | SW1-16 | SW1-17 | |
|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SW1-13-190604 | SW1-14-190603 | SW1-15-190603 | SW1-16-190603 | SW1-17-190603 | FD-190603-02 |
| | | **Sample Collection Date** | 6/4/2019 | 6/3/2019 | 6/3/2019 | 6/3/2019 | 6/3/2019 | 6/3/2019 |
| | | **Sample Type** | N | N | N | N | P | FD |
| **Analyte** | **Units** | **PAL [a]** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| 1,2-Dichloroethane | µg/L | 8.9 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Tetrachloroethene | µg/L | 2.4 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| cis-1,2-Dichloroethene | µg/L | 200 | 140 | 2.5 | 2.5 | 2.3 | 2.2 J | 2.4 |
| trans-1,2-Dichloroethene | µg/L | 200 | 1 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| 1,1,1-Trichloroethane | µg/L | 20,000 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |
| Chloroethane | µg/L | 700 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Vinyl Chloride | µg/L | 0.02 | **9.3** | **0.14** | **0.18** | **0.13** | **0.093** | **0.13** |
| 1,1-Dichloroethane | µg/L | 700 | <u>0.3 U</u> | <u>0.3 U</u> | <u>0.3 U</u> | <u>0.3 U</u> | <u>0.3 U</u> | <u>0.3 U</u> |
| 1,1-Dichloroethene | µg/L | 700 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Trichloroethene | µg/L | 0.3 | **10** | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U |

**Notes:**
[a] PALs updated from 2018 SAP (U.S. Navy, 2018) and are based on EPA Human Health Surface Water Criteria (40 CFR 131.45). Surrogates were used for cis-1,2-dichloroethene, chloroethane, 1,1-dichloroethane. State of Washington surface water criteria was used for vinyl chloride.
FD - Duplicate
J - The reported value is an estimated concentration. N - Sample is not part of a field duplicate pair. P - Parent Sample of field duplicate
PAL - Project Action Limit
U - The analyte was not detected at or above the stated limit. (Sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
<u>Underlined</u> values represent analytes not detected at or above the stated limit, which exceeds the PAL.
**Bolded** values indicate that the reported concentration exceeds the PAL.
µg/L - micrograms per liter

# Table B3-31. PCB Congeners in Surface Water – 2019

| | | Location Name | SW1-18 | | SW1-19 | SW1-20 |
|---|---|---|---|---|---|---|
| | | **Sample Name** | SW1-18-190603 | FD-190603-01 | SW1-19-190603 | SW1-20-190603 |
| | | **Sample Collection Date** | 6/3/2019 | 6/3/2019 | 6/3/2019 | 6/3/2019 |
| | | **Sample Type** | P | FD | N | N |
| **Analyte** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** |
| PCB-001 | pg/L | NA | 14 J | 12 J | 300 | 11 J |
| PCB-002 | pg/L | NA | 19 U | 20 U | 23 J | 20 U |
| PCB-003 | pg/L | NA | 1.9 J | 1.5 J | 100 J | 1.9 J |
| PCB-004 | pg/L | NA | 120 J | 130 J | 4,200 | 130 J |
| PCB-005 | pg/L | NA | 24 U | 25 U | 23 U | 25 U |
| PCB-006 | pg/L | NA | 49 J | 46 J | 1,700 | 47 J |
| PCB-007 | pg/L | NA | 24 U | 25 U | 31 J | 25 U |
| PCB-008 | pg/L | NA | 88 J | 78 J | 1,800 | 80 J |
| PCB-009 | pg/L | NA | 48 U | 50 U | 54 J | 51 U |
| PCB-010 | pg/L | NA | 48 U | 50 U | 110 J | 51 U |
| PCB-011 | pg/L | NA | 24 U | 25 U | 51 J | 16 J |
| PCB-012 AND 013 | pg/L | NA | 38 U | 40 U | 150 J | 11 J |
| PCB-014 | pg/L | NA | 24 U | 25 U | 23 U | 25 U |
| PCB-015 | pg/L | NA | 30 J | 29 J | 560 | 28 J |
| PCB-016 | pg/L | NA | 38 J | 40 J | 560 | 41 J |
| PCB-017 | pg/L | NA | 56 J | 51 J | 670 | 51 J |
| PCB-019 | pg/L | NA | 24 J | 24 J | 600 | 24 J |
| PCB-021 AND 033 | pg/L | NA | 40 J | 38 J | 160 J | 30 J |

## Table B3-31. PCB Congeners in Surface Water – 2019 (continued)

| | | Location Name | SW1-18 | | | | SW1-19 | | SW1-20 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Sample Name | SW1-18-190603 | | FD-190603-01 | | SW1-19-190603 | | SW1-20-190603 | |
| | | Sample Collection Date | 6/3/2019 | | 6/3/2019 | | 6/3/2019 | | 6/3/2019 | |
| | | Sample Type | P | | FD | | N | | N | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-022 | pg/L | NA | 21 | J | 17 | J | 160 | J | 17 | J |
| PCB-023 | pg/L | NA | 19 | U | 20 | U | 19 | U | 20 | U |
| PCB-024 | pg/L | NA | 19 | U | 2.6 | J | 13 | J | 1.9 | J |
| PCB-025 | pg/L | NA | 19 | J | 15 | J | 220 | | 15 | J |
| PCB-026 AND 029 | pg/L | NA | 46 | J | 39 | J | 440 | | 46 | J |
| PCB-027 | pg/L | NA | 19 | J | 17 | J | 410 | | 17 | J |
| PCB-028 AND 020 | pg/L | NA | 100 | J | 97 | J | 640 | | 94 | J |
| PCB-030 AND 018 | pg/L | NA | 110 | J | 100 | J | 1,700 | | 110 | J |
| PCB-031 | pg/L | NA | 80 | J | 76 | J | 460 | | 77 | J |
| PCB-032 | pg/L | NA | 23 | J | 22 | J | 350 | | 23 | J |
| PCB-034 | pg/L | NA | 19 | U | 20 | U | 9.3 | J | 20 | U |
| PCB-035 | pg/L | NA | 9.5 | U | 9.9 | U | 9.3 | U | 10 | U |
| PCB-036 | pg/L | NA | 9.5 | U | 9.9 | U | 9.3 | U | 10 | U |
| PCB-037 | pg/L | NA | 8.7 | J | 8 | J | 50 | J | 7.8 | J |
| PCB-038 | pg/L | NA | 19 | U | 20 | U | 19 | U | 20 | U |
| PCB-039 | pg/L | NA | 9.5 | U | 9.9 | U | 9.3 | U | 10 | U |
| PCB-040 AND 071 | pg/L | NA | 18 | J | 19 | J | 120 | J | 20 | J |
| PCB-041 | pg/L | NA | 9.5 | U | 9.9 | U | 9.3 | U | 10 | U |

## Table B3-31. PCB Congeners in Surface Water – 2019 (continued)

| | | Location Name | SW1-18 | | | | SW1-19 | | SW1-20 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Sample Name | SW1-18-190603 | | FD-190603-01 | | SW1-19-190603 | | SW1-20-190603 | |
| | | Sample Collection Date | 6/3/2019 | | 6/3/2019 | | 6/3/2019 | | 6/3/2019 | |
| | | Sample Type | P | | FD | | N | | N | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-042 | pg/L | NA | 10 | J | 11 | J | 80 | J | 12 | J |
| PCB-043 | pg/L | NA | 1.1 | J | 9.9 | U | 12 | J | 10 | U |
| PCB-044 AND 047 AND 065 | pg/L | NA | 52 | J | 53 | J | 350 | J | 54 | J |
| PCB-045 | pg/L | NA | 11 | J | 9.6 | J | 72 | J | 10 | J |
| PCB-046 | pg/L | NA | 4.9 | J | 3.9 | J | 67 | J | 4.6 | J |
| PCB-048 | pg/L | NA | 10 | J | 11 | J | 40 | J | 9.5 | J |
| PCB-050 AND 053 | pg/L | NA | 15 | J | 17 | J | 220 | J | 19 | J |
| PCB-051 | pg/L | NA | 3 | J | 3.7 | J | 32 | J | 3.3 | J |
| PCB-052 | pg/L | NA | 94 | J | 97 | J | 670 | | 100 | J |
| PCB-054 | pg/L | NA | 9.5 | U | 9.9 | U | 7.5 | J | 10 | U |
| PCB-055 | pg/L | NA | 9.5 | U | 9.9 | U | 1.5 | J | 10 | U |
| PCB-056 | pg/L | NA | 6.3 | J | 5.9 | J | 28 | J | 6.2 | J |
| PCB-057 | pg/L | NA | 9.5 | U | 1.9 | J | 2.1 | J | 10 | U |
| PCB-058 | pg/L | NA | 19 | U | 20 | U | 19 | U | 1.2 | J |
| PCB-059 AND 062 AND 075 | pg/L | NA | 6.3 | J | 6.1 | J | 59 | J | 7.1 | J |
| PCB-060 | pg/L | NA | 3.2 | J | 3.2 | J | 7.5 | J | 3.6 | J |
| PCB-061 AND 070 AND 074 AND 076 | pg/L | NA | 39 | J | 41 | J | 160 | J | 39 | J |
| PCB-063 | pg/L | NA | 1.6 | J | 20 | U | 5.3 | J | 20 | U |

## Table B3-31. PCB Congeners in Surface Water – 2019 (continued)

| | | Location Name | SW1-18 | | SW1-19 | SW1-20 |
|---|---|---|---|---|---|---|
| | | **Sample Name** | SW1-18-190603 | FD-190603-01 | SW1-19-190603 | SW1-20-190603 |
| | | **Sample Collection Date** | 6/3/2019 | 6/3/2019 | 6/3/2019 | 6/3/2019 |
| | | **Sample Type** | P | FD | N | N |
| **Analyte** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** |
| PCB-064 | pg/L | NA | 14 J | 15 J | 90 J | 15 J |
| PCB-066 | pg/L | NA | 28 J | 30 J | 90 J | 29 J |
| PCB-067 | pg/L | NA | 19 U | 1.3 J | 7.4 J | 1.1 J |
| PCB-068 | pg/L | NA | 19 U | 1.2 U | 3.7 U | 20 U |
| PCB-069 AND 049 | pg/L | NA | 43 J | 44 J | 310 J | 47 J |
| PCB-072 | pg/L | NA | 19 U | 1.3 J | 5.6 J | 0.97 J |
| PCB-073 | pg/L | NA | 19 U | 1.1 J | 19 U | 1.2 J |
| PCB-077 | pg/L | NA | 2.7 J | 2.1 J | 7.1 J | 2.3 J |
| PCB-078 | pg/L | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-079 | pg/L | NA | 9.5 U | 1.1 J | 9.3 U | 10 U |
| PCB-080 | pg/L | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-081 | pg/L | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-082 | pg/L | NA | 3.7 J | 4 J | 12 J | 3.2 J |
| PCB-083 | pg/L | NA | 1.8 J | 20 U | 7.3 J | 2.8 J |
| PCB-084 | pg/L | NA | 14 J | 14 J | 77 J | 14 J |
| PCB-088 AND 091 | pg/L | NA | 8.5 J | 9.5 J | 36 J | 9.3 J |
| PCB-089 | pg/L | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-092 | pg/L | NA | 10 J | 8.7 J | 37 J | 11 J |

## Table B3-31. PCB Congeners in Surface Water – 2019 (continued)

| | | Location Name | SW1-18 | | SW1-19 | SW1-20 |
|---|---|---|---|---|---|---|
| | | **Sample Name** | SW1-18-190603 | FD-190603-01 | SW1-19-190603 | SW1-20-190603 |
| | | **Sample Collection Date** | 6/3/2019 | 6/3/2019 | 6/3/2019 | 6/3/2019 |
| | | **Sample Type** | P | FD | N | N |
| **Analyte** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** |
| PCB-093 AND 100 | pg/L | NA | 19 U | 20 U | 3.5 J | 20 U |
| PCB-094 | pg/L | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-095 | pg/L | NA | 50 J | 59 J | 220 | 53 J |
| PCB-096 | pg/L | NA | 19 U | 20 U | 3.1 J | 0.36 J |
| PCB-098 AND 102 | pg/L | NA | 1.5 J | 20 U | 8.6 J | 2.8 J |
| PCB-099 | pg/L | NA | 29 J | 34 J | 80 J | 27 J |
| PCB-103 | pg/L | NA | 9.5 U | 9.9 U | 3.4 J | 10 U |
| PCB-104 | pg/L | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-105 | pg/L | NA | 16 J | 20 | 32 | 16 J |
| PCB-106 | pg/L | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-107 AND 124 | pg/L | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-108 AND 119 AND 086 AND 097 AND 125 AND 087 | pg/L | NA | 29 J | 32 J | 85 J | 30 J |
| PCB-109 | pg/L | NA | 2.3 J | 3.5 J | 6.2 J | 2.9 J |
| PCB-110 AND 115 | pg/L | NA | 53 J | 60 J | 160 J | 55 J |
| PCB-111 | pg/L | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-112 | pg/L | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-113 AND 090 AND 101 | pg/L | NA | 53 J | 61 J | 150 J | 58 J |
| PCB-114 | pg/L | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |

## Table B3-31. PCB Congeners in Surface Water – 2019 (continued)

| | | Location Name | SW1-18 | | | | SW1-19 | | SW1-20 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SW1-18-190603 | | FD-190603-01 | | SW1-19-190603 | | SW1-20-190603 | |
| | | **Sample Collection Date** | 6/3/2019 | | 6/3/2019 | | 6/3/2019 | | 6/3/2019 | |
| | | **Sample Type** | P | | FD | | N | | N | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-117 AND 116 AND 085 | pg/L | NA | 9.2 | U | 11 | U | 21 | J | 11 | U |
| PCB-118 | pg/L | NA | 46 | | 55 | | 99 | | 52 | |
| PCB-120 | pg/L | NA | 9.5 | U | 9.9 | U | 9.3 | U | 10 | U |
| PCB-121 | pg/L | NA | 9.5 | U | 9.9 | U | 9.3 | U | 10 | U |
| PCB-122 | pg/L | NA | 9.5 | U | 9.9 | U | 9.3 | U | 10 | U |
| PCB-123 | pg/L | NA | 9.5 | U | 9.9 | U | 2.6 | J | 1.1 | J |
| PCB-126 | pg/L | NA | 9.5 | U | 9.9 | U | 9.3 | U | 10 | U |
| PCB-127 | pg/L | NA | 19 | U | 20 | U | 19 | U | 20 | U |
| PCB-128 AND 166 | pg/L | NA | 7.6 | J | 8.5 | J | 14 | J | 8.6 | J |
| PCB-130 | pg/L | NA | 3.4 | J | 3.6 | J | 5 | J | 3.2 | J |
| PCB-131 | pg/L | NA | 19 | U | 1 | J | 1 | J | 0.89 | J |
| PCB-132 | pg/L | NA | 10 | J | 15 | J | 23 | J | 11 | J |
| PCB-133 | pg/L | NA | 9.5 | U | 9.9 | U | 1 | J | 10 | U |
| PCB-134 AND 143 | pg/L | NA | 2.2 | J | 2 | J | 4.1 | J | 1.2 | J |
| PCB-136 | pg/L | NA | 2.8 | J | 5 | J | 11 | J | 3.8 | J |
| PCB-137 | pg/L | NA | 1.9 | J | 2.1 | J | 3.8 | J | 2.3 | J |
| PCB-138 AND 163 AND 129 | pg/L | NA | 47 | J | 57 | J | 80 | J | 55 | J |
| PCB-139 AND 140 | pg/L | NA | 19 | U | 1 | J | 1.4 | J | 0.96 | J |

## Table B3-31. PCB Congeners in Surface Water – 2019 (continued)

| | | Location Name | SW1-18 | | SW1-19 | SW1-20 |
|---|---|---|---|---|---|---|
| | | **Sample Name** | SW1-18-190603 | FD-190603-01 | SW1-19-190603 | SW1-20-190603 |
| | | **Sample Collection Date** | 6/3/2019 | 6/3/2019 | 6/3/2019 | 6/3/2019 |
| | | **Sample Type** | P | FD | N | N |
| **Analyte** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** |
| PCB-141 | pg/L | NA | 4.6 J | 4.9 J | 8.7 J | 5.1 J |
| PCB-142 | pg/L | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-144 | pg/L | NA | 9.5 U | 1.3 J | 2.8 J | 1.1 J |
| PCB-145 | pg/L | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-146 | pg/L | NA | 5.4 J | 5.8 J | 9.6 J | 5.1 J |
| PCB-147 AND 149 | pg/L | NA | 23 J | 27 J | 52 J | 26 J |
| PCB-148 | pg/L | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-150 | pg/L | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-151 AND 135 | pg/L | NA | 7.9 J | 8.5 J | 19 J | 6.7 J |
| PCB-152 | pg/L | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-153 AND 168 | pg/L | NA | 31 J | 35 J | 53 J | 31 J |
| PCB-154 | pg/L | NA | 9.5 U | 1.1 J | 1.2 J | 1 J |
| PCB-155 | pg/L | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-156 AND 157 | pg/L | NA | 6.3 J | 7.8 J | 12 J | 5.3 J |
| PCB-158 | pg/L | NA | 4.5 J | 5.8 J | 7.6 J | 5.5 J |
| PCB-159 | pg/L | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-160 | pg/L | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-161 | pg/L | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |

## Table B3-31. PCB Congeners in Surface Water – 2019 (continued)

| | | **Location Name** | SW1-18 | | | | SW1-19 | | SW1-20 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SW1-18-190603 | | FD-190603-01 | | SW1-19-190603 | | SW1-20-190603 | |
| | | **Sample Collection Date** | 6/3/2019 | | 6/3/2019 | | 6/3/2019 | | 6/3/2019 | |
| | | **Sample Type** | P | | FD | | N | | N | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-162 | pg/L | NA | 19 | U | 20 | U | 19 | U | 20 | U |
| PCB-164 | pg/L | NA | 2.5 | J | 2.6 | J | 5 | J | 2.8 | J |
| PCB-165 | pg/L | NA | 9.5 | U | 9.9 | U | 9.3 | U | 10 | U |
| PCB-167 | pg/L | NA | 2.3 | J | 2.5 | J | 3.7 | J | 2.2 | J |
| PCB-169 | pg/L | NA | 9.5 | U | 9.9 | U | 0.7 | J | 10 | U |
| PCB-170 | pg/L | NA | 4.2 | J | 5.5 | J | 7.6 | J | 3.5 | J |
| PCB-171 AND 173 | pg/L | NA | 19 | U | 2 | J | 19 | U | 1.4 | J |
| PCB-172 | pg/L | NA | 9.5 | U | 9.9 | U | 1.1 | J | 10 | U |
| PCB-174 | pg/L | NA | 2.2 | J | 1.9 | J | 4.7 | J | 2.2 | J |
| PCB-175 | pg/L | NA | 19 | U | 20 | U | 19 | U | 20 | U |
| PCB-176 | pg/L | NA | 9.5 | U | 9.9 | U | 9.3 | U | 0.48 | J |
| PCB-177 | pg/L | NA | 2 | J | 1.2 | J | 3.6 | J | 2.1 | J |
| PCB-178 | pg/L | NA | 9.5 | U | 9.9 | U | 1.4 | J | 10 | U |
| PCB-179 | pg/L | NA | 1.2 | J | 1.5 | J | 2 | J | 0.65 | J |
| PCB-180 AND 193 | pg/L | NA | 5.3 | J | 6.2 | J | 11 | J | 5.2 | J |
| PCB-181 | pg/L | NA | 9.5 | U | 9.9 | U | 9.3 | U | 10 | U |
| PCB-182 | pg/L | NA | 9.5 | U | 9.9 | U | 9.3 | U | 10 | U |
| PCB-183 | pg/L | NA | 2.9 | U | 3.3 | U | 4.9 | U | 2.4 | U |

# Table B3-31. PCB Congeners in Surface Water – 2019 (continued)

| | | Location Name | SW1-18 | | | | SW1-19 | | SW1-20 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Sample Name | SW1-18-190603 | | FD-190603-01 | | SW1-19-190603 | | SW1-20-190603 | |
| | | Sample Collection Date | 6/3/2019 | | 6/3/2019 | | 6/3/2019 | | 6/3/2019 | |
| | | Sample Type | P | | FD | | N | | N | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-184 | pg/L | NA | 19 | U | 20 | U | 19 | U | 20 | U |
| PCB-185 | pg/L | NA | 19 | U | 20 | U | 19 | U | 20 | U |
| PCB-186 | pg/L | NA | 9.5 | U | 9.9 | U | 9.3 | U | 10 | U |
| PCB-187 | pg/L | NA | 4.1 | J | 3 | J | 6.9 | J | 3.4 | J |
| PCB-188 | pg/L | NA | 9.5 | U | 9.9 | U | 9.3 | U | 10 | U |
| PCB-189 | pg/L | NA | 9.5 | U | 9.9 | U | 9.3 | U | 10 | U |
| PCB-190 | pg/L | NA | 19 | U | 0.87 | J | 1 | J | 20 | U |
| PCB-191 | pg/L | NA | 19 | U | 20 | U | 19 | U | 20 | U |
| PCB-192 | pg/L | NA | 19 | U | 20 | U | 19 | U | 20 | U |
| PCB-194 | pg/L | NA | 19 | U | 0.99 | J | 2.1 | J | 0.92 | J |
| PCB-195 | pg/L | NA | 19 | U | 1.3 | J | 0.98 | J | 20 | U |
| PCB-196 | pg/L | NA | 0.52 | J | 20 | U | 19 | U | 0.54 | J |
| PCB-197 | pg/L | NA | 19 | U | 20 | U | 19 | U | 20 | U |
| PCB-198 AND 199 | pg/L | NA | 0.71 | U | 1 | U | 2.1 | U | 0.87 | U |
| PCB-200 | pg/L | NA | 19 | U | 0.21 | J | 19 | U | 0.29 | J |
| PCB-201 | pg/L | NA | 19 | U | 20 | U | 0.62 | J | 20 | U |
| PCB-202 | pg/L | NA | 9.5 | U | 9.9 | U | 9.3 | U | 0.43 | U |
| PCB-203 | pg/L | NA | 0.71 | J | 0.47 | J | 1 | J | 1.1 | J |

## Table B3-31. PCB Congeners in Surface Water – 2019 (continued)

| | | Location Name | SW1-18 | | SW1-19 | SW1-20 |
|---|---|---|---|---|---|---|
| | | **Sample Name** | SW1-18-190603 | FD-190603-01 | SW1-19-190603 | SW1-20-190603 |
| | | **Sample Collection Date** | 6/3/2019 | 6/3/2019 | 6/3/2019 | 6/3/2019 |
| | | **Sample Type** | P | FD | N | N |
| **Analyte** | **Units** | **PAL** | **Result** | **Result** | **Result** | **Result** |
| PCB-204 | pg/L | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-205 | pg/L | NA | 9.5 U | 9.9 U | 0.77 J | 10 U |
| PCB-206 | pg/L | NA | 1.2 J | 1.1 J | 1.9 J | 0.68 J |
| PCB-207 | pg/L | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-208 | pg/L | NA | 9.5 U | 9.9 U | 0.4 J | 10 U |
| PCB-209 | pg/L | NA | 1.9 U | 1.4 U | 2.3 U | 2 U |
| TOTAL PCBs | pg/L | 7 | **1,752** | **1,807** | **19,376** | **1,805** |

**Notes:**
*PAL not established in SAP (U.S. Navy, 2018); PAL used is EPA Human Health Surface Water Criteria (40 CFR 131.45)
FD – Field duplicate
P – Parent sample of field duplicate
N – Sample is not part of a field duplicate pair
J - The reported value is an estimated concentration.
U - The analyte was not detected at or above the limit of detection (LOD). (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
PCB - polychlorinated biphenyls
NA - Not applicable; NE - Not established
**Bolded** values indicate that the reported concentration exceeds the PAL.
pg/L - picograms per liter

## Table B3-32. Total PCBs (Congeners) in Surface Water - 2019

| Location Name | Sample Name | Sample type | Total PCBs (Sum of congeners with ND as null) Result (pg/L) | Total number of PCB congeners detected |
|---|---|---|---|---|
| | | **Surface Water Criterion[1]** | 7 | **--** |
| SW1-18 | SW1-18-190603 | P | **1,752** | 110 |
| SW1-18 (dup) | FD-190603-01 | FD | **1,807** | 125 |
| SW1-19 | SW1-19-190603 | N | **19,376** | 146 |
| SW1-20 | SW1-20-190603 | N | **1,805** | 128 |

**Notes:**
[1] EPA Human Health Surface Water Criteria (40 CFR 131.45)
FD – Field duplicate
N – Sample is not part of a field duplicate pair
P – Parent sample of field duplicate
PCB - polychlorinated biphenyl
**Bolded** values indicate that the reported concentration exceeds the PAL.
pg/L - picograms per liter

## Table B3-33. PCB Aroclors in Sediment - 2019

| | | **Location Name** | MA-19 | | MA-21 | | MA22 | | MA-23 | | | | TF-18 | | TF-20 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SED-MA19-190604 | | SED-MA21-190604 | | SED-MA22-190604 | | SED-MA23-190604 | | FD-190604-01 | | SED-TF18-190605 | | SED-TF20-190604 | | SED-TF21-190604 | |
| | | **Sample Collection Date** | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | |
| | | **Sample Type** | N | | N | | N | | P | | FD | | N | | N | | N | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| AROCLOR-1016 | µg/kg | NA | 99 | U | 98 | U | 97 | U | 98 | U | 99 | U | 97 | U | 98 | U | 96 | U |
| AROCLOR-1221 | µg/kg | NA | 150 | U | 150 | U | 140 | U | 150 | U | 150 | U | 140 | U | 150 | U | 140 | U |
| AROCLOR-1232 | µg/kg | NA | 200 | U | 200 | U | 190 | U | 200 | U | 200 | U | 190 | U | 200 | U | 190 | U |
| AROCLOR-1242 | µg/kg | NA | 200 | U | 200 | U | 190 | U | 200 | U | 200 | U | 190 | U | 200 | U | 190 | U |
| AROCLOR-1248 | µg/kg | NA | 150 | U | 150 | U | 140 | U | 150 | U | 150 | U | 140 | U | 150 | U | 140 | U |
| AROCLOR-1254 | µg/kg | NA | 99 | U | 98 | U | 55 | J | 70 | J | 52 | J | 97 | U | 98 | U | 96 | U |
| AROCLOR-1260 | µg/kg | NA | 99 | U | 98 | U | 97 | U | 98 | U | 99 | U | 97 | U | 98 | U | 96 | U |
| AROCLOR-1262 | µg/kg | NA | 200 | U | 200 | U | 190 | U | 200 | U | 200 | U | 190 | U | 200 | U | 190 | U |
| AROCLOR-1268 | µg/kg | NA | 200 | U | 200 | U | 190 | U | 200 | U | 200 | U | 190 | U | 200 | U | 190 | U |
| Total PCBs (Aroclor)[1] | µg/kg | 12,000 | 200 | U | 200 | U | 55 | J | 70 | J | 52 | J | 190 | U | 200 | U | 190 | U |

**Notes:**
[1] Total PCB (Aroclor) are derived based on the sum of the concentrations of Aroclors® 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268.
When all chemicals in a group are undetected, only the single highest individual chemical quantitation limit in a group should be reported and appropriately qualified. If some concentrations were detected and others were not, only the detected concentrations are included in the sum.
FD – Field duplicate
J - The reported value is an estimated concentration.
N – Sample is not part of a field duplicate pair
P – Parent Sample of field duplicate
U - The analyte was analyzed but not detected at or above LOD. (sometimes validators will elevate the limit due to the "B" qual using the 5x/10x rule so this definition is different than the lab description).
**Bolded** values indicate that the reported concentration exceeds the PAL.
µg/kg - micrograms per kilogram

## Table B3-34. PCB Congeners in Sediment – 2019

| | | **Location Name** | MA-19 | | MA-21 | | MA22 | | MA-23 | | | | TF-18 | | TF-20 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SED-MA19-190604 | | SED-MA21-190604 | | SED-MA22-190604 | | SED-MA23-190604 | | FD-190604-01 | | SED-TF18-190605 | | SED-TF20-190604 | | SED-TF21-190604 | |
| | | **Sample Collection Date** | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/5/2019 | | 6/4/2019 | | 6/4/2019 | |
| | | **Sample Type** | N | | N | | N | | P | | FD | | N | | N | | N | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-001 | pg/g | NA | 39 | | 6.4 | J | 51 | | 19 | J | 21 | | 6.5 | J | 4.1 | J | 9.7 | J |
| PCB-002 | pg/g | NA | 28 | | 38 | | 110 | | 68 | | 80 | | 52 | | 34 | | 81 | |
| PCB-003 | pg/g | NA | 1.7 | J | 4 | J | 34 | | 19 | J | 16 | J | 6.8 | J | 2.7 | J | 8.8 | J |
| PCB-004 | pg/g | NA | 100 | | 36 | | 280 | | 110 | | 140 | | 8 | J | 2.5 | J | 19 | J |
| PCB-005 | pg/g | NA | 5 | U | 4.9 | U | 4.9 | U | 4.9 | U | 4.9 | U | 4.9 | U | 4.9 | U | 5 | U |
| PCB-006 | pg/g | NA | 8.4 | J | 31 | | 280 | | 100 | | 140 | | 4.9 | J | 4.9 | U | 27 | |
| PCB-007 | pg/g | NA | 5 | U | 4.9 | U | 13 | J | 4.9 | U | 4.9 | U | 4.9 | U | 4.9 | U | 5.2 | J |
| PCB-008 | pg/g | NA | 14 | J | 50 | | 440 | | 170 | | 200 | | 25 | | 8.2 | J | 54 | |
| PCB-009 | pg/g | NA | 5 | U | 4.9 | U | 11 | J | 4.9 | U | 4.9 | U | 4.9 | U | 4.9 | U | 5 | U |
| PCB-010 | pg/g | NA | 3.4 | J | 4.9 | U | 12 | J | 6 | J | 7.1 | J | 4.9 | U | 4.9 | U | 5 | U |
| PCB-011 | pg/g | NA | 9.1 | J | 20 | U | 45 | | 27 | | 31 | | 18 | J | 9.6 | J | 28 | |
| PCB-012 AND 013 | pg/g | NA | 5 | J | 9.8 | U | 72 | | 37 | J | 42 | | 4.4 | J | 9.8 | U | 12 | J |
| PCB-014 | pg/g | NA | 5 | U | 4.9 | U | 4.9 | U | 4.9 | U | 4.9 | U | 4.9 | U | 4.9 | U | 5 | U |
| PCB-015 | pg/g | NA | 29 | | 87 | | 490 | | 250 | | 300 | | 35 | | 14 | J | 65 | |
| PCB-016 | pg/g | NA | 8.6 | J | 35 | | 220 | | 94 | | 120 | | 4.8 | J | 2 | U | 17 | J |
| PCB-017 | pg/g | NA | 11 | J | 49 | | 310 | | 150 | | 180 | | 14 | J | 4.4 | J | 38 | |
| PCB-019 | pg/g | NA | 3.3 | J | 20 | | 110 | | 51 | | 64 | | 2 | J | 2 | U | 13 | J |
| PCB-021 AND 033 | pg/g | NA | 14 | J | 33 | J | 180 | | 89 | | 94 | | 18 | J | 5.6 | J | 46 | |
| PCB-022 | pg/g | NA | 10 | J | 32 | | 150 | | 75 | | 88 | | 8.9 | J | 3.1 | J | 20 | |
| PCB-023 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-024 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-025 | pg/g | NA | 16 | J | 41 | | 250 | | 140 | | 160 | | 8.7 | J | 2.6 | J | 51 | |
| PCB-026 AND 029 | pg/g | NA | 39 | J | 78 | | 530 | | 320 | | 360 | | 12 | J | 3.9 | J | 110 | |
| PCB-027 | pg/g | NA | 6.4 | J | 29 | | 170 | | 84 | | 100 | | 5.1 | J | 0.98 | U | 49 | |
| PCB-028 AND 020 | pg/g | NA | 63 | | 170 | | 850 | | 450 | | 520 | | 67 | | 23 | J | 140 | |
| PCB-030 AND 018 | pg/g | NA | 21 | J | 92 | | 620 | | 270 | | 370 | | 13 | J | 3.6 | J | 63 | |
| PCB-031 | pg/g | NA | 54 | | 140 | | 720 | | 390 | | 430 | | 41 | | 13 | J | 110 | |
| PCB-032 | pg/g | NA | 7.2 | J | 29 | | 200 | | 110 | | 130 | | 21 | | 5.2 | J | 38 | |
| PCB-034 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-035 | pg/g | NA | 1.1 | J | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 3 | J | 0.95 | J | 4.4 | J |

**Table B3-34. PCB Congeners in Sediment – 2019 (continued)**

| | | Location Name | MA-19 | | MA-21 | | MA22 | | MA-23 | | | | TF-18 | | TF-20 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sample Name | SED-MA19-190604 | | SED-MA21-190604 | | SED-MA22-190604 | | SED-MA23-190604 | | FD-190604-01 | | SED-TF18-190605 | | SED-TF20-190604 | | SED-TF21-190604 | |
| | | Sample Collection Date | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/5/2019 | | 6/4/2019 | | 6/4/2019 | |
| | | Sample Type | N | | N | | N | | P | | FD | | N | | N | | N | |
| Analyte | Units | PAL | Result | | Result | | Result | | Result | | Result | | Result | | Result | | Result | |
| PCB-036 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-037 | pg/g | NA | 17 | J | 35 | | 140 | | 83 | | 100 | | 29 | | 10 | J | 40 | |
| PCB-038 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-039 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-040 AND 071 | pg/g | NA | 24 | J | 42 | | 390 | | 240 | | 270 | | 15 | J | 3.6 | J | 96 | |
| PCB-041 | pg/g | NA | 2 | U | 2 | U | 2 | U | 2 | U | 2 | U | 2 | U | 2 | U | 2 | U |
| PCB-042 | pg/g | NA | 9.8 | J | 27 | | 170 | | 100 | | 120 | | 11 | J | 2.6 | J | 34 | |
| PCB-043 | pg/g | NA | 1.4 | J | 4.4 | J | 36 | | 13 | J | 19 | J | 1.1 | J | 0.98 | U | 4.7 | J |
| PCB-044 AND 047 AND 065 | pg/g | NA | 56 | J | 120 | | 870 | | 570 | | 630 | | 51 | J | 11 | J | 190 | |
| PCB-045 | pg/g | NA | 4 | J | 13 | J | 78 | | 46 | | 51 | | 1.7 | U | 0.57 | U | 9.2 | J |
| PCB-046 | pg/g | NA | 2.3 | J | 8.9 | J | 49 | | 26 | | 32 | | 1.3 | J | 0.98 | U | 7.9 | J |
| PCB-048 | pg/g | NA | 4.7 | J | 10 | J | 63 | | 37 | | 42 | | 4.6 | J | 1.2 | J | 13 | J |
| PCB-050 AND 053 | pg/g | NA | 12 | J | 32 | J | 220 | | 140 | | 160 | | 6.7 | J | 1.9 | J | 63 | |
| PCB-051 | pg/g | NA | 2.1 | J | 4.5 | J | 35 | | 22 | | 26 | | 3 | J | 0.8 | J | 11 | J |
| PCB-052 | pg/g | NA | 120 | | 220 | | 1,800 | | 1,200 | | 1,400 | | 83 | | 16 | J | 480 | |
| PCB-054 | pg/g | NA | 0.99 | U | 0.98 | U | 3.9 | J | 2.5 | J | 3.2 | J | 0.98 | U | 0.98 | U | 3.5 | J |
| PCB-055 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-056 | pg/g | NA | 13 | J | 24 | | 140 | | 92 | | 100 | | 19 | J | 4.8 | J | 36 | |
| PCB-057 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-058 | pg/g | NA | 1.4 | J | 2.9 | J | 22 | | 22 | | 24 | | 1.2 | J | 0.98 | U | 4.9 | J |
| PCB-059 AND 062 AND 075 | pg/g | NA | 5.8 | J | 13 | J | 100 | | 62 | | 69 | | 4.4 | J | 1 | J | 26 | J |
| PCB-060 | pg/g | NA | 6.8 | J | 9.2 | J | 57 | | 36 | | 43 | | 11 | J | 3.1 | J | 17 | J |
| PCB-061 AND 070 AND 074 AND 076 | pg/g | NA | 58 | J | 110 | | 870 | | 370 | | 540 | | 80 | | 18 | J | 190 | |
| PCB-063 | pg/g | NA | 1.2 | J | 2.2 | J | 17 | J | 7.6 | J | 9.5 | J | 1.7 | J | 0.4 | J | 3.4 | J |
| PCB-064 | pg/g | NA | 13 | J | 30 | | 190 | | 120 | | 140 | | 13 | J | 3 | J | 39 | |
| PCB-066 | pg/g | NA | 58 | | 93 | | 730 | | 360 | | 440 | | 80 | | 18 | J | 170 | |
| PCB-067 | pg/g | NA | 1 | J | 2 | J | 17 | J | 7.4 | J | 8.9 | J | 1.2 | J | 0.98 | U | 2 | J |
| PCB-068 | pg/g | NA | 1.4 | J | 2 | J | 15 | J | 11 | J | 11 | J | 1.7 | J | 0.45 | U | 4.9 | J |

**Table B3-34. PCB Congeners in Sediment – 2019 (continued)**

| | | **Location Name** | MA-19 | | MA-21 | | MA22 | | MA-23 | | | | TF-18 | | TF-20 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SED-MA19-190604 | | SED-MA21-190604 | | SED-MA22-190604 | | SED-MA23-190604 | | FD-190604-01 | | SED-TF18-190605 | | SED-TF20-190604 | | SED-TF21-190604 | |
| | | **Sample Collection Date** | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/5/2019 | | 6/4/2019 | | 6/4/2019 | |
| | | **Sample Type** | N | | N | | N | | P | | FD | | N | | N | | N | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-069 AND 049 | pg/g | NA | 63 | | 120 | | 990 | | 690 | | 710 | | 56 | | 12 | J | 290 | |
| PCB-072 | pg/g | NA | 2 | J | 2.8 | J | 26 | | 19 | J | 18 | J | 2.2 | J | 0.42 | J | 7.4 | J |
| PCB-073 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-077 | pg/g | NA | 12 | | 15 | | 89 | | 71 | | 74 | | 25 | | 7.3 | | 41 | |
| PCB-078 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-079 | pg/g | NA | 1.8 | J | 6.2 | J | 19 | J | 19 | J | 22 | | 1.9 | J | 0.98 | U | 5.6 | J |
| PCB-080 | pg/g | NA | 0.94 | J | 1.9 | J | 9.7 | J | 13 | J | 13 | J | 1.1 | J | 0.98 | U | 3 | J |
| PCB-081 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-082 | pg/g | NA | 13 | J | 24 | | 170 | | 200 | | 210 | | 14 | J | 2.5 | J | 42 | |
| PCB-083 | pg/g | NA | 6 | J | 21 | | 77 | | 89 | | 96 | | 6.7 | J | 2.1 | J | 28 | |
| PCB-084 | pg/g | NA | 25 | | 56 | | 460 | | 220 | | 460 | | 21 | | 3.2 | J | 95 | |
| PCB-088 AND 091 | pg/g | NA | 16 | J | 31 | J | 300 | | 2 | U | 240 | | 16 | J | 2.5 | J | 61 | |
| PCB-089 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-092 | pg/g | NA | 32 | | 58 | | 410 | | 470 | | 500 | | 40 | | 7.3 | J | 110 | |
| PCB-093 AND 100 | pg/g | NA | 2 | U | 2 | U | 2 | U | 2 | U | 2 | U | 2 | U | 2 | U | 2 | U |
| PCB-094 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-095 | pg/g | NA | 56 | | 110 | | 840 | | 850 | | 980 | | 48 | | 10 | J | 200 | |
| PCB-096 | pg/g | NA | 0.59 | J | 1.3 | J | 13 | J | 11 | J | 12 | J | 0.71 | J | 0.17 | J | 3.3 | J |
| PCB-098 AND 102 | pg/g | NA | 2 | U | 3.9 | J | 39 | | 28 | J | 38 | J | 2 | U | 2 | U | 10 | J |
| PCB-099 | pg/g | NA | 130 | | 180 | | 1,500 | | 1,400 | | 1,400 | | 160 | | 31 | | 440 | |
| PCB-103 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 7.5 | J |
| PCB-104 | pg/g | NA | 0.99 | U | 0.98 | U | 0.58 | J | 0.54 | J | 0.53 | J | 0.98 | U | 0.26 | J | 0.32 | J |
| PCB-105 | pg/g | NA | 110 | | 140 | | 1,000 | | 830 | | 930 | | 120 | | 26 | | 300 | |
| PCB-106 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-107 AND 124 | pg/g | NA | 5 | J | 8.2 | J | 59 | | 47 | | 59 | | 6.3 | J | 1.2 | J | 18 | J |
| PCB-108 AND 119 AND 086 AND 097 AND 125 AND 087 | pg/g | NA | 100 | J | 170 | | 1,300 | | 1,300 | | 1,400 | | 94 | J | 17 | J | 320 | |
| PCB-109 | pg/g | NA | 19 | J | 24 | | 180 | | 160 | | 160 | | 28 | | 5.4 | J | 58 | |
| PCB-110 AND 115 | pg/g | NA | 210 | | 340 | | 2,500 | | 2,900 | | 3,000 | | 200 | | 33 | J | 630 | |
| PCB-111 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |

**Table B3-34. PCB Congeners in Sediment – 2019 (continued)**

| | | **Location Name** | MA-19 | | MA-21 | | MA22 | | MA-23 | | | | TF-18 | | TF-20 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SED-MA19-190604 | | SED-MA21-190604 | | SED-MA22-190604 | | SED-MA23-190604 | | FD-190604-01 | | SED-TF18-190605 | | SED-TF20-190604 | | SED-TF21-190604 | |
| | | **Sample Collection Date** | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/5/2019 | | 6/4/2019 | | 6/4/2019 | |
| | | **Sample Type** | N | | N | | N | | P | | FD | | N | | N | | N | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-112 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-113 AND 090 AND 101 | pg/g | NA | 180 | | 310 | | 2,300 | | 2,300 | | 2,500 | | 210 | | 39 | J | 680 | |
| PCB-114 | pg/g | NA | 3.9 | | 4.5 | | 36 | | 27 | | 38 | | 3.7 | | 0.75 | J | 10 | |
| PCB-117 AND 116 AND 085 | pg/g | NA | 38 | J | 55 | J | 430 | | 420 | | 430 | | 41 | J | 7.9 | J | 110 | |
| PCB-118 | pg/g | NA | 290 | | 400 | | 3,100 | | 2,400 | | 2,700 | | 350 | | 70 | | 870 | |
| PCB-120 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 4.9 | J |
| PCB-121 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-122 | pg/g | NA | 2.9 | J | 4 | J | 26 | | 29 | | 36 | | 3.2 | J | 0.98 | U | 6.6 | J |
| PCB-123 | pg/g | NA | 4 | | 6 | | 45 | | 31 | | 43 | | 4.2 | | 1.2 | J | 10 | |
| PCB-126 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.67 | J | 1 | U |
| PCB-127 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-128 AND 166 | pg/g | NA | 50 | | 60 | | 530 | | 710 | | 690 | | 60 | | 11 | J | 150 | |
| PCB-130 | pg/g | NA | 17 | J | 21 | | 200 | | 280 | | 280 | | 22 | | 4.4 | J | 53 | |
| PCB-131 | pg/g | NA | 2.2 | J | 3.2 | J | 30 | | 46 | | 47 | | 0.98 | U | 0.98 | U | 7.5 | J |
| PCB-132 | pg/g | NA | 45 | | 71 | | 670 | | 1,000 | | 1,000 | | 56 | | 9.5 | J | 180 | |
| PCB-133 | pg/g | NA | 2.7 | J | 3.4 | J | 32 | | 41 | | 40 | | 4.6 | J | 0.98 | J | 8.7 | J |
| PCB-134 AND 143 | pg/g | NA | 9.4 | J | 12 | J | 130 | | 170 | | 190 | | 8.5 | J | 1.8 | J | 31 | J |
| PCB-136 | pg/g | NA | 14 | J | 20 | | 220 | | 290 | | 300 | | 17 | J | 4.1 | J | 61 | |
| PCB-137 | pg/g | NA | 13 | J | 18 | J | 160 | | 240 | | 230 | | 12 | J | 2 | J | 41 | |
| PCB-138 AND 163 AND 129 | pg/g | NA | 270 | | 330 | | 2,900 | | 3,900 | | 3,900 | | 340 | | 66 | | 830 | |
| PCB-139 AND 140 | pg/g | NA | 4.5 | J | 5.6 | J | 57 | | 73 | | 74 | | 5 | J | 0.85 | J | 15 | J |
| PCB-141 | pg/g | NA | 18 | J | 29 | | 240 | | 430 | | 410 | | 18 | J | 3.1 | J | 59 | |
| PCB-142 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-144 | pg/g | NA | 5.5 | J | 7.1 | J | 71 | | 110 | | 110 | | 4.9 | J | 1.3 | J | 17 | J |
| PCB-145 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-146 | pg/g | NA | 29 | | 34 | | 310 | | 420 | | 410 | | 47 | | 11 | J | 95 | |
| PCB-147 AND 149 | pg/g | NA | 120 | | 150 | | 1,500 | | 2000 | | 2,000 | | 150 | | 31 | J | 430 | |
| PCB-148 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-150 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |

**Table B3-34. PCB Congeners in Sediment – 2019 (continued)**

| | | **Location Name** | MA-19 | | MA-21 | | MA22 | | MA-23 | | | | TF-18 | | TF-20 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SED-MA19-190604 | | SED-MA21-190604 | | SED-MA22-190604 | | SED-MA23-190604 | | FD-190604-01 | | SED-TF18-190605 | | SED-TF20-190604 | | SED-TF21-190604 | |
| | | **Sample Collection Date** | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/5/2019 | | 6/4/2019 | | 6/4/2019 | |
| | | **Sample Type** | N | | N | | N | | P | | FD | | N | | N | | N | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-151 AND 135 | pg/g | NA | 35 | J | 49 | | 460 | | 670 | | 670 | | 50 | | 12 | J | 130 | |
| PCB-152 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-153 AND 168 | pg/g | NA | 190 | | 230 | | 2,000 | | 2,500 | | 2,500 | | 270 | | 59 | | 610 | |
| PCB-154 | pg/g | NA | 3 | J | 3.6 | J | 35 | | 39 | | 37 | | 5.8 | J | 1.5 | J | 13 | J |
| PCB-155 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-156 AND 157 | pg/g | NA | 43 | | 49 | | 390 | | 450 | | 470 | | 44 | | 8.4 | | 120 | |
| PCB-158 | pg/g | NA | 28 | | 32 | | 310 | | 400 | | 410 | | 25 | | 4.4 | J | 76 | |
| PCB-159 | pg/g | NA | 0.99 | U | 0.54 | J | 3.3 | J | 7 | J | 6.2 | J | 0.48 | J | 0.98 | U | 0.88 | J |
| PCB-160 | pg/g | NA | 2 | U | 2 | U | 2 | U | 2 | U | 2 | U | 2 | U | 2 | U | 2 | U |
| PCB-161 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-162 | pg/g | NA | 1.2 | J | 1.3 | J | 10 | J | 15 | J | 15 | J | 1.3 | J | 0.33 | J | 3 | J |
| PCB-164 | pg/g | NA | 11 | J | 16 | J | 140 | | 210 | | 200 | | 13 | J | 2.2 | J | 35 | |
| PCB-165 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-167 | pg/g | NA | 15 | | 18 | | 140 | | 180 | | 180 | | 16 | | 3.2 | | 40 | |
| PCB-169 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-170 | pg/g | NA | 35 | | 36 | | 260 | | 450 | | 430 | | 39 | | 9.3 | J | 73 | |
| PCB-171 AND 173 | pg/g | NA | 9.2 | J | 11 | J | 85 | | 130 | | 130 | | 13 | J | 3.2 | J | 26 | J |
| PCB-172 | pg/g | NA | 3.7 | J | 5 | J | 35 | | 62 | | 59 | | 6.3 | J | 1.6 | J | 11 | J |
| PCB-174 | pg/g | NA | 13 | J | 19 | J | 130 | | 260 | | 250 | | 19 | J | 4.6 | J | 38 | |
| PCB-175 | pg/g | NA | 1.1 | J | 1 | J | 11 | J | 16 | J | 16 | J | 2.3 | J | 0.59 | J | 3.5 | J |
| PCB-176 | pg/g | NA | 2.4 | J | 2.7 | J | 27 | | 44 | | 44 | | 3.8 | J | 1 | J | 7.7 | J |
| PCB-177 | pg/g | NA | 13 | J | 15 | J | 110 | | 180 | | 180 | | 23 | | 6.1 | J | 38 | |
| PCB-178 | pg/g | NA | 4.7 | J | 5 | J | 46 | | 62 | | 63 | | 13 | J | 3.7 | J | 18 | J |
| PCB-179 | pg/g | NA | 5.6 | J | 6.7 | J | 65 | | 110 | | 100 | | 12 | J | 3.6 | J | 20 | |
| PCB-180 AND 193 | pg/g | NA | 45 | | 58 | | 390 | | 680 | | 640 | | 68 | | 17 | J | 120 | |
| PCB-181 | pg/g | NA | 0.53 | J | 0.62 | J | 4.3 | J | 6.7 | J | 6 | J | 0.39 | J | 0.98 | U | 1.1 | J |
| PCB-182 | pg/g | NA | 0.23 | J | 0.21 | J | 3.2 | J | 3.5 | J | 3.9 | J | 0.75 | J | 0.26 | J | 1 | J |
| PCB-183 | pg/g | NA | 14 | J | 18 | J | 130 | | 210 | | 200 | | 25 | | 6.7 | J | 43 | |
| PCB-184 | pg/g | NA | 0.99 | U | 0.98 | U | 0.72 | J | 0.88 | J | 0.77 | J | 0.31 | J | 0.13 | J | 0.29 | J |
| PCB-185 | pg/g | NA | 1.7 | J | 1.7 | J | 12 | J | 23 | | 21 | | 0.85 | J | 0.33 | J | 3.2 | J |

## Table B3-34. PCB Congeners in Sediment – 2019 (continued)

| | | Location Name | MA-19 | | MA-21 | | MA22 | | MA-23 | | | | TF-18 | | TF-20 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SED-MA19-190604 | | SED-MA21-190604 | | SED-MA22-190604 | | SED-MA23-190604 | | FD-190604-01 | | SED-TF18-190605 | | SED-TF20-190604 | | SED-TF21-190604 | |
| | | **Sample Collection Date** | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/4/2019 | | 6/5/2019 | | 6/4/2019 | | 6/4/2019 | |
| | | **Sample Type** | N | | N | | N | | P | | FD | | N | | N | | N | |
| **Analyte** | **Units** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-186 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.27 | J | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-187 | pg/g | NA | 26 | | 28 | | 250 | | 350 | | 340 | | 68 | | 20 | | 94 | |
| PCB-188 | pg/g | NA | 0.4 | U | 0.31 | U | 1.5 | J | 1.5 | J | 1.6 | J | 1 | J | 0.43 | U | 1.1 | J |
| PCB-189 | pg/g | NA | 1.6 | J | 2 | | 13 | | 21 | | 19 | | 2.1 | | 0.76 | J | 4.3 | |
| PCB-190 | pg/g | NA | 5.4 | J | 7 | J | 47 | | 76 | | 70 | | 5.7 | J | 1.4 | J | 13 | J |
| PCB-191 | pg/g | NA | 1.3 | J | 1.6 | J | 10 | J | 17 | J | 17 | J | 1.4 | J | 0.39 | J | 3.1 | J |
| PCB-192 | pg/g | NA | 0.99 | U | 0.98 | U | 0.99 | U | 0.99 | U | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-194 | pg/g | NA | 7.7 | J | 15 | J | 49 | | 86 | | 82 | | 17 | J | 4.3 | J | 18 | J |
| PCB-195 | pg/g | NA | 2.9 | J | 5 | J | 17 | J | 31 | | 29 | | 4.5 | J | 1.2 | J | 5.7 | J |
| PCB-196 | pg/g | NA | 3.7 | J | 5.8 | J | 35 | | 63 | | 59 | | 13 | J | 3.8 | J | 14 | J |
| PCB-197 | pg/g | NA | 0.51 | J | 0.41 | J | 3.6 | J | 4.1 | J | 3.9 | J | 1.3 | J | 0.5 | J | 1.4 | J |
| PCB-198 AND 199 | pg/g | NA | 8.4 | J | 11 | J | 66 | | 120 | | 110 | | 29 | J | 7.9 | J | 30 | J |
| PCB-200 | pg/g | NA | 0.66 | J | 0.88 | J | 7.2 | J | 15 | J | 14 | J | 1.6 | J | 0.53 | J | 2.3 | J |
| PCB-201 | pg/g | NA | 1.6 | J | 1.7 | J | 14 | J | 19 | J | 19 | J | 5.7 | J | 1.7 | J | 6.2 | J |
| PCB-202 | pg/g | NA | 3.4 | J | 3.7 | J | 21 | | 28 | | 27 | | 9.4 | J | 3.1 | J | 11 | J |
| PCB-203 | pg/g | NA | 4.9 | J | 6.7 | J | 42 | | 70 | | 65 | | 12 | J | 3.5 | J | 14 | J |
| PCB-204 | pg/g | NA | 0.99 | U | 0.98 | U | 0.14 | J | 0.15 | J | 0.99 | U | 0.98 | U | 0.98 | U | 1 | U |
| PCB-205 | pg/g | NA | 0.55 | J | 0.8 | J | 3.2 | J | 5.4 | J | 5.2 | J | 0.74 | J | 0.25 | U | 1 | J |
| PCB-206 | pg/g | NA | 8 | J | 9.6 | J | 50 | | 100 | | 68 | | 37 | | 7.8 | J | 29 | |
| PCB-207 | pg/g | NA | 1.2 | J | 1.2 | J | 6.4 | J | 11 | J | 9.1 | J | 5.8 | J | 1.2 | J | 4.1 | J |
| PCB-208 | pg/g | NA | 3.4 | J | 3.6 | J | 20 | | 40 | | 24 | | 21 | | 4.4 | J | 15 | J |
| PCB-209 | pg/g | NA | 15 | J | 11 | J | 58 | | 100 | | 66 | | 120 | | 14 | J | 48 | |
| TOTAL PCBs | pg/g | NE | 3,390 | | 5,357 | | 40,642 | | 38,699 | | 41,243 | | 4,005 | | 889 | | 10,541 | |
| TOTAL DIOXIN-LIKE PCB CONGENERS (Calculated PCB TEQ Concentration)[a] | pg/g | 0.7 [b] | 0.1 | | 0.1 | | 0.2 | | 0.2 | | 0.2 | | 0.1 | | 0.1 | | 0.1 | |

**Notes:**
[a] Dioxin-like PCB Congeners: PCB-77, PCB-81, PCB-105, PCB-114, PCB-118, PCB-123, PCB-126, PCB-156/157, PCB-167, PCB-169, PCB-189
[b] Based on Ecology 2017 SCUM II TEQ Value
J - The reported value is an estimated concentration. N - Sample is not part of a field duplicate pair. P - Parent sample of field duplicate. NA - Not applicable; NE - Not established; PAL - Project Action Limit; FD - Field duplicate; PCB - polychlorinated biphenyls; pg/g - picograms per gram
U - The analyte was not detected at or above the limit of detection (LOD). (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description). **Bolded** values indicate that the reported concentration exceeds the PAL.

## Table B3-35. Total PCBs (Congeners) in Sediment – 2019

| Location Name | Sample Name | Sample Type | Total PCBs (Sum of analyte value with ND as null) Result (pg/g) | Total Number of PCBs Detections |
|---|---|---|---|---|
| | | | **Freshwater** | |
| | | **SMS Sediment SCO** | **110,000** | |
| | | **SMS Sediment CSL** | **2,500,000** | |
| MA19 | SED-MA19-190604 | N | 3,390 | 163 |
| MA21 | SED-MA21-190604 | N | 5,357 | 161 |
| MA22 | SED-MA22-190604 | N | 40,642 | 171 |
| MA23 | SED-MA23-190604 | P | 38,699 | 171 |
| MA23 (dup) | FD-190604-01 | FD | 41,243 | 170 |
| TF18 | SED-TF18-190605 | N | 4,005 | 163 |
| TF20 | SED-TF20-190604 | N | 889 | 148 |
| TF21 | SED-TF21-190604 | N | 10,541 | 171 |

**Notes:**
All samples analyzed using analytical method 1668C.
CSL – cleanup screening level
DUP – Duplicate
FD - Field Duplicate
N – Sample is not part of a field duplicate pair
P – Parent sample of field duplicate
SCO - sediment cleanup objective
SMS - Sediment Management Standards (WAC 173-204-563)
**Bolded values exceed the SCO**
pg/g - picograms per gram

**Table B3-36. Slug Tests Results**

| Well Location | Date of Test | Screened Interval (ft bgs) | Test Type | Initial Displacement (ft) | K (ft/day) | Average K[1] (ft/day | Average K[1] (cm/s) | V[2] (ft/day) | Average V[2] (ft/day) | Average V[2] (cm/s) | USCS (of screened interval) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MW1-39 | 5/4/2022 | 27.5-32.5 | Falling Head - Run 1 | 1.85 | 64.48 | 111.4266667 | 4.03E-03 | 1.488 | 2.571384615 | 9.07E-04 | ML/GW-GM/SP |
| | | | Falling Head - Run 2 | 1.912 | 111.6 | | | 2.575384615 | | | |
| | | | Falling Head - Run 3 | 1.855 | 158.2 | | | 3.650769231 | | | |
| | | | Rising Head - Run 1 | 1.937 | 50.71 | 44.5 | 1.57E-02 | 1.170230769 | 1.026923077 | 3.62E-04 | |
| | | | Rising Head - Run 2 | 1.918 | 38.29 | | | 0.883615385 | | | |
| MW1-43 | 5/3/2022 | 15-25 | Falling Head - Run 1 | 2.541 | 3.521 | 3.784 | 1.33E-03 | 0.081253846 | 0.087323077 | 3.08E-05 | SP/ML |
| | | | Falling Head - Run 2 | 2.25 | 3.639 | | | 0.083976923 | | | |
| | | | Falling Head - Run 3 | 2.872 | 4.192 | | | 0.096738462 | | | |
| | | | Rising Head - Run 1 | 2.458 | 3.537 | 3.478333333 | 1.23E-03 | 0.081623077 | 0.080269231 | 2.83E-05 | |
| | | | Rising Head - Run 2 | 2.876 | 3.569 | | | 0.082361538 | | | |
| | | | Rising Head - Run 3 | 2.334 | 3.329 | | | 0.076823077 | | | |
| MW1-44 | 5/3/2022 | 18-28 | Falling Head - Run 1 | 2.593 | 2.379 | 2.742 | 9.67E-04 | 0.0549 | 0.063276923 | 2.23E-05 | SM/ML |
| | | | Falling Head - Run 2 | 2.021 | 2.785 | | | 0.064269231 | | | |
| | | | Falling Head - Run 3 | 2.14 | 3.062 | | | 0.070661538 | | | |
| | | | Rising Head - Run 1 | 2.365 | 2.163 | 2.1565 | 7.61E-04 | 0.049915385 | 0.049765385 | 1.76E-05 | |
| | | | Rising Head - Run 2 | 2.413 | 2.15 | | | 0.049615385 | | | |
| MW1-46 | 7/15/2022 | 24-34 | Falling Head - Run 1 | 2.746 | 5.776 | 5.8875 | 2.08E-03 | 0.133292308 | 0.135865385 | 4.79E-05 | SP |
| | | | Falling Head - Run 2 | 2.527 | 5.999 | | | 0.138438462 | | | |
| | | | Rising Head - Run 1 | 2.396 | 5.213 | 5.269 | 1.86E-03 | 0.1203 | 0.121592308 | 4.29E-05 | |
| | | | Rising Head - Run 2 | 2.199 | 5.325 | | | 0.122884615 | | | |
| MW1-47 | 6/24/2021 | 15 - 25 | Falling Head - Run 1 | 3.009 | 4.063 | 4.1145 | 1.45E-03 | 0.093761538 | 0.09495 | 3.35E-05 | SP/SM |
| | | | Falling Head - Run 2 | 3.32 | 4.166 | | | 0.096138462 | | | |
| | | | Rising Head - Run 1 | 2.578 | 4.088 | 4.1765 | 1.47E-03 | 0.094338462 | 0.096380769 | 3.40E-05 | |
| | | | Rising Head - Run 2 | 2.575 | 4.265 | | | 0.098423077 | | | |
| MW1-49 | 4/29/2022 | 5-15 | Falling Head - Run 1 | 2.307 | 18.88 | 20.56333333 | 7.25E-03 | 0.435692308 | 0.461653846 | 1.63E-04 | SP |
| | | | Falling Head - Run 2 | 1.769 | 21.13 | | | 0.487615385 | | | |
| | | | Falling Head - Run 3 | 2.187 | 21.68 | | | 0.500307692 | | | |
| | | | Rising Head - Run 1 | 2.094 | 18.19 | 18.29666667 | 6.45E-03 | 0.419769231 | 0.422230769 | 1.49E-04 | |
| | | | Rising Head - Run 2 | 1.923 | 17.75 | | | 0.409615385 | | | |
| | | | Rising Head - Run 3 | 2.674 | 18.95 | | | 0.437307692 | | | |
| MW1-50 | 7/15/2022 | 5-15 | Falling Head - Run 1 | 0.5189 | 2.312 | 2.483 | 8.76E-04 | 0.053353846 | 0.0573 | 2.02E-05 | SP |
| | | | Falling Head - Run 2 | 0.8537 | 2.654 | | | 0.061246154 | | | |

**Table B3-36. Slug Tests Results (continued)**

| Well Location | Date of Test | Screened Interval (ft bgs) | Test Type | Initial Displacement (ft) | K (ft/day) | Average K[1] (ft/day | Average K[1] (cm/s) | V[2] (ft/day) | Average V[2] (ft/day) | Average V[2] (cm/s) | USCS (of screened interval) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Rising Head - Run 1 | 2.532 | 8.135 | 5.328 | 1.88E-03 | 0.187730769 | 0.122953846 | 4.34E-05 | |
| | | | Rising Head - Run 2 | 4.531 | 2.521 | | | 0.058176923 | | | |
| MW1-62 | 5/4/2022 | 31-41 | Falling Head - Run 1 | 1.507 | 226.6 | 186.1333333 | 6.57E-02 | 5.229230769 | 4.295384615 | 1.52E-03 | SW/GW/ML |
| | | | Falling Head - Run 2 | 2.048 | 215.6 | | | 4.975384615 | | | |
| | | | Falling Head - Run 3 | 1.309 | 116.2 | | | 2.681538462 | | | |
| | | | Rising Head - Run 1 | 0.8755 | 178.4 | 171.7 | 6.06E-02 | 4.116923077 | 3.962307692 | 1.40E-03 | |
| | | | Rising Head - Run 2 | 1.055 | 176.3 | | | 4.068461538 | | | |
| | | | Rising Head - Run 3 | 0.9469 | 160.4 | | | 3.701538462 | | | |
| MW1-62 | 7/15/2022 | 31-41 | Falling Head - Run 1 | 1.484 | 100.3 | 169.5 | 5.98E-02 | 2.314615385 | 3.911538462 | 1.38E-03 | SW/GW/ML |
| | | | Falling Head - Run 2 | 1.475 | 238.7 | | | 5.508461538 | | | |
| | | | Rising Head - Run 1 | 0.8842 | 160.4 | 191.8 | 6.77E-02 | 3.701538462 | 4.426153846 | 1.56E-03 | |
| | | | Rising Head - Run 2 | 1.081 | 223.2 | | | 5.150769231 | | | |
| MW1-63 | 6/24/2021 | 30 - 40 | Falling Head - Run 1 | 1.233 | 172.1 | 235.9 | 8.32E-02 | 3.971538462 | 5.443846154 | 1.92E-03 | GW |
| | | | Falling Head - Run 2 | 1.488 | 299.7 | | | 6.916153846 | | | |
| | | | Rising Head - Run 1 | 1.157 | 140.9 | 152.7 | 5.39E-02 | 3.251538462 | 3.523846154 | 1.24E-03 | |
| | | | Rising Head - Run 2 | 1.008 | 164.5 | | | 3.796153846 | | | |
| MW1-64 | 5/4/2022 | 45-55 | **Data unable to process** | | | | | | | | SW/SP/MH |
| MW1-65 | 6/24/2021 | 53 - 63 | Falling Head - Run 1 | 1.556 | 162.1 | 195.25 | 6.89E-02 | 3.740769231 | 4.505769231 | 1.59E-03 | SW/GW |
| | | | Falling Head - Run 2 | 2.14 | 228.4 | | | 5.270769231 | | | |
| | | | Rising Head - Run 1 | 1.583 | 237.9 | 237.9 | 8.39E-02 | 5.49 | 5.49 | 1.94E-03 | |
| | | | Rising Head - Run 2 | 2.247 | 237.9 | | | 5.49 | | | |
| MW1-66 | 4/29/2022 | 5-20 | Falling Head - Run 1 | 1.349 | 4.631 | 4.465333333 | 1.58E-03 | 0.106869231 | 0.103046154 | 3.63E-05 | SP |
| | | | Falling Head - Run 2 | 1.79 | 4.346 | | | 0.100292308 | | | |
| | | | Falling Head - Run 3 | 1.82 | 4.419 | | | 0.101976923 | | | |
| | | | Rising Head - Run 1 | 1.304 | 4.051 | 4.041666667 | 1.43E-03 | 0.093484615 | 0.093269231 | 3.29E-05 | |
| | | | Rising Head - Run 2 | 1.556 | 4.078 | | | 0.094107692 | | | |
| | | | Rising Head - Run 3 | 1.394 | 3.996 | | | 0.092215385 | | | |
| MW1-68 | 4/29/2022 | 37-47 | Falling Head - Run 1 | 2.589 | 63.5 | 67.31 | 2.37E-02 | 1.465384615 | 1.553307692 | 5.48E-04 | CH/SM |
| | | | Falling Head - Run 2 | 1.754 | 64.42 | | | 1.486615385 | | | |
| | | | Falling Head - Run 3 | 1.454 | 74.01 | | | 1.707923077 | | | |
| | | | Rising Head - Run 1 | 1.771 | 55.96 | 57.49766667 | 2.03E-02 | 1.291384615 | 1.326869231 | 4.68E-04 | |
| | | | Rising Head - Run 2 | 2.146 | 60.91 | | | 1.405615385 | | | |

**Table B3-36. Slug Tests Results (continued)**

| Well Location | Date of Test | Screened Interval (ft bgs) | Test Type | Initial Displacement (ft) | K (ft/day) | Average K[1] (ft/day | Average K[1] (cm/s) | V[2] (ft/day) | Average V[2] (ft/day) | Average V[2] (cm/s) | USCS (of screened interval) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Rising Head - Run 3 | 2.164 | 55.623 | | | 1.283607692 | | | |
| MW1-72 | 5/11/2022 | 60-70 | Falling Head - Run 1 | 2.739 | 46.56 | 73.66 | 2.60E-02 | 1.074461538 | 1.699846154 | 6.00E-04 | SP/GP/SW |
| | | | Falling Head - Run 2 | 3.709 | 75.13 | | | 1.733769231 | | | |
| | | | Falling Head - Run 3 | 2.637 | 99.29 | | | 2.291307692 | | | |
| | | | Rising Head - Run 1 | 1.581 | 94.7 | 96.29333333 | 3.40E-02 | 2.185384615 | 2.222153846 | 7.84E-04 | |
| | | | Rising Head - Run 2 | 1.645 | 98.04 | | | 2.262461538 | | | |
| | | | Rising Head - Run 3 | 1.643 | 96.14 | | | 2.218615385 | | | |
| MW1-74 | 7/15/2022 | 45-55 | Falling Head - Run 1 | 1.145 | 162.2 | 162.2 | 5.72E-02 | 3.743076923 | 3.743076923 | 1.32E-03 | SP |
| | | | Rising Head - Run 1 | 1.444 | 58.84 | 58.84 | 2.08E-02 | 1.357846154 | 1.357846154 | 4.79E-04 | |

**Notes:**
[1] Average of rising head tests should be used for further calculations. Overall, results of multiple runs were more repeatable for rising head tests than falling head tests [initial displacement and K results]. Also, one outlier appears to exist for MW1-63 and MW1-65 falling head tests.)
[2] $V = K*i/n_e$
cm/s = centimeters per second
ft/day = feet per day
i = hydraulic gradient (=0.006, calculated from 2019 GW elevation data)
K - hydraulic conductivity
$n_e$ = effective porosity
USCS - Unified Soil Classification System
V - groundwater velocity

**Table B3-37. Lithology and Hydraulic Parameters at OU 1 Monitoring Wells (Wells with Slug Tests or Physical Characterization in Screen Interval Only)**

| Well Location | Screened Interval (ft bgs) | HSU | Lithology | | | Hydraulic Parameters | | | Slug Test Results | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Field Description [1] | USCS (field) | Mean Grain Size (Lab) - USCS/ASTM | Effective Porosity | Horizontal K (cm/s) | Vertical K (cm/s) | Average K (cm/s) [2] | Average V (fcm/s) [3] |
| MW1-39 | 27.5-32.5 | N/A (Undifferentiated drift) | Silt with clay, very fine to medium sand with trace/little silt, sandy silt (all interbedded) to sandy (fine to very coarse) gravel with little silt | ML/GW-GM/SP | N/A | N/A | N/A | N/A | 1.57E-02 | 3.62E-04 |
| MW1-43/B77 | 15-25 | Semi-confining unit | Silt with trace fine sand, 20% clay to fine sand with trace fines | SP/ML | N/A | N/A | N/A | N/A | 1.23E-03 | 2.83E-05 |
| MW1-44/B75 | 18-28 | Semi-confining unit | Silty fine sand to silt with 20-30% clay and trace fine sand | SM/ML | N/A | N/A | N/A | N/A | 7.61E-04 | 1.76E-05 |
| MW1-46/B78 | 24-34 | HSU #2 | Fine sand (trace medium to coarse), trace fines, grades to coarse sand | SP | Fine Sand | 30.1 | 7.18E-03 | N/A | 1.86E-03 | 4.29E-05 |
| MW1-47/B79 | 15-25 | Semi-confining unit & HSU #2 | Fine sand with varying amounts of silt | SP/SM | Fine Sand | 28.1 | 2.47E-05 | N/A | 1.47E-03 | 3.40E-05 |
| MW1-48/B83 | 15-25 | HSU #2 | Fine sand with varying amounts of silt | SP-SM/SP/SM | Fine Sand | 18.8 | 2.27E-05 | N/A | N/A | N/A |
| MW1-49/B80 | 5-15 | HSU #1 & Semi-confining unit | Fine sand (trace medium to coarse) | SP | N/A | N/A | N/A | N/A | 6.45E-03 | 1.49E-04 |
| MW1-50/B73 | 5-15 | HSU #1 & Semi-confining unit | Fine to medium sand, trace fines | SP | Fine Sand | 19.2 | 1.00E-03 | N/A | 1.88E-03 | 4.34E-05 |
| MW1-52/B72 | 7-17 | HSU #1 & Semi-confining unit | Fine to medium sand with trace silt and interbedded clay lenses | SP/CL/SP-SM | Fine Sand | 23.3 | 8.92E-04 | N/A | N/A | N/A |
| MW1-56 | 10 [4] | HSU #1 | Fine sand, trace fines | SP | Fine Sand | 25.1 | 1.20E-06 | N/A | N/A | N/A |
| | 22 [4] | HSU #2 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | 34 [4] | HSU #2 | Fine sand, trace fines | SP | N/A | N/A | N/A | N/A | N/A | N/A |
| MW1-58 | 7 [4] | HSU #1 | Silty gravel with sand | GM | Coarse Sand | 33.5 | 2.93E-07 | N/A | N/A | N/A |
| | 17 [4] | Semi-confining unit and/or HSU #2 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | 36 [4] | HSU #2 | Medium sand | SP | Medium Sand | 20.5 | 3.15E-06 | N/A | N/A | N/A |

**Table B3-37. Lithology and Hydraulic Parameters at OU 1 Monitoring Wells (Wells with Slug Tests or Physical Characterization in Screen Interval Only) (continued)**

| Well Location | Screened Interval (ft bgs) | HSU | Lithology | | | Hydraulic Parameters | | | Slug Test Results | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Field Description [1] | USCS (field) | Mean Grain Size (Lab) - USCS/ASTM | Effective Porosity | Horizontal K (cm/s) | Vertical K (cm/s) | Average K (cm/s) [2] | Average V (fcm/s) [3] |
| MW1-62/NP-B135 | 31-41 | HSU #3 / Fine-grained Olympia | Sandy gravel to well graded gravelly sand to silt | GW/SW/ML | N/A | N/A | N/A | N/A | 6.34E-02 | 1.46E-03 |
| MW1-63/NP-B136 | 30-40 | HSU #3 | Well graded sandy gravel | GW | N/A | N/A | N/A | N/A | 5.39E-02 | 1.24E-03 |
| MW1-65/NP-B138 | 53-63 | HSU #4 | Sandy gravel to gravelly sand | SW/GW | N/A | N/A | N/A | N/A | 8.39E-02 | 1.94E-03 |
| MW1-66/SP-B139 | 5-20 | HSU #2 | Poorly graded sand | SP | N/A | N/A | N/A | N/A | 1.43E-03 | 3.29E-05 |
| MW1-68/SP-B144 | 37-47 | Fine-grained Olympia / Top of HSU #4 | Clay, with minor organic (peat) layers to silty fine sand (bottom 1-foot) | CH/SM | N/A | N/A | N/A | N/A | 2.03E-02 | 4.68E-04 |
| MW1-69/SP-B174 | 42-52 | HSU #4 | Sand and gravel with varying amounts of silt (trace to little) | SP/SW/GW | Medium Sand | 32.02 | 6.76E-04 | 6.35E-04 | N/A | N/A |
| MW1-72/NP-B177 | 60-70 | HSU #4 | Silty sandy gravel to well graded sand to silty sandy gravel to very fine to medium sand | GP/SW/SP | Fine Sand | N/A | N/A | N/A | 3.40E-02 | 7.84E-04 |
| MW1-74/DG-B179 | 45-55 | HSU #3 | Fine sand, trace fine gravel | SP | Medium Sand | N/A | 4.48E-03 [5] | 4.32E-02 [5] | 2.08E-02 | 4.79E-04 |

**Notes:**
cm/s - centimeters per second
ft bgs - feet below ground surface
HSU - hydrostratigraphic unit
K - hydraulic conductivity
[1] Field description for screened interval of well; entries with multiple descriptions are described shallow to deep, within screened interval
[2] Average *K* is average of rising head tests (see Table X). Overall, results of multiple runs were more repeatable for rising head tests than falling head tests [initial displacement and K results].
[3] $V = K*i/n_e$; i = 0.006 (calculated from 2019 GW elevation data); ne = 0.26 (2017 data)
[4] Well screen is 6-inch in length, centered at number shown
[5] Value shown is average of samples collected from 45 and 55 feet bgs

# 4.0 DECISIONS

Decisions to be made based on the data collected were established under each of the SAPs and workplans covering the investigation work performed between 2019 and 2022. Decisions regarding the geophysical survey, the upland shallow soil sampling, and the ISM PCB sampling were made in the final technical memoranda/reports covering these investigation elements (see Table 1-1) (U.S. Navy, 2022d). The subsections below address the decisions established under the original SAP covering the source investigations (U.S. Navy, 2019) and the SAP covering the vertical extent investigation and aquifer performance testing (U.S. Navy, 2022a).

## 4.1 DECISIONS FROM THE SOURCE INVESTIGATION SAP

### 4.1.1 Decision 1 – Establish the average current cVOC concentrations in wells installed in 2017, and the current cVOC concentrations in wells installed under this SAP

cVOC concentrations measured in groundwater samples from wells at the site in the timeframe 2017-2022 are tabulated in this appendix (Table B3-18). Representative concentrations for each well can be selected from these tables for use in evaluating potential future remedy optimization approaches in the future focused feasibility study.

### 4.1.2 Decision 2 – Conclude whether transport of cVOCs from groundwater to surface water is occurring to the northwest of wells MW1-17 and MW1-43

Plan view plots of cVOC concentrations in samples of groundwater, sediment porewater, and surface water from locations northwest of wells MW1-17 and MW1-43 are provided in the body of the supplemental RI report. Appendix G provides 3-dimensional views of the cVOC distribution beneath the site, including adjacent to surface water. This plume model shows a lobe of the cVOC plume from the Central Landfill elongated along the shallow east-to-west groundwater flow direction in the area of wells MW1-17 and MW1-43. The plan view plots consistently show measurable cVOC concentrations in all of the sampled media along a shallow groundwater to surface water pathway in this area of the site. VC and cis-1,2-DCE were detected at nearly every sediment porewater and surface water station from the north (downstream) end of Marsh Pond to the most downstream station sampled (SW1-17, located approximately halfway from Marsh Pond to the tide gate). These results imply that transport of cVOCs from shallow groundwater to surface water is occurring along this reach of creek, although at concentrations several orders of magnitude lower than the similar discharge around the South Plantation.

An alternative explanation for the measured concentrations in the downstream reach of Marsh Creek is that cVOCs entering surface water around the South Plantation are migrating in surface water downstream. Concentrations of VC and cis-1,2-DCE in the surface water sample collected from the south (upstream) end of Marsh Pond were an order of magnitude higher than those collected from downstream surface water. Evidence supporting this explanation includes the relative concentrations of cVOCs in sediment porewater compared to nearby surface water. In all cases of paired samples, the concentrations in surface water are the same or slightly higher than those in sediment porewater. The opposite would be expected if cVOCs were migrating from groundwater to porewater and then to surface water.

To conclude whether cVOC transport in shallow groundwater to surface water is occurring in this area, shallow groundwater samples and/or sediment porewater samples would be needed along transects between MW1-17/MW1-43 to Marsh Creek. A broad marshy area, heavily vegetated, is present along these transects. Hand collection of data might be required.

#### 4.1.3 Decision 3 – Conclude whether cVOCs are migrating from the Central Landfill hotspots to the northwest, beneath the North Plantation, as implied by the 2017 grab groundwater sample data

The evidence from the 2019 and 2022 investigations clearly indicates that cVOCs are migrating from the Central Landfill hotspots to the northwest, beneath the North Plantation. This evidence includes field PID readings from continuous soil cores, grab soil and groundwater samples, and groundwater samples from new, permanent, monitoring wells. These results, and the subsequent interpretation of the cVOC and 1,4-dioxane plume extent and architecture, are depicted in the main body of the supplement RI report in plan view figures and 3D data visualizations (Appendix G) within the conceptual site model (CSM) discussion.

#### 4.1.4 Decision 4 – Conclude whether there is a continuous plume of 1,4-dioxane present in groundwater from the Central Landfill hotspots extending beneath the North Plantation toward wells MW1-38 and MW1-39

As for cVOCs, the evidence from the 2019 and 2022 investigations clearly indicates that 1,4-dioxane is migrating from the Central Landfill hotspots to the northwest, beneath the North Plantation. The 1,4-dioxane results and interpretations are depicted in the main body of the supplemental RI report along with the cVOC results and interpretations. Three dimensional representations of the 1,4-dioxane plume are provided in Appendix G of the supplemental RI.

#### 4.1.5 Decision 5 – Establish the average current PCB concentrations in sediment in the vicinity of the stations sampled in 2017 and refine the area-weighted average PCB concentrations associated with those stations

Updated area-weighted average concentrations for PCBs in sediment were calculated in accordance with this decision requirement based on discrete sediment sampling. These results were presented in the draft technical memorandum covering 2017-2019 PCB sampling presented to the project team (U.S. Navy, 2021c). These area-weighted average concentration results were subsequently superseded by the ISM sediment sampling for PCBs and the sampling conducted in support of the revised risk assessments. The revised risk assessment, to be submitted under separate cover, will present a comprehensive evaluation of PCBs in sediment in this reach of Marsh Creek and elsewhere at OU 1, and the results of the ISM sediment sampling for PCBs are summarized in the main body of the supplemental RI report.

#### 4.1.6 Decision 6 – Conclude whether there is a PCB source area in the vicinity of well MW1-14 in the North Plantation with a transport pathway to the sediment PCB detections at MA-09 and the surface water detections at seep SP1-1

The results of grab soil samples and groundwater samples from new monitoring wells in the vicinity of well MW1-14 and the northern edge of the North Plantation in general indicated high concentrations of PCBs in soil to a depth of approximately 20 ft below the landfill surface. The locations of elevated PCBs in soil are upgradient from seep SP1-1, and a transport pathway from soil via groundwater to seep water and surface water is plausible but not definitively demonstrated by the 2017-2019 data. PCB concentrations in seep water could also be resulting from unidentified PCB sources in soil much closer to the seep, potentially within the portion of the waste body that makes up the eastern bank of Marsh Creek at the seep location. Because PCBs have been identified throughout the area upgradient of the seep, it is not a productive use of resources to continue attempting to link a particular PCB source within the landfill waste body to the seep. A more efficient use of resources is addressing the ongoing discharge of PCBs at the seep. The results of the PCB samples collected are shown on plan view maps in the main body of the supplement RI report.

#### 4.1.7 Decision 7 – Assess the lateral extent of cVOCs in marsh porewater southeast of porewater sample locations PW1-02, PW1-03, PW1-04, and PW1-10

Plan view maps included in the supplemental RI report depict the results of sediment porewater samples collected further south and west of those collected in 2017. These results show cVOC concentrations in porewater extending further south and west than identified in 2017, and also delimited in the southward and westward extent of these cVOC concentrations in porewater. The extent of cVOC occurrence in porewater is roughly equal to the estimated location of the historical shoreline prior to construction of the landfill. Along with the sharp decline in cVOC concentrations to the east of the north-south road that roughly follows the historical shoreline to the east of the landfill, this pattern of porewater cVOC concentrations is another line of evidence that the former shoreline is a controlling subsurface feature in cVOC distribution.

#### 4.1.8 Decision 8 – Assess the lateral extent of cVOCs in groundwater to the east, southeast and northwest of the South Plantation, and the location of the known groundwater divide

As noted under Decision 7, the porewater results from south and west of the South Plantation combined with the results of soil and groundwater results collected from east of the South Plantation indicate that the former shoreline is a controlling subsurface feature in cVOC distribution. This is likely because waste placement occurred at the shoreline, and groundwater flow is away from the former shoreline to the northwest. The cVOC distribution in this area is depicted in the main body of the supplemental RI report on plan view figures and 3D data visualizations (Appendix G) within the CSM discussion.

### 4.1.9 Decision 9 – Assess the depth of occurrence and expression of the upper contact of the regional aquitard within the site boundary

Continuous core lithologic data from 2017 through 2022 were used to make geologic interpretations using environmental sequence stratigraphy techniques. The results of these interpretations are presented in environmental sequence stratigraphy section main body of the supplemental RI report.

### 4.1.10 Decision 10 – Model the fate and transport of cVOCs in groundwater beneath the site

Biodegradation conditions beneath the site were evaluated based on the 2017-2019 data collected and presented to the project team in a draft technical memorandum (U.S. Navy, 2021b). This evaluation was updated based on project team input and comments and is included as a section in the main body of the supplemental RI report.

Numeric groundwater modeling was conducted based on data collected between 2017 and 2022 and presented in a draft report to the project team (GSI, 2023). The final report, incorporating project team input, is included as Appendix F to the supplemental RI report and the results are incorporated into the main body of the supplemental RI report.

### 4.1.11 Decision 11 – Present a comprehensive updated CSM based on the data obtained

The updated CSM is presented as a section of the supplemental RI report.

## 4.2 DECISIONS FROM THE VERTICAL EXTENT SAP

### 4.2.1 Decision 1 – Decide the best estimate of the depth at which COCs no longer exceed RGs (i.e., establish vertical extent of COCs) directly beneath the landfill footprint.

Figures 3-1 through 3-7 show a graphical comparison of field PID results, key cVOC concentrations in soil samples, and key cVOC concentrations in groundwater from installed vertical extent wells MW1-69 through MW1-75. Inspection of these graphics allows assessment to make Decision 1. The three-dimensional depictions of the contaminant plume beneath site presented in Appendix G of the supplemental RI incorporate the results from these deeper wells.

In the western portion of the South Plantation, represented by MW1-69 (drilled to 90 ft bgs), field PID readings and soil sample results imply that the vertical extent of cVOCs is no deeper than the first occurrence of Olympia-age strata at about 60 ft bgs. Key cVOCs were not detected in soil samples from below this depth, and field PID readings were not significantly above ambient background. MW1-69 was screened just above the Olympia-age strata, where soil samples indicated the presence of cVOCs but the field PID readings were not significantly above ambient background. The three key cVOCs were detected in the groundwater sample from this well. 1,4-Dioxane was not detected in the groundwater sample from this well.

In the eastern portion of the South Plantation, represented by MW1-70 (drilled to 100 ft bgs), field PID readings and soil sample results imply that the vertical extent of cVOCs extends at least 5 to 6 ft into the first occurrence of Olympia-age strata at about 30 ft bgs. Key cVOCs were not detected in soil samples from below 38 ft bgs, and field PID readings were not significantly above ambient background from this depth to the bottom of the boring. MW1-70 was screened in the first sand unit within the Olympia-age strata, where soil samples and field PID readings did not indicate the presence of cVOCs (except for an estimated TCE concentration of 0.0003J mg/kg in the soil sample at 100 ft bgs). Despite these indicators, the three key cVOCs were detected in the groundwater sample from this well. 1,4-Dioxane was not detected in the groundwater sample from this well.

In the Central Landfill, represented by MW1-71 (drilled to 100 ft bgs), field PID readings and soil sample results imply that the vertical extent of cVOCs extends to approximately 45 ft bgs, approximately 15 ft above the first occurrence of Olympia-age strata at about 60 ft bgs. Key cVOCs were not detected in soil samples from below 45 ft bgs, and field PID readings were not significantly above ambient background from this depth to the bottom of the boring. MW1-71 was screened in the first sand unit within the Olympia-age strata, where soil samples and field PID readings did not indicate the presence of cVOCs. The three key cVOCs were not detected in the groundwater sample from this well. 1,4-Dioxane was not detected in the groundwater sample from this well.

In the central portion of the North Plantation, represented by MW1-72 (drilled to 75 ft bgs), field PID readings and soil sample results imply that the vertical extent of cVOCs extends to approximately 45 ft bgs, at the first occurrence of Olympia-age strata. Key cVOCs were not detected in soil samples from below 45 ft bgs, within the Olympia-age strata, and field PID readings were not significantly above ambient background from this depth to the bottom of the boring. MW1-72 was screened in the first sand unit within the Olympia-age strata, where soil samples and field PID readings did not indicate the presence of cVOCs. Of the three key cVOCs, only VC was detected in the groundwater sample from this well. 1,4-Dioxane was not detected in the groundwater sample from this well.

In the northwest corner of the North Plantation, represented by MW1-73 (drilled to 100 ft bgs), field PID readings and soil sample results imply that the vertical extent of cVOCs extends to approximately 60 ft bgs, within the Olympia-age strata. Key cVOCs were not detected in soil samples from below 60 ft bgs, within the Olympia-age strata, and field PID readings were not significantly above ambient background from this depth to the bottom of the boring. MW1-73 was screened in the first significant sand unit within the Olympia-age strata, where soil samples and field PID readings did not indicate the presence of cVOCs. Of the three key cVOCs, only TCE was detected in the groundwater sample from this well. 1,4-Dioxane was not detected in the groundwater sample from this well.

#### 4.2.2 Decision 2 - Decide if the depth of the last documented COC exceedance indicates that the vertical extent of COCs has not yet been identified, warranting future additional investigation.

At the areas investigated, the last documented concentrations of cVOCs in soil and groundwater samples imply that the vertical extent of cVOCs has been documented.

In the western portion of the South Plantation, represented by MW1-69 (drilled to 90 ft bgs), the low concentrations of cVOCs in the groundwater sample from this well, the low PID response below the installed well depth, and the lack of cVOC detections in soil samples from below the installed well depth, provide lines of evidence to support that the vertical extent of cVOCs at this location does not extend below the first occurrence of Olympia-age strata at about 60 ft bgs.

In the eastern portion of the South Plantation, represented by MW1-70 (drilled to 100 ft bgs), the moderate concentrations of cVOCs in the groundwater sample from this well, the presence of at least 19 ft of silt and clay below the installed well depth, the low PID response below the installed well depth, and the minimal cVOC detections in soil samples from below the installed well depth, provide lines of evidence to support that the vertical extent of cVOCs at this location does not extend substantially below the explored depth of 100 ft bgs.

In the Central Landfill, represented by MW1-71 (drilled to 100 ft bgs), the lack of detection of the key cVOCs and 1,4-dioxane in the groundwater sample from this well (screened from 95 to 100 ft bgs), is the strongest line of evidence that this well delimits the vertical extent of these COCs in this area. The vertical extent is likely to be somewhere in the depth range of 45 to 100 ft bgs. The other lines of evidence (soil sample results and field PID readings) support this conclusion.

In the central portion of the North Plantation, represented by MW1-72 (drilled to 75 ft bgs), the low concentration of a single cVOC in the groundwater sample from this well (and no detection of 1,4-dioxane), the low PID response below the installed well depth, and the lack of cVOC detections in soil samples from below the installed well depth, provide lines of evidence to support that the vertical extent of cVOCs at this location does not extend below the occurrence of silt and clay within the Olympia-age strata at about 70 ft bgs.

In the northwest corner of the North Plantation, represented by MW1-73 (drilled to 100 ft bgs and screened from 95 to 100 ft bgs), the low concentration of a single cVOC (TCE at 0.094J µ/L, two orders of magnitude below the remediation goal [RG] of 5 µg/L) in the groundwater sample from this well (and no detection of 1,4-dioxane), is the strongest line of evidence that this well delimits the vertical extent of these COCs in this area.

### 4.2.3 Decision 3 – Decide if the lateral extent of contamination at depth has been defined, based on the depths and locations of existing sample data. If not, conduct future additional investigations.

The cVOC concentrations in groundwater samples from the two deeper wells installed beneath the South Plantation (MW1-69 and MW1-70) document detectable cVOC concentrations deeper than previously demonstrated in this area. Compared to concentrations in shallow groundwater, the detections in deeper groundwater are substantially lower. It is reasonable to assume based on the nature of the contaminants and the understanding of geology beneath the landfill that similar concentrations would be found everywhere beneath the South Plantation at these depths. Additional deep well investigation is not necessary to verify this assumption.

The cVOC concentrations in samples from the deep well installed in the Central Landfill (MW1-71) indicated no detectable cVOC concentrations in soil at depths greater than 45 ft bgs, or in groundwater at a screened depth interval of 95 to 100 ft bgs.

The cVOC concentrations in groundwater samples from the three deeper wells installed beneath the North Plantation (MW1-71, MW1-72, and MW1-73) document detectable cVOC concentrations deeper than previously demonstrated in this area, specifically at MW1-72 and MW1-73. Compared to concentrations in shallow groundwater, the detections in deeper groundwater are substantially lower. It is reasonable to assume based on the nature of the contaminants and the understanding of geology beneath the landfill that similar concentrations would be found everywhere beneath the North Plantation at these depths. Additional deep well investigation is not necessary to verify this assumption.

### 4.2.4 Decision 4 – Decide whether offsite historical and current wells along the Highway 308 causeway, downgradient of the landfill, adequately delimit the downgradient vertical extent of COCs.

On the Highway 308 causeway, represented by MW1-74 (drilled to 60 ft bgs) and adjacent well MW1-75 (drilled to 80 ft bgs), field PID readings and soil sample results imply no substantial cVOCs to the total depth drilled. The field PID showed sporadic responses, which could have been related to ambient conditions on the highway. The most consistent response was near the total depth of well MW1-75, in the range of 71 to 77 ft bgs. Key cVOCs were not detected in any soil samples from either well, and the three key cVOCs were not detected in the groundwater samples from either well. However, 1,4-dioxane was detected in the groundwater samples from both wells.

The detection of 1,4-dioxane above the RG of 0.44 µg/L in the shallower well (MW1-74) and below the RG in the deeper well (MW1-75), with no detection of cVOCs in either well, is the strongest line of evidence that these wells delimit the vertical extent of these COCs in this area.

#### 4.2.5 Decision 5 – Decide the best estimate of hydraulic conductivity and estimate the groundwater seepage velocity in preferential flow pathways compared to other parts of the aquifer.

As presented in Section 3.8.2, slug testing results indicated average hydraulic conductivity per well ranged from 2.16 ft/day ($7.61 \times 10^{-4}$ cm/s), screened in a silty sand, to 237.9 ft/day ($8.39 \times 10^{-2}$ cm/s), screened in well graded sand and gravel. Correspondingly, average groundwater velocity ranged from 0.05 ft/day ($1.76 \times 10^{-5}$ cm/s) to 5.49 ft/day ($1.94 \times 10^{-3}$ cm/s). These values correlate with expected values from hydrogeology literature (Freeze and Cherry, 1979).

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# ATTACHMENT 1

## Approved Field Change Request Forms

**Battelle**
**Contract No. N39430-16-D-1802**

# FIELD CHANGE REQUEST (FCR)

| **Task Order:** | **FCR Number:** | **Date:** |
|---|---|---|
| F4359 (X041) | 01 | 9/17/2019 |

| **Location:** | **NTR / RPM:** |
|---|---|
| NBK Keyport OU 1 Source Investigations | Charlie Escola/Carlotta Cellucci |
| **Document:** | **NIRIS Document #:** |
| Final Accident Prevention Plan and Site Safety and Health Plan for Keyport Operable Unit 1 Source Investigations, Naval Base Kitsap Keyport, Washington, May 21, 2019 | |

**Description** (items involved, submit sketch, if applicable)

1. Addition of Battelle geologist Steven Verdibello as an approved collateral duty Field Site Manager (FSM) and Site Safety and Health Officer (SSHO), based on the attached certifications. Mr. Verdibello's last medical fitness clearance was August 27, 2019.
2. Addition of tree felling AHA.

**Reason for Change**

1. Because of the relatively long duration of field work for this project, staffing flexibility is needed. Allowing Mr. Verdibello to act as SSHO/FSM will provide additional staffing flexibility.
2. Based on the final position of wells to be drilled during mobilization 2, trees will need to be felled to allow drill rig access. Tree felling will be performed by a professional tree removal subcontractor to Battelle.

**Battelle**
**Contract No. N39430-16-D-1802**

## FIELD CHANGE REQUEST (FCR)

| Task Order: | FCR Number: | Date: |
|---|---|---|
| F4359 (X041) | 01 | 9/17/2019 |

**Recommended Disposition** (submit sketch, if applicable)

The following additions or changes are made to the Accident Prevention Plan (APP) and Site Safety and Health Plan (SSHP) for Keyport Operable Unit 1 Source Investigations:

1. Add Steven Verdibello as Alternate SSHO in Table 2 of the APP.
2. On page 10 of the APP, add Steven Verdibello as an Alternate SSHO along with Samuel Moore and Michael Meyer (as currently listed).
3. On page 12 of the APP add Steven Verdibello as an Alternate Field Site Manager (FSM)
4. On Figure 2 of the APP, add Steven Verdibello as an Alternate SSHO and FSM
5. In Table 3, add Steven Verdibello as an Alternate SSHO and FSM with a mobile phone number of 845.625.7194
6. In the attachments to the APP, including the SSHP and the activity hazard analyses (AHAs), add Steven Verdibello as an Alternate SSHO, FSM, and Competent Person.
7. Add a tree felling AHA (number 11) to the APP.

**Additional Details**

None

**Battelle**
**Contract No. N39430-16-D-1802**

## FIELD CHANGE REQUEST (FCR)

| **Task Order:** | **FCR Number:** | **Date:** |
|---|---|---|
| F4359 (X041) | 01 | 9/17/2019 |

Will this change result in a contract cost or time change? ☐ Yes ☒ No

**Estimate of contract cost or time charge** (if any)

| Preparer (signature) | Date | Preparer's Title | Reviewer (signature and title) | Date |
|---|---|---|---|---|
| [signature] | 9/27/2019 | Battelle PM | N/A | N/A |

| Navy RPM approval (signature) | Date | Battelle PM approval (signature) | Date |
|---|---|---|---|
| ☐ Comments (attached) ☐ No Comments | | [signature] ☐ Comments (attached) ☒ No Comments | 9/27/19 |

| Battelle QAO approval (signature) | Date | Battelle SS/SSHO approval (signature) | Date |
|---|---|---|---|
| N/A ☐ Comments (attached) ☐ No Comments | N/A | [signature] ☐ Comments (attached) ☐ No Comments | 9/27/19 |

| Battelle Program Manager approval (signature) | Date | Other approval (signature and title) | Date |
|---|---|---|---|
| N/A ☐ Comments (attached) ☐ No Comments | N/A | N/A ☐ Comments (attached) ☐ No Comments | N/A |

Distribution: Project File
Site File
Navy RPM
Battelle PM

# Activity Hazard Analysis (AHA)-11

| | | | | | | |
|---|---|---|---|---|---|---|
| Activity/Work Task: **Tree Felling** | Overall Risk Assessment Code (RAC) (Use highest code) | | | | | **H** |
| Project Location: NBK Keyport OU 1, Washington | **Risk Assessment Code (RAC) Matrix** | | | | | |
| Contract Number: N44255-14-D-9013 | **Severity** | **Probability** | | | | |
| Date Prepared: 9/16/2019 | | Frequent | Likely | Occasional | Seldom | Unlikely |
| Prepared by (Name/Title): Steve Verdibello/Researcher | Catastrophic | E | E | H | H | M |
| | Critical | E | H | H | M | L |
| Reviewed by (Name/Title): Ryan Moon/Battelle Safety, Health and Emergency Response Representative | Marginal | H | M | M | L | L |
| | Negligible | M | L | L | L | L |

| | | |
|---|---|---|
| **Notes: (**Field Notes, Review Comments, etc.)<br><br>Tree felling, to clear areas for monitoring well drilling, will be performed by a subcontractor.<br><br>The Competent Person for this AHA is Damon DeYoung | Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above) | |
| | **"Probability**" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely. | **RAC Chart** |
| | **"Severity"** is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible | **E = Extremely High Risk**<br>**H = High Risk** |
| | Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA. | **M = Moderate Risk**<br>**L = Low Risk** |

| Job Steps | Hazards | Controls | RAC |
|---|---|---|---|
| General Safety Requirements | Sunburn<br>Heat stress<br>Cold stress<br>Dehydration | **<u>Weather:</u>**<br>• Wear appropriate clothing for hot or cold weather.<br>• Sun block<br>• Lip balm<br><br>**<u>Dehydration:</u>**<br>• Drink at least 1 quart of water per hour.<br>• Refer to Section 3.4.7 and 3.4.8 in SSHP (Attachment 1) for specific details on heat stress and cold stress signs and symptoms. | **L** |

| | | | |
|---|---|---|---|
| 1. Mobilize to site. | 1. Multiple hazards | 1a. See Mobilization/Site Setup AHA. | **L** |
| 2. Equipment set-up | 2a. Worker could be struck by vehicles operating at the site | 2a. See corresponding entry in AHA table for Mobilization/Site Set up | **M** |
| | 2b. Worker could be struck by other vehicles and objects. | 2b. See corresponding entry in AHA table for Mobilization/Site Set up | **M** |
| 3. Manual Material Handling | 3a. Lifting and moving equipment can expose to injury (including, but not limited to, strains, lacerations, and pinch points). | 3a. Use mechanical lifting devices whenever feasible to lift and move heavy loads. Do not exceed one's physical abilities and limitations when lifting heavy loads, never lift more than 50 lbs. individually and maintain ergonomically correct posture when lifting. Have others help lift heavy loads and Avoid repetitive lifting and movements. If such activities are necessary, take frequent breaks, alternate work activities, and stay hydrated. To protect oneself from lacerations, ensure materials to be handled are free of sharp edges, protrusions, burrs, and slivers, etc. Wear leather work-gloves and long-sleeved shirt and pants. | **M** |
| | 3b. Nuisance dust exposure | 3b. Avoid exposure to dust. Use dust control (i.e. water spray) as necessary and possible. Wear half-face nuisance dust respirator if visible dust is present in work area. | **L** |
| | 3c. Struck-by and caught in or between. | 3c. Wear high-visibility reflective vests at all times in work areas. Make eye contact with operators of vehicles. Use traffic controls or barricades, if necessary, to keep traffic away from workers. Wear proper PPE at all times, including leather work gloves, long-sleeved work shirts, and full-length work pants and stage first aid kit and emergency eyewash in work area. | **H** |
| | 4a. Struck by flying debris | 4a. Wear safety glasses with sideshields and hard hat. Stage emergency eyewash in work area. Stabilize items to be cut before cutting and stay clear of falling cut limbs. | |
| | 4b. Contact with surface utilities or other fixtures | 4b. Inspect area to be cleared prior to cutting/clearing. Flag (or remove, if possible) all surface fixtures or obstructions prior to cutting/clearing. | |

| | | | |
|---|---|---|---|
| 4. Operating chain saws | 4c. Contact with stinging or biting insects or poison ivy<br><br>4d. Nuisance dust exposure<br><br>4e. Slips, trips, and falls<br><br>4f. Thermal stress<br><br>4g. Fuel spill<br><br>4f. Contact with saw blade<br><br>4g. Hearing loss | 4c. Wear insect repellant as needed and avoid disturbing insect nests. Have first aid kit available to treat insect stings (if allergic to any insect bites, notify SSHO). Avoid contact with poison ivy, if possible. Wear disposable protective clothing (i.e., Tyvek coveralls) when working around poisonous plants. Wash skin with soap and water if contact with poisonous plants occurs. Use barrier creams to keep poisonous plant resins off skin.<br><br>4d. Avoid exposure to dust. Use dust control (i.e. water spray) as necessary and possible. Wear half-face nuisance dust respirator if visible dust is present in work area.<br><br>4e. Clear all ground hazards from the working location. Practice good housekeeping to keep the ground around the work site clear of obstructions, equipment and other tripping hazards. Wear appropriate foot protection to prevent slips and trips. Use caution when working on uneven and wet ground surfaces.<br><br>4f. Refer to Section 3.4.7 in SSHP (Attachment 1) for specific details on heat stress signs and symptoms.<br><br>4g. Sorbent pads shall be placed around the point of refueling when refueling is underway. A sufficiently stocked portable spill kit, properly sized for the fuel volume on site, shall be immediately on hand in the work area and at the refueling station, and will be restocked immediately upon use. Keep caps on cutting fuel tanks until ready to refuel.<br><br>4f. Use saws only as intended and inspect saws for damage or defects before and after each use. Turn saw off when not in use. Ensure chain saw is equipped with automatic chain brake or anti-kickback device, and that the saw teeth are sharp and the chain is properly lubricated and tensioned. Always keep cutting end of saw positioned away from the operator and other workers and do not operate saw above shoulder height. Use both hands when starting and operating a chain saw. Do not touch "kickback zone" of the blade to material being cut. Wear safety glasses with side shields, leather gloves, long-sleeved shirt, steel-toed safety boots, and cut-resistant chaps.<br><br>4g. Wear hearing protection | **M**<br><br>**M**<br><br>**L**<br><br>**L**<br><br>**M**<br><br>**L**<br><br>**L** |

| | | | |
|---|---|---|---|
| 5. Refueling gasoline powered cutting tools | 5a. Dermal contact with fuel and lubricants<br><br>5b. Fire | 5a. Wear nitrile gloves when handling fueling and lubricating equipment. Wear PPE (i.e. hard hat, safety glasses) as appropriate and wash skin with soap and water if dermal contact occurs.<br><br>5b. Refuel offsite at the start of the work day when equipment is cold, with equipment engine off. Establish control zone around refueling area and isolate all ignition sources in refueling area. Stage fire extinguisher in refueling area. Bond and ground fuel cans to equipment being refueled. | **L**<br><br>**L** |
| 6. Tree felling | 6a. Struck by falling tree, tree limbs, or other debris from tree<br><br>6b. Tree contact with powerlines, overhead structures, or ground infrastructure. | 6a. Establish drop zone around tree to be felled that shall be at least twice the height of the tree and keep all personnel clear of drop zone. Establish and communicate escape route. Maintain and communicate situational awareness. Maintain safe distance away from trees that are rotting, cracking, and buckling. Inspect trees for loose limbs, hangers, broken tops, chunks, or other overhead material, and appropriately plan for these hazards. Use ropes and winches to control the direction of tree fall. Assess and plan for cutting of branches or trunks that are under compression from overlying material, or from the position of the branch/trunk to be cut. Make a plan for each cut based on accepted best practices – only personnel trained for tree felling shall make cuts. Communicate hazards to crewmembers. Workers must remain at least two tree lengths apart from each other and drop zone at all times. Operator shall consider weather factors for tree felling including, rain, wind, etc.<br><br>6b. Clear all obstructions and ground infrastructure from drop zone and account for powerlines and other overhead structures present in the fall path within 2 times the height of the tree. | **H** |
| 7. Bucking | 7a. Struck by falling rounds or other debris from bucking operation<br><br>7b. Contact with saw blade | 7a. Follow controls for chain saw use in item 4 above. Keep feet, legs, and other body parts and equipment clear of area beneath round to be cut off. Buck logs only by cutting an unsupported end and allowing the bucked round to fall free of the cut. Do not buck logs with both ends supported.<br><br>7b. Follow controls for chain saw use and bucking in items 4 and 7a above. Position body to not be in line with cut during bucking. Do not touch “kickback zone” of the blade to material being cut. | |
| 8. Chipping | 8a. Struck by chips | 8a. Position discharge chute of chipper in a safe direction. Mark exclusion zone 1 and ½ times the throw distance of the chipper. | |

| | | | |
|---|---|---|---|
| | 8b. Contact with or pulled into chipper.<br><br>8c. Hearing loss<br>8d. Struck by runaway chipper | 8b. Tightly secure all loose clothing, hair, and any dangling tools prior to approaching chipper. Release your grip on each piece being fed into the chipper well before touching the infeed guard. Protect yourself from contacting operating chipper components by guarding the infeed and discharge ports and preventing the opening of the access covers or doors until the drum or disc completely stops. When servicing and/or maintaining chipping equipment (i.e., "unjamming") use a lockout system to ensure that the equipment is de-energized.<br><br>8c. Wear hearing protection.<br><br>8d. Prevent detached trailer chippers from rolling or sliding on slopes by chocking the trailer wheels. | |

| Equipment to be Used | Training Requirements/Competent or Qualified Personnel name(s) | Inspection Requirements |
|---|---|---|
| PPE<br>• Long pants, shirts with sleeves, hardhat (when overhead hazard exists), safety-toed boots, safety vest.<br>• Safety glasses with side shields.<br>• Leather gloves.<br>• Standard work clothing or chemical-resistant Tyvek® coveralls if poisonous plants are present.<br>• Cut-resistant chaps.<br>• Hearing protection<br>Nitrile or equivalent (laboratory) gloves while refueling; Vehicles; Hand tools and portable power equipment (including chain saws); Temporary power supplies (i.e. GFCI, extension cords, plug-operated tools) | • Daily tailgate safety meeting/ Damon DeYoung<br>• Site specific orientation/ Damon DeYoung<br>• Hazard observation and communication/ Damon DeYoung<br>• All drivers/operators will have valid operator's licenses) for the vehicle they will be driving. / Damon DeYoung<br>• Field personnel will be 40-hour HAZWOPER certified with 8-hour refresher/ Damon DeYoung<br>• Spill response procedure/ Damon DeYoung<br>• Subcontractor health and safety training and awareness of approved Health and Safety Plan/ Damon DeYoung | Preshift/Post maintenance<br>Daily inspection of plug-operated tools and chain saws by user. |

# Steven M. Verdibello, PG | Battelle

**Proposed Role:** Researcher

## Education and Training

MS, Earth and Environmental Sciences/Wright State University
BS, Geological Sciences/The Ohio State University

## Qualifications

Mr. Verdibello is a licensed professional geologist with seven years of experience conducting environmental due diligence assessments, remedial investigations, remediation of contaminated sites, and aquifer testing. Mr. Verdibello has acted as a safety and health officer and been designated the "competent person" for several sites and projects from 2014 to 2019.

Mr. Verdibello has a combination of field experience and office-related experience (i.e. data analysis, technical writing, etc.). He has conducted field work, including sampling for various media (soil, groundwater, air, soil vapor) and operation of a Geoprobe® drill rig, at a variety of commercial and residential sites. Mr. Verdibello has also served as a junior project manager and project manager for four years, which includes supervision of junior staff members during the aforementioned assessments, investigations, and remediation projects.

## Employment History

| | |
|---|---|
| 2019-Present | Researcher |
| | Battelle |
| 2012–2019 | Geologist/Hydrogeologist/Project Manager |
| | HydroEnvironmental Solutions, Inc. |

## Battelle Experience

Mr. Verdibello first joined Battelle in August 2019 as a Researcher in the Site Restoration Division.

## Prior Professional Experience

Perform soil and groundwater sampling, data analysis, sub-contractor oversight, and technical report writing. Interact directly with clients and regulatory agencies to achieve site-specific goals. Promoted to supervisory role to manage projects and review tasks completed by junior staff members.

- Phase I and II Environmental Site Assessments (ASTM Standard) for environmental due diligence.
- Oversight and perform remedial actions at variety of contaminated sites. Examples include: excavation and end-point sampling, in-situ chemical oxidation, enhanced bio-remediation, monitoring well installation, groundwater monitoring and sampling (includes low-flow sampling), soil vapor extraction systems.
- Health and Safety Plans (HASPs) and Safety and Health Officer (SHO) for several projects/sites.
    - ➢ Example: State of New Jersey MTBE Litigation Project (Princeton, NJ)
    - ➢ Example: Brownfield Cleanup Program (BCP) Site (Pleasantville, NY)
- Subsurface investigations – soil, groundwater, and soil vapor sampling to characterize subsurface conditions at variety of sites. Investigations include professional input for remedial action and compliance.
- Construction dewatering design in New York City and associated NYCDEP permitting. Designated as competent person at several construction dewatering sites.
- Aquifer testing via pumping tests and slug tests for hydrogeological parameters for various purposes.

- Compile comprehensive proposals and budgets for projects. Includes sub-contractor oversight and review of project progress (operational and fiscal).
- Professional consulting for local municipalities. Includes technical review and attendance at Town/Village meetings to provide support for government boards.
- Networking and marketing, which includes attending various events or one-on-one meetings with clients or others related to the industry.

## Professional Activities and Recognition

### Registrations/Certifications

New York State Licensed Professional Geologist
OSHA 10-hour Construction Certification
OSHA 30-hour Construction Certification
OSHA-HAZWOPER (40-hr) Certification (Annual 8-hour Refresher]
OSHA Supervisor Certification (8-hour)
New York State Licensed Asbestos Inspector
National Groundwater Association (NGWA) Member

HEARTSAVER

# Heartsaver® First Aid CPR AED

American Heart Association®

## Steve Verdibello

**has successfully completed the cognitive and skills evaluations in accordance with the curriculum of the American Heart Association Heartsaver® First Aid CPR AED Program.**

**Optional modules completed:**

**Issue Date**
9/18/2019

**Training Center Name**
Loren-Lynn, Inc. DBA SOS Technologies and AED Results

**Training Center ID**
OH50581

**Training Center Address**
5880 Sawmill Rd
Dublin OH 43017 USA

**Training Center Phone Number**
(614) 389-2620

**Recommended Renewal Date**
09/2021

**Instructor Name**
Ronald Cunningham

**Instructor ID**
07180699856

**eCard Code**
196006875025

**QR Code**

To view or verify authenticity, students and employers should scan this QR code with their mobile device or go to www.heart.org/cpr/mycards.

# Certificate of Completion

*For Successfully Completing The*

***Wright State University - 40 Hour HazWoper - Course***

This certificate is presented to:

## Steve Verdibello

In accordance with the
OSHA Hazardous Waste Operations and Emergency Response Course
{meets the requirements of 1910.120(e)(8)}

| June 8, 2012 | 06081240HR/RAS | [signature] |
|---|---|---|
| Date | Certificate number | Instructor |

**RICK A. SHIVERDECKER**

Email: ras12254@aol.com

---

**Wright State** **HAZWOPER**
**University** **Training**

Name Steve Verdibello

Issue 06/8/12 Trainer Rick A. Shiverdecker

**Student has meet the requirements of 29CFR1910.120(e)(8)**

# Certificate of Completion

**This is to certify that**

Steven Verdibello

**Has completed**

HAZWOPER 8 hr Annual Refresher

**Completion Date:** 06/14/2019

**Course Duration:** 8.0

360training.com

6801 N Capital of Texas Hwy, Bldg I, Suite 250 ♦ Austin, TX 78731 ♦ 877.881.2235 ♦ www.360training.com

(CUT HERE)

This is your pocket card which may be used for proof of completion of your training. This training is intended to provide supervisor awareness for recognizing and preventing hazards on a construction site. Workers must receive additional training as required for the specific hazards of their job or federal, state, and local requirements.

OSHAcampus.com is a trademark of 360training.com, Inc.

Questions? Visit www.oshacampus.com

safety@oshacampus.com
877.881.2235

This Card May Not Be

(FOLD)

360training.com

This certifies that the person named below successfully completed a

Steven Verdibello

HAZWOPER 8 hr Annual Refresher

06/14/2019
Completed

Curtis Chambers
Trainer Name

# Certificate of Completion

**This is to certify that**

Steven Verdibello

**Has completed**

HAZWOPER 8 hr Annual Refresher

**Completion Date:** 06/14/2019

**Course Duration:** 8.0

360training.com

6801 N Capital of Texas Hwy, Bldg I, Suite 250 ♦ Austin, TX 78731 ♦ 877.881.2235 ♦ www.360training.com

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Questions? Visit www.oshacampus.com

safety@oshacampus.com
877.881.2235

This Card May Not Be Reproduced

(FOLD)

360training.com

This certifies that the person named below successfully completed a

Steven Verdibello

HAZWOPER 8 hr Annual Refresher

Curtis Chambers
Trainer Name

06/14/2019
Completed

**Student Affiliation:**
*HydroEnvironmental Solutions, Inc*
*200700416*

Compliance Solutions
"Today's Training...Tomorrow's Solution"

3980 Quebec St., 2nd Floor, Denver CO 80207-1633 800-711-2706

# *Certificate of Completion*

***Steven Verdibello***

has successfully completed training and passed all testing requirements for

***OSHA HAZWOPER Site Supervisor***
***as per 29 CFR 1910.120***

Presented this
*Sunday, July 14, 2019*

***Certificate Number: 754977142***

***Compliance Solutions Occupational Trainers, Inc.***

**Jeffrey E. Kline**
***President/CEO***

# Certificate of Completion

360training.com®

## This Certifies That

Steven Verdibello

### is awarded this certificate for

OSHA 30 Hour Outreach Training Program - Construction

**Credit Hours:** 30.00

**Completion Date:** 08/19/2019

Curtis Chambers, Trainer C 26-0106073 and G 26-0079775

"As an OSHA authorized trainer, I verify that I have conducted this OSHA outreach training class in accordance with OSHA Outreach Training Program requirements. I will document this class to my authorizing OSHA training organization. Upon successful review of my documentation, I will provide each student their completion card within 90 days of the end of the class."

6801 N Capital of Texas Hwy, Bldg I, Suite 250 ♦ Austin, TX 78731 ♦ 877.881.2235 ♦ www.360training.com

# QuES&T

Quality Environmental Solutions & Technologies, Inc.
1376 Route 9, Wappingers Falls, NY 12590
Phone (845) 298-6031 Fax (845) 298-6251

HEREBY CERTIFIES THAT

## *STEVEN VERDIBELLO*

HAS SUCCESSFULLY COMPLETED A TRAINING SEMINAR IN:

## *NYS/EPA INSPECTOR REFRESHER*

MEETING THE REQUIREMENTS OF NYSDOH 10 NYCRR, PART 73 AND TSCA TITLE II AND HAS BEEN AWARDED THIS CERTIFICATE BY:

***PAUL A. RODRIGUEZ***
TRAINING DIRECTOR

NOTE: Official record of successful completion is DOH 2832 Certificate of Completion of Asbestos Safety Training

NOTE: DOH 2832 - A $20 fee shall be charged for replacement of Certificate of Completion DOH 2832

**ON THIS DATE: 6/12/2019**

**CERTIFICATE NUMBER: 842041**

**EXPIRATION DATE: 6/12/2020**

**Battelle**
**Contract No. N39430-16-D-1802**

## FIELD CHANGE REQUEST (FCR)

| **Task Order:** F4359 (X041) | **FCR Number:** 02 | **Date:** 4/28/2022 |
|---|---|---|
| **Location:** NBK Keyport OU 1 Source Investigations | | **NTR / RPM:** Charlie Escola/Carlotta Cellucci |
| **Document:** Final Accident Prevention Plan and Site Safety and Health Plan for Keyport Operable Unit 1 Source Investigations, Naval Base Kitsap Keyport, Washington, May 21, 2019 | | **NIRIS Document #:** |

**Description** (items involved, submit sketch, if applicable)

1. Addition of Battelle geologist Hunter Butler as an approved collateral duty Field Site Manager (FSM) and Site Safety and Health Officer (SSHO), based on the attached certifications. Mr. Butler's last medical fitness clearance was April 1, 2022.

**Reason for Change**

1. Because of the relatively long duration of field work for this project, staffing flexibility is needed. Allowing Mr. Butler to act as SSHO/FSM will provide additional staffing flexibility.

**Battelle**
**Contract No. N39430-16-D-1802**

## FIELD CHANGE REQUEST (FCR)

| **Task Order:** | **FCR Number:** | **Date:** |
|---|---|---|
| F4359 (X041) | 02 | 4/28/2022 |

**Recommended Disposition** (submit sketch, if applicable)

The following additions or changes are made to the Accident Prevention Plan (APP) and Site Safety and Health Plan (SSHP) for Keyport Operable Unit 1 Source Investigations:

1. Add Hunter Butler as FSM and SSHO via this FCR as an addendum to the APP.

**Additional Details**

None

**Battelle**
**Contract No. N39430-16-D-1802**

## FIELD CHANGE REQUEST (FCR)

| **Task Order:** | **FCR Number:** | **Date:** |
|---|---|---|
| F4359 (X041) | 02 | 4/28/2022 |

Will this change result in a contract cost or time change? ☐ Yes ☒ No

**Estimate of contract cost or time charge** (if any)

| Preparer (signature) | Date | Preparer's Title | Reviewer (signature and title) | Date |
|---|---|---|---|---|
| [signature] | 4/28/22 | Battelle PM | N/A | N/A |

| Navy RPM approval (signature) | Date | Battelle PM approval (signature) | Date |
|---|---|---|---|
| ☐ Comments (attached) ☐ No Comments | | [signature]<br>☐ Comments (attached) ☒ No Comments | 4/28/22 |

| Battelle QAO approval (signature) | Date | Battelle SS/SSHO approval (signature) | Date |
|---|---|---|---|
| N/A<br>☐ Comments (attached) ☐ No Comments | N/A | ☐ Comments (attached) ☐ No Comments | |

| Battelle Program Manager approval (signature) | Date | Other approval (signature and title) | Date |
|---|---|---|---|
| N/A<br>☐ Comments (attached) ☐ No Comments | N/A | N/A<br>☐ Comments (attached) ☐ No Comments | N/A |

Distribution: Project File
Site File
Navy RPM
Battelle PM

# ATTACHMENT 2

## Daily Field Reports

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| DAILY FIELD REPORT<br>4/25/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Partly cloudy, 47 – 63 F, SW-W wind at 0-10 mph, gusting to 12 mph. | |
| **To:** Carlotta Cellucci | |
| **From:** Michael Meyer | |

**PERSONNEL ON SITE:**
Battelle: Michael Meyer, Angela Piemonte, and Hunter Butler; Holt Services: Jeffery Johnson and Kelly Arndt.

**SUMMARY OF WORK COMPLETED:**
Continued mobilization onto proposed monitoring well location SP-B175/MW1-70. Initiated drilling advance for collection of soil samples and installation of monitoring well assembly for SP-B175/MW1-70. Advanced and sampled soils to 50 ft bgs; collected geotechnical soil samples at 15 ft bgs, 25 ft bgs, and 38 bgs; collected analytical samples at 25 ft bgs, 38 ft bgs and 50 ft bgs; and completed the soil logs. Initiated setup of pumping and monitoring equipment for development of new HVDP pilot test monitoring wells.

**DEVIATIONS FROM WORKPLAN:**
None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
Monitored slip-trip-fall and pinch-point hazards around drilling rig during sampling operations due to uneven and saturated ground conditions, and utilization of an automated sampling drive-hammer. Driller improved on hammer handling and setup process by using the skid steer to manage the heavy hammer.

**FIELD ACTIVITY CHRONOLOGY:**
0615 A. Lewis called in sick, advised drillers ETA 0800.
0715 H. Butler onsite Keyport, prepare for day.
0720 M. Meyer onsite, continued prep for drilling and development operations, calibrate PIDs.
0755 Holt Drilling onsite.
0800 M. Meyer offsite for drilling support supplies. Conducted a tailgate H&S meeting. Topics included: heavy lifting with use of automatic hammer, proper PPE, equipment inspections, tight work areas, and footing on uneven ground were some topics discussed.
0810 Continue prep to drill well SP-B175/MW1-70.
0830 M. Meyer back onsite, continue setup operations. Advised Terra Core samplers in from Eurofins Lab by FedEx by 1200 today.
0910 Start to drill SP-B175/MW1-70.
1025 Reached 15 ft bgs, set up for geotech sample, cleared hole for sampling.

1145 Complete setup for geotech sampling with split-spoon sampling and auto-hammer.
1150 Collect geotech sample at 15 ft bgs.
1230 Drillers take a lunch break, M. Meyer out for FedEx sampling supplies.
1300 Drillers complete lunch break, set up to advance and sample at 25 ft bgs.
1330 M. Meyer back on site with sampling equipment.
1345 Prep for sampling at 25 ft bgs.
1430 Collect geotech and chemical sample at 25 ft bgs. Continue drilling operations to 38 ft bgs. A. Piemonte on site at Pass & Decal for badging.
1500 Break. A. Piemonte on site. Prep for sampling at 38 ft bgs. Prep for well development operations on HVDP well SP-B181/MW-76.
1527 Collect geotech and chemical sample at 38 ft bgs. Continue soil boring advance to 50 ft bgs.
1605 Advance to 50 ft bgs. Prep for sample retrieval.
1627 Chemical sample collected at 50 ft bgs.
1630 Start cleanup and secure site.
1715 Drillers offsite.
1725 H. Butler offsite
1730 M. Meyer and A. Piemonte offsite.

**SUMMARY OF FINDINGS:**

Completed mobilization and initiated soil boring at location SP-B175/MW1-70.

Soil boring for SP-B175/MW1-70 was advanced to the to the intermediate depth of approximate 50 feet bgs with a sonic drilling rig to the identify and confirm the target soil depth interval for installation of a deep-water-zone monitoring well. Soil samples were collected for geotechnical analysis at 15 ft, 25 ft and 38 ft bgs; and chemical analysis at 25 ft, 38 ft and 50 ft bgs. Soil samples were containerized, labeled, and preserved on site pending shipment to the analytical laboratory. Boring was secured at 50 ft bgs at the end of day. Elevated PID readings were noted until the last 2-3 feet of clay (47 to 50 feet bgs), when the PID consistently read 0 ppb.

**PLANS FOR THE FOLLOWING DAY:**

Tuesday April 26th we are planning to continue soil sampling and installation of well MW1-70 in the southern plantation. Well development operations for HVDP wells will recommence with SP-B181/MW-76.

**ATTACHMENTS:**

Daily tailgate H&S form.

| | |
|---|---|
| Copies to: Michael Meyer, Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

BATTELLE
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| DAILY FIELD REPORT 4/26/2022 | **Contract No.** N39430-16-D-1802, CTO N4425521F4225, F4359 **References** Draft Sampling and Analysis Plan (Battelle 2022) Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Partly cloudy, 42 – 60 F, SW-NW wind at 0-10 mph, gusting to 14 mph; lt. showers mid-day. | |
| **To:** Carlotta Cellucci | |
| **From:** Mike Meyer | |

**PERSONNEL ON SITE:**
Battelle: Michael Meyer, Angela Piemonte, and Hunter Butler; Holt Services: Jeffery Johnson and Kelly Arndt.

**SUMMARY OF WORK COMPLETED:**
Continued drilling advance for collection of soil samples and installation of monitoring well assembly for SP-B175/MW1-70. Advanced and sampled soils from 50 ft bgs to 100 ft bgs; attempted geotechnical soil samples at 55 ft bgs (two attempts) and 60 ft bgs (one attempt), no returns at either location due to apparently saturated unconsolidated granular soils not retained in sand-catcher equipped split spoon sampler; collected analytical samples at 56 ft bgs, 60 ft bgs, 70 ft bgs, 80 ft bgs, 90 bgs and 100 ft bgs; and completed the soil logs. Initiated set up and operation of pumping and monitoring equipment for completion of development of new HVDPE pilot test monitoring wells SP-B181/MW1-76 and SP-B182/MW1-77.

**DEVIATIONS FROM WORKPLAN:**
None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
Monitored slip-trip-fall and pinch-point hazards around drilling rig during sampling operations due to uneven and saturated ground conditions, and utilization of an automated sampling drive-hammer. Bobcat loader stuck in saturated soils near east gate of South Plantation due to excessive loading, unstable soils and uneven ground. Loader extracted with reduced load and safety tow strap.

**FIELD ACTIVITY CHRONOLOGY:**
A. Lewis continued out sick.
0710 H. Butler onsite Keyport, prepare for day.
0720 A. Piemonte on site, prepare for day.
0725 M. Meyer onsite, continued prep for drilling and development operations, calibrate PIDs.
0725 Holt Drilling onsite.
0815 Conducted a tailgate H&S meeting. Topics included: heavy lifting with use of automatic hammer, proper PPE, equipment inspections, tight work areas, and footing on uneven ground were some topics discussed.
0830 H. Butler offsite for tool run.
0840 Continue to drill well SP-B175/MW1-70 boring from 50 ft bgs. Start well development of SP-B181/MW1-76.

0900 H. Butler back on site. Set up for geotech sample at 55 ft bgs. with split-spoon sampling and auto-hammer.
0933 55 ft sampler retrieved, no returns due to soil conditions.
0952 Resample 55 ft bgs, again no returns.
1000 Complete development of SP-B181/MW1-76. Move on to SP-B182/MW1-77, start development.
1025 Advance to 60 ft bgs, attempt to collect geotech sample, again no return.
1040 Collect analytical sample at 56 ft bgs.
1045 Collect analytical sample at 60 ft bgs.
1100 Advance boring to 70 ft bgs.
1130 Lunch break.
1150 M. Meyer call to C. Cellucci to advise of soil conditions to 70 bgs. Agreed to advance and sample to 100 ft bgs to attempt to identify lower confining layer and granular soils beneath.
1200 Collect chemical samples at 64 ft and 70 ft bgs. Continue drilling operations to 100 ft bgs.
1240 Advance boring to 80 ft bgs.
1315 Advance boring to 90 ft bgs.
1320 Collect chemical sample at 80 ft bgs.
1335 Collect chemical sample at 90 ft bgs.
1400 Advance boring to 100 ft bgs.
1405 M. Meyer call to C. Cellucci to advise of soil conditions to 100 bgs. Agreed to set well at 80 ft bgs.
1415 Start preparations to set well at 80 ft bgs.
1430 Collect chemical sample at 100 ft bgs. Complete well development of SP-B182/MW1-77.
1500 M. Meyer off site.
1630 Monitoring well installed and set at 80 ft bgs. Start cleanup operations.
1645 Bobcat overloaded and stuck in unstable saturated soils near east gate. Start extraction operations.
1715 Bobcat extracted from unstable soils, continue cleanup operations.
1730 Drillers offsite.
1735 Site secured. A. Piemonte and H. Butler offsite.

**SUMMARY OF FINDINGS:**

Completed soil sampling and monitoring well installation at location SP-B175/MW1-70.

Soil boring for SP-B175/MW1-70 was advanced to the to the final depth of 100 feet bgs with a sonic drilling rig to identify and confirm the target soil depth interval for installation of a deep-water-zone monitoring well. Monitoring well MW1-70 was installed at depth of 80 ft bgs. Soil samples were attempted for geotechnical analysis at 55 ft and 60 ft bgs, no recovery for either depth; and chemical analysis at 56 ft, 60 ft, 70 ft, 80 ft, 90 ft and 100 bgs. Soil samples were containerized, labeled, and preserved on site pending shipment to the analytical laboratory. PID readings from soil cores below 50 feet were typically near ambient background concentrations.

Monitoring wells MW1-76 and MW1-77 were developed until water parameters were achieved in accordance with the SAP.

**PLANS FOR THE FOLLOWING DAY:**

Wednesday April 27th crew will mobilize to the southwest corner of the southern plantation for soil sampling and installation of deep well SP-B174/MW1-69.

HVDPE subcontractor crew to mobilize on site and initiate set up for performance of pilot test operations.

**ATTACHMENTS:**

Daily tailgate H&S form.

| | |
|---|---|
| Copies to: Michael Meyer, Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

BATTELLE
It can be done

| DAILY FIELD REPORT 4/27/2022 | **Contract No.** N39430-16-D-1802, CTO N4425521F4225, F4359 **References** Draft Sampling and Analysis Plan (Battelle 2022) Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Partly cloudy, 40 – 58 F, NW-SE wind at 0-8 mph, gusting to 10 mph; lt. showers PM. | |
| **To:** Carlotta Cellucci | |
| **From:** Michael Meyer | |

**PERSONNEL ON SITE:**
Battelle: Michael Meyer, Angela Piemonte, and Hunter Butler; Holt Services: Jeffery Johnson and Kelly Arndt.

**SUMMARY OF WORK COMPLETED:**
Cleanup and demobilized following installation of monitoring well assembly for SP-B175/MW1-70.

Mobilized to site of sampling location SP-B174/MW1-69 at southwest corner of southern plantation. Advanced and sampled soils from 0 ft bgs to 48 ft bgs; geotechnical soil samples collected at 10 ft bgs a 48 ft bgs; collected analytical samples at 10 ft bgs, 16 ft bgs, 20 ft bgs, 25 ft bgs, 35 bgs and 45 ft bgs; and prepared the soil logs.

**DEVIATIONS FROM WORKPLAN:**
No deviations from the workplan.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
Monitored set up operations at SP-B174/MW1-69 due to surrounding trees, uneven ground and relocation of perimeter fencing to access the boring site. Monitored slip-trip-fall and pinch-point hazards around drilling rig during sampling operations due to uneven and saturated ground conditions, and utilization of an automated sampling drive-hammer.

**FIELD ACTIVITY CHRONOLOGY:**
A. Lewis continued out sick.
0700 H. Butler onsite Keyport, prepare for day.
0730 A. Piemonte on site, continued prep for drilling and development operations, calibrate PIDs. Holt Drilling onsite.
0735 Conducted tailgate H&S meeting. Topics included: heavy lifting with use of automatic hammer, proper PPE, equipment inspections, tight work areas, and footing on uneven ground were some topics discussed.
0745 Started cleanup and demobilization from SP-B175/MW1-70.
1020 Move drill rig to SP-B174/MW1-69.
1100 M. Meyer on site.
1230 Lunch break. Driller received and unloaded additional supplies.

1315 Back from lunch break, remove perimeter fence from south side of SP-B174/MW1-69. Final set up of drill rig.
1423 Initiate advance and sampling at SP-B174/MW1-69.
1440 Set up for geotech sample at 10 ft bgs with split-spoon sampling and auto-hammer.
1500 10 ft geotech sampler retrieved, continue boring advance to 48 ft bgs.
1530 Collect analytical samples at 10 ft, 16 ft, and 20 feet bgs.
1645 Advance boring to 48 ft bgs. Set up for geotech sample at 48 ft bgs with split-spoon sampling and auto-hammer. Collect analytical samples at 25 ft, 35 ft, and 45 feet bgs.
1702 48 ft geotech sampler retrieved. Secure borehole and drill rig. Start cleanup operations.
1715 M. Meyer off site.
1730 Drillers offsite.
1800 Site secured. A. Piemonte and H. Butler offsite.

**SUMMARY OF FINDINGS:**

Completed soil sampling and monitoring well installation at location SP-B175/MW1-70. Clean up, decon equipment and remobilized to location SP-B174/MW1-69.

Soil boring for SP-B174/MW1-69 was advanced to the intermediate depth of 48 feet bgs with a sonic drilling rig to the identify and confirm the target soil depth interval for installation of a deep-water-zone monitoring well. Soil samples were collected for planned geotechnical analysis at 10 ft and 48 ft bgs; and chemical analysis at 10 ft, 16 ft, 20 ft, 25 ft, 35 ft and 45 bgs. Soil samples were containerized, labeled, and preserved on site pending shipment to the analytical laboratory. PID readings up to 209 ppm were measured in the upper 10 feet of the boring, decreasing to near ambient background concentrations below 21 feet bgs.

**PLANS FOR THE FOLLOWING DAY:**

Thursday April 27th crew will continue soil sampling and installation of deep well SP-B174/MW1-69.

HVDP contracting crew to mobilize on site and initiate set up for performance of pilot test operations.

**ATTACHMENTS:**

Daily tailgate H&S form.

| | |
|---|---|
| Copies to: Michael Meyer, Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ______________________ |

BATTELLE
It can be done

| DAILY FIELD REPORT<br>4/28/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Partly cloudy, 40 – 58 F, NW-SE wind at 0-8 mph, gusting to 10 mph; lt. showers PM. | |
| **To:** Carlotta Cellucci | |
| **From:** Hunter Butler | |

**PERSONNEL ON SITE:**

Battelle: Michael Meyer, Angela Piemonte, Samuel Moore and Hunter Butler; Holt Services: Jeffery Johnson and Kelly Arndt; Cal Clean: Davis Rios, Kevin Kaiser.

**SUMMARY OF WORK COMPLETED:**

Continued drilling advance for collection of soil samples and installation of monitoring well assembly for SP-B174/MW1-69. Advanced and sampled soils from 50 ft bgs to 90 ft bgs; collected geotechnical soil samples at 52 ft bgs and 58 ft bgs; collected analytical samples at 56 ft bgs, 70 ft bgs, 80 ft bgs, and 90 bgs and 100 ft bgs; and prepared the soil logs. Initiated set up and operation of pumping and monitoring equipment for completion of development of new HVDPE pilot test monitoring well SP-B175/MW1-70.

HVDPE mobilized on site to initiate set up of HVDPE system for pilot testing starting 05-02-22. Started moving treatment and support equipment from covered storage on site to eastern perimeter of southern plantation.

**DEVIATIONS FROM WORKPLAN:**

The sampling rationale for well MW1-69 established in the SAP indicated that the well would be installed below the clay previously identified in the area beginning at 55 feet bgs. Because the clay was found to be 28 feet thick during drilling of the well bore fore MW1-69, the Navy directed Battelle to install the well above the clay to reduce the vertical distance between the historical shallow contaminated samples and the results from this deeper well.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Monitored drilling operations at SP-B174/MW1-69 due to surrounding trees, uneven ground and relocation of perimeter fencing to access the boring site. Monitored slip-trip-fall and pinch-point hazards around drilling rig during sampling operations due to uneven and saturated ground conditions, and utilization of an automated sampling drive-hammer.

**FIELD ACTIVITY CHRONOLOGY:**

A. Lewis continued out sick.
0700 H. Butler onsite Keyport. Cal Clean on site. H. Butler offsite for supplies.
0720 H. Butler and A. Piemonte on site, continued prep for drilling and development operations, calibrate PIDs. Holt Services onsite.

0815 Conducted tailgate H&S meeting. Topics included: HVDPE equipment moving activities; heavy lifting with use of automatic hammer, proper PPE, equipment inspections, tight work areas, and footing on uneven ground were some topics discussed.
0845 Continue to drill well SP-B174/MW1-69 boring from 48 ft bgs. S. Moore prepped for slug testing.
0900 Set up for geotech sample at 52 ft bgs with split-spoon sampling and auto-hammer.
0928 52 ft geotech sample contains only gravel, fines washed out during extraction. Continue to drill to 58 ft bgs.
1023 Advance to 58 ft bgs. Set up for geotech sample with split-spoon sampling and auto-hammer.
1043 Collect 58 ft bgs geotech sample.
1120 Collect analytical sample at 52 feet bgs. Continue advance to 70 ft bgs.
1145 Advance to 70 ft bgs. Need to refill drill rig potable water supply.
1200 Lunch break. Driller refilled drill rig potable water supply. M. Meyer offsite to pick up vacuum system sampling supply shipment.
1250 Drill crew back in, continue drilling to 80 ft bgs.
1300 Advanced to 80 ft bgs. Call to M. Meyer, advised consolidated soils to 80 ft bgs, directed to advance to 90 ft bgs.
1340 Advanced to 90 ft bgs. M. Meyer back on site. Set up A. Piemonte for groundwater sampling April 29th.
1350 90 ft bgs core retrieved, unconsolidated soils from 80 ft to 87 ft bgs. M. Meyer called C. Cellucci and advised of boring condition. Directed by C. Cellucci to set well at 52 ft bgs. Begin preparations to set monitoring well at 52 ft bgs.
1413 Collect analytical sample at 73 feet bgs.
1425 Collect analytical sample at 83 feet bgs.
1430 M. Meyer off site.
1500 S. Moore starts development of monitoring well SP-B175/MW1-70. A. Piemonte off site to collect sampling containers from A. Lewis.
1520 Monitoring well pipe installed at 52 ft bgs, continue backfill.
1635 Monitoring well SP-B174/MW1-69 complete at 52 ft bgs. Secure borehole and drill rig. Start cleanup operations.
1645 A. Piemonte back on site.
1700 Drillers off site.
1800 Completed development of MW1-70.
1830 Site secured. A. Piemonte, S. Moore and H. Butler offsite.

**SUMMARY OF FINDINGS:**

Completed soil sampling and monitoring well installation at location SP-B174/MW1-69.

Soil boring for SP-B174/MW1-69 was advanced to the to the final depth of 90 feet bgs with a sonic drilling rig to the identify and confirm the target soil depth interval for installation of a deep-water-zone monitoring well. Monitoring well MW1-69 was installed at depth of 52 ft bgs per client direction to confirm groundwater conditions above lower confining layer. Soil samples were attempted for geotechnical analysis at 52 ft and 58 ft bgs, no recovery for 52 ft bgs and confirmed confining consolidated soils at 58 ft bgs; and chemical analysis at 52 ft, 73 ft and 83 bgs. Soil samples were containerized, labeled, and preserved on site pending shipment to the analytical laboratory.

Monitoring well MW1-70 was developed until water parameters were achieved in accordance with the SAP.

**PLANS FOR THE FOLLOWING DAY:**

Friday April 29th drilling crew will demobilize from MW1-69 and install secured monitoring well surface completions and traffic bollards at MW1-69, MW1-70, MW1-76, and MW1-77. Slug testing will commence for monitoring wells supporting HVDPE testing. Groundwater samples will be collected for baseline analysis from MW1-76, and MW1-77 prior to inclusion in HVDPE testing program.

CalClean crew continues to mobilize on site and initiate set up for performance of pilot test operations commencing Monday, May 2nd.

**ATTACHMENTS:**
Daily tailgate H&S form.

| | |
|---|---|
| Copies to: Michael Meyer, Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

BATTELLE
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| DAILY FIELD REPORT<br>4/29/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Partly cloudy, 45 – 63 F, W-S wind at 0-5 mph, gusting to 7 mph. | |
| **To:** Carlotta Cellucci | |
| **From:** Hunter Butler | |

**PERSONNEL ON SITE:**

Battelle: Angela Piemonte, Samuel Moore and Hunter Butler; Holt Services: Jeffery Johnson and Kelly Arndt; CalClean: Noel Shenoi, Davis Rios, Kevin Kaiser.

**SUMMARY OF WORK COMPLETED:**

Demobilized drilling rig from location of SP-B174/MW1-69; pressure-washed drill casing for subsequent use. Drilling crew installed surface completions at new monitoring and air-sparge well locations SP-B174/MW1-69, SP-B175/MW1-70, SP-B181/MW1-76, SP-B182/MW1-77 and AS1-1. Traffic control bollards to be installed around designated wells at a later date.

Initiated set up and operation of in-well water pressure transducers for monitoring of HVDPEE pilot test commencing Monday, May 2nd, 2022.

Collected baseline groundwater samples from new monitoring wells SP-B174/MW1-69 and SP-B175/MW1-70 prior to initiation of HVDPE pilot test.

CalClean continued on site to set up of HVDPE system for treatment program starting Monday, May 2nd, 2022. Continued moving treatment and support equipment from covered storage on site to eastern perimeter of southern plantation.

**DEVIATIONS F.ROM WORKPLAN:**

No deviations from the workplan.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Monitored demobilization operations at SP-B174/MW1-69 due to surrounding trees, uneven ground and relocation of perimeter fencing to access the boring site. Monitored slip-trip-fall and pinch-point hazards around drilling rig during demob operations due to uneven and saturated ground conditions. Monitored moving and forklift operations for CalClean during HVDPE equipment location and set up.

**FIELD ACTIVITY CHRONOLOGY:**

A. Lewis continued out sick.

0700 H. Butler onsite Keyport. CalClean on site.

0720 A. Piemonte and S. Moore on site, continued prep for drilling and development operations, calibrate PIDs. Holt Services onsite, continued prep for groundwater sampling, transducer installation operations, and monitoring well box installs; calibrate PIDs. A. Piemonte and S. Moore completed chain-of-custody review prior to laboratory courier pickup.

0725 Holt Services onsite, initial meeting to start demobilization from SP-B174-MW1-69.

0800 Laboratory courier at main gate for sample pickup. Samples transferred.

0815 Conducted individual tailgate H&S meetings for Battelle, CalClean and Holt. Topics included: HVDPE equipment moving activities; heavy lifting of automatic hammer, proper PPE, equipment inspections, tight work areas, and footing on uneven ground were some topics discussed.

0900 S. Moore starts performance of slug tests south plantation monitoring wells. A. Piemonte starts set up for HVDPE groundwater monitoring well sampling.

0915 Demobilized drill rig and support equipment from SP-B174/MW1-69. Start installation of surface completion well boxes for SP-B174/MW1-69 and SP-B181/MW1-76.

1115 A. Piemonte completes groundwater monitoring well sampling at SP-B182/MW1-77; moves to SP-B181/MW1-76.

1145 Completed installation of monitoring well boxes at MW1-69 and MW1-76. Moved to east end of southern plantation for completion of remaining well boxes.

1200 Lunch break.

1230 H. Butler off site.

1245 H. Butler on site. Drillers continue fabrication of well box framing for east end wells.

1300 Meet with CalClean on forklift operations.

1315 A. Piemonte starts groundwater monitoring well purging at SP-B181/MW1-76.

1435 Groundwater parameters stabilized, collect groundwater sample at SP-B181/MW1-76.

1455 Groundwater sampling completed, start cleanup.

1515 Drilling crew completed well box installations for AS1-1, MW1-70 and MW1-77. Drilling crew starts decon operations and preparation for drilling operations in central parking lot on Monday, May 2nd, 2022.

1615 Drillers off site. Continue slug testing and groundwater pressure transducer installation and monitoring.

1815 Complete slug testing and groundwater pressure transducer installation and monitoring, start cleanup operations.

1845 Site secured. A. Piemonte, S. Moore and H. Butler offsite.

**SUMMARY OF FINDINGS:**

No drilling conducted today. Responses of wells to sampling and slug testing matched expectations.

**PLANS FOR THE FOLLOWING DAY:**

Monday, May 2nd, 2022 drilling crew will mobilize to proposed monitoring well location SP-B176-MW1-71 in the middle of asphalt parking area the central landfill and start drilling and sampling activities.

Initiate and complete well development of SP-B174-MW1-69.

CalClean to start pilot test operations commencing Monday, May 2nd.

**ATTACHMENTS:**

Daily tailgate H&S form.

| Copies to: Michael Meyer, Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |
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BATTELLE
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| **DAILY FIELD REPORT**<br>**5/2/2022** | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Overcast to partly cloudy, 48 – 68 F, SW-W wind at 0-5 mph, showers AM. | |
| **To:** Carlotta Cellucci | |
| **From:** Hunter Butler | |

**PERSONNEL ON SITE:**

Battelle: Angela Piemonte, Samuel Moore and Hunter Butler; Holt Services: Jeffery Johnson and Kelly Arndt; CalClean: Noel Shenoi, Davis Rios, Kevin Kaiser.

**SUMMARY OF WORK COMPLETED:**

Mobilized to location CL-B176/MW1-71 in the middle of the Central Landfill. Advanced boring and sampled soils from 0 ft bgs to 50 ft bgs; geotechnical soil samples collected at 25 ft bgs and 48 ft bgs; collected analytical samples at 8 ft bgs, 28 ft bgs, 40 ft bgs and 45 ft bgs; and prepared the soil logs.

Continued set up and operation of in-well pressure transducers for monitoring of HVDPE pilot test commencing Tuesday, May 3rd, 2022.

CalClean continued on site to set up of HVDPE system for treatment program starting Tuesday, May 3rd, 2022. Continued installation of treatment and support equipment into test wells in the eastern portion of the southern plantation.

**DEVIATIONS FROM WORKPLAN:**

No deviations from the workplan.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

None today.

**FIELD ACTIVITY CHRONOLOGY:**

A. Lewis continued out sick.
0715 H. Butler on site Keyport. CalClean on site.
0720 A. Piemonte on site.
0725 M. Meyer and Holt Services onsite.
0735 S. Moore on site.
0750 Conducted individual tailgate H&S meetings for Battelle, CalClean and Holt. Topics included: HVDPE equipment moving activities; heavy lifting of automatic hammer, proper PPE, equipment inspections, tight work areas, and footing on uneven ground were some topics discussed.

0800 A. Piemonte continued prep for drilling and development operations, calibrate PIDs.
0815 M. Meyer and S. Moore discussion with CalClean on well head assembly requirements for testing.
0915 Drillers start mobilization to CL-B176-MW1-71.
0930 Set up on CL-B176-MW1-71. C. Cellucci on site for meeting on startup of CalClean operations.
1012 Drillers initiate drilling operations with cutting of parking lot asphalt at boring location. Install mud tub for drilling fluid capture.
1040 Drillers out for pumping equipment and lunch break.
1145 Back from lunch break, final set up of drill rig.
1215 Initiate advance and sampling at CL-B176/MW1-71.
1235 Install 5-foot secondary containment casing for fluid control.
1248 Collect analytical sample at 8 ft bgs.
1340 Set up for geotech sample at 25 ft bgs with split-spoon sampling and auto-hammer.
1400 Clear cable tangle in drill rig hoist winch.
1431 25 ft geotech sampler retrieved, continue boring advance to 45 ft bgs.
1450 M. Meyer off site. S. Moore initiates development of MW1-69.
1505 Advance to 30 ft bgs.
1545 Advance to 40 ft bgs. Collect analytical samples at 28 ft and 40 ft bgs.
1620 Advance boring to 45 ft bgs. Set up for geotech sample at 45 ft bgs with split-spoon sampling and auto-hammer.
1655 45 ft geotech sampler retrieved.
1705 Advance to 50 ft bgs, set casing. Secure borehole and drill rig. Start cleanup operations.
1715 Drillers offsite.
1723 Collect analytical sample at 45 feet bgs. Continue cleanup operations.
1745 Site secured. A. Piemonte, S. Moore and H. Butler offsite.

**SUMMARY OF FINDINGS:**

Soil boring for CL-B176/MW1-71 was advanced to the intermediate depth of 50 feet bgs with a sonic drilling rig to the identify and confirm the target soil depth interval for installation of a deep-water-zone monitoring well. Soil samples were collected for planned geotechnical analysis at 25 ft and 45 ft bgs; and chemical analysis at 8 ft, 28 ft, 40 ft and 45 ft bgs. Field PID readings were as high as 6,188 ppb (at 28 ft bgs), dropping to below 200 ppb by 50 ft bgs.

CalClean continued on site to set up of HVDPE system for treatment program starting Tuesday, May 3rd, 2022. Continued installation of testing equipment in the eastern perimeter of southern plantation.

**PLANS FOR THE FOLLOWING DAY:**

Tuesday, May 3rd, 2022 drilling crew will continue advancement, sampling and installation of monitoring well location CL-B176-MW1-71 in the middle of asphalt parking area the middle of the landfill and start drilling and sampling activities.

Initiate and complete well development of SP-B174-MW1-69. CalClean to start pilot test operations commencing Tuesday, May 3rd, 2022.

**ATTACHMENTS:**

Daily tailgate H&S form.

| | |
|---|---|
| Copies to: Michael Meyer, Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT** |

| | |
|---|---|
| | Signed: ___________________________ |

**BATTELLE**
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| **DAILY FIELD REPORT**<br>**5/3/2022** | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 44-59 degrees F, South wind at 3mph, gusting to 6 mph, cloudy with sun breaks | |
| **To:** Carlotta Cellucci | |
| **From:** Hunter Butler | |

**PERSONNEL ON SITE:**
Battelle: Michael Meyer, Angela Piemonte, Samuel Moore, Andy Lewis, and Hunter Butler; Holt Services: Jeffery Johnson and Kelly Arndt; Cal-Clean: Noel Shenoi, Kevin Kauser, and Davis Rios.

**SUMMARY OF WORK COMPLETED:**
Completed boring to 100 ft bgs at MW1-71, metal casing broke while installing monitoring well casing. Will return tomorrow to work on the fix to remove metal casing. HVDPE Pilot Test system started, minor issues to a pump with new parts arriving tomorrow by Fed-Ex. System should be fully operational tomorrow after the fix has been made. Well MW1-69 was surged and developed. Slug testing was completed in wells MW1-43 and MW1-44, aquifer.

**DEVIATIONS FROM WORKPLAN:**
Collected soils samples for chemical analysis at 95 ft and 100 ft bgs in targeted soils identified at those depths instead of proposed samples at projected target location from 75 ft to 80 ft bgs, based on the deeper drilling depth required and the sampling objectives.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
Access to wells located outside the Southern tree plantation fencing had blackberries near ground elevation that created a trip hazard. Cut back and pushed blackberries to the side and bought wood planks to allow assess to the wells that are in the marsh areas.

**FIELD ACTIVITY CHRONOLOGY:**
0645 A. Lewis onsite.
0700 H. Butler onsite, site briefing conducted.
0720 Holt Drilling onsite.
0730 M. Meyer, S. Moore and A. Piemonte onsite.
0735 Conducted a tailgate H&S meeting with Battelle and Holt Drilling.
0745 Holt Drilling set up work area, filled water tanks, and set up drums around MW1-71.
0810 Conducted a tailgate H&S meeting with Cal-Clean.
0900 Holt Drilling started to drill on MW1-71.
0902 Battelle and Cal-Clean collected first round of water level measurements in the Southern tree plantation.

0917 A. Lewis offsite after advising H. Butler, ASSHO, to buy loppers and plywood to fix areas to access wells outside the Southern tree plantation fenced area along the marsh.
0952 A. Lewis back onsite, advised H. Butler.
1120 Start to surge well MW1-69 and work on development.
1210 Cal-Clean work on setting pumps to run system, M. Meyers and S. Moore supporting efforts.
1330 Reached stable setting for the Pilot Study pumps.
1410 Complete well development at well MW1-69, start to clean and demob from well location.
1440 Complete well decon and demob from well MW1-69.
1455 Complete boring at well MW1-71 at 100 ft bgs. M. Meyer called C. Cellucci to confirm the depth of the monitoring well installation; well to be set at 100 ft bgs. Start to place casing and demob.
1510 M. Meyer offsite.
1515 A. Lewis demob site support truck. H. Butler and A. Piemonte still working on soil characterization and sampling.
1600 A. Lewis and S. Moore set up on well MW1-43 to complete aquifer slug testing. Moved to MW1-44 to set up to complete the aquifer slug test.
1700 Aquifer slug testing is complete at well MW1-43.
1715 Holt Drilling offsite, metal casing broke off with 60 ft left below ground. H. Butler called M. Meyer to advise. Monitoring well construction operations and well location secured pending determination of drill casing removal. Will return in the morning to continue work.
1755 Complete the aquifer slug testing at well MW1-44.
1805 Cal-Clean and Battelle staff off site.

**SUMMARY OF FINDINGS:**

Soil boring for SP-B176/MW1-71 was advanced to 100 ft bgs to identify a target water bearing zone beneath low-transmissivity soils identified from approximately 50 to 60 ft bgs in adjacent soil boring and monitoring well locations. Clay was found extending to approximately 95 feet bgs, and the well was installed with a 5-foot screen from 95 to 100 feet bgs in a saturated sand.

Soil samples were collected for planned geotechnical analysis at 55 ft bgs; and chemical analysis at 55 ft, 60 ft, 65 ft, 70 ft, and within the screened interval at 95 ft and 100 bgs. Soil samples were containerized, labeled, and preserved on site pending shipment to the analytical laboratory. Only three PID readings up to 155 ppb (approximately 35 ppb background) were measured in the lower 50 feet of the boring, remaining or decreasing to near ambient background concentrations below 86 feet bgs.

**PLANS FOR THE FOLLOWING DAY:**

Complete the removal of casing broken downhole at MW1-71, set casing. Set up and start to bore/sample at well location MW1-72. Complete aquifer slug tests in Northern tree plantation.

**ATTACHMENTS:**

Daily tailgate H&S form.

| Copies to: Michael Meyer, Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |
|---|---|

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<table>
<tr><td>DAILY FIELD REPORT<br>5/4/2022</td><td>Contract No.<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>References<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019)</td></tr>
<tr><td colspan="2">Project: G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation</td></tr>
<tr><td colspan="2">Location: Naval Base Kitsap Keyport, WA OU1</td></tr>
<tr><td>Client: Naval Facilities Engineering Command Northwest</td><td>Contractor: Battelle</td></tr>
<tr><td colspan="2">Weather: 45-65 degrees F, NW wind at 0-5mph, gusting to 7 mph, partly cloudy with sun breaks</td></tr>
<tr><td colspan="2">To: Carlotta Cellucci</td></tr>
<tr><td colspan="2">From: Hunter Butler</td></tr>
</table>

**PERSONNEL ON SITE:**

Battelle: Michael Meyer, Angela Piemonte, Samuel Moore, Andy Lewis, and Hunter Butler; Holt Services: Jeffery Johnson and Kelly Arndt; Cal-Clean: Noel Shenoi, Kevin Kauser, and Davis Rios.

**SUMMARY OF WORK COMPLETED:**

Completed installation of PVC monitoring well casing in MW1-71 after reconnecting metal drill casing separated during completion operations. Demobilized from MW1-71, cleaned equipment and moved to MW1-72 in north plantation. Causeway aquifer slug testing completed.

**DEVIATIONS FROM WORKPLAN:**

Completed final surface installation of MW1-71 with bentonite grout from 47 ft bgs to ground surface instead of bentonite chips to surround and encase lodged PVC casing at that depth. Remainder of monitoring well MW1-71 completed to depth per workplan.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Controlled drill cuttings, displaced water and grouting operations during well completion with combination of surface containment and vacuuming operations to minimize surface impacts and potential slip hazards.

**FIELD ACTIVITY CHRONOLOGY:**

0645 A. Lewis onsite. Cal Clean onsite.
0700 H. Butler onsite, site briefing conducted.
0725 S. Moore, A. Piemonte and Holt Drilling onsite.
0745 Conducted a tailgate H&S meeting with Battelle and Holt Drilling.
0755 Holt Drilling set up work area, continue recovery operations for disconnected drill casing in MW1-71.
0800 A. Lewis conducted a tailgate H&S meeting with Cal-Clean. S. Moore and A. Piemonte conduct QC audit of COCs for laboratory shipment, A. Lewis joins audit after H&S meeting with Cal Clean.
0830 Drilling crew reconnects drill casing for extraction in MW1-71. Seven-foot section of PVC well pipe vibrates loose during drill casing extraction and lodges at 47 feet bgs. Drill crew continues extraction operations on PVC section.
0900 A. Piemonte offsite for lab courier pick up of samples.
0945 A. Piemonte, S. Moore and A. Lewis mobilize for slug testing and water level measurements on the causeway.

1020 Call to M. Meyer and advise of drill casing conditions for MW1-71; unable to retrieve 7-foot section of PVC well casing. Determined that full grouting of remaining well borehole and PVC casing in-place appropriate resolution to well condition and completion of the well. Advised drillers to backfill remaining well borehole annulus with grout. Set up for well grouting operations.
1130 MW1-71 grouted to ground surface.
1200 Drill casing removed from MW1-71, start cleanup operations.
1215 Lunch break.
1300 Return from lunch, continue cleanup of MW1-71.
1430 Mobilize drill rig to NP-B177/MW1-72 in north plantation. Move soil and water drums from MW1-71 to storage.
1515 Drill crew pressure wash drill equipment and casings.
1545 M. Meyer on site for status update, continue cleanup operations and mobilization to NP-B177/MW1-72.
1600 Drilling crew offsite.
1645 Battelle staff off site.

**SUMMARY OF FINDINGS:**

Monitoring well MW1-71 completed at 100 ft bgs. Completed collection of groundwater elevations and slug testing of monitoring wells on the causeway. Continued monitoring operation support for Cal Clean pilot testing program.

**PLANS FOR THE FOLLOWING DAY:**

Start to advance and sample at well location MW1-72. Complete aquifer slug tests in northern tree plantation. Continue monitoring operation support for Cal Clean pilot testing program.

**ATTACHMENTS:**

Daily tailgate H&S form.

| | |
|---|---|
| Copies to: Michael Meyer, Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

| DAILY FIELD REPORT<br>5/5/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Overcast to partly cloudy, 45 – 52 F, SW-W wind at 0-9 mph, showers all day. | |
| **To:** Carlotta Cellucci | |
| **From:** Hunter Butler | |

**PERSONNEL ON SITE:**

Battelle: Angela Piemonte and Hunter Butler; Holt Services: Jeffery Johnson and Kelly Arndt; Cal Clean: Noel Shenoi, Davis Rios, Kevin Kaiser.

**SUMMARY OF WORK COMPLETED:**

Mobilized to site of sampling location NP-B177/MW1-72 in the northern plantation. Advanced and sampled soils from 0 ft bgs to 75 ft bgs; geotechnical soil samples collected at 40 ft bgs and 75 ft bgs; collected analytical samples at 7 ft, 30 ft, 35 ft, 40 ft, 45 ft, 50 ft, 55 ft, 60 ft, 65 ft and 75 ft bgs; and prepared the soil logs.

Continued monitoring operation support for Cal Clean pilot testing program.

**DEVIATIONS F.ROM WORKPLAN:**

No soil returns after 3 attempts to collect geotechnical sample at 65 ft bgs. Collected grab sample of 65-foot soil cuttings for grain-size analysis.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

None today.

**FIELD ACTIVITY CHRONOLOGY:**

0715 H. Butler on site. A. Lewis and A. Piemonte on site. Cal Clean on site.
0730 Holt Drilling onsite.
0745 Conducted individual tailgate H&S meetings for Battelle, Cal Clean and Holt.
0800 Continued prep for drilling and development operations, calibrate PIDs.
0915 Drillers complete mobilization to NP-B177-MW1-72.
0940 Drillers initiate drilling and sampling of NP-B177-MW1-72.
1015 Collect analytical sample at 7 ft bgs.
1050 Advance to 40 ft bgs. Advise M. Meyer of progress.
1105 40 ft cuttings out, set up for geotech sample with split-spoon sampling and auto-hammer.
1120 40 ft geotech sampler retrieved.
1145 Collect analytical samples at 30 ft, 35 ft and 40 ft bgs.
1200 50 ft cuttings out, lunch break.

1245 Back from lunch, continue drilling to 60 ft bgs.
1330 60 ft cuttings out.
1345 Collect analytical sample at 45 feet bgs.
1400 Collect analytical samples at 50 ft, 55 ft and 60 ft bgs.
1415 Set up for geotech sample at 65 ft bgs.
1425 65 ft geotech sampler retrieved, no returns. Repeat attempt at 65 ft, still no returns.
1441 Collect analytical sample at 65 feet bgs
1445 Advise M. Meyer, try 3rd attempt geotech sample at 65 ft.
1500 A. Lewis initiates development of MW1-71.
1525 No returns in split spoon sampler at 65 ft bgs in 3rd try, grab bulk sample, continue to 70 ft bgs.
1555 65-foot cuttings out, all sand. Advise M. Meyer, continue to 70 bgs, all sand.
1630 Advance boring to 75 ft bgs, silt and peat. Advise M. Meyer, continue to 75 ft bgs. Set up for geotech sample at 75 ft bgs, set well at 70 ft bgs.
1643 Collect analytical sample at 75 feet bgs.
1705 75 ft geotech sampler retrieved. Secure borehole and drill rig. Complete development of MW1-71. Start cleanup operations.
1715 Drillers offsite.
1723 Continue cleanup operations.
1730 Site secured. A. Piemonte, A. Lewis and H. Butler offsite.

**<u>SUMMARY OF FINDINGS:</u>**

Mobilized to site of sampling location NP-B177/MW1-72 in the northern plantation. Advanced and sampled soils from 0 ft bgs to 75 ft bgs; geotechnical soil samples collected at 40 ft bgs and 75 ft bgs; collected analytical samples at 7 ft, 30 ft, 35 ft, 40 ft, 45 ft, 50 ft, 55 ft, 60 ft, 65 ft and 75 ft bgs; and prepared the soil logs. Field PID readings were as high as 1,203 ppb at 9 ft bgs, dropping to below 100 ppb at 11 ft bgs. Values as high as 244 ppb were measured in the 30-44 ft bgs range, with values all below 200 ppb deeper than 44 ft bgs.

Completed development of monitoring well MW1-71.

Cal Clean continued pilot test operations in the eastern perimeter of southern plantation.

**<u>PLANS FOR THE FOLLOWING DAY:</u>**

Friday, May 6th, 2022, drilling crew will continue the installation of monitoring well NP-B177-MW1-72.

Cal Clean continue pilot test operations in the eastern perimeter of southern plantation.

**<u>ATTACHMENTS</u>:**

Daily tailgate H&S form.

| | |
|---|---|
| Copies to: Michael Meyer, Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT 5/6/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 44-55 degrees F, W wind at 0-5mph, overcast, showers through mid-day. | |
| **To:** Carlotta Cellucci | |
| **From:** Hunter Butler | |

**PERSONNEL ON SITE:**
Battelle: Michael Meyer, Angela Piemonte, Andy Lewis, and Hunter Butler; Holt Services: Jeffery Johnson and Kelly Arndt; Cal-Clean: Noel Shenoi, Kevin Kauser, and Davis Rios.

**SUMMARY OF WORK COMPLETED:**
Completed installation of PVC monitoring well casing in MW1-72. Demobilized from MW1-72, cleaned equipment and moved to MW1-73 in north plantation.

**DEVIATIONS FROM WORKPLAN:**
Completed final installation of MW1-72 with bentonite grout from 53 ft bgs to ground surface instead of bentonite chips to minimize soil heaving and potential chip bridging during well installation. Remainder of monitoring well MW1-72 completed to depth per workplan.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
Controlled drill cuttings, displaced water and grouting operations during well completion to minimize surface impacts and potential slip hazards.

**FIELD ACTIVITY CHRONOLOGY:**
0645 A. Lewis onsite. Cal Clean onsite.
0720 H. Butler onsite.
0725 A. Piemonte on site.
0730 M. Meyer and Holt Drilling onsite.
0745 Conducted a tailgate H&S meeting with Battelle and Holt Drilling.
0800 M. Meyer and A. Lewis check on functional status of bumped well in southern plantation.
0830 Drilling crew starts installation of monitoring well in MW1-71.
0900 M. Meyer off site.
0930 Well pipe, screen sand and bentonite chip seal installed to 70 ft bgs, allowed to hydrate. Set up for grouting operations.
1100 MW1-72 grouted to ground surface, start cleanup and decon operations.
1200 Mobilize drill rig to NP-B177/MW1-73 in north plantation. Lunch break.
1230 Return from lunch, continue cleanup and set on MW1-73.

1400 Drill crew finish pressure wash drill equipment and casings and move on to MW1-73. Continue cleanup operations in parking area.
1430 Drilling crew offsite.
1445 Battelle staff off site.

**SUMMARY OF FINDINGS:**
Monitoring well MW1-72 completed at 70 ft bgs.

Continued monitoring operation support for Cal Clean pilot testing program.

**PLANS FOR THE FOLLOWING DAY:**
Monday, May 9th, 2022, start advance and soil sampling at well location MW1-73. Complete well development of MW1-72. Continue monitoring operation support for Cal Clean pilot testing program.

**ATTACHMENTS:**
Daily tailgate H&S form.

| | |
|---|---|
| Copies to: Michael Meyer, Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT<br>5/9/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 42-55 degrees F, South wind at 5 mph, gusting to 10 mph, cloudy with sun breaks | |
| **To:** Carlotta Cellucci | |
| **From:** Hunter Buter | |

**PERSONNEL ON SITE:**

Battelle: Angela Piemonte, Andy Lewis, and Hunter Butler; Holt Services: Jeffery Johnson and Kelly Arndt; Cal-Clean: Kevin Kauser.

**SUMMARY OF WORK COMPLETED:**

Completed boring to 80 ft bgs at MW1-73. Well MW1-72 was surged and developed. Drums in the northern plantation from MW1-72 were palletized.

**DEVIATIONS FROM WORKPLAN:**

NA

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Mud from plantations were kept within the plantations, Bobcat stayed inside the plantations to not track mud onto asphalt. Creating a cleaner work area and less slippery mud in parking area. Removed frayed section of drill rig winch cable, reattached hoist assembly.

**FIELD ACTIVITY CHRONOLOGY:**

0700 A. Lewis and H. Butler onsite, discussed day’s work.
0715 A. Piemonte onsite.
0730 Holt Drilling onsite. Conducted a tailgate H&S meeting, topics included Slips/Trips/Falls, tight work areas, no heavy lifting, cold stress-take breaks as needed, proper PPE, ergonomics were some topics discussed.
0740 Conducted a tailgate H&S meeting with CalClean.
0750 H. Butler offsite, Holt Drilling mob to MW1-73, cleaning equipment.
0900 A. Lewis and A. Piemonte set up on MW1-72 to complete the surge well and complete well development.
0920 H. Butler onsite.
0950 Set up on well MW1-73, start drilling.
1050 Collect analytical sample at 7 ft bgs.
1102 purge complete at MW1-72 for well development, 100 gallons purged. Cleaned and decon DC pump.
1130 Drilling break to remove frayed section of winch cable and replace hoist assembly. Set up for geotech sample at 30 ft bgs. A. Lewis support sampling at MW1-73, alongside H. Butler and A. Piemonte.
1220 Collect geotech sample at 30 ft bgs.

1225 Holt Drilling breaks for lunch.
1255 Holt Drilling completes lunch and continues work at MW1-73.
1310 A. Lewis onsite dumpster to dispose of common waste and check in with Cal-Clean.
1325 Collect analytical sample at 40 ft bgs.
1345 Advance to 50 ft bgs. Set up for geotech sample at 50 ft bgs.
1350 Collect analytical sample at 48 ft bgs.
1400 No sample recovery at 50 ft bgs; resampled with partial recovery.
1430 Coned off drums in parking lot.
1505 Advance to 58 ft bgs. Set up for geotech sample at 58 ft bgs.
1515 Collect geotech sample at 58 ft bgs. Collect analytical sample at 55 ft bgs.
1605 Collect analytical samples at 60 ft, 65 ft and 70 ft bgs.
1620 Drillers drilled to 80ft bgs at MW1-73, ran out of water until next day. Advised M. Meyer of clay soils to 80 ft bgs. Filled tanks with water and placed inside plantation. Dug bollard holes for MW1-72, will set later. All full drums from MW1-72 were palletized, prep for next day.
1715 H. Butler and A. Piemonte offsite.
1745 A. Lewis and Holt Drilling offisite.

**SUMMARY OF FINDINGS:**

Soil boring for NP-B178/MW1-73 was advanced to 80 feet bgs with a sonic drilling rig to attempt to identify and confirm the target soil depth interval for installation of a deep-water-zone monitoring well. Deep target water bearing zone beneath low-transmissivity soils identified from approximately 50 to 60 ft bgs in adjacent soil boring and monitoring well location was not identified to 80 ft bgs. Additional soil sampling tentatively planned to identify target soils at 90 ft bgs.

Soil samples were collected for planned geotechnical analysis at 30 ft, 50 ft and 58 ft bgs; and chemical analysis at 7 ft, 30 ft, 40 ft, 48 ft, 55 ft, 60 ft, 65 ft and 70 ft. Soil samples were containerized, labeled, and preserved on site pending shipment to the analytical laboratory.

Only five elevated PID readings from 597 to 1344 ppb (approximately 0 to 130 ppb background) were measured in scattered locations in the lower 32 feet of the boring.

**PLANS FOR THE FOLLOWING DAY:**

Complete installation of MW1-73, slug test MW1-72, Navy and Regulator site walk, work on installation of monuments and bollards, start demob.

**ATTACHMENTS:**

Daily tailgate H&S form.

| | |
|---|---|
| Copies to: Michael Meyer, Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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<table>
<tr><td colspan="2">DAILY FIELD REPORT<br>5/10/2022</td><td>Contract No.<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>References<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019)</td></tr>
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<tr><td colspan="3">Location: Naval Base Kitsap Keyport, WA OU1</td></tr>
<tr><td colspan="2">Client: Naval Facilities Engineering Command Northwest</td><td>Contractor: Battelle</td></tr>
<tr><td colspan="3">Weather: 41-57 degrees F, SSE wind 6 mph, gusting to 10 mph, overcast with sun breaks</td></tr>
<tr><td colspan="3">To: Carlotta Cellucci</td></tr>
<tr><td colspan="3">From: Hunter Butler</td></tr>
</table>

**PERSONNEL ON SITE:**

Battelle: Michael Meyer, Angela Piemonte, Andy Lewis, and Hunter Butler; Holt Services: Jeffery Johnson and Kelly Arndt; Cal-Clean: Kevin Kauser and Noel Shenoi, Site walk visitors see daily safety briefing.

**SUMMARY OF WORK COMPLETED:**

Installed well at MW1-73 and demob from well MW1-73. Installed surface completion monitoring well security boxes at MW1-71 and MW1-72. Collect VOC sample at treatment system. Initiate cleanup operations for demob from site.

**DEVIATIONS FROM WORKPLAN:**

Completed final installation of MW1-73 with bentonite grout from 83 ft bgs to ground surface instead of bentonite chips to minimize soil heaving and potential chip bridging during well installation. Remainder of monitoring well MW1-73 completed to depth per workplan. Collected final two soil samples at the bottom of the soil boring at 95ft and 100ft.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

NAVFAC NW and visitors onsite, shut drill rig down during site walk.

**FIELD ACTIVITY CHRONOLOGY:**

0700 A. Lewis onsite.
0710 H. Butler and A. Piemonte onsite.
0730 M. Meyer and Holt Drilling onsite. Conduct a tailgate H&S meeting. Topics included: no heavy lifting, proper PPE, pinch points, motorcycle training traffic, clean work areas, caution when backing equipment, were some topics discussed.
0750 Discuss daily tailgate meeting with CalClean.
0815 Start sampling treatment system air samples. Continued drilling of MW1-73 from 80ft to 100ft.
0845 Complete sampling treatment system air samples.
0900 C. Cellucci onsite.
0915 Drilling and sampling at MW1-73 continues and A. Lewis supports.
0940 Advanced to 100ft at MWMW1-73. Target sand encountered at 95ft, set well at 100ft. Collect analytical samples at 95 ft and 100 ft.

1000 Holt Drilling set up on MW1-71 to set monument.
1040 Holt Drilling complete flush mount well monument.
1100 Holt Drilling break for lunch.
1130 Holt complete break for lunch.
1150 Well casing complete at MW1-73, start backfilling.
1155 NAVFAC NW site walk arrived at northern plantation; drill rig shut down. Holt set bollards and monument at MW1-72.
1240 NAVFAC NW site walk complete, visitors offsite. Continue backfilling MW1-73.
1245 Holt Drilling installed concrete for well box and bollards at MW1-72.
1345 M. Meyer offsite.
1400 Initiate grout backfill for MW1-73. Start to remove drill casing.
1445 Drill casing removed and backfilling complete for MW-73.
1520 H. Butler offsite.
1525 Holt Drilling demob from MW1-73, starting to demob equipment/supplies from site, all drums palletized and removed from northern plantation. Decon all casing and soiled items, only the drill rig and bobcat left inside the plantation. Back blading the northern plantation and installation of monument for MW1-73 will happen tomorrow.
1845 Holt Drilling and Battelle offside, contacted Cal-Clean to let them know we are offsite for the day.

**SUMMARY OF FINDINGS:**

Soil boring for NP-B178/MW1-73 was advanced from the intermediate depth of 80 feet bgs with a sonic drilling rig to identify and confirm the target depth interval for installation of a deep-water-zone monitoring well. The soil boring was advanced to 100 ft bgs to identify a target water bearing zone beneath low-transmissivity soils identified from approximately 50 to 60 ft bgs in adjacent soil borings and monitoring well locations. Sand and gravel were identified at 90 ft to 100 ft bgs. Monitoring well construction confirmed with C. Cellucci in the targeted soils at 100 ft bgs.

Soil samples were collected for planned chemical analysis at the confirmed identified bottom of the soil boring at 95 ft and 100 bgs. Soil samples were containerized, labeled, and preserved on site pending shipment to the analytical laboratory. Only background level PID readings up to 18 ppb (approximately 15 ppb background) were measured in the lower 20 feet of the boring.

**PLANS FOR THE FOLLOWING DAY:**

Holt Drilling site demob, remove drill rig and bob cat from northern plantation, back blade all work areas in the southern and northern tree plantations. Develop MW1-73, install monument box and bollards at MW1-73. Install bollards at all remaining wells in southern plantation. Sample newly installed wells. Holt complete site demob, clean site and organize supplies for next well installation event planned for the causeway area.

**ATTACHMENTS:**

Daily tailgate H&S form.

| | |
|---|---|
| Copies to: Michael Meyer, Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

| DAILY FIELD REPORT<br>5/11/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 43-59 degrees F, SSW wind 12 mph, gusting to 21 mph, overcast/sun breaks/rain showers | |
| **To:** Carlotta Cellucci | |
| **From:** Hunter Butler | |

**PERSONNEL ON SITE:**

Battelle: Angela Piemonte, Andy Lewis, and Hunter Butler; Holt Services: Jeffery Johnson and Kelly Arndt; Cal-Clean: Kevin Kauser and Noel Shenoi.

**SUMMARY OF WORK COMPLETED:**

Installation of monument at MW1-73, bollards placed around all existing wells, well development at MW1-73, sampling completed at MW1-69, site cleanup and demob. Holt offsite until next well installation.

**DEVIATIONS FROM WORKPLAN:**

None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Last day that Holt will be onsite, discussed not to rush and take time to demob.

**FIELD ACTIVITY CHRONOLOGY:**

0700 A. Lewis onsite.
0715 H. Butler and A. Piemonte onsite.
0730 Holt Drilling onsite. Conduct a tailgate H&S meeting. Topics included; tight work areas, no heavy lifting, pinch points, proper PPE, hydration, ergonomics, were some topics discussed.
0745 Conduct tailgate H&S with CalClean.
0750 Holt Drilling continues demob, installation of bollards, installation of monument at MW1-73, backblading site, and clean equipment. All drums in both plantations were palletized and stored undercover at laydown, except three drums in the northern plantation that will get moved on next event.
0915 Ship samples via MC Delivery pickup to Eurofins in Fife.
0945 Surge well MW1-73.
1025 H. Butler offsite.
1043 Start to develop well MW1-73, set purge rate to 1G/Min.
1045 A. Piemonte set up and starts the aquifer slug test at MW1-72.
1200 A. Piemonte completes aquifer slug test at MW1-72.
1315 A. Lewis completes well development at MW1-73.
1350 A. Lewis and A. Piemonte set up to purge and sample MW1-69.

1600 Holt Drilling lifted well monument MW1-57 to try to fix the kink in channel zero. After lifting monument, the kink remains at about 4ft.
1655 Collect samples at MW1-69.
1720 Arrived back at the northern plantation shed to clean, demob, repack samples; support Holt demob; and prepare for next day.
1740 Holt Drilling offsite.
1800 Contacted CalClean and stated we are offsite, Battelle offsite.

**SUMMARY OF FINDINGS:**
No significant findings from the work performed today.

**PLANS FOR THE FOLLOWING DAY:**
Complete vapor sampling AM; sample wells MW1-71 and MW1-72; organize bottles and count; ship vapor samples and physical soil samples; and complete site cleanup.

**ATTACHMENTS:**
Daily tailgate H&S form.

| | |
|---|---|
| Copies to: Michael Meyer, Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

| DAILY FIELD REPORT<br>5/12/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 49-51 degrees F, S. Wind at 12 MPH, gusting to 29 MPH, Overcast with rain showers | |
| **To:** Carlotta Cellucci | |
| **From:** Andy Lewis | |

**PERSONNEL ON SITE:**
Battelle: Angela Piemonte and Andy Lewis; Cal-Clean: Kevin Kauser.

**SUMMARY OF WORK COMPLETED:**
Sampled vapor ports at the treatment system, set up and sampled at MW1-71 and MW1-72.

**DEVIATIONS FROM WORKPLAN:**
None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
Heavy winds in the afternoon, tent was kept upright by heavy sand buckets strapped to canopy.

**FIELD ACTIVITY CHRONOLOGY:**
0815 vapor samples collected by Cal-Clean and A. Piemonte.
0910 A. Lewis onsite, conducted a tailgate H&S meeting with A. Piemonte. Topics included; slips/trips/falls, no heavy lifting, cold stress, pinch points, proper PPE, traffic in parking lot were some topics included.
0915 set up on MW1-71 to sample.
0944 start purge at MW1-71 set purge rate to 200 ml/min.
1230 collect samples at MW1-71 (MSMSD)
1315 break down at MW1-71 and mob to MW1-72 to sample.
1345 set up on MW1-72.
1409 start to purge at MW1-72, purge rate set to 200 ml/min.
1504 complete purging at MW1-72.
1508 collect sample from MW1-72.
1514 collect duplicate sample from MW1-72.
1535 demob from MW1-72, set some outdoor items at MW1-73 to sample tomorrow, clean and calibrate equipment.
1610 A. Piemonte off site.
1615 A. Lewis met with Cal Clean to discuss sampling of the treatment system next week.
1640 A. Lewis offsite.

**SUMMARY OF FINDINGS:**

Well MW1-71 exhibited high turbidity readings despite substantial previous development effort. Nearly 3 hours of purging was required to meet the sampling criteria.

**PLANS FOR THE FOLLOWING DAY:**
Sample well MW1-73, complete bottle count for follow up sample event, clean equipment and organize shed, file field forms, prep for next event, confirm drum count, button up site, demob.

**ATTACHMENTS:**
Daily tailgate H&S form.

| | |
|---|---|
| Copies to: Michael Meyer, Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

BATTELLE
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| DAILY FIELD REPORT 5/13/2022 | **Contract No.** N39430-16-D-1802, CTO N4425521F4225, F4359 **References** Draft Sampling and Analysis Plan (Battelle 2022) Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 43-57 degrees F, SSE wind at 7 MPH, gusting to 10 MPH, overcast w/sun and showers | |
| **To:** Carlotta Cellucci | |
| **From:** Andy Lewis | |

**PERSONNEL ON SITE:**
Battelle: Angela Piemonte, H. Butler, and Andy Lewis; Cal-Clean: Kevin Kauser.

**SUMMARY OF WORK COMPLETED:**
Purge/sample MW1-73, ship samples by Fed-ex and MC Delivery, treatment system running, mob/demob, bottle count, and cleaning of equipment.

**DEVIATIONS FROM WORKPLAN:**
None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
Removed cones from motorcycle course and placed back into place as an outer perimeter.

**FIELD ACTIVITY CHRONOLOGY**
0730 A. Lewis and A. Piemonte onsite conducted a tailgate H&S meeting. Topics included slips/trips/falls, proper PPE, no heavy lifting, ergonomics, hydrations, traffic in parking lot, were some topics discussed.
0745 met with CalClean to discuss days' work.
0800 set up on MW1-73 to purge/sample.
0839 start to purge MW1-73.
0938 complete purge at MW1-73.
0940 sample MW1-73.
0959 complete sampling at MW1-73, demob from site, clean equipment.
1011 collect rinsate sample of DTW meter.
1030 H. Butler onsite, support disposal of soil cutting samples.
1200 H. Butler offsite. Continue demob and cleaning. Prep samples for shipment for MC Delivery and Fed-Ex.
1330 A. Lewis and A. Piemonte offsite, met MC Delivery at Pass and ID.
1400 A. Piemonte shipped sample by Fed-Ex in Silverdale.
1530 End of Day.

**SUMMARY OF FINDINGS:**
No significant findings today.

**PLANS FOR THE FOLLOWING DAY:**

Next week Battelle will collect a duplicate treatment system sample of vapor with Cal-Clean.

**ATTACHMENTS:**

Daily tailgate H&S form.

| | |
|---|---|
| Copies to: Michael Meyer, Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT<br>5/20/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 54 degrees F, partly cloudy | |
| **To:** Carlotta Cellucci | |
| **From:** Michael Meyer | |

**PERSONNEL ON SITE:**
Battelle: Michael Meyer; Cal-Clean: Kevin Kauser.

**SUMMARY OF WORK COMPLETED:**
Received split vapor samples from CalClean, packaged and shipped to Pace Analytical. Staked revised locations of wells on Highway 308 causeway.

**DEVIATIONS FROM WORKPLAN:**
NA

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
None today.

**FIELD ACTIVITY CHRONOLOGY**
0830 M. Meyer onsite.
0845 Met with Cal-Clean to receive split vapor samples collected May 18, 2022 and discuss HVDPE progress.
0935 Pack samples.
1000 Stake new planned locations for MW1-74 and MW1-75 along Highway 308 and refresh location request mark.
1015 Offsite to FedEx for shipping of samples.

**SUMMARY OF FINDINGS:**
Kevin noted that during the recent heavy rains surface water rose approximately 2 feet and prevented access to at least one of the surface water measurement stations. Kevin also noted that he pumps water from secondary containment into the equalization tank. This could theoretically dilute the analytical results from the groundwater influent sample, however he pumps after taking a sample. Kevin has received a fuel delivery, which went well. The system has been running normally.

Samples collected on 5/18/22:

VR-MW1-66-220518 @0845
VR-MW1-76-220518 @0825

VR-MW1-77-220518 @0835
VR-TI-11-220518 @0815

**PLANS FOR THE FOLLOWING DAY:**
Next visit by Battelle will be week of May 31.

**ATTACHMENTS:**
None.

| | |
|---|---|
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| DAILY FIELD REPORT<br>6/27/2022<br>6/28/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 55-91 F, sun, NE wind at 15 mph, gusting to 29 mph | |
| **To:** Carlotta Cellucci | |
| **From:** Andy Lewis | |

**PERSONNEL ON SITE:**
Battelle: Andy Lewis; Cal-Clean: Kevin Kauser.

**SUMMARY OF WORK COMPLETED:**
Checked in daily with CalClean and Michael Meyer in the am/pm while onsite working alone. Labeled all soil drums with a A, B, or W. A&B drums were sampled separately, and W drums contain water and will be processed through the treatment plant at a later point. Dale Hunt with environmental moved around drums so I can open and remove all the excess water from on top of the soil drums. Eight new drums containing excess water were generated, all labeled. Dale Hunt removed three small scoops from each drum and placed in a labeled five-gallon buckets, labeled A and B. Soil was mixed and sampled. All drums were sealed back up, Dale will return to place the drums back under the covered shed. Labeled and placed a drum inside the large white shed for CalClean to fill with sediment from the treatment system. Measured from MW1-77 to MW1-53/MW1-58/P1-10 to collect the distance for MW1-77 placement. Cleaned work area in the North plantation shed, demob from site. Shipped samples by FedEx next morning.

**DEVIATIONS FROM WORKPLAN:**
NA

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
Removed branches in work areas within the southern planation to prevent tripping. Used a forklift to move drums, no drums were moved by hand.

**FIELD ACTIVITY CHRONOLOGY**
6-27-2022
0800 A. Lewis stopped at the Silverdale Fed-Ex to pick up sample bottles for IDW.
0810 Stopped at Home Depot to pick up field and sampling supplies.
0835 Arrive at NBK Keyport, called M. Meyer to check in.
0850 Arrived at Environmental to talk to D. Hunt regarding support to move drums.
0910 Arrived at CalClean trailer to check in with field staff.
0930 Arrived at drum storage to label drums A & B for sampling and W for drums only containing water.
1225 D. Hunt arrived to help me move drums.

1330 D. Hunt offsite, will return the following day to support sampling. Soil A drums; 1,2,3,4,44,45,5,11,12,13,14; Soil B drums: 33,34,40,41,42,18,19,24,25,26,28,29,30,31,37,43.
1510 Soil drum 28 had less than two inches of loose sediment, relabeled the drum water to run through the treatment plant later.
1615 Completed removing the water on top of all the soil drums that will be sampled. Labeled 8 drums containing decanted water. Sealed up all drums.
1710 Arrived at the Northern tree plantation shed to clean and demob for day. Contacted M. Meyers to check in.
1720 Offsite
1745 End of Day.

6/28/2022
0650 A. Lewis onsite NBK Keyport. Contacted M. Meyers to check in.
0700 Checked in with CalClean.
0710 Called Battelle chemist to confirm bottle order.
0720 Mob service vehicle and drove to the drum storage location. Opened all soil drums to be ready for sampling.
0745 D. Hunt with Environmental onsite to discuss sampling.
0802 D. Hunt back onsite to sample drums. Two new five-gallon buckets labeled A & B were used to collect three scoops from each drum.
0830 D. Hunt completed collecting samples. He will return later to place the drums back under the covered shed. Used a new stainless-steel spoon to mix up all the two composite samples.
0840 Collected sample from A drums using a new stainless-steel spoon. Sample ID: OU1-DRUM-S-A-220628.
0910 Collected sample from B drums using a new stainless-steel spoon. Sample ID: OU1-DRUM-S-B-220628.
0935 Packed up samples for shipment, re-iced cooler.
0955 Called D. Hunt to explain sampling is complete, so he can move drums back under cover. He will return after lunch to complete the task.
1010 Arrived back at the northern tree plantation shed to clean and demob.
1050 labeled and set up a drum for CalClean to place sediment from the treatment system, drum was placed under the large white shed.
1100 A. Lewis and CalClean measured from well MW1-77 to MW1-53/MW1-58/P1-10 to use the measurements for MW1-77 placement. MW1-53 (50’ 91”), MW1-58 (32’ 38”), and P1-10 (29’ 10 “).
1125 Sealed up cooler, added fresh ice for shipment.
1135 Called M. Meyer to check in and explain work completed.
1210 Arrived at Fed-Ex to ship one cooler next morning to lab in Fife WA.
1240 End of Day.

**SUMMARY OF FINDINGS:**
See notes above.

**PLANS FOR THE FOLLOWING DAY:**
Continue operating HVDPE plus air sparging.

**ATTACHMENTS:**
None.

| | |
|---|---|
| Copies to: Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br><br>Signed: ___________________________ |

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| DAILY FIELD REPORT<br>7/11/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 57-80 degrees F, sunny | |
| **To:** Carlotta Cellucci, Amanda Rohrbaugh | |
| **From:** Michael Meyer | |

**PERSONNEL ON SITE:**
Battelle: Michael Meyer; Conrad Norton. Cal-Clean: Kevin Kauser. Holt Services: Tyler St. Catherine; David Pine; Marlen Gross. K&D Servies: Phillip Price; Erin Bong; Alexis Bigger; Thomas Kelly

**SUMMARY OF WORK COMPLETED:**
Mobilized to site and set up on location MW1-75. Drilled to 70 feet bgs.

**DEVIATIONS FROM WORKPLAN:**
None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
Delayed drilling approximately 30 minutes to verify that Cascade Natural Gas concurred that the drill location was sufficiently far from the nearby 6-inch gas main.

**FIELD ACTIVITY CHRONOLOGY**
0700 C. Norton onsite
0725 M. Meyer onsite, unload supplies
0815 Holt Services onsite. Begin badging.
0800 Meet Rich from WDOT, C. Cellucci and A. Rohrbaugh from NAVFAC NW to discuss project. WDOT requests buffer truck to protect rig overnight.
0815 Meet Phillip Price from K&D Services. Signs are up and they are ready to close the lane when we are ready.
0900 Review lay down area and hold safety meeting. Close lane.
0945 Begin removing guardrail.
1025 A. Rohrbaugh and C. Cellucci offsite. Guardrail is pulled.
1115 Set up on MW 1-75, move flatbed to laydown.
1115 to 1145 lunch
1220 Ready to drill, hold for confirmation that no natural gas monitor is needed.
1310 Call from Shawn Neil at Cascade Natural Gas. Okay to drill. Begin B180.
1345 Cascade Natural Gas on site to review boring locations. Approved. Drilled to 30 ft bgs.
1410 Sewer district representatives visit – no issues.
1430 At 50ft

1505 Set up to collect a ring sample at 55 feet. However, drillers do not have the correct rings and do not have any caps. Decide to collect sample from gravel in next boring.
1645 Sample soil from Olympia Fm clay at 57 ft.
1615 End drilling for the day at 70ft. Used 100gal of water to control heave. Sample at 65 ft.
1630 Re-open lane.
1645 Off site.

**SUMMARY OF FINDINGS:**
Boring for well MW1-75 (boring DG-B180) drilled to 70 feet bgs. All field PID readings were zero parts per billion throughout the soil core. Collected soil samples at 57 feet and 65 feet within the peaty clay of the Olympia Formation. Held samples on ice/frozen per protocol.

**PLANS FOR THE FOLLOWING DAY:**
Continue drilling to identify a sand or gravel layer within the Olympia Formation for well installation.

**ATTACHMENTS:**
None.

| | |
|---|---|
| Copies to: Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT 7/12/2022 | **Contract No.** N39430-16-D-1802, CTO N4425521F4225, F4359 **References** Draft Sampling and Analysis Plan (Battelle 2022) Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 57-81 degrees F, sunny | |
| **To:** Carlotta Cellucci, Amanda Rohrbaugh | |
| **From:** Michael Meyer | |

**PERSONNEL ON SITE:**
Battelle: Michael Meyer; Conrad Norton. Cal-Clean: Kevin Kauser. Holt Services: Tyler St. Catherine; David Pine; Marlen Gross. K&D Servies: Phillip Price; Erin Bong; Alexis Bigger; Thomas Kelly

**SUMMARY OF WORK COMPLETED:**
Constructed MW1-75. Drilled and sampled MW1-74 to 45 feet bgs.

**DEVIATIONS FROM WORKPLAN:**
None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
Noted pinch point between casing sections on rig and remaining guard rail as casing is loaded on and removed from rig.

**FIELD ACTIVITY CHRONOLOGY**
0630. M. Meyer onsite. Set up for HVDPE split sampling
0715 C. Norton onsite. Hand off split sample Tedlar bags and jars to K. Kauser. Load up for drilling at MW1-75.
0745 Lane closed.
0800 Holt Services onsite.
0815 Tailgate H&S meeting – go over traffic control and sun impacts.
0830 Start rig and perform maintenance.
0905 Begin drilling and set up for split spoon sample in clay
0945 Collect split spoon sample at 70 feet bgs
1010 Cored 70 to 80 feet bgs, find sand at 75-80. Call C. Cellucci and A. Rohrbaugh to discuss results and setting well. Agree to set 5-foot well screen from 75-80 feet bgs, collect soil samples for analysis in areas with relatively high PID response and at the bottom of the boring where the PID reading was zero.
1030 Setting well MW1-75
1125 Set up Decon.
1200 Well construction complete except for monument, decon complete. Lunch. Discuss plan and ideas for repair of MW1-57.
1320 Move rig to MW1-74, retrieve HVDPE split samples from K. Kauser.

1340 Begin drilling MW1-74
1450 Drilled to 30 feet, drove split spoon at 30 feet, poor recovery in fine gravel.
1530 Drilled to 45 feet, dove split spoon at 45 feet, good recovery in fine sand.
1545 Holt Services off site. Process samples and pack up.
1600 Lane reopened. M. Meyer offsite.
1615 All offsite.

**SUMMARY OF FINDINGS:**

Well MW1-75 installed without issues and with minimal water added to control heave. Screening of soil from well bore for well MW1-74 showed a PID hit of 500 ppb in artificial fill at 4 feet bgs, then sporadic PID hits up to 125 ppb (43 feet bgs).

**PLANS FOR THE FOLLOWING DAY:**

Complete drilling of well bore for MW1-74, set well, and reassemble guard rail.

**ATTACHMENTS:**

None.

| | |
|---|---|
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| DAILY FIELD REPORT 7/13/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 57-81 degrees F, sunny | |
| **To:** Carlotta Cellucci, Amanda Rohrbaugh | |
| **From:** Michael Meyer, Conrad Norton | |

**PERSONNEL ON SITE:**

Battelle: Michael Meyer; Conrad Norton. Cal-Clean: Kevin Kauser. Holt Services: Tyler St. Catherine; David Pine; Marlen Gross. K&D Servies: Phillip Price; Erin Bong; Alexis Bigger; Thomas Kelly

**SUMMARY OF WORK COMPLETED:**

Drilled and sampled MW1-74 to 60 feet bgs. Constructed MW1-74. Installed flush mount surface completions at MW1-74 and MW1-75. Reinstalled guardrail posts.

**DEVIATIONS FROM WORKPLAN:**

None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

None today.

**FIELD ACTIVITY CHRONOLOGY**

0700. C. Norton onsite.
0730 Lane closed. M. Meyer onsite
0800 Holt Services onsite. Hold tailgate safety meeting and discuss plans for the day.
0815 Tower up rig.
0845 Drilled to 55 feet. Set up for split spoon sample.
0945 Drilled to 60 feet. Identify top of Olympia-aged unit by peat and clay starting at 55 feet. Confirm well construction with C. Cellucci of NAVFAC NW.
1000 Begin setting MW1-74 with screen 45-55 feet bgs.
1100 MW1-74 set. Drillers take lunch. Investigate and photograph maximum sea water runout at -4 tide occurring around this time. Set up to collect FD and MS/MSD sample from MW1-74 core.
1220 Begin resetting guard rail.
1330 M. Meyer offsite for the day.
1415 Guardrail posts are reset in original locations.
1430 Begin concrete well surface completions (2).
1430 C. Norton to Fedex to send out samples.
1520 C. Norton back onsite from Fedex.

1550 Concrete well surface completion complete, Holt services offsite for the day.
1620 KnD Services reopens lane of traffic and is complete for the day.
1630 C. Norton offsite.

**SUMMARY OF FINDINGS:**
Lithology at MW1-74 was as anticipated. Sporadic low level PID hits were found in the MW1-74 core, with the most notable at 56 feet bgs in the peat layer.

**PLANS FOR THE FOLLOWING DAY:**
Develop wells MW1-74 and MW1-75. Reinstall guardrail on posts. Demobilize from highway location.

**ATTACHMENTS:**
None.

| | |
|---|---|
| Copies to: Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ____________________________ |

| DAILY FIELD REPORT<br>7/14/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 57-81 degrees F, sunny | |
| **To:** Carlotta Cellucci, Amanda Rohrbaugh | |
| **From:** Conrad Norton | |

**PERSONNEL ON SITE:**
Battelle: Conrad Norton. Cal-Clean: Kevin Kauser. Holt Services: Tyler St. Catherine; David Pine; Marlen Cross. K&D Services: Phillip Price; Erin Bong; Alexis Bigger; Thomas Kelly

**SUMMARY OF WORK COMPLETED:**
Developed wells MW1-74 and MW1-75, completed reinstallation of guardrail, demobilized all drilling equipment from the closed lane of traffic and demobilized the traffic control company.

**DEVIATIONS FROM WORKPLAN:**
None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
None today.

**FIELD ACTIVITY CHRONOLOGY**
0700 C. Norton onsite.
0705 KnD Services onsite.
0750 Holt Services onsite.
0800 Lane of traffic closed.
0810 Holt demobilizing drill rig and other equipment with flatbed truck.
0845 MW1-75 is surged and bailed.
0910 Development pumping begins at MW1-75.
0930 Drillers reinstalling guardrail.
1045 Drillers out to lunch.
1145 Driller return from lunch.
1220 Development pumping of MW1-75 complete with 750 L purged.
1230 MC Delivery picks up samples from B179 and B180.
1235 Bail and surge of MW1-74.
1250 Development pumping begins at MW1-74.
1300 Drillers loading all drums (soil and water) onto flatbed truck for transport to staging area.
1400 Development pumping at MW1-74 complete.

1410 Contacted KnD services to call off their services for Friday 7/15
1430 Drillers are demobilized from the road.
1445 KnD is given permission to open up the lane.
1515 Drillers assess damaged CMT well in South Plantation.
1530 Traffic control offsite.
1545 Holt Services offsite.
1615 C. Norton offsite.

**SUMMARY OF FINDINGS:**

Development of MW1-74 and MW1-75 was challenging due to high turbidity. Guardrail has been reinstalled to its original state.

**PLANS FOR THE FOLLOWING DAY:**

Investigate potential solutions for damaged CMT well at the South Plantation. Organize drums and complete demobilization.

**ATTACHMENTS:**

None.

| | |
|---|---|
| Copies to: Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT<br>7/15/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 57-81 degrees F, sunny | |
| **To:** Carlotta Cellucci, Amanda Rohrbaugh | |
| **From:** Conrad Norton | |

**PERSONNEL ON SITE:**

Battelle: Michael Meyer, Conrad Norton. Cal-Clean: Kevin Kauser. Holt Services: Tyler St. Catherine; David Pine; Marlen Cross.

**SUMMARY OF WORK COMPLETED:**

Holt Services repaired previously damaged CMT well located in the South Plantation. Holt Demobilized from the site. Battelle performed slug tests at five wells.

**DEVIATIONS FROM WORKPLAN:**

None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

None today.

**FIELD ACTIVITY CHRONOLOGY**

0750 C. Norton onsite.
0810 Holt Services onsite and working to repair previously broken CMT well.
0815 M. Meyer onsite.
0915 Holt successfully manipulates the position of the CMT well to open up pinched tube.
1000 Holt completes reinstallation/repair of CMT well back to original.
1005 Holt positions all drums from the site in the hazmat temporary storage location.
1045 Holt Services demobilized from the site.
1100 Battelle performing slug tests at five wells.
1530 Battelle offsite for the day.

**SUMMARY OF FINDINGS:**

CMT well with previously pinched/blocked sampling tube is repaired and all sample tubes are operable.

**PLANS FOR THE FOLLOWING DAY:**

Monday – Complete sampling of GW at MW1-74 and MW1-75.

**ATTACHMENTS:**

None.

| | |
|---|---|
| Copies to: Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br><br>Signed: ___________________________ |

BATTELLE
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| DAILY FIELD REPORT 7/18/2022 | **Contract No.** N39430-16-D-1802, CTO N4425521F4225, F4359 **References** Draft Sampling and Analysis Plan (Battelle 2022) Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 57-81 degrees F, sunny | |
| **To:** Carlotta Cellucci, Amanda Rohrbaugh | |
| **From:** Conrad Norton | |

**PERSONNEL ON SITE:**
Battelle: Conrad Norton. Cal-Clean: Kevin Kauser.

**SUMMARY OF WORK COMPLETED:**
Battelle collected groundwater samples from the recently installed groundwater monitoring wells MW1-74 and MW-75.

**DEVIATIONS FROM WORKPLAN:**
None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
None today.

**FIELD ACTIVITY CHRONOLOGY**
0750 C. Norton onsite.
1030 Calibrations of sampling equipment complete.
1200 Sampling equipment set-up at MW1-74
1515 Sampling complete at MW1-74
1530 Set-up for sampling at MW1-75
1800 Sampling complete at MW1-75
1930 IDW/Decon water drum started in hazmat temporary storage area.
2015 C. Norton offsite.

**SUMMARY OF FINDINGS:**
Newly installed wells performed as expected, allowing collection of groundwater samples at MW1-74 and MW1-75.

**PLANS FOR THE FOLLOWING DAY:**
Package and ship groundwater samples to various laboratories. Collect HVDPE split samples from CalClean. Change the inoperable data logger in MW1-49 and add one to MW1-53.

**ATTACHMENTS:**

None.

| | |
|---|---|
| Copies to: Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ____________________________ |

| DAILY FIELD REPORT 7/19/2022 | **Contract No.** N39430-16-D-1802, CTO N4425521F4225, F4359 **References** Draft Sampling and Analysis Plan (Battelle 2022) Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 57-81 degrees F, sunny | |
| **To:** Carlotta Cellucci, Amanda Rohrbaugh | |
| **From:** Conrad Norton | |

**PERSONNEL ON SITE:**
Battelle: Conrad Norton. Cal-Clean: Kevin Kauser.

**SUMMARY OF WORK COMPLETED:**
Battelle packed and shipped groundwater samples from the previous day's sampling of monitoring wells MW1-74 and MW-75. Battelle packaged and shipped weekly split samples provided by CalClean from the HVDPE system. Swapped an inoperable data logger at MW1-49 and added a data logger to MW1-53.

**DEVIATIONS FROM WORKPLAN:**
None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
None today.

**FIELD ACTIVITY CHRONOLOGY**
0430 C. Norton onsite.
0630 All GW samples packed for shipment
0715 Data logger in MW1-49 swapped for operable data logger.
0725 Data logger added to MW1-53
0745 Split Samples from the HVDPE system collected
0830 C. Norton offsite with all samples
1000 All samples and sampling equipment shipped at Fedex near SeaTac Airport.

**SUMMARY OF FINDINGS:**
The data logger that was in place in MW1-49 was still exhibiting a communication error at the time of replacement.

**PLANS FOR THE FOLLOWING DAY:**
Field deployment complete.

**ATTACHMENTS:**
None.

| | |
|---|---|
| Copies to: Steven Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT<br>7/26/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 67-92 degrees F, sunny | |
| **To:** Carlotta Cellucci, Amanda Rohrbaugh | |
| **From:** Andy Lewis | |

**PERSONNEL ON SITE:**

Battelle: Andy Lewis, Cal-Clean: Kevin Kauser and Noel Shewol, Pacific Coast Carbon: Jay Jones and Dakota Mazzanti.

**SUMMARY OF WORK COMPLETED:**

Cal-Clean continued to clean and pack equipment as part of demobilization. Northern plantation shed was cleaned and organized. Went over the drum inventory and what drums were processed through the treatment system. Pacific Coast Carbon set up and started to vacuum out carbon. Downloaded two levelogers, cleaned, stored. Shipped equipment out by Fed-Ex.

**DEVIATIONS FROM WORKPLAN:**

None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Overhead power lines are present in the work area and the crew made sure to stay away from the lines.

**FIELD ACTIVITY CHRONOLOGY**

0725 A. Lewis picked up supplies at local retail.
0800 Arrived onsite, spoke to D. Hunt regarding support with a forklift.
0815 Met with K. Kauser to discuss today's work and water drum placement and inventory.
0900 Arrived at the North Plantation shed to clean and organize.
1100 Pacific Coast Carbon onsite, J. Jones had badging issues.
1130 D. Hunt escorted J. Jones onsite, H&S briefing conducted.
1140 Pacific Coast Carbon setting up equipment.
1245 Started to download levelogger at well P1-10.
1330 Completed download at P1-10 and probe was cleaned and labeled.
1345 Started to download levelogger at well MW1-53.
1350 Pacific Coast Carbon starts to vacuum carbon.
1405 Complete download at MW1-53 and probe was cleaned and labeled.

1406 Forklift operator is offsite, Pacific Coast Carbon moved trailer and set supersacks in a row, will move tomorrow.
1425 Tested two leveloggers that were not working, still not working. Contacted manufacturer for an address to ship back and RMA number.
1440 N. Shenoi onsite, conducted a H&S meeting.
1515 Cleaned defective leveloggers for shipment.
1530 Pacific Coast Carbon offsite.
1545 Cal-Clean offsite.
1615 Arrived at the Northern Plantation shed to prepare equipment for shipment and tidy up.
1630 Offsite to Fed-Ex to ship equipment.
1640 Onsite Fed-Ex to ship equipment.
1705 Arrived at hotel/office to work on daily report, work on levelogger paperwork, and scans.
1830 End of day.

**SUMMARY OF FINDINGS:**
To better match the work schedule for Keyport Hazardous Waste personnel, plan to arrive at the site at 0600 tomorrow to start work, D. Hunt will provide escort.

**PLANS FOR THE FOLLOWING DAY:**
Complete the vacuum work, sample all remaining sediment/soil drums, continue to demob Cal-Clean equipment.

**ATTACHMENTS:**
Daily tailgate H&S form.

| | |
|---|---|
| Copies to: Steven Verdibello, Gail DeRuzzo, Michael Meyer, Ellyn Fitch | **Battelle - DAILY FIELD REPORT**<br>Signed: ______________________ |

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| DAILY FIELD REPORT<br>7/27/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 63-90 degrees F, ENE wind at 6mph, Sun | |
| **To:** Carlotta Cellucci, Amanda Rohrbaugh | |
| **From:** Andy Lewis | |

**PERSONNEL ON SITE:**

Battelle: Andy Lewis, Cal-Clean: Kevin Kauser and Noel Shenoi, Pacific Coast Carbon: Jay Jones and Dakota Mazzanti.

**SUMMARY OF WORK COMPLETED:**

Cal-Clean continued to clean and pack equipment as part of demobilization. Pacific Coast Carbon completed cleaning all the carbon vessels. Transferred left over water that couldn't be processed by the treatment system into drums, labeled all the empty drums, empty.

**DEVIATIONS FROM WORKPLAN:**

None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Small bee hive near the treatment system, Kevin with CalClean showed the site crew where it was at. It is outside the fence and not in a normal pathway.

**FIELD ACTIVITY CHRONOLOGY**

0535 A. Lewis onsite to prep for day and load truck.
0550 CalClean and Pacific Coast Carbon onsite, conducted a tailgate H&S meeting.
0610 Pacific Coast Carbon preps for day along with CalClean.
0615 NBK Keyport Environmental onsite to support with a forklift.
0620 A. Lewis starts to open all the soil and water drums.
0745 Complete opening all the soil and water drums.
0805 Called M. Meyer to discuss soil and water drum inventory. All the processed water drums only have 2-4 inches of water without much sediment. So we will consolidate the water drums into fewer drums and sample later.
0835 Started to transfer water starting with the drums on the outside of the white tent.
1035 All the drums outside of the tent have been transferred and closed up.
1045 Begin processing drums inside the white tent.
1150 Noel with CalClean onsite, conducted a tailgate H&S meeting.
1200 Pacific Coast Carbon completed their work, start to demob and load up equipment.
1250 Noel with Calclean and Pacific Coast Carbon offsite.

1255 Called D. Hunt and asked if he could place the drums that are outside into Building 1032.
1305 D. Hunt onsite to move drums.
1325 D. Hunt offsite, CalClean continues to demob.
1345 Completed transferring the water into drums in the white tent.
1355 Called M. Meyer to discuss the sampling and drums, there are 16 drums to sample for soil.
1415 Decant water from the soil drums.
1550 Called M. Meyer and realized I decanted and sampled from 8 EA drums that were poorly labeled.
1630 Re-collected samples from only the 8 drums that were part of Battelle and AECOM work, drum 60, 62, 69, 61, 63, 68, soil cutting from 2021 from Battelle, and AECOM soil cutting Keyport OU1.
1700 Created a composite sample of all the remaining soil drums, OU1-DRUM-S-C-220727.
1730 Complete sampling, packed and placed samples on ice, sealed up all remaining drums and placed empty drums on pallets.
1815 Labeled and sealed up treatment system drums, Back Flush and System Decon water.
1845 A. Lewis offsite.
1905 Arrive to Hotel/Office to complete daily, scan, and prepare for next day.
1930 End of Day.

**SUMMARY OF FINDINGS:**
Initial demobilization of HVDPE system is complete. CalClean offsite approximately 1800. Sampling of remaining soil IDW complete, and water IDW consolidated for sampling.

**PLANS FOR THE FOLLOWING DAY:**
Surveyors will be onsite around 0900 and plan to work until approximately 1500. CalClean staff will be offsite tomorrow morning, returning in a week to transport a couple of trailers back to California. All new wells and repaired well MW1-57 will be surveyed in. Remaining leveloggers will be downloaded, cleaned, and removed. Peat samples will be shipped to DirectAMS for bulk carbon fraction by FedEx. The two defective leveloggers will be shipped to manufacturer for inspections and possible repair. All drums will be inventoried and confirmed they are labeled properly. Document CalClean work areas.

**ATTACHMENTS:**
Daily tailgate H&S form.

| | |
|---|---|
| Copies to: Steven Verdibello, Gail DeRuzzo, Michael Meyer, Ellyn Fitch | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT<br>7/28/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 67-91 degrees F, NE wind at 10 mph, Sun | |
| **To:** Carlotta Cellucci, Amanda Rohrbaugh | |
| **From:** Andy Lewis | |

**PERSONNEL ON SITE:**
Battelle: Andy Lewis, BRH: Stephen Wilson and Kaylyn Alcantara

**SUMMARY OF WORK COMPLETED:**
CalClean offsite as early as 0600. All leveloggers were downloaded. Shipped peat samples, unused Pace bottles, and defective leveloggers back to manufacturer by Fed-Ex. Drum inventory. Surveyed all new wells and repaired well MW1-57. Packed up unused bottles and freezer for a hand delivery tomorrow.

**DEVIATIONS FROM WORKPLAN:**
None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
Found a 4x4 inch block with nails that could have been a puncture in the southern plantation, picked up and placed in the trash dumpster.

**FIELD ACTIVITY CHRONOLOGY**
0715 A. Lewis arrived onsite Keyport.
0730 Walked to all the wells that will be surveyed to make sure they are all labeled.
0805 Went through unused bottles and set aside for shipment from the Pilot Study work.
0830 Called M. Meyer to discuss what peat samples we want to ship to DirectAMS.
0920 BRH surveying onsite, discussed days work and conducted a daily tailgate safety meeting.
0955 BRH started to survey.
1000 A. Lewis packed up peat samples from MW1-73 47.0 ft, MW1-73 57.0 ft, MW1-73 69.0 ft, and MW1-79 57ft.
1052 Offsite to Fed-Ex.
1115 Onsite Fed-Ex to ship peat samples, defective leveloggers, and unused bottles from Pace.
1205 Back onsite Keyport, met up with surveyors to discuss progress.
1215 Started to download leveloggers.
1515 BRH surveying offsite.
1554 Arrived at the North Plantation shed to drop off leveloggers.
1615 Arrived at the white tent/building 1032 to complete a drum inventory. Building 1032 56 drums total (24 on left side and 32 on right side) 26 soil (L. 16, R. 10), empty drums 25 (L. 6, R. 19), To be sampled for water 5 (L. 2, R. 3).

Note one drum on the left side part of the inventory has water that needs to be sampled from an EA drum. 20 spent carbon supersacks. White Tent; Battelle/AECOM/2021, 25 drums; soil 8, water to be sampled 4, empty 13. Note two of the "to be sampled" drums are back by the CalClean trailers. There are two drums of soil that are still not known and three empty new drums. In the white tent EA has 16 drums; 5 empty, 8 soil, 3 pending analysis.
1715 Completed a site walk, end of project. Holt items in building 1032; 3 bollards, 2 stick up monuments, 1 flush mount monument, 2 empty/new drums, 1 full pallet of hole plug, 3 partial pallets of hole plug, post hole digger. Inside white tent 16 super sacks of new carbon; CalClean items: 4 trailers, miscellaneous construction materials, buckets and hoses, using about ½ of the white tent space. Outside space CalClean has an additional 11 trailers, 2 large tanks, all the trailers have tarps over them. Southern Plantation there are hoses and saw horses w/valves nicely placed on a tarp. Overall CalClean has a perfectly clean and organized work site.
1755 Picked up garbage and A. Lewis offsite.
1815 Onsite office/hotel to complete daily, scans, prepare for next day.
1900 End of Day.

**SUMMARY OF FINDINGS:**

Survey of all the new wells and repaired well MW1-57 completed. All leveloggers downloaded. FedEx shipments completed (Peat samples, defective leveloggers, and unused Pace bottles). Drum inventory and site walk.

**PLANS FOR THE FOLLOWING DAY:**

Pick up freezer, unused bottles, and samples hand deliver to Eurofins at 0730.

**ATTACHMENTS:**

Daily tailgate H&S form.

| | |
|---|---|
| Copies to: Steven Verdibello, Gail DeRuzzo, Michael Meyer, Ellyn Fitch | **Battelle - DAILY FIELD REPORT**<br>Signed: ____________________ |

| DAILY FIELD REPORT<br>7/29/2022 | **Contract No.**<br>N39430-16-D-1802, CTO N4425521F4225, F4359<br>**References**<br>Draft Sampling and Analysis Plan (Battelle 2022)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|

| | |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 67-91 degrees F, NE wind at 10 mph, Sun | |
| **To:** Carlotta Cellucci, Amanda Rohrbaugh | |
| **From:** Andy Lewis | |

**PERSONNEL ON SITE:**
Battelle: Andy Lewis

**SUMMARY OF WORK COMPLETED:**
Picked up freezer, IDW samples, and unused bottles. Hand delivered these items to Eurofins Laboratory in Fife.

**DEVIATIONS FROM WORKPLAN:**
None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
Allowed bad drivers to pass and go around me on the highway.

**FIELD ACTIVITY CHRONOLOGY**
0525 Depart hotel/office.
0543 Onsite Keyport to pick up freezer, unused bottles, and samples.
0602 Offsite Keyport.
0711 Onsite Eurofins Laboratory to deliver freezer, unused bottles, and IDW soil samples.
0739 Depart Eurofins laboratory, to airport. End of day.

**SUMMARY OF FINDINGS:**
Delivered freezer, unused bottles, and IDW samples to Eurofins Laboratory in Fife.

**PLANS FOR THE FOLLOWING DAY:**
No work planned for following day.

**ATTACHMENTS:**
NA

| Copies to: Steven Verdibello, Gail DeRuzzo, Michael Meyer, Ellyn Fitch | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |
|---|---|

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| DAILY FIELD REPORT 8/3/2022 | **Contract No.** N39430-16-D-1802, CTO N4425521F4225, F4359 **References** Draft Sampling and Analysis Plan (Battelle 2022) Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** G24790.79 and G24790.30 - Naval Base Kitsap Keyport, WA OU1 HVDPE Pilot Testing and Vertical Extent Investigation | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** 52-72 degrees, overcast clearing to sunny | |
| **To:** Carlotta Cellucci, Amanda Rohrbaugh | |
| **From:** Michael Meyer | |

**PERSONNEL ON SITE:**
Battelle: Michael Meyer

**SUMMARY OF WORK COMPLETED:**
Collected final IDW samples, downloaded baralogger data, labeled CMT ports, and completed final demobilization.

**DEVIATIONS FROM WORKPLAN:**
None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
None today.

**FIELD ACTIVITY CHRONOLOGY**
0840 M. Meyer on site. Gather sampling gear from shed. Identify and mark drums for composite samples "D" and "E."
0900 Check in with Kenny Eiford in Building 1051 regarding support for drum sampling.
0930 With support of Keyport Hazardous Waste staff, collect composite water IDW sample "OU1-DRUM-W-E-220803" from drums 14, 20, 32, 49, 53, 59, 66, 75.
0945 Collect field blank for PFAS analysis.
1045 Collect composite soil sample "OU1-DRUM-S-D-220803" from two soil drums generated during GSI sampling effort. Download data from barometric pressure datalogger and store baralogger in shed with other dataloggers. Write port numbers and total depth of sampling ports inside lids of the three CMT wells, install new lock on MW1-57. Leave a table printout in the shed describing the CMT well ports. Collect all outdated paperwork and plans for recycling.
1145 Offsite to FedEx for sample shipping.

**SUMMARY OF FINDINGS:**
Battelle is now fully demobilized from NBK Keyport.

**PLANS FOR THE FOLLOWING DAY:**
No work planned for following day.

**ATTACHMENTS:**

NA

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|---|---|
| Copies to: Steven Verdibello, Gail DeRuzzo, Michael Meyer, Ellyn Fitch | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

BATTELLE
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| DAILY FIELD REPORT<br>06 / 03 / 2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359<br>**Reference**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Mostly cloudy, high 66 F, winds E 4 mph | |
| **To:** Carlotta Cellucci | |
| **From:** Samuel Moore | |

**PERSONNEL ON SITE:**

Michael Meyer, Samuel Moore, Caitlyn Farragher (Battelle)

**SUMMARY OF WORK COMPLETED:**

- Held the pre-con meeting
- Collected 7 surface water samples from locations SW1-14 through SW1-20, downstream from the marsh pond.

**DEVIATIONS FROM WORKPLAN:**

- None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Discussed hazards of slips/trips/falls wading into the stream during surface water sampling.

**FIELD ACTIVITY CHRONOLOGY**

0720 Michael Meyer on site. Caitlyn Farragher at Pass & ID for badging.
0740 Samuel Moore on site.
0805 Held pre-con meeting. Pass & ID background check process lead to delays in badging for C. Farragher.
0900 M. Meyer off site. Picked up and organized equipment and supplies.
1130 Dropped off equipment and supplies at the site.
1200 Broke for lunch.
1300 Back on site.
1320 Held tailgate safety meeting. Provided C. Farragher with site orientation. Began equipment organization, preparation and calibrations.
1520 Began surface water sampling at northernmost station and worked south and upstream. Numerous mussels and barnacles are present in the muddy fines of the northern portion of the stream, which becomes more channelized with a sandy bottom just around historical sediment sampling station SP1-1. This northern area has a distinct odor associated with degradation of aquatic vegetation. Upstream of station SP1-1, the presence of mussels, barnacles, and the odor diminish. The stream becomes deeper nearing the marsh pond to the south, while the tree cover decreases and is replaced by firmer grassy soil

at its banks. The marsh pond itself is an expansive shallow water body with significant sedimentation and reedy growth.

1543 Collected surface water sample SW1-19, immediately downstream of SP1-1. In this area, the stream essentially is split into two, with one main deep flowing section (from which this sample was collected) and another lower velocity flow parallel to the west.

1553 Collected surface water sample SW1-20, in front of the seep and historical station SP1-1. The seep had an easily identifiable color of oxidized iron and a steady trickle into the deeper stream.

1558 Collected surface water sample SW1-18, immediately upstream of SP1-1, and a duplicate sample FD-190603-01. Water quality parameter readings indicated a significant rise in pH (from 5.74 at SW1-20 to 7.27 at SW1-18). Oxidation-reduction potential readings also steadily increased while moving upstream (from +47 mV at SW1-20 to +200 mV at SW1-14 just downstream of the marsh pond).

1607 Collected surface water sample SW1-17, in the scoured channel in the open grass field. Collected duplicate FD-190603-02 and MS/MSD samples.

1626 Collected surface water sample SW1-16, along channel under some Scotch Broom foliage. Some mussels present in a small muddy dam nearby the sample.

1638 Collected surface water sample SW1-15 at the bend in the channel just downstream of the old footbridge. The stream at this bend is a deeper pool (around 1.5 ft).

1657 Collected surface water sample SW1-14 just upstream of the old footbridge and immediately downstream of the marsh pond. The stream direction reversed flow during this time due to the incoming tide, which carried a significant amount of water into the channel before the tide gate prevented further inundation.

1732 Performed post-calibrations, packaged samples and stored equipment for the evening.

1745 All off site.

**SUMMARY OF FINDINGS**

Surface water samples were collected from 7 locations SW1-14 through SW1-20. All surface water samples were located along the steadily flowing stream downstream from the marsh pond. Surface water samples were observed to be increasingly oxidative while moving upstream toward the marsh pond. Tidal influence reverses stream flow toward the pond when the tide is coming in.

**PLANS FOR THE FOLLOWING DAY:**

Collect the remaining surface water sample from the location upstream from the pond (SW1-13). Begin collecting sediment samples.

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Caitlyn Farragher | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

| DAILY FIELD REPORT<br>06 / 04 / 2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359<br>**Reference**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Partly cloudy, high 68 F, winds ENE 4 mph | |
| **To:** Carlotta Cellucci | |
| **From:** Samuel Moore | |

**PERSONNEL ON SITE:**
Samuel Moore, Caitlyn Farragher (Battelle)

**SUMMARY OF WORK COMPLETED:**

- Collected 1 surface water sample from location SW1-13, immediately upstream from the marsh pond.
- Collected 6 sediment samples from locations MA19, MA21, MA22 and MA23 along the streambed and from locations TF21 and TF20 in the tide flats.
- Collected 3 porewater samples from locations PW1-25, PW1-26 and PW1-27 in the streambed nearby SP1-1.

**DEVIATIONS FROM WORKPLAN:**

- None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
Very high presence of pollen/allergens on site, especially when moving through overgrown areas in tall grass/reeds.

**FIELD ACTIVITY CHRONOLOGY**

0730 Caitlyn Farragher on site, preparing equipment and performing pre-calibrations.
0750 Samuel Moore on site.
0810 Collected equipment blank EB-190604-01 off surface water sampling equipment.
0815 Held tailgate safety meeting.
0845 Departed for surface water sampling at southernmost station, immediately upstream of the marsh pond. The approach consisted of following the stream from historical station MA12 downstream through the woody area into an open grass and reed-covered marsh. Several stream channels wind through this area before debouching into the marsh pond, which covers the northern section of the open area. Remnants of the old wooden nature boardwalk trail bordering the south side of this trail are still present.
0915 Collected surface water sample SW1-13 located just upstream of the marsh pond. Water quality parameter measurements indicated that this location had a lower pH (6.22 versus 7.78 at SW1-14) and lower ORP (+27 mV versus +200 mV at SW1-14) than the sample collected immediately downstream from the marsh pond.

0930 Returned to shed to store surface water sampling equipment and to prepare sediment sampling equipment. Departed for stations MA19, MA21, MA22 and MA23; which cover from upstream SP1-1 to nearly the outfall to the tide gate.

1007 Collected five-point composite sediment sample MA19, upstream from SP1-1 by approximately 25 meters. The sample consisted of silty fine SAND (0% gravel/90% sand/10% fines [shorthanded as 0/90/10]) that was wet, loose, and dark brown with some red and black mixed in. Mussels and root material were also present in the sample.

1026 Collected five-point composite sediment sample MA21, downstream from SP1-1 by approximately 10 meters. The sample consisted of clayey fine SAND with fine gravel (10/70/20) that was wet, loose, and dark brown with some red and black mixed in. Shells, mussels and small shrimp were also present in the sample.

1033 Collected five-point composite sediment sample MA22, downstream from MA09 by approximately 10 meters. The sample consisted of fine sandy CLAY with very little gravel (5/20/75) and was wet, very soft, and nearly black. Some worms were present in the sample, along with a noticeable hydrogen sulfide odor.

1044 Collected five-point composite sediment sample MA23, downstream from MA09 by approximately 20 meters, and duplicate FD-190604-01. The sample consisted of clayey fine SAND (10/60/30) that was wet, very loose, and nearly black. Some worms, vegetations, mussels and shell fragments were also present in the sample, along with a slight hydrogen sulfide odor.

1110 Dropped off samples at shed and broke for lunch.

1200 Back on site, preparing equipment for sediment sampling in the tide flats.

1215 Departed for sediment sampling in tide flats. During low tide, several spits are accessible and sediment samples can be collected by constructing temporary walkways with fiberboard sheeting along these spits to protect the sampling team from becoming entrapped in the soft sediment surface. One spit extends outward in front of the tide gate (towards TF21); another nearly crosses the tide flats extending from the eastern shore south of the tide gate towards the causeway (reaching TF20). Numerous mussels, clams, barnacles, crabs, worms were present on the sediment surface. Gulls and cranes were observed landing on the tide flats.

1228 Collected five-point composite sediment sample TF21. The sample consisted of clayey fine SAND with fine gravel (10/60/30) that was wet, very loose, and olive grey (on the surface) to dark grey (immediately beneath the surface). A significant amount of shell fragments was present in the sample, along with a vegetative odor.

1304 Collected five-point composite sediment sample TF20. The sample consisted of clayey fine SAND (0/70/30) that was wet, very loose, and dark olive grey. Worms and clam shells were also present in the sample.

1330 Incoming tide precluded sampling from the third and final sediment station in the tide flats. Returned to shed to drop off samples and prepare equipment for porewater sampling.

1347 Collected equipment blank EB-190604-02 off the steel mixing bowl used for sediment sampling and mixing.

1400 Prepared equipment for porewater sampling.

1445 Departed for porewater locations PW1-25, PW1-26 and PW1-27, in the streambed near SP1-1 coincident with surface water samples collected on June 3, 2019 (SW1-18, SW1-19, and SW1-20, respectively).

1456 Began purging at porewater location PW1-26. Water quality parameters stabilized rapidly, although turbidity measured 950 NTU. Dissolved oxygen was measured to be quite high (at 1.30 mg/L) compared to samples PW1-27 and PW1-25 (at 0.15 and 0.09 mg/L, respectively). Collected sample at 1507.

1520 Began purging at porewater location PW1-27. Water quality parameters stabilized rapidly and with quite low turbidity (2.5 NTU). Collected parent sample and field duplicate at 1533.

1545 Began purging at porewater location PW1-25. Water quality parameters stabilized rapidly with low turbidity (42.6 NTU). Collected sample at 1559.

All three samples were under somewhat reducing conditions (between -47 mV and -90 mV) and mildly acidic (from 6.47 to 6.69).

1610 Returned to the shed to drop of samples, store equipment and perform post-calibrations.

1640 All off site.

## SUMMARY OF FINDINGS

One surface water sample was collected from location SW1-13, immediately upstream from the marsh pond. This sample was observed to be less oxidizing and more acidic than the sample collected immediately downstream from the pond. Four sediment samples were collected from the streambed; samples downstream were observed to have increased fines and more evidence of reducing conditions which are amenable to biodegradation (e.g., hydrogen sulfide odor). Two sediment samples were collected from the tide flats. Three porewater samples were collected near station SP1-1. These porewater samples had similar water quality parameters—and all mildly reducing, acidic conditions—except that one downstream sample (PW1-26) indicated high turbidity and high dissolved oxygen, while the other two samples indicated low turbidity and anoxic conditions.

## PLANS FOR THE FOLLOWING DAY:

Collect the remaining sediment sample from the tide flats. Begin collecting porewater samples immediately downstream from the marsh pond. Package and ship samples.

## ATTACHMENTS:

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Caitlyn Farragher, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

BATTELLE
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| DAILY FIELD REPORT<br>06 / 05 / 2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359<br>**Reference**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** AM clouds, PM mostly sunny, high 66 F, winds S 14 mph | |
| **To:** Carlotta Cellucci | |
| **From:** Samuel Moore | |

**PERSONNEL ON SITE:**

Samuel Moore, Caitlyn Farragher (Battelle)

**SUMMARY OF WORK COMPLETED:**

- Collected 5 porewater samples from locations PW1-20 through -24 in the streambed downstream of the marsh pond.
- Collected 1 sediment sample from location TF18 in the tide flats.
- Shipped all samples collected to their respective analytical laboratories.

**DEVIATIONS FROM WORKPLAN:**

- Sample TF18 was intended to be collected from the exact same historical sampling location, but even at the lowest tide level, the field team was not able to access that location on foot. The sample was instead collected on the farthest point of the longest spit jutting out from the northwest corner of the tide flats, approximately 25 m short of the historical location.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Care must be taken standing on fiberboard platforms in the tide flats, which can unexpectedly slide on slopes.

**FIELD ACTIVITY CHRONOLOGY**

0730 Caitlyn Farragher and Samuel Moore on site, preparing equipment and performing pre-calibrations.

0810 Held tailgate safety meeting.

0822 Collected equipment blank EB-190605-01 off porewater PushPoint sampler for PCB congeners.

0900 Departed for porewater sampling in the streambed just downstream of the marsh pond. The outlet of the marsh pond consists of numerous channels that wind north through the tall reedy growth due west of the Central Lot. These channels join and become a singular deeper flow just upstream from the old wooden nature boardwalk north of the pond. This section of the stream—between the marsh pond and location SP1-1—is where the banks consist of firmer, grassy soil and the streambed consists mainly of sandy sediment.

0928 Began setup and purging at porewater location PW1-24, east of monitoring well MW1-18. Water quality parameters stabilized rapidly with very low turbidity (0.0 NTU). Collected sample at 0946. Also collected, duplicate FD-190605-01 and extra volume for MS/MSD samples.

1002 Began setup and purging at porewater location PW1-23, 20 m farther upstream from PW1-24. Water quality parameters stabilized rapidly with very low turbidity (1.0 NTU). Collected sample at 1018.

1037 Began setup and purging at porewater location PW1-22, 20 m farther upstream from PW1-23 and immediately downstream from the old wooden nature boardwalk. Water quality parameters stabilized rapidly with very low turbidity (0.0 NTU). Collected sample at 1048.

1106 Began setup and purging at porewater location PW1-21, immediately upstream from the old wooden nature boardwalk. The first attempted location would not produce any water, so a second attempt was made 1 ft away, which was productive. Water quality parameters stabilized rapidly with very low turbidity (0.0 NTU). Collected sample at 1128.

1143 Began setup and purging at porewater location PW1-20, at the northeastern corner of the channels that wind through the reedy growth immediately north of the marsh pond. Multiple attempts would not produce any water due to the high fraction of organic clay in the top 1 ft of the sediment. An attempt was finally made to push the PushPoint sampler through the softer sediment into the sandy layer beneath (1.5 ft bgs), which was productive. Water quality parameters stabilized rapidly with low turbidity (17.9 NTU). While the previous samples indicated high conductivity readings (30.2 to 45.4 mS/cm), sample PW1-20 indicated relatively low conductivity (0.942 mS/cm). Collected sample at 1205.
All porewater samples had low dissolved oxygen (0.00 to 1.33 mg/L), relatively neutral pH (6.60 to 7.05) and reducing conditions (-4 mV to -116 mV)

1215 Returned to shed to store porewater sampling equipment and to prepare sediment sampling equipment. Departed for sediment sampling station TF18 in the northern end of the tide flats. Historical location of station TF18 could not be reached by foot on the longest spit from the northwest corner of the tide flats even at the lowest tide. The spit has likely eroded since that sample was collected, rendering it inaccessible. Sample TF18 was instead collected on the farthest point of the longest spit jutting out from the northwest corner of the tide flats, approximately 25 m north of the historical location

1241 Collected five-point composite sediment sample TF18. The sample consisted of very fine sandy CLAY (0/20/80) that was damp, medium stiff, and dark olive grey with some black, red, and tan mottled. Small crabs and shell fragments were also present in the sample.

1300 Returned to shed to drop off samples and equipment.

1310 Broke for lunch.

1350 Returned to site. Performed post-calibrations, stored equipment, and prepared samples for shipment.

1500 All off site; shipped samples to their respective laboratories.

## SUMMARY OF FINDINGS

Five porewater samples were collected downstream from the marsh pond. These porewater samples had similar water quality parameters—low turbidity with anoxic, reducing, neutral pH conditions. All samples had high conductivity except for the deeper sample closest to the marsh pond. One sediment sample was collected from the tide flats.

## PLANS FOR THE FOLLOWING DAY:

Collect the remaining porewater samples south of the South Plantation. Package and ship samples.

## ATTACHMENTS:

None

| Copies to: Michael Meyer, Damon DeYoung, Caitlyn Farragher, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |
|---|---|

| DAILY FIELD REPORT<br>06 / 06 / 2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359<br>**Reference**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** AM partly cloudy, high 61 F, winds SSW 5-10 mph; PM scattered showers | |
| **To:** Carlotta Cellucci | |
| **From:** Samuel Moore | |

**PERSONNEL ON SITE:**

Samuel Moore, Caitlyn Farragher (Battelle)

**SUMMARY OF WORK COMPLETED:**

- Collected 8 porewater samples from locations PW1-11, -12, -15, -16, -17, -18, -28, and -29, south of the South Plantation.
- Prepared to ship all samples collected to their respective analytical laboratories.

**DEVIATIONS FROM WORKPLAN:**

- Station PW1-13 is located in an elevated area between two stream flows and would not produce porewater. This station was abandoned. A new location, PW1-28, was selected to the northeast between stations PW1-12 and PW1-13.
- Station PW1-14 is located in soft clayey sediment that would not produce adequate flow of porewater to sample. This station was abandoned. A new location, PW1-29, was selected to the west of PW1-14 between stations PW1-12 and PW1-15.
- Station PW1-19 is located in an elevated area between two stream flows and would not produce porewater. This station was abandoned and no sample was collected.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Sufficiently clearing vegetation is necessary to avoid trip hazards in soft, slick sediment south of the South Plantation.

**FIELD ACTIVITY CHRONOLOGY**

0730 Caitlyn Farragher on site, preparing equipment and performing pre-calibrations.

0810 Samuel Moore on site. Held tailgate safety meeting.

0830 Departed for porewater sampling in the marsh woodland to the south of South Plantation. South of the South Plantation and west of Bradley Road there is an initial drop in elevation, but the marsh itself is a relatively flat surface. Beginning from the storm drain outfall in the northeast corner of the marsh there is a seasonal creek that follows the border of the South Plantation heading west and bending northwest, which eventually ends in the marsh pond west of the site. Due to the flow, this ditch has been channelized, resulting in a firmer sandy surface than the rest of the marsh. During the sampling, the seasonal creek had a steady flow due to rainfall. Another creek flows from the south, west of the marsh, and seemingly joins the seasonal creek before the pond. The rest of the marsh sediment has soft organic clay surface with occasional flows of porewater between firmer and more dry sediment. The entire marsh is heavily vegetated with a mix of trees, blackberries, bracken ferns and tall grass. A variety of birds, slugs and salamanders were all observed during the sampling.

0903 Began setup and purging at porewater location PW1-17, closest to Bradley Road along the transect farthest south from the South Plantation. Water quality parameters could not be measured prior to sampling due to the very low production rate, but a sample was collected and a single measurement was conducted. Collected sample at 0915.

0940 Began setup and purging at porewater location PW1-18, due west of PW1-17. After several attempts a steady flow was achieved. Water quality parameters stabilized rapidly but with high turbidity. Collected sample at 0956.

1013 Began setup at porewater location PW1-19, farthest southwest from the South Plantation. Could not produce porewater with numerous attempts in the area. Abandoned location.

1034 Began setup at porewater location PW1-13, nearby piezometer. Moved to several locations within the vicinity, all with no production from the top 2 ft of sediment. Abandoned location.

1058 Began setup and purging at porewater location PW1-15, in softer sediment by large decayed root structure. Could not collect sufficient sample for water quality parameter measurements. Collected sample at 1118.

1145 Began setup at porewater location PW1-14, which is nearby Bradley Road. Could not produce porewater with numerous attempts. Abandoned location.

1200 Broke for lunch.

1300 Back on site.

1326 Began setup and purging at porewater location PW1-12, southeast of monitoring well MW1-54. Steady rain began and continued throughout sampling. Water quality parameters stabilized rapidly with high turbidity (316 NTU). Collected sample at 1355.

1414 Began setup and purging at porewater location PW1-11, in the northeast corner of the marsh. Water quality parameters stabilized rapidly with high turbidity (260 NTU). Collected sample at 1426. Rain stopped.

1440 Began setup and purging at porewater location PW1-28, a new station approximately 25 ft west of PW1-12. Water quality parameters stabilized rapidly with high turbidity (572 NTU). Collected sample at 1452.

1501 Began setup and purging at porewater location PW1-29, a new station approximately 50 ft south of PW1-12. Water quality parameters stabilized rapidly with high turbidity (161 NTU). Collected sample at 1523.

1538 Began setup and purging at porewater location PW1-16, mid-way in the marsh along Bradley Road. Insufficient water was produced to collect water quality parameter measurements, but a sample was able to be collected from the very slow flow at 1542. Sporadic rain fell during sampling.

Mildly reducing conditions but high dissolved oxygen was identified in samples PW1-17 and PW1-18. However, the remaining samples, nearer the seasonal creek, all demonstrated very low dissolved oxygen and mildly oxidizing conditions—likely due to the percolation of recent rainfall. Virtually all samples in the marsh demonstrated high turbidity, low conductivity and mild acidity.

1600 Returned to shed. Performed post-calibrations and stored equipment for the weekend.

1625 Collected EB-190606-01 off porewater probe and submitted rinsate for VOCs.

1630 C. Farragher left site to pick up shipments at FedEx. S. Moore prepared paperwork and samples for shipment.

1700 C. Farragher returned and dropped off equipment.

1730 All off site.

**SUMMARY OF FINDINGS**

Eight porewater samples were collected from the marsh south of the South Plantation. Obtaining sufficient production rates for water quality parameter measurements was difficult given the lithology and sporadic nature of the porewater pathways.

**PLANS FOR THE FOLLOWING DAY:**

Package and ship samples. Direct-push technology drilling to commence Monday, June 10.

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Caitlyn Farragher, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT<br>6/10/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** clear skies, sunny, up to 78°F | |
| **To:** Carlotta Cellucci | |
| **From:** Damon DeYoung | |

**PERSONNEL ON SITE:**

Damon DeYoung (DD), Caitlyn Farragher (CF), Michael Meyer (MM), Michael Running (MR; Holt), Leon Atencio (LA; Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed boring CL-B106, collected 3 soil samples and 2 groundwater samples

**DEVIATIONS FROM WORKPLAN:**

- None

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Add safety observations/good catches.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0645 | DD onsite, preparing for first day of drilling |
| 0700 | CF onsite |
| 0720 | MM onsite |
| 0820 | MR onsite |
| 0830 | Geoprobe kickoff meeting with onsite and phone participants (Carlotta Cellucci, Gail DeRuzzo). Stage drums in the fabric building and label waste drums with specific core origins. Stage core temporarily near shed in case a second review is warranted. |
| 1000 | CF to fedex for bottle pickup |
| 1058 | Began drilling CL-B106 (NE corner of parking lot near Bradley Rd) |
| 1505 | Completed boring CL-B106 down to 35 ft bgs |
| 1515 | Holt Services offsite for lunch |
| 1550 | Holt Services onsite with lunch |
| 1600 | Abandoned CL-B106 |
| 1620 | Prepped bottles for drilling tomorrow |
| 1640 | Holt Services offsite for the day |
| 1830 | Battelle staff offsite for the day |

**SUMMARY OF FINDINGS:**

- CL-B106 had slight detections on PID (17 ppm at 9 ft, 17 ppm at 12 ft)

**PLANS FOR THE FOLLOWING DAY:**

Continue drilling, starting at CL-B107 at 7 a.m.

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br>Caitlyn Farragher, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT<br>6/11/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** clear skies, sunny, up to 85°F, winds from the west | |
| **To:** Carlotta Cellucci | |
| **From:** Damon DeYoung | |

**PERSONNEL ON SITE:**

Damon DeYoung (DD), Caitlyn Farragher (CF), Michael Running (MR; Holt), Leon Atencio (LA; Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed boring CL-B107, collected 3 soil samples and 2 groundwater samples
- Completed boring CL-B108, collected 2 soil samples and 2 groundwater samples
- Completed boring CL-B109, collected 3 soil samples and 2 groundwater samples
- Shipped two coolers of samples to APPL for analysis

**DEVIATIONS FROM WORKPLAN:**

- Due to refusal at 26 ft bgs in boring CL-B108 only 2 soil samples were collected in this boring (the plan called for 3 soil samples).

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

The OU1 parking lot was used as over-flow parking for the main parking lot north of Building 893 due to an event held at Keyport today. The field team employed safety delineators to deter traffic from entering the drilling area.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0640 | CF onsite, preparing for drilling today |
| 0645 | DD onsite |
| 0730 | Holt Services onsite, held tailgate meeting |
| 0750 | Began drilling CL-B107 |
| 0940 | Completed CL-B107 |
| 1025 | Abandoned CL-B107 |
| 1030 | Began drilling CL-B108 |
| 1130 | Megan Maki (NAVFAC Water Resources) discussed the water pipe reconnection at the OU1 shed. Carlotta will have to call in a work order to make a permanent connection. The following contacts were provided by Megan:<br>Megan Maki megan.maki@navy.mil<br>Michael Austria Michael.austria@navy.mil 360-476-2319<br>After hours 360-476-2325 mechanical dispatch |
| 1225 | Completed CL-B108 |

| | |
|---|---|
| 1305 | Holt Services offsite for lunch |
| 1340 | Holt Services onsite |
| 1345 | Abandoned CL-B108 |
| 1405 | Began drilling CL-B109 |
| 1515 | CF offsite to FedEx for sample shipment drop-off. |
| 1615 | Completed CL-B109 |
| 1630 | CF returned |
| 1650 | Abandoned CL-B109 |
| 1705 | Holt Services offsite for the day. |
| 1710 | Prepared soil sampling and groundwater sampling kits for tomorrow |
| 1750 | Battelle staff offsite for the day |

**SUMMARY OF FINDINGS:**

- Elevated PID detections were observed in shallow waste bodies in borings CL-B108 (up to 2036 ppm at 8 ft bgs) and CL-B109 (up to 1040 ppm at 3 ft bgs).
- Drilling activities penetrated the deep clay unit in borings CL-B107 (32 ft bgs) and CL-B109 (37 ft bgs); the clay could not be reached in CL-B108 due to refusal at 26 ft bgs.

**PLANS FOR THE FOLLOWING DAY:**

Continue the drilling program, starting at CL-B105, then move into the North Plantation during the hot portion of the day.

**ATTACHMENTS:**

None

| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br>Caitlyn Farragher, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |
|---|---|

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| DAILY FIELD REPORT<br>6/12/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** sunny, hot up to 91°F, light to no wind | |
| **To:** Carlotta Cellucci | |
| **From:** Damon DeYoung | |

**PERSONNEL ON SITE:**

Damon DeYoung (DD), Caitlyn Farragher (CF), Michael Running (MR; Holt), Leon Atencio (LA; Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed boring CL-B105, collected 3 soil samples and 2 groundwater samples
- Completed boring NP-B110, collected 3 soil samples and 2 groundwater samples
- Completed boring NP-B111, collected 3 soil samples and 2 groundwater samples

**DEVIATIONS FROM WORKPLAN:**

- None

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Purposefully drilled borings located in the North Plantation to stay in partial shade during today's heatwave to minimize the potential for heat related illness.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0640 | CF onsite to prep for drilling |
| 0645 | DD onsite |
| 0705 | Holt onsite |
| 0715 | Tailgate |
| 0730 | Began drilling CL-B105 |
| 0930 | Completed drilling CL-B105, refusal at 40 ft |
| 1030 | Abandoned CL-B105 |
| 1040 | Began drilling NP-B110 |
| 1320 | Completed drilling NP-B110, refusal at 40 ft |
| 1330 | MR offsite for lunch |
| 1400 | MR back with lunch |
| 1430 | Abandoned NP-B110 |
| 1440 | Began drilling NP-B111 |
| 1630 | Completed drilling NP-B111 |
| 1740 | Abandoned NP-B111 |
| 1745 | Holt offsite for the day |

1745 CF and DD prepared for drilling activities on Thursday
1755 CF and DD offsite for the day

**SUMMARY OF FINDINGS:**

- Elevated PID detections were observed in shallow waste bodies in borings CL-B105 (up to 20.25 ppm at 10 ft bgs) and NP-B110 (up to 21.35 ppm at 8 ft bgs).
- PID readings did not exceed 100 ppb in boring NP-B111. All PID observations were limited to the upper 20 ft.
- Drilling activities penetrated the deep clay unit in boring CL-B111 (38.8 ft bgs); the clay could not be reached in borings CL-B105 and NP-B110 due to refusal at 40 ft bgs.

**PLANS FOR THE FOLLOWING DAY:**

Continue drilling in the North Plantation, beginning at NP-B113.

**ATTACHMENTS:**

Boring logs for CL-B105, NP-B110, and NP-B111

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br>Caitlyn Farragher, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

| DAILY FIELD REPORT<br>6/13/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** sunny, warm up to 82°F, mild winds from the west | |
| **To:** Carlotta Cellucci | |
| **From:** Damon DeYoung | |

**PERSONNEL ON SITE:**

Damon DeYoung (DD), Caitlyn Farragher (CF), Michael Running (MR; Holt), Leon Atencio (LA; Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed boring NP-B114, collected 4 soil samples and 2 groundwater samples
- Completed boring NP-B113, collected 3 soil samples and 1 groundwater sample
- Completed boring NP-B117, collected 1 soil sample
- Completed boring NP-B117s (step-out), collected 3 soil samples and 2 groundwater sample

**DEVIATIONS FROM WORKPLAN:**

- Collected one additional soil sample in boring NP-B114 where minor PID readings were observed in deeper core depths.
- Collected only one groundwater sample from boring NP-B113 due to sands clogging the screen in the 25 to 29 ft depth.
- Performed a small (2 foot) step-out adjacent to boring NP-B117 due to refusal in the original boring at 11 ft. The step-out boring was labeled NP-B117s (i.e., "s" for step-out). A soil sample from each borehole was collected at 10 ft to observe lateral variability.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

All field activities were conducted safely and efficiently.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0600 | CF onsite to prep for drilling |
| 0635 | DD onsite |
| 0710 | Holt onsite |
| 0715 | Tailgate |
| 0730 | Began drilling NP-B114 |
| 0940 | Completed drilling NP-B114 |
| 0950 | Began drilling NP-B113 |
| 1100 | Holt offsite for lunch |
| 1120 | Holt onsite with lunch |
| 1145 | Continued drilling NP-B113 |

| | |
|---|---|
| 1235 | Completed drilling NP-B113 |
| 1250 | Abandoned NP-B114 |
| 1340 | Began drilling NP-B117 |
| 1355 | Hit refusal in NP-B117, abandoned the boring and stepped out |
| 1405 | Began drilling NP-B117s (step-out) |
| 1545 | Abandoned NP-B113, after trying unsuccessfully to obtain groundwater from the 25 to 29 ft screen interval |
| 1645 | Completed drilling NP-B117s |
| 1715 | Abandoned NP-B117s |
| 1720 | Prepared for drilling activities tomorrow. |
| 1730 | Holt Services offsite for the day |
| 1800 | CF offsite. DD spoke with the motorcycle training range operator; Monday and Tuesday June 17-18 are open for drilling in the motorcycle range area (no classes until Wednesday). |
| 1810 | DD offsite for the day. |

**SUMMARY OF FINDINGS:**

- Elevated PID readings were observed in boring NP-B114 in the 8 to 14 ft depth range, with minor PID readings at 23 and 33 ft.
- Boring NP-B113 had no PID detections in the depth range of 8 to 14 ft. Minor PID readings were observed between 20 and 30 ft.
- Boring NP-B117s had a black oil substance covering waste material at the 13.5 to 14 ft depth range. Elevated PID readings in the borehole were observed in the 10 to 14 ft depth, the 27 to 30 ft depth, and the 35 to 40 ft depth ranges. The combination of dense gravel and the hard clay unit at the 39.5 ft depth prevented further coring below the 40 ft depth.
- The deep clay unit was observed across the three boreholes drilled today at depths between 37.5 and 39.5 ft.

**PLANS FOR THE FOLLOWING DAY:**

Continue drilling in the North Plantation, beginning at NP-B112.

**ATTACHMENTS:**

Boring logs for NP-B114, NP-B113, NP-B117 and NP-B117s.

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore | **Battelle - DAILY FIELD REPORT** |
| Caitlyn Farragher, Gail DeRuzzo | Signed: ___________________________ |

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| **DAILY FIELD REPORT**<br>**6/14/2019** | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** overcast day, light winds from the northeast, 70°F | |
| **To:** Carlotta Cellucci | |
| **From:** Damon DeYoung | |

**PERSONNEL ON SITE:**

Damon DeYoung (DD), Caitlyn Farragher (CF), Michael Running (MR; Holt), Leon Atencio (LA; Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed boring NP-B112, collected 3 soil samples and 2 groundwater samples
- Completed boring NP-B115, collected 3 soil samples and 2 groundwater samples
- Collected 1 equipment rinsate blank

**DEVIATIONS FROM WORKPLAN:**

- None

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

All field activities were conducted safely and efficiently.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0630 | CF onsite, prepping for drilling, soil and groundwater sampling |
| 0635 | DD onsite |
| 0705 | Holt onsite |
| 0730 | Tailgate meeting |
| 0735 | Began drilling NP-B112 |
| 0920 | Completed drilling NP-B112 |
| 0935 | Began drilling NP-B115 |
| 1105 | Completed drilling NP-B115 |
| 1115 | Abandoned NP-B112 |
| 1155 | Abandoned NP-B115 |
| 1200 | Prepared sampling supplies for next week |
| 1210 | Holt offsite for the weekend |
| 1355 | CF and DD offsite for the weekend |

**SUMMARY OF FINDINGS:**

- Very limited PID observations from the two boreholes today. NP-B115 had a black substance covering waste debris in the 8 ft depth range (a sample was collected).

- The deep clay unit was observed at shallower depths in today's borings. The clay was reached at 31 ft in NP-B112 and 27.5 ft in NP-B115.

**PLANS FOR THE FOLLOWING DAY:**

Continue the drilling effort for the source investigation at central landfill borings CL-B102, CL-B103, and CL-B104 on Monday 6-17-2019 while no motorcycle training activities are scheduled.

**ATTACHMENTS:**

Boring logs for NP-B112 and NP-B115.

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore | **Battelle - DAILY FIELD REPORT** |
| Caitlyn Farragher, Gail DeRuzzo | Signed: ___________________________ |

BATTELLE
It can be done

| DAILY FIELD REPORT<br>6/17/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** overcast sky, low 60s in the morning, warms to low 70s in the mid afternoon. | |
| **To:** Carlotta Cellucci | |
| **From:** Damon DeYoung | |

**PERSONNEL ON SITE:**

Damon DeYoung (DD), Caitlyn Farragher (CF), Michael Running (MR; Holt), Leon Atencio (LA; Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed boring CL-B103, collected 4 soil samples and 2 groundwater samples
- Completed boring CL-B102, collected 3 soil samples and 2 groundwater samples

**DEVIATIONS FROM WORKPLAN:**

- Collected one additional soil sample in boring CL-B103 where minor PID readings were observed in deeper core depths (i.e., 39 ft bgs).

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

All field activities were conducted safely and efficiently.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0630 | CF onsite, prepping for soil/groundwater sampling |
| 0645 | DD onsite |
| 0715 | Holt onsite |
| 0730 | Tailgate meeting, working in the northwest corner of the motorcycle range area today. |
| 0740 | Cleared brush near boring CL-B103 |
| 0810 | Began drilling at boring CL-B103 |
| 1055 | Completed boring CL-B103 |
| 1115 | Began drilling boring CL-B102 |
| 1140 | Holt offsite for lunch |
| 1200 | Holt onsite with lunch |
| 1430 | DD attended OU1 project review conference call |
| 1520 | Project review call completed |
| 1545 | Completed boring CL-B102 |
| 1710 | Abandoned CL-B102 |
| 1720 | Abandoned CL-B103 |

**SUMMARY OF FINDINGS:**

- Elevated PID readings were observed in the two borings today (CL-B102 and CL-B103) at similar depths; in the 12 to 20 ft range, and the 31 to 39 ft range. Samples were collected in these depth ranges from each borehole for laboratory analyses.
- The deep clay unit was observed at 42 ft (CL-B102) and 44 ft (BL-B103)

**PLANS FOR THE FOLLOWING DAY:**

Continue the drilling program in the Central Landfill area beginning with boring CL-B104.

**ATTACHMENTS:**

Boring logs for CL-B102 and CL-B103.

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br>Caitlyn Farragher, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

| DAILY FIELD REPORT<br>6/18/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** drizzling, overcast sky, low to mid 60s. | |
| **To:** Carlotta Cellucci | |
| **From:** Damon DeYoung | |

**PERSONNEL ON SITE:**

Damon DeYoung (DD), Caitlyn Farragher (CF), Michael Running (MR; Holt), Leon Atencio (LA; Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed boring CL-B104, collected 3 soil samples and 2 groundwater samples
- Completed boring CL-B101, collected 3 soil samples and 2 groundwater samples

**DEVIATIONS FROM WORKPLAN:**

- None

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

All field activities were conducted safely and efficiently.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0615 | DD and CF onsite, prepping for soil/groundwater sampling |
| 0715 | Holt onsite |
| 0720 | Tailgate meeting, working in the northwest corner of the motorcycle range area today. |
| 0735 | Began drilling at boring CL-B104 |
| 0915 | Completed boring CL-B104 |
| 1010 | Abandoned boring CL-B104 |
| 1030 | Began drilling boring CL-B101 |
| 1110 | Holt offsite for lunch |
| 1135 | Holt onsite with lunch |
| 1520 | Completed boring CL-B101 |
| 1525 | CF offsite for FedEx dropoff |
| 1545 | Abandoned boring CL-B101 |
| 1605 | Holt offsite for the day |
| 1620 | Prepped for soil and groundwater sampling tomorrow. |
| 1705 | DD and CF offsite for the day |

**SUMMARY OF FINDINGS:**

- In boring CL-B104, PID detections were observed at 9 ft, 22 to 28 ft, and 31 to 32 ft. Three soil samples were collected (9 ft, 28 ft, and 32 ft depths). Two groundwater samples were collected (9 to 14 ft and 24 to 28 ft).
- In boring CL-B101, PID detections were observed between 32 and 40 ft. Three soil samples were collected (9 ft, 32 ft, and 40 ft depths). Two groundwater samples were collected (5 to 10 ft and 36 to 40 ft).
- The deep clay unit was observed at 48 ft in CL-B101.

**PLANS FOR THE FOLLOWING DAY:**

Continue the drilling program in the North Plantation area beginning with the northern-most boring NP-B125.

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br><br>Caitlyn Farragher, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br><br>Signed: ___________________________ |

| DAILY FIELD REPORT<br>6/19/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** overcast sky, low 60s in the morning, warms to low 70s in the mid afternoon. | |
| **To:** Carlotta Cellucci | |
| **From:** Damon DeYoung | |

**PERSONNEL ON SITE:**

Damon DeYoung (DD), Caitlyn Farragher (CF), Michael Running (MR; Holt), Leon Atencio (LA; Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed boring NP-B125, collected 3 soil samples and 2 groundwater samples
- Completed boring NP-B123, collected 3 soil samples and 2 groundwater samples along with a groundwater field duplicate and MS/MSD
- Collected one equipment blank and one source blank

**DEVIATIONS FROM WORKPLAN:**

- None

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

All field activities were conducted safely and efficiently.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0615 | DD and CF onsite, prepping for soil/groundwater sampling |
| 0715 | Holt onsite |
| 0730 | Tailgate meeting, working in the northwest corner of the site, north of the North Plantation. |
| 0735 | Began drilling at boring NP-B125 |
| 1145 | Completed boring NP-B125 |
| 1200 | MR offsite for lunch |
| 1220 | MR onsite with lunch |
| 1315 | Abandoned NP-B125 |
| 1335 | Began drilling NP-B123 |
| 1645 | Completed boring NP-B123 |
| 1710 | Holt offsite |
| 1715 | CF and DD prepped for soil/groundwater sampling tomorrow |
| 1930 | CF and DD offsite for the day |

**SUMMARY OF FINDINGS:**

- NP-B123 had elevated PID readings at 19 ft associated with a black contaminant zone. One soil sample was collected. A parent and field duplicate groundwater sample was collected along with an MS/MSD. Analytes include VOCs, 1,4-dioxane, PCBs, and TPH-Dx.

**PLANS FOR THE FOLLOWING DAY:**

Continue the drilling program within the area north of the North Plantation.

**ATTACHMENTS:**

Boring logs for CL-B104, CL-B101, NP-B125, and NP-B123.

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br>Caitlyn Farragher, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT<br>6/20/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** overcast sky, low 60s in the morning, warms to high 60s in the afternoon. | |
| **To:** Carlotta Cellucci | |
| **From:** Damon DeYoung | |

**PERSONNEL ON SITE:**

Damon DeYoung (DD), Caitlyn Farragher (CF), Michael Running (MR; Holt), Leon Atencio (LA; Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed boring NP-B124
- Completed boring NP-B121
- Began boring NP-B122

**DEVIATIONS FROM WORKPLAN:**

- None

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

All field activities were conducted safely and efficiently.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0630 | DD and CF onsite, prepping for soil/groundwater sampling |
| 0720 | Holt onsite |
| 0730 | Tailgate meeting, continue working in the northwest corner of the site, north of the North Plantation. |
| 0740 | Abandoned NP-B123 |
| 0755 | Began drilling boring NP-B124 |
| 1020 | Completed boring NP-B124 |
| 1045 | Began drilling boring NP-B121 |
| 1115 | Holt offsite for lunch |
| 1135 | Holt onsite with lunch |
| 1345 | Completed drilling boring NP-B121 |
| 1415 | CF offsite to ship samples via FedEx |
| 1445 | Abandoned NP-B121 |
| 1500 | Abandoned NP-B124 |
| 1515 | Began drilling boring NP-B122 |
| 1545 | Stopped at 15 ft in boring NP-B122 for the day, set a temporary well |
| 1600 | Holt offsite for the day |
| 1610 | Began collecting groundwater at NP-B122 from 10 to 15 ft, and prepped for tomorrow |

1935 CF and DD left site for dinner due to the very low flow rate in the temporary well at NP-B122.

2055 CF and DD onsite, completed the groundwater sample collection at NP-B122.

2105 CF and DD offsite for the day

**SUMMARY OF FINDINGS:**

- In boring NP-B124, PID detections were limited to the 9 ft depth. A soil sample was collected at this interval.
- In boring NP-B121, PID detections were observed between 4 and 14 ft. Samples were collected at 5 and 13 ft where the highest PID readings were observed. A field duplicate soil sample was collected associated with the 13 ft depth (labeled as 14 ft in accordance with the SAP).
- In boring NP-B122, PID detections were observed between 4 and 15 ft. Samples were collected at 5 and 9 ft where the highest PID readings were observed.

**PLANS FOR THE FOLLOWING DAY:**

Continue the drilling program within the area north of the North Plantation.

**ATTACHMENTS:**

Boring logs for NP-B124 and NP-B121

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br>Caitlyn Farragher, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT 6/21/2019 | **Contract No.** N39430-16-D-1802, TO N3943018F4359 (CTO 41) **References** Sampling and Analysis Plan (Battelle 2019) Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** overcast sky, low 60s in the morning, warms to high 60s in the afternoon. | |
| **To:** Carlotta Cellucci | |
| **From:** Damon DeYoung | |

**PERSONNEL ON SITE:**
Damon DeYoung (DD), Caitlyn Farragher (CF), Michael Running (MR; Holt), Leon Atencio (LA; Holt)

**SUMMARY OF WORK COMPLETED:**
- Completed boring NP-B122, collected 3 soil samples and 2 groundwater samples
- Completed boring NP-B119, collected 3 soil samples and 2 groundwater samples
- Began boring NP-B116, collected 1 soil sample, 1 groundwater sample and 1 duplicate groundwater sample

**DEVIATIONS FROM WORKPLAN:**
- None

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
All field activities were conducted safely and efficiently.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0630 | DD and CF onsite, prepping for soil/groundwater sampling |
| 0715 | Holt onsite |
| 0720 | Tailgate meeting, continue working in the northwest corner of the site, north of the North Plantation. |
| 0730 | Continued drilling boring NP-B122 |
| 0915 | Completed drilling boring NP-B122 |
| 0930 | Began drilling boring NP-B119 |
| 1140 | Completed drilling boring NP-B119 |
| 1140 | Holt offsite for lunch |
| 1155 | Holt onsite with lunch |
| 1220 | Abandoned boring NP-B119 |
| 1230 | Abandoned boring NP-B122 |
| 1250 | Began drilling boring NP-B116 |
| 1340 | Stopped drilling for the day at NP-B116 at 15 ft |
| 1430 | Holt offsite |
| 1500 | CF and DD offsite for the weekend to ship sample coolers. |

**SUMMARY OF FINDINGS:**

- Elevated PID readings (~1112 ppb) were observed in shallow soil (~5 ft) in boring NP-B122; a corresponding soil sample was collected.
- The deep clay was observed in boring NP-B122 at 32 ft.
- Relatively low PID readings were observed in boring NP-B119 from 5 to 8 ft (up to 224 ppb); a corresponding soil sample was collected.
- The deep clay was observed in boring NP-B119 at 28 ft.
- No PID detections were observed in the first 15 ft of boring NP-B116.

**PLANS FOR THE FOLLOWING DAY:**

Continue the drilling program within the North Plantation.

**ATTACHMENTS:**

Boring logs for NP-B122 and NP-B119

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br><br>Caitlyn Farragher, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br><br>Signed: ___________________________ |

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| DAILY FIELD REPORT<br>6/24/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Mostly cloudy, high 71 F, winds variable 5 mph | |
| **To:** Carlotta Cellucci | |
| **From:** Samuel Moore | |

**PERSONNEL ON SITE:**

Samuel Moore (SM), Damon DeYoung (DD), Caitlyn Farragher (CF), Michael Running (MR; Holt), Leon Atencio (LA; Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed boring NP-B116; collected 2 soil samples and 1 groundwater sample.
- Completed boring NP-B120; collected 5 soil samples and 2 groundwater samples.
- Began boring NP-B118; collected 2 soil samples and 1 groundwater sample.

**DEVIATIONS FROM WORKPLAN:**

- None

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

All field activities were conducted safely and efficiently.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0630 | SM, DD and CF onsite, prepping for soil/groundwater sampling. |
| 0705 | Holt onsite |
| 0725 | Tailgate meeting, continue working in the northwest corner of the site, in the North Plantation. |
| 0740 | Started drilling NP-B116. |
| 0855 | Completed drilling NP-B116; met refusal at 40 ft bgs. |
| 0930 | Started drilling NP-B120. |
| 0950 | Met refusal at NP-B120. Renamed NP-B120A. Started drilling step-out. |
| 1258 | Completed drilling NP-B120; met refusal at 49.5 ft bgs. |
| 1524 | Started drilling NP-B118. |
| 1530 | DD left to drop off samples for shipment. |
| 1600 | DD returned to site. |
| 1615 | Holt completed boring NP-B118 to 20 ft bgs and set up first depth of groundwater sampling. Holt off site. |
| 1755 | All off site. |

**SUMMARY OF FINDINGS:**

- Elevated readings (234 ppm) were observed in boring NP-B116 at 34 ft bgs; deep clay was observed in boring NP-B116 at 40 ft bgs.
- Elevated readings (834 and 702 ppm) were observed at 12.5 ft bgs and 42 ft bgs, respectively. Deep clay was not observed before reaching refusal at 49.5 ft bgs.
- Elevated readings (410 ppm) were observed in boring NP-B118 at 16 ft bgs.

**PLANS FOR THE FOLLOWING DAY:**

Complete the drilling program within the North Plantation. Continue the drilling program with borings on the south side of the Central Lot.

**ATTACHMENTS:**

Boring logs for NP-B116 and NP-B120

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br><br>Caitlyn Farragher, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br><br>Signed: ___________________________ |

| DAILY FIELD REPORT<br>6/25/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Mostly sunny, high 74 F, winds calm becoming SE 5 mph | |
| **To:** Carlotta Cellucci | |
| **From:** Samuel Moore | |

**PERSONNEL ON SITE:**

Samuel Moore (SM), Caitlyn Farragher (CF), Damon DeYoung (DD), Michael Running (MR; Holt), Leon Atencio (LA; Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed boring NP-B118; collected 1 soil sample and 1 groundwater sample.
- Completed boring CL-B99; collected 3 soil samples and 2 groundwater samples.
- Completed boring CL-B100; collected 3 soil samples and 2 groundwater samples.

**DEVIATIONS FROM WORKPLAN:**

- Met refusal at 26 ft bgs at boring CL-B99 prior to encountering deep clay aquitard; however, the deep clay aquitard was identified in nearby boring CL-B100.
- Four soil samples were collected at CL-B100 versus three as specified in the SAP. The highest shallow PID detection was identified within the wood debris layer, which could not be sampled. Therefore, two samples were collected: one in the soil immediately below this layer and one in the second-highest detection above this layer.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

All field activities were conducted safely and efficiently.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0630 | SM and CF onsite, prepping for soil/groundwater sampling. |
| 0730 | Holt onsite |
| 0735 | Tailgate meeting, continue working in the northwest corner of the site, in the North Plantation, then transition to southern side of the Central Lot. |
| 0755 | Continued drilling NP-B118. |
| 0900 | Completed drilling NP-B118; encountered deep clay aquitard at 35 ft bgs. |
| 0940 | Backfilled borings NP-B116, NP-B120, and NP-B118. |
| 1000 | Began drilling CL-B99. |
| 1118 | Completed boring CL-B99; met refusal on gravel at 26 ft bgs prior to deep clay aquitard. |
| 1120 | Holt off site for refuel. |
| 1145 | Holt back on site; backfilled CL-B99. |

| | |
|---|---|
| 1200 | Off site for lunch. |
| 1245 | Began drilling CL-B100 |
| 1445 | Completed drilling CL-B100; encountered deep clay aquitard at 37 ft bgs. |
| 1520 | Dropped samples off for FedEx pickup. Abandoned boring CL-B100. |
| 1530 | DD on site. CF back on site. Determined order of remaining boring locations. Stored equipment for evening. |
| 1700 | All off site. |

**SUMMARY OF FINDINGS:**

- No elevated readings were observed in boring NP-B118 below 16 ft bgs; deep clay was observed in boring NP-B118 at 34 ft bgs.
- Elevated PID readings (2057 ppm) were observed in boring CL-B99 at 12 ft bgs. Met refusal at gravel layer at 26 ft bgs prior to aquitard; however, no elevated readings were detected below 16 ft bgs.
- Elevated PID readings (572 ppm) were observed in boring CL-B100 at 10 ft bgs; deep clay was observed in boring CL-B100 at 37 ft bgs.

**PLANS FOR THE FOLLOWING DAY:**

Continue the drilling program with borings on the south of the Central Landfill along Bradley Road and in the SouthPlantation.

**ATTACHMENTS:**

Boring logs for NP-B118, CL-B99 and CL-B100

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore | **Battelle - DAILY FIELD REPORT** |
| Caitlyn Farragher, Gail DeRuzzo | Signed: __________________________ |

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| DAILY FIELD REPORT<br>6/26/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Mostly cloudy, high 70 F, winds calm becoming E 5 to 10 mph | |
| **To:** Carlotta Cellucci | |
| **From:** Samuel Moore | |

**PERSONNEL ON SITE:**

Samuel Moore (SM), Caitlyn Farragher (CF), Damon DeYoung (DD), Michael Running (MR; Holt), Leon Atencio (LA; Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed boring SP-B91; collected 2 soil samples and 1 groundwater sample.
- Completed boring SP-B93; collected 3 soil samples and 2 groundwater samples.
- Completed boring SP-B94; collected 2 soil samples and 2 groundwater samples.

**DEVIATIONS FROM WORKPLAN:**

- Elevated detections were not observed in boring SP-B91, and as such multiple samples were not collected. Also, a lower water-bearing unit was not identified, and therefore no deep groundwater sample could be collected.
- Refusal was encountered at SP-B93 prior to the aquitard in the clay layer, likely in the gravel bed just above the aquitard.
- Elevated detections were not observed in boring SP-B94, and as such multiple samples were not collected.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

All field activities were conducted safely and efficiently.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0630 | SM and CF onsite, prepping for soil/groundwater sampling. |
| 0715 | Holt onsite. |
| 0730 | Tailgate meeting, begin working in the southeast corner of the site and in the South Plantation. |
| 0735 | Begin drilling SP-B91. |
| 0930 | Completed drilling SP-B91; continuous clay layer between 9.6 and 40 ft bgs with no elevated detections. |
| 0945 | Abandoned boring SP-B91. |
| 1010 | Started drilling SP-B93. |
| 1210 | Completed drilling SP-B93; met refusal at 40 ft bgs at gravel layer likely just above aquitard. |
| 1230 | Holt off site to grab lunch. |
| 1300 | Holt back on site. |

| | |
|---|---|
| 1335 | Abandoned boring SP-B93. |
| 1340 | Started drilling SP-B94. |
| 1520 | DD on site. |
| 1540 | Completed boring SP-B94; encountered deep clay aquitard at 39.4 ft bgs. |
| 1600 | Attempted to locate borings CL-B27 and -B28 within soil stockpiles. Packed up equipment for overnight storage. |
| 1715 | All off site. |

**SUMMARY OF FINDINGS:**

- Elevated PID readings were not observed at any depth in boring SP-B91. A continuous clay layer was observed between 9.6 and 40 ft bgs.
- Elevated PID readings (1,989 and 1,901 ppb) were observed in boring SP-B93 between 12 and 13 ft bgs; deep clay was not encountered, but refusal was at the gravel bed layer at 40 ft bgs, likely just above the aquitard.
- Elevated PID readings were not observed at any depth in boring SP-B94. The deep clay aquitard was encountered at 39.4 ft bgs.

**PLANS FOR THE FOLLOWING DAY:**

Continue the drilling program with borings southwest of the Central Landfill.

**ATTACHMENTS:**

Boring logs for SP-B91, SP-B93 and SP-B94

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore | **Battelle - DAILY FIELD REPORT** |
| Caitlyn Farragher, Gail DeRuzzo | Signed: ___________________________ |

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| DAILY FIELD REPORT<br>6/27/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Cloudy, high 67 F, some light rain in the morning, winds SSW 8 mph | |
| **To:** Carlotta Cellucci | |
| **From:** Samuel Moore | |

**PERSONNEL ON SITE:**

Samuel Moore (SM), Caitlyn Farragher (CF), Michael Running (MR; Holt), Leon Atencio (LA; Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed boring CL-B95; collected 3 soil samples and 2 groundwater samples.
- Completed boring CL-B96; collected 3 soil samples and 2 groundwater samples.

**DEVIATIONS FROM WORKPLAN:**

- Stepped out CL-B96 10 ft to the north to avoid proximity with buried electrical.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Confirmed electrical near CL-B96 is locked out/tagged out.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0700 | SM and CF onsite, prepping for soil/groundwater sampling. |
| 0715 | Holt onsite. |
| 0730 | Tailgate meeting, begin working in the southeast corner of the site and in the South Plantation. |
| 0750 | Abandoned boring SP-B94. |
| 0800 | Begin drilling CL-B95. |
| 0945 | Completed boring CL-B95; encountered deep clay aquitard at 33 ft bgs. |
| 1030 | Began drilling CL-B96. |
| 1055 | Abandoned boring CL-B95. |
| 1205 | Completed boring CL-B96; encountered deep clay aquitard at 39.8 ft bgs. |
| 1240 | Abandoned boring CL-B96. |
| 1330 | Holt off site. |
| 1345 | SM and CF left for lunch. |
| 1445 | SM and CF returned from lunch. Organizing equipment and supplies and preparing for demobilization. |
| 1700 | All off site. |

**SUMMARY OF FINDINGS:**

- Elevated PID readings (1053 ppb) were observed in boring CL-B95 at 13 ft bgs; deep clay was encountered at 33 ft bgs.
- Elevated PID readings (664 ppb) were observed in boring CL-B96 at 5 ft bgs. The deep clay aquitard was encountered at 39.8 ft bgs.

**PLANS FOR THE FOLLOWING DAY:**

Continue the drilling program with borings east of the South Plantation. Demobilize from first mobilization.

**ATTACHMENTS:**

Boring logs for CL-B95 and CL-B96

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br>Caitlyn Farragher, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

| DAILY FIELD REPORT<br>6/28/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** partly cloudy sky, low 60s in the morning, warms to high 60s in the afternoon. | |
| **To:** Carlotta Cellucci | |
| **From:** Damon DeYoung | |

**PERSONNEL ON SITE:**

Damon DeYoung (DD), Michael Meyer (MM), Michael Running (MR; Holt), Leon Atencio (LA; Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed boring SP-B090, collected 3 soil samples (plus 1 soil duplicate) and 2 groundwater samples (plus 1 groundwater duplicate)
- Collected equipment blank EB-190628-01

**DEVIATIONS FROM WORKPLAN:**

- None

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Traffic flagging personnel from Chugach were used to mitigate vehicular traffic concerns while drilling in the roadway along Bradley Road. All field activities were conducted safely and efficiently.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0640 | DD onsite, prepping for soil/groundwater sampling |
| 0650 | Chugach onsite prepping road flagging |
| 0655 | MM onsite |
| 0715 | Holt onsite |
| 0730 | Tailgate meeting, last day in the field, performing in-road boring SP-B090, |
| 0745 | Began drilling boring SP-B090 |
| 0920 | Completed drilling boring SP-B090 |
| 0945 | Abandoned boring SP-B090 |
| 1010 | Collected equipment blank in the OU1 shed. |
| 1105 | Holt demobilized all drilling equipment offsite |
| 1200 | DD and MM demobilized all sampling equipment offsite |

**SUMMARY OF FINDINGS:**

- No PID detections were observed in boring SP-B090.

**PLANS FOR THE FOLLOWING DAY:**

All field activities have been completed for this first mobilization.

**ATTACHMENTS:**

Boring log for SP-B090

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br><br>Caitlyn Farragher, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br><br>Signed: ___________________________ |

BATTELLE
It can be done

| DAILY FIELD REPORT<br>9/30/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** clear skies, warm ~high 60's | |
| **To:** Carlotta Cellucci | |
| **From:** Damon DeYoung | |

**PERSONNEL ON SITE:**

Damon DeYoung (DD), Steven Verdibello (SV), Michael Meyer (MM), Carlotta Cellucci (CC), Arthur Wisehart (AW), Michael Levi Jr. (ML, Holt), Michael Weatherford (MW, Holt)

**SUMMARY OF WORK COMPLETED:**

- Began boring CL-B132, collected 2 soil samples and 1 groundwater sample

**DEVIATIONS FROM WORKPLAN:**

- None

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Water line project kicked off today and personnel were using the garage near boring CL-B132 as a laydown area. .

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0645 | DD and SV at Pass and ID office for badging |
| 1000 | Holt onsite for kickoff meeting |
| 1120 | Tailgate meeting, working in the fabric building at CL-B132. DD and SV left the site to pickup supplies at FedEx |
| 1300 | Began drilling at boring CL-B132 |
| 0615 | Holt offsite for the day |
| 0630 | DD and SV offsite for the day |

**SUMMARY OF FINDINGS:**

- In boring CL-B132, PID detections were observed throughout the soil column. The PID meter read a steady background concentration between 30 and 200 ppb (possibly due to drill rig and adjacent front end loader activities) and may have impacted the readings of the soil core results.
- Collected CL-B132-S-07-190930 at 1355
- Collected CL-B132-GW-15-190930 at 1530
- Collected CL-B132-S-27-190930 at 1635

**PLANS FOR THE FOLLOWING DAY:**

Continue the drilling program just north of the South Plantation to allow the water line project space for pipe laydown. After CL-B132 is complete, the drilling program will continue to CL-B131.

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br><br>Steve Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br><br>Signed: ___________________________ |

| DAILY FIELD REPORT 10/1/2019 | **Contract No.** N39430-16-D-1802, TO N3943018F4359 (CTO 41) **References** Sampling and Analysis Plan (Battelle 2019) Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** clear skies, cool ~low 60's | |
| **To:** Carlotta Cellucci | |
| **From:** Damon DeYoung | |

**PERSONNEL ON SITE:**

Damon DeYoung (DD), Steven Verdibello (SV), Arthur Wisehart (AW), Michael Levi Jr. (ML, Holt), Michael Weatherford (MW, Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed boring CL-B132, collected 1 groundwater sample
- Completed boring SP-B141, no samples collected; clay encountered at 55 ft bgs.

**DEVIATIONS FROM WORKPLAN:**

- None

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Water line project kicked off today and personnel were using the garage near boring CL-B132 as a laydown area. .

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0715 | DD and SV onsite |
| 0800 | Holt onsite |
| 0820 | Tailgate meeting, working in the fabric building at CL-B132. |
| 1015 | Installed deeper temp well in CL-B132, purged until 10:30 |
| 1230 | Abandoned boring CL-B132 |
| 1330 | Began drilling boring SP-B141 to target top of clay |
| 1610 | Completed and abandoned boring SP-B141 |
| 1640 | Cleared the site adjacent to boring location MW1-59 |
| 1730 | Holt offsite for the day |
| 1800 | DD and SV offsite |

**SUMMARY OF FINDINGS:**

- Collected CL-B132-GW-45-191001 at 1030
- In boring SP-B141, PID detections were elevated in the 15 to 20 ft bgs range. Minor PID detections were observed in the 36 to 40 ft bgs range. No samples were collected in SP-B141; the clay aquitard was encountered at 55 ft bgs.

**PLANS FOR THE FOLLOWING DAY:**

Continue the drilling program at boring MW1-59 to the south of the south plantation.

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br>Steve Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

BATTELLE
It can be done

| DAILY FIELD REPORT<br>10/2/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** clear skies, cool ~low 60's | |
| **To:** Carlotta Cellucci | |
| **From:** Damon DeYoung | |

**PERSONNEL ON SITE:**

Damon DeYoung (DD), Steven Verdibello (SV), Arthur Wisehart (AW), Michael Levi Jr. (ML, Holt), Michael Weatherford (MW, Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed boring SP-B130 and installed monitoring well MW1-59
- Collected soil sample SP-B130-S-65-191002 at 1205
- Began boring SP-B140

**DEVIATIONS FROM WORKPLAN:**

- None

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Field activities were performed safely in accordance with the APP.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0700 | DD and SV onsite preparing for the field day |
| 0800 | Holt onsite |
| 0830 | Tailgate meeting, working south of the south plantation |
| 1205 | Completed boring SP-B130, total depth 75 ft bgs; collected soil sample at 65 ft bgs |
| 1220 | Began setting well MW1-59 in boring SP-B130 |
| 1445 | Completed well installation at MW1-59 |
| 1600 | Began boring SP-B140 |
| 1700 | Drilled SP-B140 to 40 ft, will finish (to 60 ft) tomorrow, 10/3/19. Casing left in ground |
| 1705 | Holt offsite for the day |
| 1730 | DD and SV decontaminated soil sampling equipment |
| 1800 | DD and SV offsite for the day |

**SUMMARY OF FINDINGS:**

- In boring SP-B130 slight PID detections were limited to a narrow depth range (38 to 39 ft bgs) with a reading of 7 ppb.
- Collected soil sample SP-B130-S-65-191002 at 1205
- In boring SP-B140, elevated PID detections were observed in shallow soils (down to 15 ft bgs).

**PLANS FOR THE FOLLOWING DAY:**

Continue the drilling program at SP-B140, then move to the motorcycle range.

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br>Steve Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

BATTELLE
It can be done

| **DAILY FIELD REPORT**<br>**10/3/2019** | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** cloudy, windy with a 40% chance of rain, cool ~high 50's | |
| **To:** Carlotta Cellucci | |
| **From:** Damon DeYoung | |

**PERSONNEL ON SITE:**

Damon DeYoung (DD), Steven Verdibello (SV), Arthur Wisehart (AW), Michael Levi Jr. (ML, Holt), Michael Weatherford (MW, Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed boring SP-B140 in the middle of the south plantation. The clay aquitard was intercepted at 57 ft bgs.
- Completed boring CL-B134. Collected soil and groundwater samples at 50 ft and duplicates at 49 ft.

**DEVIATIONS FROM WORKPLAN:**

- Only one soil and one groundwater sample was collected from CL-B-134 (work plan listed 2 soils and 2 groundwater samples).

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Field activities were performed safely in accordance with the APP.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0700 | DD and SV onsite preparing for the field day |
| 0800 | Holt onsite |
| 0810 | Tailgate meeting, working at boring SP-B140 |
| 1055 | Completed boring SP-B140 down to 60 ft bgs. |
| 1140 | Setup on boring CL-B134 near historic boring B18 |
| 1200 | Began drilling boring CL-B134 |
| 1500 | Collected soil sample from CL-B134 at 50 ft. Collected duplicate (labelled 49 ft). Set temporary 2-inch well (5 ft of screen) to 50 ft bgs for grab groundwater sample |
| 1620 | Collected groundwater samples from CL-B134, collected parent (50 ft) and duplicate (49 ft) |
| 1700 | Holt offsite |
| 1715 | DD and SV offsite for the day. |

**SUMMARY OF FINDINGS:**

- In boring SP-B140, minor PID detections were observed in the deeper soil column from 47 to 55 ft bgs.
- In boring CL-B134, PID detections were observed from the surface to 40 ft bgs. Soil and groundwater samples were collected at 50 ft bgs (with duplicates labelled as 49 ft).
-

**PLANS FOR THE FOLLOWING DAY:**

Continue the drilling program at CL-B142.

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br><br>Steve Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br><br>Signed: ___________________________ |

BATTELLE
It can be done

| DAILY FIELD REPORT<br>10/4/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** cloudy, windy with a 20% chance of rain, cool ~high 50's | |
| **To:** Carlotta Cellucci | |
| **From:** Damon DeYoung | |

**PERSONNEL ON SITE:**

Damon DeYoung (DD), Steven Verdibello (SV), Arthur Wisehart (AW), Michael Levi Jr. (ML, Holt), Michael Weatherford (MW, Holt), Waag Tree Service (2 workers)

**SUMMARY OF WORK COMPLETED:**

- Abandoned CL-B134.
- Drilled to 90 ft bgs at NP-B135, collected two soil samples.

**DEVIATIONS FROM WORKPLAN:**

- Two soil samples were collected from NP-B135, work plan proposed one sample. Drilled deeper than anticipated.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Field activities were performed safely in accordance with the APP.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0700 | DD and SV onsite preparing for the field day |
| 0750 | Holt onsite |
| 0810 | Tailgate meeting, pulling temporary well and abandoning CL-B134 borehole |
| 0845 | DD and SV off-site to Fedex to ship samples to APPL |
| 0900 | Holt called to report broken hydraulic hose on drill rig |
| 1000 | DD and SV and Holt all back on site. Holt was able to obtain part needed to fix hose. |
| 1030 | Drill rig back to operational. Holt trying to extract temporary well – left 20 ft of screen/casing inside borehole, poured in bentonite chips to seal hole |
| 1145 | Holt setting up at MW1-62 location in north plantation (NP-B135F). Begin drilling at 1215 |
| 1530 | DD off site. |
| 1615 | Drilled to completion depth of 90 ft bgs, will set well on Monday (10/7/19). Holt off-site. |
| 1705 | SV off site. |

**SUMMARY OF FINDINGS:**

- At NP-B135, significant PID detections were observed from 31 to 39 ft bgs. Soil sample was collected at 38 ft bgs.
- Soil sample collected at 78 ft bgs (directly above clay layer), in isolated zone of elevated PID reading

**PLANS FOR THE FOLLOWING DAY:**

Install well at NP-B135 (MW1-62). Then continue to MW1-63.

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br>Steve Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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It can be done

<table>
<tr><td>DAILY FIELD REPORT<br>10/7/2019</td><td colspan="2">Contract No.<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>References<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019)</td></tr>
<tr><td colspan="3">Project: 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations</td></tr>
<tr><td colspan="3">Location: Naval Base Kitsap Keyport, WA OU1</td></tr>
<tr><td colspan="2">Client: Naval Facilities Engineering Command Northwest</td><td>Contractor: Battelle</td></tr>
<tr><td colspan="3">Weather: cloudy, windy with a 60% chance of rain, cool ~high 50's</td></tr>
<tr><td colspan="3">To: Carlotta Cellucci</td></tr>
<tr><td colspan="3">From: Steven Verdibello</td></tr>
</table>

**PERSONNEL ON SITE:**

Steven Verdibello (SV), Lauren March (LM), Arthur Wisehart (AW), Michael Levi Jr. (ML, Holt), Michael Weatherford (MW, Holt), Michael Meyer (MM), Carlotta Cellucci

**SUMMARY OF WORK COMPLETED:**

- Set well (MW1-62) to 41 ft bgs.
- Drilled to 75 ft bgs at NP-B136, collected two soil samples.

**DEVIATIONS FROM WORKPLAN:**

- Two soil samples were collected from NP-B136, work plan proposed one sample. Drilled deeper than anticipated.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Field activities were performed safely in accordance with the APP.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0730 | SV onsite preparing for the field day; LM at Pass & ID office |
| 0800 | Holt onsite |
| 0830 | Tailgate safety meeting |
| 0900 | After discussion, Holt setting well (MW1-62) to 41 ft bgs. |
| 1130 | MW1-62 complete, moving drill rig to NP-B136 (MW1-63) location |
| 1145 | Begin drilling NP-B136 |
| 1400 | Holt off site for lunch |
| 1600 | Drilled to completion depth of 90 ft bgs (did not recover material from 75 to 90 ft) |
| 1630 | Holt off site. |
| 1640 | Collected grab soil samples at 36 and 66 ft bgs |
| 1710 | SV and LM off site. |

**SUMMARY OF FINDINGS:**

- At NP-B1365, significant PID detections were observed from 31 to 39 ft bgs. Soil sample was collected at 36 ft bgs.
- Soil sample collected at 66 ft bgs (directly above clay layer), in zone of elevated PID reading

**PLANS FOR THE FOLLOWING DAY:**

Install well at NP-B136 (MW1-63). Then continue to NP-B137 (MW1-64).

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br>Steve Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

BATTELLE
It can be done

| DAILY FIELD REPORT<br>10/8/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** cloudy, windy, light rain in morning, cool ~low 50's | |
| **To:** Carlotta Cellucci | |
| **From:** Steven Verdibello | |

**PERSONNEL ON SITE:**

Steven Verdibello (SV), Lauren March (LM), Arthur Wisehart (AW, Holt), Michael Levi Jr. (ML, Holt), Michael Weatherford (MW, Holt)

**SUMMARY OF WORK COMPLETED:**

- Installed well MW1-63 to 40 ft bgs.
- Drilled NP-B137 to 60 ft bgs (clay observed at 55 ft bgs). Set well (MW1-64) to 55 ft bgs.
- Collected one soil sample at NP-B137 at a depth of 52 ft bgs.

**DEVIATIONS FROM WORKPLAN:**

- None

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Field activities were performed safely in accordance with the APP.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0730 | SV and LM on site preparing for the field day (Holt running late due to gathering well development supplies) |
| 0830 | Holt onsite |
| 0830 | Tailgate safety meeting |
| 0900 | Holt setting well (MW1-63) to 40 ft bgs |
| 1045 | MW1-63 complete, moving drill rig to NP-B137 (MW1-64) location |
| 1130 | Begin drilling NP-B137 |
| 1245 | Drilled to completion depth of 60 ft bgs (silty clay observed from 55 to 60 ft) |
| 1300 | Holt and LM off site for lunch |
| 1340 | Collected grab soil sample (cVOCs, PCB congeners, TPH-D) at 52 ft bgs |
| 1530 | Completed installation of MW1-64 to 55 ft bgs |
| 1600 | Holt off site |
| 1615 | SV and LM off site. |

**SUMMARY OF FINDINGS:**

- At NP-B137, elevated PID detections were observed from 38 to 45 ft bgs and 48 to 56 ft bgs. Soil sample was collected at 52 ft bgs for cVOCs, PCB congeners, and TPH-D.

**PLANS FOR THE FOLLOWING DAY:**

Continue drilling program at NP-B138 (MW1-65).

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br><br>Steve Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br><br>Signed: ___________________________ |

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<table>
<tr><td colspan="2">DAILY FIELD REPORT<br>10/9/2019</td><td colspan="2">Contract No.<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>References<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019)</td></tr>
<tr><td colspan="4">Project: 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations</td></tr>
<tr><td colspan="4">Location: Naval Base Kitsap Keyport, WA OU1</td></tr>
<tr><td colspan="3">Client: Naval Facilities Engineering Command Northwest</td><td>Contractor: Battelle</td></tr>
<tr><td colspan="4">Weather: sunny, calm, cool ~high 40's to low 50's</td></tr>
<tr><td colspan="4">To: Carlotta Cellucci</td></tr>
<tr><td colspan="4">From: Steven Verdibello</td></tr>
</table>

**PERSONNEL ON SITE:**

Steven Verdibello (SV), Arthur Wisehart (AW, Holt), Michael Levi Jr. (ML, Holt), Michael Weatherford (MW, Holt)

**SUMMARY OF WORK COMPLETED:**

- Finished installing monument for MW1-64 and bollards for all SP wells.
- Drilled NP-B138 to 85 ft bgs (clay observed at 63 ft bgs). Set well (MW1-65) to 63 ft bgs.
- Collected soil samples at NP-B138 at a depth of 6 ft bgs (including duplicate) and 62 ft bgs.

**DEVIATIONS FROM WORKPLAN:**

- None

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Field activities were performed safely in accordance with the APP.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0720 | SV on site preparing for the field day |
| 0745 | Holt onsite |
| 0800 | Tailgate safety meeting |
| 0830 | Holt setting well monument for MW1-64 and bollards for MW1-63 and MW1-64 |
| 0900 | Scott Elkind of Sealaska stopped by to check in. Had heard about tree removal |
| 0925 | Moving drill rig to NP-B138 (MW1-65) location |
| 1100 | Begin drilling NP-B138 |
| 1130 | Collected grab soil sample (cVOCs, PCB congeners, TPH-D) at 6 ft bgs |
| 1315 | MM on site to discuss well placement (MW1-65) |
| 1345 | Holt off site for lunch |
| 1350 | After discussion with Carlotta – will install two (deep and shallow) wells at this location |
| 1405 | Collected grab soil sample (cVOCs, PCB congeners, TPH-D) at 62 ft bgs |
| 1545 | Well (MW1-65) and sand pack installed. Will complete well and drill shallow well tomorrow after mechanic fixes slight diesel leak |
| 1550 | Holt off site |
| 1630 | SV off site. |

**SUMMARY OF FINDINGS:**

- At NP-B138, elevated PID detections were observed from 1 to 15 ft bgs; isolated detection at 44 ft bgs; and 57 to 63 ft bgs. Also, PID detections were observed in peat layers at depths greater than 63 ft bgs (in silty clay unit. Soil samples were collected at 6 and 62 ft bgs for cVOCs, PCB congeners, and TPH-D.

**PLANS FOR THE FOLLOWING DAY:**

Complete installation of MW1-65. Continue drilling program at NP-B143 (MW1-67).

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br>Steve Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT 10/10/2019 | **Contract No.** N39430-16-D-1802, TO N3943018F4359 (CTO 41) **References** Sampling and Analysis Plan (Battelle 2019) Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** sunny, calm, cool ~high high 50's | |
| **To:** Carlotta Cellucci | |
| **From:** Steven Verdibello | |

**PERSONNEL ON SITE:**

Steven Verdibello (SV), Lauren March (LM), Arthur Wisehart (AW, Holt), Michael Levi Jr. (ML, Holt), Michael Weatherford (MW, Holt)

**SUMMARY OF WORK COMPLETED:**

- Finished installing MW1-65. Drilled NP-B143 and installed MW1-67.
- Drilled CL-B142 to 60 ft bgs (clay observed at 46 ft bgs).

**DEVIATIONS FROM WORKPLAN:**

- Installed two wells at NP-B138 location – one deep (NP-B138; MW1-65) and one shallow (NP-B143; MW1-67).

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Field activities were performed safely in accordance with the APP.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0900 | SV and LM on site preparing for the field day. Cleaning terra-cores and preparing samples for the lab |
| 1000 | Holt, including Mechanic, onsite; Tailgate safety meeting |
| 1050 | LM off site to Fed Ex for sample shipping |
| 1130 | Holt mechanic off site. Drill rig in good, working order |
| 1200 | Pulled casing at NP-B138; began drilling NP-B143;<br>LM began well development at MW1-62 |
| 1330 | Installation of MW1-67 complete. Setting up at boring CL-B142. |
| 1400 | Begin drilling at CL-B142 |
| 1620 | Stop well development – water visibly clear for >20 minutes – turbidity <30 NTU at final reading |
| 1700 | Completed CL-B142 to 60 ft bgs (clay observed at 46 ft) |
| 1715 | Holt off site |
| 1745 | SV and LM off site. |

**SUMMARY OF FINDINGS:**

- At NP-B143, elevated PID detections were observed from 1 to 15 ft bgs.
- At CL-B142, the clay unit was observed at 46 ft bgs.

**PLANS FOR THE FOLLOWING DAY:**

Abandon the CL-B142 borehole. Continue drilling program at CL-B133 (MW1-61).

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br>Steve Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

| DAILY FIELD REPORT<br>10/11/2019 | Contract No.<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** sunny, calm, warm ~low 60's | |
| **To:** Carlotta Cellucci | |
| **From:** Steven Verdibello | |

**PERSONNEL ON SITE:**

Steven Verdibello (SV), Arthur Wisehart (AW, Holt), Michael Levi Jr. (ML, Holt), Michael Weatherford (MW, Holt)

**SUMMARY OF WORK COMPLETED:**

- Abandoned CL-142 borehole
- Drilled CL-B133 to 60 ft bgs (clay observed at 41 ft bgs). Set well (MW1-61) to 13 ft bgs.
- Collected soil samples at CL-B133 at depths of 6, 13, 29, and 38 ft bgs

**DEVIATIONS FROM WORKPLAN:**

- Collected four soil samples from CL-B133; SAP called for two soil samples. Installed shallow monitoring well instead of deeper (on top of deep clay layer) well.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Field activities were performed safely in accordance with the APP.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0725 | SV on site preparing for the field day. |
| 0750 | Holt onsite |
| 0810 | Tailgate safety meeting |
| 0930 | CL-B142 borehole abandoned |
| 0945 | Begin drilling at CL-B133 (MW1-61) |
| 1245 | CL-B133 complete. Observed clay layer at 41 ft. |
| 1300 | Holt off site for lunch |
| 1350 | Will set well, per Michael Meyer, to 13 ft bgs |
| 1500 | MW1-61 installed to 13 ft bgs. Holt needs equipment for flush-mount manhole, will install on Monday, 10/14 |
| 1530 | Holt off site; SV preparing samples/labels. Quick inventory of supplies for next week and GW sampling the following week. |
| 1630 | SV off site |

**SUMMARY OF FINDINGS:**

- At CL-B133, elevated PID detections were observed from 1 to 15 ft bgs (>1,000 PPB). PID detections were observed throughout the soil column, with results >1,000 ppb at: 22, 29, and 41 to 43 ft bgs. Soil samples were collected at 6, 13, 29, and 38 bgs for cVOCs.

**PLANS FOR THE FOLLOWING DAY:**

Complete installation of MW1-61. Continue drilling program in south plantation vicinity

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br><br>Steve Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br><br>Signed: ___________________________ |

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| DAILY FIELD REPORT 10/14/2019 | **Contract No.** N39430-16-D-1802, TO N3943018F4359 (CTO 41) **References** Sampling and Analysis Plan (Battelle 2019) Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** cloudy calm, cool ~low to mid 50's | |
| **To:** Carlotta Cellucci | |
| **From:** Steven Verdibello | |

**PERSONNEL ON SITE:**

Steven Verdibello (SV), Michael Meyer (MM), Arthur Wisehart (AW, Holt), Michael Levi Jr. (ML, Holt)

**SUMMARY OF WORK COMPLETED:**

- Completed installation of MW1-61 (flush-mount manhole)
- Drilled CL-B98 to 40 ft bgs (clay observed at 37 ft bgs)
- Collected soil samples at CL-B98 at depths of 2 and 30 ft bgs
- Collected grab groundwater samples at CL-B98 from screened intervals of 10 to 15 ft bgs and 32 to 37 ft bgs

**DEVIATIONS FROM WORKPLAN:**

- None

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Field activities were performed safely in accordance with the APP.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0715 | SV and MM on site preparing for the field day. Holt running late – new helper couldn't get badge (office closed due to holiday) |
| 0900 | MM and SV begin well development at MW1-63. (Begin pumping at 0920) |
| 0940 | Holt on site |
| 1100 | Flush-mount manhole installed at MW1-61, preparing to drill CL-B98 |
| 1245 | Holt off site for lunch |
| 1300 | Collected grab groundwater sample with temporary well screen set from 10 to 15 ft bgs. |
| 1325 | Continue drilling CL-B98 |
| 1430 | Completed CL-B98 to total depth of 40 ft bgs (clay aquitard observed at 37 ft bgs). Collected soil samples at 2 and 30 ft bgs |
| 1520 | Collected grab groundwater sample with temporary well screen set from 32 to 37 ft bgs. |
| 1600 | MM halfway done with well development of MW1-64. |
| 1630 | Holt set up on SP-B131 for tomorrow (10/15). Off site at 1630. |
| 1700 | SV and MM off site |

**SUMMARY OF FINDINGS:**

- At CL-B98, elevated PID detections were observed from 1 to 2 ft bgs, and from 29 to 35 ft bgs. Soil samples were collected at 2 and 30 ft bgs for cVOCs. Grab groundwater samples were collected from 10 to 15 ft bgs (5-ft pre-packed well screen and PVC casing), and from 32 to 37 ft bgs.

**PLANS FOR THE FOLLOWING DAY:**

Continue drilling program in south plantation vicinity (SP-B131)

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br><br>Steve Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br><br>Signed: ___________________________ |

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| DAILY FIELD REPORT 10/15/2019 | **Contract No.** N39430-16-D-1802, TO N3943018F4359 (CTO 41) **References** Sampling and Analysis Plan (Battelle 2019) Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** cloudy calm, cool ~low to mid 50's | |
| **To:** Carlotta Cellucci | |
| **From:** Steven Verdibello | |

**PERSONNEL ON SITE:**
Steven Verdibello (SV), Arthur Wisehart (AW, Holt), Michael Levi Jr. (ML, Holt), Cody Weller (CW, Holt)

**SUMMARY OF WORK COMPLETED:**

- Drilled SP-B131 to 80 ft bgs (clay observed at 75 ft bgs)
- Collected soil samples at SP-B131 at depths of 6 and 23 ft bgs
- Collected grab groundwater samples at SP-B131 from screened intervals of 10 to 15 ft bgs and 35 to 40 ft bgs

**DEVIATIONS FROM WORKPLAN:**
- None

**SAFETY OBSERVATIONS AND GOOD CATCHES:**
Field activities were performed safely in accordance with the APP.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0720 | SV on site preparing for the field day |
| 0810 | Holt on site; 2nd helper at Pass & ID |
| 0930 | Tailgate safety meeting |
| 0950 | Following prep and equipment decon, begin SP-B131 |
| 1000 | Collected equipment blank for grab GW sampling (used pump and tubing after decon) |
| 1050 | Collected grab groundwater sample with temporary well screen set from 10 to 15 ft bgs. Collected volume for MS/MSD |
| 1100 | Collected soil sample (VOCs and TOC) at 6 ft bgs |
| 1445 | Completed SP-B131 to total depth of 80 ft bgs (clay aquitard observed at 75 ft bgs). Collected soil samples at 6 and 23 ft bgs |
| 1500 | Collected grab groundwater sample with temporary well screen set from 35 to 40 ft bgs. |
| 1630 | Holt off site |
| 1645 | SV off site |

**SUMMARY OF FINDINGS:**

- At SP-B131, elevated PID detections were observed from 6 to 7 ft bgs, and at 15 ft bgs. Soil samples were collected at 6 and 23 ft bgs for cVOCs and TOC. Grab groundwater samples were collected from 10 to 15 ft bgs (5-ft pre-packed well screen and PVC casing), and from 35 to 40 ft bgs. Clay aquitard was observed at 75 ft bgs.

**PLANS FOR THE FOLLOWING DAY:**

Continue drilling program in south plantation vicinity (SP-B92, along Bradley Road)

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br>Steve Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT 10/16/2019 | **Contract No.** N39430-16-D-1802, TO N3943018F4359 (CTO 41) **References** Sampling and Analysis Plan (Battelle 2019) Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** cloudy, light rain, cool ~low to mid 50's | |
| **To:** Carlotta Cellucci | |
| **From:** Steven Verdibello | |

**PERSONNEL ON SITE:**

Steven Verdibello (SV), Michael Meyer (MM), Arthur Wisehart (AW, Holt), Michael Levi Jr. (ML, Holt), Cody Weller (CW, Holt)

**SUMMARY OF WORK COMPLETED:**

- Drilled SP-B-92 to 45 ft bgs (deep clay aquitard not encountered)
- Collected soil samples at SP-B92 at depths of 13 and 28 ft bgs
- Collected grab groundwater samples at SP-B92 from screened intervals of 10 to 15 ft bgs and 25 to 30 ft bgs. Collected equipment blank for GW grab sampling
- Drilled SP-B144 to 50 ft bgs (will continue tomorrow); collected soil sample at 50 ft bgs

**DEVIATIONS FROM WORKPLAN:**

- Added SP-B144 to drilling program (MW1-68) - deeper well adjacent to SP-B139 (MW1-66)

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Field activities were performed safely in accordance with the APP.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0720 | SV and MM on site preparing for the field day |
| 0810 | Holt on site |
| 0820 | Tailgate safety meeting |
| 1000 | Following prep and equipment decon, begin SP-B92 |
| 0940 | Collected equipment blank for grab GW sampling (used pump and tubing after decon) |
| 1050 | Collected grab groundwater sample with temporary well screen set from 10 to 15 ft bgs. |
| 1200 | Completed SP-B92 to total depth of 45 ft bgs (deep clay aquitard not encountered, no PID detections). Collected soil samples at 13 and 28 ft bgs |
| 1230 | Collected grab groundwater sample with temporary well screen set from 25 to 30 ft bgs. |
| 1315 | Equipment decon and setting up at SP-B144 (MW1-68) |
| 1715 | SV off site |

**SUMMARY OF FINDINGS:**

- At SP-B92, no PID detections were observed below 21 ft bgs. Soil samples were collected at 13 and 28 ft bgs for cVOCs and TOC. Grab groundwater samples were collected from 10 to 15 ft bgs (5-ft pre-packed well screen and PVC casing), and from 25 to 30 ft bgs. Deep clay aquitard was not encountered to 45 ft bgs.
- At SP-B144, significant PID detections were observed from 1 to 50 ft bgs.

**PLANS FOR THE FOLLOWING DAY:**

Finish SP-B144, install MW1-68; then install SP-B139 (MW1-66)

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br>Steve Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT 10/17/2019 | **Contract No.** N39430-16-D-1802, TO N3943018F4359 (CTO 41) **References** Sampling and Analysis Plan (Battelle 2019) Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** cloudy, steady rain, cool ~low to mid 50's | |
| **To:** Carlotta Cellucci | |
| **From:** Steven Verdibello | |

**PERSONNEL ON SITE:**

Steven Verdibello (SV), Michael Meyer (MM), Arthur Wisehart (AW, Holt), Michael Levi Jr. (ML, Holt), Cody Weller (CW, Holt)

**SUMMARY OF WORK COMPLETED:**

- Drilled SP-B144 to 80 ft bgs (deep clay aquitard not encountered); installed MW1-68 to 57 ft bgs
- Drilled SP-B139 to 20 ft bgs; collected soil sample at 9 ft bgs (and field duplicate)

**DEVIATIONS FROM WORKPLAN:**

- Added SP-B144 to drilling program (MW1-68) - deeper well adjacent to SP-B139 (MW1-66)

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

Field activities were performed safely in accordance with the APP.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0715 | SV and MM on site preparing for the field day |
| 0755 | Holt on site |
| 0800 | Tailgate safety meeting |
| 0940 | Completed SP-B144 to 80 ft bgs (deeper clay aquitard not encountered) |
| 0945 | Setting well (MW1-68) to 57 ft bgs |
| 1130 | MW1-68 installation complete; begin SP-B139 (MW1-66) |
| 1400 | Completed SP-B139 to total depth of 20 ft bgs. Collected soil sample at 9 ft (including MS/MSD and FD) |
| 1500 | MM done with developing five NP MWs; MM off site |
| 1810 | Holt and SV off site. Holt left drums and surge block. Holt demob from site |

**SUMMARY OF FINDINGS:**

- At SP-B139, significant PID readings were detected from 1 to 20 ft bgs.

**PLANS FOR THE FOLLOWING DAY:**

Continue to develop wells, prepare for GW monitoring activities

**ATTACHMENTS:**

None

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung, Samuel Moore<br><br>Steve Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br><br>Signed: ___________________________ |

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| DAILY FIELD REPORT 10/18/2019 | Contract No. N39430-16-D-1802, TO N3943018F4359 (CTO 41) References Sampling and Analysis Plan (Battelle 2019) Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Mostly cloudy with occasional rain, high 54 F, winds S 10 mph | |
| **To:** Carlotta Cellucci | |
| **From:** Samuel Moore | |

**PERSONNEL ON SITE:**

Samuel Moore (SM), Max Zelenevich (MZ), Steve Verdibello (SV; Battelle)

**SUMMARY OF WORK COMPLETED:**

- Mobilized and prepared equipment and supplies for groundwater sampling.
- Began development of MW1-68.
- Collected porewater samples PW1-30, -31, and -32.

**DEVIATIONS FROM WORKPLAN:**

- Porewater sample location PW1-32 was moved 10 ft west of the planned location to align with stream.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

All field activities were conducted safely and efficiently.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0730 | SV onsite, prepping for development of MW1-68. |
| 0830 | SM and MZ onsite, transporting equipment and supplies for groundwater sampling. Reorganized storage shed for porewater and groundwater sampling effort. Picked up more equipment purchased necessary supplies for the week. |
| 1130 | SM and MZ back onsite. |
| 1200 | Held tailgate safety meeting. |
| 1215 | Broke for lunch. |
| 1300 | SM and MZ back onsite. Prepared equipment for porewater sampling. |
| 1330 | SV offsite. |
| 1340 | Departed towards porewater locations PW1-30 through -32, in the north-south streambed to the southwest of the South Plantation and to the west of prior porewater sampling locations. |
| 1357 | Began purging at porewater location PW1-32. Actual sampling location of PW1-32 was moved 10 ft west of the planned location to align with the streambed. Water quality parameters stabilized rapidly, with final turbidity measuring 95.6 NTU and dissolved oxygen measuring 0.31 mg/L. Collected sample at 1415, along with a field duplicate and MS/MSD. |
| 1440 | Began purging at porewater location PW1-31. Water quality parameters stabilized rapidly, with final turbidity measuring 51.3 NTU. Dissolved oxygen was measured to be 5.40 mg/L, but numerous air |

| | |
|---|---|
| | bubbles were seen entering the line, which likely caused the elevated readings. Collected sample at 1455. |
| 1512 | Began purging at porewater location PW1-30. Water quality parameters stabilized rapidly, with final turbidity measuring 17.9 NTU and dissolved oxygen measuring 0.50 mg/L. Collected sample at 1529. In general, samples indicated low conductivity, turbidity, and dissolved oxygen in a mildly reducing, neutral environment. |
| 1340 | Started drilling SP-B94. |
| 1555 | Collected equipment blank EB-191018-01 off of the PushPoint sampler. Performed post-calibrations. Packed up samples and equipment. |
| 1640 | All off site. |

**SUMMARY OF FINDINGS:**

- Three porewater samples were collected from upstream and west of previous porewater sampling locations. These samples were indicative of anoxic, mildly reducing neutral conditions with low suspended solids.

**PLANS FOR THE FOLLOWING DAY:**

Proceed with groundwater monitoring well development at locations MW1-59 and -66 and sampling at locations MW1-18, -65, -51, -54, -52 and -49.

**ATTACHMENTS:**

None.

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung<br>Max Zelenevich, Steve Verdibello, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT<br>10/21/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Cloudy with rain showers, high 58 F, winds S 10 to 15 mph | |
| **To:** Carlotta Cellucci | |
| **From:** Samuel Moore | |

**PERSONNEL ON SITE:**

Samuel Moore (SM), Max Zelenevich (MZ), Zach Cotter (ZC), Michael Meyer (MM; Battelle)
Emily Ryan (ER; GSI); Tom Boyd (TB; NRL)

**SUMMARY OF WORK COMPLETED:**

- Completed development of MW1-68.
- Collected five groundwater samples from monitoring wells MW1-18, MW1-65, MW1-51, MW1-54, and MW1-52.

**DEVIATIONS FROM WORKPLAN:**

- A quantitative microbial population sample was not collected at MW1-51.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

All field activities were conducted safely and efficiently.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0715 | MM onsite, prepping for development of MW1-68 and preparing surge block for development of MW1-66. MZ onsite, calibrating groundwater sampling equipment. |
| 0745 | SM and ZC onsite, preparing sampling equipment. ZC picked up thermal imaging camera. |
| 1000 | Began purging at groundwater monitoring well MW1-65. Water quality parameters stabilized slowly, with final turbidity high but stable at 57.0 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 1215. |
| 1020 | ER onsite. |
| 1033 | Began purging at groundwater monitoring well MW1-18. Water quality parameters stabilized quickly, with final turbidity at 14.3 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 1131. |
| 1200 | MM completed development of MW1-68. |
| 1225 | Broke for lunch. |
| 1357 | SM, MZ, MM, and ZC back onsite. ER and TB on site. |
| 1440 | Began purging at groundwater monitoring well MW1-51. Water quality parameters stabilized with final turbidity at 9.8 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 1601. A quantitative microbial population sample was erroneously not collected. |

| | |
|---|---|
| 1455 | Began purging at groundwater monitoring well MW1-54. Water quality parameters stabilized with a high but stable final turbidity at 194 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 1601. |
| 1625 | Began purging at groundwater monitoring well MW1-52. Water quality parameters stabilized rapidly with final turbidity at 9.6 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 1710. |
| 1620 | MM offsite. |
| 1730 | ER and TB offsite. SM performed end-of-day calibrations and ZC packed up equipment. |
| 1840 | All off site. |

**SUMMARY OF FINDINGS:**

- Five groundwater samples were collected from monitoring wells MW1-18, -65, -51, -54 and -52. These samples were indicative of anoxic, reducing conditions with low suspended solids. Samples collected north of the North Plantation were neutral in pH and samples collected in the South Plantation were of moderately basic.

**PLANS FOR THE FOLLOWING DAY:**

Proceed with groundwater monitoring well development at location MW1-59 and sampling at locations MW1-42, -45, -49, -50, -53, and -57.

**ATTACHMENTS:**

None.

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung<br>Max Zelenevich, Zach Cotter, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT<br>10/22/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Cloudy with AM rain, high 57 F, winds light and variable | |
| **To:** Carlotta Cellucci | |
| **From:** Samuel Moore | |

**PERSONNEL ON SITE:**

Samuel Moore (SM), Max Zelenevich (MZ), Zach Cotter (ZC; Battelle)
Tom Boyd (TB; NRL)

**SUMMARY OF WORK COMPLETED:**

- Completed development of MW1-59.
- Collected six groundwater samples from monitoring wells MW1-57-10, -57-16, -57-32, -42, -45, and -49.
- Collected microbial sample from MW1-51.

**DEVIATIONS FROM WORKPLAN:**

- None.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

All field activities were conducted safely and efficiently. Noted slipping hazard in mud near entrance of South Plantation.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0800 | ZC onsite, procuring ice. |
| 0815 | MZ onsite, calibrating groundwater sampling equipment. |
| 0830 | SM onsite, preparing bottle sets. TB onsite. |
| 0935 | Tailgate safety meeting. |
| 0950 | Began purging at groundwater monitoring well MW1-45. Water quality parameters stabilized gradually, with final turbidity high but stable at 94.7 NTU and dissolved oxygen measuring 0.00 mg/L. Sulfate reducing conditions noted by ORP -221 mV and hydrogen sulfide odor. Collected sample at 1115. |
| 1017 | Began purging at groundwater monitoring well MW1-42. Water quality parameters stabilized quickly, with final turbidity at 0.0 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 1055. Recollected sample volume due to accidentally collecting initial sample from after the sonde. |
| 1032 | Began purging at groundwater monitoring well MW1-57-10 (CMT channel 1). Water quality parameters stabilized slowly and the recharge rate of the well appeared to be quite slow, with numerous air bubbles in the sample line. Final turbidity stabilized at 170 NTU and dissolved oxygen measured 8.96 mg/L due to the air in the sample line. Collected sample at 1134. |
| 1300 | Packing up samples for shipment. |

| | |
|---|---|
| 1400 | SM left site to ship samples and equipment. |
| 1420 | MZ and ZC offsite for lunch. |
| 1500 | SM back onsite, preparing to sample MW1-57-16. TB onsite and checked in to see progress to sampling well MW1-49. |
| 1515 | Began purging at groundwater monitoring well MW1-57-16 (CMT channel 6). Water quality parameters stabilized quickly with a final turbidity of 20.8 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 1550. |
| 1530 | MZ and ZC back onsite. MZ working on developing MW1-59. |
| 1643 | Began purging at groundwater monitoring well MW1-57-32 (CMT middle channel). Water quality parameters stabilized quickly with a final turbidity of 5.1 NTU and dissolved oxygen measuring 0.32 mg/L. Collected sample at 1708. |
| 1651 | Began purging at groundwater monitoring well MW1-49. TB back onsite to help collect samples. Water quality parameters stabilized very quickly with a final turbidity of 3.3 NTU and dissolved oxygen measuring 0.08 mg/L. Collected sample and field duplicate at 1738. |
| 1725 | Began purging at MW1-51 to collect microbial DNA sample that was erroneously missed on October 21, 2019. Collected sample at 1735. |
| 1750 | Performed end-of-day calibrations and packed up equipment. |
| 1905 | All off site. |

**SUMMARY OF FINDINGS:**

- Six groundwater samples were collected from monitoring wells MW1-57-10, -16, and 32 and MW1-42, -45, and -49. Samples at MW1-57 were indicative of anoxic, neutral conditions with increasing clarity with depth. Samples MW1-42, -45, and -49 were indicative of anoxic, reducing conditions with low suspended solids. One sample was collected for microbial population at MW1-51.

**PLANS FOR THE FOLLOWING DAY:**

Proceed with groundwater monitoring well development at location MW1-66 and sampling at locations MW1-58, -60, -43, -50, -53, -55, and -59.

**ATTACHMENTS:**

None.

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung<br>Max Zelenevich, Zach Cotter, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT 10/23/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Partly cloudy, high 57 F, winds NNE 5 to 10 mph | |
| **To:** Carlotta Cellucci | |
| **From:** Samuel Moore | |

**PERSONNEL ON SITE:**

Samuel Moore (SM), Max Zelenevich (MZ), Zach Cotter (ZC), Michael Meyer (MM; Battelle)
Tom Boyd (TB; NRL), Carlotta Cellucci (CC; NAVFAC NW)

**SUMMARY OF WORK COMPLETED:**

- Completed development of MW1-66 and MW1-61.
- Collected seven groundwater samples from monitoring wells MW1-58-9, -58-19, -43, -60, -59, -50, and -53.

**DEVIATIONS FROM WORKPLAN:**

- Water quality parameters were not recorded during development of MW1-61 or -66. These wells were developed in the same manner as the previous wells: surging for ten minutes followed by pumping for approximately 55 gallons of recovered volume. The effluent was visibly inspected to determine whether turbidity met requirements for successful development.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

All field activities were conducted safely and efficiently. Noted hazards working in areas with high concentrations of COCs.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0715 | MM, SM, MZ, and ZC onsite. Performing calibrations and equipment preparation. |
| 0800 | MM collecting thermal images of the stream to the north and northwest of the site. |
| 0820 | Tailgate safety meeting. |
| 0830 | CC onsite. |
| 0900 | TB onsite, preparing to develop MW1-66. |
| 0840 | Began purging at groundwater monitoring well MW1-60. Water quality parameters stabilized gradually, with final turbidity high but stable at 124 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 0940. |
| 0930 | Began purging at groundwater monitoring well MW1-43. Water quality parameters stabilized quickly, with final turbidity at 9.8 NTU and dissolved oxygen measuring 0.06 mg/L. Collected sample at 1007. |
| 1030 | MM and CC offsite. |

| | |
|---|---|
| 1032 | Began purging at groundwater monitoring well MW1-58-9 (CMT channel 1). Water quality parameters stabilized slowly and the recharge rate of the well appeared to be quite slow, with numerous air bubbles in the sample line until the flowrate was reduced. Final turbidity stabilized at 9.1 NTU and dissolved oxygen measured 0.01 mg/L. Collected sample at 1036. |
| 1030 | Began purging at groundwater monitoring well MW1-59. Water quality parameters stabilized slowly with high but stable final turbidity of 233 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 1300. |
| 1056 | Completed development of MW1-66. |
| 1115 | Packing up samples for shipment. |
| 1230 | SM left site to ship samples and equipment. ZC offsite for lunch. |
| 1330 | SM and ZC back onsite. MZ offsite for lunch. TB onsite, fixing surge block for developing MW1-61. |
| 1417 | Began purging at groundwater monitoring well MW1-58-19 (CMT channel 2). Sheen present on surface of discharge. Water quality parameters stabilized slowly with final turbidity at 26.0 NTU and dissolved oxygen measured 0.00 mg/L. Collected sample at 1531. |
| 1510 | TB developing MW1-61 by surging and purging. |
| 1515 | Began purging at groundwater monitoring well MW1-50. Water quality parameters stabilized quickly—except for dissolved oxygen, which was somewhat erratic. This might have been due to the presence of some air in the influent or the shallow screen interval of the well. The final turbidity was measured to be 1.1 NTU and dissolved oxygen was 2.25 mg/L. Collected sample at 1636. A field duplicate was collected for microbial analysis from this location: FD-191023-01. |
| 1550 | Began purging at groundwater monitoring well MW1-53. Water quality parameters stabilized gradually, with final turbidity at 9.6 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 1705; also collected MS/MSD volumes. |
| 1615 | Completed development of MW1-61. |
| 1630 | Began purging at groundwater monitoring well MW1-58-39.5 (CMT middle channel). Purged dry before water quality parameter sonde could be filled. Allowed to recharge for sample collection on October 24. |
| 1700 | TB offsite. |
| 1800 | Performed end-of-day calibrations and packed up equipment. |
| 1840 | All off site. |

**SUMMARY OF FINDINGS:**

- Seven groundwater samples were collected from monitoring wells MW1-58-9, -58-19, -43, -60, -59, -50, and -53. Samples at MW1-58 were indicative of anoxic, neutral conditions but oxidizing conditions in its middle depth; sheen was observed on the discharge during purging of MW1-58. Samples MW1-43, -60, -59, and -53 were indicative of mildly basic, anoxic, reducing conditions with low suspended solids. Sample MW1-50 was indicative of oxic, oxidizing conditions with neutral pH.

**PLANS FOR THE FOLLOWING DAY:**

Proceed with groundwater monitoring well sampling at locations MW1-58-39.5, -56-12, -56-24, -55, -44, -66, -64, -62 and -63.

**ATTACHMENTS:**

None.

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung<br>Max Zelenevich, Zach Cotter, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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<table>
<tr><td>DAILY FIELD REPORT<br>10/24/2019</td><td colspan="2">Contract No.<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>References<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019)</td></tr>
<tr><td colspan="3">Project: 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations</td></tr>
<tr><td colspan="3">Location: Naval Base Kitsap Keyport, WA OU1</td></tr>
<tr><td colspan="2">Client: Naval Facilities Engineering Command Northwest</td><td>Contractor: Battelle</td></tr>
<tr><td colspan="3">Weather: Mostly sunny, high 60 F, winds E 4 mph</td></tr>
<tr><td colspan="3">To: Carlotta Cellucci</td></tr>
<tr><td colspan="3">From: Samuel Moore</td></tr>
</table>

**PERSONNEL ON SITE:**

Samuel Moore (SM), Max Zelenevich (MZ), Zach Cotter (ZC; Battelle)
Tom Boyd (TB; NRL), Arthur Wisehart (AW) and Michael Levi Jr. (ML; Holt)

**SUMMARY OF WORK COMPLETED:**

- Relocated drums to staging area.
- Collected eight groundwater samples from monitoring wells MW1-58-9, -58-19, -58-39, -44, -64, -55, -66, and -62

**DEVIATIONS FROM WORKPLAN:**

- Monitoring wells MW1-56 and -58 were confused on October 23, so samples labeled MW1-58 were in fact MW1-56. This led to the realization that a microbial sample intended to be analyzed at MW1-56 was not collected. Instead, a microbial sample was collected from the shallow interval of MW1-58.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

All field activities were conducted safely and efficiently. Noted hazards of working around a forklift, which was moving around the site to stage drums.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0800 | SM, MZ, and ZC onsite. Performing calibrations and equipment preparation. |
| 0832 | Tailgate safety meeting. |
| 0900 | Attempted to collect a sample at groundwater monitoring well MW1-56-deep (CMT middle channel). Could not collect any volume or detect groundwater with the oil-water interface probe. |
| 0910 | Began purging at groundwater monitoring well MW1-44. Water quality parameters stabilized quickly, with final turbidity at 5.9 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 1005. |
| 0920 | Corrected error in sampling, since bottles collected on October 23, 2019 for MW1-58 were in fact from location MW1-56. Ensured all drums were properly labelled before they were relocated to the staging area. |
| 0945 | Holt (AW and ML) onsite to stage well development drums and apply well ID labels to two newly installed wells. |

| | |
|---|---|
| 0958 | Began purging at groundwater monitoring well MW1-64. Water quality parameters stabilized gradually, with final turbidity high but stable at 145 NTU and dissolved oxygen measuring 0.05 mg/L. Collected sample at 1110. |
| 1000 | TB onsite deploying carbon flux traps. |
| 1003 | Began purging at groundwater monitoring well MW1-58-9 (CMT channel 1). Water quality parameters stabilized slowly and the recharge rate of the well appeared to be quite slow, with numerous air bubbles in the sample line even at lowest flow possible. Final turbidity stabilized at 49.1 NTU and dissolved oxygen measured 6.87 mg/L, likely due to air in the line. Collected sample at 1149. |
| 1135 | Began purging at groundwater monitoring well MW1-55. Water quality parameters stabilized slowly with final turbidity at 59.8 NTU and dissolved oxygen measured 0.00 mg/L. Collected sample at 1315. |
| 1200 | Holt (AW and ML) offsite. |
| 1230 | Packing up samples for shipment. ZC offsite for lunch. |
| 1340 | ZC back onsite. SM offsite to ship samples, MZ offsite for lunch. |
| 1430 | All back onsite. TB onsite to assist with collection of samples. |
| 1443 | Began purging at groundwater monitoring well MW1-66. Water quality parameters stabilized gradually, with final turbidity at 148 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 1606. |
| 1500 | Began purging at groundwater monitoring well MW1-62. Water quality parameters stabilized gradually, with final turbidity at 10.0 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 1700. |
| 1505 | Began purging at groundwater monitoring well MW1-58-19 (CMT channel 2). Water quality parameters stabilized quickly with a final turbidity stabilized at 7.8 NTU and dissolved oxygen measured 0.26 mg/L. Collected sample at 1549. |
| 1600 | TB offsite. |
| 1623 | Began purging at groundwater monitoring well MW1-58-39.5 (CMT middle channel). Water quality parameters stabilized quickly with a final turbidity at 19.7 NTU and dissolved oxygen measured 0.03 mg/L. Collected sample at 1708. |
| 1730 | Performed end-of-day calibrations and packed up equipment. |
| 1834 | All off site. |

**SUMMARY OF FINDINGS:**

- Eight groundwater samples were collected from monitoring wells MW1-58-9, -58-19, -58-39.5, -44, -64, -55, -66, and -62. All samples were reflective of anoxic, reducing conditions of low suspended solids, with the exception of shallow well MW1-58-9, which contained a high dissolved oxygen due to its low recharge rate.

**PLANS FOR THE FOLLOWING DAY:**

Proceed with groundwater monitoring well sampling at locations MW1-2, -46, -47, -55, -63, -48, and -61.

**ATTACHMENTS:**

None.

| Copies to: Michael Meyer, Damon DeYoung | **Battelle - DAILY FIELD REPORT** |
|---|---|

| | |
|---|---|
| Max Zelenevich, Zach Cotter, Gail DeRuzzo | Signed: ___________________________ |

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| DAILY FIELD REPORT<br>10/25/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Mostly sunny, high 57 F, winds SW becoming NE 10 to 20 mph | |
| **To:** Carlotta Cellucci | |
| **From:** Samuel Moore | |

**PERSONNEL ON SITE:**

Samuel Moore (SM), Max Zelenevich (MZ), Zach Cotter (ZC; Battelle)

**SUMMARY OF WORK COMPLETED:**

- Collected four groundwater samples from monitoring wells MW1-2, -46, -47, and -63.

**DEVIATIONS FROM WORKPLAN:**

- Microbial samples were collected using 1 L amber glass containers versus Bio-Flo filters.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

All field activities were conducted safely and efficiently.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0800 | MZ and ZC onsite. Performing calibrations and equipment preparation. |
| 0855 | Began purging at groundwater monitoring well MW1-47. Water quality parameters stabilized gradually, with final turbidity at 47.8 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 1030. |
| 0900 | Began purging at groundwater monitoring well MW1-46. Water quality parameters stabilized very slowly, with a low final turbidity and very low dissolved oxygen. Collected sample and field duplicate at 1108. |
| 1100 | SM onsite. |
| 1130 | MZ off site for lunch. Returned at 1230. |
| 1237 | Began purging at groundwater monitoring well MW1-2. Water quality parameters stabilized very quickly, with final turbidity at 1.5 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 1302. |
| 1245 | ZC off site for lunch. Returned at 1345. |
| 1300 | Began purging at groundwater monitoring well MW1-63. Water quality parameters stabilized very slowly, with final turbidity at 73.9 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 1445. |
| 1330 | Packing up samples for shipment. |
| 1515 | ZC offsite to ship sample coolers. Packing up equipment for shipment. |
| 1630 | MZ off site. |

1700 SM offsite to ship equipment. All off site.

**SUMMARY OF FINDINGS:**

- Four groundwater samples were collected from monitoring wells MW1-2, -46, -47, and -63. All samples were reflective of anoxic, mildly acidic, reducing conditions of low suspended solids.

**PLANS FOR THE FOLLOWING DAY:**

Proceed with groundwater monitoring well sampling at locations MW1-61, -48, -67, and -68.

**ATTACHMENTS:**

None.

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung<br>Max Zelenevich, Zach Cotter, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

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| DAILY FIELD REPORT 10/28/2019 | Contract No. N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Partly cloudy, high 52 F, winds light and variable | |
| **To:** Carlotta Cellucci | |
| **From:** Samuel Moore | |

**PERSONNEL ON SITE:**

Samuel Moore (SM) and Zach Cotter (ZC; Battelle)

**SUMMARY OF WORK COMPLETED:**

- Collected four groundwater samples from monitoring wells MW1-67, MW1-48, MW1-61, and MW1-68.

**DEVIATIONS FROM WORKPLAN:**

- Microbial sample at MW1-68 was collected using a 1 L amber glass container versus Bio-Flo filters.
- MNA parameters—including sulfide and dissolved organic carbon—at MW1-48, -61, and -68 were collected into unpreserved 1 L amber glass containers for the laboratory to subsample and preserve as necessary. These samples were shipped overnight at the end of the day for arrival at the laboratory the morning of October 29.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

All field activities were conducted safely and efficiently.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0840 | SM and ZC onsite. Performing calibrations and equipment preparation. |
| 1020 | Began purging at groundwater monitoring well MW1-67. Water quality parameters stabilized with final turbidity at 5.0 NTU and dissolved oxygen measuring 0.02 mg/L. Collected sample at 1118. |
| 1030 | Began purging at groundwater monitoring well MW1-48. Water quality parameters stabilized gradually, with final turbidity at 26.3 NTU and dissolved oxygen measuring 0.75 mg/L. Vapor was observed in the sample line, which could be due to saturation of dissolved gases or air entering the influent. Collected sample at 1126. |
| 1220 | Collected equipment blank EB-191028-01 off the bladder pump used at MW1-48. |
| 1301 | Collected equipment blank EB-191028-92 off the bladder pump used at MW1-67. |
| 1304 | Began purging at groundwater monitoring well MW1-61. Water quality parameters stabilized very slowly, with final turbidity at 42.2 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 1452. |
| 1400 | Began purging at groundwater monitoring well MW1-68. Water quality parameters stabilized with final turbidity at 75.6 NTU and dissolved oxygen measuring 0.00 mg/L. Collected sample at 1456. |
| 1500 | Packing up samples for shipment. |

| | |
|---|---|
| 1530 | SM offsite to ship sample coolers. ZC performing end-of-day calibrations and decontamination. |
| 1630 | SM back onsite. Packing up for the day. |
| 1700 | All off site. |

**SUMMARY OF FINDINGS:**

- Four groundwater samples were collected from monitoring wells MW1-48, -67, -61, and -68. All samples were reflective of anoxic, reducing conditions of low suspended solids.

**PLANS FOR THE FOLLOWING DAY:**

Proceed with groundwater elevation survey across site. Supervise survey of newly installed sample locations. Ship remaining samples and return rental equipment. Organize storage shed for future use. Demobilize site.

**ATTACHMENTS:**

None.

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung<br>Zach Cotter, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

BATTELLE
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| DAILY FIELD REPORT<br>10/29/2019 | **Contract No.**<br>N39430-16-D-1802, TO N3943018F4359 (CTO 41)<br>**References**<br>Sampling and Analysis Plan (Battelle 2019)<br>Accident Prevention Plan (Battelle 2019) |
|---|---|
| **Project:** 100125424 Naval Base Kitsap Keyport, WA OU1 Source Investigations | |
| **Location:** Naval Base Kitsap Keyport, WA OU1 | |
| **Client:** Naval Facilities Engineering Command Northwest | **Contractor:** Battelle |
| **Weather:** Sunny, high 49 F, winds E 15 mph | |
| **To:** Carlotta Cellucci | |
| **From:** Samuel Moore | |

**PERSONNEL ON SITE:**

Samuel Moore (SM) and Zach Cotter (ZC; Battelle)

**SUMMARY OF WORK COMPLETED:**

- Recollected one groundwater sample from monitoring well MW1-2.
- Supervised survey of sampling locations.
- Conducted sitewide groundwater elevation survey during low-low tide.
- Demobilized from site.

**DEVIATIONS FROM WORKPLAN:**

- While not technically a deviation from the workplan, a groundwater sample from MW1-2 was recollected to obtain sufficient volume for QC samples for analysis of PCB congeners. The previous parent sample collected at this location—MW1-2-191025—was not submitted for analysis.

**SAFETY OBSERVATIONS AND GOOD CATCHES:**

All field activities were conducted safely and efficiently.

**FIELD ACTIVITY CHRONOLOGY:**

| | |
|---|---|
| 0815 | SM onsite. Marking out locations for survey. |
| 0900 | ZC onsite, performing calibrations and preparing equipment. |
| 0930 | SM off site for meeting. Back onsite at 1100. |
| 1000 | Began purging at groundwater monitoring well MW1-2. A groundwater sample from MW1-2 had to be recollected in order to obtain sufficient volume for QC samples for analysis of PCB congeners. Water quality parameters stabilized quickly with final turbidity at 4.0 NTU and dissolved oxygen measuring 0.00 mg/L. The remaining water quality parameters closely matched those recorded while purging MW1-2 on Friday October 25, 2019. Collected sample at 1045, along with a field duplicate and MS/MSD volume. |
| 1030 | Surveyors from Bush, Roed & Hitchings onsite. |
| 1130 | Packing up samples for shipment. Packing up rental equipment for return shipment. |
| 1300 | Left site to ship sample coolers and equipment and have lunch. |
| 1430 | Back onsite. Bush, Roed & Hitchings offsite. Relocated one purge water drum at MW1-61 to the staging area. |

| | |
|---|---|
| 1450 | Initiated site-wide groundwater elevation survey. Low-low tide at Poulsbo, WA was identified to be 12:34; tidal lag for onsite wells is estimated to be between 2 and 4 hours, which coincides with the survey duration. Collected groundwater elevation measurements from all wells sampled during this mobilization. |
| 1650 | Packing up remaining equipment for shipment, organizing storage shed, and cleaning up site for post-sampling activities. |
| 1730 | ZC off site to ship equipment. |
| 1815 | SM offsite. All off site. |

**SUMMARY OF FINDINGS:**

- One groundwater sample was recollected from monitoring well MW1-2 to obtain additional volume for QC samples. The sample was reflective of anoxic, reducing conditions and low suspended solids; these conditions were observed during purging at this well on October 25, 2019.

**PLANS FOR THE FOLLOWING DAY:**

None.

**ATTACHMENTS:**

None.

| | |
|---|---|
| Copies to: Michael Meyer, Damon DeYoung<br>Zach Cotter, Gail DeRuzzo | **Battelle - DAILY FIELD REPORT**<br>Signed: ___________________________ |

# ATTACHMENT 3

## Boring and Well Logs

# BATTELLE

**Project: Keyport OU 1 Source Investigation**
**Site: OU 1**
**Boring Log: CL-B95**

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/26/2019<br>Geologist: Samuel Moore<br>Total Depth: 35<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259131.1<br>Easting (NAD 83): 1198957.9<br>Surface Elevation (NAVD 88): 14.27<br>Borehole Abandoned: Yes<br>Backfill Method: 3/8" Holeplug Bentonite<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|
| 0 – 8.7 | GW | Clayey sandy GRAVEL, dark greenish gray, GLEY1 4/10Y, dense, wet | 45 | 35 | 20 |
| 8.7 – 14 | SP | Fine SAND, dark gray, GLEY1 4/N, medium dense, wet | 0 | 100 | 0 |
| 14 – 21.5 | CL | Sandy CLAY, dark gray, GLEY1 4/N, medium stiff, wet | 0 | 20 | 80 |
| 21.5 – 29 | SC | Clayey SAND, dark gray, GLEY1 4/N, medium dense, wet | 0 | 80 | 20 |
| 29 – 33 | GW | Clayey sandy GRAVEL, dark greenish gray, GLEY1 4/10Y, very dense, wet | 60 | 25 | 15 |
| 33 – 35 | CH | CLAY, very dark gray, GLEY1 3/N, very stiff, dry (Clover Park Aquitard) | 0 | 0 | 100 |

| Sample Interval (ft bgs) | Measured Recovery | Sample ID Date/Time |
|---|---|---|
| 0 – 5 | 3 | |
| 5 – 10 | 3.1 | CL-B95-S-7-190627; 06/27/2019 at 0817 |
| 10 – 15 | 5 | CL-B95-GW-13-190627; 06/27/2019 at 0840<br>CL-B95-S-13-190627; 06/27/2019 at 0825 |
| 15 – 20 | 3.8 | |
| 20 – 25 | 4 | |
| 25 – 30 | 3.5 | |
| 30 – 35 | 5 | CL-B95-S-33-190627; 06/27/2019 at 0945<br>CL-B95-GW-33-190627; 06/27/2019 at 1010 |

| Depth (ft bgs) | Headspace PID (ppb) |
|---|---|
| 2 | 0 |
| 3 | 0 |
| 4 | 31 |
| 5 | 201 |
| 7 | 231 |
| 8 | 0 |
| 9 | 0 |
| 10 | 151 |
| 11 | 39 |
| 12 | 427 |
| 13 | 1053 |
| 14 | 713 |
| 15 | 110 |
| 16 | 0 |
| 17 | 0 |
| 18 | 0 |
| 19 | 0 |
| 20 | 0 |
| 21 | 0 |
| 22 | 0 |
| 23 | 0 |
| 24 | 0 |
| 25 | 0 |
| 27 | 0 |
| 28 | 0 |
| 29 | 0 |
| 30 | 0 |
| 31 | 0 |
| 32 | 0 |
| 33 | 0 |
| 34 | 0 |
| 35 | 0 |

| Depth (ft bgs) | Comments |
|---|---|
| 0 | Dark organic material 7.9 to 8.1 and 8.5 to 8.7. Poor recovery |
| 5 | Poor recovery |
| 6.5 | DTW: Shallow |
| 14.8 | Wet sandy slough on top 1.2 ft. DTW: Deep |
| 25 | Crushed core liner on gravel layer |
| 30 | Encountered clay aquitard at 33 ft bgs. |
| 33 | Deep confining aquitard |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: CL-B96

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/27/2019<br>Geologist: Samuel Moore<br>Total Depth: 40<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259153.4<br>Easting (NAD 83): 1198894.4<br>Surface Elevation (NAVD 88): 14.15<br>Borehole Abandoned: Yes<br>Backfill Method: 3/8" Holeplug Bentonite<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|
| 0–8 | GW | Clayey sandy GRAVEL, dark gray, 10YR 4/1, dense, damp | 45 | 35 | 20 |
| 8–13.5 | SP | Fine SAND, very dark gray, GLEY1 3/N, medium dense, wet | 0 | 100 | 0 |
| 13.5–17 | SW | Gravelly fine to medium SAND, black, GLEY1 2.5/N, medium dense, wet | 30 | 70 | 0 |
| 17–22.5 | CH | CLAY, dark gray, GLEY1 4/N, medium stiff, damp | 0 | 0 | 100 |
| 22.5–39.5 | SP/ CL | Interbedded fine clayey SAND with CLAY, dark gray, GLEY 1 4/N, dense, wet | 5 | 80 | 15 |
| 39.5–40 | GW | Clayey sandy GRAVEL, very dark gray, GLEY1 3/N, very dense, wet | 70 | 25 | 5 |
| 40–42 | CH | CLAY, very dark gray, GLEY1 3/N, dry, very stiff (Clover Park Aquitard) | 0 | 0 | 100 |

| Depth (ft bgs) | Headspace PID (ppb) |
|---|---|
| 3 | 0 |
| 4 | 136 |
| 5 | 664 |
| 7 | 325 |
| 8 | 264 |
| 9 | 0 |
| 10 | 0 |
| 11 | 0 |
| 12 | 0 |
| 13 | 0 |
| 14 | 0 |
| 15 | 0 |
| 16 | 0 |
| 17 | 0 |
| 18 | 0 |
| 19 | 0 |
| 20 | 0 |
| 22 | 0 |
| 23 | 0 |
| 24 | 0 |
| 25 | 0 |
| 26 | 0 |
| 27 | 0 |
| 28 | 0 |
| 29 | 0 |
| 30 | 0 |
| 31 | 0 |
| 32 | 0 |
| 33 | 0 |
| 34 | 0 |
| 35 | 0 |
| 36 | 0 |
| 37 | 0 |
| 38 | 0 |
| 39 | 0 |
| 40 | 0 |

| Sample Interval (ft bgs) | Measured Recovery |
|---|---|
| 0–5 | 2.5 |
| 5–10 | 3.5 |
| 10–15 | 5 |
| 15–20 | 5 |
| 20–25 | 3.4 |
| 25–30 | 4.5 |
| 30–35 | 5 |
| 35–40 | 5 |

| Depth (ft bgs) | Sample ID Date/Time | Comments |
|---|---|---|
| 0 | | Foam wetted with NAPL at 5 ft bgs reads 19 ppm on PID; wood debris 7.6 to 8.0 ft bgs. Poor recovery |
| 4–5 | CL-B96-S-5-190627; 06/27/2019 at 1042 | |
| 5.5 | | DTW: Deep |
| 7 | | DTW: Shallow |
| 12–15 | CL-B96-S-13-190627; 06/27/2019 at 1048<br>CL-B96-GW-15-190627; 06/27/2019 at 1058 | |
| 20 | | Wet gravelly sand slough on top 1.6 ft. |
| 22 | | Clay at 18.0 to 18.2, 19.8 to 20.0, and 22.3 to 23.1 |
| 25 | | Wet gravelly sand slough on top |
| 38–41 | CL-B96-S-39-190627; 06/27/2019 at 1205<br>CL-B96-GW-40-190627; 06/27/2019 at 1240 | Deep clay aquitard |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: CL-B98

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/14/2019<br>Geologist: Steve Verdibello<br>Total Depth: 40<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot concrete cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | Grading % Gravel | Grading % Sand | Grading % Fines |
|---|---|---|---|---|---|
| 0–3 | SM | Silty gravelly SAND, greenish gray, GLEY1-5/10Y | 30 | 50 | 20 |
| 3–6 | MH | Gravelly sandy SILT, greenish gray, GLEY1-5/10GY | 20 | 20 | 60 |
| 6–21 | SP | Poorly graded SAND, trace GRAVEL, dark greenish gray, GLEY1-4/5G_/1, some mottled brown from 6 to 8 ft) | 5 | 95 | 0 |
| 21–23 | GW | Sandy GRAVEL, greenish black, GLEY1-2.5/10GY | 70 | 30 | 0 |
| 23–24 | SP | Poorly graded SAND, greenish black, GLEY1-2.5/10GY | 0 | 100 | 0 |
| 24–28 | SW | Sandy GRAVEL, greenish black, GLEY1-2.5/10GY | 60 | 40 | 0 |
| 28–30 | CH | Silty CLAY (some black organic material), very dark gray, GLEY1-3/N | 0 | 0 | 100 |
| 30–33 | SM | Gravelly silty SAND, dark gray, GLEY1-4/N | 10 | 60 | 30 |
| 33–34 | SP | SAND, dark gray, GLEY1-4/N | 0 | 100 | 0 |
| 34–37 | GP | Sandy GRAVEL, dark gray, GLEY1-4/N | 70 | 30 | 0 |
| 37–40 | CH | CLAY, some black organic silt (peat), very dark gray-GLEY1-3/N | 0 | 0 | 100 |

| Depth (ft bgs) | Headspace PID (ppb) | Measured Recovery | Sample ID Date/Time |
|---|---|---|---|
| 1 | 7999 | | |
| 2 | 20650 | 5 | CL-B98-S-2-191014 |
| 3 | 281 | | |
| 4 | 158 | | |
| 5 | 1081 | | |
| 6 | 126 | | |
| 7 | 129 | 5 | |
| 8 | 134 | | |
| 9 | 150 | | |
| 10 | 123 | | CL-B98-GW-15-191014 |
| 11 | 160 | | |
| 12 | 334 | 5 | |
| 13 | 261 | | |
| 14 | 215 | | |
| 15 | 224 | | |
| 16 | 373 | | |
| 17 | 142 | 5 | |
| 18 | 159 | | |
| 19 | 134 | | |
| 20 | 0 | | |
| 21 | 29 | | |
| 22 | 111 | 5 | |
| 23 | 0 | | |
| 24 | 0 | | |
| 25 | 0 | | |
| 26 | 81 | | |
| 27 | 214 | 5 | |
| 28 | 106 | | |
| 29 | 3405 | | |
| 30 | 6696 | | CL-B98-S-30-191014 |
| 31 | 1286 | | |
| 32 | 4405 | 5 | CL-B98-GW-37-191014 |
| 33 | 3598 | | |
| 34 | 5335 | | |
| 35 | 665 | | |
| 36 | 292 | | |
| 37 | 154 | 5 | |
| 38 | 112 | | |
| 39 | 154 | | |
| 40 | 234 | | |

BATTELLE

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: CL-B99

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/25/2019<br>Geologist: Samuel Moore<br>Total Depth: 26<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259281.5<br>Easting (NAD 83): 1199062.1<br>Surface Elevation (NAVD 88): 15.22<br>Borehole Abandoned: Yes<br>Backfill Method: 3/8" Holeplug Bentonite<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Headspace PID (ppb) | Measured Recovery | Sample ID Date/Time | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 0 | GM | Sandy clayey GRAVEL, mottled very dark brown (10YR 2/2) and dark gray (10YR 4/1), dry, medium dense | 40 | 30 | 30 | | | | Poor recovery |
| 2 | | | | | | 0 | 2.8 | | |
| | | | | | | 0 | | | |
| 4 | | | | | | 16 | | | |
| 5 | | | | | | 0 | | | Poor recovery. DTW: Shallow |
| 7 | | | | | | | 1.6 | | |
| 8 | | | | | | 0 | | | |
| | | | | | | 0 | | | |
| 10 | GM | Clayey sandy GRAVEL, dark gray, 10YR 4/1, very loose, wet | 40 | 30 | 30 | 150 | | | |
| 12 | | | | | | 2057 | 3 | CL-B99-S-12-190625; 06/25/2019 at 1016 | |
| 13 | CH | Fine sandy CLAY, dark gray, 10YR 4/1, medium stiff, damp | 0 | 40 | 60 | 248 | | | Becoming gravelly at 25 to 26 ft bgs. Met refusal on gravel at 26 ft. Top 0.5 feet could be slough. DTW: Deep |
| 14 | | | | | | 17 | | | |
| 14.5 | SP | Fine SAND, dark gray, 10YR 4/1, medium dense, damp | 5 | 95 | 0 | | | CL-B99-GW-15-190625; 06/25/2019 at 1030 | |
| 15 | | | | | | 335 | | | |
| | | | | | | 954 | | | |
| 16 | | | | | | 247 | | CL-B99-S-17-190625; 06/25/2019 at 1056 | |
| 17 | | | | | | 0 | 4.5 | | |
| 18 | | | | | | 0 | | | |
| 19 | | | | | | 0 | | | |
| 20 | | | | | | 0 | | | |
| 21 | | | | | | 0 | | | |
| 22 | | | | | | 0 | 5 | | |
| 23 | | | | | | 0 | | | |
| 24 | | | | | | 0 | | | |
| 25 | | | | | | 0 | 1 | CL-B99-S-26-190625; 06/25/2019 at 1111 | Slough on top. Met refusal on gravel at 26 ft bgs. |
| 26 | | | | | | 0 | | | |

# BATTELLE

## Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: CL-B100

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/25/2019<br>Geologist: Samuel Moore<br>Total Depth: 40<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259269.7<br>Easting (NAD 83): 1198905.3<br>Surface Elevation (NAVD 88): 14.5<br>Borehole Abandoned: Yes<br>Backfill Method: 3/8” Holeplug Bentonite<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|
| 0–8 | SM | Clayey gravelly SAND, dark gray, 10YR 4/1, damp, dense | 30 | 40 | 30 |
| 8–13 | SM | Wood debris, dry becoming wet at 9 ft | | | |
| 13–14 | SP | Silty SAND, very dark gray, GLEY1 3/N, wet, dense | 0 | 85 | 15 |
| 14–21 | CL | CLAY with interbedded sands, very dark greenish gray, GLEY1 3/10Y, wet, medium stiff | 0 | 10 | 90 |
| 21–35.7 | SC | Clayey SAND, very dark greenish gray, GLEY1 3/10Y, wet, dense | 0 | 80 | 20 |
| 35.7–37 | SW | Gravelly SAND, very dark greenish gray, GLEY1 3/10Y, wet, dense | 40 | 60 | 0 |
| 37–40 | CH | CLAY, very dark greenish gray (GLEY1 3/10Y) becoming dark gray (10YR 4/1) at 39 ft bgs, very stiff, dry (Clover Park Aquitard) | 0 | 0 | 100 |

Headspace PID (ppb):

| Depth | 2 | 3 | 4 | 5 | 7.5 | 9 | 10 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PID | 0 | 0 | 104 | 358 | 0 | 0 | 572 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 68 | 5 | 252 | 0 | 34 | 125 | 0 | 4 | 69 | 184 | 108 | 35 | 12 | 37 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |

Measured Recovery:

| Interval (ft) | 0–5 | 5–10 | 10–15 | 15–20 | 20–25 | 25–30 | 30–35 | 35–40 |
|---|---|---|---|---|---|---|---|---|
| Recovery | 4 | 2.5 | 2.5 | 5 | 5 | 5 | 5 | 5 |

| Approx. Depth (ft) | Sample ID Date/Time | Comments |
|---|---|---|
| 5 | CL-B100-S-5-190625; 06/25/2019 at 1307 | Poor recovery |
| 6.5–7 | | DTW: Deep<br>DTW: Shallow |
| 12.5–14.5 | CL-B100-S-13-190625; 06/25/2019 at 1303<br>CL-B100-GW-15-190625 ; 06/25/2019 at 1330 | Fine sand at 16.0 to 16.2; 16.6 to 16.7; 17.6 to 17.7 |
| 21.5 | CL-B100-S-22-190625; 06/25/2019 at 1400 | |
| 35 | | Encountered deep clay aquitard at 37 ft bgs. |
| 36–40 | CL-B100-S-37-190625; 06/25/2019 at 1443<br>CL-B100-GW-39-190625 ; 06/25/2019 at 1505 | Wood debris layer at 39.0 to 39.1 |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: CL-B101

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/18/2019<br>Geologist: Damon DeYoung<br>Total Depth: 50<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259272.6<br>Easting (NAD 83): 1198841<br>Surface Elevation (NAVD 88): 13.97<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot concrete cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|
| ASPHALT | ASPHALT, black | 100 | 0 | 0 |
| GM | Clayey sandy GRAVEL, light brownish gray, 10YR-6/2 | 70 | 20 | 10 |
| CONCRETE | CONCRETE, white | 100 | 0 | 0 |
| SM | Silty SAND, dark yellowish brown, 10YR-4/6, waste layer at 8.7 to 9 ft | 0 | 80 | 20 |
| SW | Gravelly well graded (fine to coarse) SAND, minor clay, very dark bluish gray, GLEY2-3/10B | 20 | 75 | 5 |
| CH | Silty sandy CLAY, bluish gray, GLEY2-6/5PB | 0 | 10 | 90 |
| ML | Clayey sandy SILT, bluish gray, GLEY2-5/5B, finely laminated, fine SAND bed from 22 to 23 ft | 0 | 40 | 60 |
| SP | Poorly graded fine SAND, bluish gray, GLEY2-5/5B, minor silt laminae from 27.8 to 29 ft | 0 | 90 | 10 |
| ML | Clayey sandy gravelly SILT | 10 | 20 | 70 |
| SM | Silty gravelly SAND | 20 | 70 | 10 |
| CH | CLAY, contains thin peat laminae (Clover Park Aquitard) | 0 | 0 | 100 |

Depth (ft bgs): 0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52

Headspace PID (ppb), top to bottom: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 35, 17, 32, 0, 12, 24, 16, 72, 105, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0

Measured Recovery, top to bottom: 2.8, 2, 4, 5, 5, 5, 5, 5, 5, 5

| Sample ID Date/Time |
|---|
| CL-B101-S-09-190618; 06/18/2019 1050 |
| CL-B101-GW-10-190618; 06/18/2019 1155 |
| CL-B101-S-32-190618; 06/18/2019 1250 |
| CL-B101-GW-35-190618; 06/18/2019 1315 |
| CL-B101-S-40-190618; 06/18/2019 1405 |

Comments:
- Top 0.5 ft of core is loose material, may be caved material from shallower depth
- Top 0.3 ft of core is loose material, may be caved material from shallower depth
- Top 0.5 ft of core is loose material, may be caved material from shallower depth
- Top 1.8 ft of core is loose material, may be caved material from shallower depth
- Core sleeve partially caught in the drill rod, the lodged section of core was poured out of the drill rod.

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: CL-B102

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/17/2019<br>Geologist: Damon DeYoung<br>Total Depth: 45<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259479.3<br>Easting (NAD 83): 1198787.1<br>Surface Elevation (NAVD 88): 10.74<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot soil cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|
| SM | Silty gravelly SAND, very pale brown, 10YR-7/3, contains minor waste debris (copper wire) | 20 | 60 | 20 |
| SM | Silty SAND, dark yellowish brown, 10YR-4/4, saturated | 0 | 70 | 30 |
| SP | Poorly graded fine SAND, greenish gray, GLEY1-5/5GY, minor gravel | 10 | 90 | 0 |
| ML | Clayey sandy SILT, dark gray, GLEY1-4/N, finely laminated | 0 | 20 | 80 |
| SM | Silty fine SAND, dark gray, GLEY1-4/N | 0 | 80 | 20 |
| MH | Clayey sandy SILT, dark gray, GLEY1-4/N, finely laminated | 0 | 30 | 70 |
| SW | Well graded clayey silty gravelly SAND, bluish black, GLEY2-2.5/5PB | 20 | 70 | 10 |
| ML | Clayey SILT, bluish gray, GLEY2-5/10B | 0 | 0 | 100 |
| SM | Silty SAND, dark bluish gray, GLEY2-4/5PB | 0 | 80 | 20 |
| ML | Clayey SILT, greenish gray, GLEY2-6/10BG | 0 | 0 | 100 |
| SW | Well graded SAND, dark bluish gray, GLEY2-4/10B, minor gravel | 10 | 90 | 0 |
| SP | Silty poorly graded SAND, dark greenish gray, GLEY2-4/10G | 0 | 80 | 20 |
| ML | Clayey SILT, greenish gray, GLEY2-6/10BG, contains peat between 28 and 30 ft | 0 | 0 | 100 |
| SW | Silty gravelly well graded SAND, very dark bluish gray, GLEY2-3/5B, contains wood at 39 ft | 20 | 70 | 10 |
| CH | CLAY, bluish gray, GLEY2-5/5B, contains peat laminae from 44 to 45 ft (Clover Park Aquitard) | 0 | 0 | 100 |

Depth (ft bgs): 0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48

Headspace PID (ppb), top to bottom: 0, 0, 0, 0, 0, 0, 0, 82, 30, 146, 378, 263, 89, 162, 599, 730, 400, 0, 4, 0, 0, 0, 0, 0, 0, 0, 0, 21, 30, 410, 87, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0

Measured Recovery, top to bottom: 1.9, 3.2, 5, 5, 3.5, 4.3, 4, 4, 5

| Sample ID Date/Time | Comments |
|---|---|
| CL-B102-GW-13-190617; 06/17/2019 1245 | |
| CL-B102-S-14-190617; 06/17/2019 1140 | |
| CL-B102-S-19-190617; 06/17/2019 1300 | |
| CL-B102-S-33-190617; 06/17/2019 1420 | |
| CL-B102-GW-35-190617; 06/17/2019 1630 | |

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: CL-B103

BATTELLE

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/17/2019<br>Geologist: Damon DeYoung<br>Total Depth: 45<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259518.3<br>Easting (NAD 83): 1198800.1<br>Surface Elevation (NAVD 88): 9.97<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot soil cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|
| SM | Clayey gravelly SAND, mottled reddish brown and gray, 10YR-5/1 | 10 | 50 | 40 |
| SP | Poorly graded SAND, very dark grayish brown, 10YR-3/2, minor silt | 0 | 80 | 10 |
| SW | Well graded SAND, dark bluish gray, GLEY2-4/5PB | 0 | 100 | 0 |
| MH | Clayey SILT, finely laminated, grades downward to a sandy SILT, bluish gray, GLEY2-6/5PB | 0 | 30 | 70 |
| SP | Poorly graded fine SAND, bluish gray, GLEY2-6/10B | 0 | 100 | 0 |
| ML | SILT, gray, GLEY1-6/N, finely laminated with minor fine sand laminae, contains peat from 38.5 to 39.5 ft | 0 | 10 | 90 |
| SP | Poorly graded fine to medium SAND, dark bluish gray, GLEY2-4/5PB, contains minor silt and gravel | 10 | 80 | 10 |
| CH | Finely laminated CLAY, bluish gray, GLEY2-5/10B, very stiff, contains well compacted peat (Clover Park Aquitard) | 0 | 0 | 100 |

Headspace PID (ppb), top to bottom: 0, 0, 0, 0, 0, 0, 0, 48, 323, 72, 15, 0, 0, 1, 87, 350, 115, 39, 13, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 7, 3, 0, 48, 85, 96, 14, 0, 0, 0, 0, 0

| Sample Interval (ft bgs) | Measured Recovery | Sample ID Date/Time | Comments |
|---|---|---|---|
| 0–5 | 2.5 | | Top 0.5 ft of core is loose material, may be caved material from shallower depth |
| 5–10 | 3.8 | CL-B103-S-09-190617; 06/17/2019 0830<br>CL-B103-GW-09-190617; 06/17/2019 0855 | Top 1.5 ft of core is loose material, may be caved material from shallower depth |
| 10–15 | 5 | CL-B103-S-12-190617; 06/17/2019 0920 | |
| 15–20 | 5 | CL-B103-S-19-190617; 06/17/2019 0935 | |
| 20–25 | 5 | | Top 2 ft of core is loose material, may be caved material from shallower depth |
| 25–30 | 5 | | |
| 30–35 | 3.5 | | |
| 35–40 | 4.2 | CL-B103-S-39-190617; 06/17/2019 1045<br>CL-B103-GW-40-190617; 06/17/2019 1200 | |
| 40–45 | 5 | | |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: CL-B104

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/18/2019<br>Geologist: Damon DeYoung<br>Total Depth: 45<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259527.1<br>Easting (NAD 83): 1198822<br>Surface Elevation (NAVD 88): 13.89<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot concrete cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Sample ID Date/Time | Comments |
|---|---|---|---|---|---|---|---|
| 0–3 | | | | | | | |
| 3–4.5 | GM | Silty sandy GRAVEL, light yellowish brown, 10YR-6/4, dry (top soil) | 50 | 30 | 20 | | |
| 4.5–9 | SM | Clayey gravelly SAND, brown, 10YR-4/3, color changes to brown at 8 ft | 20 | 60 | 20 | CL-B104-S-09-190618; 06/18/2019 0750 | |
| 9–11 | GM | Clayey sandy GRAVEL, dark greenish gray, GLEY2-4/10BG, waste material (wood, plastic) with product sheen, mild contaminant odor | 50 | 30 | 20 | | Top 1.5 ft of core is loose material, may be caved material from shallower depth |
| 11–14 | SP | Poorly graded fine to medium SAND, greenish gray, GLEY1-6/10Y, minor gravel | 5 | 95 | 0 | CL-B104-GW-14-190618; 06/18/2019 0815 | |
| 14–18.3 | CL | Silty CLAY, light gray, GLEY1-7/N, grades downward to silty sandy CLAY at 16.5 to 18.3 ft | 0 | 10 | 90 | | |
| 18.3–26.5 | SP | Poorly graded SAND, light bluish gray, GLEY2-7/5PB, laminated silty fine SAND interbedded with medium SAND from 23.7 to 25 ft | 0 | 90 | 10 | | |
| 26.5–27 | GM | Silty sandy GRAVEL, bluish gray, GLEY2-5/10B | 60 | 30 | 10 | CL-B104-S-28-190618; 06/18/2019 0855<br>CL-B104-GW-28-190618; 06/18/2019 0930 | |
| 27–30 | ML | Clayey sandy SILT, bluish gray, GLEY2-6/5PB, finely laminated, contains peat at 28.8 ft | 0 | 20 | 80 | | |
| 30–31 | GM | Clayey silty sandy GRAVEL, light bluish gray, GLEY2-7/10B | 70 | 20 | 10 | | |
| 31–33.5 | CL | Silty CLAY, bluish gray, GLEY2-6/5PB, contains peat beds at 32 ft and 33.5 (Clover Park Aquitard) | 0 | 0 | 100 | CL-B104-S-32-190618; 06/18/2019 0910 | |
| 33.5–35 | ML | Clayey fine sandy SILT, greenish gray, GLEY2-6/10G, finely laminated | 0 | 20 | 80 | | The entire retrieved core is loose material, may be caved material from shallower depth |
| 35–40 | none | Poor recovery | | | | | |

| Sample Interval (ft bgs) | Measured Recovery |
|---|---|
| 0–5 | 2.5 |
| 5–10 | 2.3 |
| 10–15 | 5 |
| 15–20 | 5 |
| 20–25 | 5 |
| 25–30 | 5 |
| 30–35 | 5 |
| 35–40 | 1.6 |

| Depth (ft bgs) | Headspace PID (ppb) |
|---|---|
| 3 | 0 |
| 4 | 0 |
| 5 | 0 |
| 8 | 0 |
| 9 | 46 |
| 10 | 0 |
| 11 | 0 |
| 12 | 0 |
| 13 | 0 |
| 14 | 0 |
| 15 | 0 |
| 16 | 0 |
| 17 | 0 |
| 18 | 0 |
| 19 | 0 |
| 20 | 0 |
| 21 | 0 |
| 22 | 7 |
| 23 | 8 |
| 24 | 25 |
| 25 | 40 |
| 26 | 16 |
| 27 | 22 |
| 28 | 131 |
| 29 | 0 |
| 30 | 0 |
| 31 | 17 |
| 32 | 47 |
| 33 | 0 |
| 34 | 0 |
| 35 | 0 |
| 38 | 0 |
| 39 | 0 |
| 40 | 0 |

BATTELLE

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: CL-B105

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/12/2019<br>Geologist: Damon DeYoung<br>Total Depth: 40<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259565.6<br>Easting (NAD 83): 1198960<br>Surface Elevation (NAVD 88): 16.65<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot concrete cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | Grading % Gravel | Grading % Sand | Grading % Fines |
|---|---|---|---|---|---|
| 0–3 | | | | | |
| 3–9 | GM | Clayey silty sandy GRAVEL, light bluish gray, GLEY2-8/5PB, landfill debris present (styrofoam, glass, wood) throughout | 50 | 30 | 20 |
| 9–13 | SM | Clayey silty SAND, bluish gray, GLEY2-6/10B, 0.5 ft section of broken glass from12 to 12.5 ft, very high PID at 10 ft, contaminant odor across glass zone and in drilling bit at 10 ft | 5 | 60 | 35 |
| 13–17.5 | SP | Poorly graded SAND, grayish brown, 2.5Y-5/2, saturated, PID readings decrease downward, slight sheen on saturated sand at 13 ft, water stained brown from 15 to 17.5 ft | 0 | 90 | 10 |
| 17.5–22 | ML | Clayey sandy SILT, bluish gray, GLEY2-5/5PB, finely laminated 1 to 3 mm laminae of alternating fine sand, silt and clay | 0 | 30 | 70 |
| 22–37 | SW | Well graded SAND, dark bluish, GLEY2-4/5PB, minor gravel throughout | 10 | 90 | 0 |
| 37–40 | GM | Clayey sandy GRAVEL, dark bluish gray, GLEY2-4/5B | 60 | 30 | 10 |

| Depth (ft bgs) | Headspace PID (ppb) | Measured Recovery | Sample ID Date/Time | Comments |
|---|---|---|---|---|
| 0–5 (interval) | | 2.5 | | |
| 3 | 0 | | | |
| 4 | 0 | | | |
| 5 | 0 | | | |
| 5–10 (interval) | | 2 | | |
| 8 | 440 | | | |
| 9 | 435 | | | Collected soils at 10 and 13 ft. |
| 10 | 20250 | | CL-B105-S-10-190612; 6/12/2019 0740 | |
| 10–15 (interval) | | 4 | | |
| 11 | 3721 | | | |
| 12 | 94 | | | |
| 13 | 2856 | | CL-B105-S-13-190612; 6/12/2019 0750 | Collected groundwater from 10 to 15 ft |
| 14 | 210 | | CL-B105-GW-15-190612; 6/12/2019 0820 | |
| 15 | 0/0 | | | |
| 15–20 (interval) | | 5 | | |
| 16 | 0 | | | |
| 17 | 0 | | | |
| 18 | 4 | | | |
| 19 | 134 | | | |
| 20 | 10/72 | | | |
| 20–25 (interval) | | 5 | | |
| 21 | 52 | | | Gravel content increases toward bottom of interval |
| 22 | 225 | | | |
| 23 | 144 | | | |
| 24 | 62 | | | |
| 25 | 32/154 | | | |
| 25–30 (interval) | | 5 | | |
| 26 | 59 | | | |
| 27 | 127 | | | |
| 28 | 124 | | | |
| 29 | 161 | | | |
| 30 | 28/9 | | | |
| 30–35 (interval) | | 5 | | |
| 31 | 21 | | | |
| 32 | 0 | | | |
| 33 | 93 | | | |
| 34 | 22 | | | |
| 35 | 25/35 | | | |
| 35–40 (interval) | | 5 | | |
| 36 | 85 | | | Collected soil at 39 ft and groundwater from 36 to 40 ft. Refusal at 40 ft. |
| 37 | 81 | | CL-B105-S-39-190612; 6/12/2019 0930 | |
| 38 | 172 | | CL-B105-GW-40-190612; 6/12/2019 1000 | |
| 39 | 246 | | | |
| 40 | 18 | | | |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: CL-B106

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/10/2019<br>Geologist: Damon DeYoung<br>Total Depth: 35<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259574.2<br>Easting (NAD 83): 1199171.8<br>Surface Elevation (NAVD 88): 15.55<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips, concrete top 1 foot<br>Monitoring Device Installed: Yes<br>Device Type: Temporary groundwater well points |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Sample ID Date/Time | Comments |
|---|---|---|---|---|---|---|---|
| 0–1.5 | | | | | | | |
| 1.5–3.5 | SM | Gravelly silty SAND, gray, 10YR-5/1 | 30 | 60 | 10 | | |
| 3.5–7 | SC | Gravelly clayey SAND, dark gray, 10YR-4/1, saturated at 6 ft bgs. | 15 | 50 | 35 | | DTW measured in drill rod casing. |
| 7–7.8 | NONE | Wood shavings, olive, 5Y-5/4 | 0 | 0 | 0 | | |
| 7.8–8.3 | ML | Rooty organic rich CLAY, very dark brown, 7.5YR-2.5/2, grades downward to silty SAND | 0 | 20 | 80 | | |
| 8.3–15 | ML | Clayey gravelly sandy SILT, greenish gray (GLEY1-5/5GY), mottled with brown (7.5YR-4/6) varves (~1mm) throughout, interbeds of fine sand (2 mm to 40 mm thick) | 10 | 30 | 60 | | Collected soil at 20 ft and set groundwater screen from 15 to 20 ft. |
| 15–20 | SM | Gravelly silty SAND, dark grayish brown, 10YR-4/2 | 10 | 80 | 10 | CL-B106-S-20-190610; 6/10/2019 1200<br>CL-B106-GW-20-190610; 6/10/2019 1235 | |
| 20–23 | SM | No recovery | | | | | |
| 23–24.5 | SP | Silty gravelly SAND, yellowish brown, 10YR-5/4, poorly graded, saturated and flowing | 10 | 80 | 10 | | |
| 24.5–26 | SP | Silty gravelly SAND, very dark grayish brown, 2.5Y-3/2, poorly graded | 40 | 50 | 10 | | |
| 26–32.5 | SP | Gravelly SAND, black, GLEY1-2.5/N, grades to higher gravel content at 28 feet. | 40 | 50 | 10 | CL-B106-S-27-190610; 6/10/2019 1340 | Collected soil at 27 ft. |
| 32.5–35 | CL | CLAY, very dark greenish gray, GLEY1-3/5G/1 (Lawton Clay) | 0 | 0 | 100 | CL-B106-GW-32-190610; 6/10/2019 1505<br>CL-B106-S-33-190610; 6/10/2019 1405 | Presume this interval penetrates the Lawton Clay. |

| Sample Interval (ft bgs) | Measured Recovery |
|---|---|
| 0–5 | 3.5 |
| 5–10 | 4 |
| 10–15 | 4.5 |
| 15–20 | 5 |
| 20–25 | 3 |
| 25–30 | 5 |
| 30–35 | 5 |

| Depth (ft bgs) | Headspace PID (ppb) |
|---|---|
| 3 | 29 |
| 4 | 0 |
| 5 | 0 |
| 6 | 0 |
| 7 | 0 |
| 8 | 0 |
| 9 | 17 |
| 10 | 0 |
| 11 | 0 |
| 12 | 17 |
| 13 | 0 |
| 14 | 0 |
| 15 | 0/0 |
| 16 | 0 |
| 17 | 0 |
| 18 | 0 |
| 19 | 0 |
| 20 | 0 |
| 23 | 0 |
| 24 | 0 |
| 25 | 0/0 |
| 26 | 0 |
| 27 | 0 |
| 28 | 0 |
| 29 | 0 |
| 30 | 0/0 |
| 31 | 0 |
| 32 | 0 |
| 33 | 0 |
| 34 | 0 |
| 35 | 0 |

BATTELLE

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: CL-B107

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/11/2019<br>Geologist: Damon DeYoung<br>Total Depth: 35<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259617.8<br>Easting (NAD 83): 1199168.6<br>Surface Elevation (NAVD 88): 16.22<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chip with 1-foot concrete cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Headspace PID (ppb) | Measured Recovery | Sample ID Date/Time | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 0–2 | | | | | | | | | |
| 2–5 | GM | Sandy clayey GRAVEL, grayish green, GLEY1-4/5G/2 | 50 | 30 | 20 | 0, 0, 0, 0 | 3 | | |
| 5–8.5 | SM | Silty gravelly SAND, brown, 7.5YR-4/3, slight PID reading 22 ppm, root material at 8 ft | 20 | 60 | 20 | 22, 0 | 3 | CL-B107-S-07-190611; 6/11/2019 0800 | Collect soil at 7 ft and groundwater screened at 5 to 10 ft |
| 8.5–9.5 | ML | Sandy clayey SILT, greenish gray (GLEY1-5/5G/1), mottled with orangish brown, thin interbedded sand laminae ~1 cm thick | 5 | 35 | 60 | 0 | | CL-B107-GW-10-190611; 6/11/2019 0830 | |
| 9.5–12 | SW | Well graded SAND, greenish gray, GLEY1-5/10Y, saturated | 5 | 90 | 5 | 0, 0 | | | |
| 12–17 | SW | Well graded SAND, yellowish brown, 10YR-5/4, minor interbeds of silty SAND | 5 | 80 | 15 | 0, 0, 0, 0, 0 | 5 | | |
| 17–17.5 | GM | Sandy silty GRAVEL, yellowish red, 5YR-4/6 | 80 | 10 | 10 | 0 | 5 | | |
| 17.5–19.5 | ML | Sandy clayey SILT, dark bluish gray, GLEY2-4/5B, saturated | 5 | 25 | 70 | 0, 0 | | | |
| 19.5–32 | SM | Gravelly silty SAND, very dark bluish gray, GLEY2-3/5PB, saturated | 20 | 70 | 10 | 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 | 4, 5 | CL-B107-S-22-190611; 6/11/2019 0910 | |
| 32–35 | CL | Lean CLAY, very dark bluish gray, GLEY2-3/5PB, low moisture (Lawton Clay) | 0 | 0 | 100 | 0, 0, 0, 0 | 5 | CL-B107-GW-32-190611; 6/11/2019 1020<br>CL-B107-S-33-190611; 6/11/2019 0945 | |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: CL-B108

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/11/2019<br>Geologist: Damon DeYoung<br>Total Depth: 26<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259609<br>Easting (NAD 83): 1199109.5<br>Surface Elevation (NAVD 88): 17.01<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot concrete cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary groundwater wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Headspace PID (ppb) | Measured Recovery | Sample ID Date/Time | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 0–3 | | | | | | | 2.5 | | |
| 3 | GM | Sandy clayey GRAVEL, greenish gray, GLEY1-6/10GY | 50 | 30 | 20 | 3, 199 | | | Collect soil at 7 ft and groundwater screened at 5 to 10 ft |
| 4.5 | SM | Gravelly clayey SAND, dark greenish gray, GLEY1-4/10GY, elevated PID readings, woody material, landfill debris (treated wood, metal wire fragments, fabric), interbedded clay layers ~2 cm thick. | 20 | 60 | 20 | 0, 524, 2036, 72 | 3 | CL-B108-S-08-190611; 6/11/2019 1040 | |
| 9.5 | PT | Sandy clayey PEAT, olive brown, 2.5Y-4/4, landfill debris (treated wood, metal wire fragments, fabric) | 5 | 10 | 10 | 358/73 | | | |
| 10 | ML | Clayey sandy SILT, olive brown, 2.5Y-4/4 | 5 | 20 | 75 | 9 | 5 | | |
| 11 | ML | Clayey sandy SILT, grayish green, GLEY1-4/5G/2, minor interbeds of silty sand ~1 cm thick spaced 2 to 5 cm apart, mottled orangish brown, elevated PID readings | 5 | 35 | 60 | 651, 314, 77 | | CL-B108-GW-12-190611; 6/11/2019 1140 | |
| 13.5 | SP | Poorly graded SAND, brown, 10YR-4/3, saturated | 0 | 100 | 0 | | | | |
| 14 | CL | Silty CLAY, pale brown, 10YR-6/3 | 5 | 25 | 70 | 0, 0, 0 | | | |
| 16.5 | SP | Poorly graded SAND, dark yellowish brown, 10YR-4/3 | 0 | 90 | 10 | 0, 0, 0, 0/18, 0 | 5 | | Collected soil sample at 22 ft |
| 22 | SM | Silty SAND, dark yellowish brown, 10YR-4/3, interbedded silty sand and sand laminae <1 cm each. | 0 | 50 | 50 | 0, 0 | 5 | CL-B108-S-22-190611; 6/11/2019 1220 | |
| 24 | GM | Sandy clayey GRAVEL, dark grayish brown, 2.5Y-4/2 | 70 | 20 | 10 | 0, 0, 0 | 1 | CL-B108-GW-25-190611; 6/11/2019 1335 | Hit refusal at 26 ft; likely against large cobble/till rock. Hit refusal at 26 ft. |

KEYPORT_GEOPROBE_AUG2019.SDG

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: CL-B109

Permit Number: 19-EP111
EHS Case Number: NA
Project: 100125424
Date Logged: 6/11/2019
Geologist: Damon DeYoung
Total Depth: 40
Reviewer: Michael Meyer

Drilling Contractor: Holt Services, Inc.
Driller: Michael Running
Drilling Equipment: Geoprobe 7822DT
Drilling Method: Direct push
Boring Diameter: 1.5 inch
Sampler Type: Macro core
Hammer Type: Pneumatic

Northing (NAD 83): 259624.5
Easting (NAD 83): 1199069.2
Surface Elevation (NAVD 88): 17.1
Borehole Abandoned: Yes
Backfill Method: Bentonite chips with 1-foot concrete cap
Monitoring Device Installed: Yes
Device Type: Temporary monitoring wells

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|
| 3–4.5 | GM | Sandy clayey GRAVEL, greenish gray, GLEY1-6/10GY, elevated PID at 3 ft | 50 | 30 | 20 |
| 4.5–13 | ML | Gravelly, sandy clayey SILT, greenish gray, GLEY1-5/5G/1, wood debris at 10 ft | 20 | 20 | 60 |
| 13–13.5 | PT | PEAT, very dark gray, 2.5Y-3/1 | 0 | 0 | 0 |
| 13.5–14.5 | CL | Silty CLAY, very dark grayish brown (10YR-3/2) grading downward to greenish gray (GLEY1-5/5G/1), mottled with orangish brown laminae | 0 | 10 | 90 |
| 14.5–18.5 | SM | Clayey SAND, greenish gray, GLEY1-5/5GY | 0 | 70 | 30 |
| 18.5–19 | ML | Clayey SILT, olive gray, 5Y-5/2, mottled orangish brown laminae | 0 | 10 | 90 |
| 19–23.5 | SP | Poorly graded SAND, light brownish gray, 10YR-6/2, copper pipe fragment at 19.5 ft, saturated | 0 | 90 | 10 |
| 23.5–24 | ML | Sandy SILT, light gray, 10YR-7/2 | 0 | 20 | 80 |
| 24–28 | SP | Poorly graded SAND, brown, 7.5YR-4/4, saturated | 0 | 90 | 10 |
| 28–30 | ML | Fine sandy SILT, bluish gray, GLEY2-5/5PB | 0 | 30 | 70 |
| 30–37 | GM | Clayey silty sandy GRAVEL, very dark bluish gray, GLEY2-3/5PB | 40 | 30 | 30 |
| 37–40 | CH | Fat CLAY, dark gray, GLEY1-4/N, dense organic interbeds ~1 to 3 cm thick (Clover Park Aquitard) | 0 | 0 | 100 |

Headspace PID (ppb):

| Depth (ft) | 2 | 3 | 4 | 5 | 8 | 9 | 10 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PID | 22 | 1040 | 448 | 0 | 116 | 0 | 0 | 75 | 0 | 0 | 1 | 71 | 64 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Measured Recovery:

| Interval (ft) | 0–5 | 5–10 | 10–15 | 15–20 | 20–25 | 25–30 | 30–35 | 35–40 |
|---|---|---|---|---|---|---|---|---|
| Recovery | 2.5 | 2 | 2 | 4 | 5 | 5 | 5 | 5 |

| Sample ID Date/Time | Comments |
|---|---|
| CL-B109-S-03-190611; 6/11/2019 1415 | Collected soil at 3 ft |
| | Poor recovery, wood material likely prevented soil from entering core barrel. PID detections were observed in shallow soils (0 to 5 feet). Deeper PID readings (i.e., 5 to 18 feet) in core lengths where recovery was limited, may represent borehole collapse from the elevated interval (0 to 5 feet) (i.e., the PID readings may not be truly representative of the depth interval) |
| CL-B109-GW-15-190611 ; 6/11/2019 1440 | Collected soil at 18 ft |
| CL-B109-S-18-190611; 6/11/2019 1525 | |
| CL-B109-S-37-190611; 6/11/2019 1615 | |
| CL-B109-GW-37-190611 ; 6/11/2019 1640 | |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: CL-B132

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 9/30/2019<br>Geologist: Damon DeYoung<br>Total Depth: 50<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method:<br>Bentonite chips with 1-foot concrete cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary 2-inch monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|
| 0 | GM | Sandy GRAVEL, brown, 10YR-4/3 | 35 | 60 | 5 |
| | SM | Clayey gravelly SAND, greenish gray, GLEY1-5/10Y | 20 | 50 | 30 |
| 4 | Fill | WASTE, treated wood, fiberglass | | | |
| 8 | SP | Silty fine to medium SAND, mottled orangish brown from 7 to 9 ft bgs, greenish gray, GLEY1-5/10Y | 5 | 80 | 15 |
| 12 | MH | Clayey SILT, dark greenish gray GLEY2-4/10G | 0 | 5 | 95 |
| 22 | SP | Silty fine SAND, dark greenish gray GLEY2-4/10G | 0 | 80 | 20 |
| 25 | CL | Peaty CLAY, dark greenish gray GLEY2-4/10G | 0 | 0 | 100 |
| 30 | SP | Silty fine SAND, dark greenish gray GLEY2-4/10G, wood debris from 38 to 39 ft bgs | 0 | 80 | 20 |
| 40 | GM | Sandy GRAVEL, dark greenish gray GLEY2-4/10G, sand from 45 to 46 ft | 60 | 30 | 10 |
| 46 | CH | CLAY, minor peat, very dark gray GLEY1-3/N | 0 | 0 | 100 |

Depth scale: 0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52

Headspace PID (ppb), top to bottom: 115, 257, 991, 532, 30030, 235, 49, 68, 116, 645, 228, 152, 98, 237, 175, 101, 106, 103, 118, 123, 71, 98, 92, 78, 90, 100, 160, 110, 60, 35, 88, 66, 67, 109, 112, 193, 60, 0, 137, 97, 61, 97, 266, 122, 147, 147, 107, 127

Measured Recovery, top to bottom: 3.5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5

Sample ID Date/Time:
- CL-B132-S-07-190930
- CL-B132-GW-15-190930
- CL-B132-S-27-190930
- CL-B132-GW-45-191001

Comments:
- PID readings had elevated background ranging from 30 to 200 ppb through screening on 9/30/2019.
- Collected DTW after deep well install, screened 40 to 45 ft

# BATTELLE

## Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: CL-B134

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/3/2019<br>Geologist: Damon DeYoung<br>Total Depth: 60<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot concrete cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|
| 0–11 | GM | Silty sandy GRAVEL, some landfill waste (wood, metal), very dark greenish gray, GLEY-3/5GY | 60 | 30 | 10 |
| 11–13 | SM | Silty SAND, dark greenish gray, GLEY1-4/10GY, mottled with brown | 0 | 80 | 20 |
| 13–16 | CL | Silty CLAY, minor sand interbedding, very dark greenish gray GLEY1-3/10GY | 0 | 0 | 100 |
| 16–17 | SM | Silty SAND, dark bluish gray, GLEY2-4/5B | 0 | 80 | 20 |
| 17–24 | SP | Poorly graded SAND, dark bluish gray, GLEY2-4/5B | 0 | 100 | 0 |
| 24–25 | GM | Silty sandy GRAVEL, dark bluish gray, GLEY2-4/5B | 70 | 20 | 10 |
| 25–26 | ML | Sandy SILT, dark bluish gray, GLEY2-4/5B | 0 | 30 | 70 |
| 26–29 | SW | Gravelly SAND (increased gravel with depth), very dark gray, GLEY1-3/N | 40 | 60 | 0 |
| 29–40 | GW | Gravelly SAND (increased gravel with depth), very dark gray, GLEY1-3/N | 40 | 60 | 0 |
| 40–43 | GW | Sandy GRAVEL, very dark gray, GLEY1-3/N | 90 | 10 | 0 |
| 43–50 | SW | Well graded gravelly SAND, very dark gray, GLEY1-3/N | 30 | 70 | 0 |
| 50–60 | ML | SILT, with minor organics (peat), dark gray, GLEY1-4/N | 0 | 0 | 100 |

| Sample Interval (ft bgs) | Measured Recovery | Headspace PID (ppb) | Sample ID Date/Time |
|---|---|---|---|
| 0–5 | 3 | 0, 79, 472, 3150 | |
| 5–10 | 3 | 16460, 16370, 3169 | |
| 10–15 | 5 | 52, 60, 127, 481, 1124 | |
| 15–20 | 5 | 113, 84, 56, 197, 138 | |
| 20–25 | 5 | 293, 10, 0, 299, 135 | |
| 25–30 | 5 | 1608, 9535, 24470, 9800, 19920 | |
| 30–35 | 5 | 1324, 974, 6953, 5084, 580 | |
| 35–40 | 3 | 256, 184, 2255 | |
| 40–45 | 5 | 0, 0, 0, 0, 0 | |
| 45–50 | 5 | 0, 0, 0, 0, 0 | CL-B134-GW-50-191003<br>CL-B134-GW-49-191003 (duplicate of 50)<br>CL-B134-S-49-191003 (duplicate of 50)<br>CL-B134-S-50-191003 |
| 50–55 | 5 | 0, 0, 0, 0, 0 | |
| 55–60 | 5 | 0, 0, 0, 0 | |

Comments:

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: CL-B142

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/10/2019<br>Geologist: Steve Verdibello<br>Total Depth: 60<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot concrete cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Headspace PID (ppb) | Comments |
|---|---|---|---|---|---|---|---|
| 0–3 | GW | Sandy GRAVEL (some landfill waste debris), olive, 5Y-4/3 | 70 | 30 | 0 | 77 | *10 feet of heave – additional material collected in core barrels |
| 3–5 | SM | Silty gravelly SAND (some landfill waste debris), dark greenish gray, GLEY1-4/10Y | 30 | 50 | 20 | 907, 22530 | |
| 5–10 | NR | No Recovery | | | | | |
| 10–13 | SP | Poorly graded SAND, very dark gray, GLEY1-3/N | 0 | 100 | 0 | 646, 1196, 1337 | |
| 13–19 | SM | Sandy SILT, minor gravel, gray, GLEY1-5/N | 5 | 20 | 75 | 1316, 4495, 1728, 1138, 755, 1475 | |
| 19–34 | SP | Poorly graded SAND, dark gray, GLEY1-4/N | 0 | 100 | 0 | 2226, 435, 1611, 429, 335, 331, 2447, 3884, 685, 1282, 444, 124, 36, 85, 62 | |
| 34–35 | SM | Silty SAND, gray, GLEY1-5/N | 0 | 80 | 20 | 290 | |
| 35–37 | GW | Sandy GRAVEL, gray, GLEY1-5/N | 60 | 40 | 0 | 90, 445 | |
| 37–40 | SM | Silty SAND, gray, GLEY1-5/N | 0 | 70 | 30 | 42, 115, 269 | |
| 40–46 | SM | Silty SAND (some organic silt – peat), gray, GLEY1-5/N | 0 | 80 | 20 | 30, 100, 504, 620, 385, 92 | |
| 46–60 | CL | Silty CLAY, minor organics, dark gray, GLEY1-4/N | 0 | 0 | 100 | 0, 0, 18, 8, 73, 12, 44, 15, 15, 13, 22, 28, 32, 312 | |

| Run (ft bgs) | Measured Recovery |
|---|---|
| 0–5 | 3 |
| 5–10 | 0 |
| 10–15 | 5 |
| 15–20 | 5 |
| 20–25 | 5 |
| 25–30 | 5 |
| 30–35 | 5 |
| 35–40 | 5 |
| 40–45 | 5 |
| 45–50 | 5 |
| 50–55 | 5 |
| 55–60 | 5 |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: NP-B110

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/12/2019<br>Geologist: Damon DeYoung<br>Total Depth: 40<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259590.3<br>Easting (NAD 83): 1198925.9<br>Surface Elevation (NAVD 88): 16.16<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot concrete cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Sample ID Date/Time | Comments |
|---|---|---|---|---|---|---|---|
| 0–2 | | | | | | | |
| 2–5 | GM | Sandy silty GRAVEL, light gray, 2.5Y-7/2 | 60 | 30 | 10 | | |
| 5–14 | SM | Clayey silty gravelly SAND, bluish gray, GLEY2-5/10B, landfill waste, (plastic, rubber, metal wire, fabric, dark organics [peat]) | 20 | 50 | 30 | NP-B110-S-08-190612; 6/12/2019 1055 | Collected soils at 8 ft and 14 ft (and duplicate at 14 ft) |
| 14–17 | SP | Poorly graded medium SAND, dark bluish gray, GLEY2-4/5B, saturated, black contaminated layer at 15.5 to 16 ft, strong contaminant odor, high PID readings | 0 | 100 | 0 | NP-B110-S-14-190612; 6/12/2019 1100<br>QC-190612-01; 43628<br>NP-B110-GW-15-190612; 6/12/2019 1130<br>QC-190612-02; 6/12/2019 1140<br>NP-B110-S-16-190612; 6/12/2019 1230 | Collected groundwater (and duplicate) at 10 to 15 ft and soil at 16 ft<br>Copper wire along edge of core (23 ft) may have been pushed with the drill rods from shallower depth (no wire within core interior) |
| 17–25 | MH | Clayey sandy SILT, bluish gray, GLEY2-5/5PB, saturated, high plasticity, | 0 | 20 | 80 | | Collected groundwater at 36 to 40 ft. |
| 25–39.5 | SP | Gravelly poorly graded fine to medium SAND, dark bluish gray, GLEY2-4/10PB, saturated | 30 | 70 | 0 | | Core stuck in barrel, clay present in bottom 0.5 ft of core/drill shoe |
| 39.5–40 | CH | CLAY, dark bluish gray, GLEY2-4/10PB (Clover Park Aquitard) | 0 | 0 | 100 | NP-B110-GW-40-190612; 6/12/2019 1410 | Hit refusal at 40 ft |

Headspace PID (ppb):

| Depth (ft) | PID (ppb) | Depth (ft) | PID (ppb) |
|---|---|---|---|
| 2 | 0 | 22 | 112 |
| 3 | 9 | 23 | 0 |
| 4 | 11 | 24 | 70 |
| 5 | 0 | 25 | 73/138 |
| 6 | 30 | 26 | 51 |
| 7 | 235 | 27 | 37 |
| 8 | 21350 | 28 | 133 |
| 9 | 8375 | 29 | 20 |
| 10 | 207 | 30 | 0/57 |
| 11 | 2204 | 31 | 35 |
| 12 | 18 | 32 | 131 |
| 13 | 61 | 33 | 34 |
| 14 | 761 | 34 | 12 |
| 15 | 93/2,872 | 35 | 36/153 |
| 16 | 7695 | 36 | 204 |
| 17 | 96 | 37 | 188 |
| 18 | 216 | 38 | 35 |
| 19 | 59 | 39 | 13 |
| 20 | 78 | 40 | 4 |

Measured Recovery (ft) by sample run:

| Interval (ft) | Measured Recovery |
|---|---|
| 2–5 | 3 |
| 5–10 | 3 |
| 10–15 | 4.5 |
| 15–20 | 5 |
| 20–25 | 3.5 |
| 25–30 | 5 |
| 30–35 | 5 |
| 35–40 | 5 |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: NP-B111

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/12/2019<br>Geologist: Damon DeYoung<br>Total Depth: 40<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259647.6<br>Easting (NAD 83): 1199007.1<br>Surface Elevation (NAVD 88): 17.03<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot soil cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Sample ID Date/Time | Comments |
|---|---|---|---|---|---|---|---|
| 1.5–5 | GM | Silty sandy GRAVEL, light brownish gray, 10YR-6/2, dry | 50 | 30 | 20 | | Very poor recovery |
| 5–9 | GM | | | | | | |
| 9–14 | GM | Clayey sandy GRAVEL, dark bluish gray, GLEY2-4/5B, landfill debris (plastic) present at 9.5 to 10 ft | 60 | 20 | 20 | NP-B111-S-10-190612; 6/12/2019 1505 | Collected soil at 10 ft<br>Very poor recovery<br>Collected groundwater from 12 to 17 ft |
| 14–17.5 | SM | Laminated silty SAND, greenish gray (GLEY 2-6/5BG) mottled orangish brown laminae, grading to SILT from 16 to 17.5 | 0 | 70 | 30 | NP-B111-GW-17-190612; 6/12/2019 1530 | |
| 17.5–23 | MH/SM | Interbedded clayey SILT and clayey silty SAND, bluish gray, GLEY2-5/10B, beds are 4 to 10 cm thick | 0 | 40 | 60 | NP-B111-S-19-190612; 6/12/2019 1540 | Collected soil at 19 ft |
| 23–38 | SP | Poorly graded fine SAND, bluish gray, GLEY2-5/10B | 0 | 90 | 10 | | |
| 38–39 | GM | Clayey silty sandy GRAVEL, bluish gray, GLEY2-5/10B, basal gravel immediately overlying weathered clay surface | 60 | 20 | 20 | NP-B111-S-39-190612; 6/12/2019 1650 | Collected soil at 39 ft |
| 39–40 | CL | Silty CLAY, dark greenish gray, GLEY1-4/10GY, weathered surface contact with overlying gravel, low moisture (Clover Park Aquitard) | 0 | 0 | 100 | NP-B111-GW-40-190612; 6/12/2019 1720 | |

Headspace PID (ppb) by depth (ft bgs):

| Depth | 2 | 3 | 4 | 5 | 9 | 10 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26–40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PID | 48 | 39 | 25 | 59 | 65 | 60 | 37 | 35 | 2 | 0 | 0 | 13 | 5/0 | 0 | 0 | 0 | 0 | 0/0 | 0 (each ft) |

| Core interval (ft) | Measured Recovery | Sample Interval |
|---|---|---|
| 0–5 | 3.5 | Sampled |
| 5–10 | 1 | |
| 10–15 | 1 | |
| 15–20 | 4 | Sampled |
| 20–25 | 5 | Sampled |
| 25–30 | 5 | Sampled |
| 30–35 | 5 | Sampled |
| 35–40 | 5 | Sampled |

Water level symbol (▼) at approximately 6.5 ft.

BATTELLE

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: NP-B112

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/14/2019<br>Geologist: Damon DeYoung<br>Total Depth: 35<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259675.1<br>Easting (NAD 83): 1199041.7<br>Surface Elevation (NAVD 88): 16.35<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot soil cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Comments |
|---|---|---|---|---|---|---|
| 0–2 | | | | | | Core likely compressed |
| 2–4.7 | GM | Silty sandy GRAVEL, grayish brown, 10YR-5/2, very loose, dry | 50 | 30 | 20 | Collected soil at 8 ft across sand zone with sheen |
| 4.7–9 | SM | Clayey silty gravelly SAND, dark greenish gray, GLEY2-4/5BG, saturated, contaminant sheen | 20 | 60 | 20 | Top 1 ft of core is loose material, may be caved material from shallower depth |
| 9–12.5 | GM | Clayey sandy GRAVEL, dark greenish gray, GLEY2-4/5BG, contains wood debris | 40 | 30 | 30 | Top 1 ft of core is loose material, may be caved material from shallower depth |
| 12.5–13 | SM | Silty SAND, dark greenish gray, GLEY1-4/10Y | 0 | 80 | 20 | |
| 13–14.7 | ML | Silty sandy CLAY, light greenish gray, GLEY1-7/10GY, finely laminated fine sand beds less than 1 cm interbedded with silty clay and clay, spots of mottled orangish brown from 14 to 14.7 | 0 | 30 | 70 | Upper 1.5 ft of core is loose material, may be caved material from shallower depth |
| 14.7–29 | SP | Poorly graded SAND, greenish gray (GLEY1-6/5GY), color changes to very pale brown (10YR-7/3) at 18 ft. reddish brown oxidized zones at 19.5 ft and 27.5 ft, silty sand lenses from 22 to 23.5 ft, color changes to bluish gray (GLEY2-5/10B) at 28 ft. | 0 | 90 | 10 | |
| 29–31 | GM | Clayey sandy GRAVEL, light bluish gray, GLEY2-7/10B | 60 | 20 | 20 | |
| 31–35 | CL | CLAY, bluish gray, GLEY2-6/5PB, silty in upper1.5 ft, peat/organics prominent from 33.5 to 35 (Clover Park Aquitard). | 0 | 0 | 100 | |

Groundwater symbol (▼) at approximately 4.7 ft.

| Sample Interval (ft) | Measured Recovery |
|---|---|
| 2–5 | 3 |
| 5–10 | 2.7 |
| 10–15 | 4 |
| 15–20 | 5 |
| 20–25 | 5 |
| 25–30 | 5 |
| 30–35 | 5 |

| Depth (ft) | Headspace PID (ppb) |
|---|---|
| 2 | 0 |
| 3 | 55 |
| 4 | 0 |
| 5 | 0 |
| 7 | 83 |
| 8 | 43 |
| 9 | 0 |
| 10 | 0 |
| 11 | 0 |
| 12 | 8 |
| 13 | 0 |
| 14 | 0 |
| 15 | 0 |
| 16 | 7 |
| 17 | 34 |
| 18 | 0 |
| 19 | 0 |
| 20 | 0 |
| 21 | 0 |
| 22 | 0 |
| 23 | 0 |
| 24 | 0 |
| 25 | 0 |
| 26 | 0 |
| 27 | 24 |
| 28 | 0 |
| 29 | 0 |
| 30 | 0 |
| 31 | 0 |
| 32 | 0 |
| 33 | 0 |
| 34 | 0 |
| 35 | 0 |

| Depth (ft) | Sample ID Date/Time |
|---|---|
| 8 | NP-B112-S-08-190614; 6/14/2019 0755 |
| 15 | NP-B112-GW-15-190614; 6/14/2019 0815 |
| 27 | NP-B112-S-27-190614; 6/14/2019 0905 |
| 31 | NP-B112-GW-31-190614; 6/14/2019 1010 |
| 32 | NP-B112-S-32-190614; 6/14/2019 0920 |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: NP-B113

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/13/2019<br>Geologist: Damon DeYoung<br>Total Depth: 40<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259640.7<br>Easting (NAD 83): 1198875.5<br>Surface Elevation (NAVD 88): 14.85<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot soil cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | Grading % Gravel | Grading % Sand | Grading % Fines |
|---|---|---|---|---|---|
| 4–5 | GM | Silty sandy GRAVEL, grayish brown, 10YR-5/2, very loose, dry | 50 | 30 | 20 |
| 5–17 | SM | Clayey silty SAND, dark bluish gray, GLEY2-4/5B, landfill waste material (plastic, wood) present at14 ft | 0 | 70 | 30 |
| 17–18.7 | ML | Clayey sandy SILT, greenish gray, GLEY2-5/5BG, finely laminated, thin beds of fine sand | 0 | 30 | 70 |
| 18.7–23 | SP | Poorly graded fine to medium SAND, bluish gray, GLEY2-6/10B, gravel content increases near base (22 to 23 ft) | 5 | 90 | 5 |
| 23–24 | SM | Silty fine SAND, greenish gray, GLEY2-5/5BG | 0 | 80 | 20 |
| 24–33 | SP | Gravelly poorly graded fine to medium SAND, bluish gray, GLEY2-6/10B | 20 | 80 | 0 |
| 33–38.3 | SM | Clayey silty gravelly fine to medium SAND, greenish gray, GLEY2-5/5BG | 30 | 50 | 20 |
| 38.3–40 | CH | CLAY, dark bluish gray, GLEY2-4/10B, contains peat beds with minor gravel (Clover Park Aquitard). | 5 | 5 | 90 |

| Depth (ft bgs) | Headspace PID (ppb) |
|---|---|
| 4 | 0 |
| 5 | 0 |
| 13 | 0 |
| 14 | 0 |
| 15 | 0/0 |
| 16 | 0 |
| 17 | 0 |
| 18 | 0 |
| 19 | 0 |
| 20 | 0/32 |
| 21 | 8 |
| 22 | 4 |
| 23 | 19 |
| 24 | 0 |
| 25 | 0/0 |
| 26 | 0 |
| 27 | 100 |
| 28 | 3 |
| 29 | 6 |
| 30 | 4/0 |
| 31 | 0 |
| 32 | 0 |
| 33 | 0 |
| 34 | 0 |
| 35 | 0/0 |
| 36 | 0 |
| 37 | 0 |
| 38 | 0 |
| 39 | 0 |
| 40 | 0 |

| Interval (ft bgs) | Measured Recovery | Sample ID Date/Time | Comments |
|---|---|---|---|
| 0–5 | 1.5 | | No recovery from 5 to 10 ft |
| 5–10 | 0 | | |
| 10–15 | 2.3 | NP-B113-S-13-190613; 6/13/2019 1005<br>NP-B113-GW-15-190613 ; 6/13/2019 1100 | Collected soil at 13 ft, presumably near waste body, but there was no recovery from 5 to 10 ft so the majority of the waste body was not identified.Collected groundwater at 10 to 15 ft, very low flow/recharge rate during pumping. |
| 15–20 | 5 | NP-B113-S-20-190613; 6/13/2019 1220 | |
| 20–25 | 5 | | Collected soil at 27 ft, associated with PID hit. Attempted to collect groundwater at 25 to 29 associated with a PID hit, but flowing sands clogged the temporary well screen and prevented sample collection |
| 25–30 | 5 | NP-B113-S-27-190613; 6/13/2019 1235 | |
| 30–35 | 5 | | |
| 35–40 | 5 | | |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: NP-B114

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/13/2019<br>Geologist: Damon DeYoung<br>Total Depth: 40<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259613.6<br>Easting (NAD 83): 1198898.3<br>Surface Elevation (NAVD 88): 15.18<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot soil cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Headspace PID (ppb) | Measured Recovery | Sample ID Date/Time | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 0–3 | | | | | | | 1.8 (0–5) | | |
| 3–5 | GM | Silty sandy GRAVEL, very pale brown, 10YR-7/4, dry | 50 | 30 | 20 | 0 (3); 0 (4); 0 (5) | | | |
| 5–9 | GM | Silty sandy GRAVEL, very dark brown, 10YR-2/2, wet, contaminated waste material (wood, plastic, glass), contaminant odor | 50 | 30 | 20 | 1881 (8) | 2 (5–10) | NP-B114-S-08-190613; 6/13/2019 0755 | Collected soil at 8 ft, within zone of highest PID readings |
| 9–14 | GM | Silty sandy GRAVEL, dark greenish gray, GLEY1-4/10GY, wet, contaminated waste material (wood, plastic, glass), contaminant odor (groundwater symbol at ~12 ft) | 40 | 30 | 30 | 570 (9); 81 (10); 21 (13) | 1.7 (10–15) | NP-B114-S-15-190613; 6/13/2019 0800<br>NP-B114-GW-15-190613; 6/13/2019 0825 | Collected soil at 15 ft, in silt zone beneath the shallow waste body.Collected groundwater screened 10 to 15 ft, within the shallow waste zone. |
| 14–19 | MH | Clayey sandy SILT, greenish gray, GLEY1-6/5GY, finely laminated | 0 | 30 | 70 | 884 (14); 0 (15); 0 (16); 0 (17); 0 (18) | 4 (15–20) | | |
| 19–24.5 | ML | Clayey sandy SILT, bluish gray, GLEY2-5/5B, finely laminated | 0 | 30 | 70 | 0 (19); 0 (20); 0 (21); 0 (22); 24 (23); 1 (24) | 4 (20–25) | NP-B114-S-23-190613; 6/13/2019 0850 | Collected soil at 23 ft, associated with small hit on PID. |
| 24.5–27.5 | SP | Poorly graded SAND, bluish gray, GLEY2-5/10B, minor silt and gravel, saturated | 5 | 90 | 5 | 0/0 (25); 0 (26); 0 (27) | 5 (25–30) | | |
| 27.5–37.5 | SW | Gravelly well graded fine to coarse SAND, dark greenish gray, GLEY2-4/10BG, gravel base at 37 to 37.5, clayey gravel bed at 32 to 32.5 ft | 30 | 60 | 10 | 9 (28); 0 (29); 0 (30); 0 (31); 0 (32); 107 (33); 20 (34); 35 (35); 0 (36); 0 (37) | 4 (30–35) | NP-B114-S-33-190613; 6/13/2019 0910 | Collected soil at 33 ft, associated with small hit on PID. |
| 37.5–40 | CH | CLAY, bluish gray, GLEY2-6/10B, low moisture, contains peat beds (Clover Park Aquitard) | 0 | 0 | 100 | 0 (38); 0 (39); 0 (40) | 5 (35–40) | NP-B114-GW-40-190613; 6/13/2019 1020 | Collected groundwater screened from 36 to 40 ft, straddling the contact of basal gravel conglomerate and the underlying clay unit. |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: NP-B115

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/14/2019<br>Geologist: Damon DeYoung<br>Total Depth: 30<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259718.6<br>Easting (NAD 83): 1199042<br>Surface Elevation (NAVD 88): 16.17<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot soil cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary groundwater monitoring |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Headspace PID (ppb) | Measured Recovery | Sample ID Date/Time | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 0–3 | | | | | | | 2.5 (0–5) | | Compressed core |
| 3–4.5 | GM | Silty sandy GRAVEL, light brownish gray, 10YR-6/2, dry | 50 | 30 | 20 | 0 (3); 291 (4) | | NP-B115-S-04-190614`; 6/14/2019 0950 | Top 0.5 ft of core is loose material, may be caved material from shallower depth |
| 4.5–5 | PT | PEAT, very dark brown, 10YR-2/2 | 0 | 0 | 0 | 151 (5) | | | |
| 5–9.5 | CH | Silty sandy gravelly CLAY, greenish gray, GLEY1-5/10GY | 20 | 20 | 60 | 0 (8); 0 (9) | 2.4 (5–10) | NP-B115-S-09-190614; 6/14/2019 1000 | Top 1.8 ft of core is loose material, may be caved material from shallower depth |
| 9.5–10 | PT | PEAT, black, 10YR-2/1, contaminant odors (creosote?) | 0 | 0 | 0 | 11 | | | |
| 10–13.2 | CH | Silty sandy CLAY, grayish green, GLEY1-5/5G/2, mottled orangish brown at 8 ft | 0 | 30 | 70 | 4 (10); 0 (13) | 2.8 (10–15) | | |
| 13.2–22.7 | SP | Poorly graded SAND, greenish gray (GLEY1-6/10GY), color changes to brown (10YR-5/3) at 19 ft, red oxidized zone at 19.5 ft, color changes back to greenish gray at 20 ft | 0 | 100 | 0 | 0 (14–22) | 5 (15–20); 5 (20–25) | NP-B115-GW-15-190614 ; 6/14/2019 1020 | |
| 22.7–26.8 | GM | Clayey sandy GRAVEL, very dark grayish brown, 10YR-3/2 | 50 | 40 | 10 | 0 (23–26) | 5 (25–30) | | |
| 26.8–27.5 | SP | Poorly graded fine SAND, bluish black, GLEY2-2.5/5PB | 0 | 100 | 0 | 0 (27) | | NP-B115-S-27-190614; 6/14/2019 1100<br>NP-B115-GW-27-190614 ; 6/14/2019 1130 | |
| 27.5–30 | CL | Silty CLAY, dark bluish gray, GLEY2-4/5PB, finely laminated, contains peat laminae (Clover Park Aquitard) | 0 | 0 | 100 | 0 (28); 0 (29); 0 (30) | | | |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: NP-B116

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/21/2019<br>Geologist: Damon DeYoung<br>Total Depth: 40<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259707.7<br>Easting (NAD 83): 1198872.1<br>Surface Elevation (NAVD 88): 13.93<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Headspace PID (ppb) | Measured Recovery | Sample ID Date/Time | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 0–2.5 | | | | | | | 2.5 (0–5) | | Poor recovery |
| 2.5–4.8 | GM | Clayey silty sandy GRAVEL, very pale brown, 10YR-7/3 | 50 | 30 | 20 | 0 (3), 0 (4) | | | Top 0.5 ft of core is loose material, may be caved material from shallower depth |
| 4.8–12 | GM | Wood debris and waste (glass), grayish green, GLEY1-5/5G/2, saturated at 9.5 ft | 0 | 0 | 0 | 0 (5), 0 (8), 0 (9), 0 (10) | 2 (5–10) | | DTW: Shallow, recharged over the weekend<br>DTW: Deep<br>Top 1 ft of core is loose material, may be caved material from shallower depth |
| 12–19.5 | SP | Poorly graded SAND, fine to medium, greenish gray, GLEY2-5/5BG, orangish brown oxidation zone from 14 to 14.5 ft | 5 | 90 | 5 | 0 (12), 0 (13), 0 (14), 0 (15), 0 (16), 0 (17), 0 (18), 0 (19) | 3.8 (10–15), 5 (15–20) | NP-B116-S-13-190621; 06/21/2019 1340<br>NP-B116-GW-14-190621; 06/21/2019 1415 collected as field duplicate<br>NP-B116-GW-15-190621; 06/21/2019 1400 | Lower contact is estimated at 37 ft; the core and liner was stuck in the core barrel. |
| 19.5–20 | CH | Silty sandy CLAY, dark greenish gray, GLEY1 4/10Y, medium stiff, wet | 0 | 30 | 70 | 0 (20) | | | |
| 20–37 | SW | Gravelly well graded SAND, dark bluish gray, GLEY2 4/10B, dense, damp | 25 | 75 | 0 | 0 (21), 3 (22), 0 (24), 0 (25), 0 (26), 0 (27), 0 (28), 0 (29), 0 (30), 0 (31), 0 (32), 0 (33), 234 (34), 84 (35) | 5 (20–25), 5 (25–30), 5 (30–35) | NP-B116-S-22-190624; 06/24/2019 0755<br>NP-B116-S-34-190624; 06/24/2019 0833<br>NP-B116-GW-36-190624; 06/24/2019 1020 | Met refusal at 40 ft; sample locked in drill string |
| 37–40 | CL | Sandy silty CLAY, black, 2.5Y 2.5/1, very stiff, dry (Clover Park Aquitard) | 0 | 15 | 85 | 0 (40) | 5 (35–40) | | |

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**BATTELLE**

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: NP-B117s

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/13/2019<br>Geologist: Damon DeYoung<br>Total Depth: 40<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259702.4<br>Easting (NAD 83): 1198908.2<br>Surface Elevation (NAVD 88): 14.42<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot soil cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | Lithology | USCS Symbol | Sample Description | Grading % Gravel | Grading % Sand | Grading % Fines |
|---|---|---|---|---|---|---|
| 0–3 | | | | | | |
| 3–4.5 | Pattern: silty sandy gravel (GM) | GM | Silty sandy GRAVEL, light brownish gray, 10YR-6/2, contains wood fragments at 4 ft, dry | 50 | 30 | 20 |
| 4.5–10 | Pattern: clayey gravelly sand (SM) | SM | Clayey gravelly SAND, dark greenish gray, GLEY1-4/10Y contaminant odor | 20 | 60 | 20 |
| 10–14.5 | Pattern: clayey gravelly sand (SM) | SM | Clayey gravelly SAND, very dark grayish brown, 2.5Y-3/3, contaminant odors, black oily residue and sheen in saturated woody material at 13.5 to 14 ft | 30 | 50 | 20 |
| 14.5–17.5 | Pattern: clayey silty fine sand (SM) | SM | Clayey silty fine SAND, dark greenish gray, GLEY2-4/5BG | 0 | 70 | 30 |
| 17.5–24 | Pattern: clayey sandy silt (MH) | MH | Clayey sandy SILT, GLEY2-6/5B bluish gray, finely laminated, thin interbeds of fine sand | 0 | 30 | 70 |
| 24–25.5 | Pattern: silty fine sand (SP) | SP | Silty fine SAND, bluish gray, GLEY2-6/5B, poorly graded, saturated | 5 | 80 | 15 |
| 25.5–37.5 | Pattern: gravelly well graded sand (SW) | SW | Gravelly well graded SAND, bluish black, GLEY2-2.5/10B, saturated | 30 | 60 | 10 |
| 37.5–40 | Pattern: clayey gravel (GM) | GM | Clayey GRAVEL, dark bluish gray, GLEY2-4/10B | 70 | 10 | 20 |
| 40– | Pattern: clay (CH) | CH | CLAY, very dark grayish brown, 10YR-3/2 contains brown peat beds and minor gravel (Clover Park Aquitard) | 5 | 5 | 90 |

Headspace PID (ppb):

| Depth (ft bgs) | Headspace PID (ppb) |
|---|---|
| 3 | 0 |
| 4 | 0 |
| 5 | 76 |
| 8 | 0 |
| 9 | 55 |
| 10 | 1826 |
| 13.5 | 1125 |
| 14 | 647 |
| 15 | 0 |
| 16 | 0 |
| 17 | 0 |
| 18 | 0 |
| 19 | 0 |
| 20 | 13 |
| 21 | 0 |
| 22 | 0 |
| 23 | 0 |
| 24 | 1 |
| 25 | 77 |
| 26 | 0 |
| 27 | 260 |
| 28 | 1825 |
| 29 | 594 |
| 30 | 255 |
| 31 | 3 |
| 32 | 0 |
| 33 | 0 |
| 34 | 60 |
| 35 | 303/122 |
| 36 | 31 |
| 37 | 0 |
| 38 | 204 |
| 39 | 1185 |
| 40 | 608 |

Measured Recovery:

| Interval (ft bgs) | Measured Recovery |
|---|---|
| 0–5 | 2.5 |
| 5–10 | 2 |
| 10–15 | 1.5 |
| 15–20 | 4 |
| 20–25 | 4 |
| 25–30 | 4 |
| 30–35 | 4 |
| 35–40 | 5 |

Sample ID Date/Time:

- NP-B117s-S-10-190613; 6/13/2019 1420
- NP-B117s-GW-15-190613; 6/13/2019 1505
- NP-B117s-S-28-190613; 6/13/2019 1550
- NP-B117s-S-39-190613; 6/13/2019 1620
- NP-B117s-GW-40-190613; 6/13/2019 1655

Comments: Step-out boring from NP-B117, which met refusal at 11 fbgs.

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: NP-B118

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/24/2019<br>Geologist: Samuel Moore<br>Total Depth: 35<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259769.7<br>Easting (NAD 83): 1198969.6<br>Surface Elevation (NAVD 88): 16.31<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Comments |
|---|---|---|---|---|---|
| SM | Gravelly silty SAND, grayish brown, 10YR 5/2, dry, loose | 20 | 60 | 20 | Poor recovery |
| CONCRETE | Concrete debris | | | | |
| SW | Clayey gravelly SAND, dark gray, 10YR 3/1, medium dense, damp | 35 | 40 | 25 | Poor recovery |
| CH | Gravelly sandy CLAY, dark gray, 10YR 3/1, medium stiff, damp | 30 | 30 | 40 | |
| SM | Gravelly silty SAND, grayish brown (10YR 5/2) with white concrete debris, dry, loose | 20 | 60 | 20 | Sporadic shell hash |
| SC | Gravelly clayey SAND, dark gray, 10YR 3/1, medium dense, damp | 15 | 55 | 30 | DTW: Deep (31 to 35 ft well screen) |
| CH | CLAY, dark greenish gray, GLEY1 4/10Y, medium stiff, damp | 0 | 0 | 100 | |
| CH | CLAY with interbedded clayey fine sand, dark greenish gray (GLEY1 4/10Y) becoming dark grayish brown (10YR 4/2), stiff, wet | 0 | 40 | 60 | Sand lenses between 20.3 and 21; 22.4 to 22.5; 22.7 to 22.8; 23.4 to 23.6 |
| SP | Fine SAND, very dark greenish gray, GLEY1 3/10Y, medium dense, wet | 0 | 100 | 0 | 10YR 3/4 dark yellowish brown between 29.0 and 30.0. |
| GW | Sandy GRAVEL, dark yellowish brown, 10YR 3/4, dense, wet | 50 | 40 | 10 | |
| SP | Fine SAND, very dark greenish gray, GLEY1 3/10Y, medium dense, wet | 0 | 100 | 0 | |
| CH | CLAY, dark gray, GLEY1 4/N, very stiff, dry (Clover Park Aquitard) | 0 | 0 | 100 | Deep aquitard |

Depth scale (ft bgs): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38

Headspace PID (ppb), top to bottom: 0, 0, 1, 139, 130, 148, 153, 260, 24, 25, 410, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0

Measured Recovery, top to bottom: 1.5, 3, 3.2, 5, 5, 5, 5

| Sample ID | Date/Time |
|---|---|
| NP-B118-S-13-190624 | 06/24/2019 at 1543 |
| NP-B118-S-16-190624 | 06/24/2019 at 1557 |
| NP-B118-GW-20-190624 | 06/24/2019 at 1624 |
| NP-B118-S-34-190625 | 06/25/2019 at 0840 |
| NP-B118-GW-35-190625 | 06/25/2019 at 0910 |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: NP-B119

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/21/2019<br>Geologist: Damon DeYoung<br>Total Depth: 35<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259767.5<br>Easting (NAD 83): 1199045.2<br>Surface Elevation (NAVD 88): 16.32<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot soil cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Headspace PID (ppb) | Measured Recovery | Sample ID Date/Time | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 0–2 | | | | | | | | | Poor recovery |
| 2–4 | GM | Clayey silty sandy GRAVEL, very pale brown, 10YR-7/3, moist at 4 ft | 50 | 30 | 20 | 0 (3 ft) | 2.8 | | |
| 4–12.5 | GM | Sandy gravelly CLAY, grayish green, GLEY1-5/5G_/2, saturated at 9 ft. | 20 | 20 | 60 | 0 (4), 184 (5), 224 (7), 70 (8), 0 (9), 0 (10), 0 (11), 0 (12) | 3.6 (5–10); 4 (10–15) | NP-B119-S-07-190621; 06/21/2019 0940<br>NP-B119-S-12-190621; 06/21/2019 1010 | Top 0.5 ft of core is loose material, may be caved material from shallower depth<br>Top 1.5 ft of core is loose material, may be caved material from shallower depth |
| 12.5–13 | SP | Poorly graded SAND, bluish black, GLEY2-2.5/5B, contaminant odors | 0 | 100 | 0 | 0 (13) | | | |
| 13–19 | SP | Poorly graded SAND, fine to medium, greenish gray (GLEY2-2.5/5B), brown from 13 to 14 ft, gravelly at 14 ft, orangish brown oxidation zone from 18 to 19 ft | 5 | 90 | 5 | 0 (14), 0 (15), 0 (16), 0 (17), 0 (18), 0 (19) | 5 (15–20) | NP-B119-GW-15-190621; 06/21/2019 1000<br>NP-B119-S-15-190621; 06/21/2019 1015 | |
| 19–22 | GM | Clayey silty sandy GRAVEL, grayish brown, 10YR-5/2 | 70 | 20 | 10 | 0 (20), 0 (21) | 5 (20–25) | | |
| 22–28.7 | SW | Well graded SAND, very dark bluish gray (GLEY2-3/10B), brown from 22 to 24.5 | 0 | 100 | 0 | 0 (22), 0 (23), 0 (24), 0 (25), 0 (26), 0 (27), 0 (28) | 5 (25–30) | | |
| 28.7–35 | CL | Silty CLAY, bluish gray (GLEY2-5/5B), finely laminated, dark brown peat laminae from 32 to 34 ft (Clover Park Aquitard) | 0 | 100 | 0 | 0 (29), 0 (30), 0 (31), 0 (32), 0 (33), 0 (34), 0 (35) | 5 (30–35) | NP-B119-GW-32-190621; 06/21/2019 1145 | Hit deep clay at 29 ft |

BATTELLE

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: NP-B120

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/24/2019<br>Geologist: Samuel Moore<br>Total Depth: 49.5<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259762.6<br>Easting (NAD 83): 1198875.1<br>Surface Elevation (NAVD 88): 14.44<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Comments |
|---|---|---|---|---|---|---|
| 0 | | | | | | Poor recovery |
| 5 | GM | Clayey silty sandy GRAVEL, brown, 10Y 4/3 | 40 | 30 | 30 | DTW: Shallow |
| 9.5 | GM | Wood debris with plastic debris mixed with silty sandy clay, soft, wet | 10 | 50 | 40 | Poor recovery; DTW: Deep |
| 12.8 | SW | Clayey SAND, dark gray, 10YR 4/1, wet, medium dense | 0 | 90 | 10 | |
| 14.5 | SP | Fine SAND, dark grayish brown, 10YR 4/2, medium dense, wet | 0 | 100 | 0 | |
| 24.7 | SW | very dark gray, GLEY1 3/N, | 25 | 75 | 0 | |
| 49.5 | | | | | | Met refusal at 49.5 ft |

Headspace PID (ppb), top to bottom: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 834, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 99, 0, 0, 48, 16, 0, 0, 481, 0, 45, 0, 0, 0, 168, 702, 125, 119, 373, 107

Measured Recovery, top to bottom: 5, 3, 5, 5, 5, 5, 5, 5, 4.5

| Sample ID Date/Time |
|---|
| NP-B120-S-12.5-190624; 06/24/2019 at 1014 |
| NP-B120-GW-15-190624; 06/24/2019 at 1030 |
| NP-B120-S-29-190624; 06/24/2019 at 1122 |
| NP-B120-S-35.5-190624; 06/24/2019 at 1150 |
| NP-B120-S-42-190624; 06/24/2019 at 1205 |
| NP-B120-S-49.5-190624; 06/24/2019 at 1232 |
| NP-B120-GW-50-190624; 06/24/2019 at 1420 |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: NP-B121

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/20/2019<br>Geologist: Damon DeYoung<br>Total Depth: 40<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259782.8<br>Easting (NAD 83): 1198925.9<br>Surface Elevation (NAVD 88): 13.31<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot soil cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|
| 0–2 | | | | | |
| 2–9 | SM | Clayey silty gravelly SAND, very pale brown, 10YR-7/3, moist at 4 ft | 20 | 60 | 20 |
| 9–13 | SM | Clayey silty gravelly SAND, greenish black, GLEY1-2.5/10Y, fill material, woody waste debris at 9.5 ft, saturated at 12 ft, black aqueous staining | 20 | 60 | 20 |
| 13–15 | SM | Clayey silty SAND, minor gravel, dark greenish gray, GLEY2-4/5BG, contains shell fragments | 5 | 70 | 25 |
| 15–16.7 | CH | Silty sandy CLAY, greenish gray, GLEY2-6/5BG | 0 | 20 | 80 |
| 16.7–34.5 | SP | Poorly graded SAND, fine to medium, minor silt and gravel, bluish gray, GLEY2-5/5G, massive from 16.7 to 32.5 ft, minor fine sand/silt laminae from 32.5 to 34.5 ft | 5 | 90 | 5 |
| 34.5–35 | CL | CLAY, very dark brown, 7.5YR-2.5/3, no bedding apparent | 0 | 0 | 100 |
| 35–37.5 | SP | Poorly graded SAND, pale brown, 10YR-6/3, fine to medium, massive from 35 to 37.5 ft, minor silt laminae at 37.5 | 0 | 95 | 5 |
| 37.5–40 | GM | Clayey silty sandy GRAVEL, olive brown, 2.5YR-4/3 | 70 | 20 | 10 |

Groundwater symbol (▼) at approximately 10 ft.

Headspace PID (ppb):

| Depth (ft) | PID (ppb) |
|---|---|
| 3 | 0 |
| 4 | 56 |
| 5 | 394 |
| 9 | 44 |
| 10 | 35 |
| 12 | 32 |
| 13 | 277 |
| 14 | 48 |
| 15 | 0 |
| 16 | 0 |
| 17 | 0 |
| 18 | 0 |
| 19 | 0 |
| 20 | 0 |
| 21 | 0 |
| 22 | 0 |
| 23 | 0 |
| 24 | 0 |
| 25 | 0 |
| 26 | 0 |
| 27 | 0 |
| 28 | 0 |
| 29 | 0 |
| 30 | 0 |
| 31 | 0 |
| 32 | 0 |
| 33 | 0 |
| 34 | 0 |
| 35 | 0 |
| 36 | 0 |
| 37 | 0 |
| 38 | 0 |
| 39 | 0 |
| 40 | 0 |

| Sample Interval (ft) | Measured Recovery |
|---|---|
| 0–5 | 2.1 |
| 5–10 | 3.1 |
| 10–15 | 2.1 |
| 15–20 | 3.4 |
| 20–25 | 4.5 |
| 25–30 | 5 |
| 30–35 | 5 |
| 35–40 | 5 |

| Sample ID Date/Time |
|---|
| NP-B121-S-05-190620; 06/20/2019 1055 |
| NP-B121-S-13-190620; 06/20/2019 1100 |
| NP-B121-S-14-190620; 06/20/2019 1105 collected as field duplicate |
| NP-B121-GW-15-190620; 06/20/2019 1145 |
| NP-B121-S-34-190620; 06/20/2019 1325 |
| NP-B121-GW-35-190620; 06/20/2019 1430 |

Comments:

- 0 ft: Poor recovery
- Collected soil at 5 ft associated with PID hit
- Top 1 ft of core is loose material, may be caved material from shallower depth
- Collected soil at 13 ft associated with PID hit.Collected duplicate soil at 13 ft and called it 14 ft per SAPCollected groundwater from 10 to 15 ft.
- Top 0.5 ft of core is loose material, may be caved material from shallower depth
- Top 0.5 ft of core is loose material, may be caved material from shallower depth
- Collected soil at 34 ft, within silt/sand laminated zone. Collected groundwater corresponding to the soil sample.
- Refusal at 40 ft

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: NP-B122

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/20/2019<br>Geologist: Damon DeYoung<br>Total Depth: 34<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259803.1<br>Easting (NAD 83): 1198989.7<br>Surface Elevation (NAVD 88): 15.12<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot soil cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|
| 0–2 | | | | | |
| 2–4 | SM | Clayey silty sandy GRAVEL, very pale brown, 10YR-7/3, moist at 4 ft | 50 | 30 | 20 |
| 4–13 | GM | Sandy gravelly CLAY, dark greenish gray, GLEY2-4/10G, waste debris (wood, metal, plastic) from 4 ft to 10 ft, saturated at 9 ft | 20 | 20 | 60 |
| 13–15.5 | SM | Clayey silty SAND, minor gravel, dark greenish gray, GLEY2-4/5BG, contains shell fragments | 5 | 70 | 25 |
| 15.5–26.5 | SP | Poorly graded SAND, fine to medium, bluish gray, GLEY2-5/5G, minor silt and gravel, massive from 16.7 to 22.5 ft, minor fine sand/silt laminae from 22.5 to 24.5 ft | 5 | 90 | 5 |
| 26.5–27.2 | GM | Clayey silty sandy GRAVEL, yellowish, 10YR-5/6 | 70 | 20 | 10 |
| 27.2–32 | ML | Clayey fine sandy SILT, bluish gray, GLEY2-5/5B, finely laminated | 0 | 20 | 80 |
| 32–34 | CL | Silty CLAY, very dark brown, 10YR-2/2, finely laminated, peat bearing from 32 to 34 ft (Clover Park Aquitard) | 0 | 0 | 100 |

| Depth (ft bgs) | Headspace PID (ppb) |
|---|---|
| 3 | 0 |
| 4 | 45 |
| 5 | 1112 |
| 9 | 215 |
| 10 | 28 |
| 11 | 22 |
| 12 | 12 |
| 13 | 20 |
| 14 | 4 |
| 15 | 5 |
| 16 | 0 |
| 17 | 0 |
| 18 | 0 |
| 19 | 0 |
| 20 | 0 |
| 21 | 0 |
| 22 | 0 |
| 23 | 0 |
| 24 | 0 |
| 25 | 0 |
| 26 | 0 |
| 27 | 0 |
| 28 | 0 |
| 29 | 0 |
| 30 | 0 |
| 31 | 0 |
| 32 | 0 |
| 33 | 0 |
| 34 | 0 |

| Sample Interval (ft bgs) | Measured Recovery | Sample ID Date/Time |
|---|---|---|
| 0–5 | 2.5 | NP-B122-S-05-190620; 06/20/2019 1520 |
| 5–10 | 1.5 | NP-B122-S-09-190620; 06/20/2019 1530 |
| 10–15 | 4 | NP-B122-GW-15-190620; 06/20/2019 1700 |
| 15–20 | 5 | |
| 20–25 | 5 | |
| 25–30 | 5 | NP-B122-S-27-190621; 06/21/2019 0845<br>NP-B122-GW-28-190621; 06/21/2019 0930 |
| 30–34 | 4 | |

| Depth (ft bgs) | Comments |
|---|---|
| 0 | Poor recovery |
| 2 | Collected soil at 5 ft associated with PID hit |
| 4 | Top 0.5 ft of core is loose material, may be caved material from shallower depth |
| 9 | Top 1.5 ft of core is loose material, may be caved material from shallower depth |
| 34 | Hit refusal at 34 ft |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: NP-B123

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/19/2019<br>Geologist: Damon DeYoung<br>Total Depth: 40<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259830.8<br>Easting (NAD 83): 1198941.1<br>Surface Elevation (NAVD 88): 18.98<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot soil cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|
| 0–2 | | | | | |
| 2–9 | SM | Clayey silty gravelly SAND, very pale brown, 10YR-7/3, moist at 8 ft | 20 | 60 | 20 |
| 9–19 | SM | Clayey silty gravelly SAND, gray, GLEY1-5/N, fill material, contains waste debris (battery casing, glass, fabric), orangish yellow oxidized soil at 14.5 ft, black saturated waste at 19 ft | 10 | 80 | 10 |
| 19–29 | SP | Silty poorly graded fine SAND, minor gravel, dark bluish gray, GLEY2-4/5B, no bedding features apparent | 5 | 85 | 10 |
| 29–38.5 | SW | Silty gravelly well graded SAND, dark bluish gray, GLEY2-4/5B | 20 | 70 | 10 |
| 38.5–39.5 | GM | Clayey silty sandy GRAVEL, dark bluish gray, GLEY2-4/5B | 70 | 20 | 10 |
| 39.5–40 | CH | Silty CLAY, dark bluish gray, GLEY2-4/5B (Clover Park Aquitard) | 0 | 0 | 100 |

| Depth (ft bgs) | Headspace PID (ppb) |
|---|---|
| 2 | 0 |
| 3 | 0 |
| 4 | 0 |
| 5 | 0 |
| 7 | 0 |
| 8 | 0 |
| 9 | 0 |
| 10 | 0 |
| 15 | 0 |
| 19 | 1889 |
| 20 | 5 |
| 21 | 0 |
| 22 | 0 |
| 23 | 0 |
| 25 | 0 |
| 26 | 0 |
| 27 | 0 |
| 28 | 0 |
| 29 | 0 |
| 30 | 0 |
| 33 | 0 |
| 34 | 0 |
| 35 | 0 |
| 36 | 0 |
| 37 | 0 |
| 38 | 0 |
| 39 | 0 |
| 40 | 0 |

| Interval (ft bgs) | Measured Recovery |
|---|---|
| 0–5 | 3.1 |
| 5–10 | 2.7 |
| 10–15 | 1.5 |
| 15–20 | 1.5 |
| 20–25 | 5 |
| 25–30 | 5 |
| 30–35 | 2.5 |
| 35–40 | |

**Sample ID Date/Time**

- NP-B123-S-19-190619; 06/19/2019 1435
- NP-B123-GW-19-190619; 06/19/2019 1450 collected MS/MSD
- NP-B123-GW-20-190619; 06/19/2019 1500 collected as field duplicate
- NP-B123-S-25-190619; 06/19/2019 1620
- NP-B123-S-40-190619; 06/19/2019 1710
- NP-B123-GW-40-190619; 06/19/2019 1810

**Comments**

- Collected soil at 19 ft targeting high PID, black coated soil.
- Very poor recovery
- Measured 6/20/2019 at 0740
- Very poor recovery
- Core lodged in core barrel, used sledge hammer to break core apart and poured the core cutting from the core barrel.
- Collected soil at 40 ft, collected groundwater from 36 to 40 ft

**BATTELLE**

## Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: NP-B124

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/20/2019<br>Geologist: Damon DeYoung<br>Total Depth: 35<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259847.5<br>Easting (NAD 83): 1199004.3<br>Surface Elevation (NAVD 88): 20.05<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot soil cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|
| 0–2 | | | | | |
| 2–8 | SM | Clayey silty gravelly SAND, very pale brown, 10YR-7/3, moist at 4 ft | 20 | 60 | 20 |
| 8–19 | SM | Clayey silty gravelly SAND, bluish gray, GLEY2-5/5B, fill material, woody waste debris at 10 ft, glass fragments and white clayey material at 14 ft | 20 | 60 | 20 |
| 19–20 | SM | Clayey silty SAND, minor gravel, dark greenish gray, GLEY2-4/5BG, contains shell fragments at 18.5 to 19 ft | 5 | 70 | 25 |
| 20–25 | SP | Poorly graded fine SAND, dark greenish gray, GLEY1-4/5G/1, massive, minor silt | 0 | 95 | 5 |
| 25–26.5 | SW | Silty gravelly well graded SAND, light bluish gray, GLEY2-7/5PB | 25 | 50 | 25 |
| 26.5–27 | ML | Clayey sandy SILT, dark bluish gray, GLEY2-4/5PB | 0 | 10 | 90 |
| 27–28 | SP | Silty poorly graded fine SAND, very dark bluish gray, GLEY2-3/10B | 0 | 90 | 10 |
| 28–35 | CL | Silty sandy CLAY, very dark greenish gray, GLEY2-3/10G, finely laminated, 2 cm peat bed at 33.5 ft (Clover Park Aquitard) | 0 | 10 | 90 |

| Depth (ft bgs) | Headspace PID (ppb) |
|---|---|
| 3 | 0 |
| 4 | 0 |
| 5 | 0 |
| 8 | 0 |
| 9 | 0 |
| 10 | 114 |
| 13 | 0 |
| 14 | 0 |
| 15 | 0 |
| 17 | 0 |
| 18 | 0 |
| 19 | 0 |
| 20 | 0 |
| 21 | 0 |
| 22 | 0 |
| 23 | 0 |
| 24 | 0 |
| 25 | 0 |
| 26 | 0 |
| 27 | 0 |
| 28 | 0 |
| 29 | 0 |
| 30 | 0 |
| 31 | 0 |
| 32 | 0 |
| 33 | 0 |
| 34 | 0 |
| 35 | 0 |

| Sample Interval (ft bgs) | Measured Recovery |
|---|---|
| 0–5 | 2.1 |
| 5–10 | 3.1 |
| 10–15 | 2.1 |
| 15–20 | 3.4 |
| 20–25 | 5 |
| 25–30 | 5 |
| 30–35 | 5 |

| Sample ID Date/Time |
|---|
| NP-B124-S-10-190620; 06/20/2019 0805 |
| NP-B124-S-14-190620; 06/20/2019 0820 |
| NP-B124-GW-20-190620 ; 06/20/2019 0900 |
| NP-B124-S-28-190620; 06/20/2019 1010 |
| NP-B124-GW-29-190620 ; 06/20/2019 1230 |

Comments:

- Poor recovery
- Top 1 ft of core is loose material, may be caved material from shallower depth
- Collected soil at 10 ft associated with PID hit.Collected soil at 14 ft below glass waste.Collected groundwater from 15 to 20 ft.
- Top 0.5 ft of core is loose material, may be caved material from shallower depth
- Top 0.5 ft of core is loose material, may be caved material from shallower depth
- Top 2 ft of core is loose material, may be caved material from shallower depth

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: NP-B125

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/19/2019<br>Geologist: Damon DeYoung<br>Total Depth: 45<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259886.9<br>Easting (NAD 83): 1198964<br>Surface Elevation (NAVD 88): 21.31<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot soil cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Headspace PID (ppb) |
|---|---|---|---|---|---|---|
| 1.5–4 | SM | Clayey silty gravelly SAND, very pale brown, 10YR-7/3 | 20 | 60 | 20 | 0, 0, 0 |
| 4–19.5 | SM | Clayey silty gravelly SAND, gray, GLEY1-5/N, fill material | 10 | 80 | 10 | 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 |
| 19.5–20 | SM | Clayey silty fine SAND, black, GLEY1-2.5/N | 0 | 60 | 40 | 0 |
| 20–24 | SM | Clayey silty fine SAND, dark greenish gray, GLEY1-4/5GY, contains shell fragments, minor gravel, minor wood/root material | 5 | 80 | 15 | 0, 0, 0, 0 |
| 24–29 | ML | Clayey sandy SILT, bluish gray, GLEY2-5/5B, finely laminated interbedded sand, silt and clay beds 0.5 to 5 cm thick | 0 | 30 | 70 | 0, 0, 0, 0, 0 |
| 29–37.5 | SP | Silty poorly graded fine SAND, dark bluish gray, GLEY2-4/5B, minor gravel | 5 | 85 | 10 | 0, 0, 0, 0, 0, 0, 0, 0, 0 |
| 37.5–38 | PT | PEAT, very dark grayish brown, 10YR-3/2 | 0 | 0 | 100 | 0 |
| 38–45 | SM | Clayey silty fine SAND, dark bluish gray, GLEY2-4/5B | 0 | 60 | 40 | 0, 0, 0, 0, 0, 0, 0, 0 |

| Sample Interval (ft bgs) | Measured Recovery |
|---|---|
| 0–5 | 3 |
| 5–10 | 3.2 |
| 10–15 | 2.4 |
| 15–20 | 1.3 |
| 20–30 | 10 |
| 30–35 | 5 |
| 35–40 | 5 |
| 40–45 | 5 |

Groundwater level symbol at 12 ft.

| Depth (ft bgs) | Sample ID Date/Time | Comments |
|---|---|---|
| 10 | | Very poor recovery |
| 15 | | very poor recovery. |
| 18–20 | NP-B125-S-20-190619; 06/19/2019 0835 | Collected groundwater at 18 to 23 ft. Collected soil at 20 ft. Compressed core, collected 10 ft of soil in 5 ft core liner. |
| 23 | NP-B125-GW-23-190619; 06/19/2019 0940 | |
| 36–39 | NP-B125-S-38-190619; 06/19/2019 1040<br>NP-B125-GW-39-190619; 06/19/2019 1255 | Collected a soil sample at 38 ft and 45 ft and a groundwater sample from 35 to 39 ft. Top 3 ft of core is loose material, may be caved material from shallower depth |
| 45 | NP-B125-S-45-190619; 06/19/2019 1145 | |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: NP-B125

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/19/2019<br>Geologist: Damon DeYoung<br>Total Depth: 45<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259886.9<br>Easting (NAD 83): 1198964<br>Surface Elevation (NAVD 88): 21.31<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot soil cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|
| 2–4.5 | SM | Clayey silty gravelly SAND, very pale brown, 10YR-7/3 | 20 | 60 | 20 |
| 4.5–19.5 | SM | Clayey silty gravelly SAND, gray, GLEY1-5/N, fill material | 10 | 80 | 10 |
| 19.5–20 | SM | Clayey silty fine SAND, black, GLEY1-2.5/N | 0 | 60 | 40 |
| 20–24 | SM | Clayey silty fine SAND, dark greenish gray, GLEY1-4/5GY, contains shell fragments, minor gravel, minor wood/root material | 5 | 80 | 15 |
| 24–29 | ML | Clayey sandy SILT, bluish gray, GLEY2-5/5B, finely laminated interbedded sand, silt and clay beds 0.5 to 5 cm thick | 0 | 30 | 70 |
| 29–37.5 | SP | Silty poorly graded fine SAND, dark bluish gray, GLEY2-4/5B, minor gravel | 5 | 85 | 10 |
| 37.5–38 | PT | PEAT, very dark grayish brown, 10YR-3/2 | 0 | 0 | 100 |
| 38–45 | SM | Clayey silty fine SAND, dark bluish gray, GLEY2-4/5B | 0 | 60 | 40 |

Headspace PID (ppb): 0 at all measured intervals from 2 to 45 ft bgs.

Groundwater level symbol (▼) at approximately 12 ft bgs.

| Sample Interval (ft bgs) | Measured Recovery | Sample ID Date/Time | Comments |
|---|---|---|---|
| 0–5 | 3 | | |
| 5–10 | 3.2 | | Very poor recovery |
| 10–15 | 2.4 | | very poor recovery. |
| 15–20 | 1.3 | NP-B125-S-20-190619; 06/19/2019 0835 | Collected groundwater at 18 to 23 ft<br>Collected soil at 20 ft. |
| 20–30 | 10 | NP-B125-GW-23-190619; 06/19/2019 0940 | Compressed core, collected 10 ft of soil in 5 ft core liner. |
| 30–35 | 5 | | |
| 35–40 | 5 | NP-B125-S-38-190619; 06/19/2019 1040<br>NP-B125-GW-39-190619; 06/19/2019 1255 | Collected a soil sample at 38 ft and 45 ft and a groundwater sample from 35 to 39 ft. Top 3 ft of core is loose material, may be caved material from shallower depth |
| 40–45 | 5 | NP-B125-S-45-190619; 06/19/2019 1145 | |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: SP-B91

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/26/2019<br>Geologist: Samuel Moore<br>Total Depth: 40<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 258932.2<br>Easting (NAD 83): 1199204.5<br>Surface Elevation (NAVD 88): 13.84<br>Borehole Abandoned: Yes<br>Backfill Method: 3/8" Holeplug Bentonite<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|
| 0–4 | GM | Clayey sandy GRAVEL, dark gray, 10YR 4/1, damp, dense | 40 | 30 | 30 |
| 4–8.2 | SM | Clayey coarse SAND, very dark grayish brown, 10YR 3/2, soft, wet | 15 | 45 | 40 |
| 8.2–9.6 | SP | Fine SAND, dark bluish gray, GLEY2 4/5B, medium dense, wet | 0 | 100 | 0 |
| 9.6–40 | CH | CLAY with sporadic fine gravel, greenish gray, GLEY1 5/10Y, very stiff, dry (Lawton Clay) | 2 | 0 | 98 |

Headspace PID (ppb):

| Depth (ft bgs) | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PID | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Sample Interval (ft bgs) | Measured Recovery |
|---|---|
| 0–5 | 2.5 |
| 5–10 | 3.2 |
| 10–15 | 4 |
| 15–20 | 4 |
| 20–25 | 5 |
| 25–30 | 5 |
| 30–35 | 5 |
| 35–40 | 5 |

| Sample ID Date/Time |
|---|
| SP-B91-S-8-190626; 06/26/2019 at 0743 |
| SP-B91-GW-9-190626; 06/26/2019 at 0805 |
| SP-B91-S-30-190626; 06/26/2019 at 0933 |

| Depth (ft bgs) | Comments |
|---|---|
| 0 | Poor recovery |
| 5 | DTW: Shallow (Deep groundwater was not encountered) |
| 8 | Did not encounter deep groundwater bearing unit. 1 ft of slough on top |
| 15 | 1 ft slough on top |
| 35 | Core barrel liner split |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: SP-B92

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/16/2019<br>Geologist: Steve Verdibello<br>Total Depth: 45<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method:<br>Bentonite chips with 1-foot concrete cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|
| 0–3 | GM | Silty sandy GRAVEL, brown, 10YR-4/3 | 70 | 20 | 10 |
| 3–4 | SM | Gravelly silty SAND, dark gray, 5Y-4/1 | 20 | 30 | 50 |
| 4–5 | CH | Silty sandy CLAY (some dark brown organic material), dark gray, 5Y-4/1 | 0 | 30 | 70 |
| 5–6.5 | SM | Sandy SILT, greenish gray, GLEY1-5/10GY, some mottled orangish brown | 0 | 40 | 60 |
| 6.5–12 | SP | Very fine SAND, trace GRAVEL, olive gray, 5Y-5/2 | 10 | 90 | 0 |
| 12–13 | SW | Well graded Gravelly SAND, dark yellowish brown, 10YR-3/4 | 30 | 70 | 0 |
| 13–15 | CH | CLAY, dark gray, GLEY1-4/N | 0 | 0 | 100 |
| 15–24 | SW | Well graded SAND, black, GLEY1-2.5/N | 0 | 100 | 0 |
| 24–30 | SP | Gravelly SAND, black, GLEY1-2.5/N | 30 | 70 | 0 |
| 30–31.5 | GP | Sandy GRAVEL, dark gray, GLEY1-4/N | 80 | 20 | 0 |
| 31.5–34 | CL | Silty CLAY, dark gray, GLEY1-4/N | 0 | 0 | 100 |
| 34–38 | SM | Silty SAND, dark gray, GLEY1-4/N | 0 | 70 | 30 |
| 38–45 | GW | Well graded gravelly SAND, black, GLEY1-2.5/N | 40 | 60 | 0 |

Headspace PID (ppb):

| Depth (ft bgs) | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PID | 63 | 29 | 16 | 64 | 50 | 77 | 54 | 75 | 143 | 8 | 0 | 0 | 0 | 99 | 94 | 105 | 110 | 80 | 61 | 0 | 0 | 0 |

| Depth (ft bgs) | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PID | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Sample Interval (ft bgs) | Measured Recovery | Sample ID Date/Time |
|---|---|---|
| 0–5 | 3 | |
| 5–10 | 5 | SP-B92-GW-15-191016 |
| 10–15 | 5 | SP-B92-S-13-191016<br>SP-B92-S-12-191016 |
| 15–20 | 5 | EB-191016-02 |
| 20–25 | 5 | SP-B92-GW-30-191016 |
| 25–30 | 5 | SP-B92-S-28-191016 |
| 30–35 | 5 | |
| 35–40 | 5 | |
| 40–45 | 5 | |

Comments: (field duplicate for 13' MR sample – TOC only) PID reading ambient air at 50 – 80 ppb. Results from 16 – 21 ft bgs could be erroneous. PID settled back to 0 for ambient air – then took additional readings = all "0" in that range.

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: SP-B93

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/26/2019<br>Geologist: Samuel Moore<br>Total Depth: 40<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259025.8<br>Easting (NAD 83): 1199001.2<br>Surface Elevation (NAVD 88): 14.29<br>Borehole Abandoned: Yes<br>Backfill Method: 3/8” Holeplug Bentonite<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Comments |
|---|---|---|---|---|---|---|
| 0–4.8 | GW | Silty sandy GRAVEL, brown, 10YR 5/3, dry, loose | 45 | 35 | 20 | Poor recovery (0); Some plastic debris (~5) |
| 4.8–7.5 | GM | Sandy clayey GRAVEL, black, 10YR 2/1, medium dense, wet | 55 | 15 | 30 | DTW: Shallow (~6); Clay at 9.5 to 9.7 ft and 11.0 to 11.1 ft. |
| 7.5–13 | SP | Fine SAND with occasional clay lenses, very dark greenish gray, GLEY1 3/10Y, damp, medium dense | 0 | 90 | 10 | |
| 13–21 | CH | Interbedded CLAY and fine SAND, dark gray, GLEY1 4/N, medium stiff, wet | 0 | 15 | 85 | Sand at 13.7 to 14.1, 15.0 to 16.0, 17.5 and 19.0.; DTW: Deep (~18) |
| 21–38 | SP | Fine SAND with occasional clay lenses, dark gray, GLEY1 4/N, medium dense, wet | 0 | 95 | 5 | |
| 38–40 | GW | Clayey sandy GRAVEL, dark gray, GLEY1 4/N, damp, very dense | 60 | 25 | 15 | Met refusal at 40 ft bgs. |

| Sample Interval (ft bgs) | Measured Recovery | Sample ID Date/Time |
|---|---|---|
| 0–5 | 2.5 | |
| 5–10 | 3.3 | |
| 10–15 | 5 | SP-B93-S-12-190626; 06/26/2019 at 1034<br>SP-B93-GW-12.5-190626; 06/26/2019 at 1050 |
| 15–20 | 5 | SP-B93-S-17-190626; 06/26/2019 at 1102 |
| 20–25 | 5 | |
| 25–30 | 5 | |
| 30–35 | 5 | |
| 35–40 | 5 | SP-B93-S-40-190626; 06/26/2019 at 1201 |

| Depth (ft bgs) | Headspace PID (ppb) |
|---|---|
| 3 | 0 |
| 4 | 5 |
| 5 | 0 |
| 7 | 0 |
| 8 | 3 |
| 9 | 27 |
| 10 | 78 |
| 11 | 197 |
| 12 | 1989 |
| 13 | 1901 |
| 14 | 0 |
| 15 | 688 |
| 16 | 0 |
| 17 | 1605 |
| 18 | 0 |
| 19 | 0 |
| 20 | 0 |
| 21 | 8 |
| 22 | 0 |
| 23 | 0 |
| 24 | 0 |
| 25 | 0 |
| 26 | 0 |
| 27 | 0 |
| 28 | 0 |
| 29 | 0 |
| 30 | 0 |
| 31 | 0 |
| 32 | 0 |
| 33 | 0 |
| 34 | 0 |
| 35 | 0 |
| 36 | 0 |
| 37 | 0 |
| 38 | 0 |
| 39 | 0 |
| 40 | 0 |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: SP-B94

| | | |
|---|---|---|
| Permit Number: 19-EP111<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 6/26/2019<br>Geologist: Samuel Moore<br>Total Depth: 40<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Michael Running<br>Drilling Equipment: Geoprobe 7822DT<br>Drilling Method: Direct push<br>Boring Diameter: 1.5 inch<br>Sampler Type: Macro core<br>Hammer Type: Pneumatic | Northing (NAD 83): 259088.2<br>Easting (NAD 83): 1198875.7<br>Surface Elevation (NAVD 88): 15.6<br>Borehole Abandoned: Yes<br>Backfill Method: 3/8" Holeplug Bentonite<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|
| 0 – 14.5 | GW | Silty sandy GRAVEL, grayish brown, 10YR 5/2, dry, loose | 45 | 35 | 20 |
| 14.5 – 16 | SP/SM | Clayey SAND, dark gray, 10YR 4/1, medium dense, wet | 10 | 75 | 15 |
| 16 – 19.2 | CH | Interbedded CLAY with fine SAND, dark gray, 10YR 4/1, medium stiff, wet | 0 | 20 | 80 |
| 19.2 – 29.5 | CL | Fine SAND interbedded with sandy CLAY, dark gray, 10YR 4/1, transitioning to dark grayish brown, 10YR 4/2, at 26.7 ft, medium dense, wet | 10 | 45 | 45 |
| 29.5 – 39.5 | GW | Clayey sandy GRAVEL, dark grayish brown, 10YR 4/2, dense, wet | 65 | 25 | 10 |
| 39.5 – 40 | CH | CLAY, dark gray, GLEY1 4/N, very stiff, dry (Clover Park Aquitard) | 0 | 0 | 100 |

| Run (ft bgs) | Measured Recovery | Headspace PID (ppb) | Sample ID Date/Time | Comments |
|---|---|---|---|---|
| 0 – 5 | 2.6 | 0, 0, 0, 0 | | Wood debris at 3.0, paper debris at 9.5. Poor recovery |
| 5 – 10 | 1.5 | 0, 0, 0 | | Poor recovery; DTW: Shallow (approx. 8 ft) |
| 10 – 15 | 1.5 | 0, 0 | SP-B94-S-15-190626; 06/26/2019 at 1400 | Poor recovery |
| 15 – 20 | 5 | 0, 0, 0, 0, 0, 0 | SP-B94-GW-20-190626; 06/26/2019 at 1426 | Sand lenses at 17.5 to 18.0 and 18.8 to 18.9. |
| 20 – 25 | 0 | | | No recovery; likely loose sand that fell out of the barrel |
| 25 – 30 | 5 | 0, 0, 0, 0, 0 | | |
| 30 – 35 | 5 | 0, 0, 0, 0, 0 | | |
| 35 – 40 | 0 | 0, 0, 0, 0, 0, 0 | SP-B94-S-39-190626; 06/26/2019 at 1540<br>SP-B94-GW-39-190626; 06/26/2019 at 1640 | Deep aquitard |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: SP-B131

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/15/2019<br>Geologist: Steve Verdibello<br>Total Depth: 80<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot concrete cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Comments |
|---|---|---|---|---|---|
| GP | Sandy GRAVEL, grayish brown, 2.5Y-5/2 | 60 | 40 | 0 | |
| SM | Silty gravelly SAND, very dark gray, 2.5Y-3/1 | 30 | 50 | 20 | |
| GP | GRAVEL (coarse) | 100 | 0 | 0 | |
| SW | SAND (with minor silty interbedding), dark greenish gray, GLEY1-4/5G_/1 | 0 | 95 | 5 | |
| CH | Sandy CLAY (with some sand interbeds), gray, GLEY1-5/N | 0 | 30 | 70 | |
| SM | Silty SAND, gray, GLEY1-5/N | 0 | 60 | 40 | |
| SW | Well graded SAND, dark gray, GLEY1-4/N | 0 | 100 | 0 | |
| GW | Sandy GRAVEL (gravel percentage increases with depth), greenish black, GLEY1-2.5/5GY | 70 | 30 | 0 | |
| CH | Silty CLAY (minor organic material – decaying wood), dark gray, GLEY1-4/N | 0 | 0 | 100 | |
| SM | Silty SAND, dark gray, GLEY1-4/N | 0 | 60 | 40 | |
| SP | SAND, very dark gray, GLEY1-3/N | 0 | 100 | 0 | |
| SP | Gravelly SAND, black, GLEY1-2.5/N | 30 | 70 | 0 | |
| CH | Silty CLAY, gray, GLEY1-5/N | 0 | 0 | 100 | |
| SW | Well graded SAND (gradually grades from very fine sand at 42' to medium sand at 54') | 0 | 100 | 0 | |
| SW | Gravelly SAND (some wood), black, GLEY1-2.5/N | 10 | 70 | 0 | ~20% wood pieces |
| SW | Well graded SAND (gradually grades from very fine sand at 55' to medium sand at 68'), dark gray, GLEY1-4/N | 0 | 100 | 0 | |
| GW | Gravelly SAND (some wood pieces), black, GLEY1-2.5/N | 30 | 70 | 0 | |
| N/A | Preserved wood, little sand, dark brown, 7.5YR-3/2 | 0 | 20 | 0 | ~80% wood |
| SP | Very fine SAND, dark gray, GLEY1-4/N | 0 | 100 | 0 | |
| CH | Silty CLAY, gray, GLEY1-5/N | 0 | 0 | 100 | |

Headspace PID (ppb), in order from top: 0, 8, 0, 244, 314, 3594, 899, 194, 175, 153, 434, 694, 794, 597, 1890, 151, 80, 0, 5, 8, 74, 15, 262, 96, 51, 84, 52, 49, 75, 59, 97, 54, 84, 30, 10, 61, 39, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 205, 64, 0, 25, 0, 0, 0, 0, 0, 0, 0, 14, 0, 0, 0, 0, 0, 0, 0, 0, 0, 3, 0, 0, 0, 0, 0, 0

Measured Recovery, in order from top: 5, 5, 5, 5, 5, 5, 4, 5, 5, 5, 5, 5, 5, 5, 5, 5

| Sample ID Date/Time | Comments |
|---|---|
| EB-191015-01 | |
| SP-B131-S-6-191015 | |
| SP-B131-GW-15-191015 | (includes volume for MS/MSD) |
| SP-B131-S-23-191015 | (includes volume for MS/MSD for TOC only) |
| SP-B131-GW-40-191015 | |

Depth (ft bgs): 0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52, 56, 60, 64, 68, 72, 76, 80

# BATTELLE

**Project: Keyport OU 1 Source Investigation**
**Site: OU 1**
**Boring Log: SP-B140**

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/2/2019<br>Geologist: Damon DeYoung<br>Total Depth: 60<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot soil cap<br>Monitoring Device Installed: Yes<br>Device Type: N/A |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Comments |
|---|---|---|---|---|---|---|
| 0–5 | SP | Gravelly SAND, top soil, very dark grayish brown, 10YR-3/2 | 40 | 60 | 0 | |
| 5–10 | SP | Poorly graded SAND, dark gray, GLEY1-4/N | 0 | 100 | 0 | |
| 10–20 | ML | Clayey Sandy SILT, finely interbedded, dark gray, GLEY1-4/N | 0 | 25 | 75 | |
| 20–37 | SP | SAND, minor interbeds of SILT, dark gray, GLEY1-4/N | 0 | 95 | 5 | |
| 37–39 | GW | Sandy GRAVEL, dark gray, GLEY1-4/N | 60 | 40 | 0 | |
| 39–40 | CH | Silty gravelly CLAY, dark gray, GLEY1-4/N | 40 | 0 | 60 | |
| 40–45 | SW | Clayey gravelly SAND | 30 | 50 | 20 | |
| 45–57 | GM | Sandy clayey silty GRAVEL | 70 | 10 | 20 | |
| 57–60 | CH | CLAY | 0 | 0 | 100 | No samples collected; depth to clay aquitard only for this boring. |

Headspace PID (ppb):

| Depth (ft bgs) | PID (ppb) |
|---|---|
| 3 | 0 |
| 4 | 0 |
| 5 | 5 |
| 6 | 0 |
| 7 | 143 |
| 8 | 383 |
| 9 | 902 |
| 10 | 15500 |
| 11 | 8305 |
| 12 | 4289 |
| 13 | 38 |
| 14 | 0 |
| 15 | 0 |
| 16 | 0 |
| 17 | 0 |
| 18 | 0 |
| 19 | 0 |
| 20 | 0 |
| 21 | 218 |
| 22 | 0 |
| 23 | 0 |
| 24 | 0 |
| 25 | 0 |
| 26 | 0 |
| 27 | 0 |
| 28 | 0 |
| 29 | 0 |
| 30 | 0 |
| 31 | 0 |
| 32 | 0 |
| 33 | 0 |
| 34 | 0 |
| 35 | 0 |
| 36 | 0 |
| 37 | 0 |
| 38 | 0 |
| 39 | 0 |
| 40 | 0 |
| 41 | 0 |
| 42 | 0 |
| 43 | 0 |
| 44 | 0 |
| 45 | 0 |
| 46 | 0 |
| 47 | 65 |
| 48 | 0 |
| 49 | 0 |
| 50 | 52 |
| 51 | 0 |
| 52 | 126 |
| 53 | 67 |
| 54 | 65 |
| 55 | 80 |
| 56 | 0 |
| 57 | 0 |
| 58 | 0 |
| 59 | 0 |

Measured Recovery:

| Sample Interval (ft bgs) | Measured Recovery |
|---|---|
| 0–5 | 3 |
| 5–10 | 5 |
| 10–15 | 5 |
| 15–20 | 5 |
| 20–25 | 5 |
| 25–30 | 5 |
| 30–35 | 5 |
| 35–40 | 5 |
| 40–45 | 5 |
| 45–50 | 5 |
| 50–55 | 5 |
| 55–60 | 5 |

BATTELLE

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: SP-B141

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: NA<br>Project: 100125424<br>Date Logged: 10/1/2019<br>Geologist: Damon DeYoung<br>Total Depth: 60<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot soil cap<br>Monitoring Device Installed: Yes<br>Device Type: N/A |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Comments |
|---|---|---|---|---|---|---|
| 0–10 | GW | Sandy GRAVEL, brown, 10YR-4/3 | 50 | 45 | 5 | No samples collected. This location was an exploratory boring for identification of depth to clay aquitard. |
| 10–13 | NR | No recovery | | | | |
| 13–16 | SP | Silty gravelly poorly graded SAND, dark greenish gray, GLEY1-4/N | 10 | 80 | 10 | |
| 16–23 | MH | Clayey SILT, dark gray GLEY1-4/N | 0 | 0 | 100 | |
| 23–30 | SP | Clayey silty fine SAND, dark gray GLEY1-4/N | 0 | 70 | 30 | |
| 30–38 | SP | Fine SAND, gray 2.5Y-5/1 | 0 | 100 | 0 | |
| 38–40 | SW | Gravelly SAND, fine to coarse grained, dark grayish brown 2.5Y-4/2 | 20 | 80 | 0 | |
| 40–48 | SP | Fine SAND, dark grayish brown 2.5Y-4/2 | 5 | 90 | 5 | |
| 48–50 | SW | Gravelly SAND, fine to coarse grained, dark grayish brown 2.5Y-4/2 | 20 | 80 | 0 | |
| 50–55 | SM | Clayey gravelly SAND, dark bluish gray GLEY2-4-10B | 30 | 50 | 20 | |
| 55–60 | CH | CLAY, dark bluish gray GLEY2-4-10B | 0 | 0 | 100 | |

| Run (ft bgs) | Measured Recovery |
|---|---|
| 0–5 | 1 |
| 5–10 | 3 |
| 10–15 | 3 |
| 15–20 | 5 |
| 20–25 | 5 |
| 25–30 | 5 |
| 30–35 | 5 |
| 35–40 | 5 |
| 40–45 | 5 |
| 45–50 | 5 |
| 50–55 | 5 |
| 55–60 | 5 |

Headspace PID (ppb), top to bottom: 7, 61, 99, 87, 890, 1639, 840, 3070, 7508, 88000, 269000, 1908, 1789, 32, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 6, 18, 0, 6, 7, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0

Sample ID Date/Time: (none)

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: MW1-59/SP-B130

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/2/2019<br>Geologist: Damon DeYoung<br>Total Depth: 75<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: N/A<br>Monitoring Device Installed: Yes<br>Device Type: 2-inch PVC monitoring well |

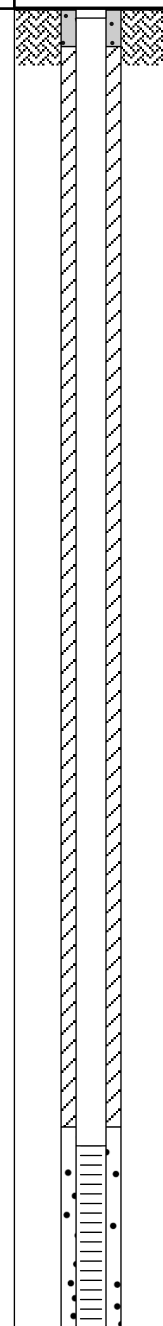
| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Sample ID Date/Time |
|---|---|---|---|---|---|---|
| 0 | SP | Gravelly SAND, brown, 10YR-4/3 | 25 | 70 | 5 | |
| | SP | SAND, grayish brown, 2.5Y-5/2 | 0 | 100 | 0 | |
| | SM | Poorly graded silty clayey SAND, gray, 2.5Y-5/1 | 0 | 60 | 40 | |
| | SP | Gravelly SAND, very dark greenish gray, GLEY1-3/10Y | 30 | 70 | 0 | |
| | CH | Sandy CLAY, dark gray, GLEY1-4/N | 0 | 30 | 70 | |
| | SM | Silty SAND, greenish gray, GLEY1-5/10Y | 0 | 80 | 20 | |
| | SM | Poorly graded silty clayey SAND trace gravel, dark gray, GLEY1-4/N | 5 | 60 | 35 | |
| | SM | Silty clayey SAND, dark gray, GLEY1-4/N | 0 | 60 | 40 | |
| | SM | Silty SAND, dark gray, GLEY1-4/N | 0 | 80 | 20 | |
| | SM | Poorly graded silty clayey SAND, dark gray, GLEY1-4/N | 0 | 60 | 40 | |
| | SP | SAND, dark grayish brown, 10YR-5/2, (at 25 to 30 ft, changes to dark gray, GLEY-4/N) | 0 | 100 | 0 | |
| | SW | Gravelly SAND, dark grayish brown, 10YR-5/2, | 40 | 60 | 0 | |
| | GC | Clayey sandy GRAVEL, very dark gray, GLEY1-3/N | 60 | 10 | 30 | |
| | CH | Sandy CLAY, very dark gray, GLEY1-3/N | 0 | 20 | 80 | |
| | GM | Well Graded silty sandy GRAVEL very dark gray, GLEY1-3/N | 50 | 25 | 25 | |
| 60 | SP | Poorly graded SAND, very dark gray, GLEY1-3/N | 0 | 100 | 0 | |
| | GC | Clayey GRAVEL, very dark gray, GLEY1-3/N | 80 | 0 | 20 | SP-B130-S-65-191002 |
| | CH | CLAY, very dark gray, GLEY1-3/N | 0 | 0 | 100 | |

Depth scale: 0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52, 56, 60, 64, 68, 72, 76

Headspace PID (ppb): 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

Measured Recovery: 3, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5

Well Construction



Surface Seal: Concrete and stick-up monument. Casing: PVC

Bentonite: Hydrated bentonite chips.

Sand: 12/20, 0.92-0.95, 261/19 BRADY TM Screen: 0.010 factory-slotted PVC

# BATTELLE

## Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: MW1-61/CL-B133

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/11/2019<br>Geologist: Steve Verdibello<br>Total Depth: 60<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: N/A<br>Monitoring Device Installed: Yes<br>Device Type: 2-inch PVC monitoring well |

Depth (ft bgs): 0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52, 56, 60

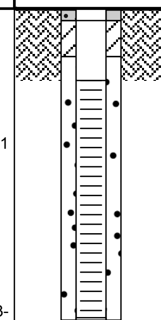
| USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|
| SM | Clayey gravelly SAND, very dark gray, GLEY1-3/N | 30 | 50 | 20 |
| Fill | WASTE (treated wood, strong odor) | | | |
| SM | Silty (organic) SAND (some landfill waste), very dark brown, 10YR-2/2. ~10% landfill waste (wood). | 0 | 60 | 30 |
| SP | Poorly graded SAND, dark greenish gray, GLEY1-4/10Y, some orangish mottling from 7 to 10 ft | 0 | 100 | 0 |
| MH | Sandy clayey SILT, gray, GLEY1-5/N | 0 | 20 | 80 |
| SM | Silty fine SAND, gray, GLEY1-5/N | 0 | 70 | 30 |
| MH | Sandy clayey SILT, gray, GLEY1-5/N | 0 | 20 | 80 |
| SP | Poorly graded SAND, dark gray, GLEY1-4/N | 0 | 100 | 0 |
| GP | Sandy GRAVEL, dark gray, GLEY1-4/N | 60 | 40 | 0 |
| CH | CLAY, black, GLEY1-2.5/N | 0 | 0 | 100 |
| CH | Gravelly CLAY, black, GLEY1-2.5/N | 40 | 0 | 60 |
| SM | Silty SAND, very dark gray, GLEY1-3/N | 0 | 70 | 30 |
| SP | Poorly graded SAND, very dark gray, GLEY1-3/N | 0 | 100 | 0 |
| GM | Silty sandy GRAVEL, very dark gray, GLEY1-3/N | 50 | 20 | 30 |
| CH | CLAY (minor black organic material), dark gray, GLEY1-4/N | 0 | 0 | 100 |

Headspace PID (ppb): 4614, 646, 11350, 92070, 111000, 34240, 8670, 3666, 3261, 1936, 2206, 1678, 1928, 847, 933, 715, 610, 860, 459, 1277, 897, 610, 757, 587, 412, 448, 1736, 507, 210, 976, 585, 169, 201, 228, 393, 430, 122, 272, 1541, 2670, 1190, 568, 245, 160, 11, 66, 89, 190, 66, 0, 76, 2, 87, 0, 62, 97, 0, 160

Measured Recovery: 5, 5, 3, 5, 5, 5, 5, 5, 5, 5, 5, 5

Sample ID Date/Time: CL-B133-S-6-191011; CL-B133-S-13-191011; CL-B133-S-29-191011; CL-B133-S-38-191011

Well Construction



Surface Seal: Concrete and flush-mount well monument.
Bentonite: Hydrated bentonite chips
Casing: PVC
Screen: 0.010 factory-slotted PVC
Sand: 12/20, 0.92-0.95, 261/19 BRADY TM

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: MW1-62/NP-B135

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/4/2019<br>Geologist: Damon DeYoung<br>Total Depth: 90<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: N/A<br>Monitoring Device Installed: Yes<br>Device Type: 2-inch PVC monitoring well |

Depth (ft bgs): 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90

| USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|
| SP | Gravelly SAND, brown, 10YR-5/3 | 40 | 60 | 0 |
| GM | Silty GRAVEL, very dark greenish gray, GLEY1-3/5 | 30 | 50 | 20 |
| OL | Landfill debris (wood), very dark grayish brown, 10YR-3/2 | 0 | 0 | 0 |
| SP | Poorly graded SAND, greenish gray, GLEY1-5/10Y. Wood debris jambed the drill string tooling; had to trip out at 13 ft to clear the drill string. | 0 | 100 | 0 |
| SP | Poorly graded gravelly SAND, greenish gray, GLEY1-5/10Y | 30 | 70 | 0 |
| MH | Clayey SILT, dark gray, GLEY1-3/N, mottled brown at 13 ft | 0 | 0 | 100 |
| SP | Poorly graded SAND, minor gravel, very dark gray, GLEY1-3/N | 5 | 95 | 0 |
| GW | Sandy GRAVEL, very dark gray, GLEY1-3/N | 90 | 10 | 0 |
| SW | Well graded Gravelly SAND, very dark gray, GLEY1-3/N | 40 | 60 | 0 |
| ML | SILT, very dark gray, GLEY1-3/N | 0 | 0 | 100 |
| SP | Poorly graded SAND, very dark gray, GLEY1-3/N | 0 | 100 | 0 |
| SP | Gravelly SAND, very dark gray, GLEY1-3/N | 30 | 70 | 0 |
| GP | Sandy GRAVEL, very dark gray, GLEY1-3/N | 90 | 10 | 0 |
| GW | Well sorted GRAVEL (gravel to cobbles), very dark gray, GLEY1-3/N | 100 | 0 | 0 |
| SP | Poorly graded gravelly SAND, very dark gray, GLEY1-3/N | 10 | 90 | 0 |
| ML | Gravelly SILT, dark gray, GLEY1-4/N | 20 | 0 | 80 |
| ML | Organic SILT (peat), black, 5Y-2.5/1 | 0 | 0 | 100 |
| CH | Silty CLAY, dark gray, GLEY1-4/N | 0 | 0 | 100 |

Headspace PID (ppb), top to bottom: 0, 607, 1154, 77000, 162000, 169000, 8551, 2262, 12, 107, 147, 637, 197, 0, 0, 0, 167, 33, 0, 3, 0, 0, 0, 0, 0, 0, 0, 3246, 2435, 939, 4337, 5645, 3762, 7098, 22540, 22639, 382, 340, 0, 0, 0, 0, 41, 0, 7, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 60, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1125, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0

Measured Recovery (per 5-ft run, 0–90 ft): 3, 5, 5, 5, 4, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5

Sample ID Date/Time:
- NP-B135-S-38-191004; 10/4/2019 1500
- NP-B135-S-78-191004; 10/4/2019 1645

Well Construction:
- Surface Seal: Concrete and stick-up well monument
- Bentonite: Hydrated bentonite chips
- Casing: PVC
- Sand: 12/20, 0.92-0.95, 261/19 BRADY TM
- Screen: 0.010 factory-slotted PVC

BATTELLE

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: MW1-63/NP-B136

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/7/2019<br>Geologist: Steve Verdibello<br>Total Depth: 75<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: N/A<br>Monitoring Device Installed: Yes<br>Device Type: 2-inch PVC monitoring well |

Depth (ft bgs): 0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52, 56, 60, 64, 68, 72, 76

| USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|
| SP | Gravelly SAND (some landfill waste debris), reddish brown, 10YR-4/3 | 40 | 60 | 0 |
| SM | Silty gravelly SAND, very dark greenish gray, GLEY1-3/10Y | 40 | 50 | 10 |
| SM | Silty SAND, very dark greenish gray, GLEY1-3/10Y | 0 | 80 | 20 |
| MH | Clayey SILT, with minor sandy interbedding, dark greenish gray, GLEY1-4/10Y | 0 | 10 | 90 |
| SW | Well graded SAND, dark gray, GLEY1-4/N | 0 | 100 | 0 |
| GW | Well graded sandy GRAVEL, dark greenish gray, GLEY1-4/10Y | 70 | 30 | 0 |
| GM | Silty sandy GRAVEL dark greenish gray, GLEY1-4/10Y | 60 | 20 | 20 |
| OH | Organic SILT (some peat), black, 2.5Y-2.5/1 | 0 | 0 | 100 |
| SM | Silty SAND, greenish black, GLEY1-2.5/10Y | 0 | 70 | 30 |
| SP | Poorly graded SAND, greenish black, GLEY1-2.5/10Y | 0 | 100 | 0 |
| GM | Silty sandy GRAVEL, greenish black, GLEY1-3/N | 70 | 20 | 10 |
| SP | Gravelly SAND, greenish black, GLEY1-3/N | 30 | 70 | 0 |
| CH | Silty CLAY (some organic material, peat) | 0 | 0 | 100 |

Headspace PID (ppb), top to bottom: 0, 0, 0, 0, 6470, 2105, 364, 72, 0, 0, 1555, 50, 171, 93, 0, 69, 3, 10, 0, 0, 0, 0, 0, 48, 35, 31, 0, 0, 0, 65, 1032, 1630, 1740, 1266, 5539, 3379, 1115, 2469, 570, 799, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 365, 385, 57, 0, 302, 189, 166, 116, 58, 218

Measured Recovery: 5 (each 5-ft run, 0–75 ft)

Sample ID Date/Time:
- NP-B136-S-36-191007; 10/07/19 1637
- NP-B136-S-66-191007; 10/07/19 1642

Well Construction:
- Surface Seal: Concrete and stick-up well monument. Casing: PVC
- Bentonite: Hydrated bentonite chips
- Sand: 12/20, 0.92-0.95, 261/19 BRADY TM
- Screen: 0.010 factory-slotted PVC

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: MW1-64/NP-B137

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/8/2019<br>Geologist: Steve Verdibello<br>Total Depth: 60<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: N/A<br>Monitoring Device Installed: Yes<br>Device Type: 2-inch PVC monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | Grading % Gravel | Grading % Sand | Grading % Fines |
|---|---|---|---|---|---|
| 0–5 | GW | Sandy GRAVEL, dark grayish brown, 2.5Y-4/2 | 70 | 30 | 0 |
| 5–10 | SW | Gravelly SAND, dark grayish brown, 2.5Y-4/2 | 40 | 60 | 0 |
| 10–34 | SP | Poorly graded SAND (gradually fines downward), dark grayish brown, 2.5Y-4/2 (10 to 25); dark greenish gray GLEY1-4/10Y (25 to 34). Poor recovery from 10 – 15; 20 – 25. | 0 | 100 | 0 |
| 34–41 | SP | Gravelly SAND, greenish black, GLEY2-2.5/5BG | 40 | 60 | 0 |
| 41–45 | GP | Sandy GRAVEL, greenish black, GLEY2-2.5/5BG | 70 | 30 | 0 |
| 45–46 | MH | SILT, very dark gray, GLEY1-3/N | 0 | 0 | 100 |
| 46–53 | SW | Well graded Gravelly SAND, greenish black, GLEY2-2.5/5BG | 40 | 60 | 0 |
| 53–55 | SP | SAND, with some wood debris, black, GLEY1-2.5/N. 10% of material = small wood pieces. | 0 | 90 | 0 |
| 55–60 | CH | Silty CLAY (some organic material, peat), black, 7.5YR-2.5/1 (organic silt); dark gray GLEY1-4/N (clay) | 0 | 0 | 100 |

| Sample Interval (ft bgs) | Headspace PID (ppb) | Measured Recovery | Sample ID Date/Time |
|---|---|---|---|
| 0–5 | 0, 0, 0 | 4 | |
| 5–10 | 0, 0, 0 | 4 | |
| 10–15 | 0, 8 | 2 | |
| 15–20 | 20, 0, 1 | 3 | |
| 20–25 | 8 | 2 | |
| 25–30 | 30, 9, 15, 17, 29, 45 | 5 | |
| 30–35 | 0, 0, 0 | 3 | |
| 35–40 | 47, 489, 558, 1230 | 4 | |
| 40–45 | 870, 827, 849, 400 | 5 | |
| 45–50 | 976, 23, 75, 186, 372, 491 | 5 | |
| 50–55 | 393, 1504, 470, 548 | 5 | NP-B137-S-52-191008; 10/08/19 1340 |
| 55–60 | 159, 204, 0, 56, 55, 160 | 5 | |

**Well Construction:**

Surface Seal: Concrete and stick-up well monument.

Casing: PVC

Bentonite: Hydrated bentonite chips

Sand: 12/20, 0.92-0.95, 261/19 BRADY TM

Screen: 0.010 factory-slotted PVC

![BATTELLE]

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: MW1-65/NP-B138

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/9/2019<br>Geologist: Steve Verdibello<br>Total Depth: 85<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: N/A<br>Monitoring Device Installed: Yes<br>Device Type: 2-inch PVC monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|
| 0 | GW | Sandy GRAVEL | 70 | 30 | 0 |
| | GW | Silty sandy GRAVEL (some landfill waste debris), dark greenish gray, GLEY1-4/10Y | 60 | 30 | 10 |
| | SM | Silty gravelly SAND (some wood debris), black, 2.5Y/N | 40 | 50 | 10 |
| | SM | Silty SAND (some wood debris), gray, GLEY1-4/N | 0 | 80 | 20 |
| | MH | SILT, with minor sandy interbedding, gray, GLEY1-4/N | 0 | 90 | 10 |
| | SP | Poorly graded SAND (minor gravel from 14 to 15 ft), olive gray, 5Y-4/2 | <5 | >95 | 0 |
| 30 | GM | Sandy silty GRAVEL, dark gray, GLEY1-4/N | 60 | 15 | 25 |
| | ML | Sandy SILT, dark gray, GLEY1-4/N | 0 | 20 | 80 |
| | SP | Gravelly SAND, dark gray, GLEY1-4/N | 30 | 70 | 0 |
| | MH | SILT (minor sand), dark gray, GLEY1-4/N | 0 | 5 | 95 |
| | GW | Sandy GRAVEL, very dark gray, GLEY1-3/N. Poor recovery from 40 to 50 ft bgs. Recovered mostly water – did not log or PID. | 80 | 20 | 0 |
| 58 | SW | Gravelly SAND, bluish black, GLEY2-2.5/5PB | 30 | 70 | 0 |
| 63 | CH | Silty CLAY (some organic material, peat, interbedded throughout), black, 7.5YR-2.5/1 (organic silt); dark gray GLEY1-4/N (clay) | 0 | 0 | 100 |
| 78 | SM | Silty SAND, dark gray GLEY1-4/N | 0 | 70 | 30 |
| 82 | CH | Silty CLAY, dark gray GLEY1-4/N | 0 | 0 | 100 |
| 85 | | | | | |

| Depth interval (ft bgs) | Headspace PID (ppb) | Measured Recovery | Sample ID Date/Time |
|---|---|---|---|
| 0–5 | 250, 2192, 12530, 13790, 22270 | 5 | NP-B138-S-5-191009; (duplicate of 6 ft) 10/09/19 1140 |
| 5–10 | 24980, 2840, 2519, 2264, 3348 | 5 | NP-B138-S-6-191009; 10/09/19 1130 |
| 10–15 | 828, 729, 329, 300, 225 | 5 | |
| 15–20 | 0, 0, 0, 0, 0 | 5 | |
| 20–25 | 0, 0, 0, 0, 0 | 5 | |
| 25–30 | 0, 0, 0, 0, 0 | 5 | |
| 30–35 | 0, 0, 0, 0, 0 | 5 | |
| 35–40 | 0, 0, 0, 0, 0 | 5 | |
| 40–45 | 307, 0 | 2 | |
| 45–50 | | 2 | |
| 50–55 | 0, 0, 0 | 3 | |
| 55–60 | 18, 0, 2, 127 | 5 | |
| 60–65 | 147, 448, 135, 155, 350 | 5 | NP-B138-S-62-191009; 10/09/19 1405 |
| 65–70 | 248, 68, 0, 0, 0 | 5 | |
| 70–75 | 0, 0, 0, 0, 0 | 5 | |
| 75–80 | 13, 0, 0, 0 | 5 | |
| 80–85 | 0, 0, 0, 0, 0 | 5 | |

**Well Construction**

Surface Seal: Concrete and stick-up well monument. Casing: PVC

Bentonite: Hydrated bentonite chips.

Sand: 12/20, 0.92-0.95, 261/19 BRADY TM

Screen: 0.010 factory-slotted PVC

BATTELLE

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: MW1-66/SP-B139

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/17/2019<br>Geologist: Steve Verdibello<br>Total Depth: 20<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 6 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: N/A<br>Monitoring Device Installed: Yes<br>Device Type: 4-inch PVC monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Headspace PID (ppb) | Measured Recovery | Sample ID Date/Time |
|---|---|---|---|---|---|---|---|---|
| 0 | SM | Silty gravelly SAND, gray, GLEY1-6/N. | 30 | 60 | 10 | | | |
| 1 | | | | | | 131000 | | |
| 2 | | | | | | 212000 | 5 | |
| 3 | | | | | | 391000 | | |
| 4 | | | | | | 292000 | | |
| 5 | SP | Organic debris (wood/roots) with some sand. ~80% = organic debris. | 0 | 20 | 0 | >10,000,000 | | |
| 6 | SP | Poorly graded SAND, dark greenish gray, GLEY1-4/10GY (from 12 to 20 ft: olive gray, 5Y-4/2). (includes volume for MS/MSD)(field duplicate of 9' sample) | 0 | 100 | 0 | >10,000,000 | | |
| 7 | | | | | | >10,000,000 | 5 | |
| 8 | | | | | | 1883000 | | |
| 9 | | | | | | >10,000,000 | | SP-B139-S-9-191017 |
| 10 | | | | | | 3096000 | | SP-B139-S-10-191017 |
| 11 | | | | | | 168000 | | |
| 12 | | | | | | 83470 | 5 | |
| 13 | | | | | | 283000 | | |
| 14 | | | | | | 3308000 | | |
| 15 | | | | | | 929000 | | |
| 16 | | | | | | 3364000 | | |
| 17 | | | | | | 7159000 | 5 | |
| 18 | | | | | | 919000 | | |
| 19 | | | | | | 1943000 | | |
| 20 | | | | | | >10,000,000 | | |

Well Construction:
- Surface Seal: Concrete and stick-up well monument.
- Bentonite: Hydrated bentonite chips.
- Casing: PVC
- Screen: 0.010 factory-slotted PVC
- Sand: 12/20, 0.92-0.95, 261/19 BRADY TM

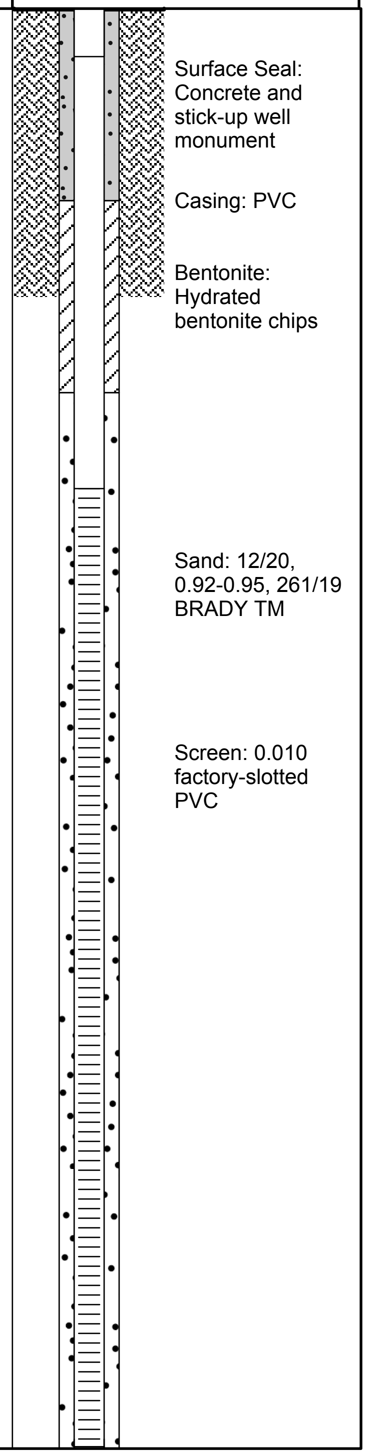
BATTELLE

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: MW1-67/NP-B143

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/10/2019<br>Geologist: Steve Verdibello<br>Total Depth: 15<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: N/A<br>Monitoring Device Installed: Yes<br>Device Type: 2-inch PVC monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Headspace PID (ppb) | Measured Recovery | Sample ID Date/Time |
|---|---|---|---|---|---|---|---|---|
| 0 | GW | Sandy GRAVEL (some landfill waste debris), black, 5Y-2.5/1. 20% = landfill waste debris (brick, wood)Poor recovery from 5 to 10 (~3 ft). | 60 | 20 | 0 | | | |
| 1 | | | | | | 270 | | |
| 2 | | | | | | 643 | | |
| 2.5 | | | | | | | 5 | |
| 3 | | | | | | 909 | | |
| 4 | | | | | | 10510 | | |
| 5 | | | | | | 9149 | | |
| 7.5 | | | | | | | 3 | |
| 8 | SM | Silty, gravelly SAND (some landfill waste debris), black, 5Y-2.5/1. 10% = landfill waste debris (brick, wood). | 30 | 50 | 10 | 1728 | | |
| 9 | | | | | | 1519 | | |
| 10 | | | | | | 1750 | | |
| 11 | | | | | | 752 | | |
| 12 | | | | | | 9799 | | |
| 12.5 | | | | | | | 5 | |
| 13 | | | | | | 44090 | | |
| 14 | | | | | | 15890 | | |
| 15 | | | | | | 4584 | | |

Well Construction



**BATTELLE**

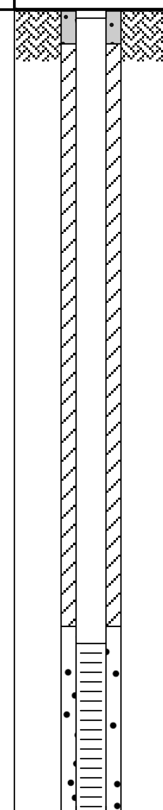
# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: MW1-68/SP-B144

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/16/2019<br>Geologist: Steve Verdibello<br>Total Depth: 80<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: N/A<br>Monitoring Device Installed: Yes<br>Device Type: 2-inch PVC monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|---|
| 0 | SM | Silty gravelly SAND, gray, GLEY1-6/N | 30 | 60 | 10 |
| 5 | SP | Poorly graded fine SAND, dark greenish gray, GLEY1-4/10GY (from 20 to 26 ft: olive gray, 5Y-4/2). Strong hydrocarbon odor; free product observed at 10 ft bgs) | 0 | 100 | 0 |
| 30 | CH | CLAY, with minor organic (peat) layers, dark gray, GLEY1-4/N. Poor recovery from 40 to 45 ft. | 0 | 0 | 100 |
| 46 | SM | Silty fine SAND, very dark gray, GLEY1-3/N | 0 | 80 | 20 |
| 48 | SP | SAND, very dark gray, GLEY1-3/N | 0 | 100 | 0 |
| 50 | GP | Sandy GRAVEL (wood from 51 to 52 ft bgs), very dark gray, GLEY1-3/N | 70 | 30 | 0 |
| 54 | SW | Gravelly SAND, very dark gray, GLEY1-3/N | 20 | 80 | 0 |
| 64 | SP | Poorly graded SAND, very dark gray, GLEY1-3/N | 0 | 100 | 0 |
| 67 | SM | Silty fine SAND, dark gray, GLEY1-4/N | 0 | 60 | 40 |
| 68 | SW | Well graded gravelly SAND, very dark gray, GLEY1-3/N | 20 | 80 | 0 |

| Headspace PID (ppb) | Measured Recovery | Sample ID Date/Time |
|---|---|---|
| 6517, 15930, 1108000, 3310000, 3027000 | 5 | |
| 777000, 249000, 289000, 731000 | 4 | |
| 249000, 361000, 748000, 1785000 | 4 | |
| 448000, 284000, 3115000, 1028000, 734800 | 5 | |
| 541400, 2618000, 581000, 9480000, >10,000,000 | 5 | |
| 1138000, 743000, 970000, 707000, 59140 | 5 | |
| 3580, 1748, 1670, 2084, 3964 | 5 | |
| 3060, 5411, 449, 743, 13900 | 5 | |
| | 1 | |
| 34490, 5335, 1764, 14430, 13200, 21690 | 5 | SP-B144-S-50-191016; 10/16/19 1615 |
| 304, 283, 222, 221, 196 | 5 | |
| | 5 | |
| 28, 18, 19, 30, 26 | 5 | |
| 76, 55, 36, 25, 40 | 5 | |
| 45, 47, 33, 31, 44 | 5 | |
| 52, 19, 55, 28, 91 | 5 | |

Well Construction



Surface Seal: Concrete and stick-up monument.
Casing: PVC
Bentonite: Hydrated bentonite chips.

Sand: 12/20, 0.92-0.95, 261/19 BRADY TM
Screen: 0.010 factory-slotted PVC

# BATTELLE

## Project: Keyport OU1 Vertical Extent Investigation
## Site: OU 1
## Boring Log: SP-B174/MW1-69

| | | |
|---|---|---|
| Permit Number: 22-EP058<br>Project Number: G24790.30<br>Date Logged: 4/27/2021<br>Geologist: Hunter Butler<br>Total Depth (ft bgs): 90<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: J. Johnson<br>Drilling Equipment: Terra Sonic Compact Crawler<br>Drilling Method: Rotosonic<br>Boring Diameter: 6-inch<br>Sampler Type: CA Split Spoon<br>Hammer Type: 140-lb Auto hammer | Northing (NAD 83): 259011.7<br>Easting (NAD 83): 1198926.2<br>Surface Elevation (NAVD 88): 14.86 ft<br>Borehole Abandoned: No<br>Backfill Method: N/A<br>Device Type: 2-inch PVC monitoring well |

| USCS Symbol | Sample Description | Gravel (%) | Sand (%) | Fines (%) |
|---|---|---|---|---|
| SW | Silty, gravelly, very coarse to very fine SAND; brown, 10YR4/3; gravels to 15mm diameter; asphalt to 75mm diameter; saturated | 20 | 70 | 10 |
| | Gravelly, very coarse to very fine SAND; dark grayish brown, 2.5Y4/2; gravels to 50mm diameter; wet | 20 | 80 | 0 |
| SM | Gravelly, silty, very coarse to very fine SAND; very dark grayish brown, 10YR3/2; slightly plastic; gravels to 30mm diameter; large and small roots, vegetation, brick; moist/wet | 10 | 60 | 30 |
| | Gravelly, silty, medium to very fine SAND; very dark grayish brown, 10YR3/2; slightly plastic; gravels to 50mm diameter; roots and wood; wet | 10 | 60 | 40 |
| | Gravelly, silty, very coarse to very fine SAND; very dark gray, 10YR3/1; gravels to 25mm diameter; some wood, leaves and roots; wet | 10 | 70 | 20 |
| | No Return | | | |
| SM | Gravelly, silty, very coarse to very fine SAND; very dark gray, 10YR3/1; slightly plastic; gravels to 45mm diameter; wet | 5 | 60 | 35 |
| MH | Gravelly, sandy (fine to very fine), SILT; black, Gley 1 N2.5/; soft; slightly plastic; gravels to 20mm diameter; wet | 5 | 35 | 60 |
| CH | Sandy (very fine to fine) SILT; very dark greenish gray, Gley 1 10Y3/1; soft; slightly plastic; wet/saturated | 0 | 40 | 60 |
| MH | CLAY; olive gray, 5Y4/2, mottled; soft; slightly plastic; wet/saturated | 0 | 100 | 0 |
| SP | Sandy (very fine to fine) SILT; very dark greenish gray, Gley 1 10Y3/1; soft; slightly plastic; wet/saturated | 0 | 40 | 60 |
| | Medium to fine SAND (trace very coarse); very dark gray, Gley 1 N3/0; wet | 0 | 100 | 0 |
| | Fine to very fine SAND; very dark greenish gray, Gley 1 10Y3/1; saturated | 0 | 100 | 0 |
| SW | Gravelly, very coarse to very fine SAND; very dark gray, Gley 1 N3/0; gravel to 15mm diameter; saturated | 10 | 85 | 5 |
| CH | Sandy (trace very coarse to very fine) CLAY; dark gray, Gley 1 N4/0; soft; slightly plastic; saturated | 0 | 10 | 90 |
| | CLAY; dark gray, Gley 1 N4/0; soft; slightly plastic | 0 | 0 | 100 |
| SW | Gravelly, very coarse to medium SAND (trace very fine); very dark gray, Gley 1 N3/0; gravels to 30mm diameter; saturated | 15 | 80 | 5 |
| MH | Sandy (very fine, non-plastic) SILT; dark gray, Gley 1 N4/0; soft; slightly plastic; interbedded; saturated | 0 | 15 | 85 |
| SW | Very coarse to very fine SAND; very dark gray, Gley 1 N4/0; trace gravels to 15mm diameter; saturated | 5 | 95 | 0 |
| SP | Fine to very fine SAND; very dark gray, Gley 1 N3/0; saturated | 0 | 100 | 0 |

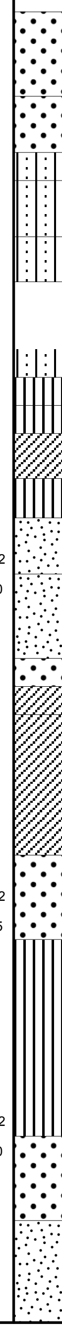
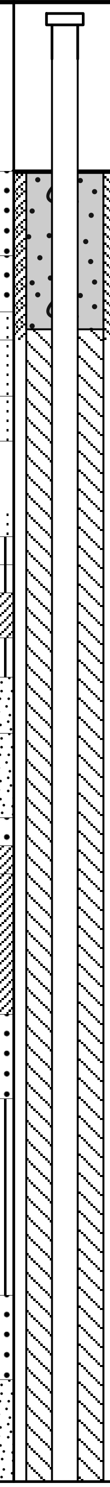
| Depth (ft bgs) | Headspace PID (ppb) |
|---|---|
| 1 | 80 |
| 2 | 93 |
| 3 | 147 |
| 4 | 232 |
| 5 | 209,900 |
| 6 | 11,250 |
| 7 | 1,031 |
| 8 | 1,031 |
| 9 | 13,010 |
| 10 | 24,000 |
| 11 | 881 |
| 12 | 1,960 |
| 13 | 371 |
| 14 | 445 |
| 15 | 385 |
| 16 | 1,500 |
| 17 | 1,279 |
| 18 | 221 |
| 19 | 182 |
| 20 | 330 |
| 21 | 2,251 |
| 22 | 127 |
| 23 | 155 |

Blow Counts: 1-5-15 (10–11.5 ft); Sample Recovery: 1

Sonic Sleeve: 2.5; 2.5; 4; 5; 5; 5

Sample ID; Date/Time:
- SP-B174-S-10-2 20427; 4/27/2022 1540
- SP-B174-S-16-2 20427; 4/27/2022 1545
- SP-B174-S-20-2 20427; 4/27/2022 1550

Depth (ft bgs): 0, 10, 20

Well Construction:

**Surface Completion:** Concrete and stick-up monument

**Bentonite Seal:** Hydrated bentonite chips in 6" dia. borehole

**Casing:** 2" diameter, Schedule 40 PVC Casing

**BATTELLE**

# Project: Keyport OU1 Vertical Extent Investigation
## Site: OU 1
## Boring Log: SP-B174/MW1-69

| | | |
|---|---|---|
| Permit Number: 22-EP058<br>Project Number: G24790.30<br>Date Logged: 4/27/2021<br>Geologist: Hunter Butler<br>Total Depth (ft bgs): 90<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: J. Johnson<br>Drilling Equipment: Terra Sonic Compact Crawler<br>Drilling Method: Rotosonic<br>Boring Diameter: 6-inch<br>Sampler Type: CA Split Spoon<br>Hammer Type: 140-lb Auto hammer | Northing (NAD 83): 259011.7<br>Easting (NAD 83): 1198926.2<br>Surface Elevation (NAVD 88): 14.86 ft<br>Borehole Abandoned: No<br>Backfill Method: N/A<br>Device Type: 2-inch PVC monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | Grading (%) Gravel | Sand | Fines | Headspace PID (ppb) | Blow Counts | Sample Recovery | Sonic Sleeve | Sample ID; Date/Time | Lithology | Well Construction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SW | Very coarse to very fine SAND; very dark gray; Gley 1 N3/0; saturated | 0 | 100 | 0 | 216 | | | | | | |
| | MH | Sandy (very fine to fine) SILT; very dark greenish gray, Gley 1 10Y3/0; soft; slightly plastic; saturated | 0 | 45 | 55 | 148<br>139<br>197<br>225<br>192 | | | 5 | SP-B174-S-25-2 20427; 4/27/2022 1621 | | |
| 30 | GP | Sandy (very coarse to fine), medium to fine GRAVEL; very dark greenish gray, Gley 1 10GY3/1; saturated | 60 | 35 | 5 | 176 | | | | | | |
| | SP | Very fine SAND; very dark gray, Gley 1 N3/0; wet | 0 | 100 | 0 | 151 | | | | | | |
| | SM | Silty SAND; very dark gray, Gley N3/0; increasing silt with depth; non-plastic; wet | 0 | 90 | 10 | 130<br>140 | | | | | | |
| | SP | Fine to very fine SAND; very dark greenish gray, Gley 1 10GY 3/1; wet | 0 | 100 | 0 | 139<br>252 | | | 10 | SP-B174-S-35-2 20427; 4/27/2022 1636 | | |
| | SW | Coarse to fine SAND; dark gray, 2.5Y4/1; grades to medium to fine at 29 ft; wet | 0 | 100 | 0 | 147<br>129<br>212<br>190 | | | | | | |
| 40 | | No Return. | | | | 141 | | | | | | Filter Pack: Sand 12/20<br>Screen: 2" diameter Schedule 40 PVC, 0.010 factory-slotted screen |
| | SP | Very fine SAND; dark olive gray, 5Y3/2; saturated | 0 | 100 | 0 | 134 | | | | SP-B174-S-45-2 20427; 4/27/2022 1655 | | |
| | SW | Gravelly, very coarse to fine SAND; very dark grayish brown, 10YR3/2; gravels to 50mm diameter; wet | 40 | 60 | 0 | 473 | | | 6 | | | |
| | GW | Silty, sandy (very coarse to very fine), coarse to fine GRAVEL; dark grayish brown; trace fines; slightly plastic; gravels to 75mm; saturated | 60<br>60 | 20<br>30 | 20<br>10 | 347<br>131 | | | | | | |
| | SW | Sandy (very coarse to fine), coarse to fine GRAVEL; dark gray, 2.5Y3/1; gravel to 50mm diameter; grades to coarse to fine gravels at 47.5 ft (90% gravel, 10% sand) | 100 | 0 | 0 | 142 | 4-20-50/4" | 1.3 | | SP-B174-S-48-2 20427; 4/27/2022 1714 | | |
| | | Coarse to fine SAND; very dark gray, Gley N3/0; wet | | | | 58 | | | | | | |
| | | Gravelly, very coarse to fine SAND; very dark gray, | | | | | | | | | | |

BATTELLE

# Project: Keyport OU1 Vertical Extent Investigation
# Site: OU 1
# Boring Log: SP-B174/MW1-69

| | | |
|---|---|---|
| Permit Number: 22-EP058<br>Project Number: G24790.30<br>Date Logged: 4/27/2021<br>Geologist: Hunter Butler<br>Total Depth (ft bgs): 90<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: J. Johnson<br>Drilling Equipment: Terra Sonic Compact Crawler<br>Drilling Method: Rotosonic<br>Boring Diameter: 6-inch<br>Sampler Type: CA Split Spoon<br>Hammer Type: 140-lb Auto hammer | Northing (NAD 83): 259011.7<br>Easting (NAD 83): 1198926.2<br>Surface Elevation (NAVD 88): 14.86 ft<br>Borehole Abandoned: No<br>Backfill Method: N/A<br>Device Type: 2-inch PVC monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | Gravel (%) | Sand (%) | Fines (%) | Headspace PID (ppb) | Blow Counts | Sample Recovery | Sonic Sleeve | Sample ID; Date/Time |
|---|---|---|---|---|---|---|---|---|---|---|
| 50 | | 2.5Y3/1; gravels to 50mm diameter; wet | 30 | 70 | 0 | 153 | | | | |
| | GW | Silty, sandy (very coarse to very fine), coarse to fine GRAVEL; very dark greenish grey, Gley 1 5GY3/1; gravels to 75mm diameter; trace fines; wet | 85 | 10 | 5 | 19 | 37-50/3” | 1.5 | 10 | SP-B174-S-52-2 20428; 4/28/2022 1120 |
| | SM | Silty, very fine SAND; very dark greenish gray, Gley 1 5GY3/1; little fines; slightly plastic; moist; grades to below | 80 | 20 | 0 | 68, 31, 97, 104 | 33/3” | 1 | | |
| | MH | Sandy SILT | 0 | 40 | 60 | 185, 134 | | | | SP-B174-S-58-2 20428; 4/28/2022 1101 |
| | | Sandy (very fine) SILT; very dark grey, Gley 1 N3/0; stiff; plastic; saturated | 0 | 40 | 60 | 124, 447 | 12-29-50 | 1.5 | | |
| 60 | SM | Silty, very fine SAND; very dark gray, Gley 1 N3/0; some fines; non-plastic; 2” peat layer, wood, organics @ 61’; moist | 0 | 60 | 40 | 374, 404, 605, 443 | | | 10 | |
| | MH | Sandy (very fine) SILT; very dark gray, Gley 1 N3/0; stiff; plastic; wet | 0 | 40 | 60 | 488, 883, 431 | | | | |
| | SM | Silty, very fine SAND; very dark gray, Gley 1 N3/0; slightly plastic; interbedded; bed of peat @ 68’; moist | 0 | 60 | 40 | 365, 508 | | | | |
| 70 | | Silty, very fine SAND; very dark gray, Gley 1 N3/0; slightly plastic; wet | 0 | 70 | 30 | 552 | | | | SP-B174-S-70-2 20428; 4/28/2022 1220 |
| | Pt | PEAT; black, Gley 1 N2.5/0; mottled; wood, organics; wet | 0 | 0 | 100 | 338 | | | 10 | |
| | | Silty, very fine SAND; very dark gray, Gley 1 N3/0; slightly plastic; wet | 0 | 70 | 30 | 315, 780 | | | | SP-B174-S-73-2 20428; 4/28/2022 1417<br>SP-B174-S-74-2 20428 (duplicate); 4/28/2022 1417 |
| | | Silty SAND; very dark gray, Gley 1 N3/0; mottled; organic inclusions; wet | 0 | 70 | 30 | 281, 293 | | | | |
| | | Silty SAND; very dark gray, Gley 1 N3/0; decreasing | | | | | | | | |

Well Construction: **Bentonite Seal:** Hydrated bentonite chips

BATTELLE

# Project: Keyport OU1 Vertical Extent Investigation
# Site: OU 1
# Boring Log: SP-B174/MW1-69

| | | |
|---|---|---|
| Permit Number: 22-EP058<br>Project Number: G24790.30<br>Date Logged: 4/27/2021<br>Geologist: Hunter Butler<br>Total Depth (ft bgs): 90<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: J. Johnson<br>Drilling Equipment: Terra Sonic Compact Crawler<br>Drilling Method: Rotosonic<br>Boring Diameter: 6-inch<br>Sampler Type: CA Split Spoon<br>Hammer Type: 140-lb Auto hammer | Northing (NAD 83): 259011.7<br>Easting (NAD 83): 1198926.2<br>Surface Elevation (NAVD 88): 14.86 ft<br>Borehole Abandoned: No<br>Backfill Method: N/A<br>Device Type: 2-inch PVC monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | Grading (%) Gravel | Sand | Fines | Headspace PID (ppb) | Blow Counts | Sample Recovery | Sonic Sleeve | Sample ID; Date/Time | Lithology | Well Construction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SM | fines with depth; wet | 0 | 80 | 20 | 260<br>534<br>228<br>312 | | | | | | |
| 80 | SP | Medium to very fine SAND; very dark grey, Gley 1 N3/0; wet | 0 | 100 | 0 | 495<br>151<br>442<br>125 | | | 10 | SP-B174-S-83-2 20428; 4/28/2022 1420 | | |
| | SW | Gravelly, coarse to very fine SAND; very dark grey, Gley 1 N3/0; gravels to 25 mm diameter | 20 | 75 | 5 | 122<br>133 | | | | | | |
| | MH | Gravelly, sandy, SILT; very dark gray, Gley 1 N3/0; stiff; slightly plastic; gravels to 20mm diameter @ 86.5' | 20 | 20 | 60 | 152 | | | | | | |
| | SP | Silty, very fine SAND; very dark gray; Gley 1 N3/0; slightly plastic; peaty, wood, organics | 0 | 80 | 20 | 118<br>181 | | | | | | |
| | | Silty SAND; very dark gray, Gley 1 N3/0; slightly plastic | 0 | 85 | 15 | 190<br>181 | | | | | | |
| 90 | | | | | | | | | | | | |

# Project: Keyport OU1 Vertical Extent Investigation
# Site: OU 1
# Boring Log: SP-B175/MW1-70

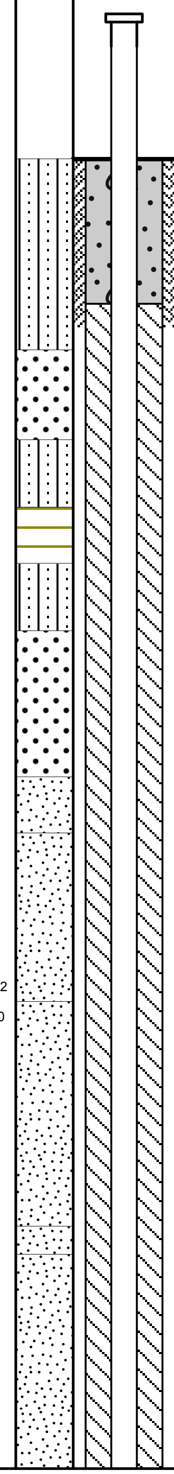
BATTELLE

| | | |
|---|---|---|
| Permit Number: 22-EP058 | Drilling Contractor: Holt Services, Inc. | Northing (NAD 83): 259003.5 |
| Project Number: G24790.30 | Driller: J. Johnson | Easting (NAD 83): 1199140.2 |
| Date Logged: 4/25/2022 | Drilling Equipment: Terra Sonic Compact Crawler | Surface Elevation (NAVD 88): 13.71 ft |
| Geologist: Hunter Butler | Drilling Method: Rotosonic | Borehole Abandoned: No |
| Total Depth (ft bgs): 100 | Boring Diameter: 6-inch | Backfill Method: N/A |
| Reviewer: Michael Meyer | Sampler Type: CA Split S | Device Type: 2-inch PVC monitoring well |
| | Hammer Type: 140-lb. Auto hammer | |

| Depth (ft bgs) | USCS Symbol | Sample Description | Grading (%) Gravel | Sand | Fines | Blow Counts | Sample Recovery | Sonic Sleeve | Sample ID; Date/Time |
|---|---|---|---|---|---|---|---|---|---|
| 0 | SM | Gravelly silty, very coarse to very fine SAND; very dark grayish brown, 10YR3/2; gravels to 30mm diameter; cobbles to 75mm diameter; upper 6” loamy soil and root and leaves; 6” silt beds at 0.5ft and 1.4ft; loose gravels from 0.5-1.0 ft; wet | 20 | 50 | 30 | | | 2.5 | |
| | SW | Gravelly, very coarse to fine SAND; very dark gray, 2.5Y3/1; gravels to 30mm diameter; dark red brick at 4.2’; roots at 4.8-5.0’; moist | 20 | 50 | 30 | | | 2.5 | |
| | SM | Silty, very coarse to very fine SAND; very dark grayish brown, 10YR3/2; trace gravel; wood, roots; dark greenish gray, 5GY4/1 at 5.8-6.2’ | 10 | 60 | 30 | | | 2.5 | |
| | Pt | PEAT; black, 10YR2/1; fibrous organics; roots; transitions to very fine sand at 7.2 ft; dark olive gray, 2.5Y2/0 N2/; hydrocarbon odor | 0 | 80 | 20 | | | | |
| | SM | Silty, very coarse to very fine SAND; very dark grayish brown, 5Y3/2; grass, roots; saturated; heavy hydrocarbon odor, sheen | 0 | 70 | 30 | | | 2.5 | |
| 10 | SW | Medium to very fine SAND; very dark gray; trace fines, trace gravels to 30mm diameter; heavy hydrocarbon odor at 8.4-9.0’; wet | 10 | 80 | 10 | | | | |
| | SP | Fine to very fine SAND; dark gray, 2.5Y4/1; dark reddish brown, mottled at 11.5’; hydrocarbon odor; wet | 0 | 100 | 0 | | | 5 | |
| | | Fine to very fine SAND; dark bluish gray, 5B4/1; slight hydrocarbon odor; moist to wet | 0 | 100 | 0 | | | | |
| | | Medium to very fine SAND; dark greenish gray, 10Y4/1; slight hydrocarbon odor; moist to wet | 0 | 100 | 0 | 11-14-12 | 0.5 | 5 | SP-B175-S-15-220425; 4/25/2022 1200 |
| | | Medium to very fine SAND; olive gray, 5Y4/2; slight odor; wet | 0 | 100 | 0 | | | | |
| 20 | | Fine to very fine SAND; olive gray, 5Y4/2; slight odor; wet | 0 | 100 | 0 | | | 5 | |

| Headspace PID (ppb) |
|---|
| 8,766 |
| 1,308 |
| 2,055 |
| 10,560 |
| 1,126 |
| 123,900 |
| 888,500 |
| 395,500 |
| 1,851,000 |
| 798,500 |
| 1,514,000 |
| 354,800 |
| 74,760 |
| 27,030 |
| 52,650 |
| 111,100 |
| 276,400 |
| 53,330 |
| 61,190 |
| 134,800 |
| 101,300 |
| 267,100 |
| 72,650 |

Lithology / Well Construction



BATTELLE

# Project: Keyport OU1 Vertical Extent Investigation
# Site: OU 1
# Boring Log: SP-B175/MW1-70

| | | |
|---|---|---|
| Permit Number: 22-EP058<br>Project Number: G24790.30<br>Date Logged: 4/25/2022<br>Geologist: Hunter Butler<br>Total Depth (ft bgs): 100<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: J. Johnson<br>Drilling Equipment: Terra Sonic Compact Crawler<br>Drilling Method: Rotosonic<br>Boring Diameter: 6-inch<br>Sampler Type: CA Split S<br>Hammer Type: 140-lb. Auto hammer | Northing (NAD 83): 259003.5<br>Easting (NAD 83): 1199140.2<br>Surface Elevation (NAVD 88): 13.71 ft<br>Borehole Abandoned: No<br>Backfill Method: N/A<br>Device Type: 2-inch PVC monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | Grading (%) Gravel | Sand | Fines | Headspace PID (ppb) | Blow Counts | Sample Recovery | Sonic Sleeve | Sample ID; Date/Time | Lithology | Well Construction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 27,810 | | | | | | |
| | | Very fine SAND; very dark greenish gray; heavy hydrocarbon odor; saturated | 0 | 100 | 0 | 232,500<br>484,400 | 1-4-26 | 1.5 | | SP-B175-S-25-0 40901; 4/25/2022 1430 | | |
| | SW | Gravelly, very coarse to medium SAND; very dark greenish gray; gravel to 35mm diameter at 29 ft; no odor; wet | 10 | 90 | 0 | 147,000<br>188,100<br>38,130 | | | | | | |
| 30 | | Gravelly, very coarse to very fine SAND; dark olive gray; gravels to 35mm diameter; 4" cobble at 30.5 ft | 20 | 80 | 0 | 11,840 | | | 8 | | | |
| | CH | CLAY; very dark gray; stiff; plastic; no odor; moist | 0 | 0 | 100 | 2,668<br>743<br>487<br>470<br>1,437<br>139<br>662 | | | | | | |
| | MH | SILT; black; N2.5/; hard; no odor; damp | 0 | 0 | 100 | 465 | | | | SP-B175-S-38-2 20425; 4/25/2022 1527 | | |
| 40 | CH | Silty CLAY; very dark gray; stiff; plastic; wet to saturated | 0 | 0 | 100 | 525<br>187<br>108<br>151<br>473<br>468<br>63<br>2<br>0<br>0<br>0 | 11-24-49 | 1.5 | 12 | | | |

# Project: Keyport OU1 Vertical Extent Investigation
## Site: OU 1
## Boring Log: SP-B175/MW1-70

| | | |
|---|---|---|
| Permit Number: 22-EP058 | Drilling Contractor: Holt Services, Inc. | Northing (NAD 83): 259003.5 |
| Project Number: G24790.30 | Driller: J. Johnson | Easting (NAD 83): 1199140.2 |
| Date Logged: 4/25/2022 | Drilling Equipment: Terra Sonic Compact Crawler | Surface Elevation (NAVD 88): 13.71 ft |
| Geologist: Hunter Butler | Drilling Method: Rotosonic | Borehole Abandoned: No |
| Total Depth (ft bgs): 100 | Boring Diameter: 6-inch | Backfill Method: N/A |
| Reviewer: Michael Meyer | Sampler Type: CA Split S | Device Type: 2-inch PVC monitoring well |
| | Hammer Type: 140-lb. Auto hammer | |

Depth (ft bgs): 50 – 75 (depth marks: 50, 60, 70)

| USCS Symbol | Sample Description | Gravel (%) | Sand (%) | Fines (%) |
|---|---|---|---|---|
| | | | | |
| SM | Silty, fine to very fine SAND; very dark gray, N3/; slightly plastic; wet | 0 | 70 | 30 |
| SW | Gravelly, very coarse to medium SAND; very dark gray, N3/; gravels to 15mm diameter; wet | 20 | 80 | 0 |
| SM | Gravelly silty, very coarse to very fine SAND; very dark gray, N3/; non-plastic; wet | 10 | 70 | 20 |
| SW | Very coarse to coarse SAND; black, N2.5/; trace gravels to 15mm diameter; wet | 5 | 95 | 0 |
| SW | Very coarse to fine SAND; black, N2.5/; wet | 0 | 100 | 0 |
| SP | Medium to very fine SAND; black, N2.5/; wet | 0 | 100 | 0 |
| SP | Very fine SAND; very dark gray, N3/; trace fines; non-plastic; wet | 0 | 90 | 10 |
| SP | Fine to very fine SAND; very dark gray, N3/; wet | 0 | 95 | 5 |
| SM | Silty, medium to very fine SAND; black, N2.5/; wood, roots, organics; peaty; moist | 0 | 85 | 15 |
| SW | Very coarse to medium SAND; black, N2.5/; wet | 0 | 100 | 0 |

Headspace PID (ppb), top to bottom: 0, 104, 110, 94, 114, 98, 328, 93, 139, 106, 160, 27, 0, 5, 20, 15, 3, 8, 13, 16, 50, 214, 59, 40

| Blow Counts | Sample Recovery |
|---|---|
| 3-6-8 | No Recovery |
| 3-6-9 | No Recovery |

Sonic Sleeve (top to bottom): 5, 5, 10, 9

| Sample ID; Date/Time |
|---|
| SP-B175-S-50-2 20425; 4/25/2022 1620 |
| SP-B175-S-56-2 20426; 4/26/2022 1040 |
| SP-B175-S-60-2 20426; 4/26/2022 1045 |
| SP-B175-S-64-2 20426; 4/26/2022 1215 |
| SP-B175-S-70-2 20426; 4/26/2022 1225 |

Well Construction:

**Filter Pack:** Sand 12/20

**Screen:** 2" diameter Schedule 40 PVC, 0.010 factory-slotted screen

BATTELLE

# Project: Keyport OU1 Vertical Extent Investigation
# Site: OU 1
# Boring Log: SP-B175/MW1-70

| | | |
|---|---|---|
| Permit Number: 22-EP058<br>Project Number: G24790.30<br>Date Logged: 4/25/2022<br>Geologist: Hunter Butler<br>Total Depth (ft bgs): 100<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: J. Johnson<br>Drilling Equipment: Terra Sonic Compact Crawler<br>Drilling Method: Rotosonic<br>Boring Diameter: 6-inch<br>Sampler Type: CA Split S<br>Hammer Type: 140-lb. Auto hammer | Northing (NAD 83): 259003.5<br>Easting (NAD 83): 1199140.2<br>Surface Elevation (NAVD 88): 13.71 ft<br>Borehole Abandoned: No<br>Backfill Method: N/A<br>Device Type: 2-inch PVC monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | Gravel (%) | Sand (%) | Fines (%) | Headspace PID (ppb) | Blow Counts | Sample Recovery | Sonic Sleeve | Sample ID; Date/Time | Well Construction |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 35 | | | | | |
| | | | | | | 134 | | | | | |
| | | | | | | 50 | | | | | |
| | | | | | | 50 | | | | | |
| 80 | | | | | | 40 | | | | SP-B175-S-80-220426; 4/26/2022 1320 | |
| | SM | Silty, very fine SAND; dark gray, N4/; slightly plastic; 2" fibrous organics at 81 ft; moist | 0 | 70 | 30 | 50 | | | | | Bentonite Seal: Hydrated bentonite chips |
| | | | | | | 50 | | | | | |
| | CH | Silty CLAY; very dark greenish gray, 5GY3/1; trace very fine sand; stiff; slightly plastic; moist | 0 | 10 | 90 | 50 | | | | | |
| | | | | | | 50 | | | | | |
| | | | | | | 70 | | | 10 | | |
| | | | | | | 50 | | | | | |
| | | | | | | 100 | | | | | |
| | | | | | | 85 | | | | | |
| | CH | Silty CLAY; dark greenish gray, 5GY4/1; stiff; plastic; moist | 0 | 0 | 100 | 40 | | | | | |
| 90 | | | | | | 85 | | | | SP-B175-S-90-220426; 4/26/2022 1335 | |
| | | | | | | 90 | | | | | |
| | | | | | | 60 | | | | | |
| | | | | | | 74 | | | | | |
| | | | | | | 80 | | | | | |
| | | | | | | 55 | | | 10 | | |
| | | | | | | 94 | | | | | |
| | | | | | | 54 | | | | | |
| | | | | | | 60<br>65 | | | | | |
| 100 | | | | | | 40 | | | | SP-B175-S-100-220426; 4/26/2022 1430 | |

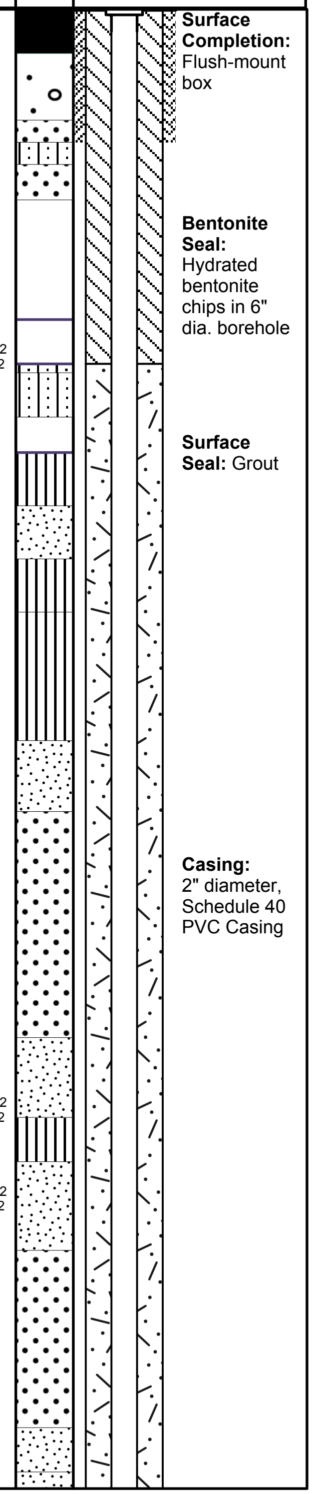
**BATTELLE**

# Project: Keyport OU1 Vertical Extent Investigation
# Site: OU1
# Boring Log: CL-B176/MW1-71

| | | |
|---|---|---|
| Permit Number: 22-EP058 | Drilling Contractor: Holt Services, Inc | Northing (NAD 83): 259491.3 |
| Project Number: G24790.30 | Driller: J Johnson | Easting (NAD 83): 1199038.1 |
| Date Logged: 5/2/2022 | Drilling Equipment: Terra Sonic Compact Crawler | Surface Elevation (NAVD 88): 16.96 ft |
| Geologist: Hunter Butler | Drilling Method: Rotosonic | Borehole Abandoned: No |
| Total Depth (ft bgs): 100 | Boring Diameter: 6-inch | Backfill Method: N/A |
| Reviewer: Michael Meyer | Sampler Type: CA Split Spoon | Device Type: 2-inch PVC monitoring well |
| | Hammer Type: 140-lb. Auto hammer | |

| Depth (ft bgs) | USCS Symbol | Sample Description | Grading (%) Gravel | Sand | Fines | Headspace PID (ppb) | Blow Counts | Sample Recovery | Sonic Sleeve | Sample ID; Date/Time |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Asphalt | Artificial fill – Class II Base fill material | 0 | 0 | 0 | | | | 2.5 | |
| | Fill | Artificial fill - wood debris to 2 feet | 0 | 0 | 0 | | | | | |
| | SW | Gravelly, very coarse to fine SAND; very dark gray, 2.5Y3/1; gravels to 15mm diameter; wet | 20 | 80 | 0 | 87 | | | | |
| | SM | Gravelly silty, very coarse to very fine SAND; very dark grayish brown, 10YR3/2; gravels to 60 mm diameter; asphalt, debris; saturated | 30 | 50 | 20 | | | | | |
| | SW | Gravelly silty, coarse to fine SAND; dark greenish gray, Gley 10Y4/1; gravels to 20mm diameter; iron staining and mottled; wet | 10 | 80 | 10 | 1,245 | | | | |
| | N/A | Shredded wood debris | | | | 26,000 | | | 2 | |
| | | No Return | | | | | | | | CL-B176-S-08-2 20502; 5/2/2022 1243 |
| | SM | Silty, coarse to very fine SAND; dark olive gray, 5Y3/2; slightly plastic; mottled; root and wood debris; moist | 0 | 80 | 20 | 1,600 | | | | |
| | | Silty, fine to very fine SAND; dark greenish gray, Gley 1, 10Y4/1; slightly plastic; root and wood debris; moist/wet | 0 | 70 | 30 | 485 | | | | |
| | N/A | Shredded wood debris | | | | 3,232 | | | | |
| 10 | MH | Sandy (fine to very fine) SILT; dark olive gray, 5Y3/2; stiff; plastic; mottled; wet | 0 | 30 | 70 | 128 | | | 5 | |
| | SP | Fine to very fine SAND; olive gray, 5Y4/2; saturated | 0 | 100 | 0 | 409 | | | | |
| | MH | Sandy (very fine) SILT; dark greenish gray, Gley 1 10Y4/1; stiff; plastic; mottled; wet | 0 | 20 | 80 | 548 | | | | |
| | | Sandy SILT; dark greenish gray, Gley 1 10Y4/1; soft; slightly plastic; saturated | 0 | 10 | 90 | 142; 158; 157 | | | 5 | |
| | SP | Fine to very fine SAND; very dark greenish gray, Gley 1 10Y3/1; saturated | 0 | 100 | 0 | 114; 263 | | | | |
| 20 | SW | Medium to fine SAND; very dark gray, Gley N3/0; wet | 0 | 100 | 0 | 153; 107; 197; 525; 584 | | | 5 | |
| | SP | Very fine SAND; dark greenish gray, Gley 1 10Y4/1; trace fines; saturated | 0 | 90 | 10 | 259; 125 | | | | CL-B176-S-25-2 20502; 5/2/2022 1431 |
| | MH | Sandy (very fine) SILT; very dark gray, Gley 1, N3/0; soft; slightly plastic; very fine sand; saturated | 0 | 20 | 80 | 337 | 2-6-12 | 1.5 | 5 | |
| | SP | Very fine SAND; very dark gray, Gley 1 N3/0; saturated | 0 | 100 | 0 | 163 | | | | CL-B176-S-28-2 20502; 5/2/2022 1600 |
| 30 | SW | Medium to fine SAND; very dark gray, Gley 1 N3/0; wet | 0 | 100 | 0 | 6,188; 2,006; 200; 126; 135 | | | | |
| | | Very fine SAND; very dark greenish gray, Gley 1 10Y3/1; saturated | 0 | 100 | 0 | 143 | | | | |

Lithology / Well Construction:



**BATTELLE**

# Project: Keyport OU1 Vertical Extent Investigation
## Site: OU1
## Boring Log: CL-B176/MW1-71

| | | |
|---|---|---|
| Permit Number: 22-EP058<br>Project Number: G24790.30<br>Date Logged: 5/2/2022<br>Geologist: Hunter Butler<br>Total Depth (ft bgs): 100<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc<br>Driller: J Johnson<br>Drilling Equipment: Terra Sonic Compact Crawler<br>Drilling Method: Rotosonic<br>Boring Diameter: 6-inch<br>Sampler Type: CA Split Spoon<br>Hammer Type: 140-lb. Auto hammer | Northing (NAD 83): 259491.3<br>Easting (NAD 83): 1199038.1<br>Surface Elevation (NAVD 88): 16.96 ft<br>Borehole Abandoned: No<br>Backfill Method: N/A<br>Device Type: 2-inch PVC monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | Gravel (%) | Sand (%) | Fines (%) | Headspace PID (ppb) | Blow Counts | Sample Recovery | Sonic Sleeve | Sample ID; Date/Time | Well Construction |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | SP | Fine to very fine SAND; very dark greenish gray, Gley 1 10Y3/1; saturated | 0 | 100 | 0 | 245 | | | | | |
| | SW | Very coarse to medium SAND; very dark gray, N3/0; wet | 0 | 100 | 0 | 118 | | | 10 | | |
| | SP | Fine to very fine SAND; very dark greenish gray, Gley 1 10Y3/1; saturated | 0 | 100 | 0 | 126, 120 | | | | | |
| | | Silty, medium to very fine SAND; very dark greenish gray, Gley 1 10Y3/1; slightly plastic, saturated | 0 | 80 | 20 | 132, 145 | | | | | |
| 40 | SW | Gravelly, very coarse to fine SAND; very dark gray, Gley N3/0; gravels to 25mm diameter; wet | 10 | 90 | 0 | 110 | | | | CL-B176-S-40-2 20502; 5/2/2022 1608 | |
| | | Coarse to fine SAND; very dark gray, Gley 1 N3/0; wet | 0 | 100 | 0 | 834, 948 | | | 5 | | |
| | MH | Gravelly sandy (fine to very fine) SILT; very dark gray, Gley 1 N3/0; very stiff; plastic; gravels to 5mm diameter; saturated | 10 | 30 | 60 | 346 | | | | | |
| | SP | Silty, fine to very fine SAND; gray, 5Y5/1; consolidated; dry | 0 | 90 | 10 | 318 | | | | CL-B176-S-45-2 20502; 5/2/2022 1650 | |
| | SW | Very coarse to medium SAND; black, Gley 1 N2.5/0; wet | 0 | 100 | 0 | 155 | 8-20-28 | 1 | | | |
| | SP | Very coarse to coarse SAND; black, Gley 1 N2.5/0; wet | 0 | 100 | 0 | 143 | | | | | |
| | SW | Very coarse to very fine SAND; very dark gray, Gley 1 N3/0; saturated | 0 | 100 | 0 | 148 | | | 5 | | **Bentonite Seal:** 20% solids grout, hydrated bentonite chips |
| | | Gravelly, very coarse to very fine SAND; black, Gley 1 N2.5/0; gravels to 15mm diameter; saturated | 20 | 80 | 0 | 145, 169 | | | | | |
| 50 | MH | Clayey SILT; very dark gray, Gley 1 N3/0; stiff; slightly plastic; peat @ 50.3', 51.2', 52.4', and 54.8'; wet | 0 | 0 | 100 | 169, 20, 21, 23, 26 | | | 5 | | |
| | | Sandy (very fine) SILT; very dark gray, Gley 1 N3/0; stiff; slightly plastic; wet | 0 | 30 | 70 | 26, 32, 30, 36 | 6-30-45 | 1.5 | 1.5, 5 | CL-B176-S-55-2 20503; 5/3/2022 0944 | |
| | SM | Silty, very fine SAND; very dark gray, Gley 1 N3/0; trace organics; moist | 0 | 80 | 20 | 41 | | | | CL-B176-S-60-2 20503; 5/3/2022 1140 | |
| 60 | Pt | PEAT; black, Gley 1 N2.5; friable black organics; moist | 0 | 0 | 100 | 33 | | | | | |
| | SM | Silty, very fine SAND; very dark gray, Gley 1 N3/0; trace organics; moist | 0 | 80 | 20 | 34 | | | | | |
| | Pt | PEAT; black, Gley 1 N2.5, friable black organics; moist | 0 | 80 | 20 | 33 | | | 5 | | |
| | | PEAT; black, Gley 1 N2.5, friable black organics; damp | 0 | 80 | 20 | 57 | | | | | |
| | SM | Silty, very fine SAND; very dark gray, Gley 1 N3/0; trace organics; moist | 0 | 80 | 20 | 43 | | | | | |
| | Pt | PEAT; black, Gley 1 N2.5, friable black organics; damp | 0 | 80 | 20 | 65 | | | | CL-B176-S-65-2 20503; 5/3/2022 1144 | |
| | | Silty, very fine SAND; very dark gray, Gley 1 N3/0; little organics; moist | 0 | 30 | 70 | 37 | | | | | |

**BATTELLE**

# Project: Keyport OU1 Vertical Extent Investigation
# Site: OU1
# Boring Log: CL-B176/MW1-71

| | | |
|---|---|---|
| Permit Number: 22-EP058<br>Project Number: G24790.30<br>Date Logged: 5/2/2022<br>Geologist: Hunter Butler<br>Total Depth (ft bgs): 100<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc<br>Driller: J Johnson<br>Drilling Equipment: Terra Sonic Compact Crawler<br>Drilling Method: Rotosonic<br>Boring Diameter: 6-inch<br>Sampler Type: CA Split Spoon<br>Hammer Type: 140-lb. Auto hammer | Northing (NAD 83): 259491.3<br>Easting (NAD 83): 1199038.1<br>Surface Elevation (NAVD 88): 16.96 ft<br>Borehole Abandoned: No<br>Backfill Method: N/A<br>Device Type: 2-inch PVC monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | Grading (%) Gravel | Sand | Fines | Headspace PID (ppb) | Blow Counts | Sample Recovery | Sonic Sleeve | Sample ID; Date/Time | Well Construction |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | MH | Sandy (very fine) SILT; very dark gray, Gley 1 N3/0; stiff; slightly plastic; peat at 65.8' and 68.6'; moist | 0 | 30 | 70 | 32, 36 | | | 5 | | |
| 70 | SM | Silty, very fine SAND; very dark gray, Gley 1 N3/0; peat including woody fragments; moist | 0 | 80 | 20 | 36, 35, 26 | | | | CL-B176-S-70-220503; 5/3/2022 1203 | |
| | Pt | PEAT; black, Gley 1 N2.5, friable black organics; moist | 0 | 0 | 100 | 40, 15 | | | 10 | | |
| | | PEAT; black, Gley 1 N2.5, friable black organics; increased decomposition; moist | 0 | 80 | 20 | 66 | | | | | |
| | SM | Silty, very fine SAND; very dark gray, Gley 1 N3/0; peat including woody fragments; moist | 0 | 80 | 20 | 55 | | | | | |
| | | Silty | 0 | 80 | 20 | 45, 48 | | | | | |
| | MH | Sandy (very fine) SILT; very dark greenish gray, Gley 1 10Y3/1; stiff; slightly plastic; moist | 0 | 30 | 70 | | | | | | |
| | | Sandy (very fine) SILT; dark gray, Gley 1, N4/0; stiff; slightly plastic; moist | 0 | 30 | 70 | 142, 61, 67 | | | | | |
| 80 | SM | Silty SAND; very dark gray; Gley 1 N3/0; stiff; plastic; moist | 0 | 80 | 20 | 14, 0 | | | 10 | | |
| | MH | Sandy SILT; very dark gray, Gley 1, 3/0; stiff; plastic; moist | 0 | 30 | 70 | 2, 0 | | | | | |
| | SM | Silty peaty, very fine SAND; very dark greenish gray, Gley 1 5G3/1; organics including peat beds at 83.7' and 84.2'; moist | 0 | 80 | 20 | 0 | | | | | |
| | CH | Sandy (very fine), silty CLAY; very dark gray, Gley 1 N3/0; very stiff; plastic; moist | 0 | 10 | 90 | 102, 3 | | | | | |
| | | Sandy silty CLAY; very dark gray, Gley 1 N3/0; organics including wood chips; moist | 0 | 10 | 90 | 9 | | | | | |
| | SM | Silty, very fine SAND; very dark gray, Gley 1 N3/0; organics; white evaporates intermittent; mottled; damp | 0 | 80 | 20 | | | | | | |
| | CH | Sandy silty CLAY; very dark gray, Gley 1 N3/0; no organics | 0 | 10 | 90 | 5 | | | | | |
| | SM | Silty, very fine SAND; very dark greenish gray, Gley 1 5GY4/1; moist | 0 | 80 | 20 | | | | | | |
| 90 | MH | Sandy (very fine) SILT; very dark greenish gray, Gley 1 10Y3/1; stiff; slightly plastic; wet | 0 | 40 | 60 | 19, 32, 30, 35, 32 | | | | | Filter Pack: 12/20 Sand<br>Screen: 0.010 factory-slotted PVC screen |
| | SM | Silty, very fine SAND; black, Gley 1 N2.5/0; wet | 0 | 80 | 20 | | | | | CL-B176-S-95-220503; 5/3/2022 1510 | |
| | | Silty, very fine SAND; black, Gley 1 N2.5/0; increasing fines with depth; wet | 0 | 70 | 30 | 33 | | | | | |
| | | Silty, fine to very fine SAND; black, Gley 1 N2.5/0; wet/saturated | 0 | 70 | 30 | 32 | | | | | |
| | SW | Coarse to fine SAND; black, Gley 1 N2.5/0; wet/saturated | 0 | 100 | 0 | 35, 47, 43, 41 | | | | CL-B176-S-100-220503; 5/3/2022 1513 | |
| 100 | | | | | | | | | | | |

**BATTELLE**

# Project: Keyport OU1 Vertical Extent Investigation
## Site: OU 1
## Boring Log: NP-B177/MW1-72

| | | |
|---|---|---|
| Permit Number: 22-EP058 | Drilling Contractor: Holt Services, Inc | Northing (NAD 83): 259642.4 |
| Project Number: G24790.30 | Driller: J. Johnson | Easting (NAD 83): 1198934.5 |
| Date Logged: 5/5/2022 | Drilling Equipment: Terra Sonic Compact Crawler | Surface Elevation (NAVD 88): 16.11 ft |
| Geologist: Hunter Butler | Drilling Method: Rotosonic | Borehole Abandoned: No |
| Total Depth (ft bgs): 75 | Boring Diameter: 6-inch | Backfill Method: N/A |
| Reviewer: Michael Meyer | Sampler Type: CA Split Spoon | Device Type: 2-inch PVC monitoring well |
| | Hammer Type: 140-lb. Auto hammer | |

| Depth (ft bgs) | USCS Symbol | Sample Description | Gravel | Sand | Fines |
|---|---|---|---|---|---|
| 0 | SM | Gravelly silty, very coarse to very fine SAND; very dark grayish brown, 10YR3/2; gravels to 75mm diameter; slightly plastic; grass, roots, organics; moist | 10 | 60 | 30 |
| | SM | Gravelly silty, very coarse to very fine SAND; very dark gray, 10Y3/1; gravels to 30mm diameter; slightly plastic; roots, organics, moist | 10 | 60 | 30 |
| | SM | Gravelly silty, very coarse to very fine SAND; black, 10YR2/1; gravels to 50mm diameter; debris, wood, roots; plastic; moist; artificial fill | 10 | 70 | 20 |
| | SM | Gravely silty, very coarse to very fine SAND; black, 10YR2/1; gravels to 20mm; peaty; wet | 10 | 70 | 20 |
| | SW | Gravelly, very coarse to fine SAND; dark olive brown, 2.5Y 3/3; gravels to 75mm diameter | 20 | 80 | 0 |
| | SW | Gravelly, very coarse to very fine SAND; very dark grayish brown, 10YR3/2; gravels to 40 mm diameter; roots and organics; wet | 20 | 80 | 0 |
| | SM | Gravelly silty, very coarse to very fine SAND; very dark gray, 5Y3/1; gravels to 50mm diameter; slightly plastic; wood, metal debris, organics; peaty at 7.0 ft; wet | 20 | 60 | 20 |
| | SM | Gravelly silty, very coarse to very fine SAND; | 20 | 50 | 30 |
| 10 | MH | Clayey sandy (fine to very fine, trace coarse) SILT; very dark greenish gray, 10Y3/1; soft; slightly plastic; 2" organic clay at 9.8'; wood to 6" in length, charred wood to 2" in length; wet/saturated | 0 | 40 | 60 |
| | SM | Gravelly silty, fine to very fine SAND; dark greenish gray, Gley 1 10Y4/1; trace very coarse to medium sand; slightly plastic; debris: wood, glass, shells, cobble; artificial fill; saturated | 0 | 60 | 40 |
| | SP | Medium to fine SAND; very dark greenish gray, Gley 1 N4/0; saturated | 0 | 100 | 0 |
| | CH | Sandy (very fine) silty CLAY; dark gray, Gley 1 N4/0; soft; slightly plastic; saturated | 0 | 10 | 90 |
| | CH | Sandy (very fine) silty CLAY; dark gray; Gley 1 N4/0; soft; slightly plastic; saturated | 0 | 5 | 95 |
| | SP | Fine to very fine SAND; very dark greenish gray, Gley 1 5GY3/1; saturated | 0 | 100 | 0 |
| | CH | Sandy (very fine) silty CLAY; dark gray, Gley 1 N4/0; soft; slightly plastic; saturated | 0 | 5 | 95 |
| 20 | CH | Sandy (medium to very fine) silty CLAY; dark gray, Gley 1 N4/0; medium stiff; slightly plastic; saturated | 0 | 5 | 95 |

Headspace PID (ppb), top to bottom: 67, 90, 49, 43, 96, 93, 1,200, 266, 1,203, 158, 98, 77, 70, 67, 92, 90, 82, 73, 78, 65, 78, 86, 73

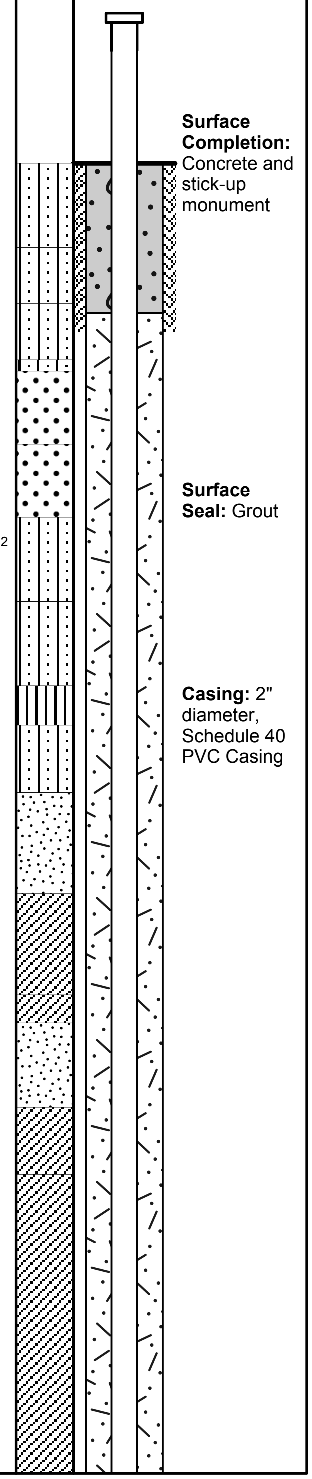
Blow Counts: —

Sample Recovery: —

Sonic Sleeve, top to bottom: 4, 3, 2, 5, 5, 5

Sample ID; Date/Time: NP-B177-S-07-2 20505; 5/5/22 1011

Lithology / Well Construction:



# Project: Keyport OU1 Vertical Extent Investigation
# Site: OU 1
# Boring Log: NP-B177/MW1-72

| | | |
|---|---|---|
| Permit Number: 22-EP058<br>Project Number: G24790.30<br>Date Logged: 5/5/2022<br>Geologist: Hunter Butler<br>Total Depth (ft bgs): 75<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc<br>Driller: J. Johnson<br>Drilling Equipment: Terra Sonic Compact Crawler<br>Drilling Method: Rotosonic<br>Boring Diameter: 6-inch<br>Sampler Type: CA Split Spoon<br>Hammer Type: 140-lb. Auto hammer | Northing (NAD 83): 259642.4<br>Easting (NAD 83): 1198934.5<br>Surface Elevation (NAVD 88): 16.11 ft<br>Borehole Abandoned: No<br>Backfill Method: N/A<br>Device Type: 2-inch PVC monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | Gravel | Sand | Fines | Headspace PID (ppb) | Blow Counts | Sample Recovery | Sonic Sleeve | Sample ID; Date/Time | Lithology | Well Construction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 66<br>68<br>92 | | | | | | |
| | SM | Silty, very fine SAND; dark gray, Gley 1 N4/0; saturated | 0 | 90 | 10 | 97<br>82 | | | 5 | | | |
| | SP | Gravelly, very fine SAND; dark gray, Gley 1 N4/0; trace coarse to medium sand; gravel to 5 mm diameter; saturated | 10 | 90 | 0 | 88 | | | | | | |
| 30 | SW | Gravelly, very coarse to very fine SAND; black; Gley 1 N2.5/0; gravels to 30mm diameter; saturated | 20 | 75 | 5 | 130 | | | | NP-B177-S-30-2 20505; 5/5/22 1131 | | |
| | SM | Gravelly silty, very coarse to very fine SAND; dark gray, Gley 1 N4/0; gravels to 10mm diameter; saturated | 5 | 80 | 15 | 72 | | | | | | |
| | | | 25 | 65 | 10 | 88 | | | | | | |
| | SW | Gravelly silty, very coarse to very fine SAND; dark gray, Gley 1 N4/0; gravels to 40 mm diameter; saturated<br>Gravelly, very coarse to very fine SAND; black, Gley 1 N2.5/0; gravels to 15mm diameter; saturated | 25 | 75 | 0 | 187 | | | | | | |
| | | Very coarse to fine SAND; very dark gray, Gley 1 N3/0; gravel to 50mm diameter at 34.5'; wet | 5 | 95 | 0 | 195<br>233<br>158 | | | 10 | NP-B177-S-35-2 20505; 5/5/22 1135<br>NP-B177-S-36-2 20505 (duplicate); 5/5/22 1142 | | |
| | GW | Sandy (very coarse to fine), very coarse to fine GRAVEL; dark gray, Gley 1 N4/0; trace fines; wet | 70 | 25 | 5 | 75<br>77 | | | | | | |
| | SW | Coarse to fine SAND; very dark gray, Gley N3/0; wet | 0 | 100 | 0 | 110 | | | | NP-B177-S-40-2 20505; 5/5/22 1147 | | |
| 40 | MH | Sandy (very fine) SILT; dark gray, Gley 1 N4/0; medium stiff; slightly plastic; saturated | 0 | 45 | 55 | 244<br>234<br>17<br>52<br>5 | 3-5-6 | 1.5 | | | | |
| | SM | Silty, fine to very fine SAND; very dark gray, Gley 1 N3/0; saturated | 0 | 85 | 15 | 97<br>30<br>13 | | | 10 | NP-B177-S-45-2 20505; 5/5/22 1345 | | |
| | | Silty, very coarse to very fine SAND; very dark gray, Gley 1 N3/0; saturated | 0 | 85 | 15 | 20 | | | | | | |
| | SW | Gravelly, very coarse to medium SAND; black, Gley 1 N2.5/0; trace fines; gravels to 15mm diameter; wet | 10 | 85 | 5 | | | | | | | |
| | SP | | 0 | 100 | 0 | 10 | | | | NP-B177-S-50-2 20505; 5/5/22 1401 | | |
| | | Fine to very fine SAND; very dark gray, Gley 1 N3/; | | | | | | | | | | |

# Project: Keyport OU1 Vertical Extent Investigation
## Site: OU 1
## Boring Log: NP-B177/MW1-72

| | | |
|---|---|---|
| Permit Number: 22-EP058 | Drilling Contractor: Holt Services, Inc | Northing (NAD 83): 259642.4 |
| Project Number: G24790.30 | Driller: J. Johnson | Easting (NAD 83): 1198934.5 |
| Date Logged: 5/5/2022 | Drilling Equipment: Terra Sonic Compact Crawler | Surface Elevation (NAVD 88): 16.11 ft |
| Geologist: Hunter Butler | Drilling Method: Rotosonic | Borehole Abandoned: No |
| Total Depth (ft bgs): 75 | Boring Diameter: 6-inch | Backfill Method: N/A |
| Reviewer: Michael Meyer | Sampler Type: CA Split Spoon | Device Type: 2-inch PVC monitoring well |
| | Hammer Type: 140-lb. Auto hammer | |

| Depth (ft bgs) | USCS Symbol | Sample Description | Gravel (%) | Sand (%) | Fines (%) | Blow Counts | Sample Recovery | Sonic Sleeve | Sample ID; Date/Time |
|---|---|---|---|---|---|---|---|---|---|
| 50 | | wet | 10 | 75 | 15 | | | | |
| | SW | Gravelly silty, very coarse to very fine SAND; very dark gray, Gley 1 N3/0; gravels to 15mm diameter | | | | | | | |
| | SW | Gravelly silty, very coarse to very fine SAND; very dark gray, Gley 1 N3/0; gravels to 40mm diameter; silt stringers at 56.5' and 57.0'; saturated | 25 | 65 | 10 | | | 10 | NP-B177-S-55-220505; 5/5/22 1407 |
| 60 | GP | Silty sandy (very coarse to very fine) GRAVEL; very dark gray, Gley 1 N3/0; fine gravel to 15mm diameter; saturated | 65 | 25 | 10 | | | | NP-B177-S-60-220505; 5/5/22 1410 |
| | SW | Very coarse to very fine SAND; very dark gray, Gley 1 N3/0; saturated | 0 | 100 | 0 | | | 5 | |
| | GP | Silty sandy (very coarse to very fine) GRAVEL; very dark gray, Gley 1 N3/0; medium to fine gravel to 20mm diameter; saturated | 50 | 40 | 10 | | | | |
| | SP | Medium to very fine SAND; black, Gley 1 N2.5/0; very fine stringer 64.7' to 65'; silt stringer at 68.2'; wet | 0 | 95 | 5 | 2-2-3 | NR | 5 | NP-B177-S-65-220505; 5/5/22 1441 |
| 70 | MH | Sandy (very fine) SILT; very dark gray, Gley 1 N3/0; hard; very plastic; peat at 70.2' to 70.6'; moist | 0 | 20 | 80 | | | | |
| | Pt | PEAT; black, Gley 1 N2.5/0; laminated organics; moist | 0 | 0 | 100 | | | | |
| | MH | Sandy (very fine) SILT; very dark gray, Gley 1 N3/0; hard; very plastic; moist | 0 | 20 | 80 | | | 5 | |
| | MH | PEAT; black, Gley 1 N2.5/0; moist | 0 | 0 | 100 | | | | |
| | MH | Sandy (very fine) SILT; very dark gray, Gley 1 N3/0; hard; very plastic; moist | 0 | 20 | 80 | | | | NP-B177-S-75-220505; 5/5/22 1643 |

Headspace PID (ppb):

| Depth (ft bgs) | PID (ppb) |
|---|---|
| 50 | 10 |
| 51 | 47 |
| 52 | 16 |
| 53 | 35 |
| 54 | 18 |
| 55 | 8 |
| 56 | 19 |
| 57 | 7 |
| 58 | 7 |
| 59 | 0 |
| 60 | 0 |
| 61 | 126 |
| 62 | 113 |
| 63 | 114 |
| 64 | 113 |
| 65 | 116 |
| 66 | 9 |
| 67 | 10 |
| 68 | 9 |
| 69 | 10 |
| 70 | 10 |
| 71 | 45 |
| 72 | 51 |
| 73 | 46 |
| 74 | 44 |
| 75 | 45 |

Well Construction:

**Bentonite Seal:** Hydrated bentonite chips in 6" dia. borehole

**Filter Pack:** Sand 12/20

**Screen:** 2" diameter Schedule 40 PVC, 0.010 factory-slotted screen

BATTELLE

# Project: Keyport OU1 Vertical Extent Investigation
## Site: OU 1
## Boring Log: NP-B178/MW1-73

| | | |
|---|---|---|
| Permit Number: 22-EP058 | Drilling Contractor: Holt Services, Inc. | Northing (NAD 83): 259763.3 |
| Project Number: G24790.30 | Driller: J. Johnson | Easting (NAD 83): 1198893 |
| Date Logged: 5/9/2022 | Drilling Equipment: Terra Sonic Compact Crawler | Surface Elevation (NAVD 88): 13.32 ft |
| Geologist: Hunter Butler | Drilling Method: Rotosonic | Borehole Abandoned: No |
| Total Depth (ft bgs): 100 | Boring Diameter: 6-inch | Backfill Method: N/A |
| Reviewer: Michael Meyer | Sampler Type: CA Split Spoon | Device Type: 2-inch PVC monitoring well |
| | Hammer Type: 140-lb. Auto hammer | |

| Depth (ft bgs) | USCS Symbol | Sample Description | Gravel (%) | Sand (%) | Fines (%) |
|---|---|---|---|---|---|
| 0 | SM | Gravelly silty, very coarse to very fine SAND; very dark grayish brown, 10YR3/2; slightly plastic fines; gravels to 30mm diameter; heavy grasses and roots; wet/saturated | 10 | 50 | 40 |
| | SW | Silty gravelly, very coarse to very fine SAND; very dark grayish brown, 10YR3/2; non-plastic; gravels to 60mm diameter; trace roots; wet | 30 | 60 | 10 |
| | | Gravelly, very coarse to very fine SAND; very dark gray, 10YR3/1; gravels to 25mm diameter; trace silt; moist | 10 | 85 | 5 |
| | N/A | No Return; hard at 3 feet – cedar boards | 0 | 0 | 0 |
| | SW | Silty gravelly, very coarse to very fine SAND; very dark gray, 10YR3/1; gravels to 20mm diameter; slightly plastic; wet | 30 | 50 | 20 |
| | SM | Gravelly silty, medium to very fine SAND; dark brown, 7.5YR3/3; slightly plastic; trace gravels to 30mm diameter; moist | 10 | 70 | 20 |
| | ML | Sandy (very fine) SILT; very dark greenish gray, Gley 1 10Y3/1; hard to stiff; slightly plastic; trace large wood debris at 5'; moist | 0 | 20 | 80 |
| | SW | Gravelly silty, very coarse to very fine SAND; very dark gray, 10YR3/1; slightly plastic; gravels to 15mm diameter; large wood debris at 6.7 feet; moist to wet | 10 | 70 | 30 |
| | GW | Silty sandy (very coarse to very fine) GRAVEL; very dark gray, 2.5Y3/1; coarse to fine gravel to 30mm diameter; slightly plastic; wet | 60 | 30 | 10 |
| | | | | | |
| | GW | Wood debris > 6" length; chips 9.5-10' | 0 | 0 | 0 |
| 10 | N/A | No Return | | | |
| | SM | Gravelly silty, very coarse to very fine SAND; very dark grayish brown, 2.5Y3/2; non plastic; gravels to 50mm diameter; large wood debris at 12'; saturated | 20 | 60 | 20 |
| | SW | Gravelly, medium to very fine SAND; very dark greenish gray, 10Y3/1; trace very coarse to coarse sand; gravels to 15mm diameter; some wood debris; saturated | 20 | 80 | 0 |
| | SP | Medium to very fine SAND; dark olive gray, 5Y3/2; saturated | 0 | 100 | 0 |
| | SP | Medium to very fine SAND; dark greenish gray, Gley 10Y4/1; saturated | 0 | 100 | 0 |
| | SP | Medium to very fine SAND; dark olive gray, 5Y3/2; saturated | 0 | 100 | 0 |
| | SP | Fine to very fine SAND; dark olive gray, 5Y3/2; thin lamina, iron staining, mottled; wet | 0 | 100 | 0 |
| | MH | Sandy SILT; very dark gray, Gley 1 N3/0; stiff; slightly plastic; very fine sand mixtures; saturated | 0 | 40 | 60 |
| 20 | | Medium to fine SAND; black, Gley N2.5/0; wet | | | |

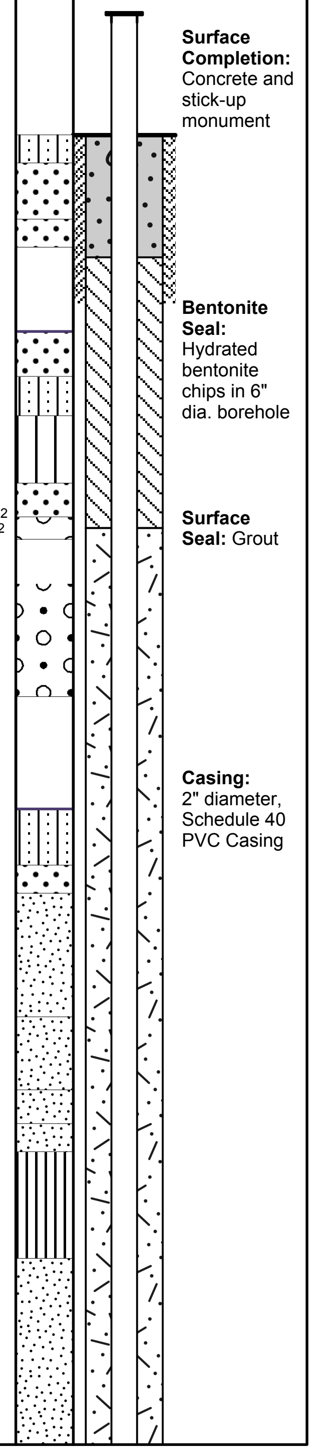
Headspace PID (ppb), top to bottom: 110, 113, 112, 113, 129, 150, 399, 243, 808, 190, 164, 153, 155, 147, 142, 143, 146, 142, 138

Sonic Sleeve, top to bottom: 3.5, 4.2, 3, 5, 5

Sample ID; Date/Time: NP-B178-S-07-2 20509; 5/9/2022 1050

Blow Counts: (none recorded)

Sample Recovery: (none recorded)



**BATTELLE**

# Project: Keyport OU1 Vertical Extent Investigation
# Site: OU 1
# Boring Log: NP-B178/MW1-73

| | | |
|---|---|---|
| Permit Number: 22-EP058<br>Project Number: G24790.30<br>Date Logged: 5/9/2022<br>Geologist: Hunter Butler<br>Total Depth (ft bgs): 100<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: J. Johnson<br>Drilling Equipment: Terra Sonic Compact Crawler<br>Drilling Method: Rotosonic<br>Boring Diameter: 6-inch<br>Sampler Type: CA Split Spoon<br>Hammer Type: 140-lb. Auto hammer | Northing (NAD 83): 259763.3<br>Easting (NAD 83): 1198893<br>Surface Elevation (NAVD 88): 13.32 ft<br>Borehole Abandoned: No<br>Backfill Method: N/A<br>Device Type: 2-inch PVC monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | Gravel (%) | Sand (%) | Fines (%) | Headspace PID (ppb) | Blow Counts | Sample Recovery | Sonic Sleeve | Sample ID; Date/Time |
|---|---|---|---|---|---|---|---|---|---|---|
| | SP | | 0 | 100 | 0 | 144, 142, 148, 148, 197, 151 | | | 5 | NP-B178-S-30-220509; 5/9/2022 1142<br>NP-B178-S-32-220509 (duplicate); 5/9/2022 1145 |
| 30 | | Medium to fine SAND; greenish black, Gley 1 10Y2.5/1; saturated | 0 | 100 | 0 | 162 | 5-1-1 | 1 | 10 | |
| | | Fine to very fine SAND; very dark gray, Gley 1 N3/0; saturated | 0 | 100 | 0 | 18, 24, 26, 18 | | | | |
| | SM | Silty, very fine SAND; dark gray, Gley 1 N4/0; slightly plastic; saturated | 0 | 60 | 40 | 40 | | | | |
| | MH | Sandy (very fine) SILT; dark gray, Gley 1 N4/0; soft; slightly plastic; saturated | 0 | 50 | 50 | 34 | | | | |
| | SW | Gravelly, very coarse to fine SAND; very dark greenish gray, Gley 1 10Y3/1; gravels to 40mm diameter; saturated | 30 | 70 | 0 | 32 | | | | |
| | SP | Fine to very fine SAND; dark greenish gray, Gley 1 10Y4/1; consolidated; wet | 0 | 100 | 0 | 83 | | | | |
| | SP | Medium to fine SAND; greenish black, Gley 1 10Y2.5/1; wet | 0 | 100 | 0 | 36 | | | | |
| 40 | SW | Gravelly, very coarse to fine SAND; very dark gray, Gley 1 N3/0; gravels to 35mm diameter; saturated | 40 | 60 | 0 | 25 | | | 9 | NP-B178-S-40-220509; 5/9/2022 1325 |
| | SW | Gravelly, very coarse to very fine SAND; very dark gray, Gley 1 N3/0; gravels to 10mm diameter; 4” cobble at 40.0’; saturated | 10 | 90 | 0 | 52, 95, 265, 181, 56, 217 | | | | |
| | SW | Gravelly, very coarse to very fine SAND; black, Gley 1 N2.5/0; gravels to 10mm diameter; wood debris, peat, organics; saturated | 10 | 80 | 10 | 237 | | | | |
| | SW | Gravelly, coarse to very fine SAND; black, Gley 1 N2.5/0; gravels to 10mm diameter; wet | 10 | 90 | 0 | 827 | | | | NP-B178-S-48-220509; 5/9/2022 1349 |
| | SW | Gravelly, very coarse to fine SAND; black, Gley 1 N2.5/0; gravels to 20mm; saturated | | | | 198 | | | | |

BATTELLE

# Project: Keyport OU1 Vertical Extent Investigation
# Site: OU 1
# Boring Log: NP-B178/MW1-73

| | | |
|---|---|---|
| Permit Number: 22-EP058<br>Project Number: G24790.30<br>Date Logged: 5/9/2022<br>Geologist: Hunter Butler<br>Total Depth (ft bgs): 100<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: J. Johnson<br>Drilling Equipment: Terra Sonic Compact Crawler<br>Drilling Method: Rotosonic<br>Boring Diameter: 6-inch<br>Sampler Type: CA Split Spoon<br>Hammer Type: 140-lb. Auto hammer | Northing (NAD 83): 259763.3<br>Easting (NAD 83): 1198893<br>Surface Elevation (NAVD 88): 13.32 ft<br>Borehole Abandoned: No<br>Backfill Method: N/A<br>Device Type: 2-inch PVC monitoring well |

| USCS Symbol | Sample Description | Gravel (%) | Sand (%) | Fines (%) |
|---|---|---|---|---|
| | | 10 | 90 | 0 |
| CL | CLAY; very dark gray, Gley 1 N3/0; stiff; plastic; wet | 0 | 0 | 100 |
| Pt | PEAT; black, Gley 1 N2.5/0; consolidated; friable organics, thin lamina; moist | 0 | 0 | 100 |
| | PEAT; black, Gley 1 N2.5/0; loose friable organics; moist | 0 | 0 | 100 |
| CL | CLAY; very dark gray, Gley 1 N2/0; stiff; plastic; wet | 0 | 0 | 100 |
| Pt | PEAT; black, Gley 1 N2.5/0; consolidated friable organics; moist | 0 | 0 | 100 |
| CL | Sandy (very fine) CLAY; very dark gray, Gley 1 N3/0; stiff; plastic; little peat inclusions; moist | 0 | 10 | 90 |
| Pt | PEAT; black, Gley 1 N2.5/0; consolidated friable organics; moist | 0 | 0 | 100 |
| CL | Silty CLAY; very dark gray, Gley 1 N3/0; stiff; plastic; moist | 0 | 0 | 100 |
| Pt | PEAT, black, Gley 1 N2.5/0; consolidated friable organics; moist | 0 | 0 | 100 |
| CL | Silty CLAY; very dark gray, Gley 1 N3/0; stiff; plastic; moist | 0 | 0 | 100 |
| | Sandy (very fine) silty CLAY; dark gray, Gley 1 N4/0; very stiff; plastic; trace very fine sand; thin peat beds at 63.5', 64.0', 64.5', and 65.0' | 0 | 10 | 90 |
| CH | Silty CLAY; very dark gray, Gley 1 N3/0; very stiff; plastic; wet | 0 | 0 | 100 |
| Pt | PEAT; black, Gley 1 N2.5/0; consolidated friable organics; moist | 0 | 0 | 100 |
| SP | Very fine SAND; very dark gray, Gley 1 N3/0; consolidated; moist | 0 | 100 | 0 |
| SM | Silty, very fine SAND; dark gray, Gley 1 N4/0; slightly plastic; wet | 0 | 60 | 40 |
| | Silty, very fine SAND; very dark gray, Gley 1 N3/0; slightly plastic; wet | 0 | 60 | 40 |
| | Silty, very fine SAND; dark gray, Gley 1 N4/0; slightly plastic; wet. Transitions to a sandy silt (see below) | 0 | 60 | 40 |
| | Sandy (very fine) SILT; dark gray, Gley 1 N4/0; very stiff; slightly plastic; wet | | | |

| Depth (ft bgs) | Headspace PID (ppb) |
|---|---|
| 50 | 115 |
| | 1,344 |
| | 312 |
| | 744 |
| | 262 |
| | 219 |
| | 7 |
| | 9 |
| | 10 |
| | 195 |
| 60 | 151 |
| | 1,225 |
| | 282 |
| | 326 |
| | 249 |
| | 275 |
| | 212 |
| | 132 |
| | 57 |
| | 459 |
| 70 | 138 |
| | 177 |
| | 192 |
| | 188 |
| | 193 |
| | 340 |

| Blow Counts | Sample Recovery |
|---|---|
| 23-50/4" | 1.6 |
| 9-18-37 | 1.5 |

Sonic Sleeve: 8; 10; 5

| Sample ID; Date/Time |
|---|
| NP-B178-S-50-2 20509; 5/9/2022 1422 |
| NP-B178-S-55-2 20509; 5/9/2022 1518 |
| NP-B178-S-58-2 20509; 5/9/2022 1534 |
| NP-B178-S-60-2 20509; 5/9/2022 1607 |
| NP-B178-S-65-2 20509; 5/9/2022 1611 |
| NP-B178-S-70-2 20509; 5/9/2022 1620 |

BATTELLE

# Project: Keyport OU1 Vertical Extent Investigation
# Site: OU 1
# Boring Log: NP-B178/MW1-73

| | | |
|---|---|---|
| Permit Number: 22-EP058<br>Project Number: G24790.30<br>Date Logged: 5/9/2022<br>Geologist: Hunter Butler<br>Total Depth (ft bgs): 100<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: J. Johnson<br>Drilling Equipment: Terra Sonic Compact Crawler<br>Drilling Method: Rotosonic<br>Boring Diameter: 6-inch<br>Sampler Type: CA Split Spoon<br>Hammer Type: 140-lb. Auto hammer | Northing (NAD 83): 259763.3<br>Easting (NAD 83): 1198893<br>Surface Elevation (NAVD 88): 13.32 ft<br>Borehole Abandoned: No<br>Backfill Method: N/A<br>Device Type: 2-inch PVC monitoring well |

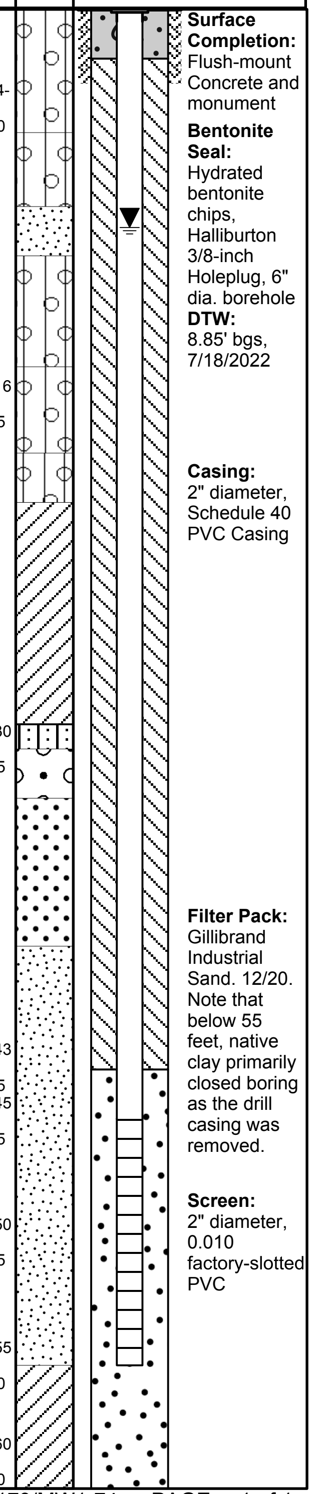
| Depth (ft bgs) | USCS Symbol | Sample Description | Gravel (%) | Sand (%) | Fines (%) | Headspace PID (ppb) | Blow Counts | Sample Recovery | Sonic Sleeve | Sample ID; Date/Time | Well Construction |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | MH | | 0 | 40 | 60 | 395, 233, 597, 289 | | | 5 | | Bentonite Seal: Hydrated bentonite chips |
| 80 | SM | Silty, very fine SAND; very dark gray, Gley 1 N3/0; slightly plastic; wet | 0 | 60 | 40 | 432, 0, 2, 3 | | | 10 | | |
| | | Silty, very fine SAND; dark gray, Gley 1 N4/0; slightly plastic; wet | 0 | 60 | 40 | 37, 34, 25 | | | | | |
| | SP | Fine to very fine SAND; very dark gray, Gley 1 N3/0; trace silt; wet | 0 | 95 | 5 | | | | | | |
| | | Very fine SAND; dark gray, Gley 1 N4/0; little silt; wet | 0 | 90 | 10 | 21, 38, 19 | | | | | Filter Pack: Sand 12/20 |
| 90 | N/A | No Return | | | | 15 | | | 8 | | Screen: 2" diameter Schedule 40 PVC, 0.010 factory-slotted screen |
| | SM/SW | Sandy SILT and very coarse to medium SAND; black, Gley 1 N2.5/0; stiff; slightly plastic; wet; mixed | 0 | 50 | 50 | 13, 9 | | | | | |
| | SW | Gravelly, very coarse to medium SAND; black, Gley N2.5/0; gravels to 10mm diameter; wet | 5 | 95 | 0 | 17, 15, 17, 18, 17, 18 | | | | NP-B178-S-95-220510; 5/10/2022 0953<br>NP-B178-S-100-220510; 5/10/2022 0959 | |
| 100 | | | | | | | | | | | |

BATTELLE

# Project: Keyport OU1 Vertical Extent Investigation
# Site: OU 1
# Boring Log: DG-B179/MW1-74

| | | |
|---|---|---|
| Permit Number: 22-EP058<br>Project Number: G24790.30<br>Date Logged: 7/12/2022<br>Geologist: Michael Meyer<br>Total Depth (ft bgs): 60<br>Reviewer: Steven Verdibello | Drilling Contractor: Holt Services, Inc.<br>Driller: Marlen Gross<br>Drilling Equipment: Terra Sonic Compact Crawler<br>Drilling Method: Rotosonic<br>Boring Diameter: 6-inch<br>Sampler Type: Modified California split spoon<br>Hammer Type: 140-lb. Auto hammer | Northing (NAD 83): 260210.6<br>Easting (NAD 83): 1198481.5<br>Surface Elevation (NAVD 88): 13.69 ft<br>Borehole Abandoned: No<br>Backfill Method: N/A<br>Device Type: 2-inch PVC monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | Gravel (%) | Sand (%) | Fines (%) | Headspace PID (ppb) | Blow Counts | Sample Recovery | Sonic Sleeve | Sample ID; Date/Time |
|---|---|---|---|---|---|---|---|---|---|---|
| 0–5 | GM | Silty SAND and GRAVEL; light brown and medium gray; interbedded; loose; roots at 4 feet; dry (Artificial fill) | 50 | 30 | 20 | 0<br>500 | | | 3 | DG-B179-S-4-220712; 7/12/22 1410 |
| 5–8 | GM | Silty SAND and GRAVEL; medium gray; medium dense; moist | 40 | 40 | 20 | 1 | | | 2 | |
| 8–10 | SP | Gravelly, fine to medium SAND; medium gray; medium dense; damp | 10 | 90 | 0 | 0 | | | | |
| 10–14.5 | GM | Silty SAND and GRAVEL; medium brown; loose; roots throughout, some seashells; dry | 40 | 40 | 20 | 0 | | | 2 | |
| 14.5–18 | GM | Silty SAND and GRAVEL; medium brown; loose; gravels up to 2 inches diameter; moist | 50 | 30 | 20 | 5<br>0 | | | 4 | DG-B179-S-16-220712; 7/12/22 1425 |
| 18–20 | GM | Silty sandy GRAVEL; mottled light brown and light gray; medium dense; gravels up to 1 inch diameter; saturated | 50 | 30 | 20 | 0 | | | | |
| 20–29 | CL | CLAY; light gray; soft; medium plasticity; beds of fine sand at 24.5 feet (4 inches thick) and 27 ft (8 inches thick); saturated | 0 | 5 | 95 | 0<br>0<br>0<br>0<br>0<br>0<br>0 | | | 3<br>5 | |
| 29–30 | SM | Silty, very fine SAND; light gray; medium dense; damp | 0 | 75 | 25 | 0 | | | | DG-B179-S-30-220712; 7/12/22 1445 |
| 30–32 | GW | Silty sandy GRAVEL; medium gray; medium dense; cobbles up to 3 inches in diameter; saturated | 60 | 30 | 10 | 0<br>0 | 10-10-10 | 0.75 | | |
| 32–38 | SW | Silty gravelly (fine) SAND; medium gray; medium dense; gravels up to 1 inch in diameter; saturated | 20 | 70 | 10 | 9<br>0<br>9<br>0<br>13<br>0 | | | 5<br>5 | |
| 38–55 | SP | Fine SAND; medium gray; dense; trace fine gravel; moist | 4 | 92 | 4 | 12<br>0<br>12<br>0<br>0<br>125<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | 2-7-47 | 1.1 | 5<br>5<br>5 | DG-B179-S-43-220712; 7/12/22 1535<br>DG-B179-S-45-220712; 7/12/22 1545<br>DG-B179-S-50-220713; 7/13/22 0845<br>DG-B179-S-55-220713; 7/13/22 0850 |
| 55–60 | CL | CLAY; blue gray; hard; low plasticity; abundant peat layers, 12 to 18 inches thick; dry | 0 | 0 | 100 | 0<br>123<br>0<br>0<br>0 | 2-3-10 | 1.5 | | DG-B179-S-60-220713; 7/13/33 1000 |

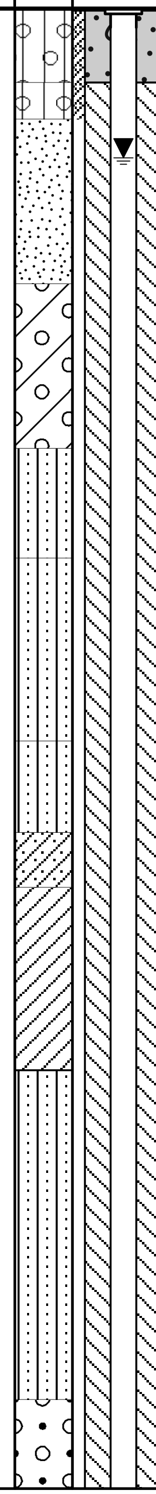


![BATTELLE]

# Project: Keyport OU1 Vertical Extent Investigation
## Site: OU 1
## Boring Log: DG-B180/MW1-75

| | | |
|---|---|---|
| Permit Number: 22-EP058<br>Project Number: G24790.30<br>Date Logged: 7/11/2022<br>Geologist: Michael Meyer<br>Total Depth (ft bgs): 80<br>Reviewer: Steven Verdibello | Drilling Contractor: Holt Services, Inc.<br>Driller: Marlen Gross<br>Drilling Equipment: Terra Sonic Compact Crawler<br>Drilling Method: Rotosonic<br>Boring Diameter: 6-inch<br>Sampler Type: Modified California split spoon<br>Hammer Type: 140-lb. Auto hammer | Northing (NAD 83): 260200.5<br>Easting (NAD 83): 1198473.7<br>Surface Elevation (NAVD 88): 13.66 ft<br>Borehole Abandoned: No<br>Backfill Method: N/A<br>Device Type: 2-inch PVC monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | Grading (%) Gravel | Sand | Fines | Headspace PID (ppb) | Blow Counts | Sample Recovery | Sonic Sleeve | Sample ID; Date/Time |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | GM | Silty SAND and GRAVEL; light brown; loose; dry (Artificial fill) | 40 | 40 | 20 | 0 | | | 4 | |
| | | Silty SAND and GRAVEL; light gray; loose; dry (Artificial fill). | 40 | 40 | 20 | 0, 0 | | | | |
| | SP | Gravelly, fine to medium SAND; light gray; moist | 10 | 90 | 0 | 0, 0, 0, 0 | | | 4 | |
| | GC | Clayey sandy GRAVEL; light gray; saturated | 50 | 25 | 25 | 0, 0, 0 | | | | |
| 10 | SM | Silty, fine SAND; dark gray; saturated | 0 | 75 | 25 | 0 | | | 2.5 | |
| | | Silty, fine SAND; dark gray; abundant shell fragments; saturated | 0 | 75 | 25 | 0, 0 | | | 2.5 | |
| 20 | | Silty, fine SAND; dark gray; saturated | 0 | 75 | 25 | 0, 0, 0 | | | 5 | |
| | SC | Silty sandy CLAY; mottled light brown and medium gray; saturated | 0 | 50 | 50 | 0, 0 | | | | |
| | CL | CLAY; medium blue gray; hard; medium plastic; saturated | 0 | 0 | 100 | 0, 0, 0, 0, 0 | | | 5 | |
| 30 | SM | Silty, fine SAND; medium gray; trace gravel; saturated | 5 | 85 | 10 | 0, 0, 0, 0, 0, 0, 0, 0, 0 | | | 5, 5 | |
| 40 | GW | Sandy (fine to coarse), fine GRAVEL; medium gray; gravels ¼ inch or smaller diameter; trace cobbles to 1 ½ inches in diameter within first foot; saturated; grades to below | 60 | 35 | 5 | 0, 0 | | | | |



Lithology / Well Construction:

**Surface Completion:** Flush-mount Concrete and monument

**DTW:** 4.06' bgs, 7/18/2022

**Bentonite Seal:** Hydrated bentonite chips, Halliburton 3/8-inch Holeplug, 12 sacks in 6" dia. borehole

**Casing:** 2" diameter, Schedule 40 PVC Casing

![BATTELLE]

# Project: Keyport OU1 Vertical Extent Investigation
## Site: OU 1
## Boring Log: DG-B180/MW1-75

| | | |
|---|---|---|
| Permit Number: 22-EP058 | Drilling Contractor: Holt Services, Inc. | Northing (NAD 83): 260200.5 |
| Project Number: G24790.30 | Driller: Marlen Gross | Easting (NAD 83): 1198473.7 |
| Date Logged: 7/11/2022 | Drilling Equipment: Terra Sonic Compact Crawler | Surface Elevation (NAVD 88): 13.66 ft |
| Geologist: Michael Meyer | Drilling Method: Rotosonic | Borehole Abandoned: No |
| Total Depth (ft bgs): 80 | Boring Diameter: 6-inch | Backfill Method: N/A |
| Reviewer: Steven Verdibello | Sampler Type: Modified California split spoon | Device Type: 2-inch PVC monitoring well |
| | Hammer Type: 140-lb. Auto hammer | |

| Depth (ft bgs) | USCS Symbol | Sample Description | Gravel (%) | Sand (%) | Fines (%) | Blow Counts | Sample Recovery | Sonic Sleeve | Sample ID; Date/Time |
|---|---|---|---|---|---|---|---|---|---|
| 42–56 | SW | Gravelly (fine), coarse SAND, some fine to medium sand; medium gray; medium dense; saturated | 10 | 85 | 5 | | | 5 / 5 / 5 | |
| 56–60 | CL | CLAY; blue gray; hard; low plasticity; abundant peat layers, 12 to 18 inches thick; dry | 0 | 0 | 100 | | | 5 | DG-B180-S-57-2 20711; 7/11/22 1545 |
| 60–70 | CL | CLAY; blue gray; hard; low plasticity; laminated peat layer, 69 to 70; dry | 0 | 0 | 100 | | | 5 / 5 / 5 | DG-B180-S-65-2 20711; 7/11/22 1615<br>DG-B180-S-70-2 20712; 7/12/22 0945 |
| 70–75 | CL | Silty CLAY; blue gray; hard; trace very fine sand; dry | 0 | 5 | 95 | 2-12-35 | N/A | 5 | DG-B180-S-73-2 20712; 7/12/22 1055 |
| 75–80 | SP | Fine SAND; medium gray; trace silt; moist | 0 | 95 | 5 | | | 5 | DG-B180-S-76-2 20712; 7/12/22 1050<br>DG-B180-S-79-2 20712; 7/12/22 1040 |

Headspace PID (ppb):

| Depth | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PID | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Depth | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PID | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 85 | 150 | 153 | 56 | 190 | 283 | 10 | 3 | 0 | 0 |

Well Construction:

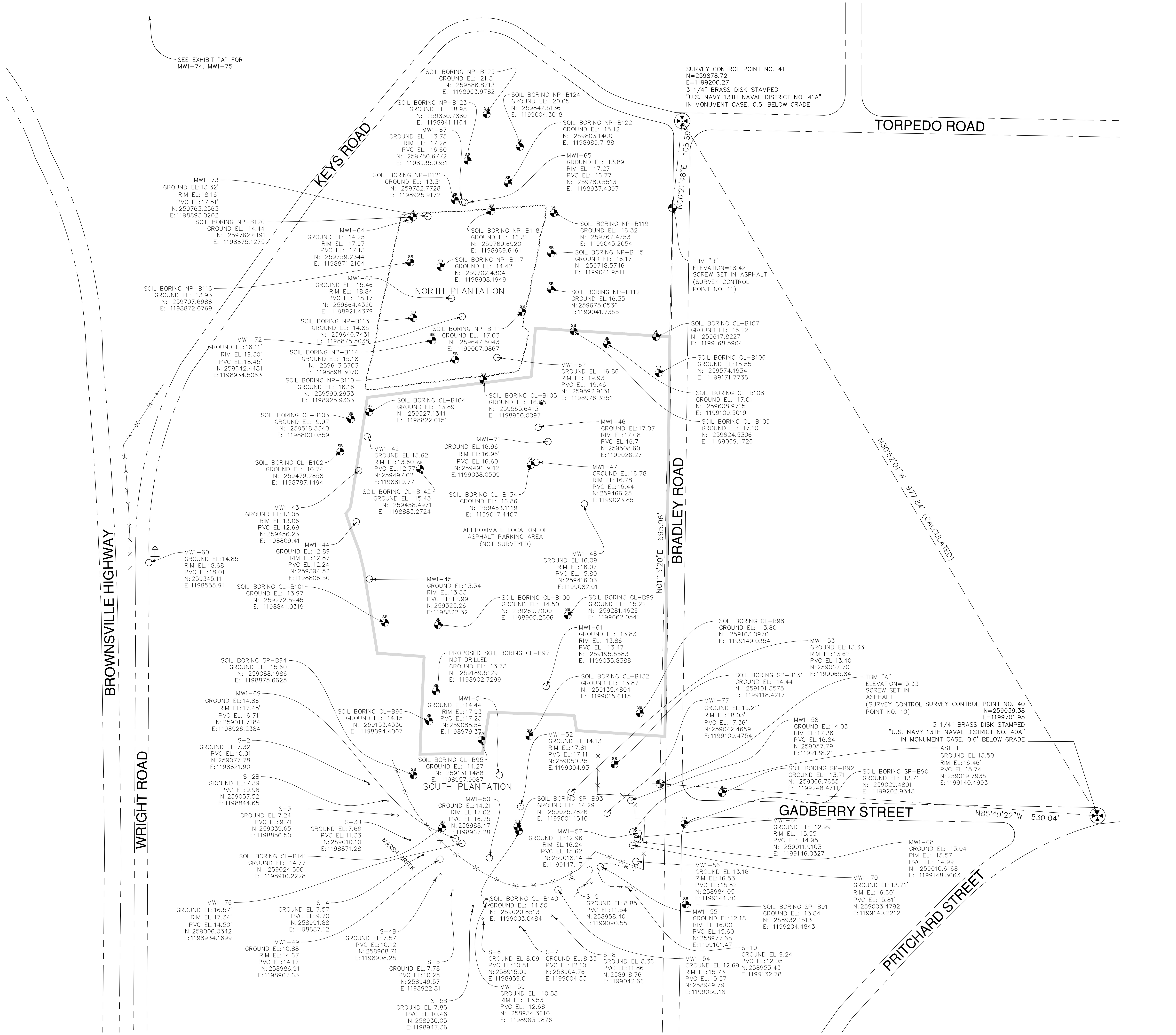
**Filter Pack:** Gillibrand Industrial Sand. 12/20. 2.5 sacks, 50 lb each

**Screen:** 2" diameter Schedule 40 PVC, 0.010 slot

# ATTACHMENT 4

## Land Survey Reports

SW 1/4, SEC 36, TWP 26 N, RGE 1 E, W.M.




NOTES:

HORIZONTAL DATUM:
NAD 83/11

BASIS OF POSITION:
WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT) SURVEY CONTROL MONUMENT "GP18308–31", MONUMENT ID = 3180.

MONUMENT DATA;
NORTHING=260301.136
EASTING=1198547.091
ELEVATION=13.064
COORDINATES PER WASHINGTON STATE PLANE COORDINATE SYSTEM, NORTH ZONE, US SURVEY FEET.

VERTICAL DATUM:
NAVD 88

PROJECT BENCHMARK:
ABOVE REFERENCED BASIS OF POSITION MONUMENT.

DERIVATION OF CALCULATION FOR REFERENCE BETWEEN "MEAN SEA LEVEL" (MSL) AND "MEAN LOWER LOW WATER" (MLLW) TO NAVD 88;
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA) TIDAL BENCHMARK "BREMERTON", STATION ID=9445958.
BENCHMARK DATA;
TIDAL EPOCH=1983 THROUGH 2001
LOCATION; LATITUDE 47°33.7' N, LONGITUDE 122°37.4' W.
TIDAL BENCHMARK ELEVATIONS;
MLLW=0.00
NAVD 88=2.52 FEET
MSL=6.82

ELEVATION CONVERSION FACTOR:

MSL +4.30'
NAVD 88
MLLW –2.52'

SITE BENCHMARKS:

| | | |
|---|---|---|
| TBM "A" | ELEVATION=13.33 | SCREW SET IN ASPHALT ON WEST SIDE OF BRADLEY ROAD, JUST NORTH OF GADBERRY STREET. |
| TBM "B" | ELEVATION=18.42 | SCREW SET IN ASPHALT ON WEST SIDE OF BRADLEY ROAD, EASTERLY OF THE NORTH LINE OF THE NORTH PLANTATION GROUP OF TREES. |

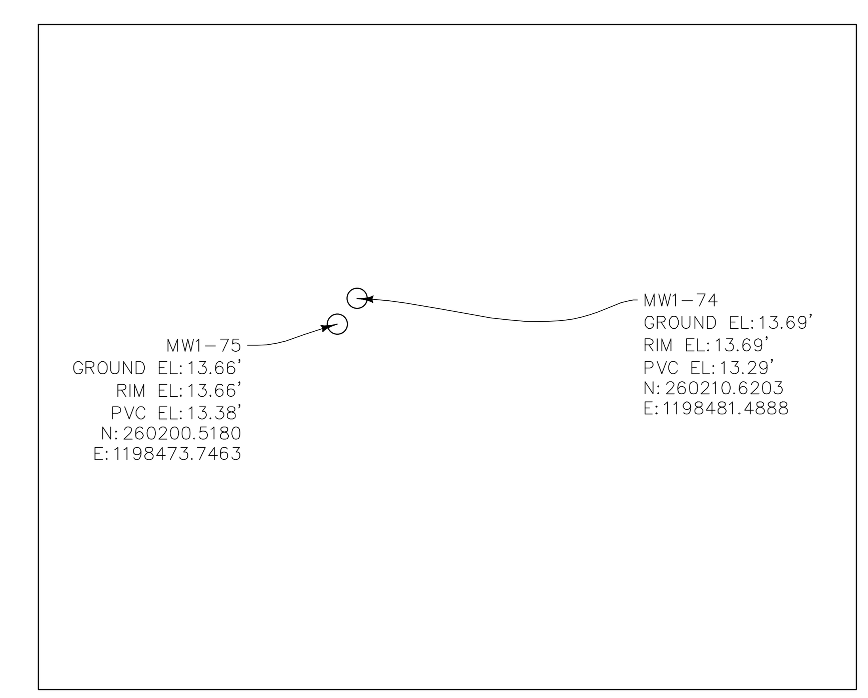
SITE SURVEY CONTROL POINTS:

| | | | | |
|---|---|---|---|---|
| 10: | N=259077.99 | E=1199173.32 | EL=13.33 | SCREW SET IN ASPHALT |
| 11: | N=259773.78 | E=1199188.57 | EL=18.42 | SCREW SET IN ASPHALT |
| 40: | N=259039.38 | E=1199701.95 | EL=15.80 | MONUMENT IN CASE |
| 41: | N=259878.72 | E=1199200.27 | EL=18.70 | MONUMENT IN CASE |

–DATE OF FIELDWORK; AUGUST, 2014 TO JULY, 2022

–LOCATION OF ROADS AND ASPHALT PARKING AREA SHOWN ON MAP IS FOR GRAPHIC ORIENTATION PURPOSES ONLY. THESE FEATURES WERE NOT SURVEYED, THEY WERE TRACED FROM AN AERIAL PHOTOGRAPH.

EXHIBIT "A"




## LEGEND

- ASPHALT (ASPH)
- CHAIN LINK FENCE (CLF)
- FOUND SURVEY MONUMENT (AS NOTED)
- SB — SOIL BORING
- TEMPORARY BENCHMARK (TBM)

# SOIL BORING AND MONITOR WELL LOCATIONS

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SOIL BORING, MONITOR WELL LOCATIONS
NAVAL BASE KITSAP
BATTELLE
KEYPORT KITSAP COUNTY WASHINGTON

| | |
|---|---|
| drawn by: CJM | checked by: TRS |
| scale: 1"=60' | date: 08/02/22 |
| job no. 2014114.04 | |
| sheet 1 of 1 | |

DATE REVISION NO

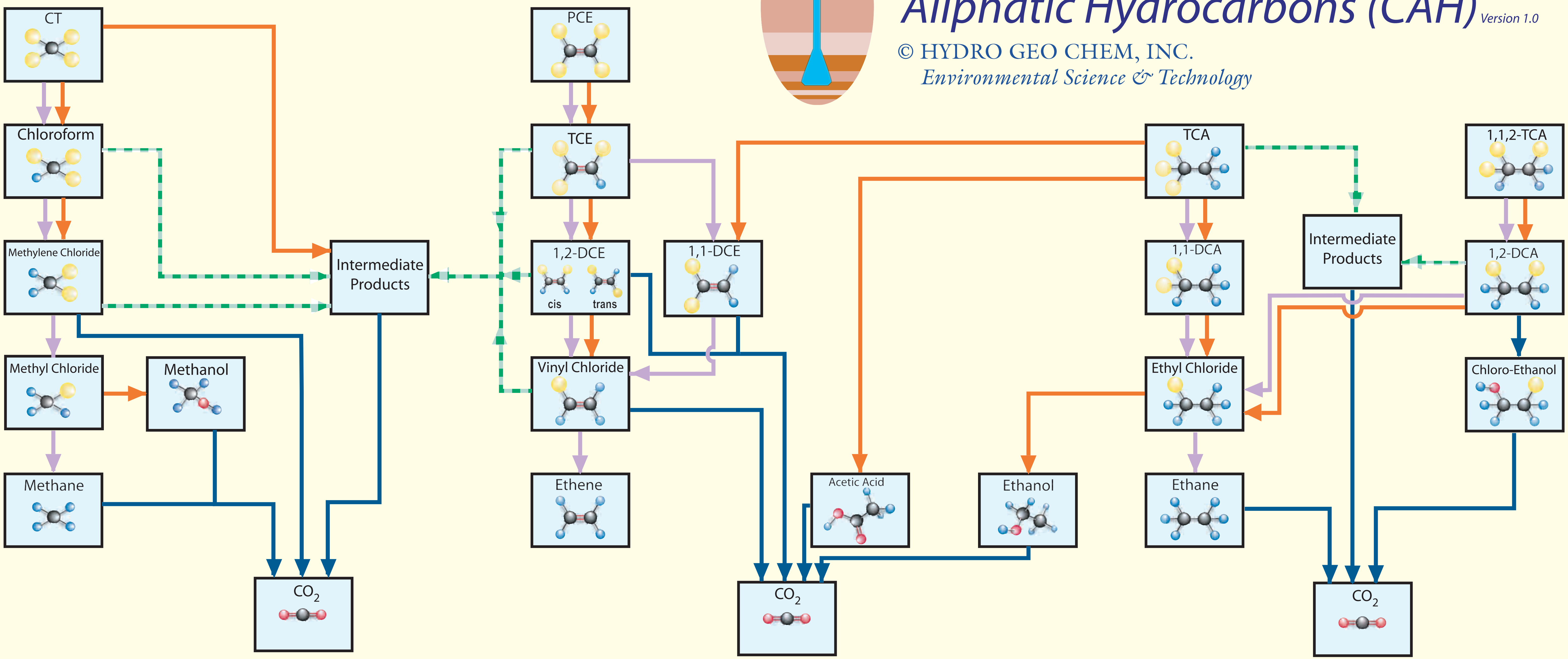
# ATTACHMENT 5

## Chlorinated Solvent Degradation Chemistry

# Natural Attenuation of Chlorinated Aliphatic Hydrocarbons (CAH) *Version 1.0*



*Environmental Science & Technology*




## LEGEND:

- Hydrogen
- Oxygen
- Carbon
- Chlorine
- Single Molecular Bond
- Double Molecular Bond
- Abiotic
- Halorespiration
- Aerobic and/or Anaerobic Oxidation
- Cometabolism

## REACTION TYPE:

**ABIOTIC:** REACTIONS WITHOUT MICROBIAL FACILITATION. CAH'S UNDERGO FOUR TYPES OF ABIOTIC REACTIONS; SUBSTITUTION OF OH FOR Cl (HYDROLYSIS), SUBSTITUTION OF HS FOR Cl (FROM SULFIDES), REDUCTIVE DECHLORINATION (FERROUS IRON), AND ELIMINATION OF HCl TO FORM A DOUBLE BOND (DEHYDRO-HALOGENATION).

**HALORESPIRATION:** ANAEROBIC REDUCTIVE DECHLORINATION DRIVEN BY HYDROGEN. IN THE CASE OF CAH'S REDUCTION REPLACES HALOGENS WITH HYDROGEN.

**AEROBIC OXIDATION:** CAH AS ELECTRON DONOR AND SOURCE OF ORGANIC CARBON FOR MICROBE; OXYGEN AS ELECTRON ACCEPTOR.

**ANAEROBIC OXIDATION:** CAH AS ELECTRON DONOR AND ORGANIC CARBON SOURCE; NITRATE, FERRIC IRON, SULFATE, OR OTHER COMPOUNDS AS ELECTRON ACCEPTORS. OCCURS IN OXYGEN-DEPLETED ZONES.

**COMETABOLISM:** (PARTIAL) DEGRADATION OF CAH'S BY ENZYMES FROM MICROBES GROWING ON DIFFERENT SUBSTRATES; MICROBE OBTAINS NO ENERGY IN THE PROCESS. LIMITED UNDER NATURAL CONDITIONS; CAN SOMETIMES BE ENGINEERED BY PROVIDING HIGH CONCENTRATIONS OF THE UTILIZABLE SUBSTRATE. MEASURED RATES VARY; (INCLUDES AEROBIC AND ANAEROBIC PATHWAYS).

## COMPOUND PROPERTIES:

| COMMON NAME | COMPOUND | CAS NUMBER | M.W. | H (atm-$m^3$/mol) | Log Koc |
|---|---|---|---|---|---|
| CT | CARBON TETRACHLORIDE | 56-23-5 | 154 | 0.02 | 2.64 |
| CHLOROFORM | TRICHLORMETHANE | 67-66-3 | 119 | 0.00375 | 1.64 |
| METHYLENE CHLORIDE | DICHLOROMETHANE | 75-09-2 | 85 | 0.00257 | 0.94 |
| METHYL CHLORIDE | CHLOROMETHANE | 74-87-3 | 51 | 0.0023 | 0.94 |
| PCE | TETRACHLOROETHENE | 127-18-4 | 166 | 0.0227 | 2.82 |
| TCE | TRICHLOROETHENE | 79-01-6 | 131 | 0.00892 | 2.10 |
| 1,2-DCE (CIS)* | CIS-1,2-DICHLOROETHENE | 156-59-2 | 97 | 0.0075 | 1.50 |
| 1,2-DCE (TRANS)* | TRANS-1,2-DICHLOROETHENE | 156-60-5 | 97 | 0.0066 | 1.77 |
| 1,1-DCE | 1,1-DICHLOROETHENE | 75-35-4 | 97 | 0.154 | 1.81 |
| VINYL CHLORIDE | CHLOROETHENE | 75-01-4 | 62.5 | 0.695 | 0.91 |
| TCA | 1,1,1-TRICHLOROETHANE | 71-55-6 | 133 | 0.00276 | 2.18 |
| 1,1,2-TCA | 1,1,2-TRICHLOROETHANE | 79-00-5 | 133 | 0.00117 | 1.75 |
| 1,2-DCA | 1,2-DICHLOROETHANE | 107-06-2 | 99 | 0.0011 | 1.15 |
| 1,1-DCA | 1,1-DICHLOROETHANE | 75-34-3 | 99 | 0.0057 | 1.48 |
| ETHYL CHLORIDE | CHLOROETHANE | 75-00-3 | 64.5 | 0.011 | 1.17 |

*CIS- AND TRANS- ISOMERS; CIS- FORM PREDOMINATES AS REACTION PRODUCT

## GENERAL NOTES:

DISCLAIMER:
This illustrates reported biodegradation pathways for common industrial pollutants. Its use should be limited to preliminary assessment of the necessary microbiological niche for a specific biodegradation reaction to occur. The chart is NOT a comprehensive reveiw of possible reaction pathways, but rather those that are generally accepted in the literature. This image (and portions thereof) may only be reproduced by permission.

REFERENCES:

EPA/540/2-90/011b, Subsurface Contamination Reference Guide
*Wiedeier, T.H. et al, Natural Attenuation of Fuels and Chlorinated Solvents in the Subsurface. John Wiley, 1999, pp. 241-297.*
*Eekert, M. et al, Applied and Environmental Microbiology, 64 (7), 1998, pp. 2350-2356.*
*Vogel, T.M., Criddle, C., McCarty, P., Environmental Science and Technology, 21 (8), 1987, pp. 722-736.*
*Krastner, M. Applied and Environmental Bicrobiology, 57 (7), 1997, pp. 2039-2046.*
*Vogel, T., McCarty, P. Environmental Science and Technology, 21 (12), 1987, pp. 1208-1213.*
*Aronson, D., Howard, P. Anaerobic Biodegradation of Organic Chemicals in Groundwater, Environmental Science Center, 1997, pp. 105-152.*


### For More Information: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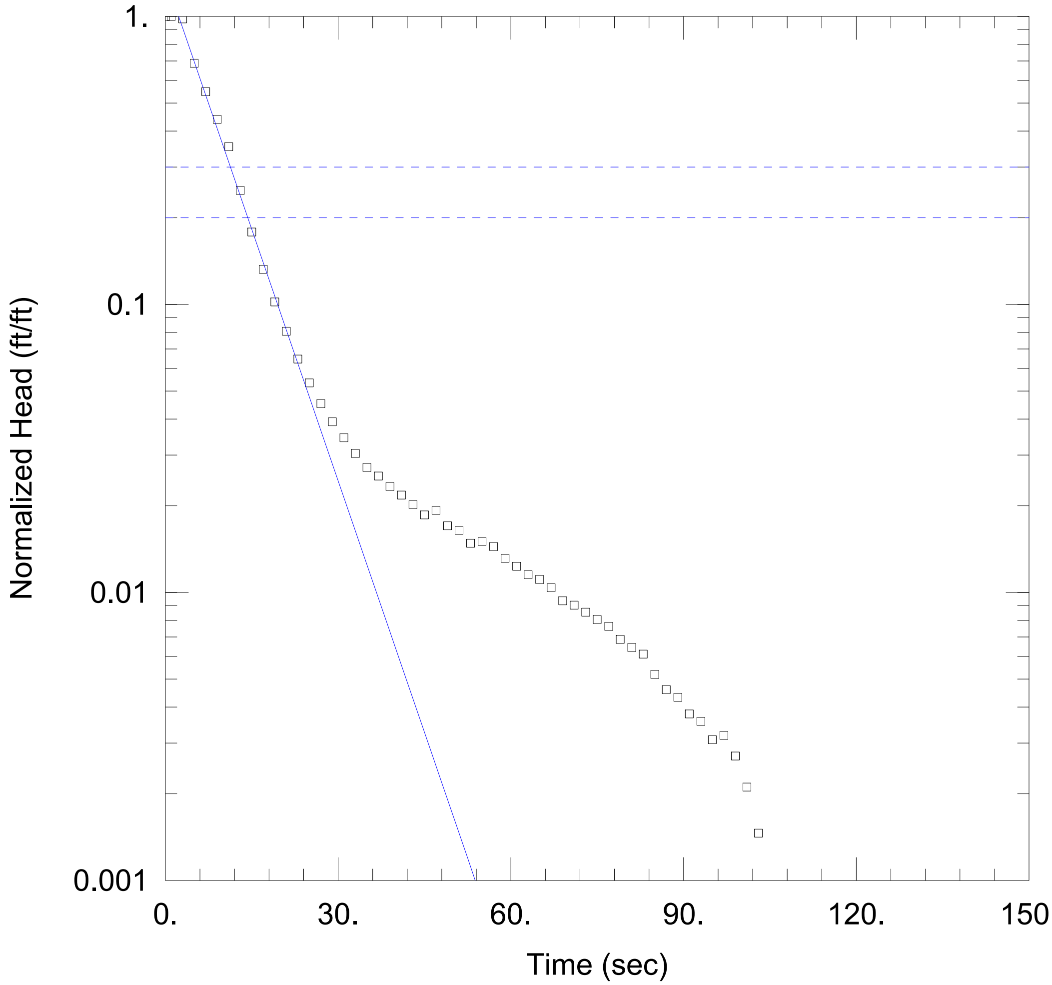
# ATTACHMENT 6

## Slug Test Reports




FALLING HEAD - RUN 1

Data Set: C:\...\MW1-39-Falling_1.aqt
Date: 06/07/22 Time: 09:04:59

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-39
Test Date: 5/04/22

AQUIFER DATA

Saturated Thickness: 44.46 ft
Anisotropy Ratio (Kz/Kr): 1.

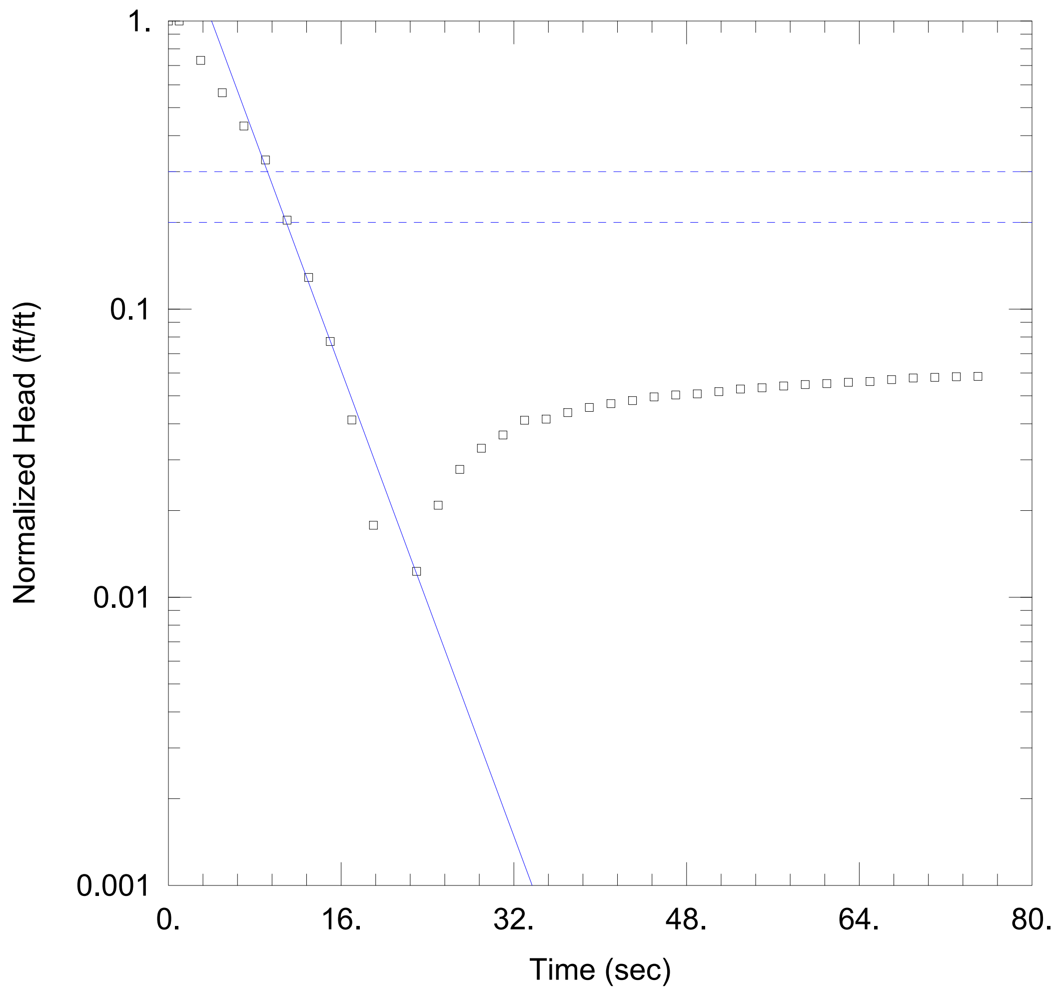
WELL DATA (MW1-39)

Initial Displacement: 1.85 ft
Total Well Penetration Depth: 23.75 ft
Casing Radius: 0.083 ft
Static Water Column Height: 23.45 ft
Screen Length: 5. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 64.48 ft/day
y0 = 2.52 ft




FALLING HEAD - RUN 2

Data Set: C:\...\MW1-39-Falling_2.aqt
Date: 06/07/22
Time: 09:38:06

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-39
Test Date: 5/11/22

AQUIFER DATA

Saturated Thickness: 44.46 ft
Anisotropy Ratio (Kz/Kr): 1.

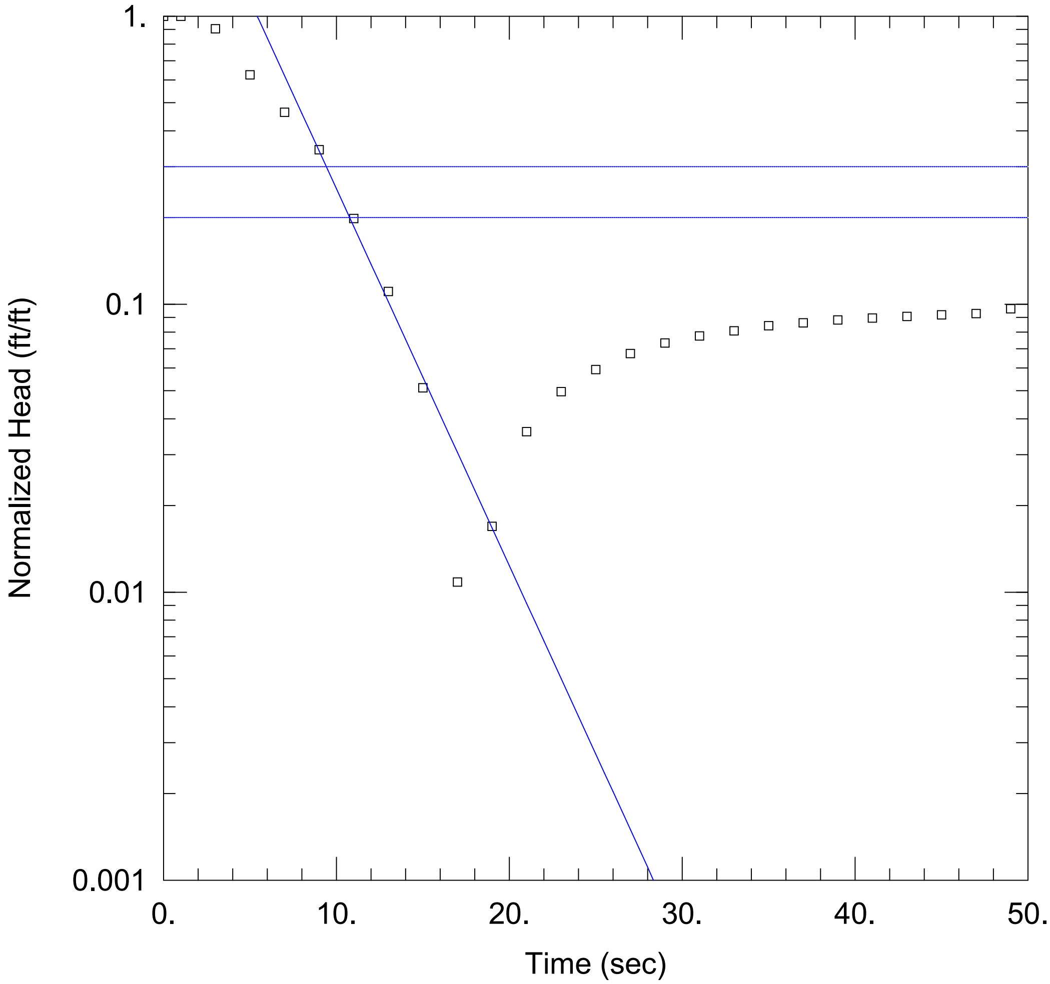
WELL DATA (MW1-39)

Initial Displacement: 1.912 ft
Total Well Penetration Depth: 23.45 ft
Casing Radius: 0.083 ft
Static Water Column Height: 23.45 ft
Screen Length: 5. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 111.6 ft/day
y0 = 4.845 ft




FALLING HEAD - RUN 3

Data Set: C:\...\MW1-39-Falling_3.aqt
Date: 10/12/22 Time: 08:47:36

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-39
Test Date: 5/11/22

AQUIFER DATA

Saturated Thickness: 44.46 ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW1-39)

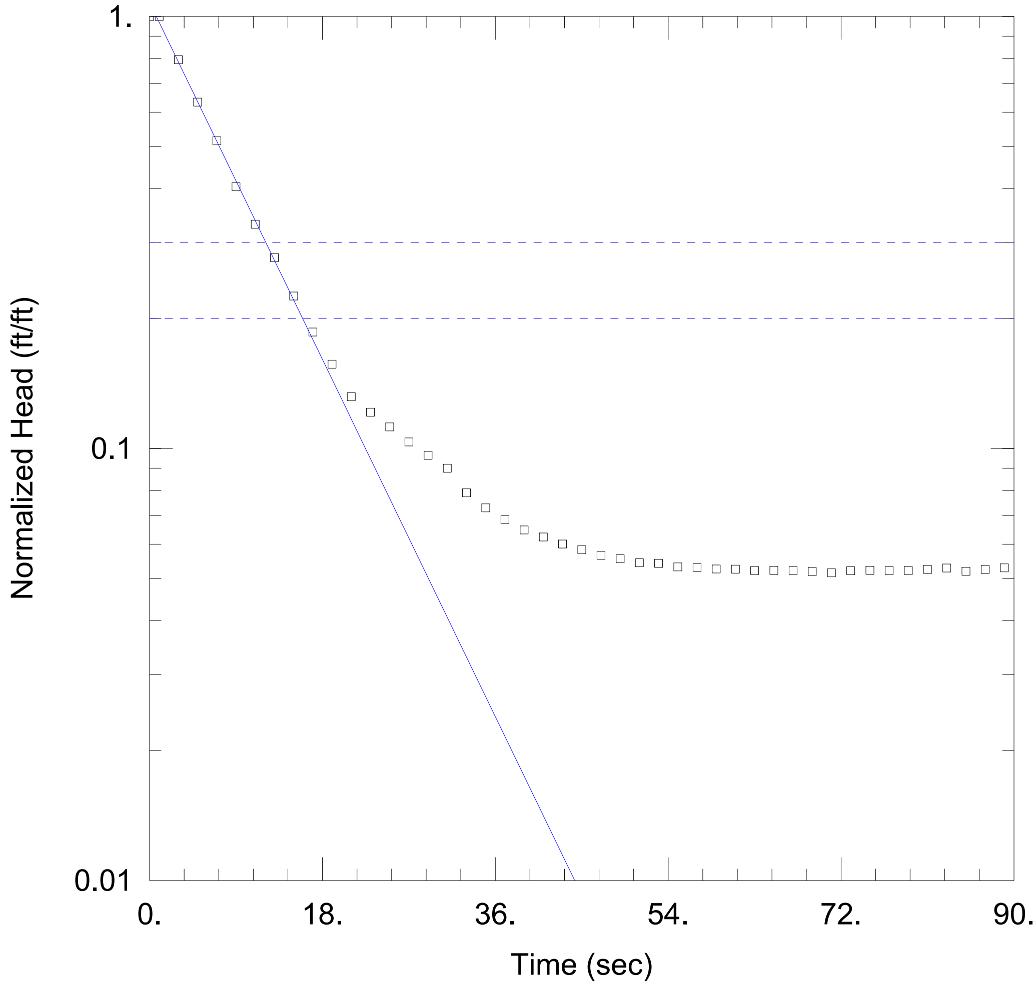
Initial Displacement: 1.855 ft
Total Well Penetration Depth: 23.45 ft
Casing Radius: 0.083 ft

Static Water Column Height: 23.45 ft
Screen Length: 5. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 144.6 ft/day y0 = 9.491 ft




RISING HEAD - RUN 1

Data Set: C:\...\MW1-39-Rising_1.aqt
Date: 06/07/22
Time: 09:50:15

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-39
Test Date: 5/11/22

AQUIFER DATA

Saturated Thickness: 44.46 ft
Anisotropy Ratio (Kz/Kr): 1.

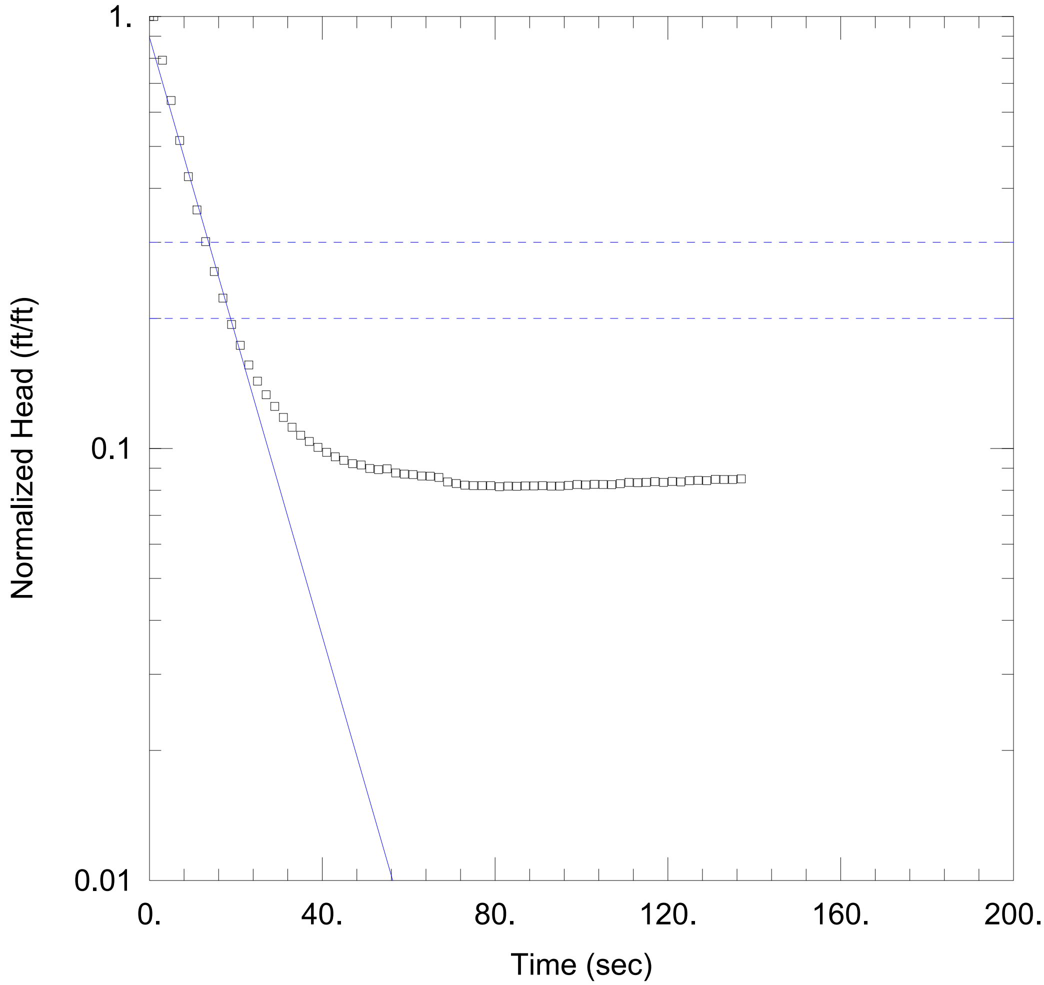
WELL DATA (MW1-39)

Initial Displacement: 1.937 ft
Total Well Penetration Depth: 23.45 ft
Casing Radius: 0.083 ft
Static Water Column Height: 23.45 ft
Screen Length: 5. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 50.71 ft/day
y0 = 2.086 ft




WELL TEST ANALYSIS

Data Set: C:\...\MW1-39-Rising_2.aqt
Date: 06/07/22 Time: 09:53:14

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-39
Test Date: 5/11/22

AQUIFER DATA

Saturated Thickness: 44.46 ft
Anisotropy Ratio (Kz/Kr): 1.

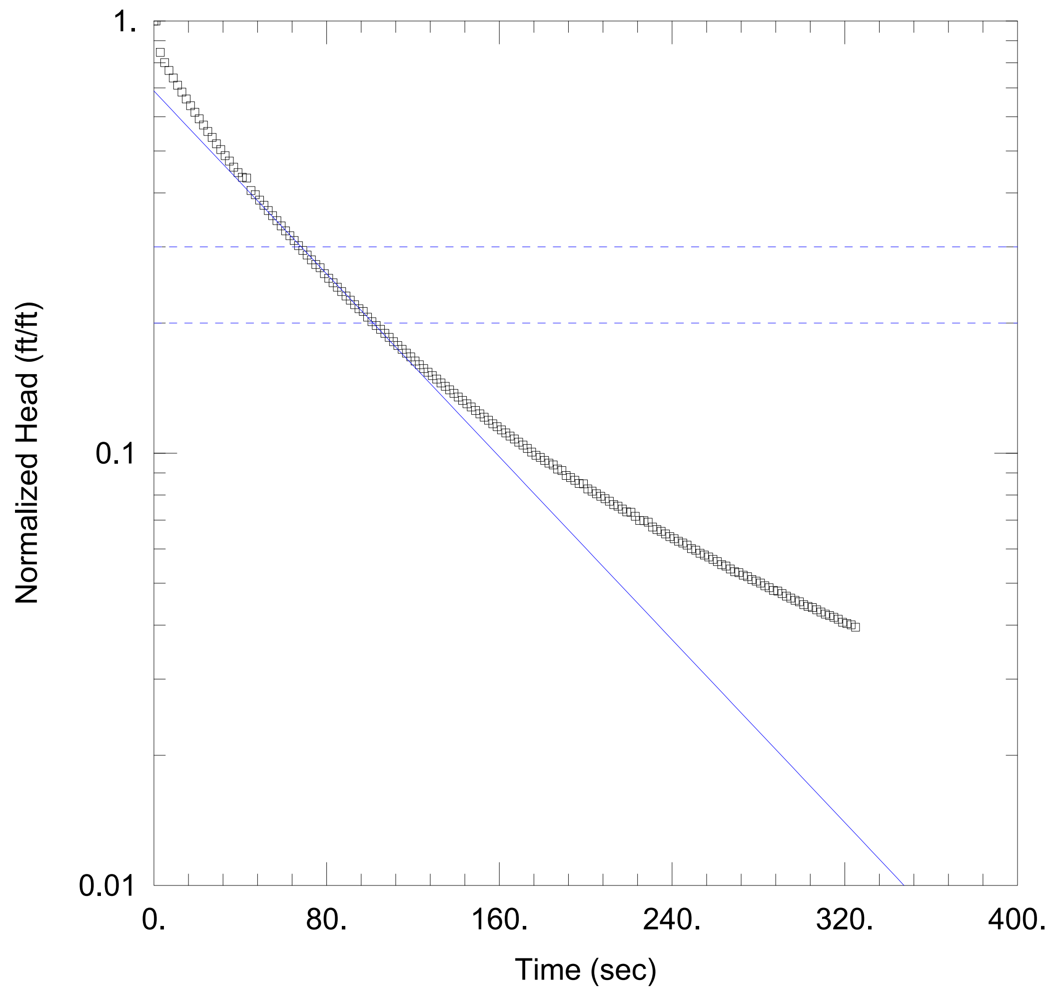
WELL DATA (MW1-39)

Initial Displacement: 1.918 ft
Total Well Penetration Depth: 23.45 ft
Casing Radius: 0.083 ft
Static Water Column Height: 23.45 ft
Screen Length: 5. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 38.29 ft/day
y0 = 1.715 ft




## FALLING - RUN 1

Data Set: C:\...\MW1-43-Falling_1.aqt
Date: 06/08/22 Time: 08:51:45

## PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-43
Test Date: 5/03/22

## AQUIFER DATA

Saturated Thickness: 25.57 ft
Anisotropy Ratio (Kz/Kr): 1.

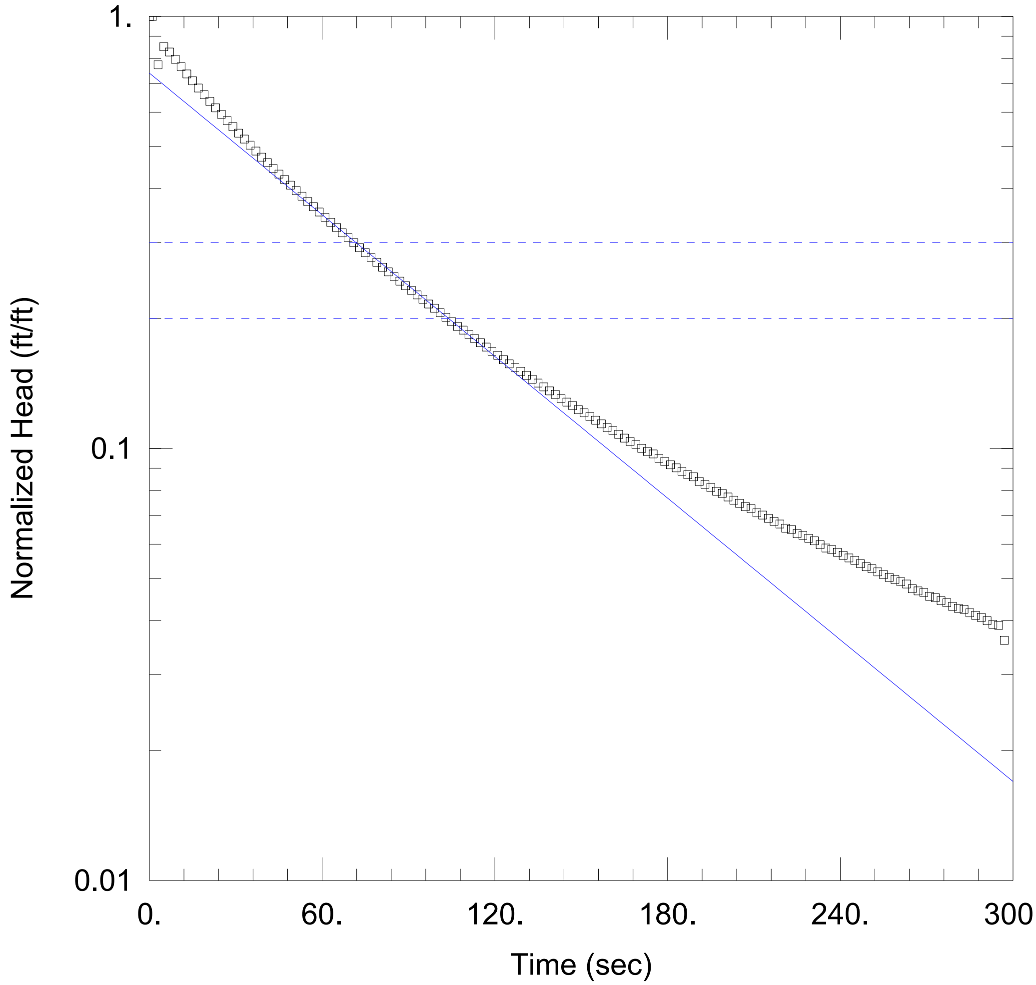
## WELL DATA (MW1-43)

Initial Displacement: 2.541 ft
Static Water Column Height: 20.52 ft
Total Well Penetration Depth: 20.52 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.521 ft/day
y0 = 1.749 ft




FALLING HEAD - RUN 2

Data Set: C:\...\MW1-43-Falling_2.aqt
Date: 06/08/22 Time: 08:53:25

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-43
Test Date: 5/03/22

AQUIFER DATA

Saturated Thickness: 25.57 ft Anisotropy Ratio (Kz/Kr): 1.

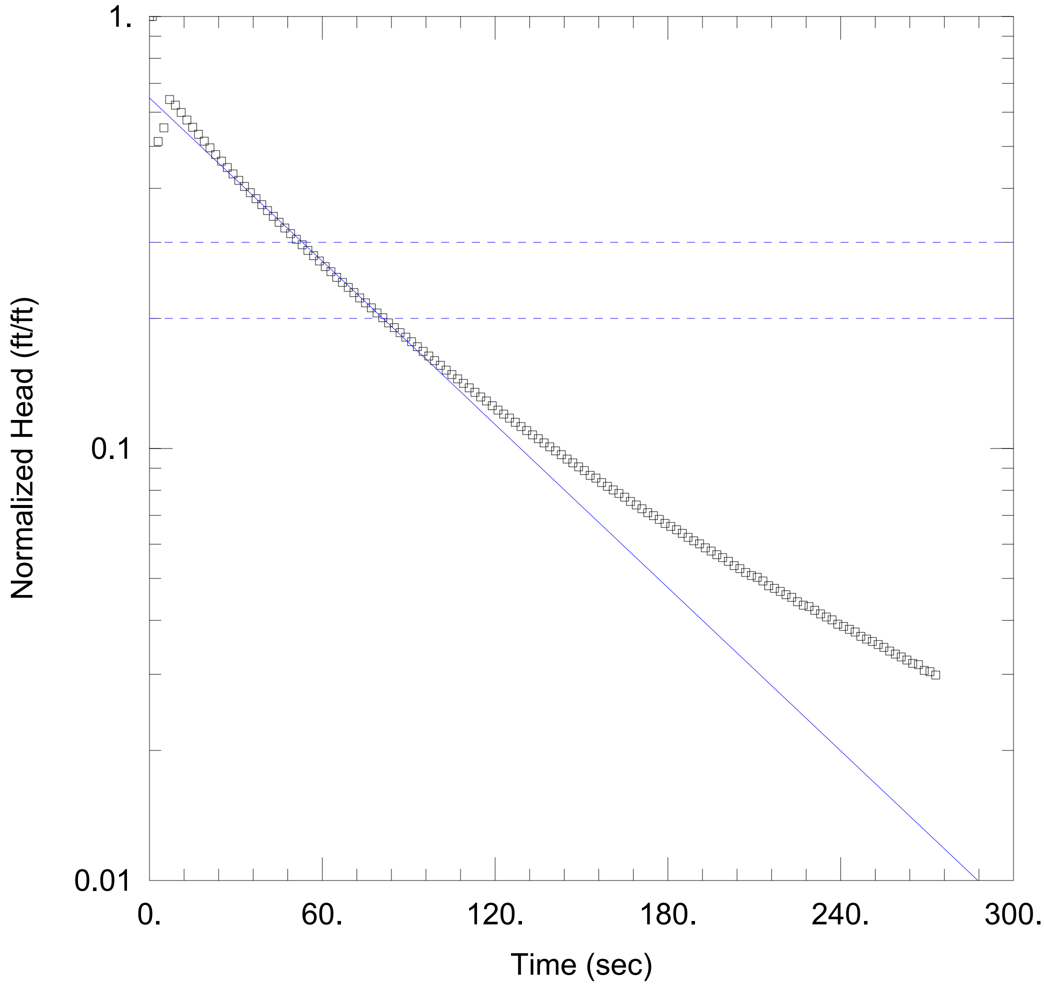
WELL DATA (MW1-43)

Initial Displacement: 2.25 ft
Total Well Penetration Depth: 20.52 ft
Casing Radius: 0.083 ft
Static Water Column Height: 20.52 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 3.639 ft/day y0 = 1.663 ft




FALLING HEAD - RUN 3

Data Set: C:\...\MW1-43-Falling_3.aqt
Date: 06/08/22 Time: 08:55:06

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-43
Test Date: 5/03/22

AQUIFER DATA

Saturated Thickness: 25.57 ft
Anisotropy Ratio (Kz/Kr): 1.

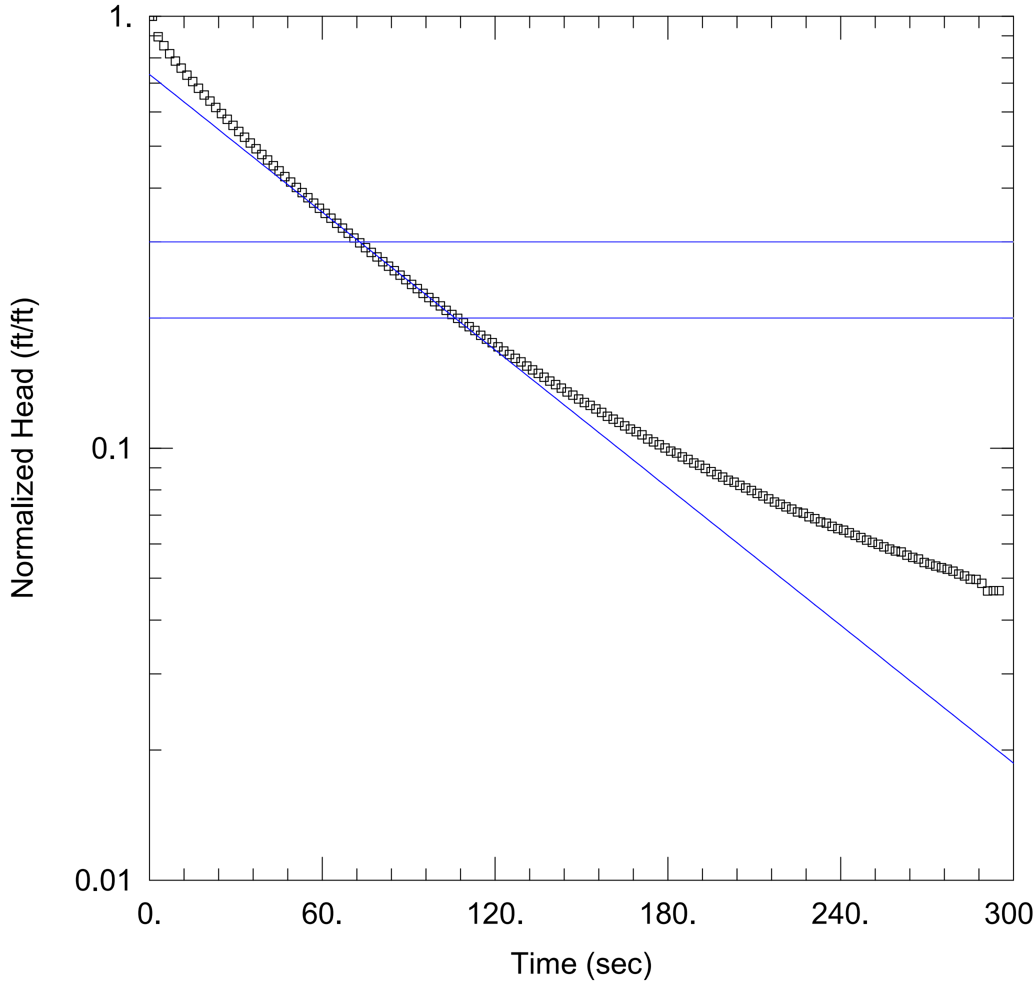
WELL DATA (MW1-43)

Initial Displacement: 2.872 ft
Total Well Penetration Depth: 20.52 ft
Casing Radius: 0.083 ft
Static Water Column Height: 20.52 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 4.192 ft/day
y0 = 1.86 ft




RISING HEAD - RUN 1

Data Set: C:\...\MW1-43-Rising_1.aqt
Date: 10/12/22
Time: 08:51:33

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-43
Test Date: 5/03/22

AQUIFER DATA

Saturated Thickness: 25.57 ft
Anisotropy Ratio (Kz/Kr): 1.

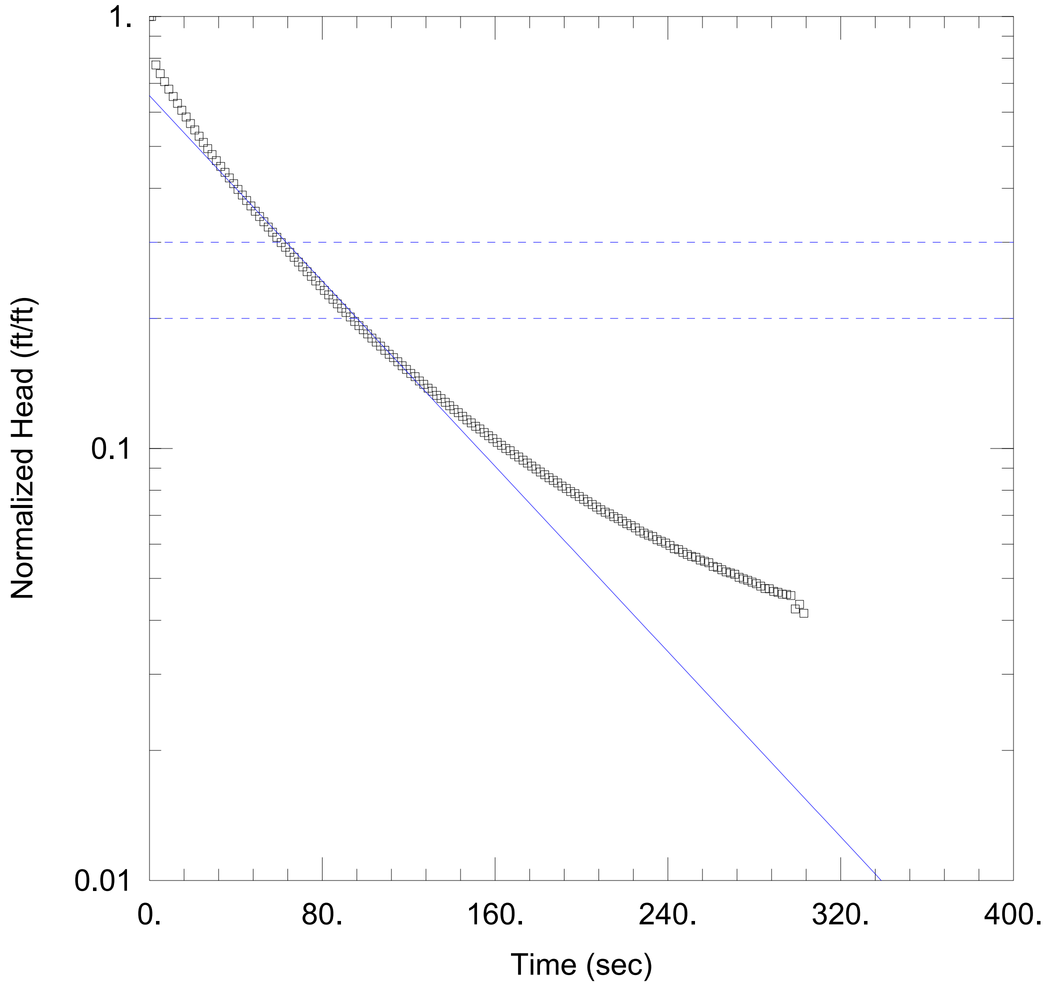
WELL DATA (MW1-43)

Initial Displacement: 2.458 ft
Total Well Penetration Depth: 20.52 ft
Casing Radius: 0.083 ft
Static Water Column Height: 20.52 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.537 ft/day
y0 = 1.801 ft




RISING HEAD - RUN 2

Data Set: C:\...\MW1-43-Rising_2.aqt
Date: 06/08/22 Time: 08:58:27

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-43
Test Date: 5/03/22

AQUIFER DATA

Saturated Thickness: 25.57 ft
Anisotropy Ratio (Kz/Kr): 1.

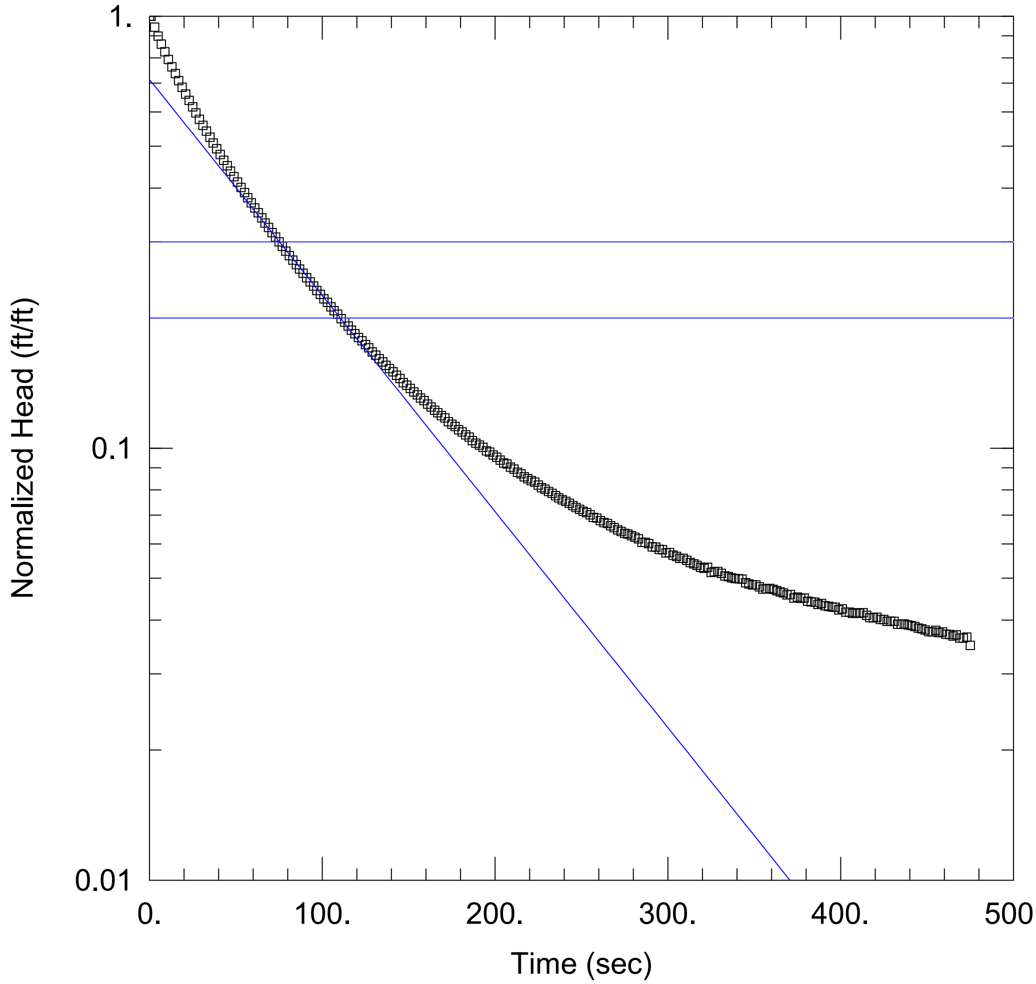
WELL DATA (MW1-42)

Initial Displacement: 2.876 ft
Total Well Penetration Depth: 20.52 ft
Casing Radius: 0.083 ft
Static Water Column Height: 20.52 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.569 ft/day
y0 = 1.884 ft




RISING HEAD - RUN 3

Data Set: C:\...\MW1-43-Rising_3.aqt
Date: 10/12/22 Time: 08:54:45

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-43
Test Date: 5/03/22

AQUIFER DATA

Saturated Thickness: 25.57 ft
Anisotropy Ratio (Kz/Kr): 1.

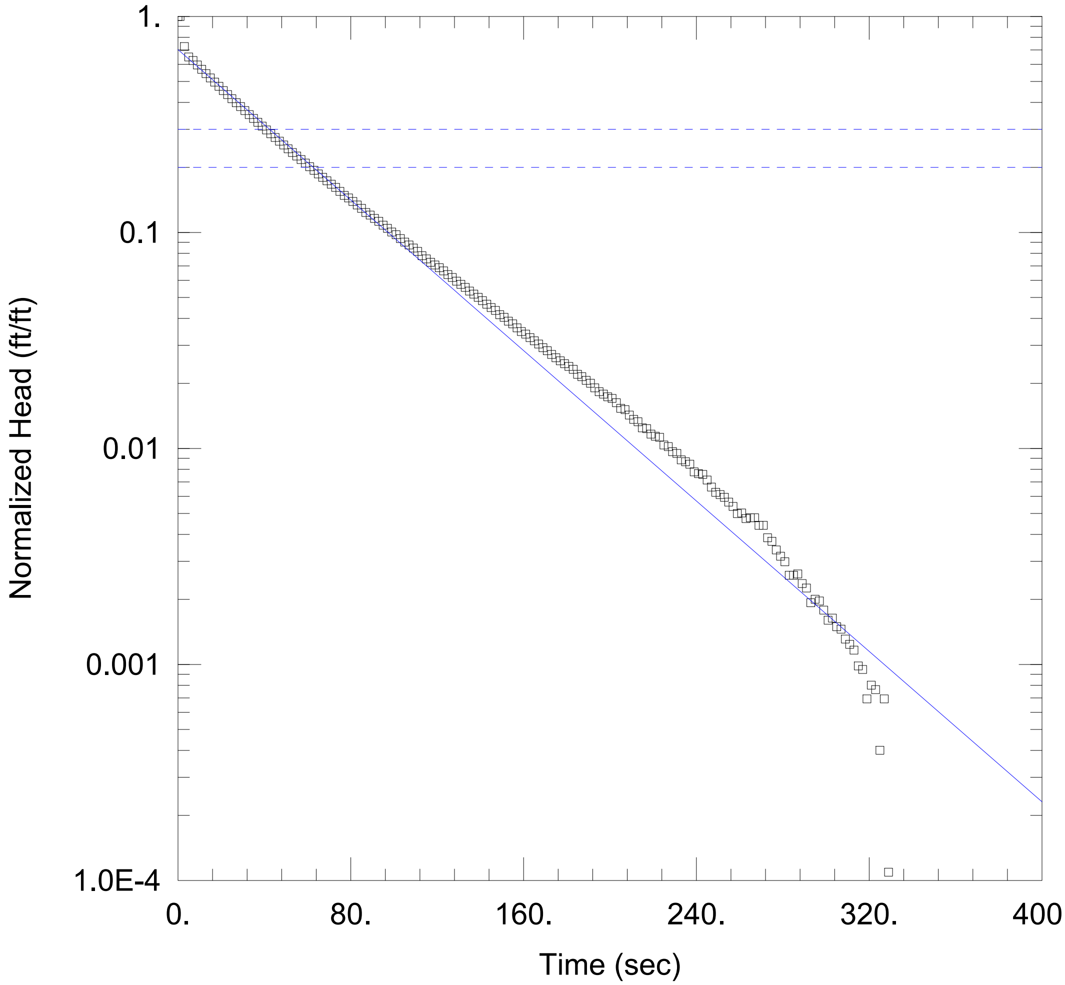
WELL DATA (MW1-43)

Initial Displacement: 2.334 ft
Total Well Penetration Depth: 20.52 ft
Casing Radius: 0.083 ft
Static Water Column Height: 20.52 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.329 ft/day
y0 = 1.665 ft




FALLING HEAD - RUN 1

Data Set: C:\...\MW1-46-Falling_1.aqt
Date: 09/07/22 Time: 12:34:39

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-46
Test Date: 7/15/22

AQUIFER DATA

Saturated Thickness: 40.25 ft
Anisotropy Ratio (Kz/Kr): 1.

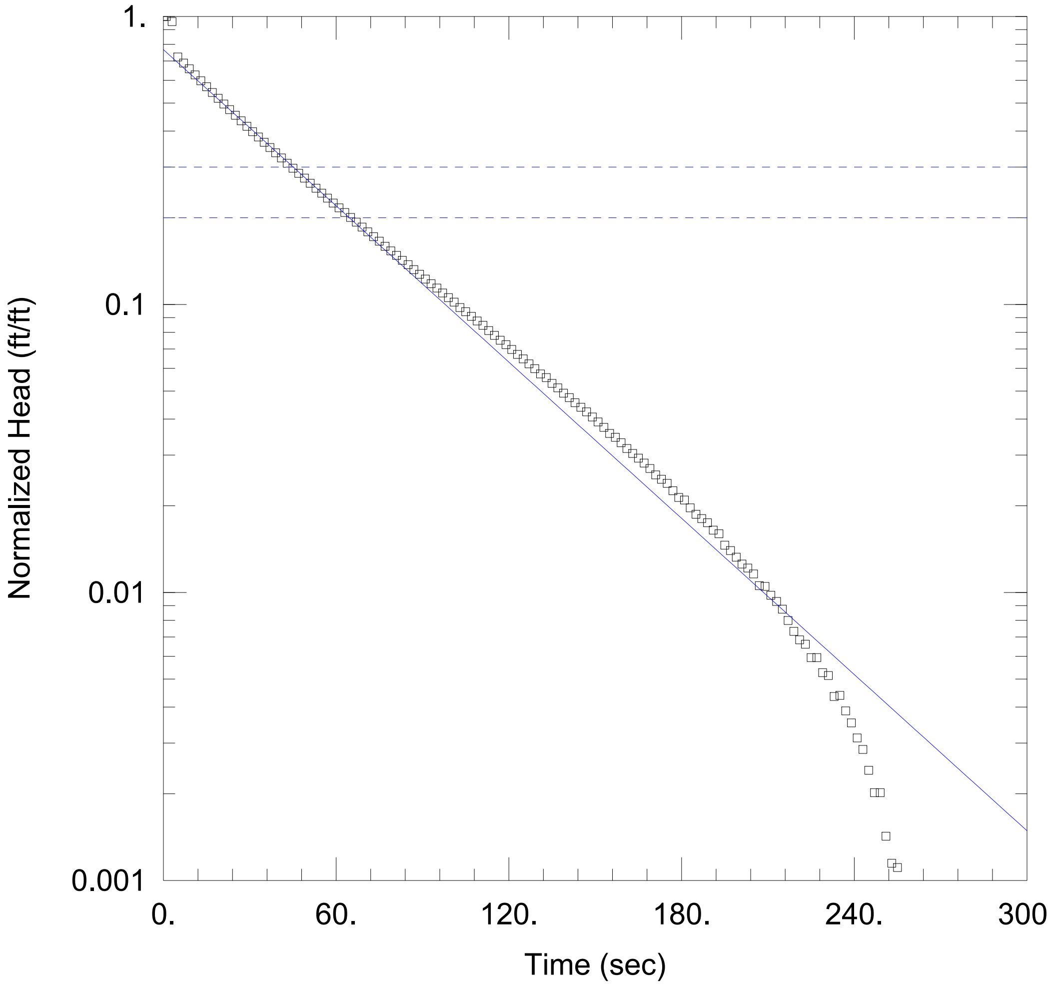
WELL DATA (MW1-46)

Initial Displacement: 2.746 ft
Total Well Penetration Depth: 25.18 ft
Casing Radius: 0.083 ft
Static Water Column Height: 25.18 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 5.776 ft/day
y0 = 1.927 ft




FALLING HEAD - RUN 2

Data Set: C:\...\MW1-46-Falling_2.aqt
Date: 09/07/22 Time: 13:33:53

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-46
Test Date: 7/15/22

AQUIFER DATA

Saturated Thickness: 40.25 ft Anisotropy Ratio (Kz/Kr): 1.

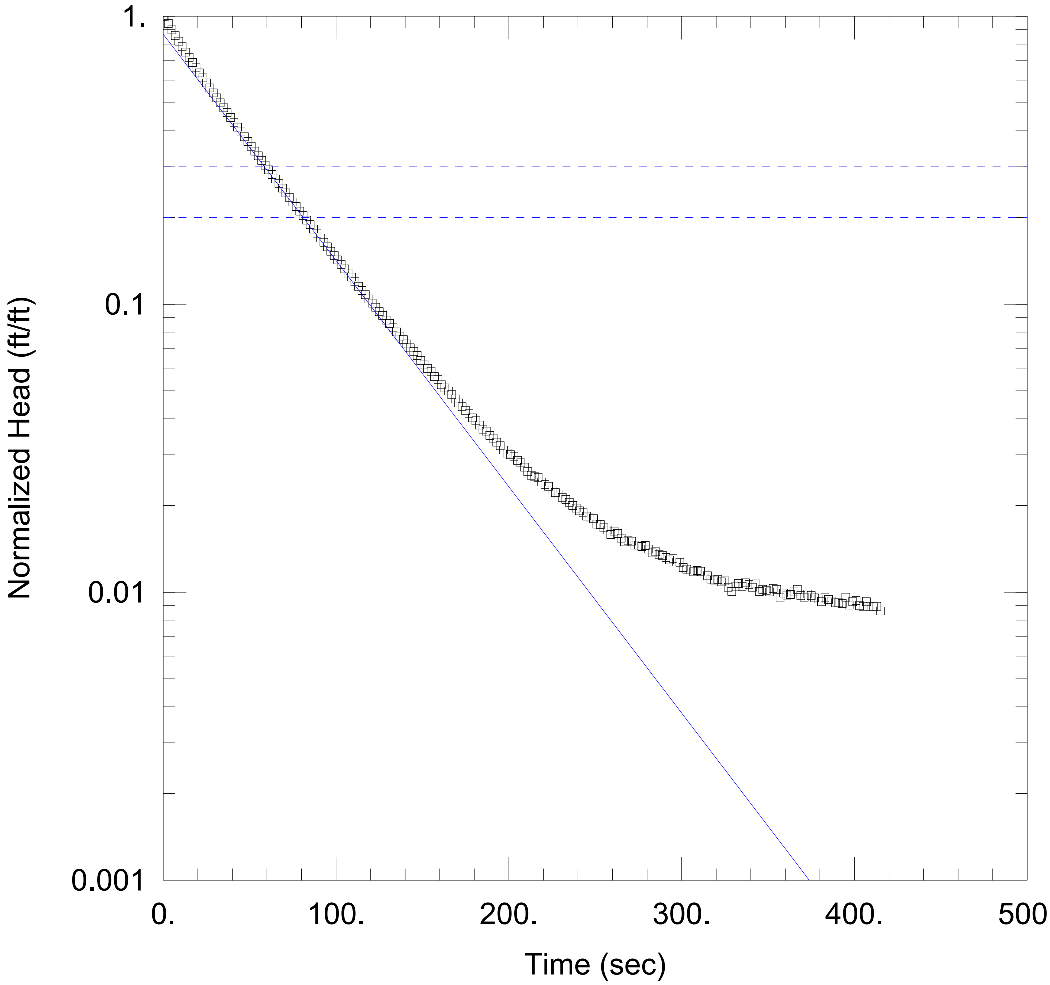
WELL DATA (MW1-46)

Initial Displacement: 2.527 ft
Total Well Penetration Depth: 25.18 ft
Casing Radius: 0.083 ft
Static Water Column Height: 25.18 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 5.999 ft/day y0 = 1.938 ft




RISING HEAD - RUN 1

Data Set:
Date: 09/07/22 Time: 12:25:14

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-46
Test Date: 7/15/22

AQUIFER DATA

Saturated Thickness: 40.25 ft Anisotropy Ratio (Kz/Kr): 1.

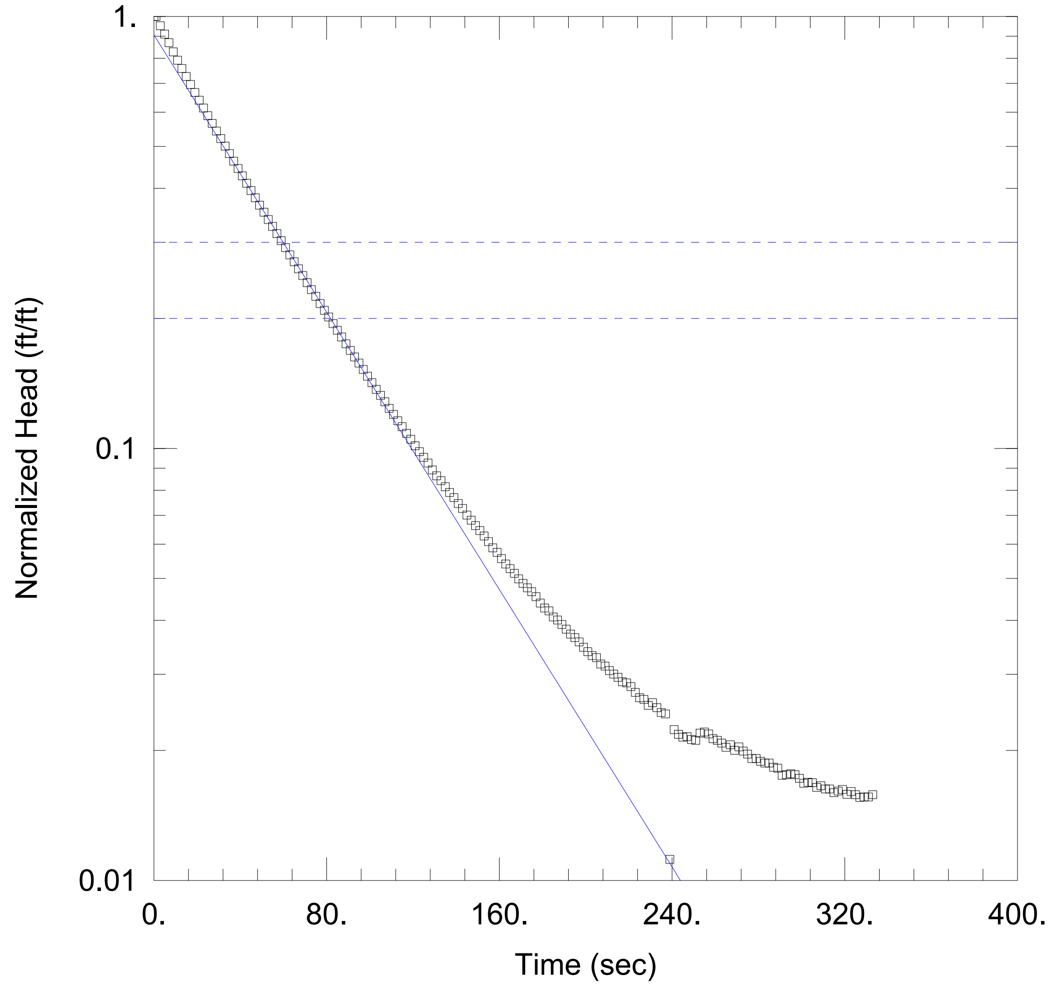
WELL DATA (MW1-46)

Initial Displacement: 2.396 ft
Total Well Penetration Depth: 25.18 ft
Casing Radius: 0.083 ft
Static Water Column Height: 25.18 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 5.213 ft/day y0 = 2.073 ft




RISING HEAD - RUN 2

Data Set: C:\...\MW1-46-Rising_2.aqt
Date: 09/07/22 Time: 14:27:44

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-46
Test Date: 7/15/22

AQUIFER DATA

Saturated Thickness: 40.25 ft Anisotropy Ratio (Kz/Kr): 1.

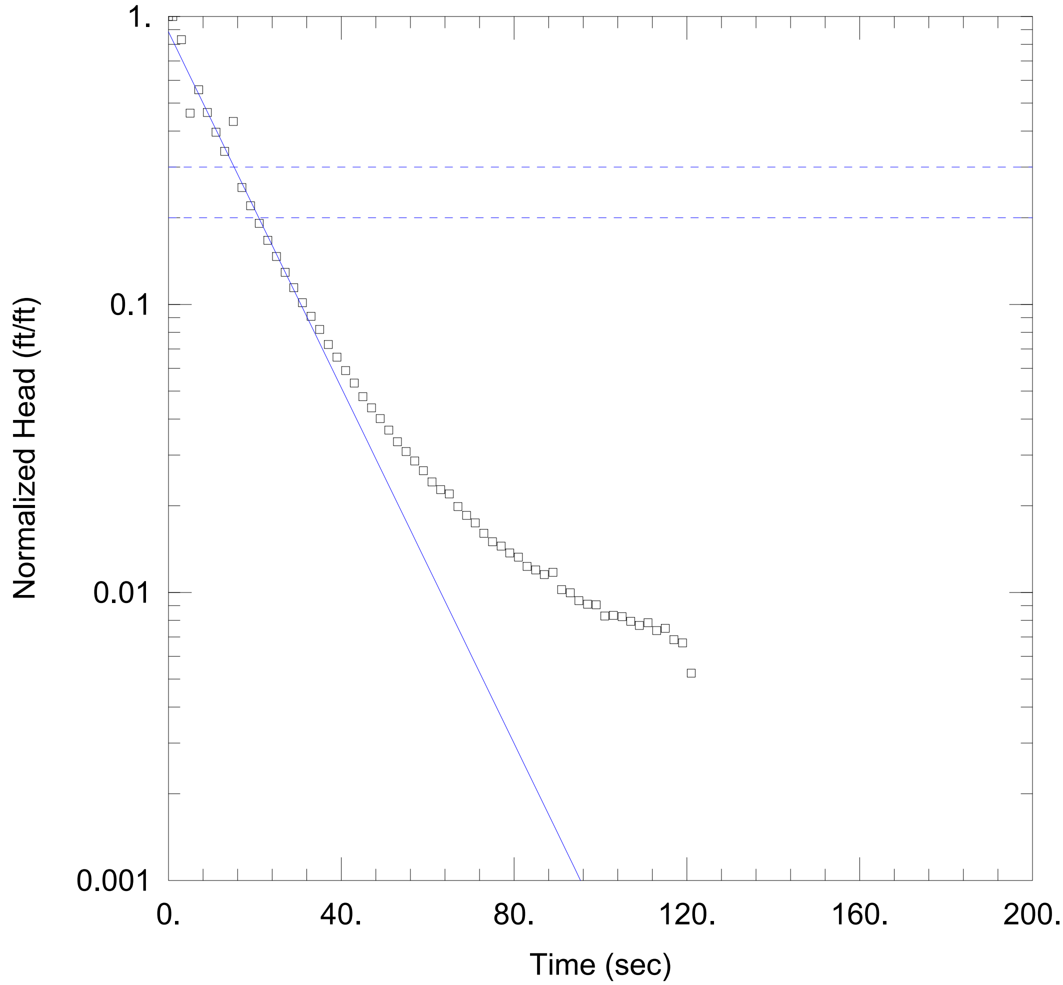
WELL DATA (MW1-46)

Initial Displacement: 2.199 ft
Total Well Penetration Depth: 25.18 ft
Casing Radius: 0.083 ft
Static Water Column Height: 25.18 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 5.325 ft/day y0 = 1.992 ft




FALLING HEAD - RUN 1

Data Set: C:\...\MW1-49-Falling_1.aqt
Date: 09/20/22 Time: 13:58:38

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-49
Test Date: 4/29/22

AQUIFER DATA

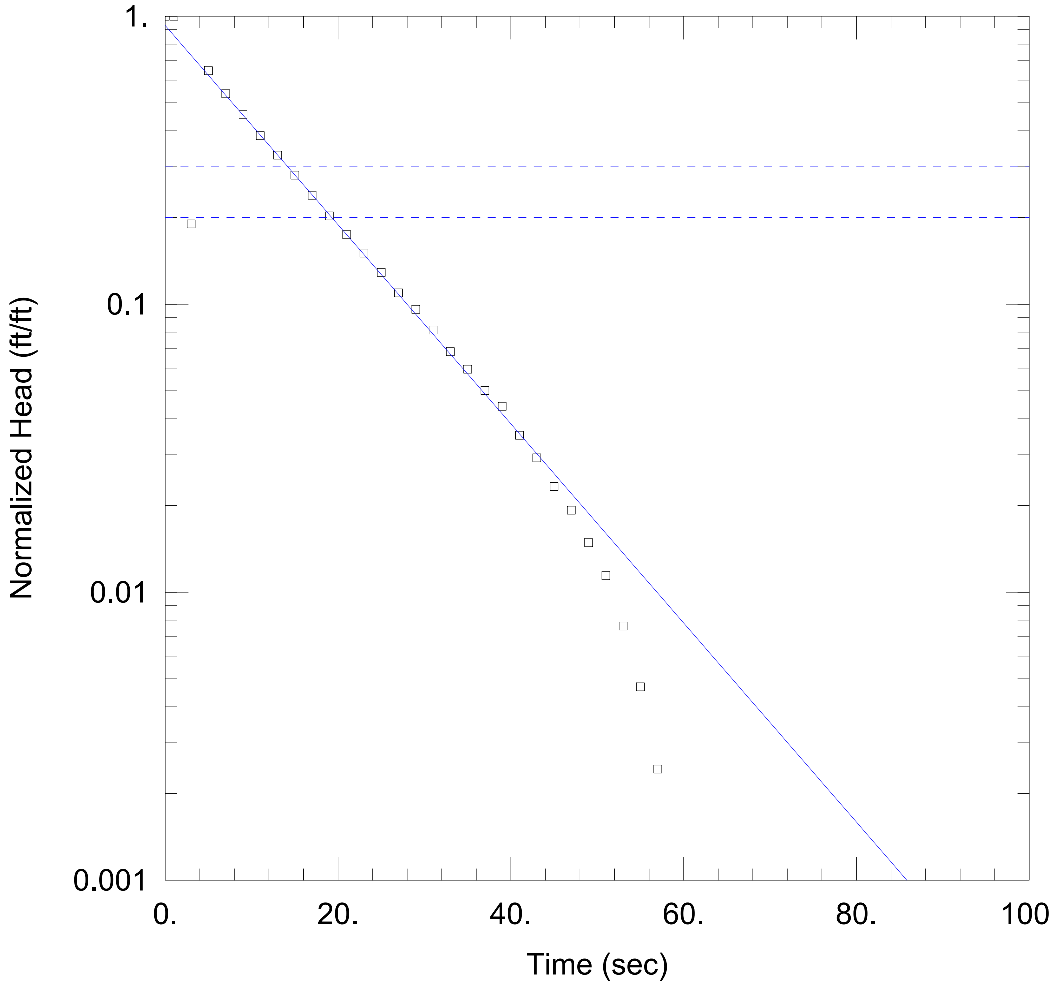
Saturated Thickness: 30.15 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW1-49)

Initial Displacement: 2.307 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.083 ft
Static Water Column Height: 8.98 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 18.88 ft/day
y0 = 2.038 ft




FALLING HEAD - RUN 2

Data Set: C:\...\MW1-49-Falling_2.aqt
Date: 09/20/22
Time: 14:13:19

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-49
Test Date: 4/29/22

AQUIFER DATA

Saturated Thickness: 30.15 ft
Anisotropy Ratio (Kz/Kr): 1.

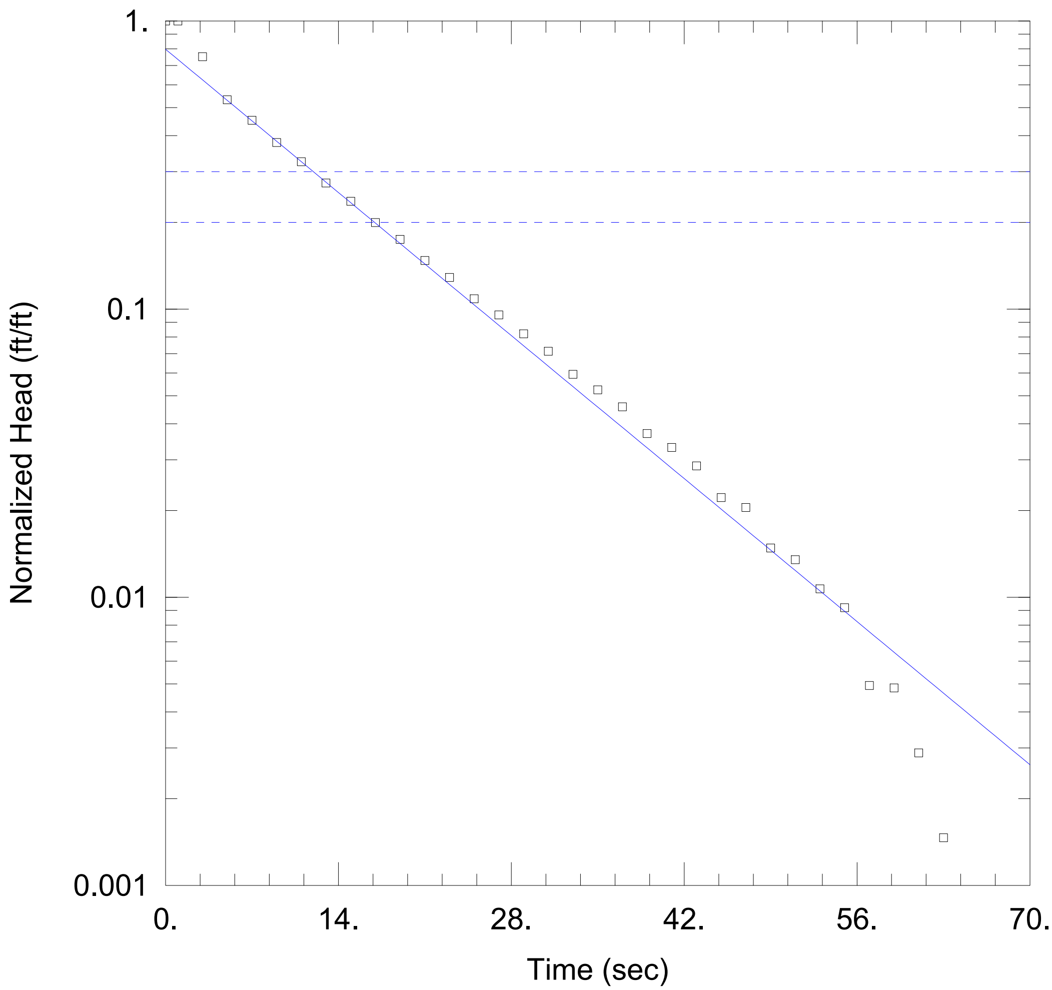
WELL DATA (MW1-49)

Initial Displacement: 1.769 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.083 ft
Static Water Column Height: 8.98 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 21.13 ft/day
y0 = 1.641 ft




FALLING HEAD - RUN 3

Data Set: C:\...\MW1-49-Falling_3.aqt
Date: 09/20/22 Time: 14:15:37

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-49
Test Date: 4/29/22

AQUIFER DATA

Saturated Thickness: 30.15 ft
Anisotropy Ratio (Kz/Kr): 1.

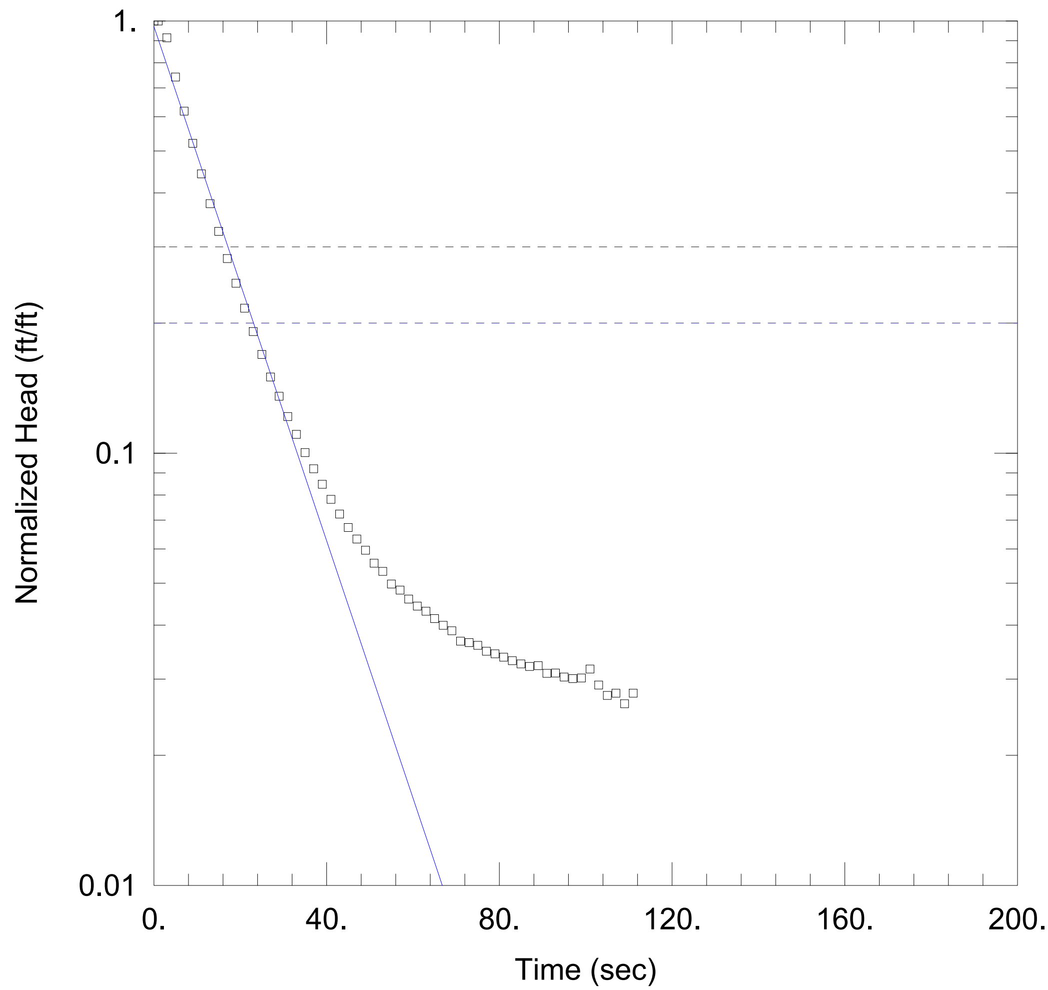
WELL DATA (MW1-49)

Initial Displacement: 2.187 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.083 ft
Static Water Column Height: 8.98 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 21.68 ft/day
y0 = 1.743 ft




RISING HEAD - RUN 1

Data Set: C:\...\MW1-49-Rising_1.aqt
Date: 09/20/22 Time: 14:16:30

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-49
Test Date: 4/29/22

AQUIFER DATA

Saturated Thickness: 30.15 ft Anisotropy Ratio (Kz/Kr): 1.

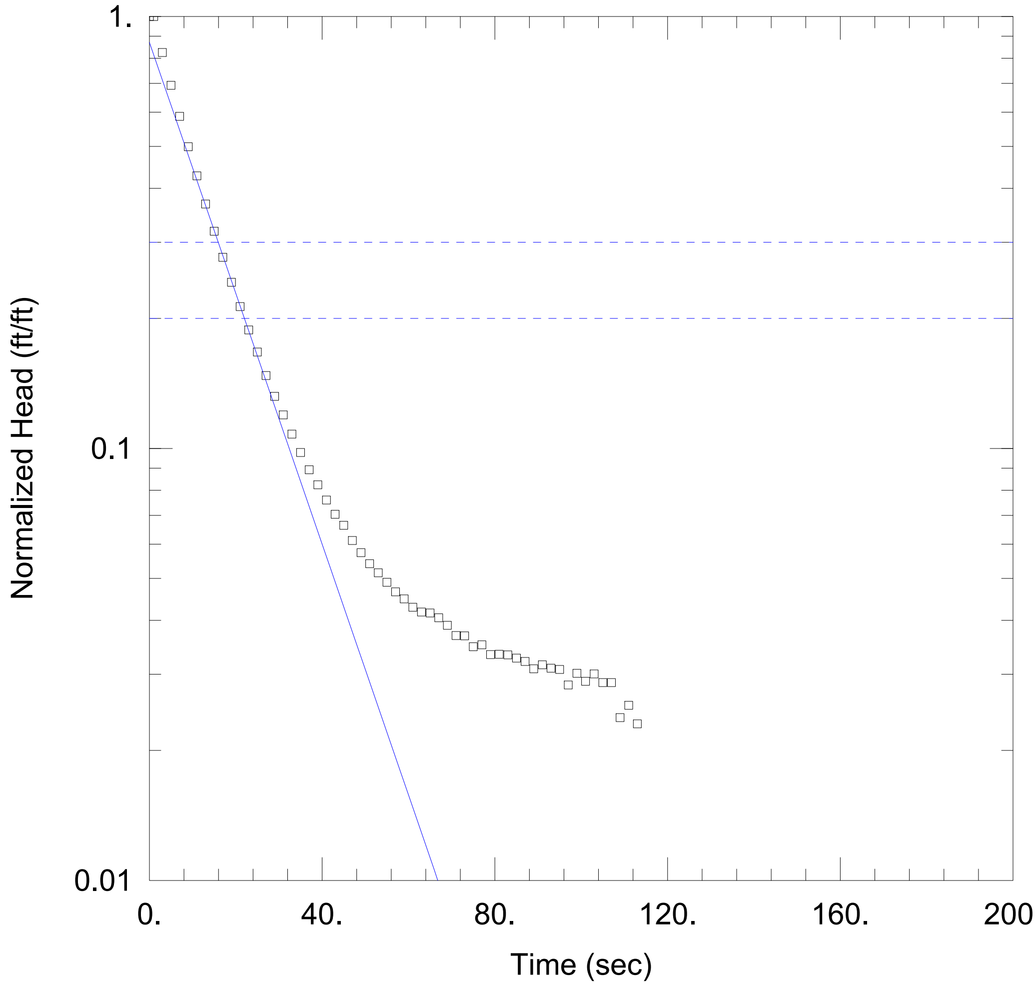
WELL DATA (MW1-49)

Initial Displacement: 2.094 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.083 ft
Static Water Column Height: 8.98 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 18.19 ft/day y0 = 2.033 ft




## RISING HEAD - RUN 2

Data Set: C:\...\MW1-49-Rising_2.aqt
Date: 09/20/22
Time: 14:18:01

## PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-49
Test Date: 4/29/22

## AQUIFER DATA

Saturated Thickness: 30.15 ft
Anisotropy Ratio (Kz/Kr): 1.

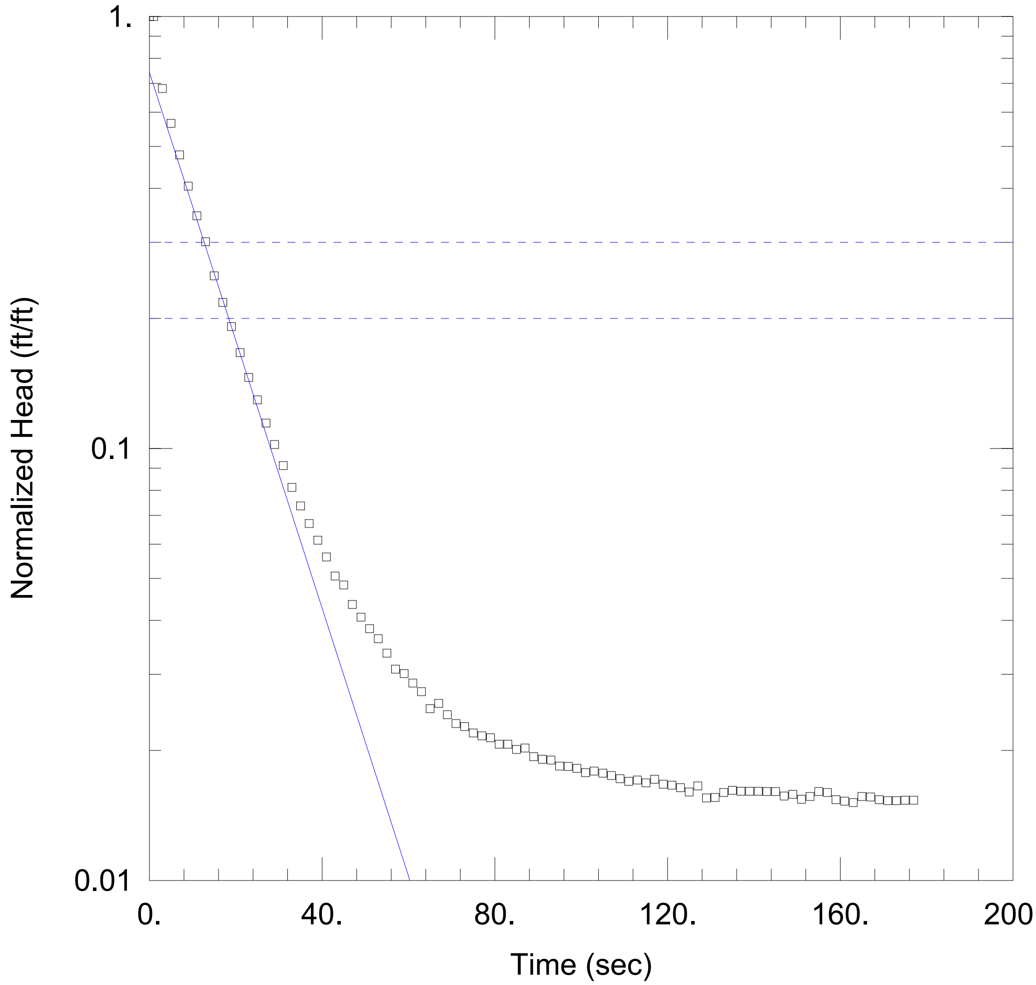
## WELL DATA (MMW1-49)

Initial Displacement: 1.923 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.083 ft
Static Water Column Height: 8.98 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 17.75 ft/day
y0 = 1.674 ft




RISING HEAD - RUN 3

Data Set: C:\...\MW1-49-Rising_3.aqt
Date: 09/20/22 Time: 14:22:03

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-49
Test Date: 4/29/22

AQUIFER DATA

Saturated Thickness: 30.15 ft
Anisotropy Ratio (Kz/Kr): 1.

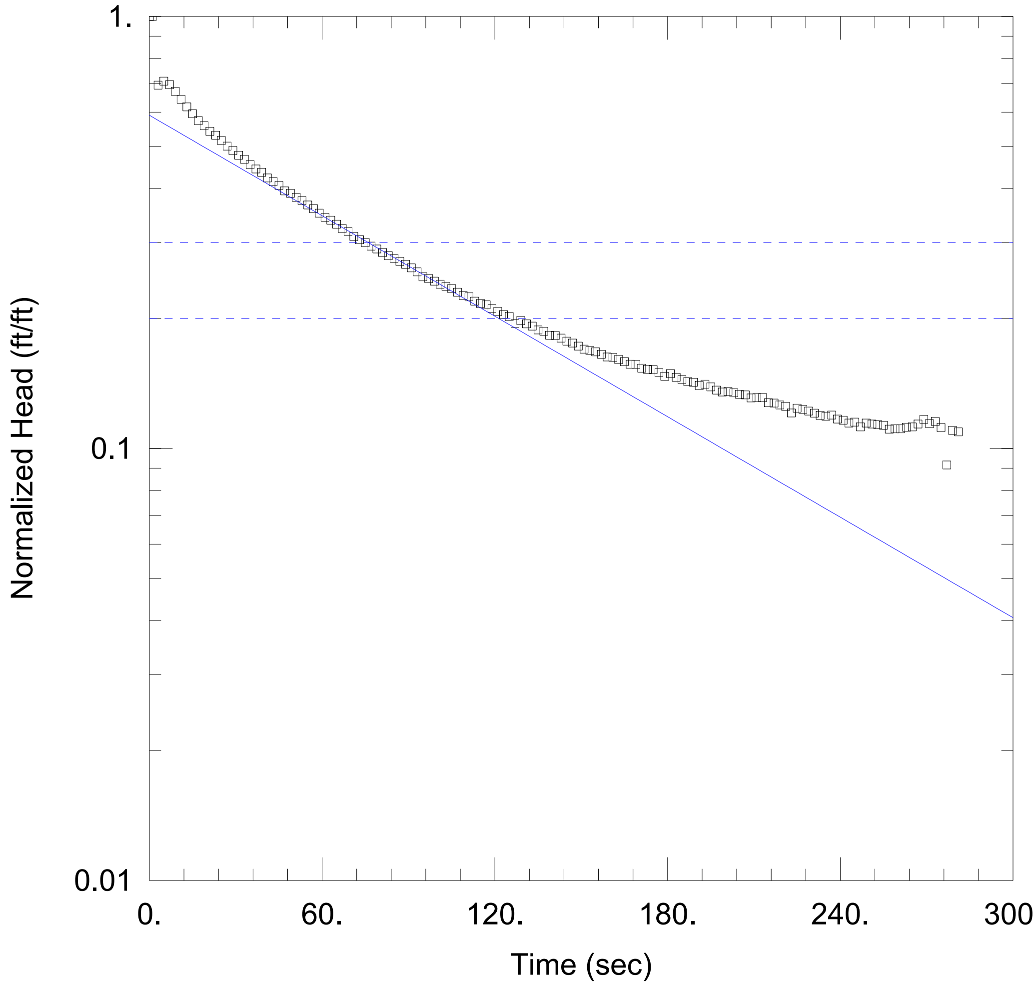
WELL DATA (MW1-49)

Initial Displacement: 2.647 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.083 ft
Static Water Column Height: 8.98 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 18.95 ft/day
y0 = 1.964 ft




FALLING HEAD - RUN 1

Data Set: C:\...\MW1-50-Falling_1_07.15.22.aqt
Date: 09/20/22 Time: 14:42:57

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-50
Test Date: 7/15/22

AQUIFER DATA

Saturated Thickness: 50.46 ft Anisotropy Ratio (Kz/Kr): 1.

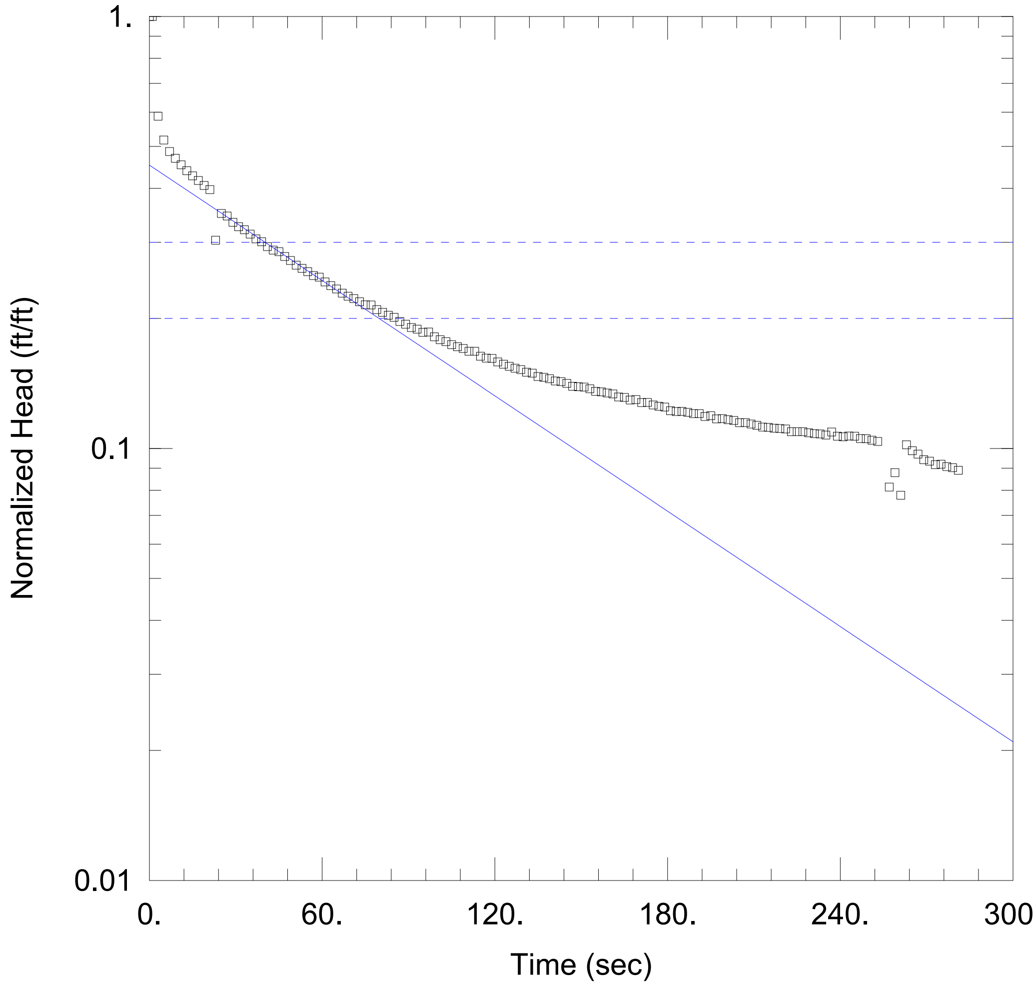
WELL DATA (MW1-50)

Initial Displacement: 0.5189 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.083 ft
Static Water Column Height: 5.46 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 2.312 ft/day y0 = 0.3064 ft




FALLING HEAD - RUN 2

Data Set: C:\...\MW1-50-Falling_2_07.15.22.aqt
Date: 09/20/22 Time: 13:45:26

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-50
Test Date: 7/15/22

AQUIFER DATA

Saturated Thickness: 50.46 ft Anisotropy Ratio (Kz/Kr): 1.

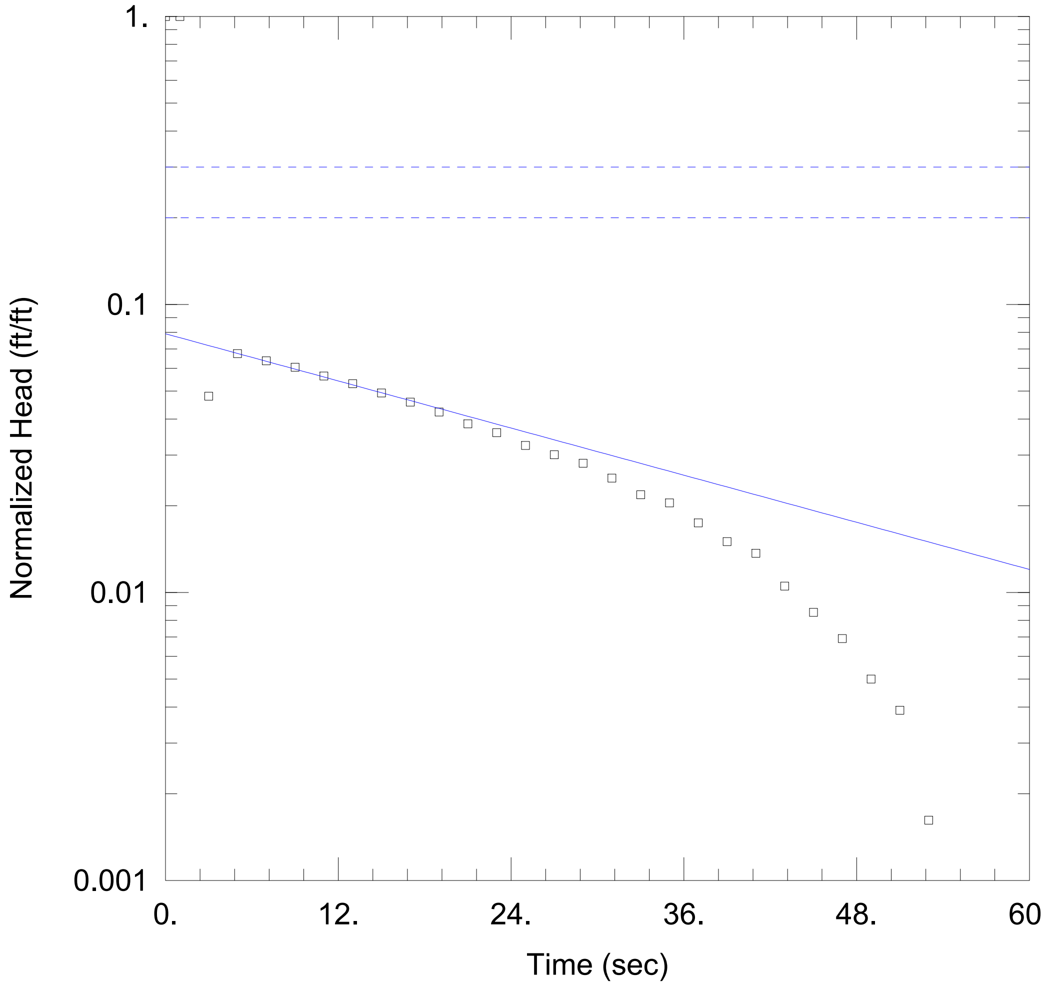
WELL DATA (MW1-50)

Initial Displacement: 0.8537 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.083 ft
Static Water Column Height: 5.46 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 2.654 ft/day y0 = 0.3865 ft




RISING HEAD - RUN 1

Data Set: C:\...\MW1-50-Rising_1_07.15.22.aqt
Date: 11/03/22 Time: 09:31:16

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-50
Test Date: 7/15/22

AQUIFER DATA

Saturated Thickness: 50.46 ft Anisotropy Ratio (Kz/Kr): 1.

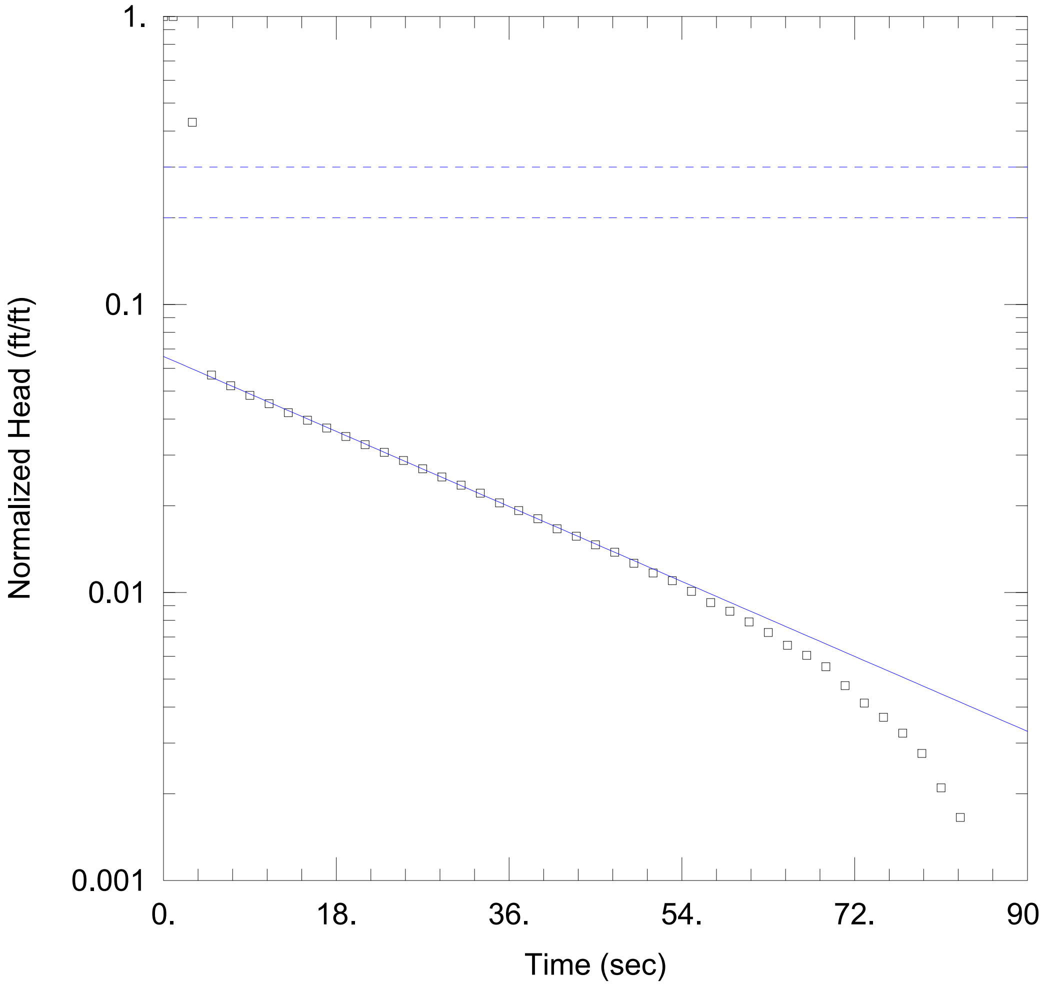
WELL DATA (MW1-50)

Initial Displacement: 1.36 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.083 ft
Static Water Column Height: 5.46 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 8.135 ft/day y0 = 0.1075 ft




## RISING HEAD - RUN 2

Data Set: C:\...\MW1-50-Rising_2_07.15.22.aqt
Date: 09/20/22 Time: 14:44:56

## PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-50
Test Date: 7/15/22

## AQUIFER DATA

Saturated Thickness: 50.46 ft
Anisotropy Ratio (Kz/Kr): 1.

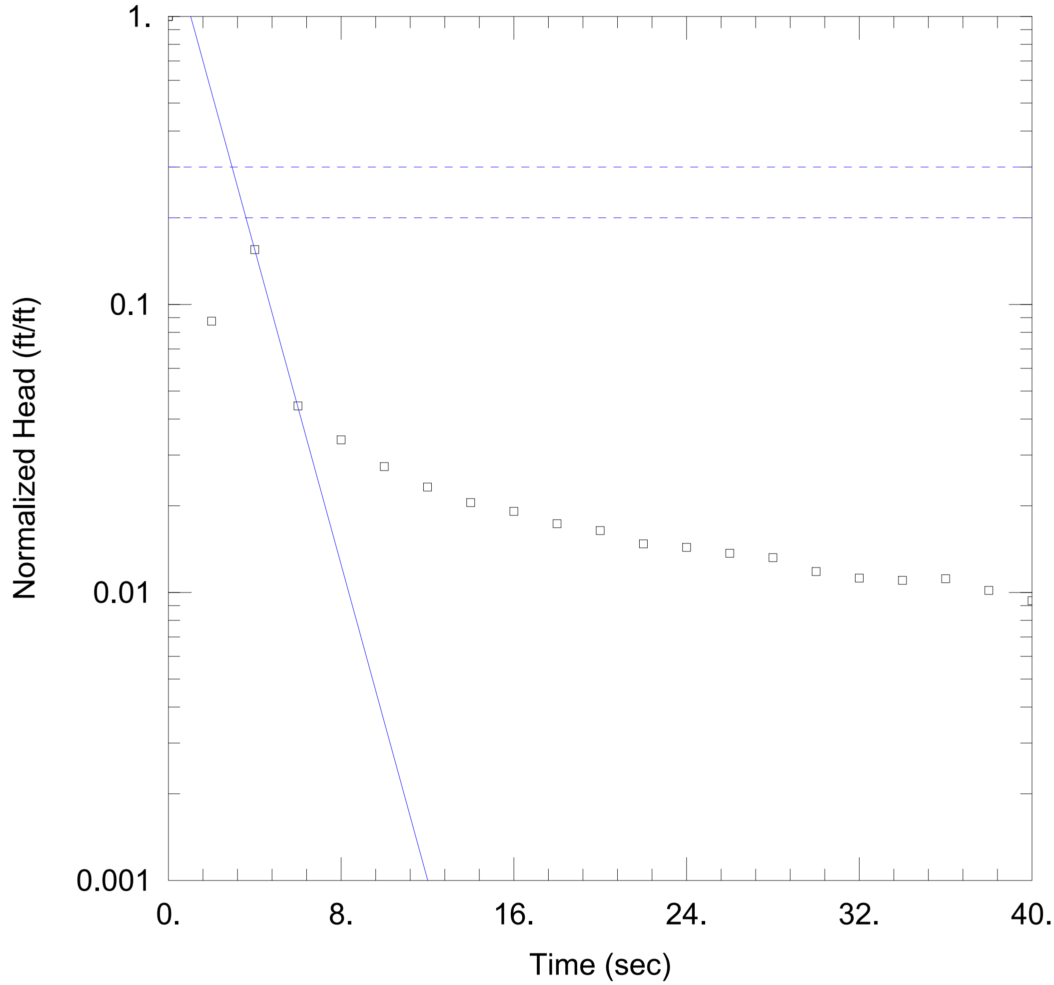
## WELL DATA (MW1-50)

Initial Displacement: 4.531 ft
Static Water Column Height: 5.46 ft
Total Well Penetration Depth: 15. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.25 ft

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.521 ft/day
y0 = 0.299 ft




FALLING HEAD - RUN 1

Data Set: C:\...\MW1-62-Falling_1.aqt
Date: 10/31/22
Time: 09:05:22

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-62
Test Date: 5/04/22

AQUIFER DATA

Saturated Thickness: 32.91 ft
Anisotropy Ratio (Kz/Kr): 1.

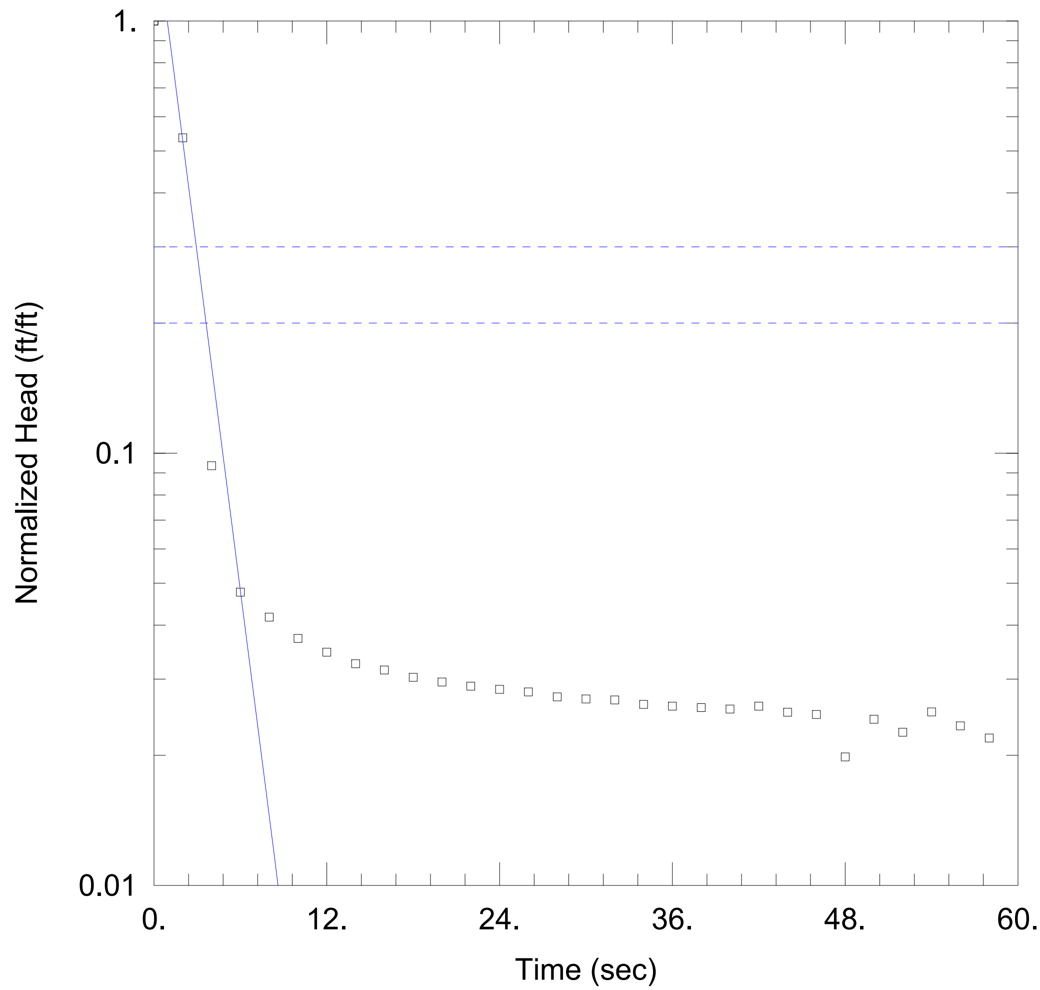
WELL DATA (MW1-62)

Initial Displacement: 1.507 ft
Total Well Penetration Depth: 32.91 ft
Casing Radius: 0.083 ft
Static Water Column Height: 32.91 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 226.6 ft/day
y0 = 2.888 ft




FALLING HEAD - RUN 2

Data Set: C:\...\MW1-62-Falling_2.aqt
Date: 10/31/22 Time: 13:00:28

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-62
Test Date: 5/04/22

AQUIFER DATA

Saturated Thickness: 32.91 ft Anisotropy Ratio (Kz/Kr): 1.

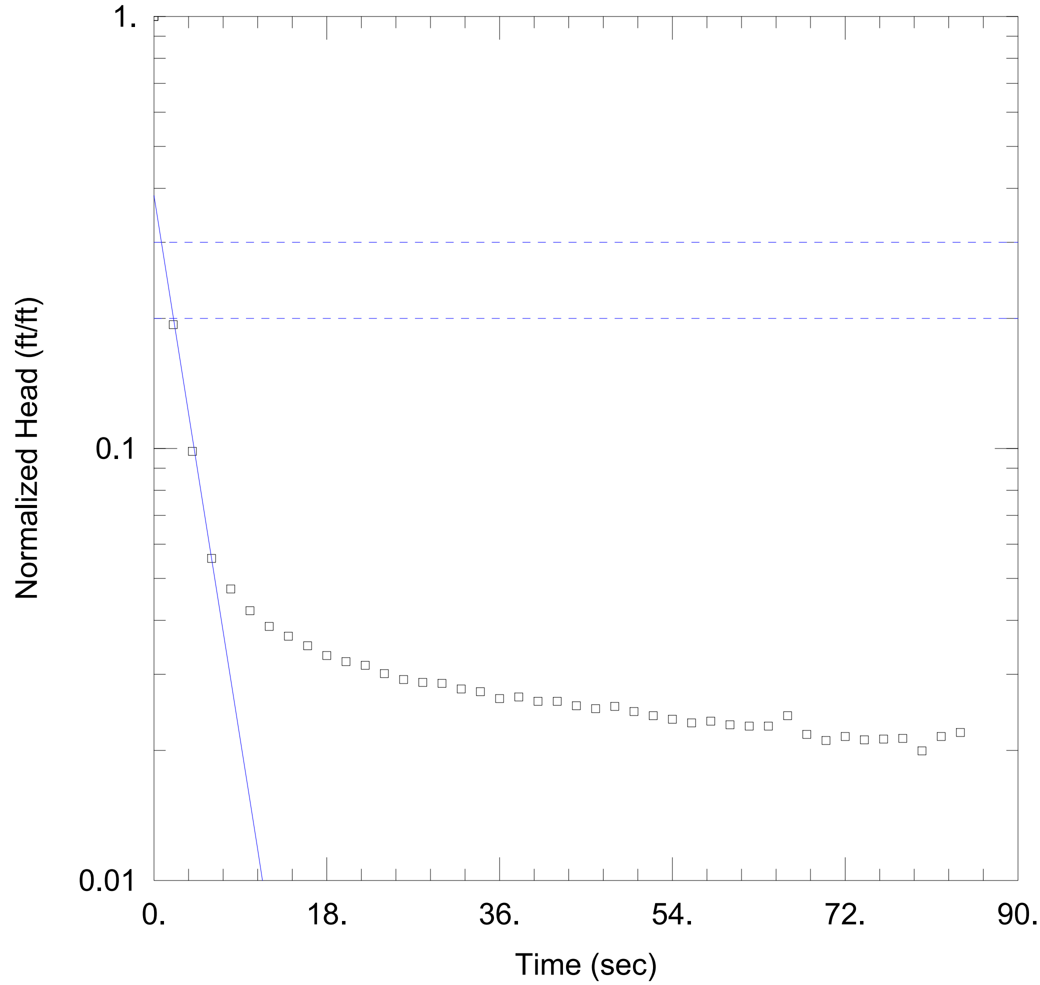
WELL DATA (MW1-62)

Initial Displacement: 2.048 ft
Total Well Penetration Depth: 32.91 ft
Casing Radius: 0.083 ft
Static Water Column Height: 32.91 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 215.6 ft/day y0 = 3.572 ft




FALLING HEAD - RUN 3

Data Set: C:\...\MW1-62-Falling_3.aqt
Date: 10/31/22 Time: 13:03:46

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-62
Test Date: 5/04/22

AQUIFER DATA

Saturated Thickness: 32.91 ft
Anisotropy Ratio (Kz/Kr): 1.

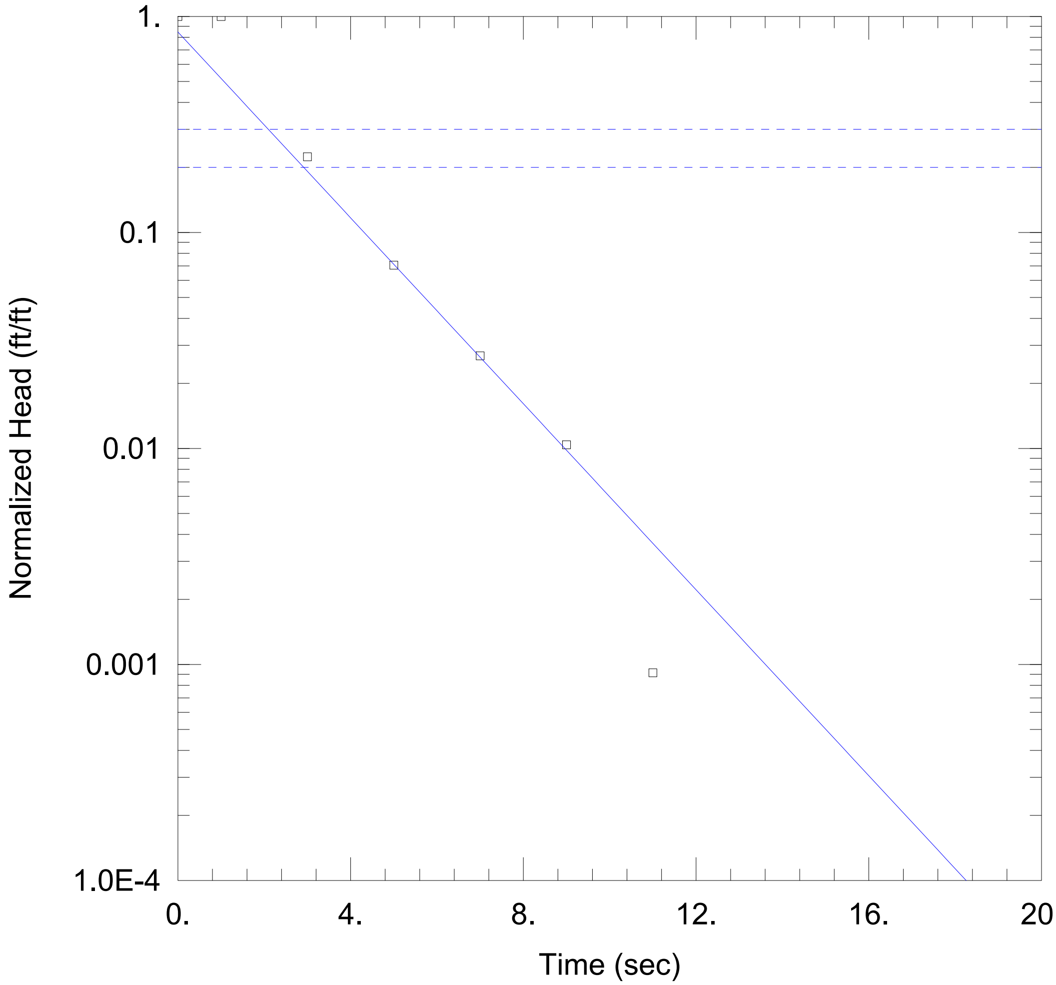
WELL DATA (MW1-62)

Initial Displacement: 1.309 ft
Total Well Penetration Depth: 32.91 ft
Casing Radius: 0.083 ft
Static Water Column Height: 32.91 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 116.2 ft/day
y0 = 0.504 ft




## RISING HEAD - RUN 1

Data Set: C:\...\MW1-62-Rising_1.aqt
Date: 10/31/22 Time: 13:07:04

## PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-62
Test Date: 5/04/22

## AQUIFER DATA

Saturated Thickness: 32.91 ft
Anisotropy Ratio (Kz/Kr): 1.

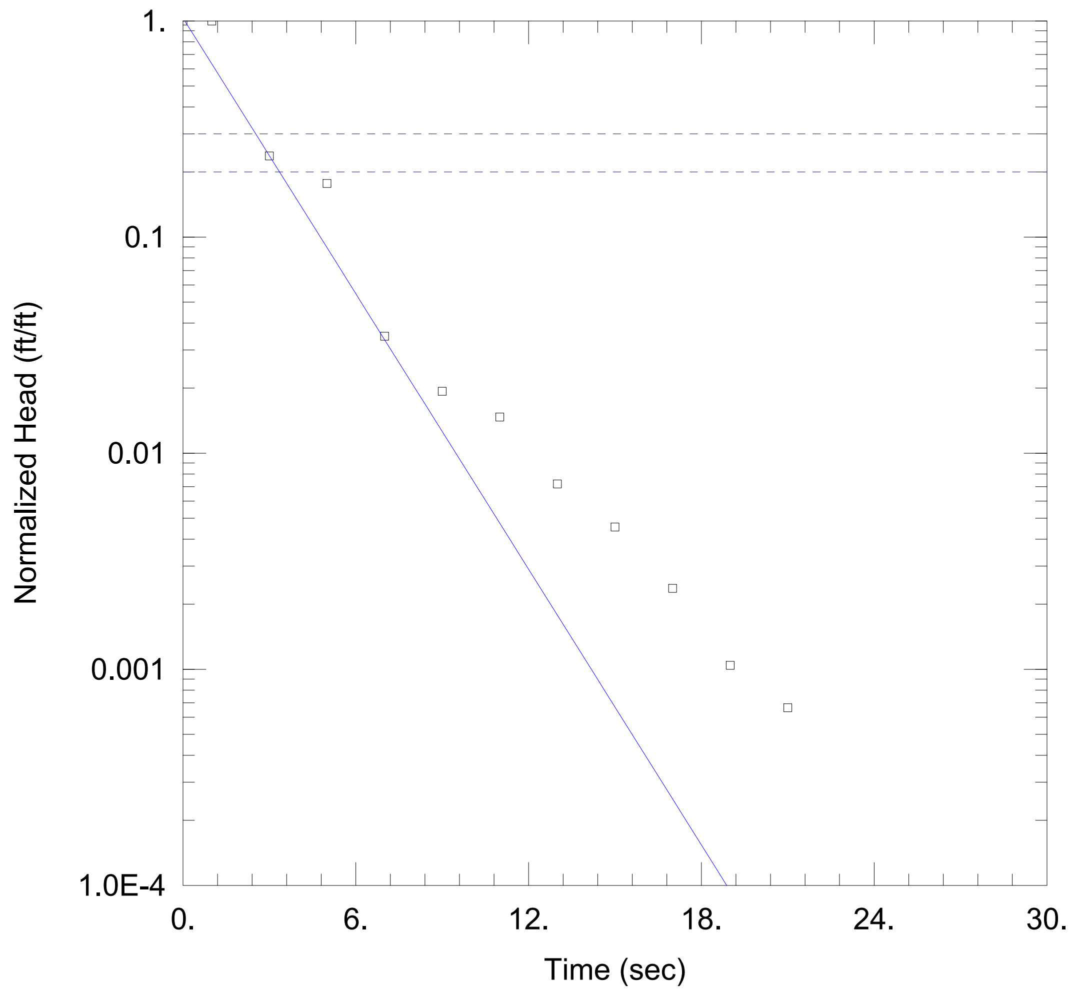
## WELL DATA (MW1-62)

Initial Displacement: 0.8755 ft
Total Well Penetration Depth: 32.91 ft
Casing Radius: 0.083 ft
Static Water Column Height: 32.91 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 178.4 ft/day
y0 = 0.7415 ft




RISING HEAD - RUN 2

Data Set: C:\...\MW1-62-Rising_2.aqt
Date: 10/31/22 Time: 13:11:03

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-62
Test Date: 5/04/22

AQUIFER DATA

Saturated Thickness: 32.91 ft
Anisotropy Ratio (Kz/Kr): 1.

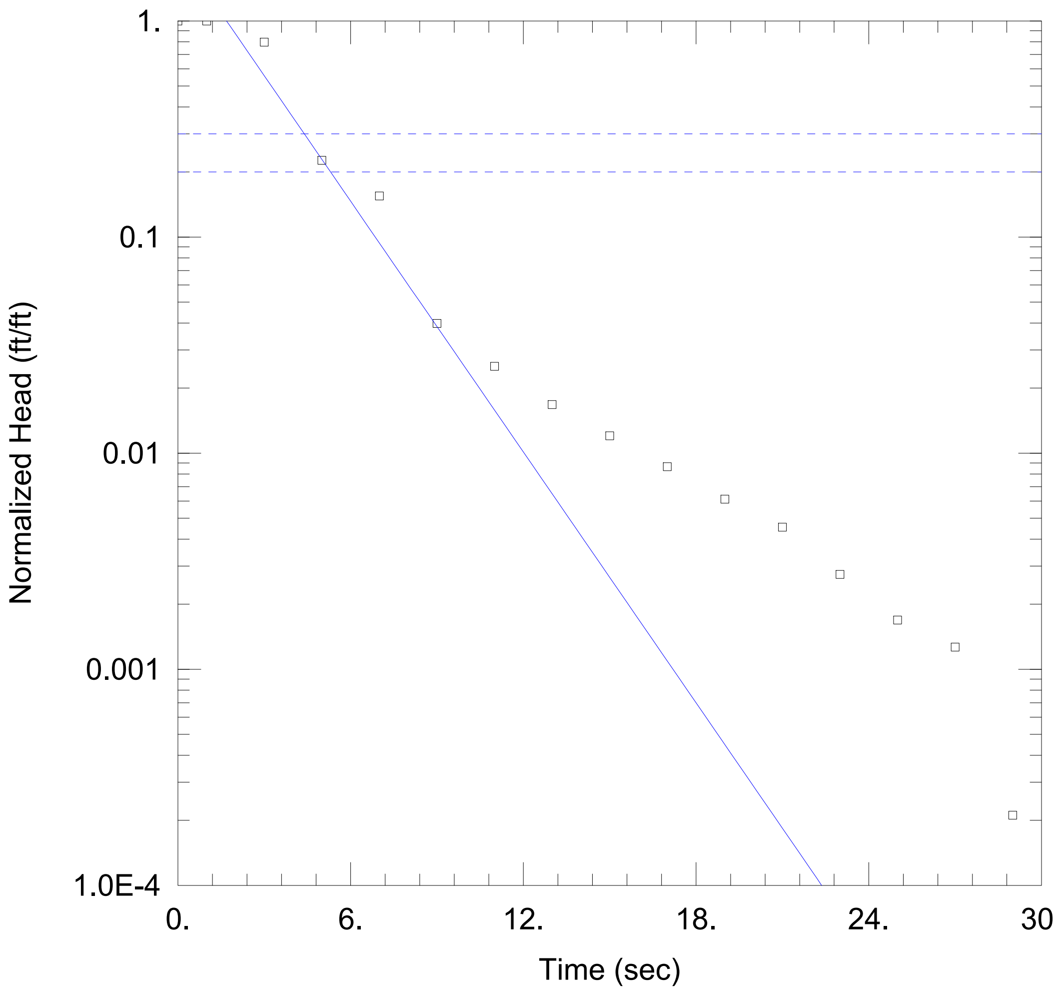
WELL DATA (MW1-62)

Initial Displacement: 1.055 ft
Total Well Penetration Depth: 32.91 ft
Casing Radius: 0.083 ft
Static Water Column Height: 32.91 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 176.3 ft/day
y0 = 1.09 ft




RISING HEAD - RUN 3

Data Set: C:\...\MW1-62-Rising_3.aqt
Date: 10/31/22 Time: 13:13:56

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-62
Test Date: 5/04/22

AQUIFER DATA

Saturated Thickness: 32.91 ft
Anisotropy Ratio (Kz/Kr): 1.

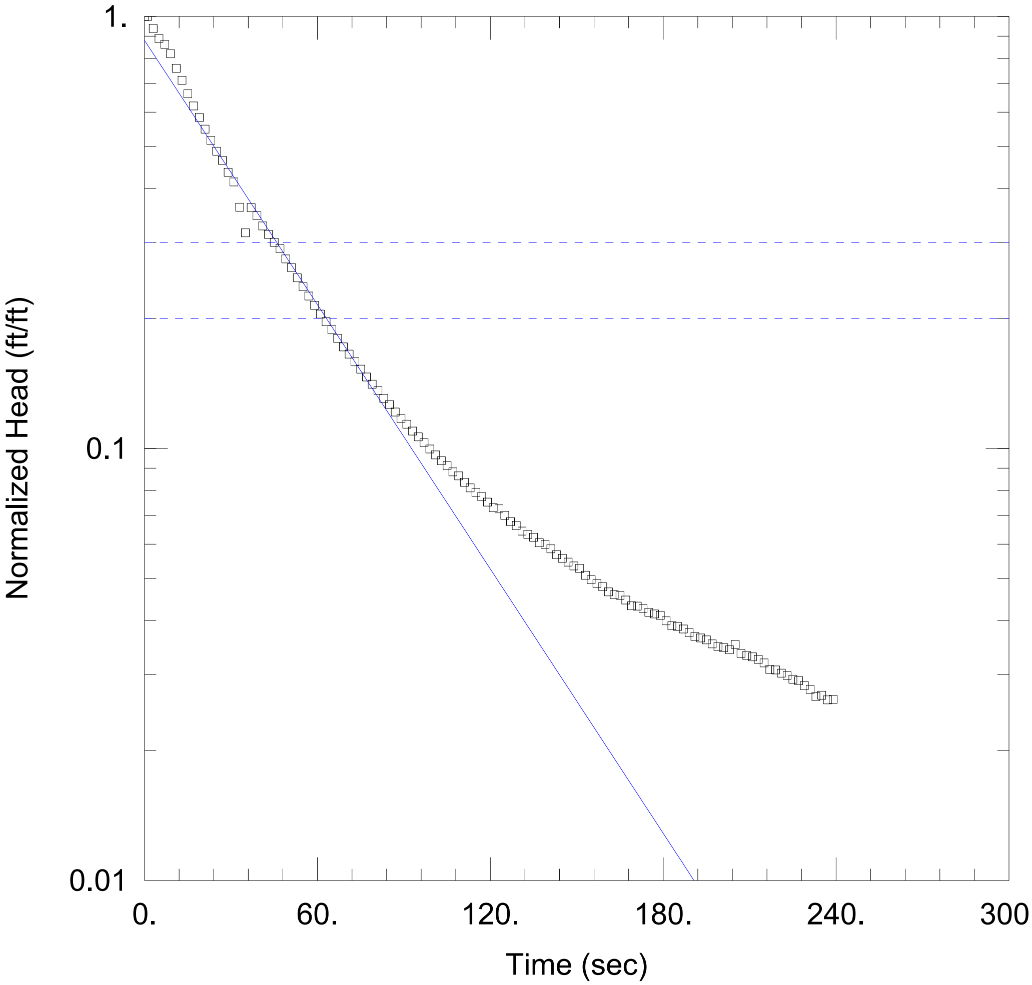
WELL DATA (MW1-62)

Initial Displacement: 0.9469 ft
Total Well Penetration Depth: 32.91 ft
Casing Radius: 0.083 ft
Static Water Column Height: 32.91 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 160.4 ft/day
y0 = 2.011 ft




FALLING HEAD - RUN 1

Data Set: C:\...\MW1-66-Falling_1.aqt
Date: 09/20/22 Time: 14:26:33

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-66
Test Date: 4/29/22

AQUIFER DATA

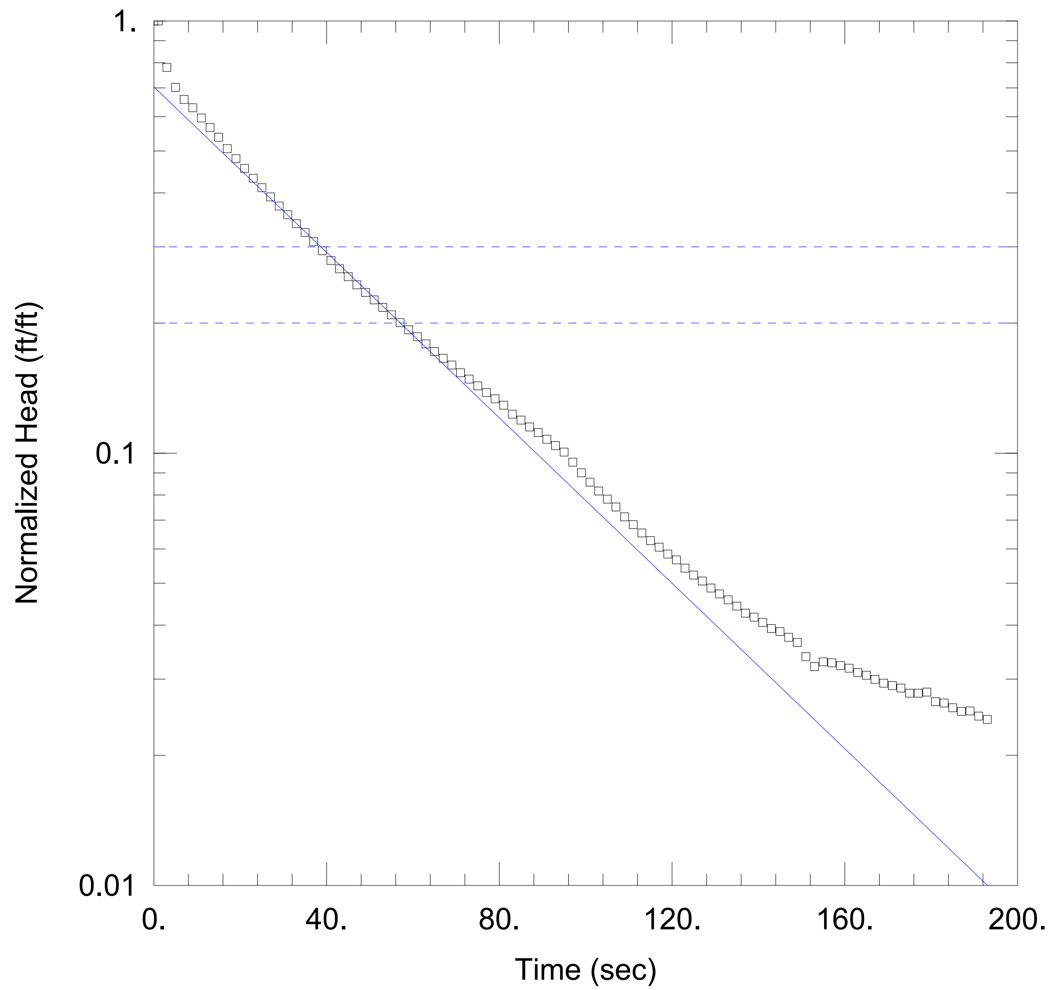
Saturated Thickness: 35.16 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW1-66)

Initial Displacement: 1.349 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.083 ft
Static Water Column Height: 20.21 ft
Screen Length: 15. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 4.631 ft/day
y0 = 1.187 ft




FALLING HEAD - RUN 2

Data Set: C:\...\MW1-66-Falling_2.aqt
Date: 09/20/22
Time: 14:28:09

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-66
Test Date: 4/29/22

AQUIFER DATA

Saturated Thickness: 35.16 ft
Anisotropy Ratio (Kz/Kr): 1.

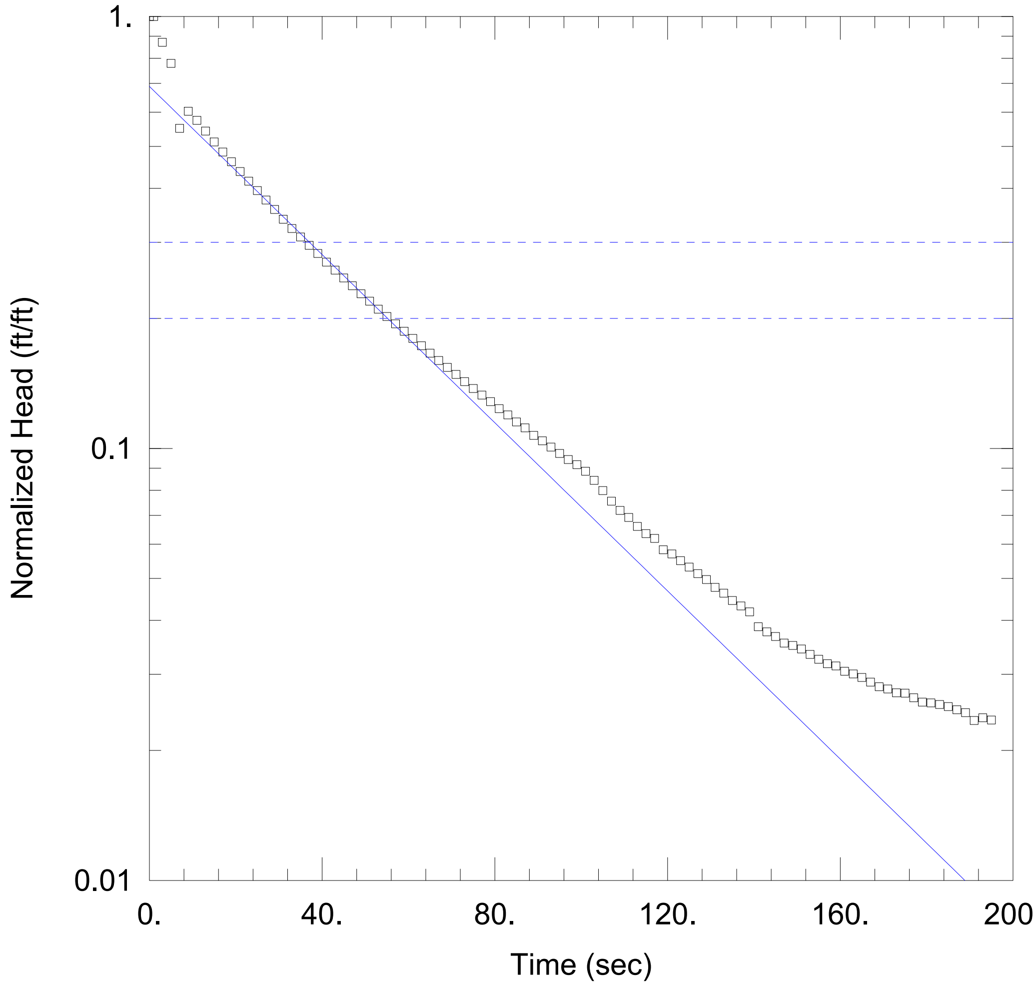
WELL DATA (MW1-66)

Initial Displacement: 1.79 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.083 ft
Static Water Column Height: 20.21 ft
Screen Length: 15. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 4.346 ft/day
y0 = 1.259 ft




## FALLING HEAD - RUN 3

Data Set: C:\...\MW1-66-Falling_3.aqt
Date: 09/20/22
Time: 14:29:04

## PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-66
Test Date: 4/29/22

## AQUIFER DATA

Saturated Thickness: 35.16 ft
Anisotropy Ratio (Kz/Kr): 1.

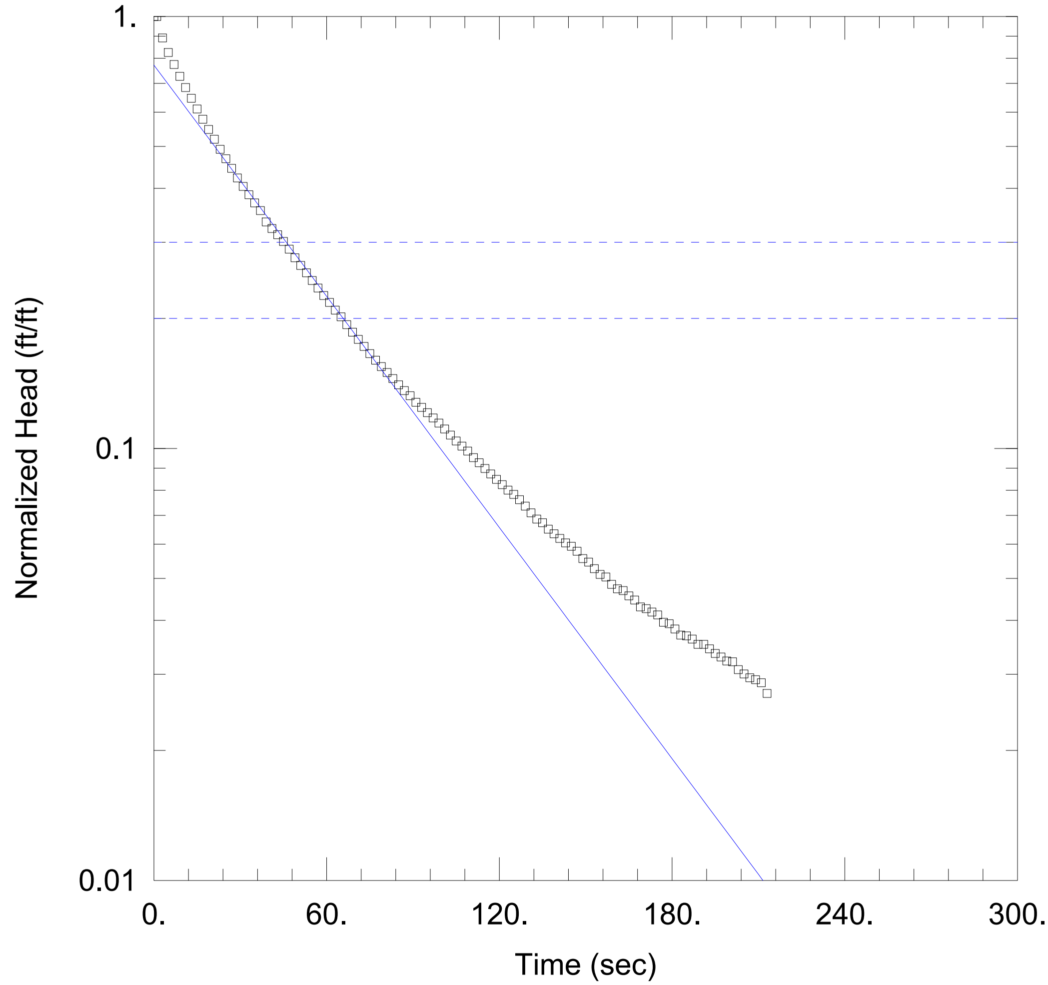
## WELL DATA (MW1-66)

Initial Displacement: 1.82 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.083 ft
Static Water Column Height: 20.21 ft
Screen Length: 15. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 4.419 ft/day
y0 = 1.253 ft




RISING HEAD - RUN 1

Data Set: C:\...\MW1-66-Rising_1.aqt
Date: 09/20/22
Time: 14:30:03

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-66
Test Date: 4/29/22

AQUIFER DATA

Saturated Thickness: 35.16 ft
Anisotropy Ratio (Kz/Kr): 1.

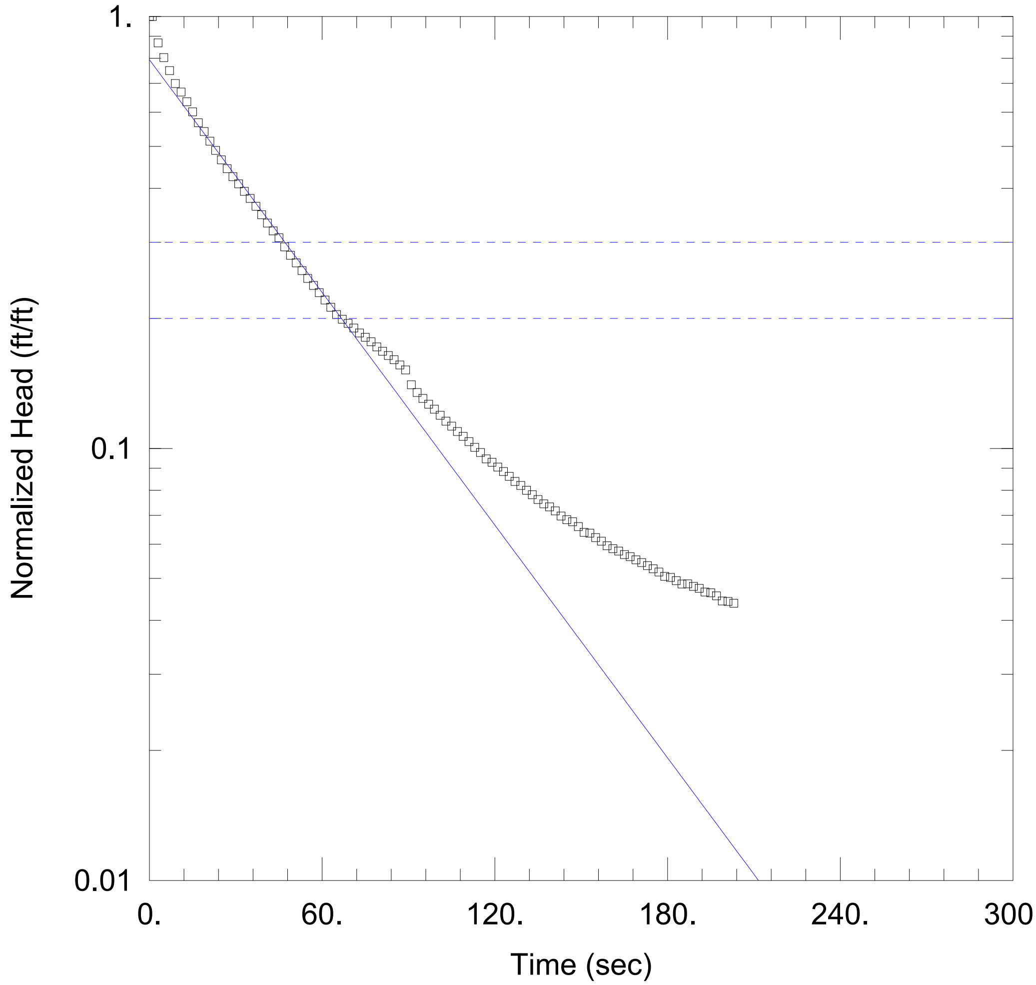
WELL DATA (MW1-66)

Initial Displacement: 1.304 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.083 ft
Static Water Column Height: 20.21 ft
Screen Length: 15. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 4.051 ft/day
y0 = 1.006 ft




RISING HEAD - RUN 2

Data Set: C:\...\MW1-66-Rising_2.aqt
Date: 09/20/22 Time: 14:31:10

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-66
Test Date: 4/29/22

AQUIFER DATA

Saturated Thickness: 35.16 ft Anisotropy Ratio (Kz/Kr): 1.

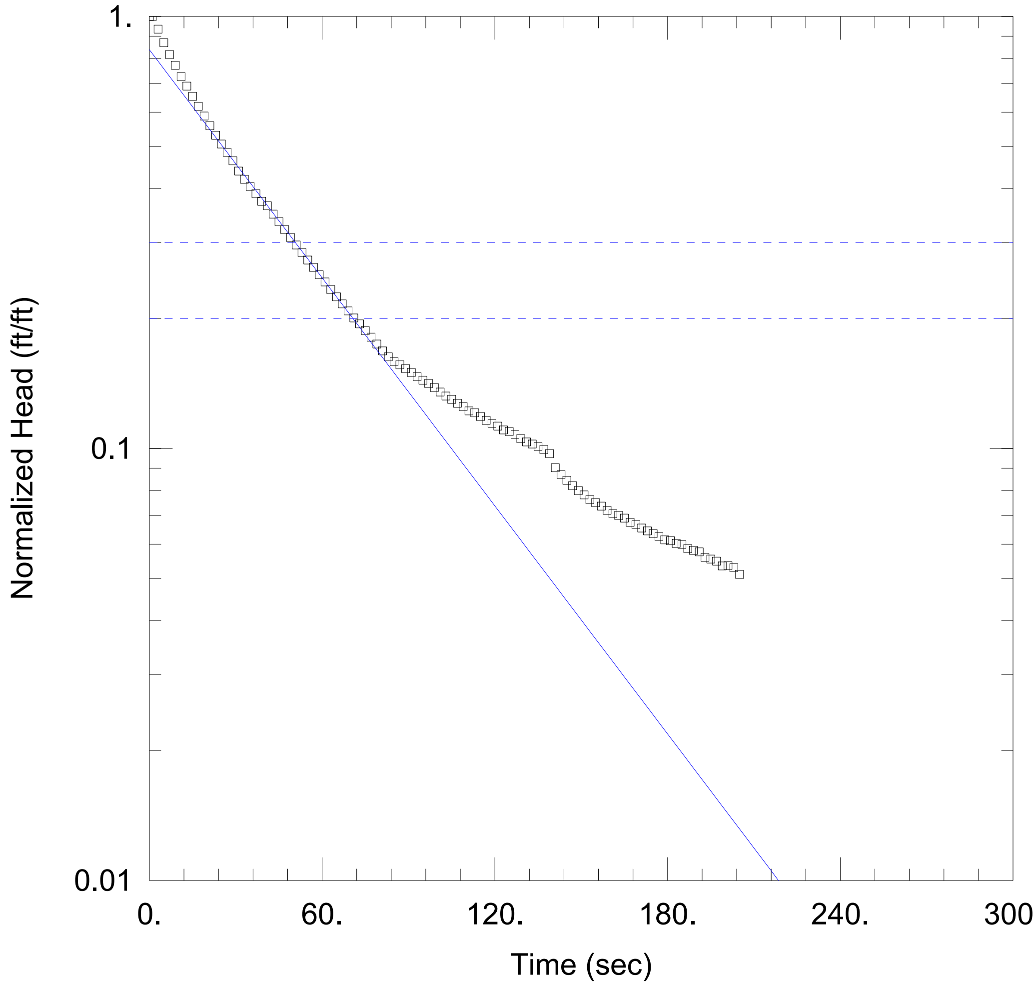
WELL DATA (MW1-66)

Initial Displacement: 1.556 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.083 ft
Static Water Column Height: 20.21 ft
Screen Length: 15. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 4.078 ft/day y0 = 1.235 ft




## RISING HEAD - RUN 3

Data Set: C:\...\MW1-66-Rising_3.aqt
Date: 09/20/22 Time: 14:32:24

## PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-66
Test Date: 4/29/22

## AQUIFER DATA

Saturated Thickness: 35.16 ft
Anisotropy Ratio (Kz/Kr): 1.

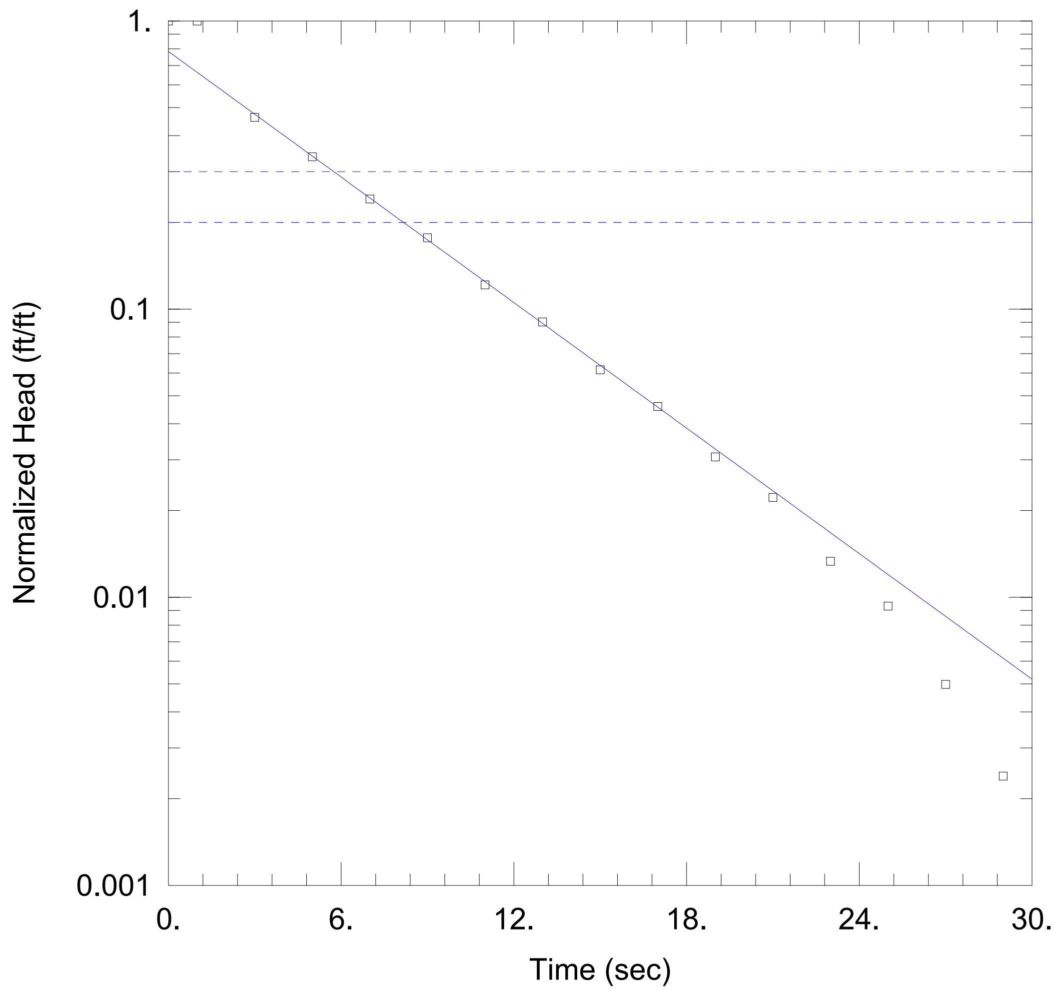
## WELL DATA (MW1-66)

Initial Displacement: 1.394 ft
Total Well Penetration Depth: 20. ft
Casing Radius: 0.083 ft
Static Water Column Height: 20.21 ft
Screen Length: 15. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.996 ft/day
y0 = 1.166 ft




FALLING HEAD - RUN 1

Data Set: C:\...\MW1-68-Falling_1.aqt
Date: 06/09/22 Time: 15:36:13

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-68
Test Date: 4/29/22

AQUIFER DATA

Saturated Thickness: 46.25 ft
Anisotropy Ratio (Kz/Kr): 1.

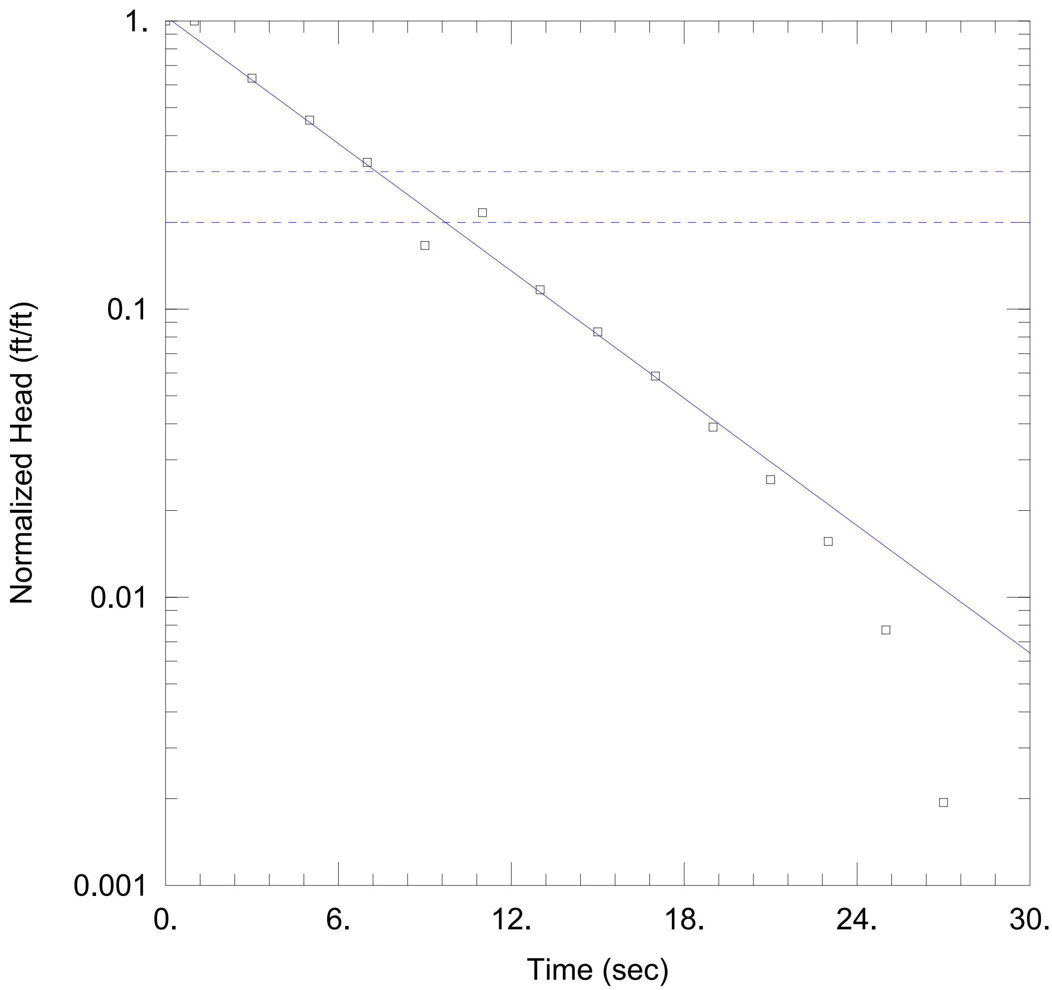
WELL DATA (MW1-68)

Initial Displacement: 2.589 ft
Total Well Penetration Depth: 46.25 ft
Casing Radius: 0.083 ft
Static Water Column Height: 46.25 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 63.5 ft/day
y0 = 2.029 ft




FALLING HEAD - RUN 2

Data Set: C:\...\MW1-68-Falling_2.aqt
Date: 06/09/22
Time: 15:40:46

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-68
Test Date: 4/29/22

AQUIFER DATA

Saturated Thickness: 46.25 ft
Anisotropy Ratio (Kz/Kr): 1.

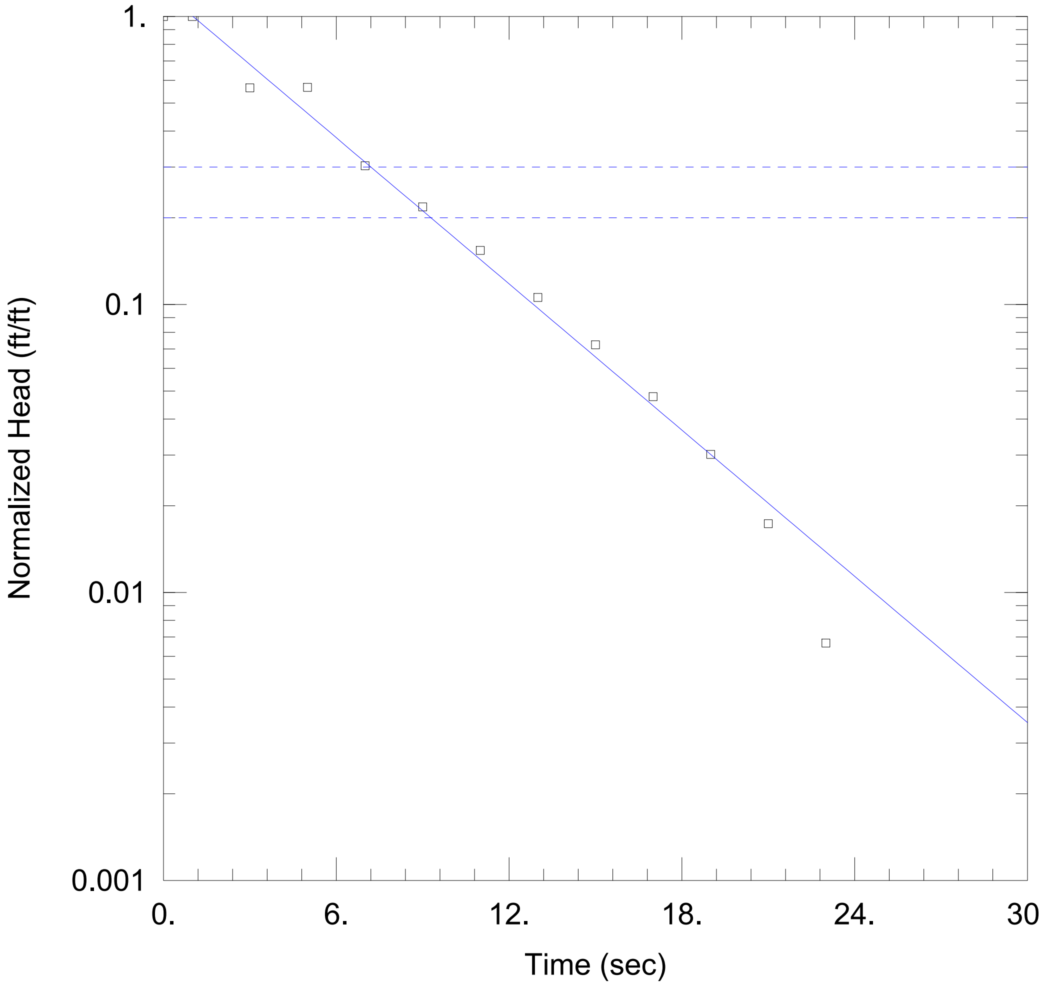
WELL DATA (MW1-68)

Initial Displacement: 1.754 ft
Total Well Penetration Depth: 46.25 ft
Casing Radius: 0.083 ft
Static Water Column Height: 46.25 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 64.42 ft/day
y0 = 1.822 ft




FALLING HEAD - RUN 3

Data Set: C:\...\MW1-68-Falling_3.aqt
Date: 06/09/22 Time: 15:44:19

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-68
Test Date: 4/29/22

AQUIFER DATA

Saturated Thickness: 46.25 ft
Anisotropy Ratio (Kz/Kr): 1.

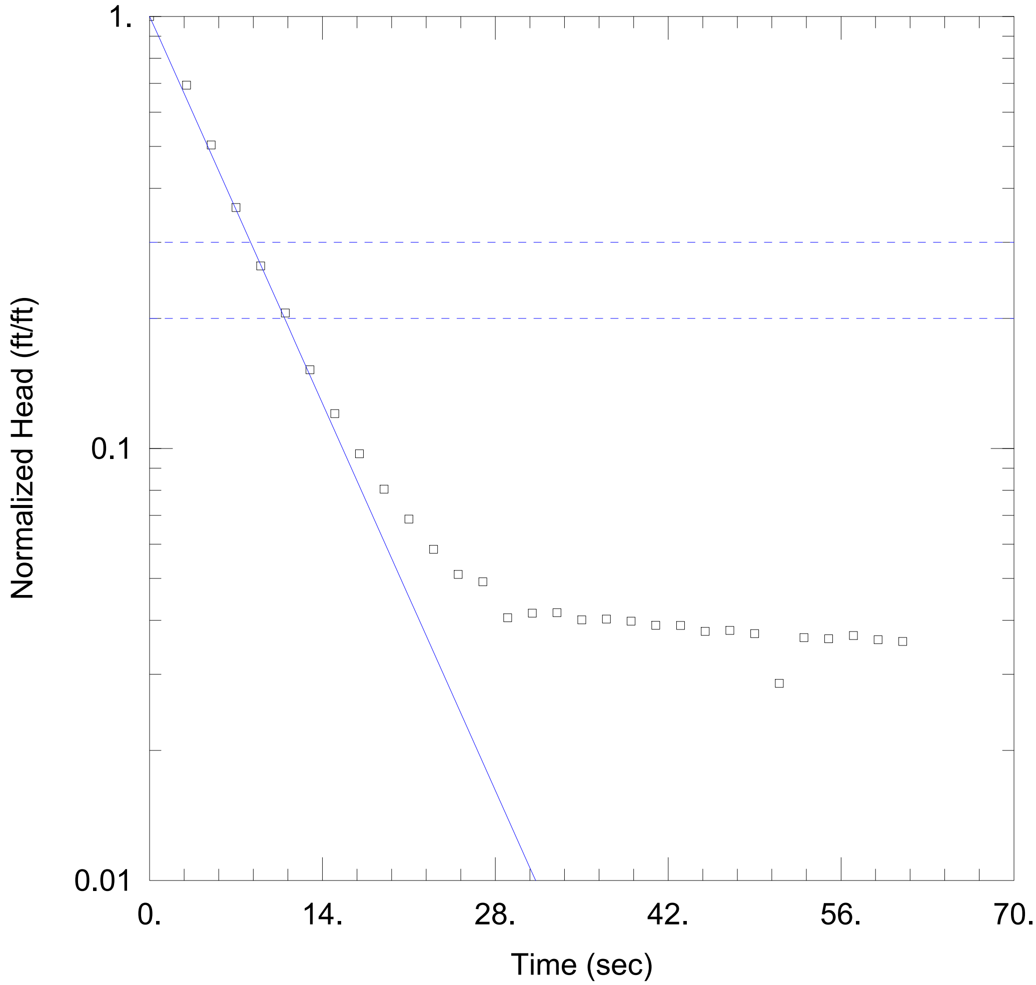
WELL DATA (MW1-68)

Initial Displacement: 1.454 ft
Total Well Penetration Depth: 46.25 ft
Casing Radius: 0.083 ft
Static Water Column Height: 46.25 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 74.01 ft/day
y0 = 1.776 ft




RISING HEAD - RUN 1

Data Set: C:\...\MW1-68-Rising_1.aqt
Date: 06/09/22
Time: 15:52:34

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-68
Test Date: 4/29/22

AQUIFER DATA

Saturated Thickness: 46.25 ft
Anisotropy Ratio (Kz/Kr): 1.

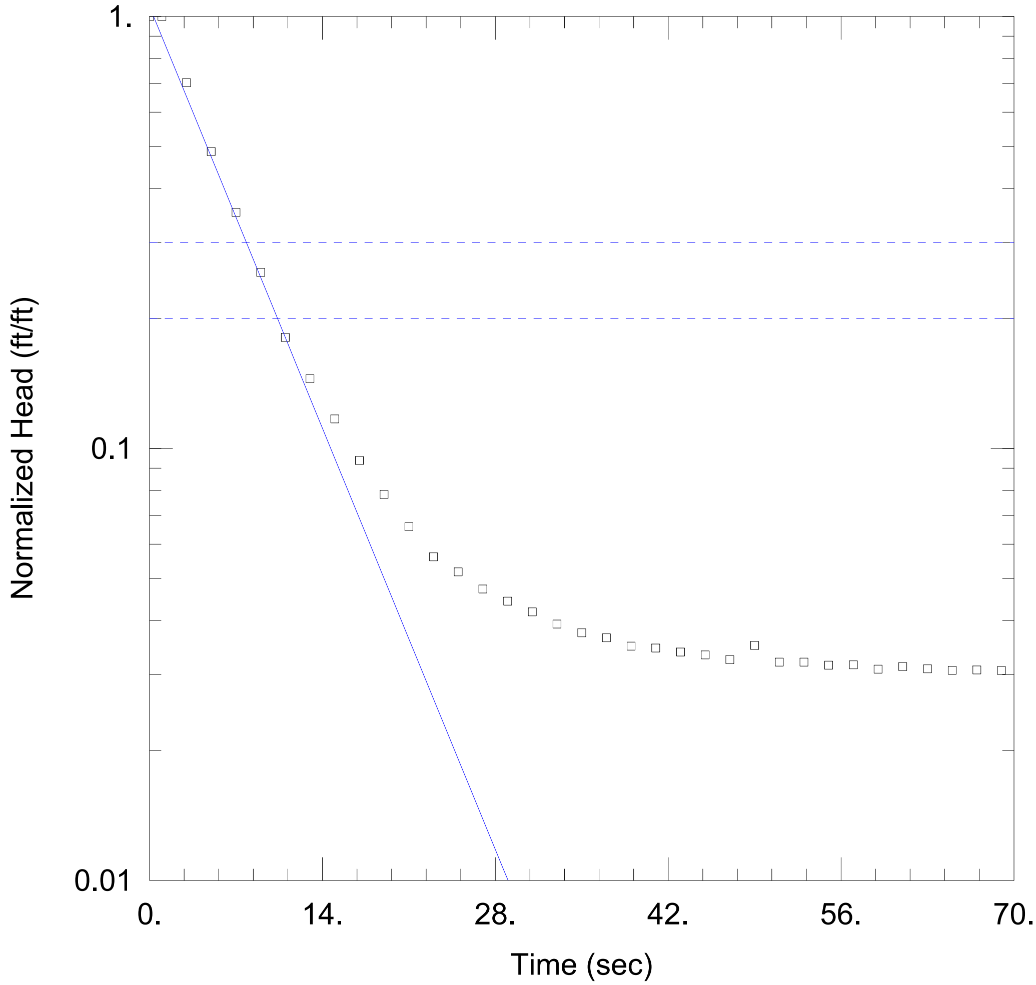
WELL DATA (MW1-68)

Initial Displacement: 1.771 ft
Total Well Penetration Depth: 46.25 ft
Casing Radius: 0.083 ft
Static Water Column Height: 46.25 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 55.96 ft/day
y0 = 1.774 ft




## RISING HEAD - RUN 2

Data Set: C:\...\MW1-68-Rising_2.aqt
Date: 06/09/22 Time: 15:56:32

## PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-68
Test Date: 4/29/22

## AQUIFER DATA

Saturated Thickness: 46.25 ft
Anisotropy Ratio (Kz/Kr): 1.

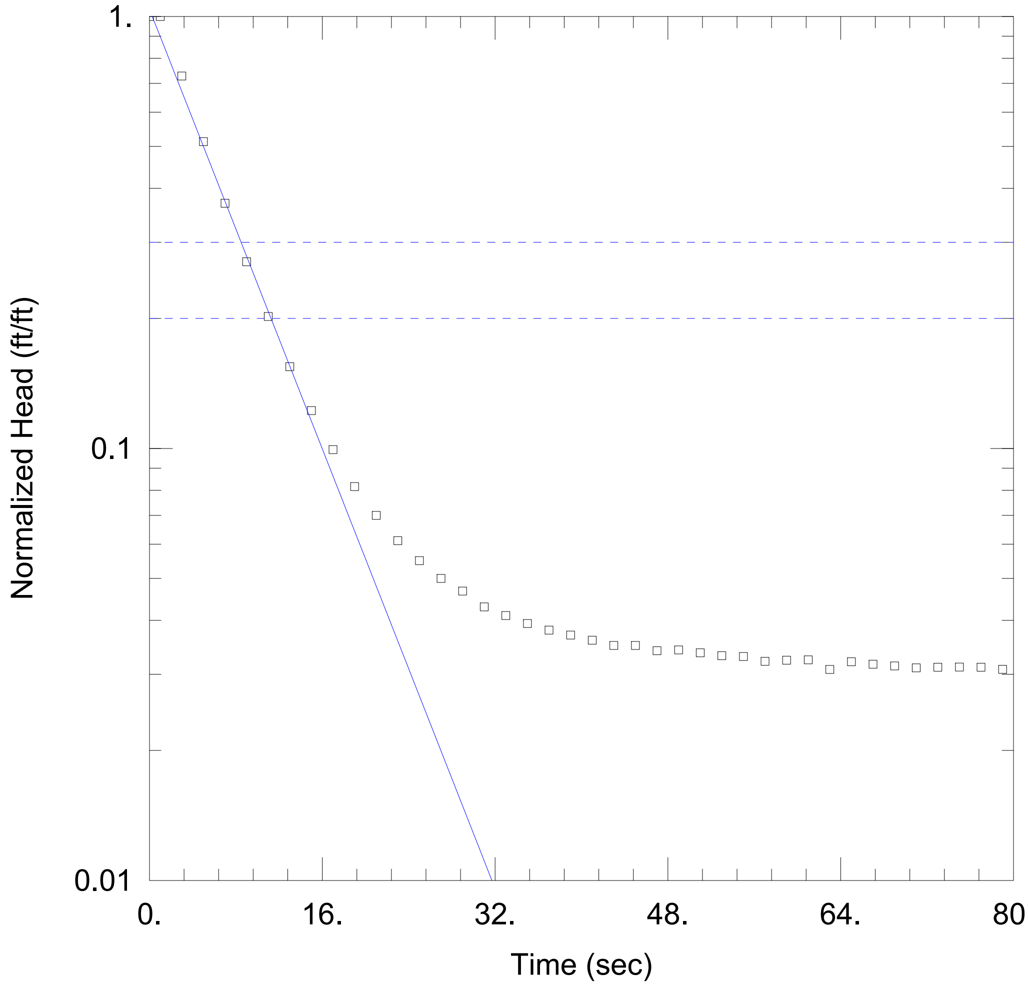
## WELL DATA (MW1-68)

Initial Displacement: 2.146 ft
Total Well Penetration Depth: 46.25 ft
Casing Radius: 0.083 ft
Static Water Column Height: 46.25 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 60.91 ft/day
y0 = 2.261 ft




RISING HEAD - RUN 3

Data Set: C:\...\MW1-68-Rising_3.aqt
Date: 06/09/22 Time: 15:59:47

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-68
Test Date: 4/29/22

AQUIFER DATA

Saturated Thickness: 46.25 ft Anisotropy Ratio (Kz/Kr): 1.

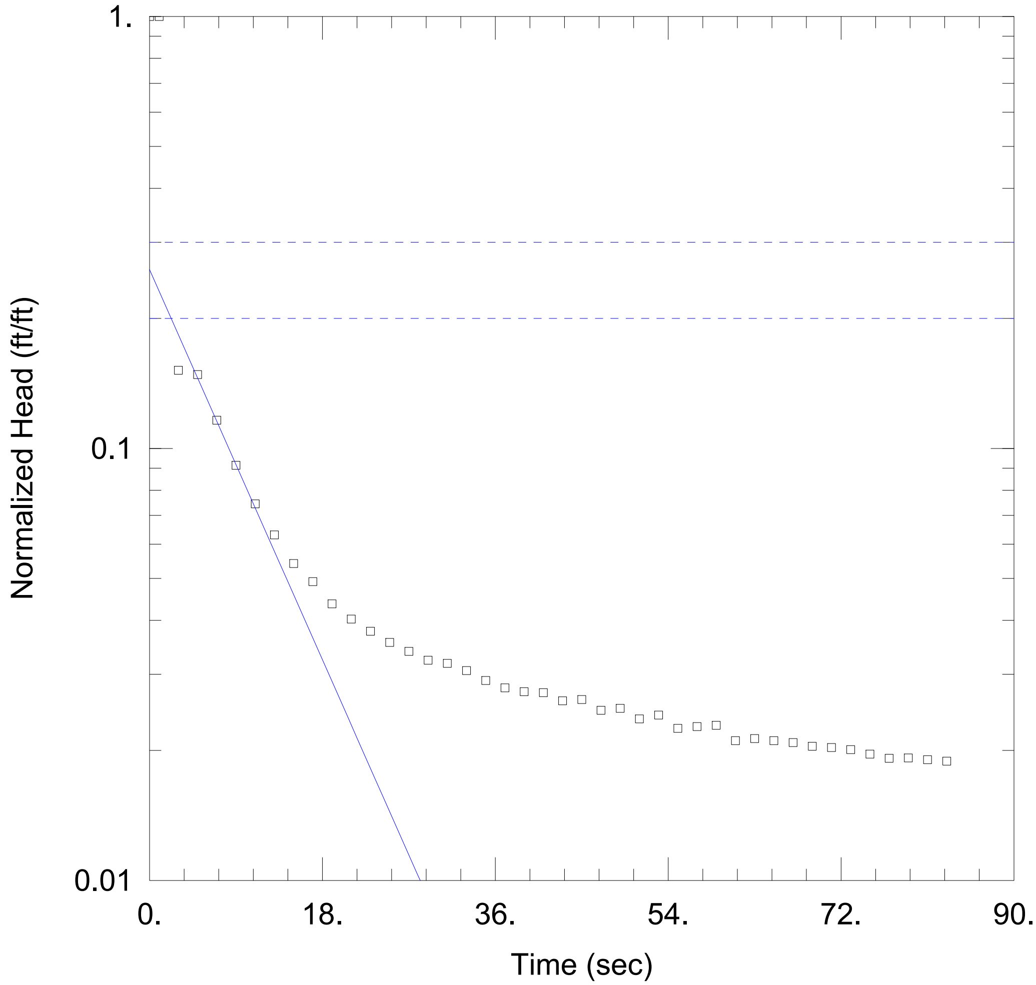
WELL DATA (MW1-68)

Initial Displacement: 2.164 ft
Total Well Penetration Depth: 46.25 ft
Casing Radius: 0.083 ft
Static Water Column Height: 46.25 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 55.62 ft/day y0 = 2.249 ft




WELL TEST ANALYSIS

Data Set: C:\...\MW1-72-Falling_1.aqt
Date: 10/31/22 | Time: 10:03:13

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-72
Test Date: 5/11/22

AQUIFER DATA

Saturated Thickness: 69.49 ft
Anisotropy Ratio (Kz/Kr): 1.

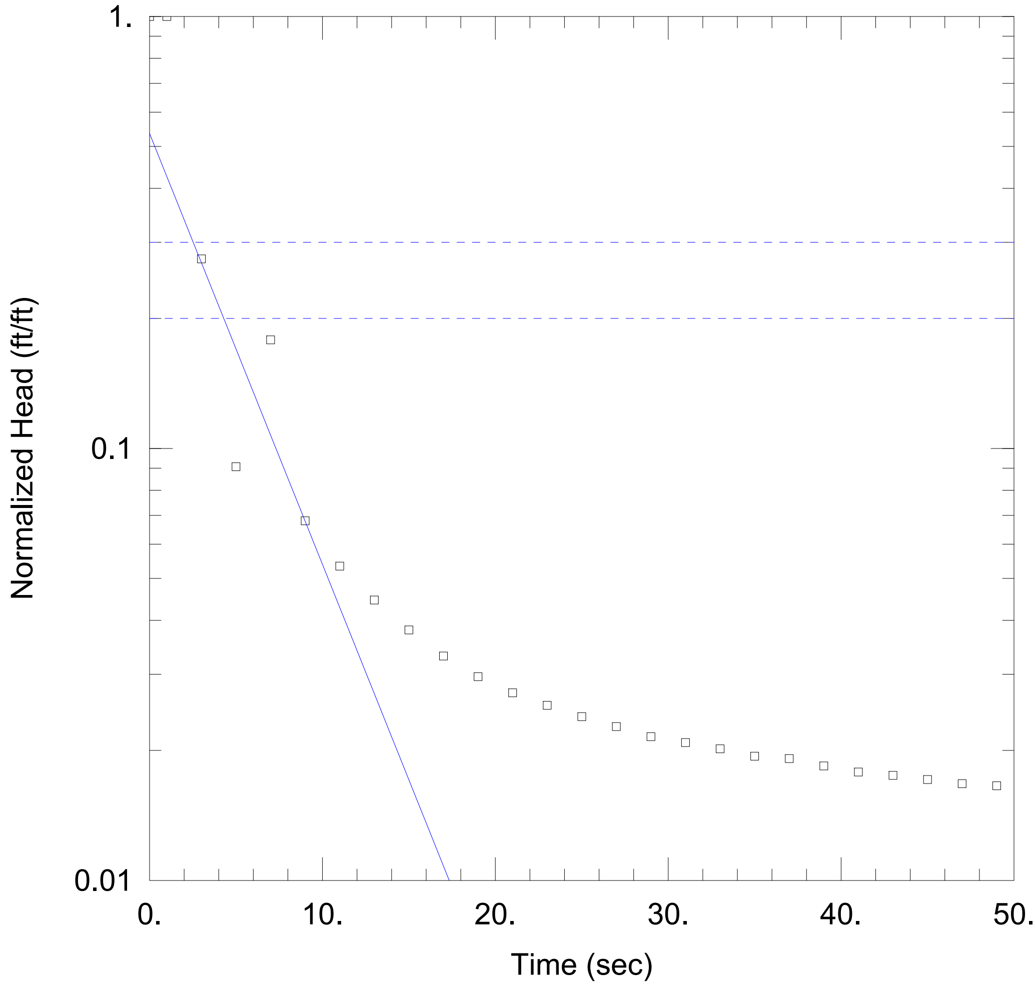
WELL DATA (MW1-72)

Initial Displacement: 2.739 ft
Total Well Penetration Depth: 70. ft
Casing Radius: 0.083 ft
Static Water Column Height: 59.49 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 46.56 ft/day
y0 = 0.7103 ft




## FALLING HEAD - RUN 2

Data Set: C:\...\MW1-72-Falling_2.aqt
Date: 10/31/22 Time: 10:01:33

## PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-72
Test Date: 5/11/22

## AQUIFER DATA

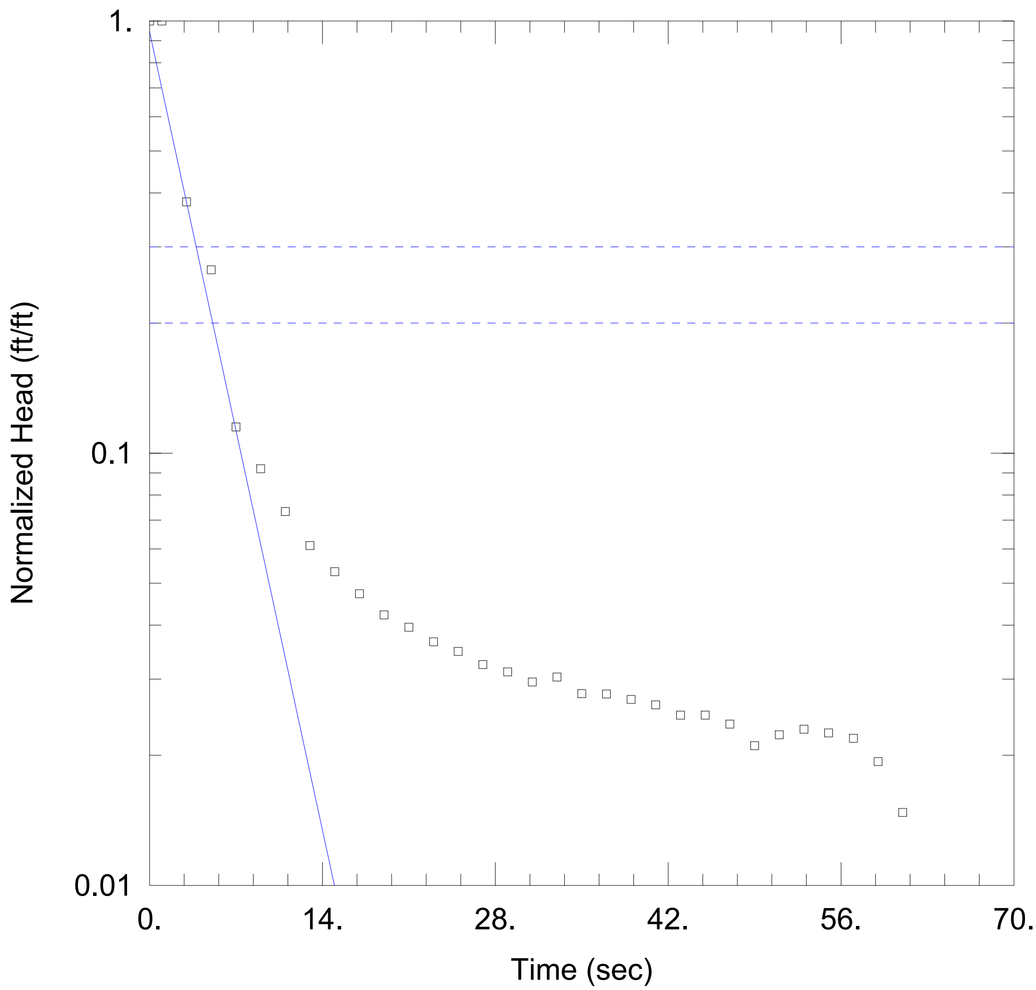
Saturated Thickness: 69.49 ft
Anisotropy Ratio (Kz/Kr): 1.

## WELL DATA (MW1-72)

Initial Displacement: 3.709 ft
Total Well Penetration Depth: 59.49 ft
Casing Radius: 0.083 ft
Static Water Column Height: 59.49 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 75.13 ft/day
y0 = 1.987 ft




FALLING HEAD - RUN 3

Data Set: C:\...\MW1-72-Falling_3.aqt
Date: 10/31/22
Time: 10:00:43

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-72
Test Date: 5/11/22

AQUIFER DATA

Saturated Thickness: 69.49 ft
Anisotropy Ratio (Kz/Kr): 1.

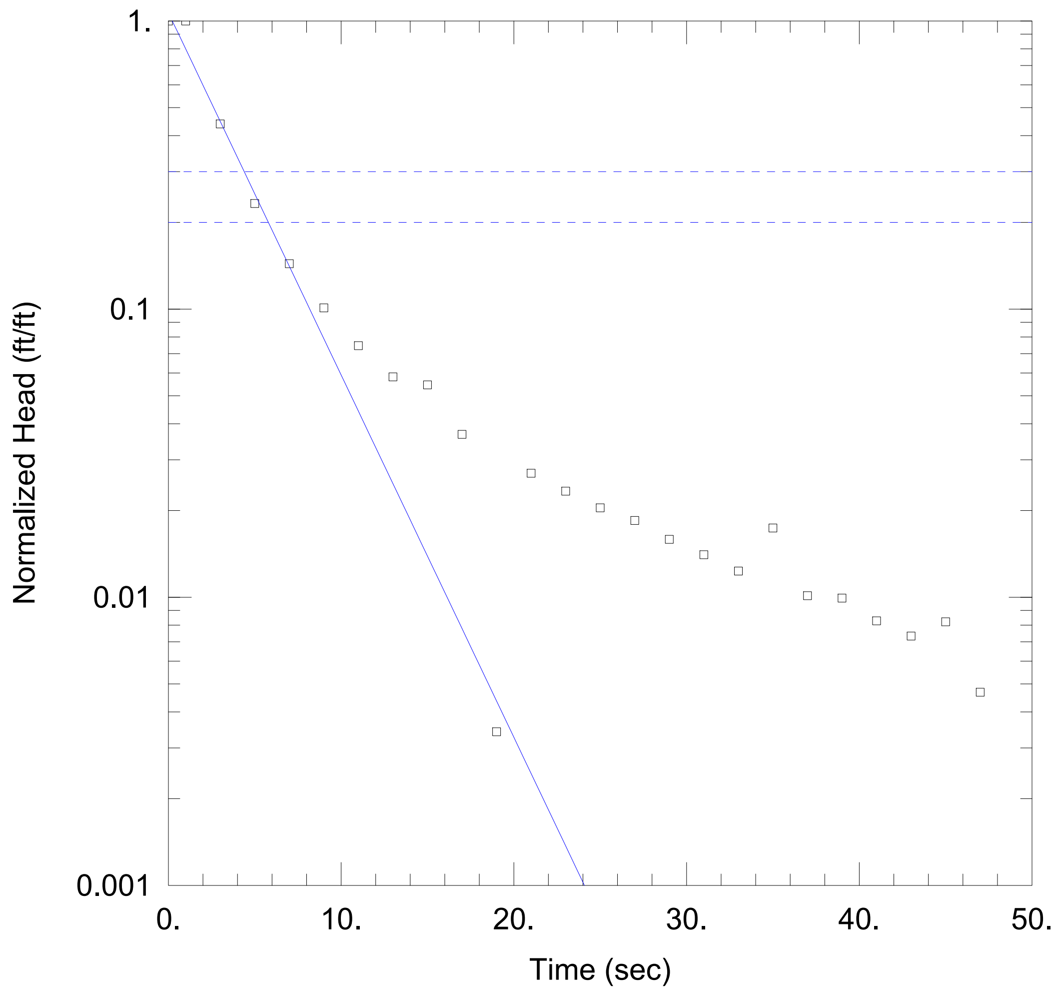
WELL DATA (MW1-72)

Initial Displacement: 2.637 ft
Total Well Penetration Depth: 59.49 ft
Casing Radius: 0.083 ft
Static Water Column Height: 59.49 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 99.29 ft/day
y0 = 2.489 ft




## RISING HEAD - RUN 1

Data Set: C:\...\MW1-72-Rising_1.aqt
Date: 10/31/22 Time: 10:05:38

## PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-72
Test Date: 5/11/22

## AQUIFER DATA

Saturated Thickness: 69.49 ft
Anisotropy Ratio (Kz/Kr): 1.

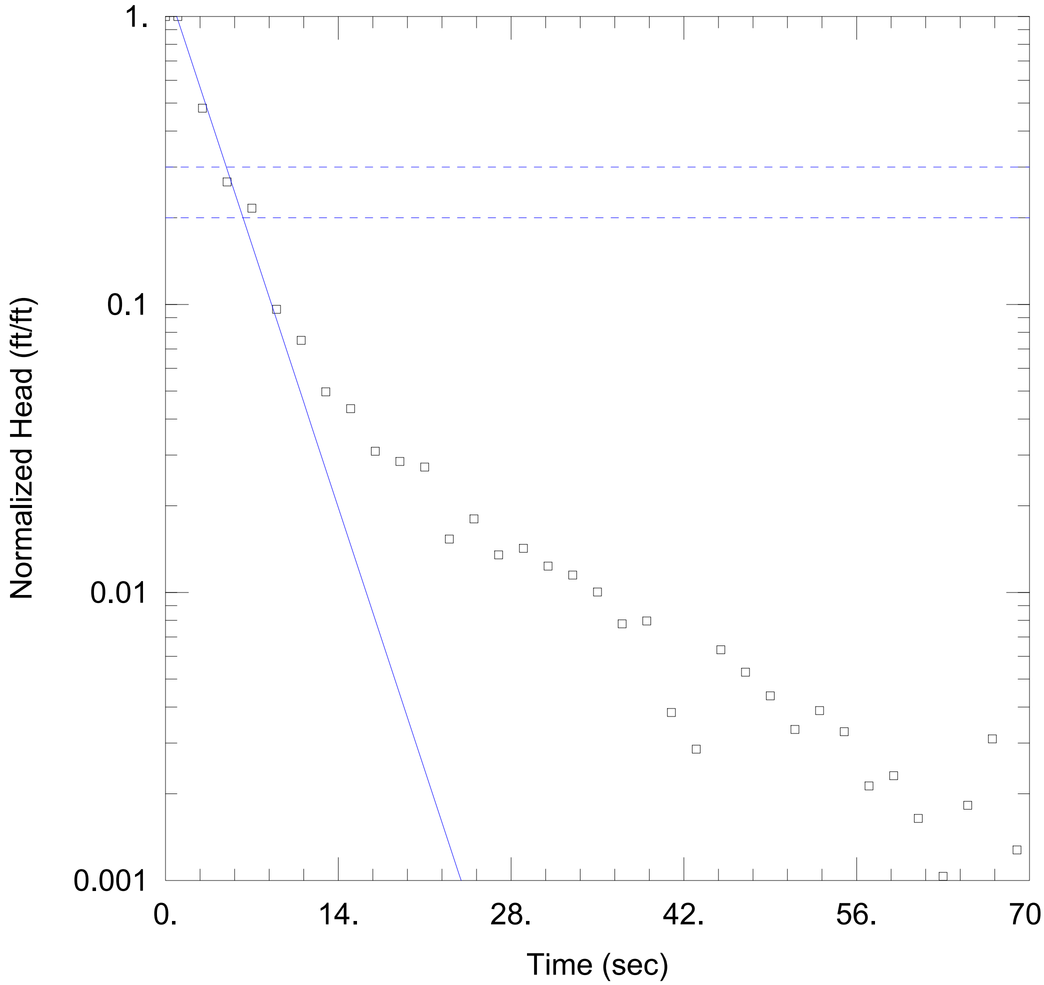
## WELL DATA (MW1-72)

Initial Displacement: 1.581 ft
Total Well Penetration Depth: 59.49 ft
Casing Radius: 0.083 ft
Static Water Column Height: 59.49 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 94.7 ft/day
y0 = 1.689 ft




RISING HEAD - RUN 2

Data Set: C:\...\MW1-72-Rising_2.aqt
Date: 06/07/22 Time: 12:34:16

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-72
Test Date: 5/11/22

AQUIFER DATA

Saturated Thickness: 69.49 ft
Anisotropy Ratio (Kz/Kr): 1.

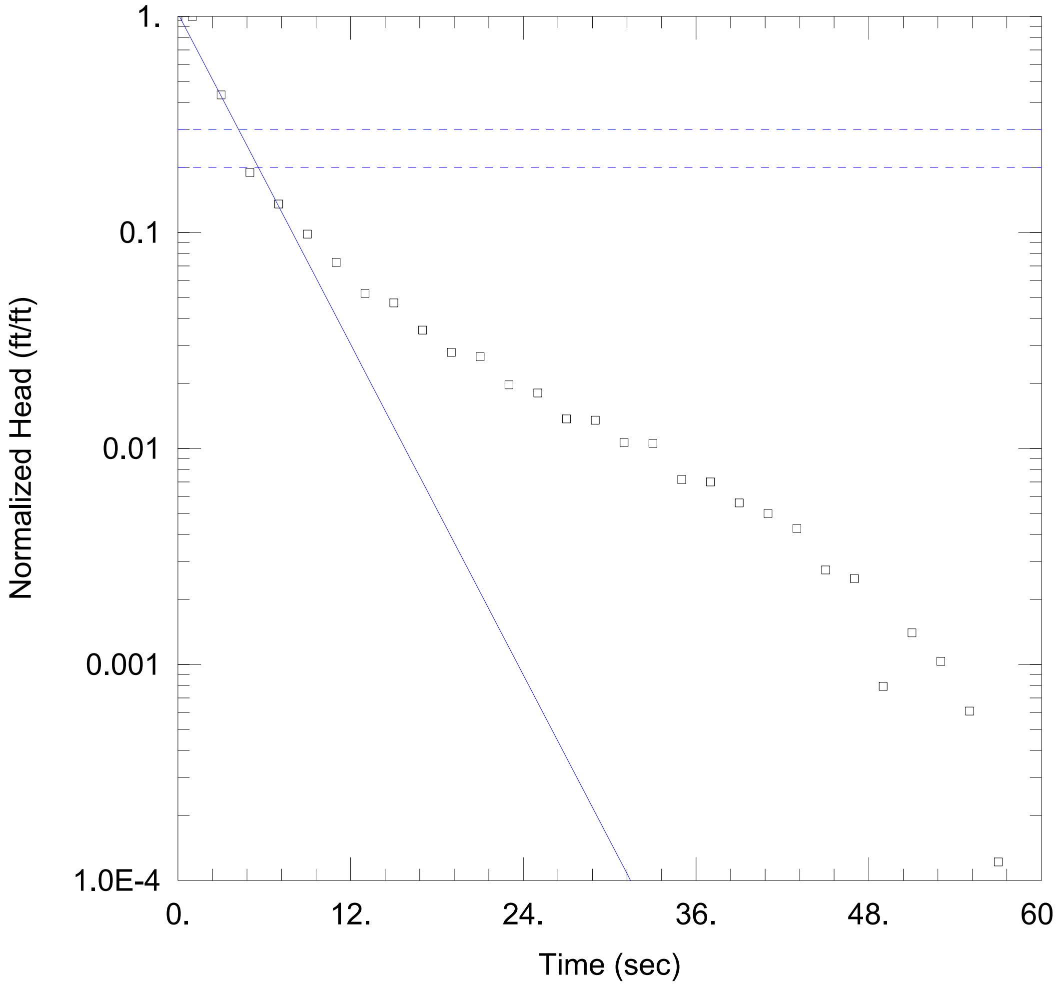
WELL DATA (mw1-72)

Initial Displacement: 1.645 ft
Total Well Penetration Depth: 59.49 ft
Casing Radius: 0.083 ft
Static Water Column Height: 59.49 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 98.04 ft/day
y0 = 2.163 ft




## RISING HEAD - RUN 3

Data Set: C:\...\MW1-72-Rising_3.aqt
Date: 10/31/22 Time: 10:07:18

## PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-72
Test Date: 5/11/22

## AQUIFER DATA

Saturated Thickness: 69.49 ft
Anisotropy Ratio (Kz/Kr): 1.

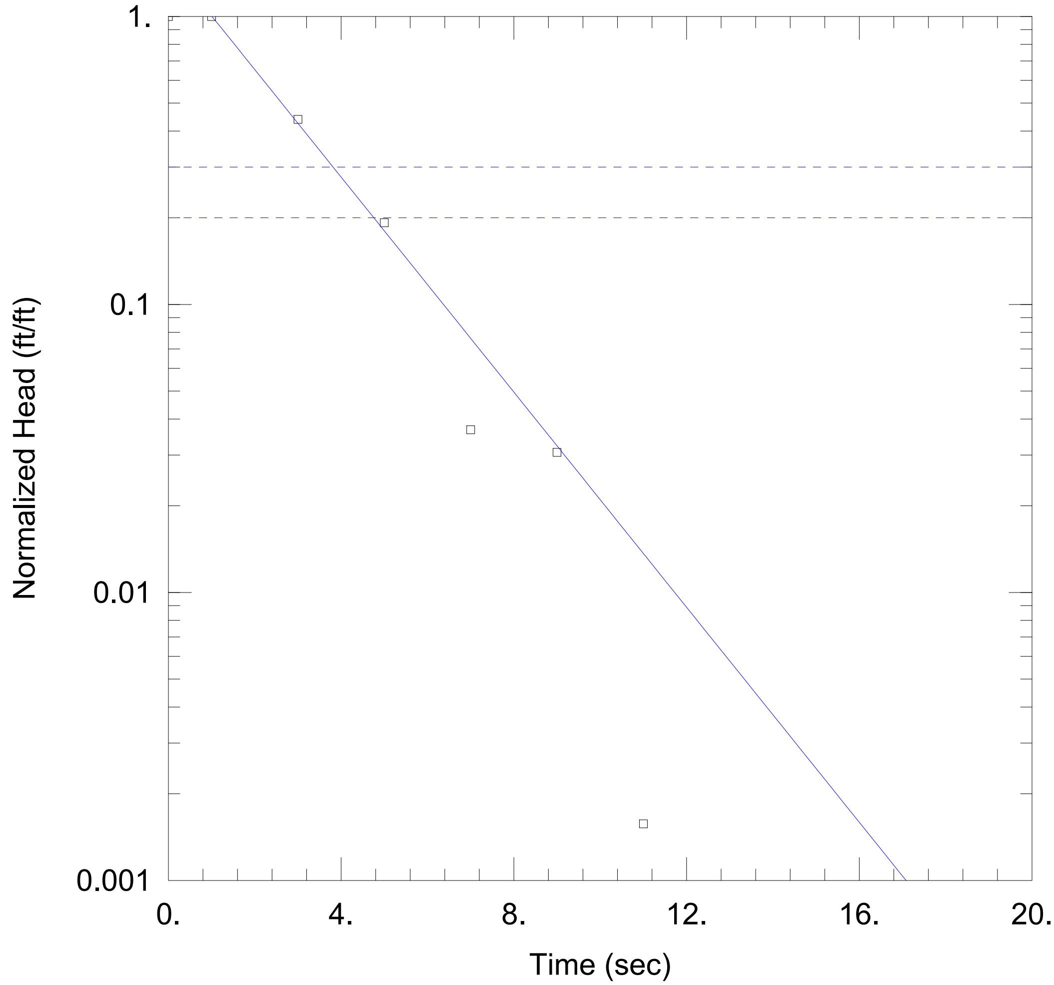
## WELL DATA (MW1-72)

Initial Displacement: 1.643 ft
Total Well Penetration Depth: 59.49 ft
Casing Radius: 0.083 ft
Static Water Column Height: 59.49 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 96.14 ft/day
y0 = 1.699 ft




FALLING HEAD - RUN 1

Data Set: C:\...\MW1-74-Falling_1.aqt
Date: 10/31/22
Time: 10:09:38

PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-74
Test Date: 7/15/22

AQUIFER DATA

Saturated Thickness: 44.39 ft
Anisotropy Ratio (Kz/Kr): 1.

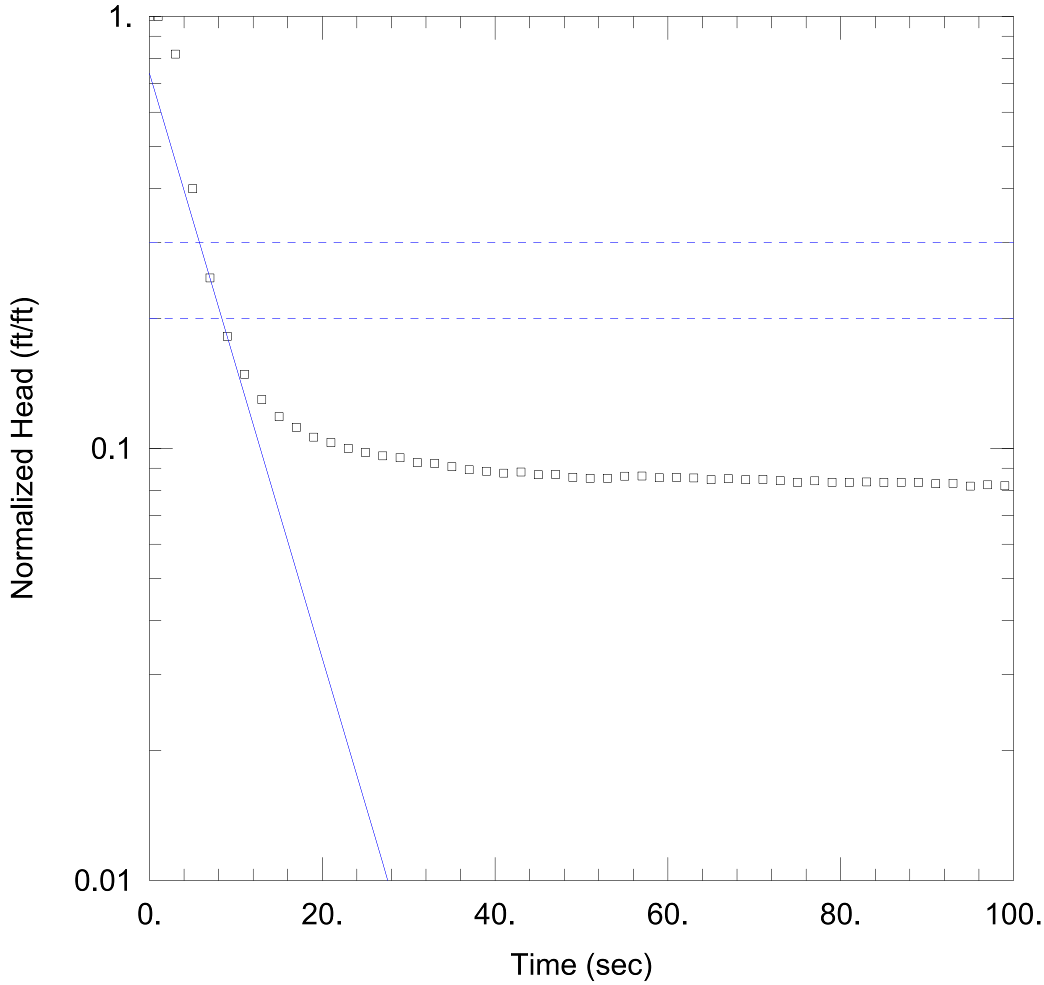
WELL DATA (MW1-74)

Initial Displacement: 1.145 ft
Total Well Penetration Depth: 44.39 ft
Casing Radius: 0.083 ft
Static Water Column Height: 44.39 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 162.2 ft/day
y0 = 1.767 ft




## RISING HEAD - RUN 1

Data Set: C:\...\MW1-74-Rising_1.aqt
Date: 10/31/22 Time: 10:10:55

## PROJECT INFORMATION

Company: Battelle
Client: NAVFAC NW
Project: 100125424
Location: Keyport OU 1
Test Well: MW1-74
Test Date: 7/15/22

## AQUIFER DATA

Saturated Thickness: 44.39 ft
Anisotropy Ratio (Kz/Kr): 1.

## WELL DATA (MW-74)

Initial Displacement: 1.444 ft
Total Well Penetration Depth: 44.39 ft
Casing Radius: 0.083 ft
Static Water Column Height: 144.4 ft
Screen Length: 10. ft
Well Radius: 0.25 ft
Gravel Pack Porosity: 0.3

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 58.84 ft/day
y0 = 1.066 ft

**Appendix C**

**Environmental Sequence Stratigraphy Attachments and Supplemental Information**

# Expanded Geological Interpretations and Facies Descriptions and Technical Glossary

This appendix serves as a supplementary compilation of technical content, which includes a thorough review of relevant depositional systems and an expanded section for geological observations, for the NBK Keyport OU 1 site. The data presented in Appendix A serves as the basis for stratigraphic interpretation of the NBK Keyport OU 1 geological framework.

## GEOGRAPHIC AND GEOLOGIC SETTING

This section summarizes the geography, historical geology, and geologic mechanisms most relevant to environmental investigations at OU 1.

### *Geographic Setting*

The NBK Keyport site is located within the Puget Lowland, a coastal province of western Washington State. The Puget Lowland is an elongate structural and topographic basin bordered to the east and west by the Cascade and Olympic Mountain ranges, respectively (Troost, 2016) (Figure C-1). The Puget Lowland is part of a greater topographic low within the region that is presently occupied by the Salish Sea, extending from the Strait of Georgia (British Columbia, Canada) into the Puget Sound of Washington State.

### *Geologic Setting*

The geologic framework of the Puget Lowland region features a foundation of deeply buried bedrock units which record a complex history of oceanic, volcanic island arc, and subduction zone processes occurring from the late Paleozoic-Mesozoic period (275 to 66 million years ago [mya]). Late Paleozoic to Mesozoic-aged strata are overlain by Eocene to Miocene-aged (56 to 5.3 mya) strata deposited during intense volcanism, tectonic faulting and folding which generated the modern landscape of western Washington state, the Olympic and Cascade mountain ranges, in addition to precursor structural/magmatic features (i.e., Calkins Range). Miocene-aged strata are unconformably overlain by Quaternary-aged (2.5 mya to present) geologic successions of the Puget Lowland, which record between 7 and 12 glaciations in the region, based on marine isotope data (Troost, 2016; Troost and Booth, 2008). The Cordilleran Ice Sheet has terminated in several lobes (Juan de Fuca, Puget, Okanagan, Columbia River, Purcell Trench, and Flathead lobes), and Alpine glaciers (originating from the Cascade and Olympic mountains) have also advanced multiple times into the Puget Lowland. Frequent glaciation-deglaciation events have resulted in a modern landscape which reflects repeated cycles of glacial and interglacial depositional settings (Booth, Haugerud, and Troost, 2003; Troost and Booth, 2008).

Generally, each glacial episode within the Puget Lowland may be characterized by the following: 1) advancement of the Cordilleran Ice Sheet into the region resulting in hydrologic damming and generation of a proglacial lake; 2) time-transgressive and widespread deposition of well-sorted sands and gravels (advancement outwash) transported by high-energy glacial meltwater drainage systems accompanied with deep subglacial scouring; 3) time-transgressive deposition of unsorted sand, gravel, silt, and clay (till) beneath the ice sheet, along with sorted to unsorted debris deposited adjacent to or on top of the ice sheet (ice contact-ice marginal deposits); and 4) time-transgressive deposition of well-sorted sand and gravels (recessional outwash) transported by the high-energy meltwater systems as the ice sheet retreated, in addition to deposition of proglacial lacustrine silt and clay as a result of dammed drainage systems blocked by the receding ice sheet. These generalized events are responsible for generating the many glacial drift sequences preserved in the stratigraphic record in the Puget Lowland. Due to high amounts of erosion by several episodic glacial events, coupled with further erosion and reworking of each sequence by interglacial alluvial processes, the vertical thickness, lateral continuity, and preservation of each glacial drift sequence is highly variable across the region (Booth, Haugerud and Troost, 2003; Troost and Booth, 2008; Troost, 2016).

During interglacial periods (time periods when the region was free of ice) sedimentation across the Puget Lowland is generally dominated by relatively low-energy fluvial systems with localized lacustrine and marine deposition occurring in the central lowland, and volcaniclastic deposition occurring along the east basin margin near the Cascade Range (Borden and Troost, 2001). Interglacial drainage systems generally transported sediment from upland areas into the central lowland and are oriented sub-perpendicular to the north-south axis of the Puget trough. The best-known modern analogue for interglacial depositional settings within the Puget Lowland is the modern landscape itself where rivers, waves, landslides, and volcanic mudslides continuously modify the landscape, generating new deposits and eroding/redistributing underlying glacial deposits (Booth and Troost, 2003). These physical processes generate extensive areas of nondeposition (generating an unconformity) and promote soil formation and erosion in upland areas. Interglacial successions are thought to have only accumulated in significant volumes within river valleys, lake basins, Puget Sound, and as colluvium along slopes. Thick interglacial successions are known to pinch out abruptly against paleo-valley walls and deposits vary substantially in subsurface elevation owing to coeval deposition within lowland and upland areas. Thickness and lateral continuity of interglacial deposits are known to be highly variable, controlled by the duration of the interglacial period, tectonic subsidence and uplift rates, paleo-altitude, and surface topography of drift left by the preceding glacial period (Troost and Booth, 2003; Borden and Troost, 2001).

### *Pleistocene and Holocene Sea-Level Variations in the Puget Lowland*

As a result of waxing and waning glacial cycles driven by the orbital behavior of the Earth, coupled with a finite volume of water made available through the global hydrological cycle, episodes of glaciation and deglaciation have been well documented to cause fourth to fifth order variations in global sea level (glacioeustasy), significantly altering sedimentation within coastal areas (Eyles, 2010; Miall, 2010). As demonstrated by $O^{16/18}$ isotope research, during periods of glacial advancement, increasing volumes of water become trapped within ice sheets via precipitation, resulting in a progressive fall in relative sea-level until glacial advancement reaches its maximum and eustatic level reaches its lowest level. Subsequently during ice sheet retreat, large volumes of glacial meltwater feed into global oceans causing a progressive rise in eustatic sea-level until a peak rise is reached correlative to a point of maximum glacial retreat. The relative magnitude of any glacioeustatic change is specific to each global glacial episode.

Furthermore, the general conceptualization of glacioeustasy is complicated by other first to third order drivers of eustatic change, local-to-regional scale variations in isostatic rebound/depression (isostasy), tectonic uplift/subsidence, anthropogenic climate change, all of which may occur coeval to one another (Miall, 2010; Booth et al., 2003).

Glacioeustatic, isostatic, and tectonic forces have created a complex record of sea-level variation within the Puget Lowland. Upon glacial retreat at the end of the Fraser glaciation (beginning of the Holocene), marine waters re-entered the freshly scoured Puget Sound with the reopening of the Strait of Juan de Fuca and Admiralty Inlet. Rising sea level was almost immediately met by rapid isostatic rebound rates (reaching upwards of 650 feet) occurring in the northern Puget Lowland due to the decrease in lithosphere overburden by the absence of ice sheet mass. Over the next 7,000 years, global sea level continued to rapidly rise by upwards of 295 feet until about 5,000 years ago (ya) when sea-level rise slowed significantly to within 16 feet of its present position and continued to slowly rise to modern sea level roughly 2,000 years ago. This pattern of global Holocene sea-level rise is broadly applicable to the Puget Lowland; however, tectonic uplift and isostatic rebound likely had a significant effect on the magnitude of relative sea-level rise and timing of topographic inundation at the local and regional scales (Booth et al., 2003). Reconstructions of sea-level histories during the Whidbey (>100,000 to 80,000 ya) and Olympia (60,000 to 23,000 ya) interglacial intervals specific to the Puget Lowland region remain elusive; however, global oxygen isotope data suggest that sea level was approximately 213 feet lower than modern sea level during the Olympia interglacial interval and fluctuated up to 19 feet higher than modern during the Whidbey interglacial interval (Lambeck et al., 2002; Troost, 2016).

### *Lithostratigraphy and Chronostratigraphy of the Puget Lowland*

Debate between geologists regarding the interpretation, correlation, and construction of a chronologic framework for Quaternary-aged strata of the Puget Lowland has been ongoing for over a century (Troost, 2016). These issues arise from the highly erosive nature of glacial deposits, which often results in the youngest glacial episode eroding away older glacial deposits, leaving behind a highly variable and discontinuous record of previous glaciations. This issue coupled with potential pitfalls involving regional correlation using lithostratigraphic methods (generation and correlation of geologic units based on observable lithological features) (Miall, 2010), can produce a complex array of formal stratigraphic nomenclature that is difficult to apply and correlate across large areas. Troost (2016) acknowledges this issue plaguing stratigraphic nomenclature of the Puget Lowland (shown in Figure C-2), noting that the assumption of consistent time-stratigraphic units (i.e. Lawton Clay being deposited all at once over wide area) rather than acknowledging the more accurate time-transgressive nature of geologic deposition has resulted in confusing stratigraphic nomenclature in the region.

The study conducted by Troost (2016) utilized a chronostratigraphic mapping approach and yielded a simplified and more correlative geologic framework for the Puget Lowland (shown in Table 1). Because of the simplicity and correlatability of the stratigraphic framework provided by the work of Troost (2016), this study will use nomenclature consistent with that model; however, ESS characterization results will be compared with pre-existing geologic models of

OU 1 and the surrounding area and the lithostratigraphic terms used at the time. Units described and interpreted in this memorandum are best considered preliminary until absolute dating methods are implemented to confirm the unit interpretations.

On a geologic scale, the depth of environmental investigations at OU 1 is shallow (less than 120 feet below modern sea level). As a result, this ESS study anticipates that geologic units encountered were likely deposited during the late Quaternary period. Only younger geologic units thought to be present beneath OU 1 are reviewed in this ESS study.

### *Review of Tidal Depositional Systems*

Tidal influences are found in a wide array of depositional settings to varying degrees (settings could be tide-dominated or wave-dominated) affecting the rivers, deltas, estuaries, protected and open coasts within the tidal limit of a continental shelf (Dalrymple, 2010). The term *tide* refers to any periodic fluctuation in water level which is generated by the deformation of the ocean surface caused by the gravitational attraction of the moon and sun (a process known as astronomical tide). A thorough review of equilibrium tidal theory is available in both works by Longhitano et al. (2012) and Dalrymple (2010). High and low tides (flood and ebb tides) generate currents capable of eroding, transporting, and depositing significant volumes of sediment. When tidal current speeds approach zero (slack-water conditions), fine-grained suspended sediment is deposited and often forms a “mud drape” over underlying sediments. When current speeds are highest during each tidal cycle, coarser-grained sediment is often transported or deposited. Periodic fluctuations in tidal current speeds may be symmetrical or asymmetrical and favoring either flood or ebb tides, which results in deposition of cyclic heterolithic (mixed lithology) strata (referred to collectively as “tidalites”) with diagnostic tidal signals (Longhitano et al., 2012). These diagnostic tidal signals (summarized in Figure 1A-D) include non-cyclical tidalite deposits which feature ascending amounts of preserved mud volumes, as a function of current speed conditions, including flaser, wavy, and lenticular bedforms (Figure 1A-C) and cyclical tidal rhythmites comprised of alternating, planar laminations of sand/silt and muddy material (Figure 1D) (Longhitano et al., 2012; Dalrymple, 2010).

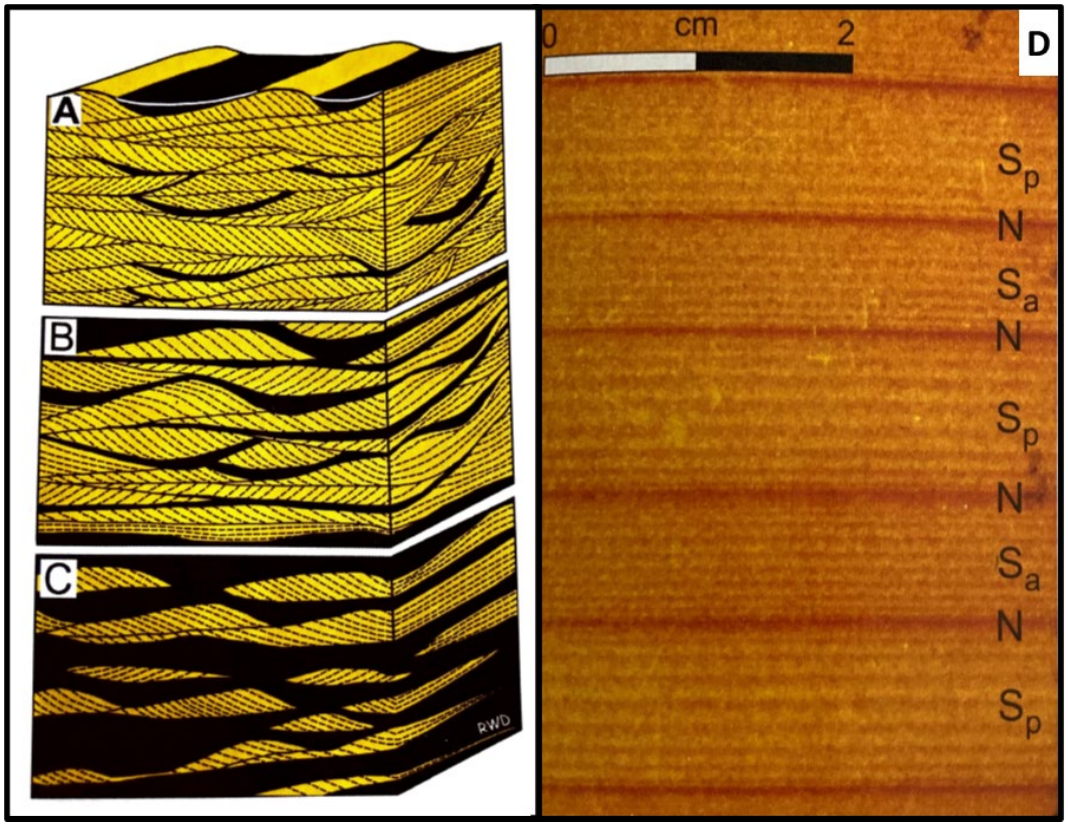



Figure 1. Conceptual drawings and images of asymmetrical and symmetrical tidal rhythmites, which are common signals of tidal influence. A) Flaser bedding, B) Wavy bedding, C) Lenticular bedding, D) Symmetrical, horizontally bedded tidal rhythmites. (Modified from Dalrymple, 2010b).

In all tidal systems, tidal processes and subsequent tidal deposits may be segmented into supratidal, intertidal, and subtidal zones (Figure 2). The supratidal zone occupies the part of the coast located above mean high-tide level and is only inundated during the highest tides (spring/neap tides) and storms; this zone may be comprised of an array of environments most commonly including salt marshes, mangrove swamps, and washover fans. The intertidal zone is the coastal area between mean low-tide and mean high-tide, experiences cyclic subaerial exposure, and includes sub-environments such as proximal tidal channels and tidal flats. The subtidal zone occurs below mean low-tide level and is dominated by tidal and wave currents. Possible sub-environments that may be observed in the subtidal zone include distal tidal channels, tide-influenced shorefaces, and delta fronts (Longhitano et al., 2012).

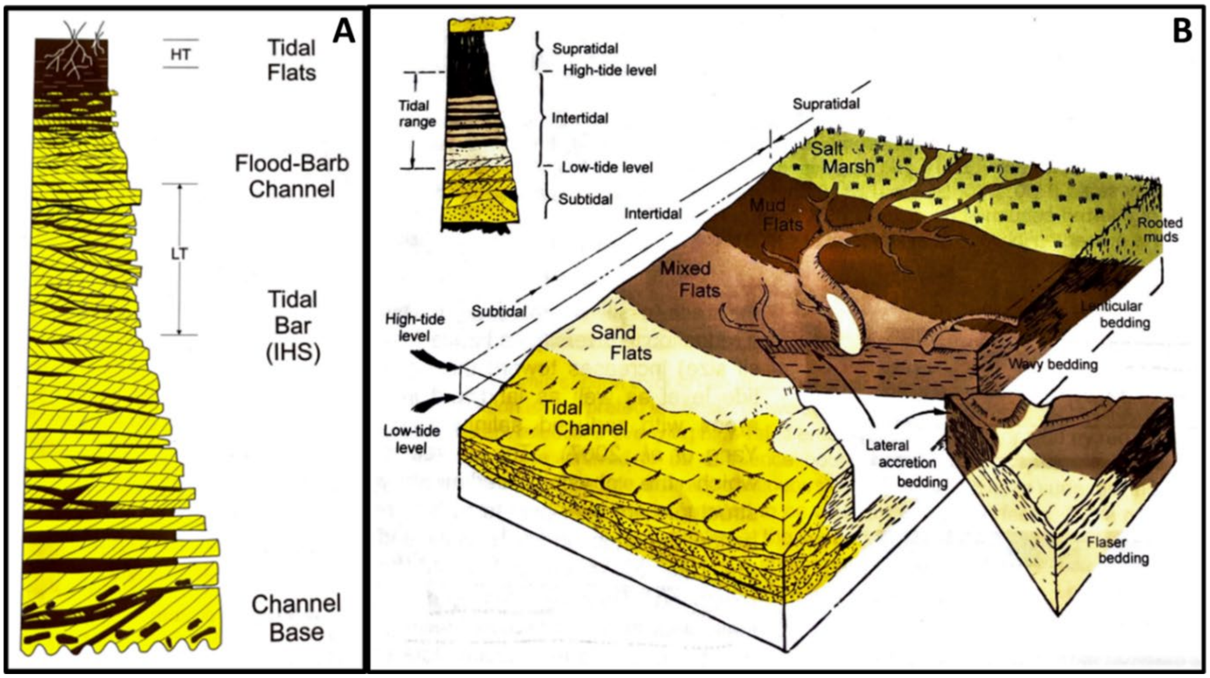



Figure 2. Typical stratigraphic succession and 3-D depositional model of tidal flat environments (from Dalrymple, 2010).

Each tidal environment is unique, but three main sub-environments can be found in almost every tidal environment—tidal channels, tidal flats, and tidal bars. These sub-environments often occur highly intermixed with one another; for example, tidal channels often contain and/or are flanked by tidal bars and upper margins of tidal channels transition to tidal flats (Dalrymple, 2010). These sub-environments yield distinct vertical successions of lithologies that will ultimately preserve unique architectural elements within the subsurface which contribute to the continuity, heterogeneity, and storage capacity of aquifers and affect the sealing capacity of aquitards. Tidal channels range in size from small gullies (>1m deep) which dissect tidal flats to large channels (10-30 m deep) that define the morphology of estuaries, deltas, etc. All tidal channels generally become more sinusoidal inland, exponentially widen seaward, and exhibit funnel-like geometries (Dalrymple, 2010). Elongate tidal bars are often found within or near tidal channels, oriented parallel to the direction of the tidal current and may be free-standing (non-bank attached) or attached to the channel bank. All tidal bars (regardless of whether bank-attached or free-standing) migrate sideways, infilling channels (at all scales), generating lateral-accretion deposits characterized by an upward fining grain-size pattern. Tidal bar deposits exhibit characteristic heterolith stratification (IHS) bedding that is generally sand-rich in deeper depths that transitions to mud-rich IHS in smaller tidal gullies located closer to mudflats and the supratidal marshes (Longhitano et al., 2012; Dalrymple, 2010).

Tidal flats develop extensively over shorelines with a large tidal range and occupy the supratidal to shallow subtidal zones and occur in two varieties including sheltered channelized tidal flats (which will be a focus of this study), and open-coast tidal flats (Dalrymple, 2010). Figure 2A displays the typical vertical facies succession of a shallowing upward transition of a tidal channel, tidal bar, and tidal flat environment. Figure 2B is an illustrative 3-D depositional model of the spatial relationships between sub-environments present within a tidal flat environment. Tidal flats often occur bordering large tidal channels of deltas or estuaries, and therefore represent the uppermost part of the channel-bar succession (Figure 2A) (Dalrymple, 2010).

Sediment surrounding these large channels is typically sandy and constitutes a zone known as the sandflat, which then grades into a mud-rich zone near the high-tide line (mudflat). Sandflats occupy the lower portion of tidal flats and can contain dune crossbedding, ripple-cross lamination, and parallel lamination where tidal current speeds are highest and flaser bedding (Figure 1A) is a common attribute observed in sandflats. Mixed flats are located landward of sandflats and contain a higher percentage of preserved mud, deposited during slack-water settling and may exhibit wavy-bedding (Figure 1B). Mudflats are located landward of sand and mixed flats (near the high tide-line) (Figure 2B), and exhibit higher volumes of mud with little sand and lenticular bedding (Figure 1C) is common. Above the mudflat zone is the supratidal range where salt marshes and terrestrial vegetation is common. Terrestrial vegetation rooting often destroys stratification, creating more homogenous sediment, and peat-accumulation is possible in both saltwater and freshwater settings. Features characteristic of supratidal zones include desiccation cracks, organic debris (such as roots and wood fragments), peat, and root-casts.

Many mud-rich tidal flat systems exhibit more complex networks of small- to medium-sized meandering tidal gullies which increase in width and coalesce seaward into larger tidal creeks, streams, and channels. Due to the development of tidal gullies and creeks via lateral accretion, inclined IHS is common. In some regions, laterally-accreted IHS tidal bars occupy most of the gross volume of tidal facies succession (as in Figure 2A), while in other areas tidal drainage networks the gullies, creeks, and channels are relatively stable (i.e. do not meander) and stratigraphic successions are volumetrically dominated by horizontally-bedded overbank tidal flat deposits. Progradation (via sea-level fall or stagnation) of channel-associated tidal flat successions generates a generalized upward-fining sequence of lithology (grain-sizes) (Figure 2A), which begin with an erosional surface created by channel erosion and exhibits a gradational decrease in grain size and thickness of sand beds into thicker proportions of mud, representing a shift to shallower relative water depths (known as a shallowing upward trend) (Dalrymple, 2010).

### *Review of Fluvial Depositional Systems*

Fluvial (river) systems are surface drainage agents which immediately develop upon the uplift of continental crust above sea level, transporting sediment and water flux on land and into the world's oceans. Generally, within any river system, sediment load is observed to volumetrically increase and sediment profiles often mature (reduction in grain size and roughness, resulting from sorting, abrasion, and selective deposition) moving downstream across its drainage path. Rivers generally exhibit a graded longitudinal profile, in which river bodies are steeper at source, while flattening out to a fraction of a degree at the river-mount or sea level (Miall, 2010).

Fluvial deposits range in size from very coarse conglomerates to fine muds, reflective of a variety of sub-environments within a drainage system, with grain-size variations being related to the energy upon which the river flows and its proximity to sources of sediments (uplifted areas such as mountain ranges). Sediment is transported in these systems via traction currents and sediment gravity flows. Traction currents transport cohesionless sediment (dispersed as individual moving grains), where large grains move via bedload (sliding/rolling along riverbed), and smaller grains move via saltation (bouncing along bed) or swept downstream via suspended load. The finest grain sizes (silt/clay) typically remain in suspended load until water velocity reaches zero, where they are slowly deposited by settling. Sediment gravity flows are less abundant in fluvial systems but may be significant. Sediment gravity flows occur when large masses of sediment are mobilized by slope failure or liquefaction along a slope. Mass wasting events manifest in both subaerial and subaqueous environments, with the gravity flow potentially originating as a landslide, subaqueous debris flow, or potentially a transformation from the former into the latter, as the gravity flow moves down slope from subaerial into subaqueous environments (Miall, 2010). All fluvial systems exhibit some combination of common architectural elements (Figure 3) upon which the fluvial sedimentary succession is comprised of. These architectural elements will be described in further detail below.

Fluvial systems take a variety of channel and floodplain architectural profiles (each characterized by their own facies model), largely based on the volume and character of sediment load, fluid discharge, and riverbank stability, which operate during seasonal floods. The varying classifications of dominant fluvial systems is summarized in Figure 3. Depending on the scale of investigation, the comprehensive drainage system of a basin, sub-basin, or watershed may be comprised of a combination of these fluvial types within different reaches downgradient. The variation between fluvial types is mainly controlled by dynamic changes to controlling variables (slope, sediment supply, accommodation space, proximity to sea level, vegetation, local climate). Additionally, river systems may transition to other profiles due to damming (such as in glacially influenced systems), causing a reduced discharge variability, potentially leading to a stabilization of the system, shifting systems to higher sinuosity profiles (meandering or anastomosing) (Miall, 2010).

Meandering rivers are sandy-bedload rivers with high-sinuous channel forms, where the large volumes of sand and gravel laterally accumulate along point bars, located on the inside of meanders (Figures 3 and 4). Channel cut banks (opposite of the point bar) are rarely preserved, but serve as a localized sediment source for the river system, fed by mass-wasting events and constant erosion. Point bar deposits are characterized by fining-upward (gravel to silt/clay) grain-size profiles, which laterally accumulate along gently-dipping accretion surfaces, locally infilling channels within meanders (i.e., channel bar deposits). A wedge-shaped levee (often referred to as an overbank levee or sand-levee) typically develops along the boundary of the channel as a result of un-channelized flow, when water levels overtop the bank (bank-full discharge). Overbank levee deposits may be extensive, interfingering with floodplain/swamp deposits; this architectural feature often exhibits a fining-upward grain-size pattern comprised of sand that transitions into silt and clay, deposited mainly by suspension settling. Floodplain sub-environments are typically characterized fine-grained (silt, clay, and peat) units yielding a subtle irregular grain-size pattern comprised mainly of silt and mud that are episodically interlaminated with sand deposited during un-channelized flow conditions (bank full discharge). In saturated swamp/bog areas located along the peripherals, where sand/silt depositional volumes are small and vegetation readily accumulates, silty peats and coals may develop. Crevasse channel-splay associations develop when the overbank level is locally breached, resulting in a potentially permanent diversion of main channel flow (initiating a river avulsion event), spilling coarse-to-fine grained sediment into the overbank and floodplain areas as broad splays (Figure 4).

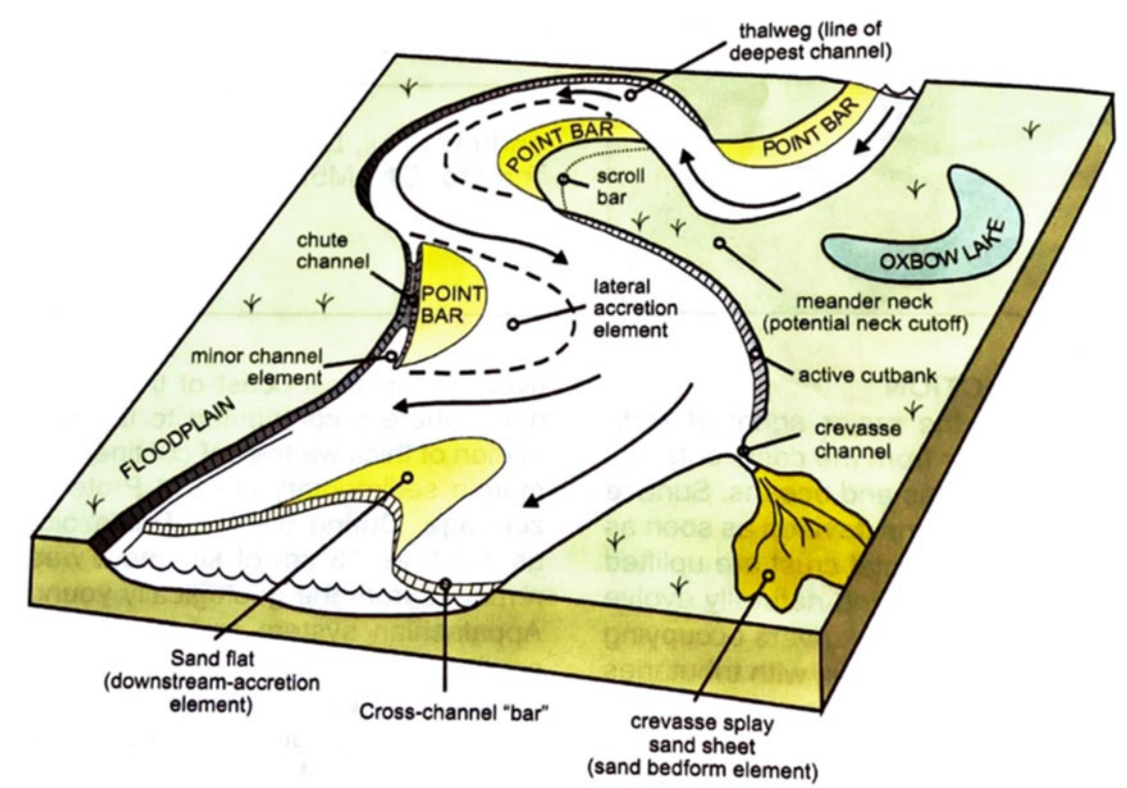



Figure 3. Conceptual diagram illustrating the main architectural elements used to describe features of all fluvial systems (from Miall, 2010).

Braided rivers (Figure 3) are broad, low-sinuosity, multi-channel fluvial systems that typically develop in areas with a large volume of coarse-grained sediment (gravel-sand bedload systems) and generate extensive coalesced fluvial sand bar deposits in the stratigraphic record. In these systems, multiple broad shallow channels are often separated by temporary bars or islands that develop as upstream-, lateral-, and downstream-accretion deposits. Braided river systems exhibit a highly variable discharge and mainly evolve from the flooding of channels, erosional diversion and subsequent initiation of new channels, and bar migration during peak-flood events. Two main profiles of braided river systems exist including sand-bed systems and gravel-bed systems. Sand-bed systems are volumetrically sand-rich and characterized by sandy bars with large 3-D sand dunes (planar-tabular cross bedded) and/or lobate unit bars (planar-cross bedded) which may coalesce into wide semi-permanent sandflats that may potentially become vegetated.

Gravel-bed braided systems develop proximal to significant sediment sources yielding gravel bedload, often occurring as glaciofluvial outwash streams (glacial outwash plains), proximal streams near alluvial fans, or rivers flowing directly from areas actively experiencing tectonic uplift. These systems tend to be gravel-rich, and feature lateral-to-downstream accretionary gravel bars, often with sand accumulating on bar-top channels during low flow conditions. Gravel-bed systems exhibit a fining upward grain-size pattern, volumetrically dominated by gravel relative to finer sediment (Miall, 2010).

Anastomosing (branching) river systems are fluvial systems comprised of two or more interconnected channels which enclose flood basins, and most commonly develop under low-energy conditions near base level (Figures 3 and 5). These systems are less common and more poorly understood than other fluvial systems, where knowledge of climatic and sedimentological controls on their formation and therefore facies models are still progressing. Channel belts within these systems are generally known to be relatively stable in position, where little lateral migration of the channel body occurs, making point bar deposits of minor importance (Miall, 2010). However, this assumption is not always accurate, as individual channel belts which may be classified as straight, meandering, or braided, are observed to be part of larger anastomosing river systems (per definition above) when evaluating the system at larger scales (Makaske, 2001). Anastomosing rivers are usually formed by avulsion in two ways: (1) by formation of a bypass, where the older channel belt remains active for some period of time or (2) by the splitting of diverted avulsive flow resulting in concurrent scour of multiple channels on the floodplain. Both types of anastomosis may coexist within the same river system, whereas the first may be long-lived versus the latter which may only represent a stage in the avulsion process. Long-lived anastomosis is caused by frequent avulsions and/or slow abandonment of old channels. These avulsions are primarily driven by aggradation (vertical accumulation) of the channel belt and/or loss of the channel capacity; additionally, avulsion can be influenced by triggers such as extreme floods, log/ice jams, in-channel aeolian dunes, and a rapid rise in base level (Makaske, 2001). Anastomosing river deposits are characterized by the preservation of a large proportion of overbank deposits, which totally encase laterally connected channel sands (Figure 4). Anastomosing channel sand bodies frequently feature ribbon-like geometries and possess poorly developed fining upward grain-size trends with abrupt flat tops. These channel bodies are often immediately surrounded by overbank crevasse splay and thick natural levee deposits, which laterally transition to fine-grained, organic-rich (peat/coal) marsh/mire or lacustrine settings of the flood-basin and surrounding floodplain (Makaske, 2001).

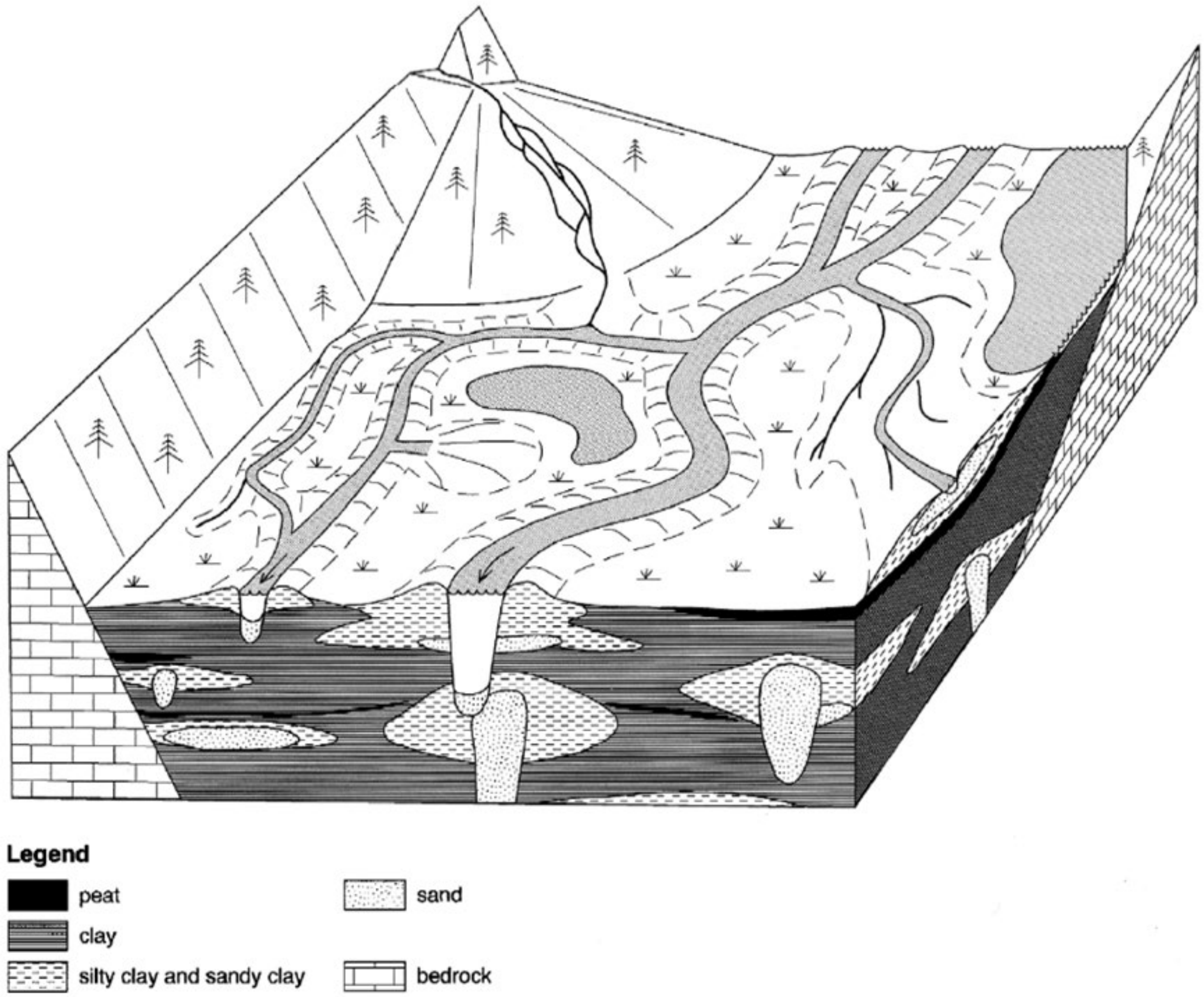



Figure 4. Facies model of a rapidly aggrading anastomosing river system in a temperate humid, montane setting. This facies model was constructed from the upper Columbia River (BC, Canada) and displays an area approximately 2 km wide with strongly exaggerated vertical scaling (from Makaske, 1998).

## Expanded ESS Facies Descriptions of Keyport OU 1 Former Landfill Site

### Anthropogenic Landfill

Anthropogenic landfill sediments were observed as discontinuous to semi-discontinuous gravel, sand (F.-C.), clay, or silts containing waste debris (glass, wood, creosote, and various debris), which generally exhibited a lack of organized grain-size patterns and no natural depositional features/structures (Plate 7). The unit was mapped as Facies WB which has variable landfill debris and Facies AF which has an excess of concrete and black top.

## Holocene-aged Tidal Deposits

### *Formation Mapping Justification*

The upper contact of the tidal unit was mapped within the former landfill footprint based on the shallowest occurrence of organic-rich silt/clay described in historical documents as the marsh bottom of the landfill during development. In areas surrounding the landfill footprint, the upper contact was mapped below anthropogenic fill or just below the ground surface within and around the footprint of the historical shoreline when geologic data were suggestive of a tidal origin. The bottom contact of the tidal package was mapped based on the first occurrence of peat, clay, or silt beneath the coarse-rich basal unit (Facies CRB). The placement of the bottom contact at the first occurrence of peat below Facies CRB was established with the following justification: (1) peat often forms in saturated marsh settings with low sediment flux and is often found in channel-distal fluvial floodplains or supratidal marsh environments (Dalrymple, 2010; Miall, 2010), therefore peat is a lithology indicative of a transition into terrestrial settings; (2) the occurrence of fully-developed peat beds within the Puget Lowland may be used as an indicator for non-glacial deposition (Troost, 2016; Borden and Troost, 2001); (3) peats, clays, and silts below Facies CRB are significantly stiffer (described as very dense to very hard) than overlying deposits, suggestive of sustained overburden pressures and; (4) intervals that feature the stiff peat, clay, and silt were historically mapped as the upper contact of the Clover Park unit.

### *Holocene Tidal Flat Facies Descriptions*

The tidal unit is interpreted to be comprised of four ESS facies including: a coarse-grained basal unit (Facies CRB), fines-rich heterolith (Facies FRH), sand-rich heterolith (Facies SRH), and organized sand and gravel (Facies OSG) (each summarized in Plate 7).

**Coarse-rich Basal Unit (Facies CRB):** is observed as normally graded to massive, gravelly sand to sandy gravel, with fine to coarse sand. Due to its variable thickness and dominance of gravel, sediment from Facies CRB is likely sourced from glacial drift bluffs within the immediate area, which were subjected to erosion and subsequent collapse where sediment was reworked, winnowed, and redistributed by tidal currents and wave action during Holocene sea-level rise. Facies CRB is interpreted to consist of highly permeable gravels and sand across most of the OU 1 site, but gradually decreases in relative permeability moving outward to the modern tidal flats, where a sand-rich profile is observed (B-B', Plate 2) until a pinchout point which occurs before the Highway 308 Causeway (A-A', Plate 1). Facies CRB is generally overlain by a sand-rich heterolithic unit (Facies SRH); however, in the South Plantation, Facies CRB is observed to be overlain by rare, thin, discontinuous silt beds (present in I-I' and N-N', Plates 5 and 6). Facies CRB overlies the bottom contact of the tidal package, occurring as an extensive gravel-rich belt draping and infilling the erosional topography of the underlying Olympia interglacial deposits.

**Sand-rich Heterolith (Facies SRH):** is observed to be a poorly to well sorted, greenish-to-blueish-grey, sand with few clay and silt sized grains with uncommon shells and trace amounts of gravel (Plate 7). Some descriptions of intervals designated as Facies SRH described the lithology as exhibiting lenticular bedding from original boring logs. Due to the overall well-sorted nature, presence of shells, low amount of silt and clay, and lenticular bedding, Facies SRH is interpreted to be tidal in origin, likely deposited as sand-rich symmetrical or asymmetrical tidalites and features a gradual increase in mud moving up-section. Facies SRH was plausibly deposited in sand-to-mixed flat environment within the intertidal range. Tidalite deposits within these settings are likely to exhibit sand-rich bedding profiles such as ripple-cross lamination, planar lamination, lenticular bedding, and transitions upward into wavy-bedding with increasing volumes of preserved mud. These sand-rich bedforms deposited in sand flat-to-lower mixed flat settings are likely to generate units with moderate to high overall permeability; however, meso- to micro-scale aquifer heterogeneities are likely present due to mud volumes incorporated within the sand-rich architecture preserved as mud-drapes. Facies SRH maintains the same thickness throughout much of the site; however, the unit thickens significantly in the southern portion of the site moving from the southern Central Landfill into the South Plantation. Within the southern portion of the study area, Facies SRH is observed to directly abut or be near to underlying interglacial deposits (I-I', N-N', Plates 5 and 6). Facies SRH is observed to interfinger and overlie the fine-grained heterolithic unit (Facies FRH), drape the gravel-rich basal unit (Facies CRB) across most of the site and may be encountered throughout the study area (B-B', D-D', G-G', I-I', N-N', Plates 2-6).

**Fines-rich Heterolith (Facies FRH):** is observed to be soft-to-stiff, very dark green-to-grey, silty-to-sandy clays or silt with interbedded to interlaminated sands, minor to moderate amounts of fine organic matter, roots with trace amounts of gravel and shells (Plate 7). Due to its interbedded and interlaminated nature, relative low sand volume, and presence of shells, woody debris and roots, Facies FRH is interpreted to be mud-rich, symmetrical or asymmetrical rhythmic tidalites deposited within the upper intertidal to lower supratidal range. Facies FRH is most likely a combination of mixed flat, mudflat, and marsh depositional environments. Common tidal bedforms in these depositional settings may feature mud-prominent profiles such as planar lamination, wavy, or lenticular bedforms. These bedding characteristics combined with the relative high volume of fine-grained sediment suggests the unit likely features meso- to micro-scale heterogeneity, likely resulting in low permeability. The unit exhibits a variable thickness, interfingers with Facies SRH in the southern Central Landfill to South Plantation areas, and directly underlies the former OU 1 landfill waste body for much of the site (D-D', G-G', I-I' and N-N', Plates 3-6). Facies FRH is the shallowest unit within the footprint of the historical shoreline, underlying most anthropogenic fill (including beneath roadways).

**Organized Sand & Gravel (Facies OSG)**: is observed to be laterally discontinuous, normally graded sequences of gravel and fine to coarse sand which cross-cuts all tidal ESS facies. Due to its well defined and normally graded nature, localized discontinuous occurrence between borings/wells, and its cross-cutting relationship with all other tidal facies, Facies OSG is interpreted to be tidal channels and small gullies. These deposits are potentially part of a greater channel/gulley network which drained ancient tidal flats of Dogfish Bay. As currently mapped these gross channel forms of Facies OSG are likely infilled by laterally accreted bar deposits of various sizes, and channel forms are plausibly comprised of several fining-upward bar deposits separated by lateral accretion surfaces. Channel forms drawn on ESS cross sections only denote their presence; however, the true scale and connectivity of these features is still unknown. The occurrence of Facies OSG is observed to cross-cut all facies interpreted to be of a tidal origin

(Facies FRH, SRH, and CRB), and occurs at a variety of scales. Tidal drainage networks are known to be very complex and dynamic systems. Facies OSG is likely of moderate to high sinuosity, given the inland location of the OU 1 site relative to the larger Port Orchard.

### Vashon Drift (Undifferentiated)

#### *Vashon Drift Formation Mapping Justification*

The Vashon Drift (Facies GD) was mapped based on historical boring log descriptions which describe sedimentary characteristics indicative of a glacial origin (till callouts, proglacial lake, advance/retreat outwash, etc.). Facies GD is interpreted to feature geologic deposits which encompass all deposits associated with episodic glaciation (known simply as glacial drift), including proglacial lacustrine deposits, advancement outwash, glacial till, and retreat/meltwater outwash.

### Pre-Vashon aged Interglacial Deposits (Olympia Formation)

#### *Interglacial Unit Mapping Justification*

The upper contact of the alluvial sedimentary package is established as the first occurrence of peat, silt, or clay beneath the coarse basal unit (Facies CRB [Plate 7]) of the tidal package or below intervals designated as glacial drift. This upper contact is commonly very stiff-to-hard platy peat with minor amounts of clay or silt. In rare instances, the contact has been observed to be softer/lighter, likely due to weathering/erosion. The unit is largely correlative across the entire site, generally occurring between -15 to -25 feet elevation(NAVD 88) or 30 to 40 feet bgs (Figure C-13). Due to the limited depth of penetration of most borings available for this study, the bottom contact of the interglacial unit was not resolvable, apart from the boring log for the PUD-1 well, which suggested the interglacial unit may extend down to a depth of 100 to 150 feet bgs, to the uppermost contact of another gravel drift deposit, which may be the Possession glacial drift.

The interglacial deposits are overlain by tidal deposits (specifically Facies CRB and SRH) within the extent of OU 1 and moving out into the periphery of the study area along the Highway 308 Causeway and into the upland areas outside of the historical shoreline, the unit is overlain by glacial drift deposits that are interpreted to be Vashon-age (A-A’ and B-B’ [Plates 1-2]). Due to the relative stratigraphic position of these terrestrial interglacial deposits with respect to the Post-Vashon tidal package and the Vashon Drift Formation, coupled with the indications of sustained overburden and consolidation, this unit is interpreted to be notably older than overlying units, likely being deposited in either the Olympia or Whidbey interglacial periods; therefore, being correlative to either the Olympia Formation (Discovery Unit) or the Whidbey/Kitsap Formations deposited during the Whidbey interglacial period. Absolute dating techniques are needed to provide a time range of deposition and identify which unit is correlative to this formation; however, relative dating techniques involving stratigraphic superposition indicate this interval to likely be Olympia Interglacial Period in age, and hereby is referred to as the Olympia Formation until contrary evidence for is chronostratigraphic designation is obtained. Regardless of its exact lithostratigraphic or chronostratigraphic designation, the unit is interpreted to be correlative to the Clover Park Aquitard (unit Qn4) originally mapped by U.S. Navy (1993) as the OU 1 aquitard. The upper contact of the Olympia Formation is substantially eroded, characterized as a scoured irregular surface, with abrupt topographic depressions and localized erosional highs. The contact abruptly deepens beneath the west side of the OU 1 site from west of the South Plantation beside the North Planation and under the modern tidal flats to the Northeast, and to the southwest west of the South Plantation (Figure C-13), apparently shallowing to the west, east and southeast. Trends in gross thickness of the unit are unknown; however, erosional topography of the upper contact controls thickness trends of the overlying tidal package, as it infills the erosional topography.

### *Interglacial Unit Facies Descriptions*

The internal stratigraphic architecture of the interglacial sedimentary package is interpreted to be comprised of three ESS facies including: Peat-rich fines (Facies PRF), thin gravel and sand (Facies TGS), and normally graded sand and gravel (Facies OSG [Plate 7]).

**Peat-rich Fines (Facies PRF):** is observed to be a very stiff to hard, platy, dark grey-to-blueish gray, wet-dry, carbonaceous to inorganic silty clay to clayey silt. Additionally, PRF has peat with tree stumps and woody/organic debris with interlaminated sand (Plate 7). Due to the presence of peat, clay, and woody debris coupled with the low occurrence of coarser grain sizes, Facies PRF is interpreted to be deposited in a terrestrial environment, probably within a distal fluvial floodplain or marsh environment. Facies PRF is observed to occupy most of the interglacial package shown in the six cross sections analyzed (Plates 1-6 of the main text) and is interpreted to be historically mapped as a continuous aquitard for NBK Keyport OU 1, thought to be equivalent to the Clover Park Unit mapped by U.S. Navy (1993, 1997).

**Organized Sand and Gravel (Facies OSG)**: is discontinuous to semi-continuous, normally graded sequence of gravel and sand (fine to coarse) (D-D', I-I' N-N' [Plates 3-6]). This facies is in the interglacial deposits as well as the tidal deposits. Due to its normal grading and its localized discontinuous occurrence between borings/wells, Facies OSG is interpreted to be fluvial channel bodies. There appears to be two distinct channel bodies present within the interglacial sedimentary package (D-D', I-I', N-N' [Plates 3-6]), and preliminary data indicate the channel bodies are oriented roughly northwest-southeast (Figure C-14), possibly extending from the South Plantation to the North Plantation. It remains unverified which fluvial style profile these channels are (meandering, anastomosing, or braided), and whether these channel bodies are laterally connected (D-D', I-I' [Plates 3 and 5]) as coalesced or laterally accreting channel-bar associations. It is also uncertain whether they are each separate channel bodies encased in low-permeability floodplain fine sediments. However, due to the dominance of flood plain sediment, sharp stratal terminations at the uppermost contacts, opposite of basal and map view profiles of channel bodies, it is hypothesized that these channel bodies are likely anastomosing (Figure C-14). A significant amount of additional data would be needed to both delineate channel body extent, and hydraulic and stratigraphic connectivity between the two channel bodies. Some insights into these issues may be resolved through additional subsurface mapping (deep well installations, barge sampling, and additional geophysical investigations) and subsequent updating of ESS mapping. However, additional techniques will be needed to evaluate stratigraphic continuity and hydraulic connectivity between these deep interglacial channel bodies.

**Thin Sand and Gravel (Facies TGS):** is observed as a rare and thin, normal to inversely graded sequence of gravel and fine to coarse sand (Plate 7). Facies TGS is observed only once within the six interim ESS cross section intervals, located laterally adjacent to Facies OSG and apparently interfingering with Facies PRF. Due to its rare and thin occurrence, normal to inversely graded grain size patterns, and its spatial association with Facies OSG and PRF, Facies TGS is interpreted to likely be fluvial channel levee or crevasse splay deposits, deposited during unchannelized flow events and directly associated with channel Facies OSG.

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## *Glossary of Terms*

Architectural Elements: Component parts of sedimentary deposits with characteristic dimensions and properties, such as channel fills, overbank splays, and floodplain clays.

Avulsion: Rapid abandonment of a river channel due to a flow diversion which causes the formation of a new channel within the adjacent floodplain.

Anastomosing River: River system consisting of multiple interweaving channels. Anastomosing rivers typically consist of a network of low-gradient, narrow, deep channels with stable banks, in contrast to braided rivers, which form on steeper gradients and display less bank stability.

Accommodation Space: The area available for deposition of sediments. The accommodation space is typically below the base-level, in which deposition is the driving force. Two major controls on accommodation space include eustatic sea level changes and the subsidence rate of the basin.

Anthropocene: An unofficial geologic epoch in which the impact of humans significantly affects the geologic record, suggested to have begun in the late 18$^{th}$ century to present day.

Base-level: A plane in a landscape that distinguishes the point in which erosion is the driving force above the plane and deposition is the driving force below the plane. For example, the base-level at a marine setting is the average sea level.

Braided River: One of a number of channel types that consists of a network of small channels separated by small and often temporary islands (called braid bars). Braided streams occur in rivers with high slope and/or large sediment load, are typically only a few feet deep.

Deltaic Environment: A sedimentary depositional environment in which sediment load from a river is discharged into a body of standing water. Deltas typically form a protuberance in the shoreline and can be dominated by fluvial processes, tidal processes, or wave processes.

Depositional Model: Refer to facies models.

Depositional Processes: Natural processes which transport, deposit, and preserve sediment, such as a stream shifting across an alluvial plain.

Depositional System: A three-dimensional association or assemblage of facies (depositional environments) genetically linked by active (modern) or inferred (ancient) environmental and sedimentary processes.

Disconformity: A type of unconformity between parallel layers of sedimentary rock. A disconformity is noted by an erosional boundary formed from erosion or nondeposition.

Facies Association/Assemblage: A group of sedimentary facies which define a depositional environment.

Facies: Bodies of sediment and/or rock recognizably different from adjacent sediment which was deposited at the same time but in a different depositional environment or sub-environment (e.g., upper shoreface and lower shoreface facies of a barrier island environment).

Facies Models: Conceptual construct summarizing the processes acting to erode, transport, deposit, and preserve sediments in particular depositional environment. Also known as Depositional Models, they typically are represented as a three-dimensional block diagram showing component parts of buried strata (architectural elements), how they fit together, and a map view showing the active depositional system and its key features.

Fluvial Environment: A sedimentary depositional environment formed from rivers or streams.

Geologic Formation: A fundamental rock division of stratigraphic classification, which can be comprised of multiple units. A formation has geologic features which makes it discernable from the underlying and overlying rock.

Geologic Prognosis: Identifying the depths of formations, their hazards, and features through geological techniques.

Geologic Unit: A fundamental rock division of stratigraphic classification. It is a volume of rock that is distinctive and mappable.

Holocene: The current geologic epoch, which ranges from 11,700 kya to present.

Hydrostratigraphic Unit (HSU): A body of sediment saturated with groundwater with limited connectivity to adjacent sediments. Clastic (sedimentary) aquifers typically are composed of multiple hydrostratigraphic units due to heterogeneous geology.

Law of Superposition: A fundamental law in sedimentology and stratigraphy that states that the oldest deposits are at the base of a sequence, while the layers above those deposits are progressively younger.

Lithology: A description of physical characteristics of a rock (or unconsolidated sediments) such as color, texture, grain size, or composition.

Lithofacies: Lateral, mappable subdivision of a designated stratigraphic unit formed under common environmental conditions of deposition, distinguished from adjacent subdivisions on the basis of lithology.

Meandering River: a river system that has a gently sloped landscape with a sinuous primary channel. Meandering rivers erode sediment typically from the cut bank outer curve of the river and deposit it in point bank inner curve of the river.

Outwash: Glacial sediments deposited by meltwater at the terminus of a glacier.

Overbank: An alluvial deposit consisting of sediment that has been deposited on the floodplain of a river or stream by flood waters that have broken through or overtopped the banks.

Sediment Supply: A major control on stratigraphy, which is the amount of sediment influx into a depositional system. Sediment supply can be affected by factors which include but are not limited to climactic changes and tectonic changes.

Sedimentary Depositional Environment: Specific depositional settings that are unique in terms of physical, chemical, and biological characteristics (e.g., lake, stream, deep marine, glacier, etc.).

Sedimentary Unit: Layers that are originally deposited as sediment from weathering processes, decaying organic matter, or chemical precipitation.

Sequence Stratigraphy: The study of the sedimentary packages through time, where the vertical succession of rocks is subdivided into genetically related units based on their conformable and unconformable surfaces.

Strata: Layers of sedimentary rocks or sediments.

Stratigraphic Architecture: The relationship of the chronostratigraphic packages of rock in a particular stratigraphic system.

Transgression: A rise in sea level, which can cause flooding of land.

Unconformity: a gap in the geologic record caused by erosion or nondeposition.

Walther's Law of Facies: Vertical changes in lithology are mirrored by similar lateral changes.


| U.S. NAVY | Figure C-1<br>Keyport Location in the Puget Lowland | Naval Base Kitsap<br>Keyport |
|---|---|---|

<table>
<tr><th colspan="2">Climate Units & Approximate Age[1]</th><th>Island County[3]</th><th>Snohomish County[4]</th><th colspan="2">N.W. King County[5]</th><th>S.W. King County[6]</th><th>Pierce County[7]</th><th>Kitsap Peninsula[8]</th><th>Mason County[9]</th><th>Thurston County[10]</th><th>Jefferson County[11]</th><th>Seattle</th></tr>
<tr><td colspan="2">HOLOCENE</td><td></td><td>Younger and Older Alluviums</td><td colspan="2">Sedimentary Deposit, Peat</td><td>Peat, Alluvium</td><td>Alluvium Peat</td><td>Alluvium</td><td>Alluvium</td><td>Alluvium</td><td></td><td></td></tr>
<tr><td rowspan="5">PLEISTOCENE</td><td>10,000<br>FRASER GLACIATION</td><td>Glacial-Marine Drift, Recessional Outwash<br>Till<br>Advance Outwash<br>[2]Esperance Sand</td><td>Marysville Sand; Arlington Gravel; Stillaguamish Sand Member of Vashon Drift<br>Till<br>Advance & Esperance Sand</td><td colspan="2">Recessional and Delta Outwash<br>Till<br>Advance Outwash<br>?</td><td>Recessional Outwash<br>Till<br>Ice-Marginal Deposits<br>Advance Outwash</td><td>All Phases of Vashon Drift (Recessional & Advance Outwash, Till)</td><td>Recessional Outwash<br>Till<br>[2]Esperance Sand<br>Advance Outwash</td><td>Recessional Outwash<br>Till<br>Advance Outwash</td><td>Recessional Outwash[1,2]<br>Till<br>Advance Outwash</td><td>Recessional Outwash<br>Till<br>Advance Outwash</td><td>Till<br>Advance Outwash</td></tr>
<tr><td>23,000<br>OLYMPIA INTER-GLACIATION</td><td>Quada Formation</td><td>Pilchuck Clay Member</td><td rowspan="2">Unnamed Sand</td><td>Upper Clay</td><td rowspan="2">Salmon Springs Drift</td><td></td><td rowspan="2">Colvos Sand</td><td rowspan="3">Kitsap Formation</td><td rowspan="3">Kitsap Formation</td><td rowspan="4">Undiffer-entiated</td><td>Lawton Formation</td></tr>
<tr><td>60,000<br>POSSESSION GLACIATION</td><td>Possession Drift</td><td>Undifferentiated Till</td><td>Unnamed Gravel</td><td>Colvos Sand, Salmon Springs Drift</td><td>Klinker Till, Beacon Till, Duwamish Formation</td></tr>
<tr><td>80,000<br>WHIDBEY INTER-GLACIATION</td><td>Whidbey Formation</td><td rowspan="2">Admiralty Clay</td><td colspan="2" rowspan="2">Lower Clay</td><td>Puyallup Formation</td><td>Kitsap Formation<br>Puyallup Formation</td><td>Kitsap Formation</td><td rowspan="2"></td></tr>
<tr><td>>100,000<br>DOUBLE-BLUFF GLACIATION</td><td>Double Bluffs Drift</td><td>Intermediate Drift</td><td>Stuck Drift?</td><td>Salmon Springs Drift</td><td>Salmon Springs Drift</td><td>Salmon Springs Drift[1,2]</td></tr>
</table>

FIGURE02_V2.CDR

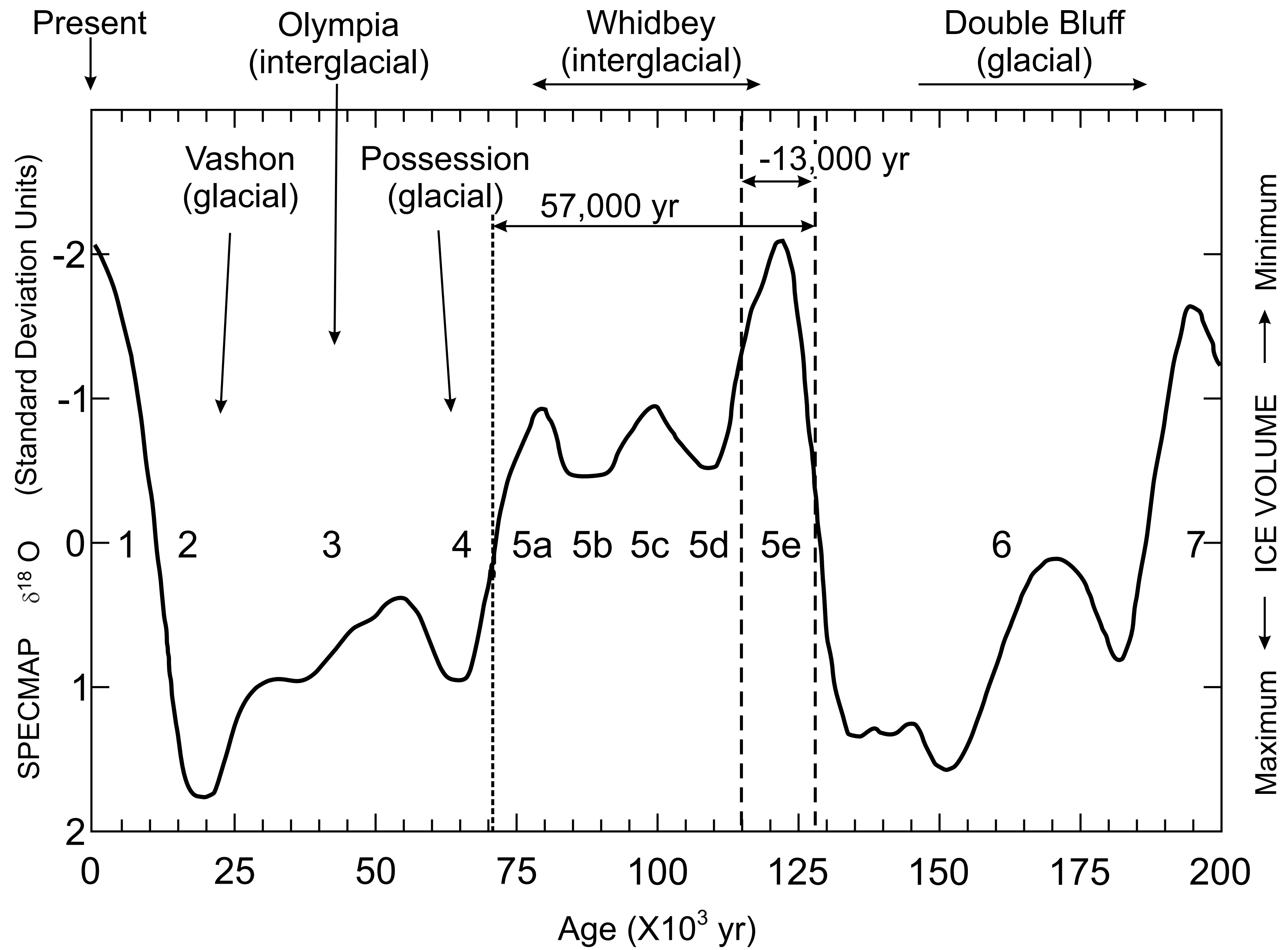
[1]Based on Marine Isotope Curve of Martinson and Others (1987) and dating work of Easterbrook (1982)
[2]Esperance Sand – Member
[3]Easterbrook, 1968
[4]Newcomb, 1952
[5]Liesch and Others, 1963
[6]Luzier, 1969
[7]Walters and Kimmel, 1968
[8]Garling, Molenaar, et al., 1965
[9]Molenaar and Noble, 1970
[10]Grimstad and Carson, 1981
[11]Grimstad and Carson, 1981

Source: Troost, 2016

**U.S. NAVY**

**Figure C-2**
**Variations in Lithostratigraphic Nomenclature Across the Puget Lowland Region**

Naval Base Kitsap Keyport



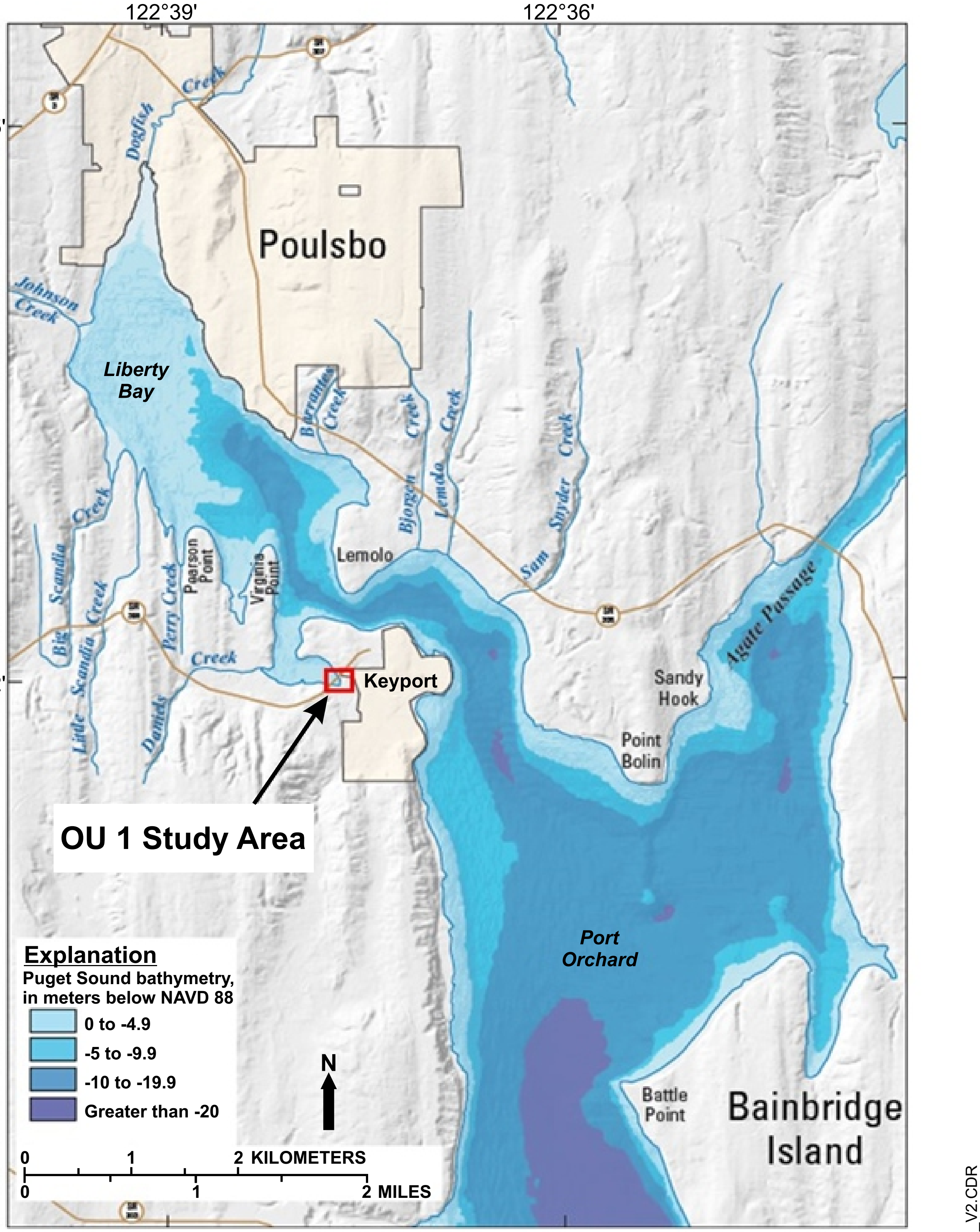

Source: Troost, 2016; modified from Winograd et al., 1997

FIGURE03_V2.CDR

**U.S. NAVY**

**Figure C-3**
**Marine Oxygen Isotope Stages (numbers 1 through 7)**
**Versus Mid- to Late-Pleistocene Stratigraphic Units**

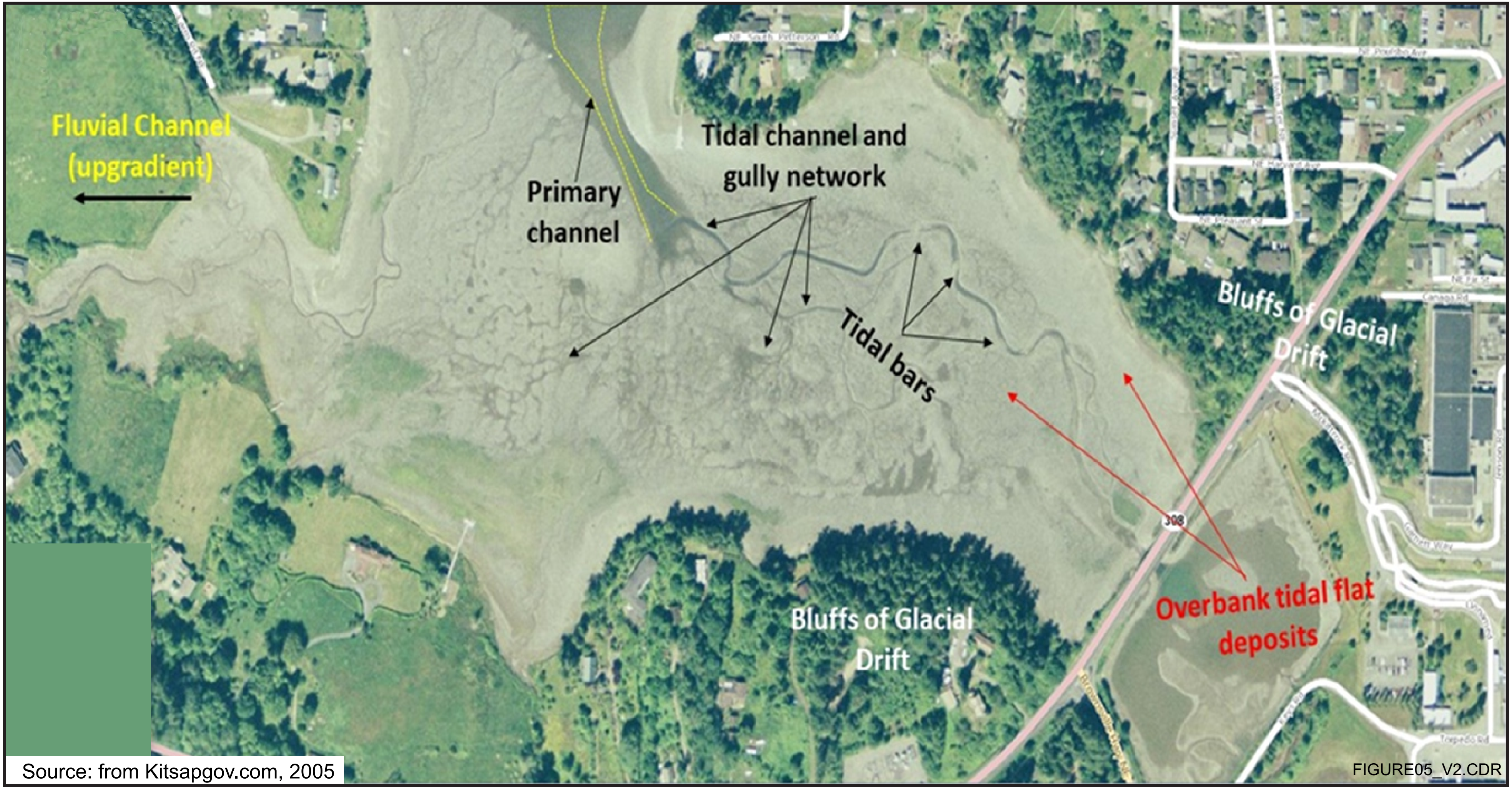
Naval Base Kitsap
Keyport




*Shaded relief map: U.S. Geological Survey National Elevation Dataset, 2000, 10-meter resolution.*
*Bathymetry: University of Washington Digital Elevation Model, 2005, 30-foot resolution.*

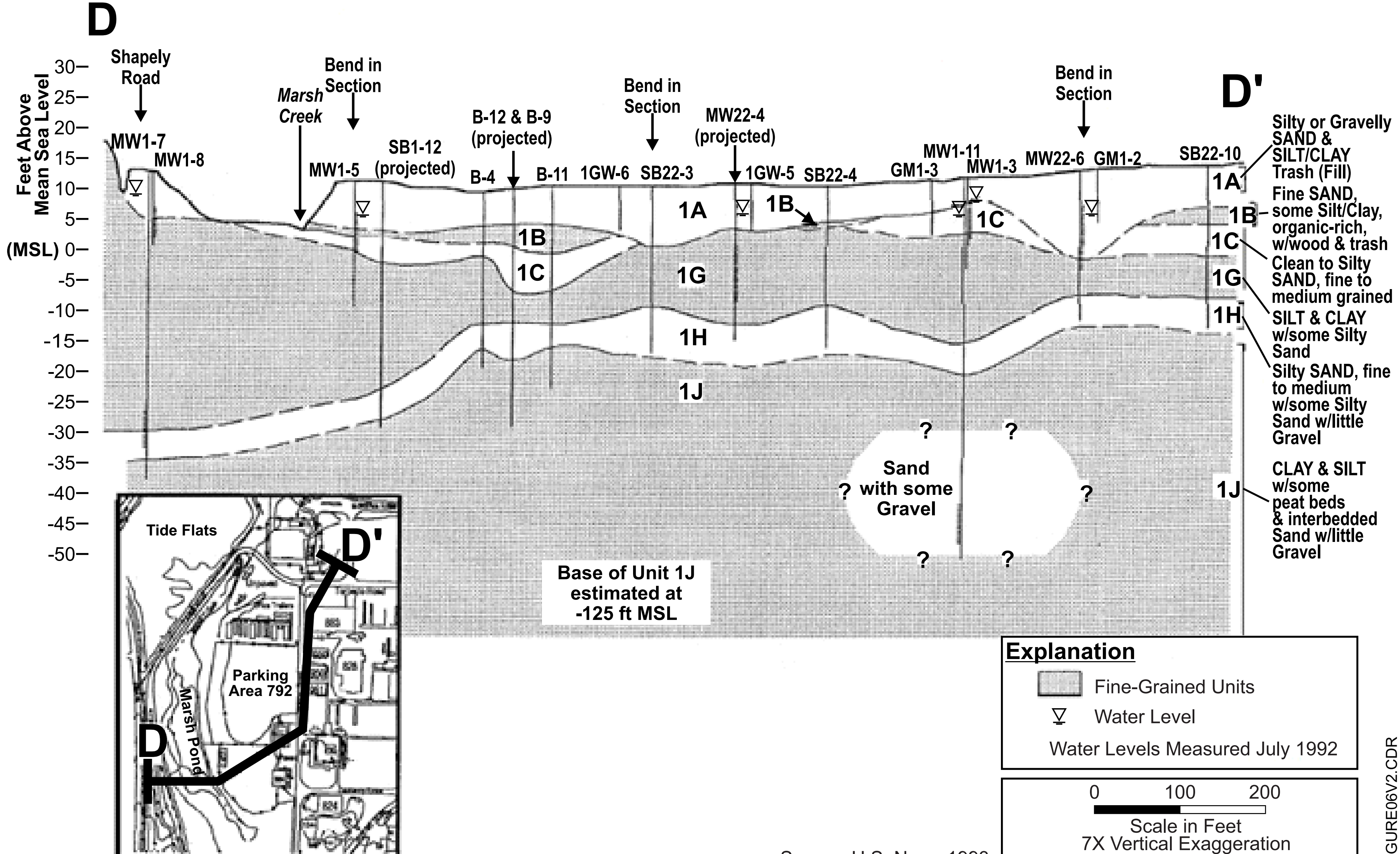
Source: Modified from Takesue et al., 2011

| U.S. NAVY | **Figure C-4**<br>**Bathymetric Map of Liberty Bay and Port Orchard** | Naval Base Kitsap<br>Keyport |
|---|---|---|




| U.S. NAVY | **Figure C-5**<br>**Interpreted Tidal Features from Exposed Tidelands of Dogfish Bay** | Naval Base Kitsap<br>Keyport |
|---|---|---|

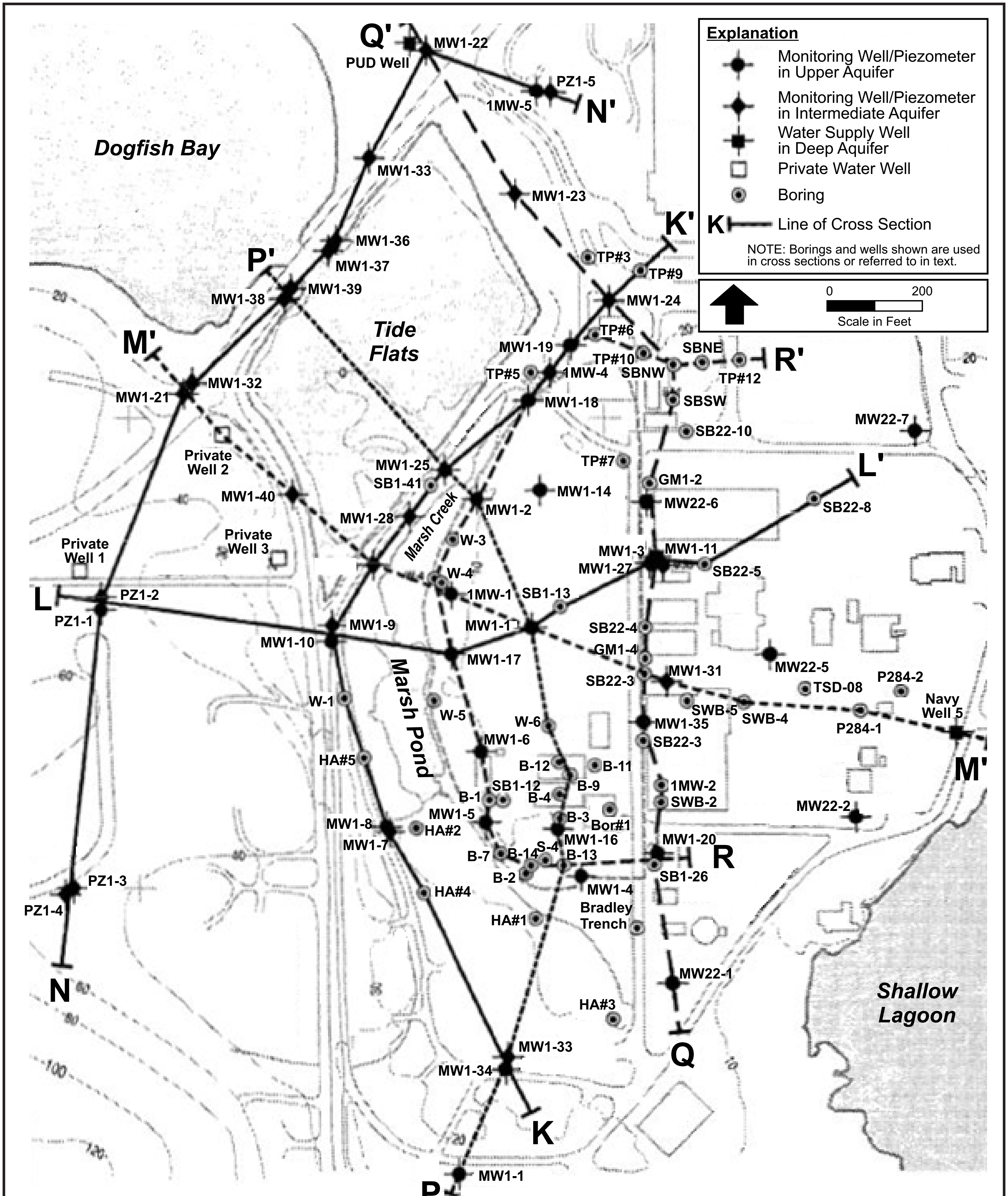
# Area 1




Source: U.S. Navy, 1993

FIGURE06V2.CDR

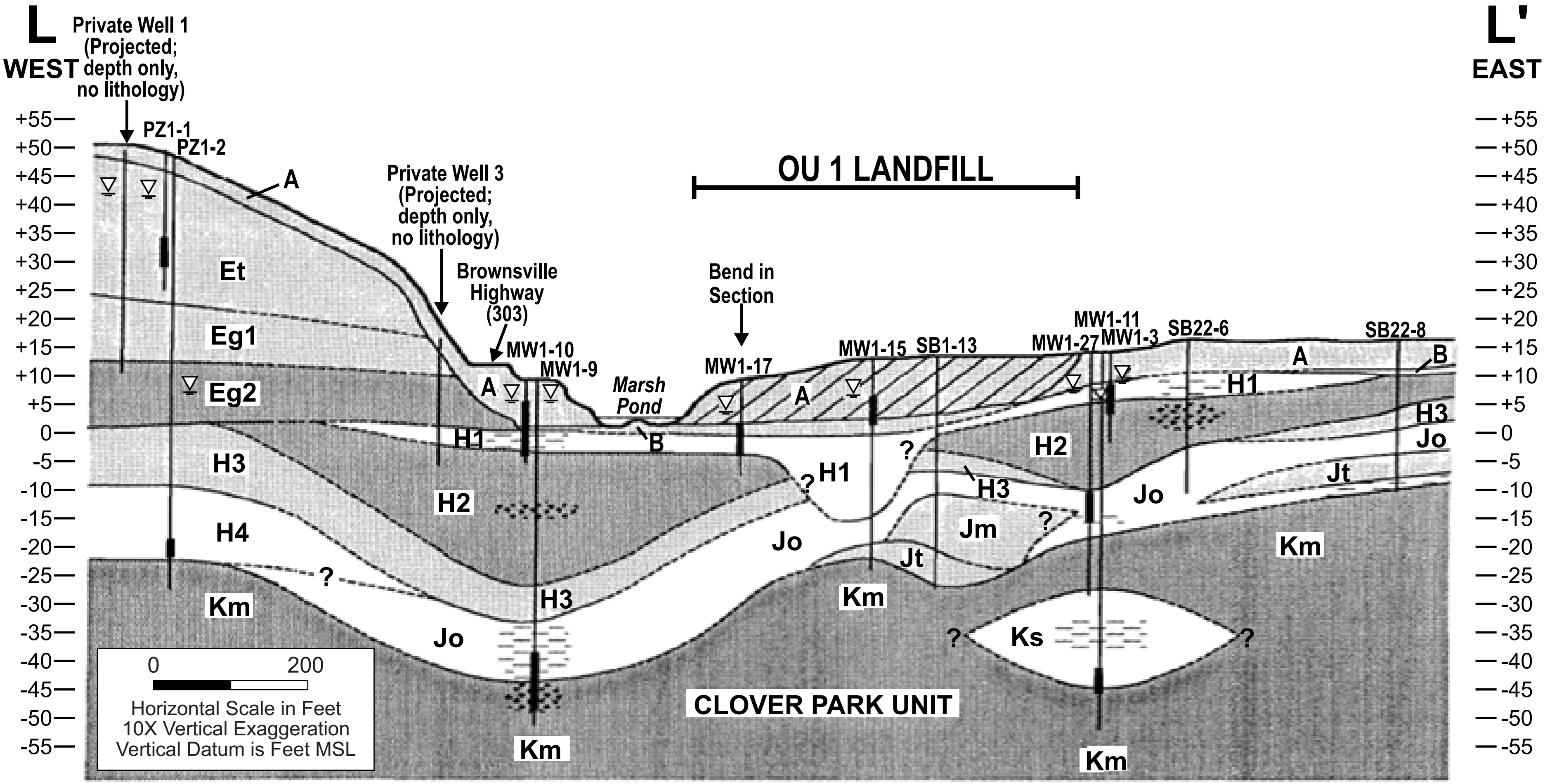
| U.S. NAVY | Figure C-6<br>Area 1 – Geologic Cross Section D-D' | Naval Base Kitsap<br>Keyport |
|---|---|---|




Source: U.S. Navy, 1997

FIGURE07_V2.CDR

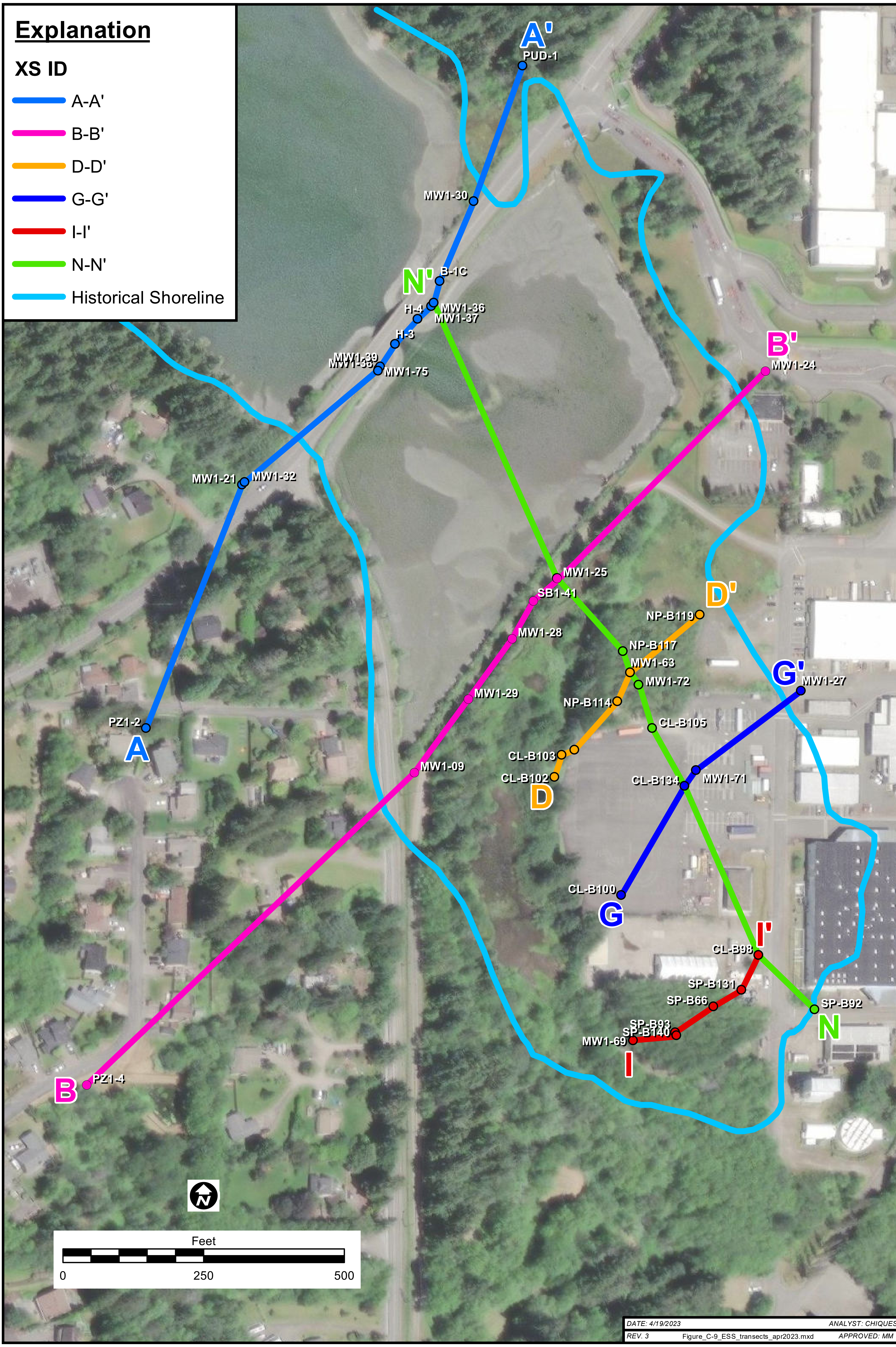
| U.S. NAVY | **Figure C-7**<br>**Location Map for Geologic Cross Sections** | Naval Base Kitsap<br>Keyport |
|---|---|---|




Source: U.S. Navy, 1997

FIGURE08_V2.CDR

| U.S. NAVY | **Figure C-8**<br>**Geologic Cross Section L-L'** | Naval Base Kitsap<br>Keyport |
|---|---|---|

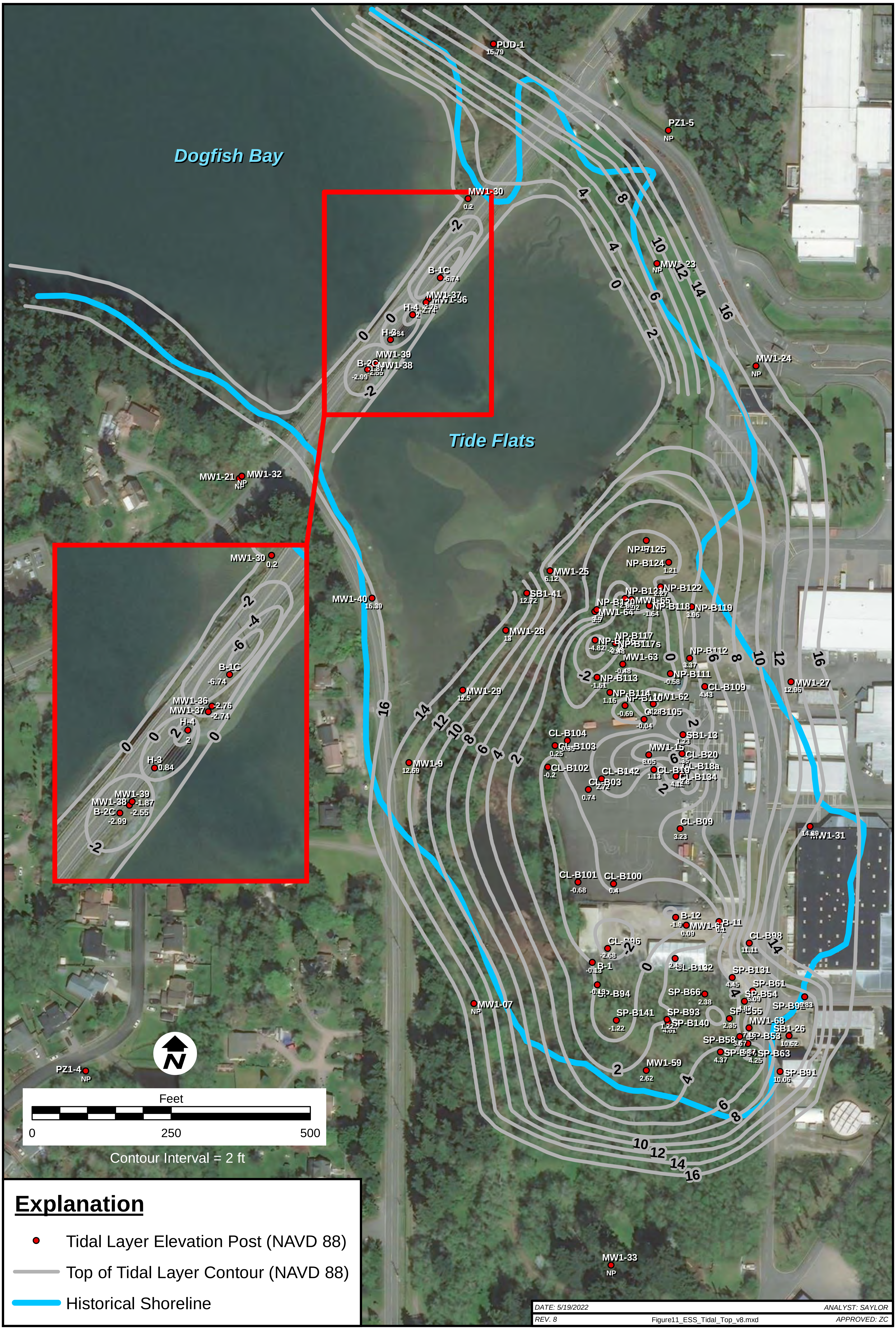



U.S. NAVY

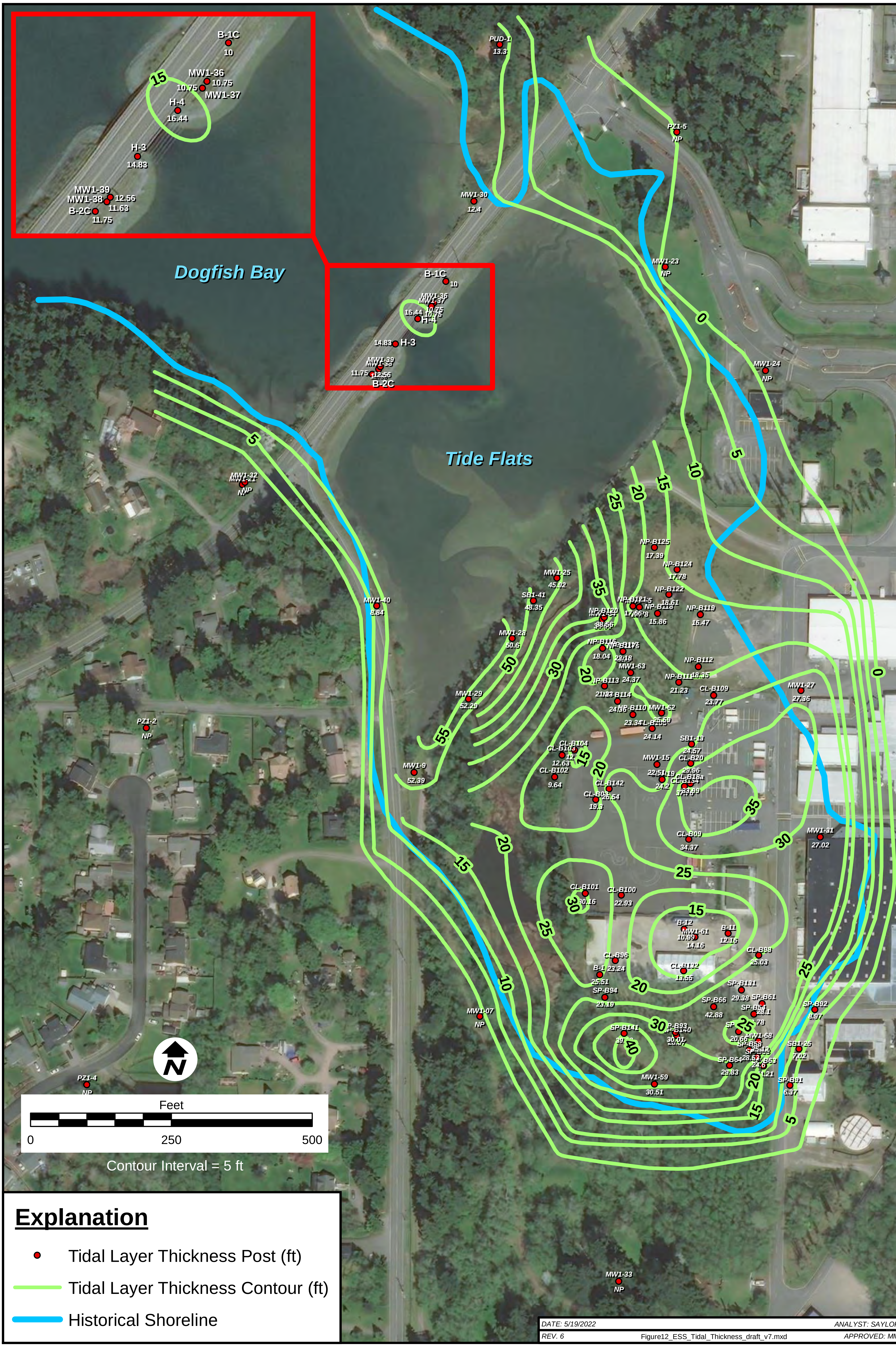
**Figure C-9**
**Location Map for ESS Cross Sections**

Naval Base Kitsap
Keyport


| U.S. NAVY | **Figure C-10**<br>**Landfill Thickness** | Naval Base Kitsap Keyport |
|---|---|---|

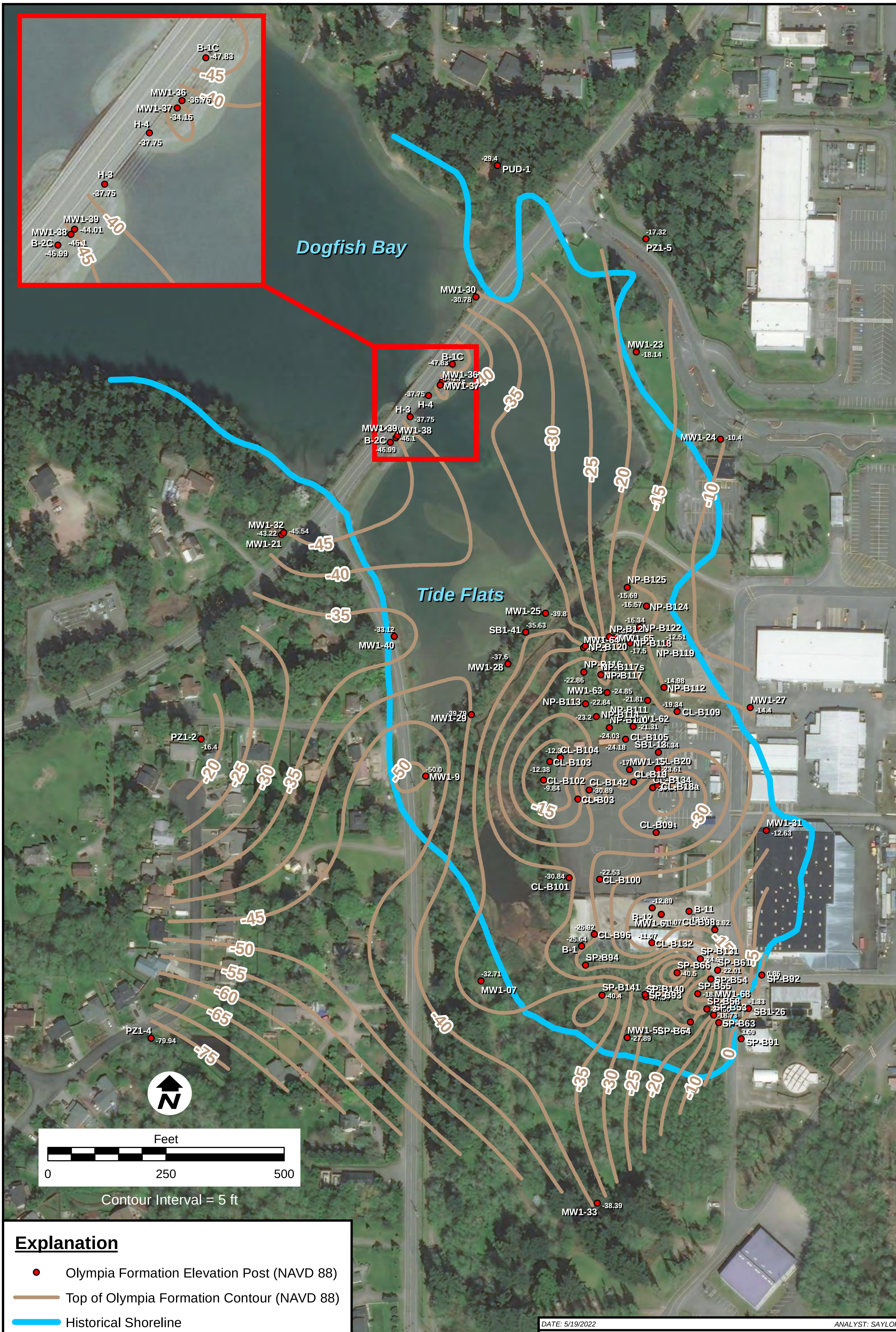



| U.S. NAVY | **Figure C-11**<br>**Top of Tidal Layer** | Naval Base Kitsap Keyport |
|---|---|---|



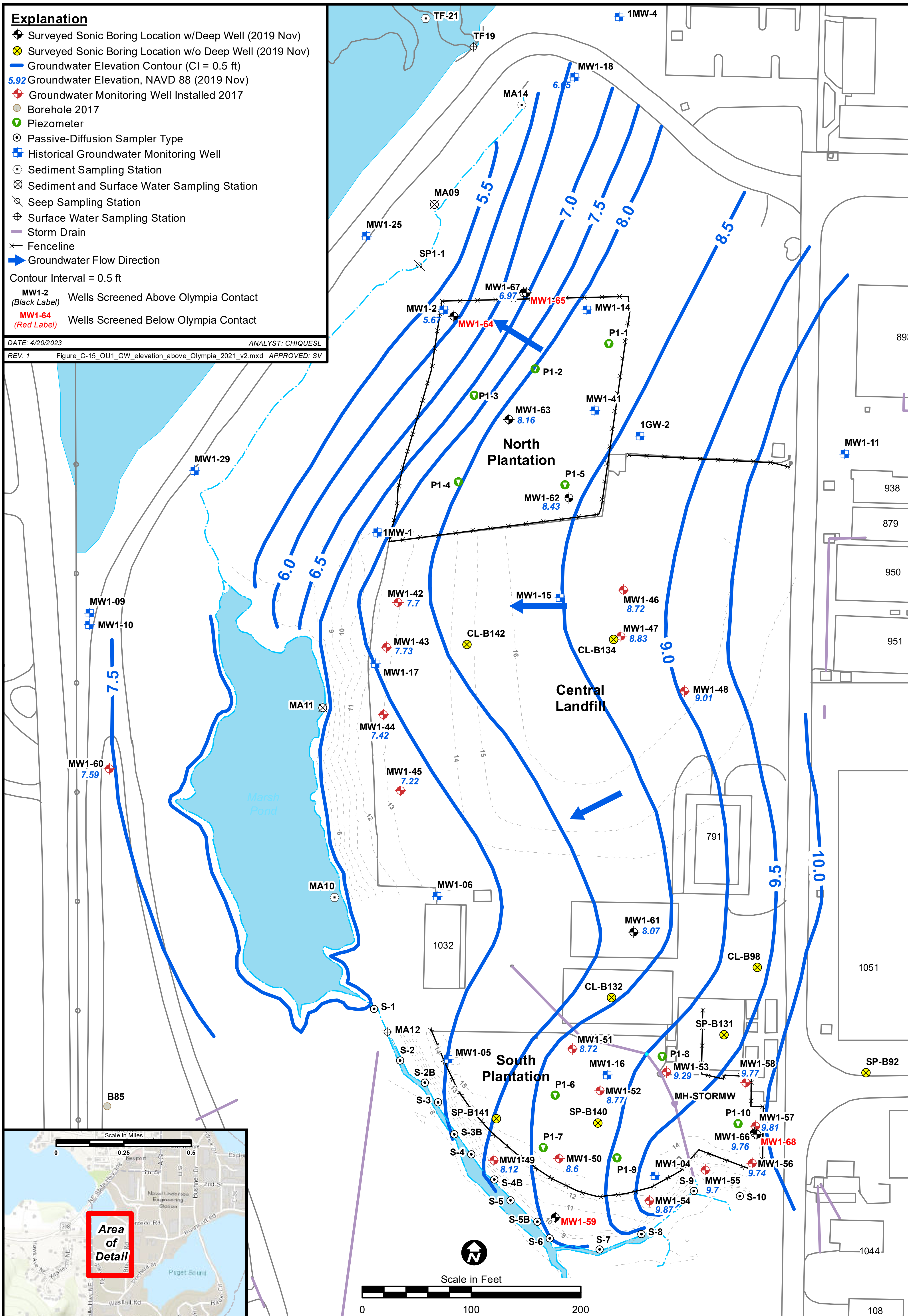

DATE: 5/19/2022 | ANALYST: SAYLOR
REV. 6 | Figure12_ESS_Tidal_Thickness_draft_v7.mxd | APPROVED: MM

| U.S. NAVY | **Figure C-12**<br>**Tidal Isopach** | Naval Base Kitsap Keyport |
|---|---|---|




| U.S. NAVY | **Figure C-13** **Top of Olympia Formation** | Naval Base Kitsap Keyport |
|---|---|---|

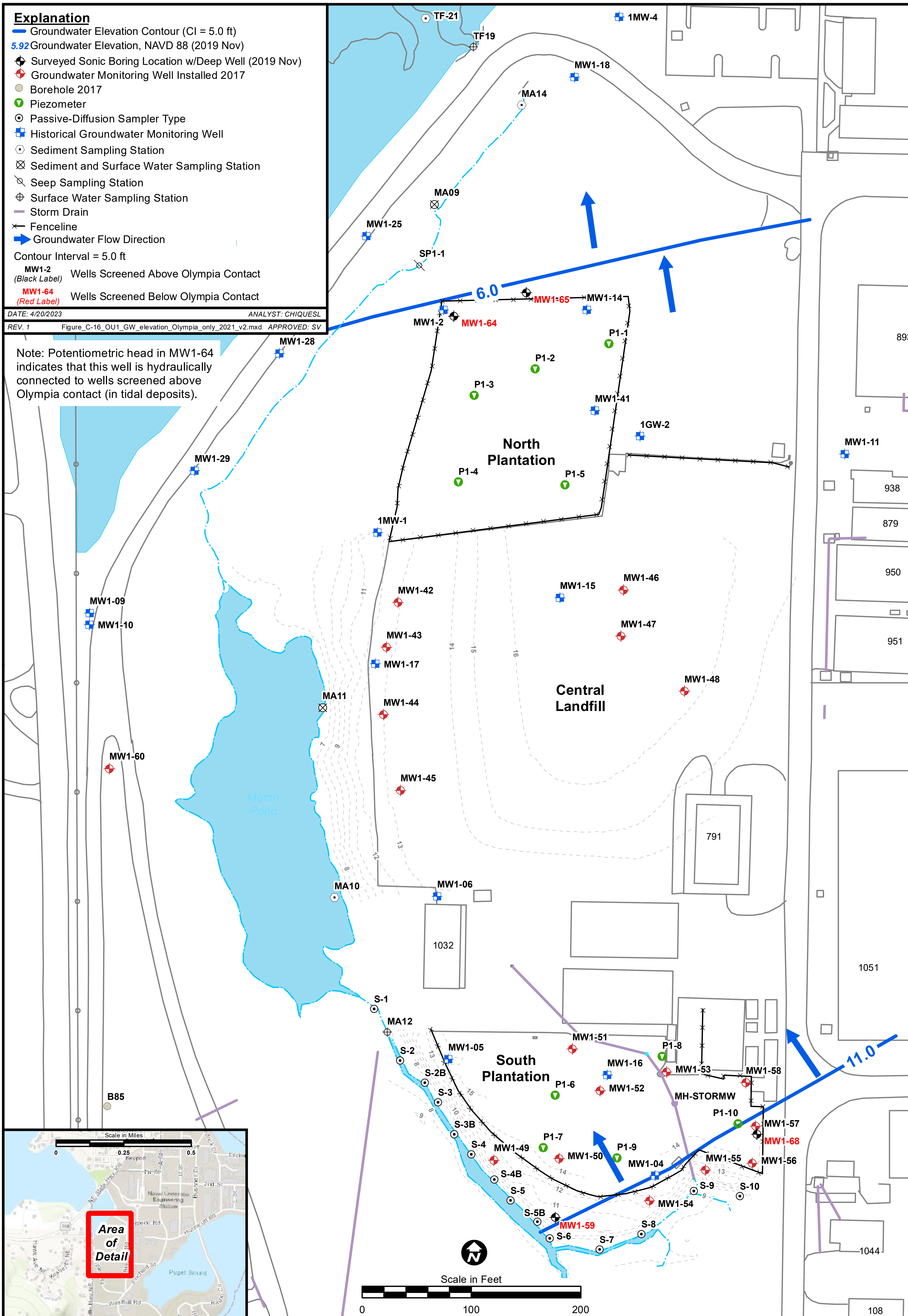

| U.S. NAVY | Figure C-14 Interpreted Fluvial Channels within the Olympia Interglacial Unit | Naval Base Kitsap Keyport |
|---|---|---|




**U.S. NAVY**

**Figure C-15**
**Groundwater Elevation Contour Map (November 2019)**
**Wells Fully Screened Above Olympia Contact Only**

Naval Base Kitsap
Keyport




U.S. NAVY

**Figure C-16**
**Groundwater Elevation Contour Map (November 2019)**
**Wells Screened Below Olympia Contact Only**

Naval Base Kitsap
Keyport

**Table C-1**

**Simplified stratigraphic column and nomenclature of the Puget Lowland Based on chronostratigraphy (Troost, 2016)**

| Geologic Unit | Reference | Age (ka) | Age Method |
|---|---|---|---|
| Vashon Drift | Armstrong et al., 1965 | 25-13.5 | $^{14}C$ |
| Olympia Interglacial Deposits | Armstrong et al., 1965<br>Troost, 1999 | 35-15<br>> 45-15 | $^{14}C$ |
| Possession Drift | Easterbrook and Rutter, 1981 | ~80 | Amino Acid |
| Whidbey Formation | Easterbrook and Rutter, 1981;<br>Easterbrook, 1994 | 107-96<br>151-102 | Amino Acid<br>Thermoluminescence |
| Double Bluff Drift | Easterbrook and Rutter, 1982;<br>Blunt et al., 1987; Easterbrook<br>et al., 1992 | 250-150<br>178-111<br>291-177 | Amino Acid<br>Amino Acid<br>Thermoluminescence |
| Salmon Springs Drift | Easterbrook, 1994 | 1000 | Inferred from Tephra |
| Lake Tapps Tephra | Easterbrook and Briggs, 1979;<br>Westgate et al., 1987 | 840<br>1000 | Fission Track<br>Fission Track |
| Puyallup Formation | Easterbrook et al., 1992 | 1690-1640 | Laser Argon, Reversely Magnetized |
| Stuck Drift | Easterbrook, 1994 | ~1600<br>>1000 | Reversely Magnetized |
| Alderton Formation | Easterbrook, 1994 | 2400-1000 | Laser Argon |
| Orting Drift | Easterbrook, 1986 | 2000? | Reversely Magnetized |

**Table C-2**
**Summary of geologic model of NBK Keyport OU 1 from RI Report (U.S. Navy, 1993)**

| RI Unit Abbrev. (1993) | Lithology | Interpretation | Described Characteristics | Thickness (feet) | Approximate Elevation (feet subsea) | KCGWAC (1991) Correlation |
|---|---|---|---|---|---|---|
| 1A | Sand, Silt, Gravel and Clay | Artificial Fill | Landfill Debris | 4-10 | 2 to17 | - |
| 1B | Silty, clay, sand, organic-rich | Marsh/Tidal Flat | Dark color, wood fragments, may contain landfill debris | 0-5 | 0 to 5 | Qn1 |
| 1C | Clean to silty fine-medium sand | Estuary Beach | Marine Shells | 0-12 | -2 to 12 | Qn1 |
| 1G | Silt, fine sand, clay | Nonglacial Fluvial/ Floodplain | Occasional Organic Debris | 10-35 | -10 to 20 | Qn3 |
| 1H | Silty-to-clean, fine to medium with local gravel | Nonglacial Fluvial/ Floodplain | Normal Grading into unit 1G | 4-10, 0-5 (gravel lenses) | -32 to 13 | Qn3 |
| 1J | Clay and silt, minor peat, some sand and gravel | Nonglacial Fluvial/ floodplain | Hard, dry, dense, two dense peat/clay zones (upper and lower) | ? | -45 to -10 | Qn4 (Clover Park Unit) |

**Table C-3**

**ESS Facies Descriptions at OU 1**

| ESS Facies | Lithology | Characteristic Descriptions, Features, and Geometry | Interpretation | Depositional Environment | Mapped Unit or Formation | Interpreted Relative Age |
|---|---|---|---|---|---|---|
| **Landfill Waste Body (WB)** | heterogeneous clay, silts, gravel, F.-C. sand | Disorganized, non-graded, heterolithic unit landfill debris (wood, concrete), odor, visible contamination (LNAPL) | Former NBK OU 1 Landfill Waste Body | Anthropogenic | **NBK OU 1 Former Landfill Wastebody** | **Holocene** |
| **Artificial Fill (AF)** | clay, silt, sand, gravel | Disorganized, non-graded, heterolithic unit, debris (concrete, black top etc.) | Artificial Fill | Anthropogenic | **Artificial Fill** | **Holocene** |
| **Overbank Muddy-Tidalite Deposits (FRH)** | silt, clay, some sand | Fines-rich heterolith, silty to sandy clay and silts with interbedded to interlaminated sands, wood fragments and debris, some silts and clays are carbonaceous, very dark green-grey to grey, mottled, soft to stiff, wet. May exhibit traces of gravel | Overbank Fines-rich Tidalites | Mixed-Mud Tidal Flat & Supratidal Marsh | **Tidal Unit** | **Holocene** |
| **Overbank Sandy-Tidalites (SRH)** | Sand (F.-C.) with fines | Clayey-silty sand (F.-C.), poor to well graded (USCS), greenish to blueish grey, planar laminations. Trace amounts of gravel | Overbank Sand-rich Tidalites | Sand to Mixed Tidal Flat | | |
| **Gravel-rich Tidal Flat Deposits (CRB)** | gravel, C. sand | Gravelly sand to sandy gravel, well sorted (poorly graded, USCS), massive to normally graded gravel and sand sequences | Gravel-rich Overbank | Sand to Mud Tidal Flat (Gravel Lag) | | |
| **Tidal Channel/Creek Deposits (OSG)** | gravel, F.-C. sand | Normally graded, well-organized sequences of gravels and sands, laterally discontinuous, presumed lenticular geometry, sequence repeats in localized areas suggesting localized stacked channel bodies and some zones may represent coalesced channel bodies | Tidal Channel/Creek Bar deposits | Tidal Channels/Creeks (Subtidal to Intertidal) | | |
| **Glacial Drift (GD)** | gravel, F.-C. sand, silt, clay | Silts, clays, sand, gravel and matrix supported gravel (till) with call outs of glacial origin in original historic boring logs. Sediment is often observed to be dense-very dense | Proglacial lacustrine, Fluvial, and Ice-contact Till Deposits | Undifferentiated Glacial Drift | **Vashon Drift** | **Pleistocene-Holocene** |
| **Floodplain/Floodbasin Fines (PRF)** | peat, silt, clay | Carbonaceous to inorganic peats, silts, and clay; may be sandy or interbedded with sand in local areas, very stiff-very dense, dark grey-blueish grey, wet-dry, may contain stumps and woody debris | Overbank Floodplain/Flood basin Fines | Fluvial Anastomosing | **Olympia Formation** | **Pleistocene** |
| **Fluvial Channel/Creek Sand and Gravel (OSG)** | gravel, F.-C. sand | Normally graded, well-organized sequences of gravels and sands, laterally discontinuous, presumed lenticular geometry, sequence repeats in localized areas suggesting localized stacked channel bodies and some zones may represent coalesced channel bodies | Fluvial Channel/Creek Bar deposits | Fluvial Anastomosing | | |
| **Crevasse Splay/Channel levee sand and gravel (TGS)** | gravel, F.-C. sand | Normal to inversely graded or massive gravel and sands, rare, found in proximity to facies OSG, likely to be discontinuous with channel-proximal thickening and channel-distal thinning thickness controls | Crevasse Splay/Channel Levee Deposits | Fluvial Anastomosing | | |

**TABLE C-4**
**GROUNDWATER SAMPLING RESULTS (2017 through 2022)**
**WITHIN OU 1 ESS CROSS SECTIONS**

| Boring/Well | Sample ID | Location [a] | Depositional Facies | Candidate HSU | GW Screen Interval (ft.) | Total VOCs [b] (µg/L) | TCE (µg/L) | cis-1,2-DCE (µg/L) | Vinyl Chloride (µg/L) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | **PAL (µg/L)** | -- | 0.3 | 16 | 0.02 |
| ***Cross Section D-D'*** | | | | | | | | | |
| CL-B102 | CL-B102-GW-13-190617 | Central | WB/FRH | HSU #1/SCU | 8 - 13 | 590 | 0.3 U | **340 J** | **230 J** |
| | CL-B102-GW-35-190617 | | OSG | HSU #4 | 31 - 35 | 42 | 0.3 U | **29** | **11** |
| CL-B103 | CL-B103-GW-09-190617 | Central | WB/FRH | HSU #1/SCU | 4 - 9 | 154 | 0.3 U | 12 | **140 J** |
| | CL-B103-GW-40-190617 | | OSG | HSU #4 | 36 - 40 | 0.34 | 0.3 U | 0.3 U | **0.34** |
| CL-B104 | CL-B104-GW-14-190618 | Central | WB/FRH | HSU #1/SCU | 9 - 14 | 1,111 | 0.3 U | **310** | **790** |
| | CL-B104-GW-28-190618 | | CRB/OSG/PRF | HSU #3/BA | 24 - 28 | 735 | **1.7 J** | **97 J** | **570 J** |
| MW1-63 | MW1-63-191025 | North | CRB | HSU#3 | 30 - 40 | 4,865 | **20** | **4,200** | **570** |
| NP-B114 | NP-B114-GW-15-190613 | North | WB/FRH | HSU #1/SCU | 10 - 15 | 0.64 | 0.3 U | 0.3 U | **0.64** |
| | NP-B114-GW-40-190613 | | CRB/OSG/PRF | HSU #3/BA | 35 - 40 | 0.27 | 0.3 U | 0.3 U | **0.27** |
| NP-B119 | NP-B119-GW-15-190621 | North | WB/OSG/FRH | HSU #1/SCU | 10 - 15 | 0.5 U | 0.3 U | 0.3 U | 0.015 U |
| | NP-B119-GW-32-190621 | | SRH/PRF | HSU #2/BA | 28 - 32 | 0.024 | 0.3 U | 0.3 U | **0.024** |
| ***Cross Section G-G'*** | | | | | | | | | |
| CL-B100 | CL-B100-GW-15-190625 | Central | WB/FRH | HSU #1/SCU | 11 - 15 | 0.22 | 0.3 U | 0.3 U | **0.22 J** |
| | CL-B100-GW-39-190625 | | SRH/CRB/PRF | HSU #2/HSU #3/ BA | 35 - 39 | 20.2 | 0.3 U | 2.6 | **16** |
| CL-B134 | CL-B134-GW-50-191003 | Central | CRB | HSU #3 | 45 - 50 | 8.35 | **0.51 J** | 7.5 | **0.34** |
| MW1-71 | MW1-71-220512 | Central | OSG | HSU #4 | 95-100 | 0.25 U | 0.15 U | 0.15 U | 0.015 U |
| MW1-27 | No sample collected in 2017 or 2019 | | | | | | | | |
| ***Cross Section I-I'*** | | | | | | | | | |
| MW1-69 | MW1-69-220511 | South | OSG | HSU #4 | 42 - 52 | 9.9 | **1.9** | 7.1 | **0.76** |
| SP-B66 | SP-B66-GW-10.0-170806 | South | WB | HSU #1 | 5 - 10 | 36,000 | 250 U M | **22,000** | **14,000** |
| SP-B93 | SP-B93-GW-12.5-190626 | South | WB/FRH | HSU #1/SCU | 7.5 - 12.5 | 22,793 | **1,600** | **19,000** | **1,900** |
| | SP-B93-GW-40-190626 | | CRB/BA | HSU #3/BA | 36 - 40 | 25.0 | **1.7** | **22** | **1.0** |
| CL-B98 | CL-B98-GW-15-191014 | Central | SRH | HSU #2 | 10 - 15 | 0.31 | 0.3 U | 0.3 U | **0.31** |
| | CL-B98-GW-37-191014 | | CRB/OSG | HSU #3 | 32 - 37 | 674 | **8** | **310** | **250** |
| SP-B131 | SP-B131-GW-15-191015 | South | FRH/SRH/OSG | SCU/HSU #2 | 10 - 15 | 192 | 0.3 UJ | **69 J** | **120** |
| | SP-B131-GW-40-191015 | | CRB/OSG | HSU #3 | 35 - 40 | 32.6 | 0.3 UJ | 3.6 J | **29 J** |
| SP-B140 | No samples collected in 2019 | | | | | | | | |
| ***Cross Section N-N'*** | | | | | | | | | |
| CL-B98 | CL-B98-GW-15-191014 | Central | SRH | HSU #2 | 10 - 15 | 0.31 | 0.3 U | 0.3 U | **0.31** |
| | CL-B98-GW-37-191014 | | CRB/OSG | HSU #3 | 32 - 37 | 674 | **8** | **310** | **250** |
| CL-B134 | CL-B134-GW-50-191003 | Central | CRB | HSU #3 | 45 - 50 | 8.35 | **0.51** | 7.5 | **0.34** |
| MW1-25 | No sample collected in 2017 or 2019 | | | | | | | | |
| MW1-36 | No sample collected in 2017 or 2019 | | | | | | | | |
| MW1-37 | No sample collected in 2017 or 2019 | | | | | | | | |
| MW1-72 | MW1-72-220512 | North | OSG | HSU #4 | 60 - 70 | 0.14 | 0.15 U | 0.15 U | **0.14** |
| MW1-63 | MW1-63-191025 | North | CRB | HSU#3 | 30 - 40 | 4,865 | **20 J** | **4,200 J** | **570 J** |
| NP-B117s | NP-B117s-GW-15-190613 | North | WB/FRH | HSU #1 | 10 - 15 | 0.034 | 0.3 U | 0.3 U | **0.034 J** |
| | NP-B117s-GW-40-190613 | | CRB | HSU #3 | 35 - 40 | 5,193 | **1.5 J** | **4,300 J** | **830 J** |
| SP-B92 | SP-B92-GW-15-191016 | South | SRH/PRF/OSG | HSU#2/HSU#4/BA | 10 - 15 | 0.15 | 0.3 UJ | 0.3 UJ | **0.15** |
| | SP-B92-GW-30-191016 | | | HSU #4/BA | 25 - 30 | 0.071 | 0.3 UJ | 0.3 UJ | **0.071** |

All samples are "grab GW" except for MW1-63, MW1-69, MW1-71, and MW1-72, which were collected from permanent MWs

[a] Locations refer to North Plantation, South Plantation, or Central Landfill

[b] Results with "U" qualifier designated as zero during summation

BA -Basal Aquitard

J - The reported value is an estimated concentration.

PAL - Project Action Limit

SCU - Semi-confining unit

U - The analyte was not detected at or above the stated limit.

UJ - The analyte was not detected at or above the stated sample quantitation limit, which is an estimated value.

µg/L - micrograms per liter

**Bolded** values indicate PAL exceedance

**TABLE C-5**
**SOIL SAMPLING RESULTS (2017 through 2022)**
**WITHIN OU 1 ESS CROSS SECTIONS**

| Boring/Well | Sample ID | Location [a] | Depositional Facies | Candidate HSU | Soil Sampling Depth (ft.) | Total VOCs [b] (µg/kg) | TCE (µg/kg) | cis-1,2-DCE (µg/kg) | Vinyl Chloride (µg/kg) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | PAL (µg/kg) | -- | 0.11 | 5.2 | 0.0062 |
| ***Cross Section D-D'*** | | | | | | | | | |
| CL-B102 | CL-B102-S-14-190617 | Central | FRH | SCU | 14 | 12,378 | 2.5 U | **12,000** | **340** |
| | CL-B102-S-19-190617 | | OSG | SCU | 19 | 4,212 | **2.7 J** | **3,900** | **180** |
| | CL-B102-S-33-190617 | | OSG | HSU#4 | 33 | 1,397 | 2.2 U | **1,300** | **74 J** |
| CL-B103 | CL-B103-S-09-190617 | Central | FRH | SCU | 9 | 76 | 2.4 U | **14** | **62** |
| | CL-B103-S-12-190617 | | FRH/SRH | SCU/HSU #2 | 12 | 3,420 | 2.6 U | **3,200** | **210** |
| | CL-B103-S-19-190617 | | SRH | HSU #2 | 19 | 2,208 | 2.5 U | **2,000** | **200 J** |
| | CL-B103-S-39-190617 | | OSG | HSU#4 | 39 | 8.9 | 2.2 U | 4.9 J | **4 J** |
| CL-B104 | CL-B104-S-09-190618 | Central | WB | HSU #1 | 9 | 1.9 | 2.3 U | 1.9 J | 2.3 U |
| | CL-B104-S-28-190618 | | PRF | BA | 28 | 2,579 | **110** | **2,000** | **380** |
| | CL-B104-S-32-190618 | | PRF | BA | 32 | 5.3 | 3.5 U | 2.2 J | **3.1 J** |
| MW1-63/NP-B136 | NP-B136-S-36-191007 | North | CRB | HSU#3 | 36 | 25.5 | **3.2 J** | **460** | **17 J** |
| | NP-B136-S-66-191007 | | PRF | BA | 66 | 4.5 U | 4.5 U | 4.5 U | 4.5 UJ |
| NP-B114 | NP-B114-S-08-190613 | North | WB | HSU #1 | 8 | 2.5 U | 2.5 U | 2.5 U | 2.5 U |
| | NP-B114-S-15-190613 | | FRH | SCU | 15 | 2.7 U | 2.7 U | 2.7 U | 2.7 U |
| | NP-B114-S-23-190613 | | FRH/SRH | SCU/HSU #2 | 23 | 46 | 2.5 U | **13** | **33** |
| | NP-B114-S-33-190613 | | CRB/OSG | HSU #3/BA | 33 | 16.9 | **1.7 J** | **12** | 2.2 U |
| NP-B119 | NP-B119-S-07-190621 | North | WB | HSU #1 | 7 | 2.5 UJ | 2.5 UJ | 2.5 UJ | 2.5 UJ |
| | NP-B119-S-12-190621 | | FRH/OSG | SCU | 12 | 2.7 U | 2.7 U | 2.7 U | 2.7 U |
| | NP-B119-S-15-190621 | | FRH/OSG | SCU | 15 | 2.5 U | 2.5 U | 2.5 U | 2.5 U |
| ***Cross Section G-G'*** | | | | | | | | | |
| CL-B100 | CL-B100-S-5-190625 | Central | WB | HSU #1 | 5 | 2.2 U | 2.2 U | 2.2 U | 2.2 U |
| | CL-B100-S-13-190625 | | FRH | SCU | 13 | 3.9 UJ | 3.9 UJ | 3.9 UJ | 3.9 UJ |
| | CL-B100-S-22-190625 | | SRH | HSU#2 | 22 | 2,371 | 2.5 UJ | **2,300** | **66 J** |
| | CL-B100-S-37-190625 | | SRH/PRF | HSU#2/BA | 37 | 39.2 | 2.3 U | 4.2 J | **29** |
| CL-B134 | CL-B134-S-50-191003 | Central | CRB/PRF | HSU#3/BA | 50 | 2.5 U | 2.5 U | 2.5 U | 2.5 U |
| MW1-71 | CL-B176-S-08-220502 | Central | WB | HSU #1 | 8 | 0.99 | 0.96 UJ | 1.9 UJ | 0.96 UJ |
| | CL-B176-S-28-220502 | Central | SRH | HSU #2 | 28 | 7,559 | 0.83 UJ | **7,400 J** | **120 J** |
| | CL-B176-S-40-220502 | Central | OSG/CRB | HSU #3 | 40 | 0.62 | 0.81 UJ | 0.62 J | 0.81 UJ |
| | CL-B176-S-45-220502 | Central | OSG/CRB | HSU #3 | 45 | 59 | 54 R | **59 J** | 54 R |
| | CL-B176-S-55-220502 | Central | PRF | BA | 55 | 2.8 UJ | 0.92 UJ | 1.8 UJ | 0.82 UJ |
| | CL-B176-S-60-220502 | Central | PRF | BA | 60 | 3.8 UJ | 1.3 UJ | 2.6 UJ | 1.3 UJ |
| | CL-B176-S-65-220502 | Central | PRF | BA | 65 | 3.4 UJ | 1.1 UJ | 2.2 UJ | 1.1 UJ |
| | CL-B176-S-70-220502 | Central | PRF | BA | 70 | 3 UJ | 0.99 UJ | 2 UJ | 0.99 U |
| | CL-B176-S-95-220502 | Central | OSG/PRF | HSU #4 | 95 | 2.5 UJ | 0.84 UJ | 1.7 UJ | 0.84 UJ |
| | CL-B176-S-100-220502 | Central | OSG | HSU #4 | 100 | 2.9 UJ | 0.97 UJ | 1.9 UJ | 0.97 UJ |
| MW1-27 | No sample collected in 2017 or 2019 | | | | | | | | |
| ***Cross Section I-I'*** | | | | | | | | | |
| MW1-69 | SP-B-174-S-10-220427 | South | FRH | SCU | 10 | 851,043 | **180,000 J** | **660,000 J** | **11,000 J** |
| | SP-B-174-S-16-220427 | South | FRH/SRH | SCU/HSU #2 | 16 | 426 | **91 J** | **290 J** | **42 J** |
| | SP-B-174-S-20-220427 | South | SRH | HSU #2 | 20 | 2.94 | **0.49 J** | 1.9 J | 1.1 R |
| | SP-B-174-S-25-220427 | South | FRH | SCU | 25 | 2.7 UJ | 0.91 UJ | 1.8 UJ | 0.91 UJ |
| | SP-B-174-S-35-220427 | South | SRH | HSU #2 | 35 | 2.5 UJ | 0.84 UJ | 1.7 UJ | 0.84 UJ |
| | SP-B-174-S-45-220427 | South | OSG | HSU #4 | 45 | 7.8 UJ | 0.78 UJ | 1.6 UJ | 7.8 UJ |
| | SP-B-174-S-52-220427 | South | OSG/PRF | HSU #4 | 52 | 0.43 | **0.43 J** | 1.4 R | 0.69 R |
| | SP-B-174-S-70-220427 | South | PRF | BA | 70 | 2.7 UJ | 0.9 UJ | 1.8 UJ | 0.9 UJ |
| | SP-B-174-S-73-220427 | South | PRF | BA | 73 | 3.9 UJ | 1.3 UJ | 2.6 UJ | 1.3 UJ |
| | SP-B-174-S-83-220427 | South | OSG | HSU #4 | 83 | 3.1 UJ | 1 UJ | 2.1 UJ | 1 UJ |
| SP-B66 | SP-B66-S-9.0-170806 | South | WB | HSU #1 | 9 | 113 | **21.4** | **84** | **6.31** |
| | SP-B66-S-10.5-170806 | | WB/FRH | HSU #1/SCU | 10.5 | 216 | **20.2** | **180 E** | **13.9** |
| SP-B93 | SP-B93-S-12-190626 | South | FRH | SCU | 12 | 811 | **90 J** | **370** | **310 J** |
| | SP-B93-S-17-190626 | | FRH | SCU | 17 | 351 | **36** | **110** | **180 J** |
| | SP-B93-S-40-190626 | | OSG/PRF | HSU #3 | 40 | 3.6 | 2.3 U | 3.6 J | 2.3 U |
| CL-B98 | CL-B98-S-2-191014 | Central | WB | HSU #1 | 2 | 4.3 | **3.6 J** | 2.2 U | 2.2 U |
| | CL-B98-S-30-191014 | | OSG/CRB | HSU #3 | 30 | 1,186 | **410 J** | **430 J** | **43 J** |
| SP-B131 | SP-B131-S-6-191015 | South | WB | HSU #1 | 6 | 3 | **3 J** | 2.5 U | 2.5 U |
| | SP-B131-S-23-191015 | | SRH/FRH | HSU #2 | 23 | 46.2 | **6.1** | **24** | **12** |
| SP-B140 | No samples collected in 2019 | | | | | | | | |
| ***Cross Section N-N'*** | | | | | | | | | |
| CL-B98 | CL-B98-S-2-191014 | Central | WB/FRH | HSU #1 | 2 | 4.3 | **3.6 J** | 2.2 U | 2.2 U |
| | CL-B98-S-30-191014 | | FRH/CRB | HSU#3 | 30 | 1,186 | **410 J** | **430 J** | **43 J** |
| CL-B105 | CL-B105-S-10-190612 | Central | WB | HSU #1 | 10 | 12 | 3.3 U | 3.3 U | **12 J** |
| | CL-B105-S-13-190612 | | WB | HSU #1 | 13 | 2.7 U | 2.7 U | 2.7 U | 2.7 U |
| | CL-B105-S-39-190612 | | SRH/CRB/OSG | HSU #2/ HSU #3 | 39 | 60 | **9.3** | **47** | **3.7 J** |
| CL-B134 | CL-B134-S-50-191003 | Central | CRB/PRF | HSU #3/BA | 50 | 2.5 U | 2.5 U | 2.5 U | 2.5 U |
| MW1-25 | No sample collected in 2017 or 2019 | | | | | | | | |
| MW1-36 | No sample collected in 2017 or 2019 | | | | | | | | |
| MW1-37 | No sample collected in 2017 or 2019 | | | | | | | | |
| MW1-72 | NP-B177-S-07-220505 | North | WB | HSU #1 | 7 | 8.3 UJ | 0.83 UJ | 1.7 UJ | 8.3 UJ |
| | NP-B177-S-30-220505 | North | OSG/SRH | HSU #2 | 30 | 25.27 | **0.57 J** | **22 J** | 2.2 R |
| | NP-B177-S-36-220505 (FD) | North | OSG/CRB | HSU #3 | 35 | 1,544 | **130 J** | **1300 J** | **75 J** |
| | NP-B177-S-40-220505 | North | OSG/CRB | HSU #3 | 40 | 131.9 | 0.89 U | **120** | **9.5 J** |
| | NP-B177-S-45-220505 | North | PRF | BA | 45 | 2.5 U | 0.83 UJ | 1.7 UJ | 0.83 UJ |
| | NP-B177-S-50-220505 | North | OSG | HSU #4 | 50 | 220 R | 88 R | 88 R | 88 R |
| | NP-B177-S-55-220505 | North | OSG | HSU #4 | 55 | 2.3 U | 0.77 UJ | 1.5 UJ | 0.77 UJ |
| | NP-B177-S-60-220505 | North | OSG | HSU #4 | 60 | 2.8 R | 0.94 R | 1.9 R | 0.94 R |
| | NP-B177-S-65-220505 | North | OSG | HSU #4 | 65 | 3.5 UJ | 1.2 UJ | 2.3 UJ | 2.1 UJ |
| | NP-B177-S-75-220505 | North | PRF | BA | 75 | 3.6 UJ | 1.2 UJ | 2.4 UJ | 1.2 UJ |
| MW1-63 | NP-B136-S-36-191007 | North | CRB | HSU #3 | 36 | 25.5 | **3.2 J** | **460** | **17 J** |
| | NP-B136-S-66-191007 | | PRF | BA | 66 | 4.5 U | 4.5 U | 4.5 U | 4.5 UJ |
| NP-B117s | NP-B117s-S-10-19063 | North | WB | HSU #1 | 10 | 3 U | 3 U | 3 U | 3 U |
| | NP-B117s-S-28-190613 | | SRH/CRB | HSU #2/ HSU #3 | 28 | 90.3 | **1.3 J** | **40 J** | **43** |
| | NP-B117s-S-39-190613 | | CRB | HSU #3 | 39 | 7,263 | **5.1 J** | **6,700** | **320** |
| SP-B92 | SP-B92-S-13-191016 | South | PRF | BA | 13 | 2.2 U | 2.2 U | 2.2 U | 2.2 U |
| | SP-B92-S-28-191016 | | OSG | HSU #4 | 28 | 2.2 | **2.2 J** | 2.3 U | 2.3 U |

**Notes:**

[a] Locations refer to North Plantation, South Plantation, or Central Landfill

[b] Results with "U" qualifier designated as zero during summation

BA - Basal Aquitard

FD - field duplicate

J - The reported value is an estimated concentration.

PAL - Project Action Limit

R - The sample results were rejected due to gross non-conformances discovered during data validation. Data qualified as rejected is not usable, thus was not used in calculating total VOCs

SCU - semi-confining unit

U - The analyte was not detected at or above the stated limit.

UJ - The analyte was not detected at or above the stated sample quantitation limit, which is an estimated value.

µg/kg – micrograms per kilogram

**Bolded** values indicate PAL exceedance

**Table C-6.** Hydrostratigraphic Units, Lithology, and Physical Parameters at OU 1

| Location ID | Soil Sample Depth (ft bgs) | HSU | Lithology: Field Description [1] | Lithology: USCS (field) | Lithology: Mean Grain Size (Lab) - USCS/ASTM | Physical Parameters (lab): Effective Porosity | Physical Parameters (lab): Total Organic Carbon (mg/kg) | Physical Parameters (lab): Dry Bulk Density (g/cc) | Physical Parameters (lab): Horizontal K (cm/s) | Physical Parameters (lab): Vertical K (cm/s) | Slug Test Results: Average K (cm/s) [2] | Slug Test Results: Average V (cm/s) [3] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW1-50/B73 | 9 | HSU #1 | Fine sand, trace fines, sand size increases to fine/medium with depth | SP | Fine Sand | 19.2 | 676 | 1.98 | 1.00E-03 | N/A | 1.88E-03 | 4.34E-05 |
| MW1-52/B72 | 12 | HSU #1 | Fine to medium sand, trace fines | SP | Fine Sand | 23.3 | 1,141 | 1.67 | 8.92E-04 | N/A | N/A | N/A |
| MW1-56/B87 | 9 | HSU #1 | Fine sand, trace fines | SP | Fine Sand | 25.1 | 770 | 1.69 | 1.20E-06 | N/A | N/A | N/A |
| MW1-58/B89 | 6.5 | HSU #1 | Silty gravel with sand | GM | Coarse Sand | 33.5 | 19,000 | 0.58 | 2.93E-07 | N/A | N/A | N/A |
| MW1-69/SP-B174 | 10 | HSU #1 | Fine to very fine sand | SP | Fine Sand | 34.63 | <500 | 1.62 | 6.79E-04 | 6.43E-04 | N/A | N/A |
| MW1-46/B78 | 28.5 | HSU #2 | Fine sand (trace medium to coarse), trace fines | SP | Fine Sand | 30.1 | 580 | 1.8 | 7.18E-03 | N/A | 1.86E-03 | 4.29E-05 |
| MW1-47/B79 | 21.5 | HSU #2 | Fine sand, trace fines | SP-SM | Fine Sand | 28.1 | 1,350 | 1.59 | 2.47E-05 | N/A | 1.47E-03 | 3.40E-05 |
| MW1-48/B83 | 18.5 | HSU #2 | Silty fine sand | SM | Fine Sand | 18.8 | 750 | 1.68 | 2.27E-05 | N/A | N/A | N/A |
| MW1-56/B87 | 29 | HSU #2 | Fine sand, trace fines | SP | Fine Sand | 33.5 | 680 | 1.82 | 2.78E-03 | N/A | N/A | N/A |
| MW1-58/B89 | 24 | HSU #2 | Fine sand | SP | Fine Sand | 35.9 | 950 | 1.90 | 5.35E-04 | N/A | N/A | N/A |
| MW1-58/B89 | 34 | HSU #2 | Medium sand | SP | Medium Sand | 20.5 | 4,100 | 1.30 | 3.15E-06 | N/A | N/A | N/A |
| MW1-70/SP-B175 | 15 | HSU #2 | Very fine to medium sand | SP | Fine Sand | 29.76 | 1,400 | 1.65 | 6.14E-04 | 5.69E-04 | N/A | N/A |
| MW1-70/SP-B175 | 25 | HSU #2 | Very fine sand | SP | Fine Sand | 31.81 | 7,600 | 1.68 | 6.32E-04 | 6.19E-04 | N/A | N/A |
| MW1-71/CL-B176 | 25 | Semi-Confining Unit and HSU #2 | Sandy silt to very fine sand | MH/SP | Fine Sand | 19.03 | 1,000 | 1.24 | 3.70E-06 | 3.45E-06 | N/A | N/A |
| MW1-71/CL-B176 | 45 | HSU #2 | Medium to coarse sand | SW | Fine Sand | 27.83 | 670 | 1.71 | 6.89E-04 | 5.03E-05 | N/A | N/A |
| MW1-73/NP-B178 | 30 | HSU #2 | Very fine to medium sand | SP | Fine Sand | 32.43 | 110 | 1.61 | 6.58E-04 | 6.00E-04 | N/A | N/A |
| MW1-73/NP-B178 | 50 | HSU #3 | Gravelly fine to very coarse sand | SW | Fine Sand | 18.2 | 540 | 1.95 | 5.56E-04 | 5.35E-04 | N/A | N/A |
| MW1-74/DG-B179 | 30 | HSU #3 | Silty sandy gravel | GW | Gravel | N/A | 250 | 1.99 | 4.49E-03 | 4.23E-03 | N/A | N/A |
| MW1-74/DG-B179 | 45 | HSU #3 | Fine sand | SP | Medium Sand | N/A | 1,700 | 1.98 | 3.63E-03 | 3.51E-03 | | |
| MW1-74/DG-B179 | 55 | HSU #3 / Top of fine-grained Olympia | Fine sand / clay interface | SP/CL | Medium Sand | N/A | 1,100 | 1.78 | 5.33E-03 | 5.13E-03 | 2.08E-02 | 4.79E-04 |
| MW1-72/NP-B177 [4] | 40 | HSU #3 / Top of fine-grained Olympia | Sandy silt | MH | Fine Sand | 30.73 | 100 | 1.73 | 5.91E-04 | 5.90E-04 | N/A | N/A |
| MW1-69/SP-B174 | 48 | HSU #4 | Fine to coarse sand | SW | Medium Sand | 32.02 | 890 | 1.80 | 6.76E-04 | 6.35E-04 | N/A | N/A |
| MW1-72/NP-B177 [4] | 65 | HSU #4 | Very fine to medium sand | SP | Fine Sand | N/A | 3 | N/A | N/A | N/A | 3.40E-02 | 7.04E-04 |
| MW1-56/B87 | 37.5 | Fine-grained Olympia | Clay | CL | Clay | 4.8 | 4,050 | 1.57 | 5.84E-08 | N/A | N/A | N/A |
| MW1-69/SP-B174 | 58 | Fine-grained Olympia | Sandy silt | MH | Fine Sand | 13.49 | 3,800 | 1.60 | 1.42E-06 | 1.24E-06 | N/A | N/A |
| MW1-70/SP-B175 | 38 | Fine-grained Olympia | Silt to silty clay | MH/CH | Fine Sand | 8.08 | 3,800 | 1.42 | 5.49E-07 | 2.45E-07 | N/A | N/A |
| MW1-71/CL-B176 | 55 | Fine-grained Olympia | Sandy silt | MH | Fine Sand | 11.16 | 18,000 | 0.85 | 3.81E-07 | 3.22E-07 | N/A | N/A |
| MW1-72/NP-B177 [4] | 75 | Fine-grained Olympia | Sandy silt | MH | Fine Sand | 13.42 | 110,000 | 1.03 | 4.76E-07 | 4.41E-07 | N/A | N/A |
| MW1-73/NP-B178 | 58 | Fine-grained Olympia | Peat to sandy clay | Pt/CL | Coarse Sand | 11.82 | 99,000 | 1.17 | 3.48E-07 | 3.14E-07 | N/A | N/A |
| MW1-75/DG-B180 | 70 | Fine-grained Olympia | Silty clay | CL | Silt | N/A | 26,000 | 1.63 | 3.03E-07 | 1.50E-07 | N/A | N/A |
| | | | | | HSU #1 Median | 25.10 | 956 | 1.67 | 6.79E-04 | 6.43E-04 | 1.88E-03 (one value) | 4.34E-05 (one value) |
| | | | | | HSU #2 Median | 29.76 | 950 | 1.68 | 6.14E-04 | 5.69E-04 | 1.67E-03 | 3.84E-05 |
| | | | | | HSU #3 Median | 24 | 540 | 1.95 | 3.63E-03 | 3.51E-03 | 2.08E-02 (one value) | 4.79E-04 (one value) |
| | | | | | HSU #4 Median | 32.02 (one value) | 447 | 180 (one value) | 6.76E-04 (one value) | 6.35E-04 (one value) | 3.4E-02 (one value) | 7.04E-04 (one value) |
| | | | | | Fine-grained Olympia Median | 11.49 | 18,000 | 1.42 | 3.81E-07 | 3.18E-07 | N/A | N/A |

**Notes:**

cm/s - centimeters per second

ft bgs - feet below ground surface

g/cc - grams per cubic centimeter

mg/kg - milligrams per kilogram

HSU - hydrostratigraphic unit

K - hydraulic conductivity

[1] Field description for screened interval of well; entries with multiple descriptions are shallow to deep, within screened interval

[2] Average *K* is average of rising head tests (see Table B3-36). Overall, results of multiple runs were more repeatable for rising head tests than falling head tests [initial displacement and K results].

[3] $V = K*i/n_e$; i = 0.006 (calculated from 2019 GW elevation data); ne = 0.26 (2017 data)

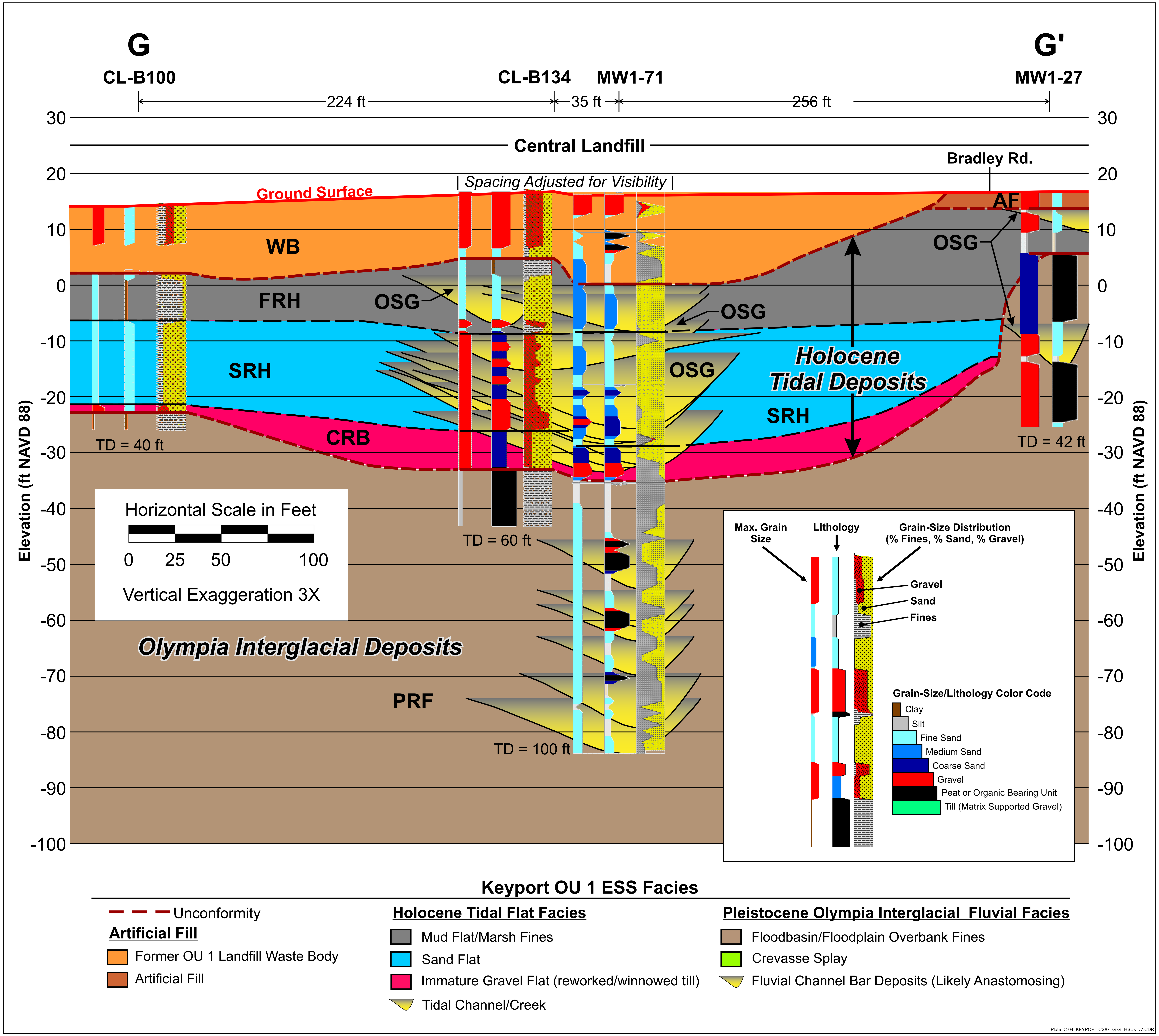

| U.S. NAVY | Plate C-1<br>Geologic Cross Section A-A' | Naval Base Kitsap<br>Keyport |
|---|---|---|


| U.S. NAVY | Plate C-2<br>Geologic Cross Section B-B' | Naval Base Kitsap<br>Keyport |
|---|---|---|


U.S. NAVY

Plate C-3
Geologic Cross Section D-D'

Naval Base Kitsap
Keyport




| U.S. NAVY | Plate C-4<br>Geologic Cross Section G-G' | Naval Base Kitsap<br>Keyport |
|---|---|---|


| | | |
|---|---|---|
| U.S. NAVY | Plate C-5<br>Geologic Cross Section I-I' | Naval Base Kitsap<br>Keyport |


U.S. NAVY

Plate C-6
Geologic Cross Section N-N'

Naval Base Kitsap
Keyport


U.S. NAVY

Plate C-7
Geologic Cross Section A-A' with Hydrostratigraphic Units

Naval Base Kitsap Keyport


U.S. NAVY

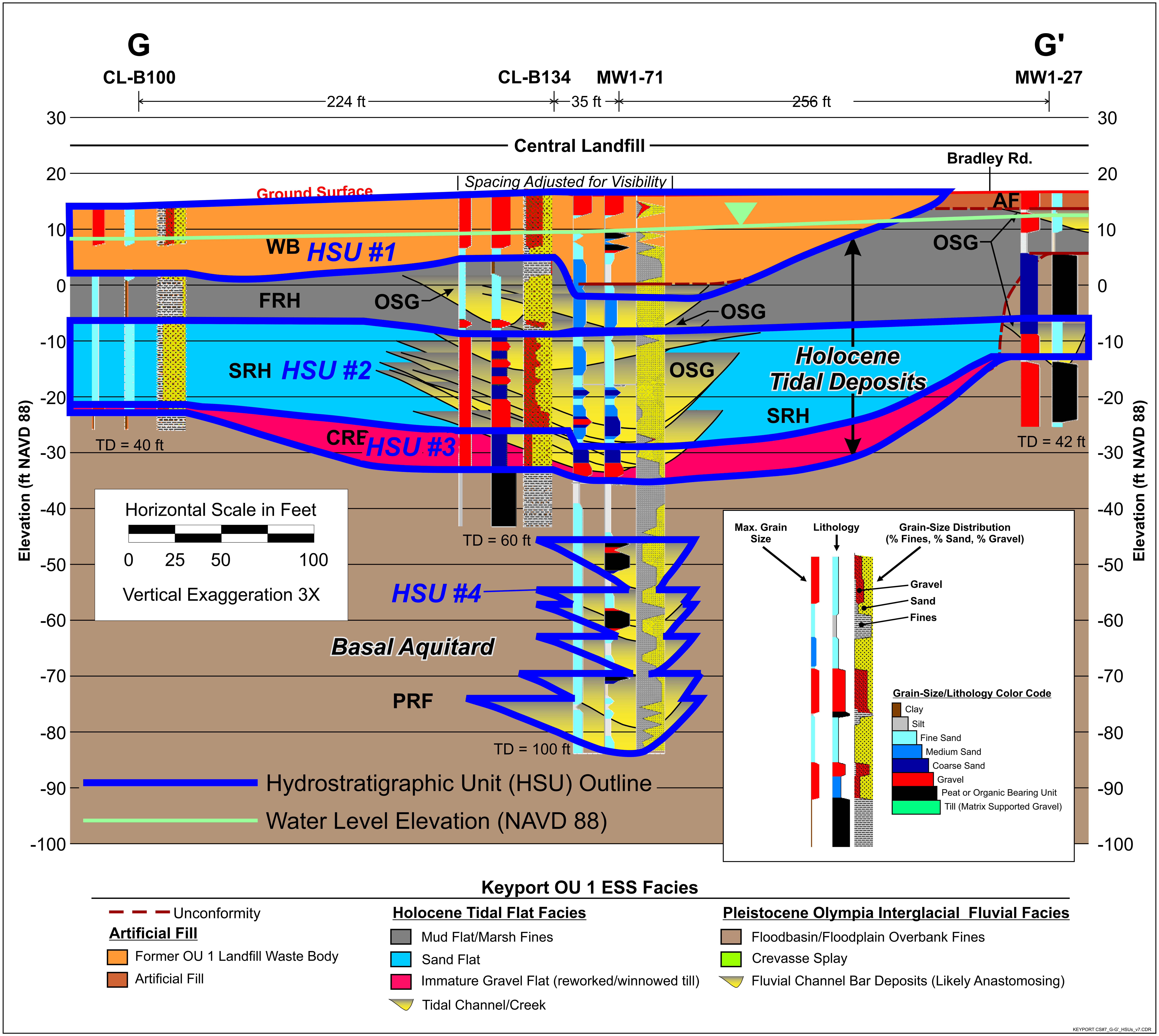
**Plate C-8**
**Geologic Cross Section B-B' with Hydrostratigraphic Units**

Naval Base Kitsap
Keyport


U.S. NAVY

Plate C-9
Geologic Cross Section D-D' with Hydrostatigraphic Units

Naval Base Kitsap
Keyport




U.S. NAVY

**Plate C-10**
**Geologic Cross Section G-G' with Hydrostratigraphic Units**

Naval Base Kitsap
Keyport


U.S. NAVY

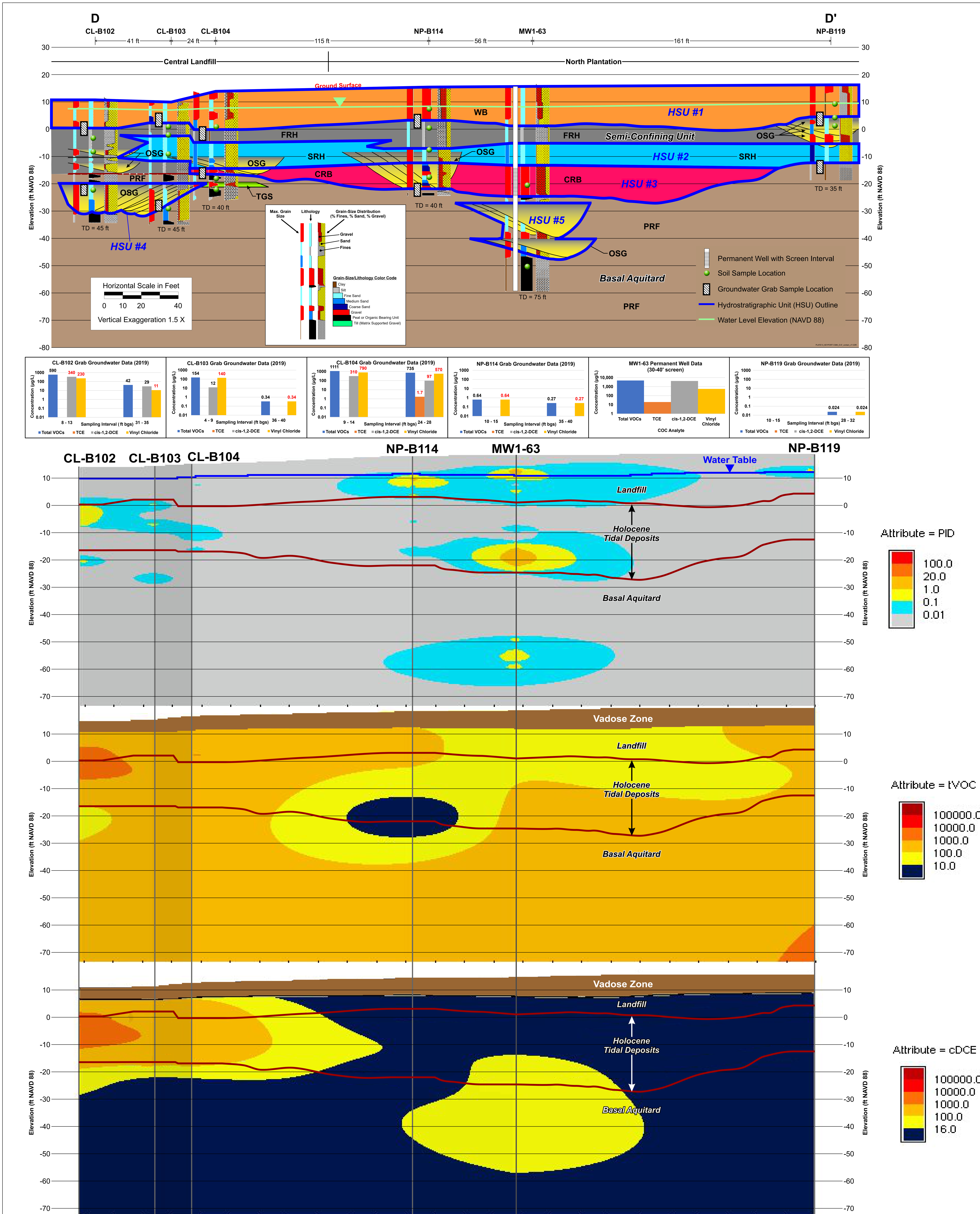
**Plate C-11**
**Geologic Cross Section I-I' with Hydrostratigraphic Units**

Naval Base Kitsap
Keyport


U.S. NAVY

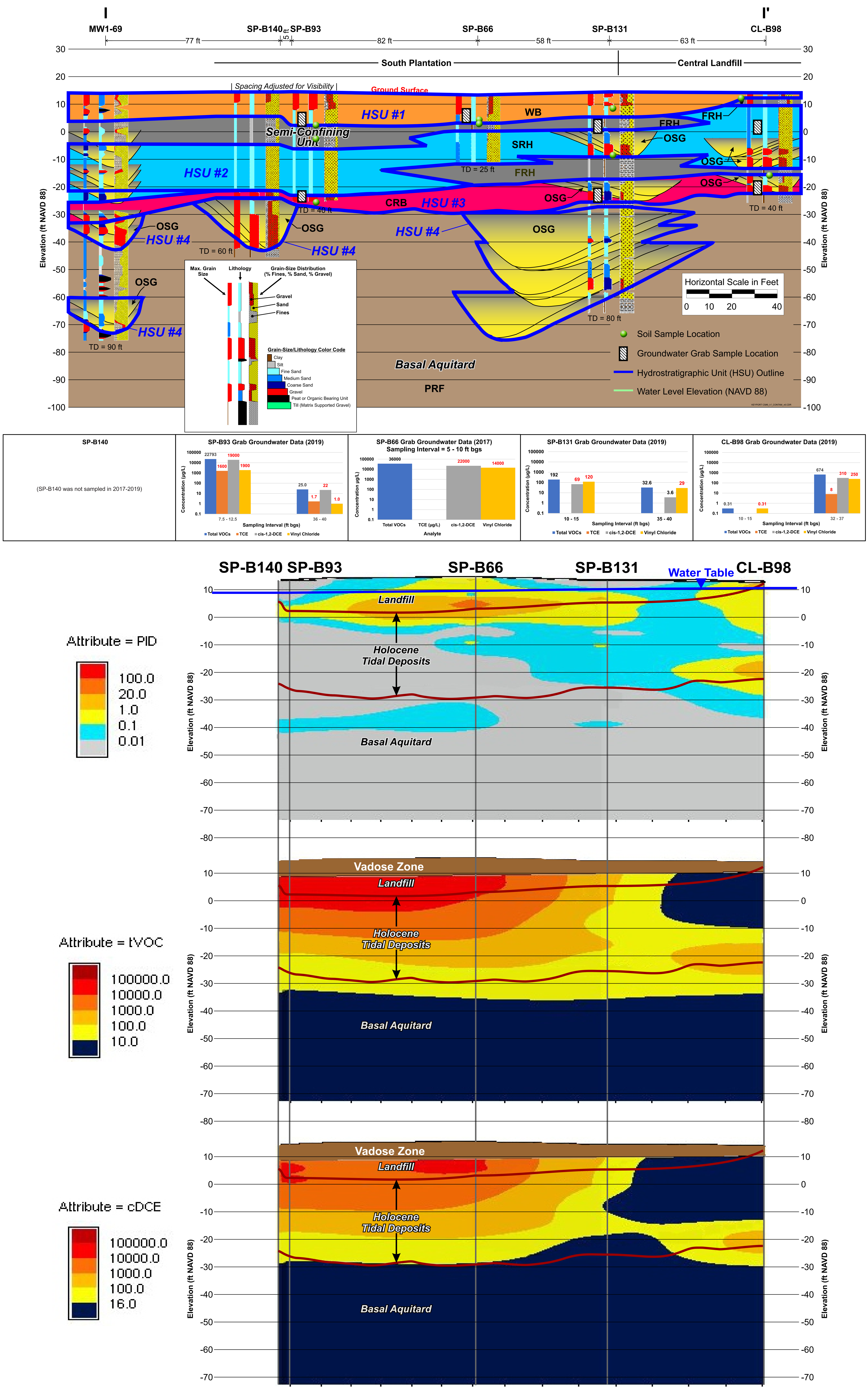
Plate C-12
Geologic Cross Section N-N' with Hydrostratigraphic Units

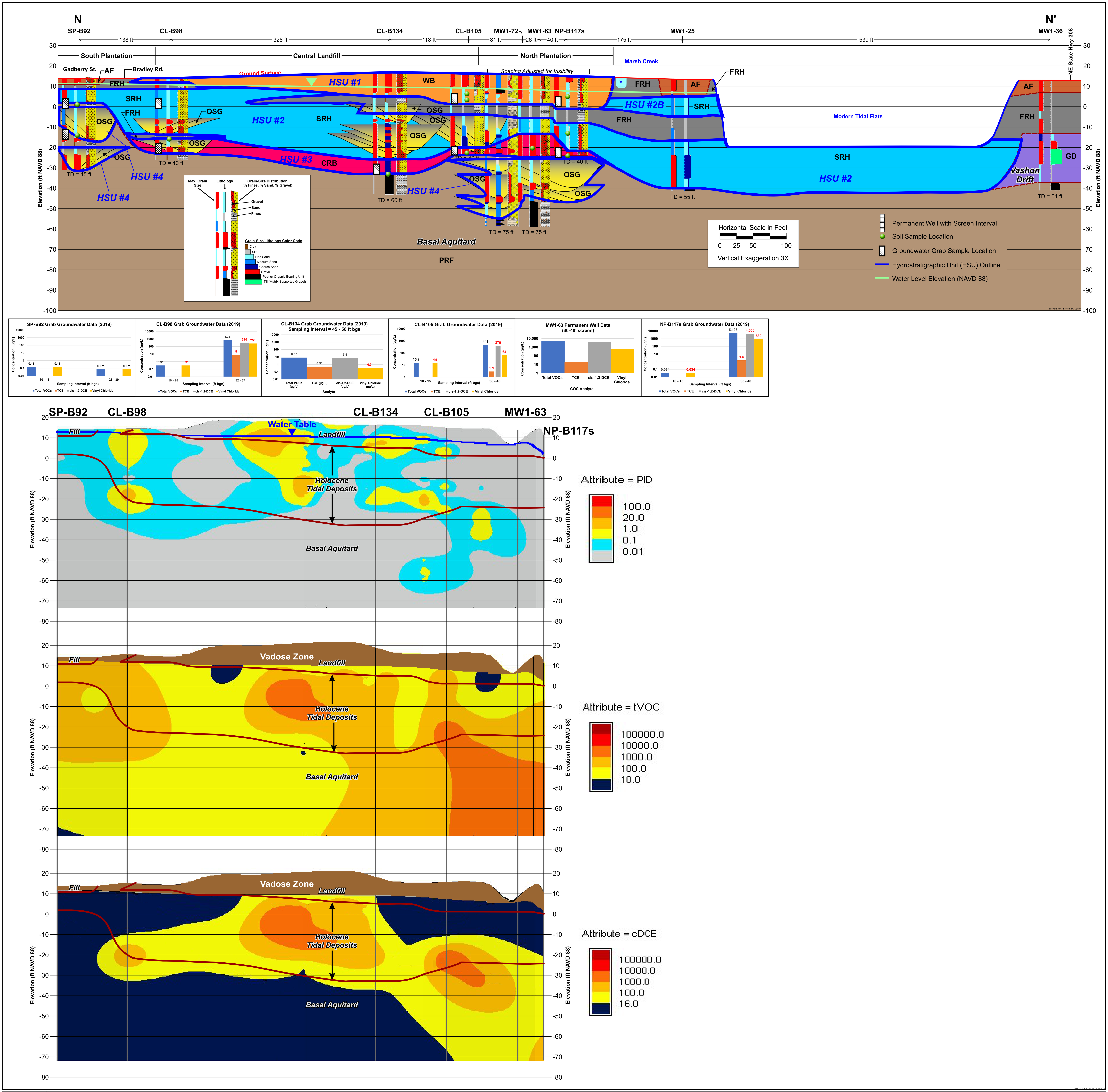
Naval Base Kitsap
Keyport




| U.S. NAVY | Plate C-13<br>Geologic Cross Section D-D' with Contaminant Data and Vertical Slices of EarthVision Model | Naval Base Kitsap<br>Keyport |
|---|---|---|


| U.S. NAVY | Plate C-14<br>Geologic Cross Section G-G' with Contaminant Data and 2D Vertical Slices of EarthVision Model | Naval Base Kitsap<br>Keyport |
|---|---|---|


I
I'
MW1-69
SP-B140
SP-B93
SP-B66
SP-B131
CL-B98
77 ft
5 ft
82 ft
58 ft
63 ft
South Plantation
Central Landfill
Spacing Adjusted for Visibility
Ground Surface
HSU #1
HSU #2
HSU #3
HSU #4
Semi-Confining Unit
WB
SRH
FRH
OSG
CRB
Basal Aquitard
PRF
TD = 25 ft
TD = 40 ft
TD = 60 ft
TD = 80 ft
TD = 90 ft
Elevation (ft NAVD 88)
Max. Grain Size
Lithology
Grain-Size Distribution (% Fines, % Sand, % Gravel)
Gravel
Sand
Fines
Grain-Size/Lithology Color Code
Clay
Silt
Fine Sand
Medium Sand
Coarse Sand
Gravel
Peat or Organic Bearing Unit
Till (Matrix Supported Gravel)
Horizontal Scale in Feet
0 10 20 40
Soil Sample Location
Groundwater Grab Sample Location
Hydrostratigraphic Unit (HSU) Outline
Water Level Elevation (NAVD 88)
SP-B140
(SP-B140 was not sampled in 2017-2019)
SP-B93 Grab Groundwater Data (2019)
SP-B66 Grab Groundwater Data (2017)
Sampling Interval = 5 - 10 ft bgs
SP-B131 Grab Groundwater Data (2019)
CL-B98 Grab Groundwater Data (2019)
Concentration (µg/L)
Sampling Interval (ft bgs)
Total VOCs
TCE
cis-1,2-DCE
Vinyl Chloride
Analyte
7.5 - 12.5
36 - 40
10 - 15
35 - 40
32 - 37
22793
1600
19000
1900
25.0
1.7
22
1.0
36000
22000
14000
192
69
120
32.6
3.6
29
0.31
674
8
310
250
Water Table
Landfill
Holocene Tidal Deposits
Basal Aquitard
Vadose Zone
Attribute = PID
100.0
20.0
1.0
0.1
0.01
Attribute = tVOC
100000.0
10000.0
1000.0
100.0
10.0
Attribute = cDCE
100000.0
10000.0
1000.0
100.0
16.0




U.S. NAVY

Plate C-16
Geologic Cross Section N-N' with Contaminant Data and 2D Vertical Slices of EarthVision Model

Naval Base Kitsap Keyport

## Appendix D

## Geophysics Report

# GEOPHYSICAL EVALUATION

## OPERABLE UNIT 1

Keyport, Washington

**PREPARED FOR:**

Battelle Memorial Institute
505 King Avenue
Columbus, Ohio 43201

**PREPARED BY:**

Atlas Technical Consultants, LLC
15115 SW Sequoia Parkway, Suite 130
Portland, Oregon 97224

September 2, 2021

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Portland, Oregon 97224
503.836.7022 | oneatlas.com

September 2, 2021

Atlas No. 420019SWG
Report No. 2R1

MR. MICHAEL MEYERS
**BATTELLE MEMORIAL INSTITUTE**
505 KING AVENUE
COLUMBUS, OHIO 43201

**Subject:** **Geophysical Evaluation**
**Operable Unit 1**
**Keyport, Washington**

Dear Mr. Meyers:

In accordance with your authorization, Atlas Technical Consultants has performed a geophysical evaluation for the Operable Unit 1 project located in Keyport, Washington. The purpose of the evaluation was to constrain the location of potential preferred migration pathways for groundwater, to obtain information about the stratigraphy within the study area through the collection of land and marine high-resolution electrical resistivity data, and to detect movement of the saltwater wedge across the site. These services were conducted on January 8th through January 18th, 2021. This report presents the survey methodology, equipment used, analysis, and results from the study.

If you have any questions, please call us at 503.836.7022.

Respectfully submitted,
**Atlas Technical Consultants LLC**

Andrew Baird
Project Geophysicist

Patrick F. Lehrmann, P.Gp. (CA), R.G. (OR)
Principal Geologist/Geophysicist

ASB:ERC:MDE:PFL:ds

Distribution: michael.meyers@battelle.com

# TABLE OF CONTENTS



## FIGURES

## 1. INTRODUCTION

In accordance with your authorization, Atlas Technical Consultants has performed a geophysical evaluation for the Operable Unit 1 project located in Keyport, Washington (Figure 1). The purpose of the evaluation is to constrain the location of potential preferred migration pathways for groundwater, to obtain information about the stratigraphy within the study area through the collection of land and marine high-resolution electrical resistivity data, and to detect movement of the saltwater wedge across the site. Our services were conducted on January 8th through January 18th, 2021. This report presents the survey methodology, equipment used, analysis, and results from the study.

## 2. SCOPE OF SERVICES

The scope of services included:

- Collection of six high-resolution, multi-electrode electrical resistivity tomography (ERT) traverses; ERT 1 through ERT 6. ERT 1 through ERT 5 utilized an Advanced Geosciences, Inc. (AGI) SuperSting R8 resistivity meter with an 84-electrode marine cable, and ERT 6 utilized an AGI SuperSting R8 resistivity meter with a 56-electrode marine cable.
- Collection of four high-resolution, multi-electrode time-lapse electrical resistivity tomography (TRP) traverses: TRP 1, TRP 1X, TRP 2, and TRP 3 using an AGI SuperSting R8 resistivity meter and a 56-electrode marine cable. Originally proposed as continuous resistivity profiles (CRP), it has been determined that the acronym TRP is a more accurate description of this method.
- Compilation and geophysical analysis of the data collected.
- Preparation of this report presenting the findings, conclusions, and recommendations.

## 3. SITE AND PROJECT DESCRIPTION

The subject property is located at Naval Base Kitsap Keyport, in Keyport, Washington (Figure 1). Specifically, our evaluation was performed within the limits of the Tidal Flats and Dogfish Bay located on the east and west side of Highway 308. Additionally, two TRP lines were conducted at the Marsh Creek and Marsh Pond areas on the base. Improvements to the land-based evaluation sites include monitoring wells, fences, signposts, and some utility features. Dense vegetation was present at some land-based locations, and tidally influenced bodies of water were present in the marine evaluation areas. Figures 2, 3, 4.1, 5.1, 6.1 and 7.1 depict the general site conditions within the study areas.

Based on team discussions with project stakeholders, it has been theorized that the tide has some influence on the movement of groundwater within the vicinity of a known on-base landfill. The results of this geophysical survey will be used to refine the conceptual site model (CSM) and inform the modeling effort and future investigations at this site; results will also be included in the source investigation report to be completed by other project stakeholders.

## 4. GEOPHYSICAL INSTRUMENTATION AND APPLICATIONS

To evaluate the presence and possible location of preferential migration pathways as well as obtain information useful for interpretation regarding the stratigraphy within the study area, our geophysical evaluation included collection of high-resolution subsurface electrical resistivity data. Two separate electrical resistivity methods were deployed to achieve the project objectives: denoted as ERT and TRP. The ERT method was utilized to characterize the shallow subsurface strata in the tide flats and identify anomalies that could be attributed to preferential migration pathways. The TRP method was utilized to assess the temporal changes in the Tidal Flats, Dogfish Bay, Marsh Creek, and Marsh Pond areas to detect movement of the saltwater wedge across the site.

When necessary, a small zodiac style vessel was used to deploy the array in the tide flats and Dogfish Bay. Electrical current was injected into the ground through 56 stainless steel or graphite electrodes, and the electric potential difference between multiple electrode pairs was measured simultaneously. The data were collected using a Dipole-Dipole and a Strong Gradient electrode configuration.

An AGI SuperSting™ R8 resistivity meter was used to conduct electrical resistivity profiles at the site in order to characterize the electrical properties of the subsurface. Profiles were conducted at locations defined by the sampling and analysis plan, as illustrated on Figure 2.

The ERT and TRP data were processed, corrected for terrain (relative elevation) variations, and were transposed onto the MLLW Datum and analyzed using EarthImager 2-D™ V2.1.7, a two-dimensional resistivity inversion software. The inversion results are presented in color gradient apparent resistivity models that illustrate the electrical resistivity contrasts in the subsurface materials.

### 4.1 ERT Profiles

The ERT profiles were collected along six parallel/subparallel transects oriented in a southwest-northeast direction, roughly perpendicular to the central axis of Dogfish Bay (Figure 2). The ERT 1 through ERT 5 transects consisted of one 56-electrode and one 28-electrode marine cables (84-electrode array) deployed in series along one alignment, floating on the water surface, with an electrode spacing of approximately 6 feet (2 meters). Due to limited accessibility, a 56-electrode stainless steel marine cable, with an electrode spacing of approximately 10 feet (3 meters), was utilized to collect ERT 6. ERT 1 through ERT 3 were located in the Tidal Flats, ERT 4 through ERT 6 were deployed in Dogfish Bay. Three collection cycles were recorded at ERT 3 through ERT 6. Due to equipment issues, ERT 4-1 through ERT 4-3 were collected using a 56-electrode array. An additional 84-electrode array was collected (ERT 4-4) once the equipment issue was resolved.

To achieve data reproducibility and quality, each ERT profile collection cycle was choreographed to be collected at approximately similar locations and tidal magnitudes at three specific temporal periods within the predicted tidal cycle.

### 4.2 TRP Profiles

To constrain the suspected temporal changes causing the migration of the saltwater/freshwater interface, four TRP profiles continuously collected electrical resistivity data over a period of 22 hours. The TRP profiles were collected along four proposed transects of variable lengths (Figure 2). Two TRP profiles, TRP 1 and TRP 1X, each consisted of one 56-electrode marine cable, with an electrode spacing of approximately 13 feet (4 meters). Each profile measured approximately 720 feet in length. TRP 1 and TRP 1X were conducted along the central axis of Tidal Flats and Dogfish Bay. The profiles were collected in a 'roll-along' configuration, with an 18-electrode overlap. The total coverage of TRP 1 and TRP 1X is approximately 1,220 linear feet with the traverses oriented in an approximate southeast-northwest direction (Figure 2). The other two TRP transects (TRP 2 and TRP 3) were located in the Marsh Creek and in the Marsh Pond areas, respectively. The TRP 2 and TRP 3 profiles were shortened due to constraints caused by surface obstructions, specifically overgrown vegetation. Additional, intermittent shortening occurred when tidal fluctuations decoupled the terminal electrodes with the ground. Data collected from decoupled electrodes produce erroneous results and were excluded in the model. Each profile measured approximately 540 feet (162 meters) and 521 feet (159 meters) long, respectively and were collected using a 56-electrode marine cable with an electrode spacing of approximately 10 feet (3 meters).

## 5. RESULTS

As described above, the primary purpose of the study was to assess the presence and evaluate the possible location of preferential migration pathways for groundwater, obtain information useful for analysis of the possible subsurface stratigraphy within the study area, and detect movement of the saltwater wedge across the site. The results of our study are presented as a series of profiles, displayed on Figures 3, 4, 5, 6, and 7. The figures are presented in color gradient form with warm (orange/red) colors representing higher recorded resistivity values and the cool colors (blue) representing higher conductivity values. Each profile has been allocated a specific standardized scale for the multiple collection cycles conducted at the site. The maximum and minimum limits for the scales were determined by calculating one standard deviation from the mean maximum and minimum recorded values for each collection cycle for that profile. The elevations have been standardized to the MLLW Datum. The results of the evaluation are discussed below.

### 5.1 ERT Profiles

The results from the electrical resistivity tomography study are presented on Figures 2 and 3.2 through 3.25. As previously mentioned, the figures are presented in color gradient form with warm (orange/red) colors representing higher recorded resistivity values and the cool colors (blue) representing higher conductivity values. The water column is depicted as a highly conductive layer in the upper portion of the profile. The results reveal lateral variability in the near surface; both conductivity and resistivity anomalies are observed with generally more conductive materials at depth. In general, the ERT profiles depict a consistent trend across the study area. Resistivity anomalies observed in the profiles expand and increase in recorded resistivity value (decrease in conductivity) during predicted ebb flow/low tide events and contract in dimension and show relatively lower recorded resistivity values (become more conductive) during predicted flood/high tide events.

### ERT 1

Variations in resistivity were recorded during the tidal cycle at profile ERT 1 during three recording periods. During the late flood tide, depicted in ERT 1-1, three to four relatively higher resistivity bodies are observed in the profile at depths of 10 to 30 feet (Figure 3.2). The relatively higher resistivity responses observed in the late flood tide contract and become relatively lower in resistivity values during the early ebb tide of ERT 1-2 (Figure 3.3). The late ebb tide shown in ERT 1-3 is concurrent with higher recorded resistivities. Anomalies expand and coalesce in ERT 1-3, forming larger relatively higher resistivity value anomalies (Figure 3.4).

### ERT 2

Variations in resistivity were recorded during the tidal cycle at profile ERT 2 during three recording periods. During the flood tide, depicted in ERT 2-1, three to four relatively higher resistivity value bodies are observed in the profile at depths of 15 to 40 feet (Figure 3.6). The responses observed in the early ebb tide, depicted in ERT 2-2, are relatively lower in recorded resistivity values (relatively higher in recorded conductivity values) (Figure 3.7) and ERT 2-3 images the response of the mid-ebb tide when three significant high resistivity responses are observed at depths of 15 to 40 feet. The lower boundary of the resistivity response extends beyond the depth of investigation in the central portion of the profile (Figure 3.8).

### ERT 3

Variations in resistivity were recorded during the tidal cycle at profile ERT 3 during three recording periods. ERT 3-1, collected during a late flood tide, identifies a horizon of relatively higher resistivity value material ranging from 5 to 30 feet in depth, with relatively lower resistivity value (relatively higher conductivity) material at depth. Between Station 310 feet and Station 400 feet there is a high resistivity response observed at depth (Figure 3.10). The responses observed in ERT 3-2 depict a similar geometry as ERT 1-1, however, the resistivity values are relatively higher in ERT 3-2 (Figure 3.11). Three to four distinct bodies with relatively higher resistivity values can be delineated in the late ebb tide of ERT 3-3. The relatively deep resistivity response between stations 310 and 400 increases greatly in resistivity value (Figure 3.12). This high resistivity response could be associated with the opening in the causeway of State Highway 308.

### ERT 4

Variations in resistivity were recorded during the tidal cycle at profile ERT 4 during four recording periods. A relatively higher resistivity value body is observed at a depth of 20 feet in the central portion of ERT 4-1, during the late flood tide (Figure 3.14). The profile does not capture the lower boundary of this response. The geometry and location of this response is similar to the high resistivity body detected in ERT 3. A generally lower resistivity value (increased conductivity value) response is observed in ERT 4-2 during this high tide event. Small, discrete features are not discernable (Figure 3.15). ERT 4-3, capturing the late ebb tide, depicts three relatively higher resistivity value anomalies recorded in the profile (Figure 3.16). An additional 84-electrode array, ERT 4-4, collected data over the period of the mid-flood tide. Two significant relatively high resistivity value bodies are observed in ERT 4-4 (Figure 3.17).

### ERT 5

Variations in resistivity were recorded during the tidal cycle at profile ERT 5 during three recording periods. ERT 5-1 collected during the late flood tide captured several relatively higher resistivity value anomalies, at approximately 10 to 40 feet in depth (Figure 3.19). The response observed in the early ebb tide of ERT 5-2 has a similar geometry and resistivity response as the late flood tide in ERT 5-1 (Figure 3.20). Relatively high resistivity value anomalies become larger, increase in resistivity values and coalesce during the late ebb tide of ERT 5-3 (Figure 3.21).

### ERT 6

Variations in resistivity were recorded during the tidal cycle at profile ERT 6 during three recording periods. A broader, relatively more diffuse resistivity response is observed, at depths of 10 to 40 feet, during the late flood tide of ERT 6-1 (Figure 3.23). During the high tide event, captured by ERT 6-2, three relatively high resistivity value bodies are observed in the central portion of the profile (Figure 3.24). A laterally extensive relatively higher resistivity value response is present during the late ebb tide of ERT 6-3 (Figure 3.25).

## 5.2 TRP Profiles

The results from the time-lapse electrical resistivity study are presented on Figures 4, 5, 6, and 7. As previously mentioned, the figures are presented in color gradient form with warm (orange/red) colors representing higher recorded resistivity values and the cool colors (blue) representing higher conductivity values. The results reveal lateral variability in the near surface; both relatively higher conductivity and resistivity bodies are observed with lower resistivity value (higher conductivity value) materials at depth. In general, the TRP profiles depict resistivity values that appear to migrate both laterally and vertically during temporal fluctuations in the tidal cycle.

### TRP 1

Several distinctive features are observed in TRP 1 (Figures 4.2 through 4.23). In the near surface there is a horizon of relatively higher resistivity values at depths of approximately 15 to 40 feet.

During the low tide events, resistivity anomalies are observed, at depths of approximately 40 feet, within the northwest limit of the Tidal Flats and at the southeast limit of Dogfish Bay. Anomalies with higher resistivities are consistently present within the vicinity of the State Highway 308 Bridge. Another, more subtle body of relatively high resistivity values is detected between Stations 315 and 420. A conductive, relatively lenticular shaped response is observed in the eastern portion of the profile, at approximately 80 feet in depth in the Tidal Flats. A wedge of relatively higher conductivity material is detected in Dogfish Bay. During tidal ebbing events resistivity values generally increase and resistivity anomalies increase in size. During tidal flooding events the resistivity values across the profile generally decrease. At Station 394, a relatively higher value resistivity anomaly is present only at low tide. This may indicate some pooling or stagnation of resistive fluid is associated with the turn of the tide generating this response (e.g., Figures 4.5 through 4.9).

### TRP 1X

A relatively higher resistivity layer spanning the length of the profile is observed at a depth of approximately 35 feet (Figure 5.3). Between stations 801 to 1,116 the vertical extent of this feature reaches the lower portions of the profile (Figure 5.4). The geometry of this feature is influenced by tidal fluctuations (Figures 5.5 through 5.8). A relatively higher conductivity value lens is observed between Stations 591 and 798 at a depth of about 80 feet (Figure 5.7). During an ebbing tidal sequence, the resistivity values increase over the length of the profile (Figures 5.2 through 5.4). The conductivity values generally increase during the flood tide (Figures 5.14 through 5.22). Relatively higher resistivity anomalies become more prominent at depths of 35 feet, during a low tide period (Figures 5.3 through 5.7). A plunging resistivity feature is observed between Stations 801 and 1037 during the "low-low" tide event (Figure 5.7).

### TRP 2

Several conductivity and resistivity features were detected during the collection cycle of TRP 2 (Figures 6.2 through 6.23). Five relatively higher resistivity anomalies were consistently observed at depths of approximately 20 feet across the profile. Two conductivity lenses are observed at approximately 50 feet deep in the southern portion of the profile and at 80 feet in the northern portion of the profile. During tidal ebbing events, the shallow resistivity anomalies in the northern half of the profile retract in size and increase in conductivity value. Collection cycles throughout tidal flooding events, depict increasing resistivity values in the northern portion of the profile. The relatively higher conductivity response in the northern portion of the profile follows the same trend as the shallow resistivity features. The response of these anomalies relative to the tide, observed in a terrestrial setting, are inverted compared to those observed in the marine profiles. The relatively higher value conductivity lens and shallow resistivity anomaly in the southern portion of the site becomes even higher in conductivity value during the high tide and increases in resistivity value during low tide.

### TRP 3

One significant resistivity response is observed in TRP 3 (Figures 7.2 through 7.24). This response has higher conductivity and is less apparent during the low tide periods (Figures 7.6 through 7.9) and has increased relative resistivity during the high tide (Figures 7.15 through 7.18). The cause of this response is unknown; however, the adjacent landfill and cultural features (e.g., concrete walls, landfill debris) potentially have some influence on this dataset.

## 6. CONCLUSIONS AND RECOMMENDATIONS

Distinct relative contrasts in resistivity values, also known as a geophysical "anomaly", are recorded in our data and appear where significant changes in the electrical properties of subsurface materials are present. These responses provide information useful in interpreting possible geological features such as changes in permeability, geologic contacts, and other parameters such as changes in fluid electrical conductivity (the inverse of resistivity) and the possible presence of clays, acquicludes, or aquitards.

In general, the availability of pore space and the chemistry of the groundwater are the most significant factors influencing the resistivity response of a material. Considering the heterogenous environment of the study area, the absolute resistivity values are not as indicative of features of interest as are relative changes. Significant relative contrasts in resistivity values vertically and laterally support the interpretation of the presence of resistivity anomalies. Resistivity anomalies are generally consistent with changes in several geologic characteristics including contrasts in fluid conductivity. With regard to detecting possible preferential migration pathways, resistivity anomalies detected on ERT and TRP lines that exhibit changes in accordance with tidal fluctuations are candidate responses. Responses with an observed delay or minimal change in resistivity contrast over time could be considered as features with possible relatively less permeability compared to anomaly features showing more rapid changes in resistivity contrast, especially when such rapid changes in the anomaly contrasts approximately correspond to, or lag just behind, known tidal fluctuations in time.

TRP 1 and TRP 1X have imaged dynamic conditions that migrate in general correspondence to known tidal fluctuations. The body of high resistivity material observed at station 394 in TRP 1X, plunging to the east, is consistently present throughout the tidal range. This relatively high resistivity anomaly could be associated with the composition of this feature and/or this feature's possible lower permeability and/or are an effect of the possible presence of an aquitard.

The resistivity of sea water is generally regarded as 0.3 Ohm-m (Chave et al., 1991; Eidesmo et al., 2002; Constable & Weiss, 2006). Within our results, during the flood tide period, resistivity values seen at the surface (a saline environment) are similar to the responses seen at depth. Anomalies with increasingly higher resistivity values may correlate with a lens of higher concentrations of freshwater. A distinct regional migration to higher resistivity values is observed from TRP 1X-1 through TRP 1X-5 (Figures 5.2 through 5.6). Considering the changes in recorded subsurface resistivity, anomalies related to the ebb tide in these figures we can attribute the recorded response to the influx of more resistive fluid across the alignment of the profile. The observed resistivity anomaly changes over time are consistent with imaging regressive migration of the saltwater wedge during our recorded time period within the tidal range. Similarly, TRP 1X-5 through TRP 1X-9 (Figures 5.6 through 5.10) depict a transgressive migration of relatively more conductive fluid.

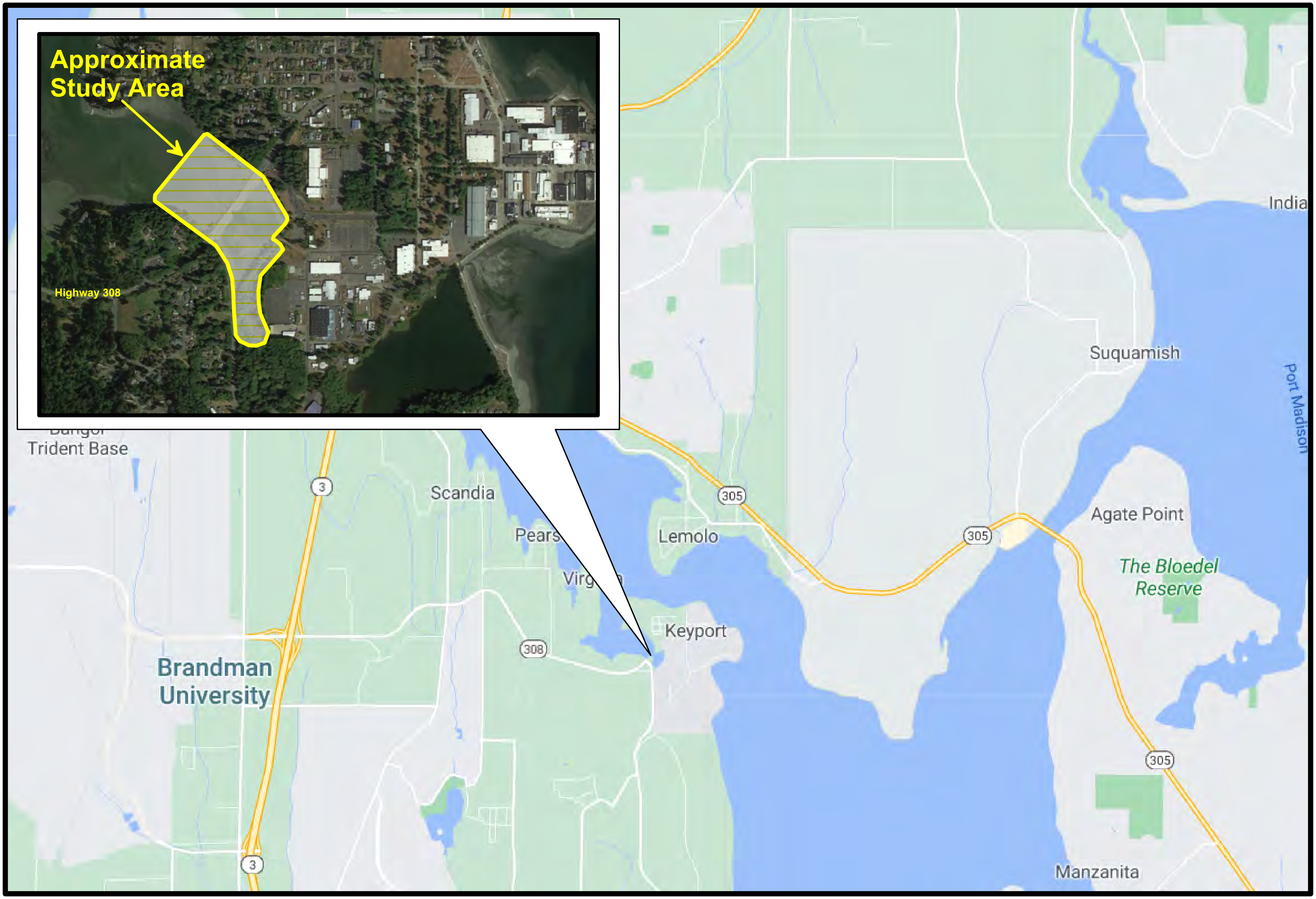
TRP 2 displays a complex series of responses. A conductive lens is observed between stations 118 and 225, at approximately 50 feet in depth. The oscillation of resistivity values of this feature in response to the tide are consistent with the values and responses seen at ERT 1 through ERT 6, TRP 1 and TRP 1X. A similar trend in resistivity values is observed from relatively shallow resistivity responses within the southern portion of the profile. It is possible that the responses detected from these features are influenced by the tide. The northern half of TRP 2 and the overall response observed in TRP 3 of mostly on-shore, land-based data have an inverted trend relative to the response of our recorded marine transect results. During a flood tide increased resistivity values are observed, and a decrease in resistivity values are observed in an ebb tide. The inverted trend and high resistivity values of these responses occur in close proximity to a known onshore existing landfill. It might be possible that the variations in resistivity values observed in the northern half of TRP 2 and the overall response observed in TRP 3 are dependent on groundwater migration or movement from the adjacent landfill, in response to changes in hydraulic conditions caused by the tidal variations "pulsating" denser, saline water periodically under the Ghyben-Hertzberg freshwater lens, rather than by water influx or egress from the tides directly.

To further assess the features described above, it is recommended that additional indirect and direct methods be used. Such methods may include additional geophysical evaluations, the excavation of exploratory trenches or test pits for land-based testing locations, and/or land based or marine borings.

## 7. LIMITATIONS

The field evaluation and geophysical analyses presented in this report have been conducted in general accordance with current practice and the standard of care exercised by consultants performing similar tasks in the project area. This study utilized industry standard equipment (i.e., electrical resistivity meters) and was conducted in general accordance with current practice. It should be noted that the presence of existing structures and surface objects (i.e., cut off posts, fences, buildings, etc.) may have potentially limited the study. Where obstructions were present, subsurface data could not be collected. Moreover, EM/ magnetic responses produced by metal surface objects and underground lines can potentially obscure subsurface features. There is no single evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may exist. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Atlas should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document. This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.




**SITE LOCATION MAP**

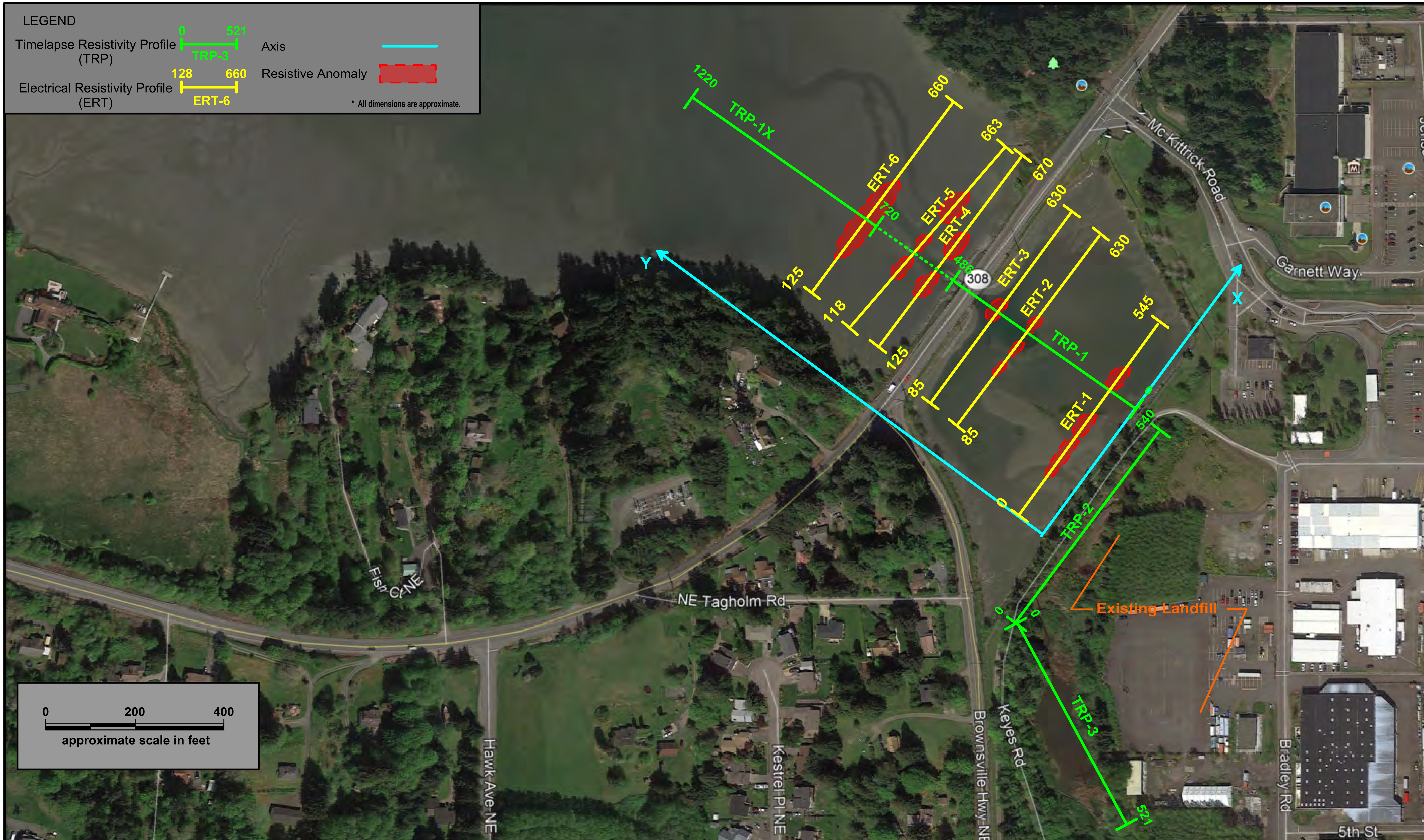
N

Operable Unit 1
Keyport, Washington

Project No.: 420019SWGREV1 | Date: 09/21

ATLAS

Figure 1




| | | | |
|---|---|---|---|
| **SITE MAP** | N | Operable Unit 1<br>Keyport, Washington<br>Project No.: 420019SWGREV1 Date: 09/21 | ATLAS<br>Figure 2 |


**SITE MAP**

N

Operable Unit 1
Keyport, Washington

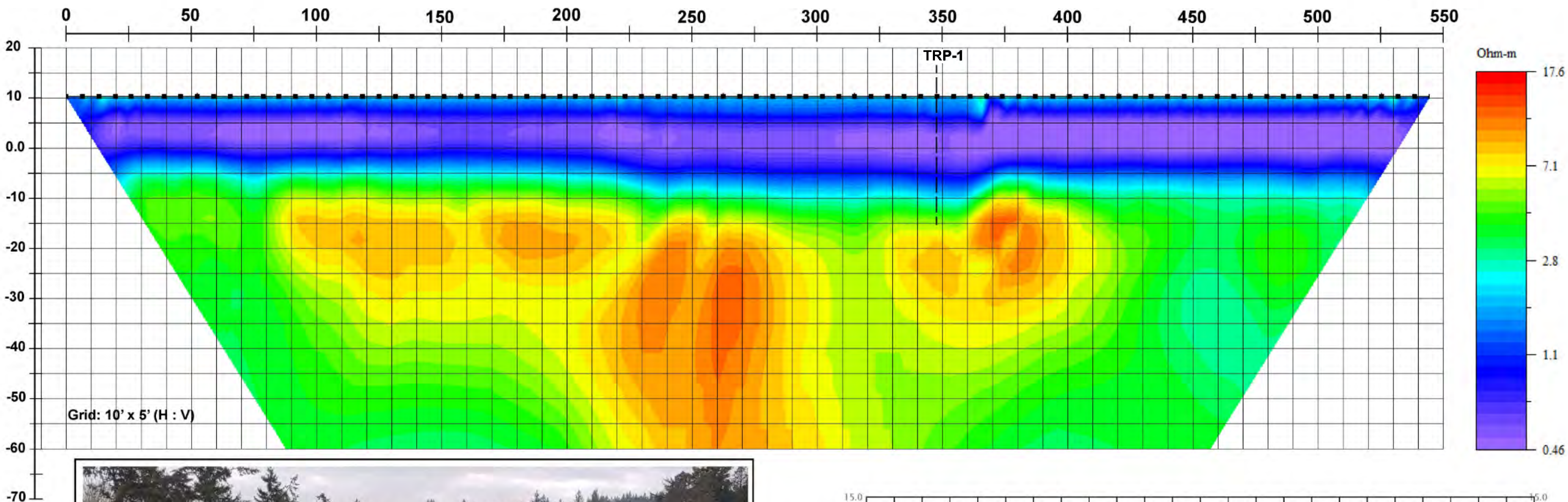
Project No.: 420019SWG REV1 | Date: 09/21

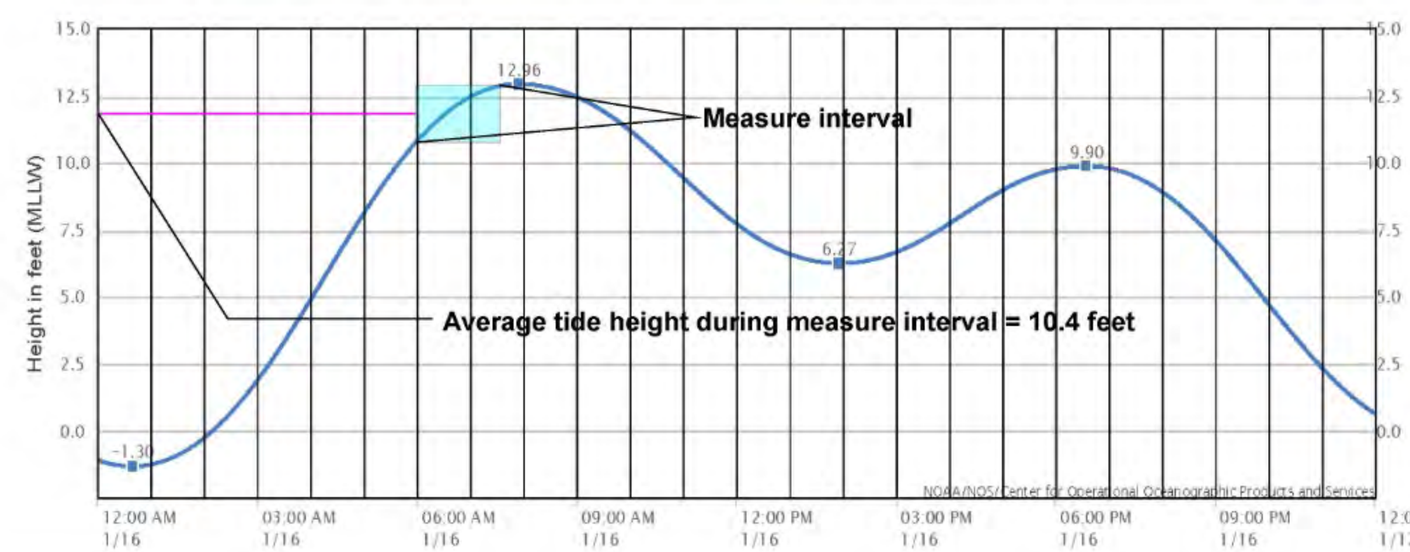
ATLAS
Figure 3.1

Azimuth ~37 degrees

# ERT 1-1: Electrical Resistivity: Dogfish Bay ~76 feet NW of Tide Gate

**(84 floating graphite electrodes on 2 m spacing, Dipole-Dipole array)**

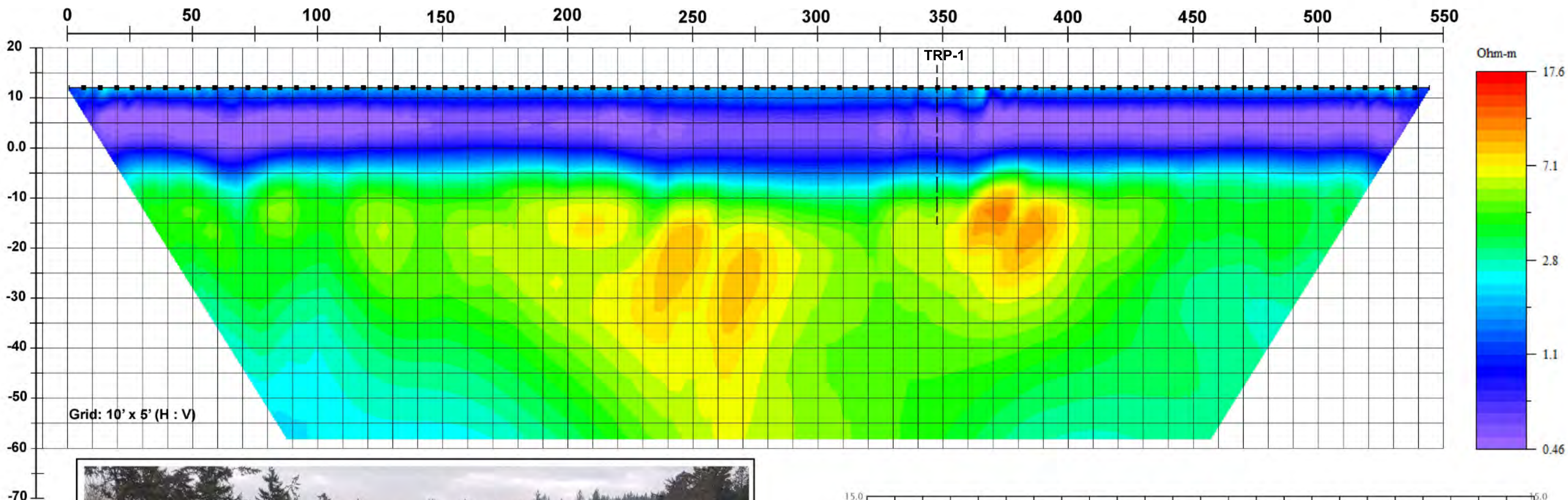


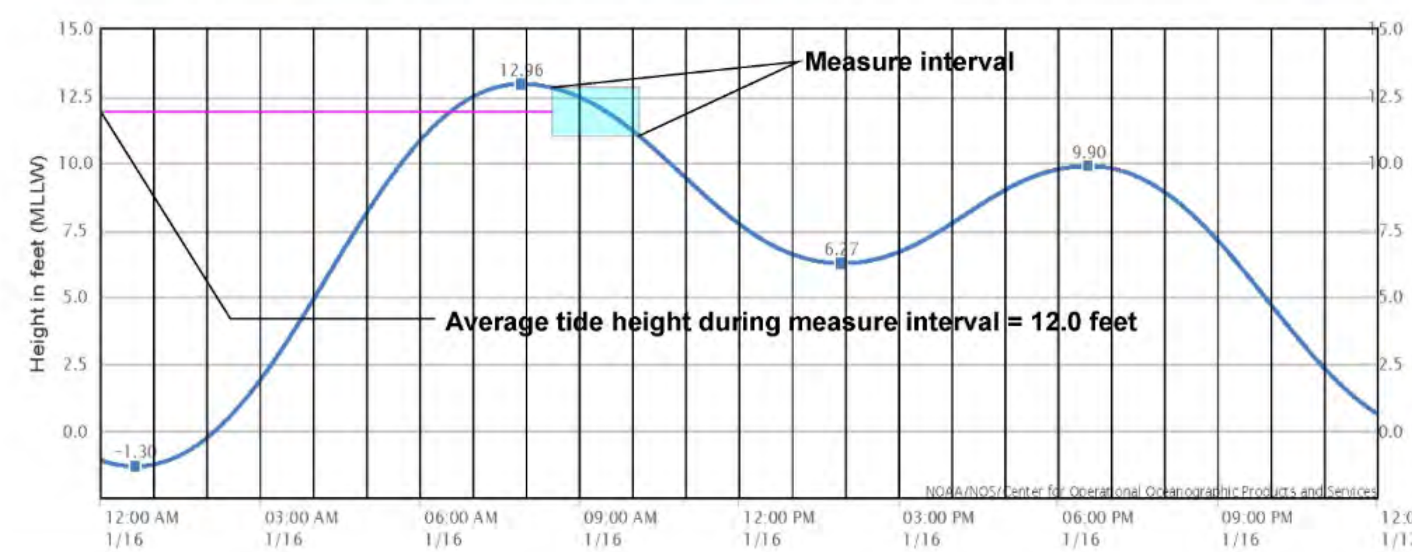




| Electrical Resistivity Profile ERT 1-1 | Operable Unit 1<br>Keyport, Washington | | ATLAS<br>Figure 3.2 |
|---|---|---|---|
| | Project No.: 420019SWG REV1 | Date: 09/21 | |

# ERT 1-2: Electrical Resistivity: Dogfish Bay ~76 feet NW of Tide Gate

**(84 floating graphite electrodes on 2 m spacing, Dipole-Dipole array)**



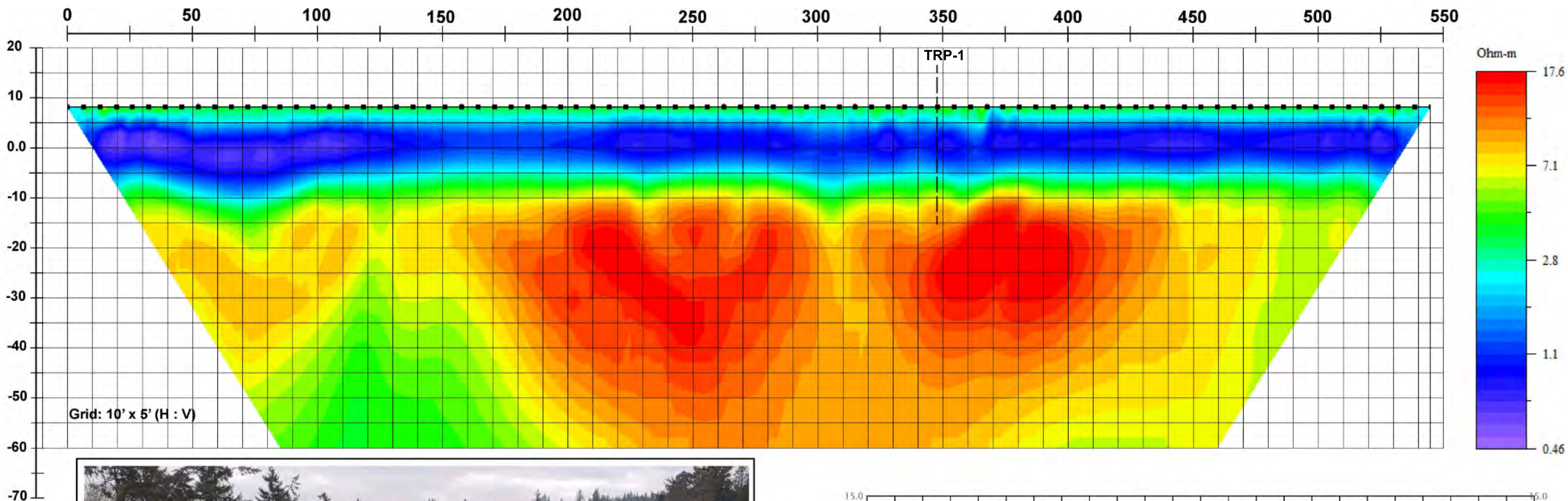



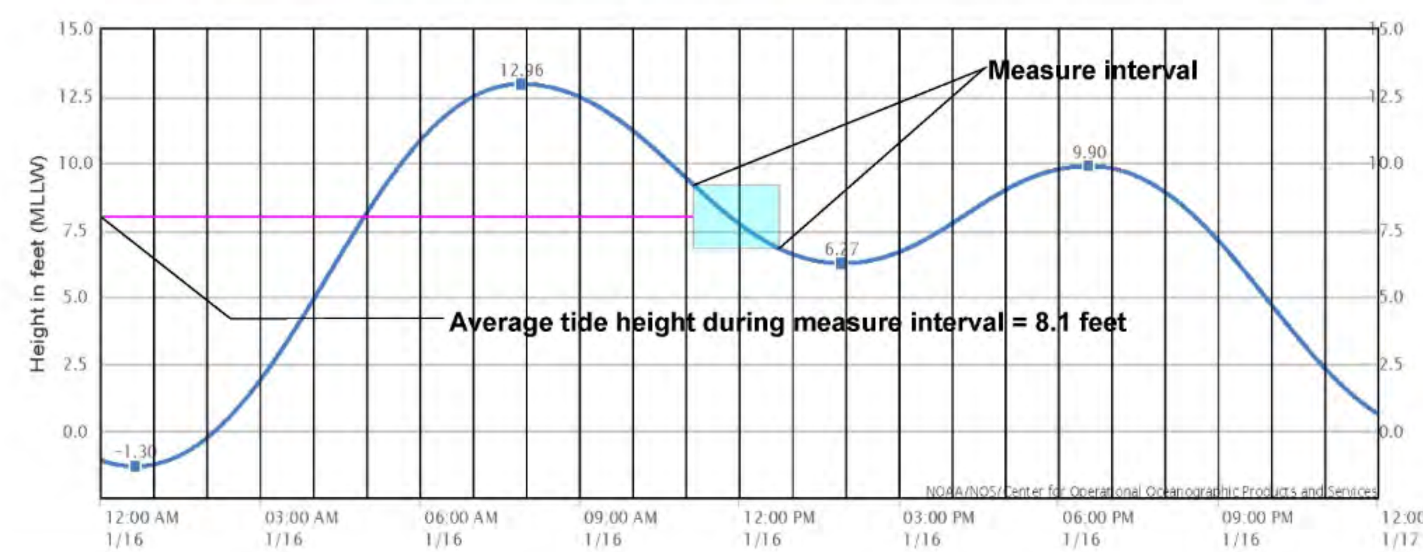

| **Electrical Resistivity Profile ERT 1-2** | Operable Unit 1<br>Keyport, Washington | | ATLAS<br>Figure 3.3 |
|---|---|---|---|
| | Project No.: 420019SWG REV1 | Date: 09/21 | |

Azimuth ~37 degrees

# ERT 1-3: Electrical Resistivity: Dogfish Bay ~76 feet NW of Tide Gate

**(84 floating graphite electrodes on 2 m spacing, Dipole-Dipole array)**




| Electrical Resistivity Profile<br>ERT 1-3 | Operable Unit 1<br>Keyport, Washington | | ATLAS<br>Figure 3.4 |
|---|---|---|---|
| | Project No.: 420019SWG REV1 | Date: 09/21 | |


SITE MAP

Operable Unit 1
Keyport, Washington

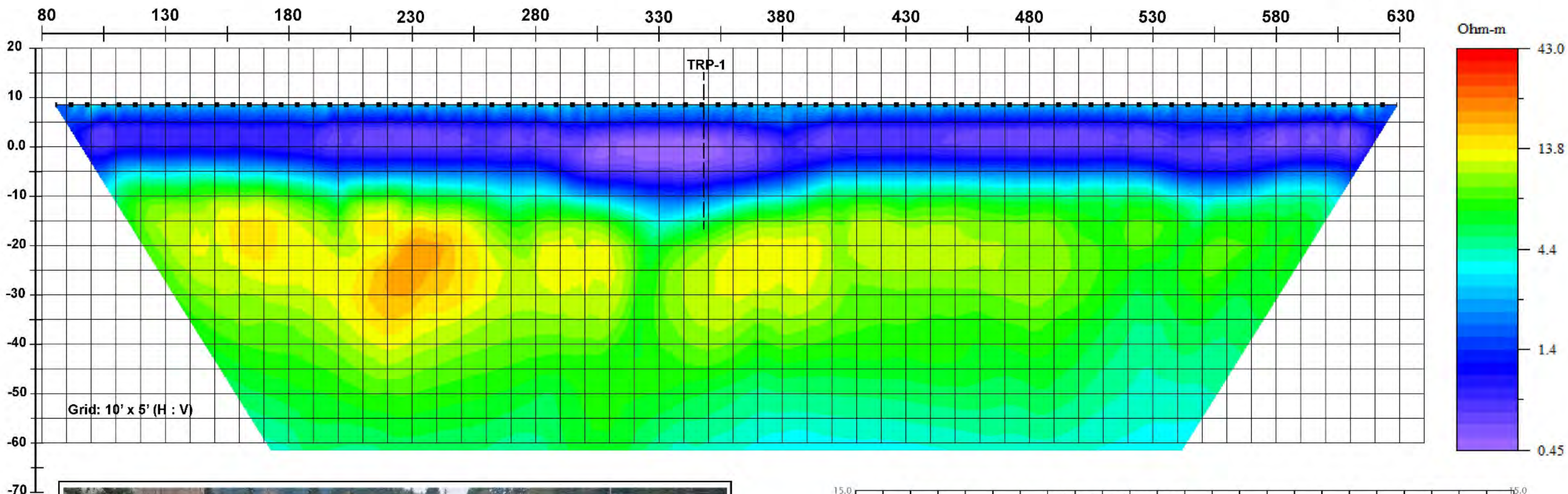
Project No.: 420019SWG REV1 | Date: 09/21

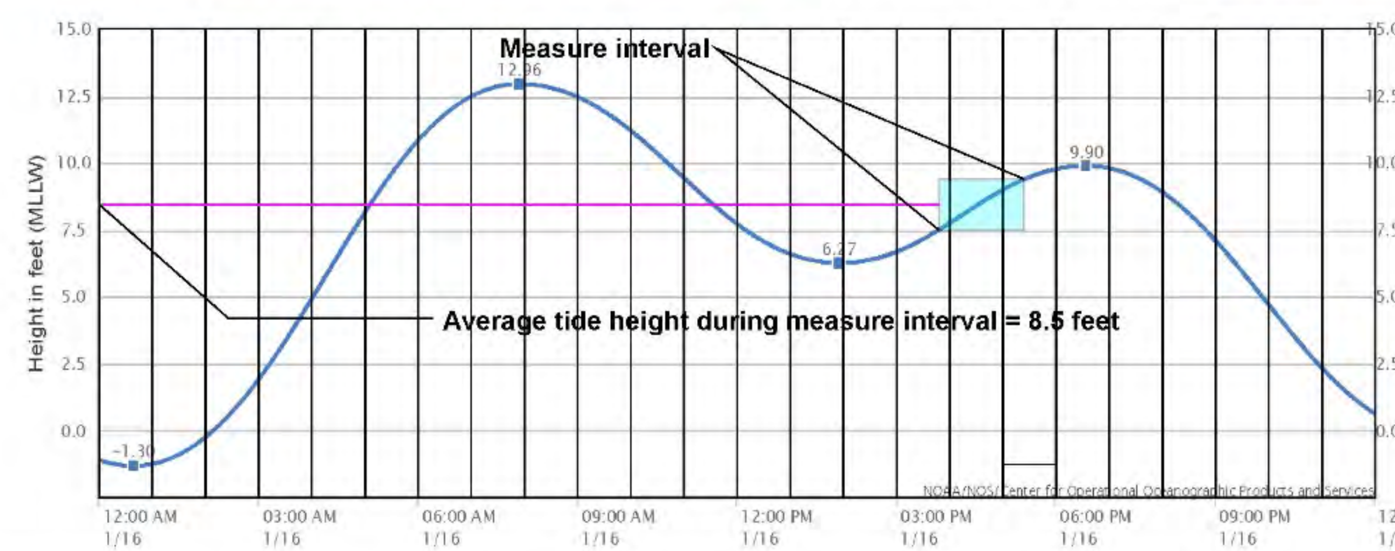
ATLAS
Figure 3.5

Azimuth ~37 degrees

# ERT 2-1: Electrical Resistivity: Dogfish Bay ~296 feet NW of Tide Gate

**(84 floating graphite electrodes on 2 m spacing, Dipole-Dipole array)**



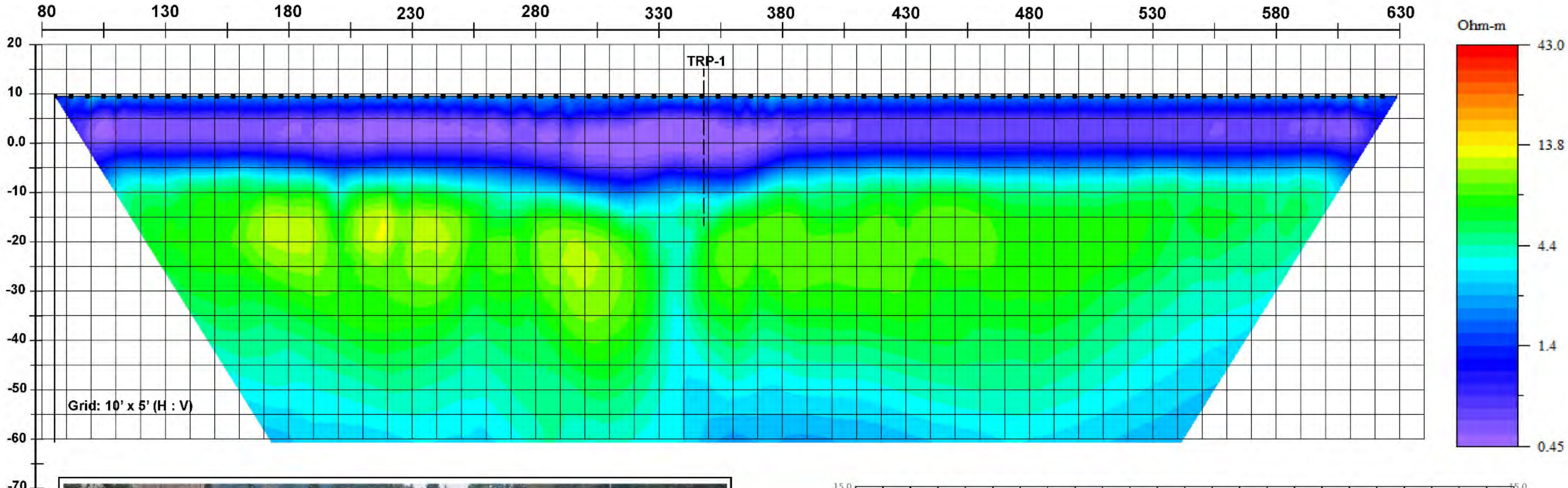



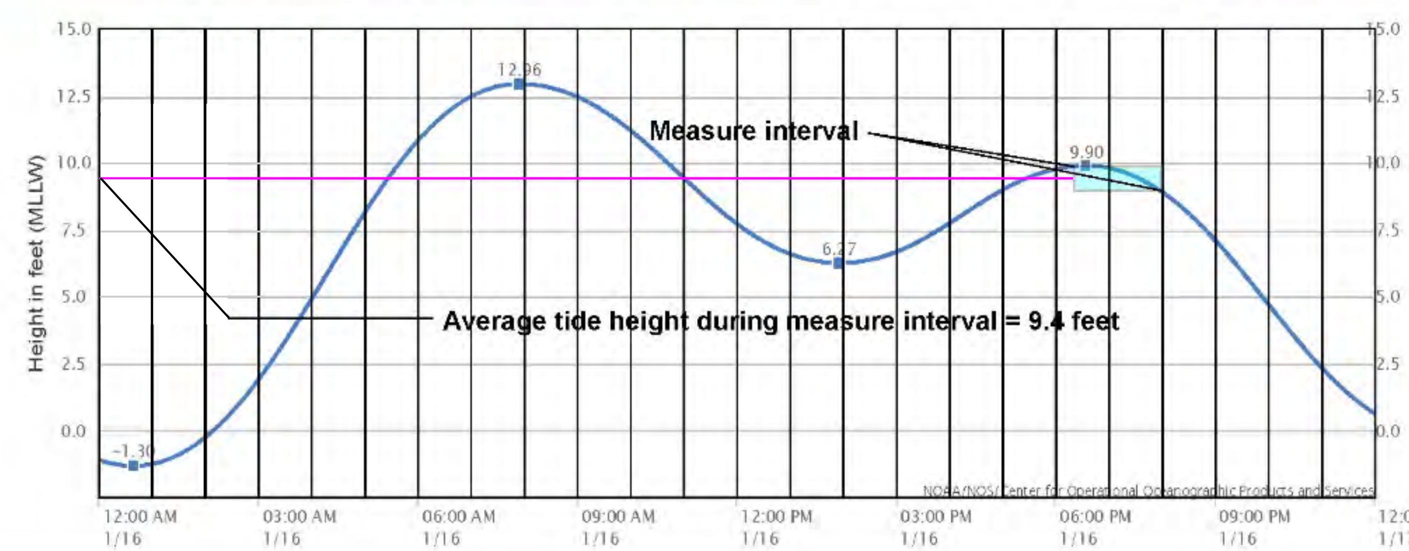

| Electrical Resistivity Profile ERT 2-1 | Operable Unit 1<br>Keyport, Washington | | ATLAS<br>Figure 3.6 |
|---|---|---|---|
| | Project No.: 420019SWG REV1 | Date: 09/21 | |

Azimuth ~37 degrees

# ERT 2-2: Electrical Resistivity: Dogfish Bay ~296 feet NW of Tide Gate

**(84 floating graphite electrodes on 2 m spacing, Dipole-Dipole array)**



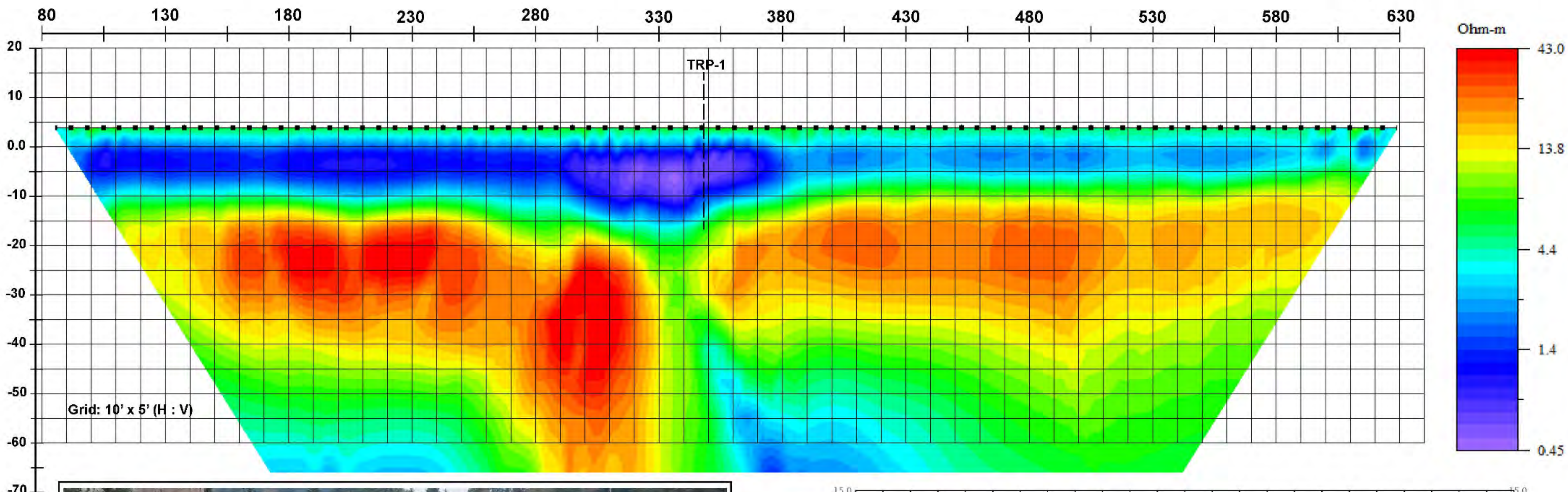



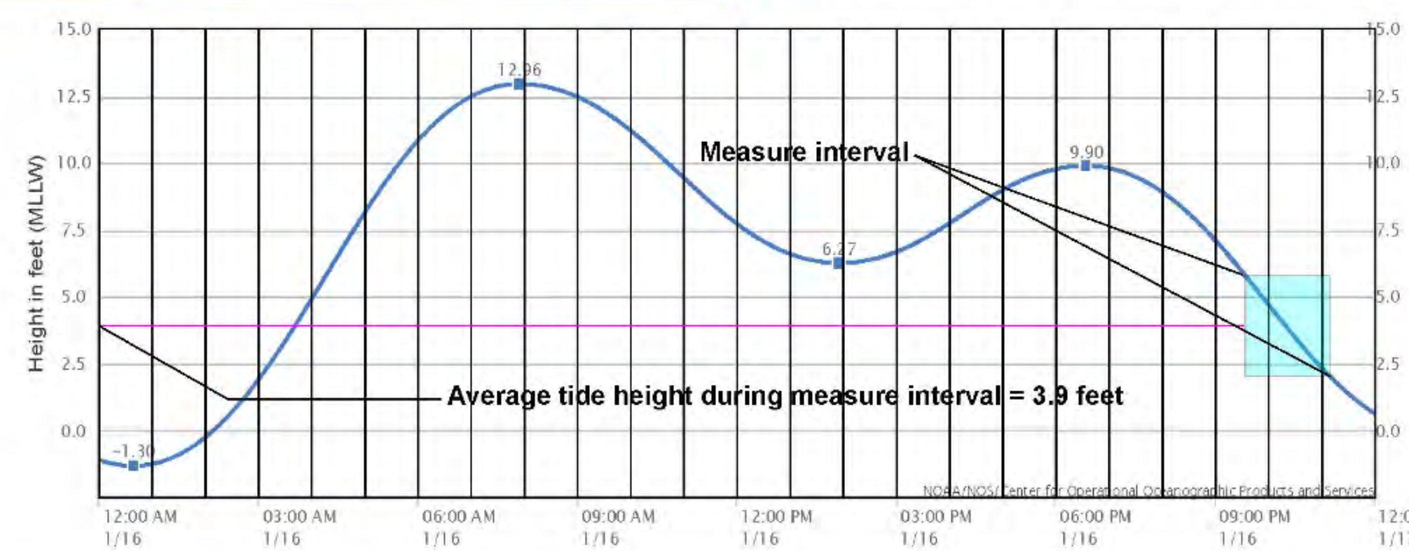

| **Electrical Resistivity Profile ERT 2-2** | Operable Unit 1<br>Keyport, Washington | | ATLAS<br>Figure 3.7 |
|---|---|---|---|
| | Project No.: 420019SWG REV1 | Date: 09/21 | |

Azimuth ~37 degrees

# ERT 2-3: Electrical Resistivity: Dogfish Bay ~296 feet NW of Tide Gate

**(84 floating graphite electrodes on 2 m spacing, Dipole-Dipole array)**




| Electrical Resistivity Profile ERT 2-3 | Operable Unit 1 Keyport, Washington | | ATLAS Figure 3.8 |
|---|---|---|---|
| | Project No.: 420019SWG REV1 | Date: 09/21 | |


**SITE MAP**

N

Operable Unit 1
Keyport, Washington

Project No.: 420019SWG REV1 | Date: 09/21

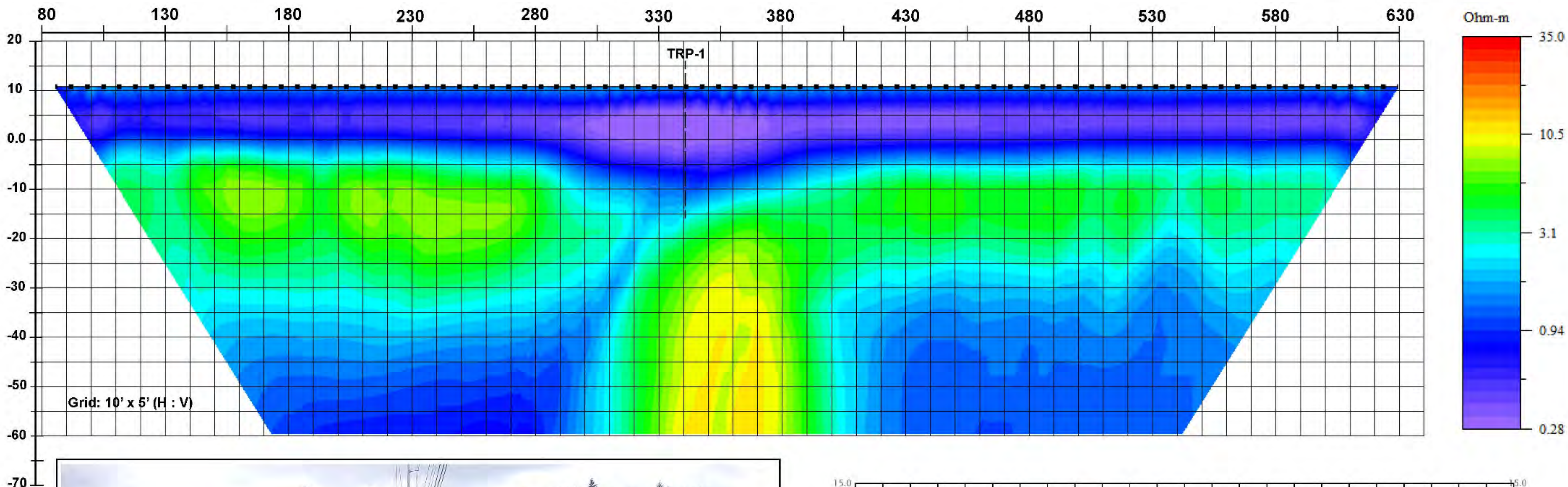
ATLAS

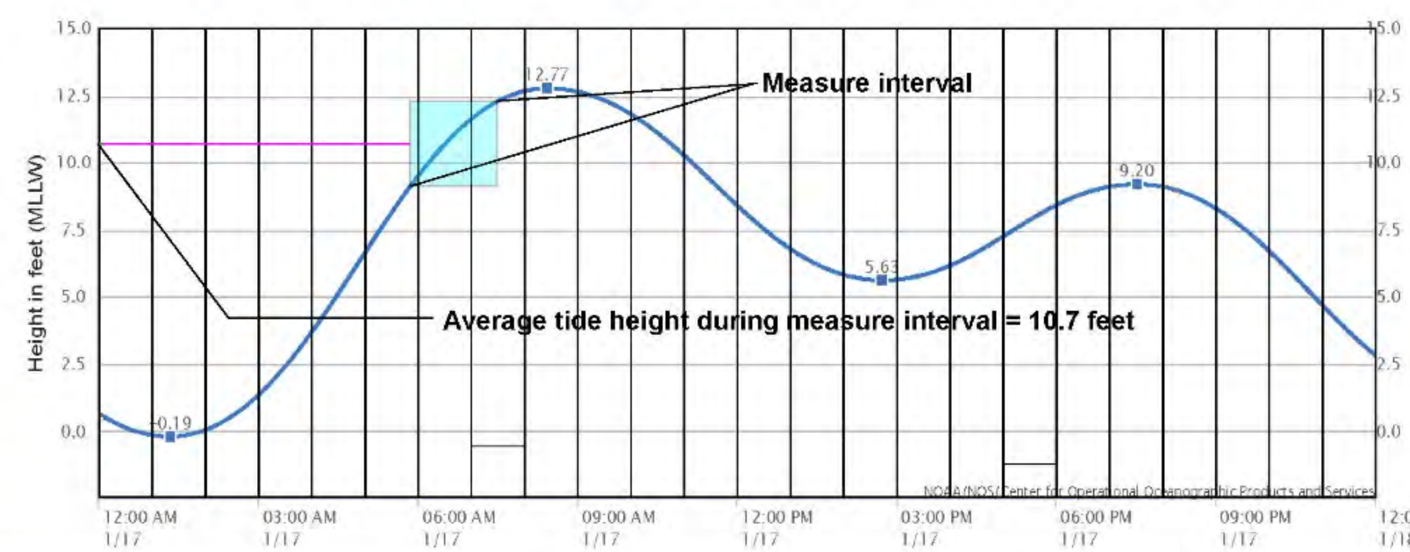
Figure 3.9

Azimuth ~37 degrees

## ERT 3-1: Electrical Resistivity: Dogfish Bay ~378 feet NW of tide gate

**(84 floating graphite electrodes on 2 m spacing, Dipole-Dipole array)**



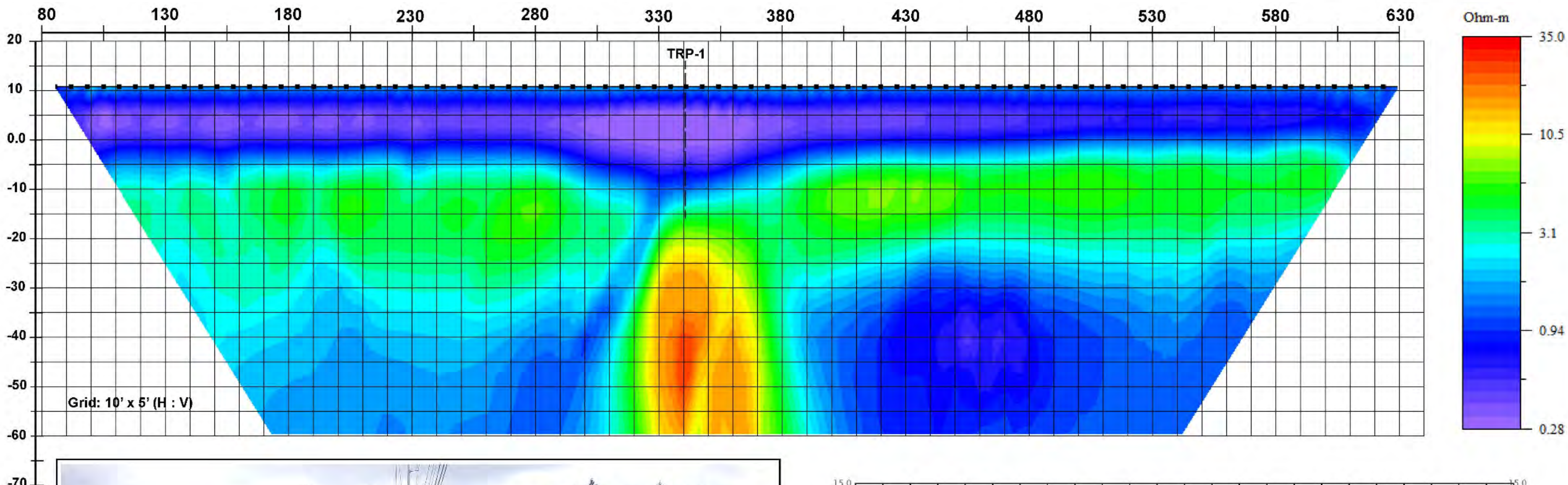



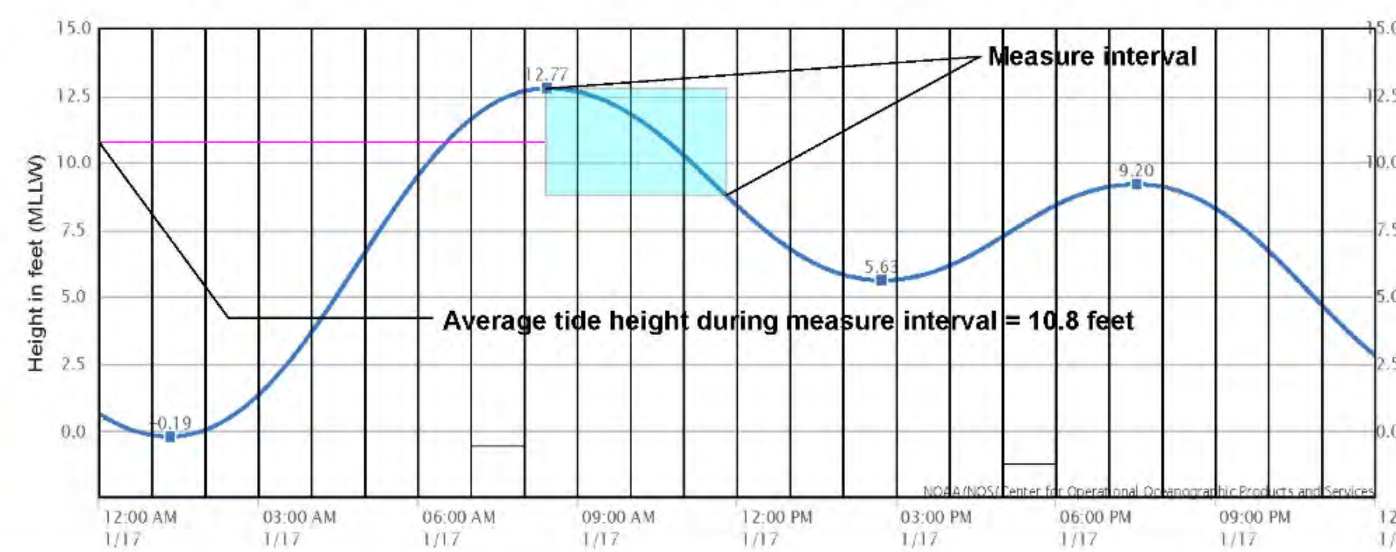

| | | |
|---|---|---|
| **Electrical Resistivity Profile ERT 3-1** | Operable Unit 1<br>Keyport, Washington | ATLAS<br>Figure 3.10 |
| | Project No.: 420019SWG REV1 — Date: 09/21 | |

Azimuth ~37 degrees

# ERT 3-2: Electrical Resistivity: Dogfish Bay ~378 feet NW of tide gate

**(84 floating graphite electrodes on 2 m spacing, Dipole-Dipole array)**



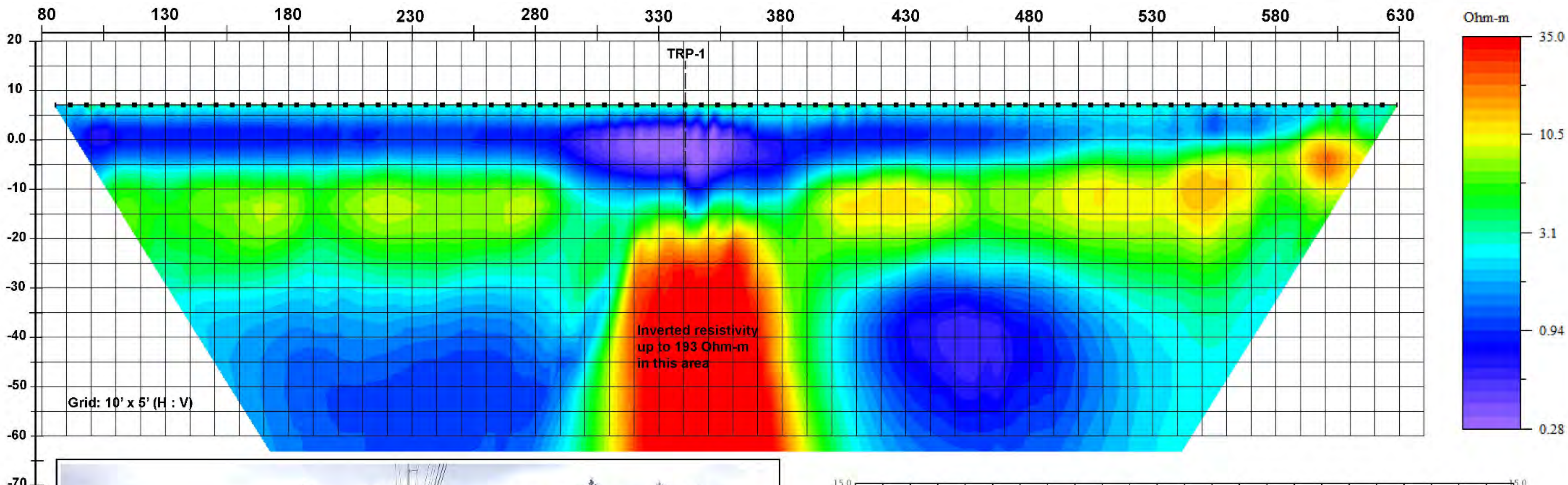



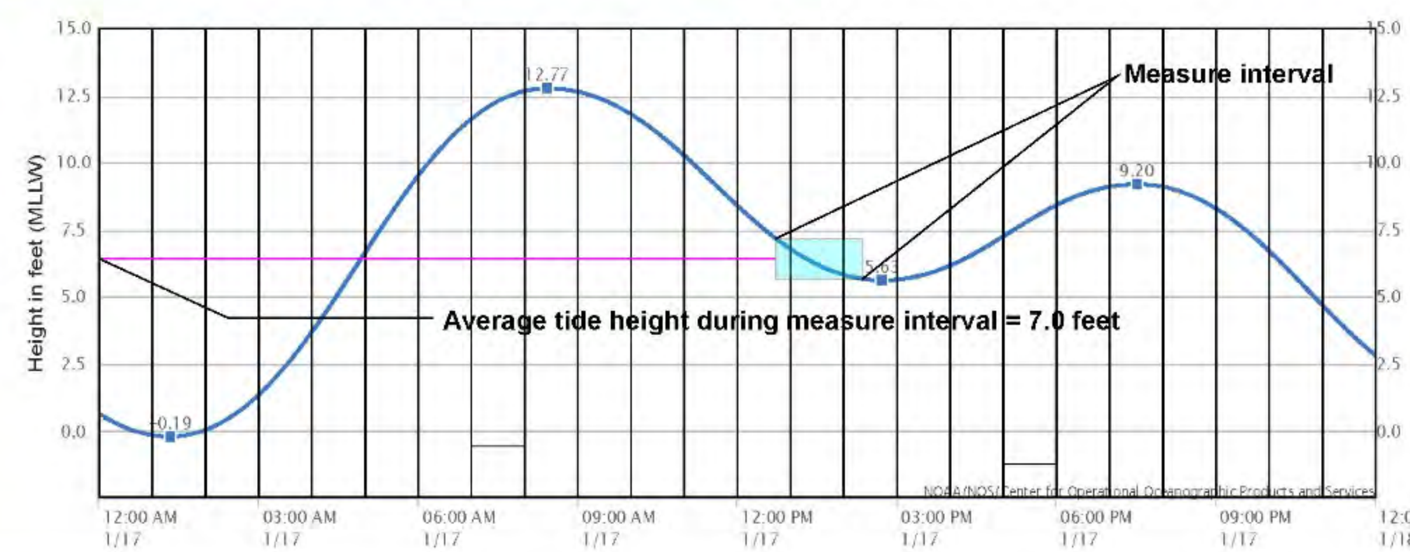

| Electrical Resistivity Profile ERT 3-2 | Operable Unit 1 Keyport, Washington | | ATLAS Figure 3.11 |
|---|---|---|---|
| | Project No.: 420019SWG REV1 | Date: 09/21 | |

Azimuth ~37 degrees

## ERT 3-3: Electrical Resistivity: Dogfish Bay ~378 feet NW of tide gate

**(84 floating graphite electrodes on 2 m spacing, Dipole-Dipole array)**



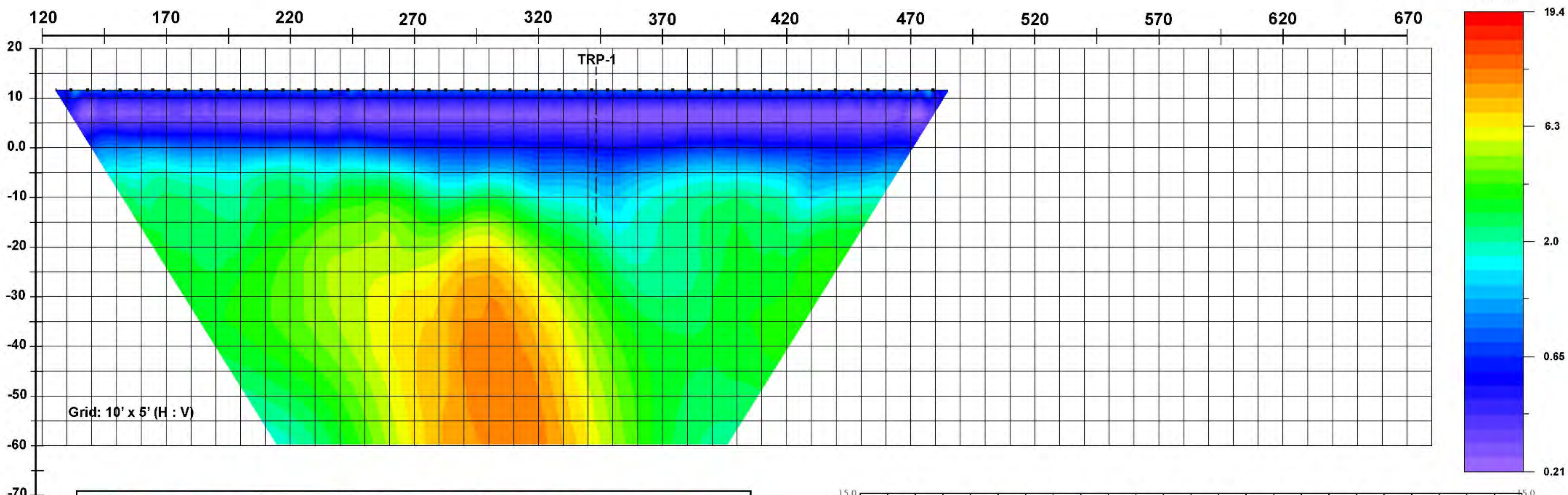

| Electrical Resistivity Profile ERT 3-3 | Operable Unit 1<br>Keyport, Washington | ATLAS<br>Figure 3.12 |
|---|---|---|
| | Project No.: 420019SWG REV1 / Date: 09/21 | |

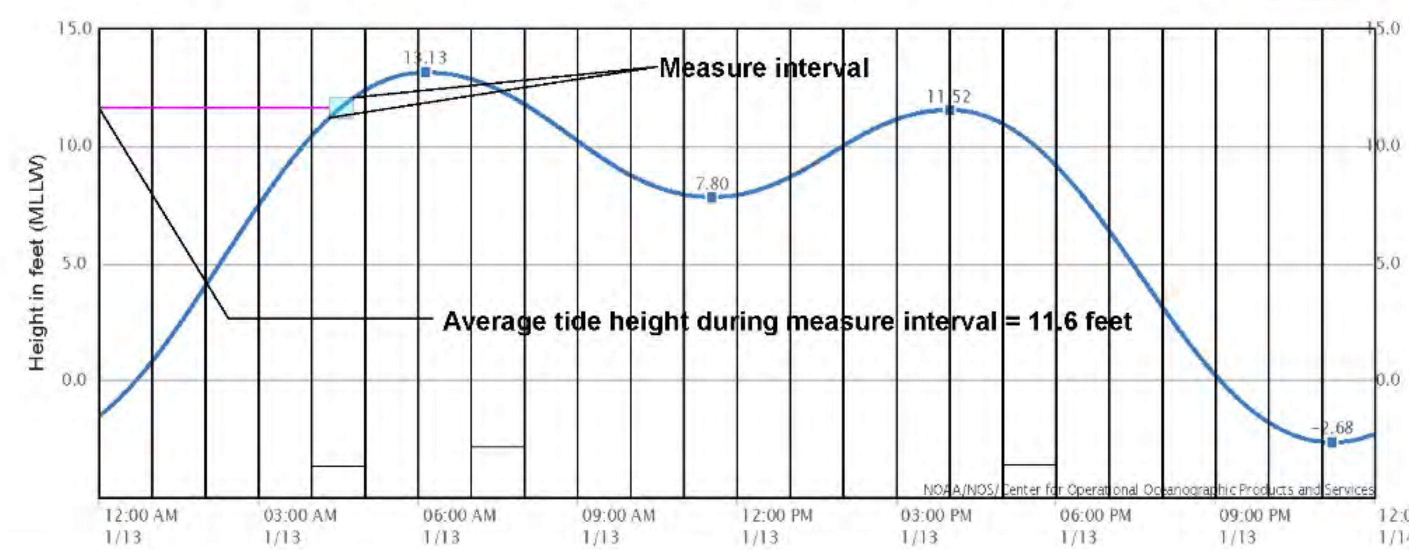

| | | | |
|---|---|---|---|
| **SITE MAP** | N | Operable Unit 1<br>Keyport, Washington<br>Project No.: 420019SWG REV1 — Date: 09/21 | ATLAS<br>Figure 3.13 |

Azimuth ~37 degrees

# ERT 4-1: Electrical Resistivity: Dogfish Bay ~544 feet NW of tide gate

**(56 floating graphite electrodes on 2 m spacing, Dipole-Dipole array)**



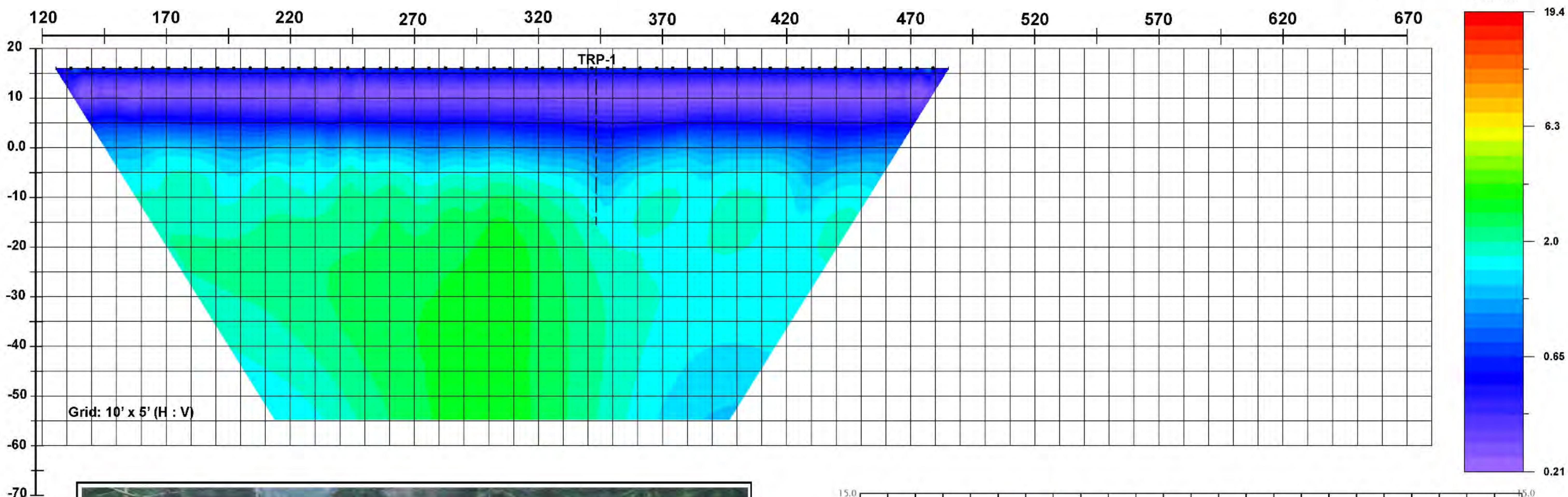



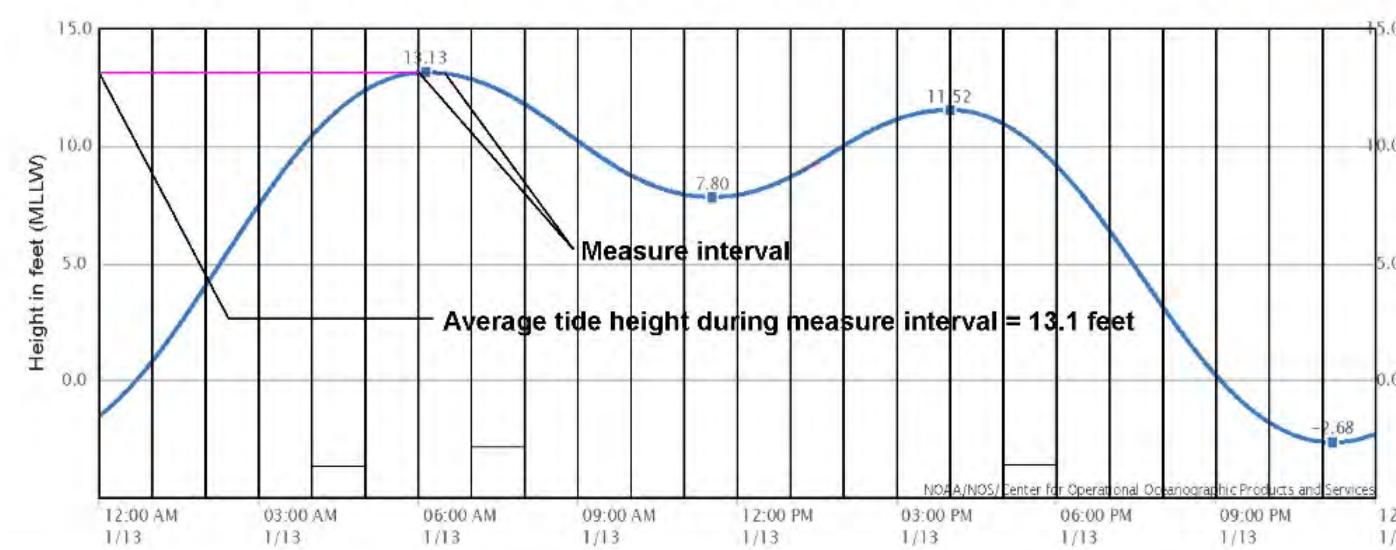

| | | |
|---|---|---|
| **Electrical Resistivity Profile ERT 4-1** | Operable Unit 1<br>Keyport, Washington<br>Project No.: 420019SWG REV1 / Date: 09/21 | ATLAS<br>Figure 3.14 |

Azimuth ~37 degrees

## ERT 4-2: Electrical Resistivity: Dogfish Bay ~544 feet NW of tide gate

**(56 floating graphite electrodes on 2 m spacing, Dipole-Dipole array)**



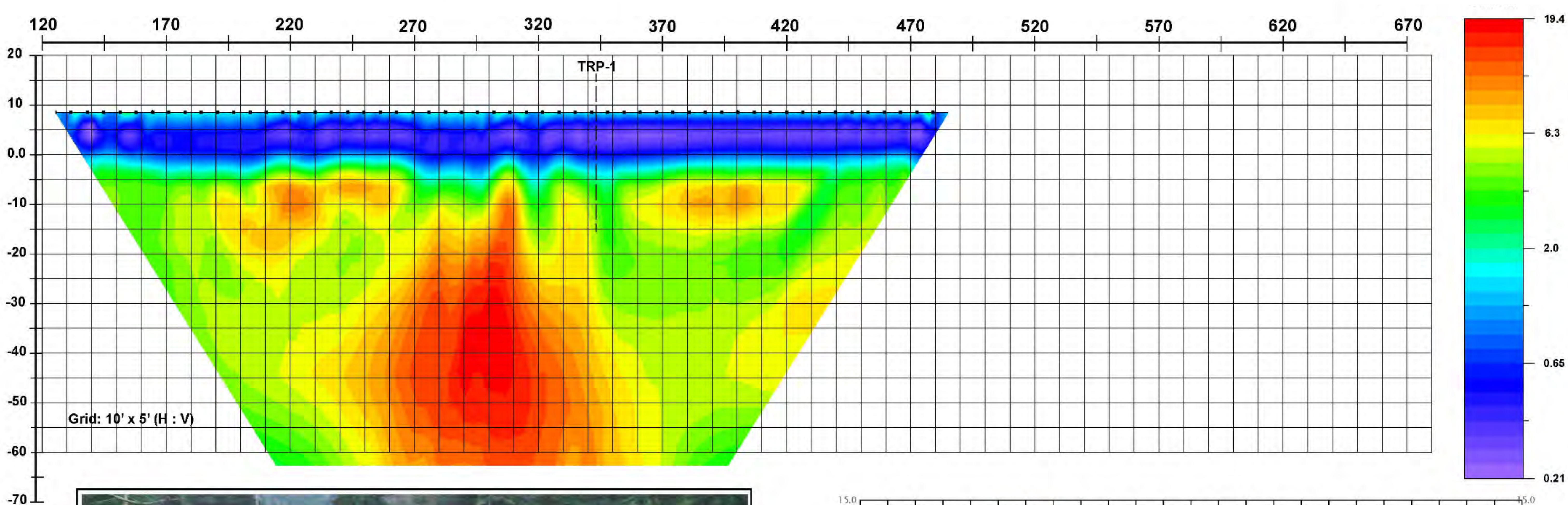



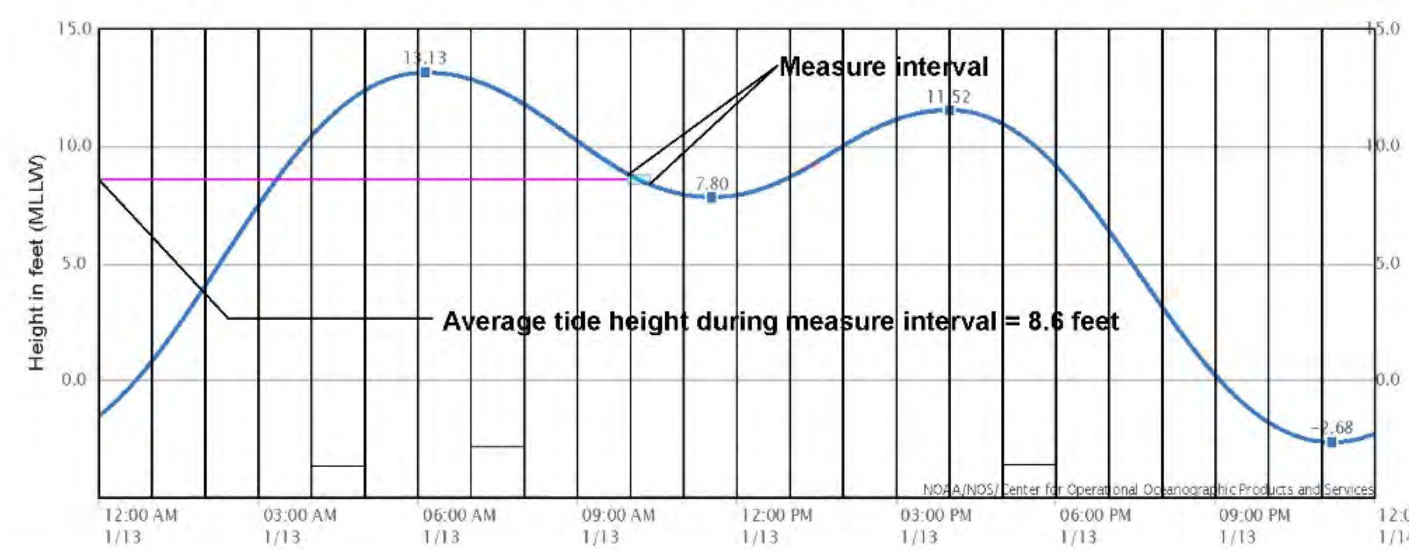

| Electrical Resistivity Profile ERT 4-2 | Operable Unit 1<br>Keyport, Washington | | ATLAS<br>Figure 3.15 |
|---|---|---|---|
| | Project No.: 420019SWG REV1 | Date: 09/21 | |

Azimuth ~37 degrees

# ERT 4-3: Electrical Resistivity: Dogfish Bay ~544 feet NW of tide gate

**(56 floating graphite electrodes on 2 m spacing, Dipole-Dipole array)**



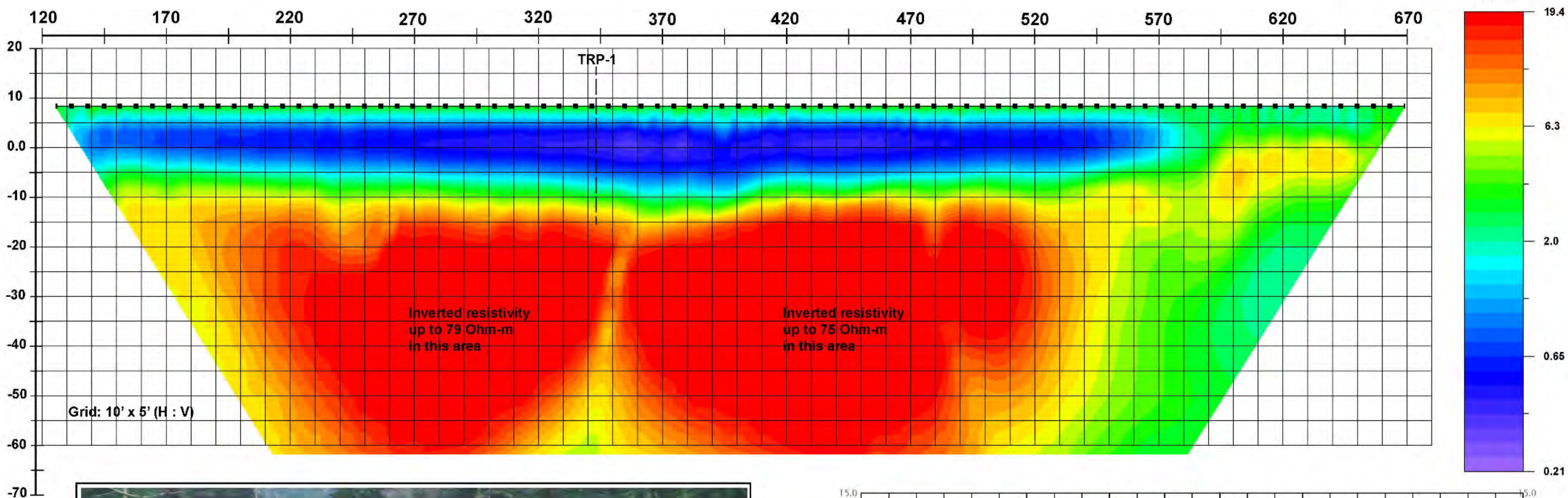



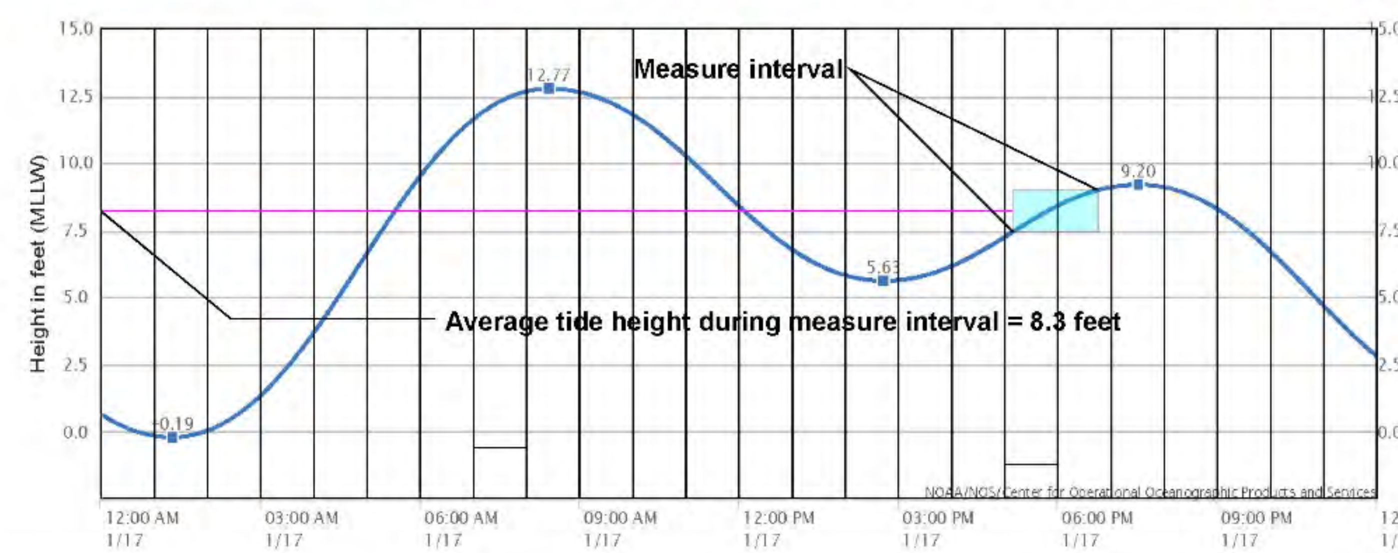

| Electrical Resistivity Profile ERT 4-3 | Operable Unit 1<br>Keyport, Washington | | ATLAS<br>Figure 3.16 |
|---|---|---|---|
| | Project No.: 420019SWG REV1 | Date: 09/21 | |

Azimuth ~37 degrees

## ERT 4-4: Electrical Resistivity: Dogfish Bay ~544 feet NW of tide gate

(84 floating graphite electrodes on 2 m spacing, Dipole-Dipole array)




| Electrical Resistivity Profile ERT 4-4 | Operable Unit 1 Keyport, Washington | ATLAS Figure 3.17 |
|---|---|---|
| | Project No.: 420019SWG REV1 — Date: 09/21 | |


**SITE MAP**

N

Operable Unit 1
Keyport, Washington

Project No.: 420019SWG REV1 | Date: 09/21

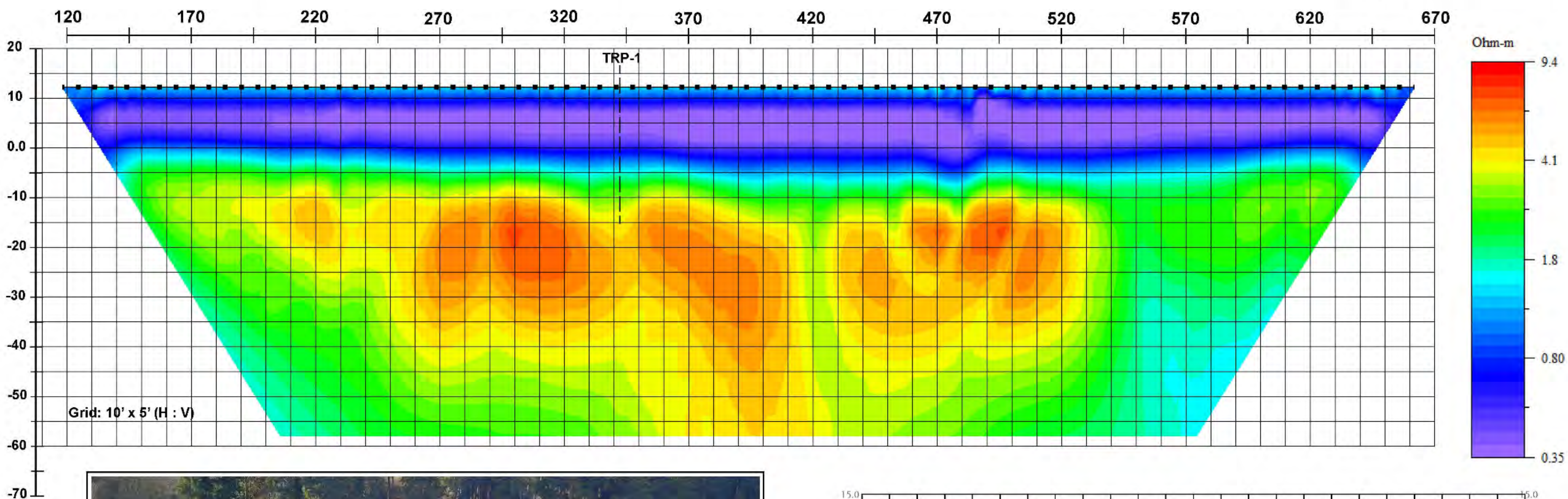
ATLAS

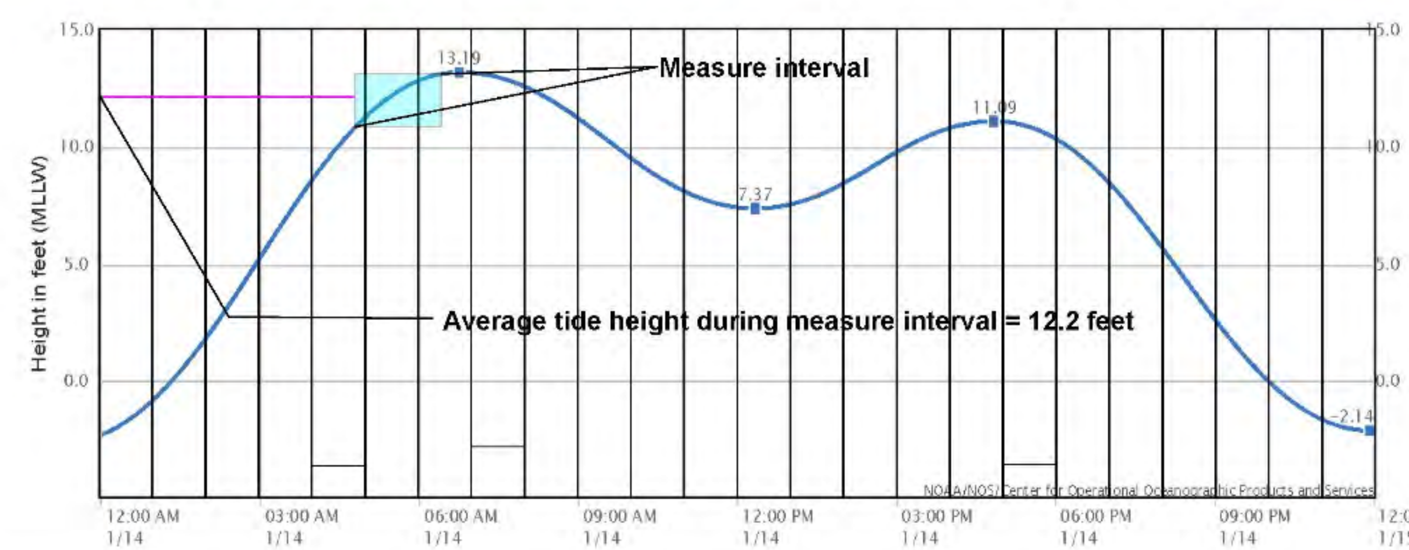
Figure 3.18

Azimuth ~40 degrees

# ERT 5-1: Electrical Resistivity: Dogfish Bay ~605 feet NW of tide gate

**(84 floating graphite electrodes on 2 m spacing, Dipole-Dipole array)**

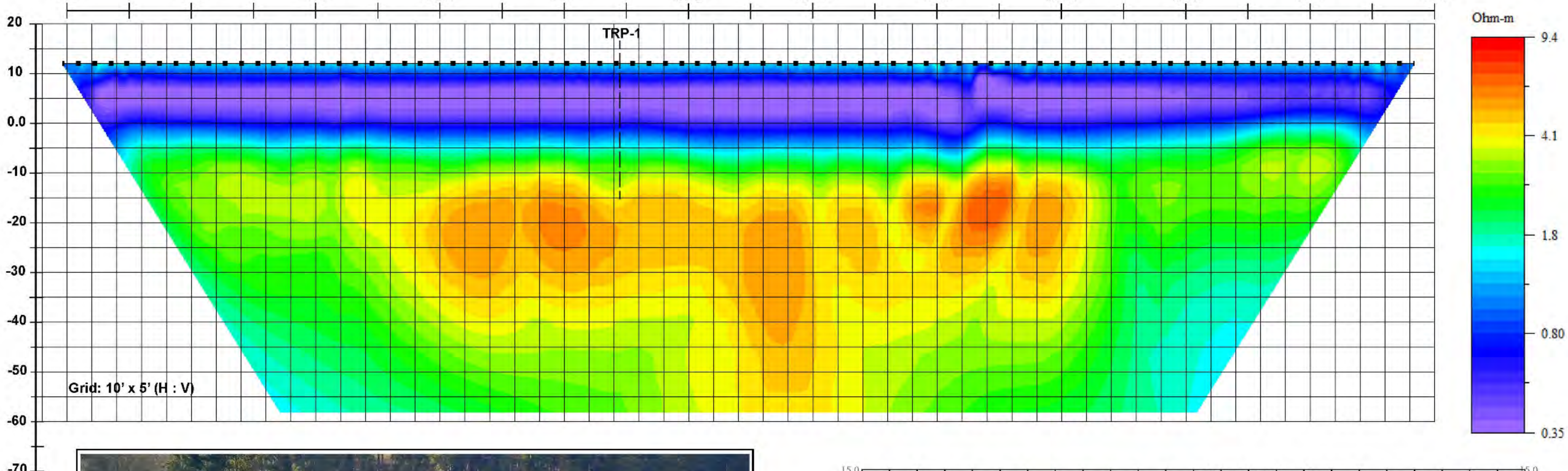


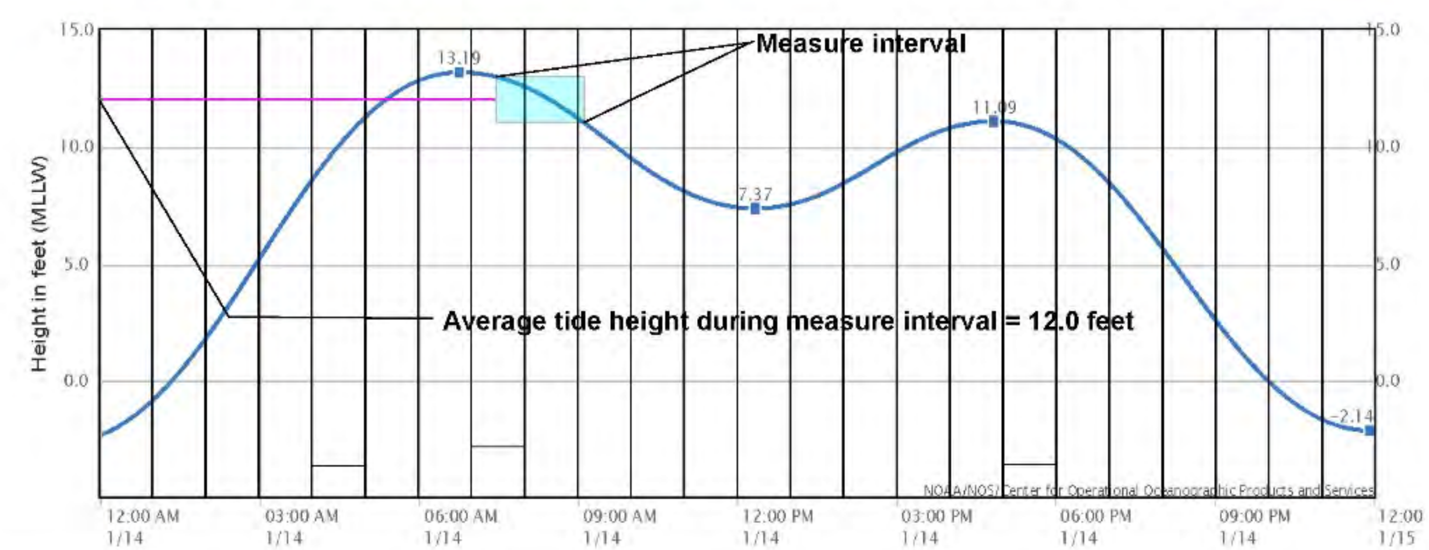




| Electrical Resistivity Profile ERT 5-1 | Operable Unit 1 Keyport, Washington | | ATLAS Figure 3.19 |
|---|---|---|---|
| | Project No.: 420019SWG REV1 | Date: 09/21 | |

# ERT 5-2: Electrical Resistivity: Dogfish Bay ~605 feet NW of tide gate

**(84 floating graphite electrodes on 2 m spacing, Dipole-Dipole array)**



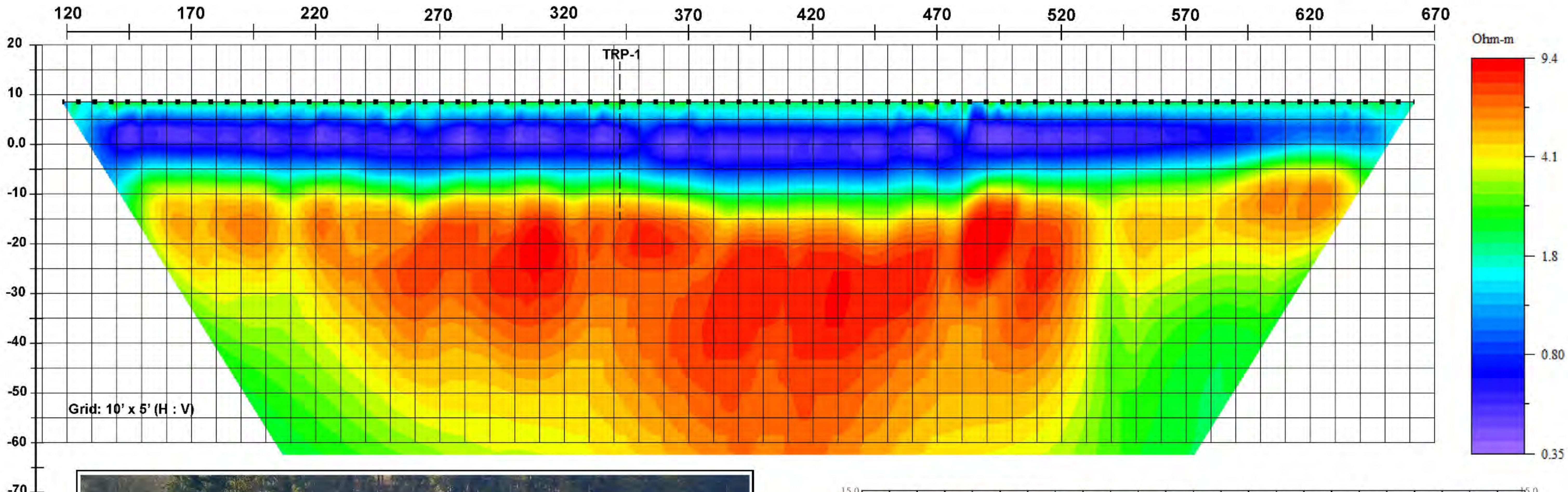



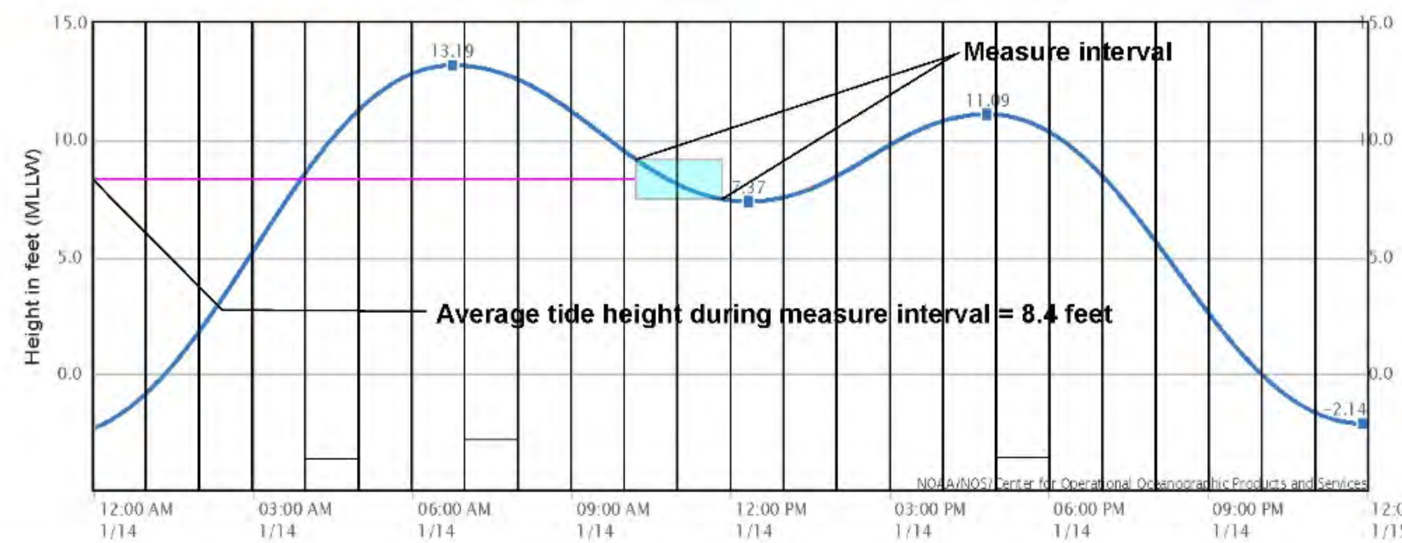

| **Electrical Resistivity Profile ERT 5-2** | Operable Unit 1<br>Keyport, Washington | ATLAS<br>Figure 3.20 |
|---|---|---|
| | Project No.: 420019SWG REV1 — Date: 09/21 | |

Azimuth ~40 degrees

# ERT 5-3: Electrical Resistivity: Dogfish Bay ~605 feet NW of tide gate

**(84 floating graphite electrodes on 2 m spacing, Dipole-Dipole array)**




| **Electrical Resistivity Profile ERT 5-3** | Operable Unit 1<br>Keyport, Washington | | Figure 3.21 |
|---|---|---|---|
| | Project No.: 420019SWG REV1 | Date: 09/21 | |


**SITE MAP**

Operable Unit 1
Keyport, Washington

Project No.: 420019SWG REV1 | Date: 09/21

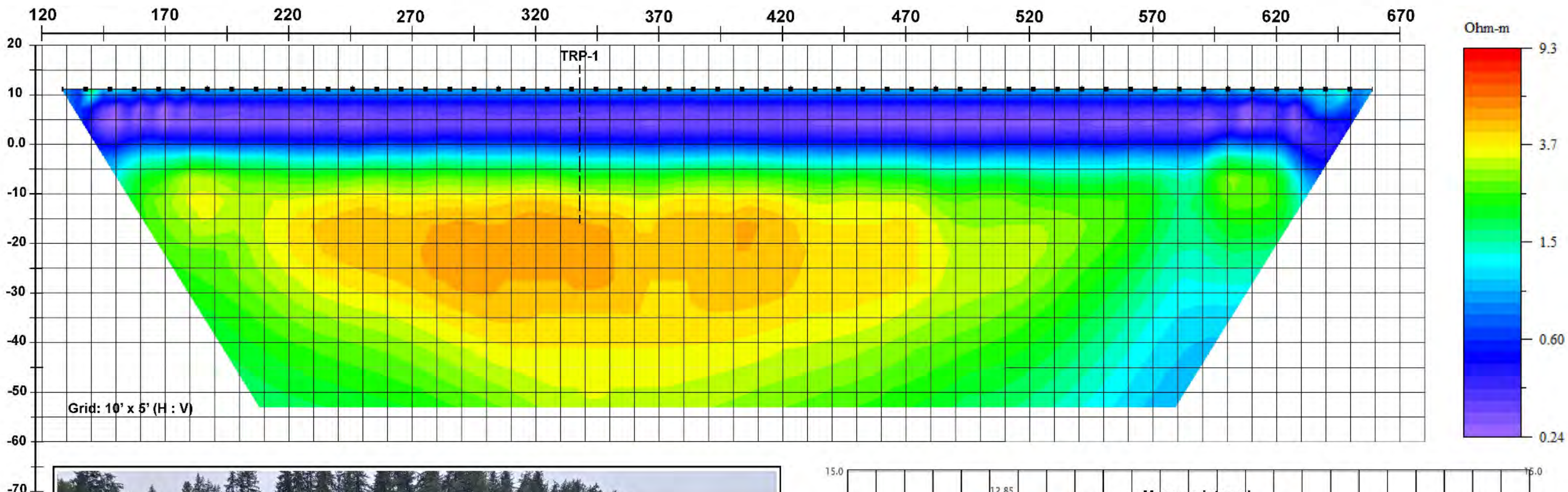
ATLAS

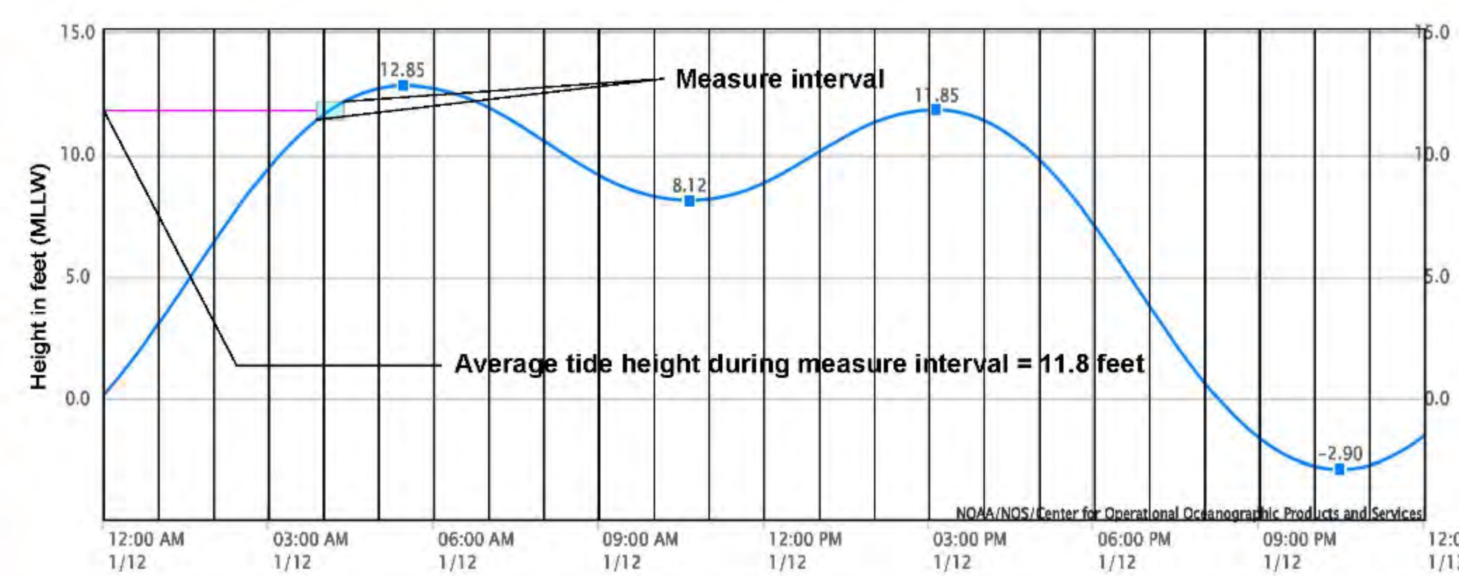
Figure 3.22

Azimuth ~37 degrees

# ERT 6-1: Electrical Resistivity: Dogfish Bay ~736' NW of tide gate

**(56 floating stainless steel electrodes on 3 m spacing, Dipole-Dipole array)**



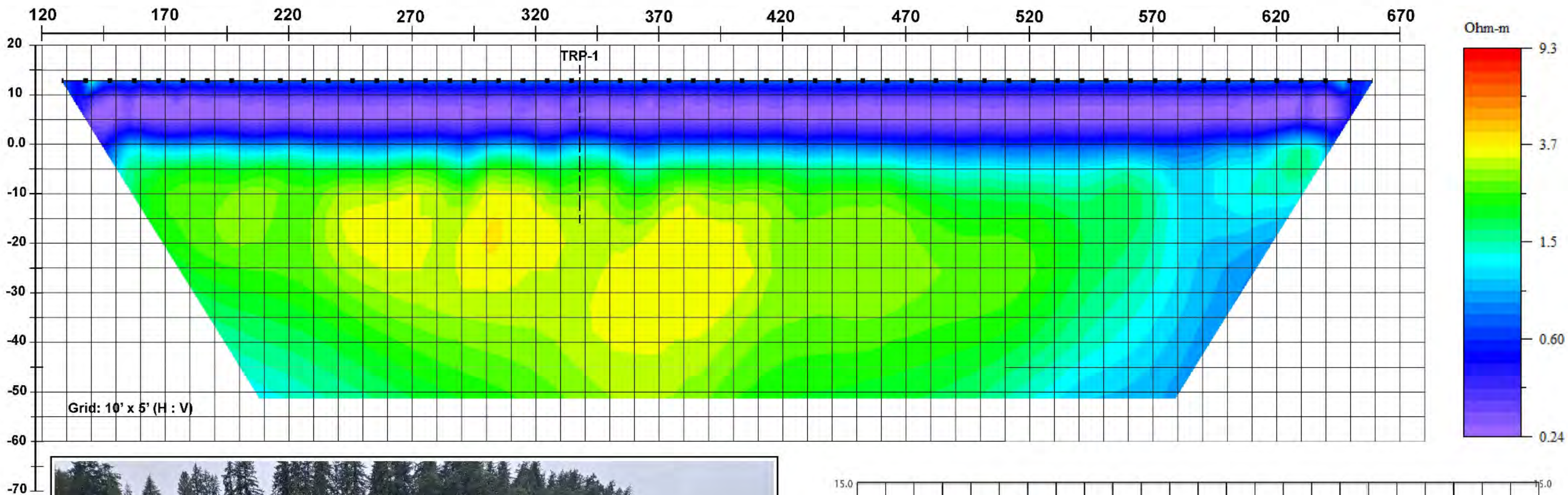



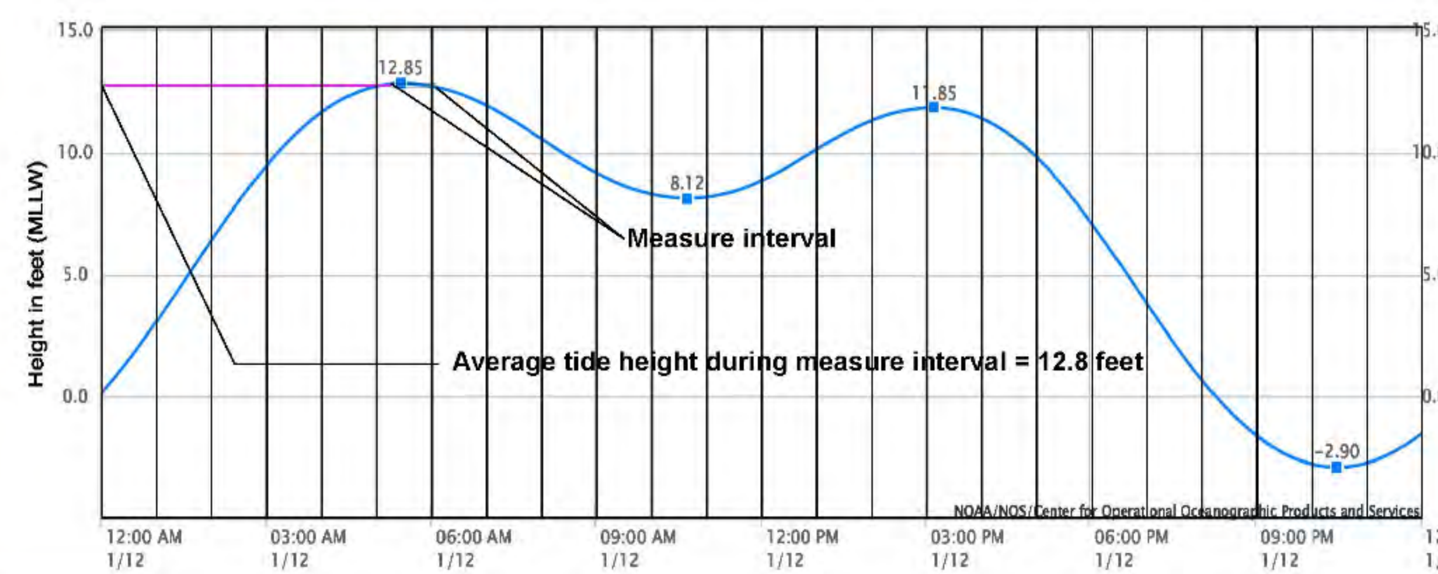

| | | |
|---|---|---|
| **Electrical Resistivity Profile ERT 6-1** | Operable Unit 1<br>Keyport, Washington<br>Project No.: 420019SWG REV1 — Date: 09/21 | ATLAS<br>Figure 3.23 |

# ERT 6-2: Electrical Resistivity: Dogfish Bay ~736' NW of tide gate

**(56 floating stainless steel electrodes on 3 m spacing, Dipole-Dipole array)**

Azimuth ~37 degrees



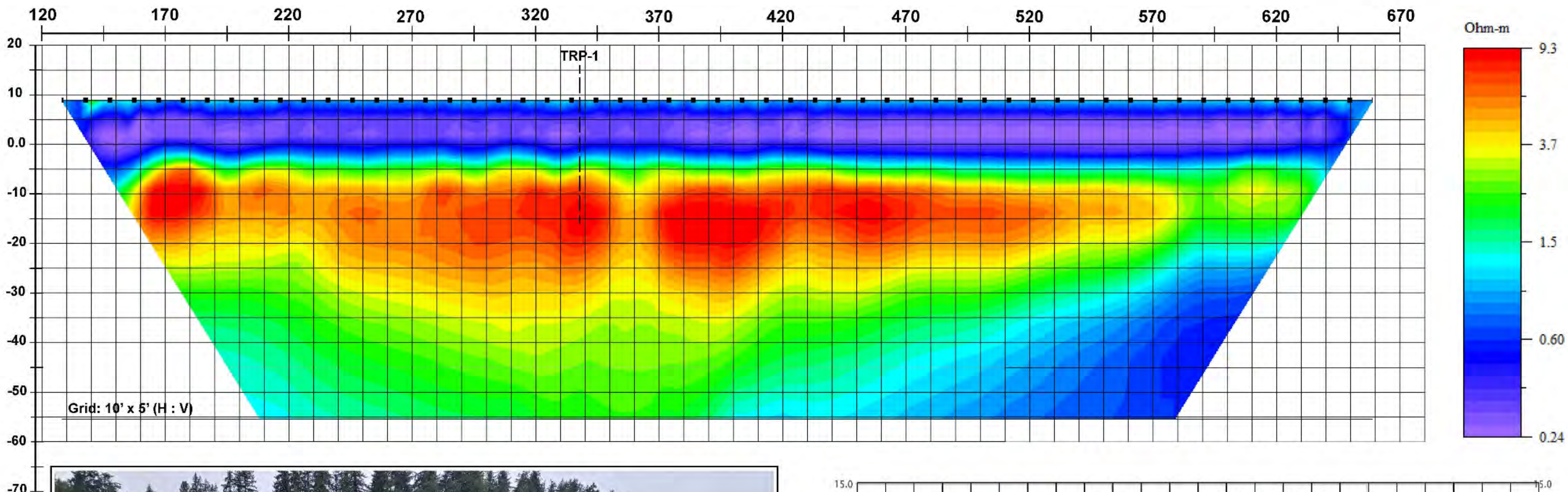



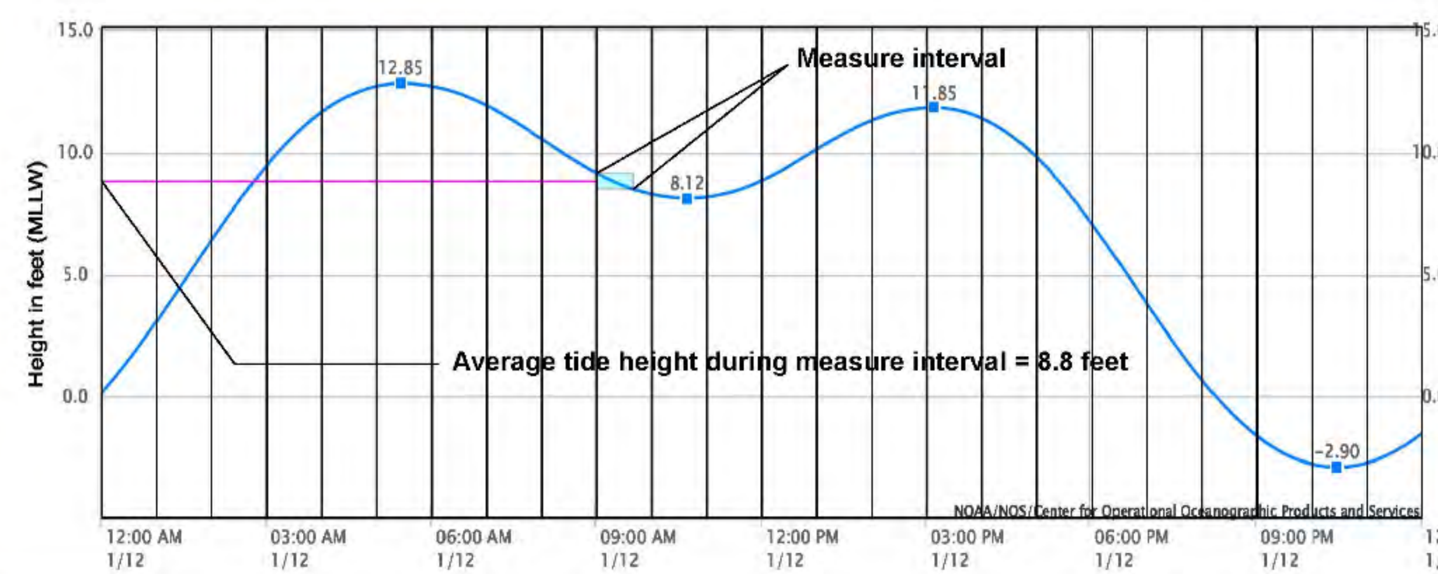

| | | |
|---|---|---|
| **Electrical Resistivity Profile ERT 6-2** | Operable Unit 1<br>Keyport, Washington<br>Project No.: 420019SWG REV1   Date: 09/21 | ATLAS<br>Figure 3.24 |

# ERT 6-3: Electrical Resistivity: Dogfish Bay ~736' NW of tide gate

(56 floating stainless steel electrodes on 3 m spacing, Dipole-Dipole array)

Azimuth ~37 degrees




| Electrical Resistivity Profile ERT 6-3 | Operable Unit 1 Keyport, Washington | ATLAS Figure 3.25 |
|---|---|---|
| | Project No.: 420019SWG REV1 — Date: 09/21 | |


**SITE MAP**

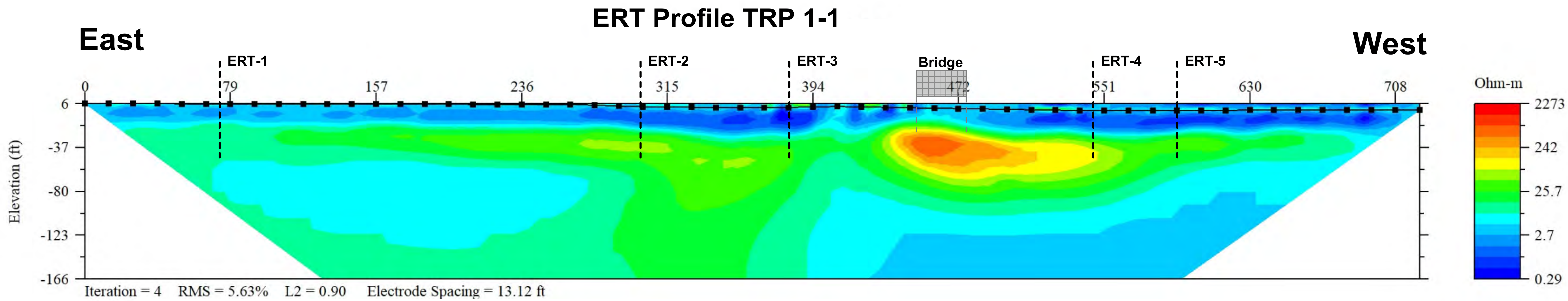
N

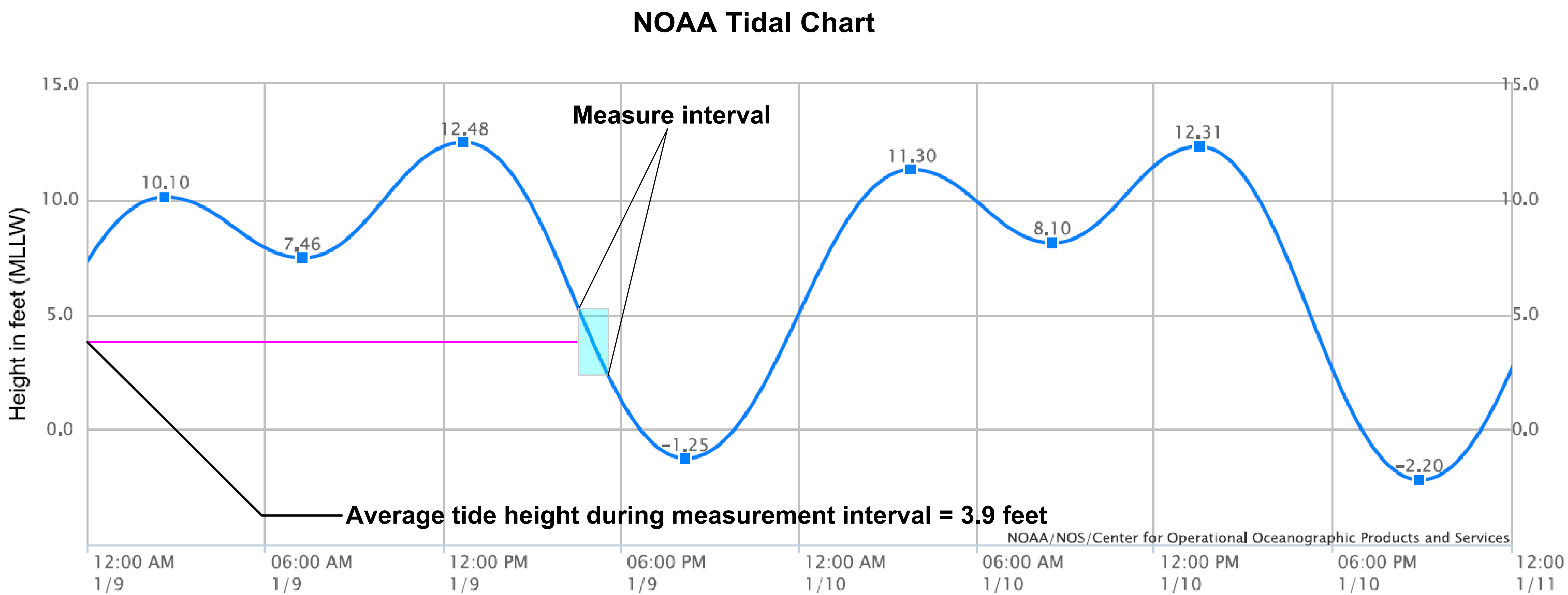
Operable Unit 1
Keyport, Washington

Project No.: 420019SWG REV1 | Date: 09/21

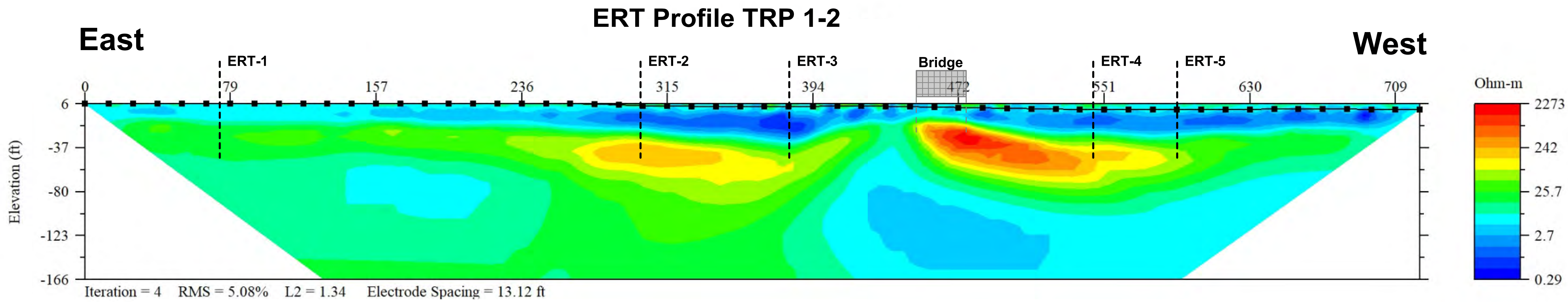
ATLAS

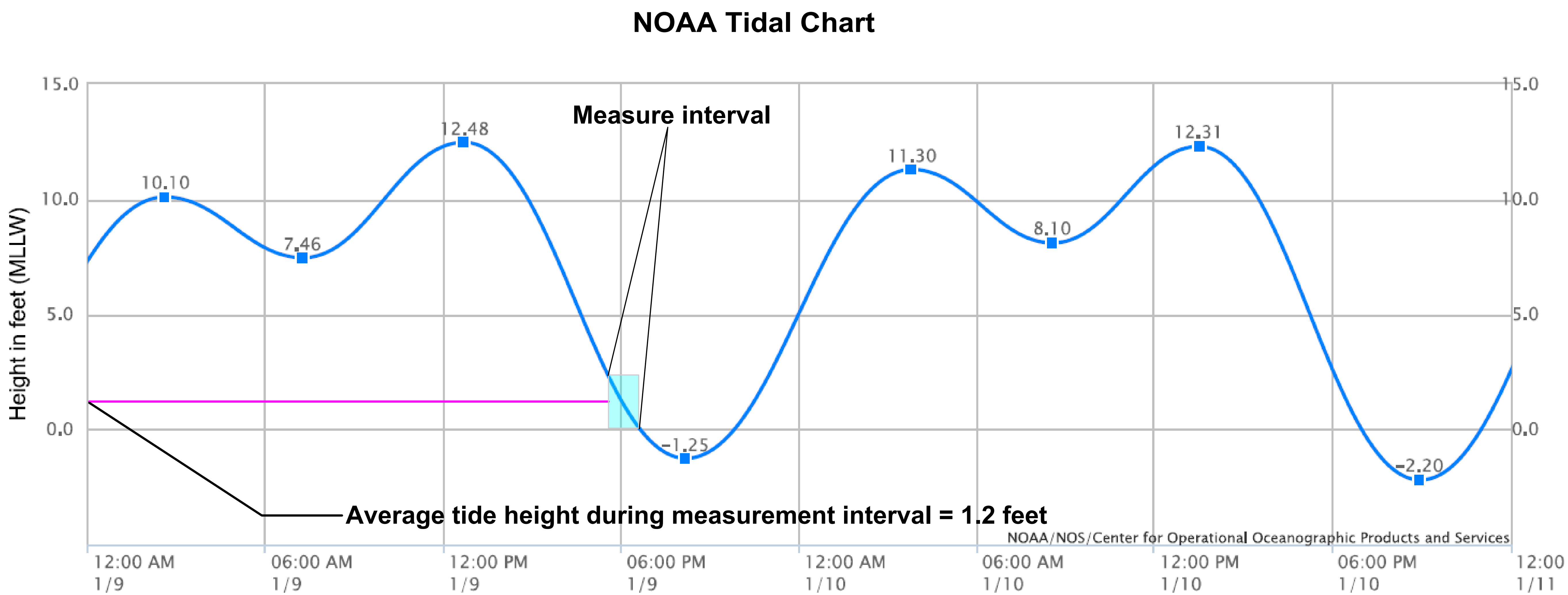
Figure 4.1



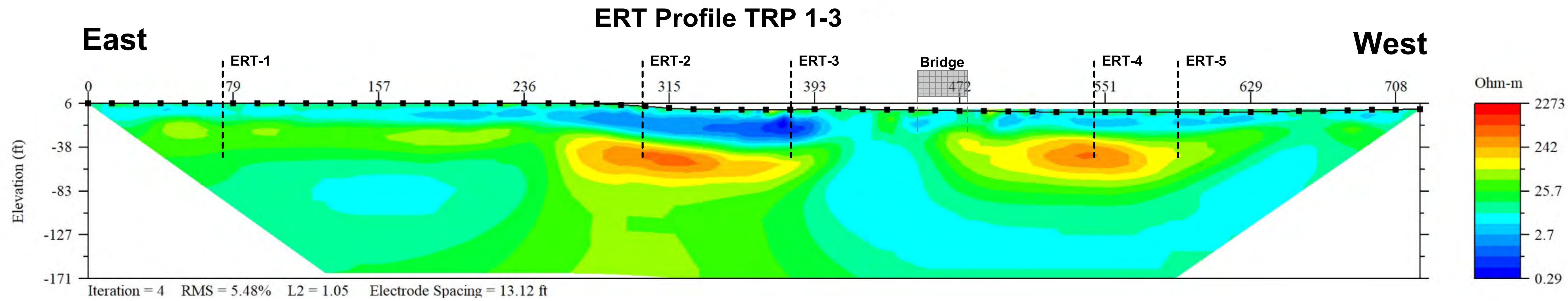



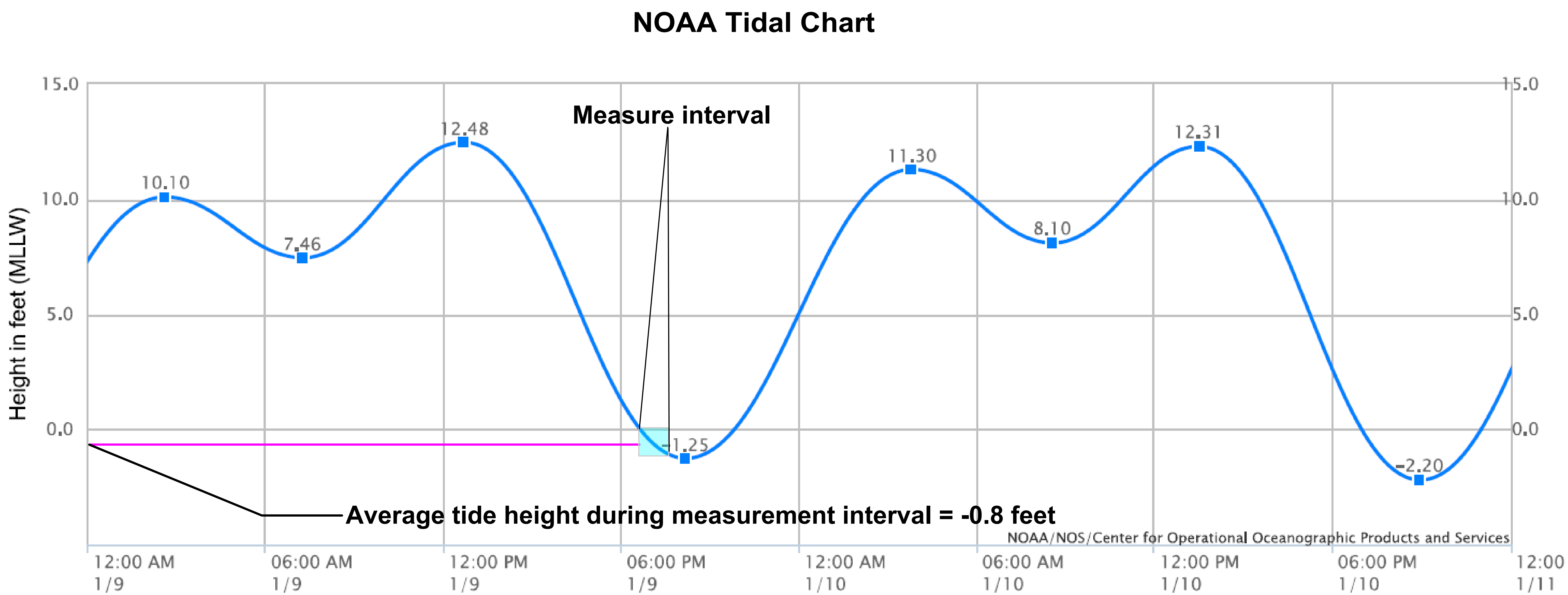

| | | |
|---|---|---|
| **Timelapse ERT Profile TRP 1-1** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 4.2 |



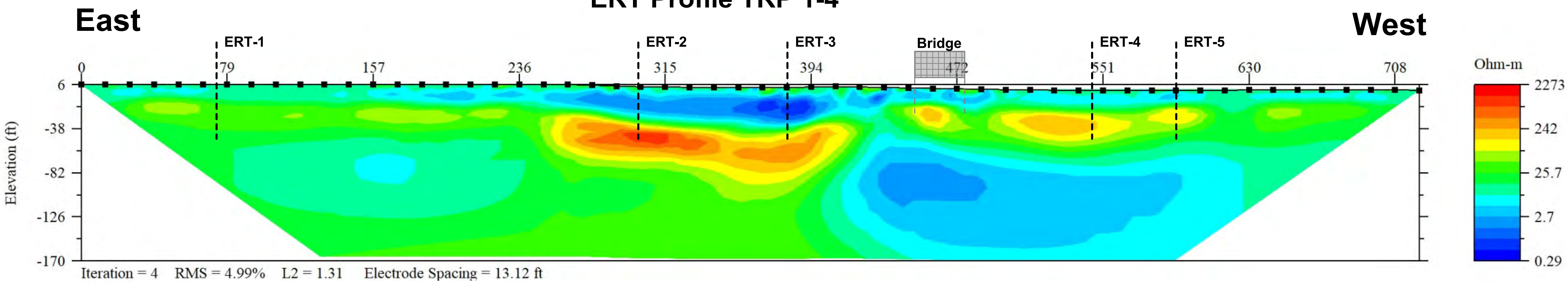

| | | |
|---|---|---|
| **Timelapse ERT Profile TRP 1-2** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 4.3 |



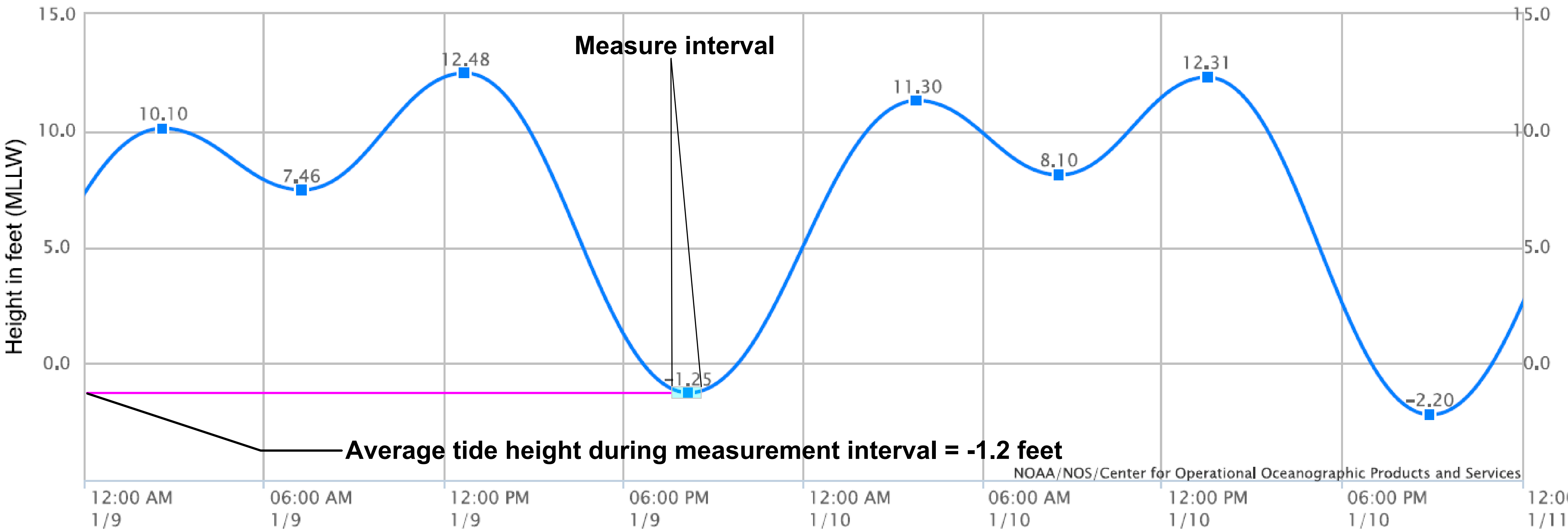




| Timelapse ERT Profile TRP 1-3 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 4.4 |
|---|---|---|

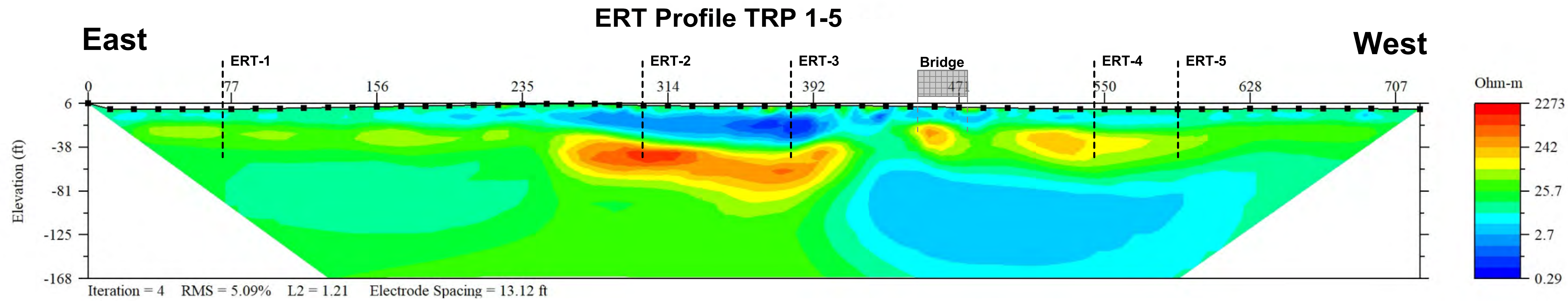
## ERT Profile TRP 1-4

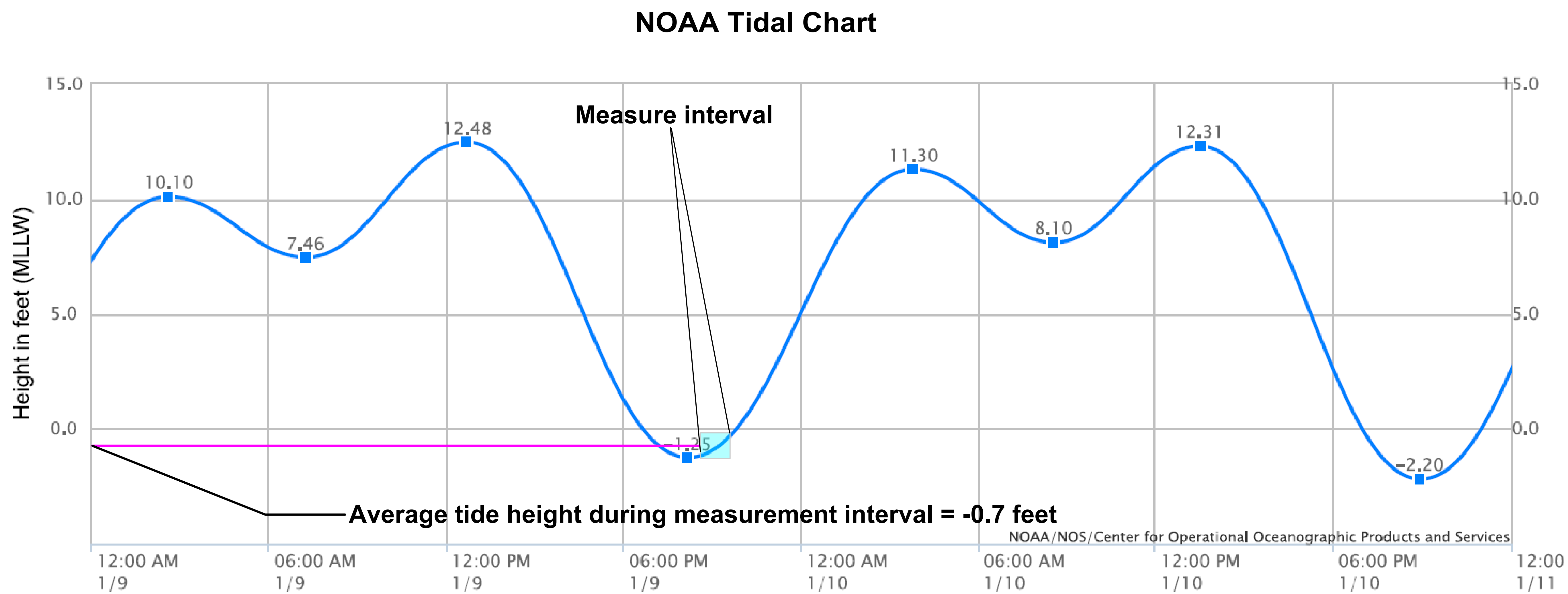



## NOAA Tidal Chart

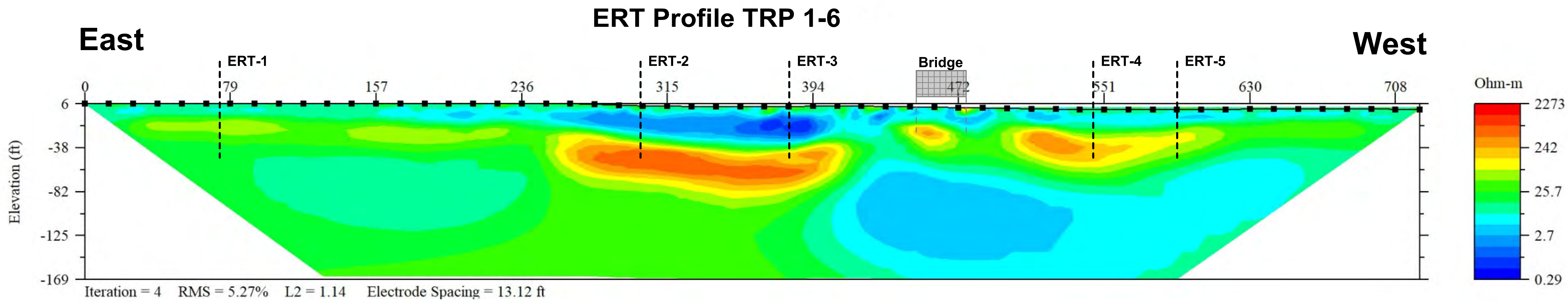


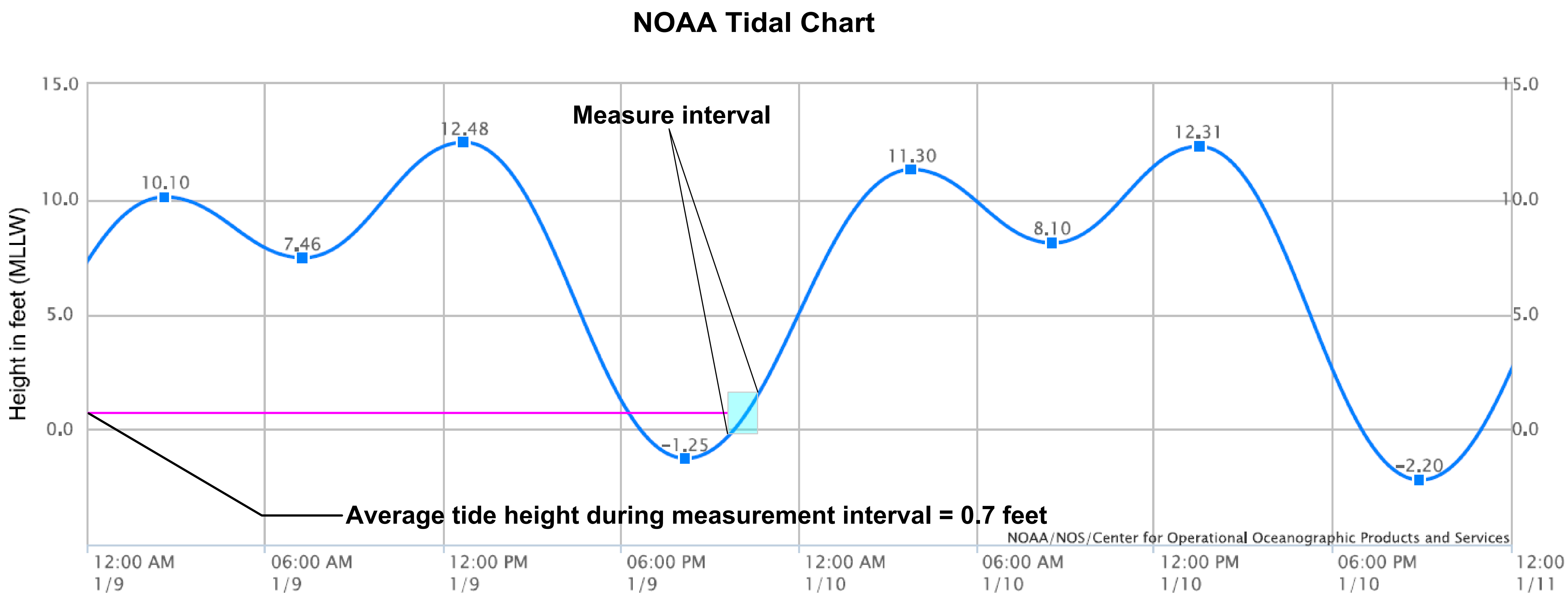

| Timelapse ERT Profile TRP 1-4 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 4.5 |
|---|---|---|



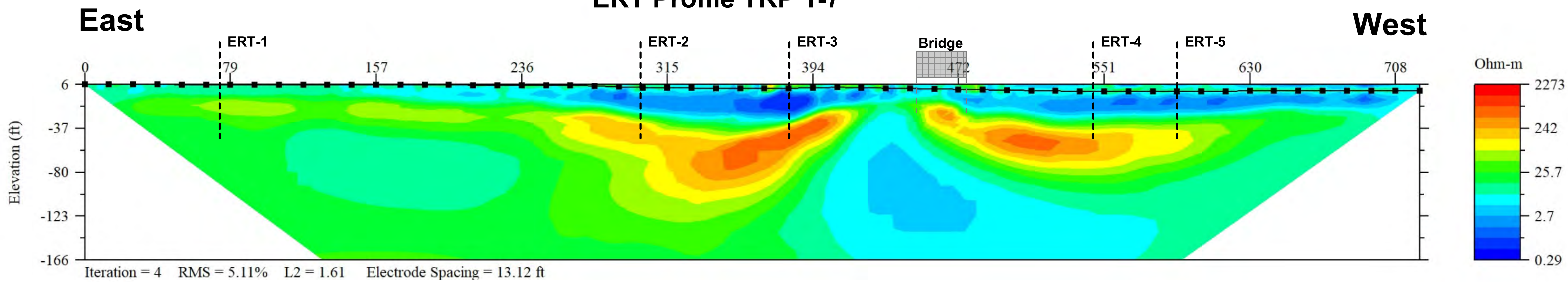

| Timelapse ERT Profile TRP 1-5 | Operable Unit 1 Keyport , Washington | ATLAS Figure 4.6 |
|---|---|---|
| | Project No.: 420019SWG REV1 Date: 09/21 | |



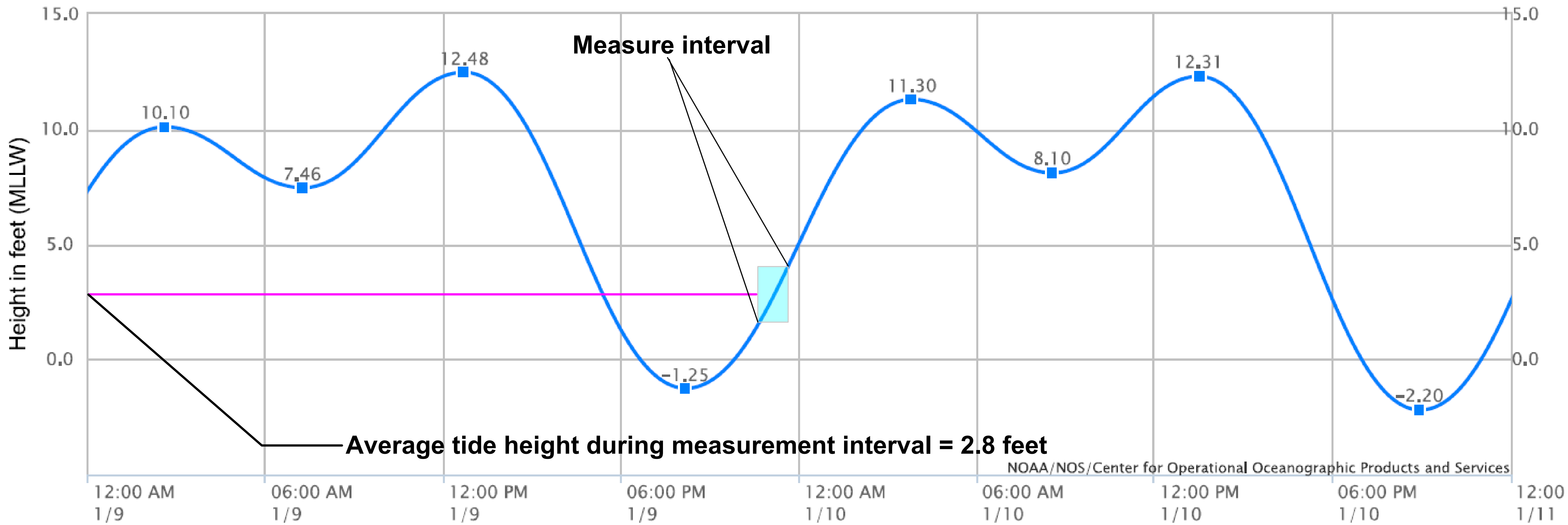




| | | |
|---|---|---|
| **Timelapse ERT Profile TRP 1-6** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 4.7 |

## ERT Profile TRP 1-7

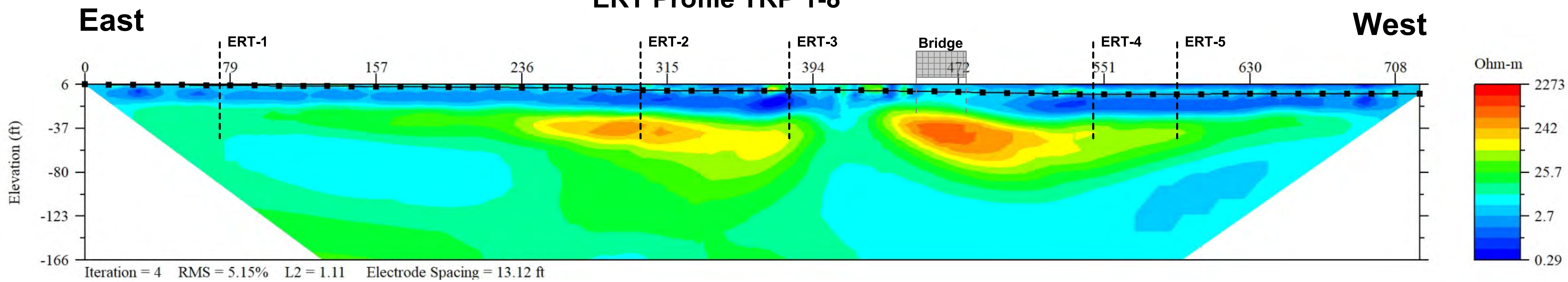



## NOAA Tidal Chart

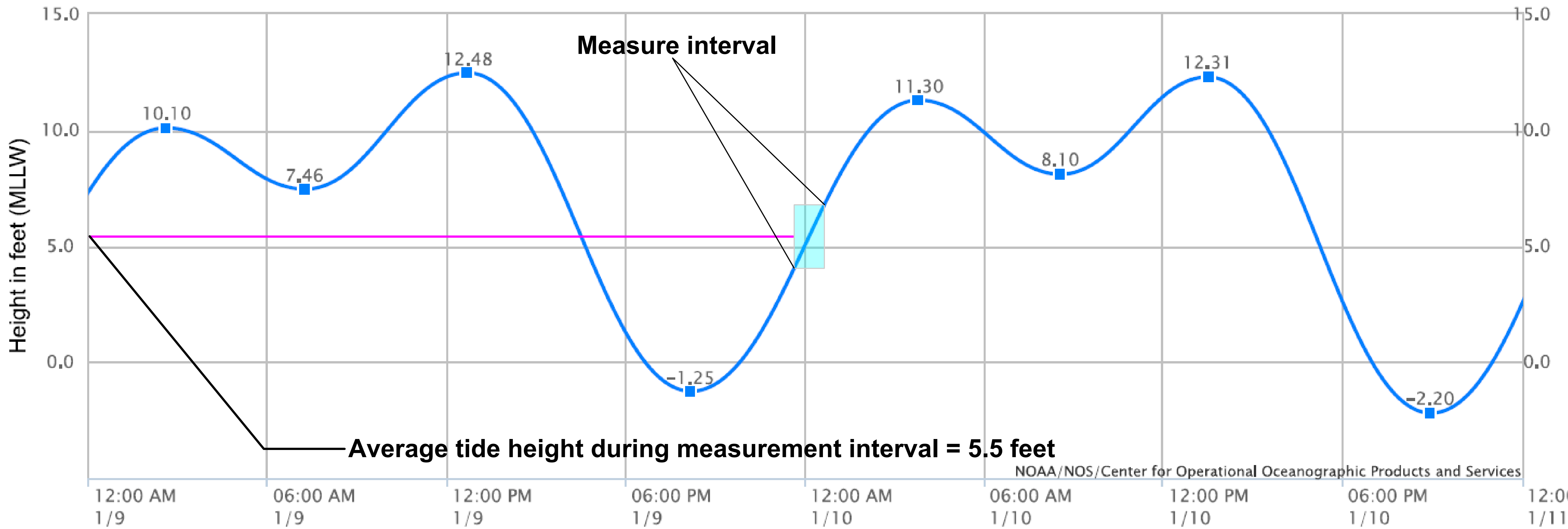



| Timelapse ERT Profile TRP 1-7 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 / Date: 09/21 | ATLAS<br>Figure 4.8 |
|---|---|---|

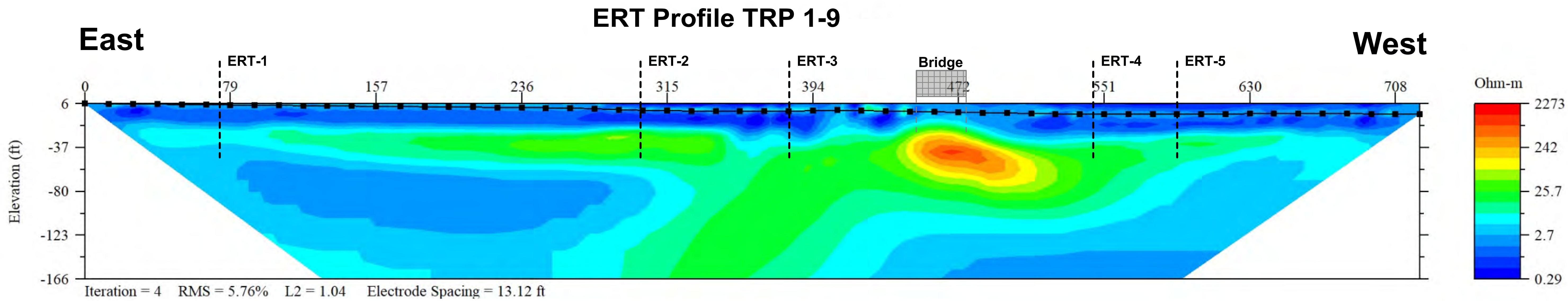
## ERT Profile TRP 1-8

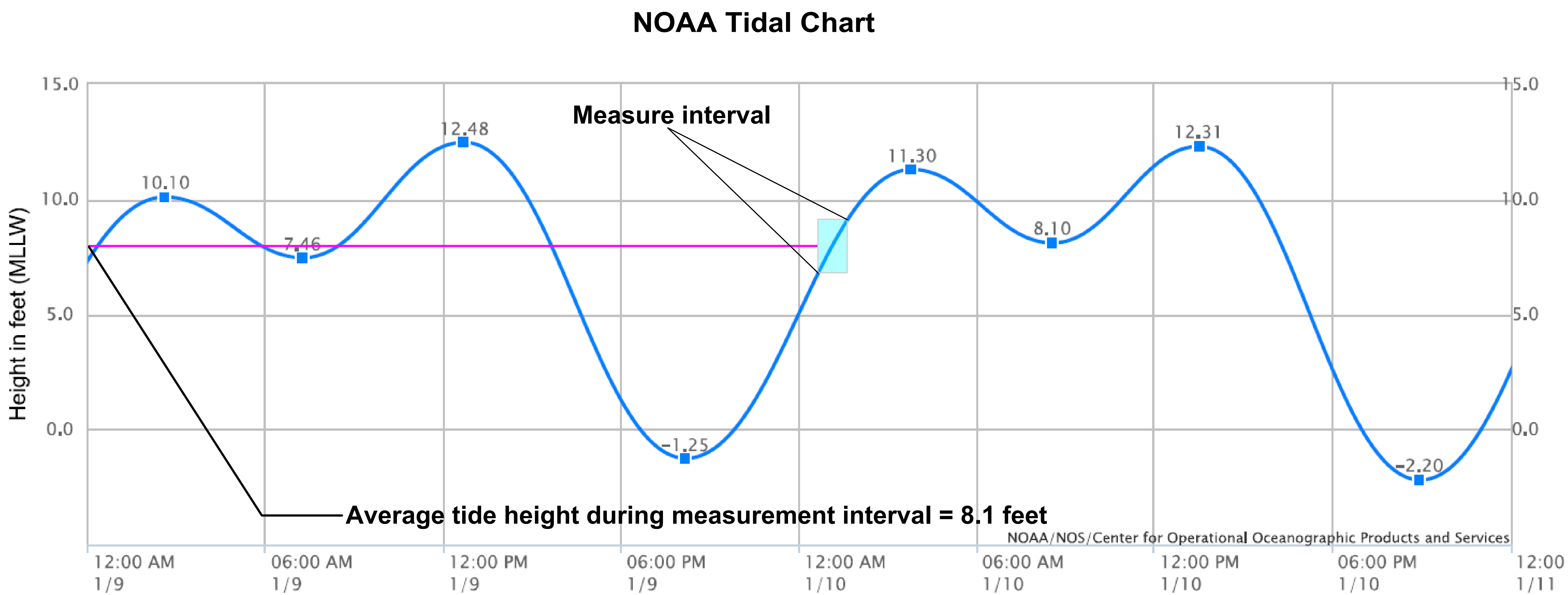



## NOAA Tidal Chart




| | | |
|---|---|---|
| **Timelapse ERT Profile TRP 1-8** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 4.9 |




| Timelapse ERT Profile TRP 1-9 | Operable Unit 1<br>Keyport, Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 4.10 |
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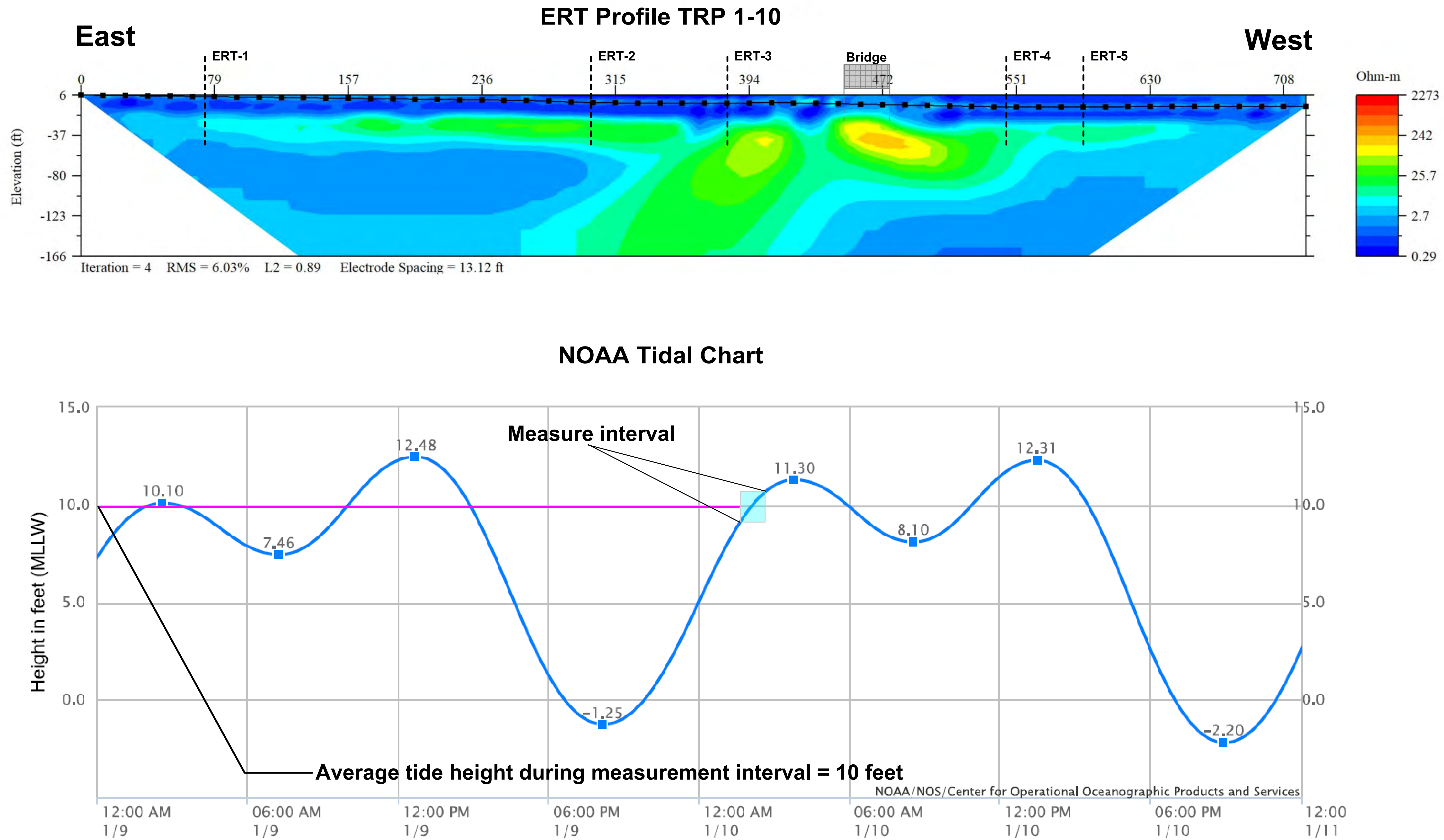


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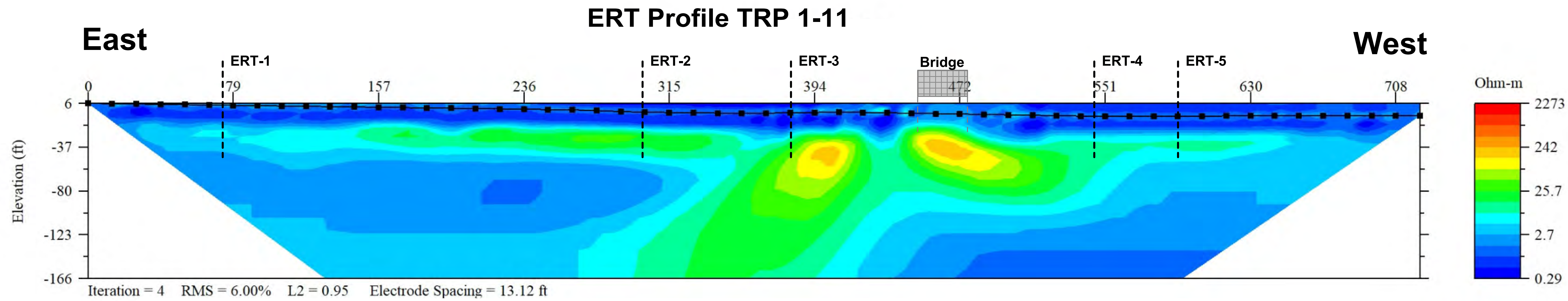
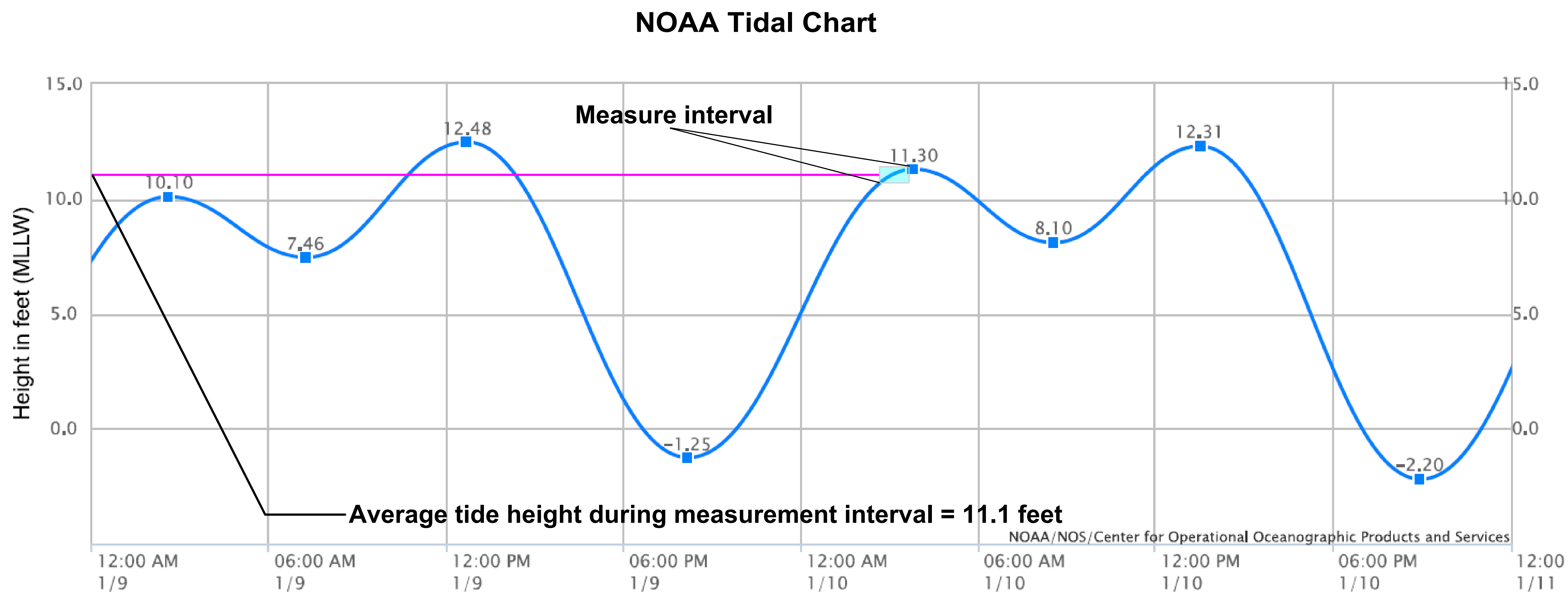
| **Timelapse ERT Profile TRP 1-10** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 4.11 |

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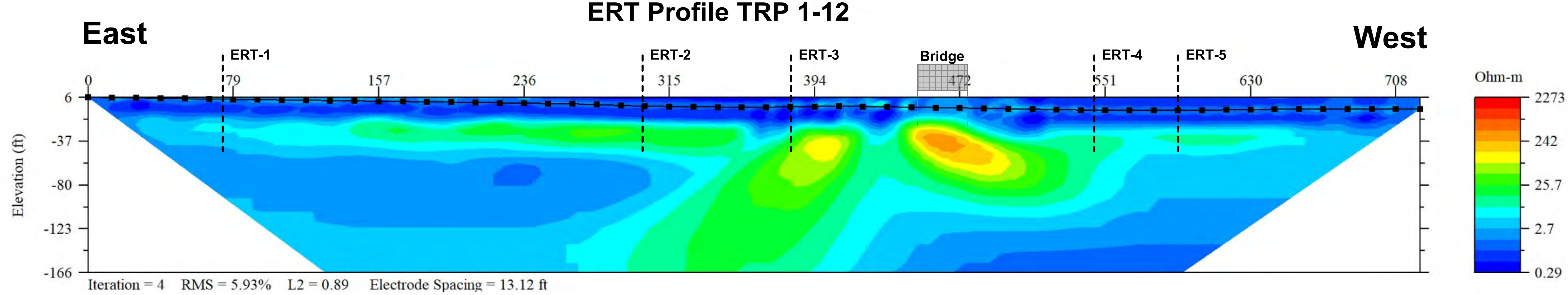
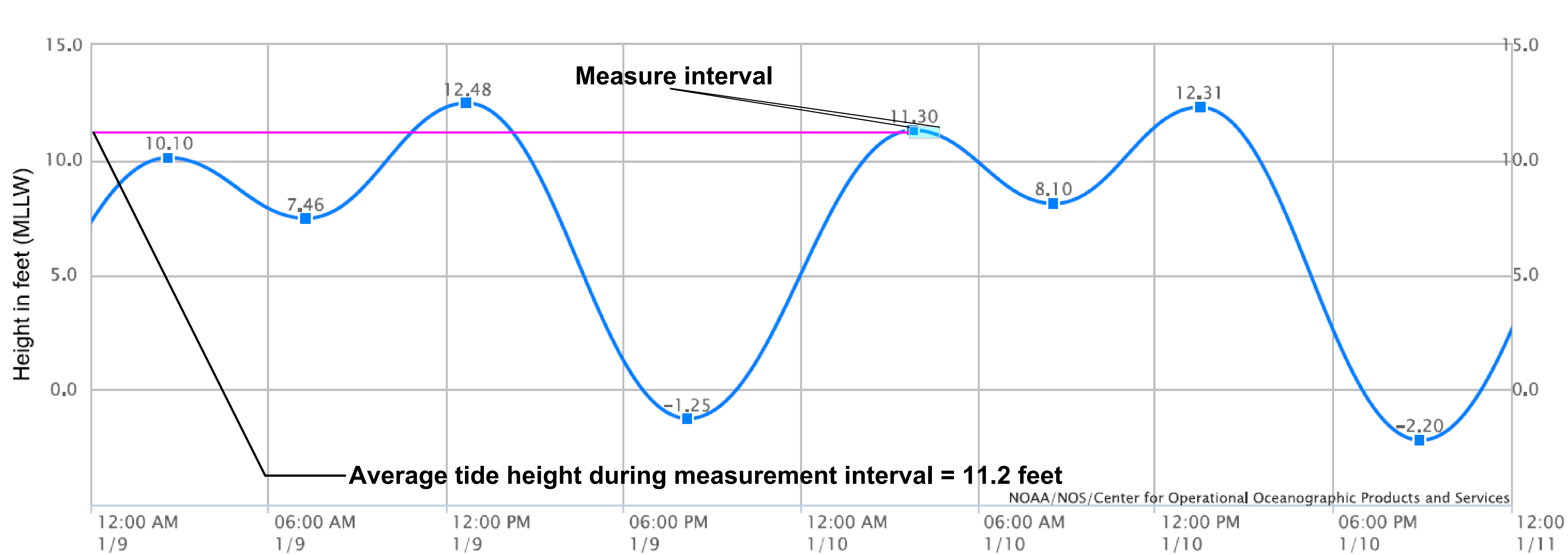
| **Timelapse ERT Profile TRP 1-11** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 4.12 |

## ERT Profile TRP 1-12




## NOAA Tidal Chart




| Timelapse ERT Profile TRP 1-12 | Operable Unit 1 Keyport , Washington | ATLAS Figure 4.13 |
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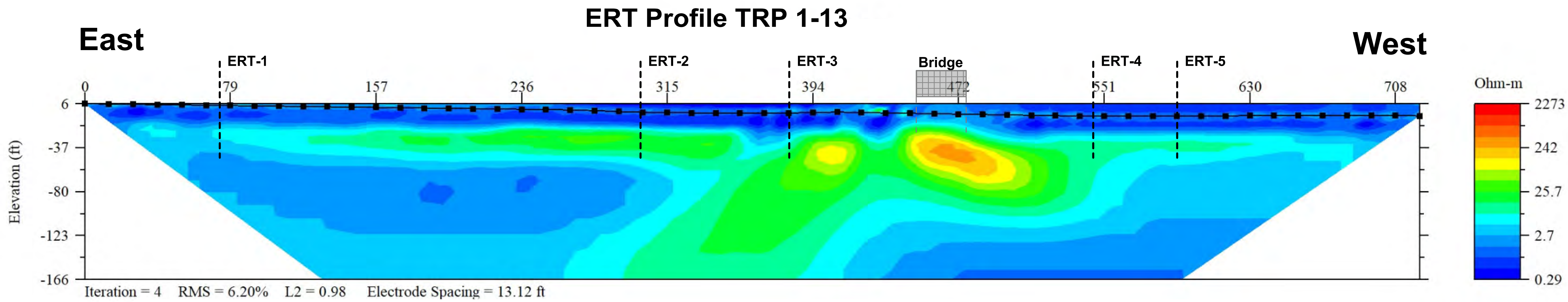
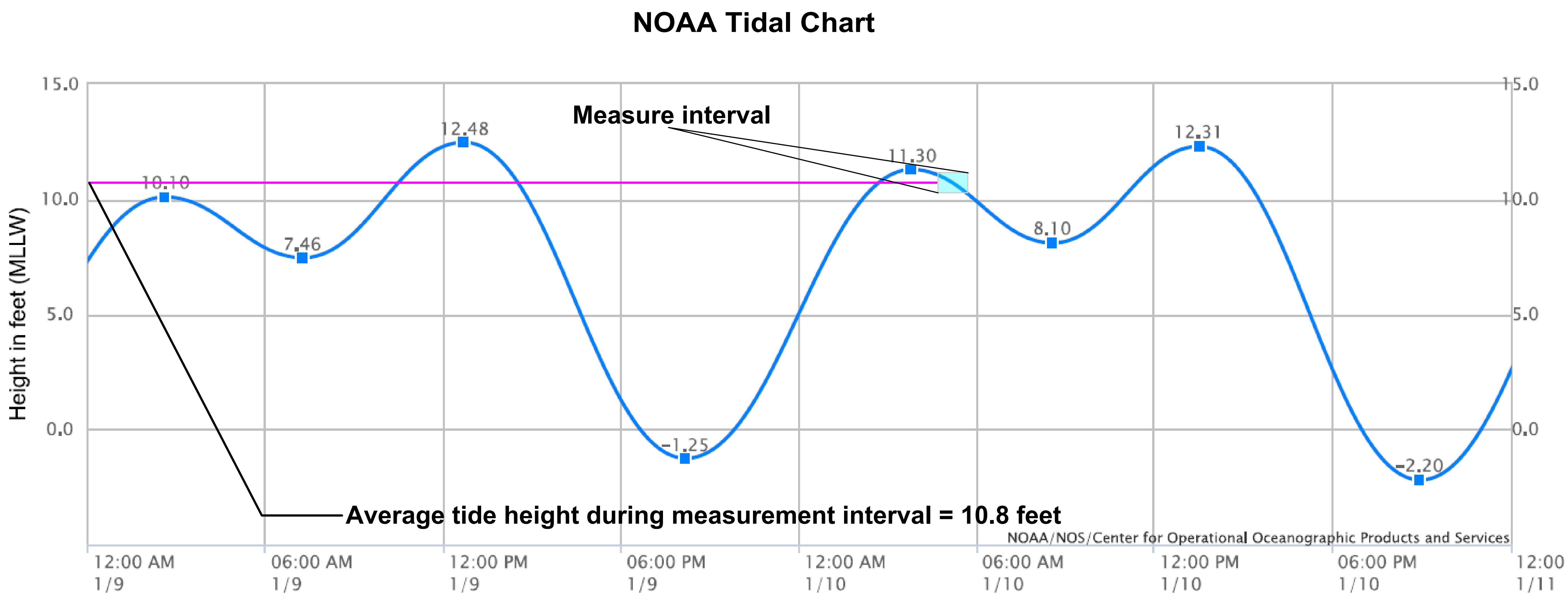
| | Project No.: 420019SWG REV1 | Date: 09/21 |

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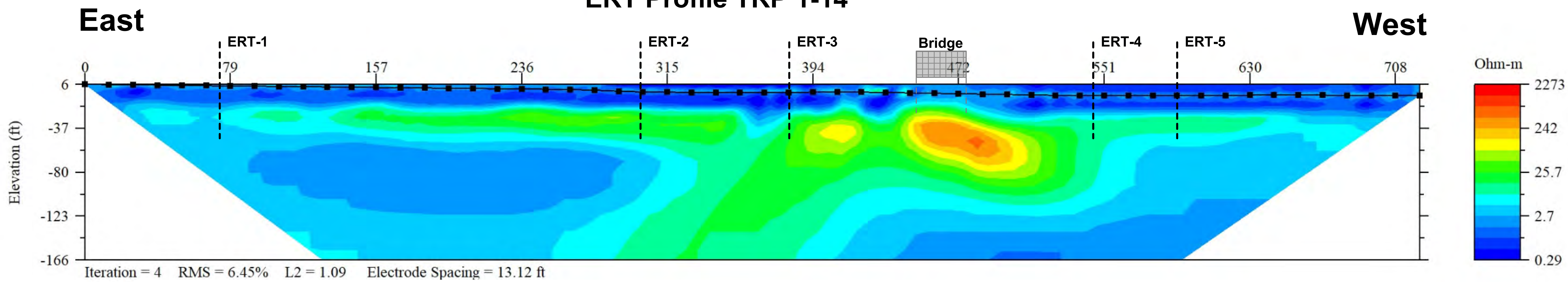
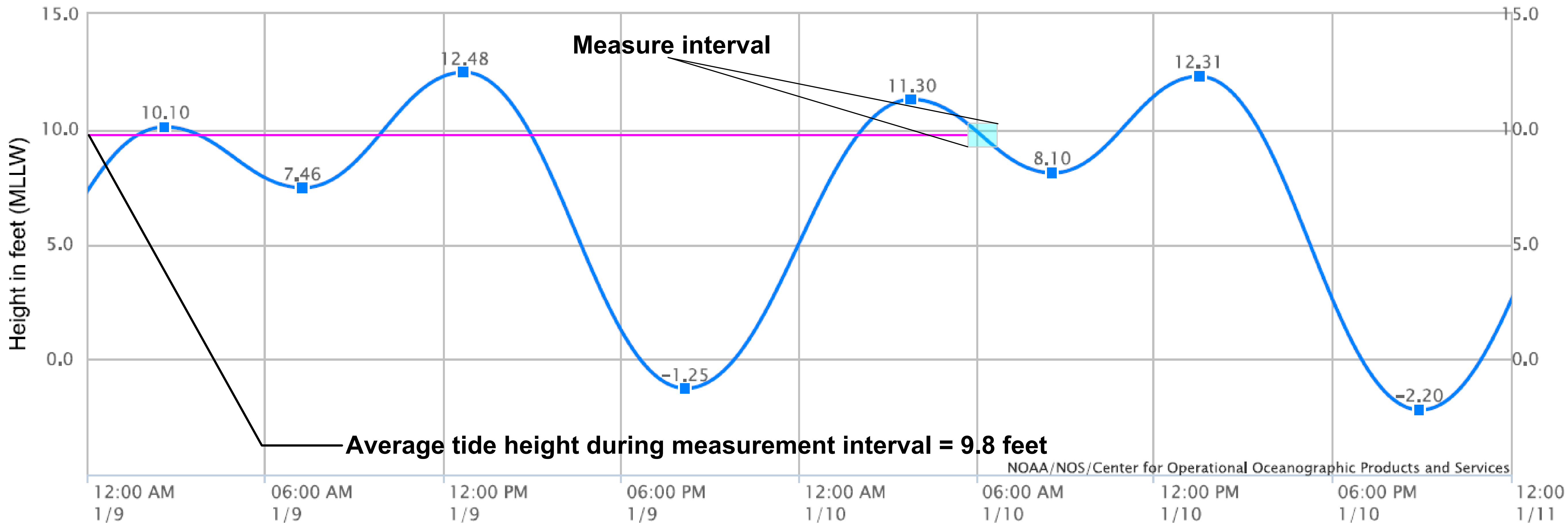
| **Timelapse ERT Profile TRP 1-13** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 4.14 |

# ERT Profile TRP 1-14




# NOAA Tidal Chart

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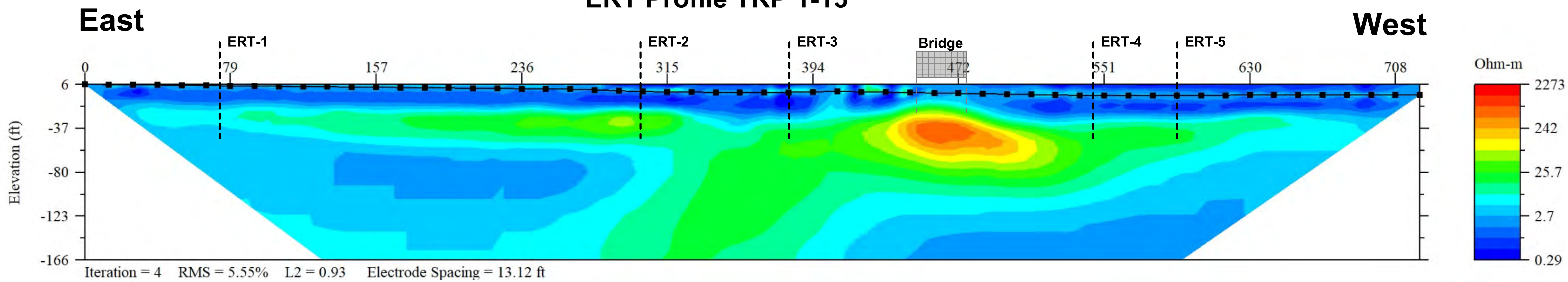
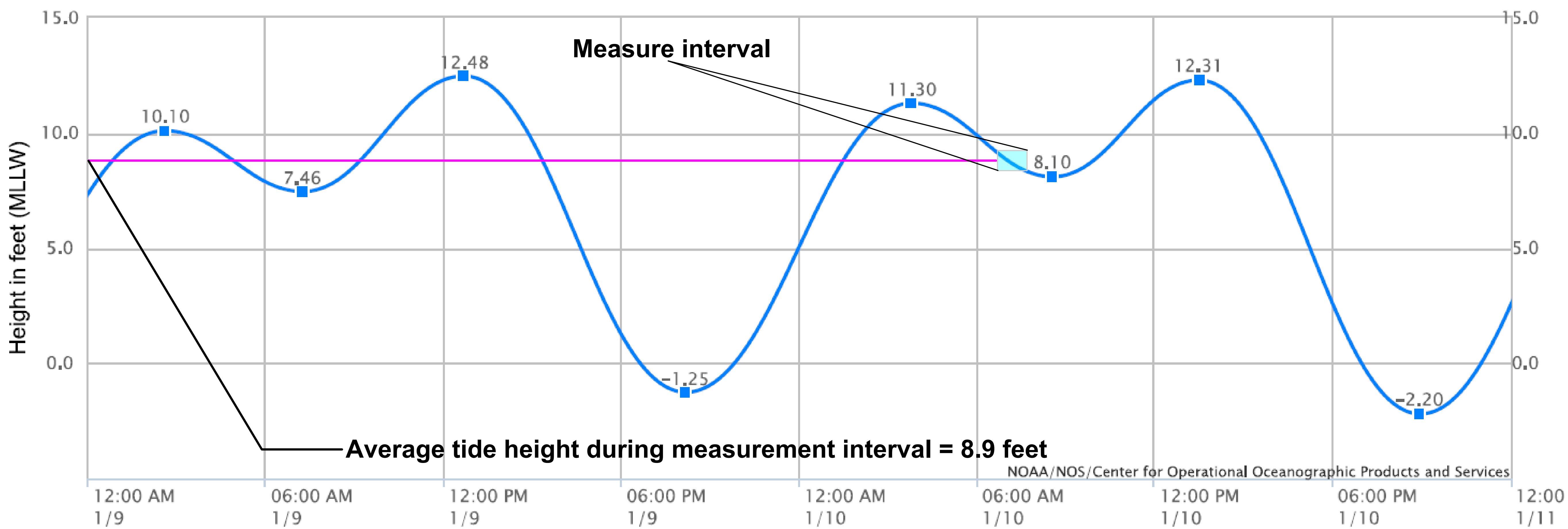
| **Timelapse ERT Profile TRP 1-14** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 4.15 |

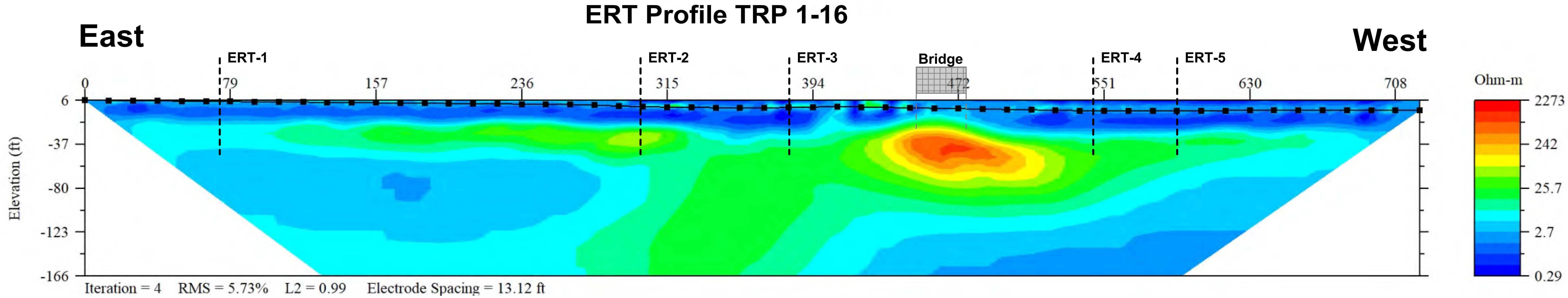
## ERT Profile TRP 1-15

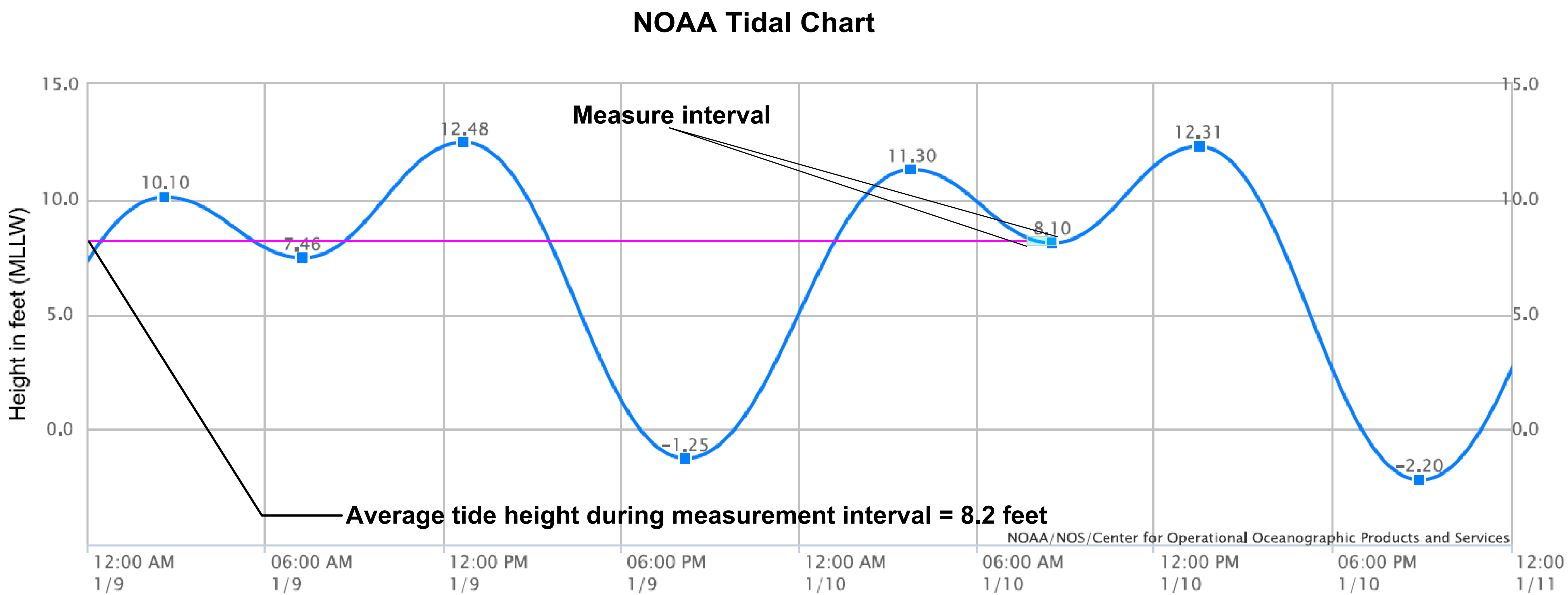



## NOAA Tidal Chart

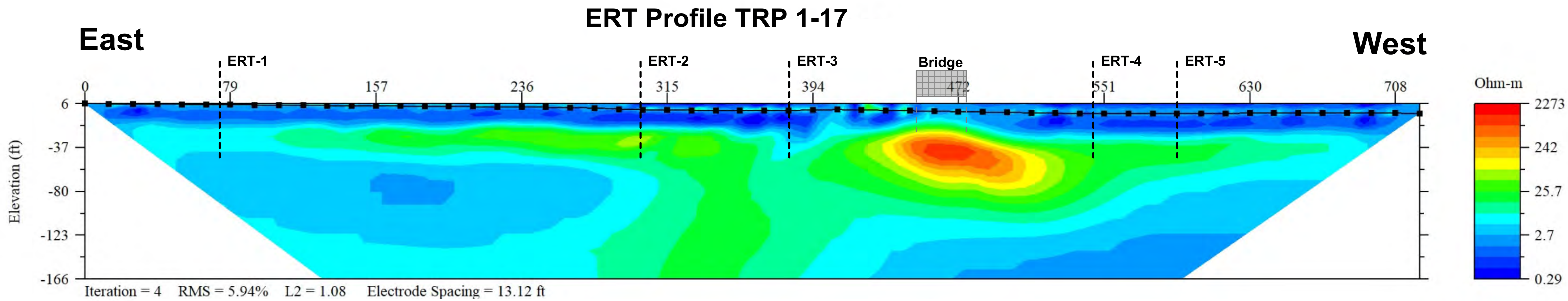


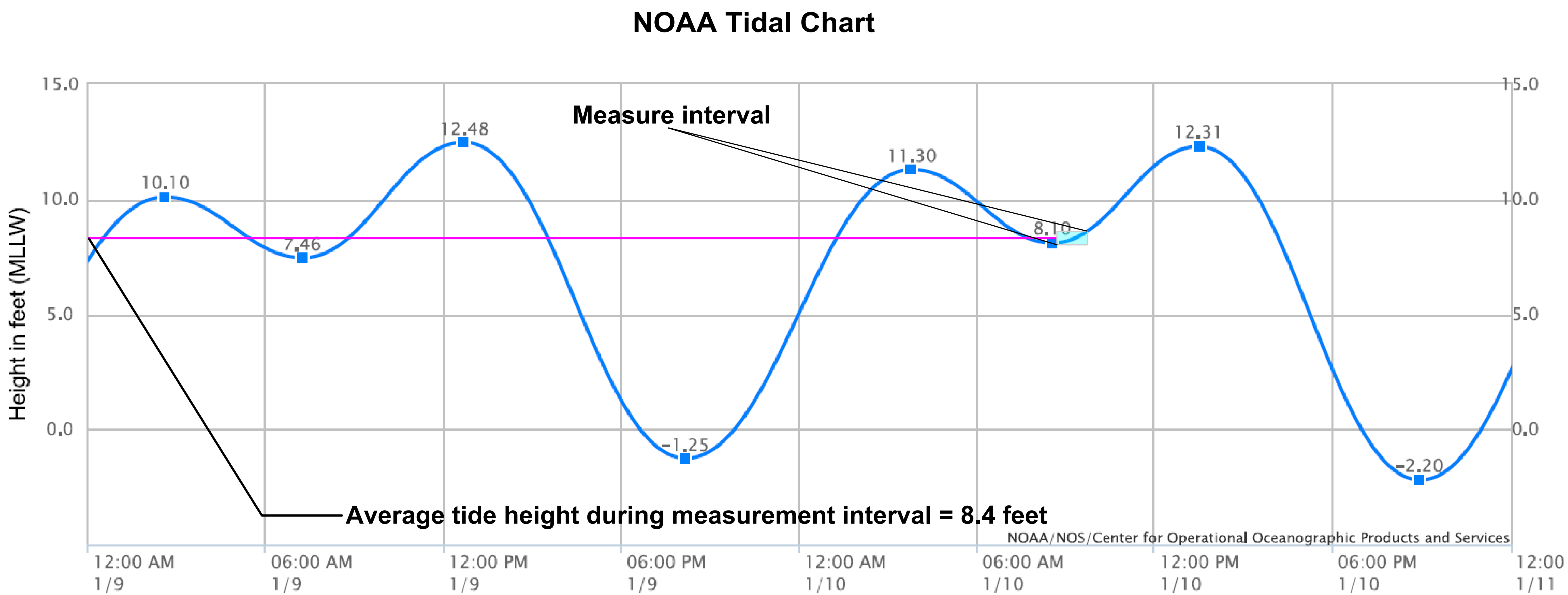

| Timelapse ERT Profile TRP 1-15 | Operable Unit 1 Keyport , Washington | ATLAS Figure 4.16 |
|---|---|---|
| | Project No.: 420019SWG REV1 Date: 09/21 | |




| Timelapse ERT Profile TRP 1-16 | Operable Unit 1 Keyport , Washington | ATLAS |
|---|---|---|
| | Project No.: 420019SWG REV1 / Date: 09/21 | Figure 4.17 |

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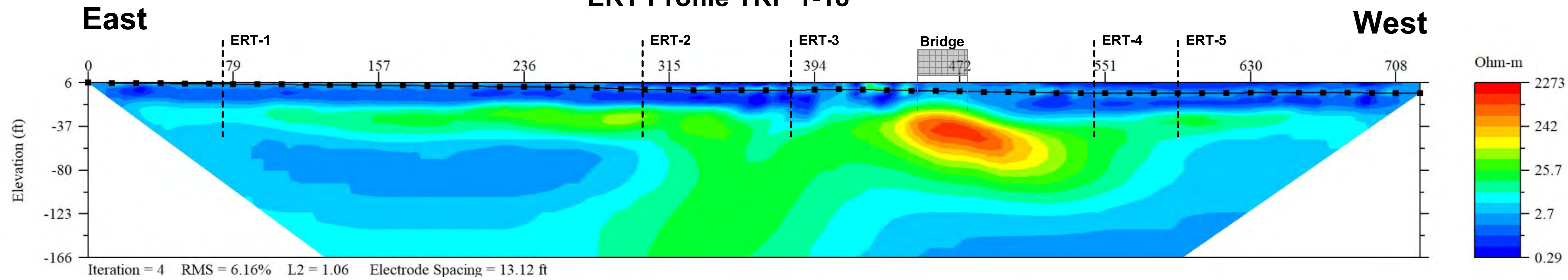
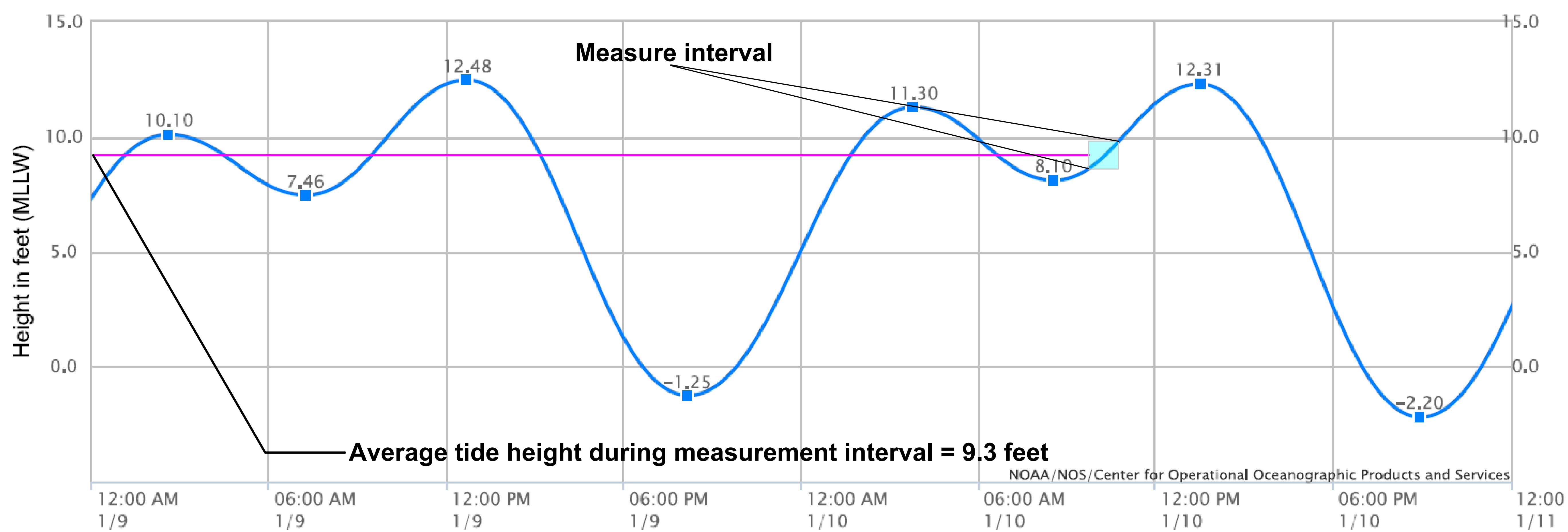
| **Timelapse ERT Profile TRP 1-17** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 4.18 |

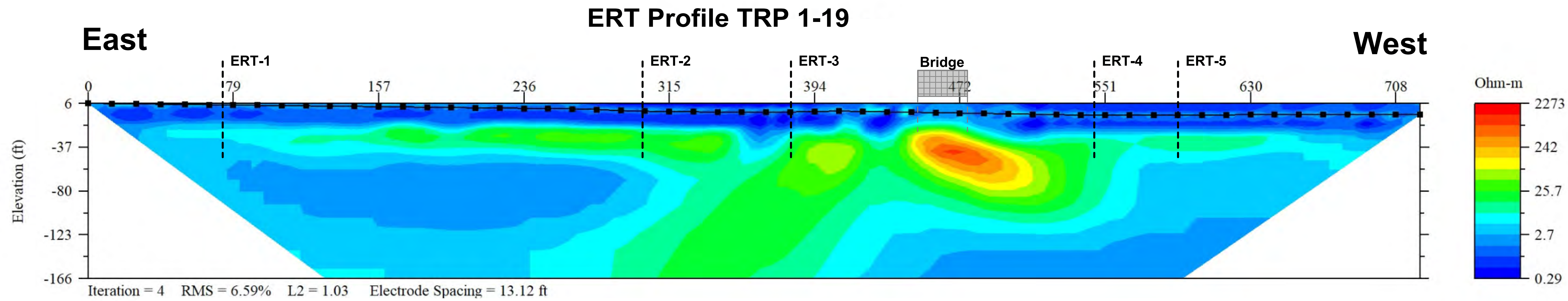
## ERT Profile TRP 1-18

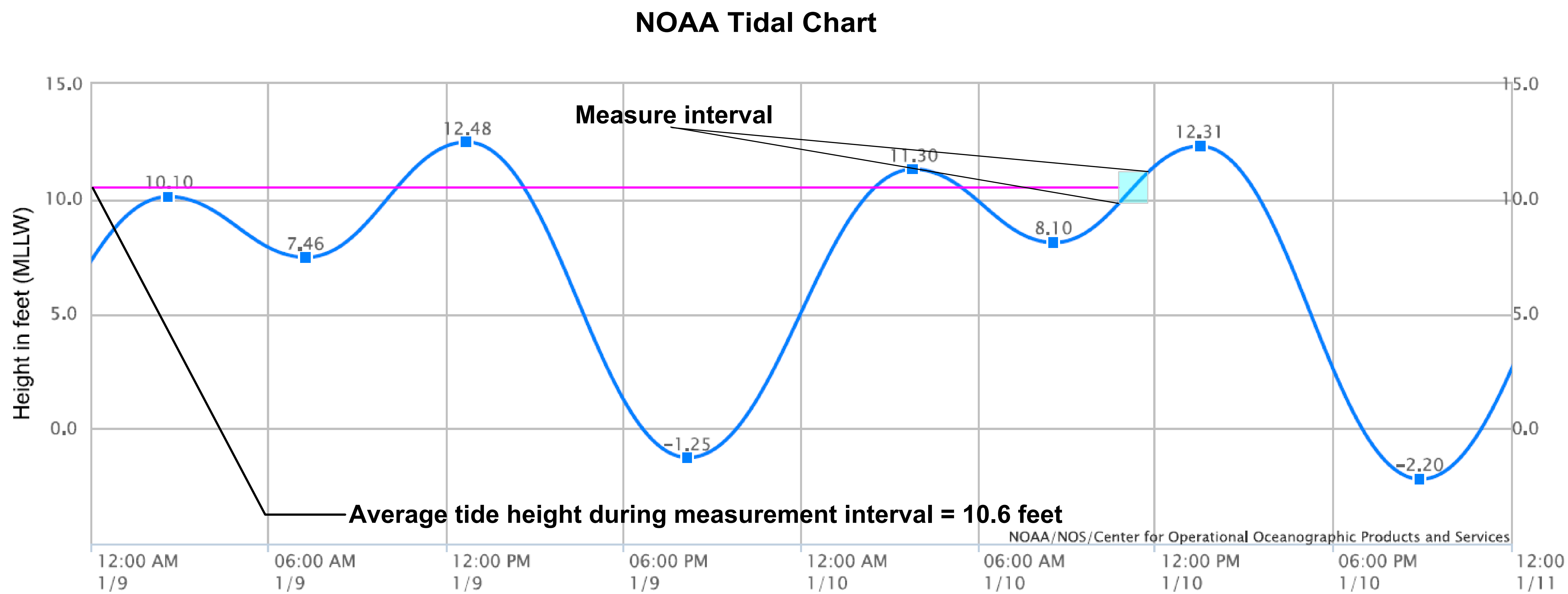



## NOAA Tidal Chart




| Timelapse ERT Profile TRP 1-18 | Operable Unit 1 Keyport , Washington | ATLAS Figure 4.19 |
|---|---|---|
| | Project No.: 420019SWG REV1 / Date: 09/21 | |

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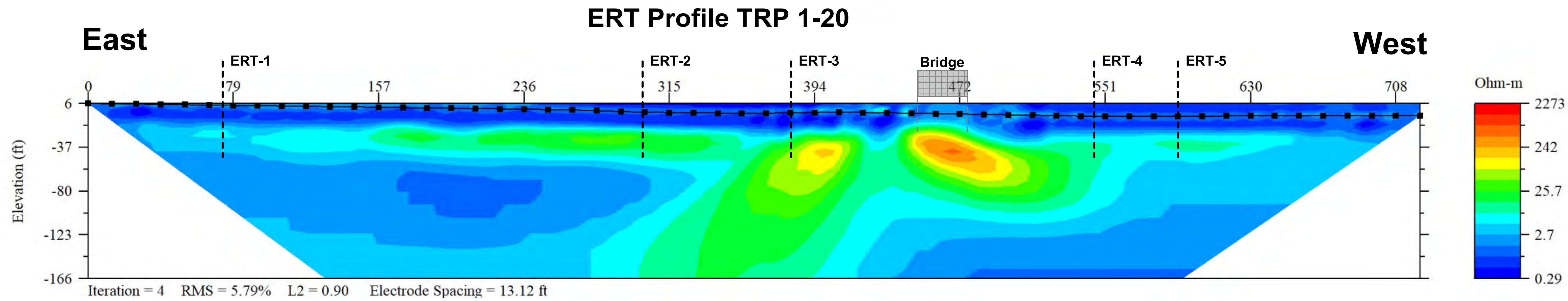
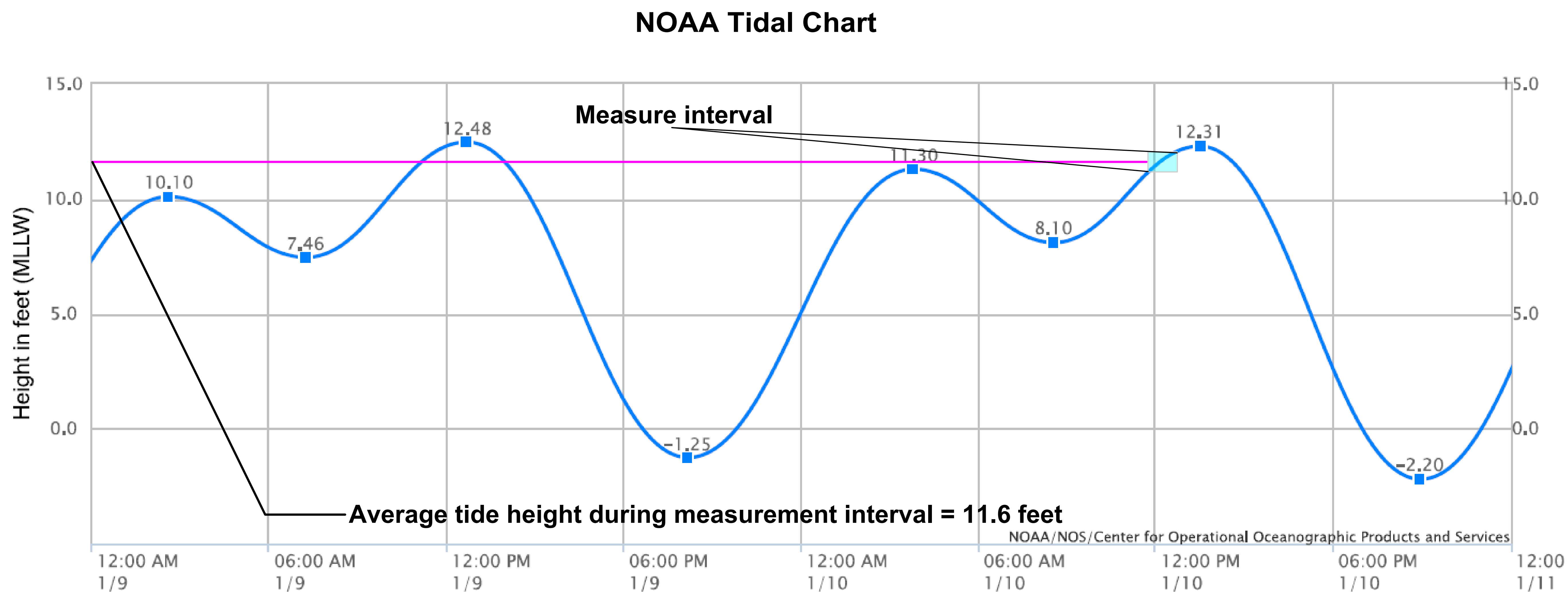
|---|---|---|
| **Timelapse ERT Profile TRP 1-19** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 4.20 |

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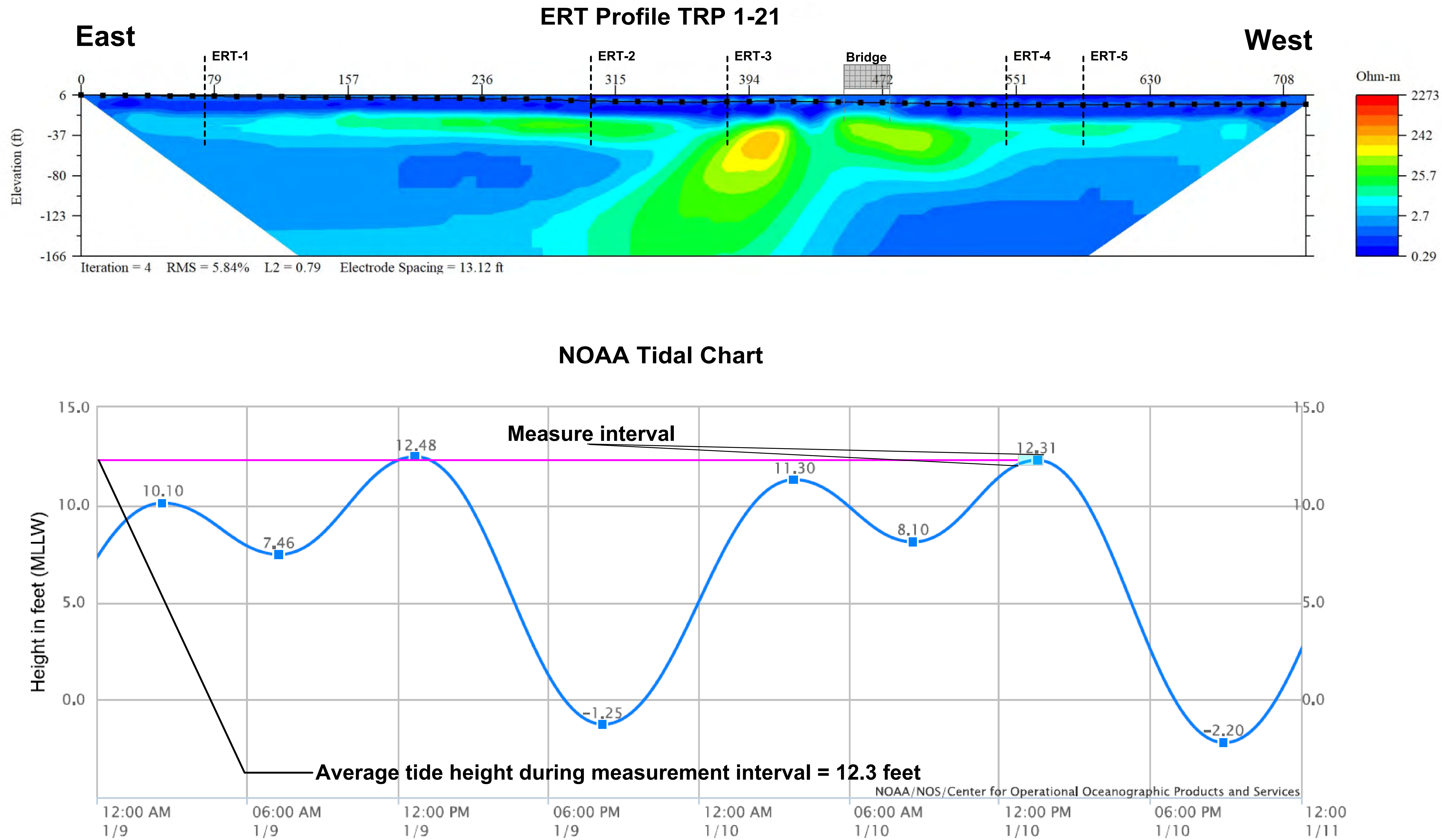
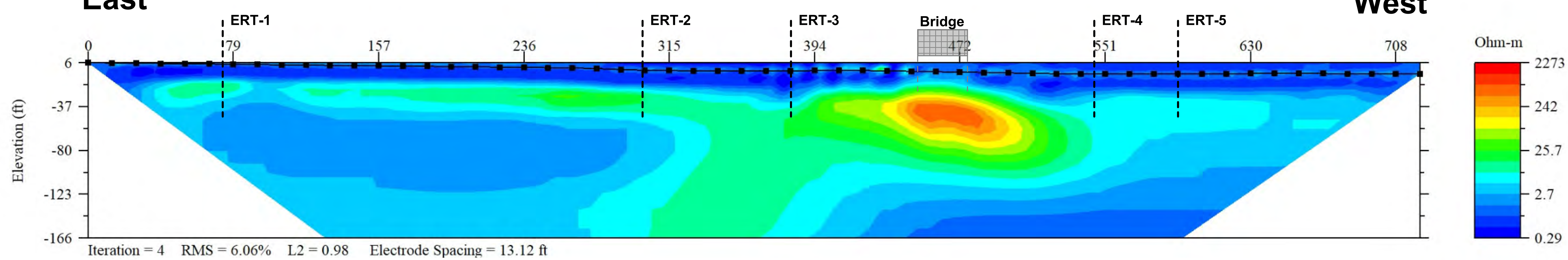
| **Timelapse ERT Profile TRP 1-20** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 / Date: 09/21 | ATLAS<br>Figure 4.21 |

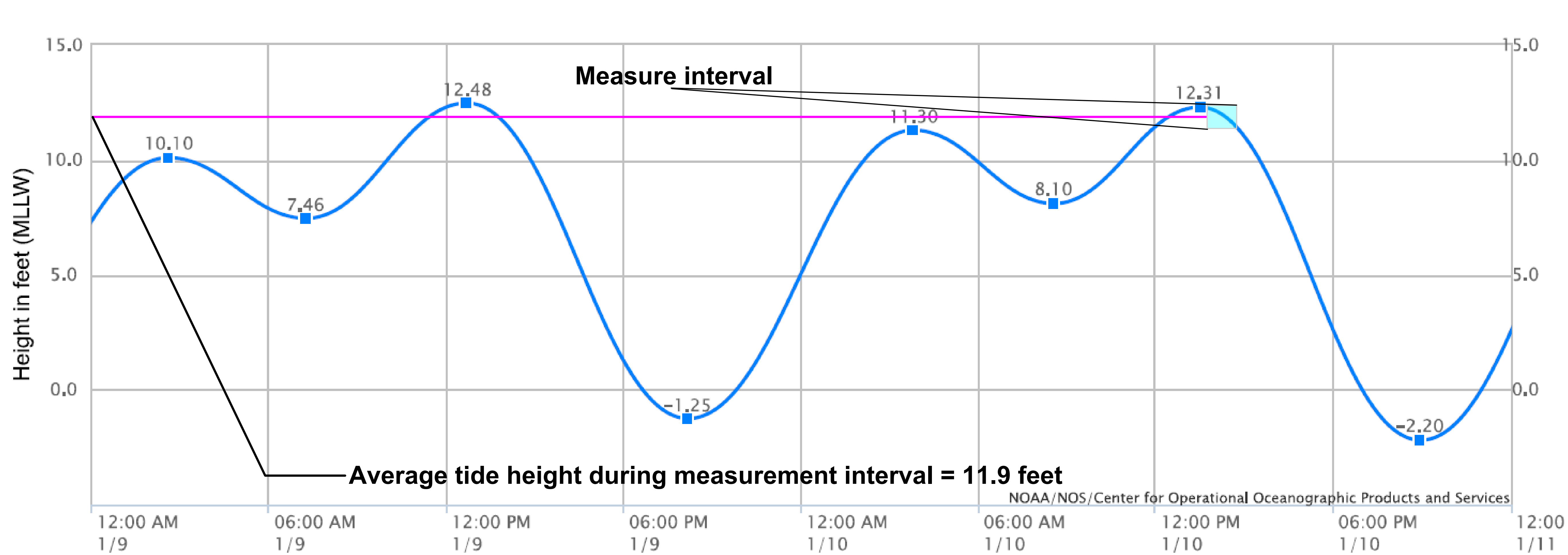



| Timelapse ERT Profile TRP 1-21 | Operable Unit 1 Keyport , Washington | ATLAS Figure 4.22 |
|---|---|---|
| | Project No.: 420019SWG REV1 / Date: 09/21 | |

## ERT Profile TRP 1-22




## NOAA Tidal Chart

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| **Timelapse ERT Profile TRP 1-22** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 4.23 |


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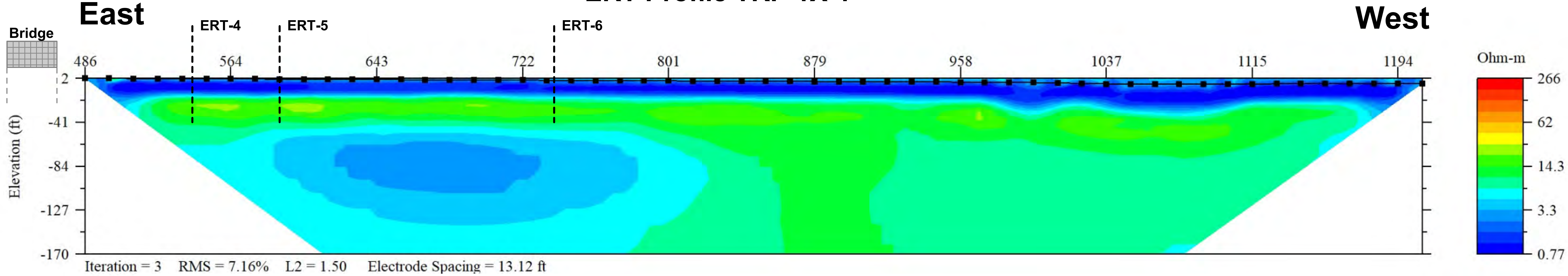
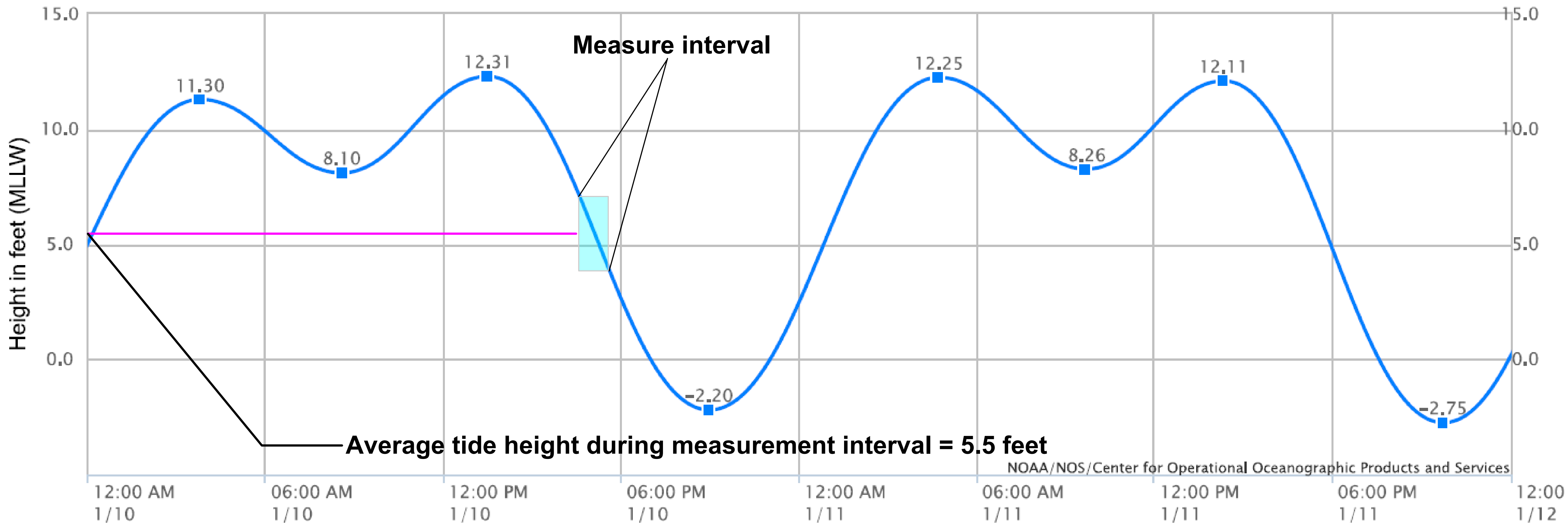
|---|---|---|---|
| **SITE MAP** | N | Operable Unit 1<br>Keyport, Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 5.1 |

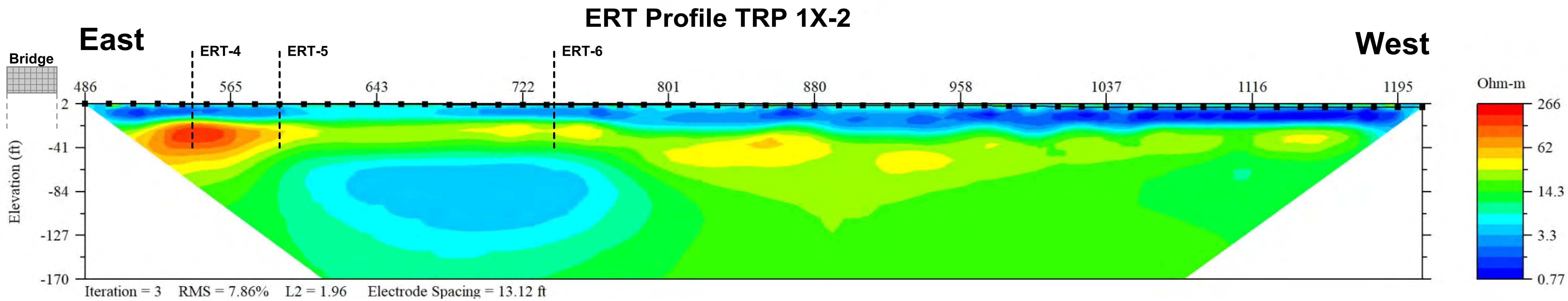
# ERT Profile TRP 1X-1

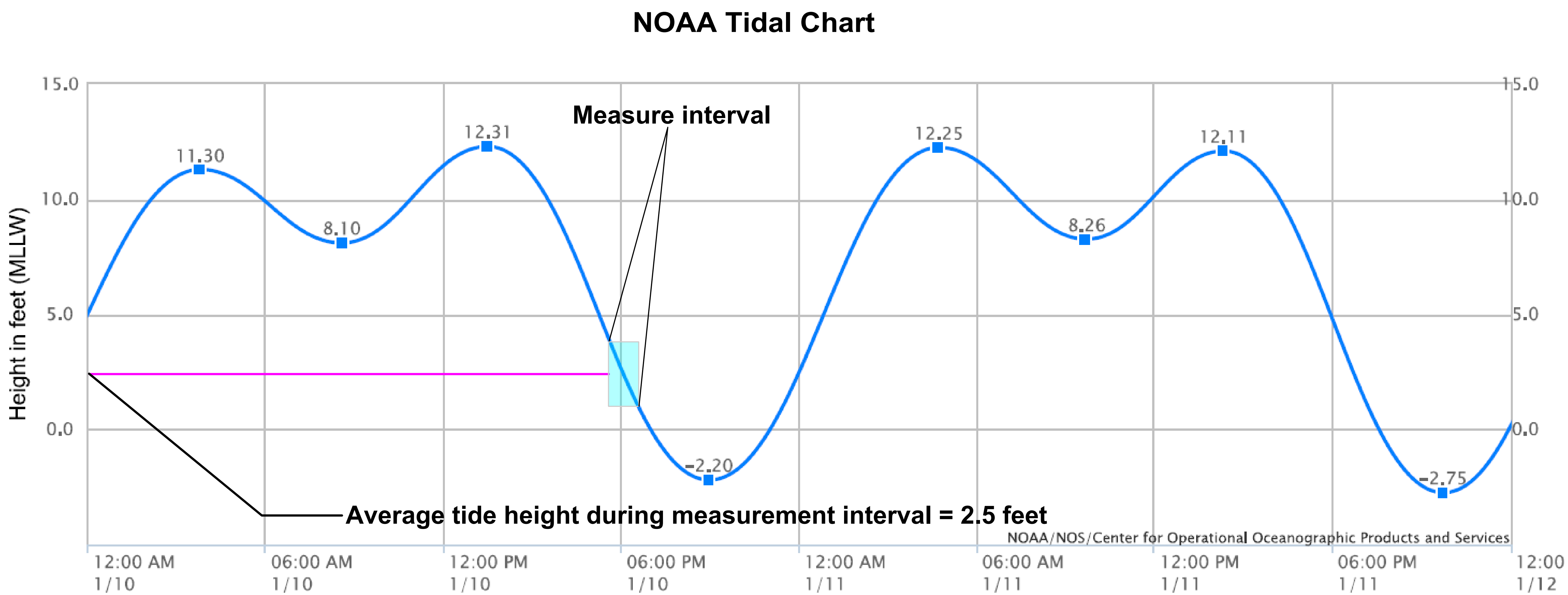



# NOAA Tidal Chart




| Timelapse ERT Profile TRP 1X-1 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 5.2 |
|---|---|---|

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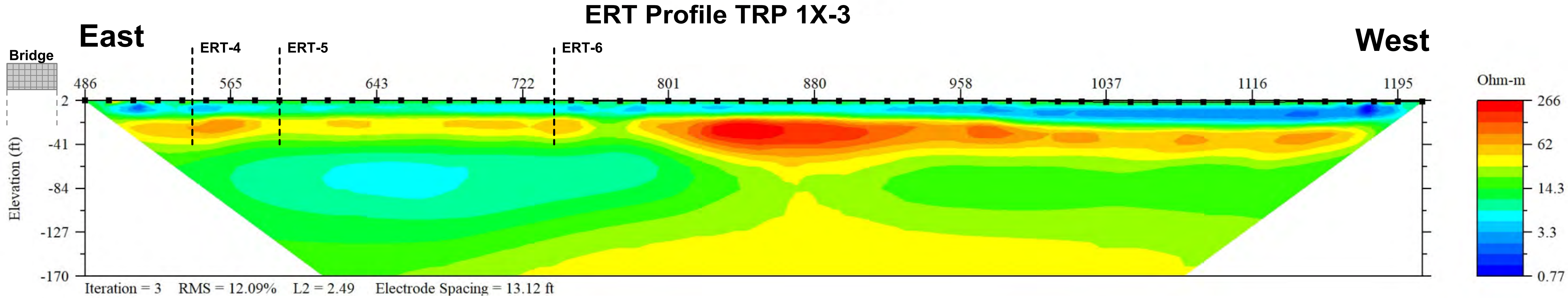
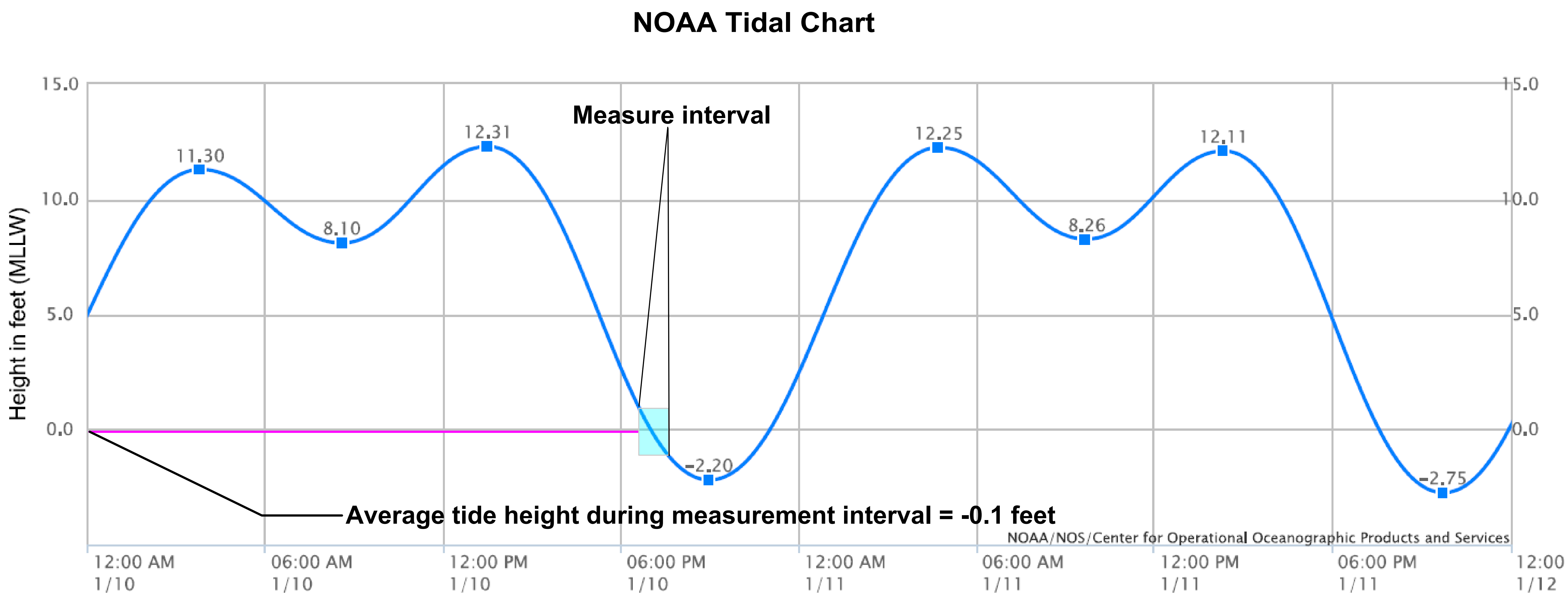
| **Timelapse ERT Profile TRP 1X-2** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 5.3 |

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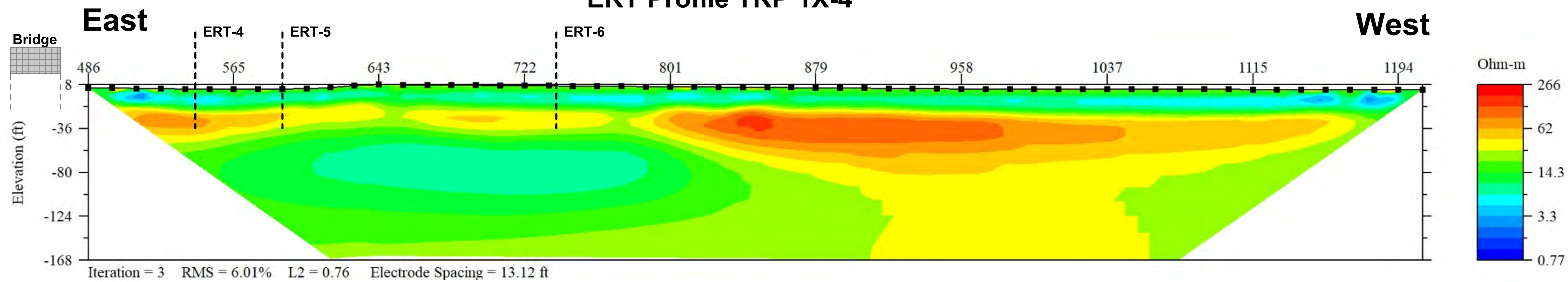
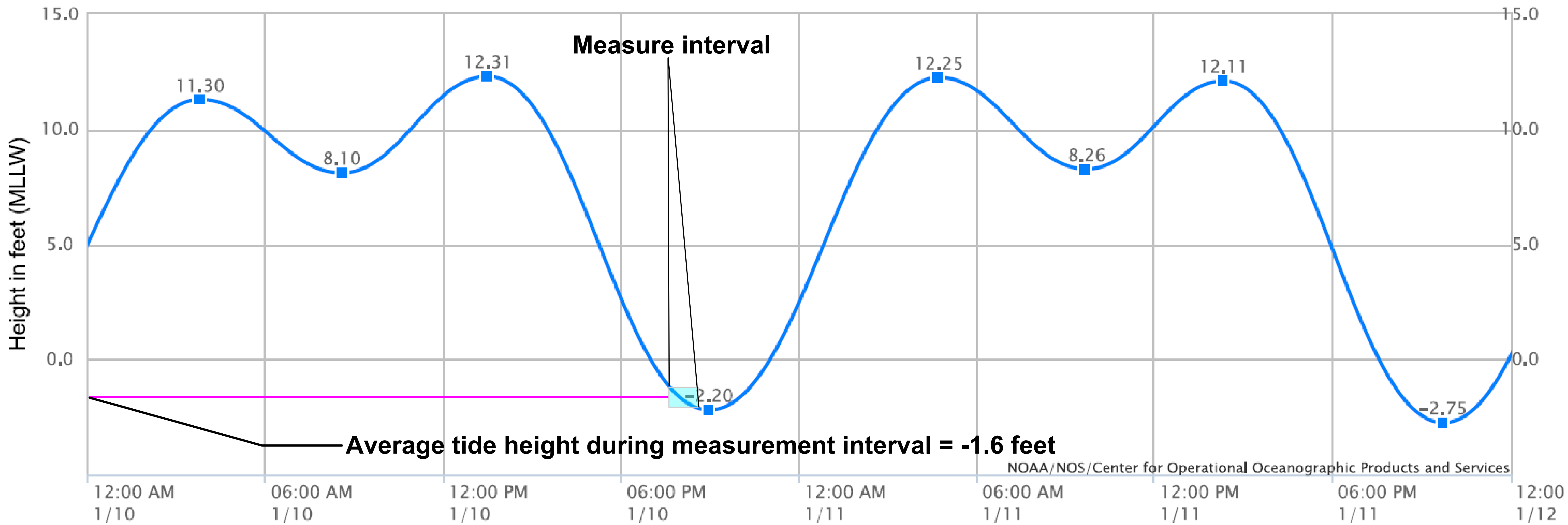
| **Timelapse ERT Profile TRP 1X-3** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 5.4 |

## ERT Profile TRP 1X-4




## NOAA Tidal Chart

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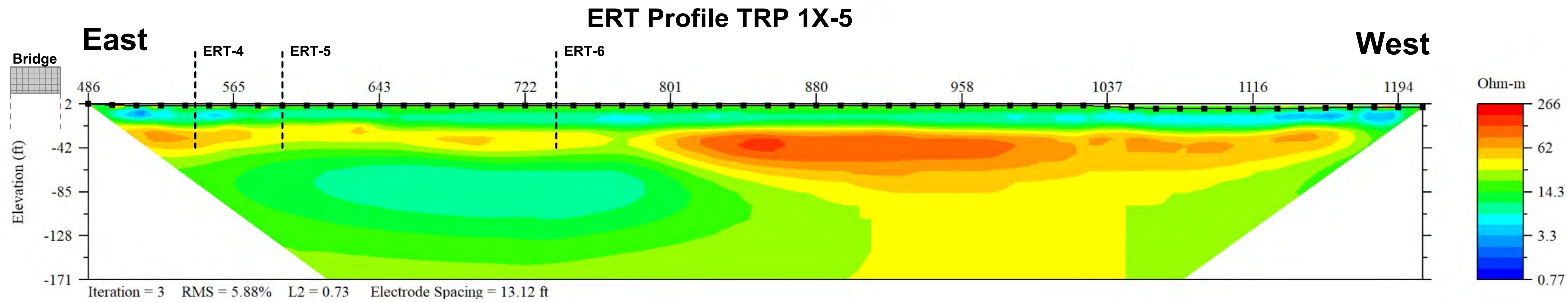
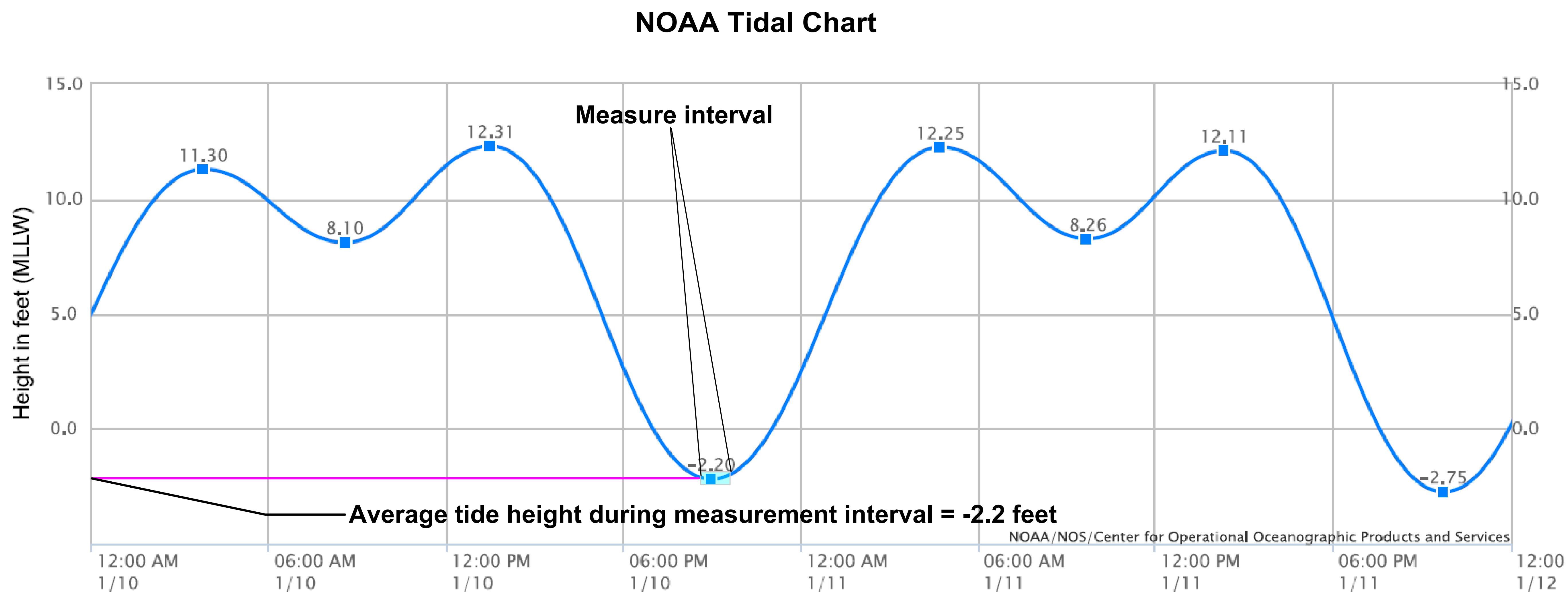
| **Timelapse ERT Profile TRP 1X-4** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 5.5 |

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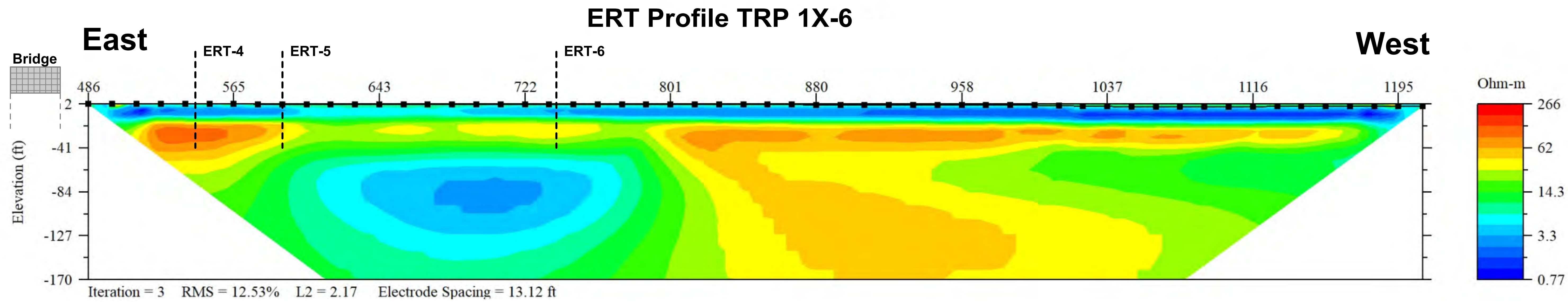
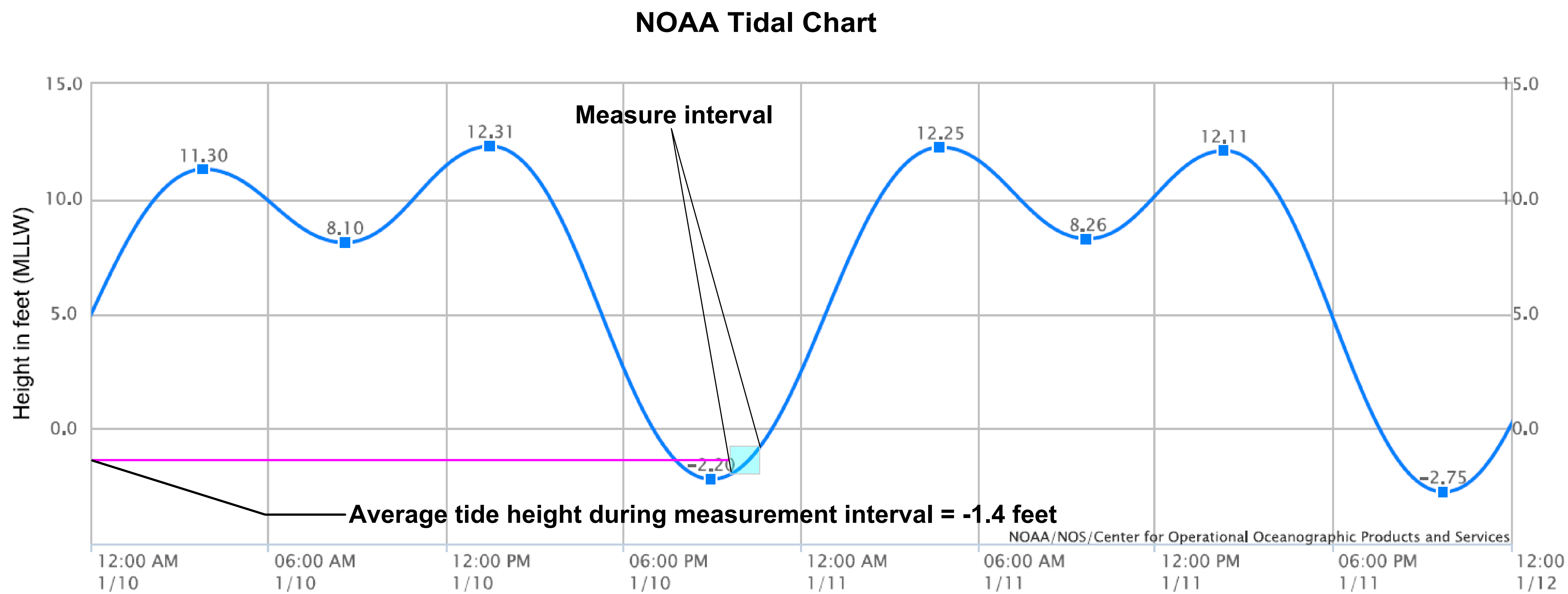
| **Timelapse ERT Profile TRP 1X-5** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 5.6 |

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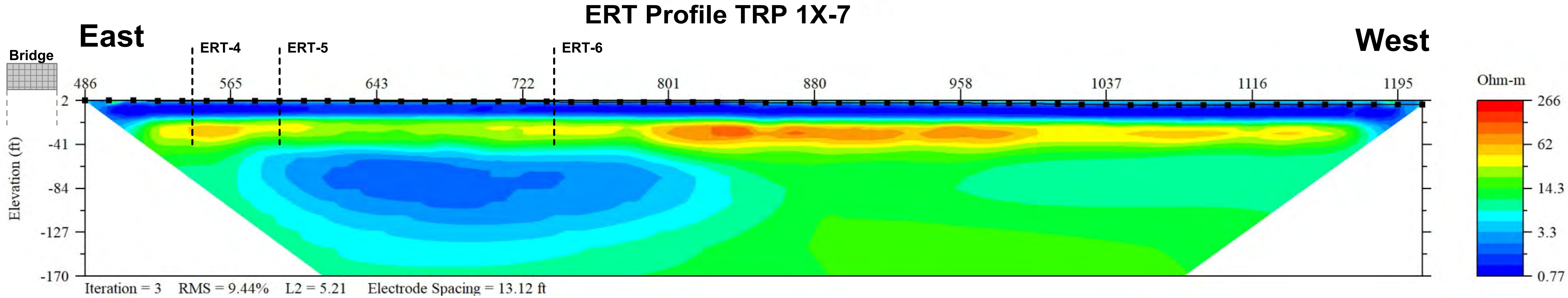
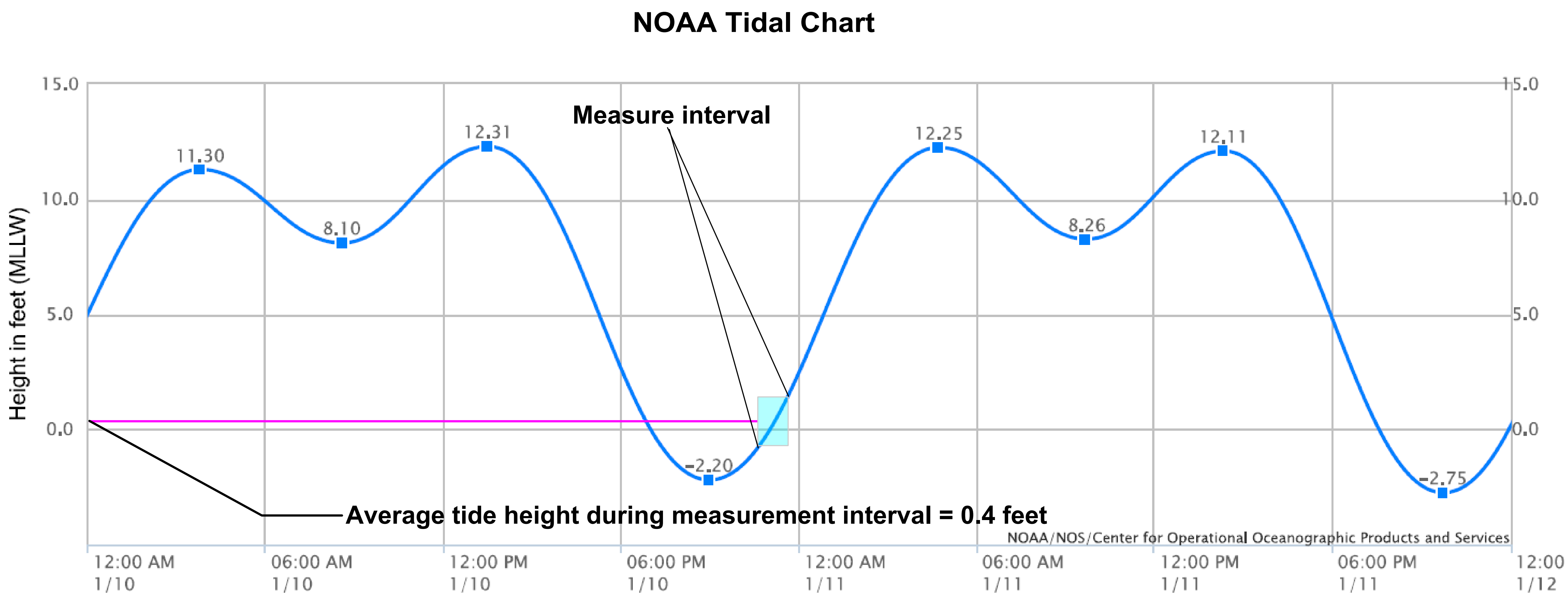
| **Timelapse ERT Profile TRP 1X-6** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 / Date: 09/21 | ATLAS<br>Figure 5.7 |

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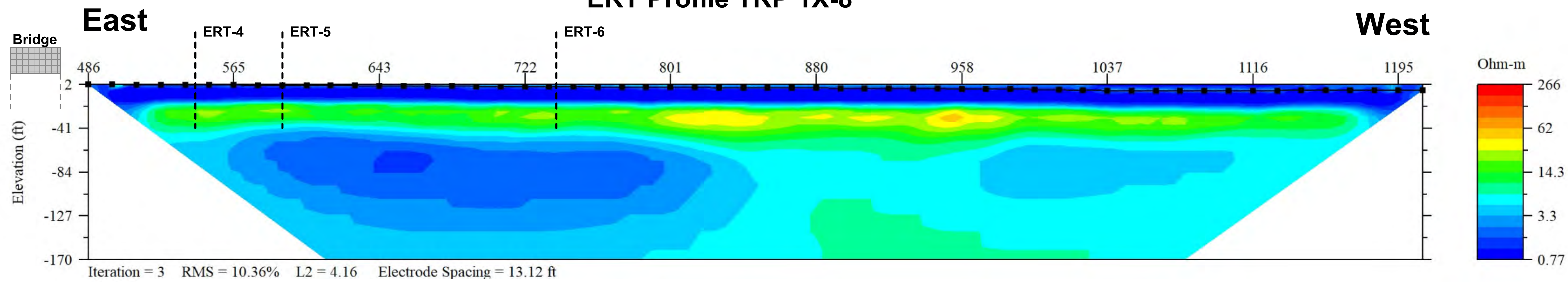
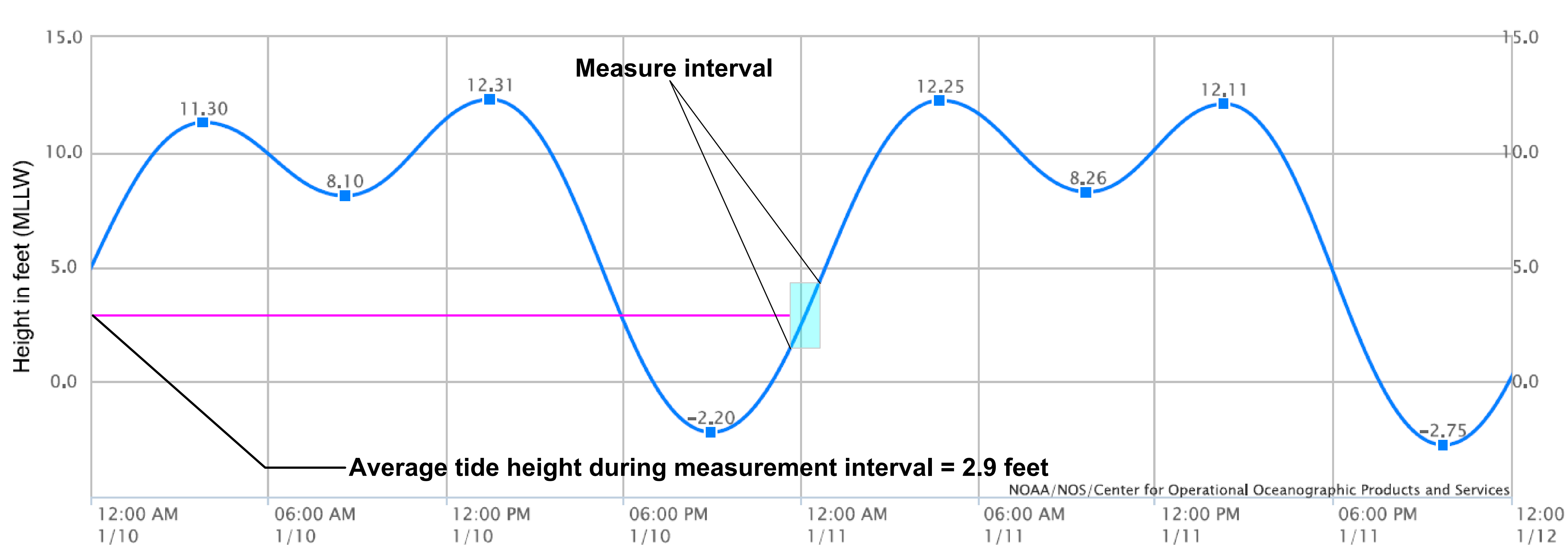
| **Timelapse ERT Profile TRP 1X-7** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 5.8 |

## ERT Profile TRP 1X-8

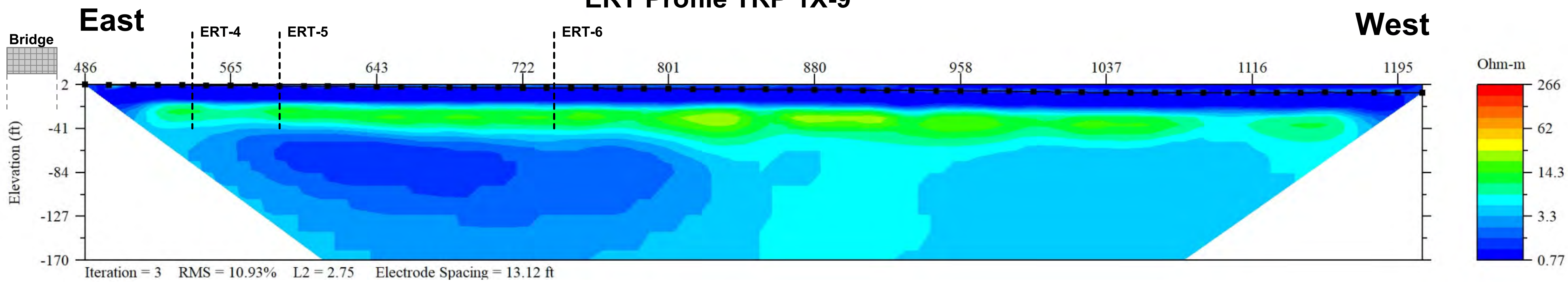



## NOAA Tidal Chart

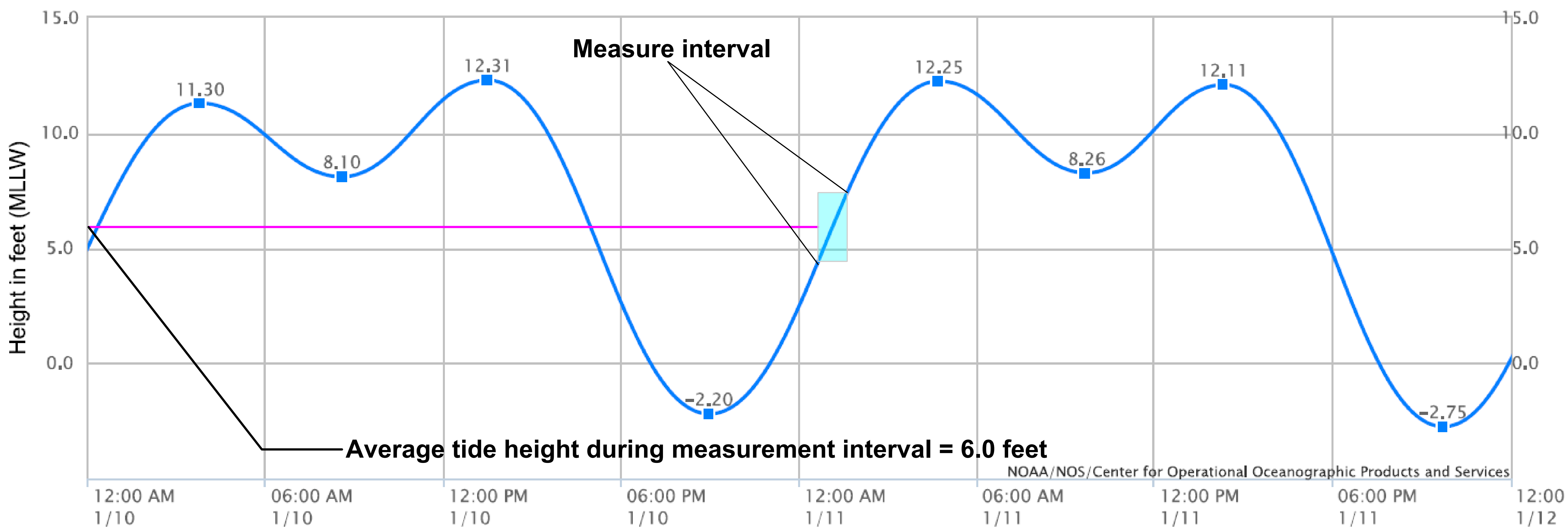



| Timelapse ERT Profile TRP 1X-8 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 · Date: 09/21 | ATLAS<br>Figure 5.9 |
|---|---|---|

ERT Profile TRP 1X-9




NOAA Tidal Chart

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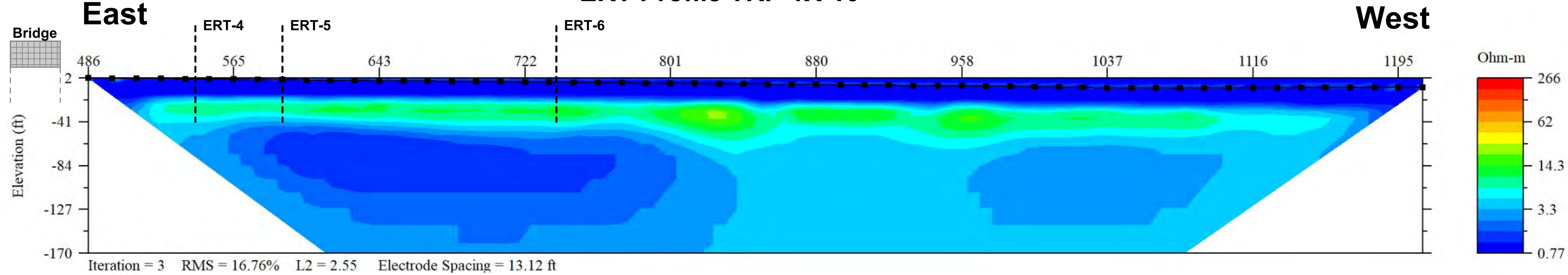
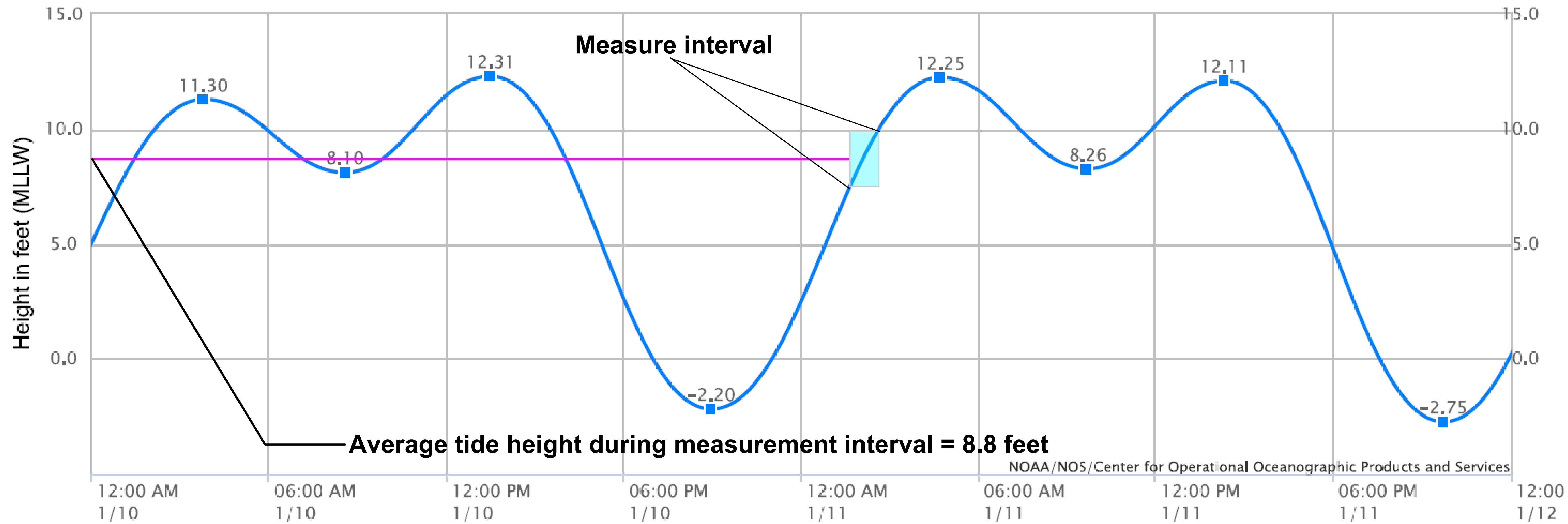
| **Timelapse ERT Profile TRP 1X-9** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 5.10 |

## ERT Profile TRP 1X-10




## NOAA Tidal Chart




| Timelapse ERT Profile TRP 1X-10 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 5.11 |
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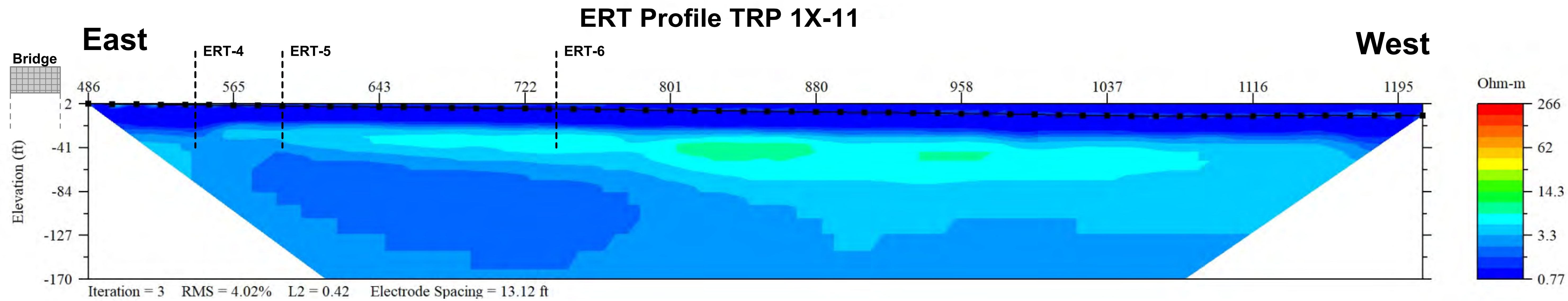


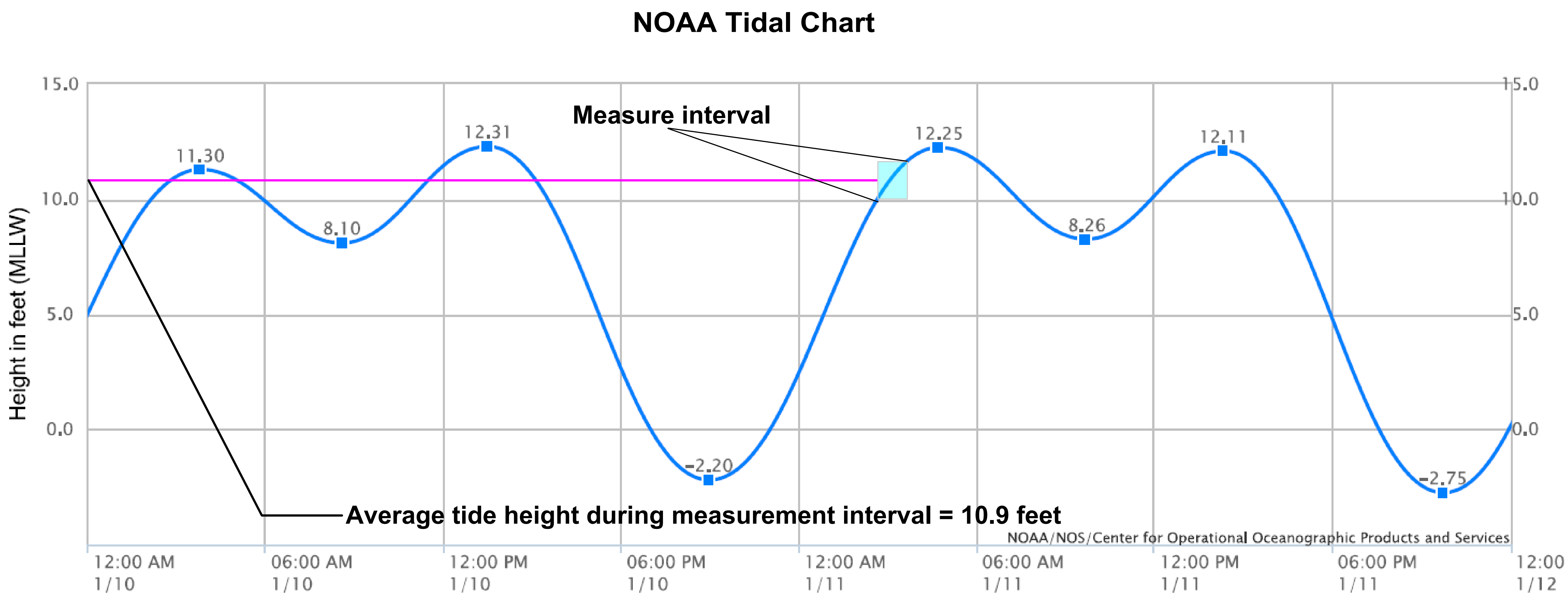


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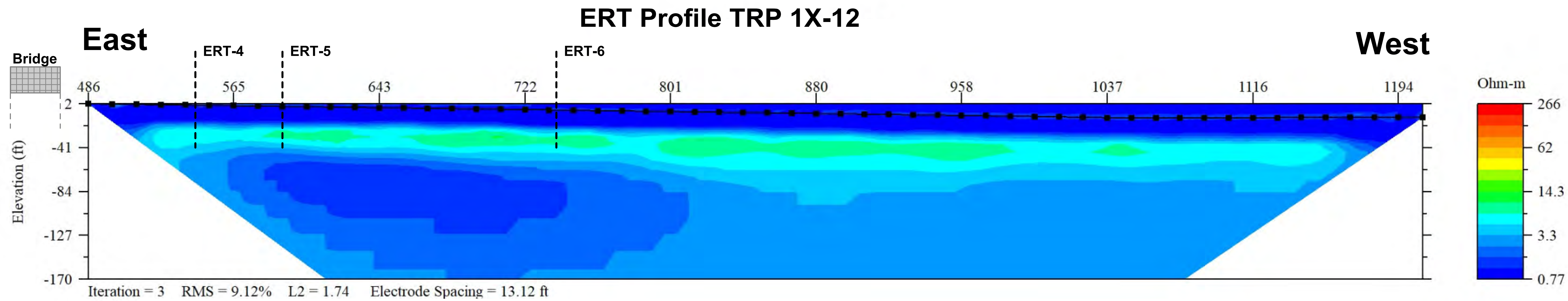
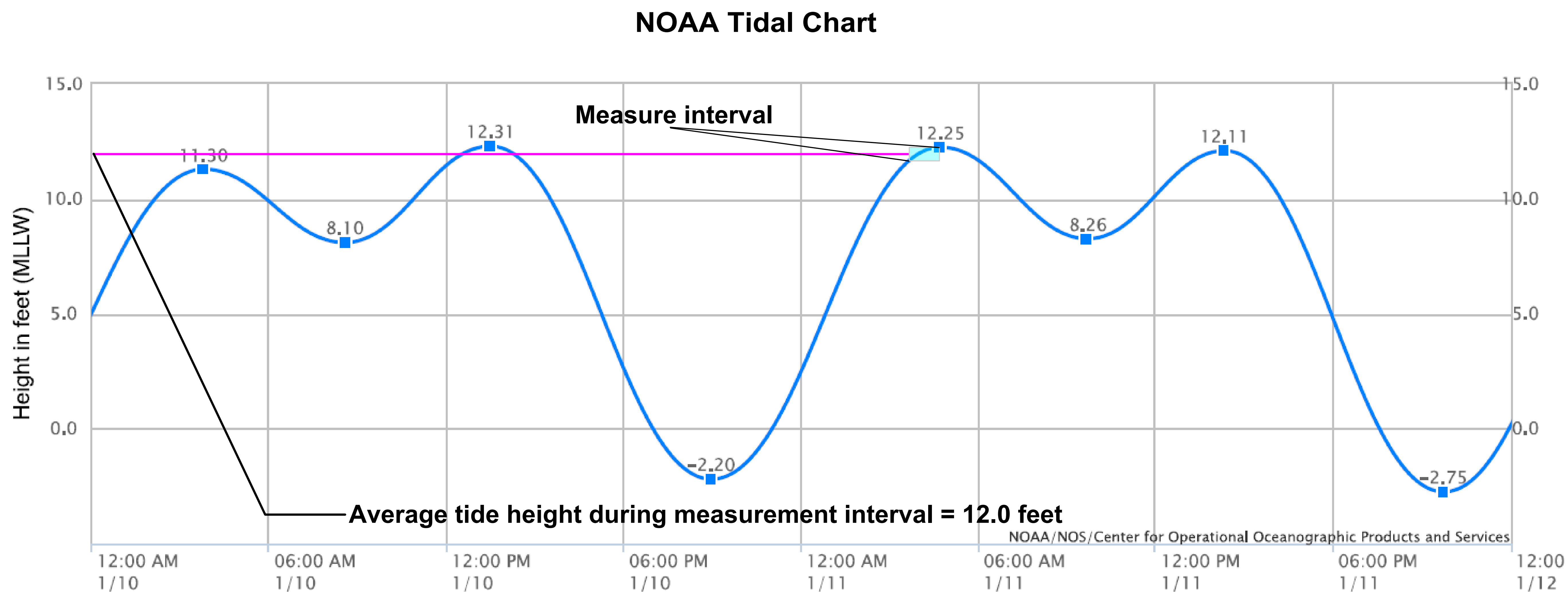
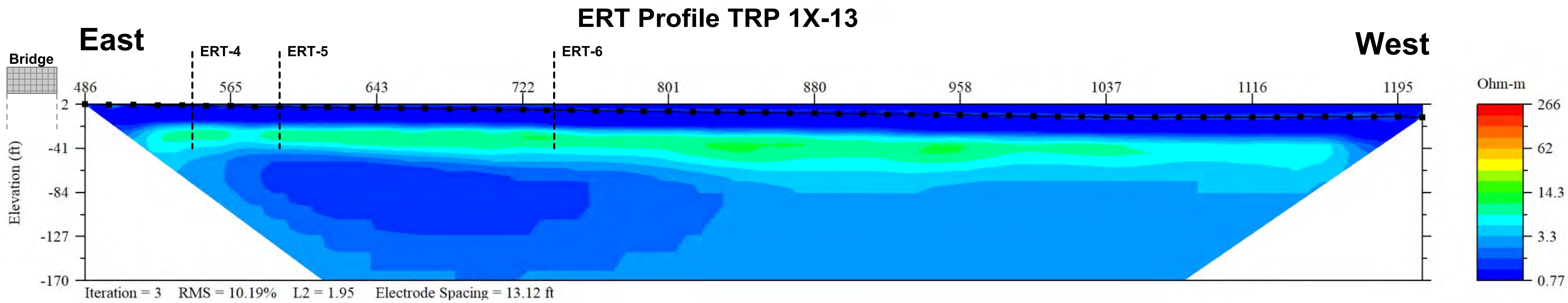
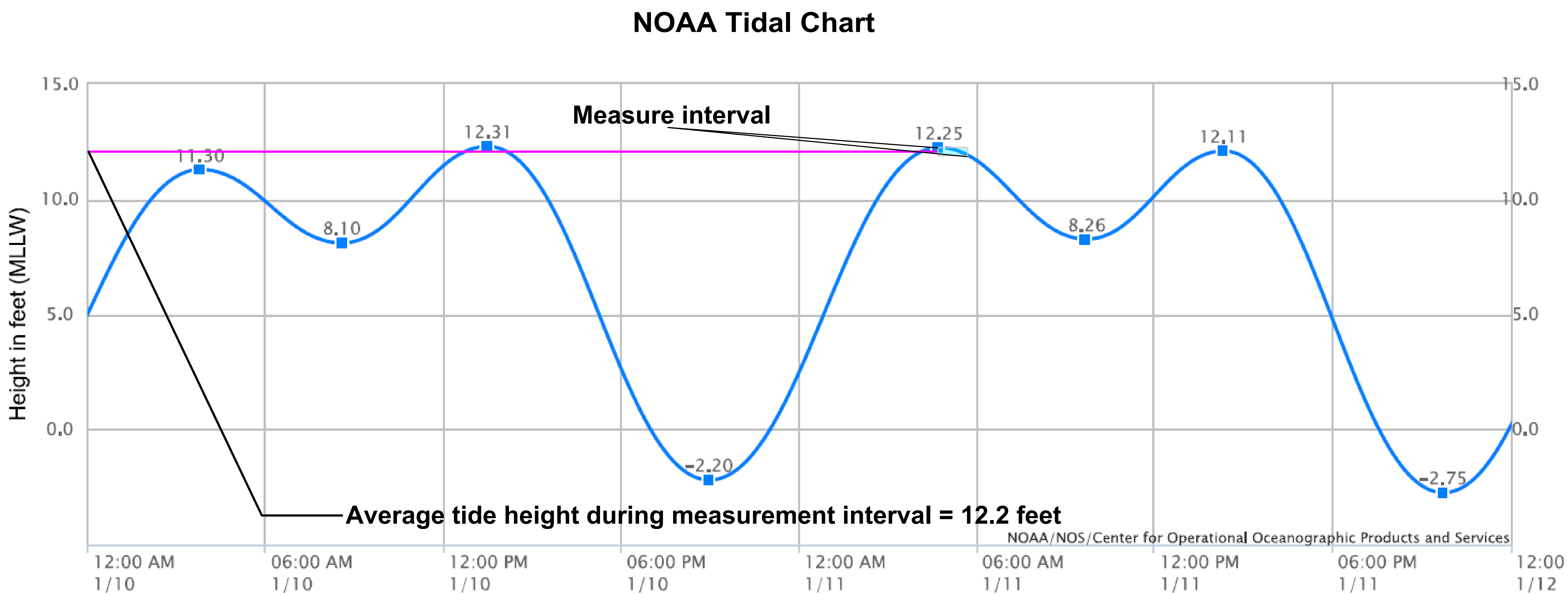
| **Timelapse ERT Profile TRP 1X-11** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 5.12 |



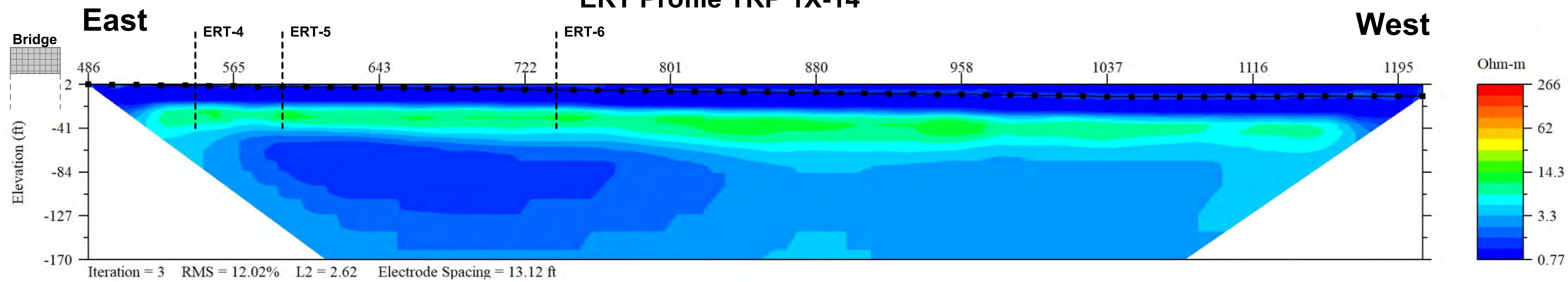

| Timelapse ERT Profile TRP 1X-12 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 5.13 |
|---|---|---|



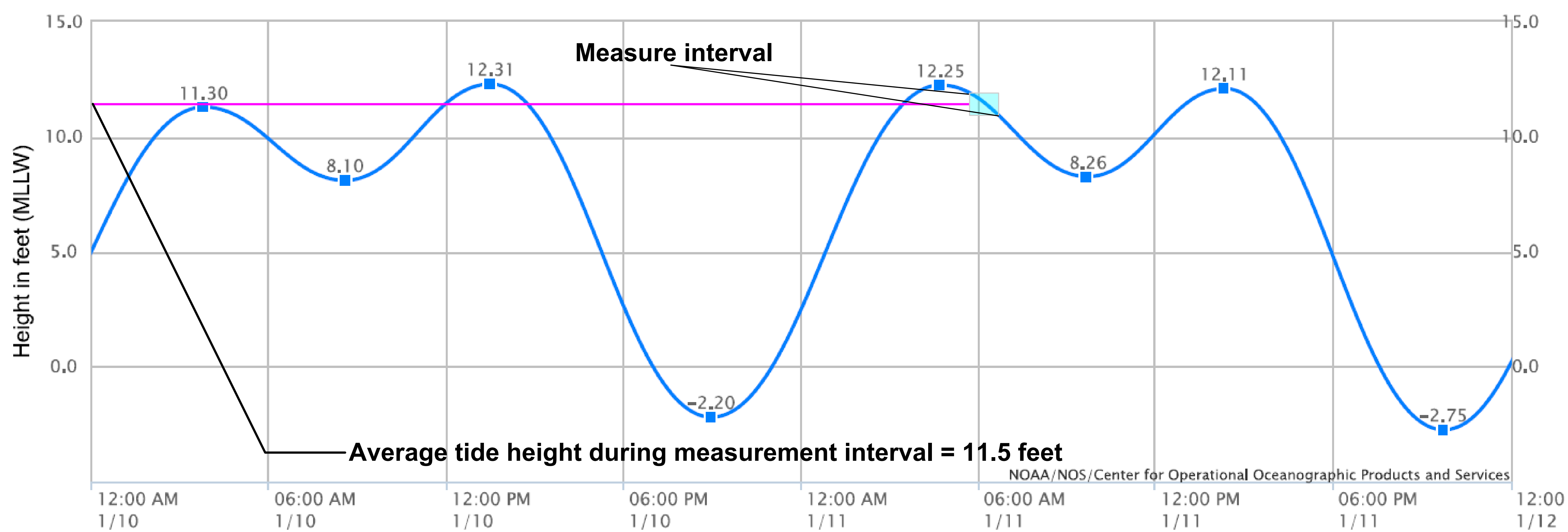




| Timelapse ERT Profile TRP 1X-13 | Operable Unit 1 Keyport , Washington | ATLAS Figure 5.14 |
|---|---|---|
| | Project No.: 420019SWG REV1 Date: 09/21 | |

## ERT Profile TRP 1X-14




## NOAA Tidal Chart




| Timelapse ERT Profile TRP 1X-14 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 5.15 |
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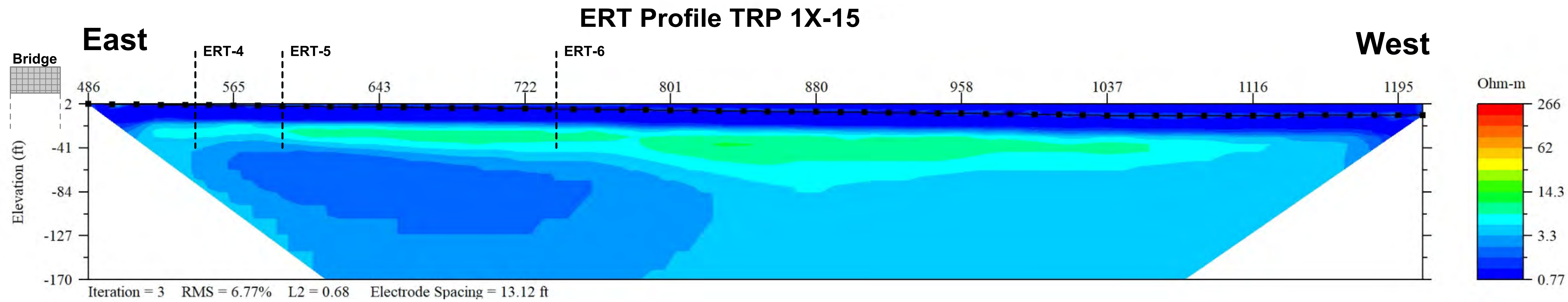
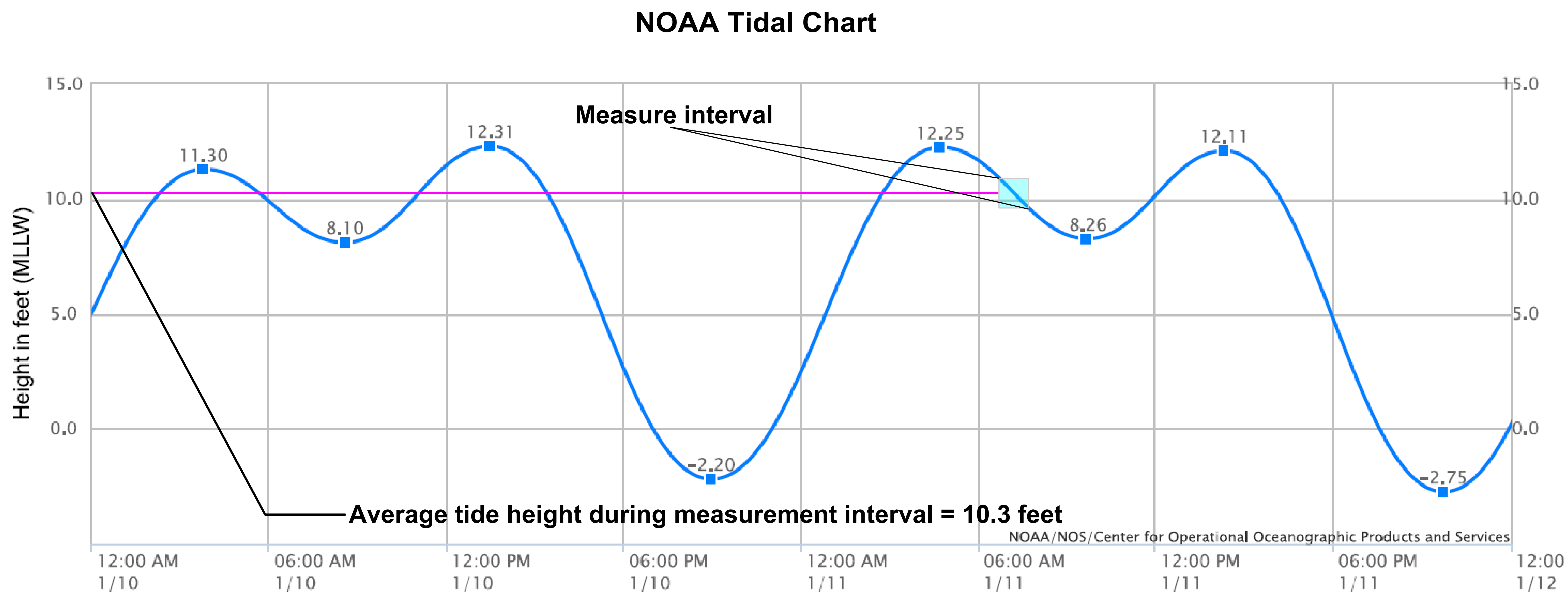
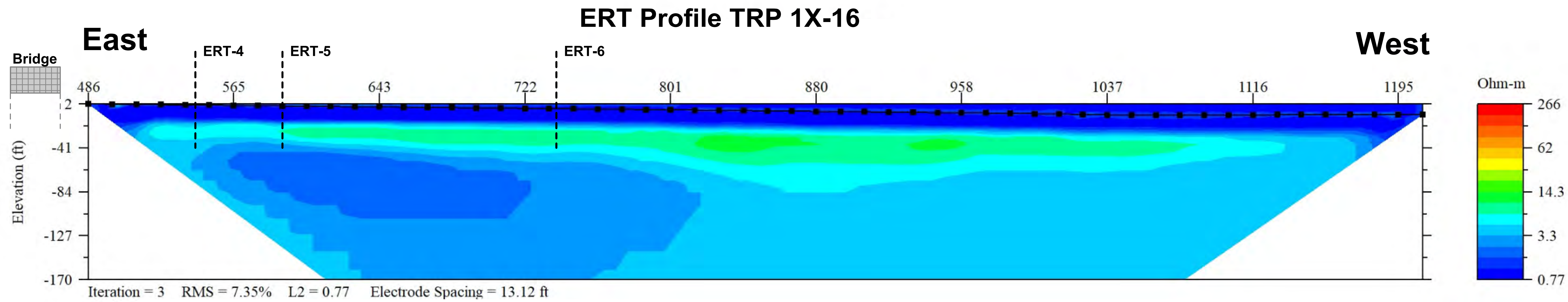
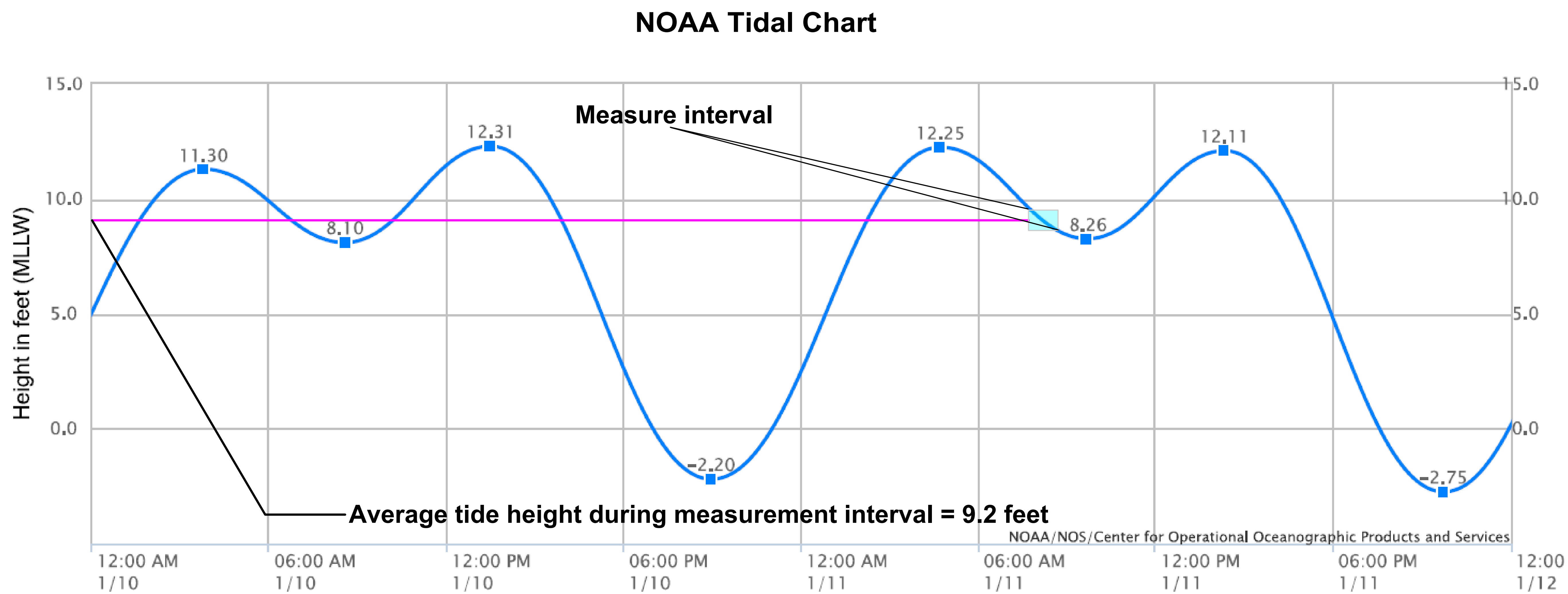



| Timelapse ERT Profile TRP 1X-15 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 5.16 |
|---|---|---|

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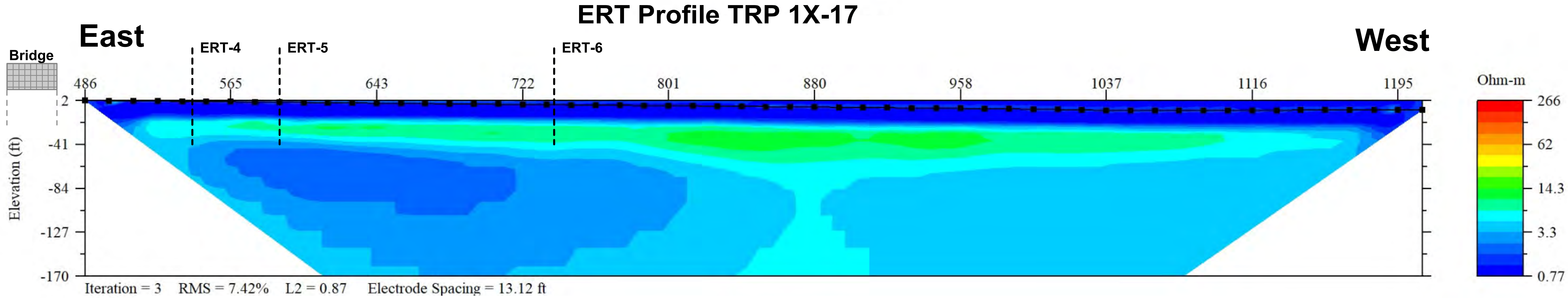
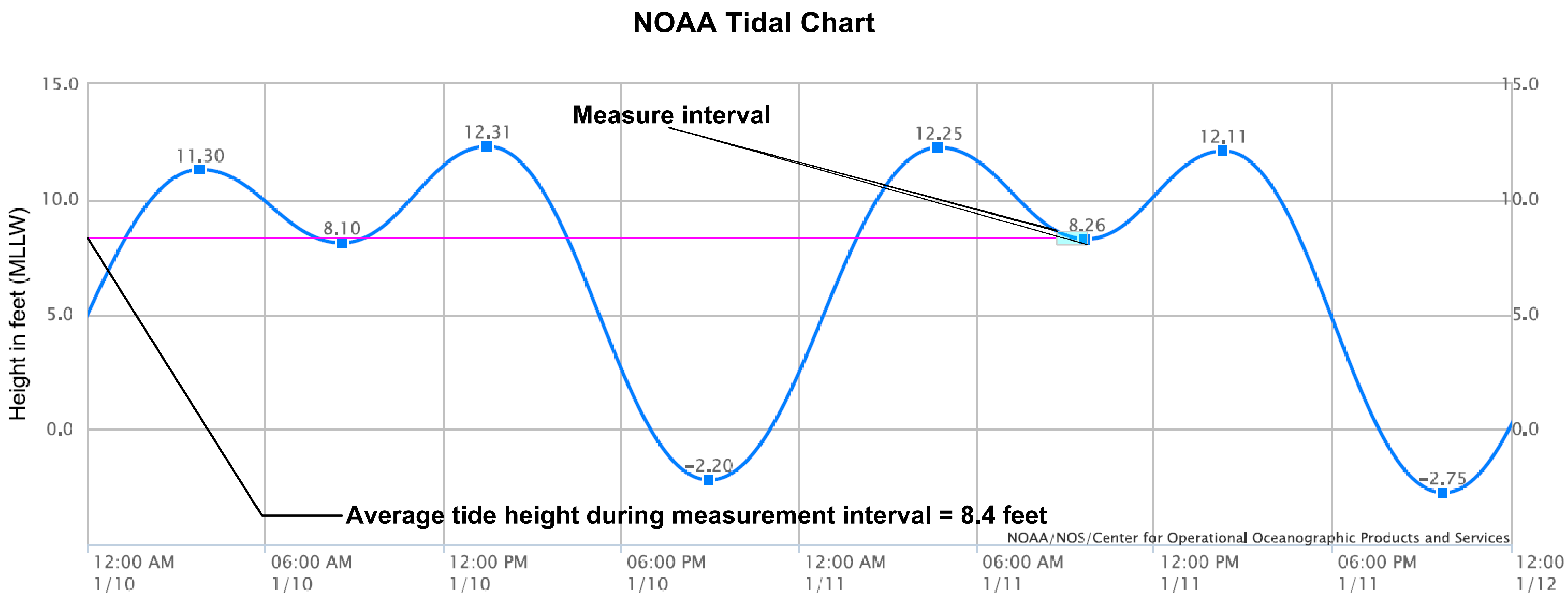
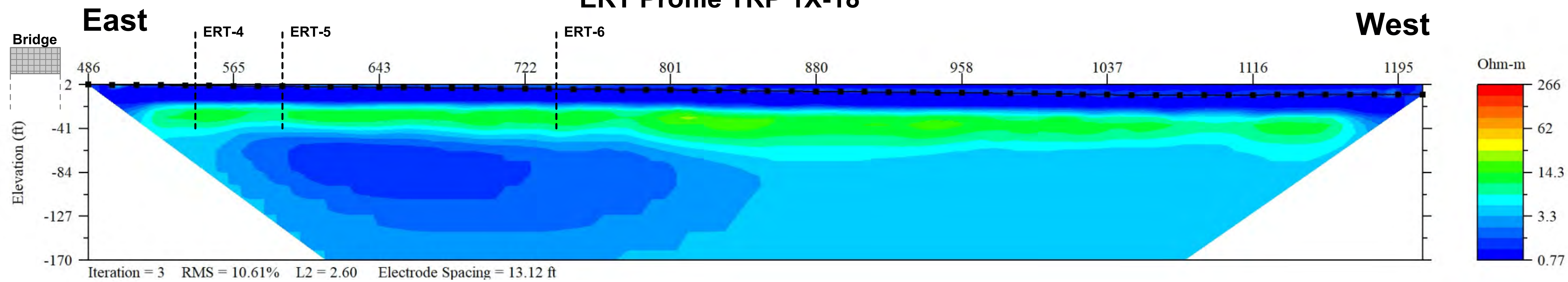
|---|---|---|
| **Timelapse ERT Profile TRP 1X-16** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 5.17 |



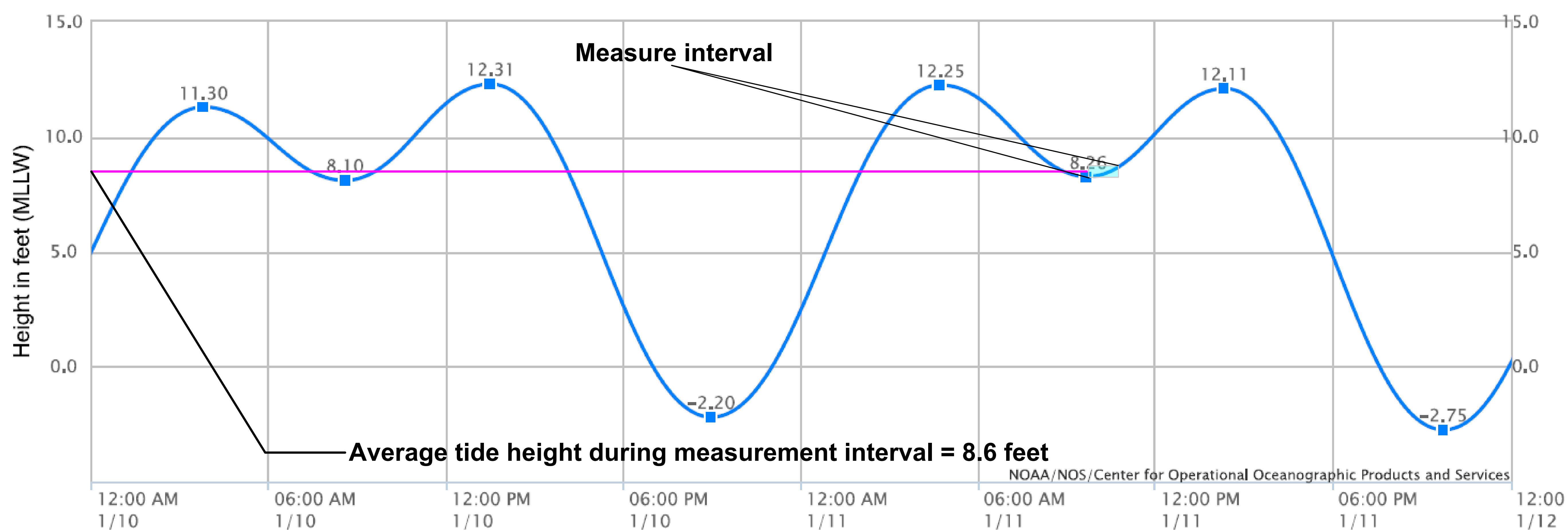




| Timelapse ERT Profile TRP 1X-17 | Operable Unit 1 Keyport , Washington | | ATLAS Figure 5.18 |
|---|---|---|---|
| | Project No.: 420019SWG REV1 | Date: 09/21 | |

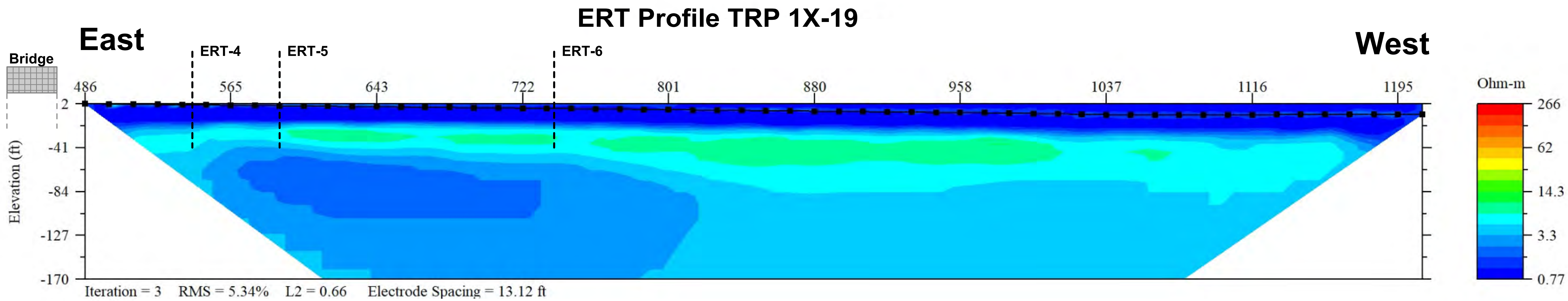
# ERT Profile TRP 1X-18

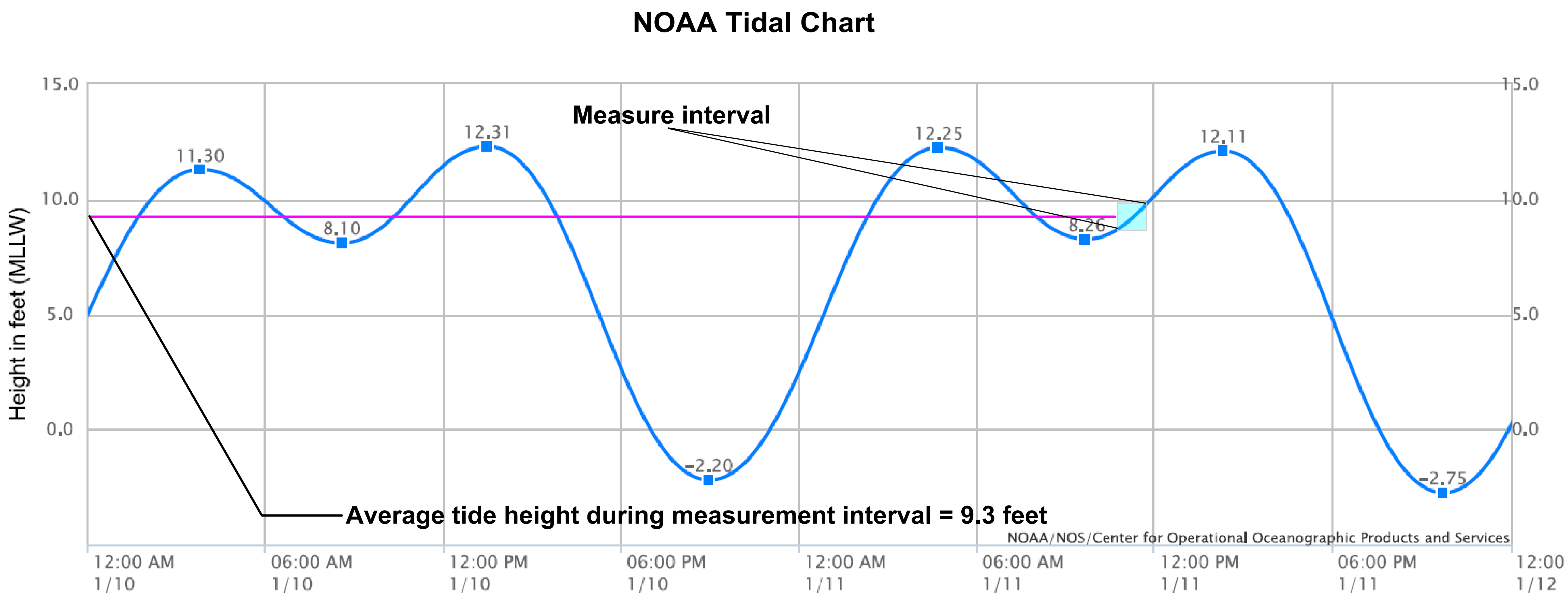



# NOAA Tidal Chart



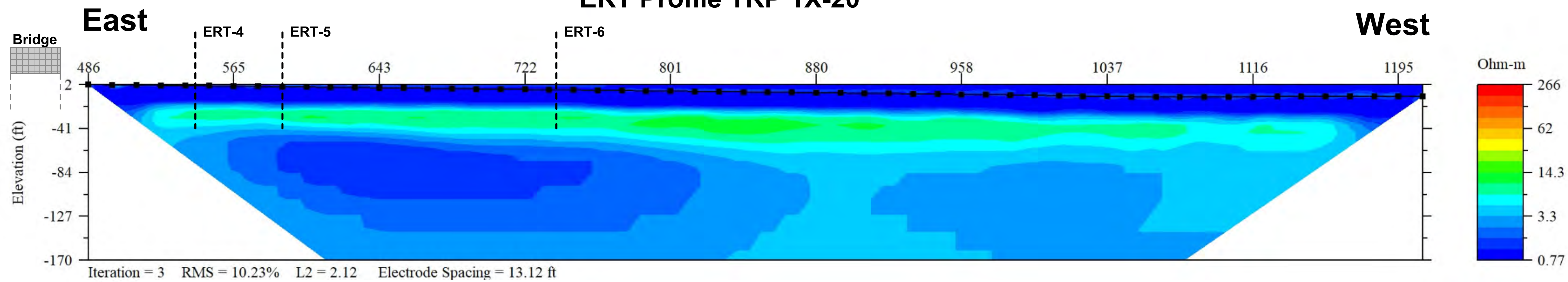

| Timelapse ERT Profile TRP 1X-18 | Operable Unit 1<br>Keyport , Washington | ATLAS<br>Figure 5.19 |
|---|---|---|
| | Project No.: 420019SWG REV1 Date: 09/21 | |



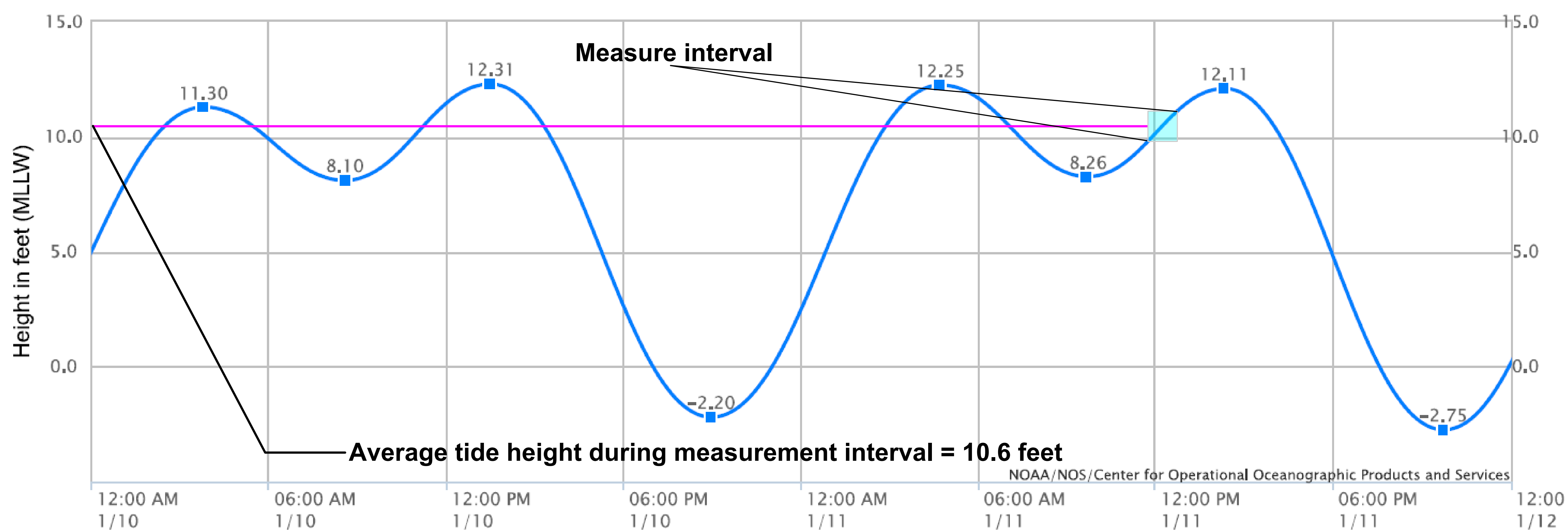




| Timelapse ERT Profile<br>TRP 1X-19 | Operable Unit 1<br>Keyport , Washington | ATLAS<br>Figure 5.20 |
|---|---|---|
| | Project No.: 420019SWG REV1 — Date: 09/21 | |

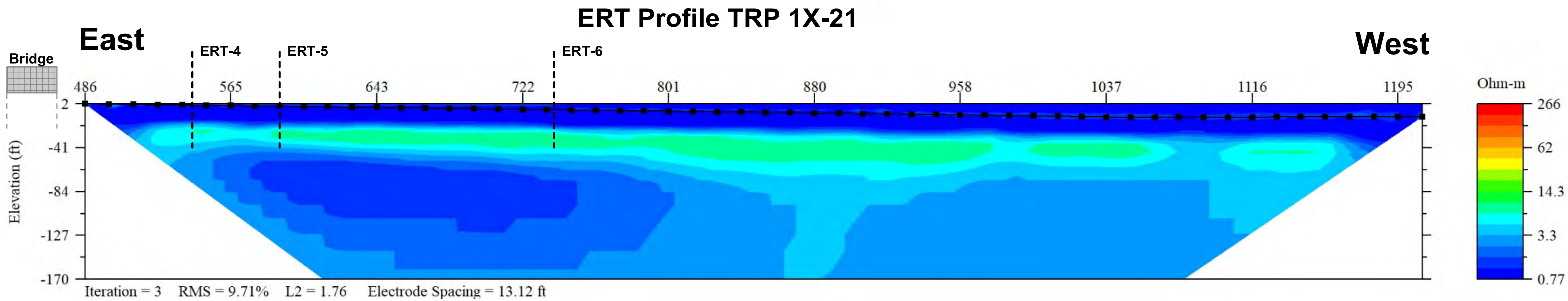
## ERT Profile TRP 1X-20

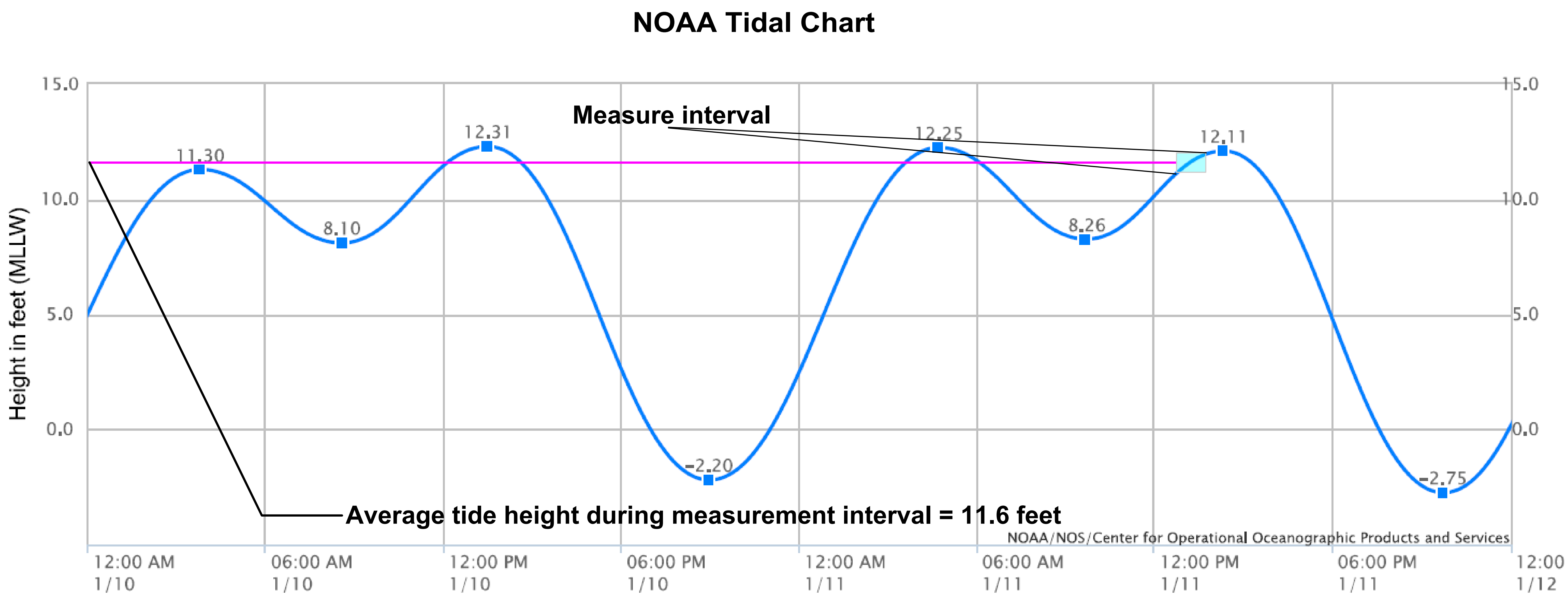



## NOAA Tidal Chart

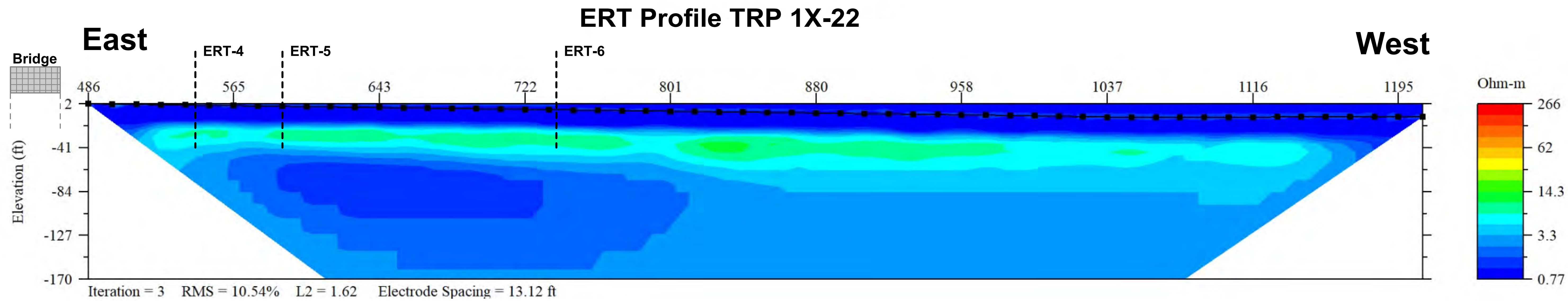


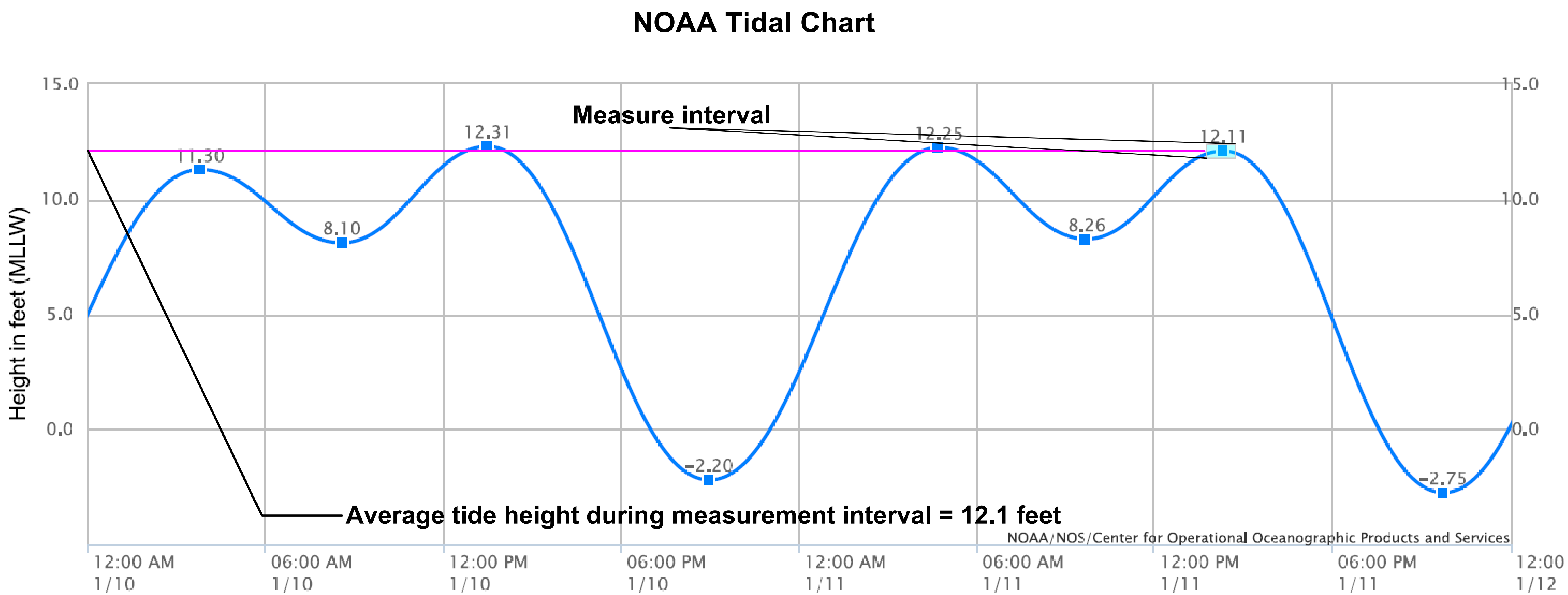

| Timelapse ERT Profile TRP 1X-20 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 · Date: 09/21 | ATLAS<br>Figure 5.21 |
|---|---|---|




| Timelapse ERT Profile TRP 1X-21 | Operable Unit 1<br>Keyport, Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS Figure 5.22 |
|---|---|---|

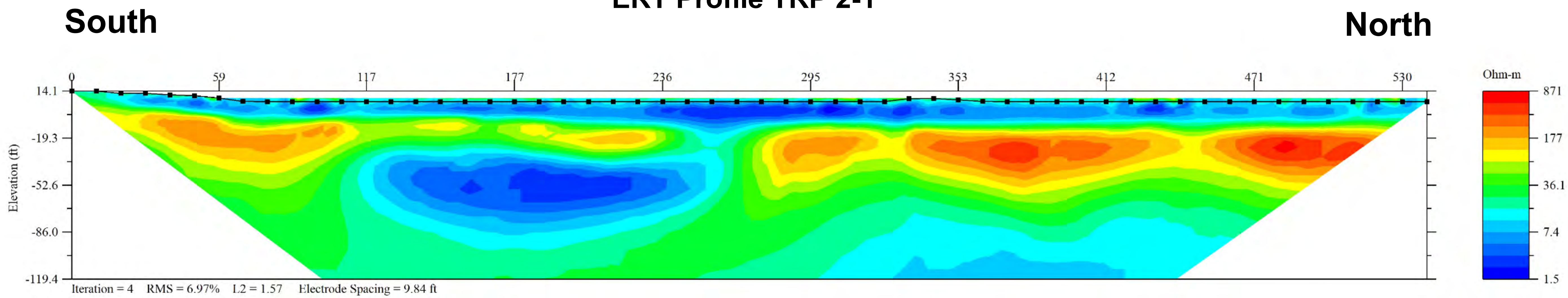


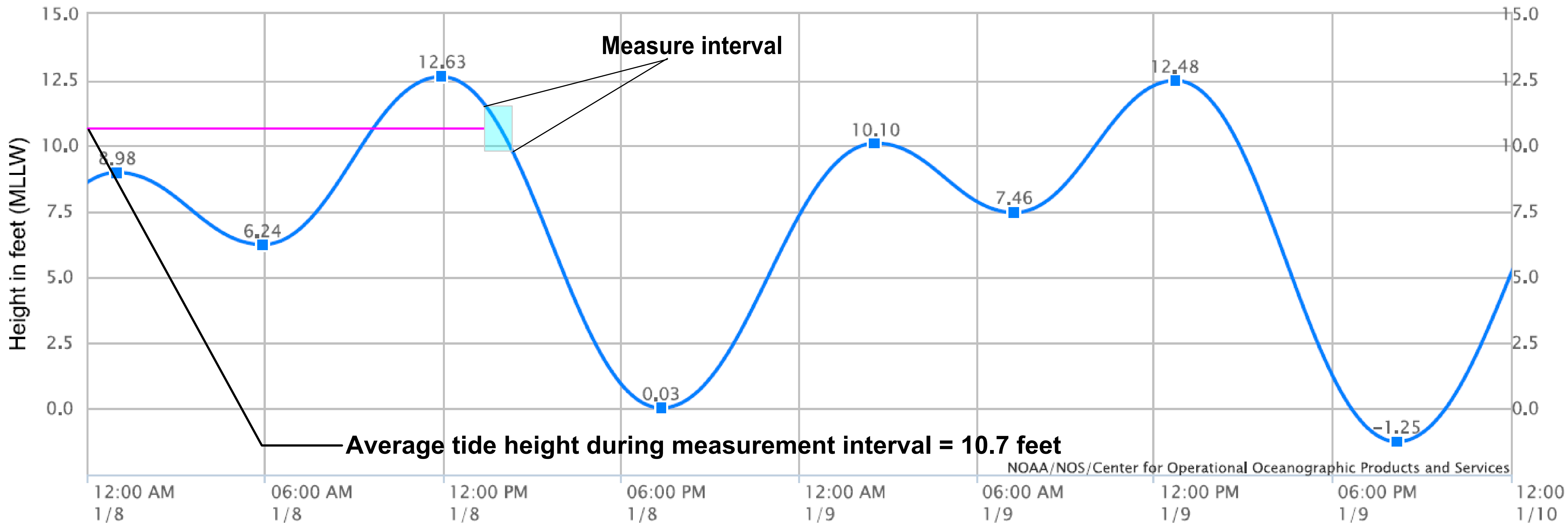

| Timelapse ERT Profile TRP 1X-22 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 5.23 |
|---|---|---|


| SITE MAP | N | Operable Unit 1<br>Keyport, Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 6.1 |
|---|---|---|---|

## ERT Profile TRP 2-1

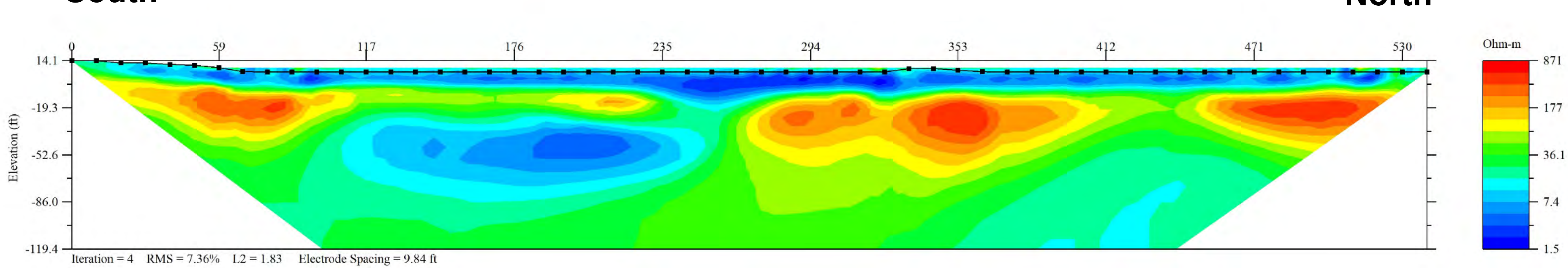



## NOAA Tidal Chart

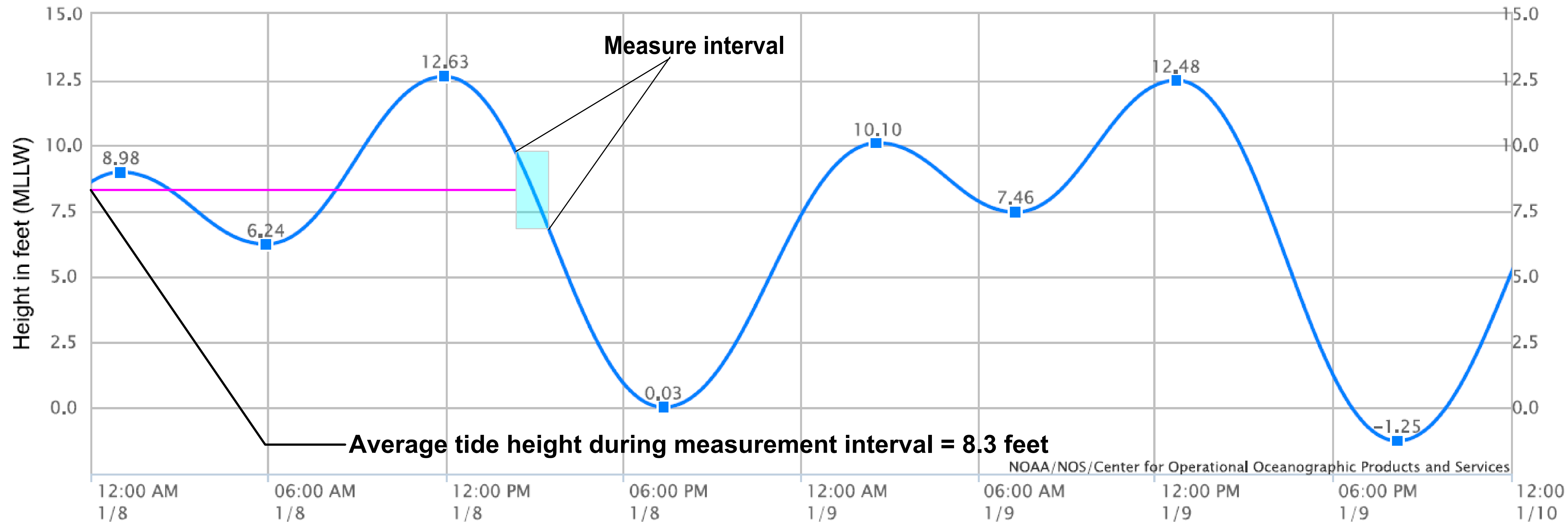



| | | |
|---|---|---|
| **Timelapse ERT Profile TRP 2-1** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 6.2 |

## ERT Profile TRP 2-2

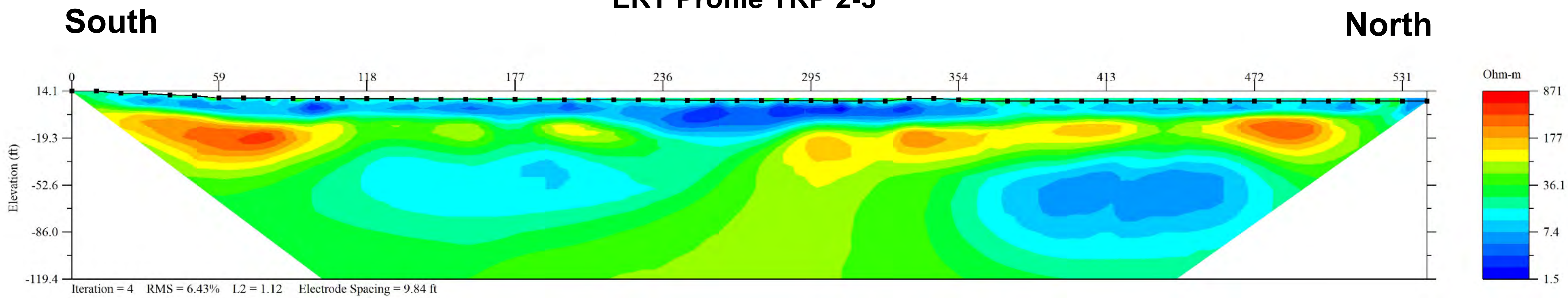



## NOAA Tidal Chart

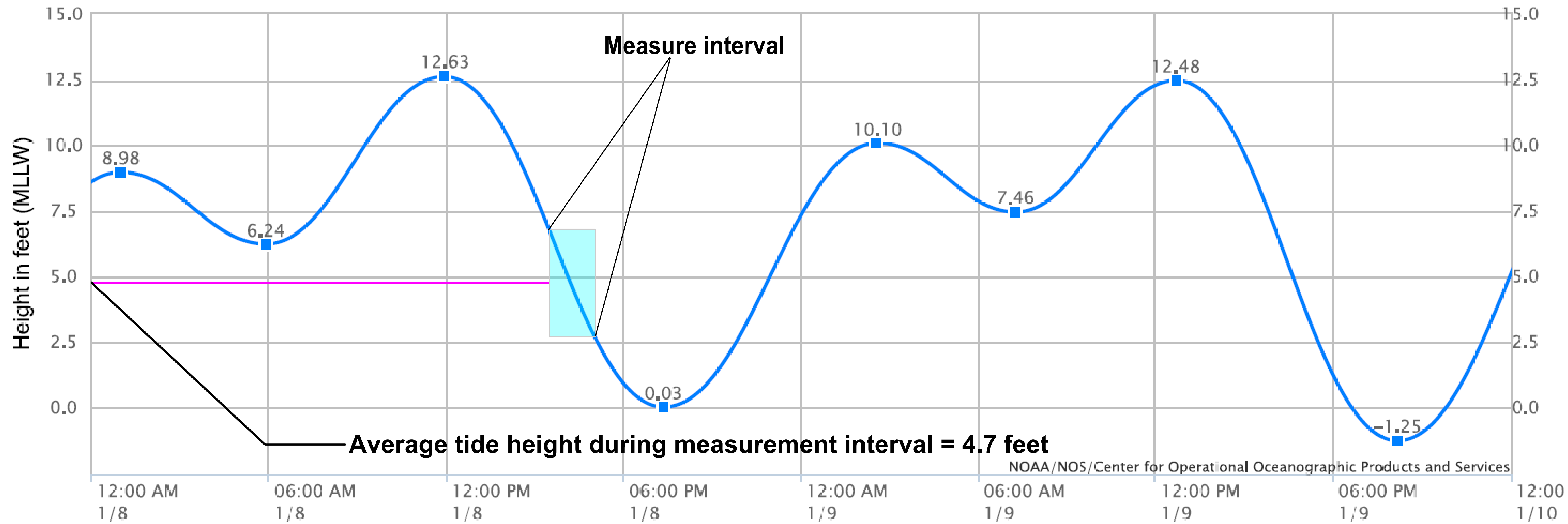



| Timelapse ERT Profile TRP 2-2 | Operable Unit 1<br>Keyport , Washington | ATLAS<br>Figure 6.3 |
|---|---|---|
| | Project No.: 420019SWG REV1   Date: 09/21 | |

## ERT Profile TRP 2-3

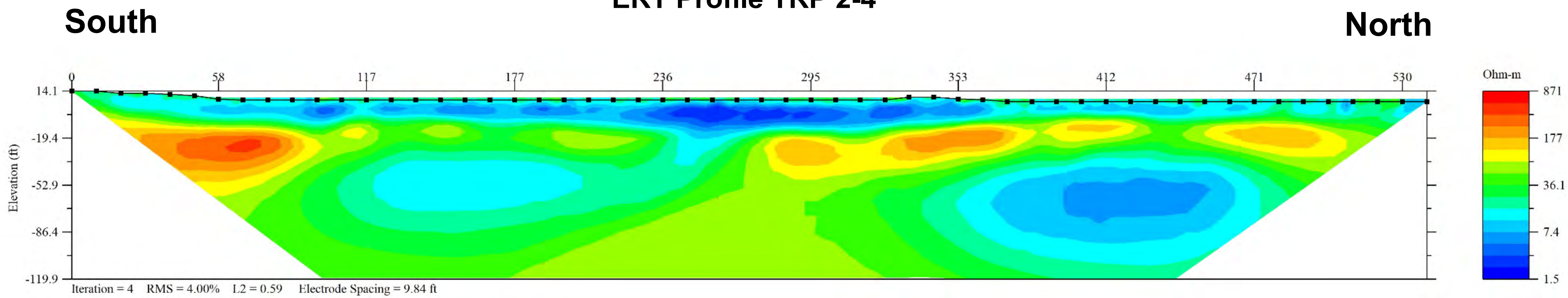



## NOAA Tidal Chart

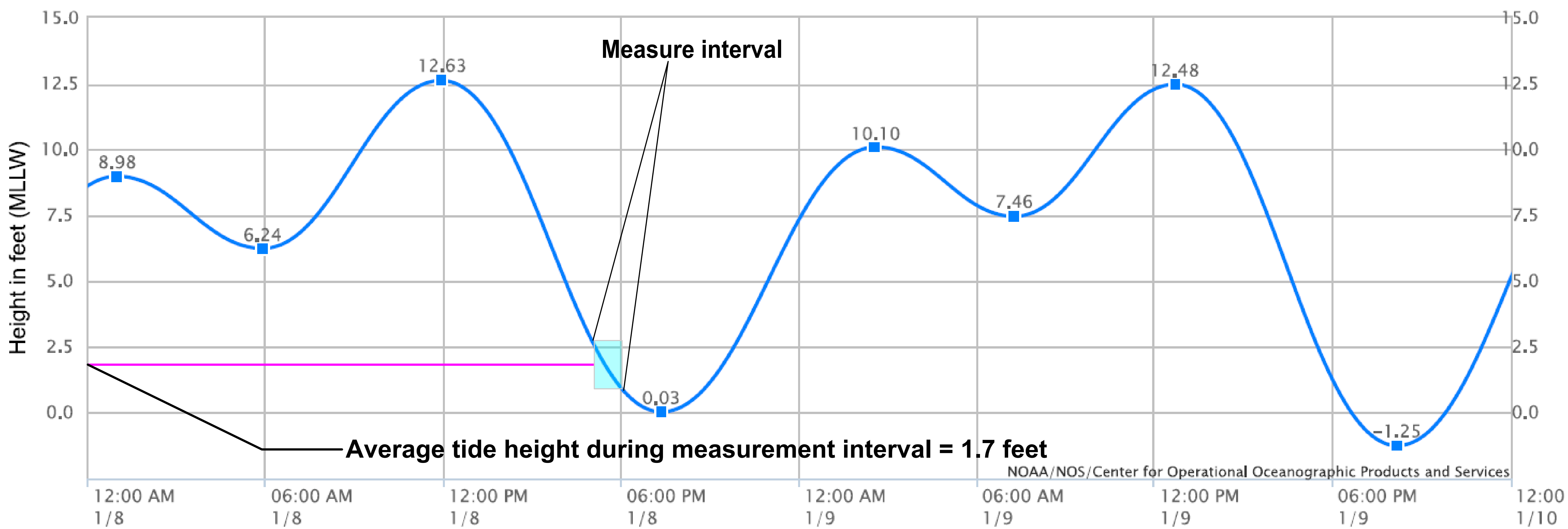



| Timelapse ERT Profile TRP 2-3 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 6.4 |
| --- | --- | --- |

## ERT Profile TRP 2-4




## NOAA Tidal Chart




| Timelapse ERT Profile TRP 2-4 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 6.5 |
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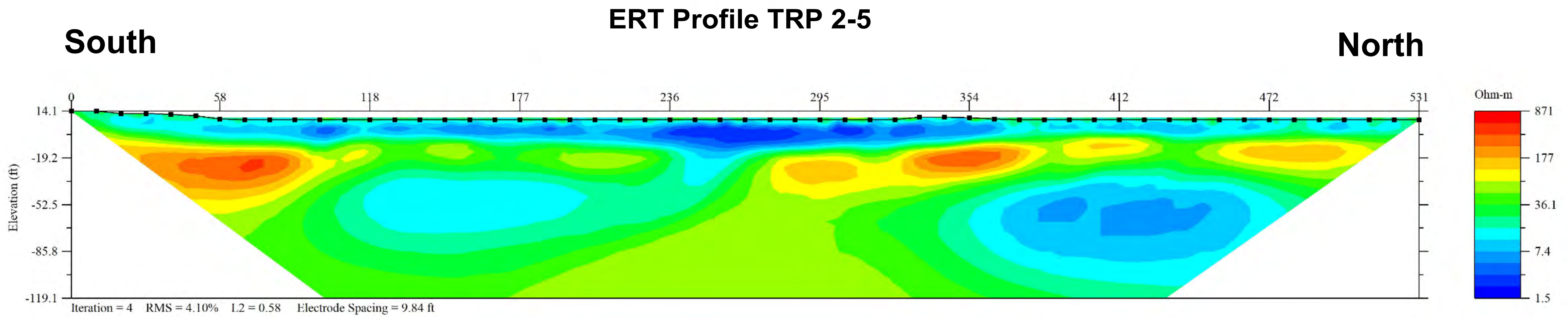
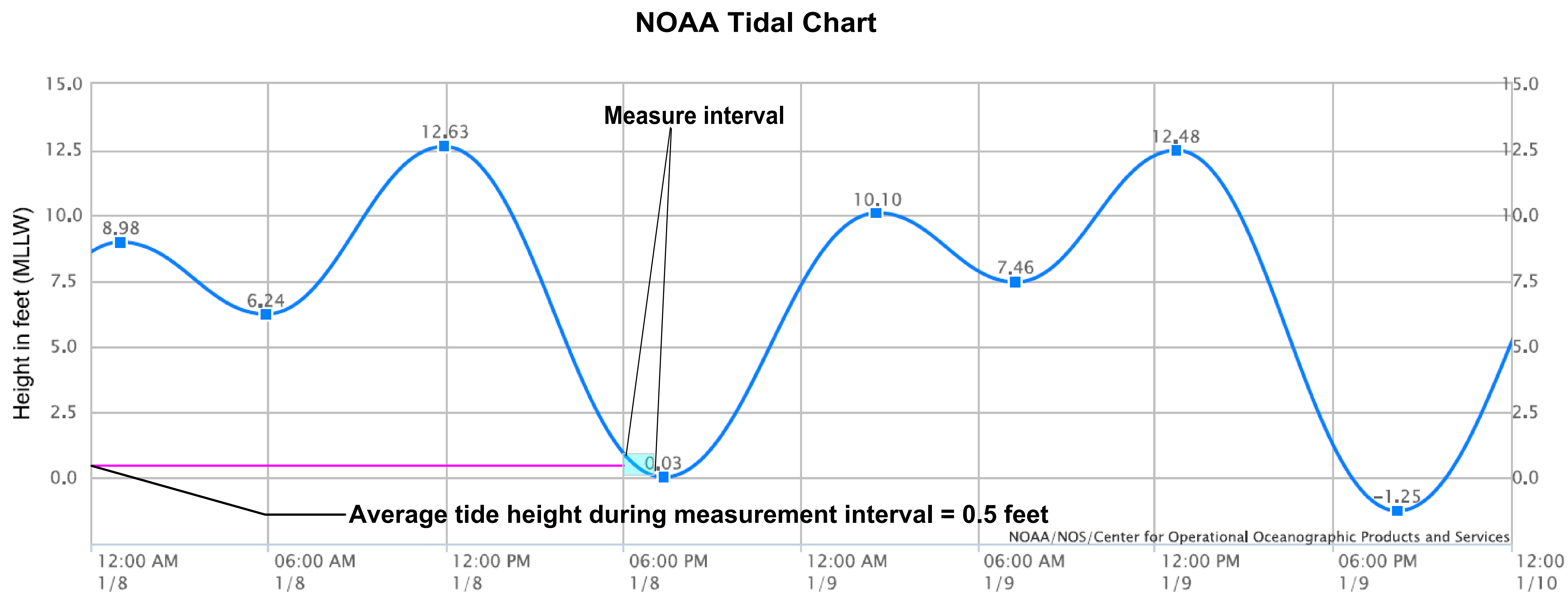
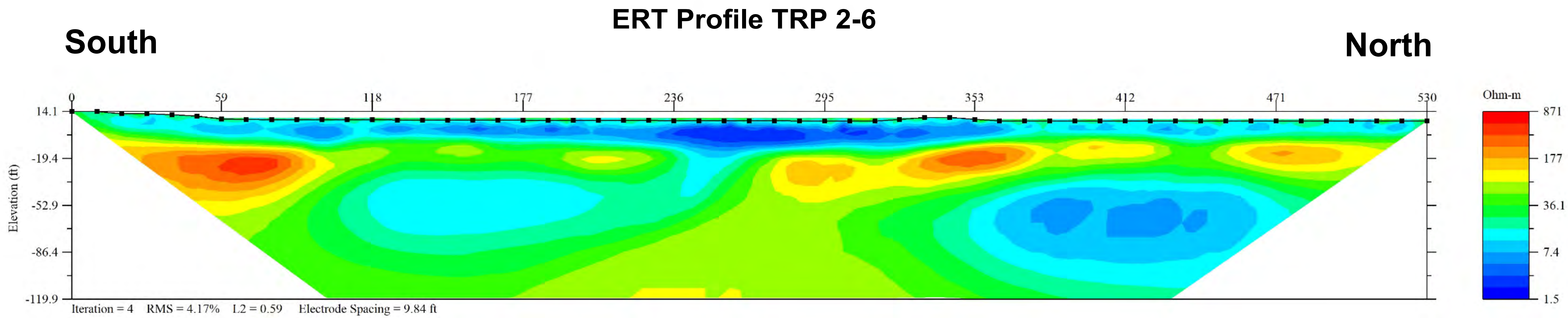
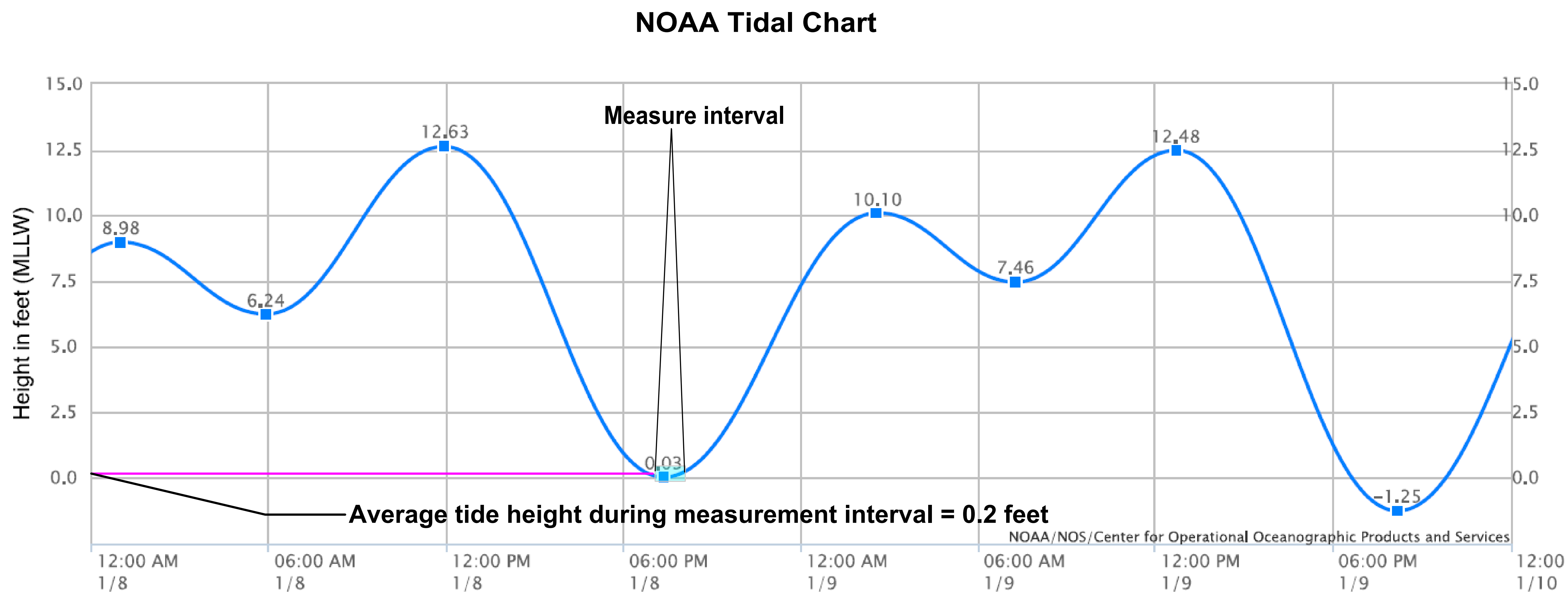


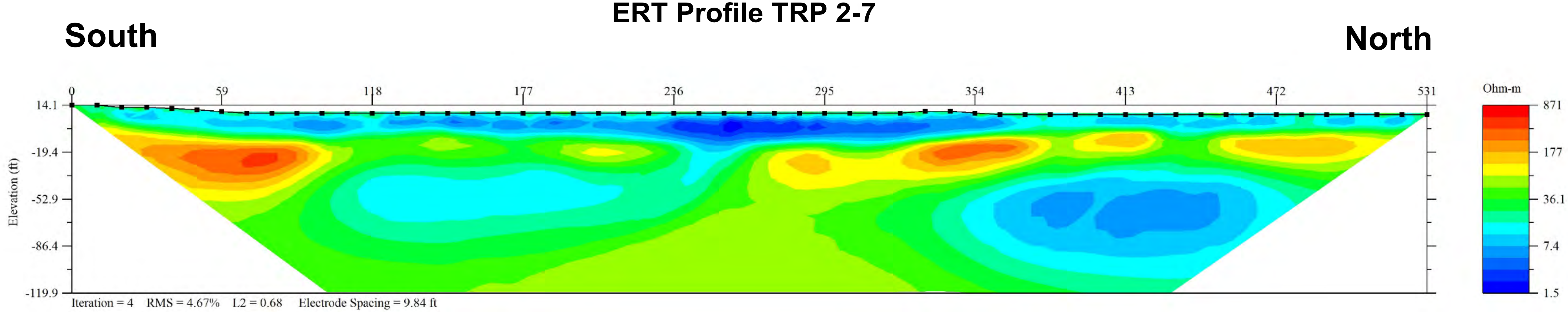

| Timelapse ERT Profile TRP 2-5 | Operable Unit 1 Keyport , Washington | | ATLAS Figure 6.6 |
|---|---|---|---|
| | Project No.: 420019SWG REV1 | Date: 09/21 | |



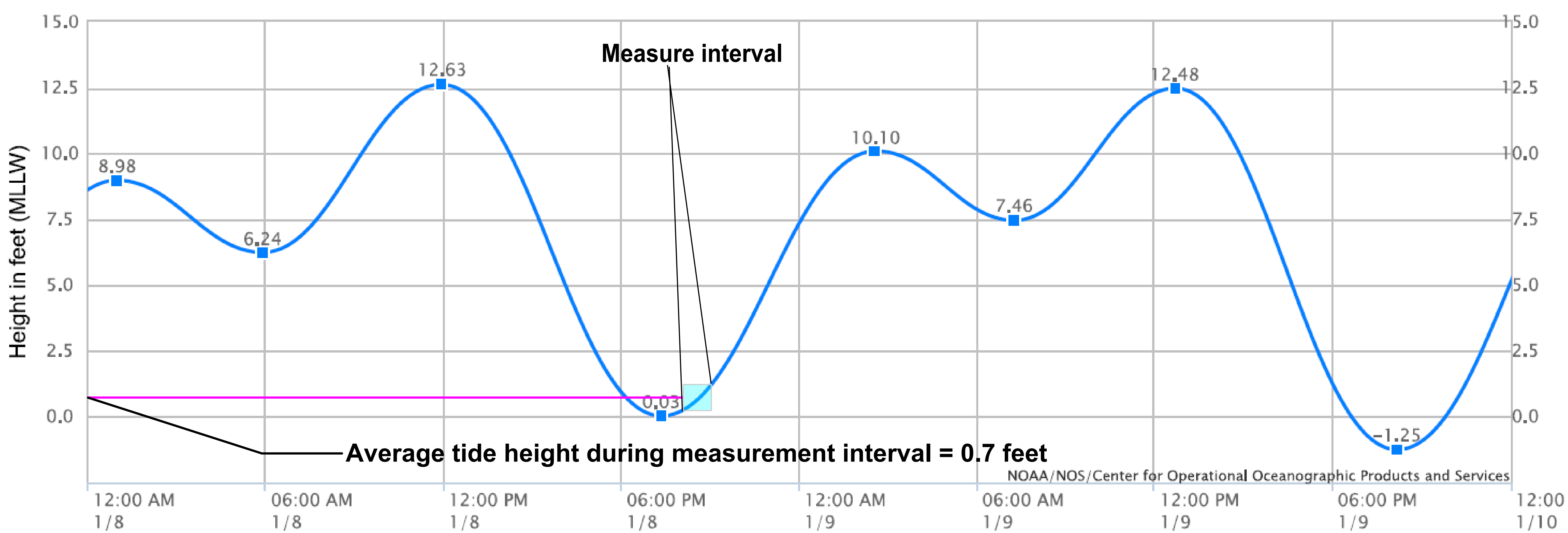




| | | |
|---|---|---|
| **Timelapse ERT Profile TRP 2-6** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 6.7 |

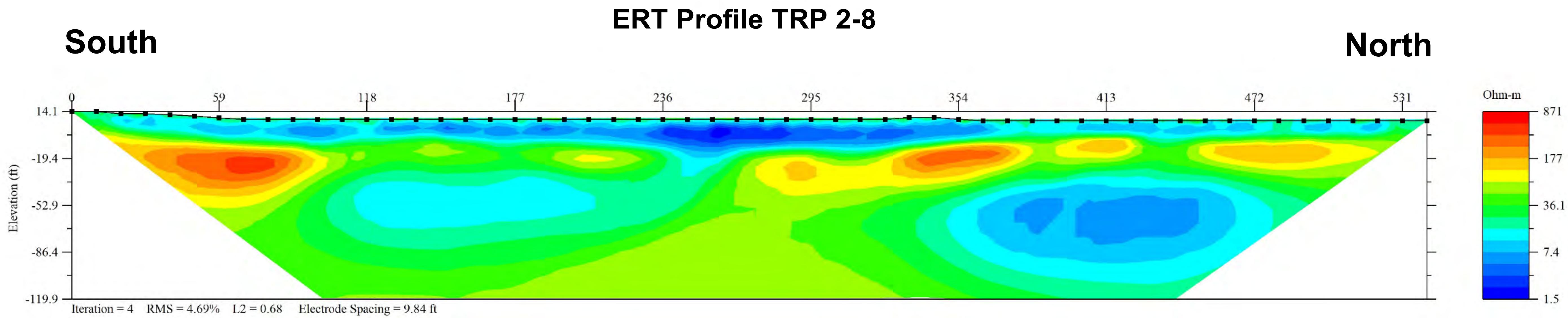
# ERT Profile TRP 2-7

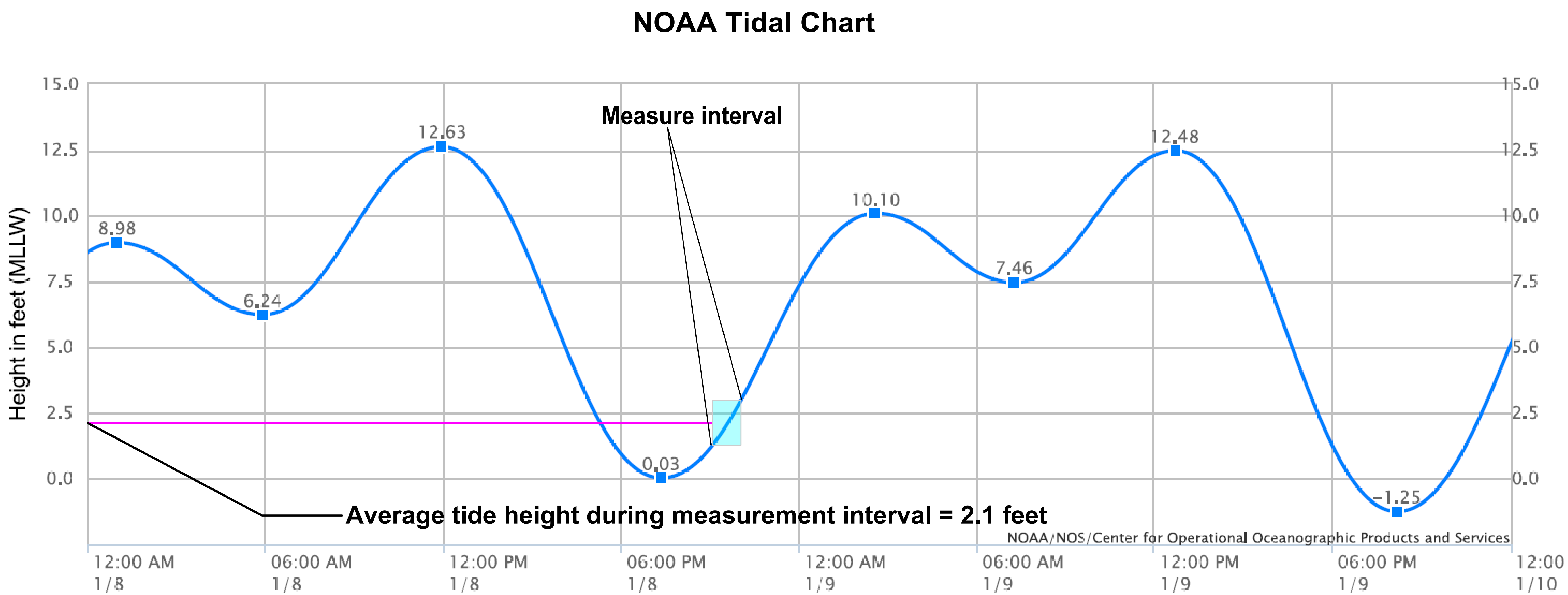



# NOAA Tidal Chart



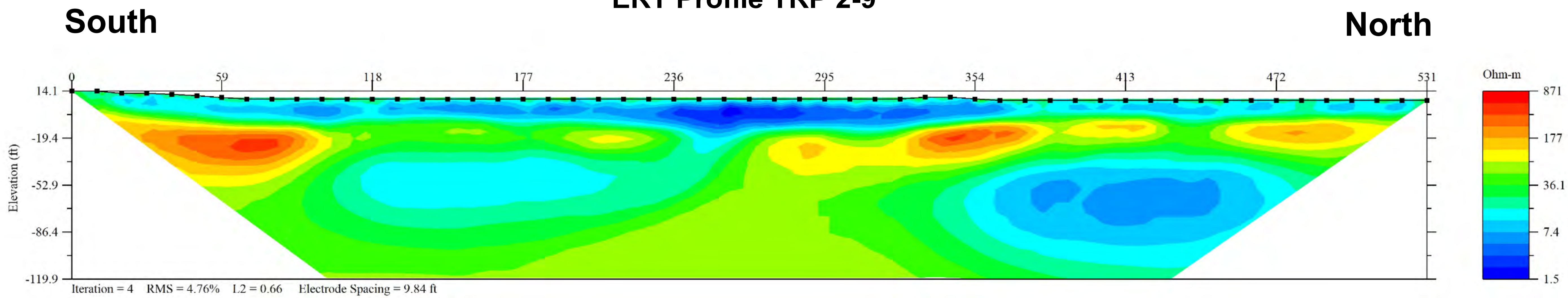

| | | |
|---|---|---|
| **Timelapse ERT Profile TRP 2-7** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 6.8 |



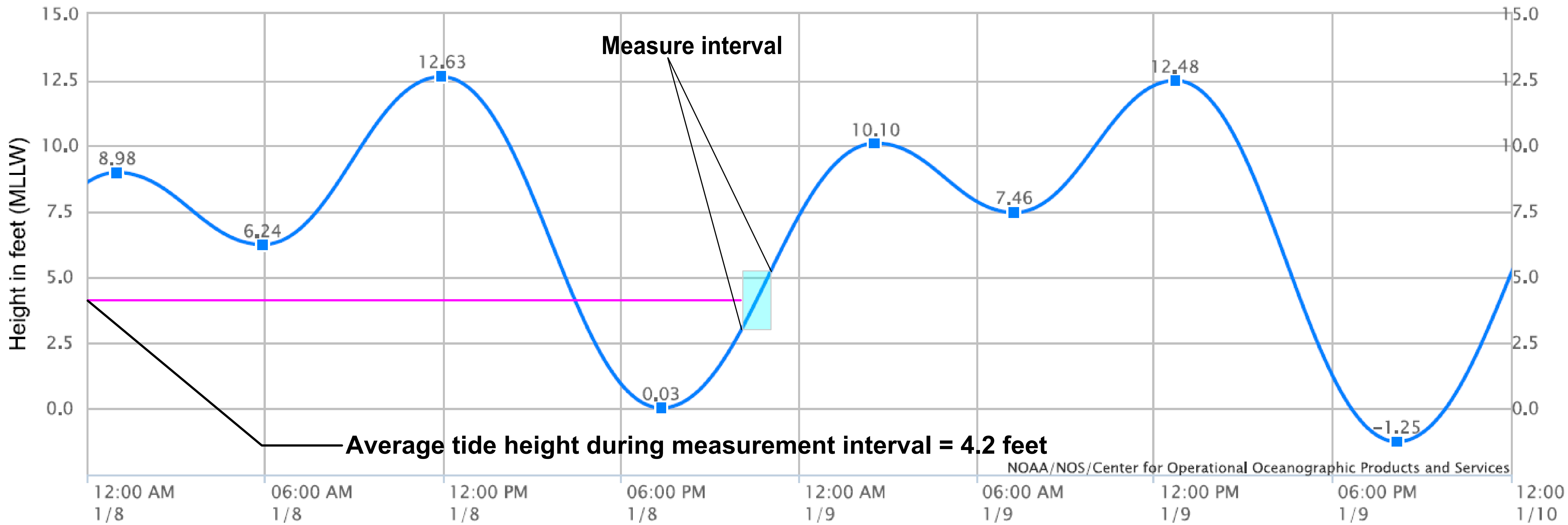




| Timelapse ERT Profile TRP 2-8 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 6.9 |
|---|---|---|

## ERT Profile TRP 2-9

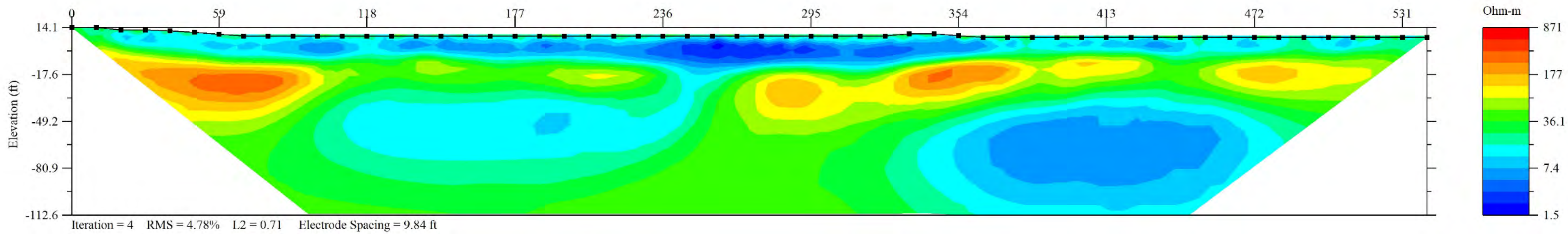



## NOAA Tidal Chart

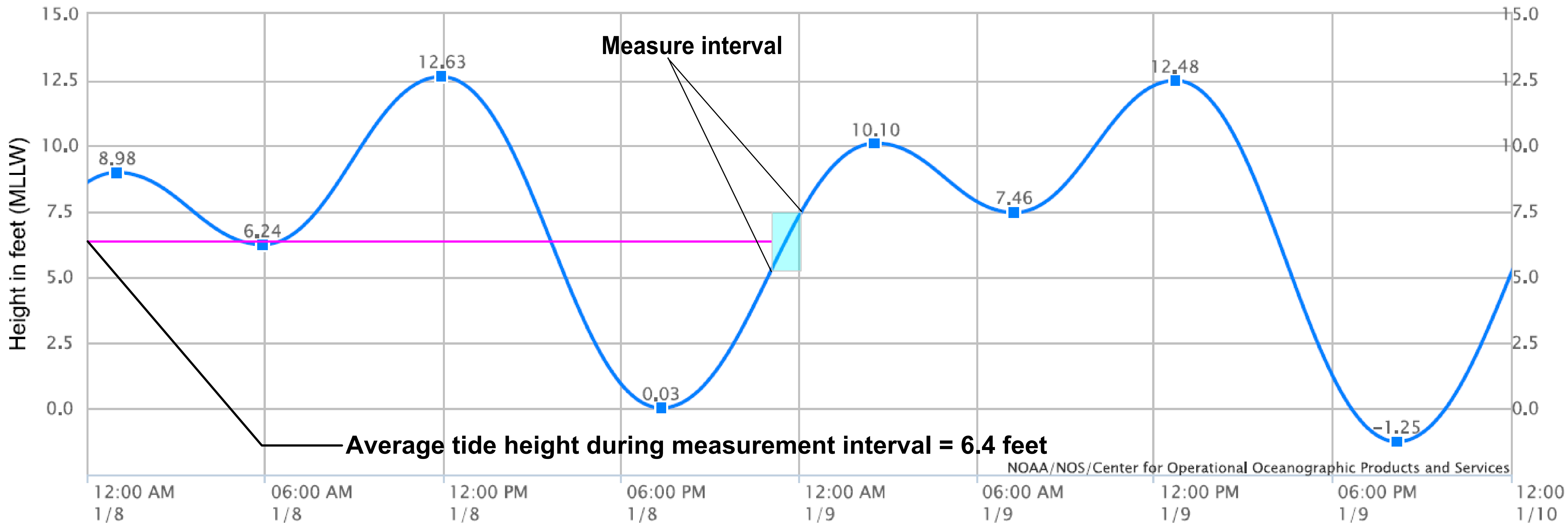



| Timelapse ERT Profile TRP 2-9 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 6.10 |
|---|---|---|

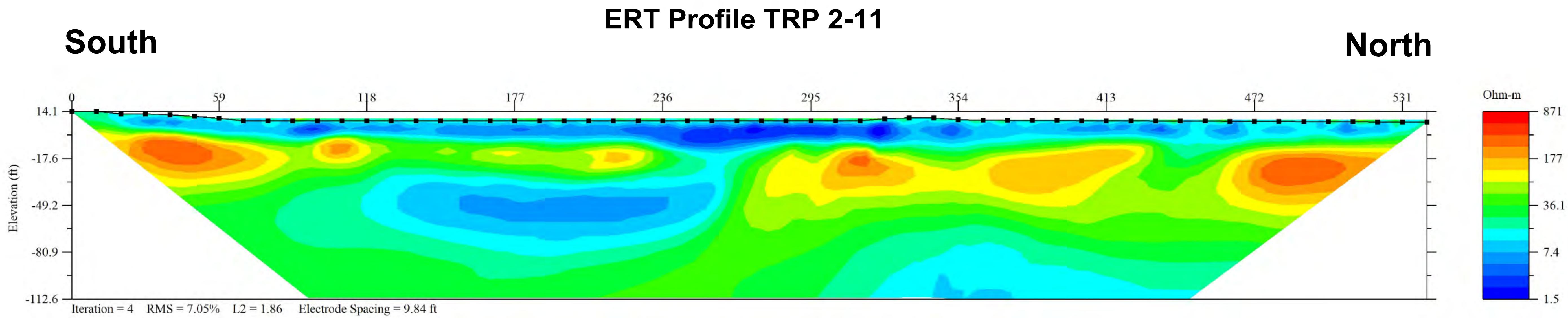
## ERT Profile TRP 2-10

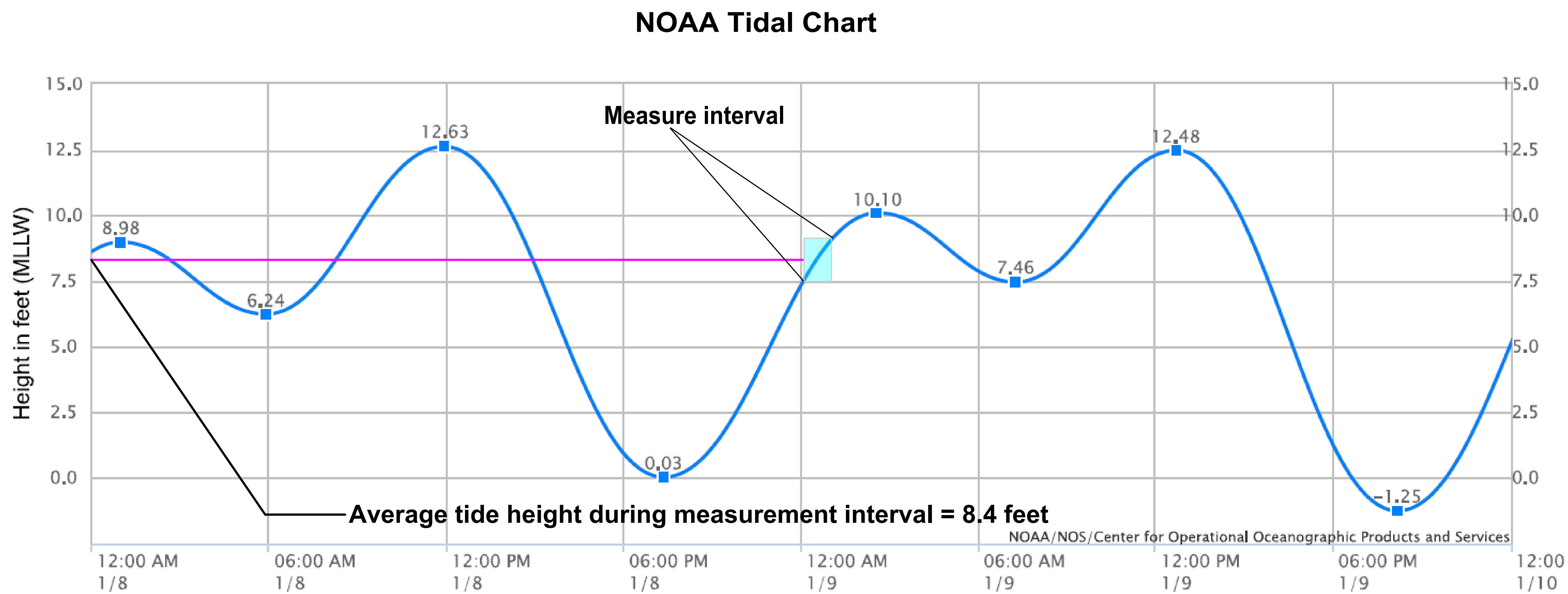



## NOAA Tidal Chart

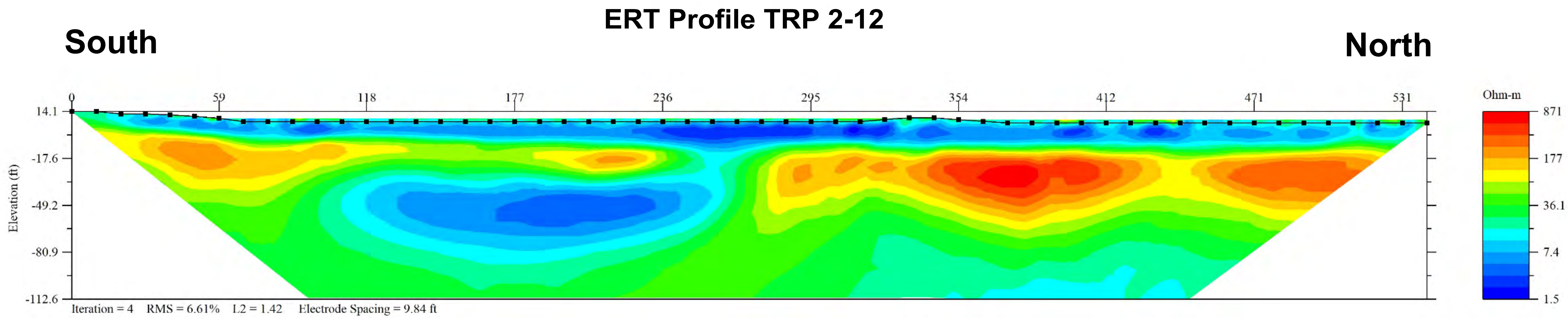


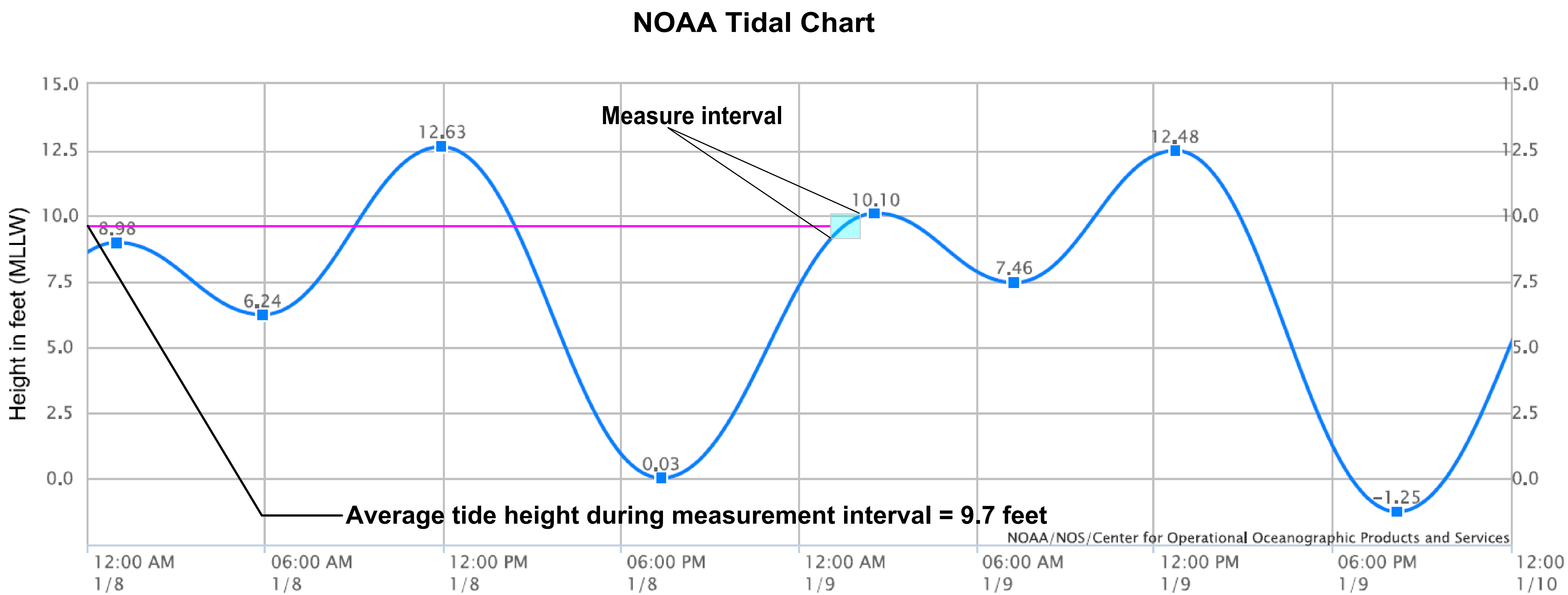

| Timelapse ERT Profile TRP 2-10 | Operable Unit 1<br>Keyport , Washington | ATLAS<br>Figure 6.11 |
|---|---|---|
| | Project No.: 420019SWG REV1 Date: 09/21 | |



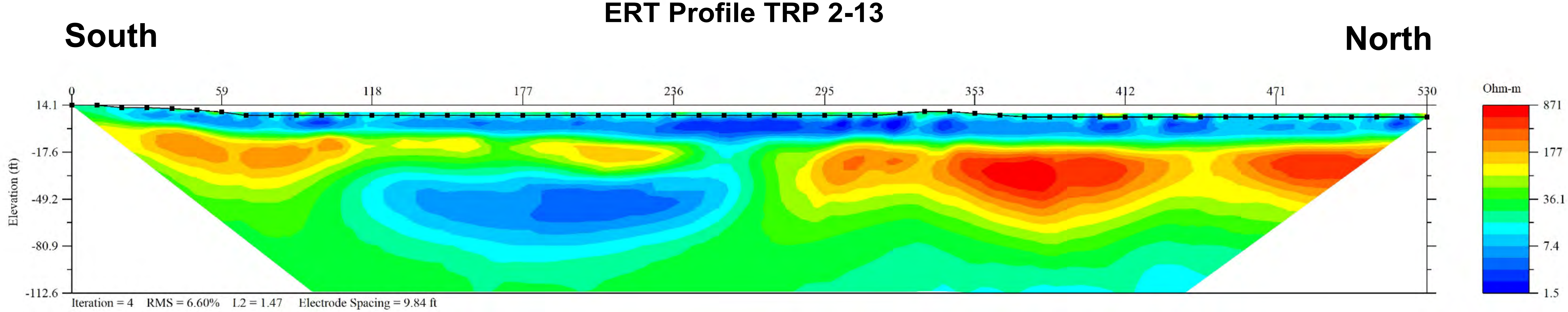

| Timelapse ERT Profile TRP 2-11 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 — Date: 09/21 | ATLAS<br>Figure 6.12 |
|---|---|---|



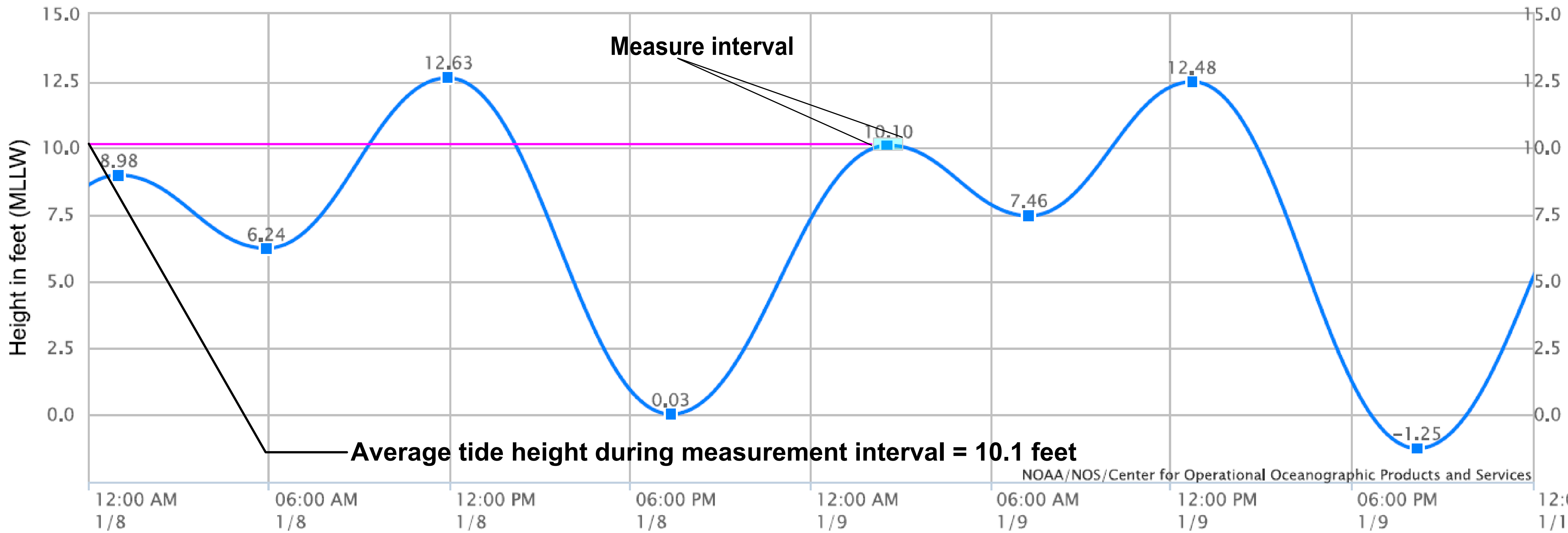




| Timelapse ERT Profile TRP 2-12 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 6.13 |
|---|---|---|

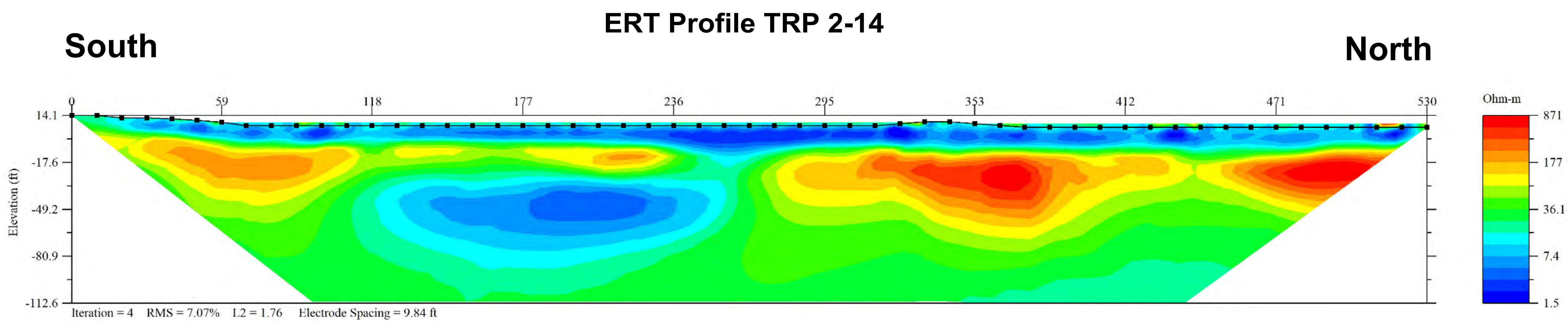
## ERT Profile TRP 2-13

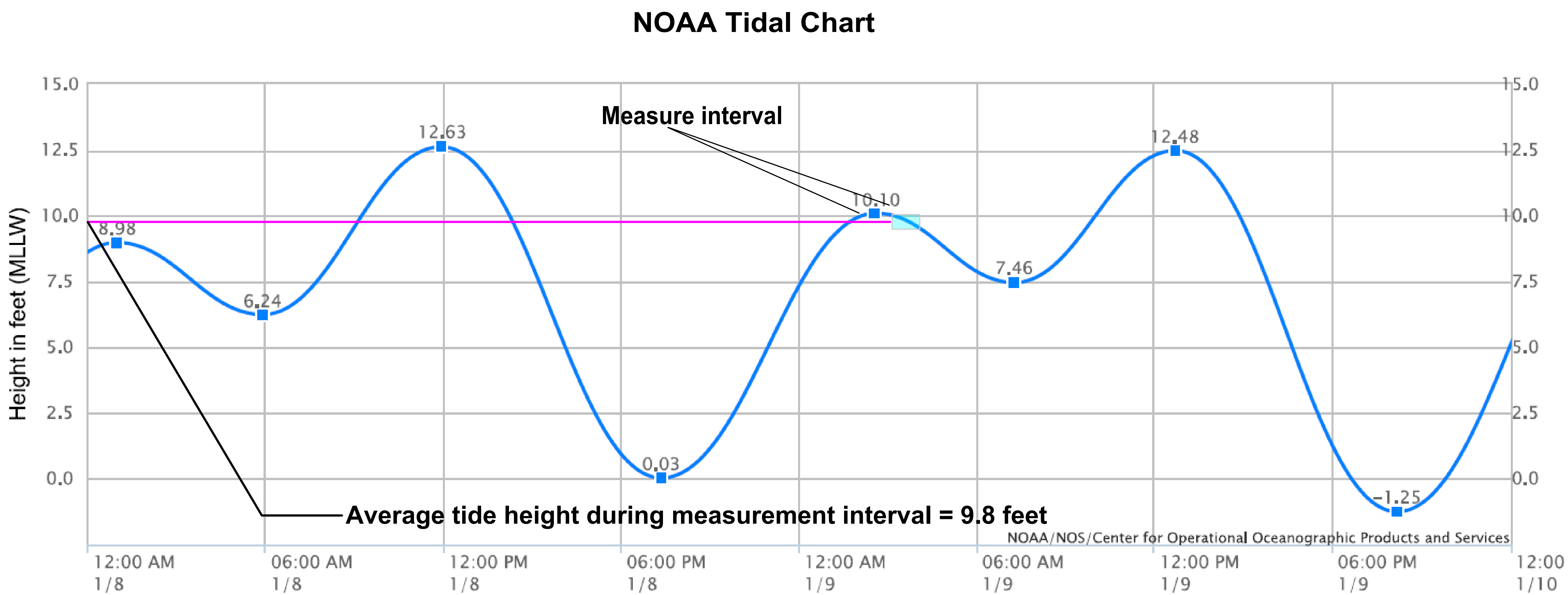



## NOAA Tidal Chart




| Timelapse ERT Profile TRP 2-13 | Operable Unit 1 Keyport , Washington | ATLAS Figure 6.14 |
|---|---|---|
| | Project No.: 420019SWG REV1 / Date: 09/21 | |




| Timelapse ERT Profile TRP 2-14 | Operable Unit 1 Keyport , Washington | ATLAS Figure 6.15 |
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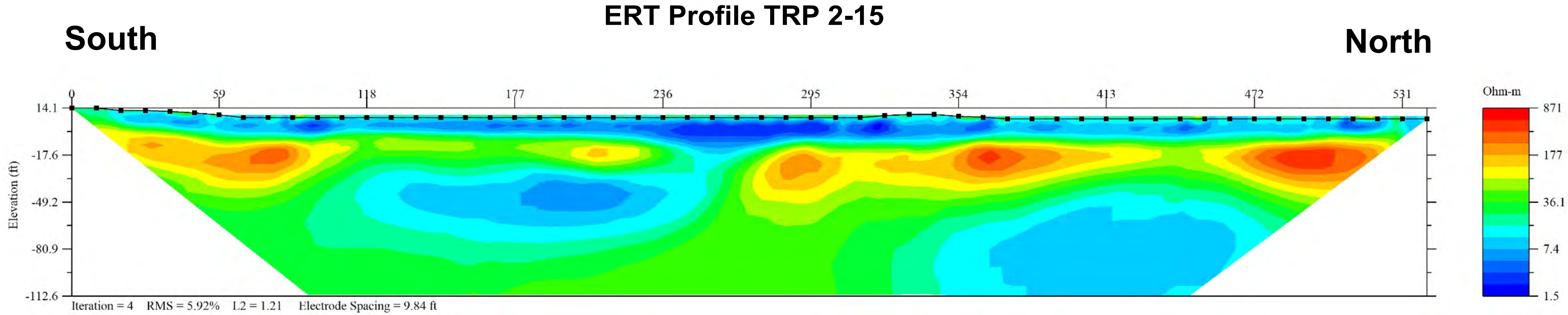
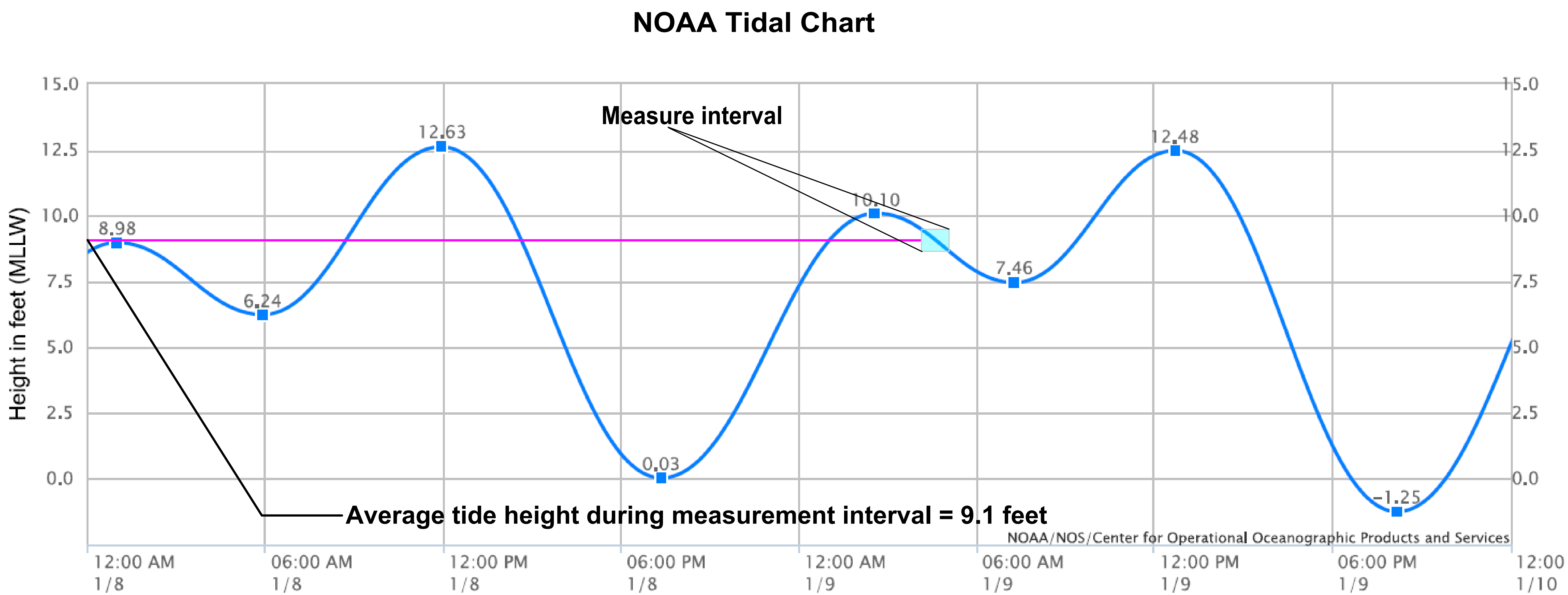
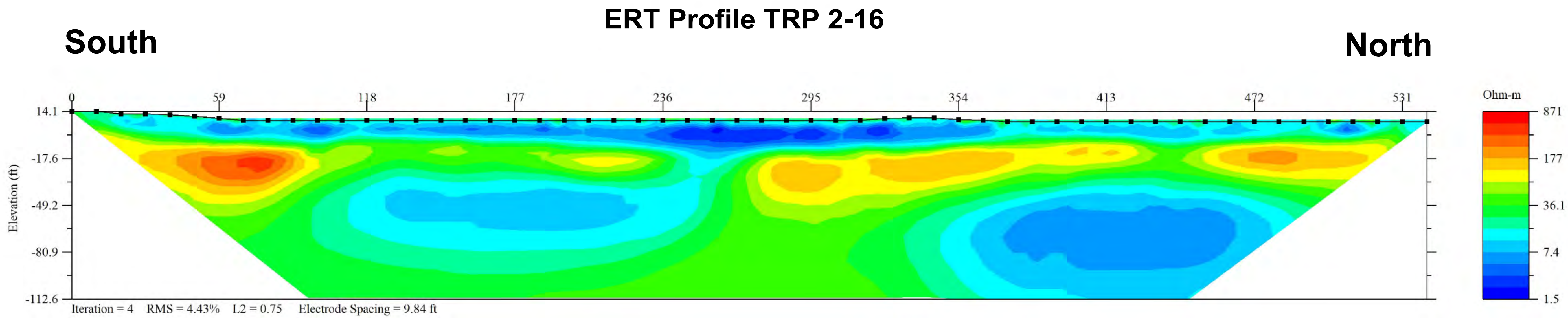
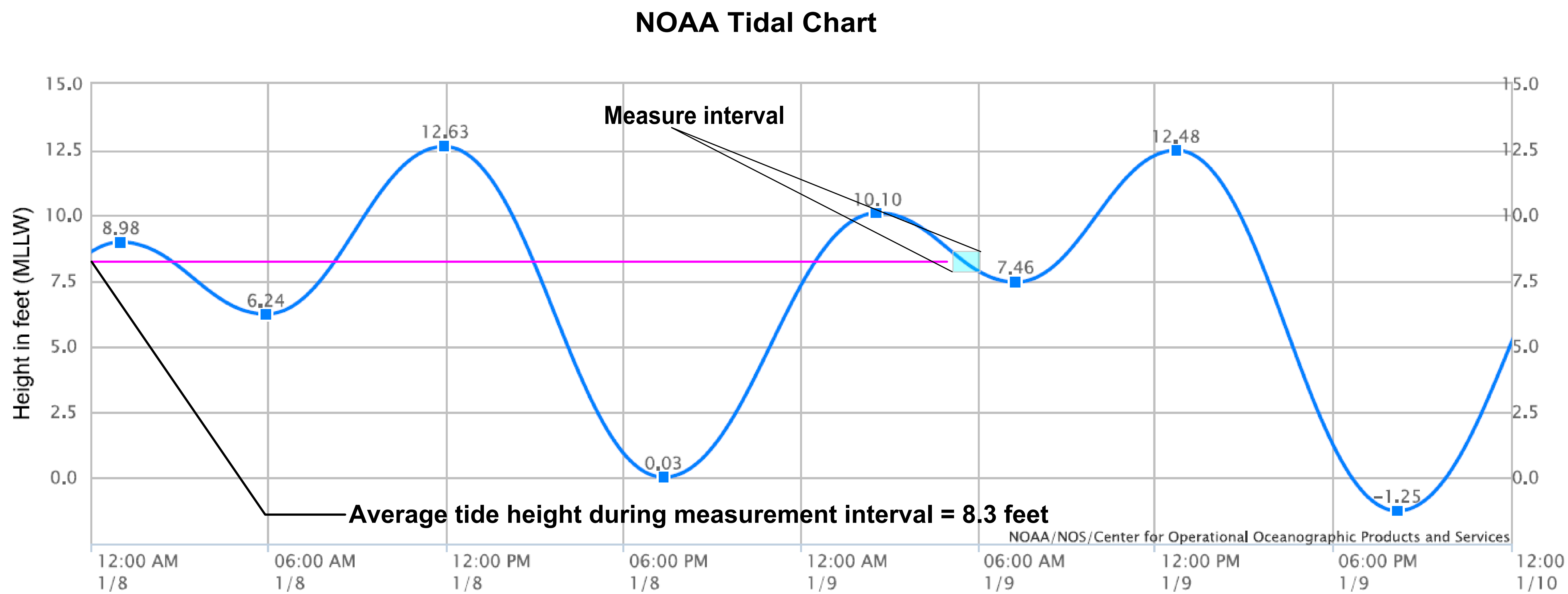
| | Project No.: 420019SWG REV1 Date: 09/21 | |




| | | |
|---|---|---|
| **Timelapse ERT Profile TRP 2-15** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 6.16 |




| Timelapse ERT Profile TRP 2-16 | Operable Unit 1<br>Keyport , Washington | ATLAS<br>Figure 6.17 |
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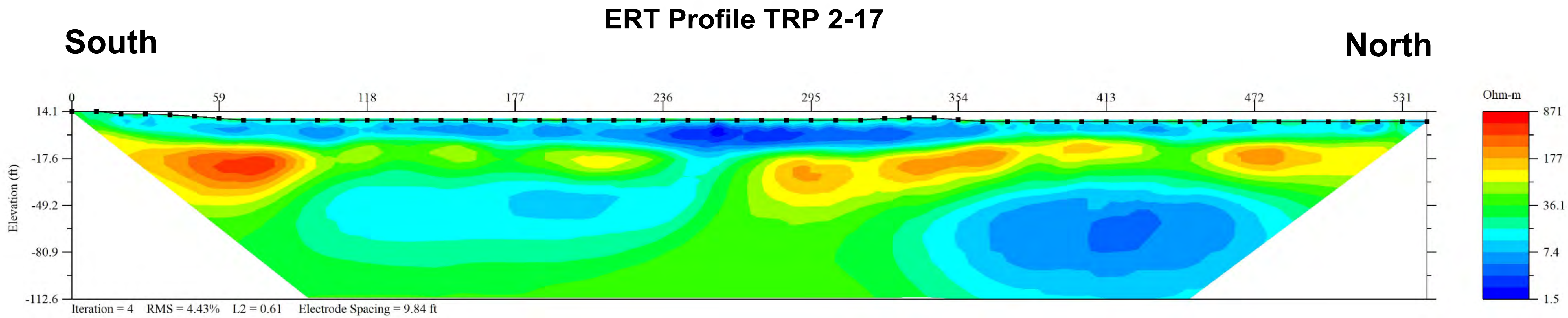
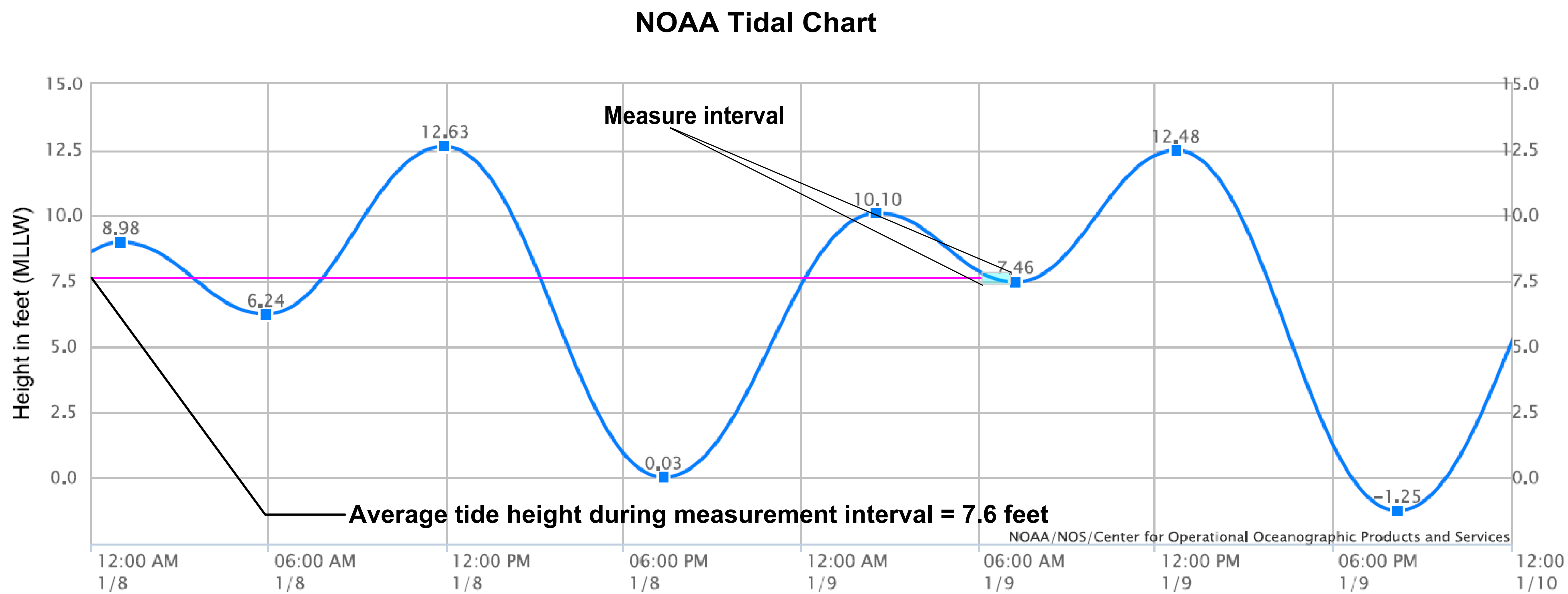
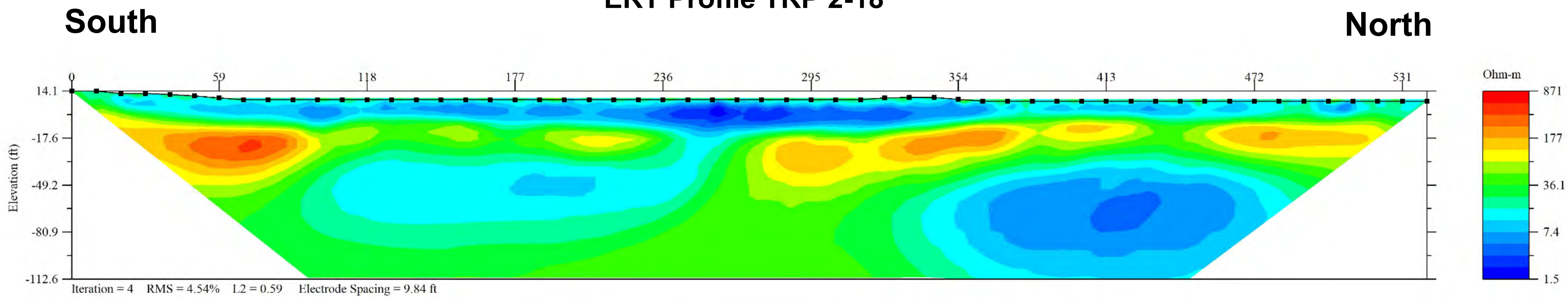
| | Project No.: 420019SWG REV1 Date: 09/21 | |



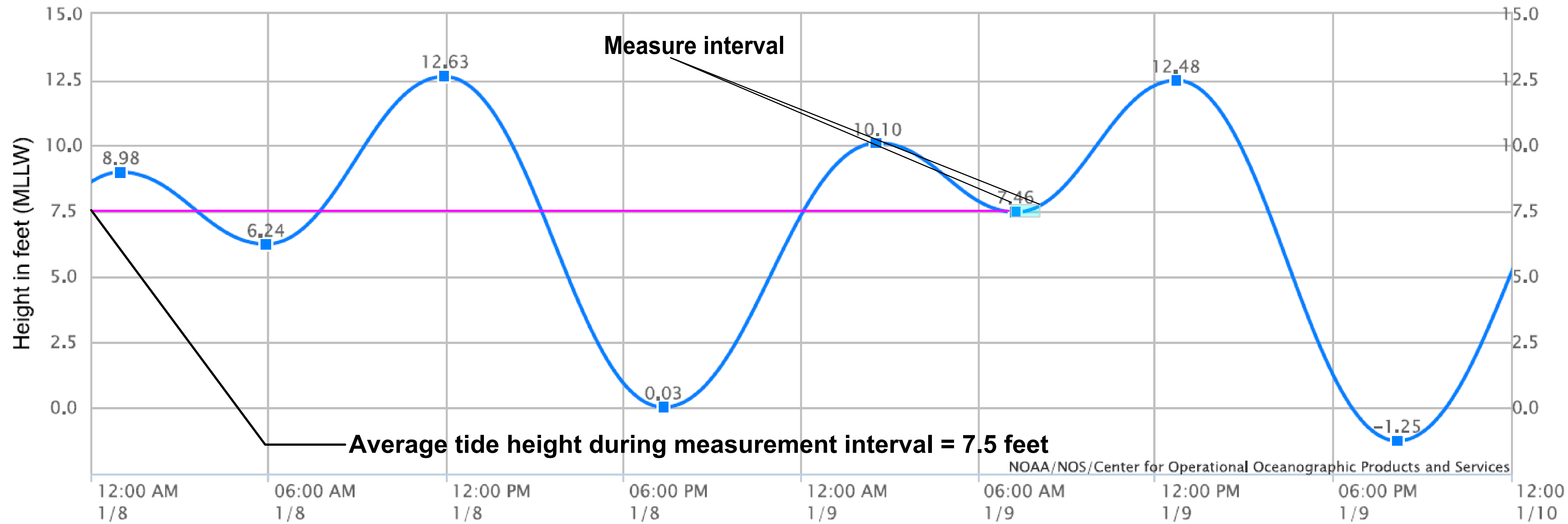




| | | |
|---|---|---|
| **Timelapse ERT Profile TRP 2-17** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 — Date: 09/21 | ATLAS<br>Figure 6.18 |

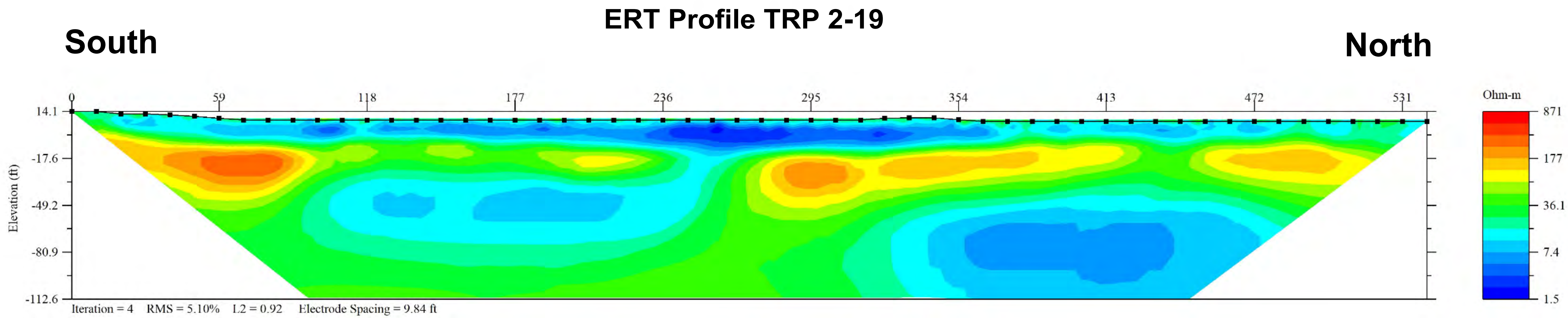
## ERT Profile TRP 2-18

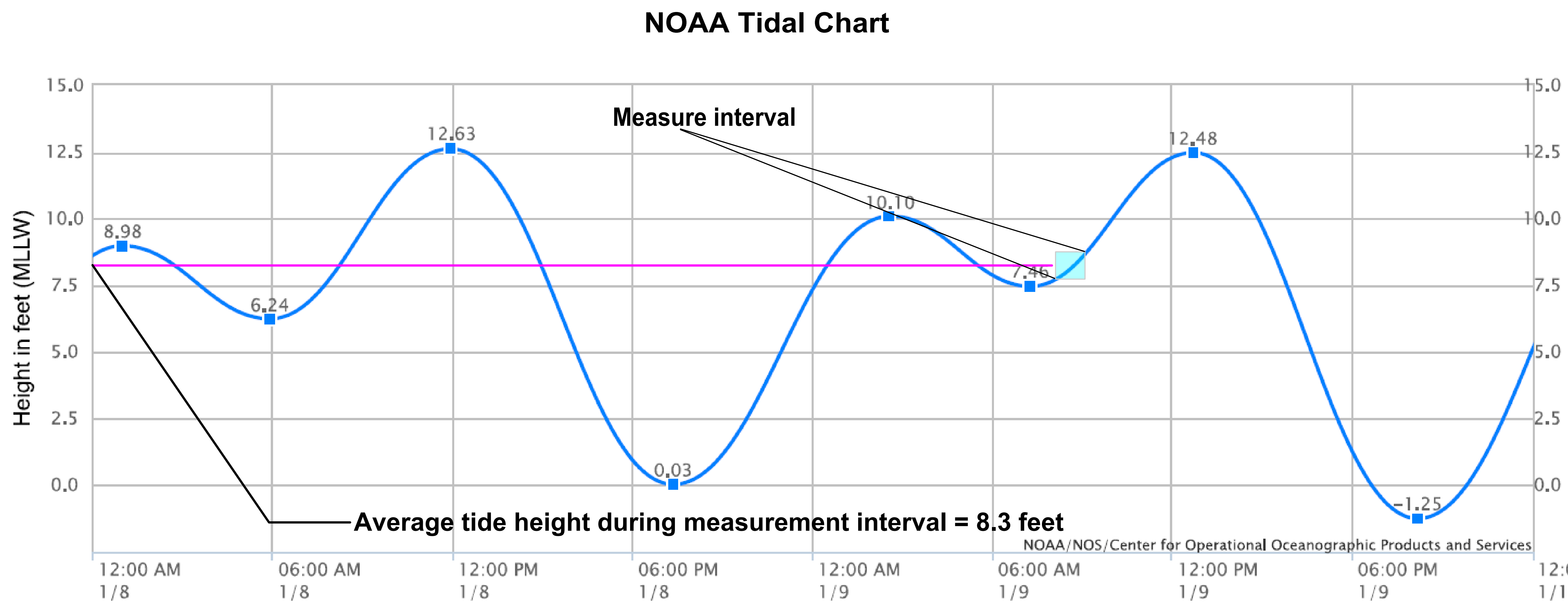



## NOAA Tidal Chart

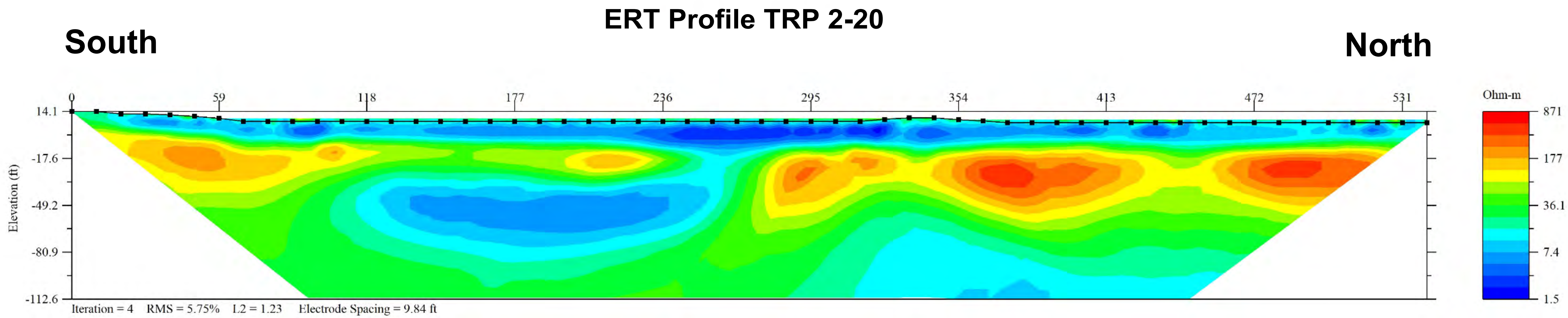


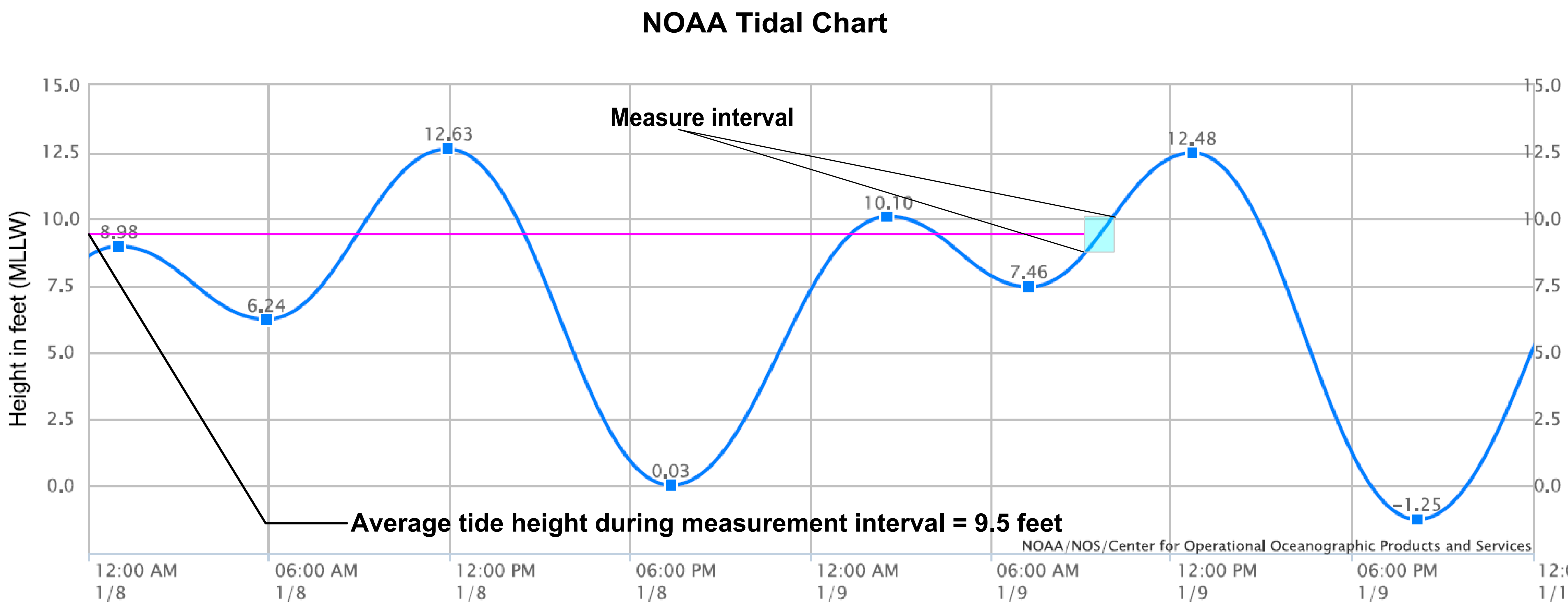

| Timelapse ERT Profile TRP 2-18 | Operable Unit 1 Keyport , Washington | | ATLAS Figure 6.19 |
|---|---|---|---|
| | Project No.: 420019SWG REV1 | Date: 09/21 | |



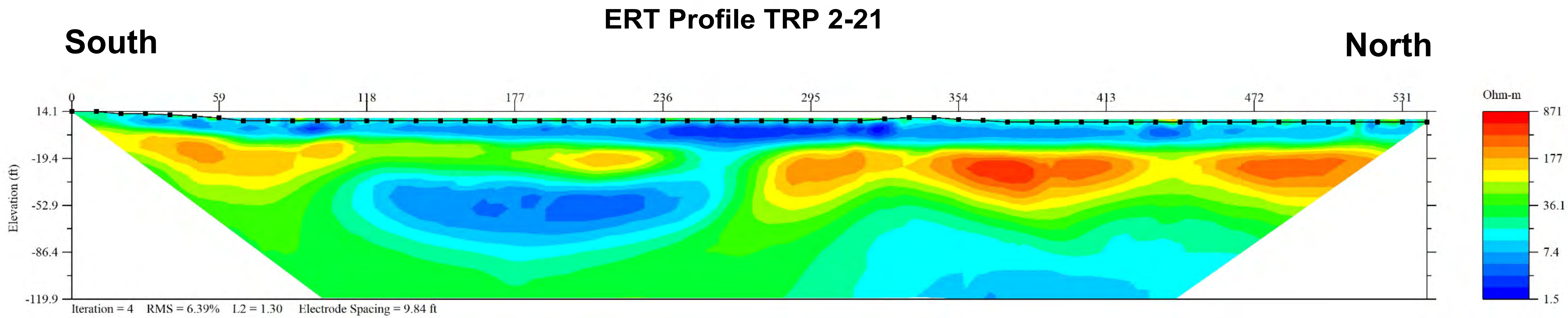



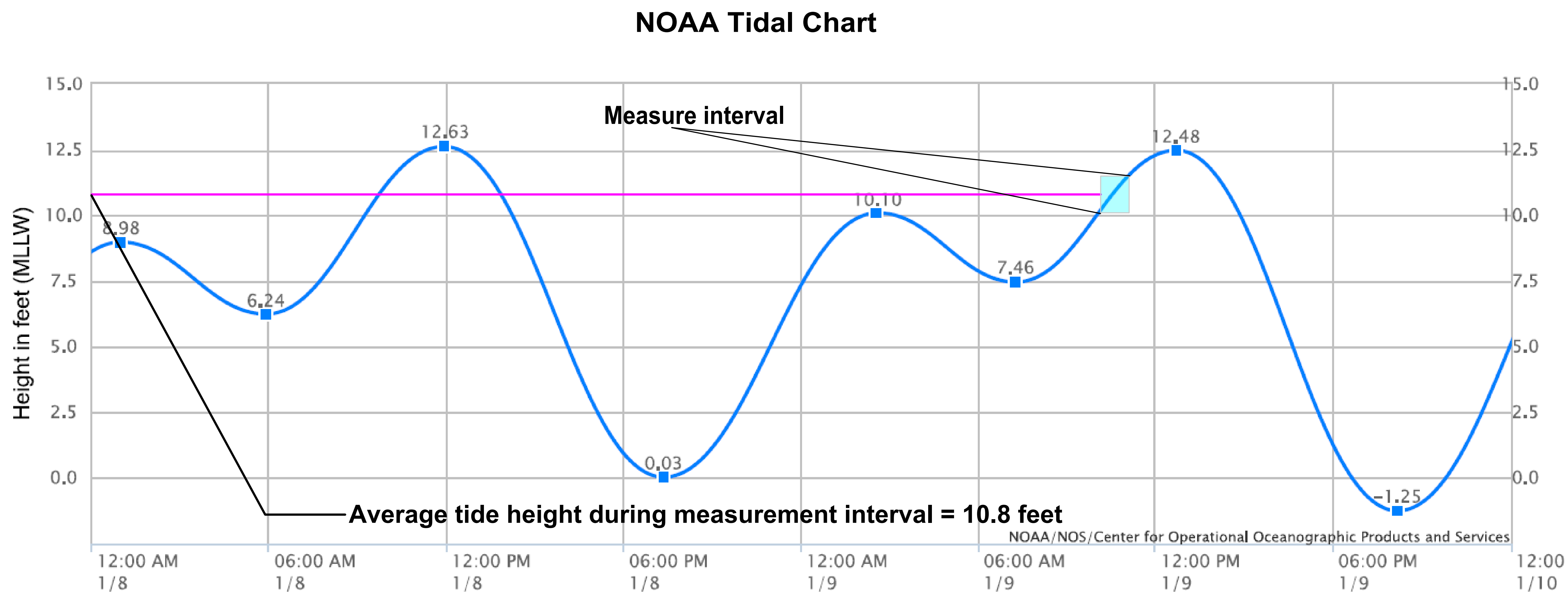

| Timelapse ERT Profile TRP 2-19 | Operable Unit 1<br>Keyport , Washington | | ATLAS<br>Figure 6.20 |
|---|---|---|---|
| | Project No.: 420019SWG REV1 | Date: 09/21 | |




| | | |
|---|---|---|
| **Timelapse ERT Profile TRP 2-20** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 6.21 |

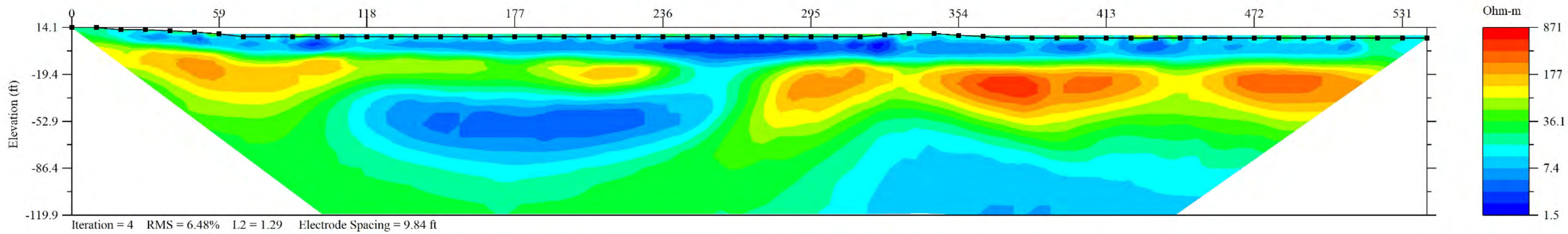


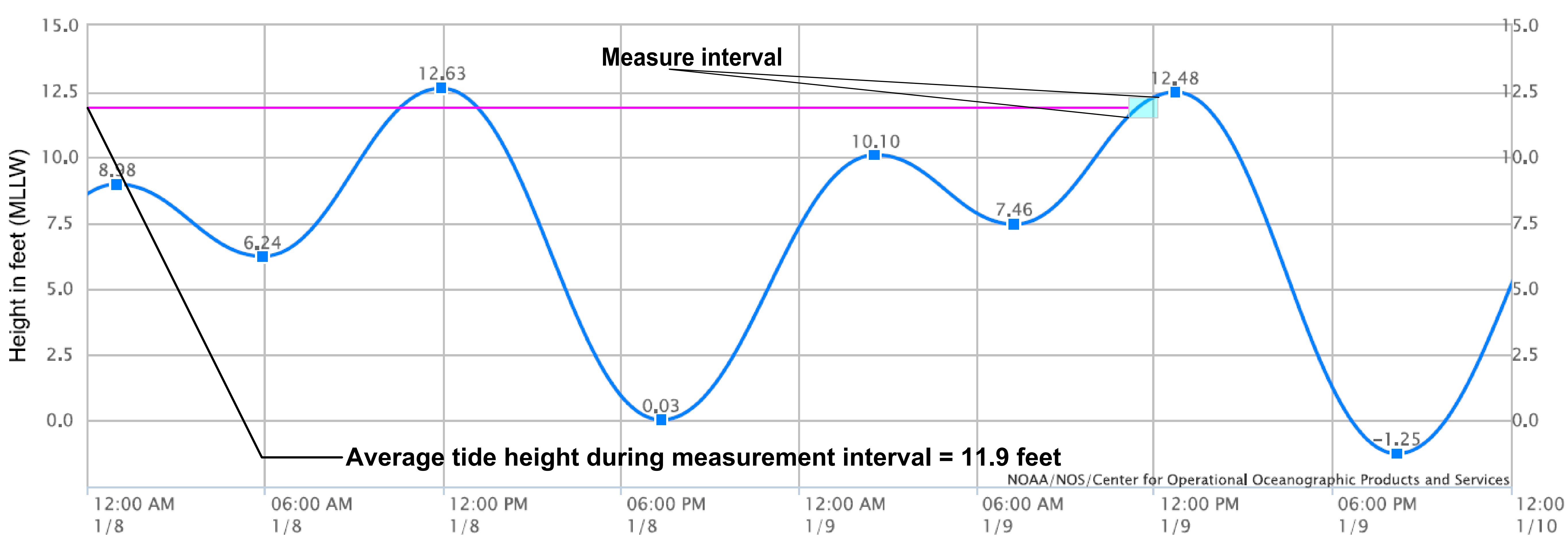

| | | |
|---|---|---|
| **Timelapse ERT Profile TRP 2-21** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 / Date: 09/21 | ATLAS<br>Figure 6.22 |

## ERT Profile TRP 2-22

South North




## NOAA Tidal Chart

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| **Timelapse ERT Profile TRP 2-22** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 6.23 |


**SITE MAP**

N

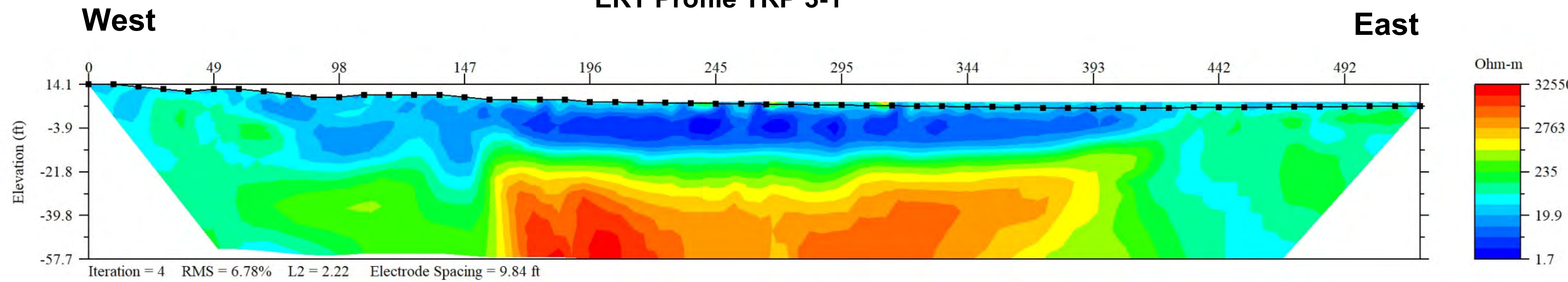
Operable Unit 1
Keyport, Washington

Project No.: 420019SWG REV1 | Date: 09/21

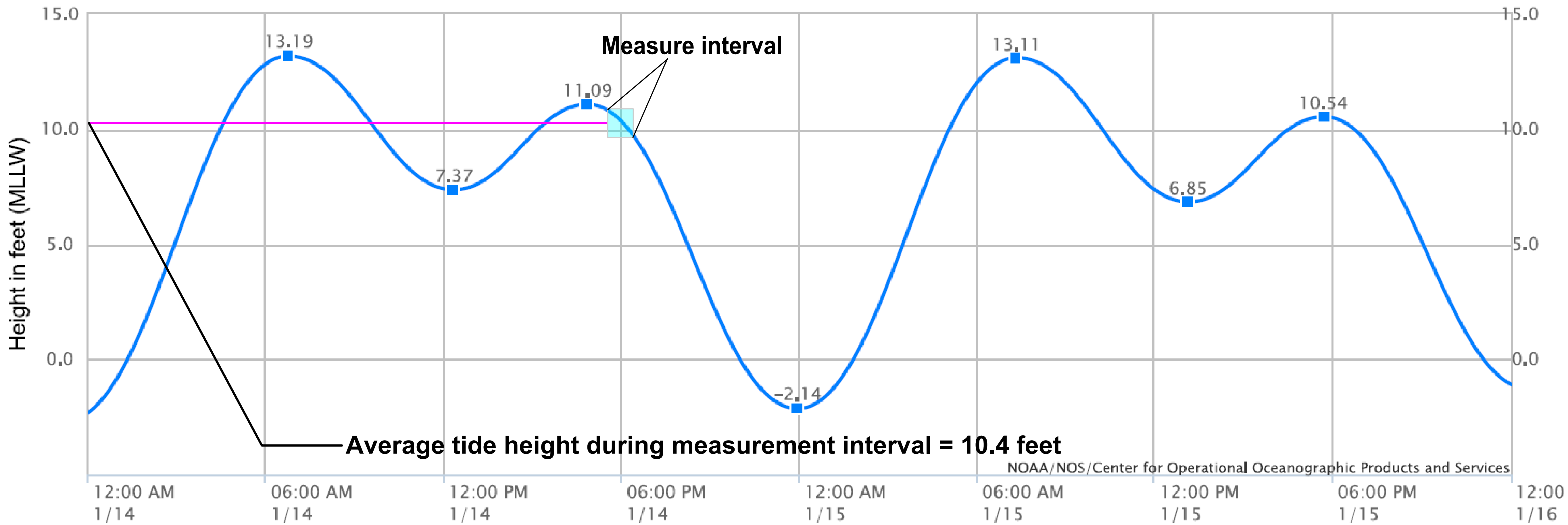
ATLAS

Figure 7.1

## ERT Profile TRP 3-1




## NOAA Tidal Chart

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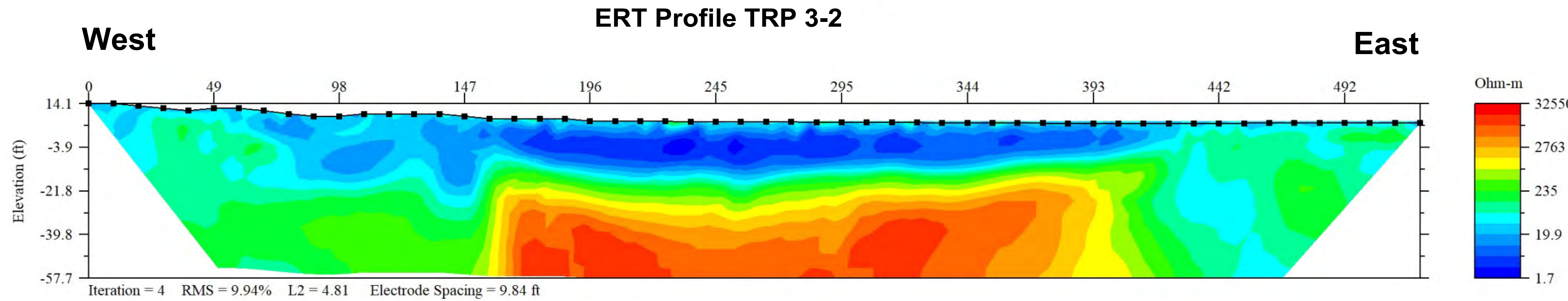
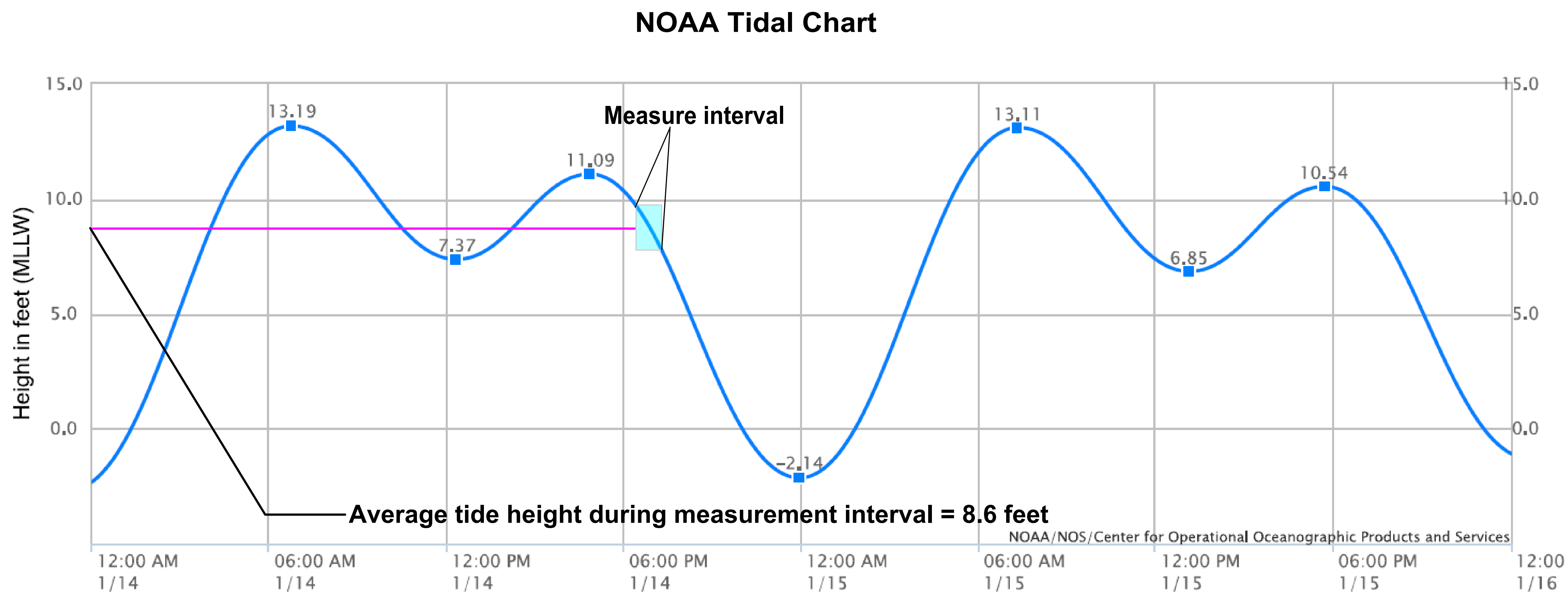
| **Timelapse ERT Profile TRP 3-1** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.2 |

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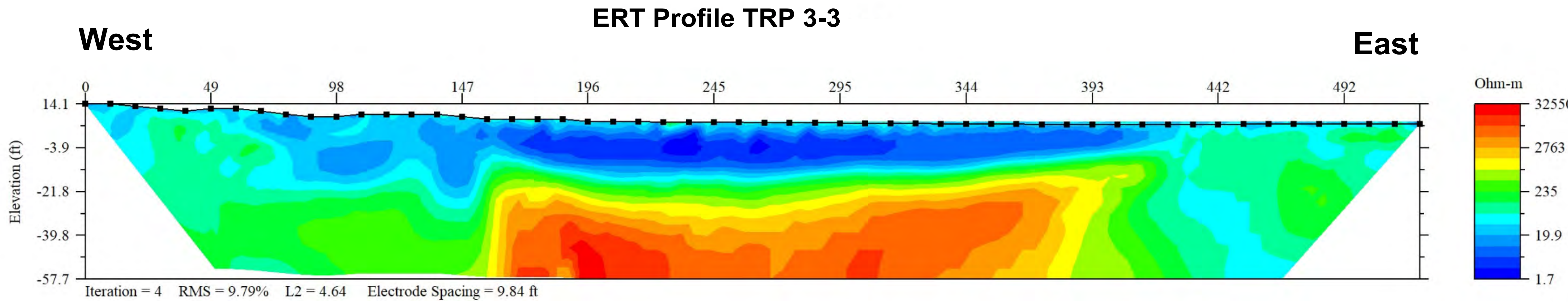
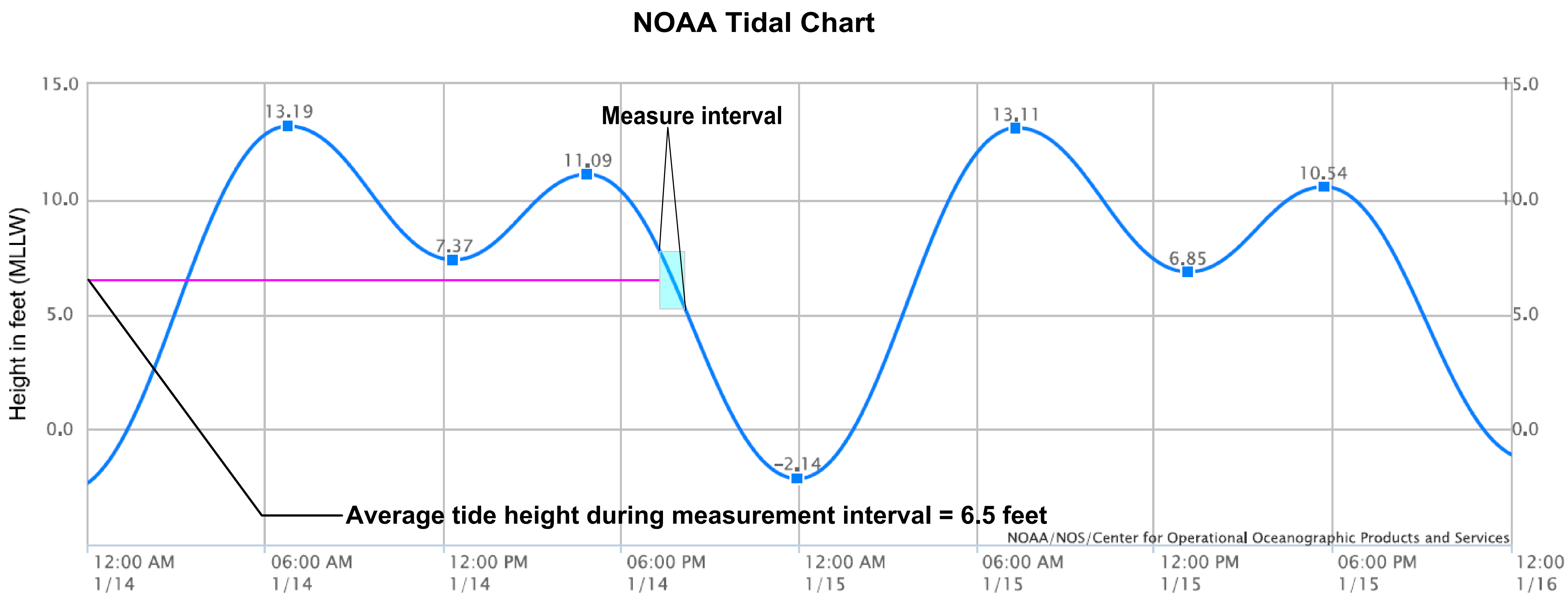
| **Timelapse ERT Profile TRP 3-2** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.3 |




| Timelapse ERT Profile TRP 3-3 | Operable Unit 1<br>Keyport , Washington | ATLAS<br>Figure 7.4 |
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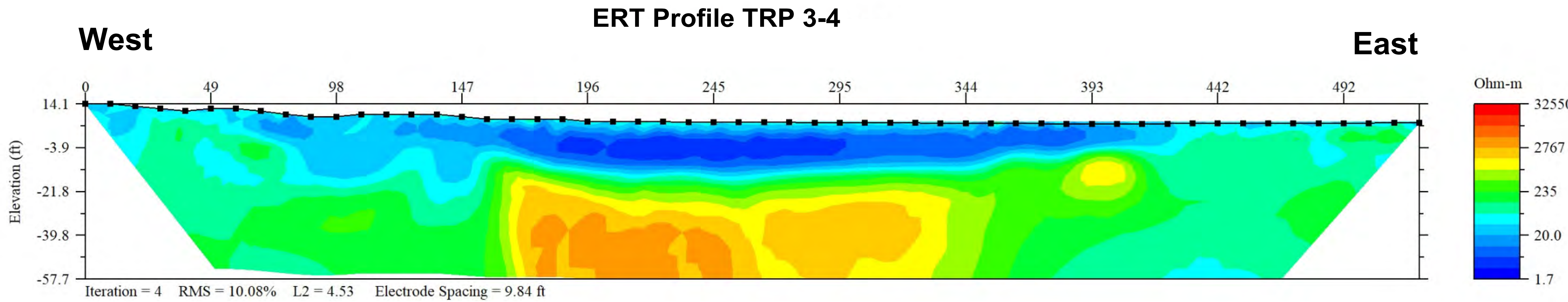
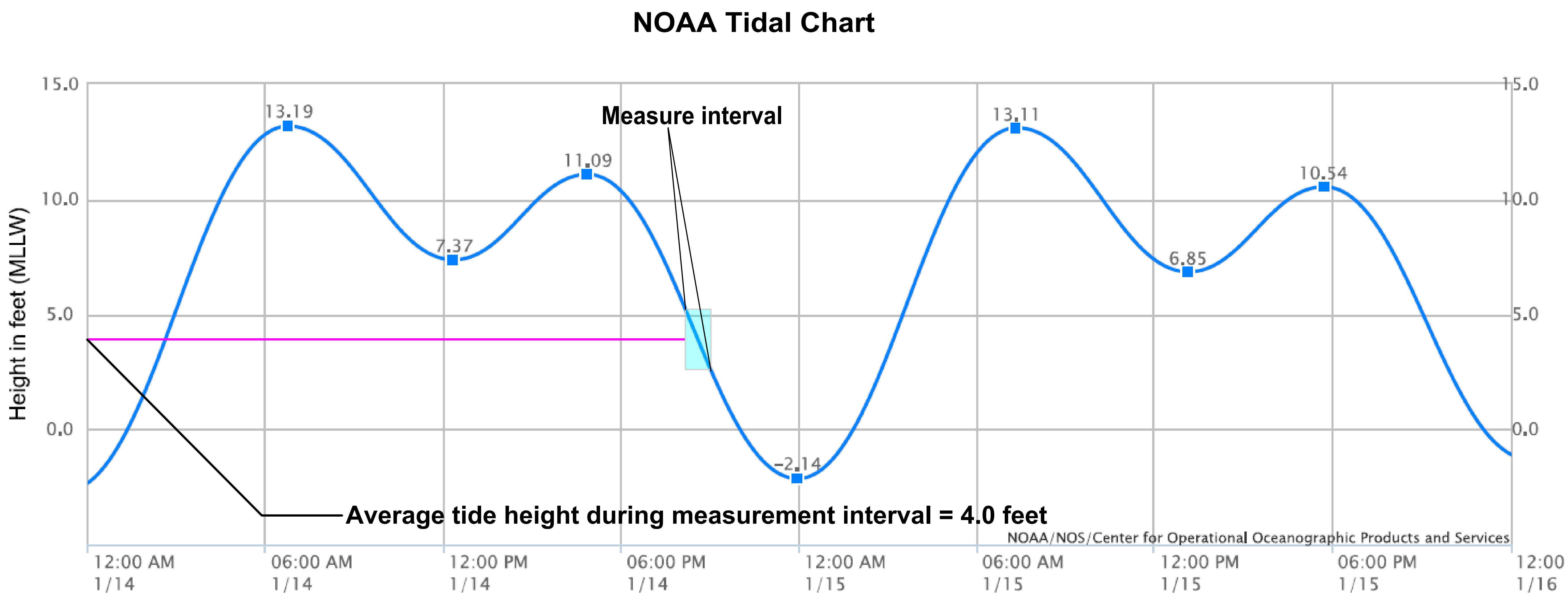
| | Project No.: 420019SWG REV1 Date: 09/21 | |




| Timelapse ERT Profile TRP 3-4 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.5 |
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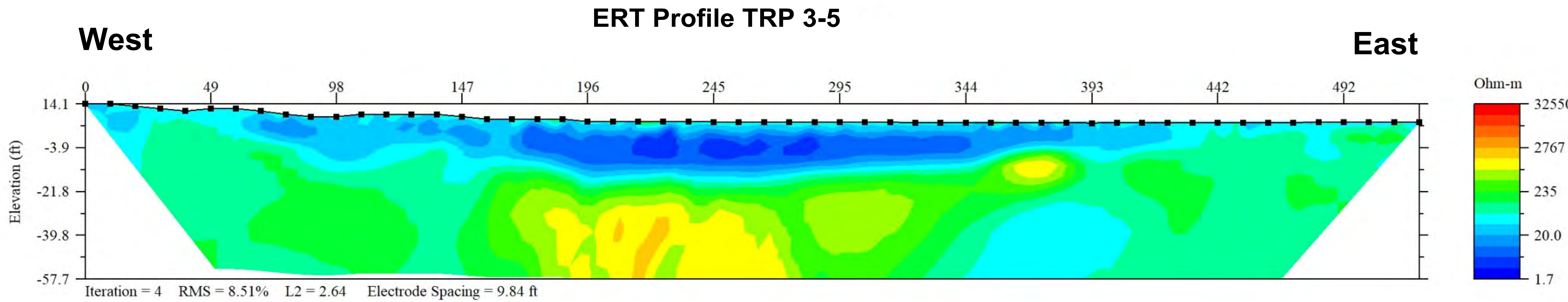


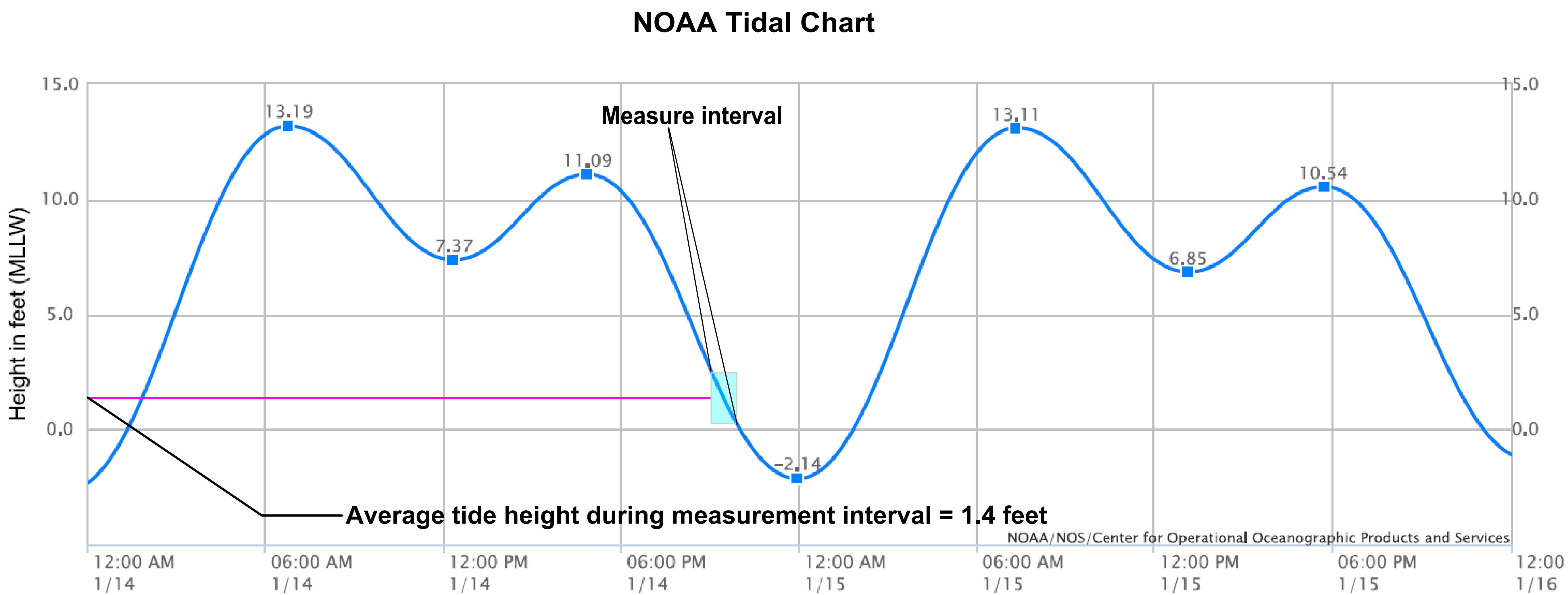


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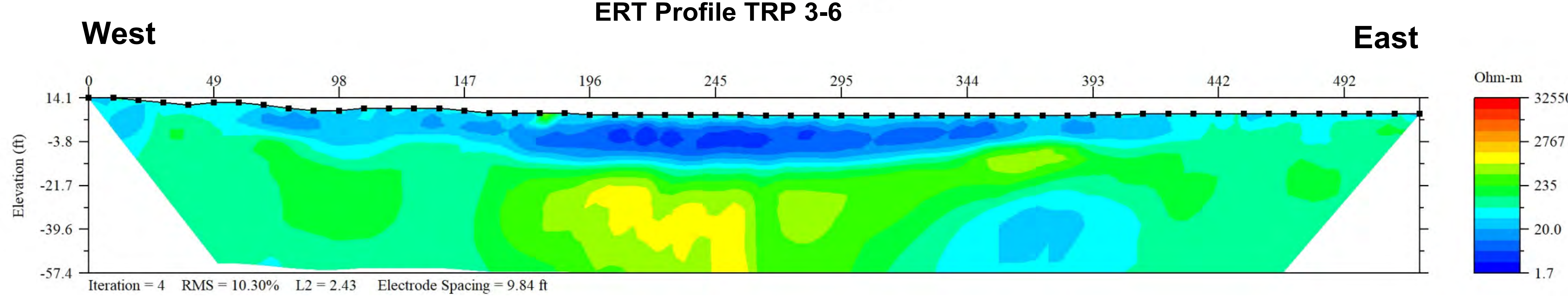
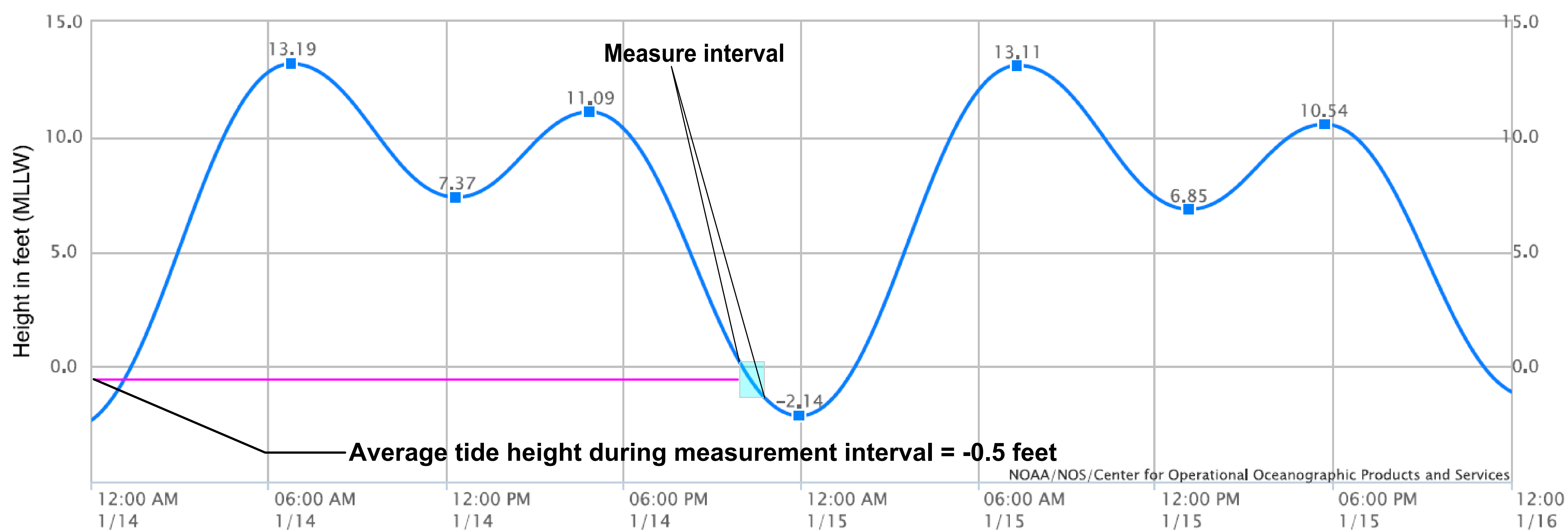
| **Timelapse ERT Profile TRP 3-5** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.6 |

## ERT Profile TRP 3-6




## NOAA Tidal Chart

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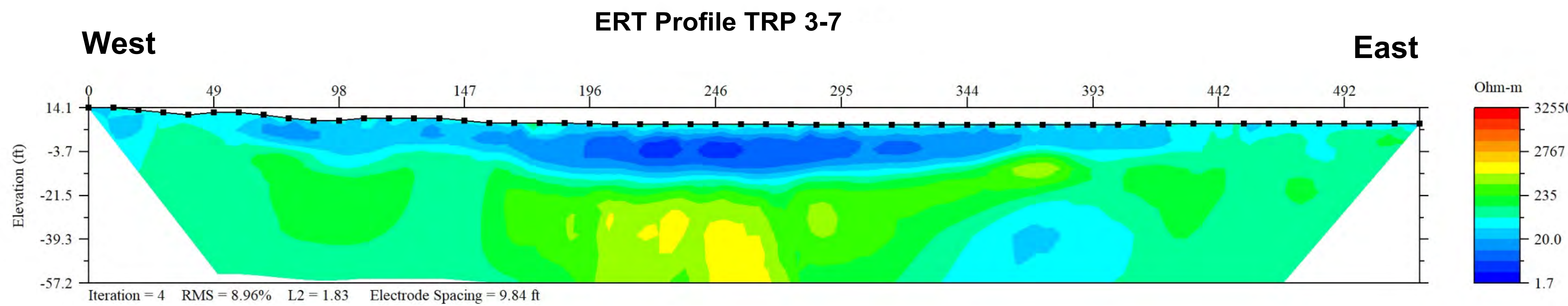
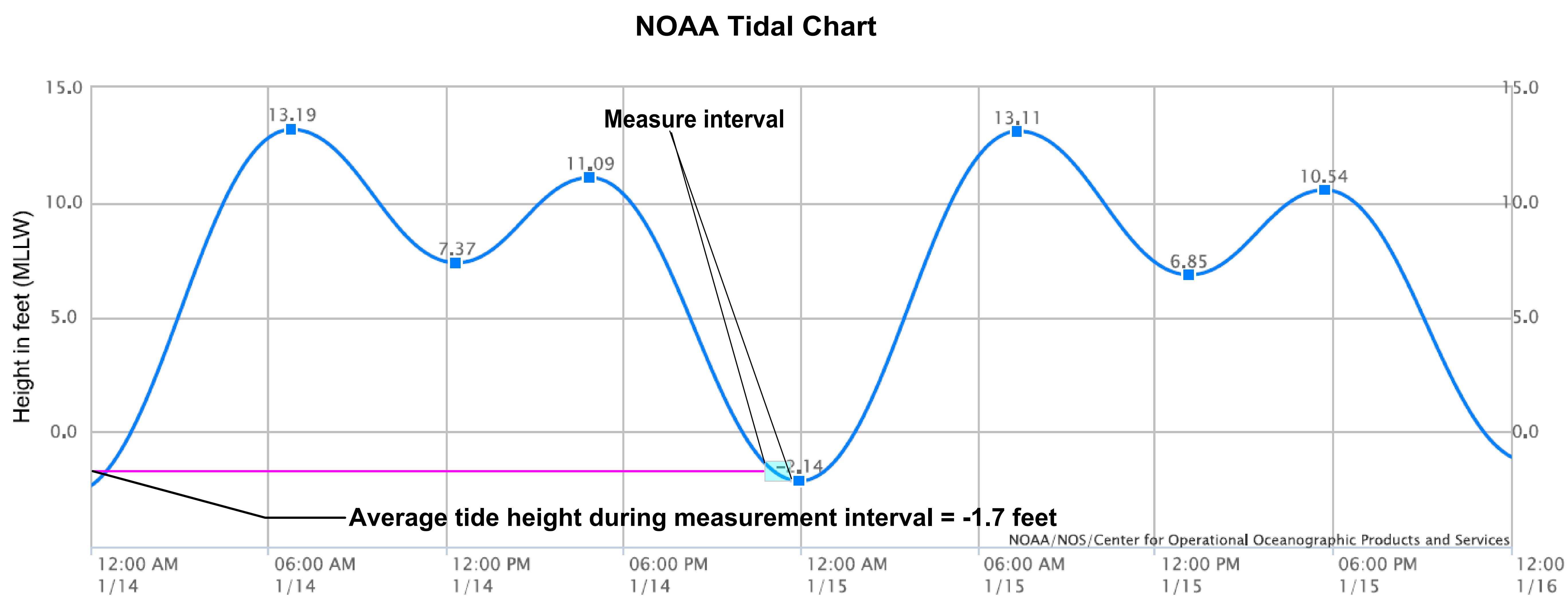
| **Timelapse ERT Profile TRP 3-6** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.7 |

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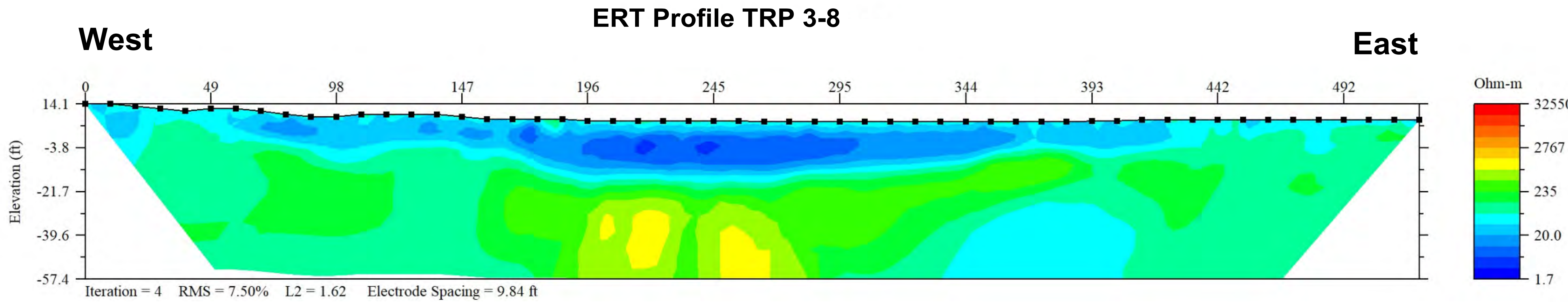
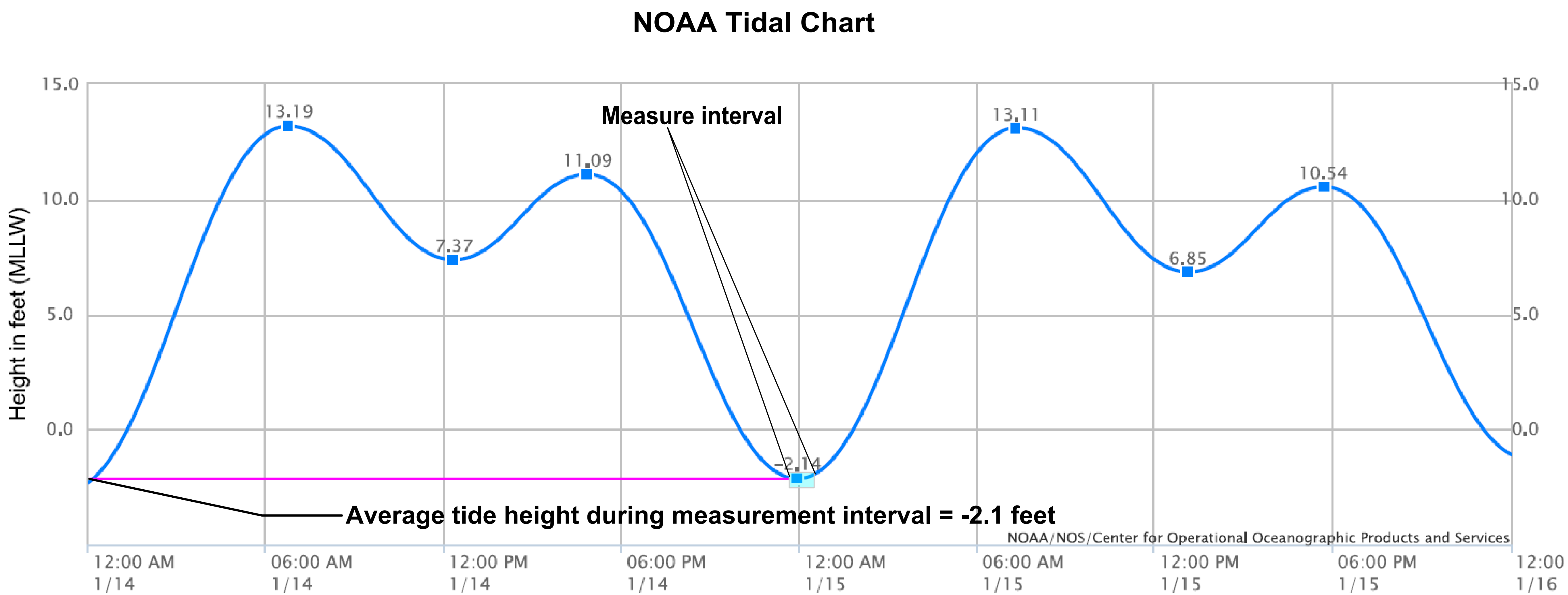
| **Timelapse ERT Profile TRP 3-7** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.8 |

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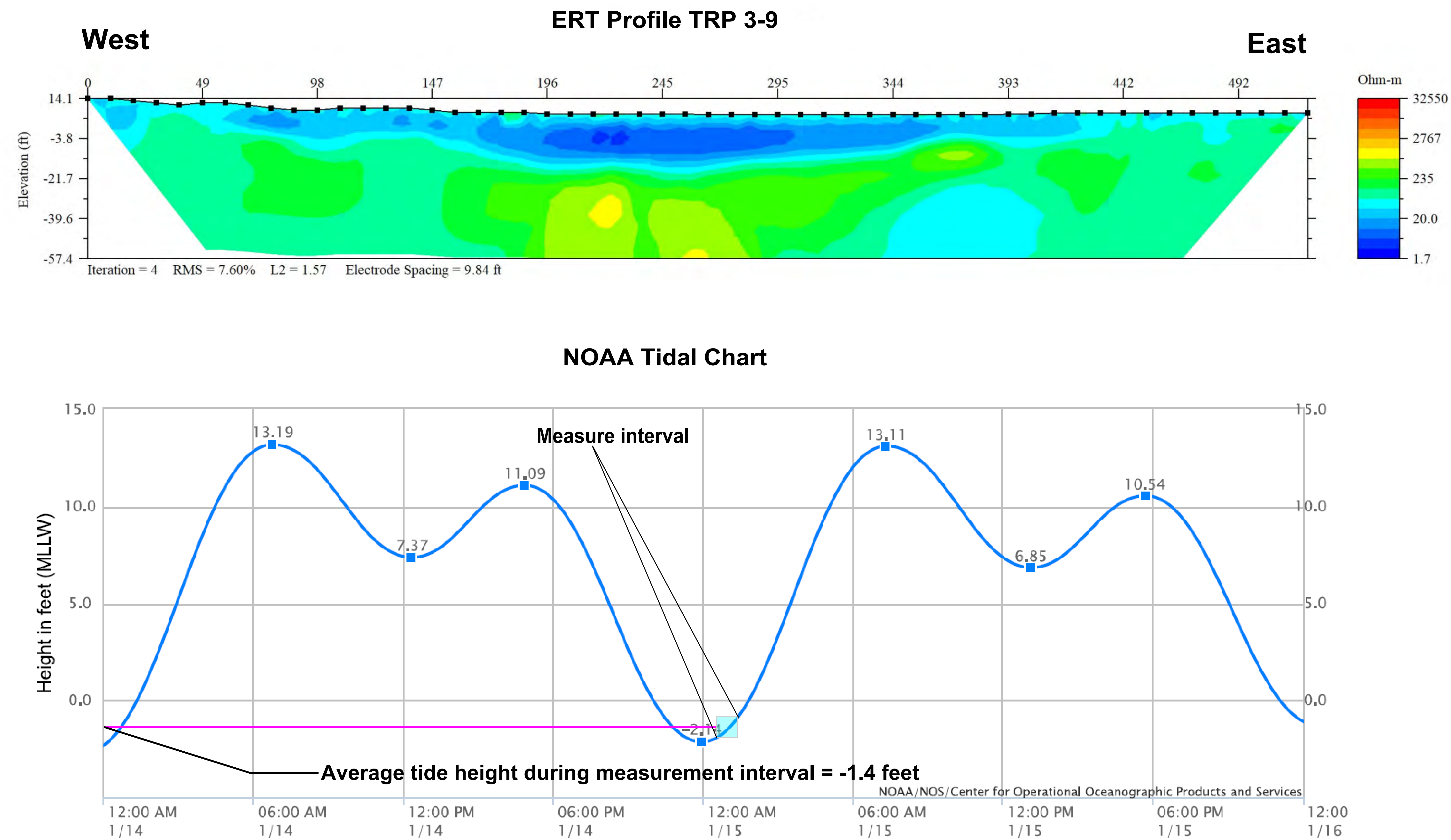
| **Timelapse ERT Profile TRP 3-8** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.9 |

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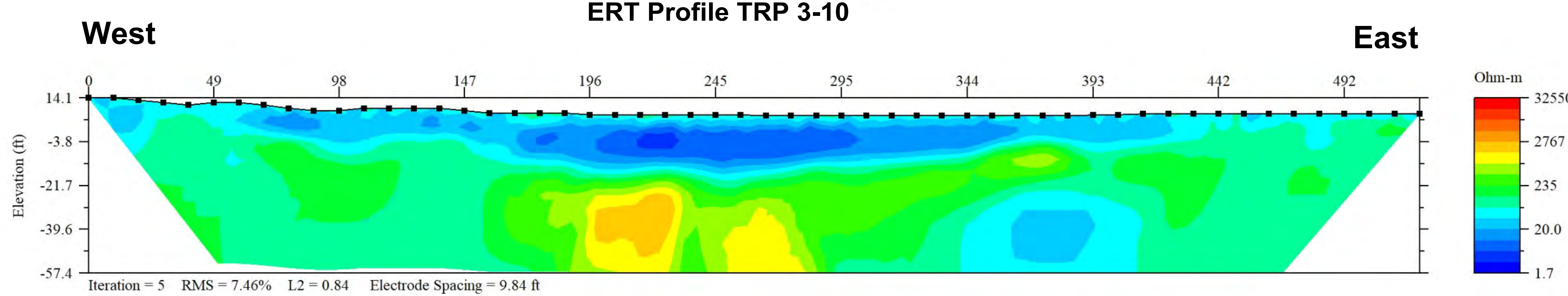
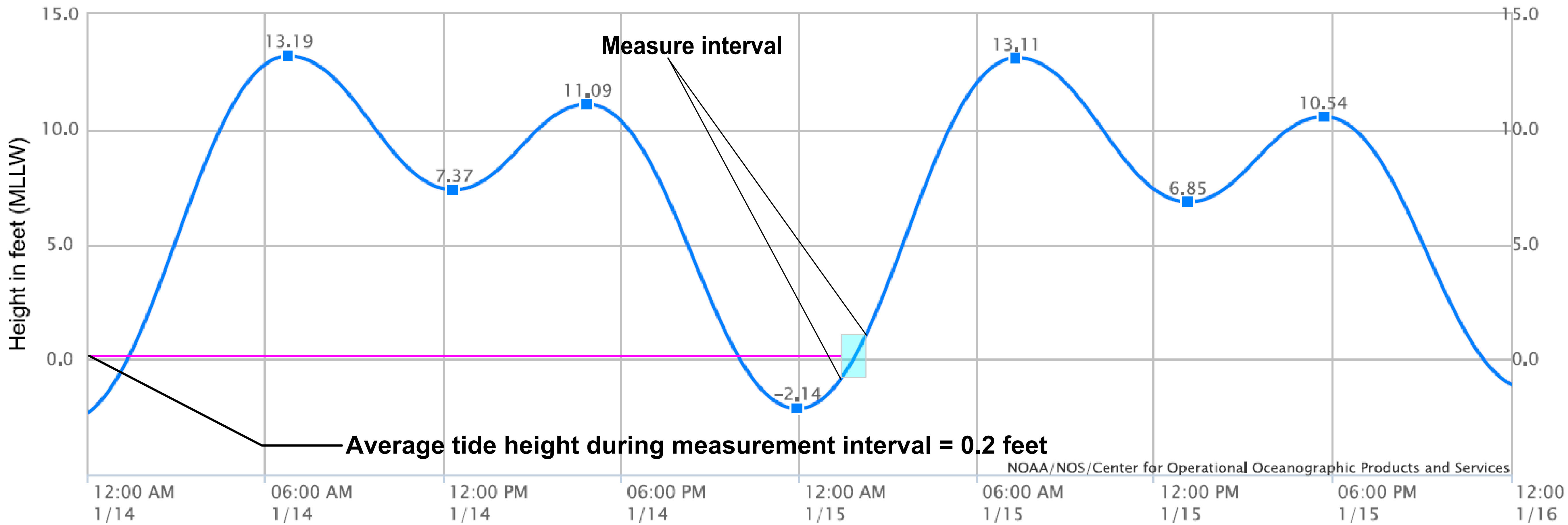
| **Timelapse ERT Profile TRP 3-9** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.10 |

## ERT Profile TRP 3-10




## NOAA Tidal Chart




| Timelapse ERT Profile TRP 3-10 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.11 |
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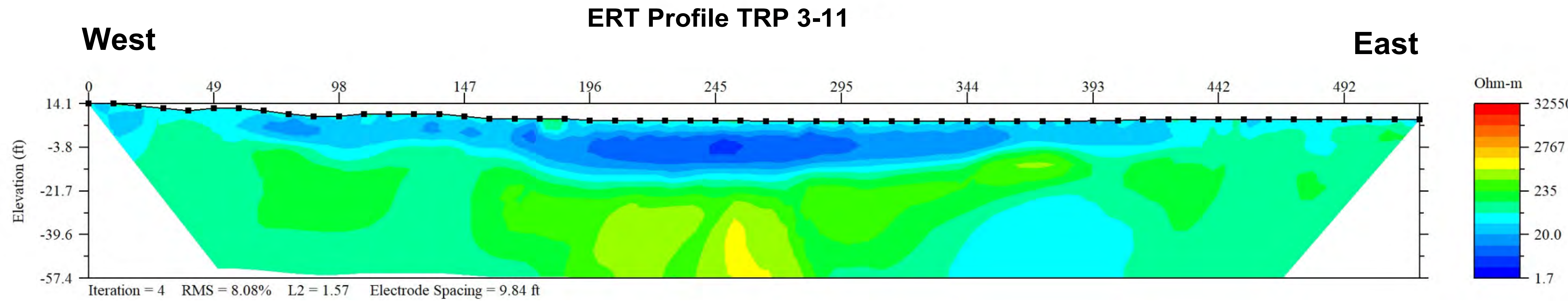


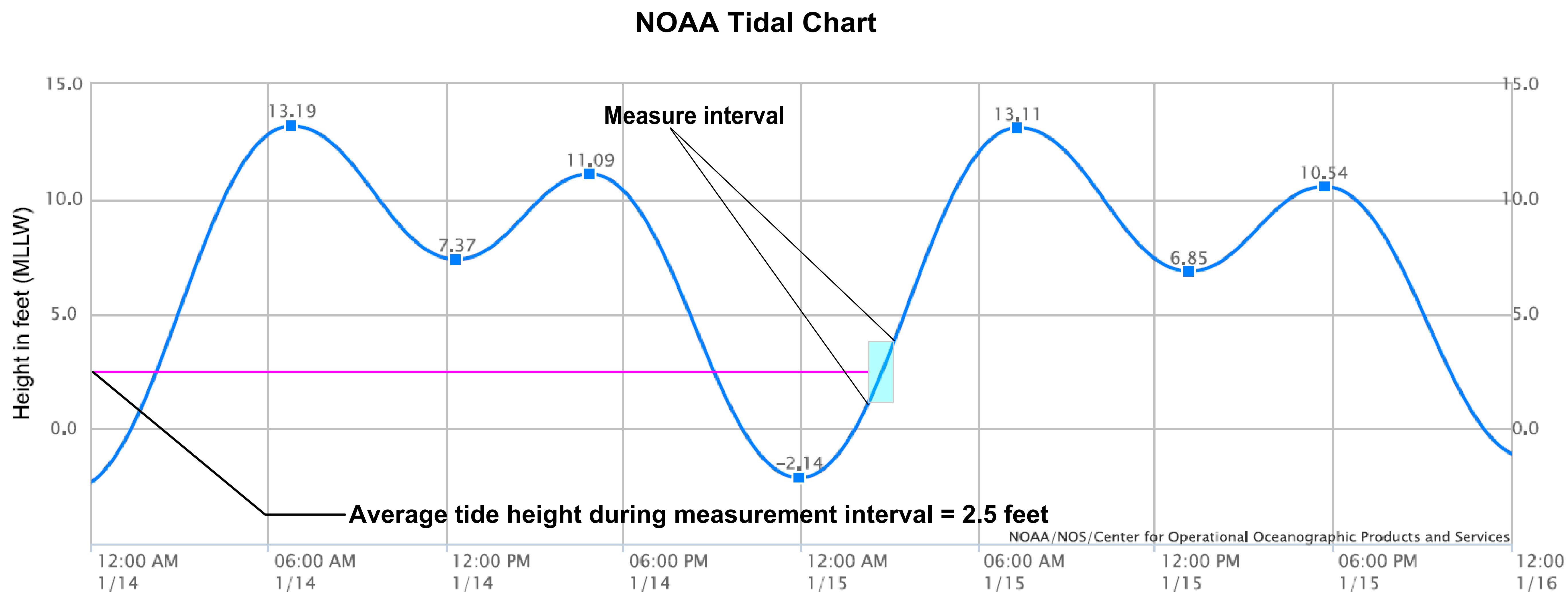


| Timelapse ERT Profile TRP 3-11 | Operable Unit 1 Keyport , Washington | ATLAS Figure 7.12 |
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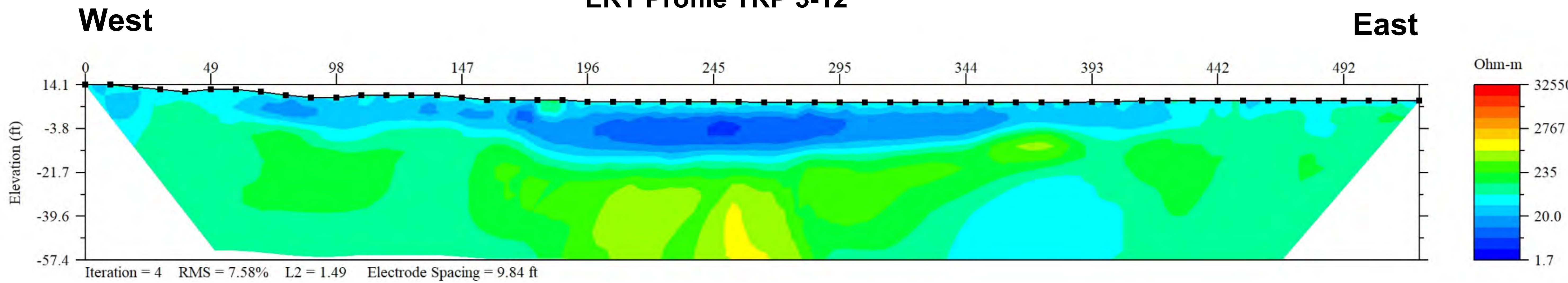
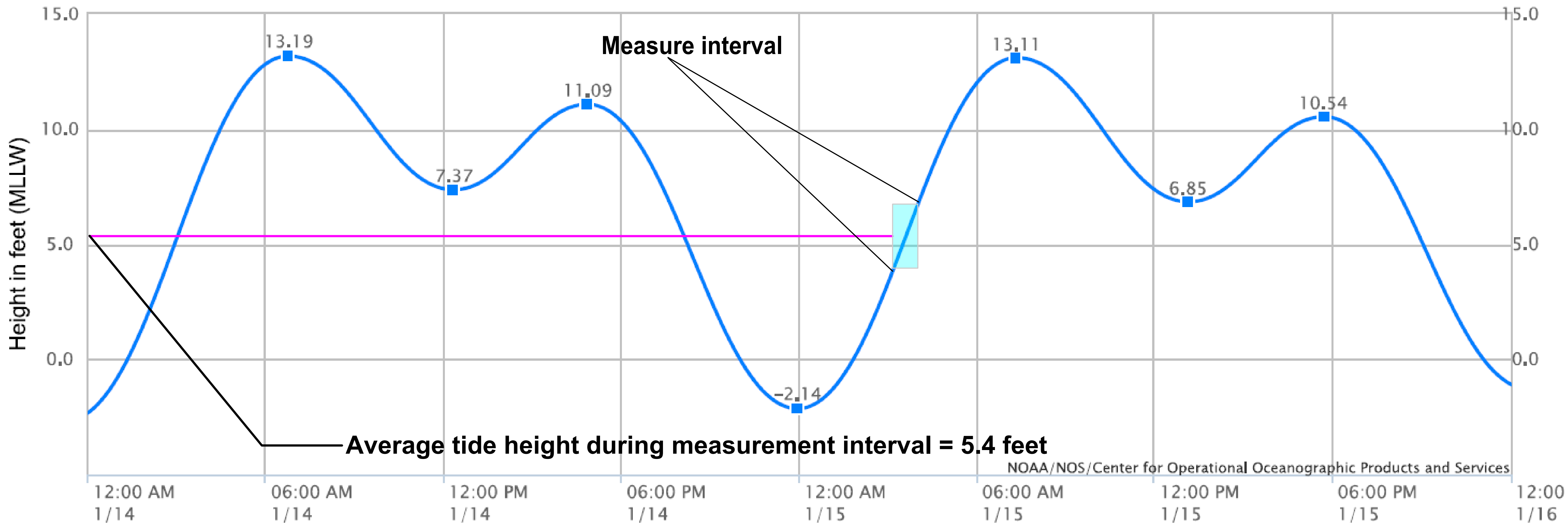
| | Project No.: 420019SWG REV1 — Date: 09/21 | |

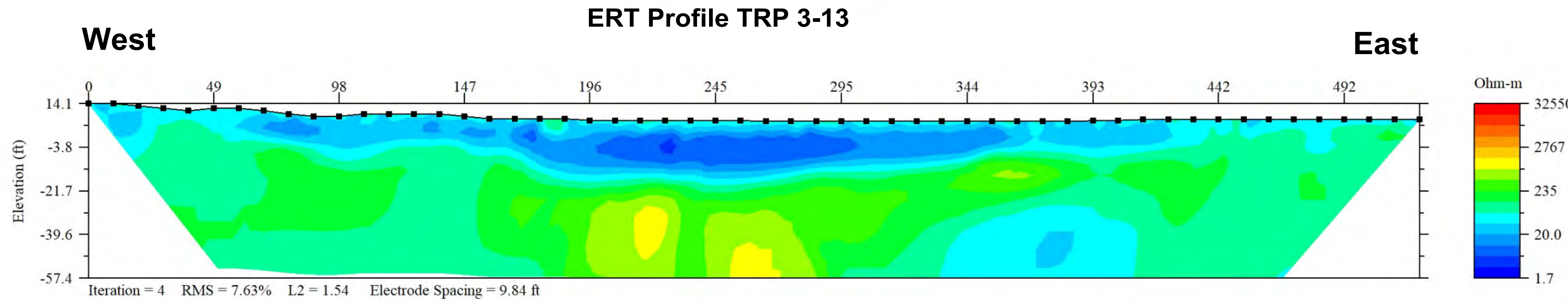
## ERT Profile TRP 3-12

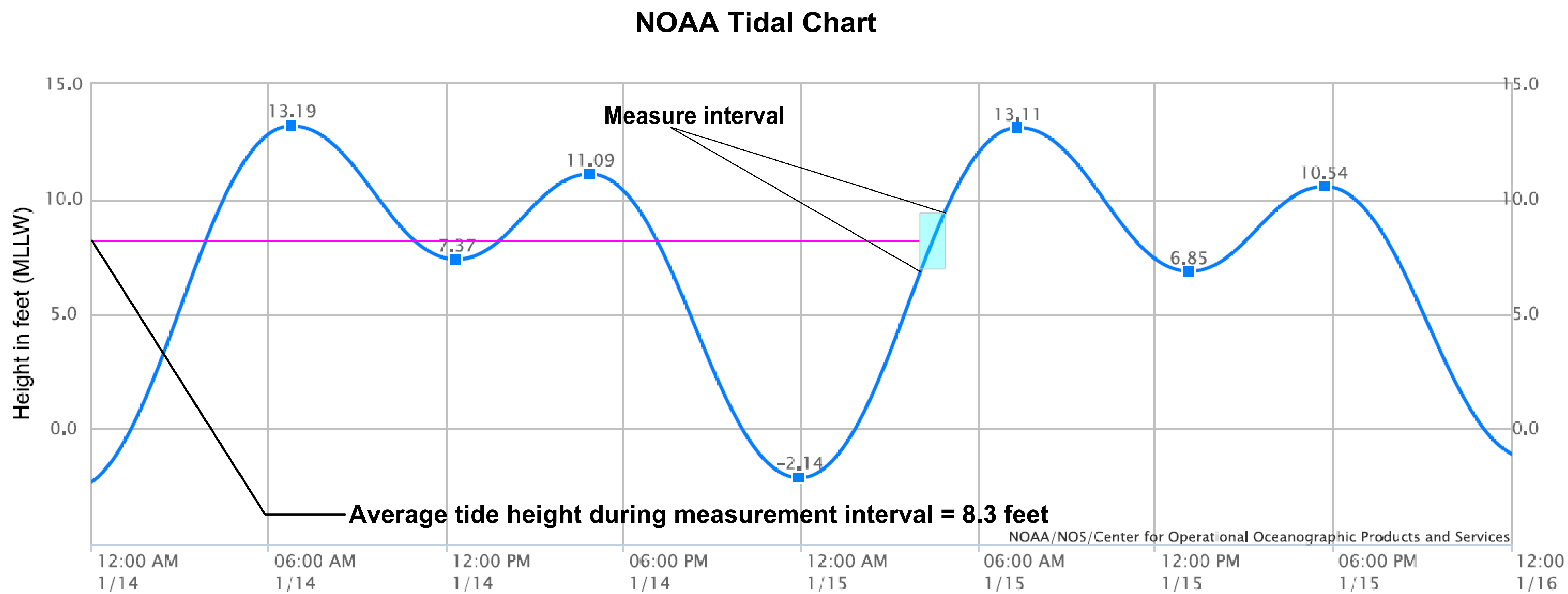



## NOAA Tidal Chart




| Timelapse ERT Profile<br>TRP 3-12 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.13 |
|---|---|---|




| Timelapse ERT Profile TRP 3-13 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.14 |
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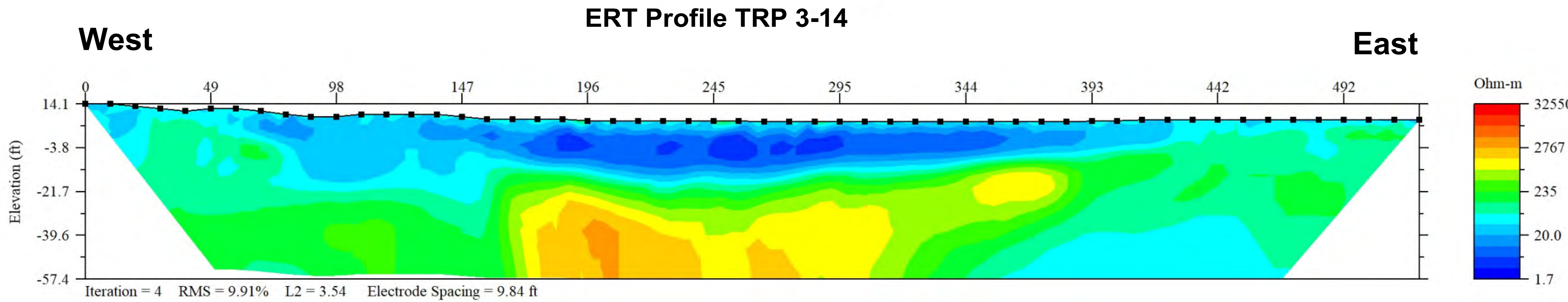


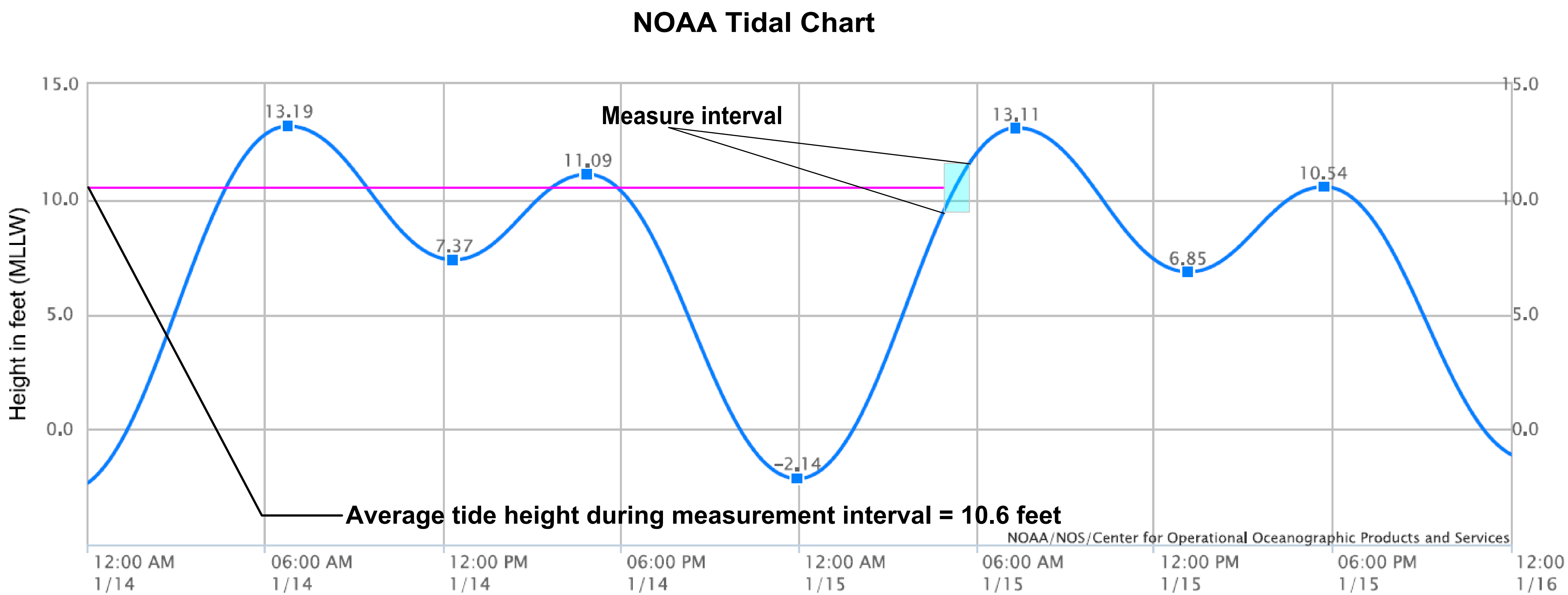


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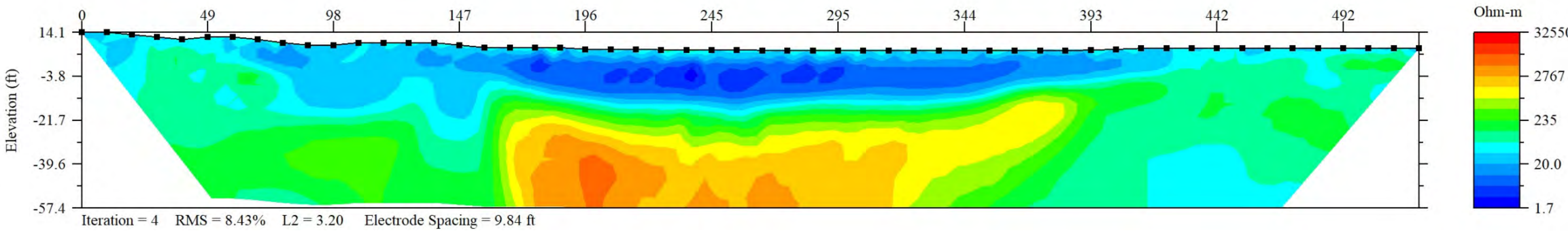
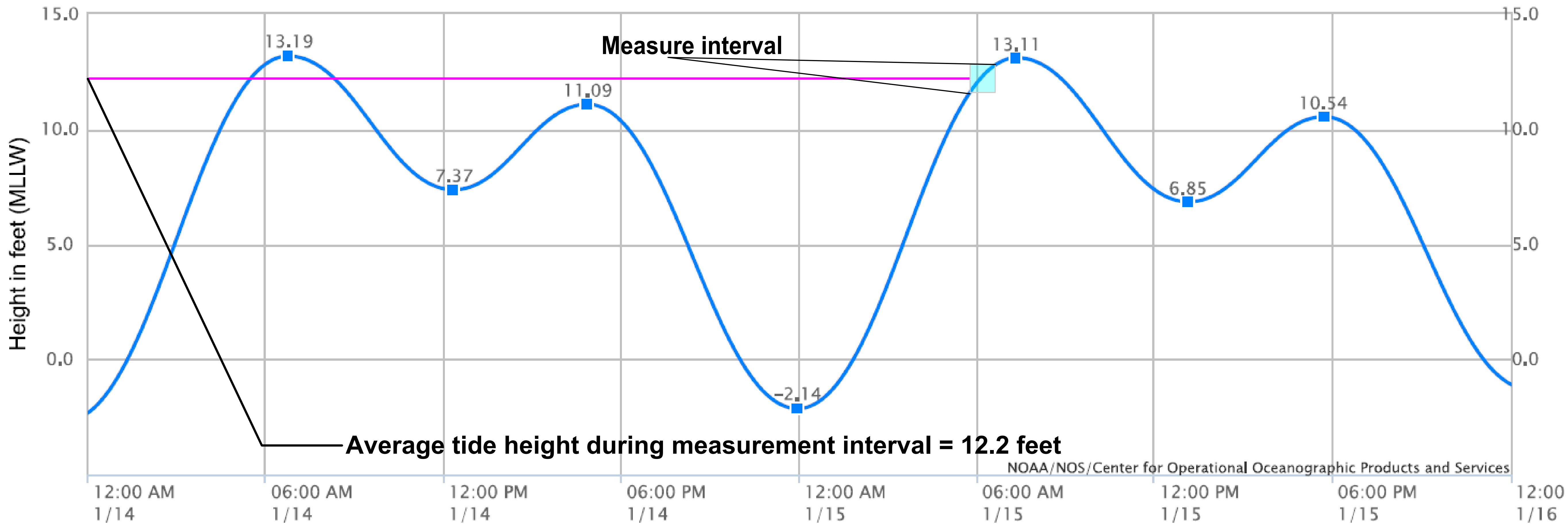
| **Timelapse ERT Profile TRP 3-14** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.15 |

# ERT Profile TRP 3-15

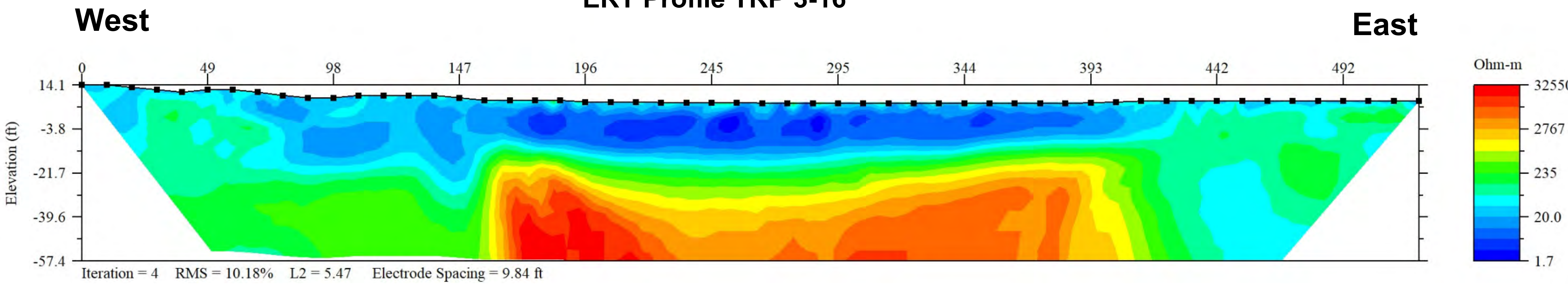



# NOAA Tidal Chart

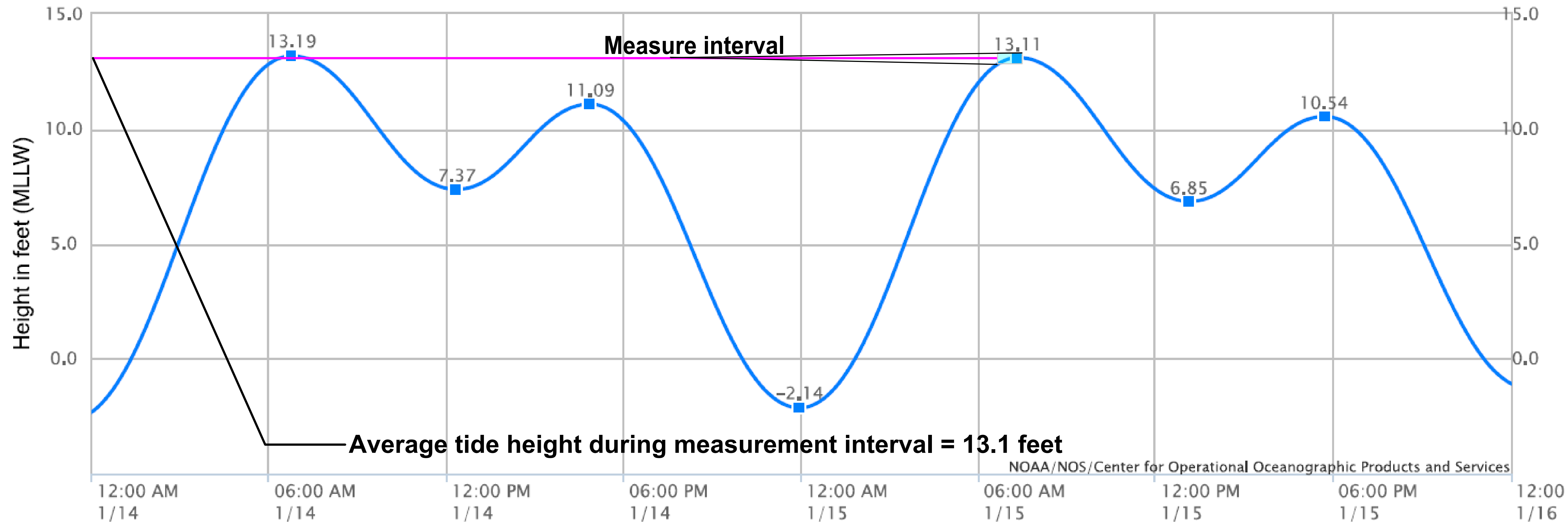



| Timelapse ERT Profile TRP 3-15 | Operable Unit 1<br>Keyport , Washington | ATLAS<br>Figure 7.16 |
|---|---|---|
| | Project No.: 420019SWG REV1 Date: 09/21 | |

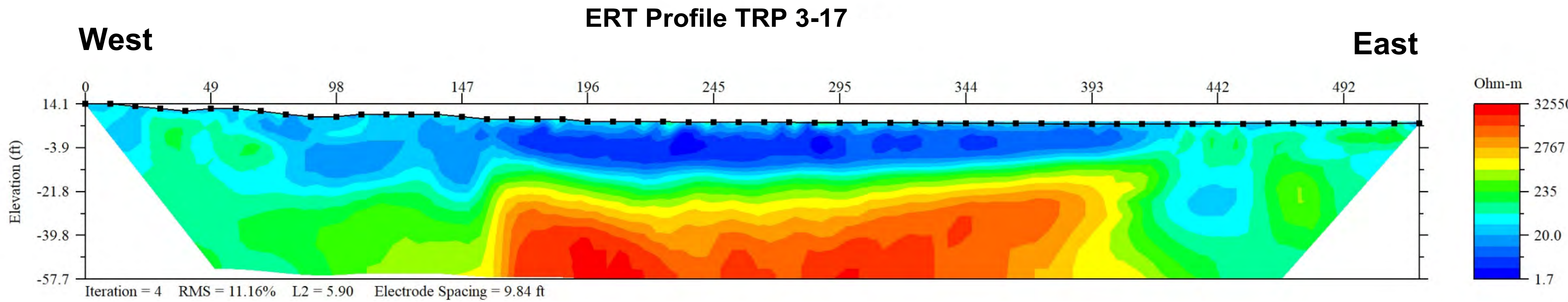
## ERT Profile TRP 3-16

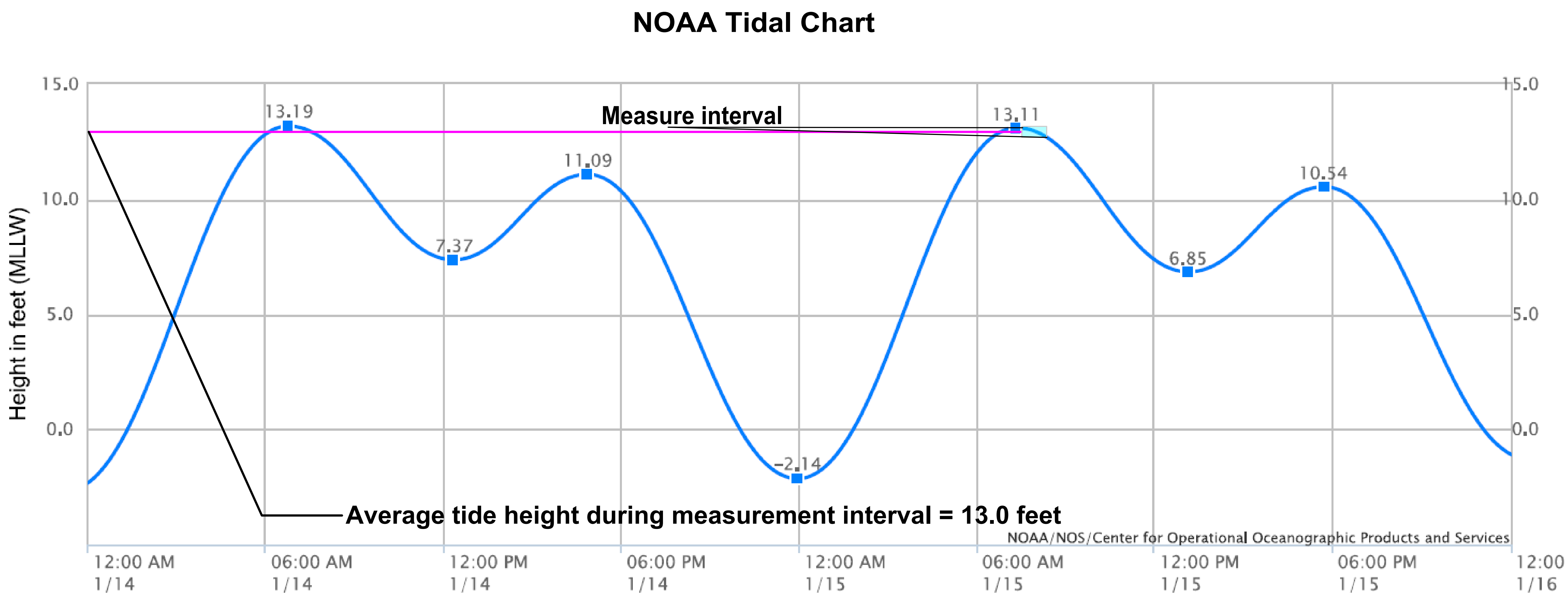



## NOAA Tidal Chart




| Timelapse ERT Profile TRP 3-16 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.17 |
|---|---|---|

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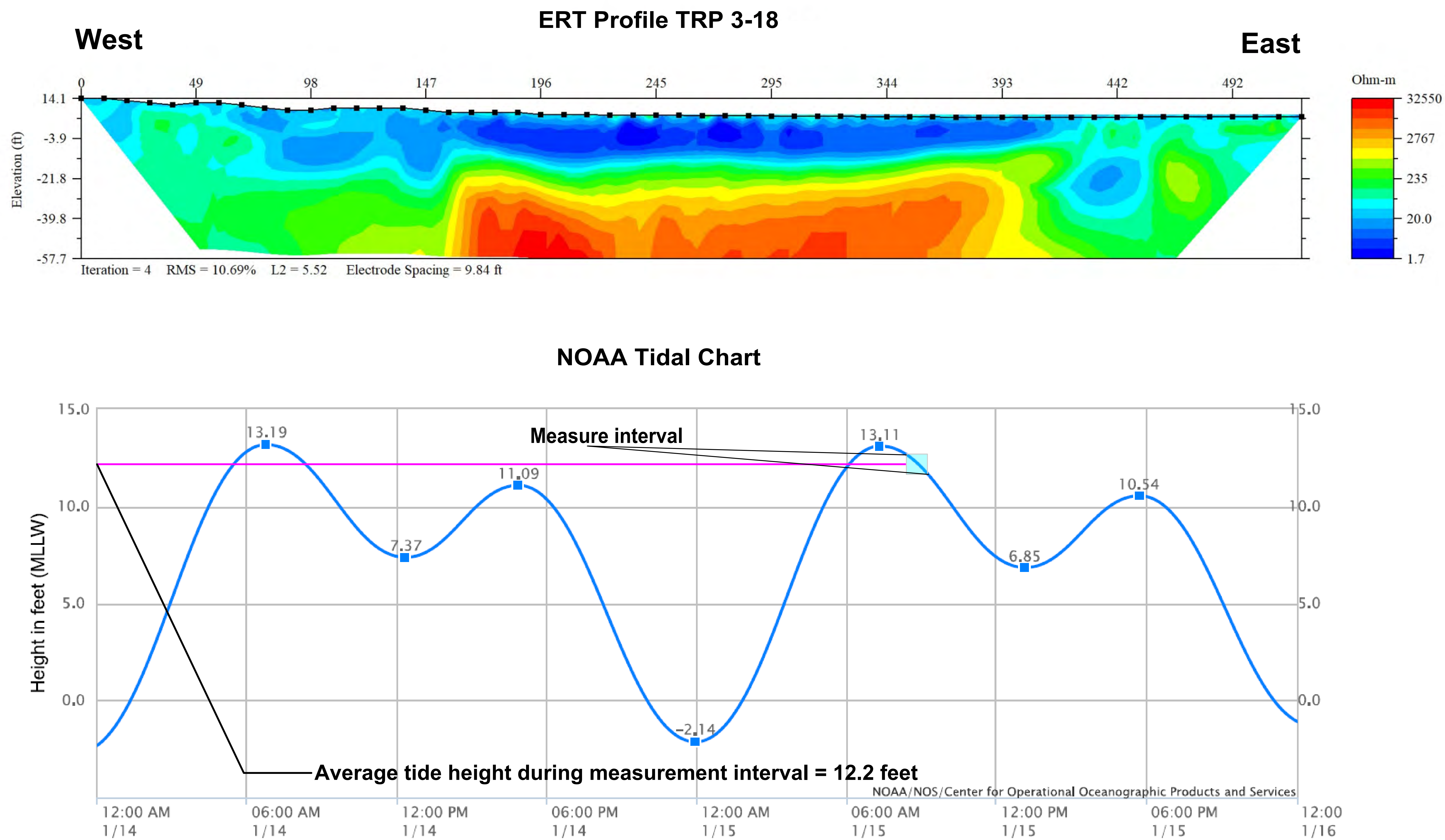
| **Timelapse ERT Profile TRP 3-17** | Operable Unit 1<br>Keyport, Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.18 |

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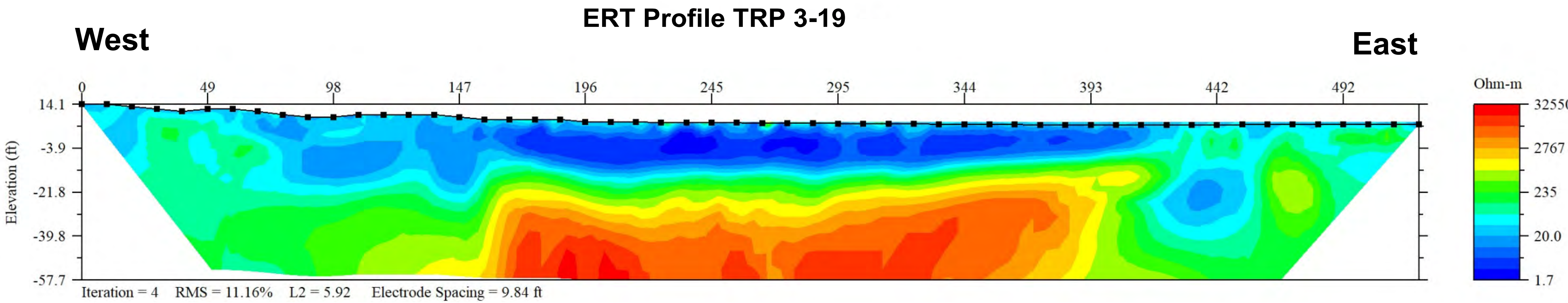
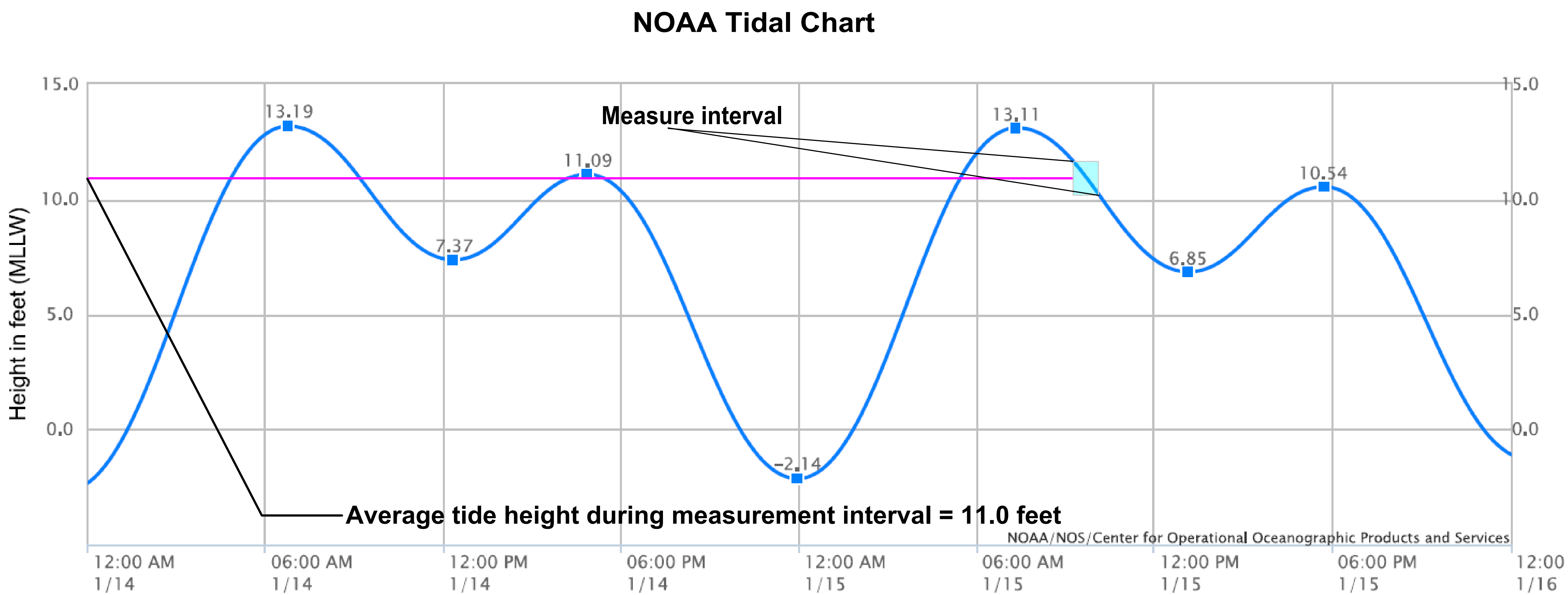
| **Timelapse ERT Profile TRP 3-18** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 — Date: 09/21 | ATLAS<br>Figure 7.19 |

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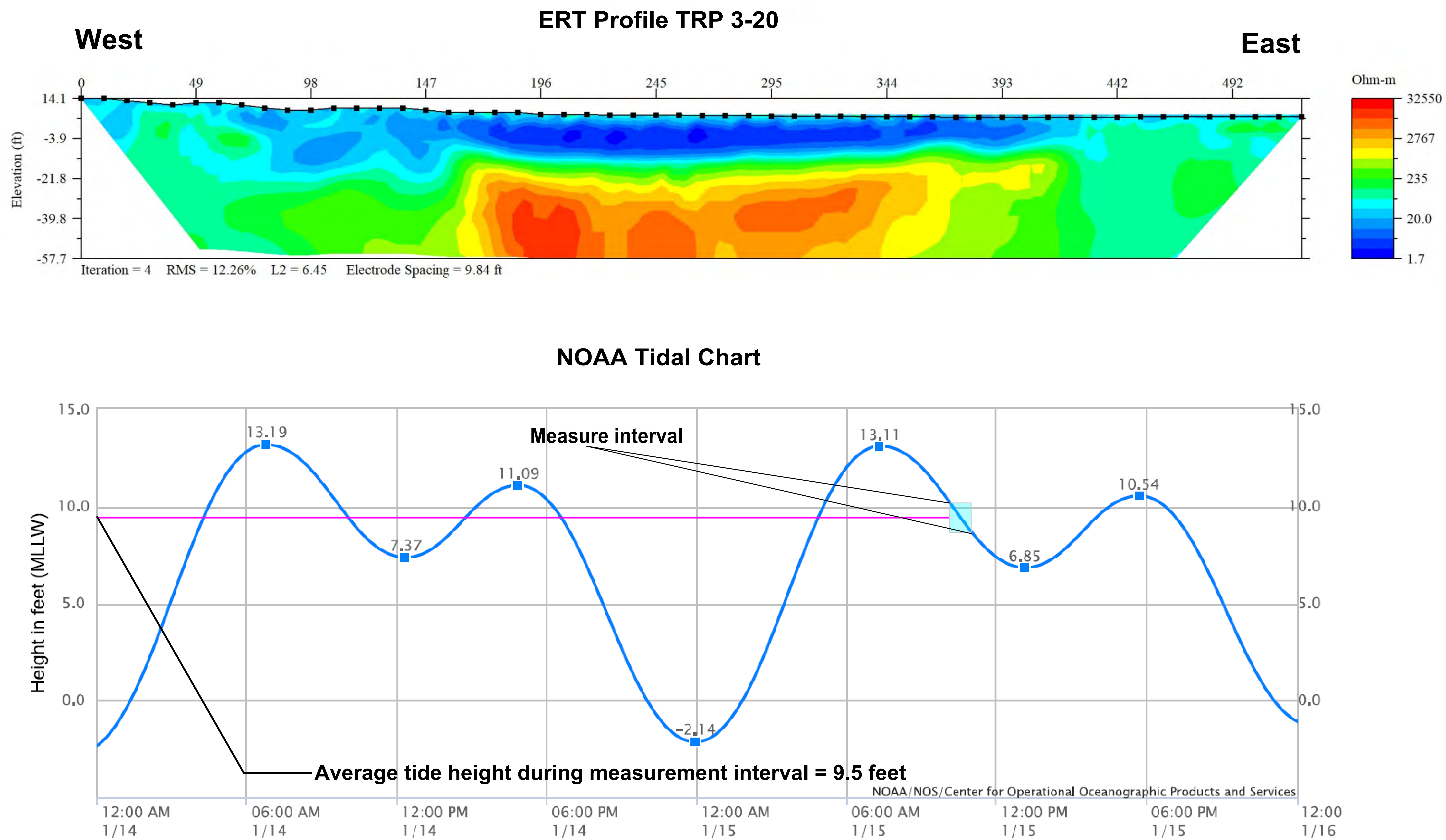
| **Timelapse ERT Profile TRP 3-19** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.20 |

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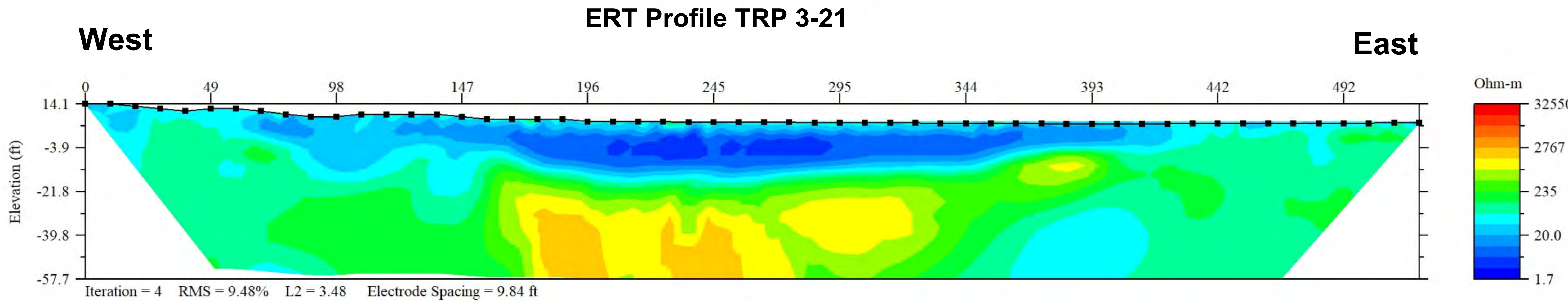


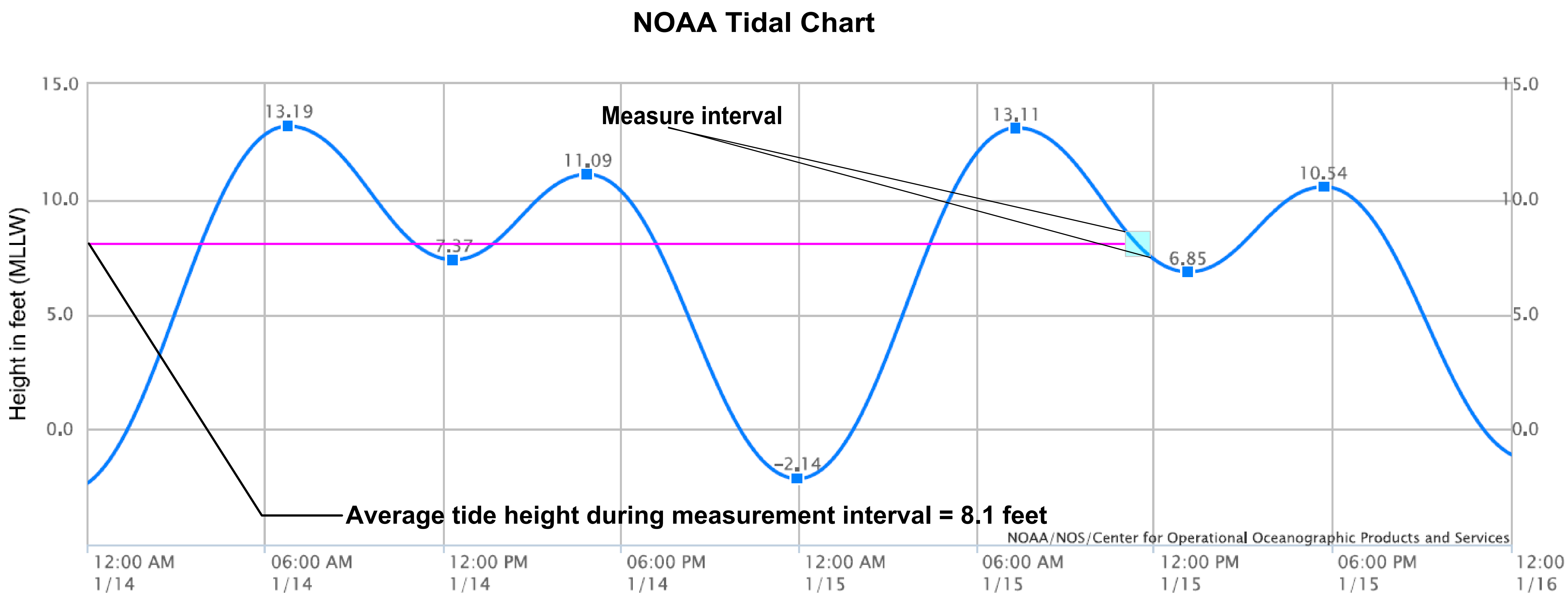


| Timelapse ERT Profile TRP 3-21 | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.22 |
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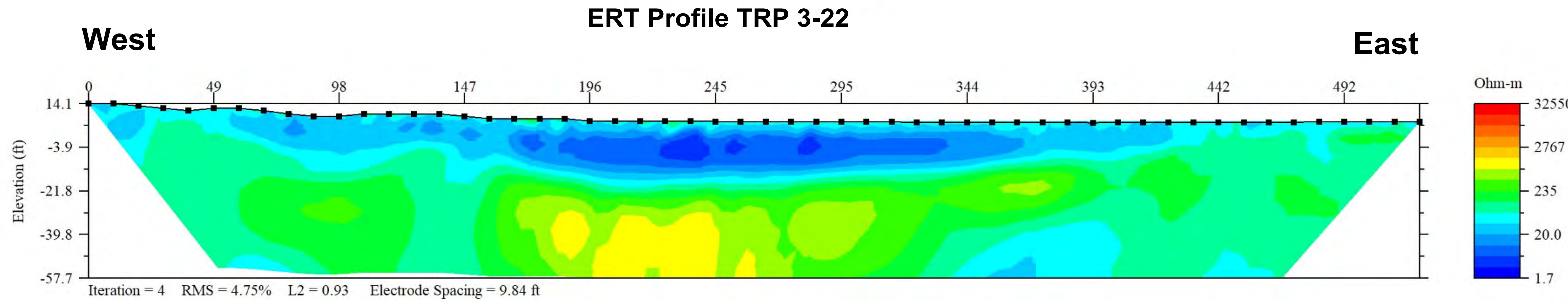


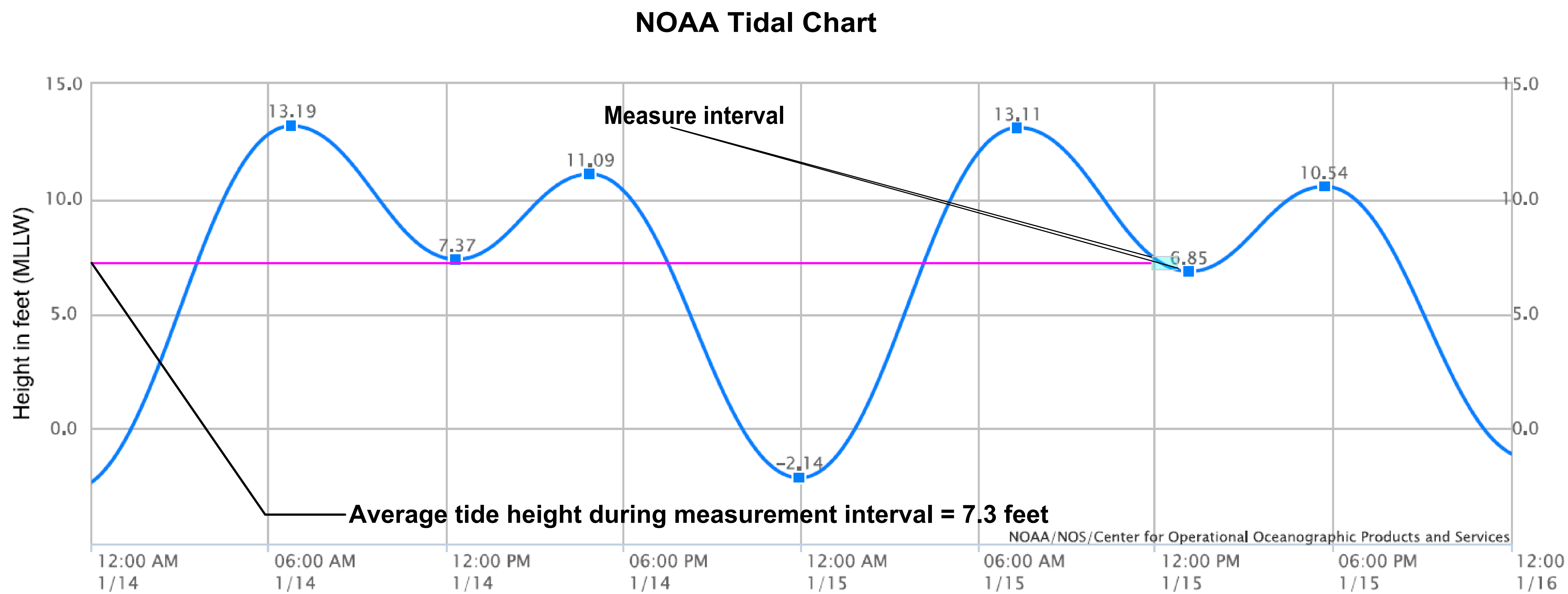


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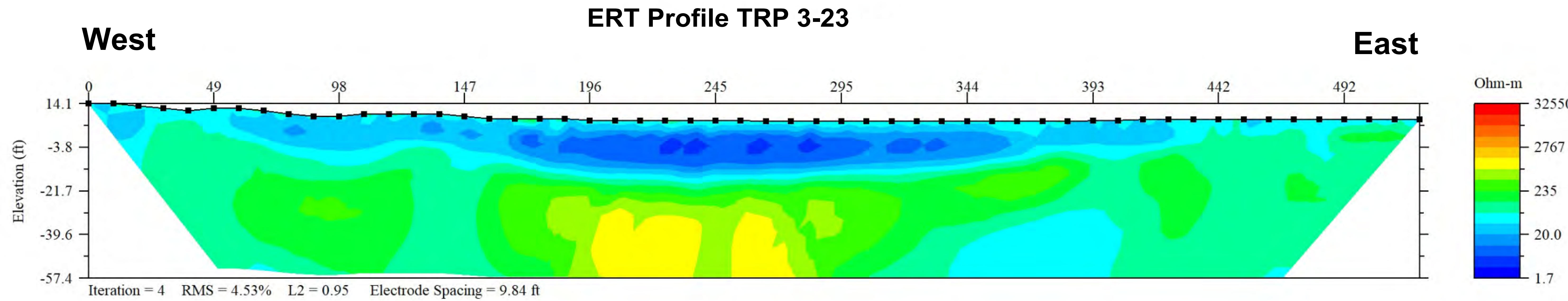
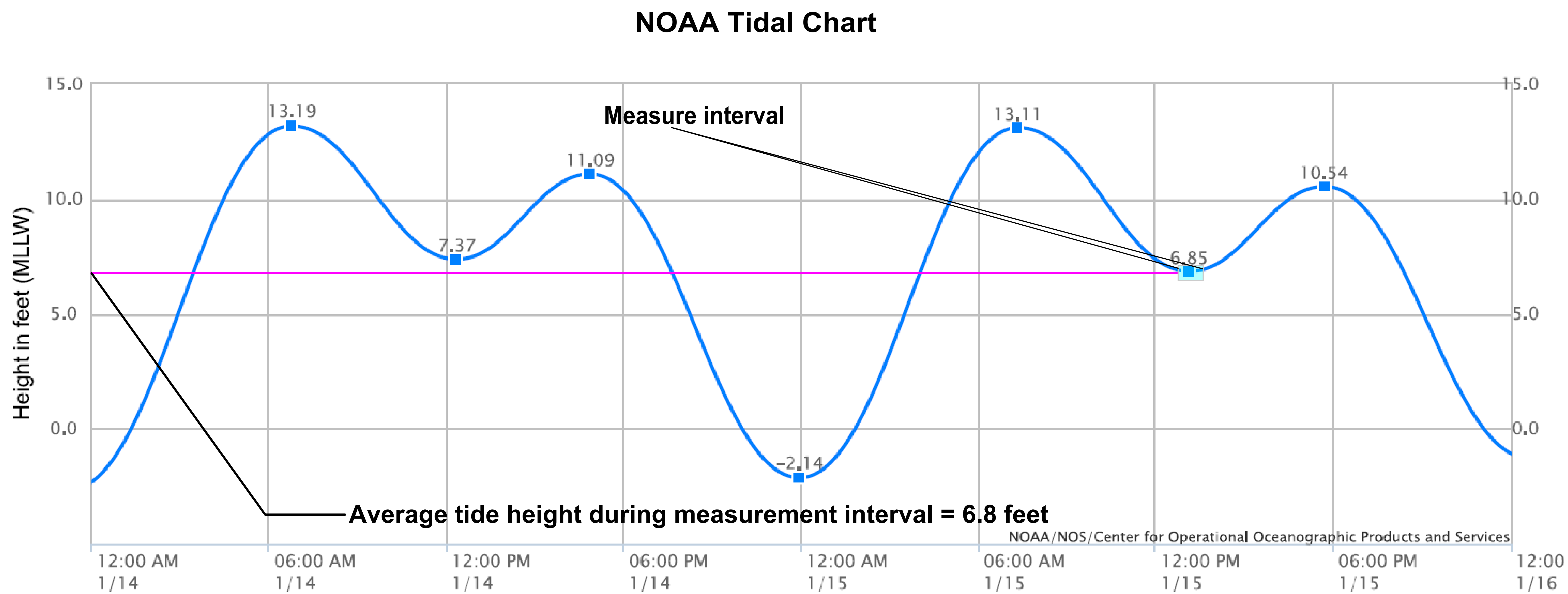
| **Timelapse ERT Profile TRP 3-22** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.23 |

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| **Timelapse ERT Profile TRP 3-23** | Operable Unit 1<br>Keyport , Washington<br>Project No.: 420019SWG REV1 Date: 09/21 | ATLAS<br>Figure 7.24 |

# Appendix E

# ISM Sampling of PCBs in Sediment Technical Memorandum

BATTELLE

DATE: 2 June 2022

TO: Carlotta Cellucci, NAVFAC NW

FROM: Caitlyn Farragher, Battelle
Michael Meyer, Battelle

SUBJECT: NBK Keyport ISM Sampling of PCBs in Sediment - Data Summary and Evaluation

## INTRODUCTION

This memorandum provides a summary and analysis of polychlorinated biphenyl (PCB) data collected using the incremental sampling methodology (ISM) in the distal reach of Marsh Creek at Operable Unit 1 (OU 1) at Naval Base Kitsap (NBK) Keyport (Figures 1 and 2). This memorandum is an interim data deliverable that supports the pending supplemental remedial investigation report for the site, which is scoped under ESTS Contract N39430-16-D-1802, Task Order N3943018F4359 (PTO X041). The site description and background are described in detail in past reports and the sampling and analysis plan (SAP) for the data collection effort (U.S. Navy, 2021), and have not been repeated in this memorandum. Comments received on a draft version of this memorandum, along with responses to those comments, are included as Attachment 3.

These results serve as baseline 95 percent upper confidence limit of the arithmetic mean (95% UCL) concentrations in the reach of Marsh Creek downstream of seep SP1-1 and will be used for comparison to future results, to establish temporal concentration trends, or concentrations before and after any future removal or remedial actions in this area.

Numerical results presented in this memorandum are compared to the marine sediment cleanup objective (SCO) as a point of reference. Ecology requires that only the results of discrete samples be used to determine compliance with regulations.

## BOTTOM LINE UP FRONT (BLUF)

The PCB evaluation concludes that total PCB concentrations in sediment in the distal reach of Marsh Creek at OU 1 exceed the marine SCO of 12 milligrams per kilogram (mg/kg) carbon normalized (OC) in all three decision units (DUs) shown in Figure 3. Calculating the 95% UCL derives a PCB concentration for DU 1 sediment of 23.3 mg/kg OC based on the Student's *t* statistic, using the Interstate Technology & Regulatory Council (ITRC) ISM Calculator (v.3.0, August 2020). Using the ITRC ISM Calculator to calculate the 95% UCL for DUs 2 and 3, respectively, derived concentrations of 54.6 mg/kg OC and 12.6 mg/kg OC, based on the Chebychev statistic. A discussion of the criteria for selecting between the Student's *t* statistic and the Chebychev statistic is included in the Data Evaluation section of this memorandum.

## SUMMARY OF DATA COLLECTION AND ANALYSIS

Sediment sampling in the reach of Marsh Creek from seep SP1-1 to the tide gate was conducted utilizing ISM techniques, with the reach of Marsh Creek divided into three DUs as established in the SAP (U.S. Navy, 2021) and shown on Figure 3.

The ISM involved collection of 35 to 38 equal-volume sediment increments within each of the three DUs. At each DU, one primary and two replicate ISM samples were collected. Each primary sample and replicate sample were representative of the entire DU at the targeted depth interval of 0 to 10 centimeters (cm). Increments for each primary sample and replicate sample were combined into a zip-lock bag for shipping, then homogenized and subsampled for analysis at the laboratory in accordance with ITRC guidance (ITRC, 2020).

Sediment increments were collected using three ASM, Inc. Soil Step Probes, one for the primary sample and one for each replicate sample. This probe was inserted 10 cm into the sediment, which equaled three quarters of the sampling window on the probe. The sample was then extruded into the appropriately-labeled zip-lock bag for each primary or replicate sample. After the completion of each DU, the three ASM samplers were decontaminated as described in the SAP before sampling the next DU.

ISM sampling began at the falling tide by marking the four corners of the three DUs (DU 1-A, DU 1/2-B, DU 1/2-C, DU 1-D, DU 2/3-E, DU 3-F, DU 3-G, and DU 2/3-H) on June 22, 2021, using the nomenclature established in the SAP, as reproduced below.

| Decision Unit Corner Identification | Description |
|---|---|
| DU 1 - A | Southwest corner of decision unit 1 |
| DU 1\|2 - B | Northwest corner of decision unit 1 and southwest corner of decision unit 2 |
| DU 1\|2 - C | Northeast corner of decision unit 1 and southeast corner of decision unit 2 |
| DU 1 - D | Southeast corner of decision unit 1 |
| DU 2\|3 - E | Northwest corner of decision unit 2 and southwest corner of decision unit 3 |
| DU 3 - F | Northwest corner of decision unit 3 |
| DU 3 - G | Northeast corner of decision unit 3 |
| DU 2\|3 - H | Northeast corner of decision unit 2 and southeast corner of decision unit 3 |

The corners were marked by a 4-foot (ft) rod of metal rebar driven halfway into the ground and stamped with a labeled orange cap in accordance with Figure 4. The corners were determined using the map, global positioning system (GPS) coordinates, and visual observations of the sediment's edge, as shown on Figure 4. The sediment edge was designated during low tide by visually identifying the edge of the wetland vegetation and the change from sediment to soil, and was confirmed during the peak high tide. The first DU sampled was DU 3 starting at the corner labeled DU 2/3-E on June 23, 2021, at 08:40 AM. The sampling pattern was generated using a random number generator for an X and Y axis number, then creating a three-point pattern that was replicated in every box of the roughly 6 ft by 6 ft grid.

Once the pattern was established, the sample and both replicates were collected in each grid throughout the entirety of the DU 3. The first 6 ft by 6 ft grid box was measured using a tape measure and the parent sampling location was determined within that grid box. The second grid box was determined measuring 6 ft perpendicular to the shoreline. This process continued until reaching the opposite shoreline. The next grid box was measured laterally to the shoreline and the process was repeated perpendicular to the shore. This process was repeated until the fourth corner of DU 3 was reached. During the sampling, one increment location within each grid square was marked with a flag in order to count the number of grid squares that the DU contained. The DU was photographed at the completion of sampling (Attachment 2). This resulted in 38 10-cm long sediment increments collected into the correctly labeled zip-lock bag for the primary and two replicate samples. When sampling was completed at 10:45 AM, the labeled sample zip-lock bags were double bagged and packed into coolers for the laboratory. The ASM, Inc. Soil Step Probes were thoroughly decontaminated at this time.

At 10:50 AM on June 23, 2021, the random number generator was used to create the pattern for DU 2. Sampling started at the corner of DU 2 labeled DU 1/2B, following the same procedure used in sampling of DU 3. Due to the area of the DU 2 being larger, the grid size was increased to an 8 ft. by 8 ft. grid, and 35 sediment increments were collected. Each grid box was sampled in the same manner as DU 3, above. DU 2 sampling was completed at 12:55 PM and the ASM Soil Step Probe was thoroughly decontaminated.

At 1:50 PM on June 23, 2021, the random number generator created the pattern for DU 1. Sampling started at the corner of DU 1 labeled DU 1-A. Due to the area of DU 1 being roughly the same area of DU 3, 38 sediment increments were collected in this area using a 6 ft by 6 ft grid. The sampling of DU 1 was completed at 3:00 PM and the ASM, Inc. Soil Step Probes were thoroughly decontaminated. After decontamination of the sampling gear was completed, an equipment blank was collected at 4:00 PM and labeled EB-210623-02.

The composite sample aliquots were sent to the Eurofins Test America West Sacramento, California laboratory for analysis. Following ISM preparation at the laboratory consisting of drying at room temperature, disaggregation, sieving, splitting, and subsampling the prime sample and two replicate samples from the subsequent analytical aliquot, each sample was analyzed by Method 1668C for the presence of PCB congeners. Total organic carbon (TOC) analysis was performed by Eurofins Test America at its Seattle, Washington laboratory. Both laboratories maintain DoD Environmental Laboratory Accreditation Program (ELAP) and Washington Department of Ecology accreditation for these procedures.

Data summary tables are included in Attachment 1, and provide:

- The measured concentrations of individual PCB congeners and TOC (Table 1)
- Summation of congener results to establish a total PCB concentration in each primary and replicate sample, and carbon-normalization (Table 2)
- ISM calculations of 95% UCL PCB concentrations for each DU using the ITRC calculator (Table 3).

For evaluation of the PCB congener data presented in this memorandum, all PCB congeners in the dataset have been summed to establish a total PCB concentration. Coelutions were counted as one congener, and congeners that were not detected above the limit of detection (LOD) were summed as zero.

## DATA EVALUATION

This section evaluates the PCB data with regard to the distribution of PCBs in the distal reach of Marsh Creek, at and downstream of seep SP1-1, and discusses the implications of the findings using ISM sampling techniques for future assessment of temporal trends. ITRC guidance (2020) recommends that comparison of either the Student's *t*-test or Chebyshev mean to the PAL be based on the relative standard deviation (RSD) of the replicates within each DU (the RSD is also known as the coefficient of variation or CV). The lower the RSD, the more precise the sampling results, and the more reproducible the data. An RSD less than 1.5 is considered to reflect good precision for estimates of the average. When the replicate RSD for a DU is less than 1.5, the Student's *t*-test result is recommended. When the replicate RSD is greater than 1.5, the Chebyshev result is recommended. The Chebyshev mean provides a more conservative (higher) estimate of the true mean, which reflects the greater uncertainty represented by the higher RSD.

Table 3 presents the RSDs of the three replicates collected from each DU. These results were used to select the appropriate test/values for comparison to PALs. The concentrations of PCBs in sediment within the study area established using ISM sampling techniques showed that concentrations in all three DUs exceeded the marine sediment SCO of 12 mg/kg OC. This conclusion is substantially different than conclusions reached over the last several years based on the results of discrete sediment samples collected within this reach of the creek. Discrete samples tended to exhibit PCB concentrations below the SCO value, with occasional, non-repeatable exceedances of the SCO at certain stations. It appears that the ISM results support the published assertion that the ISM methodology can overcome the typical high variability of sediment PCB concentrations over short distances (ITRC, 2020) and provide more representative estimates of actual mean concentrations.

DU 1 includes the area surrounding the seep, where seep water mixes with brackish water at high tide and potentially deposits PCBs throughout the DU. Of the three DUs, sediment from DU 1 exhibited the most consistently highest carbon-normalized PCB concentrations between the parent and replicate samples and the lowest standard deviation between the results of the parent and replicate samples. The 95% UCL for DU 1 was 23.3 mg/kg OC based on the Student's *t* statistic.

DU 2 spans the reach of creek between DU 1 and DU 3. The parent sediment sample from DU 2 exhibited the highest carbon-normalized PCB concentrations measured during this study, with substantially lower concentrations in the two replicate samples. This DU exhibited the highest standard deviation between the parent sample and the replicates. The 95% UCL for DU 2 was 54.6 mg/kg OC based on the Chebychev statistic, with this UCL driven higher by the substantially higher PCB concentration measured in the parent sample compared to the two replicates. A contributing factor to the high standard deviation in this DU may be the variability in organic carbon content.

DU 3 is representative of the hydrology as the creek mixes with stormwater flow (an outfall is present within this DU) and passes through the culvert and tide gate under Keys Road. Sediment samples from DU 3 consistently exhibited the lowest carbon-normalized PCB concentrations in the parent and replicate samples and the second lowest standard deviation. The 95% UCL for DU 3 was 12.6 mg/kg OC based on the Chebychev statistic.

If all three DUs are considered as a single unit (Table 3), the overall 95% UCL concentration of PCBs in sediment is 31.1 mg/kg OC, which exceeds the SCO of 12 mg/kg OC. A high standard deviation is calculated for the combined DUs. This high standard deviation across the DUs, along with the individual high standard deviations for DUs 2 and 3 and the much higher concentration in the primary sample from DU 2 compared to the replicates, indicates a high degree of heterogeneity in the distribution of PCBs in sediment within this reach of creek. To help overcome this heterogeneity and increase the representativeness of future samples (i.e., decrease the standard deviation), collecting 50 increments per primary and replicate sample and potentially bisecting DUs in an attempt to limit heterogeneity of contaminant concentrations are recommended.

## DATA USABILITY

The PCB congener and TOC data were validated by Laboratory Data Consultants, Inc. The PCB congeners were validated to Stage 4 level and the TOC data were validated to Stage 2B, as specified in the project SAP (U.S. Navy, 2021). TOC data required no qualification. One sample (DU3-SED-P-10) required estimation due to failed matrix spike recoveries associated with five congeners. One sample (DU1-SED-P-10) required estimation due to failed labeled compound recoveries associated with three congeners. PCB-1 and PCB-3 were also detected in laboratory blanks, resulting in reporting results in three and nine samples, respectively, of non-detect for these analytes. These minor qualifications do not adversely affect the quality of the data, and all sediment data are considered usable for the data quality objectives of this project.

## REFERENCES

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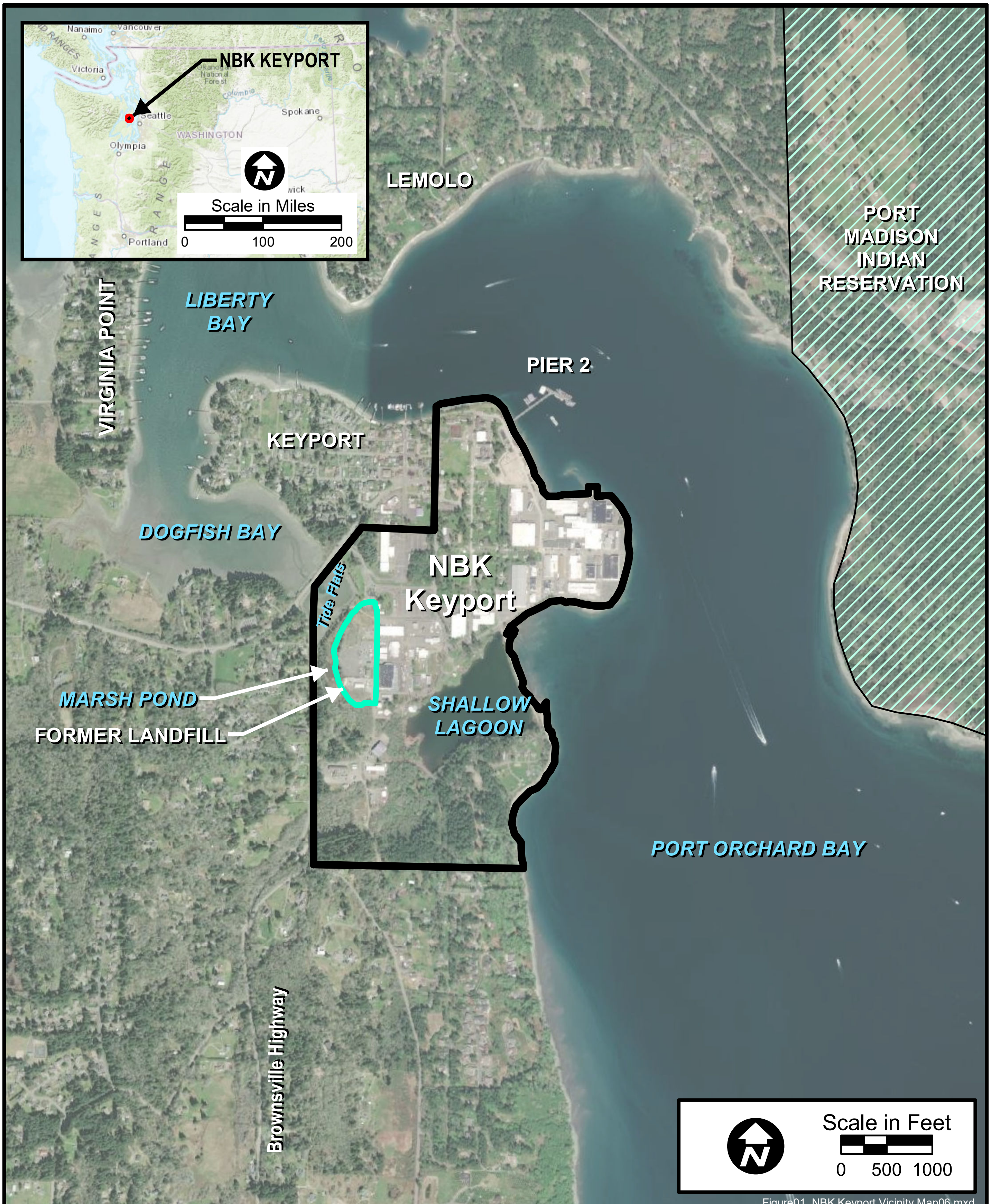
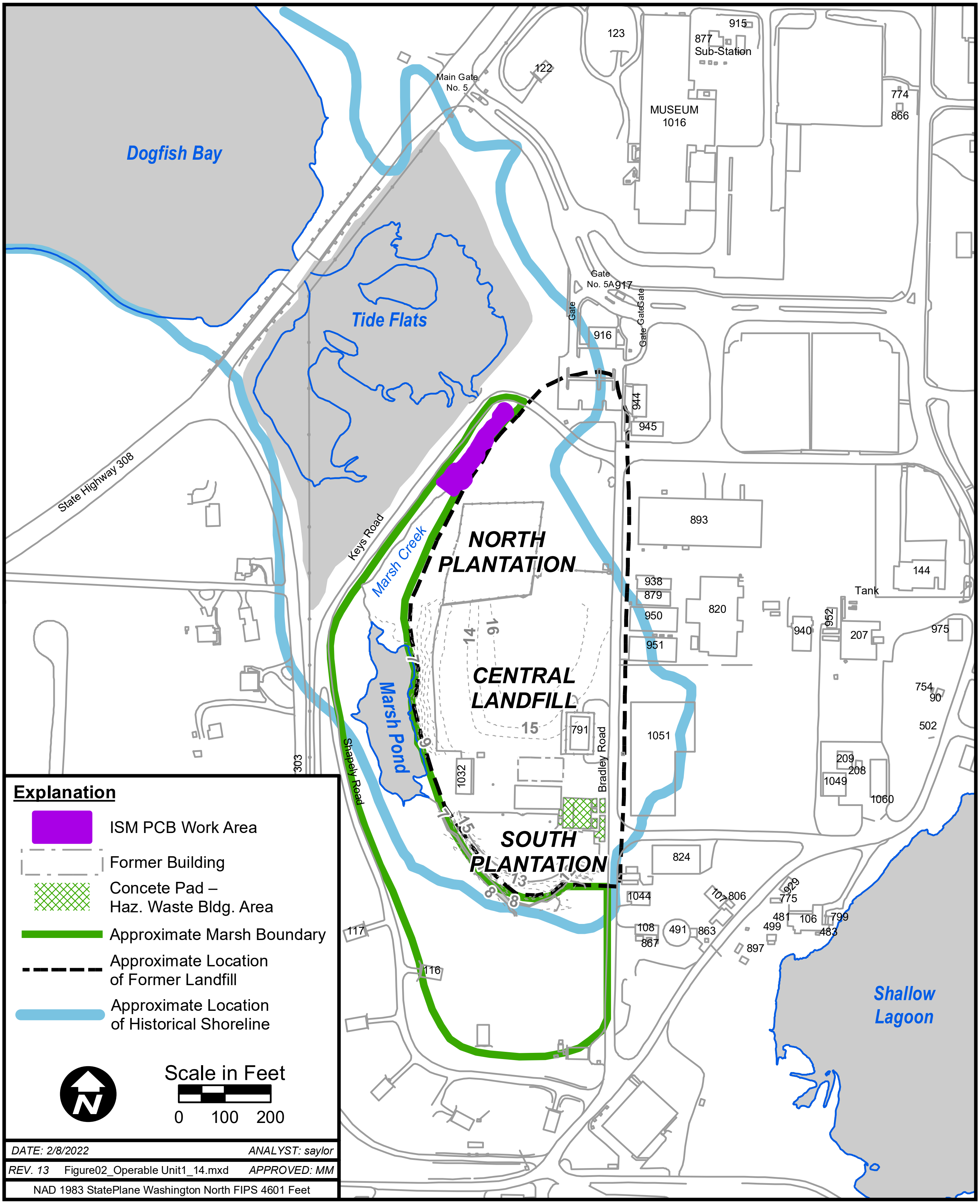
U.S. Navy. 2021. *Final Sampling and Analysis Plan for Keyport OU 1 PCB and Upland Soils Investigation, Naval Base Kitsap Keyport, Keyport, Washington*. Prepared by Battelle Memorial Institute for NAVFAC NW under Contract N39430-16-D-1802, Task Order N3943018F4359. June 17.

U.S. Navy, U.S. Environmental Protection Agency (U.S. EPA), and Washington State Department of Ecology (Ecology). 1998. *Record of Decision for Operable Unit 1, Naval Undersea Warfare Center Division, Keyport, Washington.* Prepared by URS Greiner and Science Applications International Corporation for EFA NW under CLEAN Contract No. N62474-89-D-9295, CTO 10. September 30.

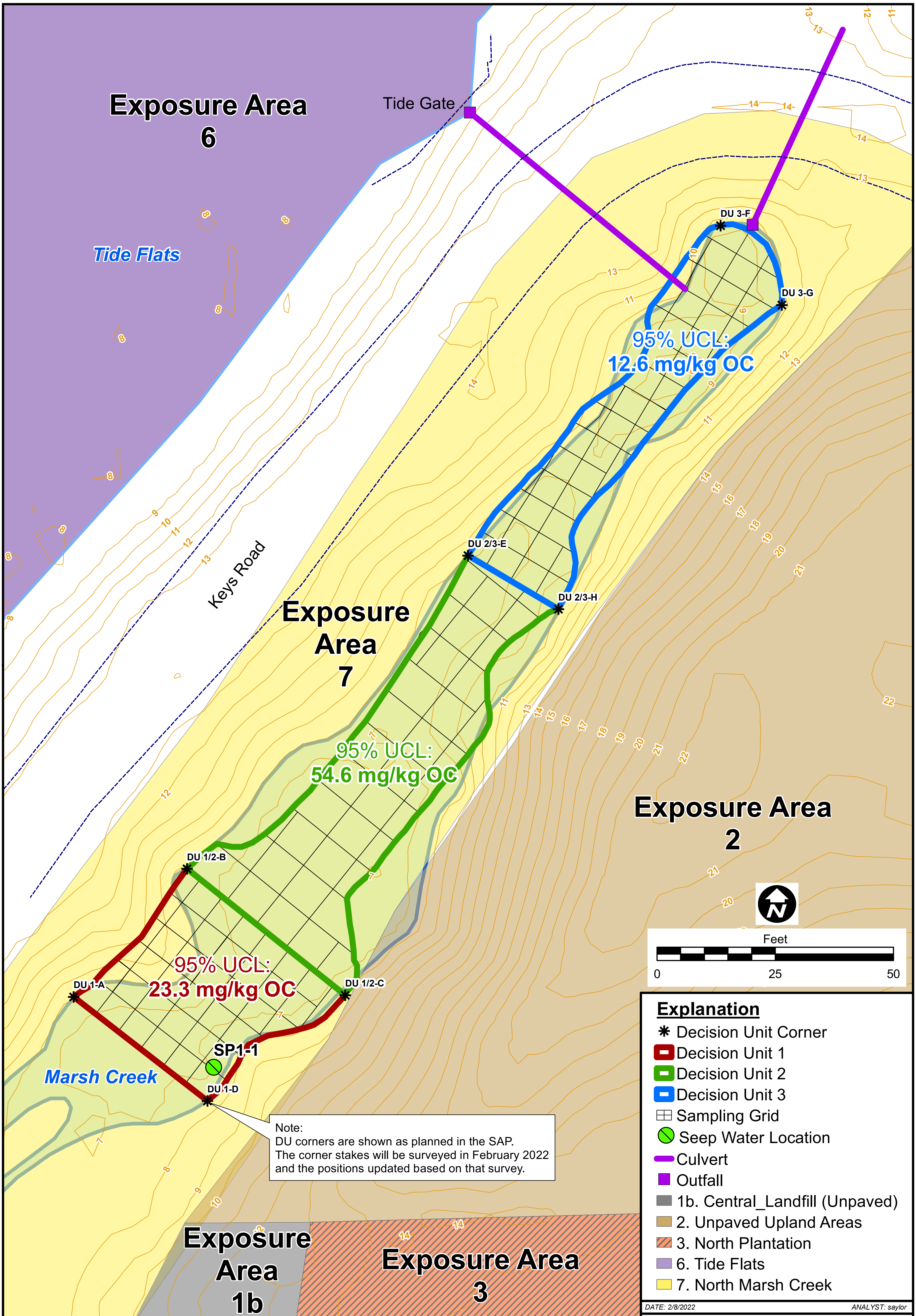
# FIGURES




| U.S. NAVY | **Figure 1**<br>**NBK Keyport Vicinity Map** | CTO F4359<br>NBK Keyport<br>ISM PCB Tech Memo |
|---|---|---|




| U.S. NAVY | Figure 2<br>Operable Unit 1 | CTO F4359<br>NBK Keyport<br>ISM PCB Tech Memo |
|---|---|---|




U.S. NAVY

**Figure 3**
**Exposure Area 7 Decision Units**

CTO F4359
NBK Keyport
ISM PCB Tech Memo

| | | |
|---|---|---|
| **U.S. NAVY** | **Figure 4**<br>**Example of Metal Rebar Stamped with Labeled Orange Caps** | NBK KEYPORT<br>ISM PCB Tech Memo |

# ATTACHMENTS

# ATTACHMENT 1: ISM PCB DATA SUMMARY TABLES

## Table 1
## ISM PCB and TOC Analytical Results

| LOCATION_NAME | | DU1 | | DU1 | | DU1 | | DU2 | | DU2 | | DU2 | | DU3 | | DU3 | | DU3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Depth Range (feet) | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | |
| SAMPLE_NAME | | DU1-SED-P-10-210623 | | DU1-SED-R1-10-210623 | | DU1-SED-R2-10-210623 | | DU2-SED-P-10-210623 | | DU2-SED-R1-10-210623 | | DU2-SED-R2-10-210623 | | DU3-SED-P-10-210623 | | DU3-SED-R1-10-210623 | | DU3-SED-R2-10-210623 | |
| ANALYTE | UNITS | ANALYTE_VALUE | Q | ANALYTE_VALUE | Q | ANALYTE_VALUE | Q | ANALYTE_VALUE | Q | ANALYTE_VALUE | Q | ANALYTE_VALUE | Q | ANALYTE_VALUE | Q | ANALYTE_VALUE | Q | ANALYTE_VALUE | Q |
| TOTAL ORGANIC CARBON | MG_KG | 14000 | | 18000 | | 14000 | | 9300 | | 10000 | | 16000 | | 10000 | | 8000 | | 8500 | |
| PCB-001 | NG_KG | 60 | J | 42 | J | 40 | J | 140 | | 39 | | 47 | J | 16 | U | 12 | U | 21 | U |
| PCB-002 | NG_KG | 47 | J | 100 | | 80 | J | 80 | | 37 | | 76 | J | 43 | | 39 | | 46 | |
| PCB-003 | NG_KG | 37 | U | 35 | U | 52 | U | 76 | U | 32 | U | 32 | U | 22 | U | 20 | U | 18 | U |
| PCB-004 | NG_KG | 150 | | 89 | J | 110 | | 230 | | 100 | | 130 | | 110 | J | 43 | | 62 | |
| PCB-005 | NG_KG | 24 | U | 24 | U | 24 | U | 4.7 | U | 4.7 | U | 24 | U | 10 | U | 4.9 | U | 4.6 | U |
| PCB-006 | NG_KG | 230 | | 240 | | 440 | | 610 | | 230 | | 170 | | 74 | | 49 | | 69 | |
| PCB-007 | NG_KG | 20 | J | 22 | J | 38 | J | 34 | | 19 | | 24 | U | 10 | U | 4.9 | U | 8.4 | J |
| PCB-008 | NG_KG | 330 | | 200 | | 190 | | 350 | | 190 | | 190 | | 240 | | 110 | | 120 | |
| PCB-009 | NG_KG | 20 | J | 15 | J | 23 | J | 26 | | 13 | J | 24 | U | 10 | U | 4.9 | U | 7.1 | J |
| PCB-010 | NG_KG | 8.9 | J | 5 | J | 24 | U | 13 | J | 6.7 | J | 24 | U | 10 | U | 4.9 | U | 4.5 | J |
| PCB-011 | NG_KG | 72 | J | 69 | J | 130 | | 190 | | 210 | | 59 | J | 39 | J | 45 | | 49 | |
| PCB-012 AND 013 | NG_KG | 65 | J | 68 | J | 130 | J | 120 | | 120 | | 48 | U | 20 | U | 29 | J | 31 | J |
| PCB-014 | NG_KG | 24 | U | 24 | U | 24 | U | 4.7 | U | 4.7 | U | 24 | U | 10 | U | 4.9 | U | 4.6 | U |
| PCB-015 | NG_KG | 320 | | 230 | | 200 | | 260 | | 180 | | 220 | | 170 | | 150 | | 130 | |
| PCB-016 | NG_KG | 450 | | 150 | | 93 | J | 170 | | 98 | | 110 | | 180 | | 81 | | 72 | |
| PCB-017 | NG_KG | 660 | | 380 | | 850 | | 640 | | 370 | | 220 | | 220 | | 110 | | 100 | |
| PCB-019 | NG_KG | 280 | | 190 | | 500 | | 300 | | 88 | | 91 | J | 61 | J | 29 | | 39 | |
| PCB-021 AND 033 | NG_KG | 870 | | 380 | | 260 | | 350 | | 170 | | 140 | J | 300 | | 180 | | 110 | J |
| PCB-022 | NG_KG | 440 | | 150 | | 92 | J | 140 | | 1.9 | U | 76 | J | 170 | | 120 | | 78 | |
| PCB-023 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-024 | NG_KG | 16 | J | 7.5 | J | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 5.2 | J | 2.9 | J | 2.4 | J |
| PCB-025 | NG_KG | 910 | | 1100 | | 3600 | | 4200 | | 1800 | | 460 | | 98 | | 77 | | 250 | |
| PCB-026 AND 029 | NG_KG | 2900 | | 3400 | | 11000 | | 12000 | | 4100 | | 1200 | | 210 | | 160 | | 560 | |
| PCB-027 | NG_KG | 290 | | 340 | | 850 | | 630 | | 280 | | 160 | | 53 | | 34 | | 55 | |
| PCB-028 AND 020 | NG_KG | 1400 | | 800 | | 790 | | 1400 | | 560 | | 470 | | 540 | | 360 | | 350 | |
| PCB-030 AND 018 | NG_KG | 1400 | | 820 | | 2500 | | 1500 | | 780 | | 510 | | 390 | | 190 | | 170 | |
| PCB-031 | NG_KG | 1400 | | 930 | | 1700 | | 2200 | | 930 | | 440 | | 440 | | 290 | | 290 | |
| PCB-032 | NG_KG | 670 | | 460 | | 1400 | | 750 | | 200 | | 240 | | 160 | | 83 | | 81 | |
| PCB-034 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-035 | NG_KG | 42 | J | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 10 | J | 0.92 | U |
| PCB-036 | NG_KG | 200 | | 290 | | 670 | | 0.94 | U | 220 | | 4.8 | U | 29 | J | 0.98 | U | 0.92 | U |
| PCB-037 | NG_KG | 530 | | 330 | | 200 | | 200 | | 96 | J | 140 | | 240 | | 140 | | 120 | |
| PCB-038 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-039 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-040 AND 071 | NG_KG | 1900 | | 2200 | | 7300 | | 4300 | | 1800 | | 1100 | | 360 | | 180 | | 340 | |
| PCB-041 | NG_KG | 9.6 | U | 9.7 | U | 9.6 | U | 1.9 | U | 1.9 | U | 9.7 | U | 43 | | 2 | U | 1.8 | U |
| PCB-042 | NG_KG | 580 | | 830 | | 590 | | 1800 | | 530 | | 320 | | 240 | | 100 | | 220 | |
| PCB-043 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 28 | J | 0.98 | U | 0.92 | U |
| PCB-044 AND 047 AND 065 | NG_KG | 4000 | | 6000 | | 7800 | | 10000 | | 4900 | | 2200 | | 990 | | 440 | | 1300 | |
| PCB-045 | NG_KG | 290 | | 180 | | 4.8 | U | 0.94 | U | 170 | | 4.8 | U | 92 | | 47 | | 57 | |
| PCB-046 | NG_KG | 160 | | 150 | | 4.8 | U | 480 | | 160 | | 4.8 | U | 41 | | 21 | | 44 | |
| PCB-048 | NG_KG | 240 | | 210 | | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 99 | | 46 | | 62 | |
| PCB-050 AND 053 | NG_KG | 1200 | | 1500 | | 5300 | | 2800 | | 790 | | 660 | | 160 | | 91 | | 160 | |
| PCB-051 | NG_KG | 290 | | 340 | | 1100 | | 690 | | 210 | | 140 | | 35 | J | 17 | J | 31 | |
| PCB-052 | NG_KG | 10000 | | 16000 | | 27000 | | 27000 | | 11000 | | 5600 | | 1700 | | 890 | | 2700 | |
| PCB-054 | NG_KG | 29 | J | 31 | J | 87 | J | 44 | | 7.9 | J | 11 | J | 2.4 | J | 1.3 | J | 1.5 | J |
| PCB-055 | NG_KG | 210 | | 4.9 | U | 96 | | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-056 | NG_KG | 770 | | 910 | | 480 | | 680 | | 250 | | 290 | | 240 | | 110 | | 240 | |
| PCB-057 | NG_KG | 100 | | 71 | J | 62 | J | 280 | | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-058 | NG_KG | 44 | J | 57 | J | 45 | J | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 53 | | 0.92 | U |
| PCB-059 AND 062 AND 075 | NG_KG | 480 | | 530 | | 770 | | 1600 | | 1000 | | 230 | J | 96 | J | 54 | J | 220 | |
| PCB-060 | NG_KG | 370 | | 340 | | 170 | | 180 | | 75 | | 110 | | 110 | | 49 | | 84 | |
| PCB-061 AND 070 AND 074 AND 076 | NG_KG | 6000 | | 9200 | | 5700 | | 7500 | | 2700 | | 2800 | | 1400 | | 700 | | 2200 | |
| PCB-063 | NG_KG | 160 | | 200 | | 110 | | 200 | | 68 | | 74 | J | 50 | | 19 | J | 36 | J |
| PCB-064 | NG_KG | 1000 | | 1500 | | 1300 | | 1900 | | 850 | | 530 | | 300 | | 140 | | 330 | |
| PCB-066 | NG_KG | 3100 | | 4300 | | 3700 | | 4800 | | 1600 | | 1700 | | 900 | | 440 | | 990 | |
| PCB-067 | NG_KG | 350 | | 280 | | 470 | | 540 | | 120 | | 100 | | 41 | | 26 | | 26 | J |
| PCB-068 | NG_KG | 170 | | 200 | | 430 | | 460 | | 170 | | 91 | J | 32 | J | 13 | J | 30 | J |
| PCB-069 AND 049 | NG_KG | 5500 | | 7600 | | 17000 | | 17000 | | 7300 | | 3000 | | 950 | | 440 | | 1300 | |
| PCB-072 | NG_KG | 340 | | 400 | | 890 | | 840 | | 340 | | 160 | | 52 | | 23 | | 59 | |
| PCB-073 | NG_KG | 4.8 | U | 110 | | 230 | | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-077 | NG_KG | 430 | | 530 | | 340 | | 370 | J | 130 | | 220 | | 120 | | 70 | | 140 | |
| PCB-078 | NG_KG | 110 | | 140 | | 85 | J | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 19 | J |
| PCB-079 | NG_KG | 200 | | 260 | | 170 | | 210 | | 64 | | 68 | J | 36 | J | 21 | | 59 | |
| PCB-080 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 99 | | 32 | | 4.8 | U | 21 | J | 13 | J | 35 | |
| PCB-081 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-082 | NG_KG | 1600 | | 2200 | | 1100 | | 1200 | | 440 | | 670 | | 300 | | 200 | | 580 | |
| PCB-083 | NG_KG | 1200 | | 1200 | | 1000 | | 820 | | 260 | | 410 | | 240 | | 120 | | 300 | |
| PCB-084 | NG_KG | 4500 | | 6900 | | 5200 | | 6200 | | 2600 | | 2000 | | 1000 | | 520 | | 1700 | |

**Table 1**
**ISM PCB and TOC Analytical Results**

| | LOCATION_NAME | DU1 | | DU1 | | DU1 | | DU2 | | DU2 | | DU2 | | DU3 | | DU3 | | DU3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Depth Range (feet) | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | |
| | SAMPLE_NAME | DU1-SED-P-10-210623 | | DU1-SED-R1-10-210623 | | DU1-SED-R2-10-210623 | | DU2-SED-P-10-210623 | | DU2-SED-R1-10-210623 | | DU2-SED-R2-10-210623 | | DU3-SED-P-10-210623 | | DU3-SED-R1-10-210623 | | DU3-SED-R2-10-210623 | |
| ANALYTE | UNITS | ANALYTE_VALUE | Q | ANALYTE_VALUE | Q | ANALYTE_VALUE | Q | ANALYTE_VALUE | Q | ANALYTE_VALUE | Q | ANALYTE_VALUE | Q | ANALYTE_VALUE | Q | ANALYTE_VALUE | Q | ANALYTE_VALUE | Q |
| PCB-088 AND 091 | NG_KG | 3200 | | 4600 | | 5800 | | 6100 | | 3200 | | 1500 | | 670 | | 400 | | 1100 | |
| PCB-089 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-092 | NG_KG | 3200 | | 4500 | | 2500 | | 3100 | | 1100 | | 1400 | | 750 | | 460 | | 1200 | |
| PCB-093 AND 100 | NG_KG | 9.6 | U | 9.7 | U | 490 | | 570 | | 1.9 | U | 9.7 | U | 4 | U | 2 | U | 1.8 | U |
| PCB-094 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-095 | NG_KG | 13000 | J | 20000 | | 17000 | | 19000 | | 8700 | | 6500 | | 3100 | | 1700 | | 4800 | |
| PCB-096 | NG_KG | 130 | | 180 | | 300 | | 240 | | 86 | | 65 | J | 25 | J | 11 | J | 34 | |
| PCB-098 AND 102 | NG_KG | 860 | | 1100 | | 1600 | | 1700 | | 450 | | 420 | | 170 | | 99 | | 240 | |
| PCB-099 | NG_KG | 9800 | J | 13000 | | 9200 | | 12000 | | 3400 | | 4400 | | 2000 | | 1300 | | 2700 | |
| PCB-103 | NG_KG | 4.8 | U | 4.9 | U | 560 | | 650 | | 260 | | 140 | | 2 | U | 29 | | 0.92 | U |
| PCB-104 | NG_KG | 6.4 | J | 7.3 | J | 22 | J | 17 | J | 4.7 | J | 2.5 | J | 2 | U | 0.37 | J | 0.76 | J |
| PCB-105 | NG_KG | 6900 | | 8400 | | 4800 | | 4400 | | 1500 | | 3000 | | 950 | | 700 | | 1700 | |
| PCB-106 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-107 AND 124 | NG_KG | 600 | | 670 | | 410 | | 560 | | 200 | | 270 | | 94 | | 79 | | 220 | |
| PCB-108 AND 119 AND 086 AND 097 AND 125 AND 087 | NG_KG | 12000 | | 15000 | | 9600 | | 9900 | | 4200 | | 4500 | | 2000 | | 1400 | | 4100 | |
| PCB-109 | NG_KG | 1300 | | 1600 | | 920 | | 1300 | | 490 | | 620 | | 260 | | 180 | | 430 | |
| PCB-110 AND 115 | NG_KG | 22000 | J | 30000 | | 23000 | | 26000 | | 9100 | | 9600 | | 4300 | | 3000 | | 1.8 | U |
| PCB-111 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-112 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-113 AND 090 AND 101 | NG_KG | 18000 | | 25000 | | 15000 | | 17000 | | 5400 | | 7200 | | 3600 | | 2300 | | 5200 | |
| PCB-114 | NG_KG | 350 | | 380 | | 4.8 | U | 260 | | 100 | | 170 | | 2 | U | 34 | | 120 | |
| PCB-117 AND 116 AND 085 | NG_KG | 2900 | | 3200 | J | 1900 | | 2900 | | 880 | | 1300 | | 520 | | 370 | | 1000 | J |
| PCB-118 | NG_KG | 20000 | | 23000 | | 14000 | | 18000 | | 5400 | | 8800 | | 3100 | | 1900 | | 4800 | |
| PCB-120 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-121 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-122 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 140 | | 2 | U | 37 | | 99 | |
| PCB-123 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 270 | | 90 | | 170 | | 2 | U | 41 | | 93 | J |
| PCB-126 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-127 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-128 AND 166 | NG_KG | 5300 | | 5300 | | 3800 | | 3200 | | 1000 | | 1900 | | 860 | | 580 | | 1400 | |
| PCB-130 | NG_KG | 2000 | | 2100 | | 1300 | | 1200 | | 390 | | 720 | | 350 | | 230 | | 570 | |
| PCB-131 | NG_KG | 410 | | 460 | | 260 | | 270 | | 89 | | 130 | | 71 | | 46 | | 110 | |
| PCB-132 | NG_KG | 7800 | | 8500 | | 4800 | | 4900 | | 1600 | | 2500 | | 1300 | | 840 | | 2200 | |
| PCB-133 | NG_KG | 330 | | 360 | | 190 | | 240 | | 77 | | 120 | | 63 | | 45 | | 99 | |
| PCB-134 AND 143 | NG_KG | 1200 | | 1400 | | 750 | | 840 | | 260 | | 440 | | 240 | | 150 | | 360 | |
| PCB-136 | NG_KG | 2100 | | 2500 | | 2100 | | 2100 | | 790 | | 730 | | 380 | | 210 | | 570 | |
| PCB-137 | NG_KG | 1700 | | 1700 | | 1200 | | 980 | | 310 | | 620 | | 290 | | 180 | | 470 | |
| PCB-138 AND 163 AND 129 | NG_KG | 29000 | | 29000 | | 20000 | | 15000 | | 5500 | | 9400 | | 4500 | | 3000 | | 7000 | |
| PCB-139 AND 140 | NG_KG | 680 | | 730 | | 520 | | 500 | | 160 | | 250 | | 120 | | 76 | | 170 | |
| PCB-141 | NG_KG | 3200 | | 3300 | | 1900 | | 1600 | | 510 | | 910 | | 560 | | 340 | | 940 | |
| PCB-142 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-144 | NG_KG | 770 | | 850 | | 530 | | 470 | | 160 | | 250 | | 140 | | 84 | | 220 | |
| PCB-145 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-146 | NG_KG | 2600 | | 2800 | | 1800 | | 1800 | | 570 | | 930 | | 510 | | 320 | | 760 | |
| PCB-147 AND 149 | NG_KG | 15000 | | 16000 | | 13000 | | 13000 | | 4000 | | 5000 | | 2600 | | 1600 | | 3900 | |
| PCB-148 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-150 | NG_KG | 4.8 | U | 4.9 | U | 65 | J | 61 | | 24 | | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-151 AND 135 | NG_KG | 4300 | | 4900 | | 2800 | | 3200 | | 980 | | 1500 | | 900 | | 560 | | 1400 | |
| PCB-152 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-153 AND 168 | NG_KG | 18000 | | 18000 | | 13000 | | 11000 | | 3600 | | 5800 | | 2900 | | 1900 | | 4300 | |
| PCB-154 | NG_KG | 300 | | 310 | | 380 | | 400 | | 130 | | 120 | | 56 | | 36 | | 71 | |
| PCB-155 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-156 AND 157 | NG_KG | 3800 | | 3300 | | 2200 | | 2300 | | 730 | | 1200 | | 490 | J | 350 | | 910 | |
| PCB-158 | NG_KG | 2900 | | 2800 | | 2100 | | 1800 | | 550 | | 920 | | 410 | | 260 | | 680 | |
| PCB-159 | NG_KG | 74 | J | 75 | J | 54 | J | 27 | J | 11 | J | 16 | J | 12 | J | 8.7 | J | 21 | |
| PCB-160 | NG_KG | 9.6 | U | 9.7 | U | 9.6 | U | 1.9 | U | 1.9 | U | 9.7 | U | 4 | U | 2 | U | 1.8 | U |
| PCB-161 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-162 | NG_KG | 110 | | 110 | | 65 | J | 64 | | 21 | | 36 | J | 17 | J | 13 | J | 35 | |
| PCB-164 | NG_KG | 1900 | | 2000 | | 1300 | | 1200 | | 370 | | 580 | | 330 | | 210 | | 500 | |
| PCB-165 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-167 | NG_KG | 1200 | | 1200 | | 800 | | 820 | | 260 | | 430 | | 200 | J | 140 | | 330 | |
| PCB-169 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-170 | NG_KG | 2700 | | 2500 | | 2100 | | 1800 | | 550 | | 930 | | 550 | | 370 | | 890 | |
| PCB-171 AND 173 | NG_KG | 930 | | 870 | | 680 | | 590 | | 190 | | 290 | | 180 | | 120 | | 280 | |
| PCB-172 | NG_KG | 460 | | 430 | | 320 | | 260 | | 88 | | 130 | | 93 | | 67 | | 160 | |
| PCB-174 | NG_KG | 1700 | | 1700 | | 1200 | | 1000 | | 310 | | 470 | | 370 | | 250 | | 610 | |
| PCB-175 | NG_KG | 140 | | 130 | | 110 | | 74 | | 23 | | 40 | J | 25 | J | 16 | J | 40 | |
| PCB-176 | NG_KG | 360 | | 360 | | 310 | | 210 | | 74 | | 100 | | 64 | | 40 | | 98 | |
| PCB-177 | NG_KG | 1100 | | 1000 | | 810 | | 720 | | 230 | | 350 | | 240 | | 170 | | 380 | |
| PCB-178 | NG_KG | 440 | | 440 | | 360 | | 240 | | 82 | | 150 | | 97 | | 63 | | 140 | |

## Table 1
## ISM PCB and TOC Analytical Results

| | LOCATION_NAME | DU1 | | DU1 | | DU1 | | DU2 | | DU2 | | DU2 | | DU3 | | DU3 | | DU3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Depth Range (feet) | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | | 0 - 0.3 | |
| | SAMPLE_NAME | DU1-SED-P-10-210623 | | DU1-SED-R1-10-210623 | | DU1-SED-R2-10-210623 | | DU2-SED-P-10-210623 | | DU2-SED-R1-10-210623 | | DU2-SED-R2-10-210623 | | DU3-SED-P-10-210623 | | DU3-SED-R1-10-210623 | | DU3-SED-R2-10-210623 | |
| **ANALYTE** | **UNITS** | **ANALYTE_VALUE** | **Q** | **ANALYTE_VALUE** | **Q** | **ANALYTE_VALUE** | **Q** | **ANALYTE_VALUE** | **Q** | **ANALYTE_VALUE** | **Q** | **ANALYTE_VALUE** | **Q** | **ANALYTE_VALUE** | **Q** | **ANALYTE_VALUE** | **Q** | **ANALYTE_VALUE** | **Q** |
| PCB-179 | NG_KG | 700 | | 710 | | 560 | | 380 | | 120 | | 220 | | 150 | | 90 | | 210 | |
| PCB-180 AND 193 | NG_KG | 3800 | | 3700 | | 2900 | | 2400 | | 730 | | 1200 | | 800 | | 540 | | 1300 | |
| PCB-181 | NG_KG | 73 | J | 68 | J | 52 | J | 54 | | 17 | J | 20 | J | 12 | J | 7.7 | J | 22 | |
| PCB-182 | NG_KG | 39 | J | 33 | J | 31 | J | 22 | | 7.5 | J | 10 | J | 6.3 | J | 2.9 | J | 8 | J |
| PCB-183 | NG_KG | 1200 | | 1100 | | 92 | J | 730 | | 240 | | 340 | | 210 | | 140 | | 340 | |
| PCB-184 | NG_KG | 5.1 | J | 5.6 | J | 6.1 | J | 3.5 | J | 1.5 | J | 1.5 | J | 2 | U | 0.74 | J | 1.6 | J |
| PCB-185 | NG_KG | 210 | | 200 | | 1300 | | 210 | | 45 | J | 65 | J | 63 | J | 41 | | 95 | |
| PCB-186 | NG_KG | 2.5 | J | 2.4 | J | 2.2 | J | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-187 | NG_KG | 1900 | | 1900 | | 1500 | | 1100 | | 360 | | 660 | | 430 | | 270 | | 600 | |
| PCB-188 | NG_KG | 6.1 | J | 5.5 | J | 5.2 | J | 5.5 | J | 2.3 | J | 2.2 | J | 1.2 | J | 1.4 | J | 2.6 | J |
| PCB-189 | NG_KG | 160 | | 140 | | 110 | | 91 | | 31 | | 48 | | 28 | | 20 | | 46 | |
| PCB-190 | NG_KG | 430 | | 400 | | 350 | | 260 | | 86 | | 140 | | 86 | | 60 | | 140 | |
| PCB-191 | NG_KG | 120 | | 120 | | 97 | | 82 | | 26 | | 36 | J | 22 | J | 16 | J | 39 | |
| PCB-192 | NG_KG | 4.8 | U | 4.9 | U | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-194 | NG_KG | 480 | | 480 | | 400 | | 330 | | 99 | | 150 | | 120 | | 88 | | 180 | |
| PCB-195 | NG_KG | 190 | | 180 | | 160 | | 120 | | 38 | | 56 | J | 45 | | 32 | | 70 | |
| PCB-196 | NG_KG | 350 | | 360 | | 290 | | 210 | | 62 | | 110 | | 86 | | 57 | | 120 | |
| PCB-197 | NG_KG | 29 | J | 27 | J | 24 | J | 15 | J | 5.8 | J | 7.3 | J | 5.5 | J | 4.9 | J | 9.9 | J |
| PCB-198 AND 199 | NG_KG | 550 | | 600 | | 460 | | 320 | | 100 | | 180 | J | 180 | | 110 | | 240 | |
| PCB-200 | NG_KG | 98 | | 97 | | 71 | J | 54 | | 15 | J | 23 | J | 25 | J | 15 | J | 34 | |
| PCB-201 | NG_KG | 97 | | 100 | | 80 | J | 58 | | 20 | | 29 | J | 27 | J | 18 | J | 39 | |
| PCB-202 | NG_KG | 120 | | 120 | | 98 | | 72 | | 29 | | 41 | J | 41 | | 29 | | 60 | |
| PCB-203 | NG_KG | 370 | | 370 | | 310 | | 210 | | 66 | | 120 | | 110 | | 69 | | 140 | |
| PCB-204 | NG_KG | 0.82 | J | 1.3 | J | 4.8 | U | 0.94 | U | 0.95 | U | 4.8 | U | 2 | U | 0.98 | U | 0.92 | U |
| PCB-205 | NG_KG | 39 | J | 34 | J | 32 | J | 25 | | 6.5 | J | 9.8 | J | 7.5 | J | 5.3 | J | 12 | J |
| PCB-206 | NG_KG | 310 | | 340 | | 300 | | 200 | | 72 | | 130 | | 170 | | 90 | | 280 | |
| PCB-207 | NG_KG | 46 | J | 49 | J | 40 | J | 28 | | 9.4 | J | 18 | J | 21 | J | 13 | J | 33 | |
| PCB-208 | NG_KG | 100 | | 120 | | 100 | | 63 | | 29 | | 49 | J | 74 | | 38 | | 120 | |
| PCB-209 | NG_KG | 220 | | 270 | | 210 | | 140 | | 69 | | 140 | | 200 | J | 93 | | 300 | |

Notes;

PCB - polychlorinated biphenyls

mg/kg - milligrams per kilogram

ng/kg - nanograms per kilogram

Q - qualifier

J - estimated

U - undetected

**Table 2**
**ISM Total PCB Results Normalized to TOC**

| | LOCATION_NAME | DU1 | DU1 | DU1 | DU2 | DU2 | DU2 | DU3 | DU3 | DU3 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Depth Range (feet) | 0 - 0.3 | 0 - 0.3 | 0 - 0.3 | 0 - 0.3 | 0 - 0.3 | 0 - 0.3 | 0 - 0.3 | 0 - 0.3 | 0 - 0.3 |
| | SAMPLE_NAME | DU1-SED-P-10-210623 | DU1-SED-R1-10-210623 | DU1-SED-R2-10-210623 | DU2-SED-P-10-210623 | DU2-SED-R1-10-210623 | DU2-SED-R2-10-210623 | DU3-SED-P-10-210623 | DU3-SED-R1-10-210623 | DU3-SED-R2-10-210623 |
| **GROUP** | **RESULT_UNITS** | **ANALYTE_VALUE** | **ANALYTE_VALUE** | **ANALYTE_VALUE** | **ANALYTE_VALUE** | **ANALYTE_VALUE** | **ANALYTE_VALUE** | **ANALYTE_VALUE** | **ANALYTE_VALUE** | **ANALYTE_VALUE** |
| TOC | MG_KG | 14000 | 18000 | 14000 | 9300 | 10000 | 16000 | 10000 | 8000 | 8500 |
| Total PCB | NG_KG | 297499.82 | 352471.6 | 311897.5 | 321542 | 118890.3 | 118598.3 | 56828.1 | 35343.21 | 77960.76 |
| Total PCB TOC NORMALIZED | NG_KG | 21249987.14 | 19581755.56 | 22278392.86 | 34574408.6 | 11889030 | 7412393.75 | 5682810 | 4417901.25 | 9171854.118 |

Notes:

TOC - total organic carbon

PCB - polychlorinated biphenyl

mg/kg - milligrams per kilogram

ng/kg - nanograms per kilogram

Total PCB is sum of PCB congeners where ND (U qualified values) are taken as zero.

## Table 3
## ISM Calculations

| Row # | IDs/Names of the DUs | DU Area (sq ft) | Replicate field sample concentrations (mg/kg OC) | | | | | | Number of Replicates | Weight | Arithmetic Mean (mg/kg OC) | SD of Replicates | calc'd SD of Increments | calc'd CV for the DU | Adj Factor | adj'd SD of Replicates | **adj'd CV for DU*** | SE of DU | 95% UCL Mean Concentration (mg/kg OC) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 | Rep 6 | | | | | | | | | | | Student's-t | Chebychev | CV of Replicates | 95% UCL |
| 1 | 1 | 1,321 | 21.25 | 19.58 | 22.28 | | | | 3 | 0.27 | 21.0 | 1.36 | 8.40 | 0.40 | 1.13 | 9.47 | 0.45 | 0.79 | 23.3 | 24.5 | Low | 23.3 |
| 2 | 2 | 2,058 | 34.57 | 11.89 | 7.41 | | | | 3 | 0.43 | 18.0 | 14.56 | 86.14 | 4.80 | 2.46 | 211.75 | 11.79 | 8.41 | 42.5 | 54.6 | High | 54.6 |
| 3 | 3 | 1,439 | 5.68 | 4.42 | 9.17 | | | | 3 | 0.30 | 6.4 | 2.46 | 15.17 | 2.36 | 1.41 | 21.43 | 3.34 | 1.42 | 10.6 | 12.6 | High | 12.6 |
| **Combined Results:** | | 4,818 | -- | -- | -- | -- | -- | -- | 9 | 1.00 | 15.4 | 6.27 | 37.15 | 2.42 | NA | 90.71 | 5.91 | 3.62 | 25.9 | 31.1 | High | 31.1 |

| df by Welch-Satterthwaite approximation: | **2.1** |
|---|---|

**Combined UCL:** 31.1 mg/kg OC >> Chebyshev 95% UCL mean

Note: Chebychev 95% UCL mean is recommended because the dispersion of the data is elevated based on the RSD/CV.

**Increments per DU:** DU 1 - 38; DU 2 - 35; DU 3 - 38

***Student's *t* mean is acceptable if the adjusted CV for a DU is "Low" (e.g., CV ≤ 1.5). For adjusted CVs >1.5, the Chebychev mean is recommended.**

**Notes**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| adj'd | = adjusted | df | = degrees of freedom | SD | = arithmetic standard deviation | sq ft | = square feet |
| calc'd | = calculated | DU | = decision unit | SE | = standard error | mg/kg OC | = milligrams per kilogram normalized for organic carbon |
| CV | = coefficient of variation (a.k.a. "RSD") | RSD | = relative standard deviation (a.k.a. "CV") | 95% UCL | = 95% upper confidence limit for arithmetic mean | | |

# ATTACHMENT 2: PHOTOLOG

Photo 1: Marking the DU boundaries with the GPS Unit.

Photo 2: Marking upstream boundary of DU1 located directly upstream from the seep.


Photo 3: Marked downstream boundaries of DU 3, looking north towards markers DU 3-G and DU 3-F.

Photo 4: Flagged sampling grid of DU 3, observing in the north direction towards boundary markers DU 3-G and DU 3-F. Replicate 1 was the flagged sampling location.

Photo 5: Flagged sampling grid of DU 3, observing in the south direction from the middle of the DU. Replicate 1 was the flagged sampling location.

Photo 6: Flagged sampling grid of DU 3, observing in the south direction towards boundary marker DU 2/3-E from the middle of the DU. Replicate 1 was the flagged sampling location.

Photo 7: Flagged sampling grid of DU 2, observing in the north direction towards the middle of the DU from boundary marker DU 1/2-B. Replicate 2 was the flagged sampling location.

Photo 8: Flagged sampling grid of DU 2, observing in the north direction towards boundary marker DU 1/2-C from the middle of the DU. Replicate 2 was the flagged sampling location.


Photo 9: Flagged sampling grid of DU 2, observing in the north direction towards the middle of the DU. Replicate 2 was the flagged sampling location.

Photo 10: Flagged sampling grid of DU 2, observing in the north direction towards the middle of the DU from boundary marker DU 1/2-C. Replicate 2 was the flagged sampling location.

Photo 11: Flagged sampling grid of DU 2, observing in the north direction towards the middle of the DU from the upstream boundary. Replicate 2 was the flagged sampling location.


Photo 12: Flagged sampling grid of DU 2, observing in the south direction towards the middle of the DU from the northern boundary. Replicate 2 was the flagged sampling location.

Photo 13: Flagged sampling grid of DU 1, observing in the north direction towards the middle of the DU from the boundary marker DU 1-A. Replicate 2 was the flagged sampling location.

Photo 14: Flagged sampling grid of DU 1, observing in the north direction towards the middle of the DU from the boundary marker DU 1-D. Replicate 2 was the flagged sampling location.

Photo 15: Flagged sampling grid of DU 1, observing in the north direction towards the middle of the DU from the southern boundary. Replicate 2 was the flagged sampling location.

Photo 16: Flagged sampling grid of DU 1, observing in the south direction towards boundary marker DU ½-C from the middle. Replicate 2 was the flagged sampling location.

Photo 17: Flagged sampling grid of DU 1, observing in the south direction towards the middle from boundary marker DU1/2-C. Replicate 2 was the flagged sampling location.

Photo 18: Flagged sampling grid of DU 1, observing in the west direction towards the middle of the DU 1 from the western boundary. Replicate 2 was the flagged sampling location.

Photo 19: Flagged sampling grid of DU 1, observing in the north direction towards the middle from boundary marker DU ½-B. Replicate 2 was the flagged sampling location.

# ATTACHMENT 3: RESPONSES TO COMMENTS ON DRAFT

**Document Title:** NBK Keyport ISM Sampling of PCBs in Sediment – Data Summary and Evaluation

**Comments by:** Bonnie Brooks, Mahbub Alam, Mike Shaljian

**Comments Received:** 4/15/22

| # | Doc/Para No. | Comment (DATE) | Comment Response (DATE) | Ecology Response (5/13/2022) |
|---|---|---|---|---|
| **1** | General | ISM cannot be used to compare to Ecology's SCO to evaluate risks to benthic organisms. It is important that the Navy clarify that this data is not appropriate to use for compliance of the benthic criteria.<br>Ecology requires that discrete samples be compared to the benthic criteria on a point by point basis to determine compliance and identity hot spots. | We will add the following sentence to the end of the Bottom Line Up Front section, Line 24, "Numercial results presented in this memorandum are compared to the marine SCO as a point of reference. Ecology requires that only the results of discrete samples be used to determine compliance with regulations." Note that this text will be moved to the Introduction based on Comment 6. | ok |
| **2** | General | When using ISM with contaminants such as PCBs, more increments are recommended to reduce the errors caused by the heterogeneous distribution of PCBs in soils and sediments. | As written, lines 141 through 145 recommend additional increments be collected during future sampling to overcome the hetergenous distribution of PCBs. No changes to the memorandum are planned based on this comment. | ok |
| **3** | Line 18<br>Table 3 | EPA does not recommend using the Chebychev statistic to calculate a 95 UCL of the mean because it results on overly conservative values. Per Felicia Barnet (EPA), EPA will be updating ProUCL to indicate this in Summer 2022. EPA does support using the Student's t-test to calculate a 95UCL of the mean for 3 replicates of ISM. | As described in the memordanum, the choice of statistical method used complies with ITRC guidance for ISM sampling, which was the guidance identified in the approved SAP. No changes to the memorandum are planned based on this comment. | Ecology believes it would be in the Navy's best interest to identify this estimate is conservative, but if it is ok if it is not included since it is still health protective. Bonnie have informed the ITRC team about this and they are deciding whether they can revise the guidance or not. It is not easy to revise ITRC guidance once the team has disbanded. |
| **4** | Line 82 | States Method 1644 was used. Is this a typo? Was 1628 used? | Thank you for noticing this typo. This will be corrected to Method 1668C. | ok |
| **5** | Table 3 | There are no units for area or concentrations. It would be helpful to add the number of increments for each area to the table. | We will add the number of increments for each DU and the units of measure to Table 3. | ok |

| # | Doc/Para No. | Comment (DATE) | Comment Response (DATE) | Ecology Response (5/13/2022) |
|---|---|---|---|---|

**Document Title:** NBK Keyport ISM Sampling of PCBs in Sediment - Data Summary and Evaluation

**Comments by:** Bonnie Brooks, Mahbub Alam, Mike Shaljian

**Comments Received:** 4/15/22

| # | Doc/Para No. | Comment (DATE) | Comment Response (DATE) | Ecology Response (5/13/2022) |
|---|---|---|---|---|
| **6** | Introduction | It would be helpful to state the objective of the project "stablishing baseline current condition and whether recontamination is occurring?". This project is not intended to comply with SMS standards, specifically with the benthic criteria Since point by point comparison is needed to comply with benthic standards. Although a case can be made whether the 95% UCL of the PCB data meets the risk based criteria for human health or natural background. See detail in the following comment. | We will move the text of lines 21 through 24 to be the last lines of the introduction. | ok |
| **7** | BLUF | While it is helpful to compare the data with SMS criteria, as written in the BLUF section and data evaluation (page 4), it is necessary to put caveat languages that the ISM results are not directly comparable to the SMS benthic criteria.<br>More appropriately, the results may be screened against the Puget Sound natural background for total PCB congeners at 3500 ng/kg (dry weight) and 0.2 ng/kg TEQ (Dioxin-like PCB congeners) for human health evaluation per SCUM Table 10-1.<br>This is a continual comment from Ecology that the PCB screening levels in soil, groundwater, sediment, and surface water need to be revisited as we discussed in the last SAP RTC meeting. | We will add the following sentence to the end of the Bottom Line Up Front section, Line 24, "Numercial results presented in this memorandum are compared to the marine SCO as a point of reference. Ecology requires that only the results of discrete samples be used to determine compliance with regulations." Note that this text will be moved to the Introductin based on Comment 6. | ok |

| # | Doc/Para No. | Comment (DATE) | Comment Response (DATE) | Ecology Response (5/13/2022) |
|---|---|---|---|---|

**Document Title:** NBK Keyport ISM Sampling of PCBs in Sediment - Data Summary and Evaluation

**Comments by: Mahbub Alam**

**Comments Received:**

| # | Doc/Para No. | Comment (DATE) | Comment Response (DATE) | Ecology Response (5/13/2022) |
|---|---|---|---|---|
| | | "*The sampling pattern was generated using a random number generator for an X and Y axis number, then creating a three-point pattern that was replicated in every box of the roughly 6 ft by 6 ft grid.*"<br>Why a random number generation was necessary? I guess all the grids were subsampled, correct? | This approach for generating the initial randomized sampling locations with the first grid square is recommended by ITRC to remove any bias on the part of the field team with regard to placement of the increments. All of the grids were then sampled with the same relative increment locations to the first grid. | |
| **8** | Data Evaluation | Organic Carbon (OC) normalized data for total PCB congeners showed highest concentration in DU2. Data evaluation discussion seemed to point to skewness of one of the replicate results resulting in higher relative standard deviation (RSD). Note that total PCB congeners (non-normalized dry weight) in DU1 is still higher than DU2. This makes sense as DU1 is closer to SP1-1. The variability in OC data, which can increase the RSD of OC normalized data, should also be considered/discussed.<br>Another hypothesis is that the source of PCBs in sediment is not only the seep(s) but also diffused shallow groundwater discharge, likely containing PCBs, at the creek through porewater matrix. There were couple of hotspots of PCBs found in exposure area 2 soils. The groundwater data was non-detect for PCB Aroclor anlaysis and no PCB congener analysis was done. It is likely there is PCBs in shallow groundwater there and it can be confirmed | We will add to line 141, "A contributing factor to the high standard deviation in this DU maybe the variability in organic carbon content." As agreed in the approved SAP, grab groundwater samples were analyzed only for PCB Aroclors, while groundwater samples from monitoring wells were also analyzed for PCB congeners. Although some transport of PCBs in groundwater is occuring as evidenced by the seep, there is currently no evidence of other seeps, or diffuse discharge of groundwater containing PCBs. This is one hypothesis, however. It is also not clear that there is a true "plume" of groundwater containing mobile PCBs, although it is possible. It is alternatively possible that there is a localized source of PCBs in the landfill waste immediately adjacent to the seep and/or the sediment contamination identified in the DUs has been present since the ROD, since no confirmation samples were collected after sediment removal. | Ecology understands there is no clear evidence that there is diffused PCB transport through groundwater to sediment and surface water. However, this has not been studied and the Navy has not proven that it is not happening. Previous PCB pore water data collected through passive samplers found widespread PCBs in pore water as well as in surface water. ISM sediment sampling also showed widespread PCB contamination in the whole area. Whether this widespread contamination is due to one seep location or combination of seep and groundwater transport, or due to left over contamiantion after remedial action, the Navy has not investigated this in detail. As such, Ecology believes diffused groundwater transport remains a viable pathway unless proven otherwise. And this pathway will also be relevant when complying with PCB surface water quality ARARs. |

| # | Doc/Para No. | Comment (DATE) | Comment Response (DATE) | Ecology Response (5/13/2022) |
|---|---|---|---|---|
| **Document Title:** NBK Keyport ISM Sampling of PCBs in Sediment - Data Summary and Evaluation | | | | |
| **Comments by:** Bonnie Brooks, Mahbub Alam, Mike Shaljian | | | | |
| **Comments Received:** 4/15/22 | | | | |
| | | with congener analysis. Besides there is a confirmed groundwater PCB plume underneath the north plantation. Bottom line, Ecology believes PCBs are transported with groundwater and making its way to creek sediment and surface water and ARAR for surface water is not met. | | |
| | | | | |

# Appendix F

# Modeling Report

# GROUNDWATER MODELING REPORT

**NAVAL BASE KITSAP KEYPORT, OPERABLE UNIT 1**
Kitsap County, Washington

**Issued:** 21 July 2023

**Prepared for:** **BATTELLE MEMORIAL INSTITUTE**
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# GROUNDWATER MODELING REPORT

## NAVAL BASE KITSAP KEYPORT, OPERABLE UNIT 1
## Kitsap County, Washington

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Final

# GROUNDWATER MODELING REPORT
**Naval Base Kitsap Keyport, Operable Unit 1**
Kitsap County, Washington

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## APPENDICES

**GROUNDWATER MODELING REPORT**
**Naval Base Kitsap Keyport, Operable Unit 1**
Kitsap County, Washington

## ACRONYMS AND ABBRIVIATIONS

| | |
|---|---|
| ARAR | Applicable or relevant and appropriate requirement |
| bgs | Below ground surface |
| cDCE | cis-1,2-dichloroethene |
| COI | Constituent of interest |
| CL | Central Landfill |
| CLARC | Cleanup Levels and Risk Calculation |
| cm/sec | Centimeters per second |
| $cm^2$/sec | Square centimeters per second |
| COPC | Chemical of potential concern |
| CSM | Conceptual site model |
| CVOC | Chlorinated volatile organic compound |
| CWA | Clean Water Act |
| DNAPL | Dense non-aqueous phase liquid |
| DON | U.S. Department of Navy |
| Ecology | Washington State Department of Ecology |
| ESS | Environmental Sequence Stratigraphy |
| ESTCP | Environmental Security Technology Certification Program |
| EXWC | Engineering and Expeditionary Warfare Center |
| foc | Fraction organic carbon |
| ft | Feet |
| ft/yr | Feet per year |
| Γ | Gamma |
| GSI | GSI Environmental Services Inc. |
| kg | Kilogram |
| Low-k | Low permeability |
| LTM | Long-term monitoring |
| MCL | Maximum contaminant level |
| MD | Matrix diffusion |
| MIP | Membrane Interface Probe |
| mg/L | Milligrams per Liter |
| mg/kg | Milligrams per kilogram |
| MNA | Monitored natural attenuation |
| MTCA | Model Toxics Control Act |
| NAPL | non-aqueous phase liquid |
| NP | North Plantation |
| NBK | Naval Base Kitsap |
| OU | Operable Unit |
| PAL | Project Action Limit |

## ACRONYMS AND ABBRIVIATIONS

| | |
|---|---|
| PCB | Polychlorinated biphenyl |
| PRB | Permeable reactive barrier |
| PQL | Practical quantitation limit |
| RG | Remediation Goal |
| ROD | Record of Decision |
| RMS | Root Mean Square |
| SP | South Plantation |
| TCE | Trichloroethene |
| U.S. | United States |
| USCS | Unified Soil Classification System |
| USGS | United States Geological Survey |
| VC | Vinyl chloride |
| VOC | Volatile organic compound |
| yr(s) | Year(s) |

**GROUNDWATER MONITORING REPORT**
**Naval Base Kitsap Keyport, Operable Unit 1**
Kitsap County, Washington

## 1.0 INTRODUCTION

This groundwater modeling report describes the objectives and approach for the development of a groundwater model to assess the effects of matrix diffusion on potential source area treatment remediation timeframes at the Area 1 former landfill comprising Operable Unit (OU) 1 of Naval Base Kitsap (NBK) Keyport in Keyport, Washington. The modeling was performed by GSI Environmental Inc. (GSI) under subcontract to Battelle Memorial Institute (Battelle) under the U.S. Department of Navy's (DON, U.S. Navy) Contract No. N39430-16-D-1802, CTO N3943018F4359 for Naval Facilities Engineering Systems Command Northwest.

## 1.1 Problem Statement

The U.S. Navy's investigation scope for NBK Keyport includes the development of a mathematical fate and transport model for chlorinated solvents in groundwater to assist with informed risk decisions and possible remediation activities at OU 1 (Bachmann and Dinicola, 2018).

In 2019, the United States Geological Survey (USGS) developed a MODFLOW/SEAWAT groundwater flow and transport model for the Keyport peninsula and vicinity including all of the NBK Keyport facility (Bachmann and Dinicola, 2018; Yager et al., 2019). This project re-examined the USGS MODFLOW model for site-specific application at NBK Keyport OU 1 in light of additional site characterization to 1) incorporate an important potential long-term source of contaminants to groundwater, matrix diffusion, and 2) perform more detailed simulations of chlorinated solvent contaminant degradation to include generation and biodegradation of daughter products.

## 1.2 Project Objectives

Two overall objectives of interest to the U.S. Navy were identified in the Groundwater Modeling Plan (GSI, 2020):

> Objective 1: Will the chlorinated solvent plume from the Keyport landfill that has been shown to be migrating towards surface water, i) discharge mostly to the stream, ii) discharge at the downgradient tide flat, iii) migrate further downgradient and discharge to Dogfish Bay, or iv) migrate beneath the bay to the vicinity of existing private drinking water wells?
>
> Objective 2: If the hotspots are remediated (e.g., with an in-situ treatment or excavation) to reduce source concentrations, would the same reduction in concentration be observed in the plume downgradient of the hotspots (for example, would a 90% reduction in source concentrations result in a 90% reduction in the downgradient plume concentrations)? Or do matrix diffusion processes reduce the effectiveness of source remediation in the downgradient plume?

As documented in the Groundwater Modeling Plan (GSI, 2020), numerical modeling would be needed to address Objective 1 (extent of plume) and semi-analytical modeling to address Objective 2 (effectiveness of remediating hotspots).

Based on additional site characterization data collected since 2020 (as detailed in Section 3.1), and in accordance with the Groundwater Modeling Plan (GSI, 2020), pursuing Objective 1 was deemed out of the current project scope. Therefore, only Objective 2 is addressed in this report (using the semi-analytical model REMChlor-MD).

## 1.3 Key Information Used for Matrix Diffusion Analysis

Groundwater flow often occurs in sandy units characterized by relatively high permeability. Such sandy units are often confined above and/or below by low permeability (low-k) units and can also contain thin lower permeability lenses embedded within. As contaminated groundwater flows through the sandy unit over time, contaminants can diffuse into the low-k confining units or embedded lenses, slowly building up significant concentrations. After the groundwater in the sandy unit has been flushed or remediated, the contaminants slowly back-diffuse from the low-k confining unit(s) or lenses into the groundwater, creating a persistent, low-concentration plume. This process of diffusion into low-k soils over time and the subsequent back-diffusion into groundwater is known as matrix diffusion.

Matrix diffusion is “recognized as a key reason to why contaminated sites exhibit sustained dissolved contaminant concentrations during long-term natural attenuation monitoring after in-situ remediation has been performed” (Farhat et al., 2020). Understanding and evaluating matrix diffusion can provide information regarding a variety of key questions, such as (Farhat et al., 2012):

1. *If I remediate a transmissive zone, but my remediation technology doesn’t remove contaminants from low-k zones in contact with the transmissive zone, will I be able to achieve my cleanup standards?*
2. *How much mass could be present in low-k zones at my site?*
3. *If I install a permeable reactive barrier [PRB], will I have trouble achieving cleanup standards downgradient of the barrier [(because of back diffusion from downgradient low-k layers/lenses)]?*
4. *If I remove all the DNAPL [dense non-aqueous phase liquid], is there a chance I’ll still be above [cleanup goals or applicable or relevant and appropriate requirements (ARARs)]?*
5. *How much longer might I have to wait for a source zone to achieve MCLs [Maximum Contaminant Levels] after the DNAPL is all gone?*

A key question is how much geologic heterogeneity is required for matrix diffusion to be an important fate and transport process. A detailed analysis of this was developed for DON, 2022b, and is reproduced in Appendix A. As described in Appendix A, remediation timeframe is impacted by not only the thickness of low-k layers/lenses within the transmissive zone, but also any overlying or underlying aquitards in contact with the plume.

## 2.0 GENERAL SITE DESCRIPTION AND BACKGROUND

### 2.1 Site Description

NBK Keyport, located in Kitsap County, Washington, occupies 340 acres, including tide flats, near the town of Keyport on a small peninsula in the central part of Puget Sound (Figure 2-1). Acquired by the U.S. Navy in 1913, the property was initially used as a quiet-water range for torpedo testing. In the early 1960s, the role of the base was expanded to include manufacturing and fabrication operations such as welding, metal plating, carpentry, sheet metal work, etc. An additional torpedo shop was built on the site in 1966. In 1978, the site's role was further expanded to include engineering and development activities for multiple undersea warfare weapons and systems. Currently, operations continue to include engineering, fabrication, assembly, and testing of underwater weapons systems (DON, 2017).

Keyport Area 1 (Site), the focus area for this investigation, is the only area within OU 1 and comprises a former landfill that received wastes from base operations between approximately the 1930s and 1973, when the landfill was closed. The landfill occupies approximately 9 acres on the western portion of the base directly adjacent to a wetlands area and tide flats that flow into Dogfish Bay. Most of the landfill itself was part of the wetlands area. The southern portion of the landfill received waste paint, paint thinners, and paint strippers from the paint and stripper shop. Additionally, a burn pile for refuse and demolition debris was located at the northern end of the landfill. Partially burned or unburned materials from this pile were placed in the landfill or the wetlands. Incinerator ash, from a trash incinerator operated at the northern end of the landfill, was also disposed of in the landfill.

The former landfill is divided into the "North Plantation" (NP), "South Plantation" (SP), and "Central Landfill" (CL) (the area between the North Plantation and the South Plantation) (Figure 2-2). The focus of this report are the South Plantation and Central Landfill.

### 2.2 Sources and Remediation History

Recent remediation efforts at the Site have included maintaining the asphalt cover over a portion of the landfill, tidal flooding and erosion mitigation, and phytoremediation using hybrid poplar trees along with monitored natural attenuation (MNA) and long-term monitoring (LTM) (DON, 2016). Phytoremediation consisted of planting two plantations, the "North Plantation" over a portion of the northern landfill and the "South Plantation" over most of the southern portion of the landfill. The area between these two plantations is referred to as the Central Landfill. Overall, phytoremediation beneath the North Plantation has been more successful at reducing chlorinated volatile organic compounds (CVOC) contaminant concentrations than phytoremediation beneath the South Plantation. The South Plantation was, therefore, the primary initial focus of additional investigations for purposes of site characterization. These investigations have since expanded to include the Central Landfill and North Plantation. The initial investigations included: (1) collection of screening level data, such as tree core samples, to identify CVOC hotpots, and (2) a geophysical survey to identify potential buried source materials (DON, 2017), as previous evaluations of monitoring data indicated high concentrations of chemicals of concern in groundwater "suggesting the presence of a residual source" (DON, 2016).

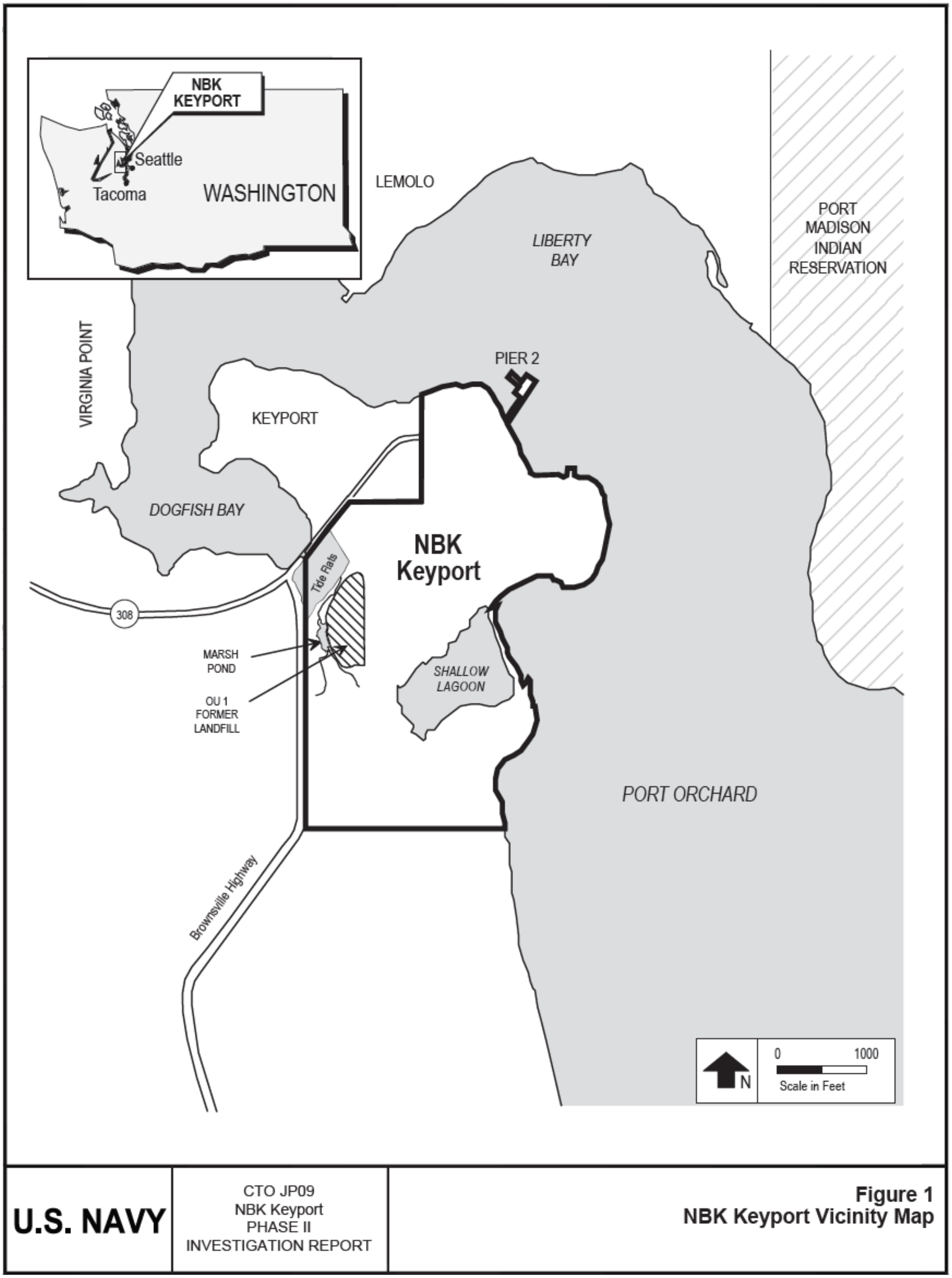



**Figure 2-1. Naval Base Keyport OU 1 location map (Source: DON, 2017)**

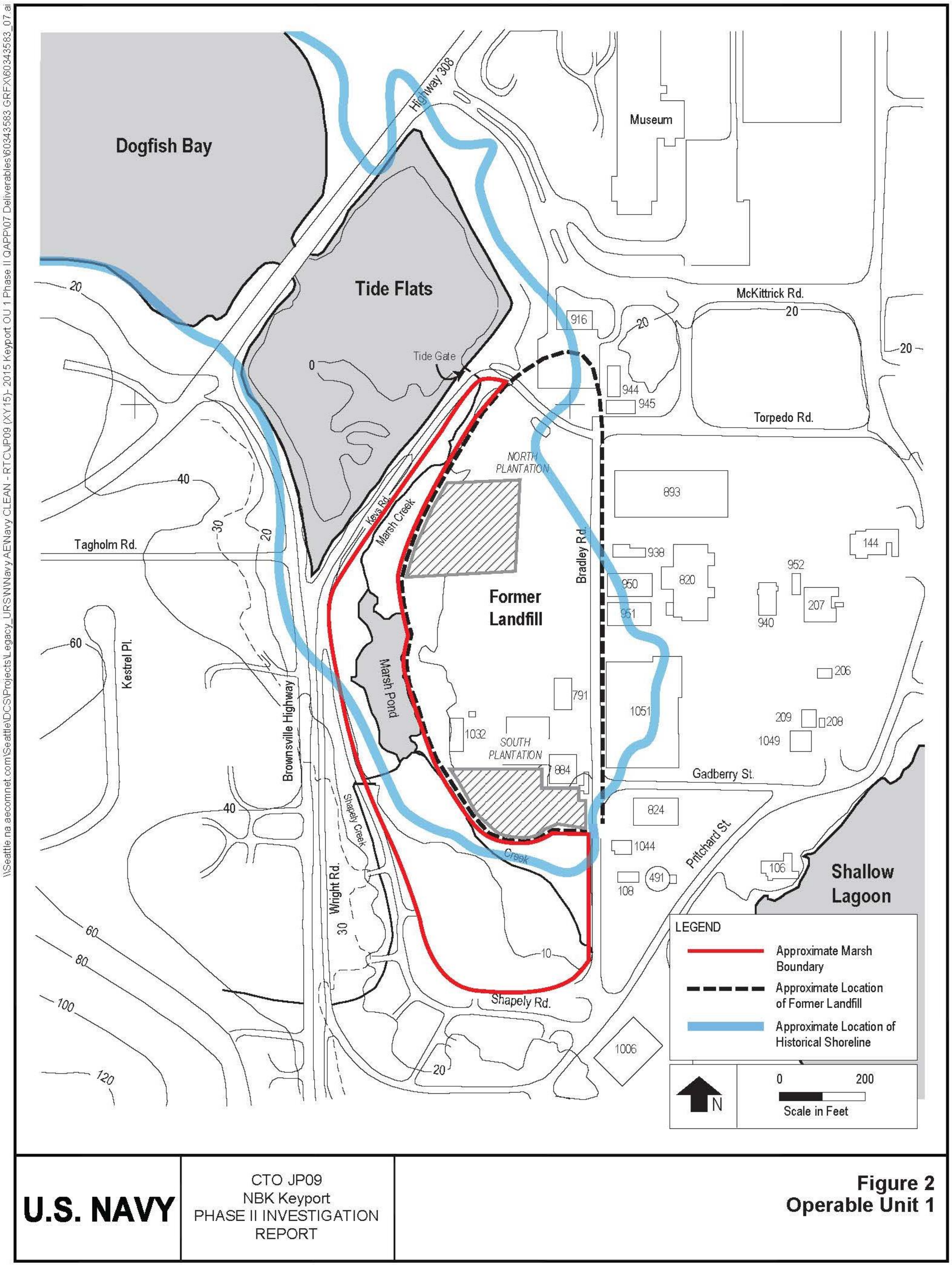



**Figure 2-2. Site location map (Source: DON, 2017)**

The Phase II investigation, started in 2016, was intended to "complete the site characterization of OU 1 and collect the data necessary to evaluate additional remedial alternatives designed to treat identified hotspots and reduce the restoration timeframe" (DON, 2017). The Phase II investigation included membrane interface probe (MIP) analysis, soil borings, and soil gas surveys. MIP data from the Phase II investigation were used to determine the "apparent lateral and vertical extent of relatively higher concentrations of CVOCs in the upper aquifer" (DON, 2017) within the footprint of the South Plantation. Sixty-one MIP borings were completed in the South Plantation, and eight borings were competed in the Central Landfill (DON, 2017).

Based on the findings and recommendations of the 2016 Phase II investigation, a supplemental investigation was conducted in 2017. This investigation included the collection and analysis of CVOCs in soil and groundwater samples from (DON, 2019):

- Forty-one (41) continuous-core, direct-push borings in the Central Landfill to assess the shallow and intermediate aquifer interconnection in this area.
- Thirty-four (34) soil borings in the South Plantation to investigate hotspots identified by the 2016 MIP investigation.
- Auger borings associated with ten (10) new groundwater monitoring wells installed in the South Plantation, seven (7) new groundwater monitoring wells installed in the Central Landfill, and one boring located on the west-northwest fence line of the South Plantation.

The 2017 investigation identified contaminant hotspot areas within the South Plantation (Figure 2-3), as well as the eastern portion of the Central Landfill (Figure 2-4). The hotspot area within the South Plantation extended to the regional aquitard, located 35 feet below ground surface (ft bgs). Non-aqueous phase liquid (NAPL) was observed between 7 and 13 ft bgs. Based on the analyses, the 2017 investigation report revised the Conceptual Site Model (CSM) to include the following key features (DON, 2019):

- Highest CVOC concentrations were exhibited in two areas of the South Plantation with one or more of the groundwater chemicals of potential concern (COPC) exceeding the Record of Decision (ROD) remedial goals everywhere beneath the South Plantation.
- CVOCs in the shallow groundwater are being transported towards surface water at two primary locations adjacent to the South Plantation due to the influence of surface water bodies on the shallow portion of the aquifer.
  - At the first location adjacent to Bradley Road, this high CVOC surface water discharge is diluted by flow from Marsh Creek and the stormwater outfall.
  - At the second location on the western edge of the South Plantation, surface water CVOC concentrations decrease with distance downstream due to dilution and degradation prior to passing through the tide gate.
- In the Central Landfill, two areas exhibited the highest CVOC concentrations in groundwater, generally following the northwest regional groundwater flow direction.
- Transport of CVOCs from the Central Landfill via groundwater to the adjacent surface water did not appear to be the major transport pathway.
- The hotspot area in the eastern portion of the Central Landfill was considered to be a possible source of on-site 1,4-dioxane contamination, which has been detected in some on-site Central Landfill wells.

- No laterally continuous aquitard separates the "upper aquifer" and the "intermediate aquifer" with overall groundwater flow being towards the northwest to the tide flats and Dogfish Bay.
- NAPL is present within the landfill and was observed as an oily substance. The current CSM includes the presence of dense DNAPL down to ~32 ft bgs in the eastern portion of the South Plantation (U.S. NRL, 2019).
- Elevated CVOC concentrations were observed in the fine-grained materials, therefore, restoration timeframes at the site were likely to be controlled by matrix diffusion effects.
- Halorespiring bacteria are present at the site at levels indicative of active dechlorination. However, an apparent absence of halorespiring bacteria in areas of high CVOC concentrations suggests that the high contaminant concentrations may be inhibiting dechlorinating activity.

In 2019, an additional investigation was planned to "verify the migration path of VOCs [volatile organic compounds] and 1,4-dioxane from the Central Landfill hotspots, the source of polychlorinated biphenyl (PCB) contamination in site sediments and better define the extent of contamination at the east side of the South Plantation, in the marsh area southeast of the South Plantation and in Marsh Creek" (DON, 2019). The regional aquitard contact within the site boundary will be updated based on the lithologic data collected from this investigation. Data for the investigation was collected through 2022. Analysis of the data is currently ongoing.

The most recent CVOC plume maps (trichloroethene [TCE], cis1,2-dichloroethene [cDCE], and vinyl chloride [VC]) are shown on Figure 2-3 and Figure 2-4 for the South Plantation and Central Landfill, respectively. 1,4-Dioxane plume maps for the Central Landfill are shown on Figure 2-5.

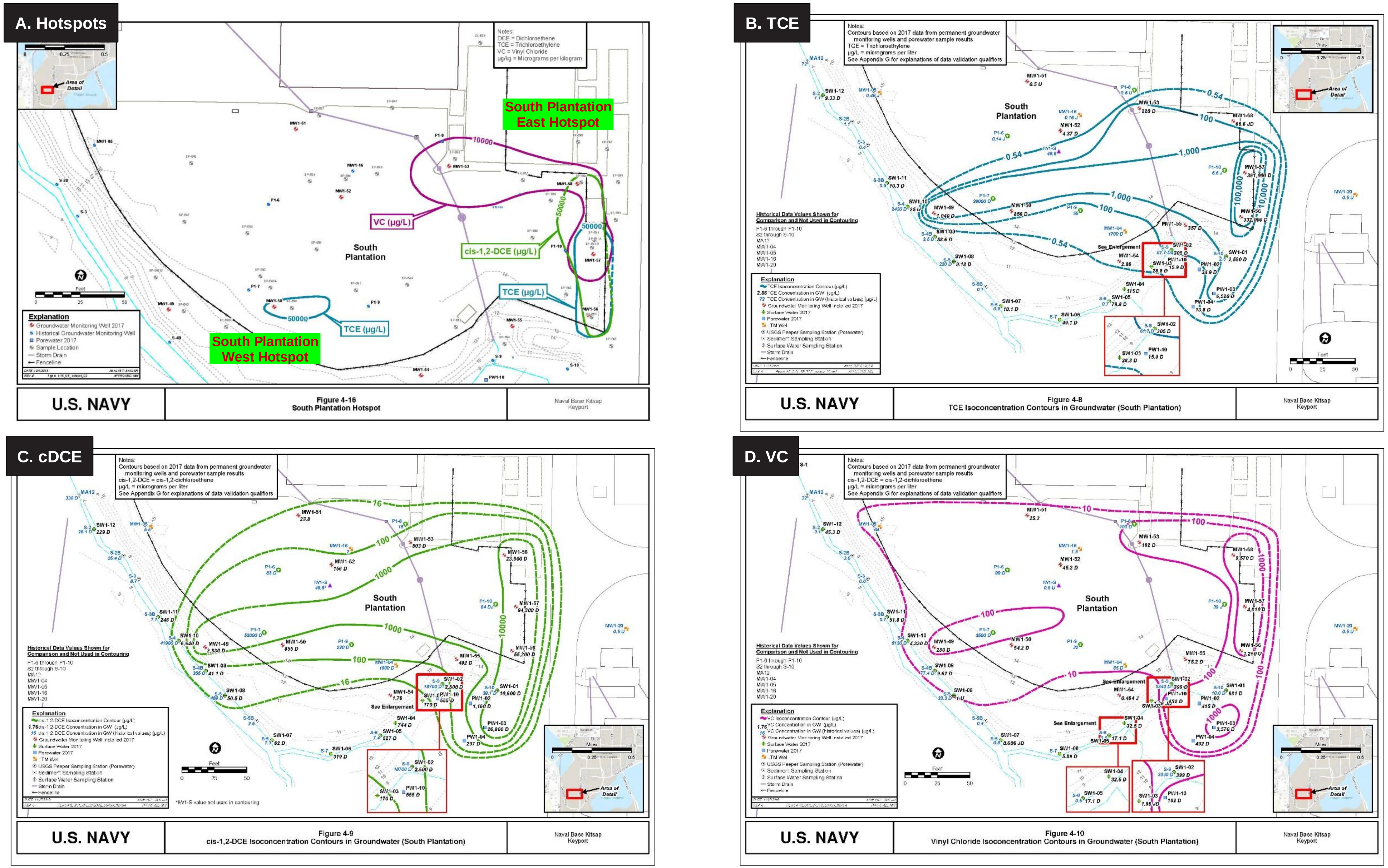



**Figure 2-3. South Plantation CVOC hotspots and plumes. Panel A: CVOC hotspots. Panel B: TCE isocontours. Panel C: cDCE isocontours. Panel D: VC isocontours (Source: DON, 2018, emphasis added)**

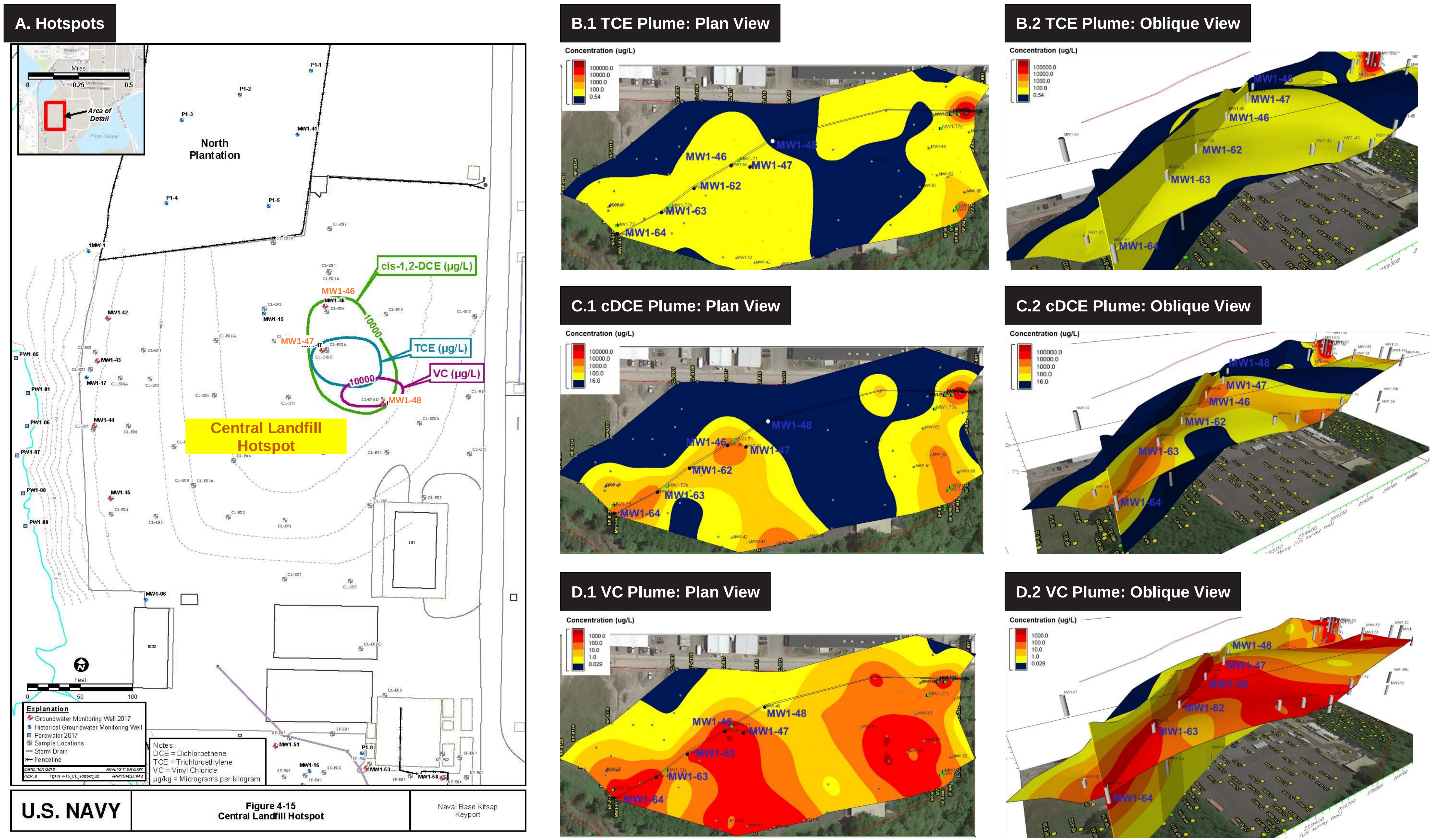



**Figure 2-4. Central Landfill CVOC hotspot and plumes (Hotspot source: DON, 2018, emphasis added; plume maps source: DON, 2022a, emphasis added)**

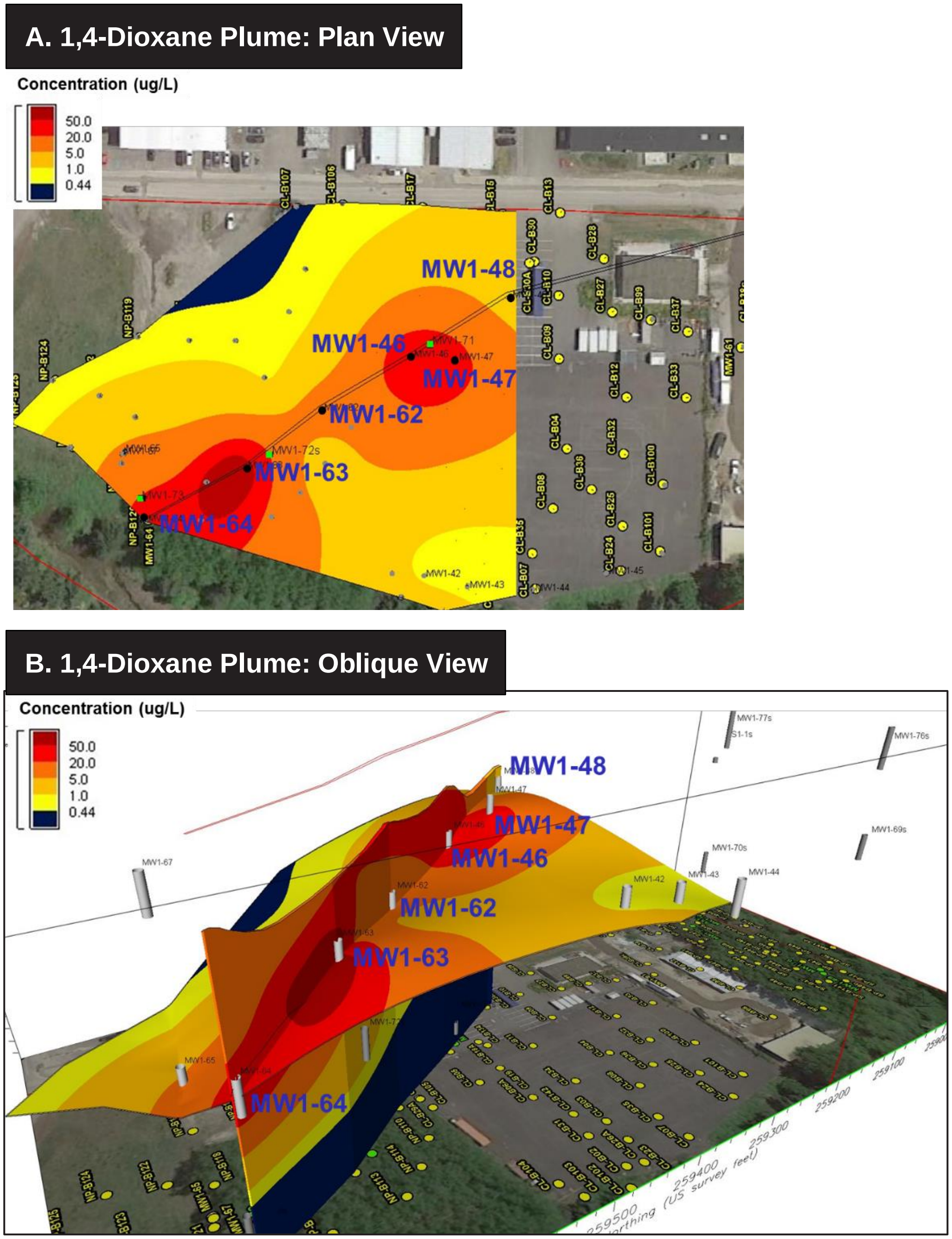



**Figure 2-5. Central Landfill 1,4-dioxane plume (Source: DON, 2022a; emphasis added)**

## 2.3 Hydrogeology

The topography of NBK Keyport rises from the shoreline to reach an average elevation of 25 to 30 feet (ft) above mean sea level. However, the southeast corner of the site is at 130 feet above mean sea level (DON, 2017). Depth to groundwater beneath the landfill is typically 4 to 5 ft bgs. Releases from the landfill to the underlying aquifer have included a variety of VOCs, including

TCE and other CVOCs. Approximately half of the landfill waste material is above the water table and the other half below it.

Freshwater bodies near OU 1 include two creeks that drain into the marsh pond, and two creeks that drain into the shallow lagoon. Marine/brackish water bodies on and near OU 1 include Liberty Bay, Dogfish Bay, tide flats, a marsh, and a shallow lagoon. Groundwater flow is tidally influenced but “not enough to change the general flow patterns” (DON, 2016).

The shallow groundwater-bearing unit (comprising both the historically differentiated “upper” and “intermediate” aquifers) occurs in interbedded fine sands and silts, with groundwater flowing primarily to the northwest to the tide flats and Dogfish Bay. All of the landfill and most of NBK Keyport is underlain by a peaty silt or clay that has been interpreted as a regionally significant aquitard, commonly about 100 ft thick, separating the shallow groundwater-bearing unit from the deeper, regional water-bearing units (DON, 2018). In portions of the landfill, the aquitard was encountered at relatively shallow depths ranging from 26 to 40 ft bgs (DON, 2017).

## 2.4 Heterogeneity

In 2021, as detailed in DON, 2022b, the U.S. Navy’s Engineering and Expeditionary Warfare Center (EXWC), in collaboration with GSI, conducted high-resolution site characterization in the South Plantation to determine the nature of plume persistence and the potential impact of persistence-related processes on treatment effectiveness. The general approach of the project was to:

- Collect select high-resolution soil and groundwater data to verify matrix diffusion is occurring in the field.
- Incorporate the data collected into a semi-analytical model with a matrix diffusion component (REMChlor-MD) developed by the Department of Defense’s Environmental Security Technology Certification Program (ESTCP) to provide better predictions of how matrix diffusion will affect plume life and, consequently, the return on investment for various plume management options.

Soil and groundwater samples were collected to identify relevant compound concentrations in different geologic media at selected locations. Soil properties such as bulk density and fraction organic carbon (foc) were also measured to quantify sorption processes (e.g., retardation factors) (DON, 2022b).

## 2.5 Parameters of Interest

As a continuation of the 2019 USGS groundwater flow and transport model development, this study focuses on the transport of chlorinated solvents at the Keyport landfill with 1,4-dioxane as an additional constituent of interest (COI). Specifically, the modeling COIs include TCE, cDCE, and VC, and 1,4-dioxane.

## 2.6 Regulatory Criteria or Standards (as detailed in Bachmann and Dinicola 2018)

The ROD for the site specifies the remediation goals. In general, the ROD requires the use of the lowest associated standard established by a regulatory agency as the remediation goals for the site. The Washington State Department of Ecology (Ecology) has established cleanup standards under the Model Toxics Control Act (MTCA) to protect beneficial uses of groundwater and surface water. Ecology also established surface water quality standards under its delegated Clean Water Act (CWA) authority (Ecology, revised 2016), which are considered ARARs of MTCA. In some cases, the ROD specified the use of a laboratory practical quantitation limit (PQL) when risk based cleanup standards are below laboratory quantification. The ROD-specified and Project Action Limit (PAL) groundwater remediation goals (RGs) for the modeling COIs in this study are presented in Table 2-1 below. Note that although 1,4-dioxane was not identified as a COI in the ROD, it is included in the table below as it is a modeling COI for this study.

**Table 2-1. Study Area Groundwater Remediation Goals**

| Contaminant | ROD Remediation Goal (µg/L) | PAL Remediation Goal (µg/L) |
|---|---|---|
| 1,4-Dioxane | Not specified | 0.44 |
| cis-1,2-Dichloroethene | 70 | 70 |
| Tetrachloroethene | 5 | 5 |
| Trichloroethene | 5 | 5 |
| Vinyl chloride | 0.5 | 0.029* |

* For vinyl chloride, the remediation goal stated is lower than the ROD specified value of 0.5 µg/L and is the PAL in accordance with the vinyl chloride Cleanup Levels and Risk Calculation (CLARC) Guidance (https://fortress.wa.gov/ecy/clarc/FocusSheets/VinylChloride.pdf). Based on the MTCA Method B groundwater cleanup level, the value is the lower value of the MTCA and state and federal MCLs.

# 3.0 GROUNDWATER MODEL DESCRIPTION

## 3.1 Groundwater Model Selection

In 2019, the USGS developed a large-scale MODFLOW/SEAWAT groundwater flow and transport model for the Keyport peninsula and vicinity, including all of the NBK Keyport facility. Based on then current and historical Site data, the site-specific groundwater flow and transport model incorporated refined lithologic Site stratigraphy and evaluated potential contaminant migration pathways (Yager et al., 2019). The USGS used this model to make a preliminary assessment regarding potential contaminant transport in groundwater from the hotspots in the Central Landfill and South Plantation. Development of the USGS groundwater model is detailed in the 2018 Quality Assurance Project Plan (Bachmann and Dinicola, 2018) and the 2019 groundwater modeling report (Yager et al., 2019).

As documented in the Groundwater Modeling Plan (GSI, 2020), this GSI/Battelle/U.S. Navy project re-examined the USGS MODFLOW model to determine if it could be updated to: 1) incorporate an important potential long-term source of contaminants to groundwater: matrix diffusion, and 2) perform more detailed simulations of chlorinated solvent contaminant degradation to include generation and biodegradation of daughter products.

Additional site characterization data has been collected since the development of the USGS model. This includes a geophysical survey to assess the stratigraphy beneath the tide flats and the temporal variation in the saltwater/freshwater interface, and an Environmental Sequence Stratigraphy (ESS) study to interpret subsurface preferential flow pathways that might account for CVOC detections in the causeway monitoring wells (MW1-38 and MW1-39 located on the causeway separating the tide flats from Dogfish Bay) and to evaluate potential contaminant transport beyond the causeway to the north-northwest.

Based on this additional Site characterization data, employment of the USGS model for this project was deemed out of the current project scope since incorporating the additional data into the model would require:

- A complete rebuild of the USGS model, rather than minor parameter updates, to incorporate the new geologic data (e.g., additional layers to account for potential preferential flow pathways, additional source zones to account for the presence of DNAPL), and consequently,
- A full re-calibration of both the flow and fate and transport models.

Therefore, in accordance with the Groundwater Modeling Plan (GSI, 2020), the semi-analytical model REMChlor-MD was selected to model four separate hotspot groundwater plumes at NBK Keyport OU 1. Because REMChlor-MD is limited to simulating individual simple groundwater flow patterns in one direction, only Objective 2 (see Section 1.2) is addressed in this report.

## 3.2 REMChlor-MD Model

REMChlor-MD (Falta et al., 2018; Farhat et al., 2018) is a semi-analytical model that specifically relates stratigraphic data to matrix diffusion input parameters but assumes that the entire plume has the same type of heterogeneity and 1-dimensional groundwater flow. REMChlor-MD is limited to simulating individual simple groundwater flow patterns in one direction. However, even with these simplifying flow assumptions, high quality simulations of the long-term change in contaminant concentration, mass, and mass discharge in the transmissive zone, concentration in an observation well, and mass in the low-k zone are provided. Additionally, the tool allows the evaluation of several types of source and plume remediation activities.

## 3.3 REMChlor-MD Model Assumptions and Limitations

REMChlor-MD has the following assumptions and limitations:

- *"REMChlor-MD is intended to be used as a screening level tool for simulating matrix diffusion effects"* (Farhat et al., 2018) and not for detailed fate and transport estimates.
- Assumes that the entire plume has the same type of geologic heterogeneity and 1-dimensional groundwater flow.
- REMChlor-MD is limited to simulating individual simple groundwater flow patterns in one direction.
- "*The contaminant source mass balance assumes that the contaminant discharge is a power function of the remaining contaminant mass using an exponent Γ (gamma). As a simplistic model of a complicated heterogeneous multiphase transport system, the best value of gamma for a given site will be subject to a range of uncertainty."* (Farhat et al., 2018). Note the equation for the power function, shown below, provides the following general behavior of a contaminant source in REMChlor-MD: gamma=0 results in a constant source concentration over time until the mass is depleted; gamma=1 results in an exponential decline over time with a long "concentration vs. time tail", and a gamma>1 results in an even longer, more persistence tail. In the equation below, $C_s(t)$ is the average contaminant concentration leaving the source zone at time $t$, $M(t)$ is the contaminant mass in the source zone at time $t$, $C_0$ is the flow-averaged source concentration corresponding to the initial source mass, $M_0$, and $\Gamma$ determines the shape of the source discharge response to changing source mass.

$$\frac{C_s(t)}{C_0} = \left(\frac{M(t)}{M_0}\right)^{\Gamma}$$

- *"The model assumes that biodegradation reactions in the plume can be described by first order decay reactions. Biogeochemical conditions that control these reactions may not be well represented by first order reactions therefore, there is considerable uncertainty in values of field scale decay rates." (*Farhat et al., 2018.)
- *"First order decay rates are a function of time and distance from the source (x), but they do not depend on the y or z coordinates. This means that a specified reaction zone will extend over the entire [REMChlor-MD] model domain in the y and z directions."* (Farhat et al., 2018.)
- The source model is based on a simple box model where an original source mass is assumed to be released to groundwater in a certain year. The mass flux leaving the source is assumed to have a simple defined relationship over time (e.g., a step function or a linear decline proportional to source mass). Therefore, the source model can simulate slow source attenuation over time with or without a rapid source remediation project and show the change in mass flux leaving the source.

- The plume model is limited to changes in first order decay rates in three spatial zones downgradient of the source during three separate time periods (space-time zones). First order decay rates can be assigned for the parent compound and all daughter products for groundwater constituents in both the transmissive zones and/or the low-k zones.
- The confidence in model simulations decreases farther out in time and farther away from the portion of the plume used for calibration.
- Note that a certain amount of degradation of CVOCs was assumed in the low-k units for the NBK Keyport models. If the degradation in these low-k units is higher at the Site than what is assumed in the models, then the forecasted remediation timeframes could be significantly lower.

# 4.0 GROUNDWATER MODELING

Because REMChlor-MD is limited to simulating groundwater flow patterns in one direction only, the NBK Keyport groundwater plumes were analyzed as:

- SP East Hotspot CVOC plume (Figure 2-3)
- SP West Hotspot CVOC plume (Figure 2-3)
- CL Northwest CVOC plume (Figure 2-4)
- CL 1,4-dioxane plume (Figure 2-5)

## 4.1 Modeling Scenarios

The REMChlor-MD modeling served as the basis for evaluating the three overall questions of interest to the U.S. Navy addressing Objective 2 at NBK Keyport, specifically:

- Question 1: How important is matrix diffusion to the CSM?
- Question 2: Can a PRB isolating the source be used to manage the groundwater plume?
- Question 3: How will removing 90% of the source mass affect the groundwater plume?

## 4.2 South Plantation East Hotspot

### *4.2.1 SP East Hotspot Modeling Approach*

For the SP East Hotspot plume, the modeling approach included:

- Estimating the CVOC mass in soil and the percent of mass in the low-k soils vs. transmissive soils based on the field data collected as part of a separate EXWC project (DON, 2022b) (Figure 4-1).
- Using the estimated mass in the step above as input or as a calibration parameter in the REMChlor-MD model.
- Using observed groundwater concentrations as a calibration parameter.
- Using the calibrated REMChlor-MD model to explore different remediation strategies under the influence of matrix diffusion.

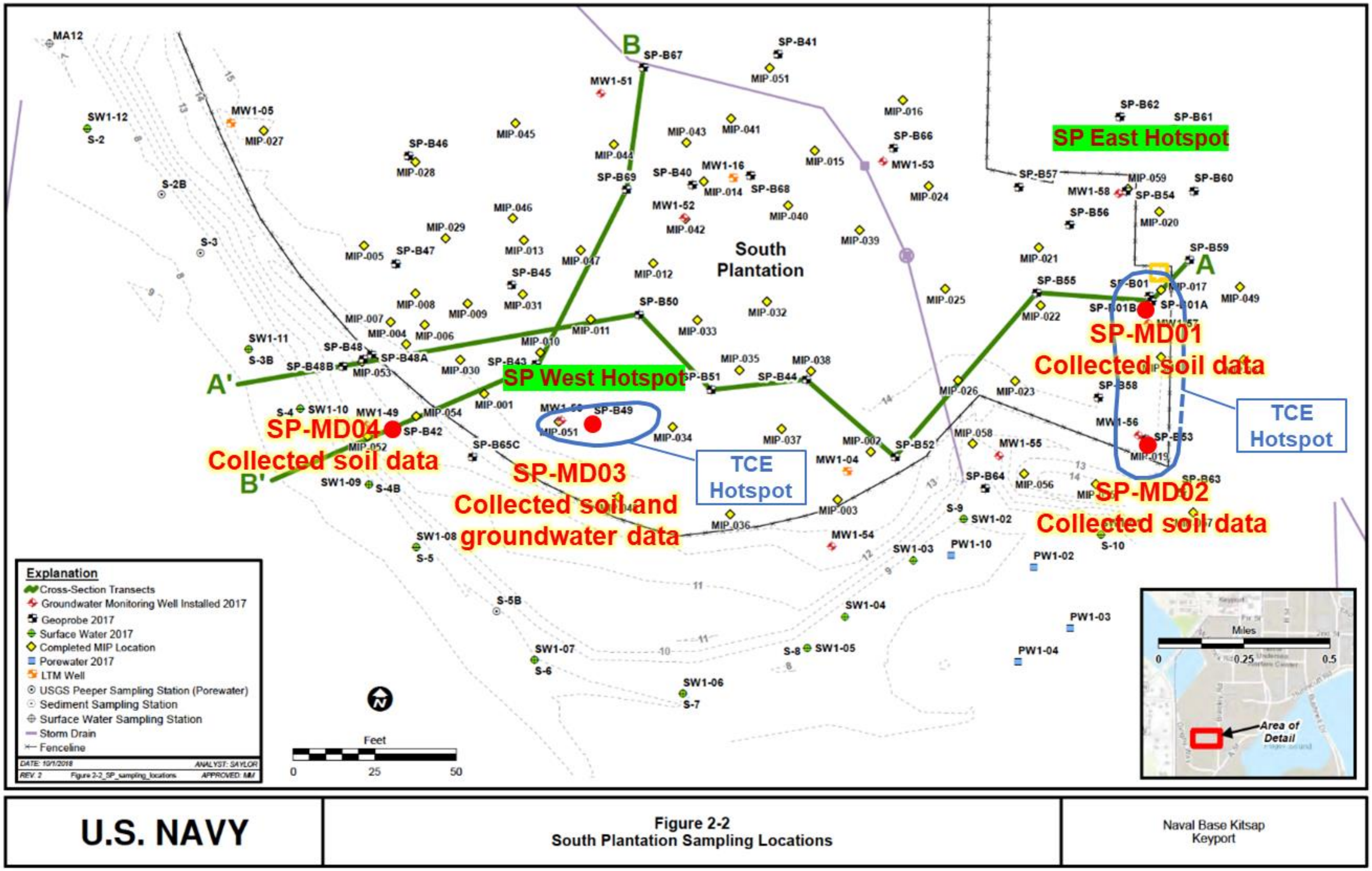



**Figure 4-1. SP modeling areas of interest. (Basemap and TCE hotspot contours source: DON, 2018; emphasis added)**

### 4.2.2 SP East Hotspot Model Input Data

The REMChlor-MD modeling domain is shown on Figure 4-2 and input data detailed in Table 4-1. Key input data/assumptions include:

- A source zone starting in 1970 was estimated based on the general timing when chlorinated solvents began to come into extensive industrial use in the U.S.
- Based on the EXWC field data collected, the East Hotspot source was assumed to be ~12 ft thick and located near the top of the transmissive zone (Figures 4-3 and 4-4).
- Key heterogeneity features for the East Hotspot were simulation of the transmissive zone comprised of ~25% low-k lenses and no overlying or underlying aquitards based on the EXWC field data collected (Figure 4-5). Matrix diffusion was incorporated into the model in both the source and the plume, i.e., matrix diffusion processes were considered present within the entire modeling domain (except for the no matrix diffusion run, Run 1 (see Table 4-4), which assumed no matrix diffusion in the plume).
- Source concentrations, source mass, transmissive zone hydraulic conductivity, retardation factors, and plume degradation rates were adjusted to match the 2017 plume iso-contours in Figure 2-3 and Figure 4-2 and the 2021 estimated mass in the transmissive and low-k zones (based on the EXWC field work).

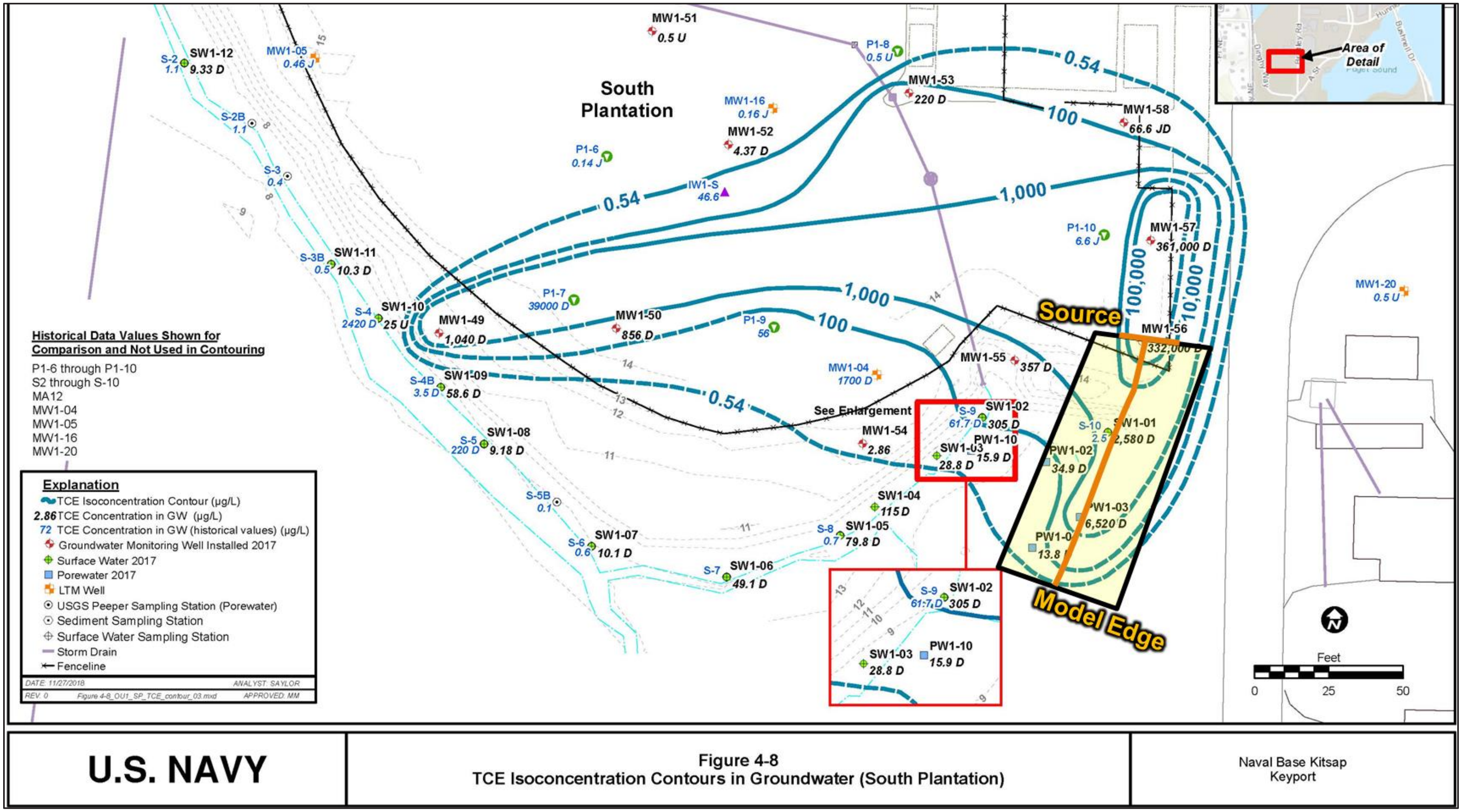


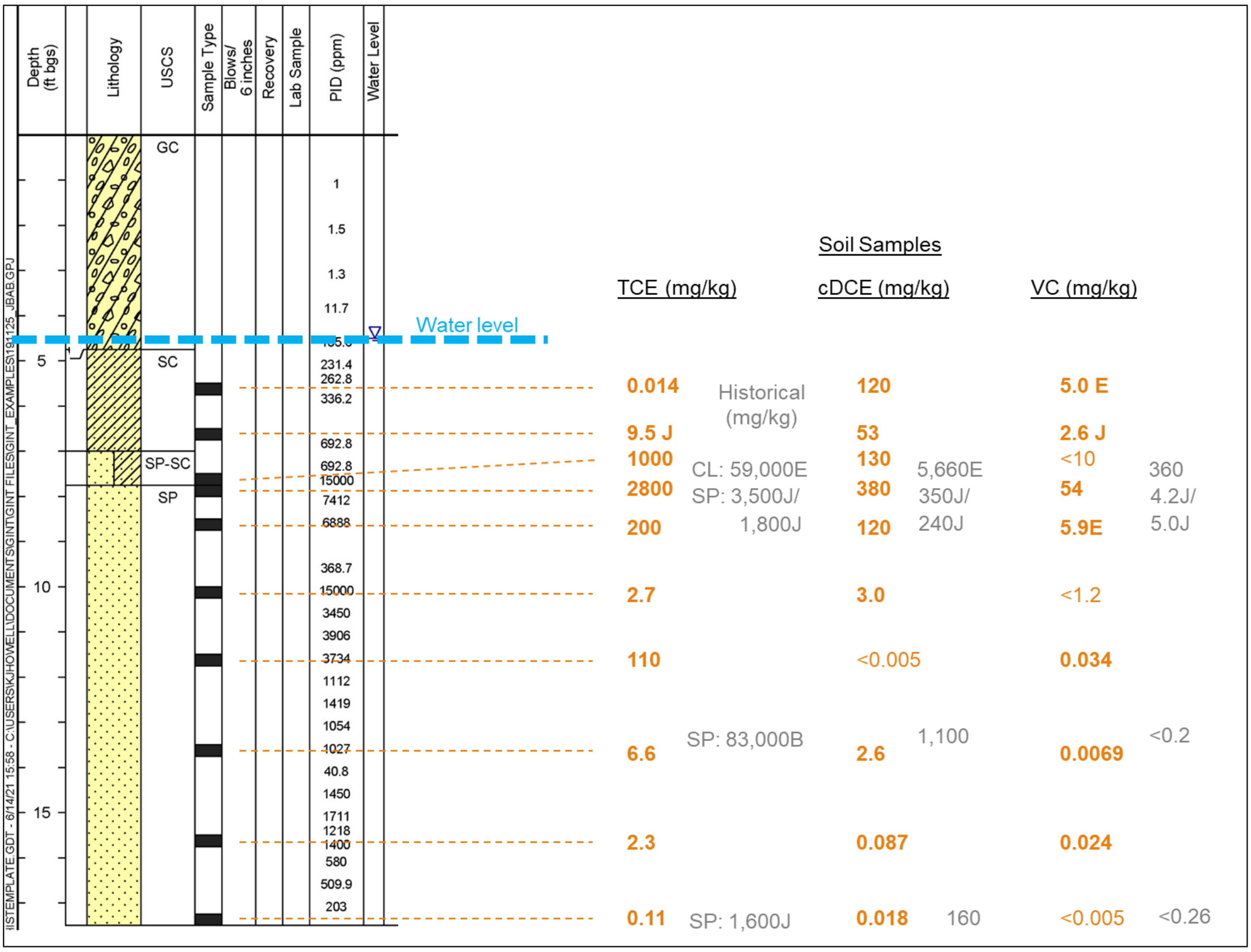

**Figure 4-2. SP East Hotspot modeling domain. (Basemap source: DON, 2018. Emphasis added)**

## Table 4-1. SP East Hotspot REMChlor-MD modeling input parameters

| Parameter | East Hotspot Plume | Notes |
|---|---|---|
| X-Direction model size (ft) | 88 | 2017 Site Recharacterization Phase II report (DON, 2018) plume figures |
| Z-Direction model size (ft) | 22 | Based on EXWC field work boring logs (DON, 2022b) |
| Source width (ft) | 13 | 2017 Site Recharacterization Phase II report (DON, 2018):<br>• SP East: width of 10,000 contour at MW1-56, (Figure 4-2) |
| Source thickness (ft) | 12.5 | Based on EXWC field work boring logs (DON, 2022b) |
| Hydraulic gradient (ft/ft) | 0.002 | Calculated from the 2017 Site Recharacterization Phase II Report Figure 4-5 (DON, 2018), |
| Transmissive zone hydraulic conductivity (cm/sec) | Initial: 2.6E-04<br>Calibrated: 1.0E-3 | 2017 Site Recharacterization Phase II report (DON, 2018) |
| Low-k zone hydraulic conductivity (cm/sec) | 1.4E-05 | REMChlor-MD default for silt |
| Transmissive zone porosity (-) | 0.28 | 2017 Site Recharacterization Phase II report (DON, 2018) |
| Low-k zone porosity (-) | 0.53 | EXWC field work (DON, 2022b) |
| Transmissive zone tortuosity (-) | 0.49 | REMChlor-MD default |
| Low-k zone tortuosity (-) | 0.41 | REMChlor-MD default |
| Transmissive zone retardation factor (-) | Initial TCE: 1.2<br>Initial cDCE: 1.1<br>Initial VC: 1.0<br>Calibrated (all COIs): 3 | Initial: calculated based on EXWC field work foc and bulk density data (DON, 2022b)<br>Final: calibrated |
| Low-k zone retardation factor (-) | Initial TCE: 5.7<br>Initial cDCE: 2.5<br>Initial VC: 1.06<br>Calibrated (all COIs): 4 | Initial: calculated based on EXWC field work foc and bulk density data (DON, 2022b)<br><br>Final: calibrated |
| Molecular diffusion coefficient ($cm^2$/sec) | 9.1E-6 | REMChlor-MD default for TCE |
| Gamma | 1 | Assumed |
| Source concentration (mg/L) | TCE: 800<br>cDCE: 0<br>VC: 0 | Calibrated |

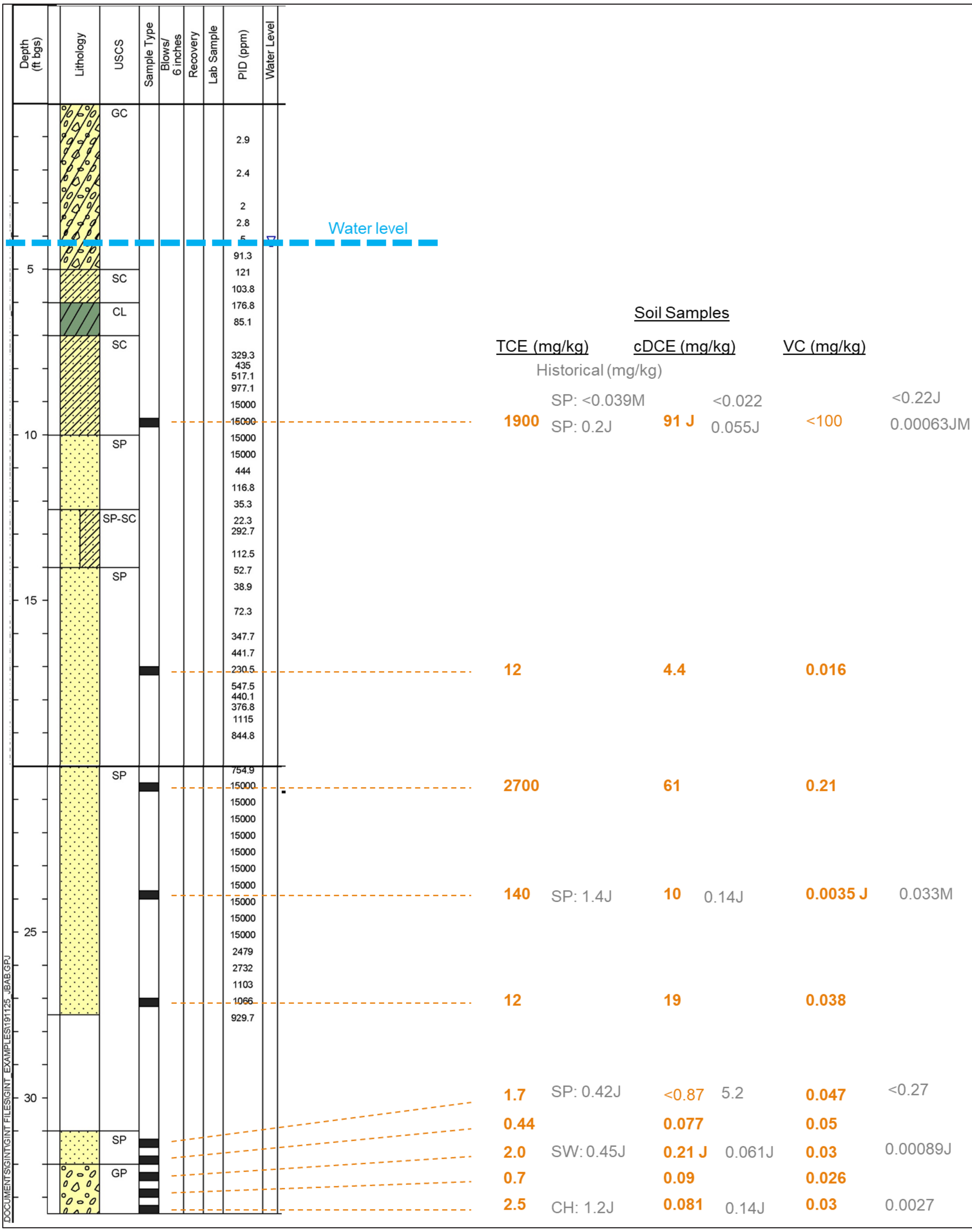
| Parameter | East Hotspot Plume | Notes |
|---|---|---|
| Source mass (kg) | TCE: 300<br>cDCE: 0<br>VC: 0 | Calibrated |
| Year source started | 1970 | Estimated |
| Heterogeneity | • No matrix diffusion in overlying or underlying low-k units<br>• Low-k material in plume thickness based on field boring logs | Based on EXWC field work boring logs (DON, 2022b) |
| Longitudinal dispersivity (ft) | 1 | Calibrated |
| Transverse dispersivity (ft) | 0.1 | $\alpha_t : \alpha_x = 0.10$ |
| Vertical dispersivity (ft) | 0.01 | $\alpha_t : \alpha_x = 0.01$ |
| Transmissive zone plume degradation half-life (yrs) | 0-47 ft from source:<br>TCE – 0.7<br>cDCE – 0.9<br>VC – 0.07<br>47 ft to plume edge:<br>TCE – 0.3<br>cDCE – 0.7<br>VC – 0.4 | Calibrated |
| Low-k zone plume degradation half-life (yrs) | All COIs: 10 | Calibrated |

cm = centimeters   ft = feet   kg = kilograms   L = liters   mg = milligrams   sec = second   yrs = years




Notes:
1. See Appendix B for soil classifications and Appendix C for boring logs.
2. Values in orange represent soil concentrations (see DON, 2022b, for details). Black rectangles represent soil sampling intervals.
3. Historical data from DON, 2018, are shown in gray text.

**Figure 4-3. EXWC SP field work USCS soil classifications and sample results at Location SP-MD01**




Notes:

1. See Appendix B for soil classifications and Appendix C for boring logs.
2. Values in orange represent soil concentrations (see DON, 2022b, for details). Black rectangles represent soil sampling intervals.
3. Historical data from DON, 2018, are shown in gray text.

**Figure 4-4. EXWC SP field work USCS soil classifications and sample results at Location SP-MD02**

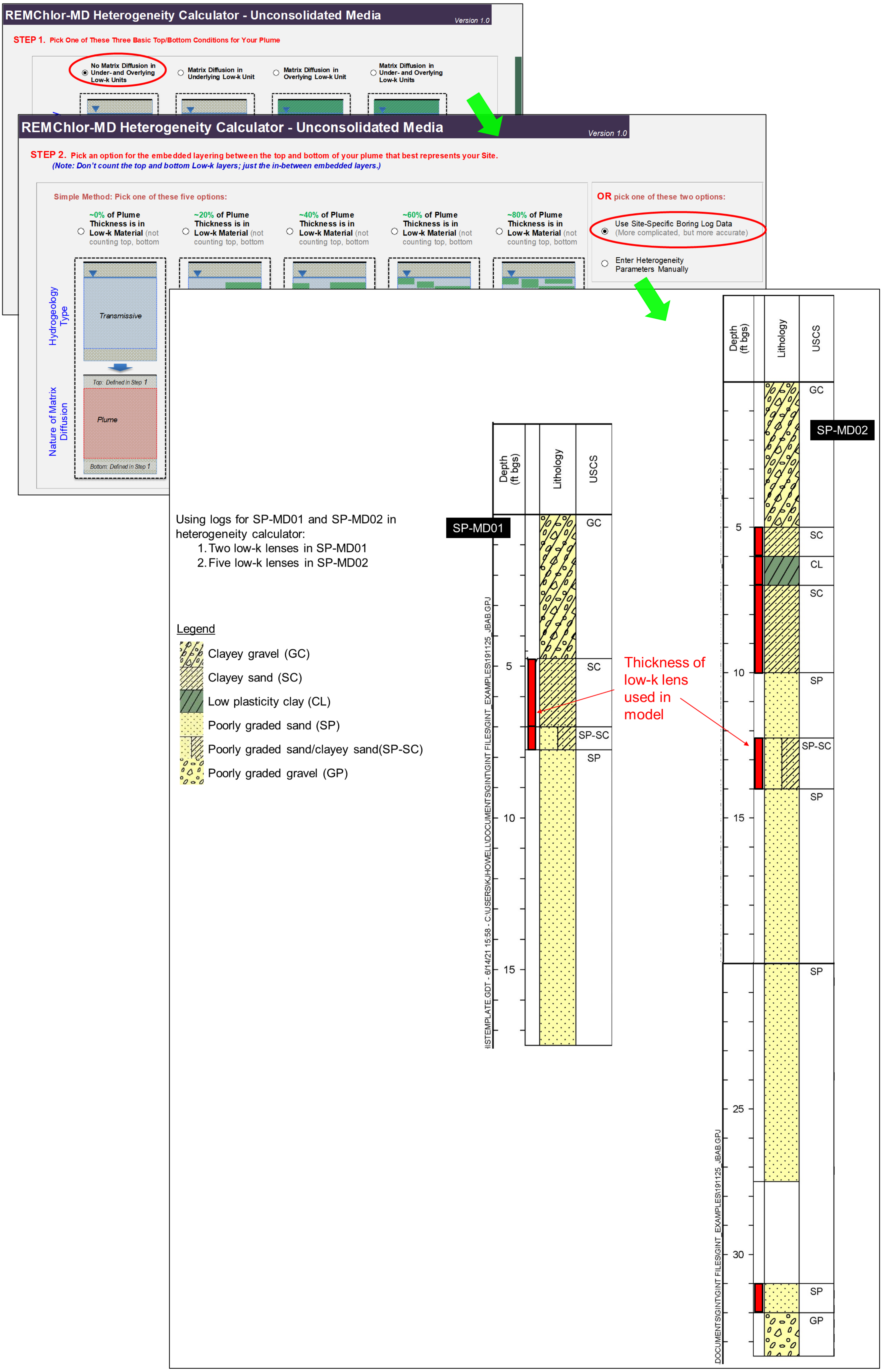



**Figure 4-5. SP East Hotspot heterogeneity features as expressed in REMChlor-MD input screens**

### *4.2.3 SP East Hotspot Model Calibration*

The East Hotspot plume model was calibrated to both the 2017 plume contours shown in Figure 4-5 (see Figure 2-3 for cDCE and VC plume contours) and the 2021 estimated mass in the transmissive and low-k zones (based on the EXWC field work, DON, 2022b). REMChlor-MD reproduced the observed concentrations and mass reasonably well. An overall Root Mean Square (RMS) error of 0.19 was obtained for the log-transformed groundwater concentrations in accordance with the Groundwater Modeling Plan (i.e., overall log transformed RMS ≤0.5 along the plume centerline) (GSI, 2020). Calibration results are presented in Tables 4-2 and 4-3 and Figure 4-6.

**Table 4-2. SP East Hotspot REMChlor-MD Calibration - Groundwater**

| | 2017 Concentration (mg/L) | | |
|---|---|---|---|
| **Monitoring Well** | **Source Area** | **Midgradient** | **Downgradient** |
| Distance from source (ft) | 0 | 44 | 88 |
| TCE (observed/simulated) | 332/310 | 3.0/3.1 | 5.4E-4/5.7E-4 |
| cDCE (observed/simulated) | 55.2/47.4 | 18.0/17.7 | 0.2/0.2 |
| VC (observed/simulated) | 1.3/1.9 | 1.0/1.1 | 0.2/0.2 |

TCE = Trichloroethene; cDCE = cis-1,2-Dichloroethene; VC = Vinyl chloride

**Table 4-3. SP East Hotspot REMChlor-MD Calibration - Mass**

| | **Observed** | **Simulated** |
|---|---|---|
| Total TCE Mass in 2021 (kg) | 134 | 116 |
| Percent Mass in Low-k Zone in 2021* | 37% | 45% |
| Percent Mass in Transmissive Zone in 2021 (kg)* | 63% | 55% |

* Total CVOC mass estimated in the low-k zone = 56 kg, total CVOC mass estimated in the transmissive zone = 95 kg. Therefore, percent of mass in the low-k zone = 56/(56+95) = 37%
CVOC = Chlorinated volatile organic compound
TCE = Trichloroethene

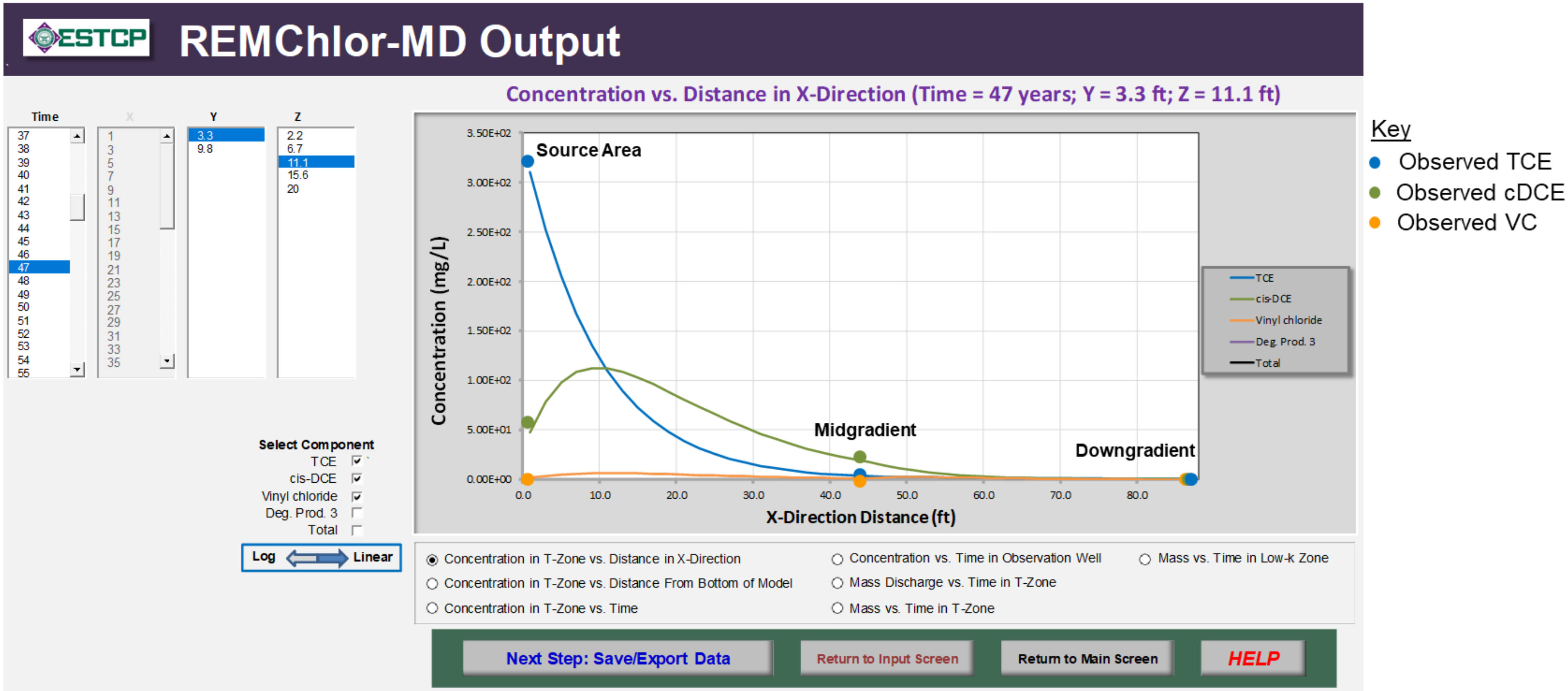



**Figure 4-6. SP East Hotspot REMChlor-MD calibration – Concentration**

### 4.2.4 SP East Hotspot Modeling Results

The impact of matrix diffusion on various remedial alternatives is summarized in Table 4-4 and Figures 4-8 through 4-10 for the East Hotspot plume. A graphical comparison of the time to reach the VC (the most conservative CVOC of interest) RG for the various remedial alternatives is presented in Figure 4-11. REMChlor-MD model input and output are shown in Appendix D.

The calibrated REMChlor-MD model was used to explore different remediation strategies under the influence of matrix diffusion. For the East Hotspot plume, impact of the remediation alternatives was evaluated by estimating, 1) the time to reach the VC RG at two locations: the stream bank and the plume boundary in the marsh (Figure 4-7); 2) the modeling COI mass remaining in the modeled plume, in both the low-k and transmissive zones, 30 years after the remediation; and 3) the modeling COI concentrations at the stream bank and plume boundary at the marsh 30 years after the remediation.

As shown on Table 4-4, even complete isolation of the source area with a PRB was unable to achieve the RG for VC 30 years after the remediation due to matrix diffusion effects. Based on the modeling, 30 years after the complete isolation of the source, VC concentrations were ~8,276-fold (0.24 mg/L compared to the RG of 2.9E-5 mg/L) and ~4,138-fold (0.12 mg/L compared to 2.9E-5 mg/L) greater than the RG at the stream bank and plume boundary, respectively. Also as shown on Table 4-4, 30 years after the complete isolation of the source with a PRB, majority of the mass within the modeled plume is in the low-k zone (~72%: 1.3 kg / 1.8 kg). This mass will continue to feed the plume for over a century as shown by the REMChlor-MD model.

An evaluation of the REMChlor-MD modeling to assess the effects of matrix diffusion on potential source area treatment remediation timeframes is detailed below.

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**Table 4-4. SP East Hotspot Remediation Scenarios Modeling Results**

| Model Runs | Detailed Questions | Is Plume Matrix Diffusion Turned On? | What Type Remediation is Assumed? | Year Vinyl Chloride is Below RG of 2.9E-5 mg/L | | Mass in 2055 (kg) | | | Concentration in 2055 (mg/L): At Stream Bank (Figure 4-7) | | | Concentration in 2055 (mg/L): At Plume Boundary in Marsh (Figure 4-7) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | At Stream Bank (Figure 4-7) | Plume Boundary in Marsh (Figure 4-7) | Low-k Zone | Trans Zone | Total | TCE (RG = 0.005 mg/L) | cDCE (RG = 0.07 mg/L) | VC (RG = 2.9E-5 mg/L) | TCE (RG = 0.005 mg/L) | cDCE (RG = 0.07 mg/L) | VC (RG = 2.9E-5 mg/L) |
| **Question 1: How important is matrix diffusion to the Conceptual Site Model?** | | | | | | | | | | | | | | |
| Run 1 | What is the impact of matrix diffusion on the groundwater CVOC plume? | No | • Plume degradation<br>• Source isolation with a PRB in 2025<br>• No plume remediation | 2052 | 2069 | 0.0 | 0.004 | 0.004 | 6.9E-07 | 1.4E-05 | 8.4E-07 | 2.1E-05 | 0.04 | 0.03 |
| Run 2 | | Yes | | 2167 | 2179 | 1.3 | 0.5 | 1.8 | 0.70 | 3.6 | 0.24 | 2.8E-04 | 0.17 | 0.12 |
| **Question 2: Can a PRB isolating the source be used to manage the groundwater plume?** | | | | | | | | | | | | | | |
| Run 3 (Basecase) | Can a PRB be used to manage the groundwater plume? | Yes | • Plume degradation only<br>• No source remediation<br>• No plume remediation | >2670 | 2626 | 6.9 | 8.0 | 14.9 | 5.13 | 20.55 | 1.26 | 4.1E-04 | 0.20 | 0.15 |
| Run 2 (same as above) | | Yes | • Plume degradation<br>• Source isolation with a PRB in 2025<br>• No plume remediation | 2167 | 2179 | 1.3 | 0.5 | 1.8 | 0.70 | 3.6 | 0.24 | 2.8E-04 | 0.17 | 0.12 |
| **Question 3: How will removing 90% of the source mass affect the groundwater plume?** | | | | | | | | | | | | | | |
| Run 3 (Basecase, same as above) | How will removing 90% of the source mass affect the groundwater plume? | Yes | • Plume degradation only<br>• No source remediation<br>• No plume remediation | >2670 | 2626 | 6.9 | 8.0 | 14.9 | 5.13 | 20.55 | 1.26 | 4.1E-04 | 0.20 | 0.15 |
| Run 4 | | Yes | • Plume degradation<br>• 90% source removal in 2025<br>• No plume remediation | 2627 | 2477 | 1.9 | 1.3 | 3.2 | 1.14 | 5.26 | 0.34 | 2.9E-04 | 0.17 | 0.12 |

RG = Remediation Goal TCE = trichloroethene cDCE = cis-1,2-dichloroethene VC = vinyl chloride

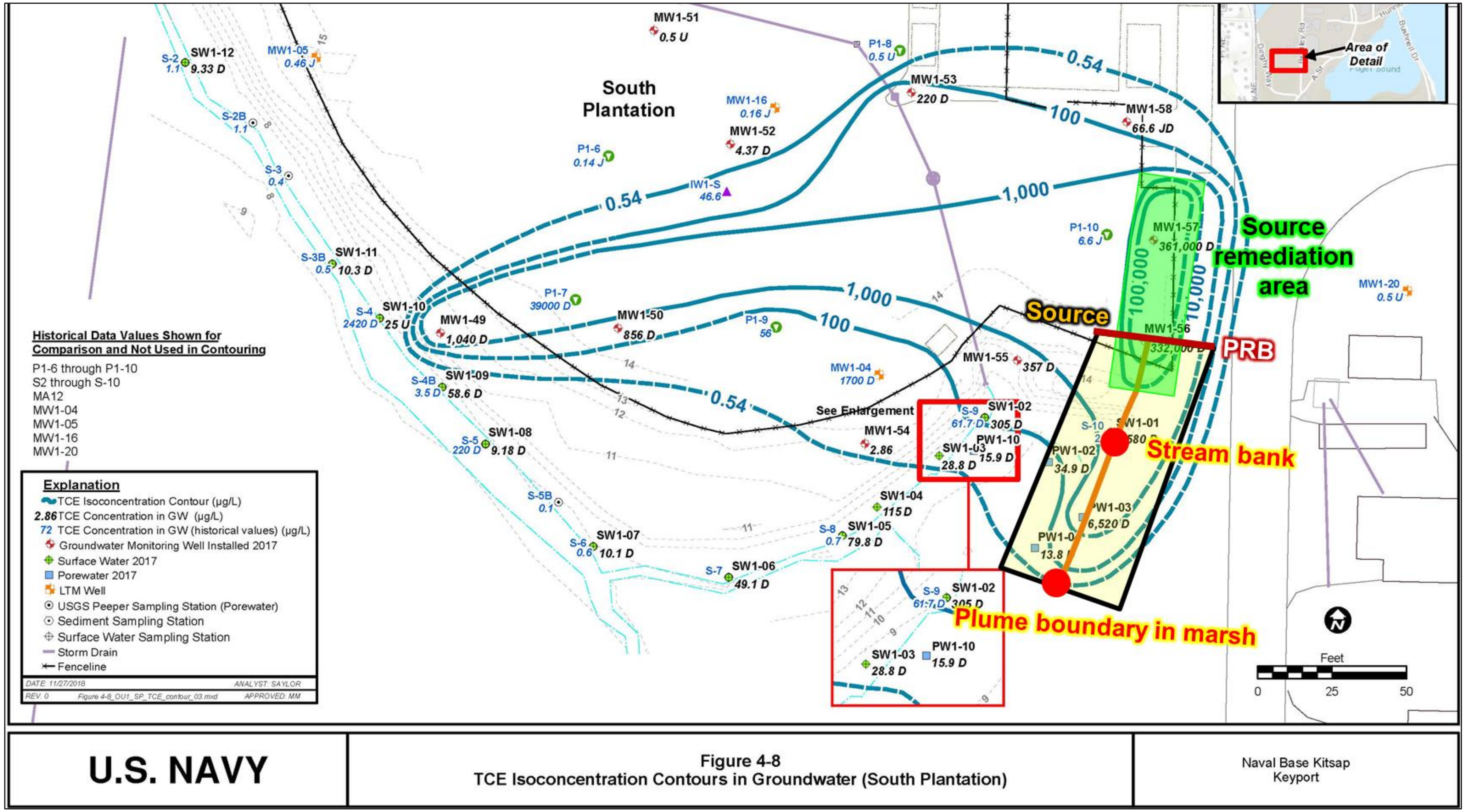



**Figure 4-7. Scenarios modeling – SP East Hotspot. (Basemap source: DON, 2018. Emphasis added)**

Based on the REMChlor-MD modeling, an overall evaluation of the three questions of interest to the U.S. Navy addressing Objective 2 is presented below.

- *Question 1: How important is matrix diffusion to the CSM?*

  *Modeling Summary:* Very important. Based on the EXWC field work data collected in 2021, approximately 37% of the total CVOC mass (Table 4-3) observed is in the East Hotspot low-k zone. For VC, the constituent with the most conservative RG, the no matrix diffusion model in the East Hotspot shows VC dropping below the RG at the stream bank **27 years** (2052 minus 2025) after 100% source isolation (Run 1). However, accounting for matrix diffusion, the model predicts the VC plume in groundwater will persist for **over 140 years** (2167 minus 2025) after 100% source isolation in year 2025 (Run 2) before reaching the VC RG (Figure 4-8). At the plume boundary in the marsh, the no matrix diffusion model in the East Hotspot shows VC dropping below the RG **44 years** (2069 minus 2025) after 100% source isolation (Run 1). However, accounting for matrix diffusion, the model predicts the VC plume in groundwater will persist for **over 150 years** (2179 minus 2025) after 100% source isolation in year 2025 (Run 2) before reaching the VC RG (Figure 4-8).

- *Question 2: Can a PRB isolating the source be used to manage the groundwater plume?*

  *Modeling Summary:* A source PRB would reduce the remediation timeframe, but it would still take over a century to reach groundwater RGs. For the East Hotspot, isolating the source with a PRB (Figure 4-7) reduces the time to reach the VC RG at the stream bank from **>645 years** (>2670 minus 2025) (for the case with no PRB, Run 3) to **~142 years** (2167 minus 2025, Run 2) (Figure 4-9). At the plume boundary at the marsh, isolating the source with a PRB reduces the time to reach the VC RG from **~600 years** (2626 minus 2025) (for the case with no PRB, Run 3) to **~154 years** (2179 minus 2025, Run 2) (Figure 4-9).

- *Question 3: How will removing 90% of the source mass affect the groundwater plume?*

  *Modeling Summary:* Removing 90% of the source mass has little impact on the long-term fate and transport of the groundwater plume. This is because removing 90% of the source mass does not equate to removing 90% of the mass contained in the low-k and transmissive zones in the plume downgradient of the source. After source removal, the mass in the low-k unit will continue to feed the plume for centuries as shown by the REMChlor-MD model. For the East Hotspot, removing 90% of the source mass decreased the remediation timeframe for VC from **>645 years** (>2670 minus 2025) (assuming no remediation, Run 3) to **~602 years** (2627 minus 2025, Run 4) at the stream bank (Figure 4-10). At the plume boundary at the marsh, removing 90% of the source mass decreased the remediation timeframe for VC from **~600 years** (2626 minus 2025) (assuming no remediation, Run 3) to **~450 years** (2477 minus 2025, Run 4) (Figure 4-10).

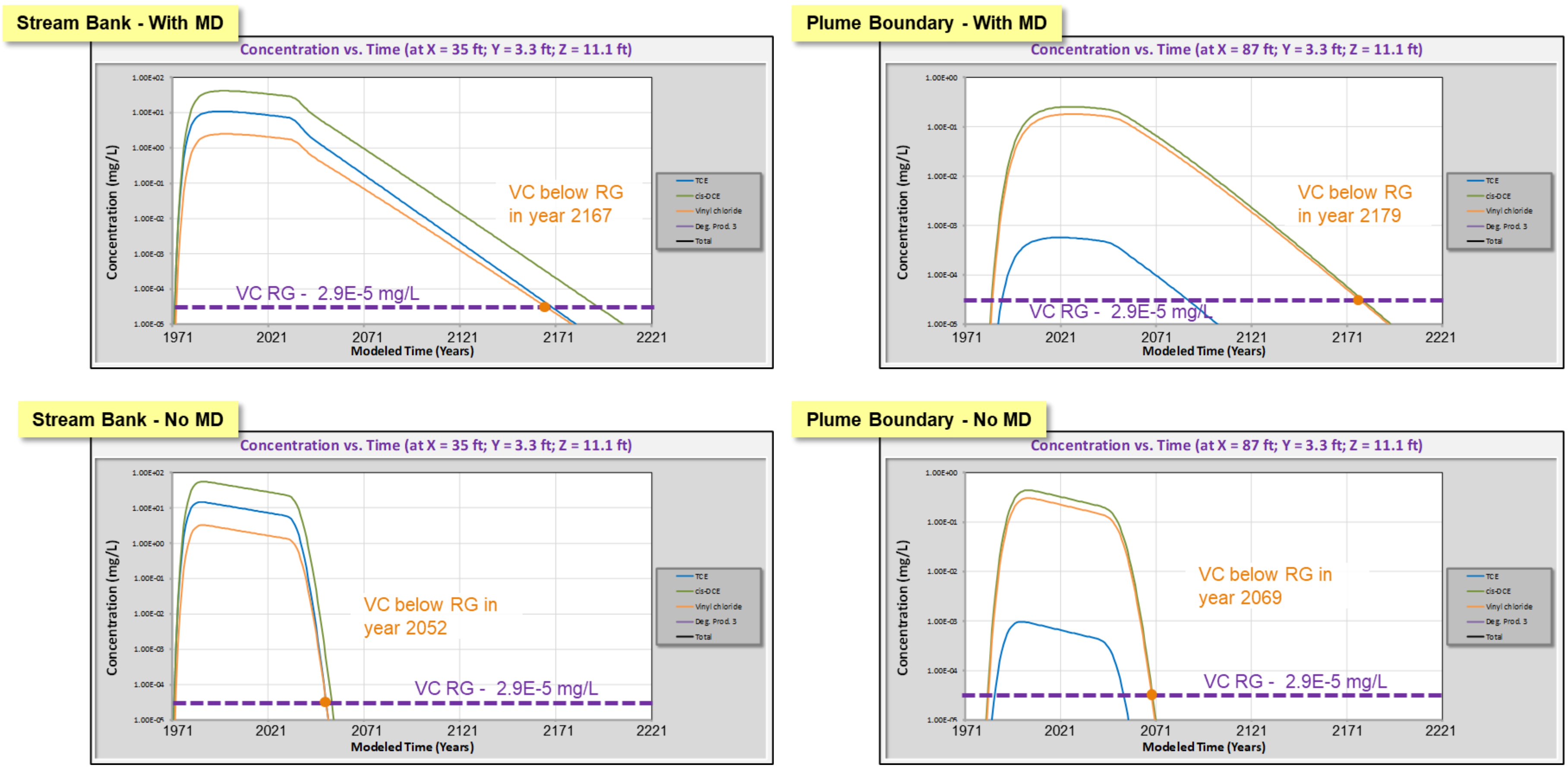



**Figure 4-8. SP East Hotspot REMChlor-MD model output: matrix diffusion vs. no matrix diffusion. Top Panels: With matrix diffusion (MD). Bottom Panels: Without matrix diffusion**

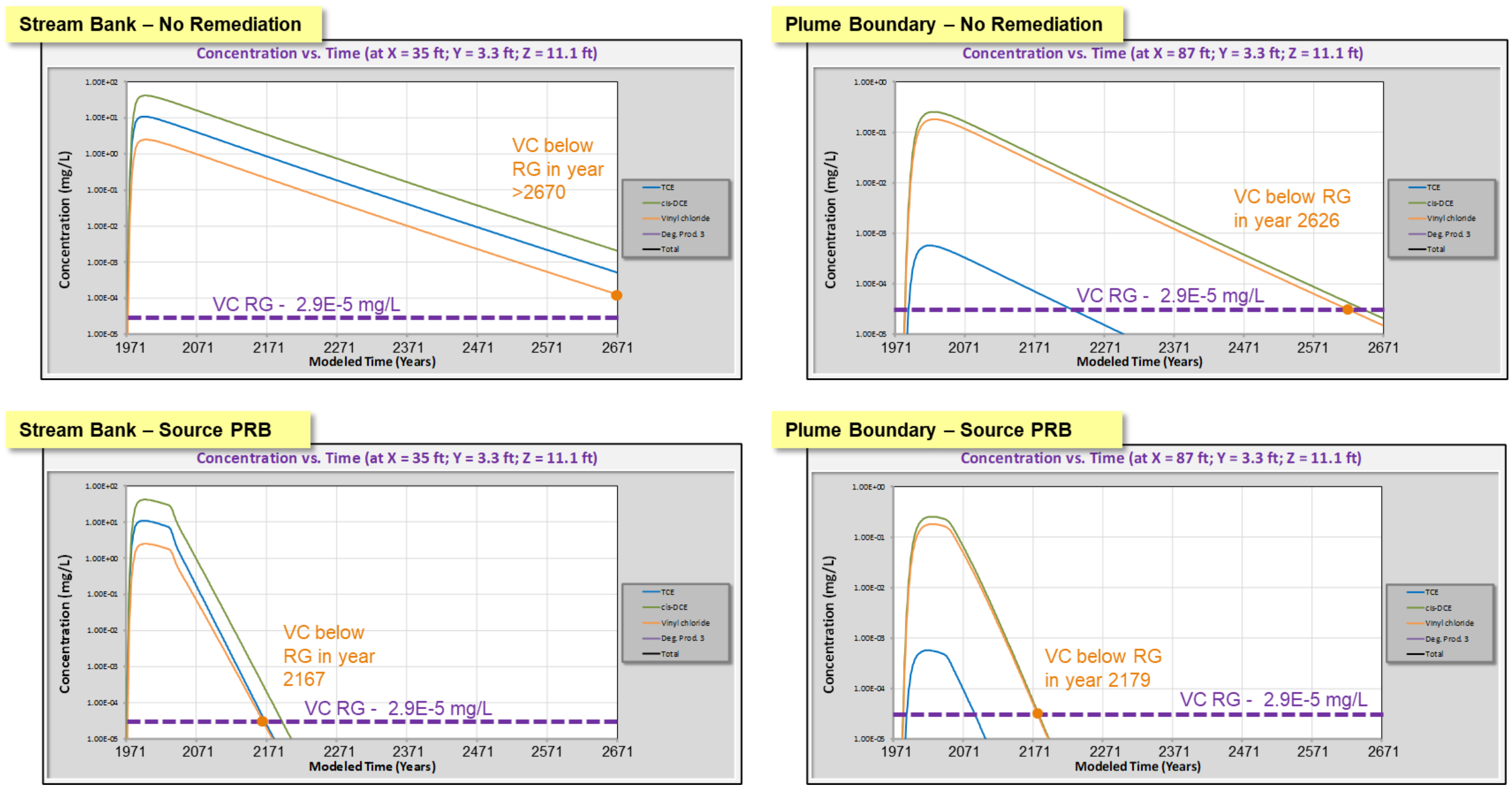



**Figure 4-9. SP East Hotspot REMChlor-MD model output: Source isolation vs. no remediation. Top Panels: No remediation. Bottom Panels: Source isolated with PRB**

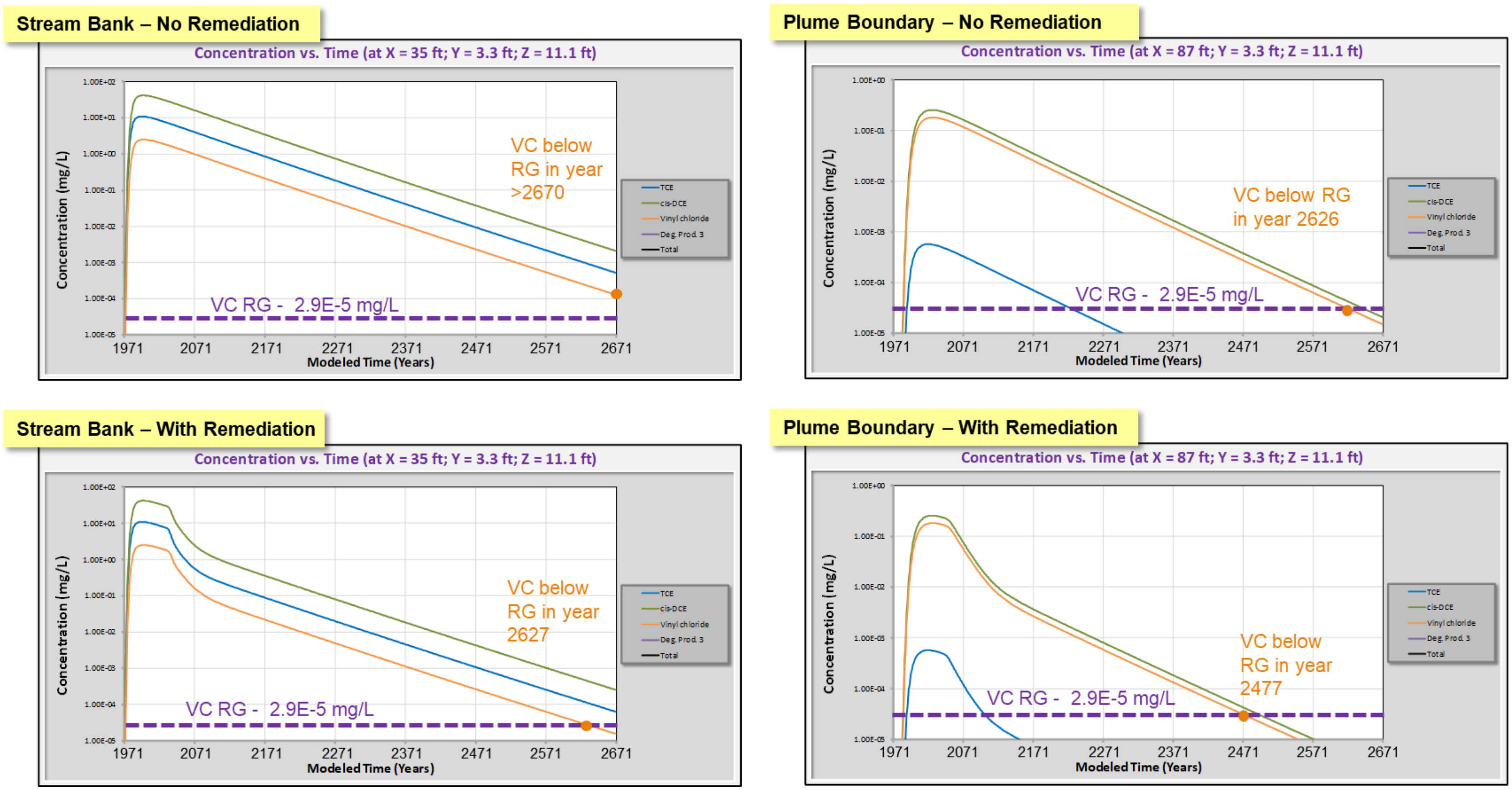



**Figure 4-10. SP East Hotspot REMChlor-MD model output: 90% Source remediation vs. no remediation. Top Panels: No remediation. Bottom Panels: 90% source remediation**

### *4.2.5 SP East Hotspot Modeling Conclusions*

The project team hypothesized that matrix diffusion processes at NBK Keyport would impact the effectiveness of source remediation in the downgradient plume. That is, the low-k zones in the impacted aquifer at NBK Keyport had higher concentrations than the surrounding transmissive units, thereby allowing back-diffusion to sustain the long-term, low-level persistent dissolved phase concentrations of CVOCs in groundwater.

Data collected by EXWC from suspected low-k geologic media at four locations, SP-MD01 through SP-MD04, showed several geologic contacts (interfaces) where there is a greater than 10x permeability contrast (e.g., a clean sand in contact with a clayey sand) that could, in theory, support matrix diffusion processes. Detections of high soil concentrations for the target CVOCs provide supporting evidence for matrix diffusion effects from low-k layer/lenses.

The REMChlor-MD model reproduced observed groundwater concentrations and constituent mass reasonably well during the calibration step and then was used to forecast general trends in remediation timeframe at the East Hotspot.

REMChlor-MD models of the East Hotspot at NBK Keyport showed that the target CVOCs (TCE, cDCE, and VC) are likely to persist for decades. The modeling runs suggested that even with complete isolation of the source with a PRB in 2025, an additional 154 years from the year 2025 are required to permanently reach the VC (the most conservative CVOC of interest) RG at the plume boundary in the marsh due to matrix diffusion effects (Figure 4-11). At the stream bank in the East Hotspot plume, an additional 142 years from the year 2025 might be needed to permanently reach sub-RG VC concentrations.

These planning-level model results suggest that matrix diffusion processes significantly reduce the effectiveness of source remediation in the downgradient plume. Even if the hotspots are remediated (e.g., with an in-situ treatment or excavation) to reduce source concentrations, the same reduction in concentration is not observed in the plume downgradient of the hotspots (i.e., a 90% reduction in source concentrations does not result in a 90% reduction in the downgradient plume concentrations). It is possible for the concentrations of plumes like the ones at NBK Keyport to “hover” just above the RGs at single-digit, part-per-billion concentrations for decades due to the on-going matrix diffusion processes.

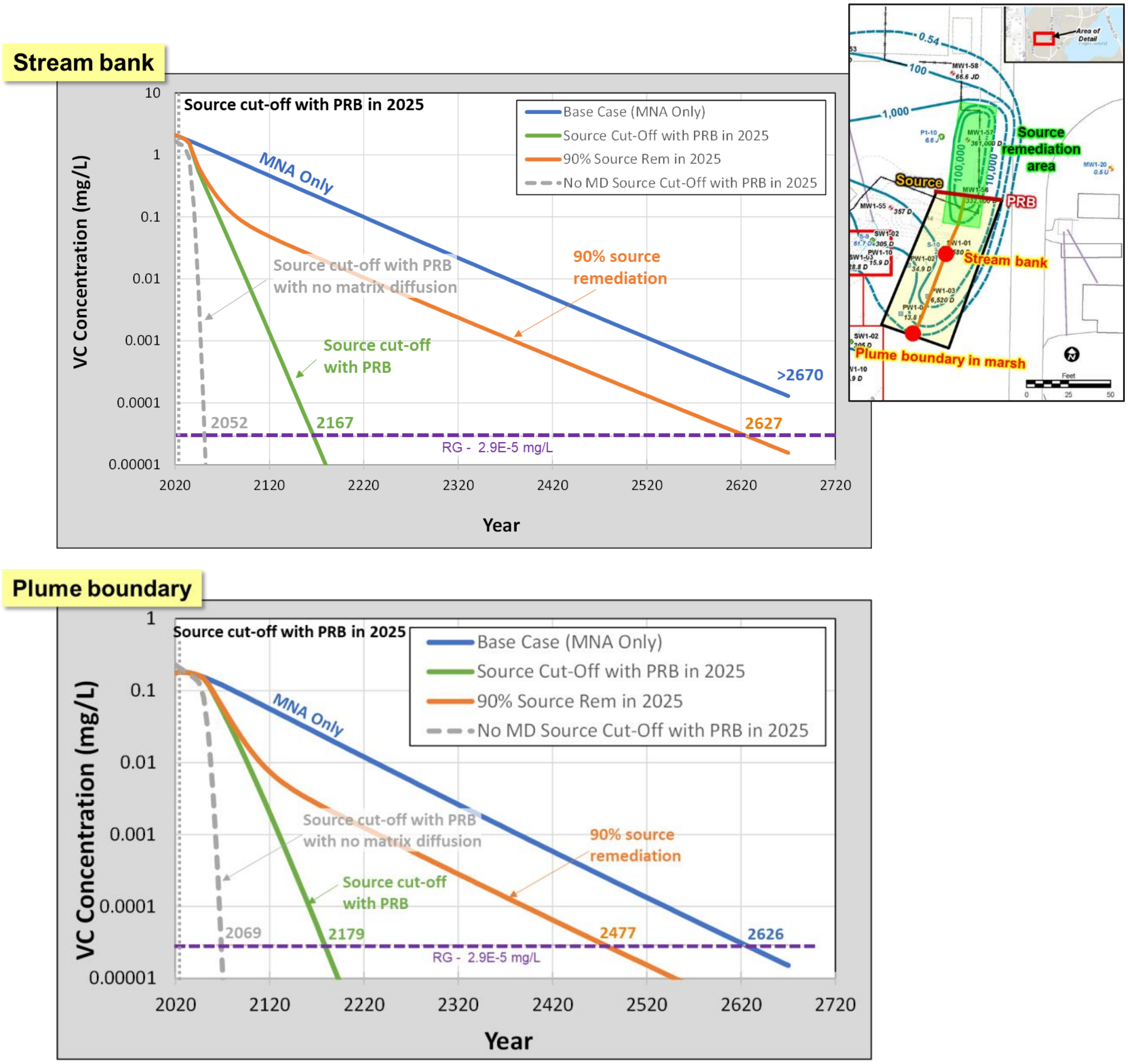



**Figure 4-11. SP East Hotspot REMChlor-MD modeling summary for vinyl chloride. Top Panel: Modeling results at the Stream Bank. Bottom Panel: Modeling results at the Plume Boundary in the marsh. (Inset map source: DON, 2018, emphasis added)**

## 4.3 South Plantation West Hotspot

### *4.3.1 SP West Hotspot Modeling Approach*

For the West Hotspot plume, the modeling approach included:

- Estimating the CVOC mass in soil and the percent of mass in the low-k soils vs. transmissive soils based on the EXWC field data (DON, 2022b) (Figure 4-1).
- Using the estimated mass in the step above as input or as a calibration parameter in the REMChlor-MD model.

- Using observed groundwater concentrations as a calibration parameter.
- Using the calibrated REMChlor-MD model to explore different remediation strategies under the influence of matrix diffusion.

### *4.3.2 SP West Hotspot Model Input Data*

The REMChlor-MD modeling domain is shown on Figure 4-12 and input data detailed in Table 4-5. Key input data/assumptions include:

- A source zone starting in 1970 was estimated based on the general timing when chlorinated solvents began to come into extensive industrial use in the U.S.
- Based on the EXWC field data collected, the West Hotspot source was assumed to be ~3 ft thick and located near the bottom of the transmissive zone (Figures 4-13 and 4-14).
- Key heterogeneity features for the West Hotspot were simulation of the transmissive zone comprised of no low-k lenses and overlying an aquitard based on the EXWC field data collected (Figure 4-15). Matrix diffusion was incorporated into the model in both the source and the plume, i.e., matrix diffusion processes were considered present within the entire modeling domain (except for the no matrix diffusion run, Run 1 (see Table 4-8), which assumed no matrix diffusion in the plume).
- Source concentrations, source mass, transmissive zone hydraulic conductivity, retardation factors, and plume degradation rates were adjusted to match the average 2017/2019 groundwater concentrations in the source area (MW1-50 and SP-489) and downgradient (MW1-49 and SP-B42) and the 2021 estimated mass in the transmissive and low-k zones (based on the EXWC field work, DON, 2022b).

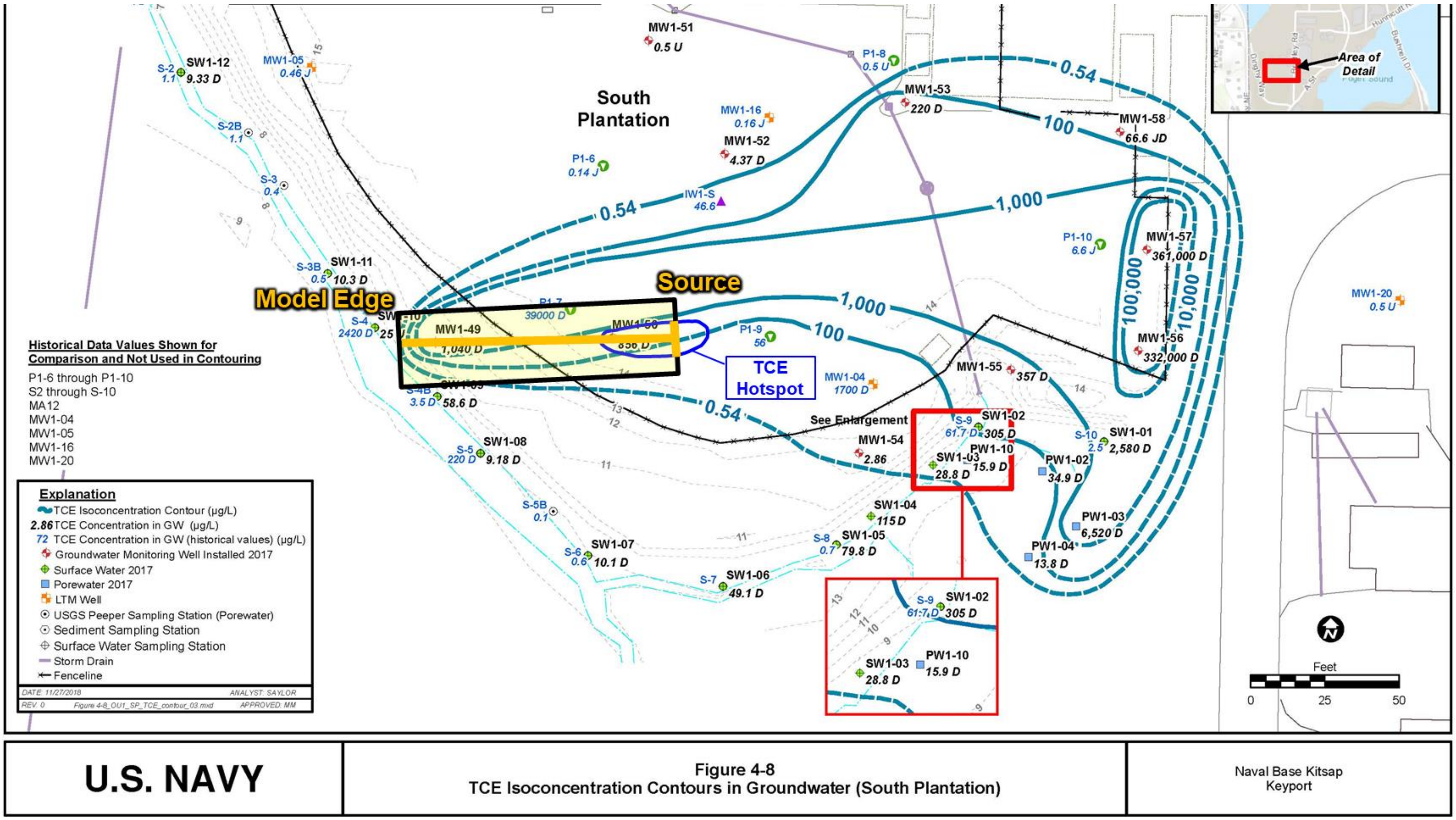


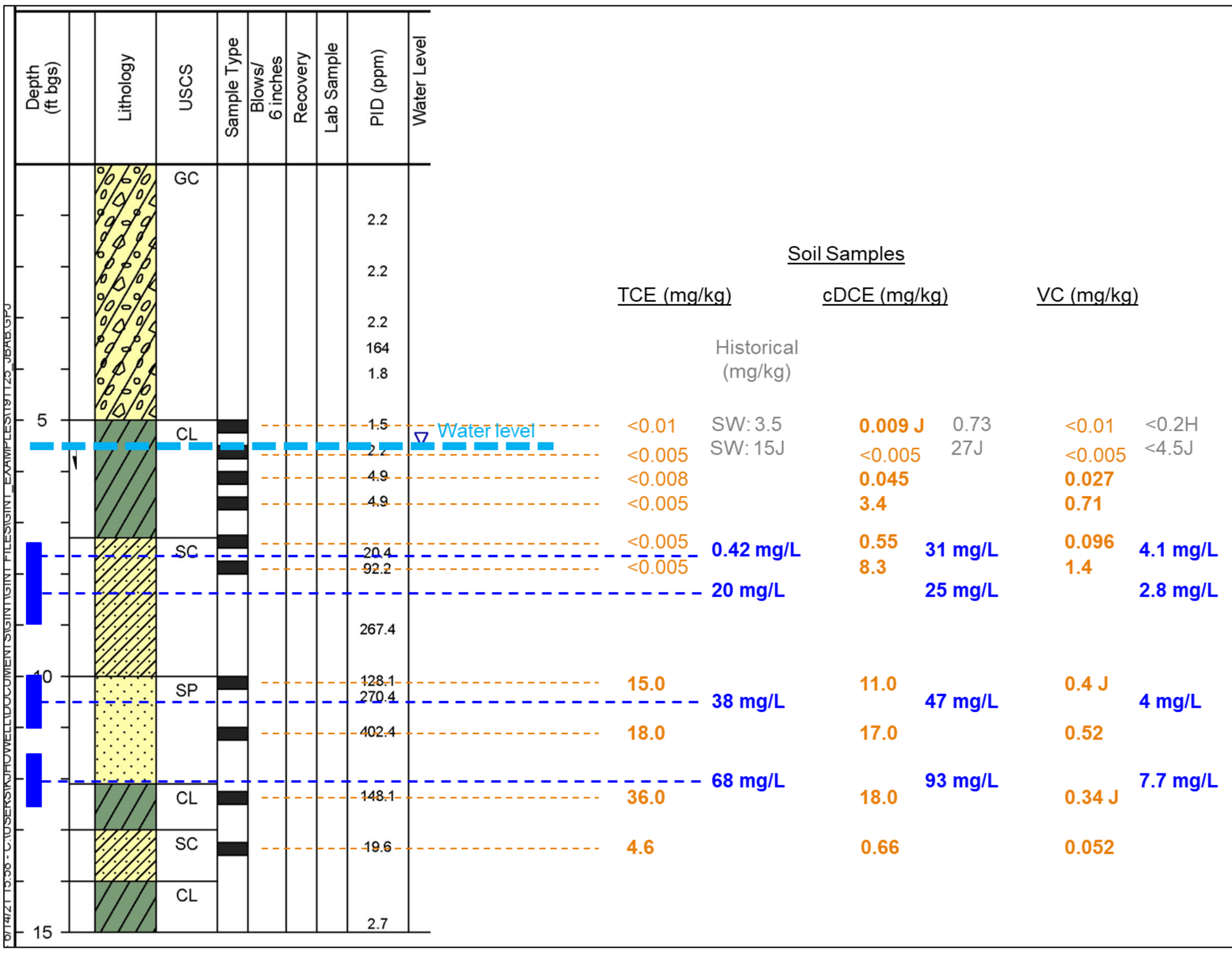

**Figure 4-12. SP West Hotspot modeling domain. (Basemap and TCE hotspot source: DON, 2018)**

## Table 4-5. SP West Hotspot REMChlor-MD modeling input parameters

| Parameter | West Hotspot Plume | Notes |
|---|---|---|
| X-Direction model size (ft) | 92 | 2017 Site Recharacterization Phase II report (DON, 2018) plume figures |
| Z-Direction model size (ft) | 3.5 | Based on EXWC field work boring logs (DON, 2022b) |
| Source width (ft) | 12 | 2017 Site Recharacterization Phase II report (DON, 2018):<br>• SP West: widest part of 50,000 contour (Figure 4-12) |
| Source thickness (ft) | 3.5 | Based on EXWC field work boring logs (DON, 2022b) |
| Hydraulic gradient (ft/ft) | 0.015 | Calculated from the 2017 Site Recharacterization Phase II Report Figure 4-5 (DON, 2018) |
| Transmissive zone hydraulic conductivity (cm/sec) | 2.6E-04 | 2017 Site Recharacterization Phase II report (DON, 2018) |
| Low-k zone hydraulic conductivity (cm/sec) | 1.4E-05 | REMChlor-MD default for silt |
| Transmissive zone porosity (-) | 0.28 | 2017 Site Recharacterization Phase II report (DON, 2018) |
| Low-k zone porosity (-) | 0.53 | EXWC field work (DON, 2022b) |
| Transmissive zone tortuosity (-) | 0.46 | REMChlor-MD default |
| Low-k zone tortuosity (-) | 0.41 | REMChlor-MD default |
| Transmissive zone retardation factor (-) | Initial TCE: 1.2<br>Initial cDCE: 1.1<br>Initial VC: 1.0<br>Calibrated (all COIs): 3.5 | Initial: calculated based on EXWC field work foc and bulk density data (DON, 2022b)<br><br>Final: calibrated |
| Low-k zone retardation factor (-) | Initial TCE: 5.7<br>Initial cDCE: 2.5<br>Initial VC: 1.06<br>Calibrated (all COIs): 5 | Initial: calculated based on EXWC field work foc and bulk density data (DON, 2022b)<br><br>Final: calibrated |
| Molecular diffusion coefficient ($cm^2/sec$) | 9.1E-6 | REMChlor-MD default for TCE |
| Gamma | 1 | Assumed |

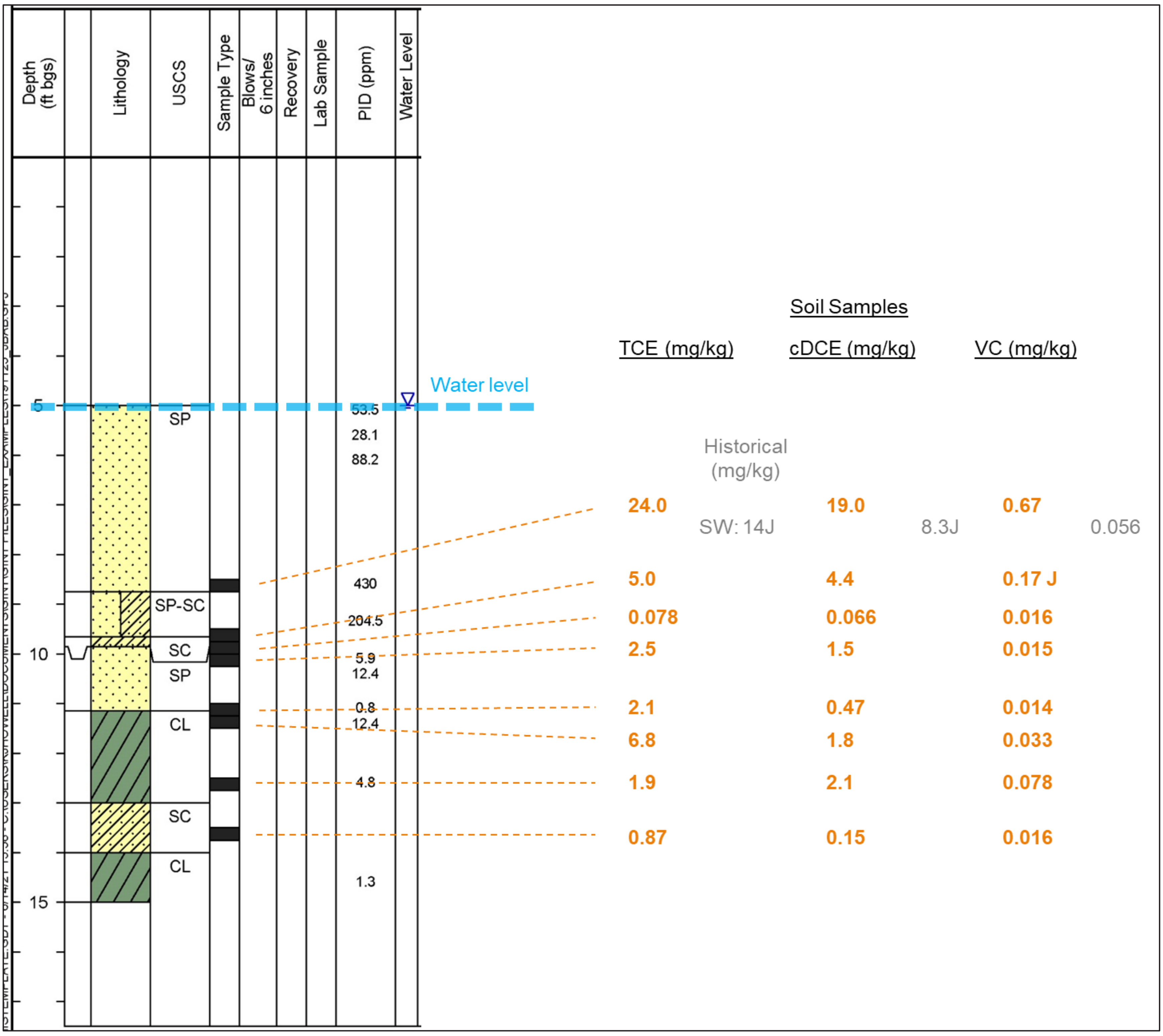
| Parameter | West Hotspot Plume | Notes |
|---|---|---|
| Source concentration (mg/L) | TCE: 35<br>cDCE: 28<br>VC: 3.9 | Calibrated |
| Source mass (kg) | TCE: 100<br>cDCE: 100<br>VC: 100 | Calibrated |
| Year source started | 1970 | Estimated |
| Heterogeneity | • Matrix diffusion in underlying low-k unit<br>• No low-k material in plume thickness based on field boring logs | Based on EXWC field work boring logs (DON, 2022b) |
| Longitudinal dispersivity (ft) | 1 | Calibrated |
| Transverse dispersivity (ft) | 0.1 | $\alpha_t : \alpha_x = 0.10$ |
| Vertical dispersivity (ft) | 0.01 | $\alpha_t : \alpha_x = 0.01$ |
| Transmissive zone plume degradation half-life (yrs) | TCE – 1.5<br>cDCE – 1.2<br>VC – 0.15 | Calibrated |
| Low-k zone plume degradation half-life (yrs) | All COIs: 10 | Calibrated |

cm = centimeters ft = feet kg = kilograms L = liters mg = milligrams sec = second yrs = years




Notes:
1. See Appendix B for soil classifications and Appendix C for boring logs.
2. Values in orange represent soil concentrations and values in blue represent groundwater concentrations (see DON, 2022b, for details). Black rectangles represent soil sampling intervals. Blue columns represent the groundwater sampling intervals.
3. Historical data from DON, 2018, are shown in gray text.

**Figure 4-13. EXWC SP field work USCS soil classifications and sample results at Location SP-MD03**




Notes:

1. See Appendix B for soil classifications and Appendix C for boring logs.
2. Values in orange represent soil concentrations (see DON, 2022b, for details). Black rectangles represent soil sampling intervals.
3. Historical data from DON, 2018, are shown in gray text.

**Figure 4-14. EXWC SP field work USCS soil classifications and sample results at Location SP-MD04**

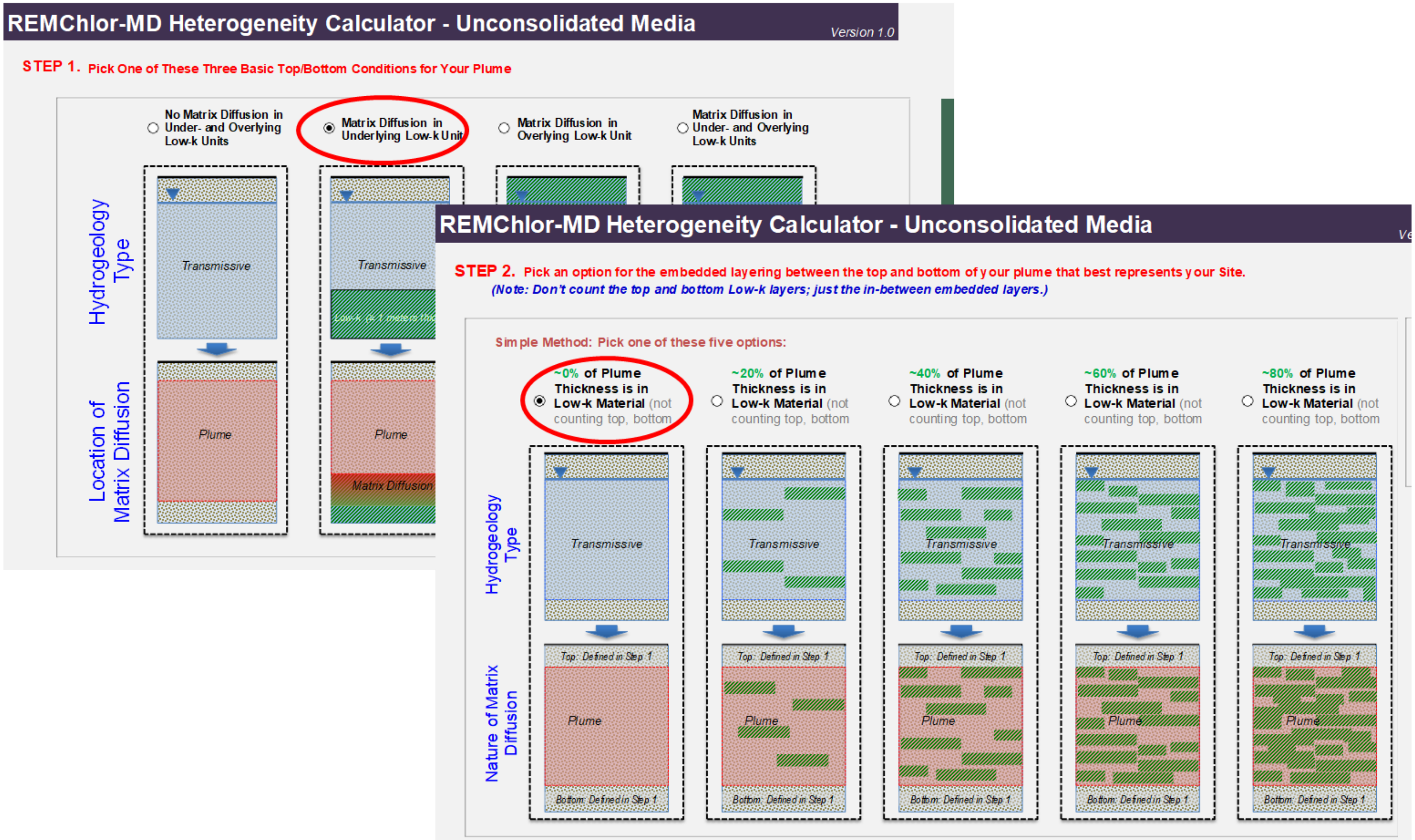



**Figure 4-15. SP West Hotspot heterogeneity features as expressed in REMChlor-MD input screens**

### 4.3.3 SP West Hotspot Model Calibration

The SP West Hotspot plume model was calibrated to both the average 2017/2019 groundwater concentrations and the 2021 estimated mass in the transmissive and low-k zones (based on the EXWC field work). REMChlor-MD reproduced the observed concentrations and mass reasonably well. An overall RMS error of 0.18 was obtained for the log-transformed groundwater concentrations in accordance with the Groundwater Modeling Plan (i.e., overall log transformed RMS ≤0.5 along the plume centerline) (GSI, 2020). Calibration results are presented in Tables 4-6 and 4-7 and Figure 4-16.

**Table 4-6. SP West Hotspot REMChlor-MD Calibration - Groundwater**

| Monitoring Well | Concentration* (mg/L) | |
|---|---|---|
| | Upgradient (MW1-50/SP-B49) | Downgradient (MW1-49/SP-B42) |
| Distance from source (ft) | 20 | 80 |
| TCE (observed/simulated) | 16.2/16.2 | 1.8/1.9 |
| cDCE (observed/simulated) | 19.7/18.2 | 2.4/3.5 |
| VC (observed/simulated) | 1.5/1.6 | 0.3/0.3 |

Notes:
* Observed concentrations are means of the 2017 and 2019 concentrations. However, for the purposes of modeling, 2017 was selected as the calibration year as a conservative measure.
TCE = Trichloroethene; cDCE = cis-1,2-Dichloroethene; VC = Vinyl chloride

**Table 4-7. SP West Hotspot REMChlor-MD Calibration - Mass**

| | Observed | Simulated |
|---|---|---|
| Low-k CVOC Mass in 2021 (kg) | 1.9 | 2.0 |
| Transmissive Zone CVOC Mass in 2021 (kg) | 3.0 | 2.3 |
| Total CVOC Mass in 2021 (kg) | 4.9 | 4.3 |

CVOC = Chlorinated volatile organic compound

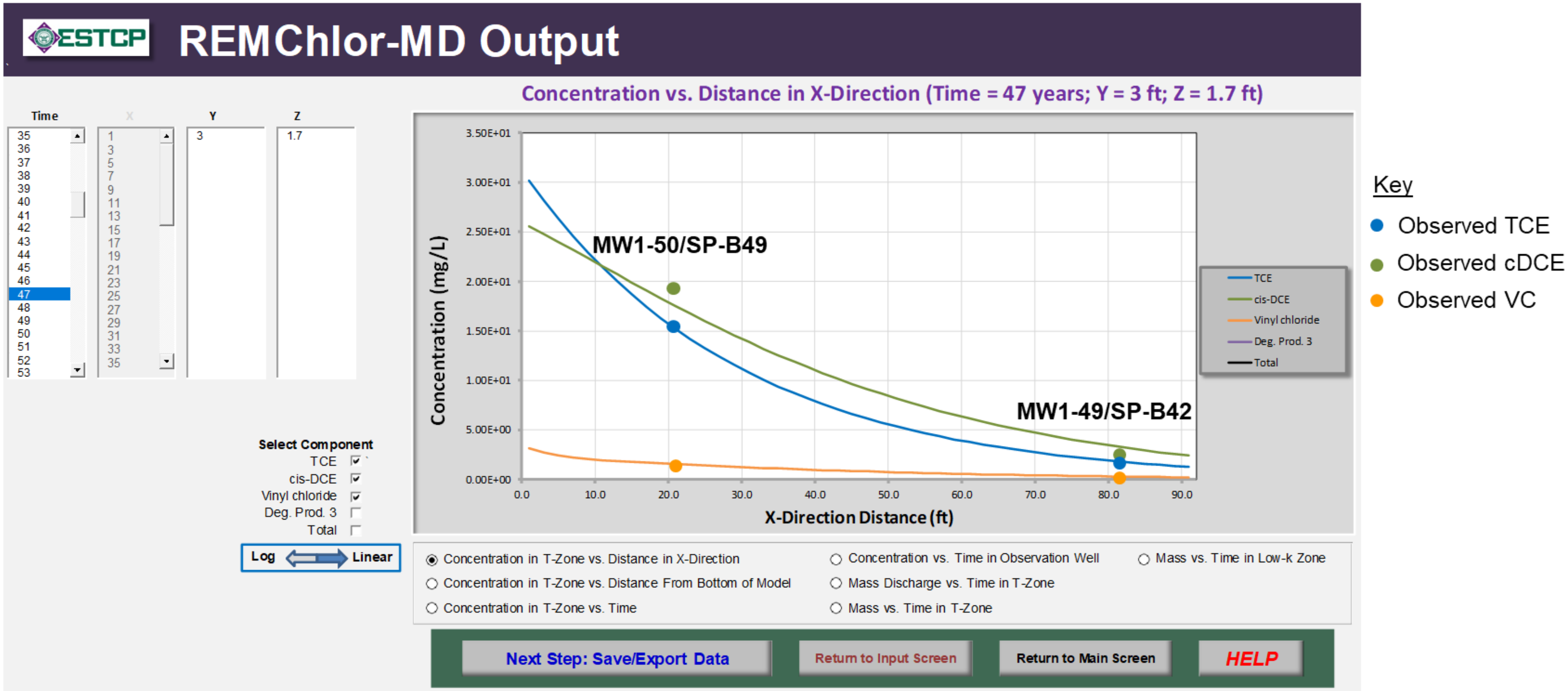



**Figure 4-16. SP West Hotspot REMChlor-MD calibration – Concentration**

#### *4.3.4 SP West Hotspot Modeling Results*

The impact of matrix diffusion on various remedial alternatives is summarized in Table 4-8 and Figures 4-18 through 4-20 for the West Hotspot plume. A graphical comparison of the time to reach the VC (the most conservative CVOC of interest) RG for the various remedial alternatives is presented in Figure 4-21. REMChlor-MD model input and output are shown in Appendix E.

The calibrated REMChlor-MD model was used to explore different remediation strategies under the influence of matrix diffusion. For the West Hotspot plume, impact of the remediation alternatives was evaluated by estimating, 1) the time to reach the VC RG at the model edge (Figure 4-17); 2) the modeling COI mass remaining in the modeled plume, in both the low-k and transmissive zones, 30 years after the remediation; and 3) the modeling COI concentrations at the model edge 30 years after the remediation.

As shown on Table 4-8, even complete isolation of the source area with a PRB was unable to achieve the RG for VC 30 years after the remediation due to matrix diffusion effects. Based on the modeling, 30 years after the complete isolation of the source, VC concentrations were ~2,379-fold greater than the RG (0.069 mg/L compared to 2.9E-5 mg/L) at the model edge. Also as shown on Table 4-8, 30 years after the complete isolation of the source with a PRB, majority of the mass within the modeled plume is in the low-k zone (~90%: 1.14 kg / 1.26 kg). This mass will continue to feed the plume for centuries as shown by the REMChlor-MD model.

An evaluation of the REMChlor-MD modeling to assess the effects of matrix diffusion on potential source area treatment remediation timeframes is detailed below.

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### Table 4-8. SP West Hotspot Remediation Scenarios Modeling Results

| Model Runs | Detailed Questions | Is Plume Matrix Diffusion Turned On? | What Type Remediation is Assumed? | Year Vinyl Chloride is Below RG of 2.9E-5 mg/L at Model Edge | Mass in 2055 (kg) | | | Concentration in 2055 at Model Edge (mg/L) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Low-k Zone | Trans Zone | Total | TCE (RG = 0.005 mg/L) | cDCE (RG = 0.07 mg/L) | VC (RG = 2.9E-5 mg/L) |
| **Question 1: How important is matrix diffusion to the Conceptual Site Model?** | | | | | | | | | | |
| Run 1 | What is the impact of matrix diffusion on the groundwater CVOC plume? | No | • Plume degradation<br>• Source isolation with a PRB in 2025<br>• No plume remediation | 2062 | 0 | 5.7E-4 | 5.7E-4 | 0.020 | 0.042 | 0.0037 |
| Run 2 | | Yes | | 2448 | 1.14 | 0.12 | 1.26 | 0.35 | 0.73 | 0.069 |
| **Question 2: Can a PRB isolating the source be used to manage the groundwater plume?** | | | | | | | | | | |
| Run 3 (Basecase) | Can a PRB be used to manage the groundwater plume? | Yes | • Plume degradation only<br>• No source remediation<br>• No plume remediation | >2670 | 2.41 | 2.23 | 4.64 | 1.29 | 2.49 | 0.23 |
| Run 2 (same as above) | | Yes | • Plume degradation<br>• Source isolation with a PRB in 2025<br>• No plume remediation | 2448 | 1.14 | 0.12 | 1.26 | 0.35 | 0.73 | 0.069 |
| **Question 3: How will removing 90% of the source mass affect the groundwater plume?** | | | | | | | | | | |
| Run 3 (Basecase, same as above) | How will removing 90% of the source mass affect the groundwater plume? | Yes | • Plume degradation only<br>• No source remediation<br>• No plume remediation | >2670 | 2.41 | 2.23 | 4.64 | 1.29 | 2.49 | 0.23 |
| Run 4 | | Yes | • Plume degradation<br>• 90% source removal in 2025<br>• No plume remediation | >2670 | 1.27 | 0.32 | 1.59 | 0.44 | 0.90 | 0.084 |

RG = Remediation Goal    TCE = trichloroethene    cDCE = cis-1,2-dichloroethene    VC = vinyl chloride

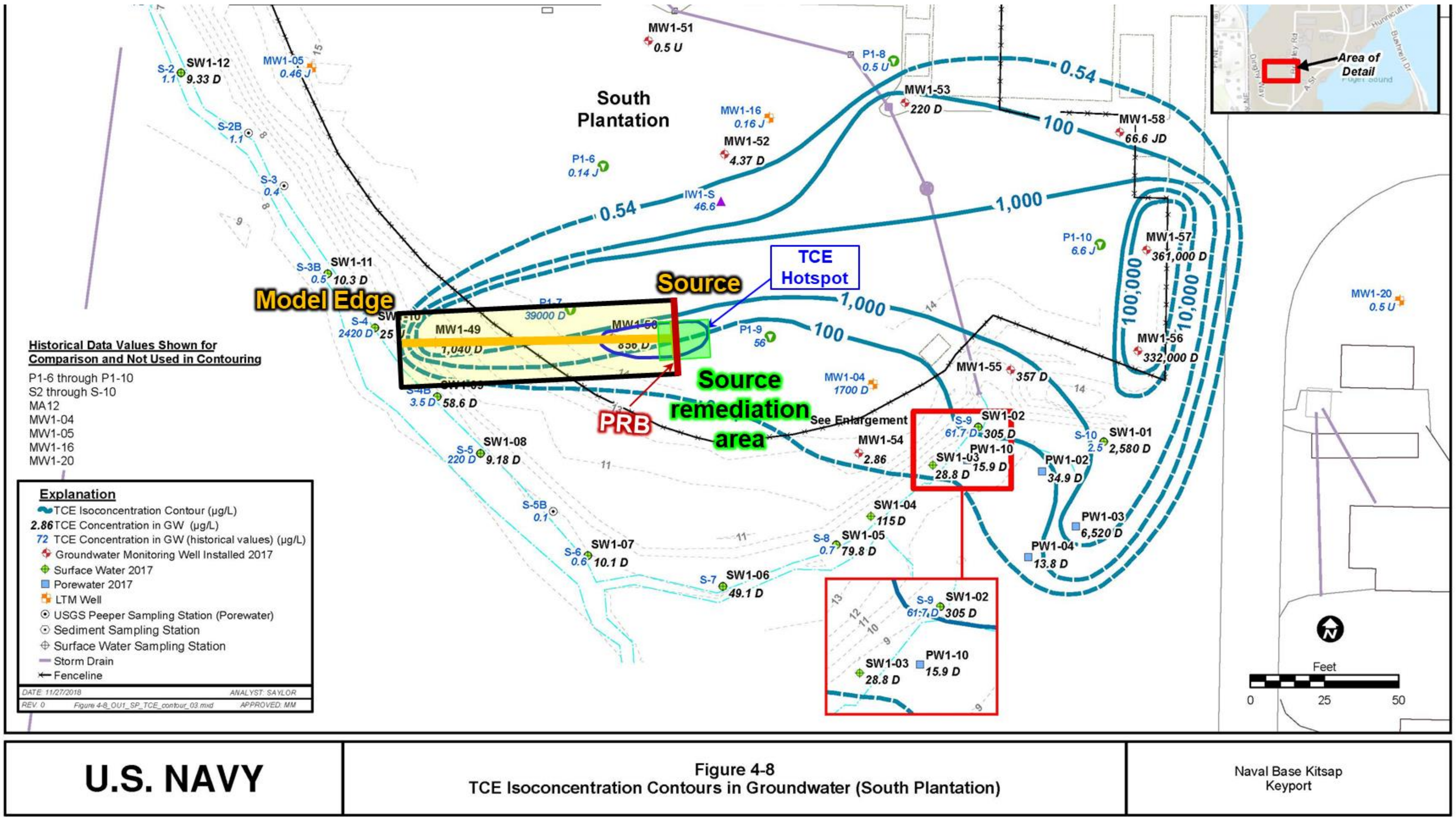



**Figure 4-17. Scenarios modeling – SP West Hotspot. (Basemap and TCE hotspot source: DON, 2018. Emphasis added)**

Based on the REMChlor-MD modeling, an overall evaluation of the three questions of interest to the U.S. Navy addressing Objective 2 is presented below.

- *Question 1: How important is matrix diffusion to the CSM?*

  *Modeling Summary:* Very important. Based on the EXWC field work data collected in 2021, approximately 39% of the total CVOC mass (Table 4-7) (low-k mass = 1.9 kg, transmissive zone mass = 3.0 kg; therefore, percent of mass in low-k zone = 1.9/4.9 = 39%) observed is in the West Hotspot low-k zone. For VC, the constituent with the most conservative RG, the no matrix diffusion model in the West Hotspot shows VC dropping below the RG 37 years (2062 minus 2025) after 100% source isolation (Run 1) at the plume boundary. However, accounting for matrix diffusion, the model predicts the VC plume in groundwater will persist for **over 420 years** (2448 minus 2025) after 100% source isolation in year 2025 (Run 2) before reaching the VC RG (Figure 4-18).

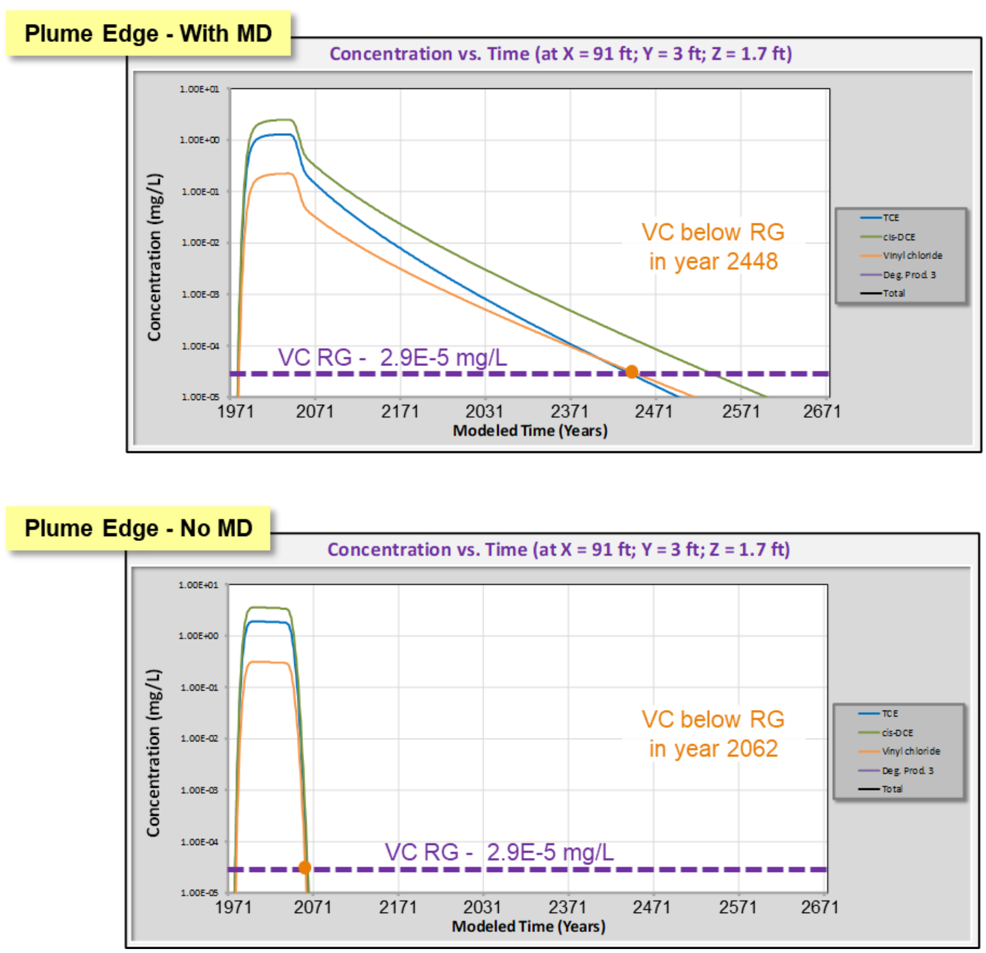



**Figure 4-18. SP West Hotspot REMChlor-MD model output at the plume boundary: matrix diffusion vs. no matrix diffusion. Top Panel: With matrix diffusion (MD). Bottom Panel: Without matrix diffusion**

- *Question 2: Can a PRB isolating the source be used to manage the groundwater plume?*

  *Modeling Summary:* A source PRB would reduce the remediation timeframe, but it would still take over a century to reach groundwater RGs. For the West Hotspot, isolating the source with a PRB (Figure 4-17) reduces the time to reach the VC RG at the plume boundary from **>645 years** (>2670 minus 2025) (for the case with no PRB, Run 3) to **~422 years** (2448 minus 2025, Run 2) (Figure 4-19).

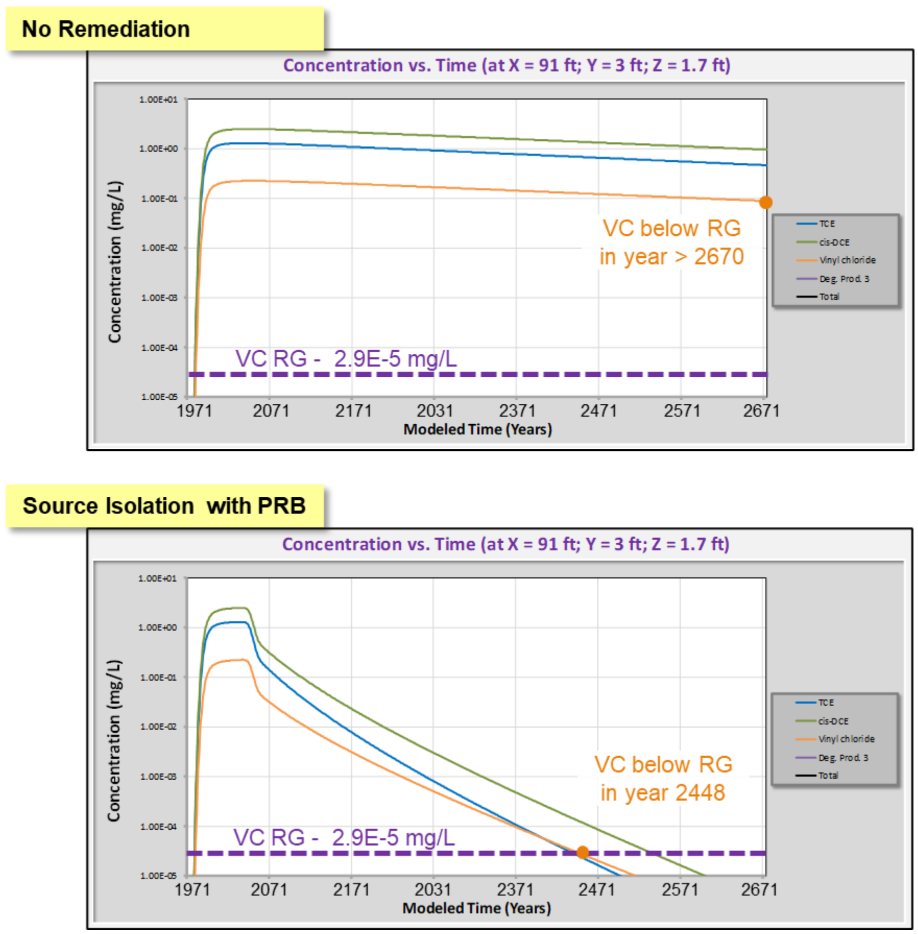
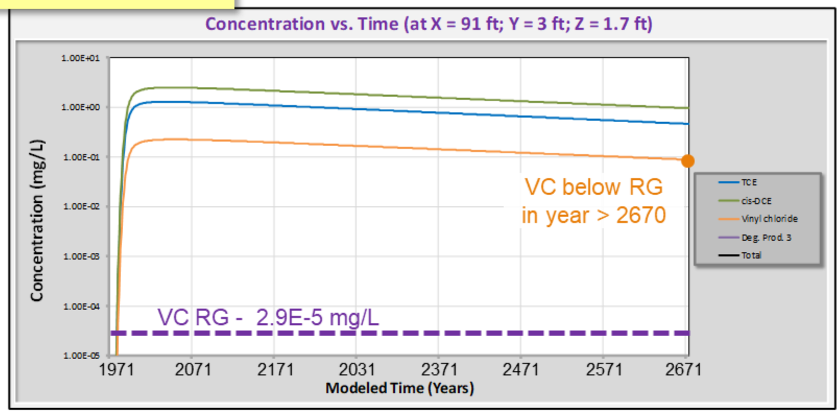



**Figure 4-19. SP West Hotspot REMChlor-MD model output at the plume boundary: Source isolation vs. no remediation**

- *Question 3: How will removing 90% of the source mass affect the groundwater plume?*

  *Modeling Summary:* Removing 90% of the source mass has little impact on the long-term fate and transport of the groundwater plume. This is because removing 90% of the source mass does not equate to removing 90% of the mass contained in the low-k and transmissive zones in the plume downgradient of the source. After source removal, the mass in the low-k unit will continue to feed the plume for centuries as shown by the REMChlor-MD model. For the West Hotspot, removing 90% of the source mass decreased the CVOC concentrations in the year 2670, however, the remediation timeframe for VC remained **>645 years** (>2670 minus 2025, Run 4) at the plume boundary (Figure 4-20) compared to the no remediation scenario (Run 3).

**No Remediation**




**90% Source Remediation**

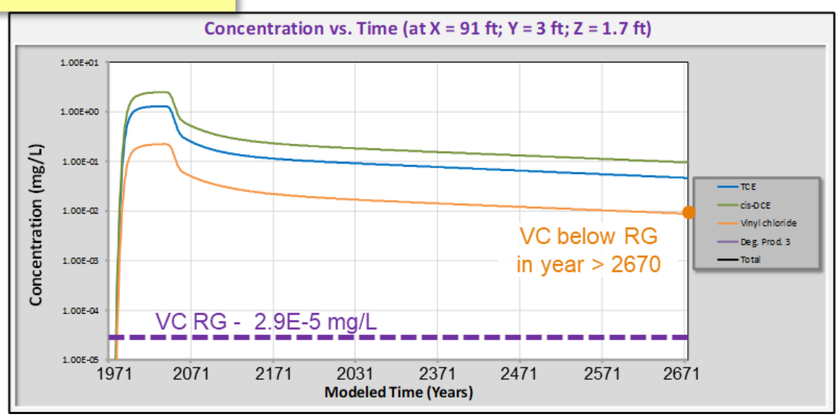



**Figure 4-20. SP West Hotspot REMChlor-MD model output at the plume boundary: 90% Source remediation vs. no remediation**

### *4.3.5 SP West Hotspot Modeling Conclusions*

The project team hypothesized that matrix diffusion processes at NBK Keyport would impact the effectiveness of source remediation in the downgradient plume. That is, the low-k zones in the impacted aquifer at NBK Keyport had higher concentrations than the surrounding transmissive units, thereby allowing back-diffusion to sustain the long-term, low-level persistent dissolved phase concentrations of CVOCs in groundwater.

Data collected by EXWC from suspected low-k geologic media at four locations, SP-MD01 through SP-MD04, showed several geologic contacts (interfaces) where there is a greater than 10x permeability contrast (e.g., a clean sand in contact with a clayey sand) that could, in theory, support matrix diffusion processes. Detections of high soil concentrations for the target CVOCs provide supporting evidence for matrix diffusion effects from low-k layer/lenses.

The REMChlor-MD model reproduced observed groundwater concentrations and constituent mass reasonably well during the calibration step and then was used to forecast general trends in remediation timeframe at the SP West Hotspot.

REMChlor-MD models of the SP West Hotspot at NBK Keyport showed that the target CVOCs (TCE, cDCE, and VC) are likely to persist for centuries. The modeling runs suggested that even with complete isolation of the source with a PRB in 2025, an additional ~422 years from the year 2025 might be required to permanently reach the VC (the most conservative CVOC of interest) RG at the plume boundary due to matrix diffusion effects (Figure 4-21).

As discussed in Section 1.3 and detailed in Appendix A, the nature of geologic heterogeneity at a site has a significant impact on the persistence of matrix diffusion and the overall predicted remediation timeframe. Specifically, the presence of aquitards that are a few feet thick and in contact with the CVOC plumes greatly increases the remediation timeframe. At the West Hotspot, the CVOC plume was in contact with clays that were more like an underlying low-k aquitard than a series of low-k lenses/layers within the transmissive zone (Figures 4-13, 4-14, and 4-15). This is in contrast to the East Hotspot where the geologic data showed several low-k lenses/layers within the transmissive zone but with no consistent aquitard present at the East Hotspot (Figures 4-3, 4-4, and 4-5). Consequently, compared to the East Hotspot, the West Hotspot plume modeling suggests that the plume will persist for several centuries even after complete isolation of the source (~422 years at the West Hotspot compared to ~154 years at the East Hotspot).

These planning-level model runs suggest that matrix diffusion processes reduce the effectiveness of source remediation in the downgradient plume. Even if the hotspots are remediated (e.g., with an in-situ treatment or excavation) to reduce source concentrations, the same reduction in concentration is not observed in the plume downgradient of the hotspots (i.e., a 90% reduction in source concentrations does not result in a 90% reduction in the downgradient plume concentrations). It is possible for the concentrations of plumes, like the ones at NBK Keyport West Hotspot, to “hover” just above the RGs at single-digit, part-per-billion concentrations for centuries due to the on-going matrix diffusion processes.

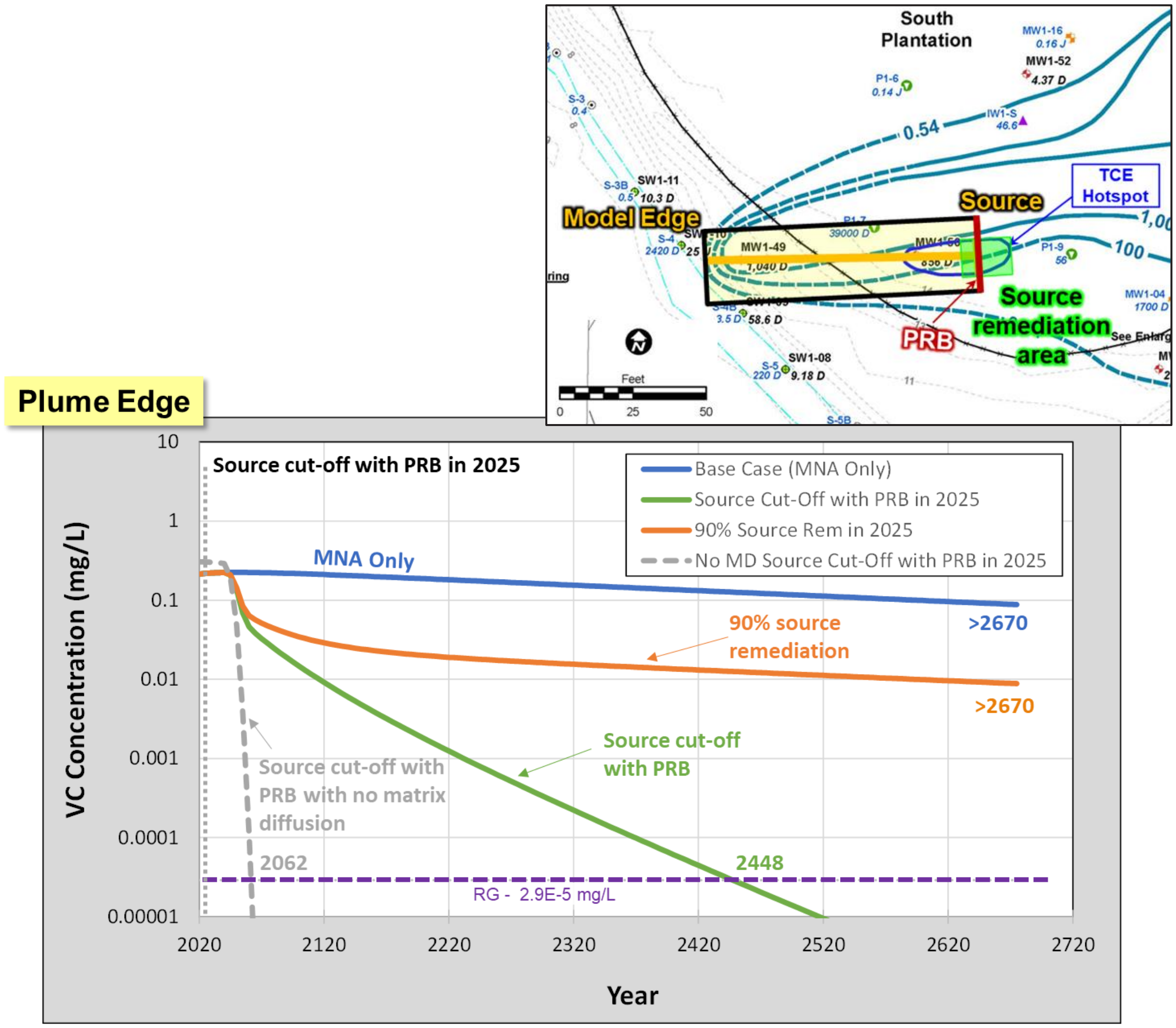



**Figure 4-21. SP West Hotspot REMChlor-MD modeling summary for vinyl chloride. (Inset map source: DON, 2018, emphasis added)**

## 4.4 Central Landfil CVOC Plume

### *4.4.1 CL Northwest CVOC Plume Modeling Approach*

For the CL Northwest CVOC plumes (Figure 2-4), the modeling approach included:

- Developing the model based on current and historical site data (Figure 4-22).
- Calibrating the model to observed groundwater concentrations.
- Using the calibrated REMChlor-MD model to explore different remediation strategies under the influence of matrix diffusion.

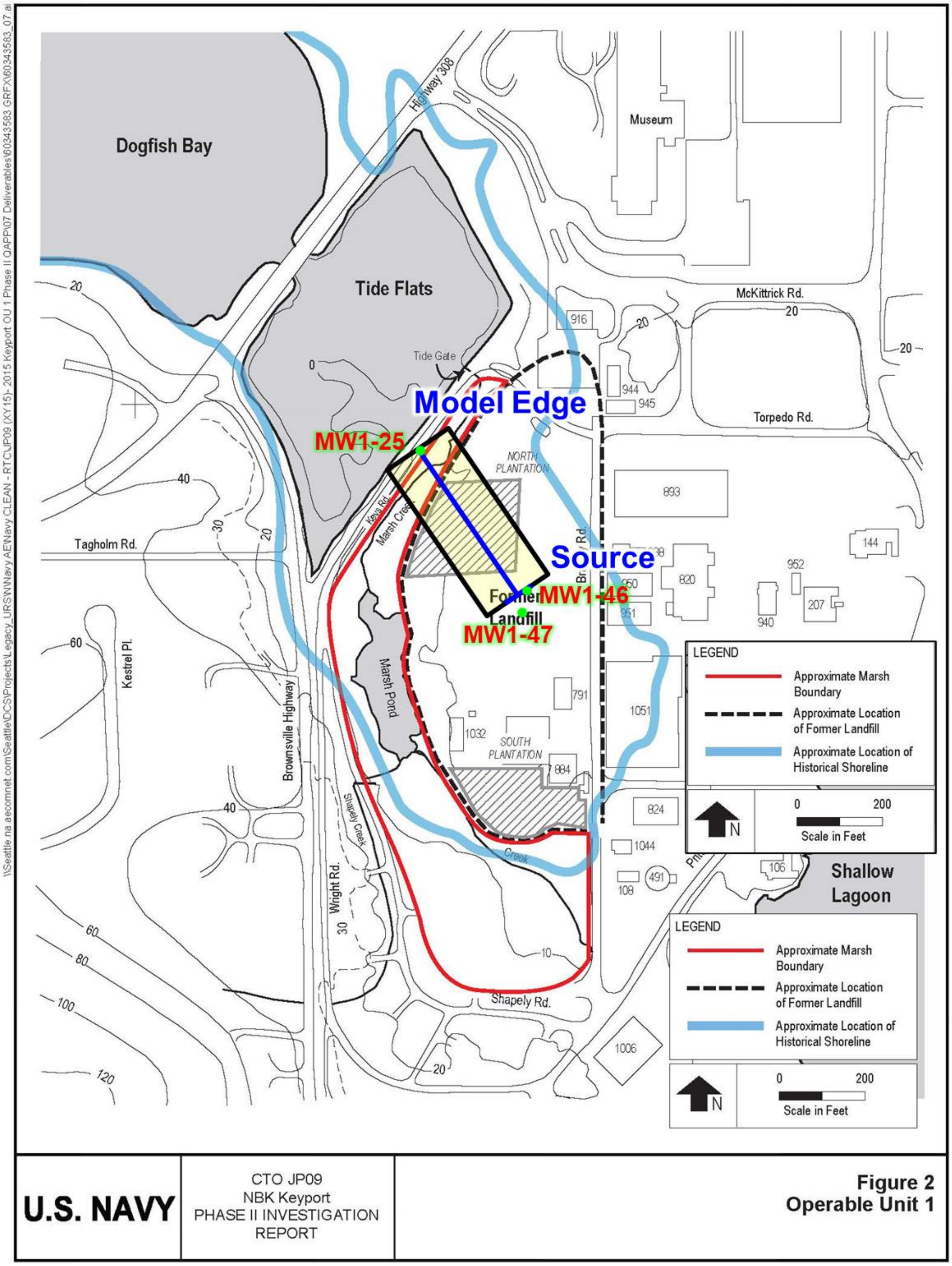



**Figure 4-22. CL Northwest CVOC plume modeling domain. (Basemap source: DON, 2017, emphasis added)**

### 4.4.2 CL Northwest CVOC Plume Model Input Data

REMChlor-MD input data are detailed in Table 4-9. Key input data/assumptions include:

- A source zone starting in 1970 was estimated based on the general timing when chlorinated solvents began to come into extensive industrial use in the U.S.
- Based on the Battelle 2022 3-D plume figures, the source was assumed to be ~20 ft thick (Figure 2-4).
- Key heterogeneity features for the CP Northwest plume were simulation of the transmissive zone comprised of ~25% low-k lenses and no overlying or underlying aquitards based on existing boring logs (Figure 4-23). Matrix diffusion was incorporated into the model in both the source and the plume, i.e., matrix diffusion processes were considered present within the entire modeling domain (except for the no matrix diffusion run, Run 1 (see Table 4-11), which assumed no matrix diffusion in the plume).
- Source concentrations, source mass, transmissive zone hydraulic conductivity, retardation factors, and plume degradation rates were adjusted to match observed concentrations in monitoring wells along the plume centerline (Figure 4-24).
- Observed concentrations along the plume centerline were collected over various years, therefore as a conservative measure, the year 2017 was selected as the calibration year. Consequently, for model calibration purposes:
    - The observed concentrations in the source area were the geometric means of the 2017 and 2019 concentrations from MW1-46 and MW1-47.
    - The observed concentrations from the downgradient wells MW1-62, MW1-63, and MW1-64 were from 2019, the only year with data collection.
    - The observed concentrations for MW1-25, the most downgradient plume centerline well, were from 2015, the most recent year of data collection.

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**Table 4-9. CL Northwest CVOC plume REMChlor-MD modeling input parameters**

| Parameter | CP Northwest CVOC Plume | Notes |
|---|---|---|
| X-Direction model size (ft) | 362 | 2017 Site Recharacterization Phase II report (DON, 2018) plume figures |
| Z-Direction model size (ft) | 20 | Assumed based on source thickness |
| Source width (ft) | 63 | Battelle 2022 3-D plume maps (DON, 2022a):<br>• Widest part of the 10,000 µg/L contour of the cDCE plume around MW1-46 |
| Source thickness (ft) | 20 | Battelle 2022 3-D plume maps (DON, 2022a):<br>• Approximate height of the 10,000 µg/L contour of the cDCE plume around MW1-64 |
| Hydraulic gradient (ft/ft) | 0.018 | Calculated from the 2017 Site Recharacterization Phase II Report Figure 4-5 (DON, 2018), |
| Transmissive zone hydraulic conductivity (cm/sec) | Initial: 2.6E-04<br>Calibrated: 1.0E-3 | 2017 Site Recharacterization Phase II report (DON, 2018) |
| Low-k zone hydraulic conductivity (cm/sec) | 1.4E-05 | REMChlor-MD default for silt |
| Transmissive zone porosity (-) | 0.28 | 2017 Site Recharacterization Phase II report (DON, 2018) |
| Low-k zone porosity (-) | 0.53 | EXWC field work (DON, 2022b), assumed same as for SP plumes |
| Transmissive zone tortuosity (-) | 0.49 | REMChlor-MD default |
| Low-k zone tortuosity (-) | 0.41 | REMChlor-MD default |
| Transmissive zone retardation factor (-) | Initial TCE: 1.2<br>Initial cDCE: 1.1<br>Initial VC: 1.0<br>Calibrated (all COIs): 3 | Initial: calculated based on EXWC field work foc and bulk density data (DON, 2022b)<br><br>Final: calibrated |
| Low-k zone retardation factor (-) | Initial TCE: 5.7<br>Initial cDCE: 2.5<br>Initial VC: 1.06<br>Calibrated (all COIs): 4 | Initial: calculated based on EXWC field work foc and bulk density data (DON, 2022b)<br><br>Final: calibrated |
| Molecular diffusion coefficient ($cm^2$/sec) | 9.1E-6 | REMChlor-MD default for TCE |
| Gamma | 1 | Assumed |
| Source concentration (mg/L) | TCE: 0.038<br>cDCE: 11.8<br>VC: 2.8 | Calibrated |

| Parameter | CP Northwest CVOC Plume | Notes |
|---|---|---|
| Source mass (kg) | TCE: 5<br>cDCE: 420<br>VC: 100 | Calibrated |
| Year source started | 1970 | Estimated |
| Heterogeneity | • No matrix diffusion in overlying or underlying low-k units<br>• Low-k material in plume thickness based on boring logs | Based on existing boring logs |
| Longitudinal dispersivity (ft) | 1 | Calibrated |
| Transverse dispersivity (ft) | 0.1 | $\alpha_t$: $\alpha_x$ = 0.10 |
| Vertical dispersivity (ft) | 0.01 | $\alpha_t$: $\alpha_x$ = 0.01 |
| Transmissive zone plume degradation half-life (yrs) | TCE – 2.1<br>cDCE – 2.0<br>VC – 0.35 | Calibrated |
| Low-k zone plume degradation half-life (yrs) | All COIs: 10 | Calibrated |

cm = centimeters ft = feet kg = kilograms L = liters mg = milligrams sec = second yrs = years

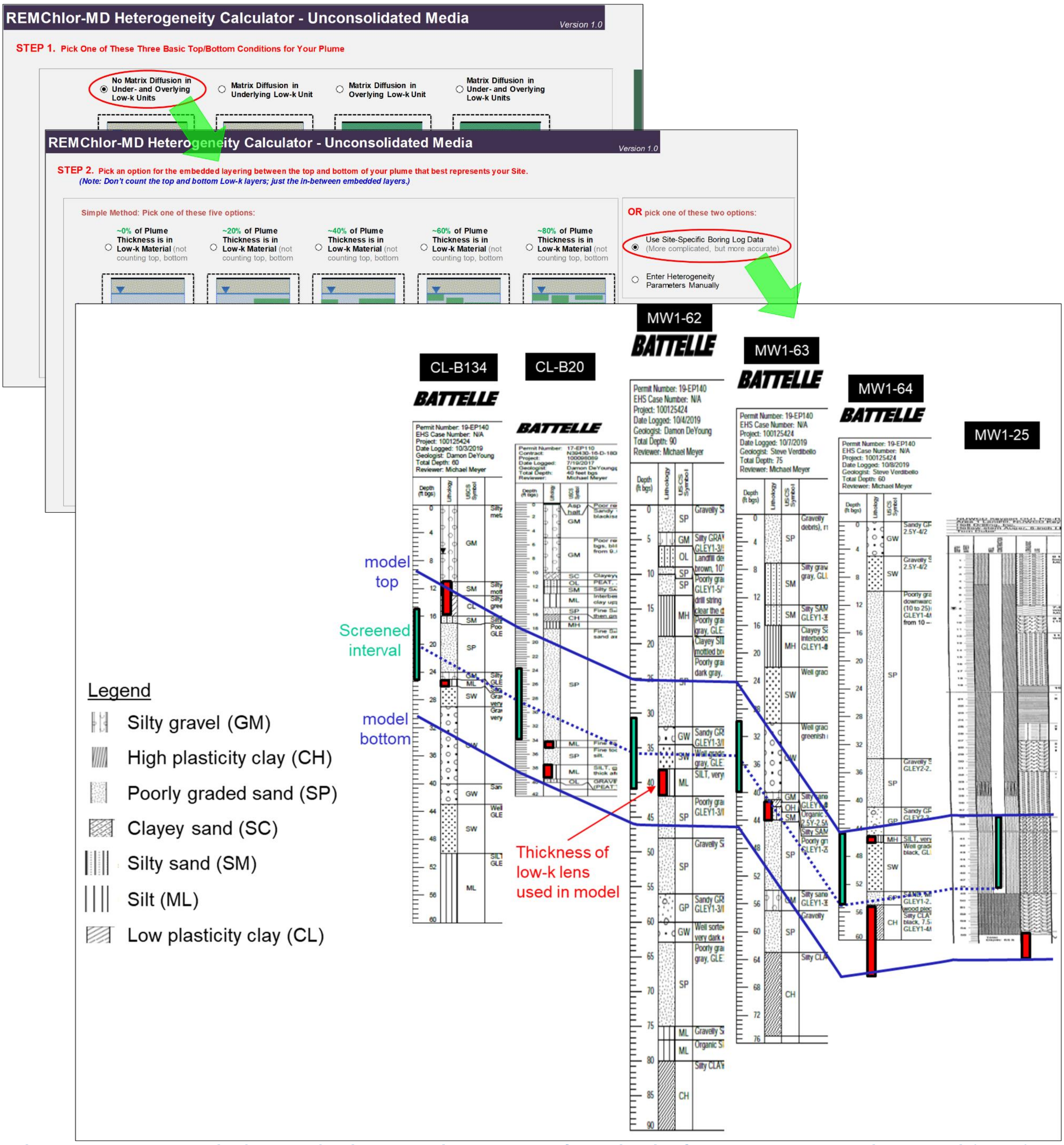



**Figure 4-23. Heterogeneity features for the CL Northwest CVOC Plume. (Boring log sources: DON, various years)** (Note that because the boring logs have been manually adjusted to align along the vertical scale, some may be hard to read. Refer to Appendix C for the individual boring logs.)

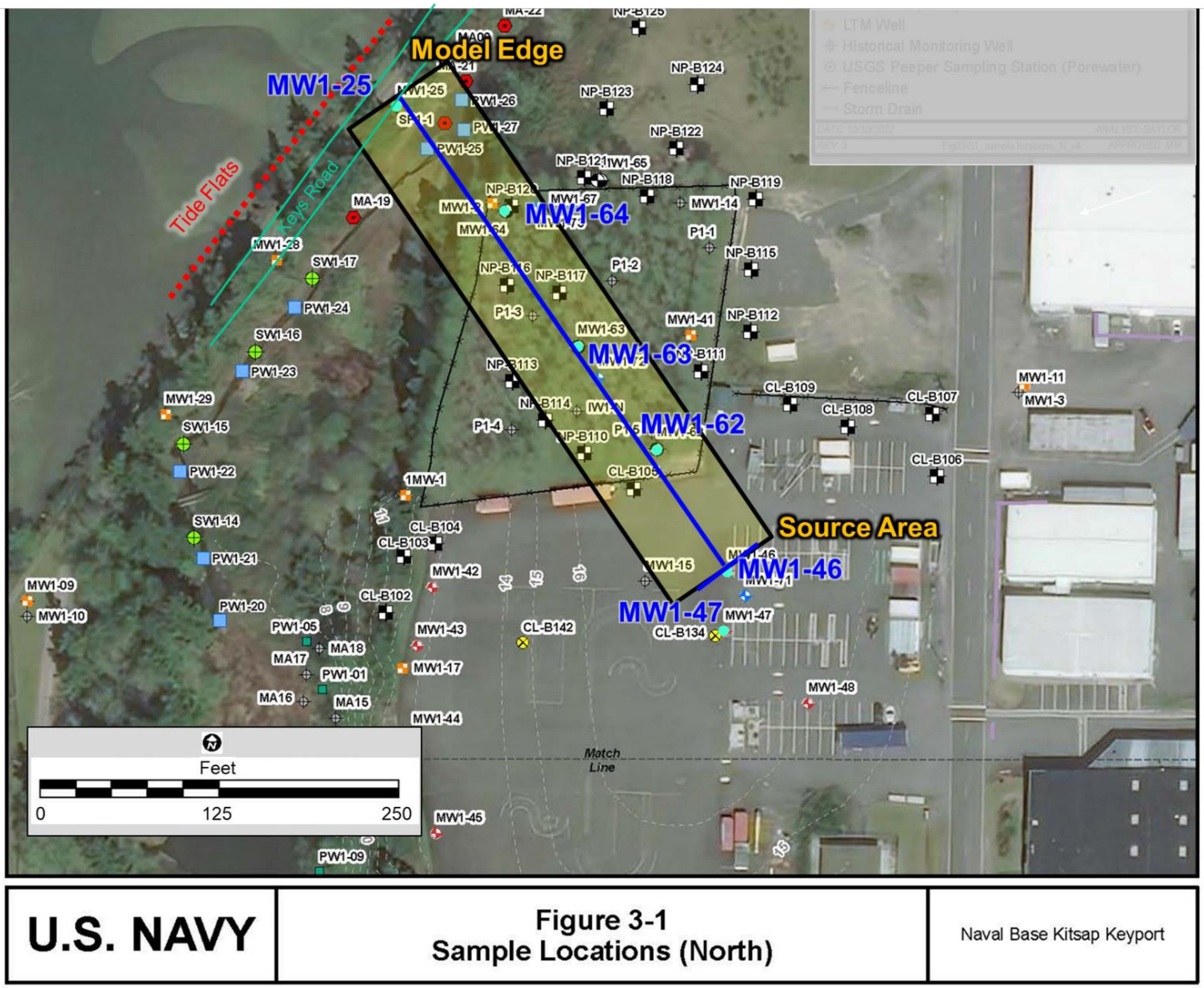



**Figure 4-24. CL Northwest CVOC Plume modeling area of interest. (Basemap source: DON, 2022a, emphasis added)**

### 4.4.3 CL Northwest CVOC Plume Model Calibration

The CL Northwest CVOC plume model was calibrated to the 2015/2017/2019 observed concentrations along the plume centerline (Figure 4-24). REMChlor-MD reproduced the observed concentrations reasonably well. An overall RMS error of 0.47 was obtained for the log-transformed groundwater concentrations in accordance with the Groundwater Modeling Plan (i.e., overall log transformed RMS ≤0.5 along the plume centerline) (GSI, 2020). Calibration results are presented in Table 4-10 and Figure 4-25.

**Table 4-10. CL Northwest CVOC Plume REMChlor-MD Calibration – Groundwater**

| Monitoring Well | 2017 Concentration (mg/L)[1] | | | | |
|---|---|---|---|---|---|
| | Source Area[2] | MW1-62[3] | MW1-63[3] | MW1-64[3] | MW1-25[4] |
| Distance from source (ft) | 1 | 98 | 189 | 256 | 361 |
| TCE (observed/simulated) | 0.019/0.031 | 0.034/0.019 | 0.020/0.012 | 0.008/0.009 | 0.005/0.005 |
| cDCE (observed/simulated) | 5.90/5.99 | 1.20/3.81 | 4.20/2.48 | 2.20/1.79 | 0.96/1.06 |
| VC (observed/simulated) | 1.40/1.40 | 0.30/0.65 | 0.57/0.41 | 0.39/0.29 | 0.16/0.17 |

Notes:
1. For the purposes of modeling, 2017 was selected as the calibration year as a conservative measure.
2. Observed concentrations are geometric means of the 2017 and 2019 concentrations from MW1-46 and MW1-47.
3. Observed concentrations are from 2019.
4. The most recent data for MW1-25 is from 2015.
5. Definitions: TCE = Trichloroethene; cDCE = cis-1,2-Dichloroethene; VC = Vinyl chloride

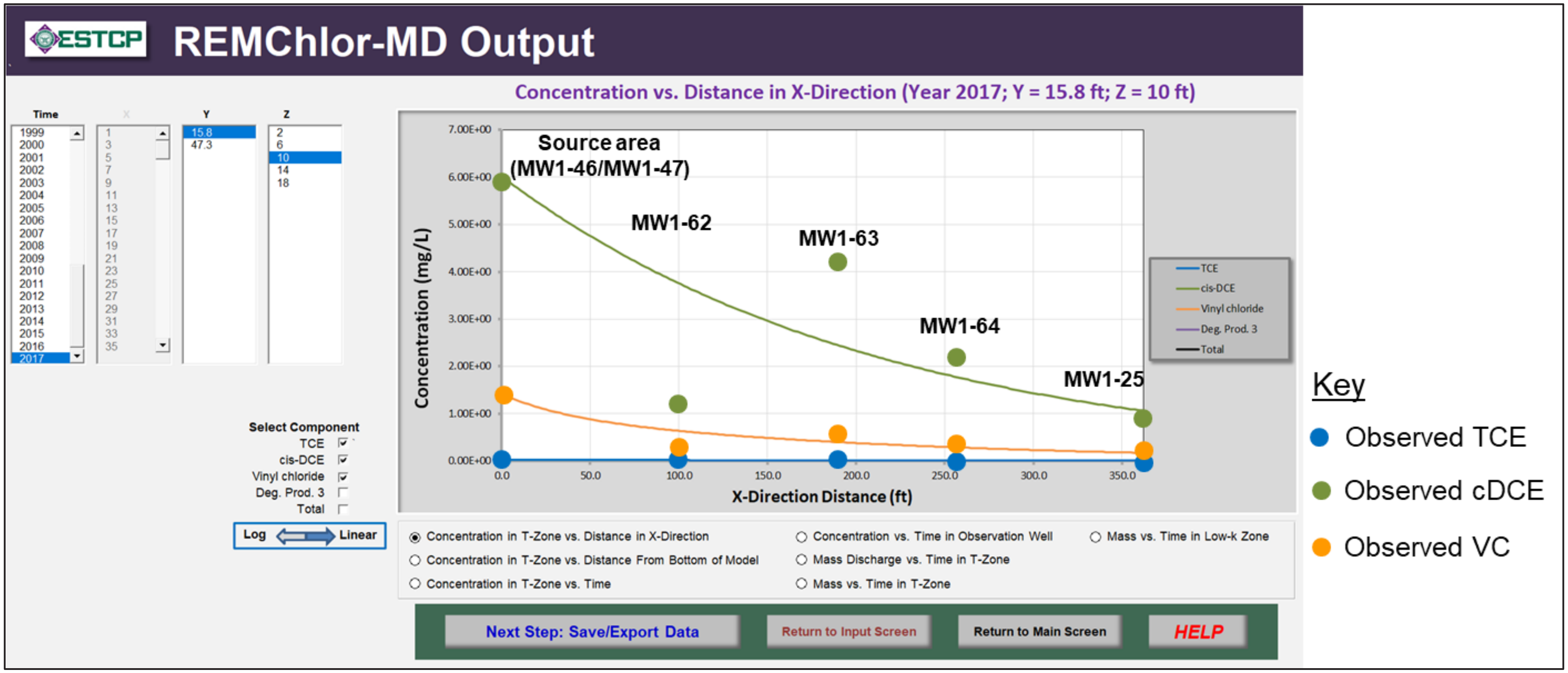



**Figure 4-25. CL Northwest CVOC Plume REMChlor-MD calibration – Concentration**

A generalized source strength vs. time calibration was performed at this site. One monitoring well, MW1-25, with a long history of concentrations over time, was available with CVOC monitoring data ranging from 1996 through 2015. The source input data (CVOC mass, initial estimated concentrations in 1970 for each CVOC) were calibrated to match the general type of the long-term historical concentrations at this well with an emphasis on the net change over this 19-year period (Figure 4-26). Considering that monitoring wells in general can exhibit significant sampling variability over time (e.g., see McHugh et al. 2011), REMChlor-MD was able to reproduce the style of the observed concentrations reasonably well over the limited historical record.

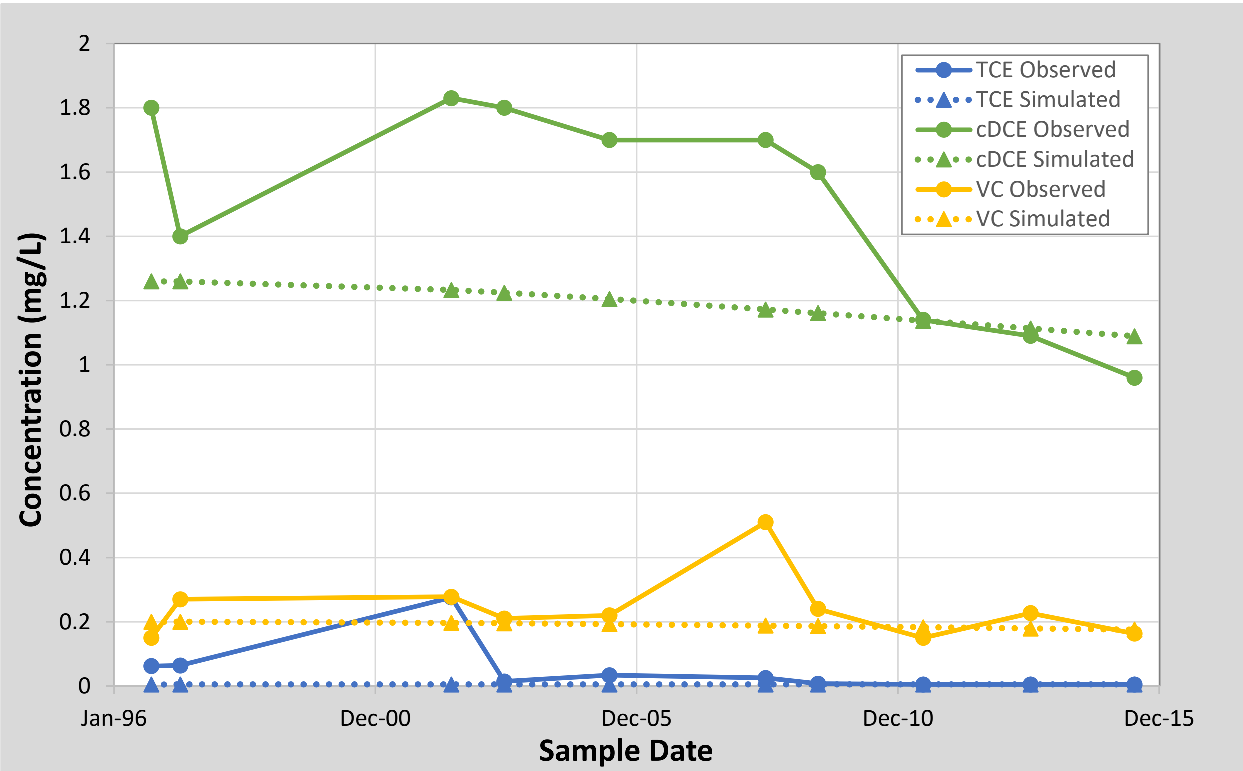



**Figure 4-26. Comparison of simulated vs observed concentrations in MW1-25**

### *4.4.4 CL Northwest CVOC Plume Modeling Results*

The impact of matrix diffusion on various remedial alternatives is summarized in Table 4-11 and Figures 4-28 through 4-30 for the CL Northwest CVOC plume. A graphical comparison of the time to reach the VC (the most conservative CVOC of interest) RG for the various remedial alternatives is presented in Figure 4-31. REMChlor-MD model input and output are shown in Appendix F.

The calibrated REMChlor-MD model was used to explore different remediation strategies under the influence of matrix diffusion. For the CL Northwest CVOC plume, impact of the remediation alternatives was evaluated by estimating, 1) the time to reach the VC RG at the model edge well MW1-25 (Figure 4-27); 2) the modeling COI mass remaining in the modeled plume, in both the low-k and transmissive zones, 30 years after the remediation; and 3) the modeling COI concentrations at MW1-25 30 years after the remediation.

As shown on Table 4-11, even complete isolation of the source area with a PRB was unable to achieve the RG for VC 30 years after the remediation due to matrix diffusion effects. Based on the modeling, 30 years after the complete isolation of the source, VC concentrations were ~586-fold greater than the RG (0.017 mg/L compared to 2.9E-5 mg/L) at MW1-25. Also as shown on Table 4-11, 30 years after the complete isolation of the source with a PRB, majority of the mass within the modeled plume is in the low-k zone (~88%: 5.1 kg / 5.8 kg). This mass will continue to feed the plume for centuries as shown by the REMChlor-MD model.

An evaluation of the REMChlor-MD modeling to assess the effects of matrix diffusion on potential source area treatment remediation timeframes is detailed below.

### Table 4-11. CL Northwest CVOC Plume Remediation Scenarios Modeling Results

| Model Runs | Detailed Questions | Is Plume Matrix Diffusion Turned On? | What Type Remediation is Assumed? | Year Vinyl Chloride is Below RG of 2.9E-5 mg/L in MW1-25 | Mass in 2055 (kg) | | | Concentration in 2055 in MW1-25 (mg/L) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Low-k Zone | Trans Zone | Total | TCE (RG = 0.005 mg/L) | cDCE (RG = 0.07 mg/L) | VC (RG = 2.9E-5 mg/L) |
| **Question 1: How important is matrix diffusion to the Conceptual Site Model?** | | | | | | | | | | |
| Run 1 | What is the impact of matrix diffusion on the groundwater CVOC plume? | No | • Plume degradation<br>• Source isolation with a PRB in 2025<br>• No plume remediation | 2048 | 0 | 0 | 0 | 0 | 0 | 0 |
| Run 2 | | Yes | | 2243 | 5.1 | 0.7 | 5.8 | 0.0004 | 0.083 | 0.017 |
| **Question 2: Can a PRB isolating the source be used to manage the groundwater plume?** | | | | | | | | | | |
| Run 3 (Basecase) | Can a PRB be used to manage the groundwater plume? | Yes | • Plume degradation only<br>• No source remediation<br>• No plume remediation | >2675 | 11.4 | 16.4 | 27.8 | 0.004 | 0.65 | 0.11 |
| Run 2 (same as above) | | Yes | • Plume degradation<br>• Source isolation with a PRB in 2025<br>• No plume remediation | 2243 | 5.1 | 0.7 | 5.8 | 0.0004 | 0.083 | 0.017 |
| **Question 3: How will removing 90% of the source mass affect the groundwater plume?** | | | | | | | | | | |
| Run 3 (Basecase, same as above) | How will removing 90% of the source mass affect the groundwater plume? | Yes | • Plume degradation only<br>• No source remediation<br>• No plume remediation | >2675 | 11.4 | 16.4 | 27.8 | 0.004 | 0.65 | 0.11 |
| Run 4 | | Yes | • Plume degradation<br>• 90% source removal in 2025<br>• No plume remediation | 2552 | 5.7 | 2.2 | 8.0 | 0.0008 | 0.14 | 0.026 |

RG = Remediation Goal  TCE = trichloroethene  cDCE = cis-1,2-dichloroethene  VC = vinyl chloride

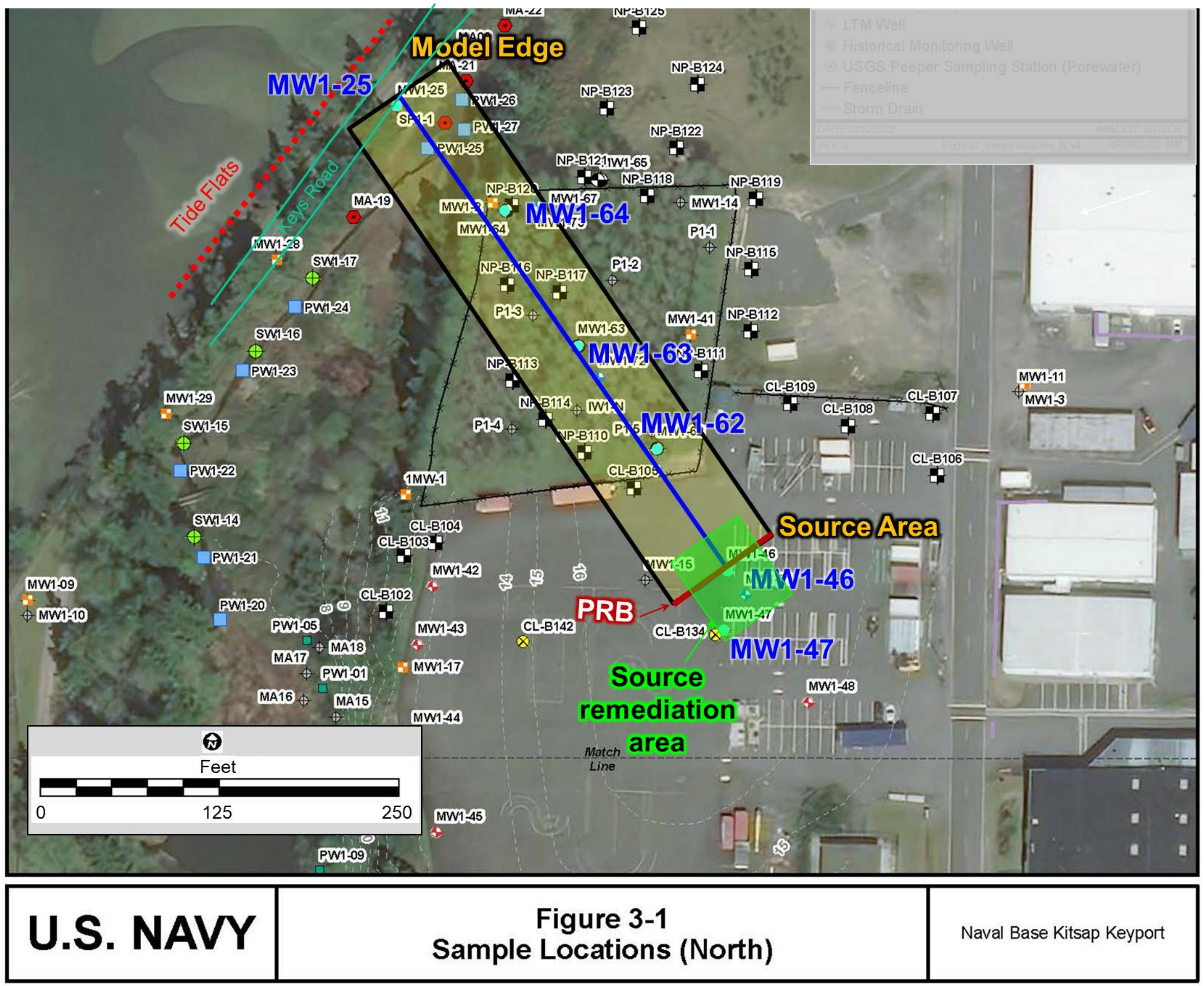



Figure 4-27. Scenarios modeling – CL Northwest CVOC Plume. (Basemap source: DON, 2022a. Emphasis added)

Based on the REMChlor-MD modeling, an overall evaluation of the three questions of interest to the U.S. Navy addressing Objective 2 is presented below.

- *Question 1: How important is matrix diffusion to the CSM?*

  *Modeling Summary:* Very important. For VC, the constituent with the most conservative RG, the no matrix diffusion model in the CL Northwest CVOC plume shows VC dropping below the RG **23 years** (2048 minus 2025) after 100% source isolation (Run 1) in the downgradient well MW1-25. However, accounting for matrix diffusion, the model predicts the VC plume in groundwater will persist for **218 years** (2243 minus 2025) after 100% source isolation in year 2025 (Run 2) before reaching the VC RG (Figure 4-28).

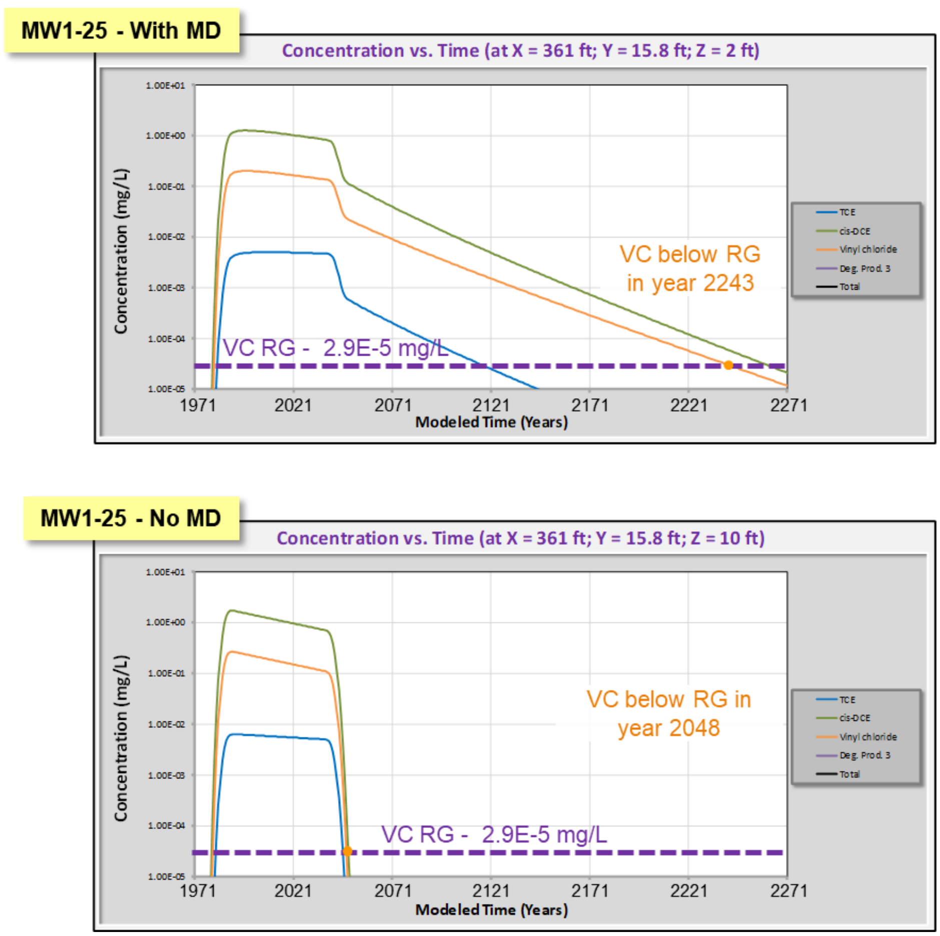
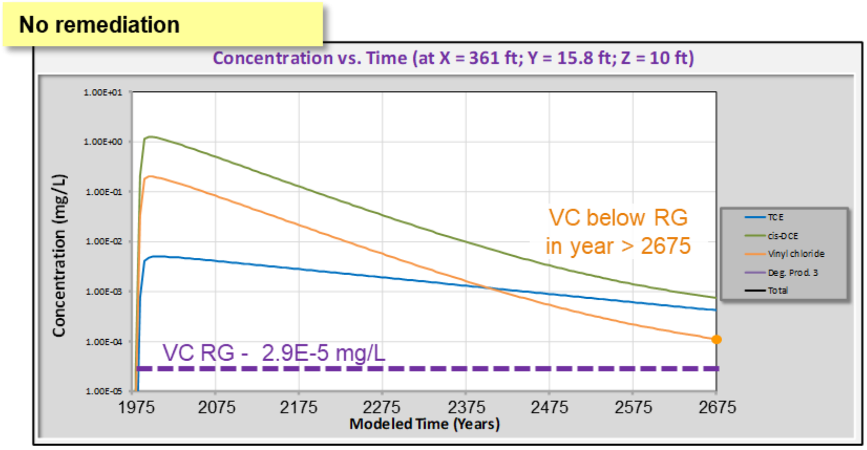



**Figure 4-28. CL Northwest CVOC plume REMChlor-MD model output at well MW1-25: matrix diffusion vs. no matrix diffusion. Top Panel: With matrix diffusion (MD). Bottom Panel: Without matrix diffusion**

- *Question 2: Can a PRB isolating the source be used to manage the groundwater plume?*

  *Modeling Summary:* A source PRB would reduce the remediation timeframe, but it would still take over a couple of centuries to reach groundwater RGs. For the CL Northwest CVOC plume, isolating the source with a PRB (Figure 4-27) reduces the time to reach the VC RG in the downgradient well MW1-25 from **>650 years** (>2675 minus 2025, Run 3) (for the case with no PRB) to **218 years** (2243 minus 2025, Run 2) (Figure 4-29) after the source isolation in 2025.



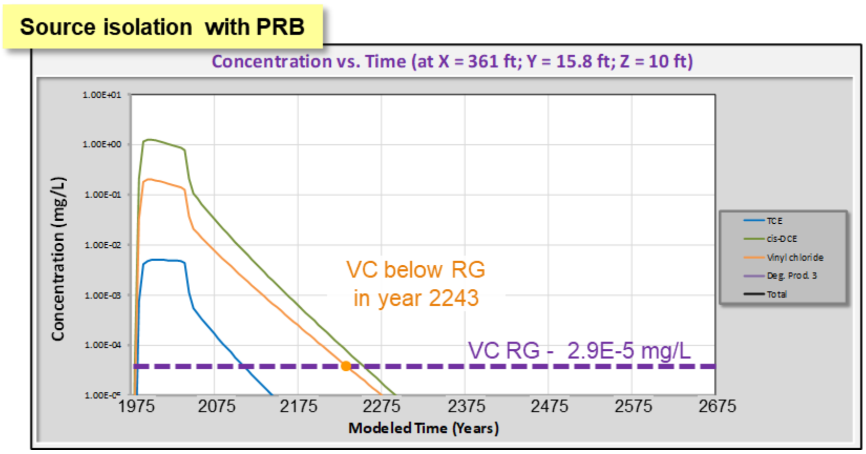




**Figure 4-29. CL Northwest CVOC plume REMChlor-MD model output at well MW1-25: Source isolation vs. no remediation**

- *Question 3: How will removing 90% of the source mass affect the groundwater plume?*

  *Modeling Summary:* Removing 90% of the source mass has little impact on the long-term fate and transport of the groundwater plume. This is because removing 90% of the source mass does not equate to removing 90% of the mass contained in the low-k and transmissive zones in the plume downgradient of the source. After source removal, the mass in the low-k unit will continue to feed the plume for centuries as shown by the REMChlor-MD model. For the CL Northwest CVOC plume, removing 90% of the source mass decreased the remediation timeframe for VC from **>650 years** (>2675 minus 2025, Run 3) (assuming no remediation) to **527 years** (2552 minus 2025, Run 4) at well MW1-25 (Figure 4-30).

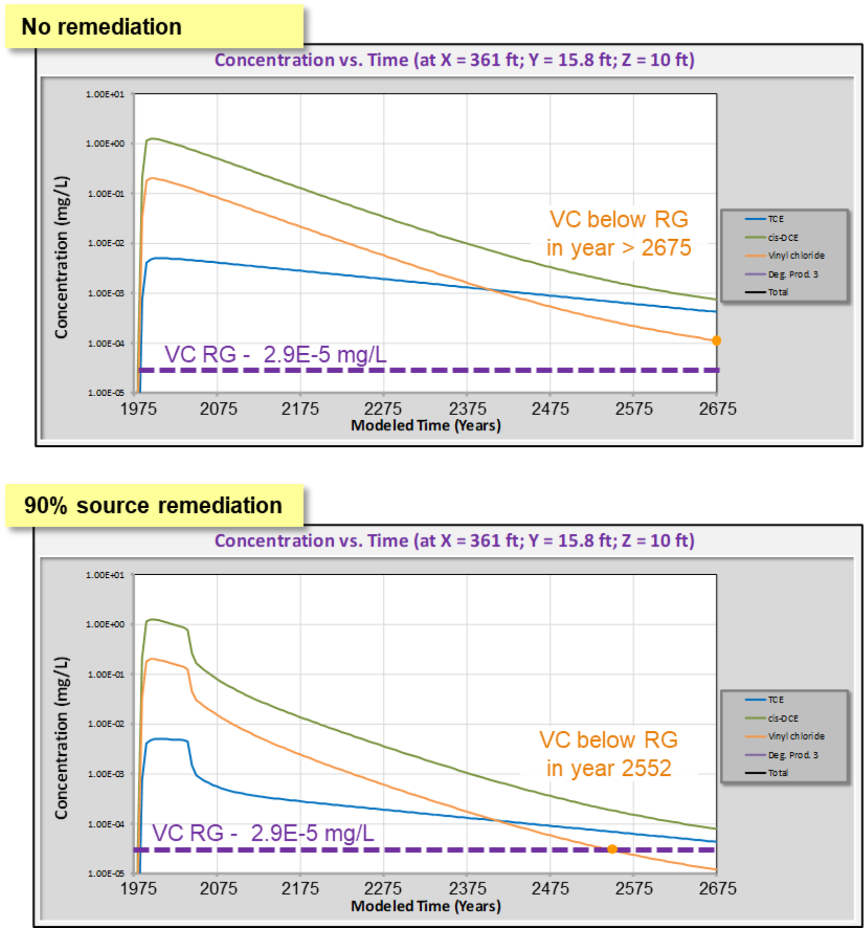



**Figure 4-30. CL Northwest CVOC plume REMChlor-MD model output at well MW1-25: 90% Source remediation vs. no remediation**

### *4.4.5 CL Northwest CVOC Plume Modeling Conclusions*

The project team hypothesized that matrix diffusion processes at NBK Keyport would impact the effectiveness of source remediation in the downgradient plume. That is, the low-k zones in the impacted aquifer at NBK Keyport had higher concentrations than the surrounding transmissive units, thereby allowing back-diffusion to sustain the long-term, low-level persistent dissolved phase concentrations of CVOCs in groundwater.

The REMChlor-MD model reproduced observed groundwater concentrations reasonably well during the calibration step and then was used to forecast general trends in remediation timeframe for the CL Northwest CVOC plume.

REMChlor-MD models of the CL Northwest CVOC plume at NBK Keyport showed that the target CVOCs (TCE, cDCE, and VC) are likely to persist for centuries. The modeling runs suggested that even with complete isolation of the source with a PRB in 2025, an additional 218 years from the year 2025 might be required to permanently reach the VC (the most conservative CVOC of interest) RG at MW1-25 due to matrix diffusion effects (Figure 4-31).

These planning-level model runs suggest that matrix diffusion processes reduce the effectiveness of source remediation in the downgradient plume. Even if the hotspots are remediated (e.g., with an in-situ treatment or excavation) to reduce source concentrations, the same reduction in concentration is not observed in the plume downgradient of the hotspots (i.e., a 90% reduction in source concentrations does not result in a 90% reduction in the downgradient plume concentrations). It is possible for the concentrations of plumes like the ones at NBK Keyport to "hover" just above the RGs at single-digit, part-per-billion concentrations for decades due to the on-going matrix diffusion processes.

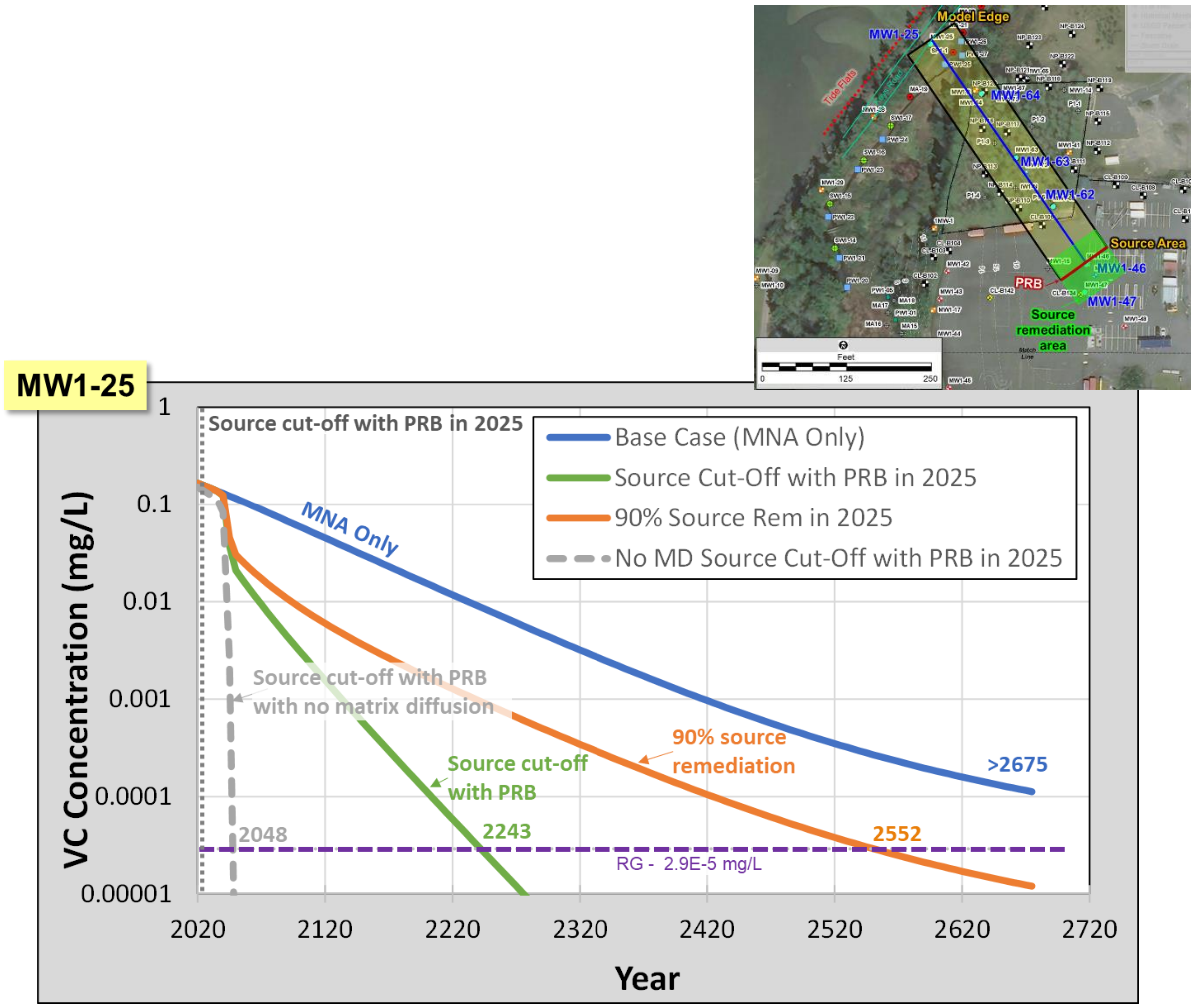



**Figure 4-31. CL Northwest CVOC Plume REMChlor-MD modeling summary for vinyl chloride. (Inset map source: DON, 2022a, emphasis added)**

## 4.5 Central Landfill 1,4-Dioxane Plume

### *4.5.1 CL 1,4-Dioxane Plume Modeling Approach*

The CL 1,4-dioxane plume (Figure 2-5) follows a similar flow direction as the CL Northwest CVOC plume (Figure 2-4), therefore, the modeling approach included:

- The same modeling domain (Figure 4-32), heterogeneity, media characteristics, and source characteristics as the CL Northwest CVOC plume. Note that while the actual 1,4-dioxane source is unclear, this source or sources did result in a 1,4-dioxane plume that then interacted with the geologic media around the plume. Because the only way to add contamination into the REMChlor-MD modeling domain is via a single source term, the assumed source in the model was assumed to generally represent the actual 1,4-dioxane source or sources at this particular site. Like the CL Northwest CVOC plume model, matrix diffusion was incorporated into the model in both the source and the plume, i.e., matrix diffusion processes were considered present within the entire modeling domain (except for the no matrix diffusion run, Run 1 (see Table 4-14), which assumed no matrix diffusion in the plume).
- Calibrating the model to observed concentrations.
- Using the calibrated REMChlor-MD model to explore different remediation strategies under the influence of matrix diffusion.

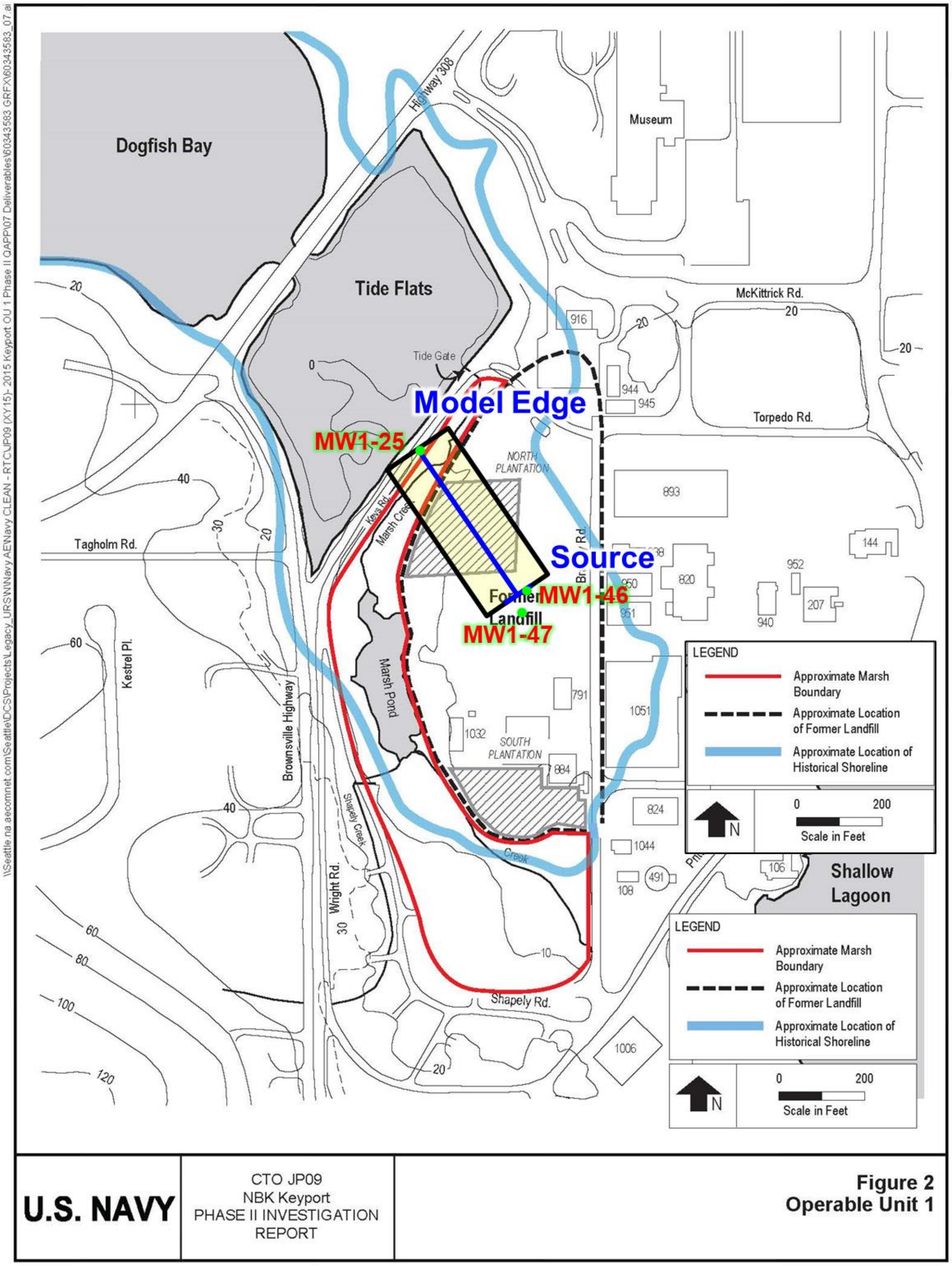



**Figure 4-32. CL 1,4-dioxane plume modeling domain. (Basemap source: DON, 2017, emphasis added)**

### 4.5.2 CL 1,4-Dioxane Plume Model Input Data

REMChlor-MD input data are detailed in Table 4-12. Key input data/assumptions that differed from the CVOC model include:

- Based on the Battelle 2022 3-D plume figures (DON, 2022a), the source width was assumed to be ~75 ft (Figure 2-5).
- Retardation factors, the molecular diffusion coefficient, and degradation rates for 1,4-dioxane were obtained from published literature, Adamson et al., 2016.
- Source concentration and mass were adjusted to match observed groundwater concentrations in monitoring wells along the plume centerline (Figure 4-33).
- Observed concentrations along the plume centerline were collected over various years, therefore, as a conservative measure, the year 2017 was selected as the calibration year. Consequently, for model calibration purposes:
  - The observed concentrations in the source area were the geometric means of the 2017 and 2019 concentrations from MW1-46 and MW1-47.
  - The observed concentrations from the downgradient wells MW1-62, MW1-63, and MW1-64 were from 2019, the only year with data collection.
  - The observed concentrations for MW1-25, the most downgradient plume centerline well, were from 2015, the most recent year of data collection.

## Table 4-12. CL 1,4-dioxane plume REMChlor-MD modeling input parameters

| Parameter | CP 1,4-Dioxane Plume* | Notes |
|---|---|---|
| X-Direction model size (ft) | 362 | 2017 Site Recharacterization Phase II report (DON, 2018) plume figures |
| Z-Direction model size (ft) | 20 | Assumed based on source thickness |
| **Source width (ft)** | **75** | **Battelle 2022 3-D plume maps (DON, 2022a):**<br>• **Widest part of the 50 µg/L contour of the plume around MW1-46** |
| Source thickness (ft) | 20 | Assumed same as CVOC model:<br>• Approximate height of the 10,000 µg/L contour of the cDCE plume around MW1-64 (Battelle 2022 3-D plume maps, DON, 2022a) |
| Hydraulic gradient (ft/ft) | 0.018 | Calculated from the 2017 Site Recharacterization Phase II Report Figure 4-5 (DON, 2018), |
| Transmissive zone hydraulic conductivity (cm/sec) | Initial: 2.6E-04<br>Calibrated: 1.0E-3 | 2017 Site Recharacterization Phase II report (DON, 2018) |
| Low-k zone hydraulic conductivity (cm/sec) | 1.4E-05 | REMChlor-MD default for silt |
| Transmissive zone porosity (-) | 0.28 | 2017 Site Recharacterization Phase II report (DON, 2018) |
| Low-k zone porosity (-) | 0.53 | EXWC field work (DON, 2022b), assumed same as for SP plumes |
| Transmissive zone tortuosity (-) | 0.49 | REMChlor-MD default |
| Low-k zone tortuosity (-) | 0.41 | REMChlor-MD default |
| **Transmissive zone retardation factor (-)** | **1.01** | **Adamson et al., 2016** |
| **Low-k zone retardation factor (-)** | **1.01** | **Adamson et al., 2016** |
| **Molecular diffusion coefficient ($m^2$/sec)** | **1.1E-9** | **Adamson et al., 2016** |
| Gamma | 1 | Assumed |
| **Source concentration (mg/L)** | **0.028** | **Calibrated** |
| **Source mass (kg)** | **2** | **Calibrated** |
| Year source started | 1970 | Estimated |

| Parameter | CP 1,4-Dioxane Plume* | Notes |
|---|---|---|
| Heterogeneity | • No matrix diffusion in overlying or underlying low-k units<br>• Low-k material in plume thickness based on boring logs | Based on existing boring logs |
| Longitudinal dispersivity (ft) | 1 | Calibrated |
| Transverse dispersivity (ft) | 0.1 | $\alpha_t$: $\alpha_x$ = 0.10 |
| Vertical dispersivity (ft) | 0.01 | $\alpha_t$: $\alpha_x$ = 0.01 |
| **Transmissive zone plume degradation half-life (yrs)** | **0** | **Adamson et al., 2016** |
| **Low-k zone plume degradation half-life (yrs)** | **0** | **Assumed** |

* The 1,4-dioxane model input values that differed from the CVOC model are in bold.
Definitions:
cm = centimeters    ft = feet    kg = kilograms    L = liters    m = meters    mg = milligrams    sec = second    yrs = years

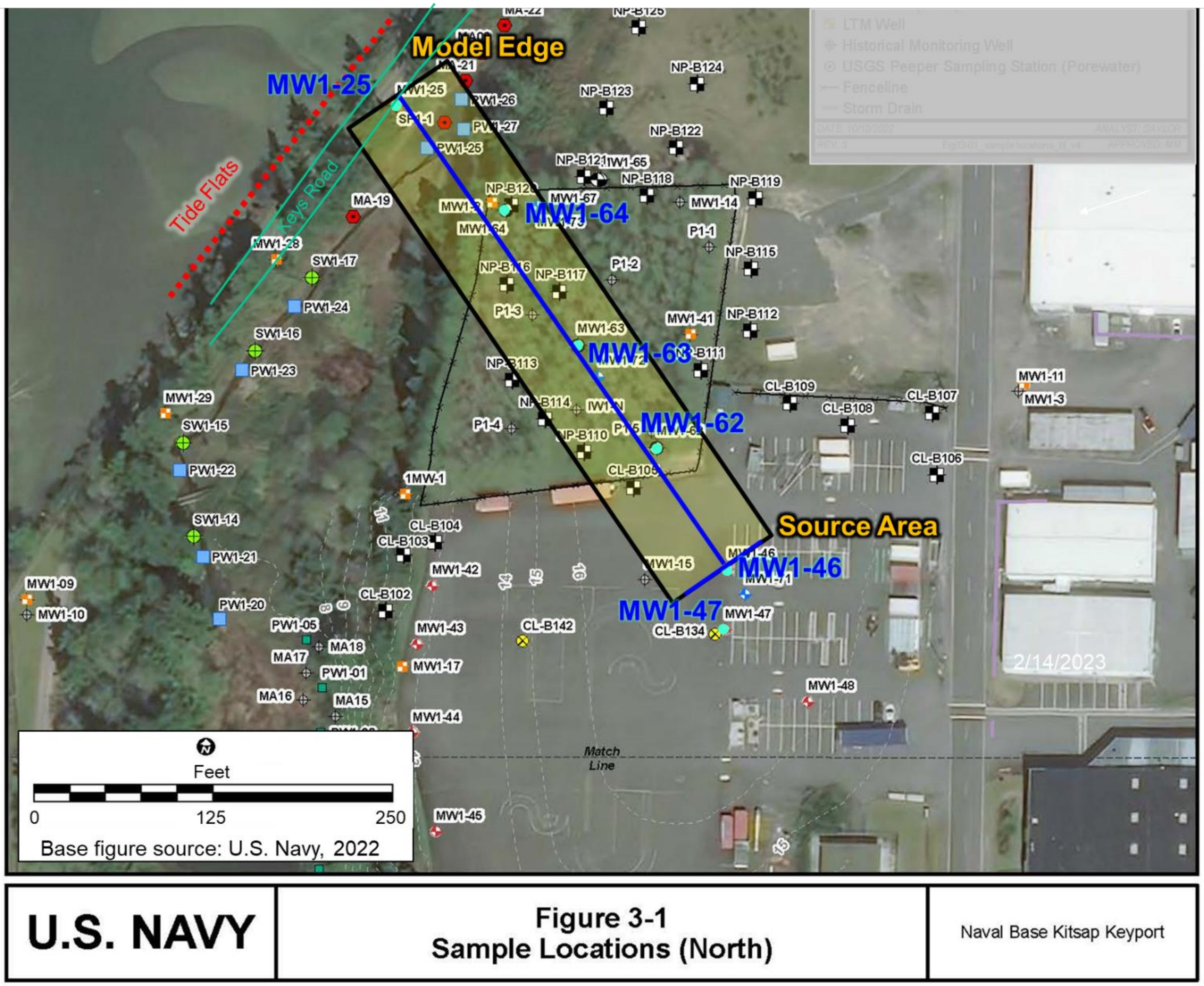



**Figure 4-33. CL 1,4-dioxane plume modeling area of interest. (Basemap source: DON, 2022a, emphasis added)**

### *4.5.3 CL 1,4-Dioxane Plume Model Calibration*

The CL 1,4-dioxane plume model was calibrated to the 2015/2017/2019 observed concentrations along the plume centerline (Figure 4-33). Note that compared to the CVOC plumes at NBK Keyport, there is considerable variability in the observed 1,4-dioxane concentrations. This plume may represent a slug-type plume pattern with higher concentrations downgradient than in the source area (Figure 4-34). Modeling a slug-type plume through a water bearing unit is inherently more difficult than a slowly dissipating source and therefore, it is not unexpected that the RMS error for the log-transformed groundwater concentrations was larger than for the other plumes modeled. Calibration results are presented in Table 4-13 and Figure 4-34.

**Table 4-13. CL 1,4-Dioxane Plume REMChlor-MD Calibration - Groundwater**

| Monitoring Well | 2017 Concentration (mg/L)[1] | | | | |
|---|---|---|---|---|---|
| | Source Area[2] | MW1-62[3] | MW1-63[3] | MW1-64[3] | MW1-25[4] |
| Distance from source (ft) | 1 | 98 | 189 | 256 | 361 |
| 1,4-Dioxane (observed/simulated) | 0.013/0.019 | 0.015/0.019 | 0.1/0.02 | 0.04/0.02 | 0.03/0.02 |

Notes:
1. For the purposes of modeling, 2017 was selected as the calibration year as a conservative measure.
2. Observed concentrations are geometric means of the 2017 and 2019 concentrations from MW1-46 and MW1-47.
3. Observed concentrations are from 2019.
4. The most recent data for MW1-25 is from 2015.

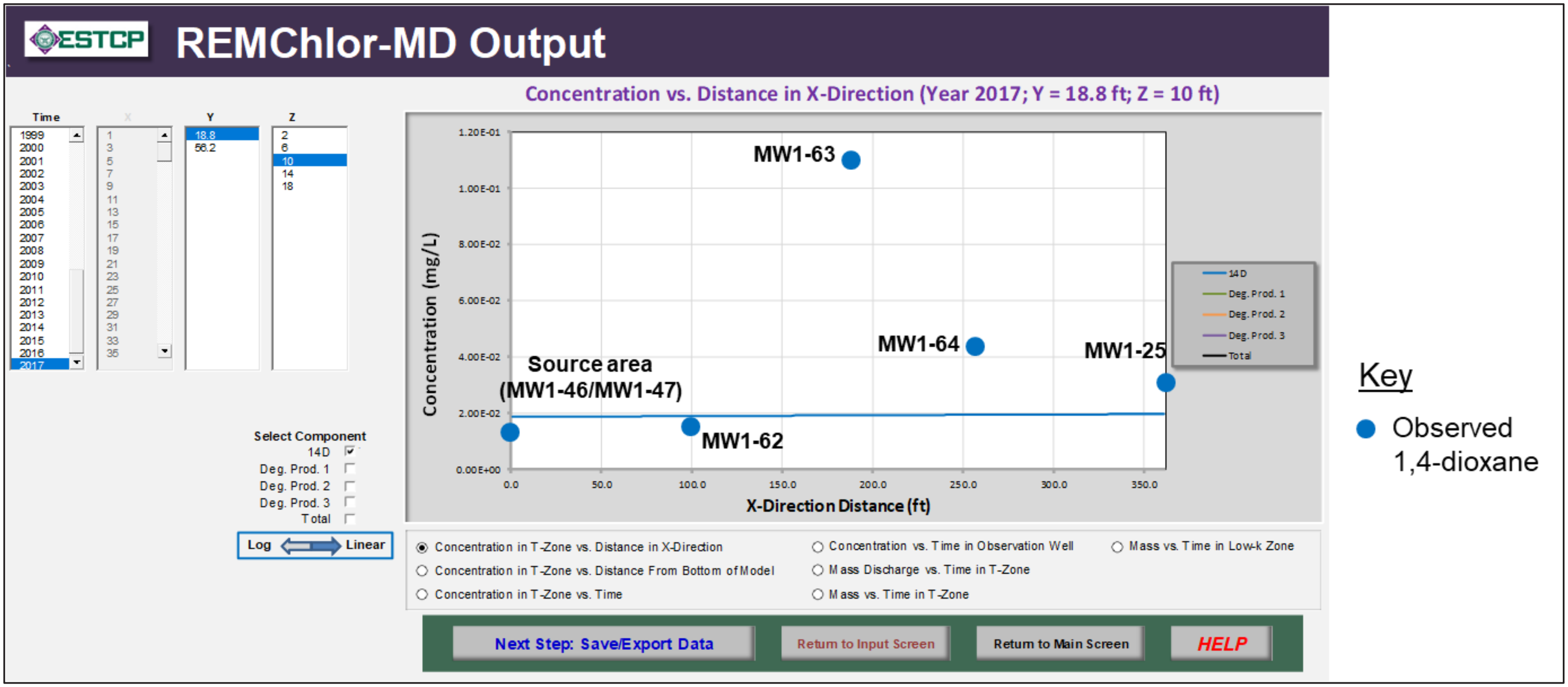



**Figure 4-34. CL 1,4-dioxane plume REMChlor-MD calibration – Concentration**

### 4.5.4 CL 1,4-Dioxane Plume Modeling Results

The impact of matrix diffusion on various remedial alternatives is summarized in Table 4-14 and Figures 4-36 through 4-38 for the CL 1,4-dioxane plume. A graphical comparison of the time to reach the 1,4-dioxane RG for the various remedial alternatives is presented in Figure 4-39. REMChlor-MD model input and output are shown in Appendix G.

The calibrated REMChlor-MD model was used to explore different remediation strategies under the influence of matrix diffusion. For the CL 1,4-dioxane plume, impact of the remediation alternatives was evaluated by estimating, 1) the time to reach the RG at the model edge well MW1-25 (Figure 4-35); 2) the modeling COI mass remaining in the modeled plume, in both the low-k and transmissive zones, 30 years after the remediation; and 3) the modeling COI concentrations at MW1-25 30 years after the remediation.

As shown on Table 4-14, even complete isolation of the source area with a PRB was unable to achieve the RG for 1,4-dioxane 30 years after the remediation due to matrix diffusion effects. Based on the modeling, 30 years after the complete isolation of the source, 1,4-dioxane concentrations were still ~60% greater than the RG (7E-4 mg/L compared to 4.4E-4 mg/L) at MW1-25. Also as shown on Table 4-14, 30 years after the complete isolation of the source with a PRB, majority of the mass within the modeled plume is in the low-k zone (~84%: 0.0046 kg / 0.0055 kg). This mass will continue to feed the plume as shown by the REMChlor-MD model.

An evaluation of the REMChlor-MD modeling to assess the effects of matrix diffusion on potential source area treatment remediation timeframes is detailed below.

GSI ENVIRONMENTAL

### Table 4-14. CL 1,4-Dioxane Plume Remediation Scenarios Modeling Results

| Model Runs | Detailed Questions | Is Plume Matrix Diffusion Turned On? | What Type Remediation is Assumed? | Year 1,4-Dioxane is Below RG of 4.4E-4 mg/L in MW1-25 | Mass in 2055 (kg) | | | Concentration in 2055 in MW1-25 (mg/L) |
|---|---|---|---|---|---|---|---|---|
| | | | | | Low-k Zone | Trans Zone | Total | 1,4-Dioxane (RG = 0.00044 mg/L) |
| **Question 1: How important is matrix diffusion to the Conceptual Site Model?** | | | | | | | | |
| Run 1 | What is the impact of matrix diffusion on the groundwater CVOC plume? | No | • Plume degradation<br>• Source isolation with a PRB in 2025<br>• No plume remediation | 2033 | 0 | 0 | 0 | 0 |
| Run 2 | | Yes | | 2061 | 4.6E-03 | 8.9E-04 | 5.5E-03 | 0.0007 |
| **Question 2: Can a PRB isolating the source be used to manage the groundwater plume?** | | | | | | | | |
| Run 3 (Basecase) | Can a PRB be used to manage the groundwater plume? | Yes | • Plume degradation only<br>• No source remediation<br>• No plume remediation | 2490 | 0.03 | 0.05 | 0.08 | 0.015 |
| Run 2 (same as above) | | Yes | • Plume degradation<br>• Source isolation with a PRB in 2025<br>• No plume remediation | 2061 | 4.6E-03 | 8.9E-04 | 5.5E-03 | 0.0007 |
| **Question 3: How will removing 90% of the source mass affect the groundwater plume?** | | | | | | | | |
| Run 3 (Basecase, same as above) | How will removing 90% of the source mass affect the groundwater plume? | Yes | • Plume degradation only<br>• No source remediation<br>• No plume remediation | 2490 | 0.03 | 0.05 | 0.08 | 0.015 |
| Run 4 | | Yes | • Plume degradation<br>• 90% source removal in 2025<br>• No plume remediation | 2204 | 0.007 | 0.005 | 0.012 | 0.002 |

RG = Remediation Goal

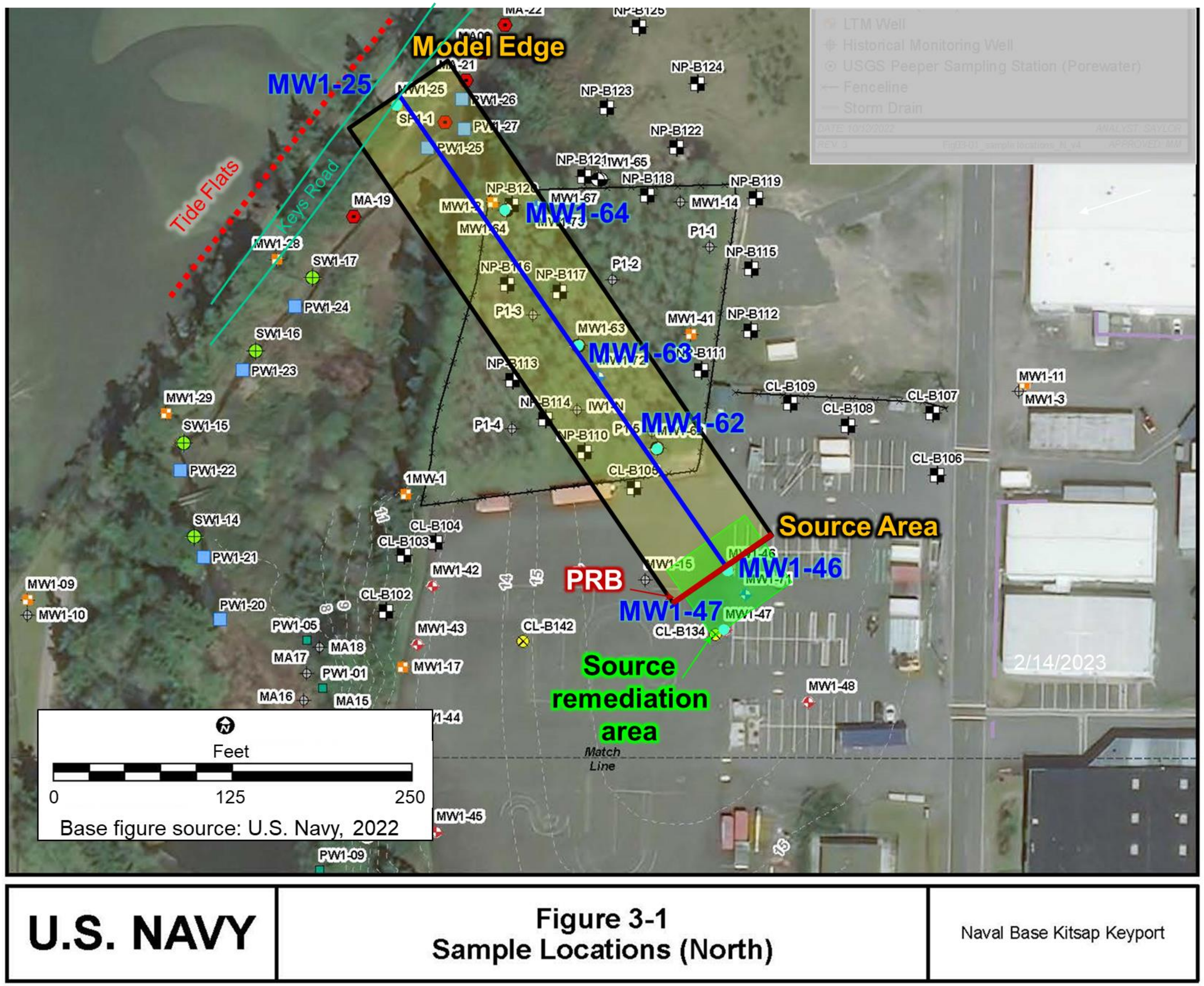



**Figure 4-35. Scenarios modeling – CL 1,4-dioxane plume. (Basemap source: DON, 2022a. Emphasis added)**

Based on the REMChlor-MD modeling, an overall evaluation of the three questions of interest to the U.S. Navy addressing Objective 2 is presented below.

- *Question 1: How important is matrix diffusion to the CSM?*

  *Modeling Summary:* Very important. For 1,4-dioxane, the no matrix diffusion model shows concentrations dropping below the RG **8 years** (2033 minus 2025) after 100% source isolation (Run 1) in the downgradient well MW1-25. While the actual 1,4-dioxane source is unclear, this source or sources did result in a 1,4-dioxane plume that then interacted with the geologic media around the plume. Because the only way to add contamination into the REMChlor-MD modeling domain is via a single source term, the assumed source in the model was assumed to generally represent the actual 1,4-dioxane source or sources at this particular site. However, even if all the sources were located and removed and if matrix diffusion is accounted for, the model predicts the groundwater plume will persist for **36 years** (2061 minus 2025) after 100% source isolation in year 2025 (Run 2) before reaching the RG in MW1-25 (Figure 4-36).

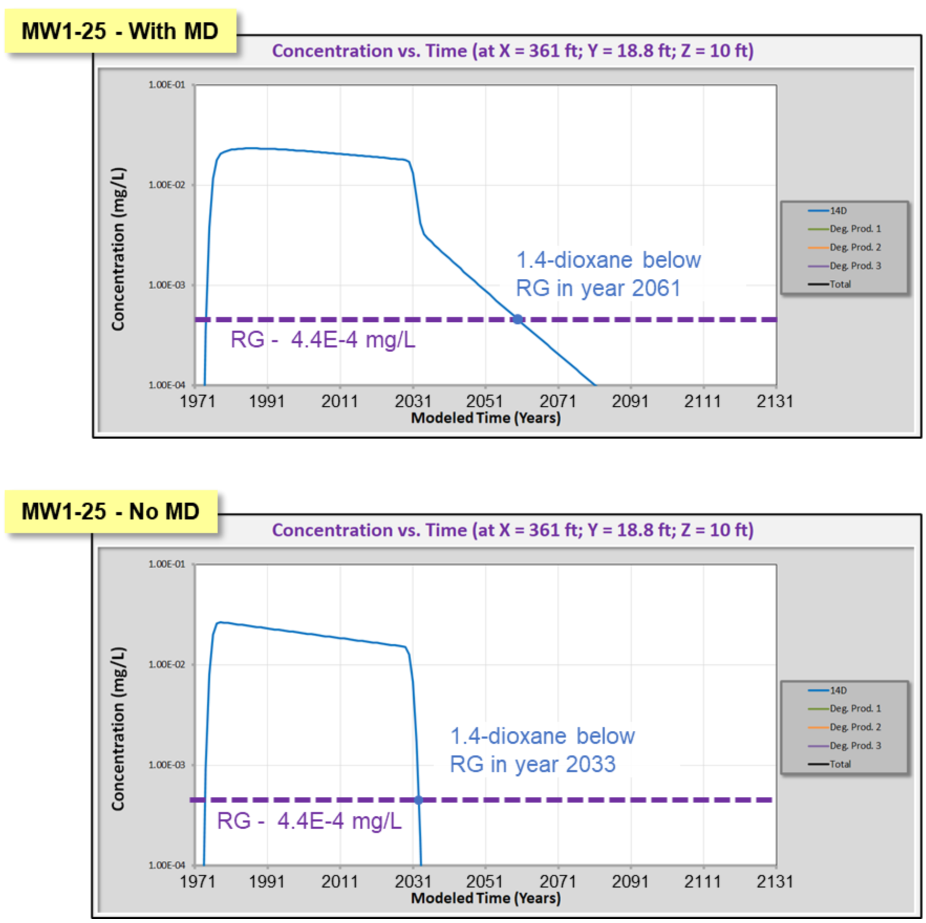



**Figure 4-36. CL 1,4-dioxane plume REMChlor-MD model output at well MW1-25: matrix diffusion vs. no matrix diffusion. Top Panel: With matrix diffusion (MD). Bottom Panel: Without matrix diffusion**

- *Question 2: Can a PRB isolating the source be used to manage the groundwater plume?*

  *Modeling Summary:* A source PRB would reduce the remediation timeframe, but it would still take several decades to reach groundwater RGs. For the CL 1,4-dioxane plume, isolating the source with a PRB (Figure 4-35) reduces the time to reach the RG in the downgradient well MW1-25 from **465 years** (2490 minus 2025, Run 3) (for the case with no PRB) to **36 years** (2061 minus 2025, Run 2) (Figure 4-37) after the source isolation in 2025.

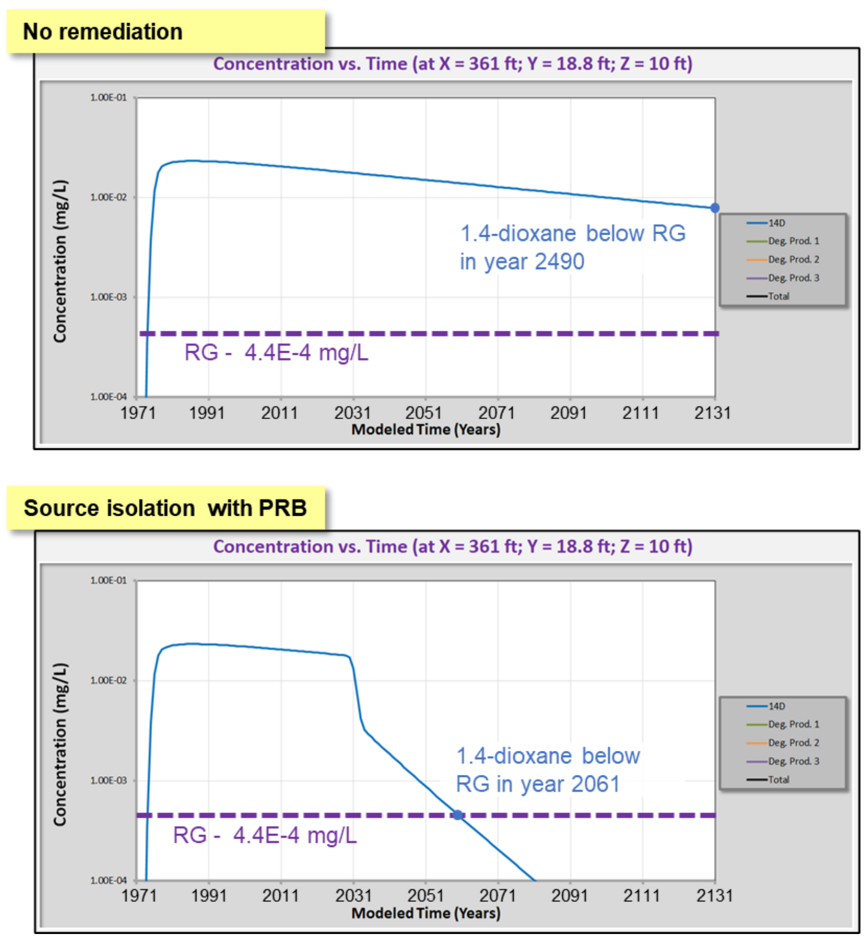



**Figure 4-37. CL 1,4-dioxane plume REMChlor-MD model output at well MW1-25: Source isolation vs. no remediation**

- *Question 3: How will removing 90% of the source mass affect the groundwater plume?*

  *Modeling Summary:* Removing 90% of the source mass has some impact on the long-term fate and transport of the groundwater plume, but the model indicates it would still take several centuries after the remediation to reach the RG at the model edge. This is because removing 90% of the source mass does not equate to removing 90% of the mass contained in the low-k and transmissive zones in the plume downgradient of the source. After source removal, the mass in the low-k unit will continue to feed the plume for centuries as shown by the REMChlor-MD model. For the CL 1,4-dioxane plume, removing 90% of the source mass decreased the remediation timeframe from **465 years**

(2490 minus 2025, Run 3) (assuming no remediation) to **179 years** (2204 minus 2025, Run 4) at well MW1-25 (Figure 4-38).

One possible factor that could result in lower remediation timeframes is the presence of on-going 1,4-dioxane degradation reactions in the low-k geologic media (e.g., silts, clays). Because these reactions are not known to occur for 1,4-dioxane, they were assumed not to be present at the CL 1,4-dioxane plume and therefore not included in the REMChlor-MD modeling.

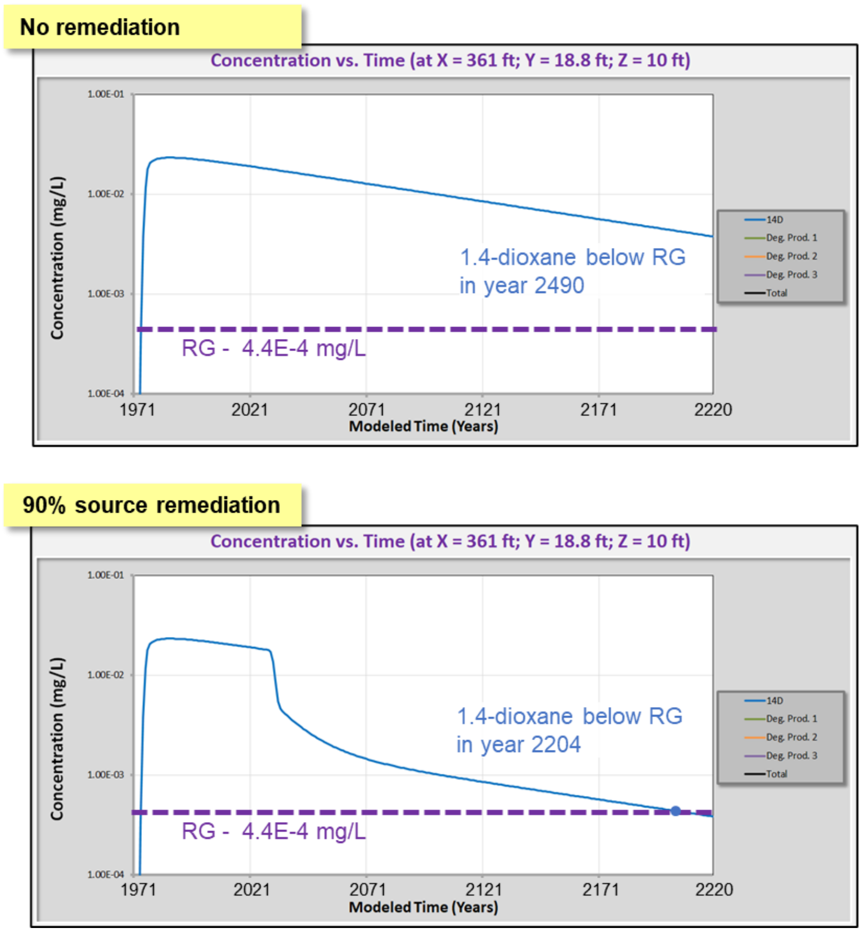



**Figure 4-38. CL 1,4-dioxane plume REMChlor-MD model output at well MW1-25: 90% Source remediation vs. no remediation**

### *4.5.5 CL 1,4-Dioxane Plume Modeling Conclusions*

The project team hypothesized that matrix diffusion processes at NBK Keyport would impact the effectiveness of source remediation in the downgradient plume. That is, the low-k zones in the impacted aquifer at NBK Keyport had higher concentrations than the surrounding transmissive units, thereby allowing back-diffusion to sustain the long-term, low-level persistent dissolved phase concentrations of 1,4-dioxane in groundwater.

The REMChlor-MD model reproduced observed groundwater concentrations reasonably well during the calibration step and then was used to forecast general trends in remediation timeframe for the CL 1,4-dioxane plume.

REMChlor-MD modeling of the CL 1,4-dioxane plume at NBK Keyport showed that the plume is likely to persist for decades. The modeling runs suggested that even with complete isolation of the source with a PRB in 2025, an additional 36 years from the year 2025 might be required to permanently reach the RG at MW1-25 due to matrix diffusion effects (Figure 4-39).

These planning-level model runs suggest that matrix diffusion processes reduce the effectiveness of source remediation in the downgradient plume. Even if the hotspots are remediated (e.g., with an in-situ treatment or excavation) to reduce source concentrations, the same reduction in concentration is not observed in the plume downgradient of the hotspots (i.e., a 90% reduction in source concentrations does not result in a 90% reduction in the downgradient plume concentrations). It is possible for the concentrations of plumes like the ones at NBK Keyport to "hover" just above the RGs at single-digit, part-per-billion concentrations for decades due to the on-going matrix diffusion processes.

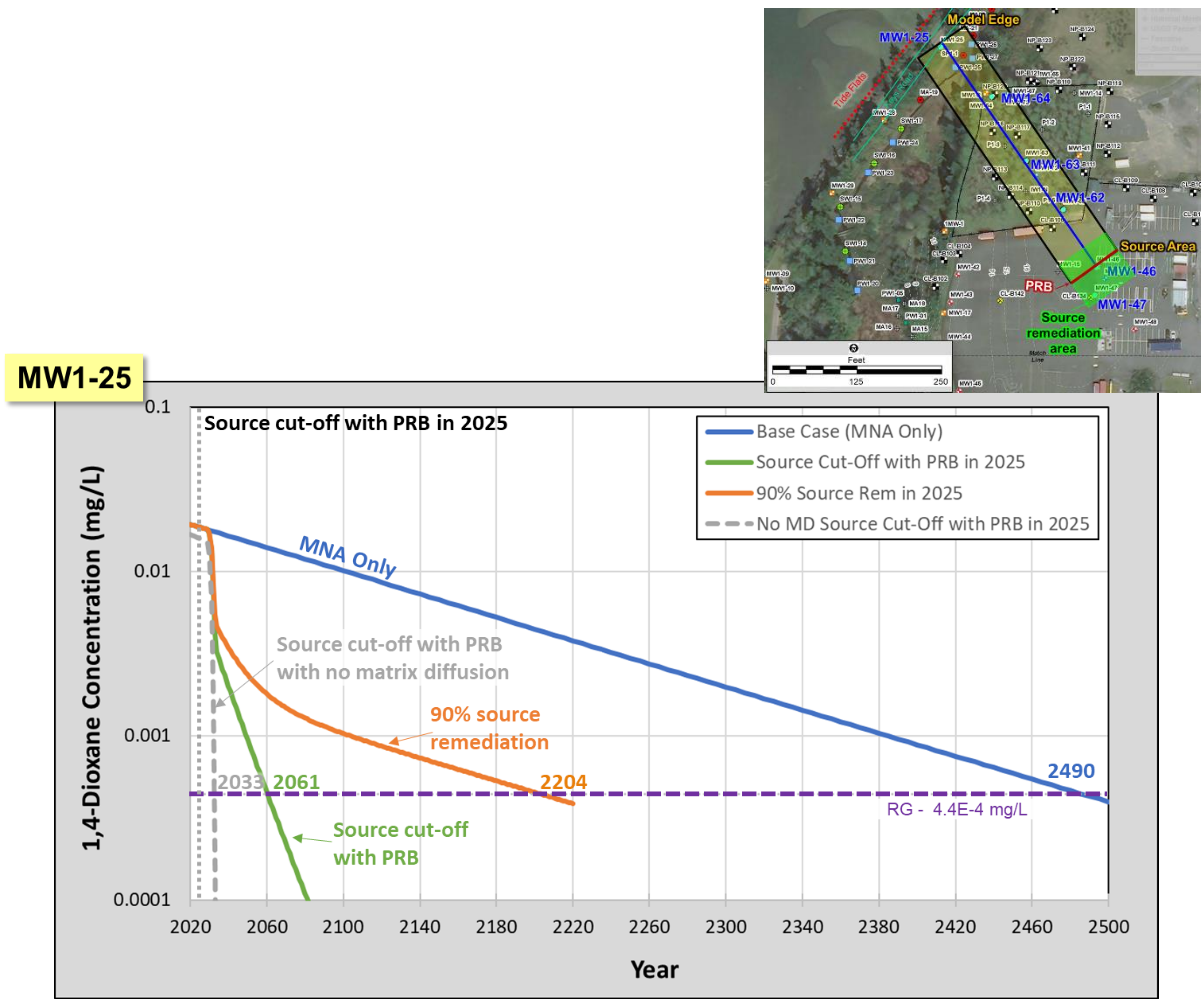



**Figure 4-39. CL 1,4-dioxane plume REMChlor-MD modeling summary at MW1-25. (Inset map source: DON, 2022a, emphasis added)**

# 5.0 SENSITIVITY ANALYSIS

Sensitivity analyses are performed on calibrated groundwater models to identify the input parameters that have the most impact on the calibration and simulation results. In accordance with the Groundwater Modeling Plan (GSI, 2020) a sensitivity analysis was performed for the following parameters:

- Groundwater velocity (high and low);
- Retardation factor (high and low);
- Initial source concentration (high and low);
- Source start time (earlier and later);
- Source mass percent removal (high and low);
- Initial source mass (high and low);
- Gamma term (high and low); and
- Decay coefficient (high and low).

The range that was varied for each parameter was based on ranges in the underlying data for each parameter used in the sensitivity analysis (Table 5-1). Table 5-2 summarizes the time to reach the RG at the downgradient edge of the model when various parameters were altered assuming no source remediation. Conclusions that can be drawn from this sensitivity analysis are:

- A comparison of the RMS errors and, as noted below, the CVOC mass for the Sensitivity Analysis runs and their respective Basecase (Table 5-2) indicates similar or worse errors than the Basecase. Since none of the parameters varied made a significant improvement to the model calibration and prediction, the Basecase model parameters were retained.
- For the SP West Hotspot plume,
    - Although a better concentration RMS error was obtained for the Later Source Start Time model compared to the Basecase (RMS error of 0.14 vs. 0.18), a comparison of the CVOC mass (the second calibration component for this plume, Table 4-7) indicated poorer agreement. For the Basecase, a ~10% error was calculated between the observed (4.9 kg) and simulated (4.3 kg) CVOC masses. The Sensitivity Analysis indicated an ~15% difference (4.1 kg compared to the observed 4.9 kg). Therefore, the Basecase model parameters were retained.
    - Similarly, although better concentration RMS errors were obtained for the Lower Initial Source Mass and Higher Gamma Term models (RMS error = 0.16 for each), the CVOC mass comparisons were worse than the Basecase. Percent errors of ~15% were calculated for both models (CVOC mass = 4.0 kg and 4.1 kg, respectively, for the Lower Initial Source Mass and Higher Gamma Term models). Therefore, the Basecase model parameters were retained.

### Table 5-1. NBK Keyport REMChlor-MD Modeling Sensitivity Analysis Input Values

| Parameter | Parameter Adjustment for Sensitivity Analysis | Units | Parameter Value | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | SP East Hotspot Plume | | SP West Hotspot Plume | | CL Northwest CVOC Plume | | CL 1,4-Dioxane Plume | |
| | | | Basecase | Sensitivity Analysis | Basecase | Sensitivity Analysis | Basecase | Sensitivity Analysis | Basecase | Sensitivity Analysis |
| HIGHER Groundwater Velocity | Double | ft/yr | 2.38 | 4.76 | 4.05 | 8.11 | 18.95 | 37.89 | 18.95 | 37.89 |
| LOWER Groundwater Velocity | Half | ft/yr | 2.38 | 1.19 | 4.05 | 2.03 | 18.95 | 9.47 | 18.95 | 9.47 |
| HIGHER Retardation Factor[1] | Double | - | 3, 4 | 6, 8 | 3.5, 5 | 7, 10 | 3, 4 | 6, 8 | 1.01, 1.01 | 2.02, 2.02 |
| LOWER Retardation Factor[1] | Half | - | 3, 4 | 1.5, 2 | 3.5, 5 | 1.75, 2.5 | 3, 4 | 1.5, 2 | 1.01, 1.01 | 1, 1 |
| HIGHER Initial Source Concentration[2] | Double | mg/L | 800 | 1600 | 35, 28, 3.9 | 70, 56, 7.8 | 0.038, 11.8, 2.8 | 0.08, 23.6, 5.6 | 0.0275 | 0.055 |
| LOWER Initial Source Concentration[2] | Half | mg/L | 800 | 400 | 35, 28, 3.9 | 17.5, 14, 1.95 | 0.038, 11.8, 2.8 | 0.02, 5.9, 1.4 | 0.0275 | 0.014 |
| LATER Source Start Time | + 10 years | Year | 1970 | 1980 | 1970 | 1980 | 1970 | 1980 | 1970 | 1980 |
| EARLIER Source Start Time | - 10 years | Year | 1970 | 1960 | 1970 | 1960 | 1970 | 1960 | 1970 | 1960 |
| HIGHER Source Mass Percent Removal | 100% | % | 0 | 100 | 0 | 100 | 0 | 100 | 0 | 100 |
| LOWER Source Mass Percent Removal | 50% | % | 0 | 50 | 0 | 50 | 0 | 50 | 0 | 50 |
| HIGHER Initial Source Mass[3] | Double | kg | 300 | 600 | 100, 100, 100 | 200, 200, 200 | 5, 420, 100 | 10, 840, 200 | 2 | 4 |
| LOWER Initial Source Mass[3] | Half | kg | 300 | 150 | 100, 100, 100 | 50, 50, 50 | 5, 420, 100 | 2.5, 210, 50 | 2 | 1 |
| HIGHER Gamma Term | Double | - | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| LOWER Gamma Term | Half | - | 1 | 0.5 | 1 | 0.5 | 1 | 0.5 | 1 | 0.5 |
| HIGHER Decay Rate – TCE[4] | Double | 1/yr | 1, 2.11 | 2, 4.21 | 0.46 | 0.92 | 0.33 | 0.66 | 0 | N/A |
| LOWER Decay Rate - TCE[4] | Half | 1/yr | 1, 2.11 | 0.5, 1.05 | 0.46 | 0.23 | 0.33 | 0.17 | 0 | N/A |
| HIGHER Decay Rate - cDCE[4] | Double | 1/yr | 0.79, 0.95 | 1.58, 1.9 | 0.58 | 1.16 | 0.35 | 0.69 | 0 | N/A |
| LOWER Decay Rate - cDCE[4] | Half | 1/yr | 0.79, 0.95 | 0.4, 0.47 | 0.58 | 0.29 | 0.35 | 0.17 | 0 | N/A |
| HIGHER Decay Rate - VC[4] | Double | 1/yr | 9.24, 1.78 | 18.48, 3.55 | 4.62 | 9.24 | 1.98 | 3.96 | 0 | N/A |
| LOWER Decay Rate - VC[4] | Half | 1/yr | 9.24, 1.78 | 4.62, 0.89 | 4.62 | 2.31 | 1.98 | 0.99 | 0 | N/A |

Notes:
1. Retardation factor values are shown as “transmissive zone, low-k zone” values.
2. If separated by commas, initial source concentration values are shown as “TCE, cDCE, VC” values, otherwise the values shown are for TCE or 1,4-dioxane as appropriate.
3. If separated by commas, initial source mass values are shown as “TCE, cDCE, VC” values, otherwise the values shown are for TCE or 1,4-dioxane as appropriate.
4. If separated by commas, decay rate values are shown as “first degradation zone, second degradation zone” values, otherwise only one degradation zone was modeled.
5. Definitions:
   % = percent cDCE = cis-1,2-dichloroethene ft/yr = feet per year kg = kilogram mg/L = milligrams per Liter N/A = not applicable TCE = trichloroethene VC = vinyl chloride yr = year

### Table 5-2. NBK Keyport REMChlor-MD Modeling Sensitivity Analysis

| Parameter | Parameter Adjustment for Sensitivity Analysis | Concentration RMS Error | | | | | | | | Year Remediation Goal Reached | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SP East Hotspot Plume | | SP West Hotspot Plume | | CL Northwest CVOC Plume | | CL 1,4-Dioxane Plume | | SP East Hotspot: Plume Boundary VC | | SP West Hotspot: Plume Boundary VC | | CL Northwest CVOC Plume: MW1-25 VC | | CL 1,4-Dioxane Plume at MW1-25 | |
| | | Basecase | Sensitivity Analysis | Basecase | Sensitivity Analysis | Basecase | Sensitivity Analysis | Basecase | Sensitivity Analysis | Basecase | Sensitivity Analysis | Basecase | Sensitivity Analysis | Basecase | Sensitivity Analysis | Basecase | Sensitivity Analysis |
| HIGHER Groundwater Velocity | Double | 0.19 | 2.79 | 0.18 | 1.00 | 0.47 | 0.53 | 0.90 | 1.15 | 2626 | 2433 | >2675 | >2675 | >2675 | 2500 | 2490 | 2230 |
| LOWER Groundwater Velocity | Half | | 5.85 | | 1.93 | | 1.23 | | 0.83 | | 2330 | | >2675 | | >2675 | | >2675 |
| HIGHER Retardation Factor | Double | | 1.37 | | 0.22 | | 0.47 | | 0.90 | | >2670 | | >2675 | | >2675 | | 2500 |
| LOWER Retardation Factor | Half | | 0.21 | | 0.22 | | 0.48 | | 0.91 | | 2602 | | >2675 | | >2675 | | 2490 |
| HIGHER Initial Source Concentration | Double | | 0.44 | | 0.77 | | 0.56 | | 0.77 | | 2348 | | >2675 | | 2580 | | 2280 |
| LOWER Initial Source Concentration | Half | | 0.45 | | 0.58 | | 0.69 | | 1.26 | | >2670 | | >2675 | | >2675 | | >2675 |
| LATER Source Start Time | + 10 years | | 0.24 | | 0.14 | | 0.49 | | 0.87 | | 2635 | | >2675 | | >2675 | | 2500 |
| EARLIER Source Start Time | - 10 years | | 0.21 | | 0.19 | | 0.47 | | 0.95 | | 2615 | | >2675 | | >2675 | | 2480 |
| HIGHER Source Mass Percent Removal | 100% | | 0.19 | | 0.18 | | 0.47 | | 0.90 | | 2179 | | 2448 | | 2243 | | 2061 |
| LOWER Source Mass Percent Removal | 50% | | 0.19 | | 0.18 | | 0.47 | | 0.90 | | 2625 | | >2675 | | >2675 | | 2405 |
| HIGHER Initial Source Mass | Double | | 0.35 | | 0.19 | | 0.55 | | 0.83 | | >2670 | | >2675 | | >2675 | | >2675 |
| LOWER Initial Source Mass | Half | | 0.46 | | 0.16 | | 0.59 | | 1.12 | | 2324 | | >2675 | | 2490 | | 2235 |
| HIGHER Gamma Term | Double | | 0.19 | | 0.16 | | 0.51 | | 1.05 | | 2625 | | >2675 | | >2675 | | >2675 |
| LOWER Gamma Term | Half | | 0.19 | | 0.19 | | 0.53 | | 0.84 | | 2625 | | >2675 | | 2505 | | 2220 |
| HIGHER Decay Rate | Double | | 4.91 | | 1.42 | | 1.24 | | N/A | | 2172 | | >2675 | | >2675 | | N/A |
| LOWER Decay Rate | Half | | 2.85 | | 0.91 | | 0.70 | | N/A | | >2670 | | >2675 | | >2675 | | N/A |

Notes:
1. Adjustment applied to the Basecase model parameter to perform the sensitivity analysis. For example, “Double” means the Basecase parameter was doubled for the sensitivity analysis model run (see Tables 4-1,4-5,4-9, and 4-12 for Basecase input values).
2. No decay rate sensitivity analysis was performed for the 1,4-dioxane model since published literature indicates a zero decay rate for the constituent.
3. Definition:
   N/A = not applicable

- For the CL 1,4-dioxane plume, although better concentration RMS errors were obtained for several of the Sensitivity Analysis parameters, the plume appears to be a slug with higher concentrations downgradient than in the source area (Figure 4-34). Modeling a slug going through a water bearing unit is inherently more difficult than a slowly dissipating source. In such cases, the modeling team felt it was more appropriate to apply more weight to the plume source area and toe concentration comparisons rather than the higher concentration slug in the middle. Consequently, for the REMChlor-MD model, the source area well was calibrated first and then parameters adjusted to match the plume length. A comparison of the RMS errors for the source and model edge wells (Table 5-3) indicates similar or worse errors than the Basecase, therefore the Basecase parameter values were retained.

**Table 5-3. Comparison of Source and Plume Edge Concentrations**

| Model | Source Area 1,4-Dioxane Concentration (mg/L) | | Model Edge (MW1-25) 1,4-Dioxane Concentration (mg/L) | | RMS Error |
|---|---|---|---|---|---|
| | Observed | Simulated | Observed | Simulated | |
| Basecase | 0.013 | 0.019 | 0.031 | 0.020 | 0.18 |
| LOWER Groundwater Velocity) | | 0.023 | | 0.023 | 0.21 |
| HIGHER Initial Source Concentration | | 0.025 | | 0.029 | 0.24 |
| HIGHER Initial Source Mass | | 0.020 | | 0.021 | 0.18 |
| LOWER Gamma Term | | 0.023 | | 0.023 | 0.21 |

## 6.0 CONCLUSIONS

A planning-level source and plume remediation model, REMChlor-MD was used to address the overall objective of interest to the U.S. Navy at NBK Keyport: if plume hotspots are remediated (e.g., with an in-situ treatment or excavation) to reduce source concentrations, would the same reduction in concentration be observed in the plume downgradient of the hotspots (for example, would a 90% reduction in source concentrations result in a 90% reduction in the downgradient plume concentrations)? Or do matrix diffusion processes reduce the effectiveness of source remediation in the downgradient plume?

REMChlor-MD uses several simplifying assumptions, such as 1-dimensional groundwater flow, but accounts for key groundwater fate and transport processes such as advection, dispersion, sorption, matrix diffusion, and the impact of remediation measures to the source and/or the plume. One REMChlor-MD model was developed for each of the four plumes of interest and calibrated to actual site data. These models demonstrate the importance and impact of matrix diffusion on persistent plumes at these sites as they show that many decades (or even centuries) might be required to achieve RGs even with complete Hotspot source removal.

***Modeling Limitations and Nature of Remediation Outcomes***

Because of the uncertainties in the underlying data and the simplifying assumptions that are inherent with the REMChlor-MD model, these results should be considered general forecasts of remediation outcomes rather than specific precise predictions.

***SP East Hotspot – Modeling Results***

Planning-level REMChlor-MD computer modeling of the SP East Hotspot at NBK Keyport OU 1 showed that the target CVOCs (TCE, cDCE, and VC) are likely to persist for many decades. Modeling runs suggested that even with complete isolation of the identified source zone with a PRB in 2025, an additional **~150 year**s from the year 2025 would be required to permanently reach the VC (the most conservative CVOC of interest) RG at the plume boundary at the marsh due to matrix diffusion effects. At the stream bank in the East Hotspot plume, an additional **~140 years** from the year 2025 might be needed to permanently reach sub-RG concentrations for VC in groundwater.

***SP West Hotspot – Modeling Results***

At the SP West Hotspot, planning-level modeling showed that the target CVOCs (TCE, cDCE, and VC) may persist for centuries. The modeling runs suggested that even with complete isolation of the source with a PRB in 2025, an additional **~400 years** from the year 2025 might be required to permanently reach the VC (the most conservative CVOC of interest) RG at the plume boundary due to matrix diffusion effects.

***CL Northwest CVOC Plume – Modeling Results***

REMChlor-MD models of the CL Northwest CVOC plume at NBK Keyport showed that the target CVOCs (TCE, cDCE, and VC) may persist for centuries. The modeling runs suggested that even with complete isolation of the source with a PRB in 2025, an additional **~200 years** from the year 2025 might be required to permanently reach the VC (the most conservative CVOC of interest) RG at MW1-25 due to matrix diffusion effects.

### *CL 1,4-Dioxane Plume – Modeling Results*

At the CL 1,4-dioxane plume at NBK Keyport, REMChlor-MD modeling showed that the plume is likely to persist for decades. The modeling runs suggested that even with complete isolation of the source with a PRB in 2025, an additional **~36 years** from the year 2025 might be required to permanently reach the RG at MW1-25 due to matrix diffusion effects.

### *High Level Summary*

Overall, the impacts of matrix diffusion effects make the contaminant mass remaining in low-k zones difficult to treat because remediation amendments (e.g., for chemical oxidation or bioremediation) cannot be easily delivered to and distributed throughout lower permeability soils such as silts and clays. These planning-level model runs suggest that matrix diffusion processes reduce the effectiveness of even complete source remediation for the cleanup of downgradient plumes. Even if the hotspots are thoroughly remediated (e.g., with an in-situ treatment or excavation), the same reduction in concentration is not observed in the plume downgradient of the hotspots (i.e., a 90% reduction in source concentrations does not result in a 90% reduction in the downgradient plume concentrations). It is possible that the concentrations of plumes like the ones at NBK Keyport may “hover” just above the RGs at single-digit, part-per-billion concentrations for many decades (or even centuries) due to the effects of on-going matrix diffusion processes.

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# APPENDICES

# APPENDIX A

Appendix A. Geologic Heterogeneity Impacts on Matrix Diffusion

# Appendix A

## Geologic Heterogeneity Impacts on Matrix Diffusion

**The following is an extract of Section 1.4 from DON, 2022b. Note that in this Appendix, “SP” and “CL” refer to soil types and not “South Plantation” and “Central Landfill”, respectively.**

A key question is how much geologic heterogeneity is required for matrix diffusion to be an important fate and transport process. For this analysis, key findings from the development of the REMChlor-MD model (Falta et al., 2018; Farhat et al., 2018) and the research team’s general experience with matrix diffusion were compiled and are summarized in this section. The REMChlor-MD model is structured around two key concepts (Figure 1-1):

1. *Are there thick low permeability aquitards above and/or below the main transmissive zone?*
2. *Are there low permeability layers/lenses within the transmissive zone?*

Working with REMChlor-MD model shows two generic hydrogeologic settings that certainly exhibit extreme matrix diffusion impacts for common site conditions (unconsolidated geology, plume age of decades, and commonly encountered groundwater velocities) (Figure 1-1):

- **Setting 1:** High contrast in the hydraulic conductivity (K) of a transmissive zone with a plume vs. a **thick (≥ 1 meter) overlying or underlying aquitard** that is in contact with the plume. “High contrast” is generally defined as a permeability (k) contrast of 10x or more between the two geologic media, and “thick” is generally defined as being a meter or more of aquitard above or below the plume in the transmissive zone (Farhat et al., 2018). Example: clean sand (SW or SP, see Appendix B for a description of the Universal Soil Classification System (USCS) soil types) with a dissolved groundwater plume flowing over a clay (CH or CL) aquitard. This is the type of hydrogeologic setting with extreme matrix diffusion described in Chapman and Parker (2005).
- **Setting 2:** High contrast in the K of a transmissive geologic media (typically sands or gravels) in contact with low-k [(low permeability)] layers and lenses (such as silts or clays), as long as the layers and lenses are relatively thick (e.g., 1 meter or more).

Note that while the two scenarios above are almost guaranteed to have significant matrix diffusion effects, many sites without thick aquitards or with thinner layers and lenses (less than 1 meter thick) will have some impact on remediation timeframe. Table 1-3 shows REMChlor-MD predicted remediation timeframe results for the REMChlor-MD User Manual’s (Farhat et al. 2018) Case Study 1 site but with six different degrees of geologic heterogeneity: no geologic heterogeneity (Case 1); no aquitards but with low-k layers and lenses (Cases 2-5) of increasing average thickness; and the actual configuration for [the Case Study 1] site, a thick aquitard underlying the transmissive unit (Case 6). The CVOC [(chlorinated volatile organic compound)] release at [the REMChlor-MD Case Study 1] site began in 1950, and complete isolation of the DNAPL [(dense non-aqueous phase liquid)] source occurred in 1994. If there had been no geologic heterogeneity (e.g., if a conventional model had been used), the groundwater cleanup standard (the Maximum Concentration Level or MCL) was predicted to be reached a mere 12 years after remediation (Case 1) as the dissolved contaminants are flushed away. On the other hand, the presence of a thick (≥1 meter) aquitard increased the remediation timeframe from 12 years to over 500 years (Case 6, the actual condition at [the Case Study 1] site).

Thin layers/lenses within the transmissive zone had an increasing impact on remediation timeframe with increasing thickness of the layers/lenses. If 20% of the transmissive zone were filled with low-k geologic media in the form of layers/lenses only 1 centimeter thick, the remediation timeframe only increased to 13 years, or about an 8% increase. For the same configuration but 15 cm thick (0.5 feet) layers/lens (Case 2), the predicted remediation timeframe increases by 17% compared to Case 1. But having an average of 30 cm thick layers/lenses (1 foot thick) increases the remediation timeframe from 12 years to 19 years (58% increase) and 100 cm thick layers/lenses to 76 years (a 500% increase).

## Table 1-3. Comparison of the increase in remediation timeframe for various configurations of geologic heterogeneity (Cases 2-5) compared to no geologic heterogeneity (Case 1)

| Case | Description | Thick Aquitard Present? | Assumed Low-k Layer/Lens Thickness (cm) | Assumed Low-k Layer/Lens Thickness (ft) | Remediation Date (-) | MCL Date (-) | Years to MCL (-) | Increase in Rem. Timeframe vs. Case 1 (%) |
|---|---|---|---|---|---|---|---|---|
| 1 | No aquitards or lenses | No | 0 | 0.000 | 1995 | 2007 | 12 | 0% |
| 2 | No aquitard + layers and lenses at 20% | No | 1 | 0.033 | 1995 | 2008 | 13 | 8% |
| 3 | No aquitard + layers and lenses at 20% | No | 15 | 0.5 | 1995 | 2009 | 14 | 17% |
| 4 | No aquitard + layers and lenses at 20% | No | 30 | 1.0 | 1995 | 2014 | 19 | 58% |
| 5 | No aquitard + layers and lenses at 20% | No | 100 | 3.3 | 1995 | 2071 | 76 | 533% |
| 6 | One aquitard on bottom, no lenses | Yes | ≥ 100 | ≥ 3.3 | 1995 | 2550 | 555 | 4525% |

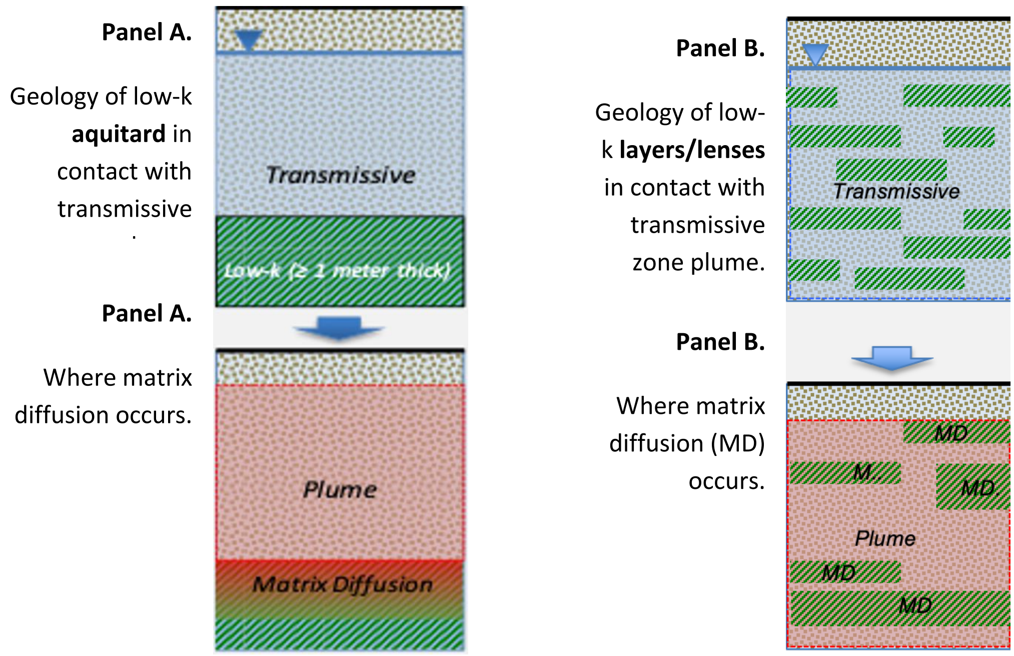



**Figure 1-1. Two geologic settings where matrix diffusion is likely (if the plume age is long, i.e., decades, and if the aquitard/lenses are thick enough) (base figure source: Farhat et al., 2018, emphasis added)**

A key question is how to distinguish between transmissive geologic media and low-k geologic media. The key concept is that for matrix diffusion to occur, there has to be a large relative difference in the hydraulic conductivity of two different types of aquifer media such as a factor of 10 or more (an order of magnitude). Table 1-4 shows an approximate range of hydraulic conductivities for groups of USCS soils, with the orange cells showing geologic contacts that can support matrix diffusion under the right conditions: relatively long plume ages (decades) and thicker lenses/layer (e.g., 1-meter-thick layers/lenses will support matrix diffusion for longer time periods than 1 cm thick layers which will support matrix diffusion for only a short time period) with thinner lenses (e.g., 6 inches thick) somewhere in the middle. For example, a soil classified as a clean gravel (either well graded, GW or poorly graded, GP) in contact with a clean sand (either SW or SP) would have a difference in hydraulic conductivity of a factor of 32 (2835 ft/day vs. 90 ft/day). In contrast, a GM soil (silty gravel) in contact with an SW soil (clean sand) may not exhibit large matrix diffusion effects (i.e., factor of only 3).

## Table 1-4. Ratio of hydraulic conductivity (K) (ft/day) where the more permeable unit K is divided by the less permeable unit K

| Ratio of Hydraulic Conductivity (K) of More Permeable Unit K Divided by the Less Permeable Unit K | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Soil Type | | GW GP | GM | SW SP | SM SC | GC | MH ML | CH CL |
| | K (ft/day) | **2835** | **269** | **90** | **2.6** | **0.9** | **0.009** | **9.00E-06** |
| GW GP | **2835** | | | | | | | |
| GM | **269** | 11 | | | | | | |
| SW SP | **90** | 32 | 3 | | | | | |
| SM SC | **2.6** | 1090 | 103 | 35 | | | | |
| GC | **0.9** | 3,150 | 299 | 100 | 3 | | | |
| MH ML | **0.009** | 315,000 | 29,889 | 10,000 | 289 | 100 | | |
| CH CL | **9.00E-06** | 315,000,000 | 29,888,889 | 10,000,000 | 288,889 | 100,000 | 1,000 | |

**RESULTS:** Matrix Diffusion Likely Less Important (green: 3 values); Matrix Diffusion Likely Important (yellow: all other values)

Notes:

- Hydraulic conductivity values from Freeze and Cherry (1979).
- See Appendix B for the USCS soil types.
- Definitions:
  ft/day = feet per day

# APPENDIX B

Appendix B. Description of the Universal Soil Classification System (USCS) soil types

# Unified Soil Classification System

**Figure 3–7** Unified Soil Classification, field identification criteria

| Major division | | Soil group | | | Subgroup | Description | Symbol |
|---|---|---|---|---|---|---|---|
| **Coarse-grained soils** > 50% of material (by weight) is of individual grains visible to the naked eye | No. 200 sieve size is about the smallest particle visible to the naked eye | **Gravel and gravely soils** < 50% of coarse fraction passes the No. 4 sieve size | Borderline cases require the use of dual,symbols | For visual classification, the 3/4 inch size may be used as equivalent to the No. 4 sieve size | **Clean gravels** Will not leave dirt stain on a wet palm | Wide range in grain sizes and substantial amounts of all intermediate particle sizes | **GW** |
| | | | | | | Predominately one size or a range of sizes with some intermediate sizes missing | **GP** |
| | | | | | **Gravels with fines** Will leave a dirt stain on a wet palm | Nonplastic fines or fines with low plasticity (for identification of fines, see characteristics of ML below) | **GM** |
| | | | | | | Plastic fines (for identification of fines, see characteristics of CL below) | **GC** |
| | | **Sand and sandy soils** > 50% half of the coarse fraction passes the No. 4 sieve size | Borderline cases require the use of dual symbols | | **Clean sands** Will not leave a dirt stain on a wet palm | Wide range in grain sizes and substantial amounts of all intermediate particle sizes | **SW** |
| | | | | | | Predominately one size or a range of sizes with some intermediate sizes missing | **SP** |
| | | | | | **Sands with fines** Will leave a dirt stain on a wet palm | Nonplastic fines or fines with low plasticity (for identification of fines, see characteristics of ML below) | **SM** |
| | | | | | | Plastic fines (for identification of fines, see characteristics of CL below) | **SC** |

| Major division | | Soil group | | Odor | Dry crushing strength | Dilatancy (shake) reaction | Toughness | Ribbon (near the P.L.) | Shine (near the P.L.) | Symbol |
|---|---|---|---|---|---|---|---|---|---|---|
| **Fine-grained soils** > 50% of material (by weight) is of individual particle not visible to the naked eye | No. 200 sieve size is about the smallest particle visible to the naked eye | **Silts and clays** (low plastic) | See identification procedures | | Slight | Rapid | Low to none | None | Dull | **ML** |
| | | | | | High | Medium to none | Medium | Weak | Slight to shiny | **CL** |
| | | | | Pronounced | Medium | Slow to none | Low | None | Dull to slight | **OL** |
| | | **Silts and clays** (highly plastic) | | | Medium | Very slow to none | Medium | Weak | Slight | **MH** |
| | | | | | Very high | None | High | Strong | Shiny | **CH** |
| | | | | Pronounced | High | None | Low to medium | Weak | Dull to slight | **OH** |
| Highly organic soils | | Readily identified by color, odor, spongy feel, and frequently by fibrous texture | | | | | | | | **PT** |

Source: Part 631 National Engineering Handbook, United States Department of Agriculture and Natural Resources Conservation Service, Washington, DC, January 2012. https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=31847.wba

# APPENDIX C

Appendix C. Boring Logs

Sources of boring logs:

- CL-B20 – DON, 2018
- CL-B134 – DON, 2020
- MW1-25 – DON, 2022a
- MW1-62 through MW1-64 – DON, 2020
- SP-MD01 through SP-MD04 – DON, 2022b

**BATTELLE**

**Project: Keyport OU 1**
**Site: Central Landfill**
**Boring Log: CL-B20**

| | | | | | |
|---|---|---|---|---|---|
| Permit Number: | 17-EP110 | Drilling Contractor: | Holt Services | Northing (NAD 83): | 259503.505 |
| Contract: | N39430-16-D-1802/CTO 010 | Driller: | Michael Running | Easting (NAD 83): | 1199028.280 |
| Project: | 100098089 | Drilling Equipment: | 7822 DT | Surface Elevation (NAVD 88): | 19.9 |
| Date Logged: | 7/19/2017 | Drilling Method: | DPT | Borehole Abandoned: | 7/19/2017 |
| Geologist: | Damon DeYoung | Boring Diameter: | 2-1/4" | Backfill Method: | Bentonite Chips/Asphalt |
| Total Depth: | 40 feet bgs | Sampler Type: | Macro-core | Monitoring Device Installed: | No |
| Reviewer: | Michael Meyer | Hammer Type: | Hydraulic | Device Type: | N/A |

| USCS Symbol | Sample Description | % Gravel | % Sand | % Fines |
|---|---|---|---|---|
| Asphalt | Poor recovery. | | | |
| GM | Sandy clayey GRAVEL, light gray to blackish brown to greenish gray (Fill). | | | |
| GM | Poor recovery, wood and metal debris to 8 ft bgs, bluish gray clay to 9.5 ft, wood debris from 9.5 to 10 ft. | 70 | 15 | 15 |
| SC | Clayey SAND, grayish brown, saturated. | 10 | 60 | 30 |
| OL | PEAT, dark brown, saturated. | <5 | 80 | 20 |
| SM | Silty SAND, brown to greenish gray. | <5 | 60 | 40 |
| ML | Interbedded clayey SILT and silty CLAY, clay up to 3 inches thick. | <5 | 10 | 90 |
| SP | Fine SAND grades to silty CLAY, brown, then grades to gray silty CLAY/ clayey SILT. | <5 | 90 | 10 |
| CH | | <5 | 10 | 90 |
| MH | | <5 | 50 | 50 |
| SP | Fine SAND, gray with thin interbeds of silty sand at 22.5, 24.5, 25.5, 27 and 29 ft. | <5 | 80 | 20 |
| ML | Fine sandy SILT. | <5 | 30 | 70 |
| SP | Fine to medium SAND firming downward to silt. | <5 | 80 | 20 |
| ML | SILT, gray, with one thin sand bed 1 inch thick at 38.5 ft. | <5 | 20 | 80 |
| OL | GRAVEL overlying dark brown organic layer (PEAT) at 40 ft bgs. | 60 | 30 | 10 |

Headspace PID (ppm), top to bottom: 2.8, 0, 0.1, 0.1, 0.4, 4.2, 1.2, 0, 0, 0.2, 0, 0, 0, 0, 0.5, 0.5, 0.1, 2, 3.8, 2.4, 7.1, 4.7, 1.1, 19.8, 58.4, 76.7, 33.1, 12.5, 0, 0.8, 0.5, 0, 0, 0, 0, 0

Measured Recovery (ft), top to bottom: 2.5, 3.5, 5, 5, 5, 5, 5, 5

| Sample ID Date/Time | Comments |
|---|---|
| B20-S25.0 @1350 | |
| B20-GW26.0 @1515 | |
| B20-S28.3 @1406 | |
| B20-S31.5 @1423 | |
| B20-GW32.0 @1537 | |

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
# Site: OU 1
# Boring Log: CL-B134

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/3/2019<br>Geologist: Damon DeYoung<br>Total Depth: 60<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: Bentonite chips with 1-foot concrete cap<br>Monitoring Device Installed: Yes<br>Device Type: Temporary monitoring wells |

| Depth (ft bgs) | USCS Symbol | Sample Description | Grading % Gravel | Grading % Sand | Grading % Fines | Headspace PID (ppb) |
|---|---|---|---|---|---|---|
| 0<br>4<br>8 | GM | Silty sandy GRAVEL, some landfill waste (wood, metal), very dark greenish gray, GLEY-3/5GY | 60 | 30 | 10 | 0<br>79<br>472<br>3150<br>16460<br>16370<br>3169 |
| 12 | SM | Silty SAND, dark greenish gray, GLEY1-4/10GY, mottled with brown | 0 | 80 | 20 | 52<br>60 |
| | CL | Silty CLAY, minor sand interbedding, very dark greenish gray GLEY1-3/10GY | 0 | 0 | 100 | 127<br>481<br>1124 |
| 16 | SM | Silty SAND, dark bluish gray, GLEY2-4/5B | 0 | 80 | 20 | 113 |
| 20 | SP | Poorly graded SAND, dark bluish gray, GLEY2-4/5B | 0 | 100 | 0 | 84<br>56<br>197<br>138<br>293<br>10<br>0 |
| 24 | GM | Silty sandy GRAVEL, dark bluish gray, GLEY2-4/5B | 70 | 20 | 10 | 299 |
| | ML | Sandy SILT, dark bluish gray, GLEY2-4/5B | 0 | 30 | 70 | 135 |
| 28 | SW | Gravelly SAND (increased gravel with depth), very dark gray, GLEY1-3/N | 40 | 60 | 0 | 1608<br>9535<br>24470 |
| 32<br>36 | GW | Gravelly SAND (increased gravel with depth), very dark gray, GLEY1-3/N | 40 | 60 | 0 | 9800<br>19920<br>1324<br>974<br>6953<br>5084<br>580<br>256<br>184 |
| 40 | GW | Sandy GRAVEL, very dark gray, GLEY1-3/N | 90 | 10 | 0 | 2255<br>0<br>0 |
| 44<br>48 | SW | Well graded gravelly SAND, very dark gray, GLEY1-3/N | 30 | 70 | 0 | 0<br>0<br>0<br>0<br>0<br>0<br>0 |
| 52<br>56<br>60 | ML | SILT, with minor organics (peat), dark gray, GLEY1-4/N | 0 | 0 | 100 | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |

| Measured Recovery | Sample ID Date/Time | Comments |
|---|---|---|
| 3 | | |
| 3 | | |
| 5 | | |
| 5 | | |
| 5 | | |
| 5 | | |
| 5 | | |
| 3 | | |
| 5 | | |
| 5 | CL-B134-GW-50-191003<br>CL-B134-GW-49-191003 (duplicate of 50)<br>CL-B134-S-49-191003 (duplicate of 50)<br>CL-B134-S-50-191003 | |
| 5 | | |
| 5 | | |

# BORING/WELL LOG

BORING/WELL NO. MW1-25

| | | | |
|---|---|---|---|
| PROJECT NAME: | NUWCD Keyport OU1 Pre-ROD Data Collection | | |
| LOCATION: | Area 1 Landfill, NUWCD Keyport, Washington | TOTAL DEPTH: | 55 feet |
| DRILLING COMPANY: | Holt Drilling, Inc. | GROUND ELEVATION: | 9.8 feet |
| DRILLING METHOD: | Hollow-stem Auger, 6-inch I.D. | DATE STARTED: | 8/9/95 |
| LOGGED BY: | Tom Dube' | DATE COMPLETED: | 8/10/95 |

| PERCENT RECOVERY/ LAB SAMPLE NUMBER | BLOW COUNTS | INTERVAL SAMPLED | DEPTH IN FEET | WELL CONSTRUCTION | LITHOLOGIC LOG | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|---|---|
| | | | 0–3 | | | **0 to 7.5 feet:** Gravelly, sandy SILT; sand is fine to medium; gravel up to 1 inch; loose to firm; dry; dark yellowish brown (10YR 4/4), some light olive brown (2.5Y 5/4). ML (Fill) |
| 33% | 2<br>2<br>2 | | 4 | | | |
| | | | 5–7 | | | |
| | | | ▼ 8 | | | **7.5 to 9 feet:** SILT, some wood/plant debris (up to 2 inch); laminated; soft to firm; wet to very moist; dark gray (2.5Y 3.5/1 to N 4/0) to dark greenish gray (2.5GY 4/1). ML |
| 100% | 1<br>0<br>0 | | 9–10 | | | **9 to 11.5 feet:** Fine to medium SAND, with some silt; loose, soft; wet; dark brown (10YR 3/3) SM |
| | | | 11–12 | | | **11.5 to 19 feet:** Fine to medium SAND, with little silt (average ~8%); medium dense; wet; olive (5Y 4/3) to dark grayish brown (2.5Y 3.5/2). SP-SM |
| 100% | 2<br>2<br>3 | | 13–15 | | | |
| | | | 16–18 | | | |
| 100% | 2<br>2<br>4 | | 19 | | | **19 to 24.5 feet:** Clayey SILT (See Page 2). |

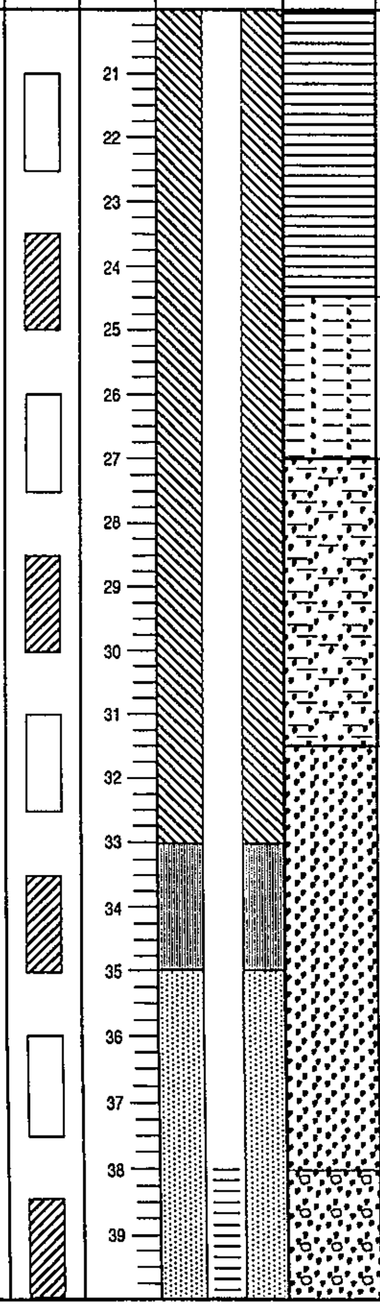
NOTE: See Monitoring Well Construction Logs for details of well completion. Water level symbol (▼) represents apparent depth of water table at time of drilling. Blow counts represent the number of 30-inch drops of the 300-pound hammer to advance the split-spoon sampler 6 inches. Lithologic information above 42 feet was supplemented with samples from nearby boring SB1-41. Blank boxes under Interval Sampled show depths from SB1-41.

# BORING/WELL LOG



BORING/WELL NO. MW1-25

| | | | |
|---|---|---|---|
| PROJECT NAME: | NUWCD Keyport OU1 Pre-ROD Data Collection | | |
| LOCATION: | Area 1 Landfill, NUWCD Keyport, Washington | TOTAL DEPTH: | 55 feet |
| DRILLING COMPANY: | Holt Drilling, Inc. | GROUND ELEVATION: | 9.8 feet |
| DRILLING METHOD: | Hollow-stem Auger, 6-inch I.D. | DATE STARTED: | 8/9/95 |
| LOGGED BY: | Tom Dube' | DATE COMPLETED: | 8/10/95 |



| PERCENT RECOVERY/ LAB SAMPLE NUMBER | BLOW COUNTS | INTERVAL SAMPLED | DEPTH IN FEET | LITHOLOGIC DESCRIPTION |
|---|---|---|---|---|
| | | | 21–22 | **19 to 24.5 feet:** Clayey SILT; mostly massive, laminated near top; moderately plastic; firm; moist; gray (5Y 5/1 to N 5/0) or olive (5Y 4.5/3). ML/CL |
| 100% | 1 2 4 | | 23.5–25 | |
| | | | 26–27 | **24.5 to 27 feet:** SILT, with little/some very fine to medium sand interbedded; firm to very firm; moist to very moist; dark gray (5Y 4.5/1 to N 4/0). ML |
| 100% | 2 5 9 | | 28.5–30 | **27 to 31.5 feet:** SILT and SAND, interbedded; sand is mostly fine to medium; well-bedded; firm, dense; moist to wet; dark gray (N 4.5/0) to olive gray (5Y 4/2). ML/SP |
| | | | 31–32.5 | **31.5 to 38 feet:** Fine to medium SAND, with trace silt; dense; wet; dark gray (N 4.5/0 to 10Y 4/0.5). SP |
| 100% | 0 0 2 | | 33.5–35 | (The upper part of this unit heaved several feet during drilling.) |
| | | | 36–37.5 | |
| 100% | 6 9 17 | | 38.5–40 | **38 to 49 feet:** SAND (See Page 3). |

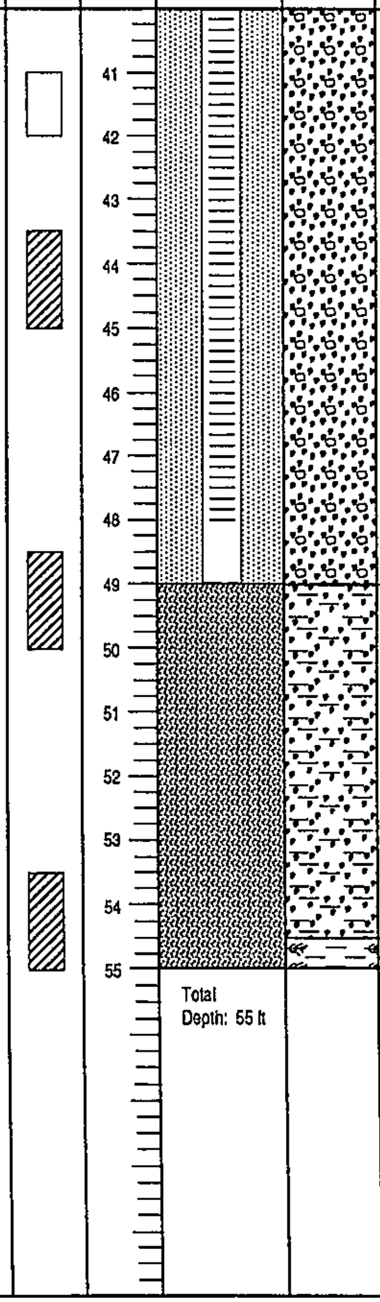
NOTE: See Monitoring Well Construction Logs for details of well completion. Water level symbol (▼) represents apparent depth of water table at time of drilling. Blow counts represent the number of 30-inch drops of the 300-pound hammer to advance the split-spoon sampler 6 inches. Lithologic information above 42 feet was supplemented with samples from nearby boring SB1-41. Blank boxes under Interval Sampled show depths from SB1-41.

# BORING/WELL LOG



BORING/WELL NO. MW1-25

| | | | |
|---|---|---|---|
| PROJECT NAME: | NUWCD Keyport OU1 Pre-ROD Data Collection | | |
| LOCATION: | Area 1 Landfill, NUWCD Keyport, Washington | TOTAL DEPTH: | 55 feet |
| DRILLING COMPANY: | Holt Drilling, Inc. | GROUND ELEVATION: | 9.8 feet |
| DRILLING METHOD: | Hollow-stem Auger, 6-Inch I.D. | DATE STARTED: | 8/9/95 |
| LOGGED BY: | Tom Dube' | DATE COMPLETED: | 8/10/95 |




| PERCENT RECOVERY/ LAB SAMPLE NUMBER | BLOW COUNTS | DEPTH IN FEET | LITHOLOGIC DESCRIPTION |
|---|---|---|---|
| | | 38–49 | **38 to 49 feet:** Fine to very coarse SAND, with some gravel (15-25%, up to 2 inch, mostly <1 inch); little silt; very dense; wet; dark gray (N 4/0 to 5Y 3.5/1). SW-SM |
| | | 43 | (25 feet of sand heave after drilling to 43 feet; bailed all heave before continuation of drilling and sampling) |
| 100% | 2<br>10<br>11 | 43.5–45 | |
| 100% | 11<br>15<br>16 | 48.5–50 | |
| | | 49–54.5 | **49 to 54.5 feet:** Very fine to fine SAND with some silt (~10-20%), trace clay, trace/little gravel (to 0.8 inch) mainly at bottom of unit; very dense; wet; very dark gray (N 3/0). SM |
| | | | (Sand in this unit heaved/sloughed during well installation.) |
| 100% | 11<br>16<br>24 | 53.5–55 | |
| | | 54.5–55 | **54.5 to 55 feet:** SILT with some peat; platy parting; hard to very hard; slightly moist; silt is dark gray (N 4/0), peat is black (N 2/0) to dark brown (7.5YR 3/2). ML/PT |

NOTE: See Monitoring Well Construction Logs for details of well completion. Water level symbol (▼) represents apparent depth of water table at time of drilling. Blow counts represent the number of 30-inch drops of the 300-pound hammer to advance the split-spoon sampler 6 inches. Lithologic information above 42 feet was supplemented with samples from nearby boring SB1-41. Blank boxes under Interval Sampled show depths from SB1-41.

BATTELLE

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: MW1-62/NP-B135

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/4/2019<br>Geologist: Damon DeYoung<br>Total Depth: 90<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: N/A<br>Monitoring Device Installed: Yes<br>Device Type: 2-inch PVC monitoring well |

Depth (ft bgs): 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90

| USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Sample ID Date/Time |
|---|---|---|---|---|---|
| SP | Gravelly SAND, brown, 10YR-5/3 | 40 | 60 | 0 | |
| GM | Silty GRAVEL, very dark greenish gray, GLEY1-3/5 | 30 | 50 | 20 | |
| OL | Landfill debris (wood), very dark grayish brown, 10YR-3/2 | 0 | 0 | 0 | |
| SP | Poorly graded SAND, greenish gray, GLEY1-5/10Y. Wood debris jambed the drill string tooling; had to trip out at 13 ft to clear the drill string. | 0 | 100 | 0 | |
| SP | Poorly graded gravelly SAND, greenish gray, GLEY1-5/10Y | 30 | 70 | 0 | |
| MH | Clayey SILT, dark gray, GLEY1-3/N, mottled brown at 13 ft | 0 | 0 | 100 | |
| SP | Poorly graded SAND, minor gravel, very dark gray, GLEY1-3/N | 5 | 95 | 0 | |
| GW | Sandy GRAVEL, very dark gray, GLEY1-3/N | 90 | 10 | 0 | |
| SW | Well graded Gravelly SAND, very dark gray, GLEY1-3/N | 40 | 60 | 0 | NP-B135-S-38-191004; 10/4/2019 1500 |
| ML | SILT, very dark gray, GLEY1-3/N | 0 | 0 | 100 | |
| SP | Poorly graded SAND, very dark gray, GLEY1-3/N | 0 | 100 | 0 | |
| SP | Gravelly SAND, very dark gray, GLEY1-3/N | 30 | 70 | 0 | |
| GP | Sandy GRAVEL, very dark gray, GLEY1-3/N | 90 | 10 | 0 | |
| GW | Well sorted GRAVEL (gravel to cobbles), very dark gray, GLEY1-3/N | 100 | 0 | 0 | |
| SP | Poorly graded gravelly SAND, very dark gray, GLEY1-3/N | 10 | 90 | 0 | |
| ML | Gravelly SILT, dark gray, GLEY1-4/N | 20 | 0 | 80 | NP-B135-S-78-191004; 10/4/2019 1645 |
| ML | Organic SILT (peat), black, 5Y-2.5/1 | 0 | 0 | 100 | |
| CH | Silty CLAY, dark gray, GLEY1-4/N | 0 | 0 | 100 | |

| Measured Recovery | Headspace PID (ppb) |
|---|---|
| 3 | 0, 607, 1154 |
| 5 | 77000, 162000, 169000, 8551, 2262 |
| 5 | 12, 107, 147, 637, 197 |
| 5 | 0, 0, 0, 167, 33 |
| 4 | 0, 3, 0, 0 |
| 5 | 0, 0, 0, 0, 0 |
| 5 | 3246, 2435, 939, 4337, 5645 |
| 5 | 3762, 7098, 22540, 22639, 382 |
| 5 | 340, 0, 0, 0, 0 |
| 5 | 41, 0, 7, 0, 0 |
| 5 | 0, 0, 0, 0, 0 |
| 5 | 0, 0, 0, 0, 0 |
| 5 | 0, 0, 0, 60, 0 |
| 5 | 0, 0, 0, 0, 0 |
| 5 | 0, 0, 0, 0, 0 |
| 5 | 0, 0, 1125, 0, 0 |
| 5 | 0, 0, 0, 0, 0 |
| 5 | 0, 0, 0, 0 |

Well Construction:

Surface Seal: Concrete and stick-up well monument
Bentonite: Hydrated bentonite chips
Casing: PVC
Sand: 12/20, 0.92-0.95, 261/19 BRADY TM
Screen: 0.010 factory-slotted PVC

**BATTELLE**

# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: MW1-63/NP-B136

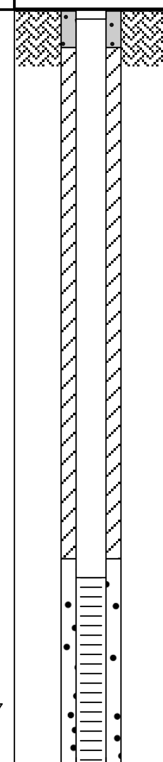
| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/7/2019<br>Geologist: Steve Verdibello<br>Total Depth: 75<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: N/A<br>Monitoring Device Installed: Yes<br>Device Type: 2-inch PVC monitoring well |

Depth (ft bgs): 0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52, 56, 60, 64, 68, 72, 76

| USCS Symbol | Sample Description | Grading % Gravel | Grading % Sand | Grading % Fines |
|---|---|---|---|---|
| SP | Gravelly SAND (some landfill waste debris), reddish brown, 10YR-4/3 | 40 | 60 | 0 |
| SM | Silty gravelly SAND, very dark greenish gray, GLEY1-3/10Y | 40 | 50 | 10 |
| SM | Silty SAND, very dark greenish gray, GLEY1-3/10Y | 0 | 80 | 20 |
| MH | Clayey SILT, with minor sandy interbedding, dark greenish gray, GLEY1-4/10Y | 0 | 10 | 90 |
| SW | Well graded SAND, dark gray, GLEY1-4/N | 0 | 100 | 0 |
| GW | Well graded sandy GRAVEL, dark greenish gray, GLEY1-4/10Y | 70 | 30 | 0 |
| GM | Silty sandy GRAVEL dark greenish gray, GLEY1-4/10Y | 60 | 20 | 20 |
| OH | Organic SILT (some peat), black, 2.5Y-2.5/1 | 0 | 0 | 100 |
| SM | Silty SAND, greenish black, GLEY1-2.5/10Y | 0 | 70 | 30 |
| SP | Poorly graded SAND, greenish black, GLEY1-2.5/10Y | 0 | 100 | 0 |
| GM | Silty sandy GRAVEL, greenish black, GLEY1-3/N | 70 | 20 | 10 |
| SP | Gravelly SAND, greenish black, GLEY1-3/N | 30 | 70 | 0 |
| CH | Silty CLAY (some organic material, peat) | 0 | 0 | 100 |

| Headspace PID (ppb) | Measured Recovery | Sample ID Date/Time |
|---|---|---|
| 0, 0, 0, 0, 6470 | 5 | |
| 2105, 364, 72, 0 | 5 | |
| 0, 1555, 50, 171, 93 | 5 | |
| 0, 69, 3, 10, 0 | 5 | |
| 0, 0, 0, 0, 48 | 5 | |
| 35, 31, 0, 0, 0 | 5 | |
| 65, 1032, 1630, 1740, 1266 | 5 | |
| 5539, 3379, 1115, 2469, 570 | 5 | NP-B136-S-36-191007; 10/07/19 1637 |
| 799, 0, 0, 0, 0 | 5 | |
| 0, 0, 0, 0, 0 | 5 | |
| 0, 0, 0, 0, 0 | 5 | |
| 0, 0, 0, 0, 0 | 5 | |
| 0, 0, 0, 0, 365 | 5 | |
| 385, 57, 0, 302, 189 | 5 | NP-B136-S-66-191007; 10/07/19 1642 |
| 166, 116, 58, 218 | 5 | |

Well Construction



Surface Seal: Concrete and stick-up well monument. Casing: PVC

Bentonite: Hydrated bentonite chips

Sand: 12/20, 0.92-0.95, 261/19 BRADY TM
Screen: 0.010 factory-slotted PVC

**BATTELLE**

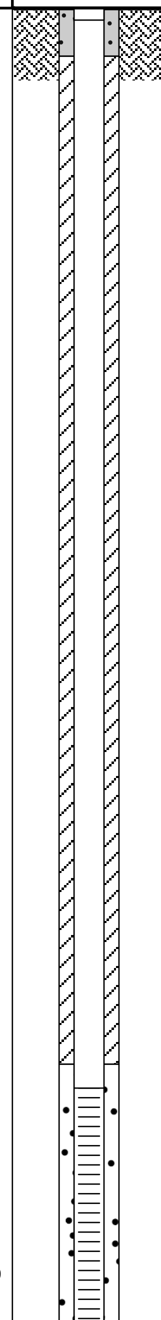
# Project: Keyport OU 1 Source Investigation
## Site: OU 1
## Boring Log: MW1-64/NP-B137

| | | |
|---|---|---|
| Permit Number: 19-EP140<br>EHS Case Number: N/A<br>Project: 100125424<br>Date Logged: 10/8/2019<br>Geologist: Steve Verdibello<br>Total Depth: 60<br>Reviewer: Michael Meyer | Drilling Contractor: Holt Services, Inc.<br>Driller: Arthur Wisehart<br>Drilling Equipment: TerraSonic TC150<br>Drilling Method: Sonic<br>Boring Diameter: 4 inch<br>Sampler Type: N/A<br>Hammer Type: N/A | Northing (NAD 83):<br>Easting (NAD 83):<br>Surface Elevation (NAVD 88):<br>Borehole Abandoned: Yes<br>Backfill Method: N/A<br>Monitoring Device Installed: Yes<br>Device Type: 2-inch PVC monitoring well |

| Depth (ft bgs) | USCS Symbol | Sample Description | % Gravel | % Sand | % Fines | Sample ID Date/Time |
|---|---|---|---|---|---|---|
| 0–5 | GW | Sandy GRAVEL, dark grayish brown, 2.5Y-4/2 | 70 | 30 | 0 | |
| 5–10 | SW | Gravelly SAND, dark grayish brown, 2.5Y-4/2 | 40 | 60 | 0 | |
| 10–34 | SP | Poorly graded SAND (gradually fines downward), dark grayish brown, 2.5Y-4/2 (10 to 25); dark greenish gray GLEY1-4/10Y (25 to 34). Poor recovery from 10 – 15; 20 – 25. | 0 | 100 | 0 | |
| 34–41 | SP | Gravelly SAND, greenish black, GLEY2-2.5/5BG | 40 | 60 | 0 | |
| 41–45 | GP | Sandy GRAVEL, greenish black, GLEY2-2.5/5BG | 70 | 30 | 0 | |
| 45–46 | MH | SILT, very dark gray, GLEY1-3/N | 0 | 0 | 100 | |
| 46–53 | SW | Well graded Gravelly SAND, greenish black, GLEY2-2.5/5BG | 40 | 60 | 0 | NP-B137-S-52-191008; 10/08/19 1340 |
| 53–55 | SP | SAND, with some wood debris, black, GLEY1-2.5/N. 10% of material = small wood pieces. | 0 | 90 | 0 | |
| 55–60 | CH | Silty CLAY (some organic material, peat), black, 7.5YR-2.5/1 (organic silt); dark gray GLEY1-4/N (clay) | 0 | 0 | 100 | |

| Interval (ft bgs) | Headspace PID (ppb) | Measured Recovery |
|---|---|---|
| 0–5 | 0, 0, 0 | 4 |
| 5–10 | 0, 0, 0 | 4 |
| 10–15 | 0, 8 | 2 |
| 15–20 | 20, 0, 1 | 3 |
| 20–25 | 8, 30 | 2 |
| 25–30 | 9, 15, 17, 29, 45 | 5 |
| 30–35 | 0, 0, 0 | 3 |
| 35–40 | 47, 489, 558, 1230 | 4 |
| 40–45 | 870, 827, 849, 400, 976 | 5 |
| 45–50 | 23, 75, 186, 372, 491 | 5 |
| 50–55 | 393, 1504, 470, 548 | 5 |
| 55–60 | 159, 204, 0, 56, 55, 160 | 5 |

**Well Construction**



Surface Seal: Concrete and stick-up well monument.

Casing: PVC

Bentonite: Hydrated bentonite chips

Sand: 12/20, 0.92-0.95, 261/19 BRADY TM

Screen: 0.010 factory-slotted PVC

# Log of Soil Boring: SP-MD01

GSI Environmental Inc.
19200 Von Karman Ave., Suite 800
Irvine, CA
Telephone: 949-679-1070

| | | | |
|---|---|---|---|
| **CLIENT** | U.S Navy | **PROJECT NAME** | Keyport |
| **GSI JOB NUMBER** | 5010-202 | **PROJECT LOCATION** | Keyport, Washington |
| **DATE STARTED** | 22 Apr 2021 | **COMPLETED** | 22 Apr 2021 |
| **GROUND ELEVATION** | NA | **DATUM** | NA |
| **DRILLING CONTRACTOR** | Cascade | **TOP OF CASING ELEVATION** | NA |
| **DATUM** | NA | **DRILLING METHOD** | Direct Push with Dual Tube Coring System |
| **LATITUDE** | NA | **LONGITUDE** | NA |
| **DRILLING EQUIPMENT** | Geoprobe 3230DT | **LOGGED BY** | K. Howell, GIT |
| **CHECKED BY** | | **GROUND SURFACE** | Grass |
| **BORING DIAMETER (in)** | 4.5 | **RESPONSIBLE PROFESSIONAL** | |
| **REG. NO.** | | | |

| Depth (ft bgs) | Soil Description | Lithology | USCS | Sample Type | Blows/ 6 inches | Recovery | Lab Sample | PID (ppm) | Water Level | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| | GROUND SURFACE | | | | | | | | | |
| | CLAYEY GRAVEL WITH SAND (GC): moist | | GC | | | | | 1<br>1.5<br>1.3<br>11.7<br>135.6 | ▽ | |
| 5 | Wet<br>CLAYEY SAND (SC): wet | | SC | | | | | 231.4<br>262.8<br>336.2<br>692.8 | | |
| | POORLY GRADED SAND WITH CLAY (SP-SC): wet | | SP-SC | | | | | 692.8<br>15000 | | |
| 10<br>15 | POORLY GRADED SAND (SP): wet | | SP | | | | | 7412<br>6888<br>368.7<br>15000<br>3450<br>3906<br>3734<br>1112<br>1419<br>1054<br>1027<br>40.8<br>1450<br>1711<br>1218<br>1400<br>580<br>509.9<br>203 | | |

Total Depth = 17.5 feet.

# Log of Soil Boring: SP-MD02

GSI ENVIRONMENTAL
GSI Environmental Inc.
19200 Von Karman Ave., Suite 800
Irvine, CA
Telephone: 949-679-1070

| | | | |
|---|---|---|---|
| **CLIENT** | U.S Navy | **PROJECT NAME** | Keyport |
| **GSI JOB NUMBER** | 5010-202 | **PROJECT LOCATION** | Keyport, Washington |
| **DATE STARTED** | 23 Apr 2021 **COMPLETED** 23 Apr 2021 | **GROUND ELEVATION** | NA **DATUM** NA |
| **DRILLING CONTRACTOR** | Cascade | **TOP OF CASING ELEVATION** | NA **DATUM** NA |
| **DRILLING METHOD** | Direct Push with Dual Tube Coring System | **LATITUDE** | NA **LONGITUDE** NA |
| **DRILLING EQUIPMENT** | Geoprobe 3230DT | **LOGGED BY** | K. Howell, GIT **CHECKED BY** |
| **GROUND SURFACE** | Grass **BORING DIAMETER (in)** 4.5 | **RESPONSIBLE PROFESSIONAL** | **REG. NO.** |

| Depth (ft bgs) | Soil Description | Lithology | USCS | Sample Type | Blows/ 6 inches | Recovery | Lab Sample | PID (ppm) | Water Level | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| | GROUND SURFACE | | | | | | | | | |
| 0–5 | CLAYEY GRAVEL WITH SAND (GC): moist<br>▽ Wet | | GC | | | | | 2.9<br>2.4<br>2<br>2.8<br>5<br>91.3 | ▽ | |
| 5–6 | CLAYEY SAND (SC): wet | | SC | | | | | 121<br>103.8 | | |
| 6–7 | SANDY LEAN CLAY (CL): wet, medium plasticity, firm | | CL | | | | | 176.8<br>85.1 | | |
| 7–10 | CLAYEY SAND (SC): wet | | SC | ■ | | | | 329.3<br>435<br>517.1<br>977.1<br>15000<br>15000 | | |
| 10–12.25 | POORLY GRADED SAND (SP): wet | | SP | | | | | 15000<br>15000<br>444<br>116.8<br>35.3 | | |
| 12.25–14 | POORLY GRADED SAND WITH CLAY (SP-SC): wet | | SP-SC | | | | | 22.3<br>292.7<br>112.5 | | |
| 14–20 (15) | POORLY GRADED SAND (SP): wet | | SP | ■ | | | | 52.7<br>38.9<br>72.3<br>347.7<br>441.7<br>230.5<br>547.5<br>440.1<br>376.8<br>1115<br>844.8 | | |





*(Continued Next Page)*

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Telephone: 949-679-1070

# Log of Soil Boring: SP-MD02

**CLIENT** U.S Navy
**PROJECT NAME** Keyport
**GSI JOB NUMBER** 5010-202
**PROJECT LOCATION** Keyport, Washington

| Depth (ft bgs) | Soil Description | Lithology | USCS | Sample Type | Blows/ 6 inches | Recovery | Lab Sample | PID (ppm) | Water Level | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| | GROUND SURFACE | | | | | | | | | |
| | POORLY GRADED SAND (SP): wet | | SP | | | | | 754.9 | | |
| | | | | | | | | 15000 | | |
| | | | | | | | | 15000 | | |
| | | | | | | | | 15000 | | |
| | | | | | | | | 15000 | | |
| | | | | | | | | 15000 | | |
| | | | | | | | | 15000 | | |
| | | | | | | | | 15000 | | |
| | | | | | | | | 15000 | | |
| 25 | | | | | | | | 15000 | | |
| | | | | | | | | 15000 | | |
| | | | | | | | | 2479 | | |
| | | | | | | | | 2732 | | |
| | | | | | | | | 1103 | | |
| | | | | | | | | 1066 | | |
| | SOIL BYPASSED WITH DRIVE POINT INSTALLED TO BYPASS SLOUGH AND REACH TARGET INTERVAL (THE SAND-CLAY INTERFACE) | | | | | | | 929.7 | | |
| 30 | | | | | | | | | | |
| | POORLY GRADED SAND (SP): wet | | SP | | | | | | | |
| | POORLY GRADED GRAVEL WITH SAND (GP): wet | | GP | | | | | | | |

Total Depth = 33.5 feet.

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Telephone: 949-679-1070

# Log of Soil Boring: SP-MD03

**CLIENT** U.S Navy
**PROJECT NAME** Keyport
**GSI JOB NUMBER** 5010-202
**PROJECT LOCATION** Keyport, Washington
**DATE STARTED** 20 Apr 2021 **COMPLETED** 21 Apr 2021
**GROUND ELEVATION** NA **DATUM** NA
**DRILLING CONTRACTOR** Cascade
**TOP OF CASING ELEVATION** NA **DATUM** NA
**DRILLING METHOD** Direct Push with Dual Tube Coring System
**LATITUDE** NA **LONGITUDE** NA
**DRILLING EQUIPMENT** Geoprobe 3230DT
**LOGGED BY** K. Howell, GIT **CHECKED BY**
**GROUND SURFACE** Grass **BORING DIAMETER (in)** 4.5
**RESPONSIBLE PROFESSIONAL** **REG. NO.**

| Depth (ft bgs) | Soil Description | Lithology | USCS | Sample Type | Blows/ 6 inches | Recovery | Lab Sample | PID (ppm) | Water Level | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| | GROUND SURFACE | | | | | | | | | |
| 0 - 5 | CLAYEY GRAVEL WITH SAND (GC): moist | | GC | | | | | 2.2, 2.2, 2.2, 164, 1.8 | | |
| 5 - 7.3 | SANDY LEAN CLAY (CL): moist, medium plasticity, firm<br>Wet | | CL | | | | | 1.5, 2.2, 4.9, 4.9 | ∇ | |
| 7.3 - 10 | CLAYEY SAND (SC): wet | | SC | | | | | 20.4, 92.2, 267.4 | | Grab groundwater samples were collected via a peristaltic pump and HDPE tubing from an SP-16 sampler. Depth-discreet samples were collected at the following depths below ground surface: 7.5 - 8', 8.75 - 9.75', 10 - 11', and 11.5 - 12.5'. |
| 10 - 12.1 | POORLY GRADED SAND (SP): wet | | SP | | | | | 128.1, 270.4, 402.4 | | |
| 12.1 - 13 | LEAN CLAY WITH SAND (CL): wet, medium plasticity, firm | | CL | | | | | 148.1 | | |
| 13 - 14 | CLAYEY SAND (SC): wet | | SC | | | | | 19.6 | | |
| 14 - 15 | LEAN CLAY WITH SAND (CL): wet, medium plasticity, firm | | CL | | | | | 2.7 | | |

Total Depth = 15.0 feet.

# Log of Soil Boring: SP-MD04

GSI ENVIRONMENTAL

GSI Environmental Inc.
19200 Von Karman Ave., Suite 800
Irvine, CA
Telephone: 949-679-1070

| | | | |
|---|---|---|---|
| **CLIENT** U.S Navy | | **PROJECT NAME** Keyport | |
| **GSI JOB NUMBER** 5010-202 | | **PROJECT LOCATION** Keyport, Washington | |
| **DATE STARTED** 21 Apr 2021 | **COMPLETED** 21 Apr 2021 | **GROUND ELEVATION** NA | **DATUM** NA |
| **DRILLING CONTRACTOR** Cascade | | **TOP OF CASING ELEVATION** NA | **DATUM** NA |
| **DRILLING METHOD** Direct Push with Dual Tube Coring System | | **LATITUDE** NA | **LONGITUDE** NA |
| **DRILLING EQUIPMENT** Geoprobe 3230DT | | **LOGGED BY** K. Howell, GIT | **CHECKED BY** |
| **GROUND SURFACE** Grass | **BORING DIAMETER (in)** 4.5 | **RESPONSIBLE PROFESSIONAL** | **REG. NO.** |

| Depth (ft bgs) | Soil Description | USCS | PID (ppm) | Water Level |
|---|---|---|---|---|
| | GROUND SURFACE | | | |
| 0 | SOIL BYPASSED WITH DRIVE POINT INSTALLED. NO SOIL COLLECTED SINCE ALL GRAVELLY SOIL (NON-TARGET INTERVAL) | | | |
| 5 | POORLY GRADED SAND (SP): wet | SP | 53.5<br>28.1<br>88.2<br>430 | ∇ |
| | POORLY GRADED SAND WITH CLAY (SP-SC): wet | SP-SC | 204.5 | |
| | CLAYEY SAND (SC): wet | SC | | |
| 10 | POORLY GRADED SAND (SP): wet | SP | 5.9<br>12.4 | |
| | SANDY LEAN CLAY (CL): wet, medium plasticity, firm | CL | 0.8<br>12.4<br>4.8 | |
| | CLAYEY SAND (SC): wet | SC | | |
| | SANDY LEAN CLAY (CL): wet, medium plasticity, firm | CL | 1.3 | |
| 15 | CORE NOT LOGGED OR SAMPLED DUE TO CORE LINER BREAKAGE, RESULTING IN UNCERTAIN CORE RECOVERY PERCENTAGE AND POOR DEPTH CONTROL | | | |

Columns: Depth (ft bgs), Soil Description, Lithology, USCS, Sample Type, Blows/ 6 inches, Recovery, Lab Sample, PID (ppm), Water Level, Notes

Total Depth = 17.5 feet.

# APPENDIX D

Appendix D. SP East Hotspot REMChlor-MD model runs


**Figure D-1. REMChlor-MD Cover Page**

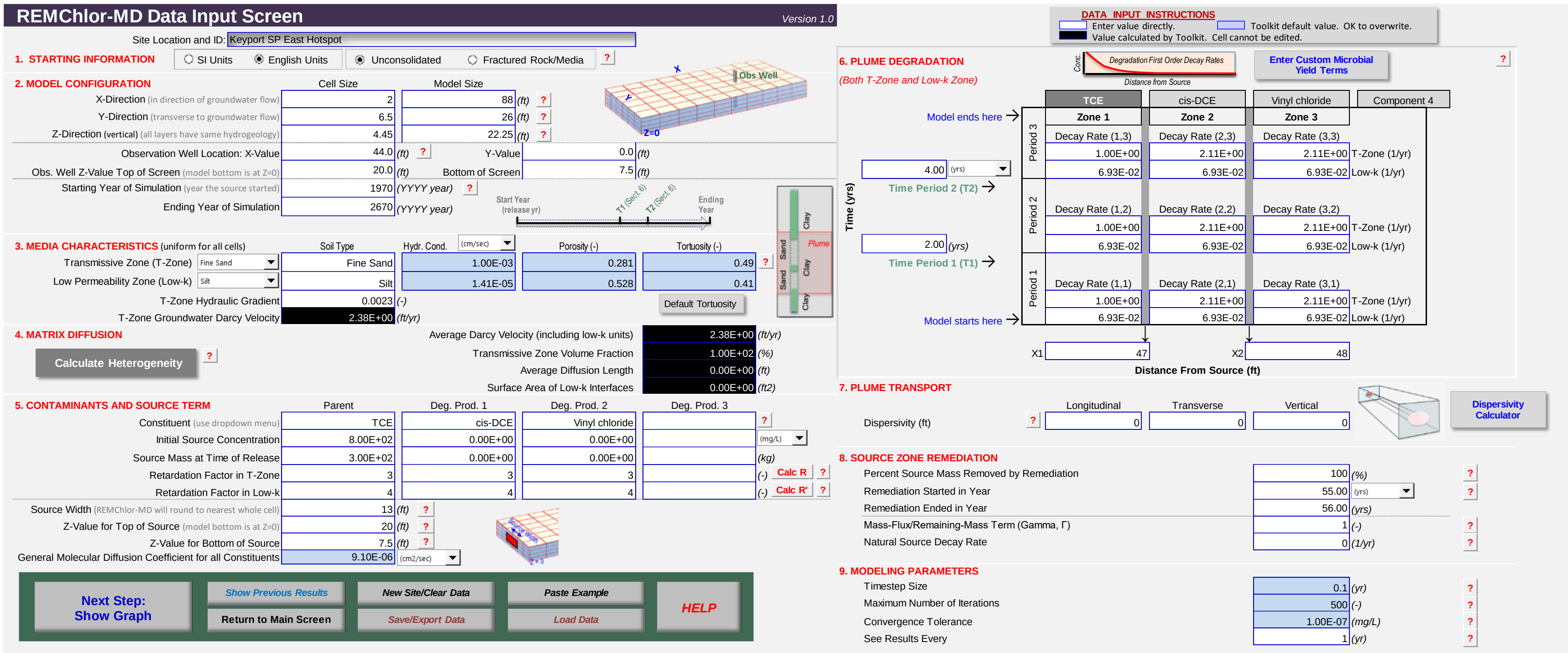



**Figure D-2. REMChlor-MD Input – Run 1**

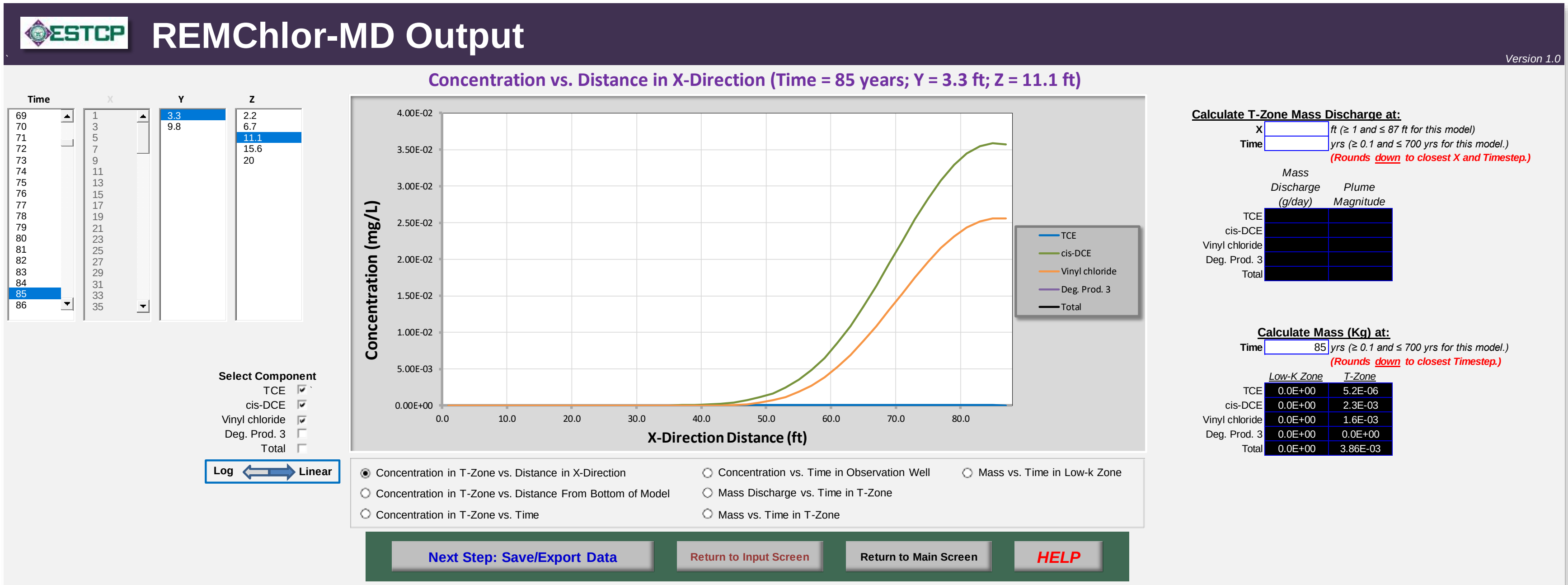



**Figure D-3. REMChlor-MD Output – Run 1 Concentration vs Distance**

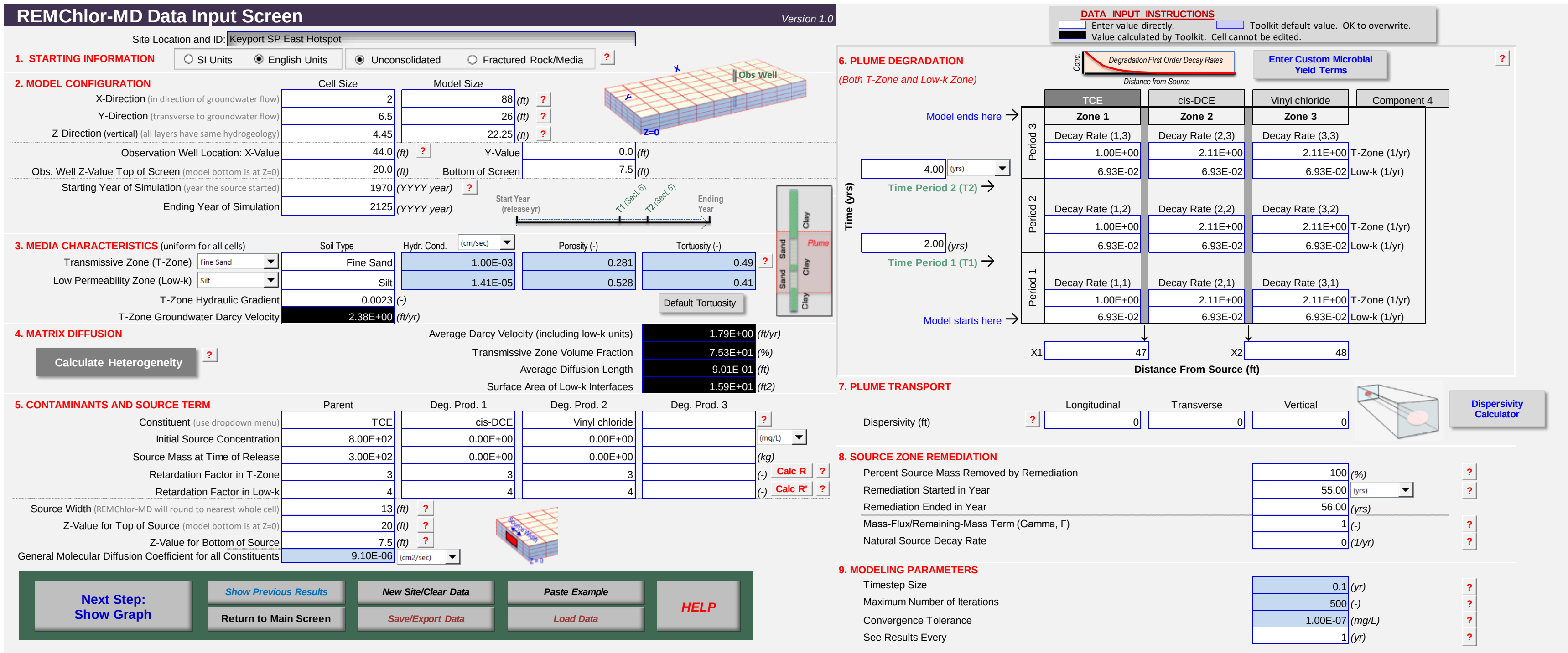



**Figure D-4. REMChlor-MD Input – Run 2**

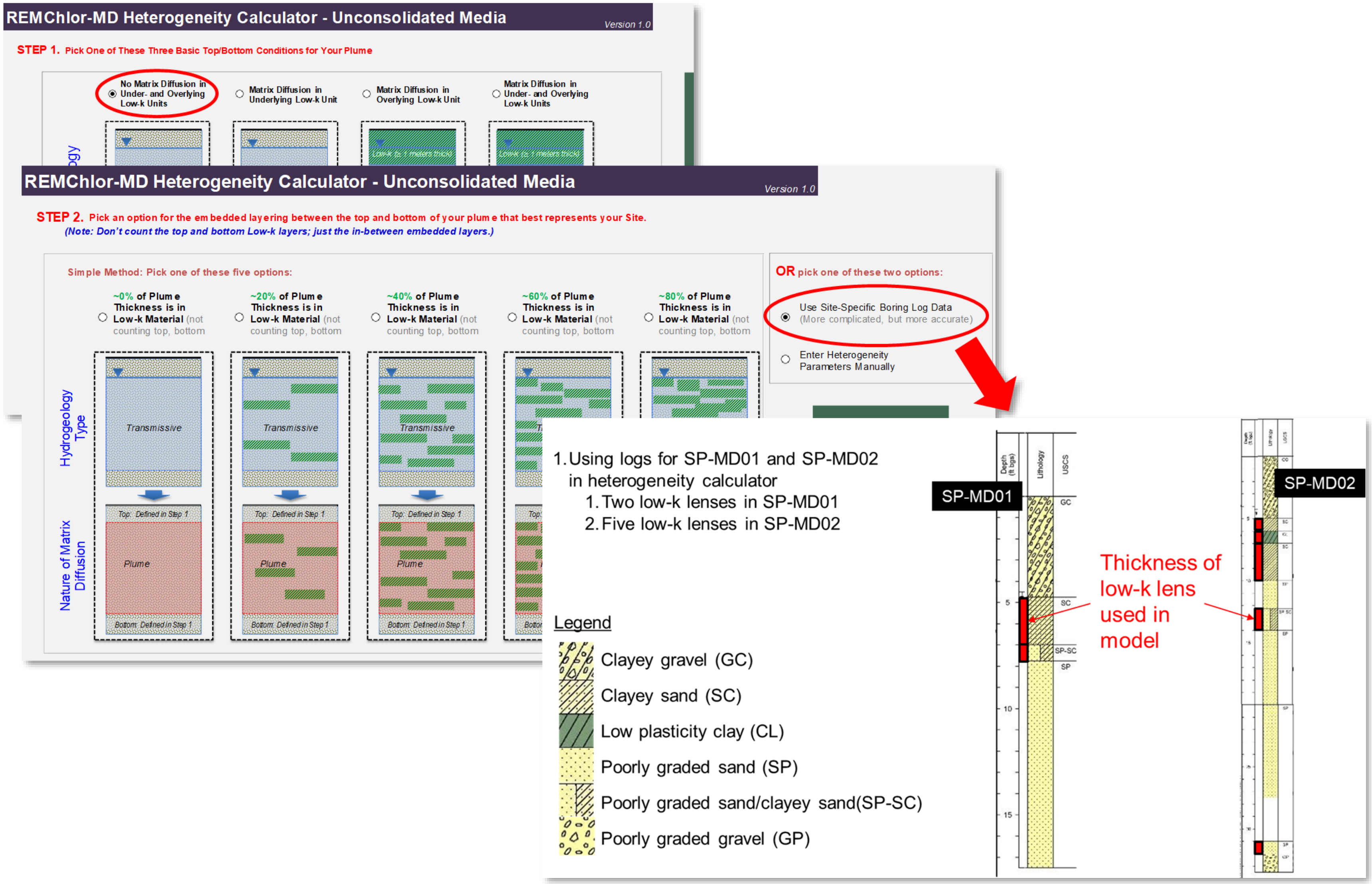



**Figure D-5. REMChlor-MD Data Input– Heterogeneity Calculator**

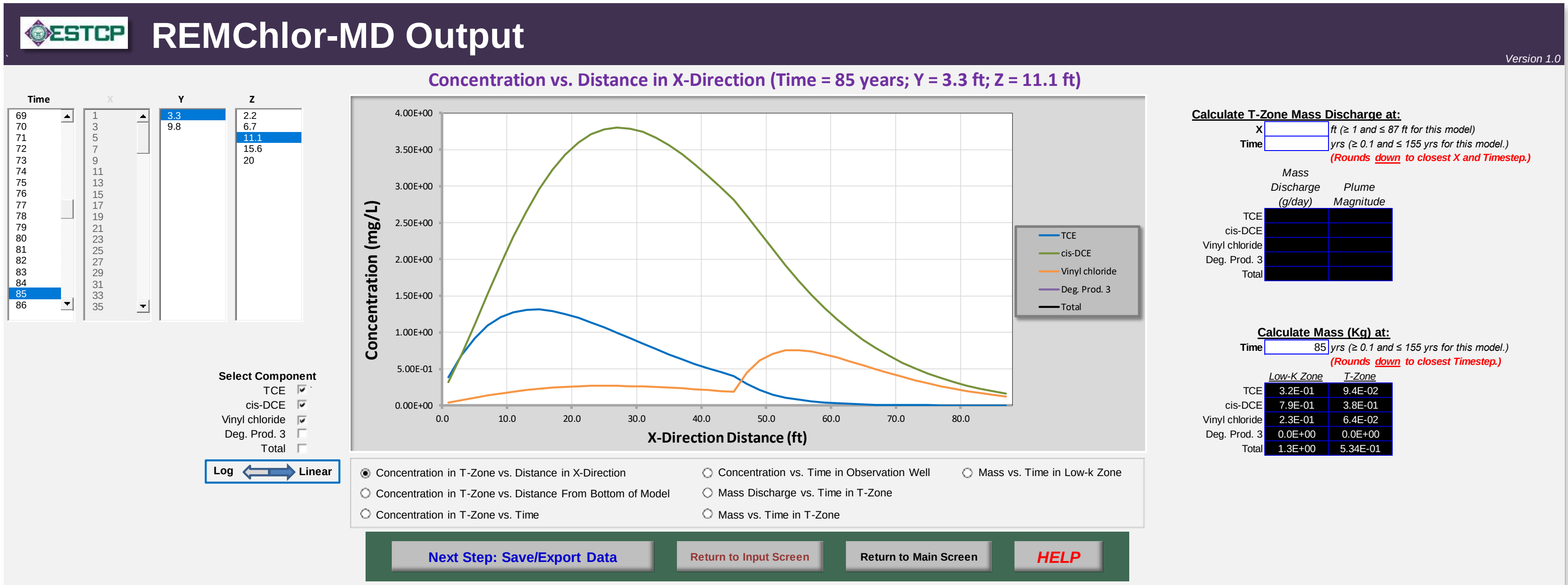



**Figure D-6. REMChlor-MD Output – Run 2 Concentration vs Distance**

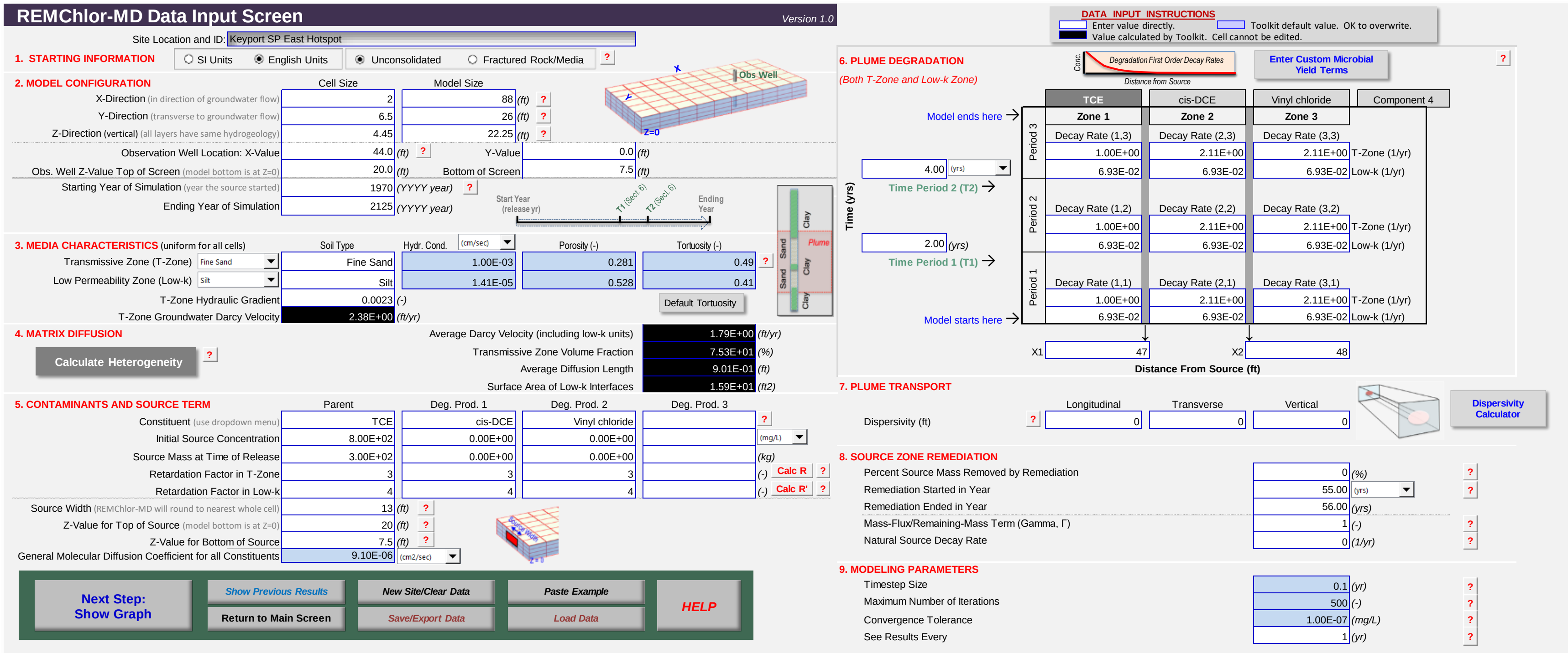



**Figure D-7. REMChlor-MD Data Input Screen – Run 3**

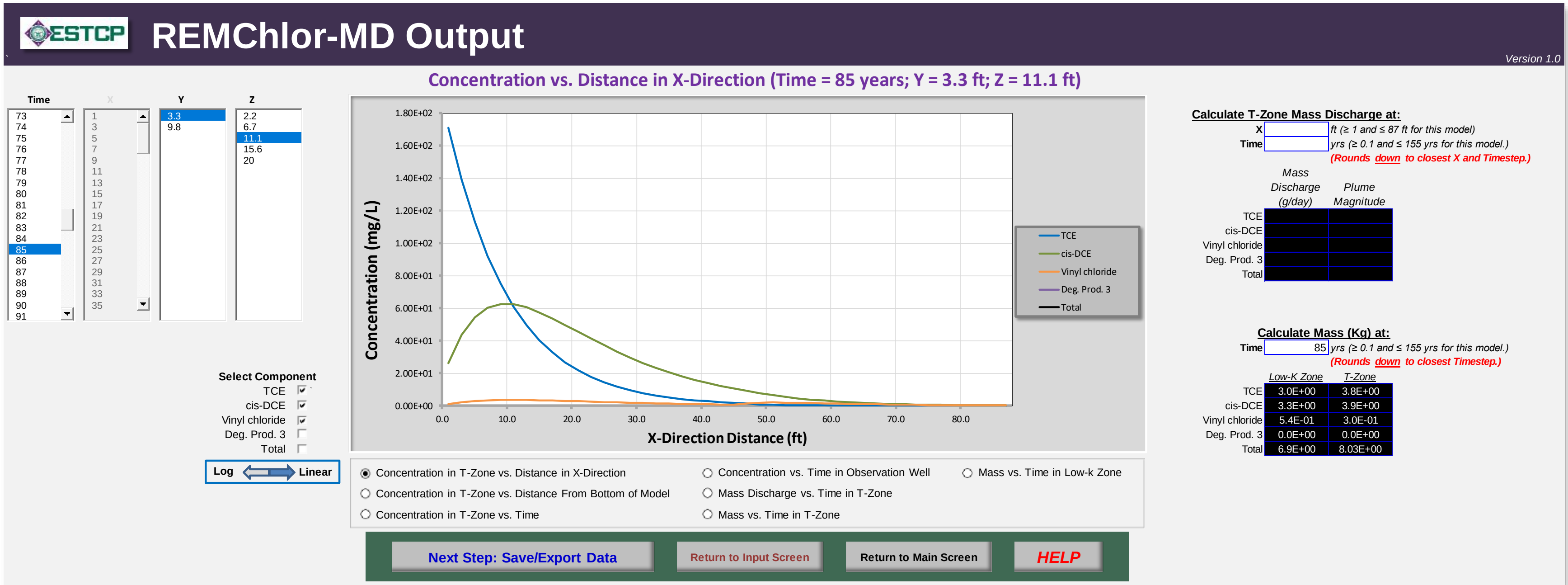



**Figure D-8. REMChlor-MD Output – Run 3 Concentration vs Distance**

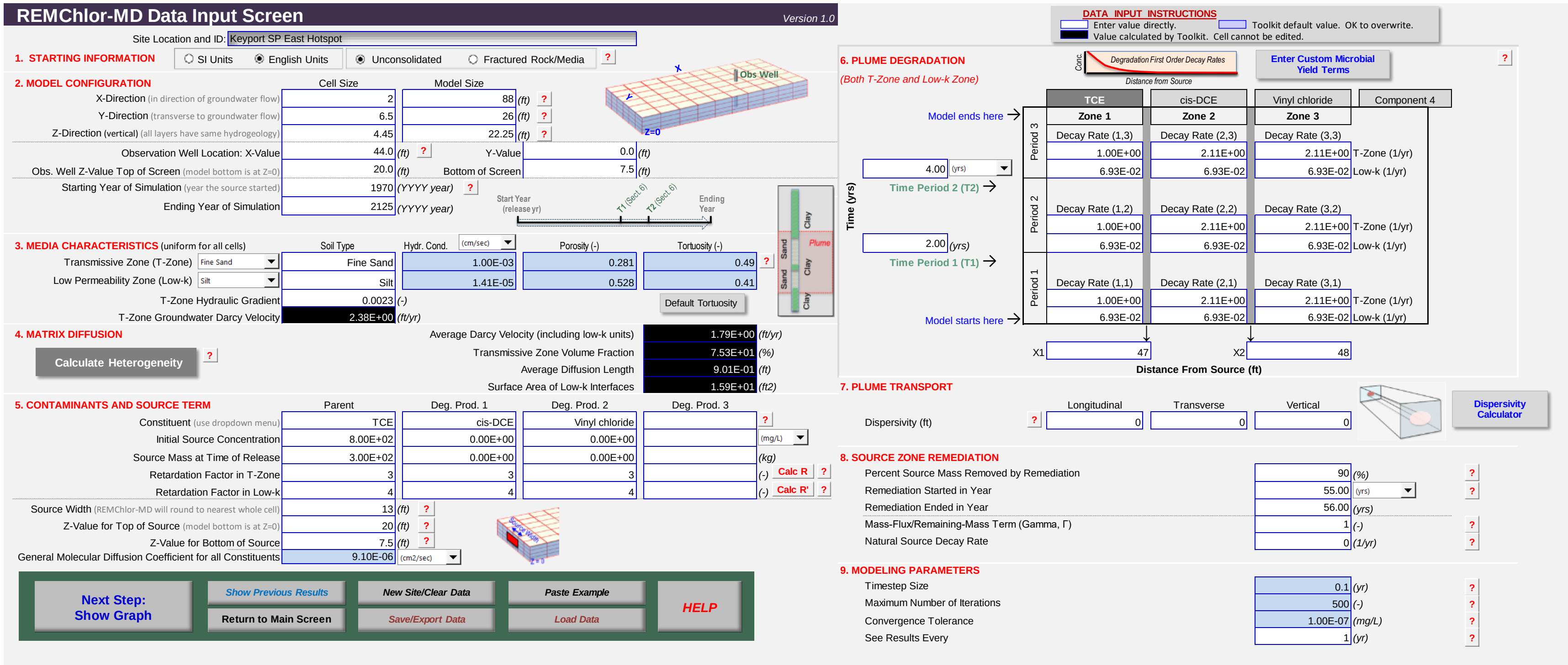



**Figure D-9. REMChlor-MD Input – Run 4**

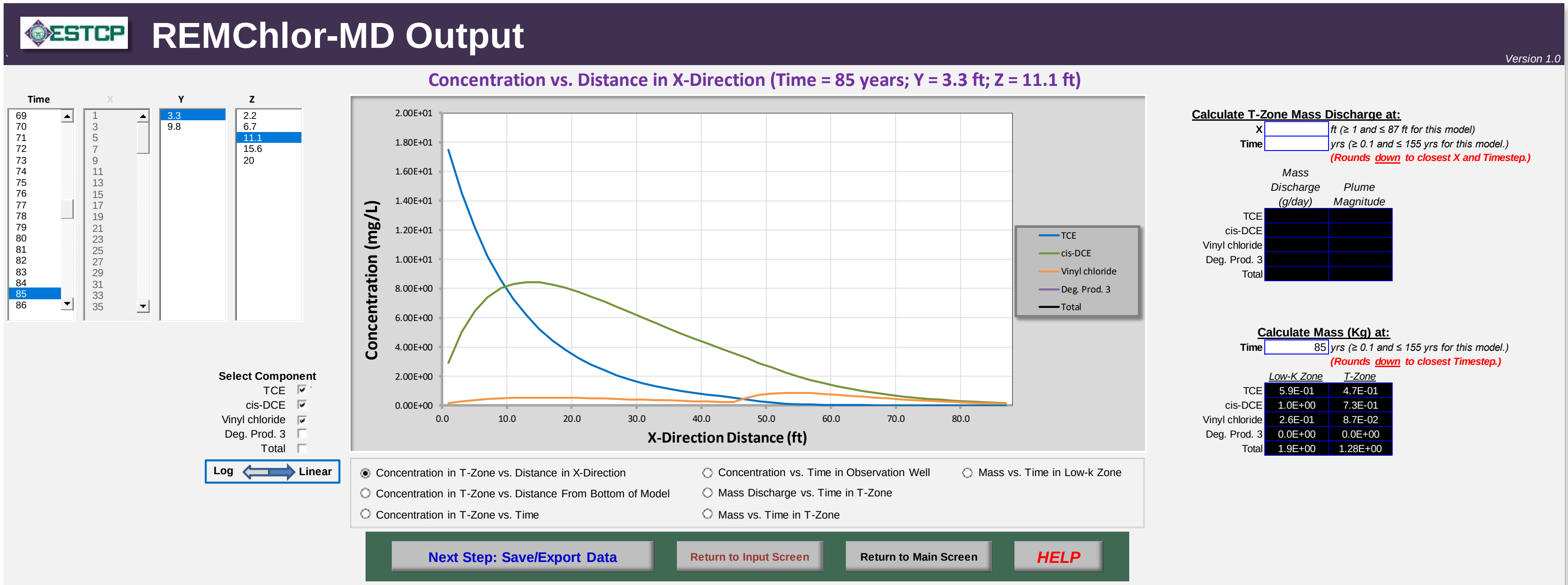



**Figure D-10. REMChlor-MD Output – Run 4 Concentration vs Distance**

# APPENDIX E

Appendix E. SP West Hotspot REMChlor-MD model runs

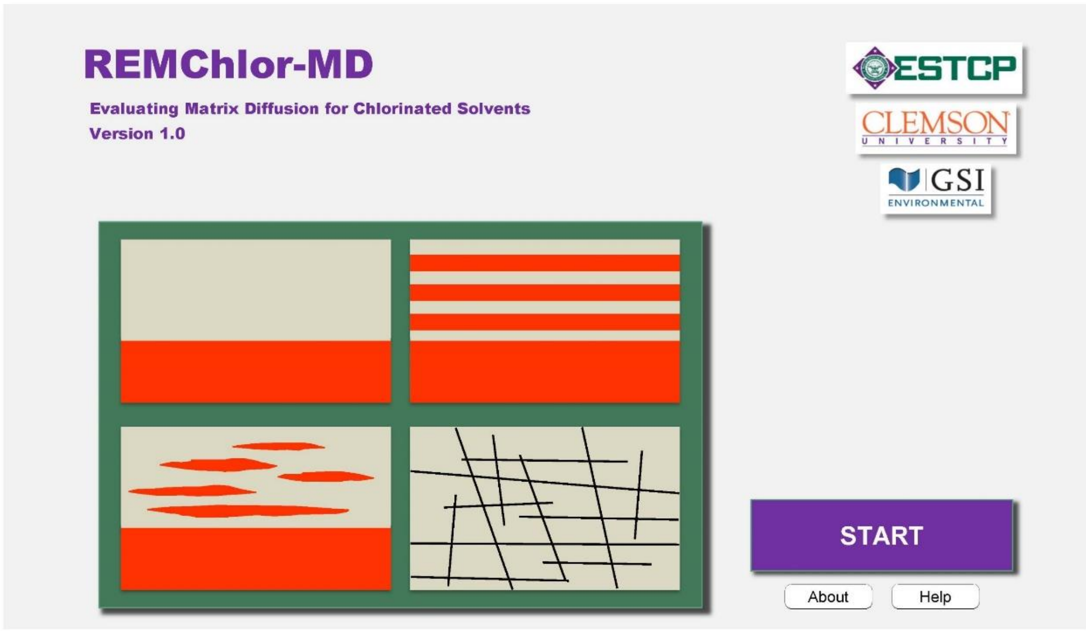



**Figure E-1. REMChlor-MD Cover Page**

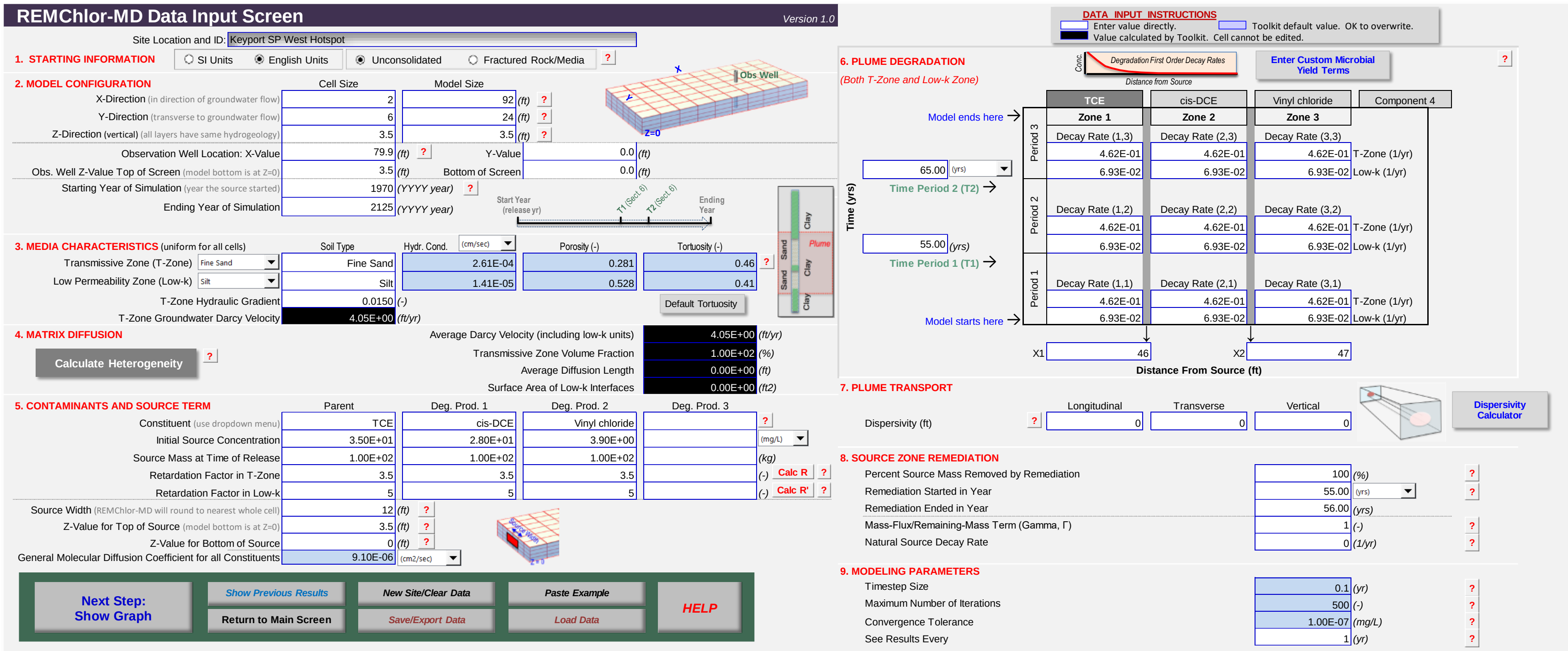



**Figure E-2. REMChlor-MD Input – Run 1**

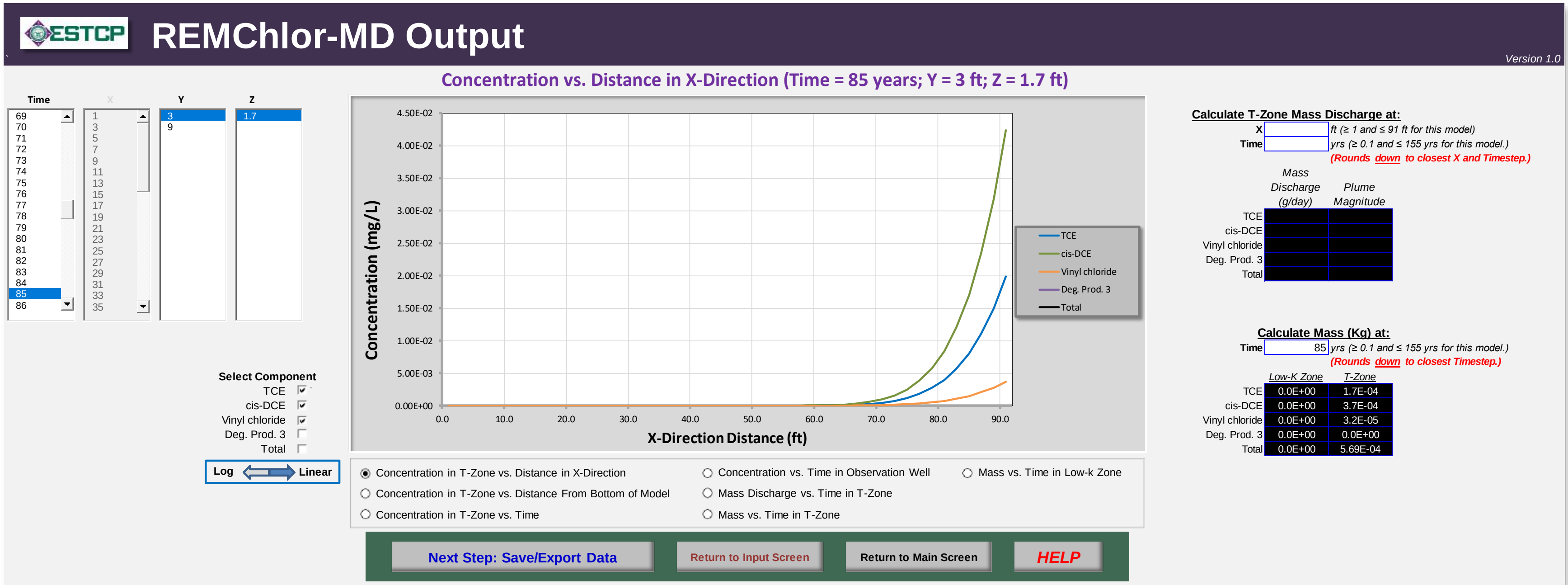



**Figure E-3. REMChlor-MD Output – Run 1 Concentration vs Distance**

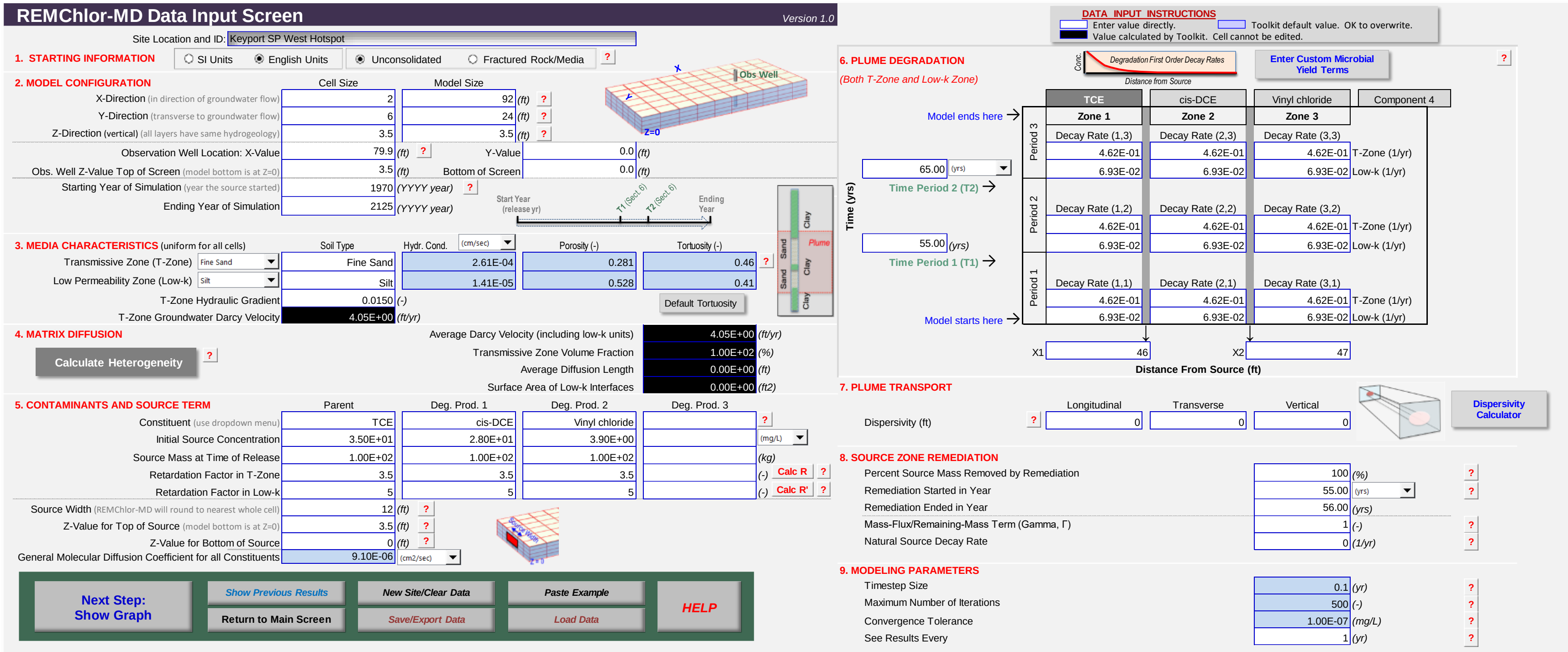



**Figure E-4. REMChlor-MD Input – Run 2**

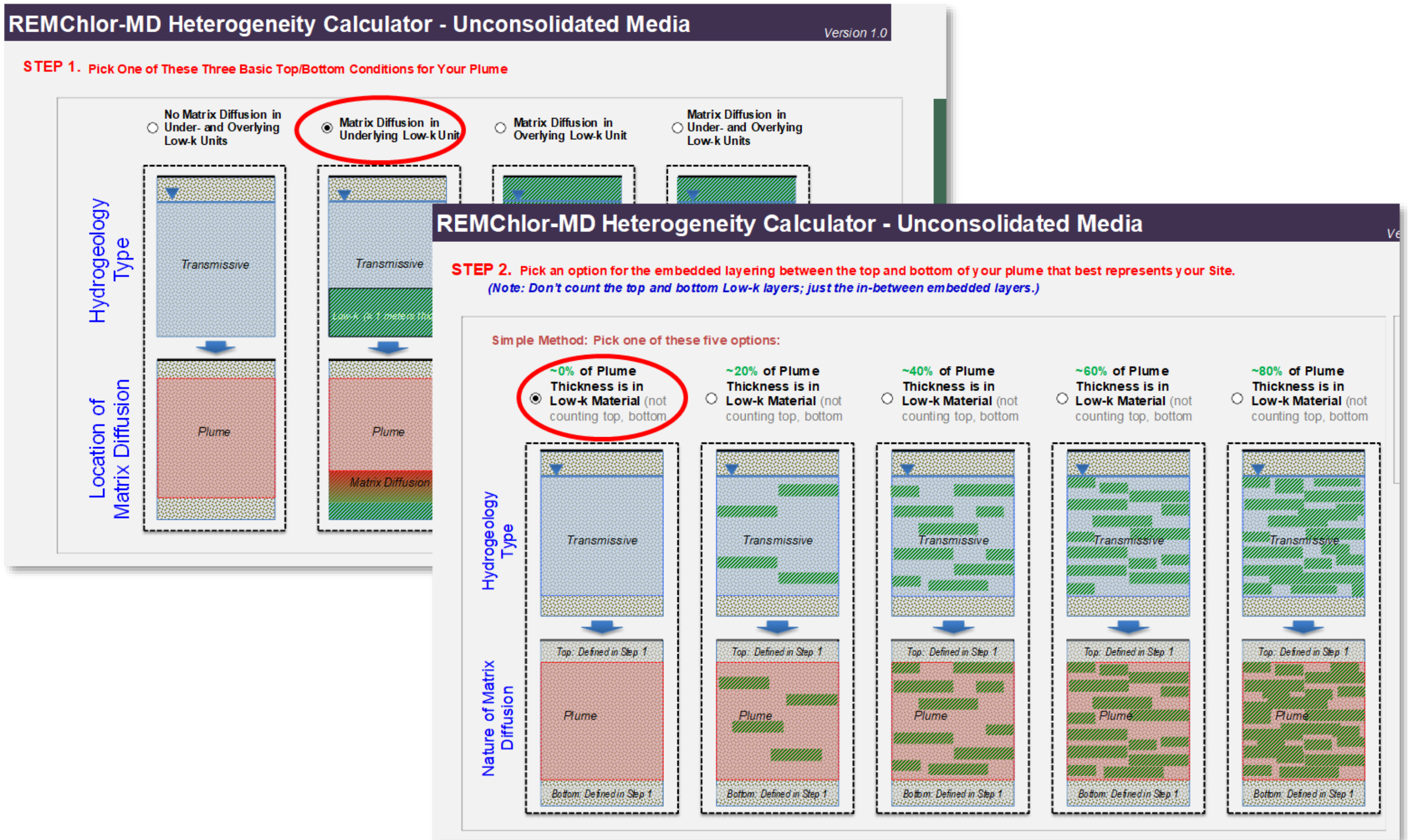



**Figure E-5. REMChlor-MD Data Input– Heterogeneity Calculator**

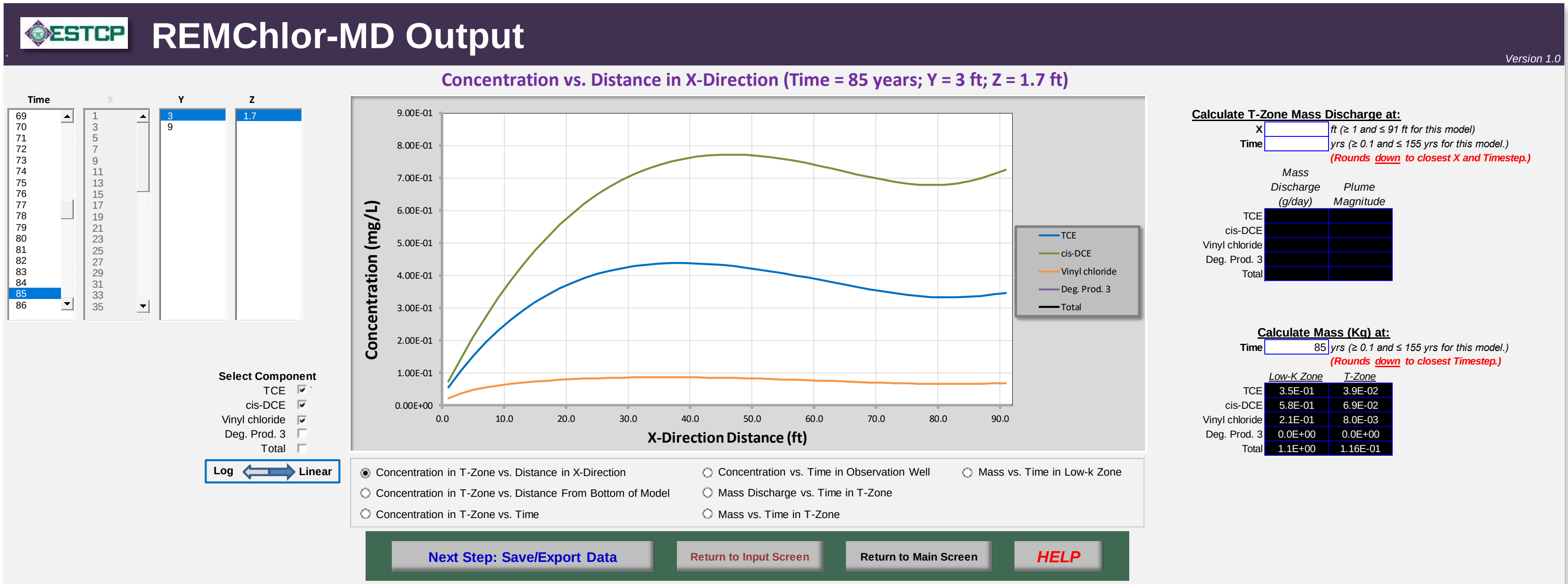



**Figure E-6. REMChlor-MD Output – Run 2 Concentration vs Distance**

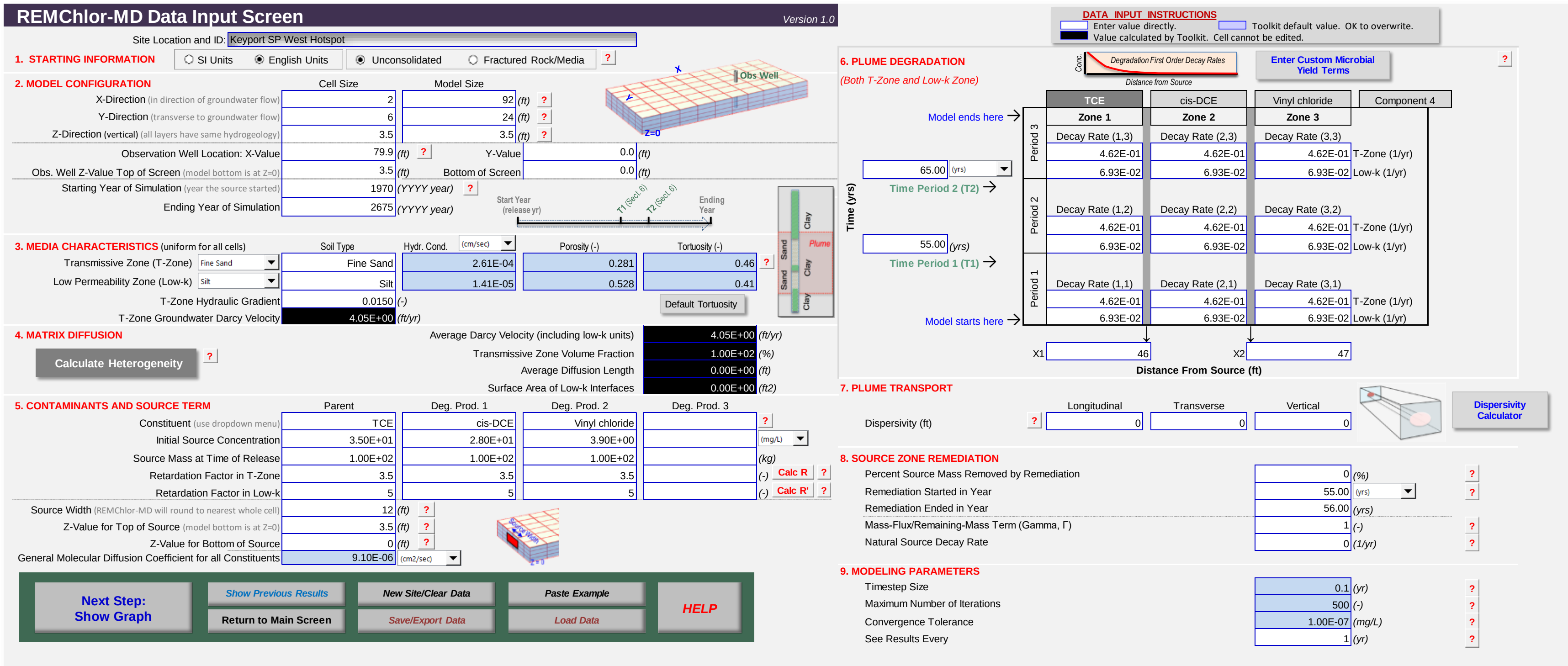



**Figure E-7. REMChlor-MD Data Input Screen – Run 3**

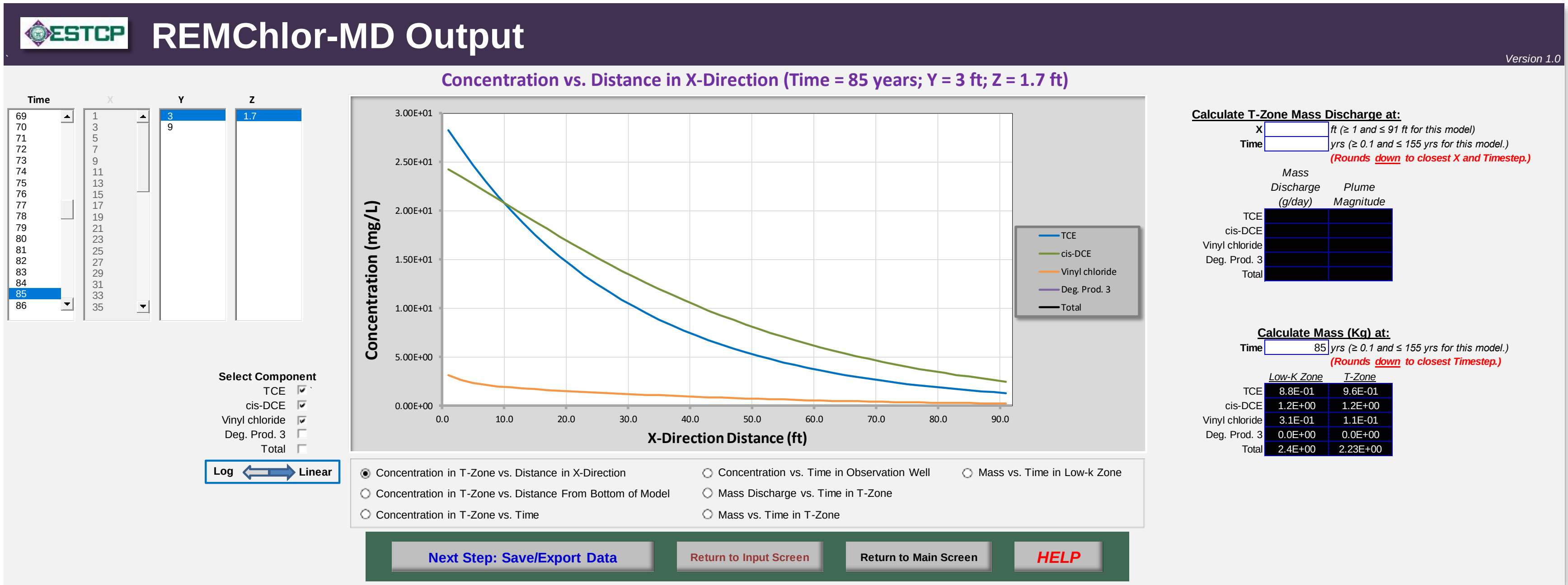



**Figure E-8. REMChlor-MD Output – Run 3 Concentration vs Distance**

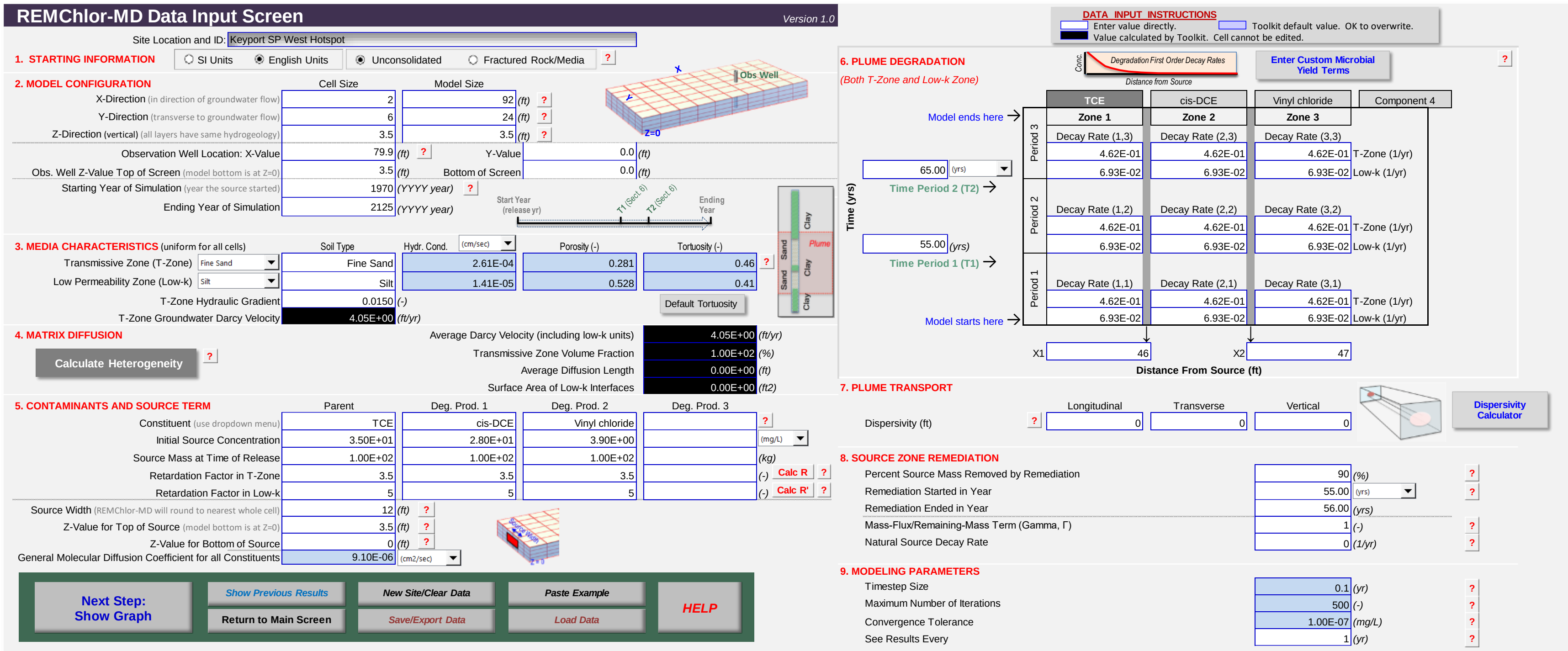



**Figure E-9. REMChlor-MD Input – Run 4**

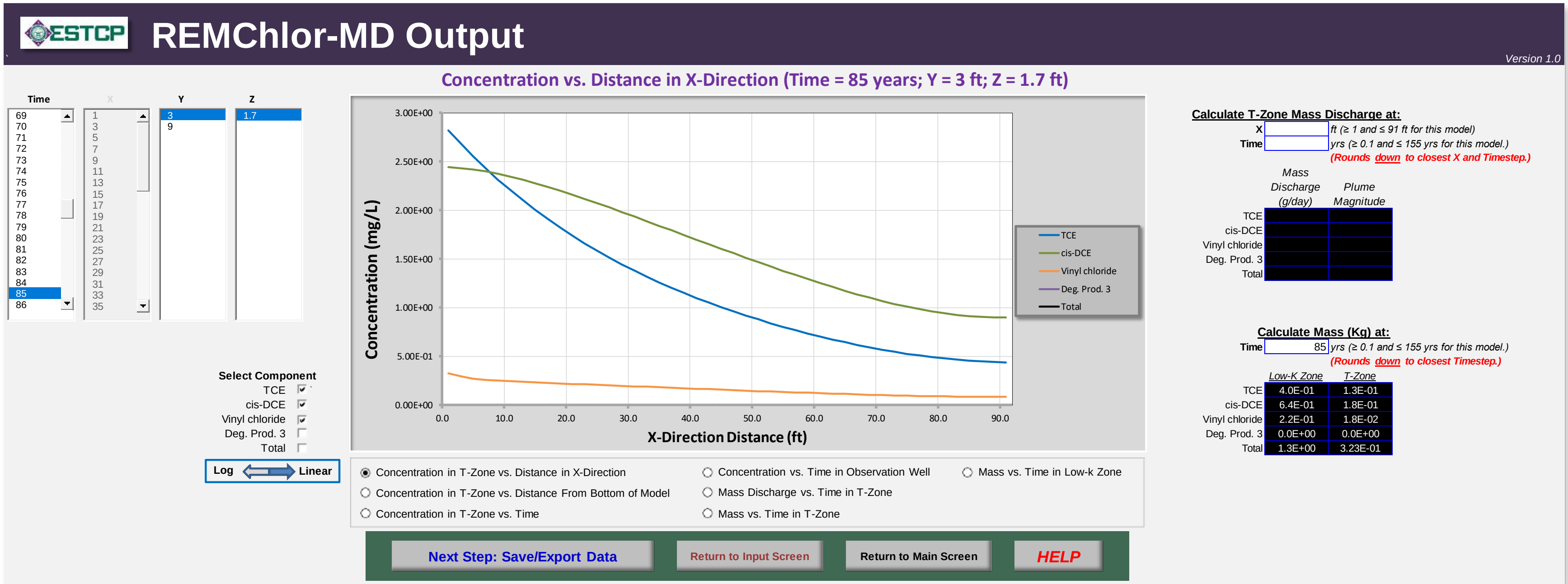



**Figure E-10. REMChlor-MD Output – Run 4 Concentration vs Distance**

# APPENDIX F

Appendix F. CL Northwest CVOC plume REMChlor-MD model runs

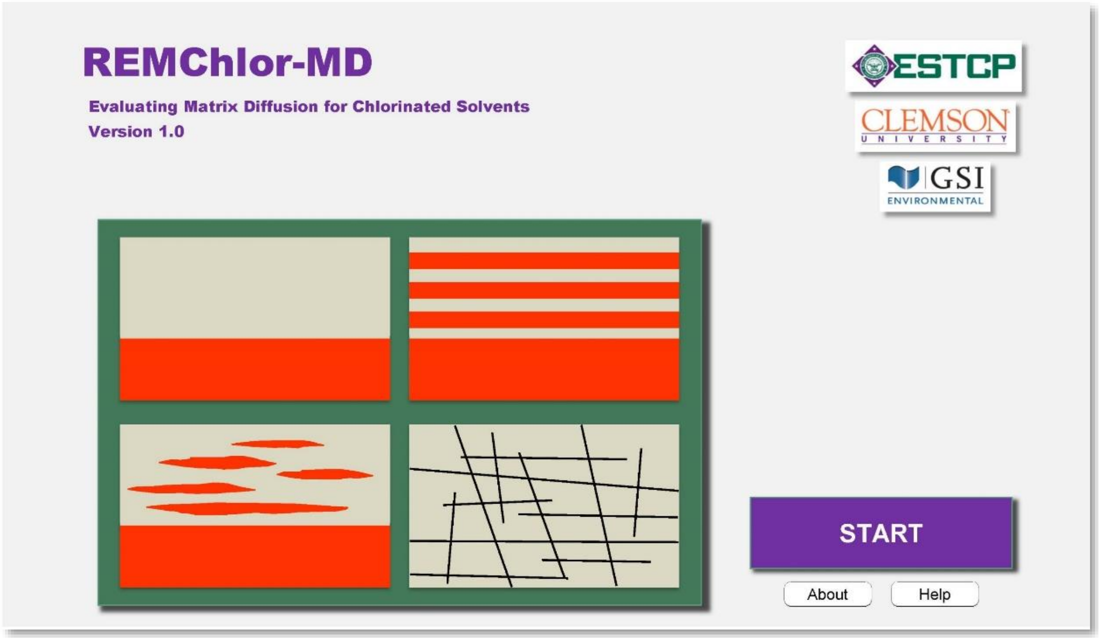



**Figure F-1. REMChlor-MD Cover Page**

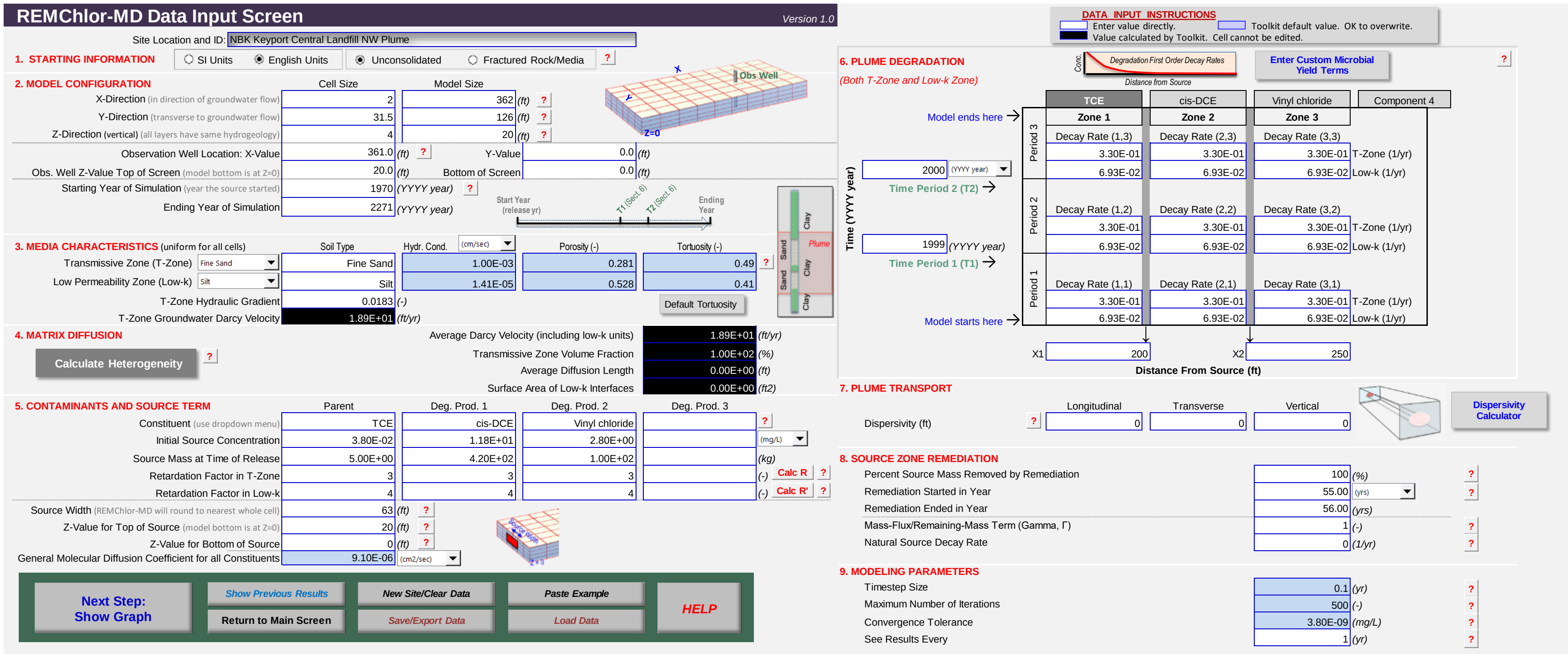



**Figure F-2. REMChlor-MD Input – Run 1**

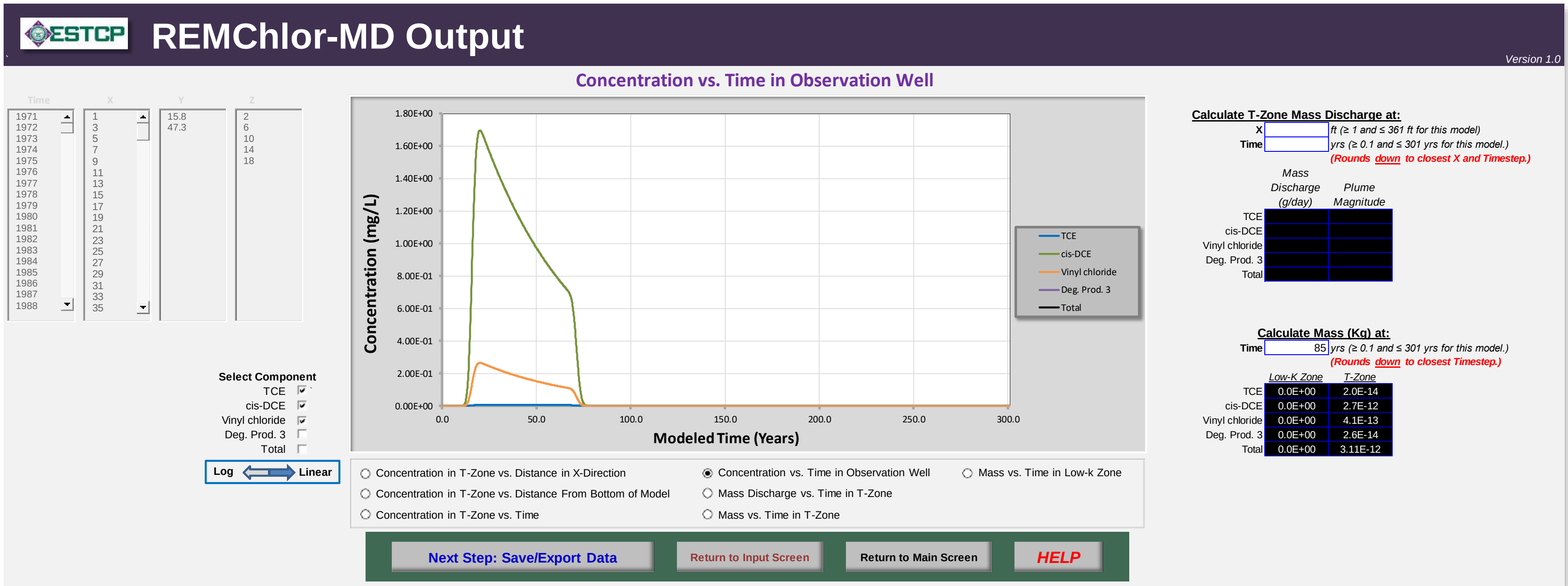



**Figure F-3. REMChlor-MD Output – Run 1 Concentration vs Time at MW1-25**

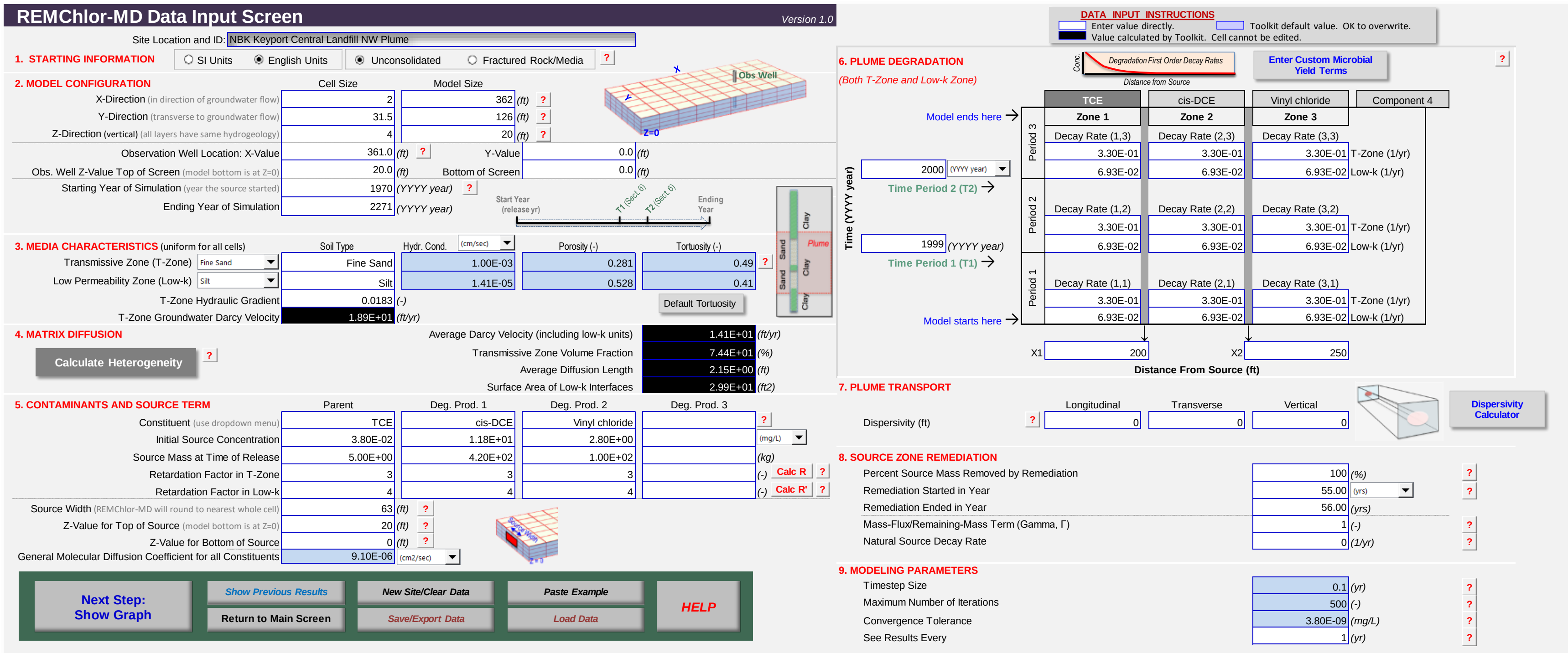



**Figure F-4. REMChlor-MD Input – Run 2**

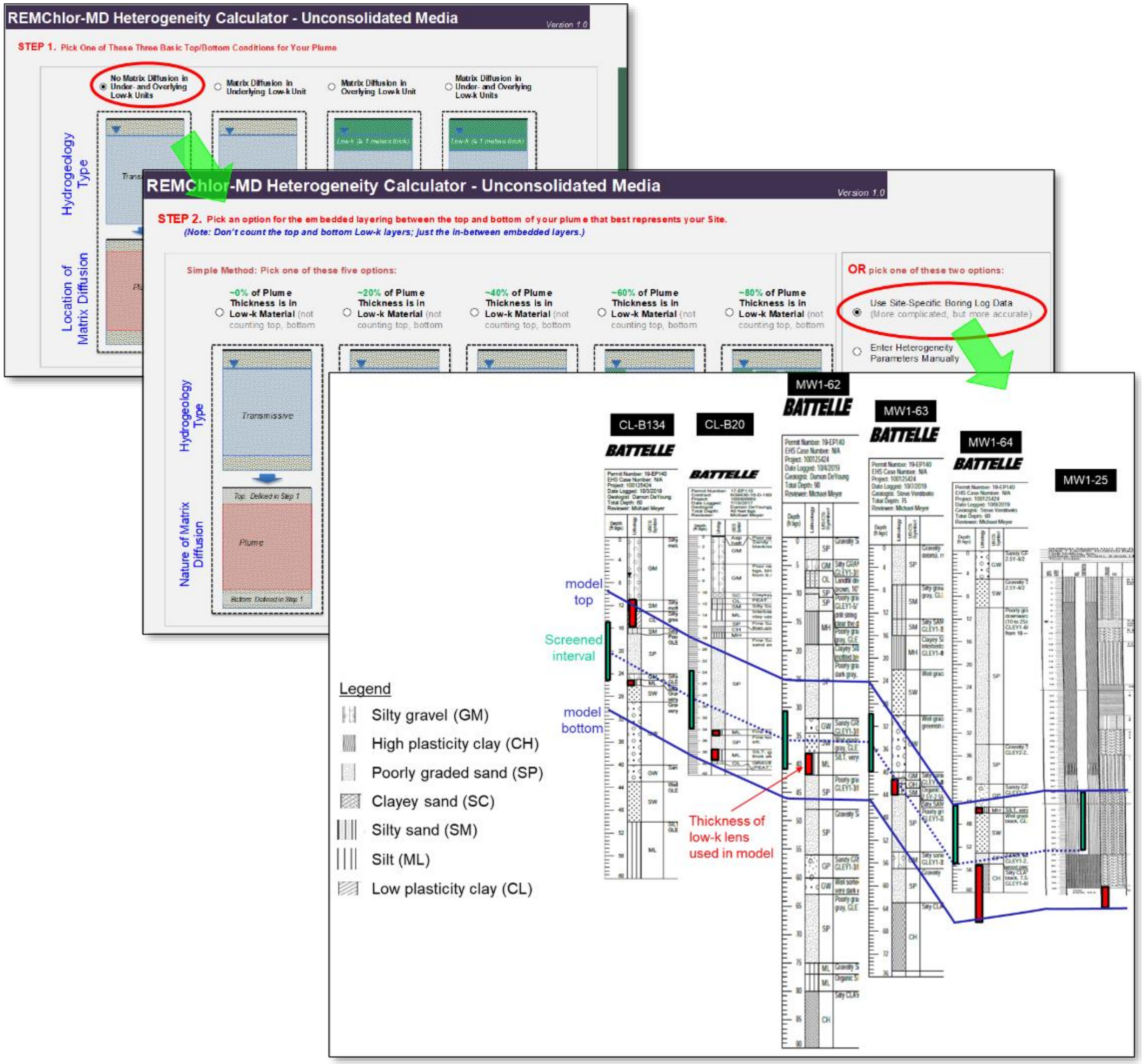



**Figure F-5. REMChlor-MD Data Input– Heterogeneity Calculator**

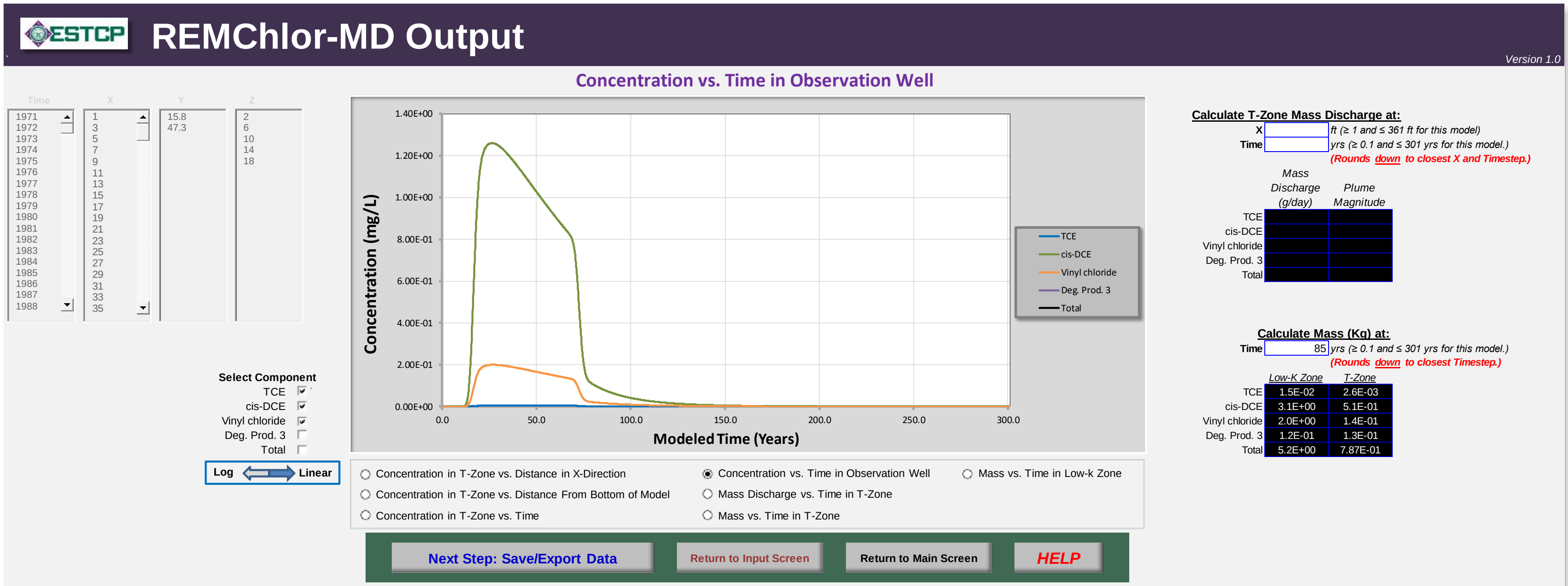



**Figure F-6. REMChlor-MD Output – Run 2 Concentration vs Time at MW1-25**

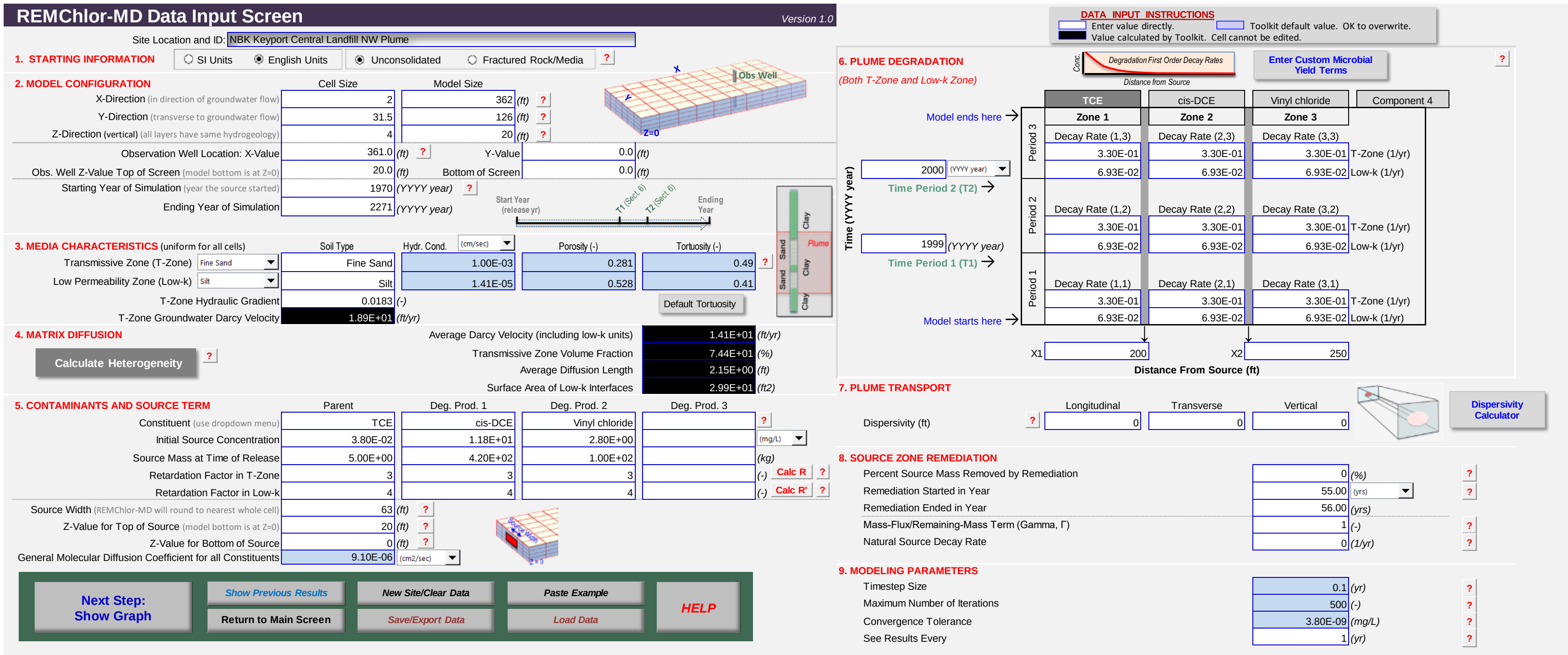



**Figure F-7. REMChlor-MD Data Input Screen – Run 3**

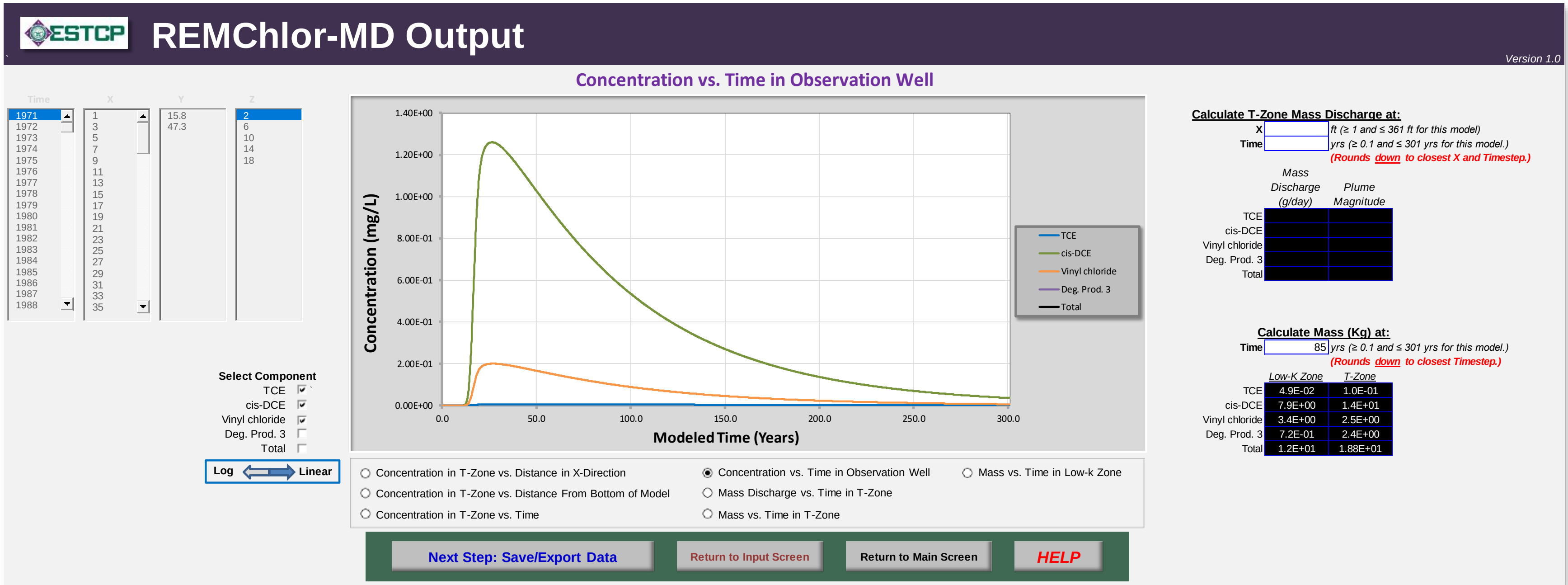



**Figure F-8. REMChlor-MD Output – Run 3 Concentration vs Time at MW1-25**

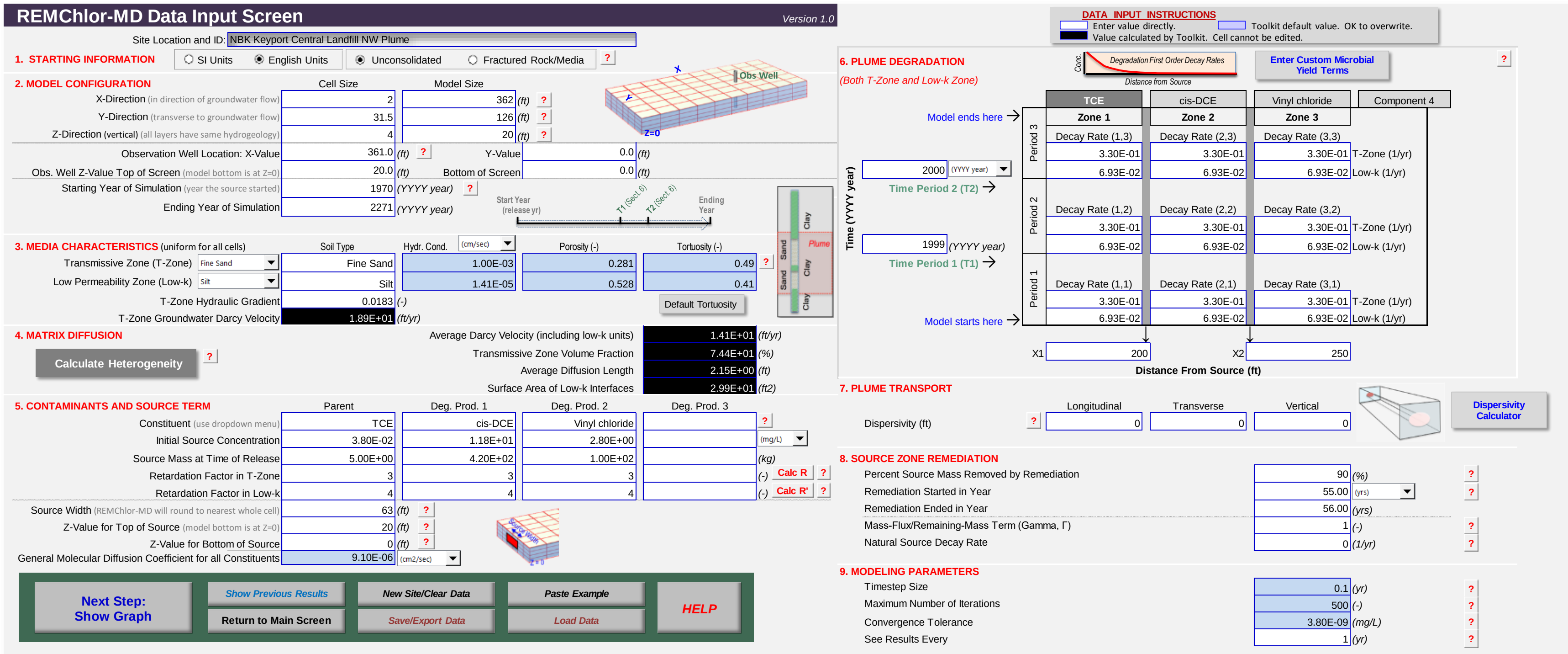



**Figure F-9. REMChlor-MD Input – Run 4**

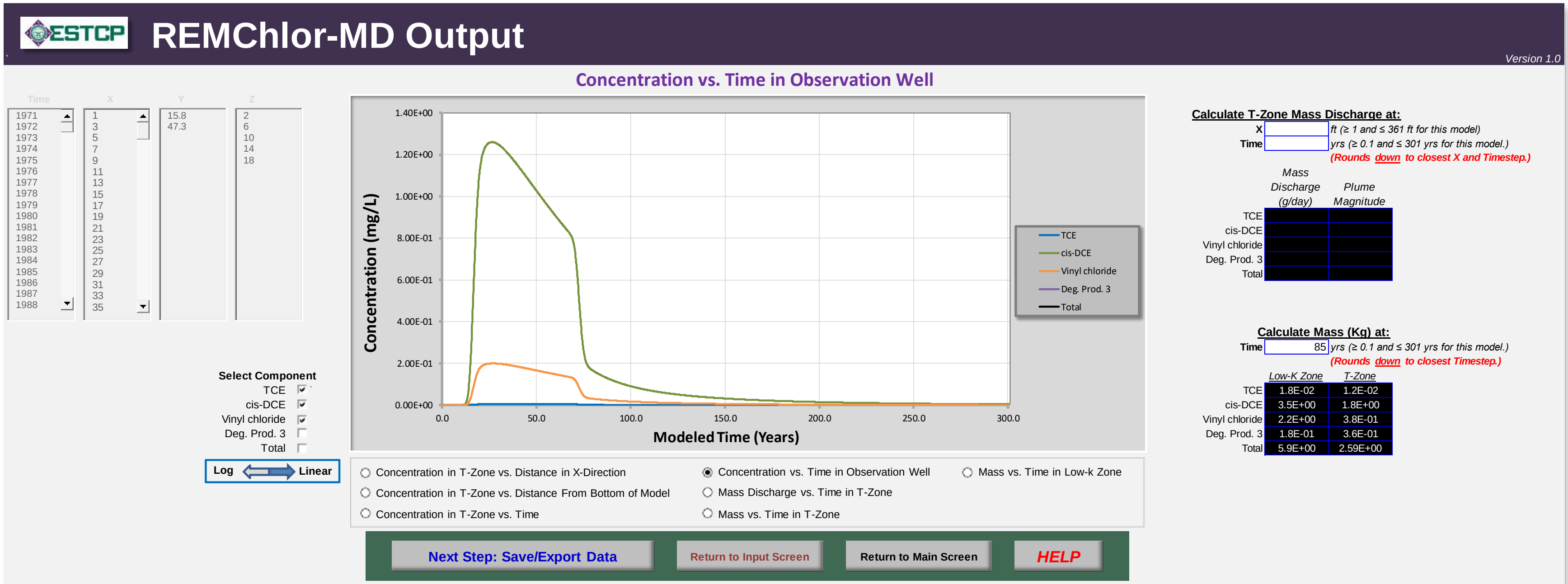



**Figure F-10. REMChlor-MD Output – Run 4 Concentration vs Time at MW1-25**

# APPENDIX G

Appendix G. CL 1,4-dioxane plume REMChlor-MD model runs

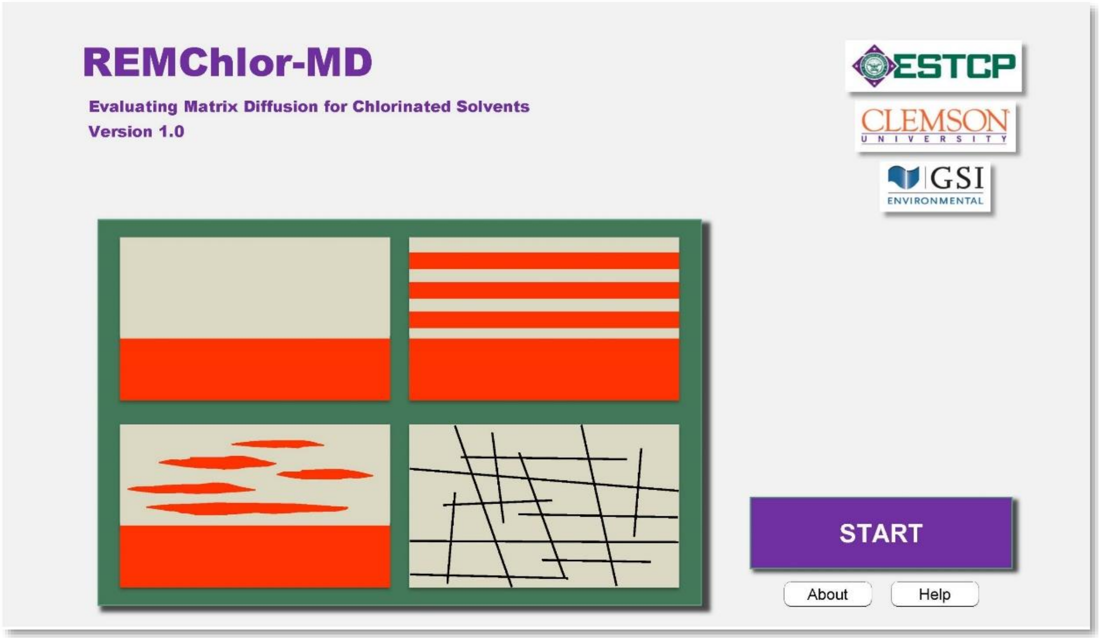



**Figure G-1. REMChlor-MD Cover Page**

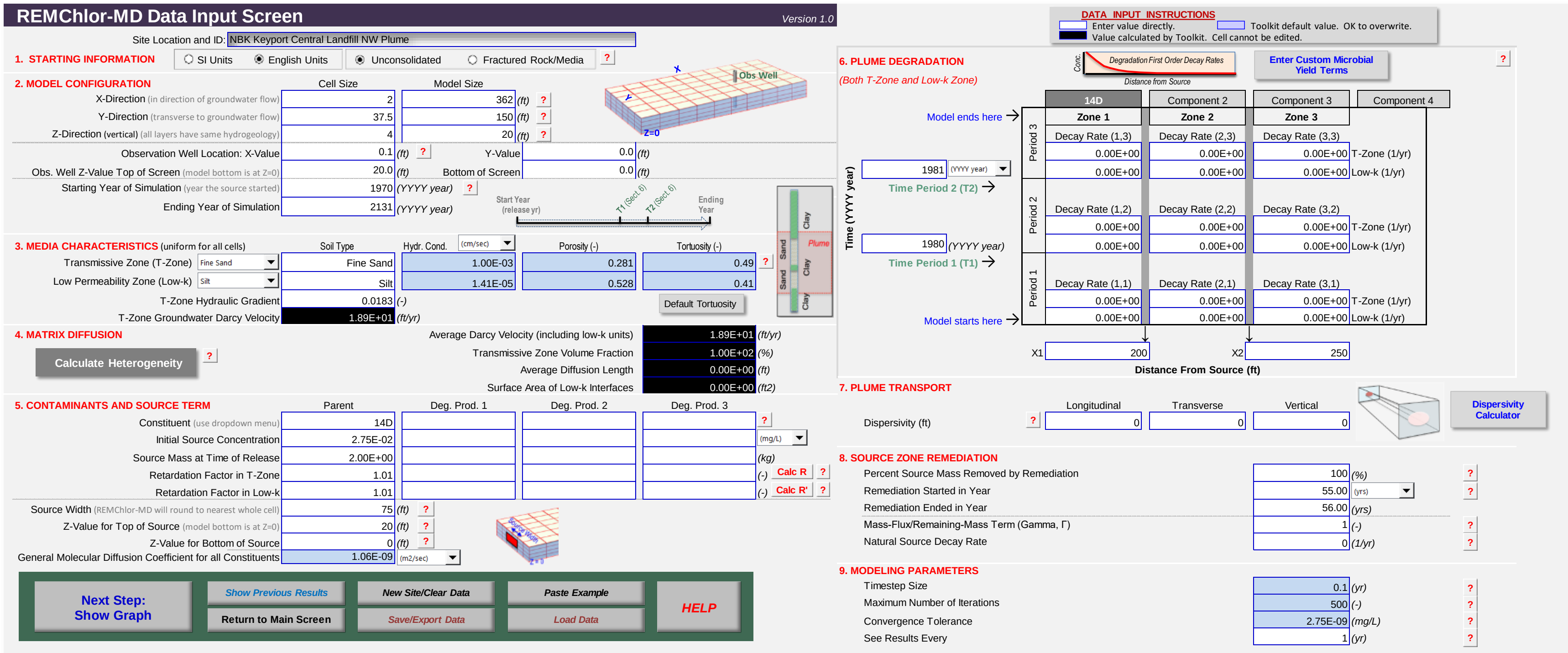



**Figure G-2. REMChlor-MD Input – Run 1**

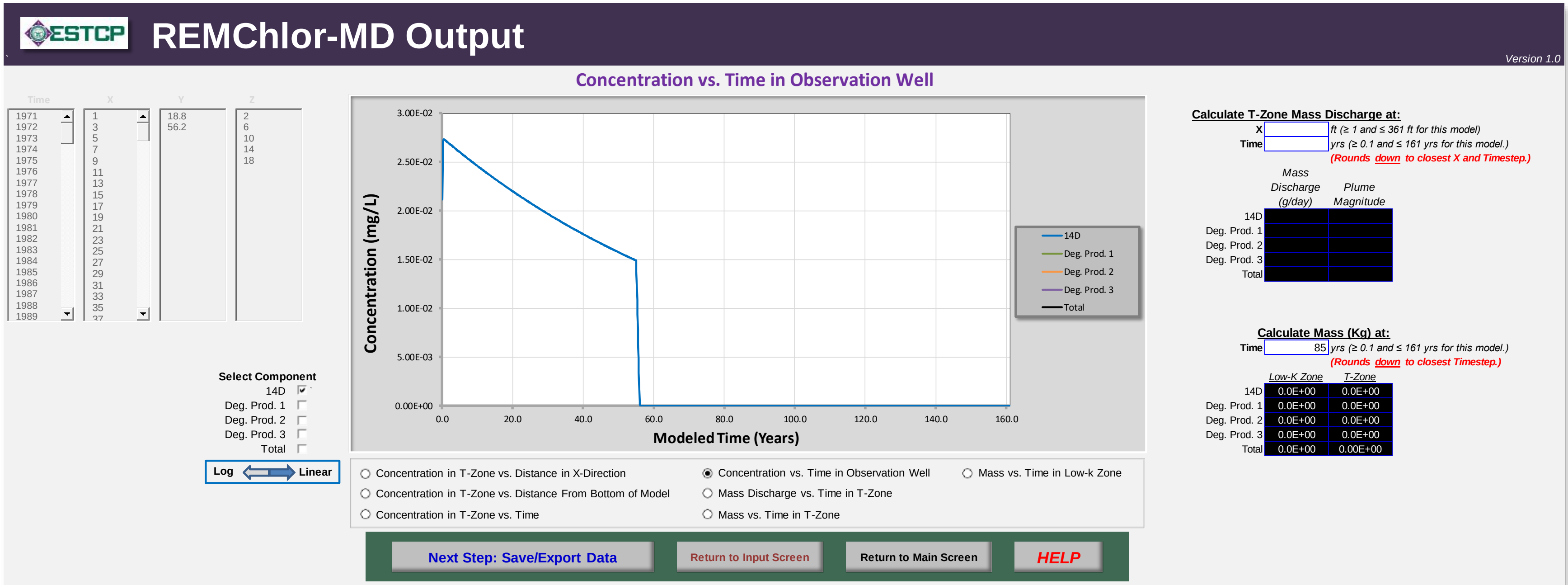



**Figure G-3. REMChlor-MD Output – Run 1 Concentration vs Time at MW1-25**

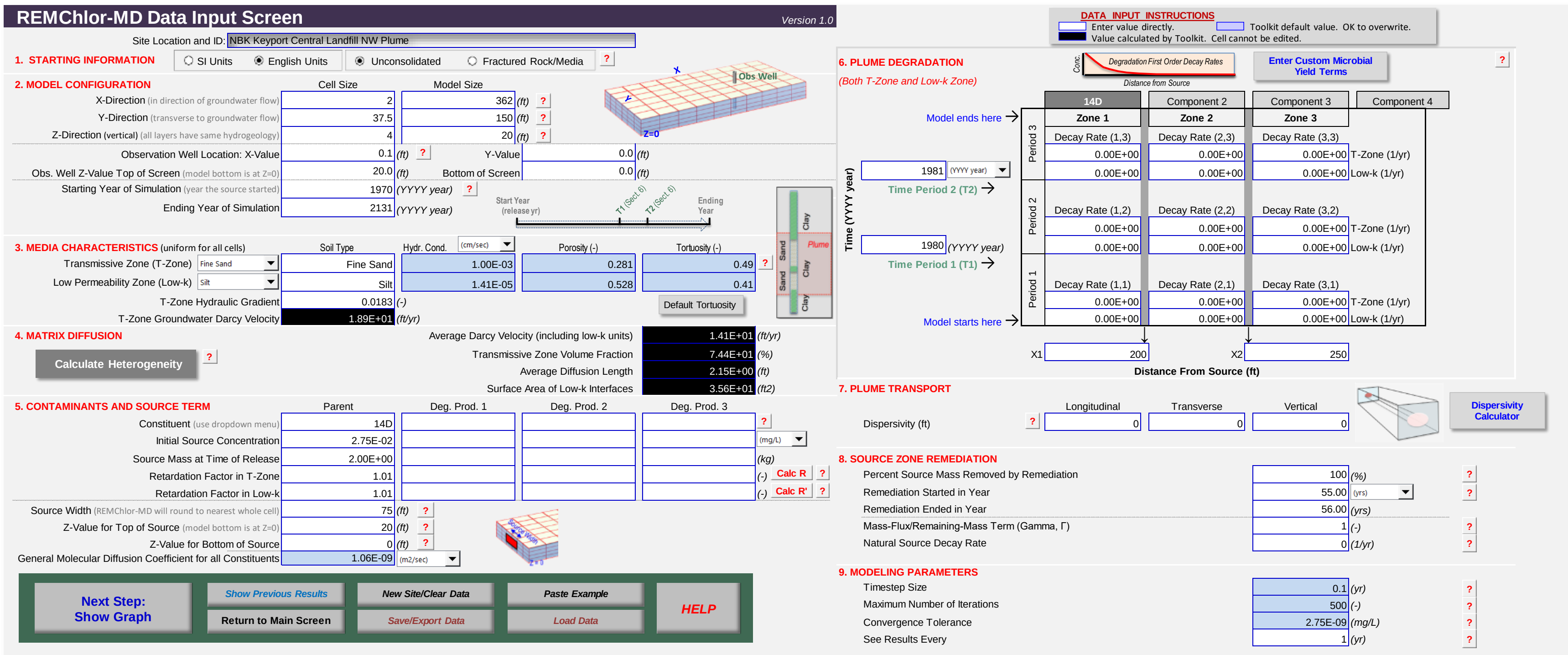



**Figure G-4. REMChlor-MD Input – Run 2**

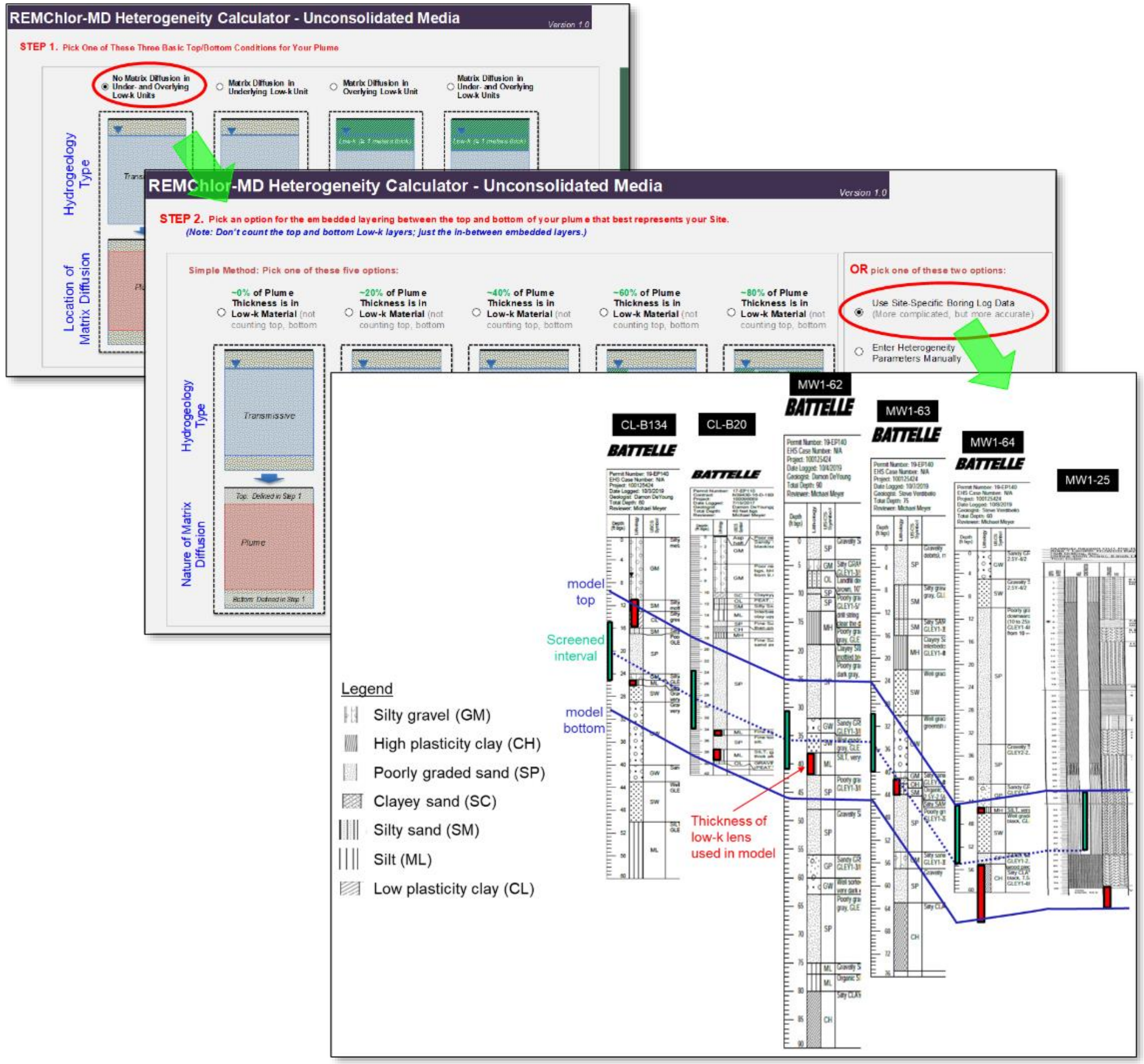



**Figure G-5. REMChlor-MD Data Input– Heterogeneity Calculator**

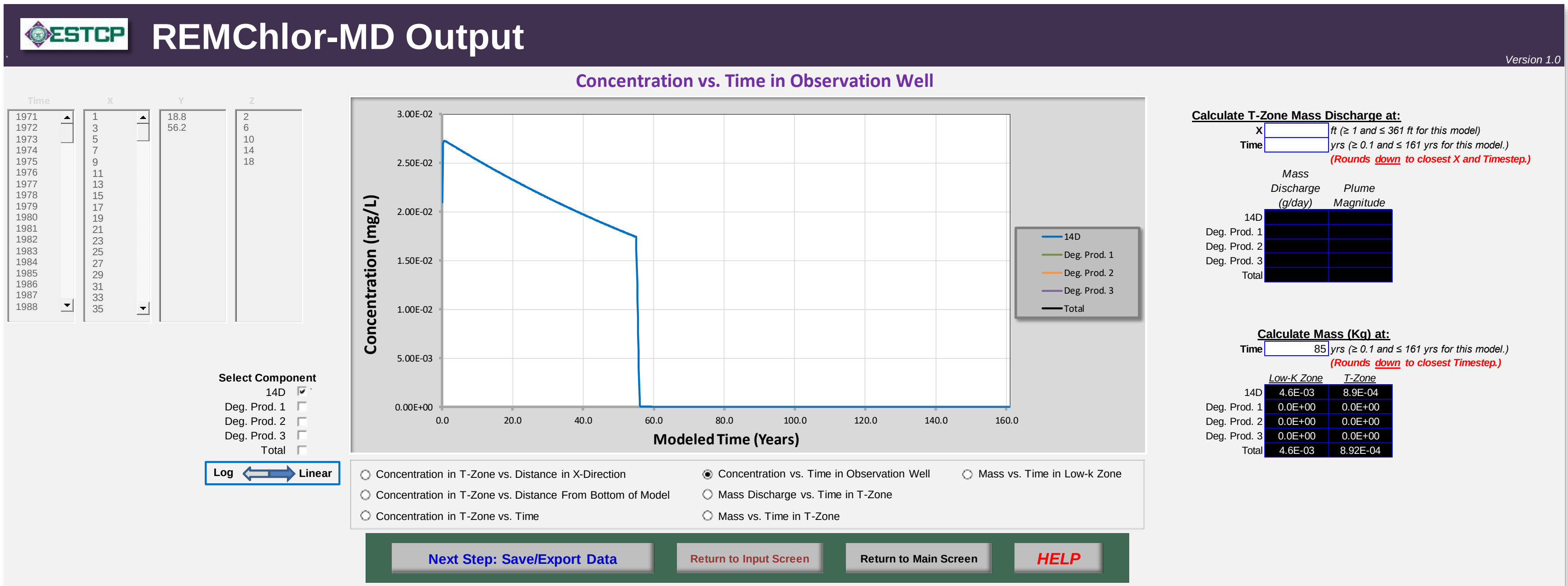



**Figure G-6. REMChlor-MD Output – Run 2 Concentration vs Time at MW1-25**

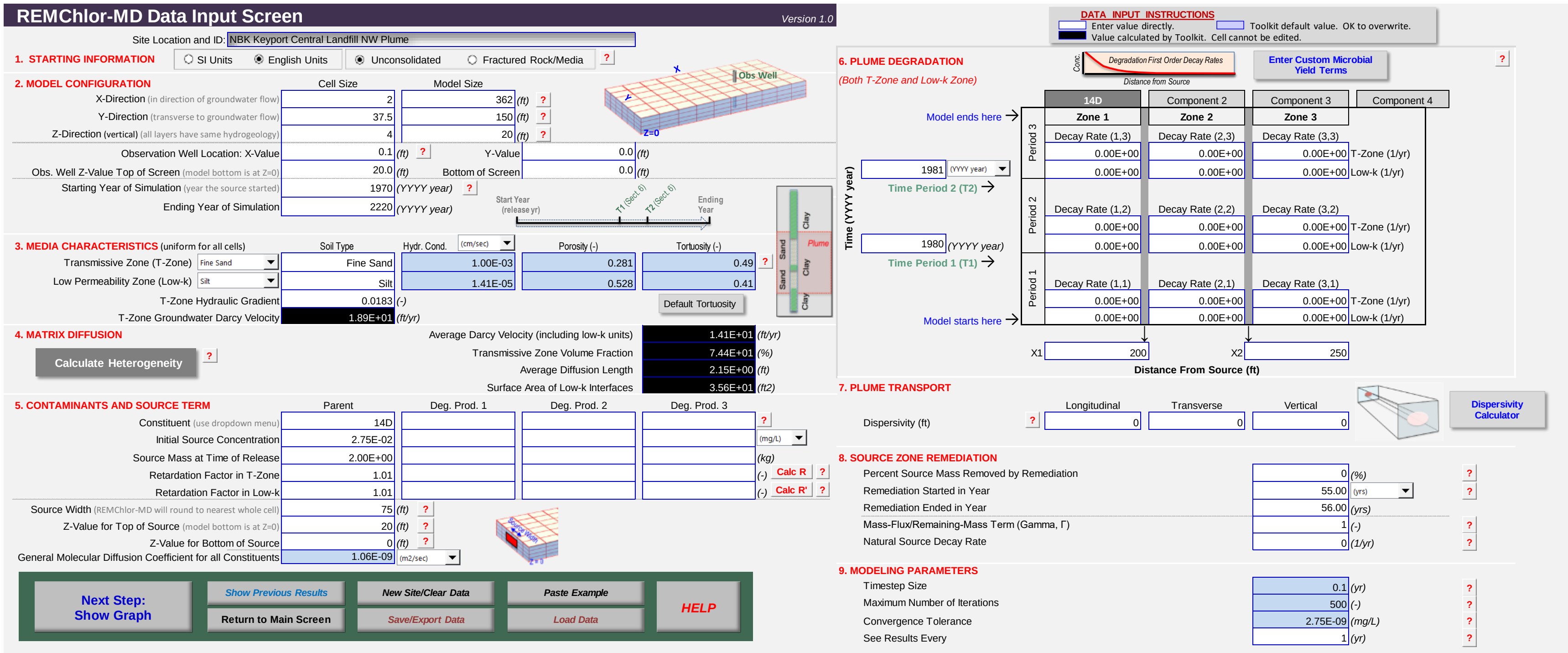



**Figure G-7. REMChlor-MD Data Input Screen – Run 3**

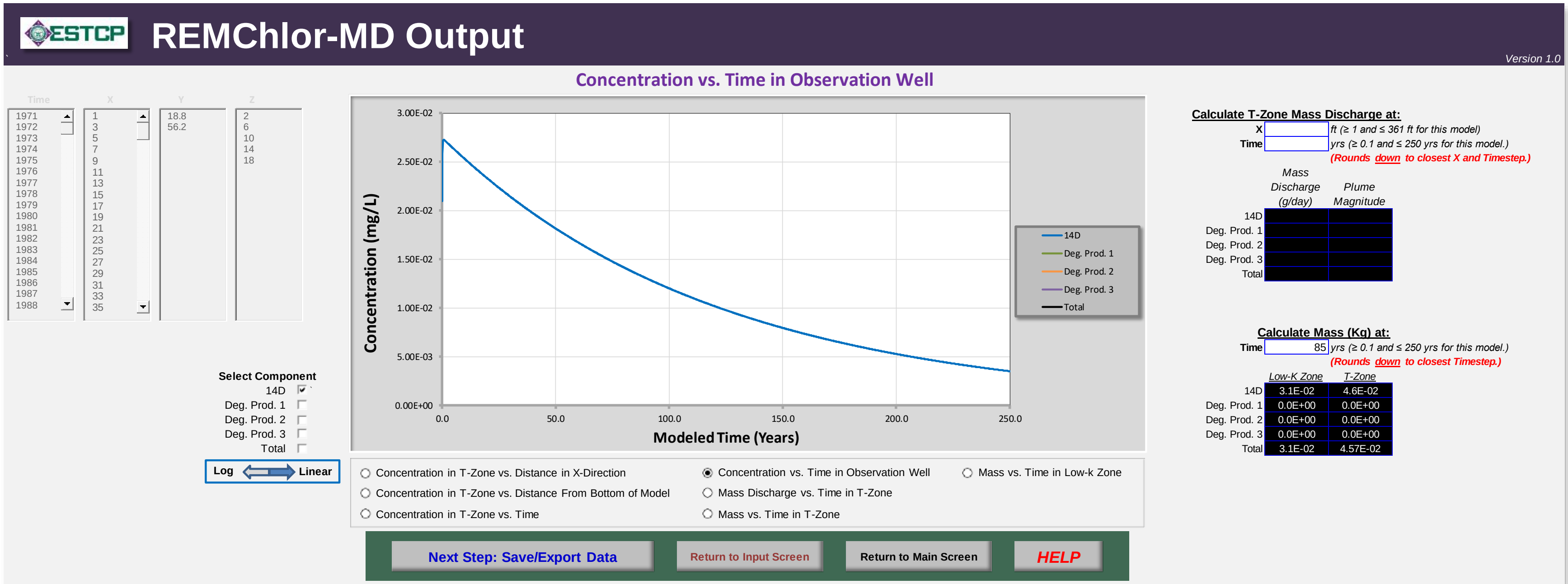



**Figure G-8. REMChlor-MD Output – Run 3 Concentration vs Time at MW1-25**

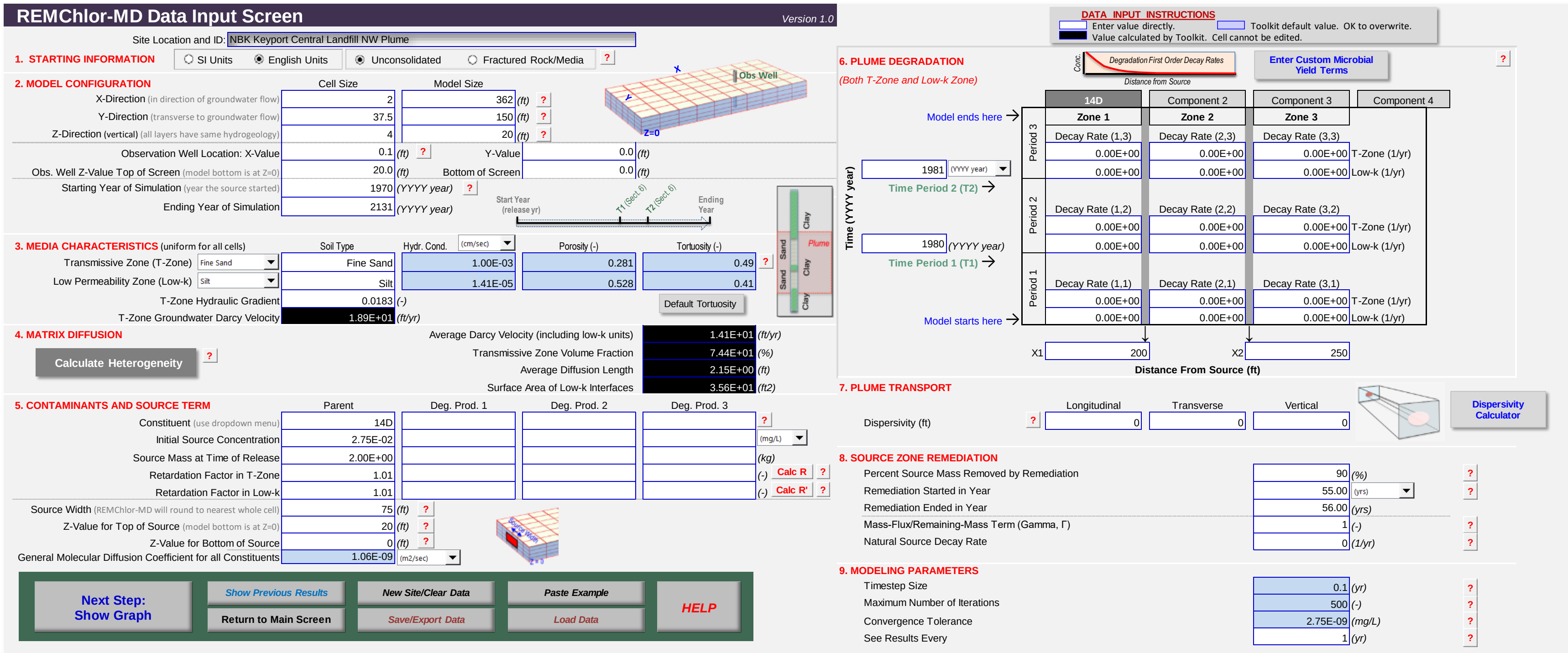



**Figure G-9. REMChlor-MD Input – Run 4**

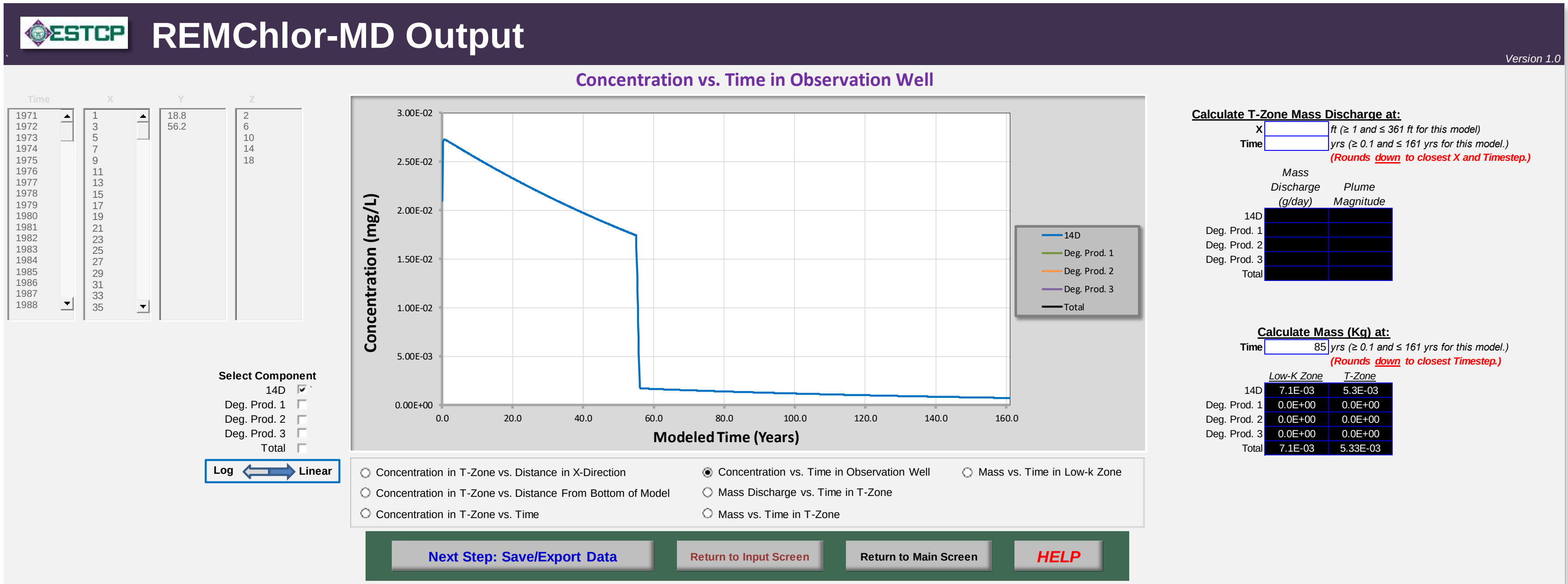



**Figure G-10. REMChlor-MD Output – Run 4 Concentration vs Time at MW1-25**

# Appendix G

## Three-Dimensional Plume Models (Provided on CD only)

# Appendix H

# Biodegradation Supplemental Info

**Table H-1. Historical Data of Upper Aquifer (1996 - 2015)**

| Well ID | Date | ORP (mV) | DO (mg/L) | pH | Nitrate + Nitrite Filtered (mg/L) | DOC - Filtered (mg/L) | Chloride - Filtered (mg/L) | Sulfate - Filtered (mg/L) | Sulfide Field Test (mg/L) | Methane (mg/L) | PCE (ug/L) | trans-1,2-DCE (ug/L) | VC (ug/L) | TCE (ug/L) | Cis-1,2-DCE (ug/L) | Iron (II) Field Test - filtered (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Southern Landfill*** | | | | | | | | | | | | | | | | |
| | Min - Max | -124 - 91 | <0.1 - 2.8 | 6 - 8.3 | <0.02 - 0.367 | 0.74 - 10.5 | 2.84 - 150 | <0.02 - 88.1 | <0.01 - 0.5 | 0.024 - 28.6 | <1 - 20 | <1 - 850 | 43.2 - 10000 | <1 - 90000 | 266 - 140000 | <0.01 - 4.2 |
| | 09-17-1996 | -- | 2.8 | 6.9 | <0.020 | -- | 14.8 | 7.1 | <0.010 | 1.2 | 20 | 109 | 970 | 7,800 | 7,300 | 1.82 |
| | 04-07-1997 | -- | 0.4 | 7.4 | 0.244 | -- | 6.6 | 8.6 | <0.010 | 0.7 | <3 | 24 | 410 | 3,300 | 1,200 | <0.010 |
| | 03-03-1998 | -- | 0.2 | -- | -- | -- | -- | -- | <0.010 | -- | -- | -- | -- | -- | -- | 0.01 |
| | 10-08-1998 | -- | 0.5 | 6.7 | -- | -- | -- | -- | <0.010 | -- | -- | -- | -- | -- | -- | 0.28 |
| | 06-07-1999 | -- | 0.1 | 6.6 | -- | -- | -- | -- | <0.010 | -- | -- | -- | -- | -- | -- | 1.24 |
| | 06-22-2000 | -26.4 | 0.1 | 6.8 | -- | -- | 19.2 | 5.5 | <0.010 | 0.561 | -- | -- | -- | -- | -- | -- |
| | 06-14-2001 | -8.5 | 0.5 | 6.5 | 0.08 | 2.5 | 22.4 | 5.42 | <0.010 | 3.65 | -- | -- | -- | -- | -- | 1.56 |
| | 06-13-2002 | -14 | 0.1 | 6.6 | 0.08 | 3.8 | 19.6 | 5.53 | <0.010 | 5.21 | -- | -- | -- | -- | -- | 1.16 |
| | 06-20-2003 | -- | 0.1 | 6.7 | <0.06 | 2.5 | 17.4 | 5.69 | <0.010 | 3.7 | -- | -- | -- | -- | -- | 0.22 |
| | 06-18-2004 | 91 | 0.1 | 6 | -- | 2.72 | 22.8 | 5.91 | <0.010 | 1.1 | <1,000 | <1,000 | 1600.00 | 32000.00 | 15000.00 | 0.12 |
| MW1-4 | 06-23-2005 | 45 | 0.1 | 7.9 | <0.06 | 0.74 | 7.32 | 8.81 | <0.010 | -- | -- | -- | -- | -- | -- | 0.03 |
| | 06-13-2006 | -1 | 0.1 | 6.6 | <0.06 | 3.89 | 19.6 | 5.71 | 0.01 | 2.1 | -- | -- | -- | -- | -- | 0.19 |
| | 06-20-2007 | -58 | <0.1 | 7 | <0.06 | 1.42 | 10.7 | 7.51 | <0.010 | 0.53 | -- | -- | -- | -- | -- | 0.23 |
| | 06-18-2008 | -- | 0.1 | 7.2 | 0.03 | 2.6 | 14.6 | 7.09 | <0.010 | 1.7 | -- | -- | -- | -- | -- | 0.19 |
| | 06-16-2009 | -95 | 0.4 | 7.7 | <0.04 | 0.78 | 9.02 | 8.68 | <0.010 | 0.73 | -- | -- | -- | -- | -- | <0.010 |
| | 06-15-2010 | -- | 0.8 | 6.9 | <0.04 | 4.51 | 15.7 | 6.37 | <0.010 | 4.1 | -- | -- | -- | -- | -- | 0.3 |
| | 06-21-2011 | -- | <0.1 | 6.9 | <0.02 | 4.60 | 16.8 | 6.18 | <0.010 | 2.9 | -- | -- | -- | -- | -- | 0.39 |
| | 06-05-2012 | -- | 0.1 | 6.8 | <0.02 | 2.31 | 13.3 | 6.34 | <0.010 | 2.8 | -- | -- | -- | -- | -- | 0.36 |
| | 07-10-2013 | -- | 0.1 | 6.6 | <0.040 | 3.29 | 13.2 | 6.49 | 0.006 | 2.1 | -- | -- | -- | -- | -- | 0.28 |
| | 06-23-2014 | -- | 0.2 | 6.9 | 0.05 | 2.01 | 9.91 | 6.92 | <0.010 | 1.6 | -- | -- | -- | -- | -- | 0.26 |
| | 07-07-2015 | -- | 0.1 | 7 | 0.367 | 1.88 | 6.96 | 6.5 | 0.01 | 0.52 | -- | -- | -- | -- | -- | 4.2 |
| | 09-17-1996 | -- | <0.1 | 6.7 | <0.020 | -- | 20.7 | 6.4 | <0.01 | 2.4 | <3 | <2 | 560 | 292 | 709 | 19.2 |
| | 04-07-1997 | -- | <0.1 | 6.6 | 0.08 | -- | 38.3 | 2.8 | 0.03 | 17.7 | <3 | <2 | 140 | 285 | 60 | 3.12 |
| | 03-04-1998 | -- | <0.1 | -- | -- | -- | -- | -- | <0.01 | -- | -- | -- | -- | -- | -- | 0.45 |
| | 10-08-1998 | -- | <0.1 | 6.4 | -- | -- | -- | -- | <0.01 | -- | -- | -- | -- | -- | -- | 11.3 |
| | 06-08-1999 | -- | 0.3 | 6.5 | -- | -- | -- | -- | 0.01 | -- | -- | -- | -- | -- | -- | 30.5 |
| | 06-22-2000 | -79.5 | M | 6.6 | -- | -- | 18.7 | 6.4 | <0.01 | 1.09 | -- | -- | -- | -- | -- | 38.8 |
| | 06-13-2001 | -69.7 | 0.3 | 6.4 | 0.12 | 9.6 | 11.7 | 6.03 | 0.01 | 2.39 | -- | -- | -- | -- | -- | 25.3 |
| | 06-13-2002 | -77 | 0.5 | 6.5 | 0.14 | 11 | 9.58 | 6.34 | 0.02 | 7.35 | -- | -- | -- | -- | -- | 20.5 |
| | 06-20-2003 | -- | 0.1 | 6.4 | <0.06 | 11 | 10.5 | 6.8 | 0.03 | 4.9 | -- | -- | -- | -- | -- | 2.98 |
| | 06-18-2004 | -- | 0.4 | 6.5 | -- | 7.17 | 9.76 | 5.56 | -- | 2.4 | <1.0 | <1.0 | 0.74 | 0.26 | 0.29 | >10.0 |
| MW1-5 | 06-22-2005 | -95 | <0.1 | 6.4 | 0.16 | 8.21 | 9.52 | 6.65 | 0.02 | -- | -- | -- | -- | -- | -- | 27.2 |
| | 06-13-2006 | -85 | 0.1 | 6.5 | 0.08 | 7.79 | 8.49 | 5.98 | 0.02 | 1.9 | -- | -- | -- | -- | -- | 14.1 |
| | 06-20-2007 | -106 | <0.1 | 6.5 | <0.06 | 8.01 | 44 | 1.68 | 0.03 | 1.1 | -- | -- | -- | -- | -- | 21 |
| | 06-18-2008 | -- | 0.3 | 6.6 | 0.15 | 5.93 | 8.37 | 7.3 | 0.01 | 1.8 | -- | -- | -- | -- | -- | 16 |
| | 06-16-2009 | -110 | 0.2 | 6.4 | 0.09 | 8.33 | 10.8 | 5.65 | 0.02 | 3.5 | -- | -- | -- | -- | -- | 14 |
| | 06-15-2010 | -- | <0.1 | 6.6 | 0.13 | 7.75 | 13.2 | 5.81 | 0.01 | 4.4 | -- | -- | -- | -- | -- | 22.8 |
| | 06-21-2011 | -- | 0.1 | 6.3 | 0.1 | 7.86 | 14.8 | 5.2 | <0.01 | 3.2 | -- | -- | -- | -- | -- | 22 |
| | 06-05-2012 | -- | 0.1 | 6.4 | 0.1 | 6.77 | 11.5 | 5.07 | 0.013 | 3.4 | -- | -- | -- | -- | -- | 26.5 |
| | 07-10-2013 | -- | 0.05 | 6.3 | 0.108 | 5.98 | 8.39 | 5.47 | 0.017 | 2 | -- | -- | -- | -- | -- | 15.5 |
| | 06-23-2014 | -- | <0.1 | 7 | 0.06 | 6.85 | 8.15 | 5.22 | 0.01 | 3.7 | -- | -- | -- | -- | -- | 23.8 |
| | 07-07-2015 | -- | <0.1 | 6.4 | <0.040 | 3.73 | 6.55 | 7.18 | 0.02 | 1.5 | -- | -- | -- | -- | -- | 8.3 |

**Table H-1. Historical Data of Upper Aquifer (1996 - 2015)**

| Well ID | Date | ORP (mV) | DO (mg/L) | pH | Nitrate + Nitrite Filtered (mg/L) | DOC - Filtered (mg/L) | Chloride - Filtered (mg/L) | Sulfate - Filtered (mg/L) | Sulfide Field Test (mg/L) | Methane (mg/L) | PCE (ug/L) | trans-1,2-DCE (ug/L) | VC (ug/L) | TCE (ug/L) | Cis-1,2-DCE (ug/L) | Iron (II) Field Test - filtered (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 09-17-1996 | -- | <0.1 | 6.5 | <0.020 | -- | 150 | 0.2 | <0.010 | 4.3 | <3 | 29 | 1,200 | 11 | 1,100 | 130 |
| | 09-17-1996 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | 04-07-1997 | -- | <0.1 | 6.5 | <0.020 | -- | 102 | 2.2 | 0.06 | 28.6 | 45 | 46 | 240 | 126 | 220 | 122 |
| | 03-04-1998 | -- | 0.3 | -- | -- | -- | -- | -- | 0.01 | -- | -- | -- | -- | -- | -- | 104 |
| | 10-08-1998 | -- | <0.1 | 6.3 | -- | -- | -- | -- | <0.01 | -- | -- | -- | -- | -- | -- | 176 |
| | 06-07-1999 | -- | 0.6 | 6.7 | -- | -- | -- | -- | 0.01 | -- | -- | -- | -- | -- | -- | 135 |
| | 06-22-2000 | -127 | 0.1 | 6.7 | -- | -- | 43.4 | 1.24 | 0.02 | 1.15 | -- | -- | -- | -- | -- | 60 |
| | 06-14-2001 | -- | 0.2 | 6.4 | 0.33 | 66 | 40 | 1.08 | 0.08 | 10.3 | -- | -- | -- | -- | -- | 55.5 |
| | 06-13-2002 | -139 | 0.9 | 6.5 | <0.05 | 71 | 17.3 | 0.4 | 0.04 | 23.9 | -- | -- | -- | -- | -- | 37.8 |
| | 06-20-2003 | -- | 0.2 | 6.5 | <0.60 | 29 | 6.81 | 0.6 | 0.06 | 9.7 | -- | -- | -- | -- | -- | 37 |
| MW1-16 | 06-22-2004 | -- | 0.1 | 6.3 | -- | 35.70 | 6.95 | 0.14 | 0.50 | 4.3 | <10 | 4.20 | 2.20 | <10 | 2.30 | >10.0 |
| | 06-23-2005 | -110 | 0.1 | 6.6 | <0.06 | 20.1 | 3.80 | 39.10 | 0.12 | -- | -- | -- | -- | -- | -- | 66 |
| | 06-13-2006 | -139 | 0.1 | 6.7 | <0.06 | 17.2 | 3.48 | 19.6 | 0.06 | 3 | -- | -- | -- | -- | -- | 14.1 |
| | 06-20-2007 | -124 | <0.1 | 6.4 | <0.06 | 18.5 | 6.54 | 9.7 | 0.13 | 2.1 | -- | -- | -- | -- | -- | 44.5 |
| | 06-18-2008 | -62.5 | 0.1 | 6.4 | <0.04 | 16.9 | 16.1 | 10.5 | 0.079 | 3.3 | -- | -- | -- | -- | -- | 28 |
| | 06-16-2009 | -80 | 0.2 | 6.4 | <0.04 | -- | 21.1 | 88.1 | 0.45 | 8.8 | -- | -- | -- | -- | -- | 43.7 |
| | 06-15-2010 | -- | 0.5 | 6.3 | <0.04 | 14.40 | 9.35 | 8.57 | 0.11 | 5.9 | -- | -- | -- | -- | -- | 22 |
| | 06-21-2011 | -- | 0.2 | 6.3 | <0.02 | 16 | 8.17 | 5.24 | 0.45 | 3.5 | -- | -- | -- | -- | -- | 17 |
| | 06-06-2012 | -- | 0.3 | 6.7 | <0.02 | 15.7 | 7.75 | 8.05 | 0.451 | 1.4 | -- | -- | -- | -- | -- | 17.5 |
| | 07-10-2013 | -- | 0.15 | 6.2 | <0.040 | 16.7 | 6.11 | 27 | 0.23 | 1.7 | -- | -- | -- | -- | -- | 27.2 |
| | 06-23-2014 | -- | 0.2 | 6 | <0.040 | 15.4 | 3.2 | 7.15 | 0.252 | 2.2 | -- | -- | -- | -- | -- | 12 |
| | 07-07-2015 | -- | 0.5 | 6.1 | <0.040 | 15.2 | 2.84 | 1.8 | 0.14 | 1.5 | -- | -- | -- | -- | -- | 8 |
| | 06-08-1999 | -- | 0.1 | 6.8 | -- | -- | -- | -- | 0.04 | -- | <400 | 170 | 5,400 | 74 | 16,000 | 0.02 |
| | 06-14-2001 | -38 | 0.2 | 6.4 | 0.23 | 34 | 47.4 | 4.91 | 0.12 | 6.33 | <20.0 | 217 | 9,900 | 371 | 16,400 | 0.95 |
| | 06-13-2002 | -11.1 | <0.1 | 6.4 | <0.05 | 26 | 37.1 | 4.31 | 0.11 | 10.7 | <20.0 | 166 | 5,140 | <20.0 | 3,660 | 1 |
| | 06-20-2003 | -- | 0.1 | 8.1 | <0.06 | 4.1 | 12.9 | 7.52 | 0.07 | 4.8 | <50 | 39.00 | 1,300 | 470 | 1,100 | 0.13 |
| | 06-18-2004 | -- | 0.1 | 8.7 | -- | 10.5 | 17.8 | 7.23 | 0.10 | 0.37 | <20 | 11.00 | 570.00 | <20 | 220.00 | 1 |
| | 06-22-2005 | -53 | 0.1 | 7.1 | <0.06 | 5.8 | 23.9 | 6.33 | 0.10 | 1.4 | <130 | 90.00 | 2900.00 | <130 | 4200.00 | 0.15 |
| | 06-13-2006 | -85 | 0.1 | 6.6 | <0.06 | 26.1 | 34.6 | 3.38 | 0.14 | 2.6 | <100 | 77.00 | 770.00 | <100 | 300.00 | 1.4 |
| P1-6 | 06-20-2007 | -274 | <0.1 | 8.3 | <0.06 | 3.88 | 10.5 | 7.14 | 0.07 | 0.38 | <8.0 | 5.40 | 140.00 | <8.0 | 84.00 | 0.08 |
| | 06-18-2008 | 218 | 0.1 | 8.3 | <0.04 | 10.3 | 22.4 | 5.52 | 0.069 | 2.2 | <200 | 130.00 | 9700.00 | <200 | 8800.00 | 0.1 |
| | 06-16-2009 | -133 | 0.1 | 8.2 | <0.04 | 3.24 | 15.9 | 6.06 | 0.06 | 2.2 | <100 | 93.00 | 2600.00 | 180.00 | 3900.00 | 0.07 |
| | 06-15-2010 | -- | 0.1 | 8.6 | <0.04 | 1.96 | 13.8 | 6.04 | 0.051 | 2.8 | <10.0 | 78.20 | 2860.00 | 23.20 | 8600.00 | 0.05 |
| | 06-21-2011 | -- | 0.1 | 8.2 | <0.02 | 2.20 | 11.3 | 6.38 | 0.05 | 1 | <10.0 | 32.00 | 1470.00 | <10.0 | 2020.00 | 0.06 |
| | 06-06-2012 | -- | 0.2 | 8.4 | <0.02 | 0.88 | 6.46 | 7.1 | 0.115 | 0.47 | <10.0 | <10.0 | 151.00 | <10.0 | 78.50 | 0.01 |
| | 07-10-2013 | -- | 0.15 | 8 | <0.040 | 1.43 | 10.9 | 5.77 | 0.022 | 0.62 | <10.0 | 18.10 | 1060.00 | <10.0 | 1540.00 | 0.03 |
| | 06-23-2014 | -- | 0.2 | 7.9 | <0.040 | 3.93 | 17.8 | 3.99 | -- | 3.5 | <10.0 | 60.70 | 3800.00 | <10.0 | 3420.00 | -- |
| | 07-07-2015 | -- | M | 8.3 | <0.040 | 1.34 | 7.69 | 5.89 | 0.01 | 0.84 | <10.0 | <10.0 | 289.00 | <10.0 | 452.00 | 0.02 |

**Table H-1. Historical Data of Upper Aquifer (1996 - 2015)**

| Well ID | Date | ORP (mV) | DO (mg/L) | pH | Nitrate + Nitrite Filtered (mg/L) | DOC - Filtered (mg/L) | Chloride - Filtered (mg/L) | Sulfate - Filtered (mg/L) | Sulfide Field Test (mg/L) | Methane (mg/L) | PCE (ug/L) | trans-1,2-DCE (ug/L) | VC (ug/L) | TCE (ug/L) | Cis-1,2-DCE (ug/L) | Iron (II) Field Test - filtered (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 06-08-1999 | -- | 0.1 | 6.7 | -- | -- | -- | -- | <0.010 | -- | <670 | 210 | 3,100 | 26,000 | 35,000 | 2.09 |
| | 06-22-2000 | -35 | 0.1 | 6.8 | -- | -- | 55.2 | 23.8 | <0.010 | 1.49 | 3.61 | 218 | 3,840 | 26,600 | 43,900 | 3.25 |
| | 06-14-2001 | -32.3 | 0.2 | 6.5 | <0.05 | 11 | 40.7 | 17.9 | <0.010 | 4.04 | <20.0 | 186 | 3,990 | 26,500 | 36,900 | 2.02 |
| | 06-14-2002 | -41 | 1.3 | 6.6 | <0.05 | 8.9 | 59.5 | 12.4 | <0.010 | 6.03 | <20.0 | 404 | 5,680 | 36,800 | 62,300 | 1.89 |
| | 06-20-2003 | -- | 0.1 | 6.6 | <0.06 | 5.6 | 41.8 | 7.51 | <0.010 | 4.8 | <2,000 | <2,000 | 2,800 | 28,000 | 35,000 | 1.31 |
| | 06-18-2004 | -- | <0.1 | 6.8 | -- | 6.9 | 56.2 | 9.8 | <0.010 | 1.7 | <3,300 | <3,300 | 5100.00 | 37000.00 | 61000.00 | 2 |
| | 06-22-2005 | -20 | 0.1 | 6.5 | <0.06 | 8.77 | 54.8 | 26.3 | <0.010 | 2.3 | <2,000 | 330.00 | 5000.00 | 28000.00 | 59000.00 | 1.92 |
| | 06-13-2006 | -60 | 0.5 | 6.6 | <0.06 | 7.64 | 48.8 | 20.2 | -- | 2.1 | <2,000 | <2,000 | 3800.00 | 24000.00 | 43000.00 | 1.82 |
| P1-7 | 06-20-2007 | -57 | 0.15 | 6.6 | <0.06 | 5.72 | 42.7 | 6.02 | <0.010 | 2.4 | <2,000 | 320.00 | 4000.00 | 33000.00 | 44000.00 | 1.18 |
| | 06-18-2008 | -18.9 | <0.1 | 6.7 | <0.04 | 6.68 | 49.3 | 6.9 | <0.010 | 3.8 | <2,000 | 370.00 | 14000.00 | 38000.00 | 65000.00 | 1.34 |
| | 06-16-2009 | -62 | 0.2 | 6.7 | <0.04 | 6.44 | 53.3 | 6.54 | 0.01 | 6.6 | <2,000 | 3900.00 | 10000.00 | 40000.00 | 92000.00 | 1.3 |
| | 06-15-2010 | -- | <0.1 | 6.8 | <0.04 | 6.36 | 35.2 | 16.7 | 0.01 | 5.5 | <50.0 | 184.00 | 3480.00 | 10900.00 | 27700.00 | 1.18 |
| | 06-21-2011 | -- | 0.3 | 6.7 | <0.02 | 6.32 | 30.5 | 16.6 | <0.010 | 2.7 | <100 | 305.00 | 1640.00 | 7580.00 | 18500.00 | 1.25 |
| | 06-05-2012 | -- | 0.3 | 7.1 | <0.02 | 5.25 | 26.2 | 10.3 | <0.010 | 4.6 | <100 | 129.00 | 2380.00 | 9230.00 | 19000.00 | 0.9 |
| | 07-10-2013 | -- | 0.1 | 6.5 | <0.040 | 4.81 | 41.1 | 5.91 | 0.008 | 3.5 | <100 | 259.00 | 4360.00 | 23900.00 | 53500.00 | 0.96 |
| | 06-23-2014 | -- | 0.2 | 7.2 | <0.040 | 4.70 | 36 | 4.63 | <0.010 | 4.7 | <100 | 305.00 | 6850.00 | 33800.00 | 55700.00 | 2.19 |
| | 07-07-2015 | -- | 0.3 | 6.8 | <0.040 | 1.62 | 12.2 | 8.28 | <0.010 | 1.1 | <100 | 144.00 | 810.00 | 16200.00 | 13700.00 | 0.59 |
| | 06-07-1999 | -- | M | 7.6 | -- | -- | -- | -- | 0.01 | -- | <710 | 210 | 3,400 | 190 | 25,000 | 0.08 |
| | 06-14-2001 | -73 | 0.1 | 7 | 0.06 | 4.7 | 17.6 | 0.13 | 0.02 | 6.9 | <20.0 | 62.1 | 4,200 | 813 | 8,570 | 0.22 |
| | 06-13-2002 | -46 | 0.3 | 6.9 | <0.05 | 8.8 | 35 | 0.3 | 0.02 | 11.3 | <20.0 | 190 | 7,700 | <20.0 | 23,700 | 0.38 |
| | 06-20-2003 | -- | 0.1 | 7.2 | <0.06 | 2.3 | 3.27 | 0.38 | <0.01 | 9.6 | <10 | <10 | 7.00 | 230 | 31 | 0.12 |
| | 06-18-2004 | -218 | 0.4 | 7.4 | -- | 3.04 | 5.91 | 0.38 | 0.01 | 1.7 | <1.0 | <1.0 | 23 | 0.26 | 2.7 | 0.01 |
| | 06-23-2005 | -147 | 0.2 | 7.5 | <0.06 | 13.8 | 4.19 | <0.18 | <0.01 | 3.4 | <1.0 | <1.0 | 21 | <1.0 | 7 | 0.12 |
| | 06-13-2006 | -124 | <0.1 | 7.5 | <0.06 | 3.22 | 7.99 | 0.36 | <0.01 | 4.5 | <20 | 4.00 | 58.00 | <20 | 620.00 | 0.02 |
| P1-8 | 06-20-2007 | -149 | 0.1 | 7.5 | <0.06 | 3.86 | 5.92 | <0.18 | <0.01 | 6.6 | <4.0 | <4.0 | 41.00 | 2.40 | 29.00 | 0.14 |
| | 06-18-2008 | -136 | <0.1 | 8 | <0.04 | 4.09 | 8.74 | 0.38 | <0.01 | 7.9 | <10 | <10 | 280.00 | <10 | 160.00 | 0.16 |
| | 06-15-2009 | -164 | <0.1 | 7.9 | <0.04 | 3.51 | 6.74 | 0.34 | <0.01 | 10 | <5.0 | <5.0 | 120.00 | <5.0 | 97.00 | 0.02 |
| | 06-15-2010 | -- | <0.1 | 7.6 | <0.04 | 3.51 | 5.97 | 0.43 | <0.01 | 13 | <1.0 | <1.0 | 147.00 | <1.0 | 188.00 | 0.1 |
| | 06-21-2011 | -- | 0.2 | 7.6 | <0.02 | 5.12 | 14.5 | <0.09 | 0.01 | 6.4 | <10.0 | 70.50 | 774.00 | <10.0 | 9090.00 | 0.11 |
| | 06-06-2012 | -- | 0.1 | 7.8 | <0.02 | 3.58 | 5.89 | 0.11 | <0.01 | 9.6 | <10.0 | <10.0 | 120.00 | <10.0 | 39.10 | 0.07 |
| | 07-10-2013 | -- | 0.2 | 7.8 | <0.040 | 3.98 | 7.59 | <0.09 | 0.014 | 8.1 | <10.0 | <10.0 | 99.70 | <10.0 | 20.90 | 0.09 |
| | 06-23-2014 | -- | 0.3 | 7.6 | <0.040 | 4.10 | 5.72 | 0.02 | <0.01 | 13 | <1.0 | <1.0 | 88.00 | <1.0 | 18.70 | <0.010 |
| | 07-07-2015 | -- | 0.1 | 7.7 | <0.040 | 4.10 | 5.89 | 0.04 | <0.01 | 11 | <1.0 | <1.0 | 107.00 | <1.0 | 18.10 | 0.08 |
| | 06-08-1999 | -- | 0.3 | 6.6 | -- | -- | -- | -- | <0.010 | -- | <2,000 | 470 | 7,200 | 48,000 | 88,000 | 0.03 |
| | 06-22-2000 | -17 | 0.1 | 6.8 | -- | -- | 58.9 | 6.6 | <0.010 | 1.7 | 4.99 | 321 | 5,790 | 87,900 | 63,900 | 0.2 |
| | 06-14-2001 | -124 | 0.1 | 7.8 | <0.05 | 1.7 | 14.3 | 7.64 | <0.010 | 1.36 | <40.0 | 32.4 | 446 | 29,200 | 7,280 | 0.05 |
| | 06-13-2002 | 17 | 0.6 | 6.5 | <0.05 | 9.8 | 70.8 | 5.62 | <0.010 | 7.54 | <20.0 | 588 | 7,900 | 90,000 | 78,700 | 0.42 |
| | 06-20-2003 | -- | 0.1 | 7 | <0.06 | 3.7 | 22.9 | 7.03 | 0.01 | 2.5 | <1,000 | <1,000 | 1,800 | 60,000 | 27,000 | <0.010 |
| | 06-18-2004 | -97 | 0.1 | 6.7 | -- | 3.97 | 26.1 | 7.33 | <0.010 | 0.71 | <1,300 | <1,300 | 2100.00 | 50000.00 | 23000.00 | 0.14 |
| | 06-23-2005 | 22 | 0.1 | 8.3 | <0.06 | 1.39 | 11.9 | 8.67 | <0.010 | 0.024 | <20 | 3.20 | 97.00 | 230.00 | 700.00 | 0.01 |
| | 06-13-2006 | -9 | 0.2 | 6.6 | <0.06 | 9.64 | 112 | 5.26 | 0.01 | 3.2 | <5,000 | 850.00 | 10000.00 | 74000.00 | 140000.00 | 0.33 |
| P1-9 | 06-20-2007 | -110 | 0.05 | 7.4 | <0.06 | 4.53 | 31.3 | 7.04 | <0.010 | 1.4 | <1,000 | 200.00 | 4200.00 | 55000.00 | 40000.00 | 0.13 |
| | 06-18-2008 | -- | <0.1 | 7.6 | <0.04 | 10.5 | 27.9 | 7.89 | <0.010 | 0.74 | <400 | 80.00 | 2000.00 | 9700.00 | 13000.00 | 0.07 |
| | 06-16-2009 | -27 | 0.2 | 6.8 | <0.04 | 6 | 72.4 | 5.44 | <0.010 | 6.7 | <2,500 | 1100.00 | 8700.00 | 62000.00 | 100000.00 | 0.15 |
| | 06-14-2010 | -- | <0.1 | 8.3 | <0.04 | 1.18 | 18.6 | 8.62 | <0.010 | 0.58 | <10.0 | 28.80 | 660.00 | 1720.00 | 7090.00 | <0.010 |
| | 06-21-2011 | -- | 0.2 | 7.5 | <0.02 | 1.99 | 28 | 7.17 | <0.010 | 1.2 | <200 | 262.00 | 2590.00 | 10200.00 | 30900.00 | 0.04 |
| | 06-05-2012 | -- | 0.2 | 8.2 | <0.02 | 0.47 | 7.66 | 8.94 | <0.010 | 0.3 | <200 | <10.0 | 107.00 | 193.00 | 495.00 | 0.01 |
| | 07-10-2013 | -- | 0.05 | 8.1 | <0.040 | 0.48 | 6.89 | 9.07 | 0.015 | 0.16 | <1.0 | 4.20 | 54.40 | 95.30 | 397.00 | <0.010 |
| | 06-23-2014 | -- | 0.6 | 8.2 | <0.040 | 0.80 | 18.4 | 7.89 | <0.010 | 0.23 | <1.0 | 17.80 | 356.00 | 906.00 | 1740.00 | 0.01 |
| | 07-07-2015 | -- | 0.1 | 8.1 | <0.040 | 0.49 | 7.53 | 8.93 | <0.010 | 0.31 | <10.0 | <10.0 | 73.70 | 391.00 | 709.00 | 0.02 |

**Table H-1. Historical Data of Upper Aquifer (1996 - 2015)**

| Well ID | Date | ORP (mV) | DO (mg/L) | pH | Nitrate + Nitrite Filtered (mg/L) | DOC - Filtered (mg/L) | Chloride - Filtered (mg/L) | Sulfate - Filtered (mg/L) | Sulfide Field Test (mg/L) | Methane (mg/L) | PCE (ug/L) | trans-1,2-DCE (ug/L) | VC (ug/L) | TCE (ug/L) | Cis-1,2-DCE (ug/L) | Iron (II) Field Test - filtered (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 06-07-1999 | -- | 0.3 | 6.7 | -- | -- | -- | -- | <0.010 | -- | <1,000 | 270 | 2,500 | 14,000 | 34,000 | 0.11 |
| | 06-22-2000 | -19 | M | 7.1 | -- | -- | 14.9 | <0.31 | <0.010 | 1.28 | 1.04 | 100 | 2,260 | 8,730 | 12,600 | 0.25 |
| | 06-13-2001 | -23.5 | 0.1 | 7.2 | <0.05 | 4.2 | 14.5 | 0.06 | <0.010 | 4.92 | <20.0 | 68.3 | 1,850 | 6,550 | 12,300 | 0.2 |
| | 06-12-2002 | 8.4 | 0.1 | 6.8 | <0.05 | 3.5 | 14.5 | <0.10 | <0.010 | 18.4 | <20.0 | 54.9 | 1,970 | 4,650 | 6,980 | 0.41 |
| | 06-19-2003 | -- | 0.1 | 6.6 | <0.06 | 3.5 | 16.5 | 2.56 | <0.010 | 8.2 | <400 | <400 | 1,100 | 2,300 | 9,400 | 0.34 |
| | 06-18-2004 | -69 | 0.1 | 6.3 | -- | 3.47 | 9.53 | <0.18 | <0.010 | 3.3 | <200 | <200 | 890.00 | 1600.00 | 3900.00 | 0.35 |
| | 06-23-2005 | 4.1 | 0.1 | 6.6 | <0.06 | 3.27 | 10.8 | <0.18 | <0.010 | 0.71 | <100 | 29.00 | 700.00 | 1100.00 | 3000.00 | 0.24 |
| | 06-13-2006 | -15 | 0.1 | 6.6 | <0.06 | 3.39 | 26.1 | <0.18 | <0.010 | 6.3 | <1,000 | 160.00 | 2500.00 | 2200.00 | 27000.00 | 0.15 |
| P1-10 | 06-20-2007 | -20.6 | <0.1 | 6.3 | <0.06 | 4.25 | 14.6 | <0.18 | <0.010 | 6.1 | <500 | 130.00 | 1700.00 | 1500.00 | 14000.00 | 0.31 |
| | 06-18-2008 | 13.9 | <0.1 | 6.8 | <0.04 | 4.21 | 7.28 | <0.18 | <0.010 | 4.7 | <200 | 60.00 | 1100.00 | 490.00 | 5800.00 | 0.23 |
| | 06-15-2009 | -6.1 | 0.1 | 6.7 | <0.04 | 4.01 | 6.62 | <0.18 | <0.010 | 3.4 | <20 | 34.00 | 140.00 | 250.00 | 1000.00 | 0.28 |
| | 06-14-2010 | -- | 0.1 | 6.7 | <0.04 | 4.99 | 6.48 | <0.18 | <0.010 | 4.1 | <10.0 | 16.20 | 43.20 | 4130.00 | 940.00 | 0.19 |
| | 06-21-2011 | -- | 0.1 | 6.8 | <0.02 | 5.52 | 5.64 | <0.09 | <0.010 | 3.6 | <10.0 | 12.70 | 182.00 | 423.00 | 936.00 | 0.25 |
| | 06-05-2012 | -- | 0.1 | 6.8 | <0.02 | 5.36 | 6.52 | 0.13 | <0.010 | 7.5 | <10.0 | 19.60 | 996.00 | 92.70 | 4390.00 | 0.28 |
| | 07-10-2013 | -- | 0.1 | 6.6 | <0.040 | 5.5 | 8.16 | <0.09 | 0.003 | 6.3 | <10.0 | 20.00 | 787.00 | 84.20 | 1660.00 | 0.32 |
| | 06-23-2014 | -- | 0.4 | 6.5 | <0.040 | 5.72 | -- | <0.02 | <0.010 | 7.2 | <10.0 | 17.70 | 1150.00 | 287.00 | 1040.00 | 0.22 |
| | 07-07-2015 | -- | 0.8 | 6.4 | <0.040 | 5.76 | 5.89 | 0.05 | <0.010 | 6.3 | <10.0 | 10.20 | 105.00 | 12.40 | 266.00 | 0.4 |
| ***Upgradient Southern Landfill*** | | | | | | | | | | 0.266 | | | | | | |
| | Min - Max | 7.2 - 290 | 0.1 - 3.4 | 6.3 - 7 | <0.02 - 0.02 | 1.27 - 1.98 | 14.5 - 43.4 | 8.34 - 20 | <0.01 - 0.001 | 0.024 - 0.266 | 0 - 0 | 0 - 0 | 0 - 0 | 0 - 0 | 0 - 0 | <0.01 - 0.34 |
| | 06-08-1999 | -- | 0.3 | 6.7 | -- | -- | -- | -- | <0.010 | -- | -- | -- | -- | -- | -- | 0.03 |
| | 06-21-2000 | 79.3 | M | 6.8 | <0.05 | -- | 14.5 | 15.5 | <0.010 | 0.008 | -- | -- | -- | -- | -- | 0.11 |
| | 06-13-2001 | 249 | 0.2 | 6.4 | <0.05 | 1.4 | 32.8 | 20 | <0.010 | 0.266 | -- | -- | -- | -- | -- | 0.011 |
| | 06-12-2002 | 179 | 0.1 | 7 | <0.05 | 1.4 | 28.9 | 16.5 | <0.010 | 0.059 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | 0.01 |
| | 06-17-2003 | 290 | 0.2 | 6.3 | <0.06 | 1.7 | 32.3 | 18 | -- | 0.09 | -- | -- | -- | -- | -- | 0.05 |
| | 06-15-2004 | 98.3 | 0.9 | 6.4 | -- | 1.56 | 35.4 | 17.8 | <0.010 | 0.027 | -- | -- | -- | -- | -- | 0.03 |
| | 06-20-2005 | 87 | 0.4 | 6.3 | <0.06 | 1.46 | 27.8 | 15.7 | <0.010 | -- | -- | -- | -- | -- | -- | 0.21 |
| | 06-13-2006 | 70 | 0.1 | 6.3 | <0.06 | 1.68 | 31.4 | 16.1 | <0.010 | 0.029 | -- | -- | -- | -- | -- | 0.08 |
| MW1-20 | 06-18-2007 | 7.2 | 0.2 | 6.8 | <0.06 | 1.76 | 25.3 | 13.8 | <0.010 | -- | -- | -- | -- | -- | -- | 0.34 |
| | 06-18-2008 | 74.2 | 3.4 | 6.6 | <0.04 | 1.55 | 38.3 | 18.6 | -- | -- | -- | -- | -- | -- | -- | 0.06 |
| | 06-15-2009 | -- | 0.3 | 6.5 | <0.04 | 1.59 | 23.9 | 13.1 | <0.010 | 0.047 | -- | -- | -- | -- | -- | 0.16 |
| | 06-14-2010 | -- | 0.5 | 6.9 | 0.02 | 1.27 | 43.4 | 17.9 | <0.010 | 0.03 | -- | -- | -- | -- | -- | 0.05 |
| | 06-20-2011 | -- | 0.3 | 6.5 | <0.02 | 1.64 | 27.1 | 13.1 | <0.010 | 0.017 | -- | -- | -- | -- | -- | 0.01 |
| | 06-05-2012 | -- | 0.2 | 6.7 | <0.02 | 1.50 | 34.4 | 13.2 | <0.010 | 0.034 | -- | -- | -- | -- | -- | <0.010 |
| | 07-09-2013 | -- | 2.5 | 6.5 | <0.040 | 1.72 | 28.2 | 11 | 0.001 | 0.22 | -- | -- | -- | -- | -- | 0.11 |
| | 06-23-2014 | -- | 0.1 | 6.5 | <0.040 | 1.90 | 20.4 | 8.34 | <0.010 | 0.093 | -- | -- | -- | -- | -- | 0.1 |
| | 07-07-2015 | -- | 0.1 | 6.4 | <0.040 | 1.98 | 22.2 | 8.76 | <0.010 | 0.032 | -- | -- | -- | -- | -- | 0.05 |

**Table H-1. Historical Data of Upper Aquifer (1996 - 2015)**

| Well ID | Date | ORP (mV) | DO (mg/L) | pH | Nitrate + Nitrite Filtered (mg/L) | DOC - Filtered (mg/L) | Chloride - Filtered (mg/L) | Sulfate - Filtered (mg/L) | Sulfide Field Test (mg/L) | Methane (mg/L) | PCE (ug/L) | trans-1,2-DCE (ug/L) | VC (ug/L) | TCE (ug/L) | Cis-1,2-DCE (ug/L) | Iron (II) Field Test - filtered (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Central Landfill*** | | | | | | | | | | | | | | | | |
| | Min - Max | -277 - -40.8 | <0.1 - 0.4 | 6.2 - 6.8 | 0 - 0 | 5.36 - 12.4 | 27.5 - 293 | 3.14 - 67.8 | <0.01 - 0.08 | 0.37 - 23.1 | 0 - 0 | <2 - 0.23 | 0.48 - 52 | 0 - 0 | 0.68 - 34 | 8.5 - 67.5 |
| | 09-17-1996 | -- | <0.1 | 6.5 | <0.020 | -- | 60.9 | 4.3 | <0.010 | 8.9 | <3 | <2 | 52 | <3 | 34 | 62.2 |
| | 04-07-1997 | -- | <0.1 | 6.6 | <0.020 | -- | 293 | 67.8 | M | 23.1 | <3 | <2 | M | <3 | 16 | 36.8 |
| | 10-09-1998 | -- | <0.1 | 6.4 | -- | -- | -- | -- | 0.02 | -- | -- | -- | -- | -- | -- | 55.6 |
| | 06-22-2000 | -40.8 | <0.1 | 6.5 | -- | -- | 158 | 19.1 | 0.02 | 2.78 | -- | -- | -- | -- | -- | 67.5 |
| | 06-12-2001 | -277 | 0.4 | 6.5 | <0.05 | 8 | 117 | 12 | 0.01 | 9.4 | -- | -- | -- | -- | -- | 48.3 |
| | 06-17-2004 | -- | <0.1 | 6.5 | -- | 7.51 | 148 | 17.8 | -- | 0.37 | <1.0 | 0.23 | 0.48 | <1.0 | 0.68 | >10.0 |
| | 06-20-2005 | -144 | <0.1 | 6.3 | <0.06 | 6.07 | 74.5 | 7.8 | 0.04 | -- | -- | -- | -- | -- | -- | 27.3 |
| | 06-20-2007 | -123 | <0.1 | 6.5 | <0.06 | 8.07 | 95.5 | 10.9 | 0.03 | 2.9 | -- | -- | -- | -- | -- | 22.2 |
| MW1-17 | 06-18-2008 | -109 | <0.1 | 6.6 | <0.04 | 6.06 | 58.7 | 7.31 | 0.037 | 5.5 | -- | -- | -- | -- | -- | 16.8 |
| | 06-15-2009 | -115 | <0.1 | 6.3 | <0.04 | 5.95 | 67.5 | 8.09 | 0.03 | 8.3 | -- | -- | -- | -- | -- | 8.5 |
| | 06-14-2010 | -104 | -- | 6.2 | <0.04 | 5.36 | 45.9 | 6.88 | 0.034 | 10 | -- | -- | -- | -- | -- | 20 |
| | 06-20-2011 | -- | 0.3 | 6.2 | <0.02 | 7.68 | 27.5 | 3.14 | 0.08 | 6.2 | -- | -- | -- | -- | -- | 23 |
| | 06-04-2012 | -- | <0.1 | 6.5 | <0.02 | 9.76 | 59 | 6.82 | 0.03 | 8.6 | -- | -- | -- | -- | -- | 30.8 |
| | 07-12-2013 | -- | <1.0 | 6.3 | <0.040 | 10 | 121.00 | 17.90 | 0.028 | 5.6 | -- | -- | -- | -- | -- | 19.2 |
| | 06-24-2014 | -- | <0.1 | 6.8 | <0.040 | 10 | 76.8 | 11.9 | 0.02 | 10 | -- | -- | -- | -- | -- | 18.8 |
| | 07-08-2015 | -- | 0.1 | 6.5 | <0.040 | 12.4 | 116.00 | 19.9 | 0.046 | 9.5 | -- | -- | -- | -- | -- | 13.5 |
| ***Northern Landfill*** | | | | | | | | | | | | | | | | |
| | Min - Max | -184 - 198 | <0.1 - 2.8 | 5.8 - 7.9 | 0 - 0 | 5 - 45 | 2.67 - 90.2 | <0.09 - 29.8 | <0.01 - 0.12 | 0.035 - 28.9 | 0 - 0 | <0.1 - 160 | <0.2 - 1000 | <0.1 - 440 | <0.1 - 4910 | 0.051 - 74 |
| | 06-09-1999 | -- | 0.3 | 6.6 | -- | -- | -- | -- | 0.01 | -- | -- | -- | -- | -- | -- | 60.5 |
| | 06-21-2000 | -75.4 | 0.1 | 6.5 | <0.05 | -- | 8.34 | <0.31 | <0.010 | 1.87 | -- | -- | -- | -- | -- | 55 |
| | 06-11-2001 | -89 | 0.3 | 6.3 | <0.05 | 14 | 9.88 | 29.8 | 0.02 | 25.3 | -- | -- | -- | -- | -- | 66 |
| | 06-10-2002 | -68 | 0.8 | 6.3 | <0.05 | 20 | 7.91 | 0.38 | 0.04 | 21.4 | -- | -- | -- | -- | -- | 51.5 |
| | 06-18-2003 | 93 | 0.1 | 6.3 | <0.06 | 20 | 9.47 | <0.18 | 0.03 | 14 | -- | -- | -- | -- | -- | 50 |
| | 06-17-2004 | -165 | 0.1 | 6.1 | -- | 19.5 | 10.6 | <0.18 | 0.02 | 7.4 | <1.0 | <1.0 | 0.23 | <1.0 | 0.27 | 57 |
| | 06-20-2005 | -- | <0.1 | 6.4 | <0.06 | 17 | 8.72 | <0.18 | 0.01 | -- | -- | -- | -- | -- | -- | 73.2 |
| | 06-12-2006 | -103 | <0.1 | 6.3 | <0.06 | 17.9 | 8.39 | <0.18 | 0.02 | 8.5 | -- | -- | -- | -- | -- | 27.5 |
| MW1-41 | 06-19-2007 | -124 | <0.1 | 6.7 | <0.06 | 19.7 | 8.69 | <0.18 | 0.01 | 6.3 | -- | -- | -- | -- | -- | 65.8 |
| | 06-16-2008 | -93 | <0.1 | 6.4 | <0.04 | 20.5 | 11.4 | <0.18 | 0.01 | 9.9 | -- | -- | -- | -- | -- | 40.8 |
| | 06-15-2009 | -99 | 0.1 | 6.2 | <0.04 | 19.4 | 15.8 | <0.18 | <0.010 | 18 | -- | -- | -- | -- | -- | 28.5 |
| | 06-14-2010 | -- | <0.1 | 6.4 | <0.04 | 17.40 | 14.5 | 0.28 | 0.017 | 24 | -- | -- | -- | -- | -- | 43 |
| | 06-20-2011 | -- | 0.1 | 6 | <0.02 | 18.9 | 12.8 | <0.09 | 0.01 | 11 | <0.1 | <0.1 | <0.2 | <0.1 | 0.2 | 63 |
| | 06-04-2012 | -- | 0.1 | 6.3 | <0.02 | 16.8 | 10.1 | 0.14 | 0.005 | 19 | -- | -- | -- | -- | -- | 47.2 |
| | 07-09-2013 | -- | 0.1 | 6.5 | <0.040 | 17.1 | 8 | 0.10 | 0.007 | 13 | -- | -- | -- | -- | -- | 40 |
| | 06-24-2014 | -- | <0.1 | 6.9 | <0.040 | 16.7 | 7.25 | 0.12 | <0.010 | 12 | -- | -- | -- | -- | -- | 54 |
| | 07-06-2015 | -- | 0.3 | 6.1 | <0.040 | 17.6 | 6.44 | 0.16 | <0.010 | 19 | -- | -- | -- | -- | -- | 49.7 |
| | 06-09-1999 | -- | 0.4 | 6.4 | -- | -- | -- | -- | <0.010 | -- | <2 | <1 | <4 | 11 | 6.1 | 59.2 |
| | 06-11-2002 | -80 | <0.1 | 6.3 | <0.05 | 17 | 9.3 | <0.10 | <0.010 | 28.9 | <0.2 | 0.1 | <0.2 | <0.2 | 0.2 | 40 |
| | 06-18-2003 | 78 | <0.1 | 6.2 | <0.06 | 18 | 10.6 | <0.18 | 0.02 | -- | <1 | <1 | <1 | <1 | 0.30 | 32.1 |
| | 06-17-2004 | -153 | 0.1 | 6 | -- | 16.4 | 9.23 | <0.18 | 0.02 | 3.7 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | 39 |
| | 06-22-2005 | -72 | <0.1 | 6.3 | <0.06 | 15 | 7.12 | <0.18 | <0.01 | 10 | <1.0 | <1.0 | <1.0 | <1.0 | 0.16 | 67.7 |
| | 06-12-2006 | -108 | <0.1 | 6.2 | <0.06 | 15.9 | 7.18 | <0.18 | 0.01 | 7.8 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | 53.5 |
| | 06-19-2007 | -139 | <0.1 | 6.1 | <0.06 | 15.2 d | 5.68 | <0.18 | 0.02 | 8.1 | -- | -- | -- | -- | -- | 49 |
| P1-1 | 06-16-2008 | -76 | 0.1 | 6.5 | <0.04 | 14.1 | 4.41 | <0.18 | 0.023 | 12 | <1.0 | <1.0 | <2.0 | <1.0 | 0.18 | 31.8 |
| | 06-15-2009 | -99 | <0.1 | 6.3 | <0.04 | 10.80 | 3.66 | <0.18 | 0.02 | 24 | <1.0 | <1.0 | <2.0 | <1.0 | 0.19 | 38 |
| | 06-14-2010 | -117 | <0.1 | 6.4 | <0.04 | 12.10 | 3.39 | 0.15 | 0.016 | 27 | <0.1 | <0.1 | <0.2 | <0.1 | <0.1 | 0.8 |
| | 06-20-2011 | -- | <0.1 | 6.4 | <0.02 | 12.6 | 3.04 | <0.09 | 0.01 | 12 | <0.1 | <0.1 | <0.2 | <0.1 | <0.1 | 41 |
| | 06-04-2012 | -- | 0.05 | 6.2 | <0.02 | 11.7 | 2.88 | 0.09 | 0.023 | 27 | <0.1 | <0.1 | <0.2 | <0.1 | <0.1 | 31.2 |
| | 07-09-2013 | -- | <0.1 | 6.2 | <0.040 | 12.2 | 2.77 | <0.09 | 0.017 | 14 | <0.1 | <0.1 | <0.2 | <0.1 | <0.1 | 35.8 |
| | 06-24-2014 | -- | 0.4 | 6.3 | <0.040 | 12.3 | 2.84 | 0.1 | 0.02 | 16 | <0.1 | <0.1 | <0.2 | <0.1 | <0.1 | 25 |
| | 07-06-2015 | -- | M | 6.2 | <0.040 | 12.7 | 2.67 | 0.13 | 0.02 | 19 | <0.1 | <0.1 | <0.2 | <0.1 | <0.1 | 35.7 |

**Table H-1. Historical Data of Upper Aquifer (1996 - 2015)**

| Well ID | Date | ORP (mV) | DO (mg/L) | pH | Nitrate + Nitrite Filtered (mg/L) | DOC - Filtered (mg/L) | Chloride - Filtered (mg/L) | Sulfate - Filtered (mg/L) | Sulfide Field Test (mg/L) | Methane (mg/L) | PCE (ug/L) | trans-1,2-DCE (ug/L) | VC (ug/L) | TCE (ug/L) | Cis-1,2-DCE (ug/L) | Iron (II) Field Test - filtered (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 06-09-1999 | -- | 0.2 | 6.8 | -- | -- | -- | -- | 0.04 | -- | <16 | 20 | 120 | 35 | 450 | 19 |
| | 06-11-2002 | -73 | <0.1 | 6.4 | <0.05 | 45 | 61.2 | 0.97 | 0.03 | 23.7 | <0.2 | 4.3 | 71.9 | <0.2 | 53.3 | 38.8 |
| | 06-18-2003 | 73 | 0.1 | 6.5 | <0.06 | 19 | 90.2 | 1.81 | 0.03 | -- | <2 | 4 | 79 | <2 | 58 | 29 |
| | 06-17-2004 | -- | <0.1 | 6.5 | -- | 21.4 | 56.6 | 0.55 | <0.010 | 5.7 | <1.0 | 2.4 | 41 | <1.0 | 15 | >10.0 |
| | 06-22-2005 | -88 | 0.1 | 6.4 | <0.06 | 20.1 | 67.5 | 0.38 | 0.03 | 8.4 | <1.0 | 1.3 | 35 | <1.0 | 11 | 59.5 |
| | 06-12-2006 | -152 | <0.1 | 6 | <0.06 | 20.3 | 51.3 | 0.24 | 0.03 | 7.1 | <1.0 | 1.2 | 16 | <1.0 | 4.6 | 39 |
| | 06-19-2007 | -136 | <0.1 | 6.5 | <0.06 | 21.8 | 55.4 | 0.24 | 0.03 | 7.1 | <1.0 | 1 | 15 | <1.0 | 1.8 | 39.5 |
| P1-3 | 06-17-2008 | -- | <0.1 | 6.4 | <0.04 | 22.8 | 31.1 | <0.18 | 0.028 | 14 | <1.0 | 0.31 | 0.67 | <1.0 | 0.17 | 32 |
| | 06-15-2009 | -160 | 0.2 | 6.2 | <0.04 | 20.1 | 44.8 | 0.11 | 0.03 | 18 | <1.0 | 0.71 | 5.8 | <1.0 | 0.73 | 2.62 |
| | 06-14-2010 | -- | 0.2 | 6.5 | <0.04 | 18.70 | 30.4 | 0.24 | 0.034 | 22 | <0.1 | 0.2 | <0.2 | <0.1 | <0.1 | 21 |
| | 06-20-2011 | -- | 0.3 | 6.3 | <0.02 | 18.8 | 21.1 | <0.09 | 0.06 | 11 | <0.2 | <0.2 | <0.4 | <0.2 | <0.2 | 47 |
| | 06-04-2012 | -- | 0.4 | 6.4 | <0.04 | 18.7 | 15 | 0.15 | 0.038 | 18 | <0.1 | 0.2 | <2.0 | <0.1 | 0.2 | 36.2 |
| | 07-09-2013 | -- | <1.00 | 6.3 | <0.040 | 19.7 | 38 | 0.09 | 0.014 | 13 | <1.0 | <1.0 | <2.0 | <1.0 | <1.0 | 20.8 |
| | 06-24-2014 | -- | <0.1 | 6.7 | <0.040 | 19.6 | 14.2 | 0.2 | <0.010 | 10 | <0.1 | <0.1 | <0.2 | <0.1 | <0.1 | -- |
| | 07-06-2015 | -- | 0.1 | 6.4 | <0.040 | 18.7 | 38.5 | 0.17 | 0.01 | 16 | <0.1 | 0.2 | 0.3 | <0.1 | <0.1 | 34.5 |
| | 06-09-1999 | -- | 0.3 | 6.9 | -- | -- | -- | -- | 0.02 | -- | <130 | 56 | 540 | 160 | 4,800 | 2.62 |
| | 06-13-2001 | -78.4 | 0.5 | 6.6 | <0.05 | 8.7 | 53.1 | 3.77 | <0.010 | 3.22 | <20.0 | 45.6 | 652 | <20.0 | 4,910 | 3.4 |
| | 06-11-2002 | -86 | 0.1 | 6.7 | <0.05 | 8 | 55.7 | 3.48 | <0.01 | 5.94 | <0.2 | 41.2 | 640 | 1.2 | 3,630 | 3.65 |
| | 06-18-2003 | 65 | 0.1 | 6.6 | <0.06 | 7 | 58.8 | 4.04 | 0.01 | 4.2 | <100 | 42.00 | 440 | <100 | 3,200 | 4.14 |
| | 06-17-2004 | -163 | 0.1 | 6.4 | -- | 7.66 | 47.9 | 4.07 | 0.02 | 1.8 | <130 | 29.00 | 370.00 | <130 | 2300.00 | 3 |
| | 06-21-2005 | -83 | 0.1 | 6.6 | <0.06 | 6.74 | 46.8 | 4.62 | <0.010 | 1.8 | <67 | 30.00 | 360.00 | <67 | 2100.00 | 2.32 |
| | 06-12-2006 | -94 | <0.1 | 6.4 | <0.06 | 6.75 | 43.7 | 4.29 | <0.010 | 1.7 | <50 | 24.00 | 280.00 | <50 | 1600.00 | 1.75 |
| P1-4 | 06-19-2007 | -99 | <0.1 | 6.7 | <0.06 | 7.08 | 43.5 | 4.7 | <0.010 | 2.5 | <40 | 24.00 | 280.00 | <40 | 1500.00 | 3.17 |
| | 06-16-2008 | -85.7 | <0.1 | 6.9 | <0.04 | 7.67 | 39.5 | 4.4 | 0.01 | 3.1 | <50 | 24.00 | 750.00 | <50 | 1600.00 | 3.5 |
| | 06-15-2009 | -100 | 0.6 | 6.8 | <0.04 | 7.48 | 39.4 | 4.13 | 0.01 | 6.4 | <40 | 34.00 | 350.00 | <40 | 1300.00 | 2.35 |
| | 06-14-2010 | -105 | 0.7 | 6.9 | <0.04 | 7.51 | 41.9 | 4.44 | 0.012 | 6.2 | <2.0 | 16.90 | 314.00 | <2.0 | 1200.00 | 0.12 |
| | 06-20-2011 | -- | <0.1 | 6.8 | <0.02 | 8.48 | 45.5 | 5.07 | <0.010 | 3.1 | <10.0 | 28.70 | 192.00 | <10.0 | 895.00 | 2.2 |
| | 06-04-2012 | -- | 0.1 | 6.9 | <0.02 | 7.29 | 52.4 | 4.92 | 0.005 | 3.5 | <10.0 | 15.50 | 249.00 | <10.0 | 1000.00 | 1.36 |
| | 07-09-2013 | -- | 0.1 | 6.7 | <0.040 | 7.3 | 74.3 | 5.02 | 0.009 | 2.2 | <10.0 | 14.00 | 146.00 | <10.0 | 630.00 | 2 |
| | 06-24-2014 | -- | 0.9 | 6.7 | <0.040 | 7.94 | 81.3 | 4.9 | <0.010 | 4.1 | <1.0 | 11.00 | 294.00 | <1.1 | 686.00 | 2.73 |
| | 07-06-2015 | -- | 0.3 | 6.8 | <0.040 | 7.85 | 87.5 | 5.69 | <0.010 | 4 | <1.0 | 11.30 | 149.00 | <1.0 | 634.00 | 4.8 |
| | 06-08-1999 | -- | 0.3 | 6.2 | -- | -- | -- | -- | 0.01 | -- | <13 | 4 | 11 | 440 | 400 | 71.5 |
| | 06-10-2002 | -59 | 0.1 | 6.2 | <0.05 | 25 | 17.2 | <0.60 | 0.02 | 23 | <0.2 | 0.8 | 0.4 | <0.2 | 0.3 | 62.3 |
| | 06-18-2003 | 65 | 0.1 | 6.2 | <0.06 | 24 | 16.5 | <0.18 | 0.02 | 18 | <25 | <25 | <25 | <25 | 7.80 | 54 |
| | 06-17-2004 | -- | <0.1 | 6.4 | -- | 22.9 | 14.5 | <0.18 | -- | 5.8 | <10 | <10 | <10 | <10 | <10 | >10.0 |
| | 06-21-2005 | -65 | 0.1 | 6.3 | <0.06 | 22.1 | 13.3 | 0.11 | 0.04 | 9.4 | <10 | <10 | <10 | <10 | <10 | 74 |
| | 06-12-2006 | -106 | <0.1 | 5.8 | <0.06 | 20.9 | 9.87 | 0.09 | 0.05 | 6.8 | <10 | <10 | <10 | <10 | <10 | 66.2 |
| | 06-19-2007 | -104 | <0.1 | 6.3 | <0.06 | 21.6 d | 9.32 | <0.18 | 0.04 | 8.5 | -- | -- | -- | -- | -- | 47.8 |
| P1-5 | 06-16-2008 | 29.2 | M | 6.3 | <0.04 | 20.7 | 10.2 | <0.18 | 0.035 | 14 | <50 | <50 | <100 | <50 | <50 | 44.5 |
| | 06-15-2009 | -165 | <0.1 | 6.3 | <0.04 | 19.3 | 12.5 | 0.17 | 0.12 | 22 | <20 | <20 | <40 | <20 | <20 | 33 |
| | 06-14-2010 | -- | <0.1 | 6.3 | <0.04 | 17.80 | 9.57 | 0.12 | 0.02 | 24 | <2.0 | <2.0 | <4.0 | <2.0 | <2.0 | 2.38 |
| | 06-20-2011 | -- | 0.4 | 6.3 | <0.02 | 18.1 | 9.28 | <0.09 | 0.03 | 9.7 | <2.0 | <2.0 | <4.0 | <2.0 | <2.0 | 38 |
| | 06-04-2012 | -- | <0.1 | 6.4 | <0.02 | 17.9 | 8.48 | <0.09 | 0.021 | 18 | <0.1 | 0.5 | <0.2 | <0.1 | 0.2 | 21.2 |
| | 07-09-2013 | -- | M | 6.1 | <0.040 | 19.3 | 6.77 | <0.09 | 0.021 | 19 | <0.1 | 0.4 | <0.2 | <0.1 | 0.1 | 18.2 |
| | 06-24-2014 | -- | 0.8 | 6.3 | <0.040 | 18.1 | 6.56 | 0.12 | 0.01 | 17 | <0.1 | 0.40 | <0.2 | <0.1 | 0.10 | 8.75 |
| | 07-06-2015 | -- | 0.2 | 6.2 | <0.040 | 19.5 | 5.81 | 0.18 | 0.03 | 14 | <1.0 | <1.0 | <2.0 | <1.0 | <1.0 | 31 |

**Table H-1. Historical Data of Upper Aquifer (1996 - 2015)**

| Well ID | Date | ORP (mV) | DO (mg/L) | pH | Nitrate + Nitrite Filtered (mg/L) | DOC - Filtered (mg/L) | Chloride - Filtered (mg/L) | Sulfate - Filtered (mg/L) | Sulfide Field Test (mg/L) | Methane (mg/L) | PCE (ug/L) | trans-1,2-DCE (ug/L) | VC (ug/L) | TCE (ug/L) | Cis-1,2-DCE (ug/L) | Iron (II) Field Test - filtered (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 09-17-1996 | -- | 2.8 | 7.9 | <0.020 | -- | 43.1 | 7.5 | <0.010 | 10 | <3 | 160 | 500 | <3 | 410 | 0.24 |
| | 04-07-1997 | -- | 0.4 | 7.2 | <0.020 | -- | 41.8 | 1.4 | 0.01 | 28.9 | <3 | 120 | 1,000 | <3 | 450 | 8 |
| | 03-05-1998 | -- | 0.1 | -- | -- | -- | -- | -- | 0.06 | -- | -- | -- | -- | -- | -- | 11.7 |
| | 10-09-1998 | -- | 0.5 | 7.7 | -- | -- | -- | -- | 0.01 | -- | -- | -- | -- | -- | -- | 0.39 |
| | 06-21-2000 | -92 | 0.5 | 7 | <0.05 | -- | 44.4 | 0.91 | <0.010 | 0.391 | -- | -- | -- | -- | -- | 13.2 |
| | 06-11-2001 | -110 | 0.7 | 7.1 | <0.05 | 12 | 49.6 | 2.23 | <0.010 | 5.61 | -- | -- | -- | -- | -- | 2.9 |
| | 06-10-2002 | -156 | 0.2 | 7.7 | <0.05 | 14 | 54 | 1.66 | <0.010 | 14.4 | -- | -- | -- | -- | -- | 7.25 |
| | 06-17-2003 | 198 | 0.1 | 7.3 | <0.06 | 10 | 54 | 2.25 | <0.010 | 7.1 | -- | -- | -- | -- | -- | 1.2 |
| | 06-16-2004 | -184 | 0.1 | 7 | -- | 7.66 | 57.6 | 1.96 | 0.03 | 1.8 | <20 | 130.00 | 730.00 | <20 | 130.00 | 0.38 |
| 1MW-1 | 06-21-2005 | -108 | 0.1 | 7.1 | <0.06 | 9.49 | 47.5 | 1.68 | 0.02 | -- | -- | -- | -- | -- | -- | 1.76 |
| | 06-12-2006 | -134 | 0.2 | 7.4 | <0.06 | 8.53 | 48.2 | 1.91 | 0.01 | 3.4 | -- | -- | -- | -- | -- | 0.8 |
| | 06-19-2007 | -164 | 0.1 | 7.3 | <0.06 | 6.79 | 7.66 | 6.37 | 0.04 | 1.7 | -- | -- | -- | -- | -- | 0.72 |
| | 06-17-2008 | -- | 0.2 | 7.4 | <0.04 | 9.6 | 39.5 | 1.32 | 0.011 | 5.4 | -- | -- | -- | -- | -- | 1.39 |
| | 06-15-2009 | -162 | 0.3 | 7.4 | <0.04 | 7.06 | 44.2 | 1.41 | 0.02 | 7.2 | -- | -- | -- | -- | -- | 0.55 |
| | 06-14-2010 | -- | 0.9 | 7 | <0.04 | 7.54 | 27.7 | 0.73 | 0.018 | 7.2 | -- | -- | -- | -- | -- | 0.71 |
| | 06-20-2011 | -- | 0.3 | 7.3 | <0.02 | 7.68 | 33.5 | 0.79 | 0.02 | 5.3 | -- | -- | -- | -- | -- | 22 |
| | 06-04-2012 | -- | 0.2 | 7.4 | <0.02 | 7.04 | 27.9 | 0.51 | 0.02 | 6.4 | -- | -- | -- | -- | -- | 0.3 |
| | 07-12-2013 | -- | 0.05 | 6 | <0.040 | 6.47 | 31 | 0.63 | 0.013 | 3.8 | -- | -- | -- | -- | -- | 0.051 |
| | 06-24-2014 | -- | 0.3 | 7.5 | <0.040 | 6.46 | 27.8 | 0.44 | 0.016 | 5.6 | -- | -- | -- | -- | -- | 0.44 |
| | 07-06-2015 | -- | 0.1 | 7.3 | <0.040 | 6.35 | 30.1 | 0.74 | 0.01 | 5.3 | -- | -- | -- | -- | -- | 0.36 |
| | 09-17-1996 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | 09-17-1996 | -- | 2.4 | 6.9 | <0.020 | -- | 49.9 | 4.6 | <0.010 | 1.2 | <3 | 21 | 87 | 28 | 1,100 | 0.23 |
| | 04-07-1997 | -- | 0.2 | 6.7 | <0.020 | -- | 44.1 | 4.6 | <0.010 | 2.5 | <3 | 30 | 160 | 30 | 1,100 | 0.13 |
| | 03-03-1998 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | 0.16 |
| | 10-07-1998 | -- | 0.1 | -- | -- | -- | -- | -- | <0.010 | -- | -- | -- | -- | -- | -- | 0.14 |
| | 06-09-1999 | -- | 0.2 | 6.8 | -- | -- | -- | -- | <0.010 | -- | -- | -- | -- | -- | -- | 0.09 |
| | 06-21-2000 | 37 | 0.1 | 6.8 | <0.05 | -- | 36 | 4.31 | <0.010 | 0.035 | -- | -- | -- | -- | -- | 0.1 |
| | 06-12-2001 | 26.8 | 0.3 | 6.5 | <0.05 | 5 | 48.2 | 5.44 | <0.010 | 0.788 | -- | -- | -- | -- | -- | 0.29 |
| | 06-11-2002 | 196 | 0.1 | 6.6 | <0.05 | 45 | 36.9 | 4.23 | <0.010 | 0.924 | -- | -- | -- | -- | -- | 0.27 |
| | 06-18-2003 | 62 | 0.1 | 6.4 | <0.06 | 6 | 41.4 | 4.28 | <0.010 | 0.98 | <2 | 4 | 79 | <2 | 58 | 0.29 |
| MW1-2 | 06-17-2004 | -- | 0.2 | 6.6 | -- | 6.67 | 39.8 | 4.32 | -- | 0.33 | <50 | 13.00 | 110.00 | 12.00 | 630.00 | 1 |
| | 06-22-2005 | -14 | <0.1 | 6.4 | <0.06 | 6.2 | 34.7 | 4.4 | <0.01 | -- | -- | -- | -- | -- | -- | 0.44 |
| | 06-12-2006 | -46.7 | 0.1 | 6.5 | <0.06 | 5.86 | 33.5 | 3.71 | <0.010 | 0.5 | -- | -- | -- | -- | -- | 0.76 |
| | 06-19-2007 | -50 | <0.1 | 6.4 | <0.06 | 6.03 | 30.5 | 3.78 | <0.010 | 0.26 | -- | -- | -- | -- | -- | 0.84 |
| | 06-17-2008 | -- | 0.1 | 6.6 | <0.04 | 6.35 | 26.1 | 3.46 | <0.010 | 0.43 | -- | -- | -- | -- | -- | 0.64 |
| | 06-15-2009 | -0.4 | 0.3 | 6.6 | <0.04 | 6.31 | 29.9 | 3.6 | 0.01 | 0.77 | -- | -- | -- | -- | -- | 1.2 |
| | 06-14-2010 | -- | <0.1 | 6.5 | <0.04 | 5.90 | 27.1 | 3.5 | <0.010 | 0.73 | -- | -- | -- | -- | -- | 1 |
| | 06-20-2011 | -- | 0.1 | 6.4 | <0.02 | 6.52 | 25.1 | 3.15 | <0.010 | 0.58 | -- | -- | -- | -- | -- | 0.82 |
| | 06-04-2012 | -- | 0.1 | 6.4 | <0.02 | 5.7 | 26 | 3.69 | <0.010 | 0.59 | -- | -- | -- | -- | -- | 1.13 |
| | 07-09-2013 | -- | 0.05 | 6.6 | <0.040 | 6.58 | 23.90 | 3.50 | <0.001 | 0.6 | -- | -- | -- | -- | -- | 1.02 |
| | 06-24-2014 | -- | 0.4 | 6.5 | <0.040 | 6.26 | 23.5 | 3.38 | <0.010 | 0.8 | -- | -- | -- | -- | -- | 1.21 |
| | 07-06-2015 | -- | 0.2 | 6.2 | <0.040 | 6.55 | 27.5 | 3.55 | <0.100 | 0.82 | -- | -- | -- | -- | -- | 1.6 |

**Table H-1. Historical Data of Upper Aquifer (1996 - 2015)**

| Well ID | Date | ORP (mV) | DO (mg/L) | pH | Nitrate + Nitrite Filtered (mg/L) | DOC - Filtered (mg/L) | Chloride - Filtered (mg/L) | Sulfate - Filtered (mg/L) | Sulfide Field Test (mg/L) | Methane (mg/L) | PCE (ug/L) | trans-1,2-DCE (ug/L) | VC (ug/L) | TCE (ug/L) | Cis-1,2-DCE (ug/L) | Iron (II) Field Test - filtered (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Upgradient North Landfill*** | | | | | | | | | | | | | | | | |
| | Min - Max | 0.5-398 | 0.02 - 4.3 | 5.5 - 6.2 | 0.502 - 1.77 | 1.1 - 2.85 | 5.08 - 23.9 | 10.7 - 18.5 | <0.01- 0.01 | <0.2 - 0.3 | 0 - 0 | 0 - 0 | 0 - 0 | 0 - 0 | 0 - 0 | <0.01 - 0.05 |
| | 06-09-1999 | -- | 0.4 | 6 | -- | -- | -- | -- | <0.010 | -- | -- | -- | -- | -- | -- | <0.010 |
| | 06-20-2000 | 178 | 0.3 | 5.9 | 0.99 | -- | 8.43 | 13 | <0.010 | 0.023 | -- | -- | -- | -- | -- | <0.010 |
| | 06-12-2001 | 221 | 4 | 6.1 | 1.14 | 1.1 | 10.1 | 13.5 | <0.010 | 0.122 | -- | -- | -- | -- | -- | 0.02 |
| | 06-10-2002 | 398 | 0.4 | 5.8 | 1.57 | 1.4 | 9.69 | 10.7 | <0.010 | 0.059 | -- | -- | -- | -- | -- | 0.01 |
| | 06-17-2003 | 200 | 4.3 | 6 | 1.77 | 1.7 | 10.3 | 11.6 | -- | 0.02 | -- | -- | -- | -- | -- | 0.05 |
| | 06-15-2004 | 195 | 0.2 | 5.7 | -- | 1.62 | 9.08 | 12.1 | <0.010 | 0.01 | -- | -- | -- | -- | -- | <0.010 |
| | 06-20-2005 | 0.5 | 0.1 | 6 | 1.59 | 1.39 | 7.52 | 15.1 | <0.010 | -- | -- | -- | -- | -- | -- | 0.01 |
| | 06-12-2006 | 136 | 0.1 | 5.5 | 1.63 | 1.35 | 6.97 | 13.6 | <0.010 | 0.4 | -- | -- | -- | -- | -- | <0.010 |
| MW1-3 | 06-18-2007 | -- | 0.6 | 5.9 | 1.08 | 1.84 | 5.88 | 15.9 | 0.01 | -- | -- | -- | -- | -- | -- | <0.010 |
| | 06-16-2008 | 261 | 0.6 | 6 | 1.09 | 2.01 | 5.08 | 17.7 | <0.010 | -- | -- | -- | -- | -- | -- | <0.010 |
| | 06-15-2009 | 206 | 0.2 | 6 | 1.01 | 1.63 | 7.31 | 18.5 | 0.01 | 0.012 | -- | -- | -- | -- | -- | 0.01 |
| | 06-14-2010 | -- | 0.5 | 5.9 | 0.92 | 1.51 | 5.64 | 17.1 | <0.010 | 0.4 | -- | -- | -- | -- | -- | 0.01 |
| | 06-20-2011 | -- | 0.1 | 5.8 | 0.64 | 2.49 | 16.4 | 17.1 | <0.010 | 0.3 | -- | -- | -- | -- | -- | 0.01 |
| | 06-04-2012 | -- | 0.2 | 5.9 | 0.99 | 1.58 | 12.4 | 16.6 | <0.010 | <0.2 | -- | -- | -- | -- | -- | <0.010 |
| | 07-09-2013 | -- | 0.02 | 5.8 | 0.923 | 1.92 | 19.2 | 17 | 0.003 | <0.2 | -- | -- | -- | -- | -- | -- |
| | 06-23-2014 | -- | 0.6 | 6.2 | 0.697 | 2.09 | 17.7 | 16.2 | <0.010 | <2 | -- | -- | -- | -- | -- | <0.010 |
| | 07-06-2015 | -- | 0.2 | 5.8 | 0.502 | 2.85 | 23.9 | 16.6 | <0.010 | <2.0 | -- | -- | -- | -- | -- | <0.010 |

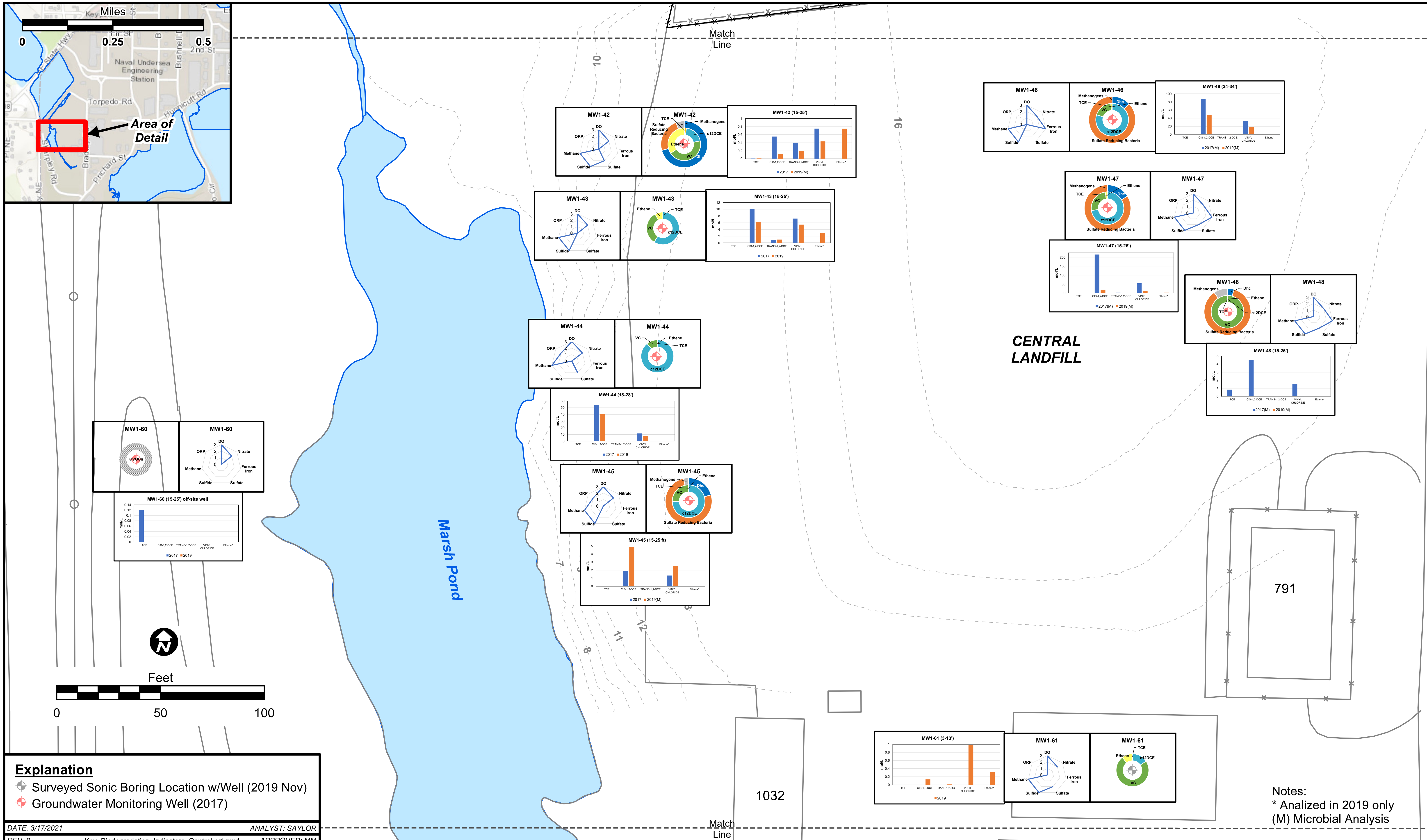
Note:
Sample is not filtered unless noted
Historical results from database as available. Not all notes and qualifiers were defined.
-- = no data   < = less than   > = greater than   M = presence verified but not quantified

**Table H-2. Biodegradation Potential**

| | | | TCE µg/L | | c12DCE µg/L | | VC µg/L | | Ethene µg/L | DO mg/L | | Nitrate mg/L | | Nitrite mg/L | | Ferrous Iron mg/L | Sulfate mg/L | | Sulfide mg/L | Methane mg/L | DOC mg/L | Chloride mg/L | ORP mV | | pH pH Unit | | Evidence for Reductive Dechlorination Score | | Evidence of Biodegradation Potential | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Evidence of Reductive Dechlorination | | Detected (2 pts) | | Detected (2 pts) | | Detected (2 pts) | | > 10 (2 pts); > 100 (3 pts) | < 1 (3 pts) | | < 1 (2 pts) | | NA | | > 1 (3 pts) | < 20 (2 pts) | | > 1 (3 pts) | > 0.5 (3 pts) | NA | NA | < -200 (2 pts) | | 5 > pH > 9 (- 2 pts) | | | | | |
| | | | 2017 | 2019 | 2017 | 2019 | 2017 | 2019 | 2019 | 2017 | 2019 | 2017 | 2019 | 2017 | 2019 | 2017 | 2017 | 2019 | 2019 | 2019 | 2019 | 2019 | 2017 | 2019 | 2017 | 2019 | 2017 | 2019 | 2017 | 2019 |
| | Well ID | Screen Intervals (ft bgs) | | | | | Southern Landfill Historic Range | | | **<0.1 - 2.8** | | **<0.02 - 0.37 (filtered)** | | | | **<0.1 - 4.2 (filtered)** | **<0.02 - 88.1 (filtered)** | | **<0.01 - 0.50 (unfiltered)** | **0.024 - 28.6 (Unfiltered)** | **0.7 - 10.5 (filtered)** | **2.84 - 150 (filtered)** | **-124 - +91** | | **6- 8.3** | | | | | |
| South Plantation | MW1-49 | 5 to 15 | 1040 | 940 | 2830 | 1300 | 280 | 100 | 4 | 0.43 | 0.08 | < 0.033 | 0.034 | < 0.033 | <0.010 | 0.19 | 16.6 | 10.8 | 2.1 | 0.046 | 1.04 | 5.85 | -57 | -87 | 7.85 | 7.51 | *11* | *14* | Limited | Limited |
| South Plantation | MW1-50 | 5 to 15 | 856 | 420 | 855 | 400 | 54.2 | 27 | < 0.47 | 0.28 | 2.25 | < 0.033 | <0.010 | < 0.033 | <0.010 | 0.03 | 9.47 | 8.47 | 0.607 | 0.028 | 0.578 | 4.71 | -13 | 36 | 7.91 | 7.45 | *11* | *8* | Limited | Limited |
| South Plantation | MW1-51 | 10 to 20 | < 0.25 | < 0.15 | 23.8 | 26 | 25.3 | 33 | 7 | 0.89 | 0 | < 0.033 | <0.010 | < 0.033 | <0.010 | 0.03 | 1.76 | 3.39 | 1.62 | 0.34 | 1.3 | 3.22 | -69 | -171 | 8.78 | 8.68 | *8* | *14* | Limited | Limited |
| South Plantation | MW1-52 | 7 to 17 | 4.37 | < 0.15 | 156 | 510 | 45.2 | 120 | 15 | 0.23 | 0 | < 0.033 | <0.010 | < 0.033 | <0.010 | -- | 0.947 | 0.713 | 1.39 | 3 | 1.76 | 3.76 | -26 | -181 | 8.76 | 8.75 | *13* | *19* | Limited | Adequate |
| South Plantation | MW1-53 | 5 to 15 | 216 | 130 | 773 | 760 | 189 | 220 | 18 | 0.22 | 0 | < 0.033 | 0.038 | < 0.033 | <0.010 | 0.03 | <0.33 | 0.21 | 1.6 | 7.5 | 3.5 | 5.17 | 25 | -131 | 8.36 | 8.23 | *13* | *19* | Limited | Adequate |
| South Plantation | MW1-54 | 29 to 39 | 2.86 | < 0.15 | 1.76 | < 0.15 | 0.464 | < 0.01 | < 0.47 | 0.66 | 0.69 | 0.577 | 1.01 | 0.105 | <0.010 | 0.03 | 5.78 | 5.05 | 1.54 | 0.0005 | 0.834 | 4.25 | 72 | 253 | 7.48 | 6.93 | *8* | *8* | Limited | Limited |
| South Plantation | MW1-55 | 26.5 to 36.5 | 357 | 3.1 | 492 | 130 | 75.2 | 24 | 1.1 | 0 | 0 | < 0.033 | < 0.044 | < 0.033 | <0.033 | 0.03 | 0.736 | 0.332 | 1.06 | 0.16 | 1.27 | 3.25 | -10 | 4 | 7.1 | 7.15 | *11* | *14* | Limited | Adequate |
| South Plantation | MW1-56-12' | 8 to 12 | 122000 | 170000 | 31000 | 200000 | < 500 | 890 | 71 | 0.26 | 0.01 | < 0.165 | <0.010 | < 0.165 | 0.112 | -- | 24.5 | 41.8 | 1 | 8.4 | 37.5 | 58.7 | -153 | -23 | 7.23 | 6.63 | *11* | *14* | Limited | Adequate |
| South Plantation | MW1-56-24' | 20 to 24 | 332000 | 590000 | 55200 | 71000 | < 625 | 72 | 1.4 | 0.24 | 0 | 0.093 | 0.038 | < 0.033 | 0.1 | 0.06 | 91 | 2.88 | 1.25 | 7 | 6.79 | 34.4 | -120 | 215 | 7.27 | 6.79 | *9* | *17* | Limited | Adequate |
| South Plantation | MW1-57-10.5' | 6 to 10.5 | 361000 | 250000 | 94300 | 260000 | 4810 | 8700 | 120 | 0.12 | 8.96 | 0.549 | <0.010 | < 0.033 | < 0.010 | 0.7 | 6.56 | 5.62 | 1.16 | 2.2 | 25.7 | 182 | -276 | -2 | 6.79 | 6.56 | *15* | *15* | Adequate | Adequate |
| South Plantation | MW1-57-16' | 12 to 16 | 218000 | 230000 | 58800 | 130000 | < 500 | 200 | 5.6 | 0.04 | 0 | 0.686 | <0.010 | 0.063 | 0.081 | -- | 4.86 | 0.306 | 0.906 | 7.7 | 9.95 | 43.3 | -205 | -3 | 6.78 | 6.36 | *11* | *14* | Limited | Adequate |
| South Plantation | MW1-57-32' | 27 to 32 | 9490 | 4600 | 2470 | 1800 | 406 | 230 | 27 | 0.05 | 0.32 | < 0.033 | <0.010 | < 0.033 | <0.010 | 0.7 | 0.667 | 0.234 | 1.48 | 3.8 | 3.97 | 5.88 | -124 | -46 | 7.06 | 7.01 | *13* | *19* | Limited | Adequate |
| South Plantation | MW1-58-9' | 5 to 9 | 66.6 | 370 | 23600 | 6900 | 9570 | 19000 | 830 | 0.56 | 6.87 | < 0.066 | <0.010 | < 0.066 | 0.242 | 1.53 | 36.2 | 0.352 | 1.95 | 6.7 | 16.5 | 99.5 | -128 | -47 | 6.98 | 6.52 | *14* | *20* | Limited | Adequate |
| South Plantation | MW1-58-19' | 15 to 19 | 27.6 | < 0.15 | 1110 | 3.1 | 106 | 9.1 | 0.91 | 0.07 | 0.26 | < 0.033 | 0.25 | < 0.033 | R | 2.18 | 1.9 | < 0.090 | 1.35 | 7.5 | 6.59 | 4.58 | -117 | -82 | 7.02 | 6.94 | *14* | *17* | Limited | Adequate |
| South Plantation | MW1-58-35' | 31 to 35 | 8.53 | < 0.15 | 79.2 | 2.1 | 9.64 | 5.2 | 1.1 | 0 | 0.03 | < 0.033 | < 0.044 | < 0.033 | 0.224 | 0.77 | 1.25 | 44.8 | 1.43 | 8.5 | 2.58 | 31 | -237 | -151 | 8.16 | 7.6 | *13* | *15* | Limited | Adequate |
| South Plantation | MW1-59 | 60 to 70 | -- | < 0.15 | -- | <0.15 | -- | < 0.015 | 0.47 | -- | 0 | -- | 0.034 | -- | <0.010 | -- | -- | 0.62 | 1.37 | 5.7 | 2.21 | 1.79 | -- | -230 | -- | 8.62 | -- | *15* | -- | Adequate |
| South Plantation | MW1-60 | 15 to 25 | 15.8 | < 0.15 | < 0.25 | < 0.15 | < 0.25 | < 0.015 | -- | 0.2 | 0 | < 0.033 | -- | < 0.033 | -- | 0.78 | < 0.330 | -- | -- | -- | -- | -- | -67 | -158 | 7.61 | 8.08 | *7* | *3* | Limited | Inadequate |
| South Plantation | MW1-66 | 5 to 20 | -- | 280000 | -- | 96000 | -- | 2200 | -- | -- | 0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -105 | -- | 6.25 | -- | *7* | -- | Limited |
| South Plantation | MW1-68 | 37 to 47 | -- | 35 | -- | 3.4 | -- | 0.062 | 7.3 | -- | 0 | -- | 0.038 | -- | < 0.010 | -- | -- | 0.43 | 1.48 | 7.6 | 2.85 | 1.89 | -- | -212 | -- | 8.41 | -- | *19* | -- | Adequate |
| | | | | | | | Central/Northern Landfill Historic Range | | | **<0.1 - 2.8** | | **<0.020 - <0.06 (filtered)** | | | | **0.05 - 74 (filtered)** | **< 0.09 - 68 (filtered)** | | **<0.01 - 0.12 (unfiltered)** | **0.04 -29 (Unfiltered)** | **5.3 - 23 (filtered)** | **2.67 - 90.2 (filtered)** | **-277 - +398** | | **5.8 - 7.9** | | | | | |
| Central Landfill | MW1-42 | 15 to 25 | 1.18 | 1.3 | 53.6 | 12 | 46.9 | 27 | 21 | 0.21 | 0.2 | < 0.033 | < 0.010 | < 0.033 | 0.052 | 0.4 | < 0.33 | 0.22 | 1.6 | 3.6 | 5.75 | 28.1 | -130 | -126 | 7.75 | 7.38 | *13* | *19* | Limited | Adequate |
| Central Landfill | MW1-43 | 15 to 25 | < 2.5 | < 3 | 982 | 610 | 452 | 340 | 82 | 0.04 | 0.06 | <0.165 | < 0.010 | < 0.165 | 0.481 | 0.67 | 20.3 | 27.8 | 1.06 | 7.3 | 6.5 | 325 | -158 | -134 | 7.75 | 7.66 | *11* | *15* | Limited | Adequate |
| Central Landfill | MW1-44 | 18 to 28 | < 12.5 | < 7.5 | 5250 | 3900 | 723 | 470 | 3.4 | 0.23 | 0 | < 0.165 | < 0.010 | < 0.165 | 0.623 | 0.03 | 14.4 | 15.8 | R | 2.5 | 5.74 | 332 | -85 | -210 | 8.59 | 8.8 | *11* | *16* | Limited | Adequate |
| Central Landfill | MW1-45 | 15 to 25 | < 0.5 | < 0.15 | 187 | 470 | 83.7 | 160 | < 0.47 | 2.89 | 0 | < 0.165 | < 0.010 | < 0.165 | < 0.010 | 0.02 | 26.3 | 21.5 | 1.33 | 6.3 | 9.64 | 108 | 9 | -221 | 8.8 | 8.84 | *6* | *17* | Limited | Adequate |
| Central Landfill | MW1-46 | 24 to 34 | < 25 | < 7.5 | 8500 | 4700 | 2050 | 1100 | 79 | 0.12 | 0 | < 0.165 | < 0.044 | < 0.165 | 1.05 | 2.4 | 52.5 | 65.5 | 1.35 | 6.3 | 9.15 | 210 | -106 | -133 | 7.05 | 7.23 | *14* | *17* | Limited | Adequate |
| Central Landfill | MW1-47 | 15 to 25 | 86.4 | < 3 | 20900 | 1800 | 3400 | 620 | 57 | 0.23 | 0 | < 0.165 | < 0.044 | < 0.165 | R | 1.91 | 1.97 | 1.59 | 1.16 | 17 | 25.1 | 24.1 | -47 | -54 | 6.82 | 6.37 | *16* | *19* | Adequate | Adequate |
| Central Landfill | MW1-48 | 15 to 25 | 111 | < 0.15 | 438 | < 0.15 | 98.2 | 0.28 | < 0.47 | 3.95 | 0.75 | < 0.066 | <0.010 | <0.0 66 | < 0.010 | 1.07 | < 0.66 | 0.363 | 1.39 | 15 | 17.4 | 21.7 | -61 | -31 | 6.78 | 6.35 | *11* | *12* | Limited | Limited |
| Central Landfill | MW1-61 | 3 to 13 | -- | < 0.15 | -- | 13 | -- | 61 | 8.8 | -- | 0 | -- | 0.036 | -- | < 0.010 | -- | -- | 0.697 | 1.45 | 10 | 5.84 | 4.32 | -- | -92 | -- | 7.4 | -- | *17* | -- | Adequate |
| North Plantation | MW1-62 | 31 to 41 | -- | 34 | -- | 1200 | -- | 300 | 11 | -- | 0 | -- | <0.044 | -- | 0.355 | -- | -- | 11.9 | 1.45 | 0.39 | 7.1 | 67.2 | -- | -136 | -- | 7.31 | -- | *16* | -- | Adequate |
| North Plantation | MW1-63 | 30 to 40 | -- | 20 | -- | 4200 | -- | 570 | 40 | -- | 0 | -- | <0.044 | -- | 0.475 | -- | -- | 8.67 | 1.64 | 8.1 | 12.1 | 84.5 | -- | -61 | -- | 6.77 | -- | *19* | -- | Adequate |
| North Plantation | MW1-64 | 45 to 55 | -- | < 7.5 | -- | 2200 | -- | 390 | 21 | -- | 0.05 | -- | < 0.010 | -- | 0.114 | -- | -- | 14.2 | 2.18 | 3.7 | 11.1 | 63.6 | -- | -78 | -- | 6.81 | -- | *19* | -- | Adequate |
| North Plantation | MW1-65 | 53 to 63 | -- | 1.3 | -- | 350 | -- | 58 | 8.2 | -- | 0 | -- | < 0.010 | -- | < 0.010 | -- | -- | 37.2 | 0.983 | 2.2 | 5.92 | 380 | -- | -241 | -- | 7.53 | -- | *17* | -- | Adequate |
| North Plantation | MW1-67 | 5 to 15 | -- | < 0.15 | -- | < 0.15 | -- | 0.05 | < 0.47 | -- | 0.02 | -- | < 0.010 | -- | < 0.010 | -- | -- | 0.624 | 1.16 | 19 | 11.6 | 20.9 | -- | -203 | -- | 8.55 | -- | *17* | -- | Adequate |

Notes
Historical range concentrations are from the USGS 2015 Reports
Historical concentrations for nitrate and nitrite were reported as nitrate + nitrite. For this report, the historical range is repeated for both nitrate and nitrite for comparison. R = indicates rejected data
Data highlighted in the light yellow indicates data from the South Plantation
Data highlighted in the pale orange indicates data from the Central Landfill
Data highlighted in the bright orange indicates data from the North Plantation
For Biodegradation scoring purposes the data values are used to indicate a detection versus no detection, or a value within a general range. So for this use of the data, validation qualifiers are not included in this presentation

| Score Range | |
|---|---|
| 0 to 5 | Inadequate evidence for reductive dechlorination of chlorinated organics |
| 6 to 14 | Limited evidence for reductive dechlorination of chlorinated organics |
| 15 to 20 | Adequate evidence for reductive dechlorination of chlorinated organics |
| > 20 | Strong evidence for reductive dechlorination of chlorinated organics |




## Explanation

- Surveyed Sonic Boring Location w/Well (2019 Nov)
- Groundwater Monitoring Well (2017)

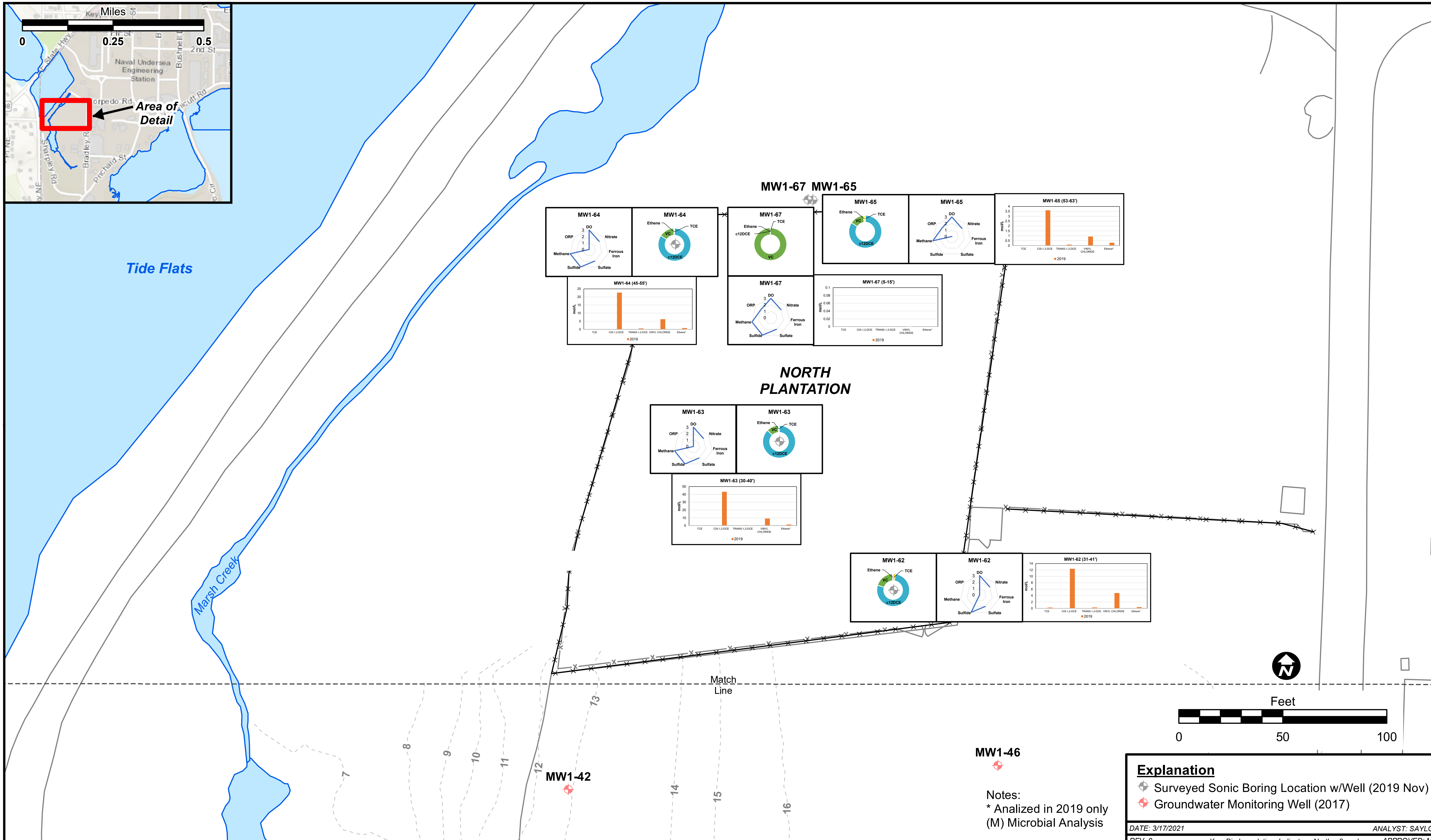
Notes:
* Analized in 2019 only
(M) Microbial Analysis

DATE: 3/17/2021 ANALYST: SAYLOR
REV. 0 Key_Biodegradation_Indicators_Central_v1.mxd APPROVED: MM

**U.S. NAVY**

# Distribution of Key Biodegradation Indicators – Central

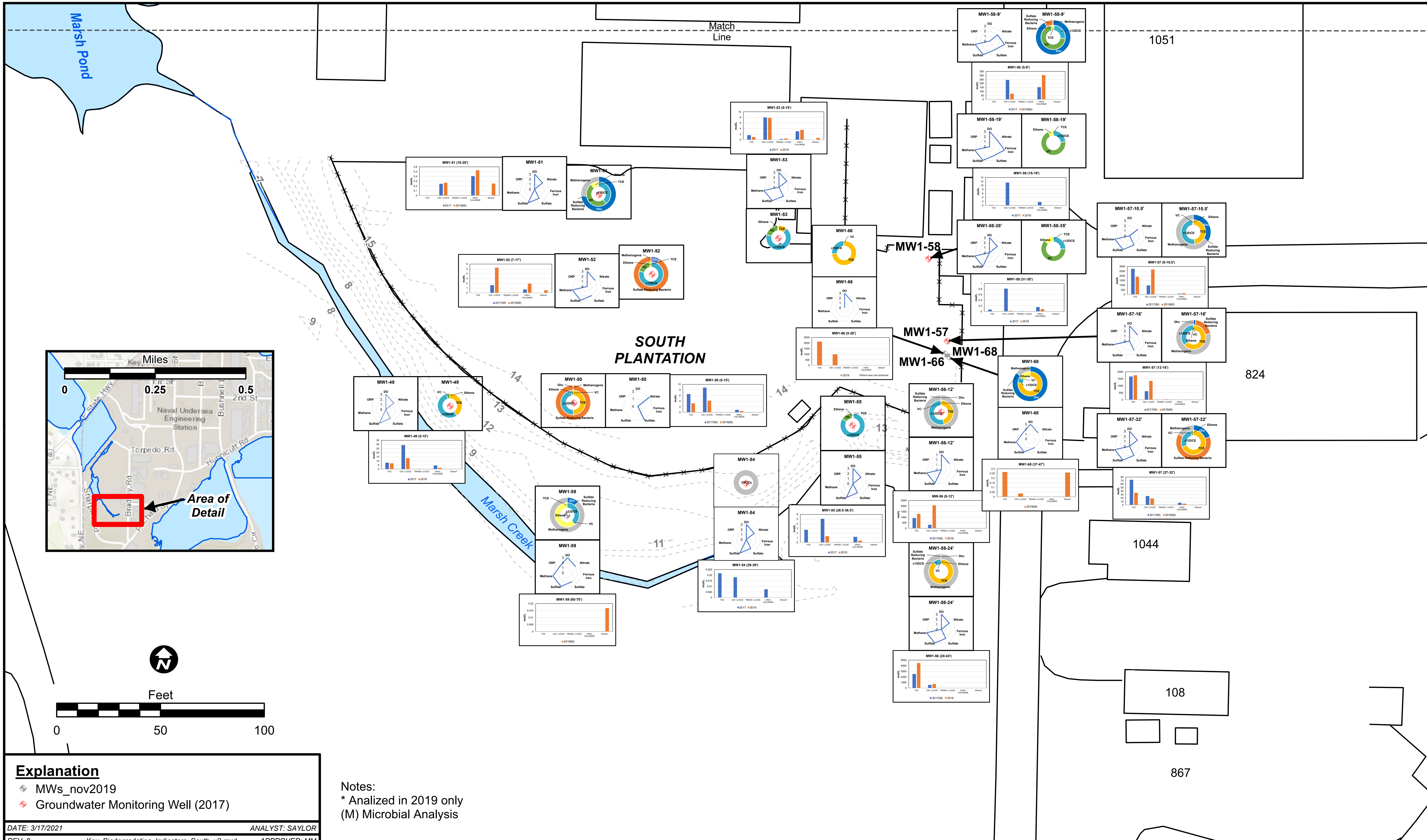
Naval Base Kitsap Keyport




**U.S. NAVY**

**Distribution of Key Biodegradation Indicators – North**

Naval Base Kitsap Keyport




**U.S. NAVY**

# Distribution of Key Biodegradation Indicators – South

Naval Base
Kitsap Keyport

# Appendix I

# 2017 PCB Data Summary

# APPENDIX I

## ATTACHMENT I-1: 2017 PCB Data Summary

## Table I1-1. PCBs in Soil (mg/kg)

| | Location Name | CL-B18a | | CL-B21 | | SP-B01 | | SP-B62 | |
|---|---|---|---|---|---|---|---|---|---|
| | Sample Name | CL-B18a-S-18.0-170718 | | CL-B21-S-12.0-170720 | | SP-B01-S-17.5-170711 | | SP-B62-S-7.0-170803 | |
| | Sample Type | N | | N | | N | | N | |
| **Analyte Name** | **PAL* (mg/kg)** | **Result** | | **Result** | | **Result** | | **Result** | |
| Aroclor-1016 | 5.6 | 0.029 | U | 0.025 | U | 0.023 | U J | 0.31 | U J |
| Aroclor-1221 | NE | 0.014 | U | 0.012 | U | 0.012 | U | 0.15 | U J |
| Aroclor-1232 | NE | 0.014 | U | 0.012 | U | 0.012 | U | 0.15 | U J |
| Aroclor-1242 | NE | 0.005 | U | 0.0043 | U | 0.0041 | U | 0.054 | U J |
| Aroclor-1248 | NE | 0.014 | U | 0.012 | U | 0.012 | U | 0.15 | U J |
| Aroclor-1254 | 0.5 | 0.053 | | 0.0062 | U | **1.1** | | 0.32 | J |
| Aroclor-1260 | 0.5 | 0.01 | U | 0.0087 | U | 0.34 | J | 0.11 | U J |

Notes:
These samples were collected from apparent residual source areas in the Central Landfill (CL-B18a and CL-B21) and South Plantation (SP-B01 and SP-B62) and the locations are not shown on figures in this memorandum.
* WAC 173-340-747; Soil Method B cleanup level
Samples analyzed using U.S. EPA Method 8082 A.
J – The result is an estimated concentration that is less than the limit of quantitation, but greater than or equal to the detection limit.
mg/kg – milligram per kilogram
N – Sample is not part of a field duplicate pair.
NE - not established
PAL – project action level
PCB – polychlorinated biphenyl
U – The compound was analyzed for, but was not detected ("non-detect") at or above the limit of detection.
U J – The analyte was not detected at the stated sample quantitation limit, which is an estimated value.

## Table I1-2. Sediment PCB Congener Analysis by EPA Method 1668A (µg/kg)

| Location Name | | MA-09 | | MA-14 | | | | MA-19 | | SP1-1 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | | SED02-10-170906 | | FD-170906-01 | | SED01-10-170906 | | SED04-10-170906 | | SED03-10-170906 | | SED05-10-170907 | |
| Sample Type | | N | | FD | | P | | N | | N | | N | |
| **Analyte** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-001 | NA | 0.036 | U | 0.0078 | U | 0.0065 | U | 0.0068 | U | 0.0064 | U | 0.0091 | U |
| PCB-002 | NA | 0.022 | J | 0.0024 | J | 0.002 | J q | 0.0019 | J q | 0.0017 | J q | 0.004 | J q |
| PCB-003 | NA | 0.039 | J | 0.0045 | J | 0.0031 | J q | 0.0026 | J q | 0.0019 | J q | 0.0072 | J |
| PCB-004 | NA | 0.42 | | 0.063 | | 0.066 | | 0.035 | | 0.029 | q | 0.041 | |
| PCB-005 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-006 | NA | 0.25 | q | 0.084 | | 0.091 | | 0.027 | | 0.031 | q | 0.056 | |
| PCB-007 | NA | 0.085 | U | 0.0029 | J q | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-008 | NA | 0.4 | | 0.14 | | 0.12 | | 0.044 | | 0.052 | | 0.13 | |
| PCB-009 | NA | 0.085 | U | 0.0047 | J q | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-010 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-011 | NA | 0.085 | U | 0.013 | U | 0.019 | U | 0.014 | U | 0.013 | U | 0.034 | U |
| PCB-012 | NA | 0.056 | J C q | 0.012 | C q | 0.012 | q C | 0.0088 | J C | 0.0073 | J C q | 0.018 | C |
| PCB-013 | NA | 0.056 | J C12 q | 0.012 | C12 q | 0.012 | q C12 | 0.0088 | J C12 | 0.0073 | J C12 q | 0.018 | C12 |
| PCB-014 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-015 | NA | 0.4 | | 0.09 | | 0.088 | | 0.051 | | 0.053 | | 0.089 | |
| PCB-016 | NA | 0.31 | | 0.062 | | 0.062 | | 0.022 | | 0.028 | | 0.045 | |
| PCB-017 | NA | 0.54 | B q | 0.086 | B | 0.085 | B | 0.03 | B | 0.035 | B | 0.096 | B |
| PCB-018 | NA | 1.6 | C | 0.21 | C | 0.21 | C | 0.089 | C | 0.089 | C | 0.17 | C |
| PCB-019 | NA | 0.19 | | 0.025 | | 0.027 | | 0.0085 | J | 0.0093 | J | 0.025 | |
| PCB-020 | NA | 1.8 | C B | 0.27 | C B | 0.25 | C B | 0.15 | C B | 0.15 | C B | 0.3 | C B |
| PCB-021 | NA | 0.82 | C B | 0.084 | C B | 0.062 | C B | 0.034 | C B | 0.032 | C B | 0.11 | C B |
| PCB-022 | NA | 0.32 | | 0.057 | | 0.048 | | 0.025 | | 0.026 | | 0.043 | |
| PCB-023 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-024 | NA | 0.014 | J | 0.0026 | J q | 0.0027 | J | 0.013 | U | 0.001 | J | 0.015 | U |
| PCB-025 | NA | 1.1 | | 0.07 | | 0.066 | | 0.044 | | 0.038 | | 0.088 | |

**Table I1-2. Sediment PCB Congener Analysis by EPA Method 1668A (µg/kg)**

| Location Name | | MA-09 | | MA-14 | | | | MA-19 | | SP1-1 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | | SED02-10-170906 | | FD-170906-01 | | SED01-10-170906 | | SED04-10-170906 | | SED03-10-170906 | | SED05-10-170907 | |
| Sample Type | | N | | FD | | P | | N | | N | | N | |
| Analyte | PAL | Result | | Result | | Result | | Result | | Result | | Result | |
| PCB-026 | NA | 3. | C | 0.13 | C | 0.13 | C | 0.1 | C | 0.08 | C | 0.14 | C |
| PCB-027 | NA | 0.25 | | 0.034 | q | 0.038 | | 0.014 | q | 0.014 | q | 0.079 | |
| PCB-028 | NA | 1.8 | B C20 | 0.27 | B C20 | 0.25 | C20 B | 0.15 | B C20 | 0.15 | B C20 | 0.3 | B C20 |
| PCB-029 | NA | 3. | C26 | 0.13 | C26 | 0.13 | C26 | 0.1 | C26 | 0.08 | C26 | 0.14 | C26 |
| PCB-030 | NA | 1.6 | C18 | 0.21 | C18 | 0.21 | C18 | 0.089 | C18 | 0.089 | C18 | 0.17 | C18 |
| PCB-031 | NA | 1.7 | B | 0.18 | B | 0.15 | B | 0.095 | B | 0.094 | B | 0.16 | B |
| PCB-032 | NA | 0.54 | B | 0.067 | B | 0.062 | B | 0.021 | B | 0.022 | B | 0.12 | B |
| PCB-033 | NA | 0.82 | B C21 | 0.084 | B C21 | 0.062 | C21 B | 0.034 | B C21 | 0.032 | B C21 | 0.11 | B C21 |
| PCB-034 | NA | 0.085 | U | 0.012 | U | 0.012 | U q | 0.013 | U | 0.013 | U | 0.0025 | J |
| PCB-035 | NA | 0.086 | | 0.0036 | J | 0.0025 | J q | 0.013 | U | 0.0018 | J | 0.0056 | J |
| PCB-036 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-037 | NA | 0.41 | | 0.052 | | 0.042 | | 0.031 | | 0.03 | | 0.057 | |
| PCB-038 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-039 | NA | 0.024 | J q | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-040 | NA | 4.7 | C | 0.15 | C | 0.14 | C | 0.087 | C | 0.078 | C | 0.37 | C |
| PCB-041 | NA | 4.7 | C40 | 0.15 | C40 | 0.14 | C40 | 0.087 | C40 | 0.078 | C40 | 0.37 | C40 |
| PCB-042 | NA | 2.1 | | 0.07 | | 0.068 | | 0.028 | | 0.033 | | 0.1 | |
| PCB-043 | NA | 0.085 | U C | 0.0088 | J C q | 0.012 | C | 0.013 | U C | 0.0094 | J C | 0.015 | U C |
| PCB-044 | NA | 15. | C B | 0.39 | C B | 0.35 | C B | 0.18 | C B | 0.18 | C B | 0.54 | C B |
| PCB-045 | NA | 0.64 | C | 0.032 | C | 0.032 | C | 0.017 | C | 0.017 | C | 0.047 | C |
| PCB-046 | NA | 0.085 | U | 0.016 | | 0.016 | | 0.0059 | J | 0.0079 | J | 0.02 | |
| PCB-047 | NA | 15. | B C44 | 0.39 | B C44 | 0.35 | C44 B | 0.18 | B C44 | 0.18 | B C44 | 0.54 | B C44 |
| PCB-048 | NA | 0.76 | B | 0.032 | B | 0.03 | B | 0.015 | B q | 0.015 | B q | 0.048 | B |
| PCB-049 | NA | 15. | C | 0.35 | C | 0.34 | C | 0.19 | C | 0.19 | C | 0.66 | C |
| PCB-050 | NA | 1.3 | C | 0.065 | C | 0.062 | C | 0.038 | C | 0.035 | C | 0.12 | C |
| PCB-051 | NA | 0.64 | C45 | 0.032 | C45 | 0.032 | C45 | 0.017 | C45 | 0.017 | C45 | 0.047 | C45 |

## Table I1-2. Sediment PCB Congener Analysis by EPA Method 1668A (µg/kg)

| | Location Name | MA-09 | | MA-14 | | | | MA-19 | | SP1-1 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sample Name | SED02-10-170906 | | FD-170906-01 | | SED01-10-170906 | | SED04-10-170906 | | SED03-10-170906 | | SED05-10-170907 | |
| | Sample Type | N | | FD | | P | | N | | N | | N | |
| Analyte | PAL | Result | | Result | | Result | | Result | | Result | | Result | |
| PCB-052 | NA | 37. | B | 0.9 | B | 0.8 | B | 0.45 | B | 0.45 | B | 1.3 | B |
| PCB-053 | NA | 1.3 | C50 | 0.065 | C50 | 0.062 | C50 | 0.038 | C50 | 0.035 | C50 | 0.12 | C50 |
| PCB-054 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.0025 | J B q |
| PCB-055 | NA | 0.2 | q | 0.0059 | J q | 0.0095 | J q | 0.0037 | J q | 0.0085 | J | 0.0069 | J q |
| PCB-056 | NA | 2.1 | | 0.077 | | 0.065 | | 0.031 | | 0.036 | | 0.097 | |
| PCB-057 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-058 | NA | 0.14 | | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.006 | J q |
| PCB-059 | NA | 0.91 | C B | 0.047 | C B | 0.047 | C B | 0.018 | C B | 0.016 | C B q | 0.058 | C B |
| PCB-060 | NA | 0.73 | | 0.029 | | 0.024 | | 0.017 | | 0.017 | | 0.041 | |
| PCB-061 | NA | 25. | C B | 0.57 | C B | 0.49 | C B | 0.25 | C B | 0.27 | C B | 0.91 | C B |
| PCB-062 | NA | 0.91 | B C59 | 0.047 | B C59 | 0.047 | C59 B | 0.018 | B C59 | 0.016 | B C59 q | 0.058 | B C59 |
| PCB-063 | NA | 0.3 | B | 0.012 | B | 0.0098 | J B | 0.0044 | J B q | 0.0054 | J B | 0.017 | B |
| PCB-064 | NA | 3.2 | B | 0.097 | B | 0.087 | B | 0.039 | B | 0.046 | B | 0.12 | B |
| PCB-065 | NA | 15. | B C44 | 0.39 | B C44 | 0.35 | C44 B | 0.18 | B C44 | 0.18 | B C44 | 0.54 | B C44 |
| PCB-066 | NA | 14. | B | 0.35 | B | 0.29 | B | 0.18 | B | 0.19 | B | 0.57 | B |
| PCB-067 | NA | 0.25 | | 0.014 | | 0.012 | | 0.0051 | J q | 0.0066 | J | 0.017 | |
| PCB-068 | NA | 0.42 | | 0.0091 | J | 0.0074 | U | 0.0045 | J | 0.0053 | J | 0.017 | |
| PCB-069 | NA | 15. | C49 | 0.35 | C49 | 0.34 | C49 | 0.19 | C49 | 0.19 | C49 | 0.66 | C49 |
| PCB-070 | NA | 25. | C61 B | 0.57 | C61 B | 0.49 | C61 B | 0.25 | C61 B | 0.27 | C61 B | 0.91 | C61 B |
| PCB-071 | NA | 4.7 | C40 | 0.15 | C40 | 0.14 | C40 | 0.087 | C40 | 0.078 | C40 | 0.37 | C40 |
| PCB-072 | NA | 0.73 | | 0.014 | | 0.012 | | 0.0064 | J | 0.0081 | J | 0.026 | |
| PCB-073 | NA | 0.085 | U C43 | 0.0088 | J C43 q | 0.012 | C43 | 0.013 | U C43 | 0.0094 | J C43 | 0.015 | U C43 |
| PCB-074 | NA | 25. | C61 B | 0.57 | C61 B | 0.49 | C61 B | 0.25 | C61 B | 0.27 | C61 B | 0.91 | C61 B |
| PCB-075 | NA | 0.91 | B C59 | 0.047 | B C59 | 0.047 | C59 B | 0.018 | B C59 | 0.016 | B C59 q | 0.058 | B C59 |
| PCB-076 | NA | 25. | C61 B | 0.57 | C61 B | 0.49 | C61 B | 0.25 | C61 B | 0.27 | C61 B | 0.91 | C61 B |
| PCB-077 | NE | 2.2 | B | 0.046 | B | 0.038 | B | 0.021 | B | 0.023 | B q | 0.066 | B |

## Table I1-2. Sediment PCB Congener Analysis by EPA Method 1668A (µg/kg)

| Location Name | | MA-09 | | MA-14 | | | | MA-19 | | SP1-1 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | | SED02-10-170906 | | FD-170906-01 | | SED01-10-170906 | | SED04-10-170906 | | SED03-10-170906 | | SED05-10-170907 | |
| Sample Type | | N | | FD | | P | | N | | N | | N | |
| Analyte | PAL | Result | | Result | | Result | | Result | | Result | | Result | |
| PCB-078 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-079 | NA | 0.66 | | 0.015 | q | 0.012 | | 0.0036 | J q | 0.0056 | J | 0.017 | |
| PCB-080 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.0026 | U |
| PCB-081 | NE | 0.046 | J B q | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-082 | NA | 6.4 | B | 0.21 | B | 0.15 | B | 0.05 | B | 0.082 | B | 0.16 | B |
| PCB-083 | NA | 45. | C B | 1.4 | C B | 1.1 | C B | 0.49 | C B | 0.61 | C B | 1.6 | C B |
| PCB-084 | NA | 15. | | 0.43 | | 0.34 | | 0.1 | | 0.16 | | 0.38 | |
| PCB-085 | NA | 9.3 | C | 0.37 | C | 0.28 | C | 0.11 | C | 0.15 | C | 0.32 | C |
| PCB-086 | NA | 37. | C B | 1.3 | C B | 0.93 | C B | 0.32 | C B | 0.47 | C B | 0.99 | C B |
| PCB-087 | NA | 37. | B C86 | 1.3 | B C86 | 0.93 | C86 B | 0.32 | B C86 | 0.47 | B C86 | 0.99 | B C86 |
| PCB-088 | NA | 9.8 | C | 0.26 | C | 0.21 | C | 0.082 | C | 0.11 | C | 0.29 | C |
| PCB-089 | NA | 0.71 | | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.014 | J q |
| PCB-090 | NA | 60. | C B | 2. | C B | 1.5 | C B | 0.56 | C B | 0.79 | C B | 1.9 | C B |
| PCB-091 | NA | 9.8 | C88 | 0.26 | C88 | 0.21 | C88 | 0.082 | C88 | 0.11 | C88 | 0.29 | C88 |
| PCB-092 | NA | 9.6 | | 0.36 | | 0.28 | | 0.091 | | 0.13 | | 0.28 | |
| PCB-093 | NA | 0.36 | C q | 0.008 | J C q | 0.012 | U C | 0.013 | U C | 0.0049 | J C q | 0.016 | C q |
| PCB-094 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-095 | NA | 50. | | 1.6 | | 1.2 | | 0.4 | | 0.57 | | 1.4 | |
| PCB-096 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-097 | NA | 37. | B C86 | 1.3 | B C86 | 0.93 | C86 B | 0.32 | B C86 | 0.47 | B C86 | 0.99 | B C86 |
| PCB-098 | NA | 2.4 | C | 0.068 | C | 0.054 | C | 0.017 | C q | 0.026 | C | 0.082 | C |
| PCB-099 | NA | 45. | C83 B | 1.4 | C83 B | 1.1 | C83 B | 0.49 | C83 B | 0.61 | C83 B | 1.6 | C83 B |
| PCB-100 | NA | 0.36 | C93 q | 0.008 | J C93 q | 0.012 | U C93 | 0.013 | U C93 | 0.0049 | J C93 q | 0.016 | C93 q |
| PCB-101 | NA | 60. | B C90 | 2. | B C90 | 1.5 | C90 B | 0.56 | B C90 | 0.79 | B C90 | 1.9 | B C90 |
| PCB-102 | NA | 2.4 | C98 | 0.068 | C98 | 0.054 | C98 | 0.017 | C98 q | 0.026 | C98 | 0.082 | C98 |
| PCB-103 | NA | 0.62 | | 0.012 | U | 0.013 | | 0.0052 | J | 0.013 | U | 0.024 | |

## Table I1-2. Sediment PCB Congener Analysis by EPA Method 1668A (µg/kg)

| Location Name | | MA-09 | | MA-14 | | | | MA-19 | | SP1-1 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Name** | | SED02-10-170906 | | FD-170906-01 | | SED01-10-170906 | | SED04-10-170906 | | SED03-10-170906 | | SED05-10-170907 | |
| **Sample Type** | | N | | FD | | P | | N | | N | | N | |
| **Analyte** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-104 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-105 | NE | 19. | B | 0.69 | B | 0.48 | B | 0.26 | B | 0.31 | B | 0.66 | B |
| PCB-106 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-107 | NA | 3.8 | B | 0.18 | B | 0.11 | B | 0.053 | B | 0.067 | B | 0.16 | B |
| PCB-108 | NA | 1.8 | C B | 0.061 | C B | 0.041 | C B | 0.017 | C B | 0.016 | C B q | 0.053 | C B |
| PCB-109 | NA | 37. | B C86 | 1.3 | B C86 | 0.93 | C86 B | 0.32 | B C86 | 0.47 | B C86 | 0.99 | B C86 |
| PCB-110 | NA | 77. | C B | 2.6 | C B | 1.9 | C B | 0.69 | C B | 0.98 | C B | 1.9 | C B |
| PCB-111 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-112 | NA | 0.36 | | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.0095 | J q |
| PCB-113 | NA | 60. | B C90 | 2. | B C90 | 1.5 | C90 B | 0.56 | B C90 | 0.79 | B C90 | 1.9 | B C90 |
| PCB-114 | NE | 1.2 | B | 0.028 | B q | 0.022 | B | 0.015 | B q | 0.018 | B | 0.035 | B |
| PCB-115 | NA | 77. | B C110 | 2.6 | B C110 | 1.9 | C110 B | 0.69 | B C110 | 0.98 | B C110 | 1.9 | B C110 |
| PCB-116 | NA | 9.3 | C85 | 0.37 | C85 | 0.28 | C85 | 0.11 | C85 | 0.15 | C85 | 0.32 | C85 |
| PCB-117 | NA | 9.3 | C85 | 0.37 | C85 | 0.28 | C85 | 0.11 | C85 | 0.15 | C85 | 0.32 | C85 |
| PCB-118 | NE | 58. | B | 1.9 | B | 1.4 | B | 0.74 | B | 0.86 | B | 2. | B |
| PCB-119 | NA | 37. | B C86 | 1.3 | B C86 | 0.93 | C86 B | 0.32 | B C86 | 0.47 | B C86 | 0.99 | B C86 |
| PCB-120 | NA | 0.63 | B | 0.012 | U | 0.01 | J B | 0.0051 | J B q | 0.0075 | J B | 0.0086 | J B q |
| PCB-121 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-122 | NA | 0.95 | B | 0.026 | B q | 0.021 | B | 0.009 | J B | 0.014 | B | 0.029 | B |
| PCB-123 | NE | 1. | | 0.036 | | 0.018 | q | 0.011 | J | 0.013 | | 0.034 | |
| PCB-124 | NA | 1.8 | B C108 | 0.061 | B C108 | 0.041 | C108 B | 0.017 | B C108 | 0.016 | B q C108 | 0.053 | B C108 |
| PCB-125 | NA | 37. | B C86 | 1.3 | B C86 | 0.93 | C86 B | 0.32 | B C86 | 0.47 | B C86 | 0.99 | B C86 |
| PCB-126 | NE | 0.085 | U | 0.0067 | U | 0.012 | U | 0.013 | U | 0.0037 | U | 0.0058 | U |
| PCB-127 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-128 | NA | 11. | C B | 0.58 | C B | 0.37 | C B | 0.15 | C B | 0.21 | C B | 0.45 | C B |
| PCB-129 | NA | 60. | C B | 3.2 | C B | 2.1 | C B | 0.82 | C B | 1.1 | C B | 2.6 | C B |

## Table I1-2. Sediment PCB Congener Analysis by EPA Method 1668A (µg/kg)

| | Location Name | MA-09 | | MA-14 | | | | MA-19 | | SP1-1 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sample Name | SED02-10-170906 | | FD-170906-01 | | SED01-10-170906 | | SED04-10-170906 | | SED03-10-170906 | | SED05-10-170907 | |
| | Sample Type | N | | FD | | P | | N | | N | | N | |
| **Analyte** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-130 | NA | 4. | | 0.21 | | 0.13 | | 0.051 | | 0.069 | | 0.16 | |
| PCB-131 | NA | 0.92 | | 0.041 | | 0.026 | | 0.013 | U | 0.011 | J q | 0.027 | |
| PCB-132 | NA | 20. | B | 0.91 | B | 0.55 | B | 0.16 | B | 0.26 | B | 0.62 | B |
| PCB-133 | NA | 0.83 | | 0.039 | | 0.022 | | 0.0099 | J | 0.012 | J | 0.03 | |
| PCB-134 | NA | 3.7 | C | 0.16 | C | 0.11 | C | 0.031 | C | 0.049 | C | 0.12 | C |
| PCB-135 | NA | 12. | C B | 0.5 | C B | 0.37 | C B | 0.11 | C B | 0.16 | C B | 0.33 | C B |
| PCB-136 | NA | 6. | | 0.21 | | 0.15 | | 0.041 | q | 0.063 | | 0.16 | |
| PCB-137 | NA | 3.4 | B | 0.18 | B | 0.11 | B | 0.041 | B | 0.059 | B | 0.13 | B |
| PCB-138 | NA | 60. | B C129 | 3.2 | B C129 | 2.1 | C129 B | 0.82 | B C129 | 1.1 | B C129 | 2.6 | B C129 |
| PCB-139 | NA | 1.4 | C B | 0.061 | C B | 0.038 | C B | 0.016 | C B | 0.019 | C B q | 0.054 | C B |
| PCB-140 | NA | 1.4 | B C139 | 0.061 | B C139 | 0.038 | C139 B | 0.016 | B C139 | 0.019 | B C139 q | 0.054 | B C139 |
| PCB-141 | NA | 7.8 | B | 0.39 | B | 0.24 | B | 0.07 | B | 0.12 | B | 0.22 | B |
| PCB-142 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-143 | NA | 3.7 | C134 | 0.16 | C134 | 0.11 | C134 | 0.031 | C134 | 0.049 | C134 | 0.12 | C134 |
| PCB-144 | NA | 1.6 | B | 0.068 | B | 0.049 | B | 0.015 | B q | 0.022 | B | 0.037 | B q |
| PCB-145 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-146 | NA | 6.8 | B | 0.36 | B | 0.23 | B | 0.089 | B | 0.13 | B | 0.32 | B |
| PCB-147 | NA | 43. | C B | 1.9 | C B | 1.3 | C B | 0.45 | C B | 0.63 | C B | 1.7 | C B |
| PCB-148 | NA | 0.034 | J q | 0.0016 | J q | 0.012 | U | 0.013 | U | 0.013 | U | 0.0015 | J q |
| PCB-149 | NA | 43. | B C147 | 1.9 | B C147 | 1.3 | C147 B | 0.45 | B C147 | 0.63 | B C147 | 1.7 | B C147 |
| PCB-150 | NA | 0.041 | J q | 0.0017 | J q | 0.0015 | J | 0.013 | U | 0.013 | U | 0.0021 | J q |
| PCB-151 | NA | 12. | C135 B | 0.5 | C135 B | 0.37 | C135 B | 0.11 | C135 B | 0.16 | C135 B | 0.33 | C135 B |
| PCB-152 | NA | 0.043 | J q | 0.012 | U | 0.0009 | J q | 0.013 | U | 0.013 | U | 0.00096 | J q |
| PCB-153 | NA | 39. | C B | 2. | C B | 1.4 | C B | 0.56 | C B | 0.72 | C B | 1.9 | C B |
| PCB-154 | NA | 0.085 | U | 0.027 | B | 0.012 | U | 0.0071 | J B q | 0.013 | B | 0.021 | B |
| PCB-155 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |

## Table I1-2. Sediment PCB Congener Analysis by EPA Method 1668A (µg/kg)

| Location Name | | MA-09 | | MA-14 | | | | MA-19 | | SP1-1 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample Name** | | SED02-10-170906 | | FD-170906-01 | | SED01-10-170906 | | SED04-10-170906 | | SED03-10-170906 | | SED05-10-170907 | |
| **Sample Type** | | N | | FD | | P | | N | | N | | N | |
| **Analyte** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-156 | NE | 8.1 | C B | 0.34 | C B | 0.2 | C B | 0.096 | C B | 0.13 | C B | 0.29 | C B |
| PCB-157 | NE | 8.1 | C156 B | 0.34 | C156 B | 0.2 | C156 B | 0.096 | C156 B | 0.13 | C156 B | 0.29 | C156 B |
| PCB-158 | NA | 6.6 | B | 0.33 | B | 0.2 | B | 0.085 | B | 0.12 | B | 0.24 | B |
| PCB-159 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-160 | NA | 60. | B C129 | 3.2 | B C129 | 2.1 | C129 B | 0.82 | B C129 | 1.1 | B C129 | 2.6 | B C129 |
| PCB-161 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-162 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-163 | NA | 60. | B C129 | 3.2 | B C129 | 2.1 | C129 B | 0.82 | B C129 | 1.1 | B C129 | 2.6 | B C129 |
| PCB-164 | NA | 4. | B | 0.19 | B | 0.12 | B | 0.039 | B | 0.063 | B | 0.13 | B |
| PCB-165 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-166 | NA | 11. | C128 B | 0.58 | C128 B | 0.37 | C128 B | 0.15 | C128 B | 0.21 | C128 B | 0.45 | C128 B |
| PCB-167 | NE | 2.5 | B | 0.12 | B | 0.074 | B | 0.033 | B | 0.046 | B | 0.096 | B |
| PCB-168 | NA | 39. | B C153 | 2. | B C153 | 1.4 | C153 B | 0.56 | B C153 | 0.72 | B C153 | 1.9 | B C153 |
| PCB-169 | NE | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-170 | NA | 5. | B | 0.31 | B | 0.18 | B | 0.069 | B | 0.1 | B | 0.19 | B |
| PCB-171 | NA | 1.6 | C B | 0.099 | C B | 0.062 | C B | 0.024 | C B | 0.033 | C B | 0.06 | C B |
| PCB-172 | NA | 0.63 | B | 0.042 | B | 0.028 | B | 0.008 | J B | 0.015 | B | 0.02 | B q |
| PCB-173 | NA | 1.6 | C171 B | 0.099 | C171 B | 0.062 | C171 B | 0.024 | C171 B | 0.033 | C171 B | 0.06 | C171 B |
| PCB-174 | NA | 3. | B | 0.21 | B | 0.14 | B | 0.036 | B | 0.059 | B | 0.1 | B |
| PCB-175 | NA | 0.13 | | 0.0088 | J | 0.008 | J | 0.0023 | J | 0.0031 | J q | 0.0064 | J |
| PCB-176 | NA | 0.48 | B | 0.029 | B | 0.018 | B | 0.0064 | J B | 0.0077 | J B | 0.014 | J B q |
| PCB-177 | NA | 2.1 | B | 0.14 | B | 0.095 | B | 0.035 | B | 0.046 | B | 0.093 | B |
| PCB-178 | NA | 0.55 | | 0.049 | | 0.031 | | 0.012 | J | 0.014 | | 0.036 | |
| PCB-179 | NA | 1.3 | B | 0.086 | B | 0.063 | B | 0.018 | B | 0.025 | B | 0.057 | B |
| PCB-180 | NA | 6.5 | C B | 0.46 | C B | 0.3 | C B | 0.1 | C B | 0.15 | C B | 0.27 | C B |
| PCB-181 | NA | 0.13 | | 0.006 | J | 0.0036 | J | 0.0013 | J q | 0.0013 | J q | 0.0037 | J |

# Table I1-2. Sediment PCB Congener Analysis by EPA Method 1668A (µg/kg)

| | Location Name | MA-09 | | MA-14 | | | | MA-19 | | SP1-1 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sample Name | SED02-10-170906 | | FD-170906-01 | | SED01-10-170906 | | SED04-10-170906 | | SED03-10-170906 | | SED05-10-170907 | |
| | Sample Type | N | | FD | | P | | N | | N | | N | |
| **Analyte** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-182 | NA | 0.061 | J B | 0.012 | U | 0.0023 | U | 0.013 | U | 0.013 | U | 0.0027 | U |
| PCB-183 | NA | 2.4 | C B | 0.17 | C B | 0.11 | C B | 0.039 | C B | 0.052 | C B | 0.11 | C B |
| PCB-184 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-185 | NA | 2.4 | B C183 | 0.17 | B C183 | 0.11 | C183 B | 0.039 | B C183 | 0.052 | B C183 | 0.11 | B C183 |
| PCB-186 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-187 | NA | 3.1 | B | 0.27 | B | 0.19 | B | 0.072 | B | 0.086 | B | 0.2 | B |
| PCB-188 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-189 | NE | 0.2 | B | 0.014 | B | 0.0081 | U | 0.0028 | U | 0.0047 | U | 0.0085 | U |
| PCB-190 | NA | 0.81 | B | 0.047 | B | 0.028 | B | 0.0088 | J B q | 0.016 | B | 0.027 | B |
| PCB-191 | NA | 0.2 | B | 0.01 | J B q | 0.0024 | U | 0.0025 | U | 0.0045 | U | 0.0058 | J B |
| PCB-192 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-193 | NA | 6.5 | C180 B | 0.46 | C180 B | 0.3 | C180 B | 0.1 | C180 B | 0.15 | C180 B | 0.27 | C180 B |
| PCB-194 | NA | 0.82 | B | 0.071 | B | 0.051 | B | 0.017 | B q | 0.025 | B | 0.047 | B |
| PCB-195 | NA | 0.31 | B | 0.028 | B | 0.018 | q B | 0.0068 | J B | 0.0099 | J B | 0.017 | B |
| PCB-196 | NA | 0.3 | B | 0.028 | B | 0.023 | B | 0.0081 | J B | 0.0099 | J B | 0.019 | B |
| PCB-197 | NA | 0.026 | J B | 0.0023 | U | 0.0013 | U | 0.0012 | U | 0.013 | U | 0.0025 | U |
| PCB-198 | NA | 0.6 | C B | 0.069 | C B | 0.052 | C B | 0.018 | C B | 0.024 | C B | 0.051 | C B |
| PCB-199 | NA | 0.6 | C198 B | 0.069 | C198 B | 0.052 | C198 B | 0.018 | C198 B | 0.024 | C198 B | 0.051 | C198 B |
| PCB-200 | NA | 0.063 | J B | 0.0058 | J B q | 0.0051 | J B | 0.013 | U | 0.013 | U | 0.004 | J B |
| PCB-201 | NA | 0.065 | J | 0.0081 | J | 0.0062 | J | 0.0021 | J q | 0.0034 | J q | 0.0068 | J q |
| PCB-202 | NA | 0.12 | B | 0.013 | B q | 0.016 | B | 0.0075 | J B | 0.007 | J B | 0.018 | B |
| PCB-203 | NA | 0.41 | B | 0.038 | B | 0.028 | B | 0.01 | J B | 0.013 | B | 0.022 | B |
| PCB-204 | NA | 0.085 | U | 0.012 | U | 0.012 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-205 | NA | 0.037 | J B | 0.003 | U | 0.0034 | U | 0.013 | U | 0.013 | U | 0.015 | U |
| PCB-206 | NA | 0.28 | B | 0.052 | B | 0.043 | B | 0.019 | B | 0.019 | B | 0.05 | B |
| PCB-207 | NA | 0.034 | J B | 0.0068 | J B | 0.0048 | U | 0.0029 | U | 0.013 | U | 0.007 | J B |

## Table I1-2. Sediment PCB Congener Analysis by EPA Method 1668A (µg/kg)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location Name** | | MA-09 | | MA-14 | | | | MA-19 | | SP1-1 | | TF-21 | |
| **Sample Name** | | SED02-10-170906 | | FD-170906-01 | | SED01-10-170906 | | SED04-10-170906 | | SED03-10-170906 | | SED05-10-170907 | |
| **Sample Type** | | N | | FD | | P | | N | | N | | N | |
| **Analyte** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-208 | NA | 0.072 | J B q | 0.022 | B | 0.016 | B | 0.0078 | J B | 0.0055 | J B q | 0.022 | B |
| PCB-209 | NA | 0.18 | B | 0.068 | B | 0.055 | B | 0.038 | B | 0.023 | B | 0.063 | B |
| MONOCHLORO- BIPHENYL | NE | 0.097 | | 0.015 | | 0.012 | q | 0.011 | J q | 0.01 | J q | 0.02 | q |
| DICHLORO- BIPHENYL | NE | 1.6 | q | 0.41 | q | 0.4 | q | 0.18 | q | 0.18 | q | 0.37 | |
| TRICHLORO- BIPHENYL | NE | 13. | B q | 1.3 | B q | 1.2 | q B | 0.66 | B q | 0.65 | B q | 1.4 | B |
| TETRACHLORO- BIPHENYL | NE | 130. | B q | 3.3 | B q | 3. | q B | 1.6 | B q | 1.7 | B q | 5.2 | B q |
| PENTACHLORO- BIPHENYL | NE | 410. | B q | 13. | B q | 10. | q B | 4. | B q | 5.4 | B q | 12. | B q |
| HEXACHLORO- BIPHENYL | NE | 240. | B q | 12. | B q | 7.7 | q B | 2.9 | B q | 4. | B q | 9.5 | B q |
| HEPTACHLORO- BIPHENYL | NE | 28. | B | 2. | B q | 1.3 | q B | 0.44 | B q | 0.62 | B q | 1.2 | B q |
| OCTACHLORO- BIPHENYL | NE | 2.8 | B | 0.27 | B q | 0.2 | q B | 0.071 | B q | 0.092 | B q | 0.19 | B q |
| NONACHLORO- BIPHENYL | NE | 0.39 | B q | 0.081 | B | 0.064 | q B | 0.03 | B | 0.025 | B q | 0.078 | B |
| Total POLY- CHLORINATED BIPHENYLS (PCBS) | (1) | 830. | B q | 33. | B q | 24. | q B | 9.9 | B q | 13. | B q | 30. | B q |

Notes:
(1) See Table A1-3 for comparison of these data to the PAL.
B – The analyte was found in an associated blank, as well as in the sample.
C – Indicates a co-eluting PCB congener. If a number is associated with the C qualifier, this corresponds to the result of the lower co-eluting PCB (i.e., the C12 qualifier reported for a PCB-013 result indicates this PCB co-elutes with PCB-012).
FD – field duplicate
J – The reported value is an estimated concentration.
N – Sample is not part of a field duplicate pair.
NA – Not applicable
NE – not established
P – Parent sample of field duplicate.
PAL – project action limit
PCB – polychlorinated biphenyls
q – One or more quality control criteria failed.
U – The analyte was not detected at or above the limit of detection. (Sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
µg/kg – micrograms per kilogram

## Table I1-3. Total PCBs in Sediment (µg/kg)

| Location Name | Sample Name | Sample type | Total PCBs (Sum of analyte value with ND as null) Result (µg/kg) | | Total number of PCBs detections | Total Organic Carbon % | Total PCBs (TOC Normalized)[a] (mg/kg OC) |
|---|---|---|---|---|---|---|---|
| | | | **Freshwater** | | | | **Marine** |
| | | **SMS Sediment SCO** | **110** | | | | **12** |
| | | **SMS Sediment CSL** | **2500** | | | | **65** |
| MA-09 | SED02-10-170906 | N | **830.** | B q | 169 | 1.6 | **51.9** |
| MA-14 (DUP) | FD-170906-01 | FD | 33. | B q | 164 | 0.53 | 6.2 |
| MA-14 | SED01-10-170906 | N | 24. | q B | 157 | 0.51 | 4.7 |
| MA-19 | SED04-10-170906 | N | 9.9 | B q | 151 | 0.58 | 1.7 |
| SP1-1 | SED03-10-170906 | N | 13. | B q | 157 | 0.56 | 2.3 |
| TF-21 | SED05-10-170907 | N | 30. | B q | 166 | 0.79 | 3.8 |

Notes:
[a] – If percent TOC is between 0.5 and 3.5, then PCB concentrations TOC-normalized with units of mg/kg OC. To calculate TOC-normalized values, the concentration in µg/kg is divided by the decimal fraction TOC times 1,000 µg/mg.
All samples analyzed using analytical method 1668A.
B – The analyte was found in an associated blank, as well as in the sample.

CSL – contaminant screening level
DUP – duplicate
FD – field duplicate
N – Sample is not part of a field duplicate pair
P – Parent sample of field duplicate.
q – One or more quality control criteria failed.
PCB – polychlorinated biphenyl
SCO – sediment cleanup objective
TOC – total organic carbon
µg/kg – microgram per kilogram

**Bolded** values exceed the SCO.

## Table I1-4. PCB Aroclor Analysis in Sediments (µg/kg)

| | | Location Name | MA-09 | MA-14 | MA-14 | MA-19 | SP1-1 | TF-21 |
|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | SED02-10-170906 | FD-170906-01 | SED01-10-170906 | SED04-10-170906 | SED03-10-170906 | SED05-10-170907 |
| | | **Sample type** | N | FD | P | N | N | N |
| **Analyte** | **Units** | **ROD RG (mg/kg OC)** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| AROCLOR-1016 | µg/kg | NE | 48. U | 31. U | 31. U | 36. U | 35. U | 39. U J |
| AROCLOR-1221 | µg/kg | NE | 75. U | 48. U | 49. U | 57. U | 55. U | 62. U |
| AROCLOR-1232 | µg/kg | NE | 94. U | 60. U | 62. U | 71. U | 69. U | 77. U |
| AROCLOR-1242 | µg/kg | NE | 110. U | 71. U | 73. U | 83. U | 81. U | 91. U |
| AROCLOR-1248 | µg/kg | NE | 75. U | 48. U | 49. U | 57. U | 55. U | 62. U |
| AROCLOR-1254 | µg/kg | NE | 350. J | 46. U | 47. U | 54. U | 52. U | 59. U |
| AROCLOR-1260 | µg/kg | NE | 120. J | 33. U Q | 33. U Q | 38. U Q | 37. U Q | 42. U Q |
| AROCLOR-1262 | µg/kg | NE | 130. U | 82. U | 84. U | 96. U | 94. U | 100. U |
| AROCLOR-1268 | µg/kg | NE | 100. U | 65. U | 66. U | 76. U | 74. U | 82. U |
| Total PCB Aroclors | mg/kg OC | 12 | **29.38** J | 8.68 U | 9.22 U | 1.61 U | 1.66 U | 7.47 U |
| CARBON | mg/kg | NE | 16,00. | 5,300. J | 5,100. J | 5,800. | 5,600. J | 7,900. J |

Notes:
Samples analyzed for Aroclor analysis by method 8082 A, carbon analysis by 9060.
FD – field duplicate
J – The reported value is an estimated concentration.
mg/kg – milligram per kilogram
N – Sample is not part of a field duplicate pair.
NE – not established
OC – organic carbon
P – Parent sample of field duplicate.
PCB – polychlorinated biphenyl
Q – One or more quality control criteria failed.
RG – remedial goal
ROD – record of decision
U – The analyte was analyzed but not detected at or above limit of detection. (Sometimes validators will elevate the limit due to the "B" qual using the 5x/10x rule so this definition is different than the lab description).
µg/kg – microgram per kilogram
U J - The analyte was analyzed but not detected. The sample quantitation limit is an estimated value.
Total PCB (Aroclor) are derived based on the sum of the detected concentrations of Aroclors® 1016, 1221, 1232, 1242, 1248, 1254 and 1260.

When all chemicals in a group are undetected, only the single highest individual chemical quantitation limit in a group should be reported and appropriately qualified. If some concentrations were detected and others were not, only the detected concentrations are included in the sum.
**Bolded** value exceeds the ROD RG.

## Table I1-5. Calculated Total Dissolved PCB* and Diffusive PCB Flux Obtained via Passive Samplers (PEDs)

| PED Type | Location | Calculated Water Concentration (ng/L) [1] | | Calculated Flux** (µg/m²/yr) |
|---|---|---|---|---|
| *PED Frames* | | Porewater | Surface Water | |
| PED-01 | TF-21 | 3.3 | 0.6 | 191 |
| PED-02 | MA-14 | 8.9 | 0.8 | 574 |
| PED-03 | MA-09 | 14.6 | NA | N/A |
| PED-04 | SP1-1 | 2.2 | NA | N/A |
| PED-05 | MA-19 | 3.4 | 0.6 | 200 |
| PED-06 | *new* | 2.6 | 0.5 | 148 |
| *Piezometers/Wells* | | Groundwater[2] | | |
| PED-07 | P1-1 | 6.0 | | NA |
| PED-08 | P1-2 | 1.1 | | NA |
| PED-09 | MW1-14 | 129.2 | | NA |
| PED-10 | MW1-2 | 0.9 | | NA |

Notes:

1 Sediment porewater and surface water PCB concentrations were compared to both the freshwater chronic standard (14 ng/L) and marine chronic standard (30 ng/L) WQS for surface waters of Washington WAC 173-201A.

2 Groundwater values are compared to the criteria of 0.17 ng/L for human health consumption of organisms in WAC 173-201A, Table 240.

* In PCB summations congeners not detected above the detection limit were counted as zero and within co-eluting congener groups calculations were conducted on the one with the lowest PED-water partition coefficient which results in the highest (more conservative) total PCB estimate (see text for more information).

** Positive values of flux indicate transport from porewater to surface water.

NA – Not Available – surface water portion of PED damaged during deployment.

PCB – polychlorinated biphenyl

PED - passive polyethylene device

ng/L – nanogram per liter

µg/m²/yr – micrograms per squared meters per year

**ATTACHMENT I-2: 2019 PCB & TPH Data Summary Tables**

## Table I2-1. PCB Aroclors in Soil (µg/kg)

| | | Location Name | NP-B118 | NP-B118 | NP-B118 | NP-B119 | NP-B119 | NP-B119 | NP-B120 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | NP-B118-S-13-190624 | NP-B118-S-16-190624 | NP-B118-S-34-190625 | NP-B119-S-07-190621 | NP-B119-S-12-190621 | NP-B119-S-15-190621 | NP-B120-S-12.5-190624 |
| | | **Sample type** | N | N | N | N | N | N | N |
| **Analyte** | **Units** | **PAL (µg/kg)** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| AROCLOR-1016 | µg/kg | 5,600 | 26 U | 25 U | 24 U | 25 UJ | 27 UJ | 25 UJ | **16,000 J** |
| AROCLOR-1221 | µg/kg | NE | 26 U | 25 U | 24 U | 25 UJ | 27 UJ | 25 UJ | 5,100 UJ |
| AROCLOR-1232 | µg/kg | NE | 13 U | 12 U | 12 U | 13 UJ | 14 UJ | 12 UJ | 2,600 UJ |
| AROCLOR-1242 | µg/kg | NE | 13 U | 12 U | 12 U | 13 UJ | 14 UJ | 12 UJ | 2,600 UJ |
| AROCLOR-1248 | µg/kg | NE | 13 U | 12 U | 12 U | 13 UJ | 14 UJ | 12 UJ | 2,600 UJ |
| AROCLOR-1254 | µg/kg | 500 | 13 U | 12 U | 12 U | 13 UJ | 85 J | 12 UJ | 2,600 UJ |
| AROCLOR-1260 | µg/kg | 500 | 13 U | 12 U | 12 U | 13 UJ | 14 UJ | 12 UJ | 2,600 UJ |
| AROCLOR-1262 | µg/kg | NE | 15 U | 15 U | 15 U | 15 UJ | 16 UJ | 15 UJ | 3,100 UJ |
| AROCLOR-1268 | µg/kg | NE | 15 U | 15 U | 15 U | 15 UJ | 16 UJ | 15 UJ | 3,100 UJ |
| Total PCB Aroclors | µg/kg | 500 | 26 U | 25 U | 24 U | 25 UJ | 85 J | 25 UJ | **16,000 J** |

| | | Location Name | NP-B120 | NP-B120 | NP-B120 | NP-B120 | NP-B121 | NP-B121 | NP-B121 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | NP-B120-S-29-190624 | NP-B120-S-35.5-190624 | NP-B120-S-42-190624 | NP-B120-S-49.5-190624 | NP-B121-S-05-190620 | NP-B121-S-13-190620 | NP-B121-S-14-190620 |
| | | **Sample type** | N | N | N | N | N | P | FD |
| **Analyte** | **Units** | **PAL (µg/kg)** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| AROCLOR-1016 | µg/kg | 5,600 | 22 U | 23 U | 22 U | 21 U | 48,000 U | 29 UJ | 15 UJ |
| AROCLOR-1221 | µg/kg | NE | 22 U | 23 U | 22 U | 21 U | 48,000 U | 29 UJ | 30 UJ |
| AROCLOR-1232 | µg/kg | NE | 11 U | 12 U | 11 U | 11 U | 24,000 U | 15 UJ | 15 UJ |
| AROCLOR-1242 | µg/kg | NE | 11 U | 12 U | 11 U | 11 U | 24,000 UJ | 15 UJ | 16 UJ |
| AROCLOR-1248 | µg/kg | NE | 11 U | 12 U | 11 U | 11 U | 24,000 UJ | 15 UJ | 15 UJ |
| AROCLOR-1254 | µg/kg | 500 | 11 U | 12 U | 11 U | 11 U | **210,000 J** | 15 UJ | 15 UJ |
| AROCLOR-1260 | µg/kg | 500 | 11 U | 12 U | 11 U | 11 U | 24,000 UJ | 15 UJ | 15 UJ |
| AROCLOR-1262 | µg/kg | NE | 13 U | 14 U | 13 U | 13 U | 29,000 UJ | 18 UJ | 18 UJ |
| AROCLOR-1268 | µg/kg | NE | 13 U | 14 U | 13 U | 13 U | 29,000 UJ | 18 UJ | 18 UJ |
| Total PCB Aroclors | µg/kg | 500 | 22 U | 23 U | 22 U | 21 U | **210,000 J** | 29 UJ | 30 UJ |

## Table I2-1. PCB Aroclors in Soil (µg/kg)

| | | **Location Name** | NP-B121 | NP-B122 | NP-B122 | NP-B122 | NP-B123 | NP-B123 | NP-B123 |
|---|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | NP-B121-S-34-190620 | NP-B122-S-05-190620 | NP-B122-S-09-190620 | NP-B122-S-27-190621 | NP-B123-S-19-190619 | NP-B123-S-25-190619 | NP-B123-S-40-190619 |
| | | **Sample type** | N | N | N | N | N | N | N |
| **Analyte** | **Units** | **PAL (µg/kg)** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| AROCLOR-1016 | µg/kg | 5,600 | 24 UJ | 160 J | 2,300 U | 25 UJ | 31 UJ | 28 UJ | 28 UJ |
| AROCLOR-1221 | µg/kg | NE | 24 UJ | 21 UJ | 2,300 U | 25 UJ | 31 UJ | 28 UJ | 28 UJ |
| AROCLOR-1232 | µg/kg | NE | 12 UJ | 11 UJ | 1,200 U | 13 UJ | 16 UJ | 14 UJ | 14 UJ |
| AROCLOR-1242 | µg/kg | NE | 12 UJ | 11 UJ | 1,200 UJ | 13 UJ | 16 UJ | 14 UJ | 14 UJ |
| AROCLOR-1248 | µg/kg | NE | 12 UJ | 11 UJ | 1,200 UJ | 13 UJ | 16 UJ | 14 UJ | 14 UJ |
| AROCLOR-1254 | µg/kg | 500 | 12 UJ | 11 UJ | **8,000 J** | 13 UJ | 130 J | 14 UJ | 14 UJ |
| AROCLOR-1260 | µg/kg | 500 | 12 UJ | 11 UJ | <u>1,200 UJ</u> | 13 UJ | 16 UJ | 14 UJ | 14 UJ |
| AROCLOR-1262 | µg/kg | NE | 14 UJ | 13 UJ | 1,400 UJ | 15 UJ | 19 UJ | 17 UJ | 17 UJ |
| AROCLOR-1268 | µg/kg | NE | 14 UJ | 13 UJ | 1,400 UJ | 15 UJ | 19 UJ | 17 UJ | 17 UJ |
| Total PCB Aroclors | µg/kg | 500 | 24 UJ | 160 J | **8,000 J** | 25 UJ | 130 J | 28 UJ | 28 UJ |

| | | **Location Name** | NP-B124 | NP-B124 | NP-B124 | NP-B125 | NP-B125 | NP-B125 |
|---|---|---|---|---|---|---|---|---|
| | | **Sample Name** | NP-B124-S-10-190620 | NP-B124-S-14-190620 | NP-B124-S-28-190620 | NP-B125-S-20-190619 | NP-B125-S-38-190619 | NP-B125-S-45-190619 |
| | | **Sample type** | N | N | N | N | N | N |
| **Analyte** | **Units** | **PAL (µg/kg)** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| AROCLOR-1016 | µg/kg | 5,600 | 23 UJ | 24 U | 25 U | 1400 U | 24 U | 24 U |
| AROCLOR-1221 | µg/kg | NE | 23 UJ | 24 U | 25 U | 1400 U | 24 U | 24 U |
| AROCLOR-1232 | µg/kg | NE | 11 UJ | 12 UJ | 13 U | 700 U | 12 UJ | 12 U |
| AROCLOR-1242 | µg/kg | NE | 11 UJ | 12 UJ | 13 UJ | 700 UJ | 12 UJ | 12 UJ |
| AROCLOR-1248 | µg/kg | NE | 11 UJ | 12 UJ | 13 UJ | 700 UJ | 12 UJ | 12 UJ |
| AROCLOR-1254 | µg/kg | 500 | 270 J | **810 J** | 13 UJ | **6,500 J** | 12 UJ | 12 UJ |
| AROCLOR-1260 | µg/kg | 500 | 11 UJ | 12 UJ | 13 UJ | <u>700 UJ</u> | 12 UJ | 12 UJ |
| AROCLOR-1262 | µg/kg | NE | 14 UJ | 15 UJ | 15 UJ | 840 UJ | 15 UJ | 14 UJ |
| AROCLOR-1268 | µg/kg | NE | 14 UJ | 15 UJ | 15 UJ | 840 UJ | 15 UJ | 14 UJ |
| Total PCB Aroclors | µg/kg | 500 | 270 J | **810 J** | 25 U | **6,500 J** | 24 U | 24 U |

Notes:
Samples analyzed using EPA Method 8082 A.
FD – field duplicate
J – The result is an estimated concentration that is less than the limit of quantitation, but greater than or equal to the detection limit.
N – Sample is not part of a duplicate pair.
NE – not established
P – Parent sample of field duplicate.
PAL – project action limit
PCB – polychlorinated biphenyl
U – The compound was analyzed for, but was not detected ("non-detect") at or above the limit of detection.
µg/kg – microgram per kilogram
UJ - The analyte was not detected at the stated sample quantitation limit, which is an estimated value
<u>Underlined</u> values represent analytes not detected at or above the stated limit, which exceeds the PAL
**Bolded** values indicate that the reported concentration exceeds the PAL.

## Table I2-2. PCB Congeners in Soil (pg/g)

| | Location Name | NP-B137 | | NP-B138 | | NP-B138 | | NP-B138 | |
|---|---|---|---|---|---|---|---|---|---|
| | Sample Name | NP-B137-S-52-191008 | | NP-B138-S-5-191008 | | NP-B138-S-6-191008 | | NP-B138-S-62-191008 | |
| | Sample Type | N | | FD | | P | | N | |
| Analyte | PAL | Result | | Result | | Result | | Result | |
| PCB-001 | NA | 11 | U | 800 | J | 540 | | 11 | U |
| PCB-002 | NA | 11 | U | 82 | J | 38 | J | 11 | U |
| PCB-003 | NA | 28 | U | 420 | J | 140 | J | 28 | U |
| PCB-004 | NA | 28 | U | 1,200 | J | 940 | | 28 | U |
| PCB-005 | NA | 28 | U | 510 | U | 52 | U | 28 | U |
| PCB-006 | NA | 28 | U | 430 | J | 330 | | 28 | U |
| PCB-007 | NA | 28 | U | 510 | U | 52 | U | 28 | U |
| PCB-008 | NA | 28 | U | 2,500 | | 1,700 | | 28 | U |
| PCB-009 | NA | 28 | U | 510 | U | 52 | U | 28 | U |
| PCB-010 | NA | 28 | U | 510 | U | 52 | U | 28 | U |
| PCB-011 | NA | 110 | U | 2,000 | U | 210 | U | 110 | U |
| PCB-012 AND 013 | NA | 56 | U | 1,000 | U | 100 | U | 57 | U |
| PCB-014 | NA | 28 | U | 510 | U | 52 | U | 28 | U |
| PCB-015 | NA | 28 | U | 1,800 | J | 1,400 | J | 28 | U |
| PCB-016 | NA | 11 | U | 3,000 | | 3,500 | | 11 | U |
| PCB-017 | NA | 11 | U | 4,400 | | 4,200 | | 11 | U |
| PCB-019 | NA | 11 | U | 850 | J | 810 | J | 11 | U |
| PCB-021 AND 033 | NA | 11 | U | 3,500 | J | 4,800 | | 11 | U |
| PCB-022 | NA | 11 | U | 2,000 | | 2,500 | | 11 | U |
| PCB-023 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-024 | NA | 5.6 | U | 100 | J | 84 | J | 5.7 | U |
| PCB-025 | NA | 5.6 | U | 6,700 | J | 580 | J | 5.7 | U |
| PCB-026 AND 029 | NA | 11 | U | 19,000 | J | 1,500 | J | 11 | U |
| PCB-027 | NA | 5.6 | U | 610 | J | 590 | | 5.7 | U |
| PCB-028 AND 020 | NA | 5.4 | J | 12,000 | | 8,500 | | 5.1 | J |
| PCB-030 AND 018 | NA | 23 | U | 6,900 | | 7,000 | | 23 | U |
| PCB-031 | NA | 5.6 | J | 12,000 | | 9,800 | | 5.3 | J |
| PCB-032 | NA | 11 | U | 2,400 | | 2,500 | | 11 | U |
| PCB-034 | NA | 5.6 | U | 100 | U | 58 | J | 5.7 | U |
| PCB-035 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-036 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-037 | NA | 5.6 | U | 2,700 | | 2,000 | J | 5.7 | U |
| PCB-038 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-039 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-040 AND 071 | NA | 1.4 | U | 8,400 | | 5,700 | | 1.9 | J |
| PCB-041 | NA | 11 | U | 200 | U | 21 | U | 11 | U |
| PCB-042 | NA | 5.6 | U | 18,000 | J | 4,200 | J | 1.8 | J |
| PCB-043 | NA | 5.6 | U | 1,700 | J | 10 | U | 5.7 | U |
| PCB-044 AND 047 AND 065 | NA | 9.3 | J | 100,000 | | 45,000 | | 11 | J |
| PCB-045 | NA | 5.6 | U | 100 | U | 1,700 | | 5.7 | U |
| PCB-046 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-048 | NA | 5.6 | U | 2,100 | | 1,600 | | 5.7 | U |
| PCB-050 AND 053 | NA | 11 | U | 2,900 | J | 2,700 | | 11 | U |
| PCB-051 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-052 | NA | 15 | J | 190,000 | | 120,000 | | 17 | J |
| PCB-054 | NA | 5.6 | U | 100 | U | 20 | J | 5.7 | U |
| PCB-055 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-056 | NA | 5.6 | U | 8,800 | | 5,600 | | 1.2 | J |
| PCB-057 | NA | 5.6 | U | 1,100 | J | 3,400 | J | 5.7 | U |
| PCB-058 | NA | 5.6 | U | 860 | J | 10 | U | 5.7 | U |
| PCB-059 AND 062 AND 075 | NA | 17 | U | 4,900 | J | 940 | J | 17 | U |
| PCB-060 | NA | 5.6 | U | 1,100 | J | 2,100 | | 5.7 | U |
| PCB-061 AND 070 AND 074 AND 076 | NA | 8 | J | 120,000 | | 67,000 | | 8.8 | J |
| PCB-063 | NA | 5.6 | U | 3,700 | J | 850 | J | 5.7 | U |
| PCB-064 | NA | 2.7 | J | 20,000 | | 12,000 | | 2.7 | J |
| PCB-066 | NA | 3.5 | J | 79,000 | J | 20,000 | J | 4.3 | J |
| PCB-067 | NA | 5.6 | U | 6,500 | | 10 | U | 5.7 | U |
| PCB-068 | NA | 5.6 | U | 4,300 | J | 350 | J | 5.7 | U |
| PCB-069 AND 049 | NA | 4.9 | J | 110,000 | J | 28,000 | J | 7.7 | J |
| PCB-072 | NA | 5.6 | U | 5,800 | J | 470 | J | 5.7 | U |
| PCB-073 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-077 | NA | 5.6 | U | 1,300 | | 640 | | 5.7 | U |
| PCB-078 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-079 | NA | 5.6 | U | 2,000 | | 1,200 | | 5.7 | U |
| PCB-080 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-081 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-082 | NA | 5.6 | U | 13,000 | | 18,000 | | 5.7 | U |
| PCB-083 | NA | 5.6 | U | 34,000 | | 17,000 | | 1.8 | J |

## Table I2-2. PCB Congeners in Soil (pg/g)

| | Location Name | NP-B137 | | NP-B138 | | NP-B138 | | NP-B138 | |
|---|---|---|---|---|---|---|---|---|---|
| | Sample Name | NP-B137-S-52-191008 | | NP-B138-S-5-191008 | | NP-B138-S-6-191008 | | NP-B138-S-62-191008 | |
| | Sample Type | N | | FD | | P | | N | |
| **Analyte** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-084 | NA | 5.7 | J | 75,000 | | 69,000 | | 5.3 | J |
| PCB-088 AND 091 | NA | 2.1 | J | 36,000 | | 23,000 | | 2.4 | J |
| PCB-089 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-092 | NA | 3.6 | J | 79,000 | | 43,000 | | 4.6 | J |
| PCB-093 AND 100 | NA | 11 | U | 3,100 | J | 21 | U | 11 | U |
| PCB-094 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-095 | NA | 17 | J | 290,000 | | 210,000 | | 17 | J |
| PCB-096 | NA | 5.6 | U | 1,000 | J | 990 | | 5.7 | U |
| PCB-098 AND 102 | NA | 11 | U | 5,900 | | 3,400 | | 11 | U |
| PCB-099 | NA | 5.2 | J | 190,000 | | 72,000 | | 9.7 | J |
| PCB-103 | NA | 5.6 | U | 4,800 | | 10 | U | 5.7 | U |
| PCB-104 | NA | 5.6 | U | 12 | J | 5 | J | 5.7 | U |
| PCB-105 | NA | 4.8 | J | 53,000 | | 71,000 | | 2.8 | J |
| PCB-106 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-107 AND 124 | NA | 11 | U | 4,500 | | 5,000 | | 11 | U |
| PCB-108 AND 119 AND 086 AND 097 AND 125 AND 087 | NA | 9.8 | J | 150,000 | | 140,000 | | 9.1 | J |
| PCB-109 | NA | 1 | J | 38,000 | J | 11,000 | J | 5.7 | U |
| PCB-110 AND 115 | NA | 15 | J | 330,000 | | 220,000 | | 18 | J |
| PCB-111 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-112 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-113 AND 090 AND 101 | NA | 15 | J | 360,000 | | 230,000 | | 18 | J |
| PCB-114 | NA | 5.6 | U | 3,100 | | 3,900 | J | 5.7 | U |
| PCB-117 AND 116 AND 085 | NA | 17 | U | 22,000 | | 21,000 | | 17 | U |
| PCB-118 | NA | 13 | | 450,000 | | 200,000 | | 15 | |
| PCB-120 | NA | 5.6 | U | 3,600 | | 10 | U | 5.7 | U |
| PCB-121 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-122 | NA | 5.6 | U | 100 | U | 2,100 | | 5.7 | U |
| PCB-123 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-126 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-127 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-128 AND 166 | NA | 1.3 | J | 30,000 | | 32,000 | | 11 | U |
| PCB-130 | NA | 1.2 | J | 15,000 | | 13,000 | | 5.7 | U |
| PCB-131 | NA | 5.6 | U | 2,500 | | 2,900 | | 5.7 | U |
| PCB-132 | NA | 3.7 | J | 84,000 | | 62,000 | | 4.2 | J |
| PCB-133 | NA | 5.6 | U | 2,900 | | 1,700 | | 5.7 | U |
| PCB-134 AND 143 | NA | 11 | U | 13,000 | | 9,900 | | 11 | U |
| PCB-136 | NA | 1.9 | J | 23,000 | | 20,000 | | 1.2 | J |
| PCB-137 | NA | 5.6 | U | 11,000 | | 11,000 | | 5.7 | U |
| PCB-138 AND 163 AND 129 | NA | 9.3 | J | 190,000 | | 190,000 | | 6.5 | J |
| PCB-139 AND 140 | NA | 11 | U | 4,100 | | 3,100 | | 11 | U |
| PCB-141 | NA | 1.2 | J | 18,000 | | 23,000 | | 5.7 | U |
| PCB-142 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-144 | NA | 5.6 | U | 4,800 | | 5,700 | | 5.7 | U |
| PCB-145 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-146 | NA | 0.85 | J | 32,000 | | 18,000 | | 0.91 | J |
| PCB-147 AND 149 | NA | 7.1 | J | 140,000 | | 100,000 | | 7.2 | J |
| PCB-148 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-150 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-151 AND 135 | NA | 2.7 | J | 49,000 | | 35,000 | | 11 | U |
| PCB-152 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-153 AND 168 | NA | 6.2 | J | 160,000 | | 110,000 | | 5.8 | J |
| PCB-154 | NA | 5.6 | U | 2,900 | | 1,100 | | 5.7 | U |
| PCB-155 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-156 AND 157 | NA | 1.8 | J | 24,000 | | 26,000 | | 0.81 | J |
| PCB-158 | NA | 1.3 | J | 18,000 | | 20,000 | | 5.7 | U |
| PCB-159 | NA | 5.6 | U | 170 | J | 190 | J | 5.7 | U |
| PCB-160 | NA | 11 | U | 200 | U | 21 | U | 11 | U |
| PCB-161 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-162 | NA | 5.6 | U | 470 | J | 540 | | 5.7 | U |
| PCB-164 | NA | 5.6 | U | 13,000 | | 10,000 | | 5.7 | U |
| PCB-165 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-167 | NA | 0.71 | J | 7,200 | | 7,600 | J | 0.34 | J |
| PCB-169 | NA | 0.63 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-170 | NA | 5.6 | U | 12,000 | | 16,000 | | 5.7 | U |
| PCB-171 AND 173 | NA | 11 | U | 3,700 | J | 4,600 | | 11 | U |
| PCB-172 | NA | 5.6 | U | 1,300 | J | 1,800 | | 5.7 | U |
| PCB-174 | NA | 0.7 | U | 7,100 | | 8,400 | | 11 | U |
| PCB-175 | NA | 5.6 | U | 470 | J | 570 | | 5.7 | U |

**Table I2-2. PCB Congeners in Soil (pg/g)**

| Location Name | | NP-B137 | | NP-B138 | | NP-B138 | | NP-B138 | |
|---|---|---|---|---|---|---|---|---|---|
| Sample Name | | NP-B137-S-52-191008 | | NP-B138-S-5-191008 | | NP-B138-S-6-191008 | | NP-B138-S-62-191008 | |
| Sample Type | | N | | FD | | P | | N | |
| **Analyte** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-176 | NA | 5.6 | U | 1,600 | J | 1,600 | | 5.7 | U |
| PCB-177 | NA | 5.6 | U | 5,700 | | 5,900 | | 5.7 | U |
| PCB-178 | NA | 5.6 | U | 1,800 | J | 1,800 | | 5.7 | U |
| PCB-179 | NA | 5.6 | U | 3,100 | | 3,100 | | 5.7 | U |
| PCB-180 AND 193 | NA | 1.4 | U | 14,000 | | 18,000 | | 1.3 | U |
| PCB-181 | NA | 5.6 | U | 100 | J | 120 | J | 5.7 | U |
| PCB-182 | NA | 5.6 | U | 93 | J | 110 | J | 5.7 | U |
| PCB-183 | NA | 5.6 | U | 4,700 | | 5,800 | | 1.3 | J |
| PCB-184 | NA | 5.6 | U | 15 | J | 12 | J | 5.7 | U |
| PCB-185 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-186 | NA | 5.6 | U | 100 | U | 3 | J | 5.7 | U |
| PCB-187 | NA | 5.6 | U | 8,300 | | 8,500 | | 5.7 | U |
| PCB-188 | NA | 5.6 | U | 20 | J | 17 | J | 5.7 | U |
| PCB-189 | NA | 5.6 | U | 490 | | 610 | J | 5.7 | U |
| PCB-190 | NA | 5.6 | U | 1,200 | J | 1,400 | | 5.7 | U |
| PCB-191 | NA | 5.6 | U | 490 | J | 600 | | 5.7 | U |
| PCB-192 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-194 | NA | 5.6 | U | 340 | J | 420 | | 5.7 | U |
| PCB-195 | NA | 5.6 | U | 63 | J | 50 | J | 5.7 | U |
| PCB-196 | NA | 5.6 | U | 290 | J | 360 | | 5.7 | U |
| PCB-197 | NA | 5.6 | U | 28 | J | 30 | J | 5.7 | U |
| PCB-198 AND 199 | NA | 11 | U | 550 | J | 600 | | 11 | U |
| PCB-200 | NA | 5.6 | U | 17 | J | 8 | J | 5.7 | U |
| PCB-201 | NA | 5.6 | U | 89 | J | 98 | J | 5.7 | U |
| PCB-202 | NA | 5.6 | U | 130 | J | 130 | J | 5.7 | U |
| PCB-203 | NA | 5.6 | U | 87 | J | 52 | J | 5.7 | U |
| PCB-204 | NA | 5.6 | U | 100 | U | 10 | U | 5.7 | U |
| PCB-205 | NA | 5.6 | U | 100 | U | 11 | J | 5.7 | U |
| PCB-206 | NA | 5.6 | U | 95 | J | 140 | J | 5.7 | U |
| PCB-207 | NA | 5.6 | U | 100 | U | 8 | J | 5.7 | U |
| PCB-208 | NA | 5.6 | U | 43 | J | 65 | J | 5.7 | U |
| PCB-209 | NA | 3.1 | U | 130 | J | 180 | J | 2 | U |
| TOTAL POLYCHLORINATED BIPHENYLS (PCBS) | 500,000[1] | 186 | | **3,834,944** | | **2,521,200** | | 199 | |

Notes:
[1] MTCA Method B carcinogen direct contact, lowest single Aroclor value.
FD – field duplicate
J – The reported value is an estimated concentration.
N – Sample is not part of a field duplicate pair.

NA – not applicable
P – Parent sample of field duplicate.
PAL – project action limit
PCB – polychlorinated biphenyls

pg/g – picograms per gram
U – The analyte was not detected at or above the limit of detection. (Sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
**Bolded** values indicate that the reported concentration exceeds the PAL.

## Table I2-3. TPH Results in Soil Samples (µg/kg)

| Location Name | Sample Name | Sample Type | PAL (µg/kg) | TPH-Diesel Range C12-C24 (µg/kg) |
|---|---|---|---|---|
| NP-B118 | NP-B118-S-13-190624 | N | 2,000,000 | 260,000 |
| | NP-B118-S-16-190624 | N | 2,000,000 | 1,200 U |
| | NP-B118-S-34-190625 | N | 2,000,000 | 1,200 U |
| NP-B119 | NP-B119-S-07-190621 | N | 2,000,000 | 1,300 U |
| | NP-B119-S-12-190621 | N | 2,000,000 | **3,200,000** |
| | NP-B119-S-15-190621 | N | 2,000,000 | 1,200 U |
| NP-B120 | NP-B120-S-12.5-190624 | N | 2,000,000 | 490,000 |
| | NP-B120-S-29-190624 | N | 2,000,000 | 1,100 U |
| | NP-B120-S-35.5-190624 | N | 2,000,000 | 1,200 U |
| | NP-B120-S-42-190624 | N | 2,000,000 | 1,100 U |
| | NP-B120-S-49.5-190624 | N | 2,000,000 | 1,100 U |
| NP-B121 | NP-B121-S-05-190620 | N | 2,000,000 | 2,000,000 |
| | NP-B121-S-13-190620 | P | 2,000,000 | 290,000 J |
| | NP-B121-S-14-190620 | FD | 2,000,000 | 53,000 J |
| | NP-B121-S-34-190620 | N | 2,000,000 | 1,200 U |
| NP-B122 | NP-B122-S-05-190620 | N | 2,000,000 | 1,600,000 |
| | NP-B122-S-09-190620 | N | 2,000,000 | 890,000 |
| | NP-B122-S-27-190621 | N | 2,000,000 | 1,300 U |
| NP-B123 | NP-B123-S-19-190619 | N | 2,000,000 | 49,000 |
| | NP-B123-S-25-190619 | N | 2,000,000 | 1,400 U |
| | NP-B123-S-40-190619 | N | 2,000,000 | 1,400 U |
| NP-B124 | NP-B124-S-10-190620 | N | 2,000,000 | 50,000 |
| | NP-B124-S-14-190620 | N | 2,000,000 | 150,000 |
| | NP-B124-S-28-190620 | N | 2,000,000 | 1,300 U |
| NP-B125 | NP-B125-S-20-190619 | N | 2,000,000 | 88,000 |
| | NP-B125-S-38-190619 | N | 2,000,000 | 25,000 |
| | NP-B125-S-45-190619 | N | 2,000,000 | 1,200 U |
| NP-B137 | NP-B137-S-52-191008 | N | 2,000,000 | 1,200 U |
| NP-B138 | NP-B138-S-5-191009 | FD | 2,000,000 | 2,700 J |
| | NP-B138-S-6-191009 | P | 2,000,000 | 1,100 UJ |
| | NP-B138-S-62-191009 | N | 2,000,000 | 1,100 U |

Notes:
Samples analyzed using U.S. EPA Method NWTPH-Dx.
FD – field duplicate
J – The reported value is an estimated concentration.
N – Sample is not part of a duplicate pair.
P – Parent sample of field duplicate
PAL – project action limit

## Table I2-2. PCB Congeners in Soil (pg/g)

TPH – total petroleum hydrocarbons
U – The analyte was analyzed but not detected at or above the stated limit. (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
UJ – The analyte was analyzed but not detected. the sample quantitation limit is an estimated value.
µg/kg – micrograms per kilogram
**Bolded** values indicate that the reported concentration exceeds the PAL.

## Table I2-4. TPH Results in Grab Groundwater Samples (µg/L)

| Location Name | Sample Name | Sample Type | PAL (µg/L) | TPH-Diesel range C12-C24 (µg/L) |
|---|---|---|---|---|
| NP-B118 | NP-B118-GW-20-190624 | N | 500 | 310 |
| | NP-B118-GW-35-190625 | N | 500 | 50 U |
| NP-B119 | NP-B119-GW-15-190621 | N | 500 | 410 |
| | NP-B119-GW-32-190621 | N | 500 | **1,200 J** |
| NP-B120 | NP-B120-GW-15-190624 | N | 500 | 320 |
| | NP-B120-GW-50-190624 | N | 500 | 210 |
| NP-B121 | NP-B121-GW-15-190620 | N | 500 | 260 |
| | NP-B121-GW-35-190620 | N | 500 | 150 |
| NP-B122 | NP-B122-GW-15-190620 | N | 500 | **920** |
| | NP-B122-GW-28-190621 | N | 500 | 50 U |
| NP-B123 | NP-B123-GW-19-190619 | P | 500 | 300 U |
| | NP-B123-GW-20-190619 | FD | 500 | 390 U |
| | NP-B123-GW-40-190619 | N | 500 | 210 U |
| NP-B124 | NP-B124-GW-20-190620 | N | 500 | 260 |
| | NP-B124-GW-29-190620 | N | 500 | 50 U |
| NP-B125 | NP-B125-GW-23-190619 | N | 500 | 260 U |
| | NP-B125-GW-39-190619 | N | 500 | 50 U |

Notes:
Samples analyzed using U.S. EPA Method NWTPH-Dx.
FD – field duplicate

J – The reported value is an estimated concentration.
N – Sample is not part of a duplicate pair.
P – Parent sample of field duplicate.
PAL – project action limit
TPH – total petroleum hydrocarbons
U – The analyte was analyzed but not detected at or above the stated limit. (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
µg/L – micrograms per liter
**Bolded** values indicate that the reported concentration exceeds the PAL.

## Table I2-5. PCB Aroclors in Grab Groundwater Samples (µg/L)

| | | Location Name | NP-B118 | NP-B118 | NP-B119 | NP-B119 | NP-B120 | NP-B120 | NP-B121 |
|---|---|---|---|---|---|---|---|---|---|
| | | Sample Name | NP-B118-GW-20-190624 | NP-B118-GW-35-190625 | NP-B119-GW-15-190621 | NP-B119-GW-32-190621 | NP-B120-GW-15-190624 | NP-B120-GW-50-190624 | NP-B121-GW-15-190620 |
| | | Sample type | N | N | N | N | N | N | N |
| **Analyte** | **Units** | **PAL (µg/L)** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| AROCLOR-1016 | µg/L | 1.12 | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| AROCLOR-1221 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| AROCLOR-1232 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| AROCLOR-1242 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| AROCLOR-1248 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| AROCLOR-1254 | µg/L | 0.0438 | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| AROCLOR-1260 | µg/L | 0.0438 | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| AROCLOR-1262 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| AROCLOR-1268 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |
| Total PCB Aroclors | µg/L | 0.1 | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ |

| | | Location Name | NP-B121 | NP-B122 | NP-B122 | NP-B123 | NP-B123 | NP-B123 | NP-B124 |
|---|---|---|---|---|---|---|---|---|---|
| | | Sample Name | NP-B121-GW-35-190620 | NP-B122-GW-15-190620 | NP-B122-GW-28-190621 | NP-B123-GW-19-190619 | NP-B123-GW-20-190619 | NP-B123-GW-40-190619 | NP-B124-GW-20-190620 |
| | | Sample type | N | N | N | P | FD | N | N |
| **Analyte** | **Units** | **PAL (µg/L)** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| AROCLOR-1016 | µg/L | 1.12 | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| AROCLOR-1221 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| AROCLOR-1232 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| AROCLOR-1242 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| AROCLOR-1248 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| AROCLOR-1254 | µg/L | 0.0438 | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| AROCLOR-1260 | µg/L | 0.0438 | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| AROCLOR-1262 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| AROCLOR-1268 | µg/L | NE | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |
| Total PCB Aroclors | µg/L | 0.1 | 0.008 U | 0.008 U | 0.008 U | 0.008 UJ | 0.008 UJ | 0.008 U | 0.008 UJ |

**Table I2-5. PCB Aroclors in Grab Groundwater Samples (µg/L)**

| | | Location Name | NP-B124 | NP-B125 | NP-B125 |
|---|---|---|---|---|---|
| | | Sample Name | NP-B124-GW-29-190620 | NP-B125-GW-23-190619 | NP-B125-GW-39-190619 |
| | | Sample type | N | N | N |
| **Analyte** | **Units** | **PAL (µg/L)** | **Result** | **Result** | **Result** |
| AROCLOR-1016 | µg/L | 1.12 | 0.008 U | 0.008 UJ | 0.008 UJ |
| AROCLOR-1221 | µg/L | NE | 0.008 U | 0.008 UJ | 0.008 UJ |
| AROCLOR-1232 | µg/L | NE | 0.008 U | 0.008 UJ | 0.008 UJ |
| AROCLOR-1242 | µg/L | NE | 0.008 U | 0.008 UJ | 0.008 UJ |
| AROCLOR-1248 | µg/L | NE | 0.008 U | 0.008 UJ | 0.008 UJ |
| AROCLOR-1254 | µg/L | 0.0438 | 0.008 U | 0.008 UJ | 0.008 UJ |
| AROCLOR-1260 | µg/L | 0.0438 | 0.008 U | 0.008 UJ | 0.008 UJ |
| AROCLOR-1262 | µg/L | NE | 0.008 U | 0.008 UJ | 0.008 UJ |
| AROCLOR-1268 | µg/L | NE | 0.008 U | 0.008 UJ | 0.008 UJ |
| Total PCB Aroclors | µg/L | 0.1 | 0.008 U | 0.008 UJ | 0.008 UJ |

Notes:
Samples analyzed using U.S. EPA Method 8082 A.
FD – field duplicate
J – The result is an estimated concentration that is less than the limit of quantitation, but greater than or equal to the detection limit.
P – Parent sample of field duplicate.
PAL – project action limit
PCB – polychlorinated biphenyl
N – Sample is not part of a duplicate pair.
NE – not established
MS/MSD – matrix spike/matrix spike duplicate

U – The compound was analyzed for, but was not detected ("non-detect") at or above the limit of detection.
UJ – The analyte was not detected at the stated sample quantitation limit, which is an estimated value.
µg/L – micrograms per liter

## Table I2-6. TPH in Groundwater Monitoring Wells (µg/L)

| Location Name | Sample Name | Sample Type | PAL (µg/L) | TPH-Diesel range C12-C24 (µg/L) |
|---|---|---|---|---|
| MW1-42 | MW1-42-191022 | N | 500 | 96 |
| MW1-43 | MW1-43-191023 | N | 500 | 110 |
| MW1-44 | MW1-44-191024 | N | 500 | 48 J |
| MW1-45 | MW1-45-191022 | N | 500 | 44 J |
| MW1-46 | MW1-46-191025 | P | 500 | 110 |
| | FD-191025-01 | FD | 500 | 120 |
| MW1-47 | MW1-47-191025 | N | 500 | **690** |
| MW1-48 | MW1-48-191028 | N | 500 | **780** |
| MW1-62 | MW1-62-191024 | N | 500 | 350 |
| MW1-63 | MW1-63-191025 | N | 500 | 220 |
| MW1-64 | MW1-64-191024 | N | 500 | 270 |
| MW1-65 | MW1-65-191021 | N | 500 | 48 J |
| MW1-67 | MW1-67-191028 | N | 500 | **780** |

Notes:
Samples analyzed using U.S. EPA Method NWTPH-Dx.
FD – field duplicate
J – The reported value is an estimated concentration.
MS/MSD – matrix spike/matrix spike duplicate
N – Sample is not part of a duplicate pair.

P – Parent sample of field duplicate
PAL – project action limit
TPH – total petroleum hydrocarbon
U – The analyte was analyzed but not detected at or above the stated limit. (sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).
µg/L – micrograms per liter
**Bolded** values indicate that the reported concentration exceeds the PAL.

## Table I2-7. PCB Congeners in Groundwater Monitoring Wells (pg/L)

| Location Name | | MW1-2 | | | | MW1-18 | | MW1-64 | | MW1-65 | | MW1-67 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | | MW1-2-191029 | | FD-191029-01 | | MW1-18-191021 | | MW1-64-191024 | | MW1-65-191021 | | MW1-67-191028 | |
| Sample Type | | P | | FD | | N | | N | | N | | N | |
| Analyte | PAL | Result | | Result | | Result | | Result | | Result | | Result | |
| PCB-001 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 8.1 | J | 11 | J | 520 | |
| PCB-002 | NA | 19 | U | 19 | U | 1.8 | J | 19 | U | 19 | U | 38 | J |
| PCB-003 | NA | 9.5 | U | 9.5 | U | 0.9 | J | 9.5 | U | 1.7 | J | 77 | J |
| PCB-004 | NA | 24 | U | 24 | U | 24 | U | 26 | J | 24 | U | 1,900 | |
| PCB-005 | NA | 24 | U | 24 | U | 24 | U | 24 | U | 24 | U | 49 | J |
| PCB-006 | NA | 24 | U | 24 | U | 24 | U | 24 | U | 24 | U | 410 | |
| PCB-007 | NA | 24 | U | 24 | U | 24 | U | 24 | U | 24 | U | 51 | J |
| PCB-008 | NA | 24 | U | 24 | U | 24 | U | 11 | J | 24 | U | 710 | |
| PCB-009 | NA | 47 | U | 48 | U | 47 | U | 48 | U | 48 | U | 81 | J |
| PCB-010 | NA | 47 | U | 48 | U | 47 | U | 48 | U | 48 | U | 110 | J |
| PCB-011 | NA | 24 | U | 24 | U | 24 | U | 16 | U | 24 | U | 24 | U |
| PCB-012 AND 013 | NA | 38 | U | 38 | U | 38 | U | 38 | U | 39 | U | 37 | J |
| PCB-014 | NA | 24 | U | 24 | U | 24 | U | 24 | U | 24 | U | 24 | U |
| PCB-015 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 110 | J |
| PCB-016 | NA | 47 | U | 48 | U | 47 | U | 9.3 | J | 5.7 | J | 230 | |
| PCB-017 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 11 | J | 5.1 | J | 270 | |
| PCB-019 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 6.8 | J | 3.5 | J | 200 | |
| PCB-021 AND 033 | NA | 38 | U | 38 | U | 38 | U | 5.3 | J | 3.7 | J | 90 | J |
| PCB-022 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 3.4 | J | 1.6 | J | 76 | J |
| PCB-023 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-024 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 7.5 | J |
| PCB-025 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 90 | J |
| PCB-026 AND 029 | NA | 38 | U | 38 | U | 38 | U | 3.5 | J | 1.8 | J | 230 | J |
| PCB-027 | NA | 19 | U | 19 | U | 19 | U | 2.6 | J | 19 | U | 64 | J |
| PCB-028 AND 020 | NA | 38 | U | 38 | U | 3 | J | 12 | U | 7 | J | 280 | J |
| PCB-030 AND 018 | NA | 47 | U | 48 | U | 2.2 | J | 20 | J | 11 | J | 530 | |
| PCB-031 | NA | 19 | U | 19 | U | 19 | U | 12 | U | 19 | U | 310 | |
| PCB-032 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 5.9 | J | 3.3 | J | 130 | J |
| PCB-034 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-035 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-036 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-037 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 2.4 | J | 1.4 | J | 23 | J |
| PCB-038 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-039 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-040 AND 071 | NA | 19 | U | 19 | U | 19 | U | 3.1 | J | 2.8 | J | 84 | J |
| PCB-041 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-042 | NA | 19 | U | 19 | U | 19 | U | 2.5 | J | 3.7 | J | 77 | J |
| PCB-043 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.9 | J |

## Table I2-7. PCB Congeners in Groundwater Monitoring Wells (pg/L)

| Location Name | | MW1-2 | | | | MW1-18 | | MW1-64 | | MW1-65 | | MW1-67 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | | MW1-2-191029 | | FD-191029-01 | | MW1-18-191021 | | MW1-64-191024 | | MW1-65-191021 | | MW1-67-191028 | |
| Sample Type | | P | | FD | | N | | N | | N | | N | |
| **Analyte** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-044 AND 047 AND 065 | NA | 71 | U | 71 | U | 71 | U | 14 | U | 72 | U | 370 | J |
| PCB-045 | NA | 19 | U | 19 | U | 19 | U | 2 | J | 1.2 | J | 61 | J |
| PCB-046 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 31 | J |
| PCB-048 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 1.1 | J | 25 | J |
| PCB-050 AND 053 | NA | 38 | U | 38 | U | 0.69 | J | 1.9 | J | 1.3 | J | 66 | J |
| PCB-051 | NA | 19 | U | 0.76 | J | 1.6 | J | 2.3 | J | 1 | J | 18 | J |
| PCB-052 | NA | 19 | U | 19 | U | 19 | U | 13 | J | 39 | J | 700 | |
| PCB-054 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 2.8 | J |
| PCB-055 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-056 | NA | 19 | U | 19 | U | 0.54 | J | 1.3 | J | 2 | J | 30 | J |
| PCB-057 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 2.3 | J |
| PCB-058 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-059 AND 062 AND 075 | NA | 57 | U | 57 | U | 57 | U | 57 | U | 58 | U | 27 | J |
| PCB-060 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 9.8 | J |
| PCB-061 AND 070 AND 074 AND 076 | NA | 38 | U | 38 | U | 38 | U | 7.2 | U | 15 | J | 220 | J |
| PCB-063 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 7.4 | J |
| PCB-064 | NA | 19 | U | 19 | U | 0.78 | J | 3.3 | U | 3.7 | J | 82 | J |
| PCB-066 | NA | 9.5 | U | 9.5 | U | 1.5 | J | 3.1 | U | 9 | J | 120 | J |
| PCB-067 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 6.3 | J |
| PCB-068 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 4 | J |
| PCB-069 AND 049 | NA | 38 | U | 38 | U | 1.9 | J | 5.8 | J | 18 | J | 310 | J |
| PCB-072 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 5.5 | J |
| PCB-073 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-077 | NA | 9.5 | U | 9.5 | U | 1.2 | J | 9.5 | U | 9.6 | U | 3.3 | J |
| PCB-078 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-079 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-080 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-081 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-082 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 1.4 | J | 15 | J |
| PCB-083 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 3.3 | J | 22 | J |
| PCB-084 | NA | 3.3 | J | 3.5 | J | 19 | U | 3.4 | J | 7.5 | J | 120 | J |
| PCB-088 AND 091 | NA | 19 | U | 19 | UJ | 1.2 | J | 1.2 | J | 3 | J | 61 | J |
| PCB-089 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-092 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 1.8 | J | 5.1 | J | 66 | J |
| PCB-093 AND 100 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-094 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-095 | NA | 19 | U | 19 | U | 5.2 | J | 9.6 | U | 23 | J | 390 | |
| PCB-096 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 2.9 | J |
| PCB-098 AND 102 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 9.8 | J |
| PCB-099 | NA | 19 | U | 19 | U | 19 | U | 3.9 | U | 10 | J | 110 | J |

**Table I2-7. PCB Congeners in Groundwater Monitoring Wells (pg/L)**

| Location Name | | MW1-2 | | | | MW1-18 | | MW1-64 | | MW1-65 | | MW1-67 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | | MW1-2-191029 | | FD-191029-01 | | MW1-18-191021 | | MW1-64-191024 | | MW1-65-191021 | | MW1-67-191028 | |
| Sample Type | | P | | FD | | N | | N | | N | | N | |
| Analyte | PAL | Result | | Result | | Result | | Result | | Result | | Result | |
| PCB-103 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-104 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-105 | NA | 19 | U | 19 | U | 19 | U | 1.6 | U | 19 | U | 35 | |
| PCB-106 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-107 AND 124 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-108 AND 119 AND 086 AND 097 AND 125 AND 087 | NA | 57 | U | 57 | U | 57 | U | 5.9 | U | 58 | U | 140 | J |
| PCB-109 | NA | 1 | J | 9.5 | U | 9.5 | U | 9.5 | U | 1.5 | J | 13 | J |
| PCB-110 AND 115 | NA | 19 | U | 19 | U | 19 | U | 9.3 | U | 20 | J | 270 | J |
| PCB-111 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-112 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-113 AND 090 AND 101 | NA | 28 | U | 29 | U | 28 | U | 8.1 | U | 22 | J | 270 | J |
| PCB-114 | NA | 9.5 | U | 9.5 | U | 1 | J | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-117 AND 116 AND 085 | NA | 57 | U | 57 | U | 57 | U | 1.2 | J | 58 | U | 24 | J |
| PCB-118 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 8.4 | U | 17 | U | 170 | |
| PCB-120 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-121 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-122 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-123 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-126 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-127 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-128 AND 166 | NA | 1.9 | J | 2.1 | J | 2.4 | J | 1.4 | U | 0.96 | J | 15 | J |
| PCB-130 | NA | 9.5 | U | 9.5 | U | 1.1 | J | 9.5 | U | 9.6 | U | 5.3 | J |
| PCB-131 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-132 | NA | 19 | U | 19 | U | 3.4 | J | 2 | U | 3.5 | J | 35 | J |
| PCB-133 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-134 AND 143 | NA | 38 | U | 38 | U | 38 | U | 38 | U | 0.64 | J | 7.4 | J |
| PCB-136 | NA | 9.5 | U | 9.5 | U | 0.6 | J | 1.2 | J | 1.1 | J | 18 | J |
| PCB-137 | NA | 19 | U | 19 | U | 0.5 | J | 19 | U | 19 | U | 4.6 | J |
| PCB-138 AND 163 AND 129 | NA | 57 | U | 57 | U | 57 | U | 7.8 | U | 7.7 | U | 87 | J |
| PCB-139 AND 140 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 2 | J |
| PCB-141 | NA | 9.5 | U | 9.5 | U | 1.4 | J | 1.3 | U | 0.72 | J | 11 | J |
| PCB-142 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-144 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 4.3 | J |
| PCB-145 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-146 | NA | 19 | U | 19 | UJ | 1.6 | J | 0.72 | U | 1 | J | 13 | J |
| PCB-147 AND 149 | NA | 38 | U | 38 | U | 38 | U | 4.7 | U | 39 | U | 79 | J |
| PCB-148 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-150 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-151 AND 135 | NA | 38 | U | 38 | UJ | 38 | U | 1.8 | U | 39 | U | 31 | J |

## Table I2-7. PCB Congeners in Groundwater Monitoring Wells (pg/L)

| Location Name | | MW1-2 | | | | MW1-18 | | MW1-64 | | MW1-65 | | MW1-67 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | | MW1-2-191029 | | FD-191029-01 | | MW1-18-191021 | | MW1-64-191024 | | MW1-65-191021 | | MW1-67-191028 | |
| Sample Type | | P | | FD | | N | | N | | N | | N | |
| Analyte | PAL | Result | | Result | | Result | | Result | | Result | | Result | |
| PCB-152 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-153 AND 168 | NA | 38 | U | 38 | U | 38 | U | 5.3 | U | 39 | U | 68 | J |
| PCB-154 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-155 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-156 AND 157 | NA | 19 | U | 19 | UJ | 19 | U | 1.2 | U | 19 | U | 19 | U |
| PCB-158 | NA | 19 | U | 19 | U | 1 | J | 0.72 | U | 0.88 | J | 8.7 | J |
| PCB-159 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-160 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-161 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-162 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-164 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 5.6 | J |
| PCB-165 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-167 | NA | 9.5 | U | 9.5 | U | 1.3 | J | 0.44 | U | 0.7 | J | 4.1 | J |
| PCB-169 | NA | 9.5 | U | 9.5 | U | 1.4 | J | 9.5 | U | 0.42 | J | 9.5 | U |
| PCB-170 | NA | 19 | U | 19 | U | 19 | U | 1.7 | U | 19 | UJ | 8.2 | J |
| PCB-171 AND 173 | NA | 19 | U | 0.69 | J | 19 | U | 19 | U | 19 | U | 2.2 | J |
| PCB-172 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-174 | NA | 19 | U | 19 | U | 19 | U | 1.2 | U | 19 | U | 7.1 | J |
| PCB-175 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-176 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 1.1 | J |
| PCB-177 | NA | 19 | U | 0.72 | J | 1.1 | J | 19 | U | 19 | U | 4 | J |
| PCB-178 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 0.39 | U | 9.6 | U | 9.5 | U |
| PCB-179 | NA | 19 | U | 0.52 | J | 0.57 | J | 0.25 | U | 19 | U | 2.8 | J |
| PCB-180 AND 193 | NA | 38 | U | 38 | U | 38 | U | 2.9 | U | 39 | U | 14 | J |
| PCB-181 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-182 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-183 | NA | 19 | U | 19 | U | 19 | U | 1.5 | U | 19 | U | 19 | U |
| PCB-184 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-185 | NA | 19 | U | 19 | U | 0.31 | J | 0.32 | U | 19 | U | 0.67 | J |
| PCB-186 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-187 | NA | 19 | U | 19 | U | 1.4 | J | 1.1 | U | 1.1 | J | 7.5 | J |
| PCB-188 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-189 | NA | 9.5 | U | 9.5 | U | 1.1 | J | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-190 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 1.3 | J |
| PCB-191 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-192 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-194 | NA | 19 | U | 19 | U | 19 | U | 1.5 | U | 19 | U | 2.7 | J |
| PCB-195 | NA | 19 | U | 19 | U | 0.29 | J | 19 | U | 0.3 | J | 0.73 | J |
| PCB-196 | NA | 19 | U | 19 | U | 0.4 | J | 0.59 | U | 19 | U | 1.7 | J |
| PCB-197 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |

**Table I2-7. PCB Congeners in Groundwater Monitoring Wells (pg/L)**

| Location Name | | MW1-2 | | | | MW1-18 | | MW1-64 | | MW1-65 | | MW1-67 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | | MW1-2-191029 | | FD-191029-01 | | MW1-18-191021 | | MW1-64-191024 | | MW1-65-191021 | | MW1-67-191028 | |
| Sample Type | | P | | FD | | N | | N | | N | | N | |
| **Analyte** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| PCB-198 AND 199 | NA | 19 | U | 19 | U | 19 | U | 1.5 | U | 0.42 | J | 3 | J |
| PCB-200 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 0.64 | J |
| PCB-201 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 0.72 | J |
| PCB-202 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-203 | NA | 19 | U | 0.28 | J | 0.59 | J | 0.82 | U | 19 | U | 1.6 | J |
| PCB-204 | NA | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-205 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-206 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 4.3 | U | 9.6 | U | 2.3 | J |
| PCB-207 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-208 | NA | 9.5 | U | 9.5 | U | 9.5 | U | 9.5 | U | 9.6 | U | 9.5 | U |
| PCB-209 | NA | 19 | UJ | 19 | U | 19 | U | 5.7 | U | 19 | U | 19 | U |
| TOTAL POLYCHLORINATED BIPHENYLS (PCBS) | 100,000 | 6.2 | | 8.6 | | 44 | | 156 | | 263 | | 11,076 | |

Notes:
FD – Field duplicate
J – The reported value is an estimated concentration.
N – Sample is not part of a field duplicate pair,
NA – not available
P – Parent sample of field duplicate
PAL– project action limit
PCB – polychlorinated biphenyl

U – The analyte was not detected at or above the limit of detection.
(Sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).

pg/L – picograms per liter

## Table I2-8. PCB Congeners in Porewater (pg/L)

| | Location Name | PW1-25 | | PW1-26 | | PW1-27 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Sample Name | PW1-25-190604 | | PW1-26-190604 | | PW1-27-190604 | | FD-190604-02 | |
| | Sample Type | N | | N | | P | | FD | |
| Analyte | PAL | Result | | Result | | Result | | Result | |
| PCB-001 | NA | 23 | J | 40 | J | 150 | J | 140 | J |
| PCB-002 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-003 | NA | 2.6 | J | 2.4 | J | 2.6 | J | 2 | J |
| PCB-004 | NA | 92 | J | 420 | | 220 | | 210 | |
| PCB-005 | NA | 24 | U | 24 | U | 24 | U | 24 | U |
| PCB-006 | NA | 24 | U | 69 | J | 91 | J | 91 | J |
| PCB-007 | NA | 24 | U | 24 | U | 24 | U | 24 | U |
| PCB-008 | NA | 24 | U | 100 | J | 100 | J | 98 | J |
| PCB-009 | NA | 48 | U | 48 | U | 48 | U | 48 | U |
| PCB-010 | NA | 48 | U | 48 | U | 48 | U | 48 | U |
| PCB-011 | NA | 24 | U | 24 | U | 24 | U | 24 | U |
| PCB-012 AND 013 | NA | 38 | U | 39 | U | 38 | U | 38 | U |
| PCB-014 | NA | 24 | U | 24 | U | 24 | U | 24 | U |
| PCB-015 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-016 | NA | 18 | J | 150 | J | 130 | J | 120 | J |
| PCB-017 | NA | 20 | J | 220 | | 120 | J | 130 | J |
| PCB-019 | NA | 21 | J | 120 | J | 70 | J | 72 | J |
| PCB-021 AND 033 | NA | 7.4 | J | 76 | J | 38 | J | 39 | J |
| PCB-022 | NA | 5.1 | J | 56 | J | 37 | J | 41 | J |
| PCB-023 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-024 | NA | 19 | U | 19 | U | 4.6 | J | 4 | J |
| PCB-025 | NA | 8.1 | J | 91 | J | 47 | J | 52 | J |
| PCB-026 AND 029 | NA | 24 | J | 350 | J | 160 | J | 170 | J |
| PCB-027 | NA | 12 | J | 70 | J | 21 | J | 24 | J |
| PCB-028 AND 020 | NA | 27 | J | 200 | J | 120 | J | 130 | J |
| PCB-030 AND 018 | NA | 51 | J | 350 | J | 230 | J | 230 | J |
| PCB-031 | NA | 28 | J | 180 | J | 110 | J | 120 | J |
| PCB-032 | NA | 12 | J | 100 | J | 63 | J | 63 | J |
| PCB-034 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-035 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-036 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-037 | NA | 9.6 | U | 12 | J | 5.3 | J | 7.1 | J |
| PCB-038 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-039 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-040 AND 071 | NA | 13 | U | 190 | J | 49 | J | 49 | J |
| PCB-041 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-042 | NA | 5.8 | J | 160 | J | 40 | J | 43 | J |
| PCB-043 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-044 AND 047 AND 065 | NA | 110 | J | 820 | | 250 | J | 290 | J |
| PCB-045 | NA | 5.3 | J | 46 | J | 29 | J | 31 | J |
| PCB-046 | NA | 3.8 | J | 48 | J | 13 | J | 12 | J |
| PCB-048 | NA | 2.8 | J | 35 | J | 8.5 | J | 8.8 | J |
| PCB-050 AND 053 | NA | 15 | J | 110 | J | 27 | J | 31 | J |
| PCB-051 | NA | 51 | J | 190 | | 67 | J | 72 | J |
| PCB-052 | NA | 79 | J | 1200 | | 380 | | 410 | |
| PCB-054 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-055 | NA | 9.6 | U | 2.9 | J | 9.6 | U | 1.5 | J |
| PCB-056 | NA | 2.4 | U | 41 | J | 15 | J | 15 | J |
| PCB-057 | NA | 9.6 | U | 9.7 | U | 2.4 | J | 2.4 | J |
| PCB-058 | NA | 19 | U | 18 | J | 7 | J | 5.8 | J |
| PCB-059 AND 062 AND 075 | NA | 3.2 | J | 79 | J | 16 | J | 15 | J |
| PCB-060 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-061 AND 070 AND 074 AND 076 | NA | 19 | U | 280 | J | 86 | J | 82 | J |
| PCB-063 | NA | 19 | U | 10 | J | 2.1 | J | 2.2 | J |
| PCB-064 | NA | 6.7 | U | 130 | J | 39 | J | 38 | J |
| PCB-066 | NA | 13 | U | 200 | | 52 | J | 50 | J |
| PCB-067 | NA | 19 | U | 11 | J | 6.5 | J | 7.2 | J |
| PCB-068 | NA | 34 | J | 170 | J | 45 | J | 53 | J |
| PCB-069 AND 049 | NA | 32 | J | 810 | | 200 | J | 210 | J |
| PCB-072 | NA | 19 | U | 14 | J | 4.6 | J | 4.7 | J |
| PCB-073 | NA | 19 | U | 11 | J | 19 | U | 19 | U |
| PCB-077 | NA | 9.6 | U | 6.5 | J | 2.2 | J | 2.2 | J |
| PCB-078 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-079 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-080 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-081 | NA | 9.6 | U | 4.5 | J | 9.6 | U | 9.6 | U |

## Table I2-8. PCB Congeners in Porewater (pg/L)

| Location Name | | PW1-25 | | PW1-26 | | PW1-27 | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sample Name | | PW1-25-190604 | | PW1-26-190604 | | PW1-27-190604 | | FD-190604-02 | |
| Sample Type | | N | | N | | P | | FD | |
| Analyte | PAL | Result | | Result | | Result | | Result | |
| PCB-082 | NA | 2.9 | J | 9.7 | U | 11 | J | 11 | J |
| PCB-083 | NA | 19 | U | 15 | J | 8.7 | J | 7 | J |
| PCB-084 | NA | 12 | J | 210 | | 88 | J | 92 | J |
| PCB-088 AND 091 | NA | 7.2 | J | 200 | J | 44 | J | 44 | J |
| PCB-089 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-092 | NA | 7.3 | J | 95 | J | 47 | J | 43 | J |
| PCB-093 AND 100 | NA | 19 | U | 12 | J | 19 | U | 4.1 | J |
| PCB-094 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-095 | NA | 46 | J | 670 | | 280 | | 280 | |
| PCB-096 | NA | 19 | U | 5.5 | J | 2.1 | J | 19 | U |
| PCB-098 AND 102 | NA | 19 | U | 35 | J | 6.6 | J | 6.7 | J |
| PCB-099 | NA | 18 | J | 310 | | 72 | J | 74 | J |
| PCB-103 | NA | 9.6 | U | 19 | J | 3.8 | J | 9.6 | U |
| PCB-104 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-105 | NA | 8.3 | J | 37 | | 20 | | 17 | J |
| PCB-106 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-107 AND 124 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-108 AND 119 AND 086 AND 097 AND 125 AND 087 | NA | 18 | J | 190 | J | 89 | J | 85 | J |
| PCB-109 | NA | 9.6 | U | 20 | J | 7.4 | J | 6.1 | J |
| PCB-110 AND 115 | NA | 37 | J | 490 | | 190 | J | 190 | J |
| PCB-111 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-112 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-113 AND 090 AND 101 | NA | 35 | J | 490 | J | 160 | J | 160 | J |
| PCB-114 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-117 AND 116 AND 085 | NA | 5.3 | J | 24 | J | 20 | J | 20 | J |
| PCB-118 | NA | 23 | | 250 | | 75 | | 68 | |
| PCB-120 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-121 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-122 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-123 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-126 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-127 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-128 AND 166 | NA | 2.6 | U | 20 | J | 8.5 | J | 7.3 | J |
| PCB-130 | NA | 9.6 | U | 6.2 | J | 4.8 | J | 4.5 | J |
| PCB-131 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-132 | NA | 5.6 | J | 36 | J | 24 | J | 21 | J |
| PCB-133 | NA | 9.6 | U | 3 | J | 9.6 | U | 9.6 | U |
| PCB-134 AND 143 | NA | 1.1 | J | 8.1 | J | 4.7 | J | 4.8 | J |
| PCB-136 | NA | 2.2 | U | 32 | J | 12 | J | 12 | J |
| PCB-137 | NA | 19 | U | 3.8 | J | 2.1 | J | 19 | U |
| PCB-138 AND 163 AND 129 | NA | 17 | J | 120 | J | 57 | J | 48 | J |
| PCB-139 AND 140 | NA | 19 | U | 2.3 | J | 1.2 | J | 1.3 | J |
| PCB-141 | NA | 9.6 | U | 11 | J | 5.4 | J | 6.2 | J |
| PCB-142 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-144 | NA | 9.6 | U | 2.5 | J | 2.2 | J | 2 | J |
| PCB-145 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-146 | NA | 2.3 | J | 22 | J | 7.8 | J | 7.5 | J |
| PCB-147 AND 149 | NA | 13 | J | 150 | J | 51 | J | 48 | J |
| PCB-148 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-150 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-151 AND 135 | NA | 3.9 | U | 41 | J | 20 | J | 18 | J |
| PCB-152 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-153 AND 168 | NA | 14 | U | 120 | J | 42 | J | 36 | J |
| PCB-154 | NA | 9.6 | U | 4.7 | J | 1.4 | J | 9.6 | U |
| PCB-155 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-156 AND 157 | NA | 2.6 | J | 11 | J | 5.7 | J | 3.7 | J |
| PCB-158 | NA | 2 | J | 11 | J | 5.8 | J | 3.9 | J |
| PCB-159 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-160 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-161 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-162 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-164 | NA | 0.72 | J | 7.8 | J | 3.8 | J | 3.1 | J |
| PCB-165 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-167 | NA | 1.4 | J | 5.2 | J | 2.2 | J | 1.5 | J |
| PCB-169 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-170 | NA | 19 | U | 8.1 | J | 19 | U | 2 | J |

**Table I2-8. PCB Congeners in Porewater (pg/L)**

| | Location Name | PW1-25 | | PW1-26 | | PW1-27 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Sample Name | PW1-25-190604 | | PW1-26-190604 | | PW1-27-190604 | | FD-190604-02 | |
| | Sample Type | N | | N | | P | | FD | |
| Analyte | PAL | Result | | Result | | Result | | Result | |
| PCB-171 AND 173 | NA | 19 | U | 2.2 | J | 19 | U | 19 | U |
| PCB-172 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-174 | NA | 0.96 | J | 4.7 | J | 1.9 | J | 3.1 | J |
| PCB-175 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-176 | NA | 9.6 | U | 1 | J | 9.6 | U | 9.6 | U |
| PCB-177 | NA | 19 | U | 4.9 | J | 1.7 | J | 1.2 | J |
| PCB-178 | NA | 9.6 | U | 9.7 | U | 1.7 | J | 9.6 | U |
| PCB-179 | NA | 19 | U | 3.1 | J | 1.6 | J | 19 | U |
| PCB-180 AND 193 | NA | 38 | U | 14 | J | 7.1 | J | 5.8 | J |
| PCB-181 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-182 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-183 | NA | 1.6 | U | 5.5 | J | 2.1 | J | 1.9 | J |
| PCB-184 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-185 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-186 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-187 | NA | 19 | U | 9.3 | J | 6.3 | J | 19 | U |
| PCB-188 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-189 | NA | 9.6 | U | 0.78 | J | 9.6 | U | 9.6 | U |
| PCB-190 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-191 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-192 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-194 | NA | 19 | U | 2.6 | J | 1.4 | J | 19 | U |
| PCB-195 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-196 | NA | 19 | U | 0.91 | J | 1.1 | J | 19 | U |
| PCB-197 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-198 AND 199 | NA | 19 | U | 1.6 | J | 0.98 | J | 0.87 | J |
| PCB-200 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-201 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-202 | NA | 9.6 | U | 0.55 | J | 9.6 | U | 9.6 | U |
| PCB-203 | NA | 19 | U | 1.6 | J | 0.76 | J | 1.1 | J |
| PCB-204 | NA | 19 | U | 19 | U | 19 | U | 19 | U |
| PCB-205 | NA | 9.6 | U | 9.7 | U | 9.6 | U | 9.6 | U |
| PCB-206 | NA | 9.6 | U | 1 | J | 2.5 | J | 0.91 | J |
| PCB-207 | NA | 9.6 | U | 9.7 | U | 0.29 | J | 9.6 | U |
| PCB-208 | NA | 9.6 | U | 9.7 | U | 0.39 | J | 9.6 | U |
| PCB-209 | NA | 0.61 | U | 1.1 | U | 2.7 | J | 0.92 | U |
| TOTAL POLY-CHLORINATED BIPHENYLS (PCBS) | 170 (a)<br>14,000 (b)<br>30,000 (c) | 960 | | 10,945 | | 4,480 | | 4,532 | |

Notes:

(a) Criteria for consumption of organisms WAC 173-201A, Table 240
(b) Aquatic life freshwater chronic standard WAC 173-201A
(c) Aquatic life marine standard WAC 173-201A

FD – field duplicate
J – The reported value is an estimated concentration.
N – Sample is not part of a field duplicate pair.
NA – Not applicable
P – Parent sample of field duplicate.

PCB – Polychlorinated biphenyls

pg/L – picograms per liter
U – The analyte was not detected at or above the limit of detection. (Sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).

**Table I2-9. PCB Congeners in Surface Water (pg/L)**

| | Location Name | SW1-18 | SW1-19 | | SW1-20 |
|---|---|---|---|---|---|
| | Sample Name | SW1-18-190603 | FD-190603-01 | SW1-19-190603 | SW1-20-190603 |
| | Sample Type | P | FD | N | N |
| Analyte | PAL | Result | Result | Result | Result |
| PCB-001 | NA | 14 J | 12 J | 300 | 11 J |
| PCB-002 | NA | 19 U | 20 U | 23 J | 20 U |
| PCB-003 | NA | 1.9 J | 1.5 J | 100 J | 1.9 J |
| PCB-004 | NA | 120 J | 130 J | 4,200 | 130 J |
| PCB-005 | NA | 24 U | 25 U | 23 U | 25 U |
| PCB-006 | NA | 49 J | 46 J | 1,700 | 47 J |
| PCB-007 | NA | 24 U | 25 U | 31 J | 25 U |
| PCB-008 | NA | 88 J | 78 J | 1,800 | 80 J |
| PCB-009 | NA | 48 U | 50 U | 54 J | 51 U |
| PCB-010 | NA | 48 U | 50 U | 110 J | 51 U |
| PCB-011 | NA | 24 U | 25 U | 51 J | 16 J |
| PCB-012 AND 013 | NA | 38 U | 40 U | 150 J | 11 J |
| PCB-014 | NA | 24 U | 25 U | 23 U | 25 U |
| PCB-015 | NA | 30 J | 29 J | 560 | 28 J |
| PCB-016 | NA | 38 J | 40 J | 560 | 41 J |
| PCB-017 | NA | 56 J | 51 J | 670 | 51 J |
| PCB-019 | NA | 24 J | 24 J | 600 | 24 J |
| PCB-021 AND 033 | NA | 40 J | 38 J | 160 J | 30 J |
| PCB-022 | NA | 21 J | 17 J | 160 J | 17 J |
| PCB-023 | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-024 | NA | 19 U | 2.6 J | 13 J | 1.9 J |
| PCB-025 | NA | 19 J | 15 J | 220 | 15 J |
| PCB-026 AND 029 | NA | 46 J | 39 J | 440 | 46 J |
| PCB-027 | NA | 19 J | 17 J | 410 | 17 J |
| PCB-028 AND 020 | NA | 100 J | 97 J | 640 | 94 J |
| PCB-030 AND 018 | NA | 110 J | 100 J | 1,700 | 110 J |
| PCB-031 | NA | 80 J | 76 J | 460 | 77 J |
| PCB-032 | NA | 23 J | 22 J | 350 | 23 J |
| PCB-034 | NA | 19 U | 20 U | 9.3 J | 20 U |
| PCB-035 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-036 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-037 | NA | 8.7 J | 8 J | 50 J | 7.8 J |
| PCB-038 | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-039 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-040 AND 071 | NA | 18 J | 19 J | 120 J | 20 J |
| PCB-041 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-042 | NA | 10 J | 11 J | 80 J | 12 J |
| PCB-043 | NA | 1.1 J | 9.9 U | 12 J | 10 U |
| PCB-044 AND 047 AND 065 | NA | 52 J | 53 J | 350 J | 54 J |
| PCB-045 | NA | 11 J | 9.6 J | 72 J | 10 J |
| PCB-046 | NA | 4.9 J | 3.9 J | 67 J | 4.6 J |
| PCB-048 | NA | 10 J | 11 J | 40 J | 9.5 J |
| PCB-050 AND 053 | NA | 15 J | 17 J | 220 J | 19 J |
| PCB-051 | NA | 3 J | 3.7 J | 32 J | 3.3 J |
| PCB-052 | NA | 94 J | 97 J | 670 | 100 J |
| PCB-054 | NA | 9.5 U | 9.9 U | 7.5 J | 10 U |
| PCB-055 | NA | 9.5 U | 9.9 U | 1.5 J | 10 U |
| PCB-056 | NA | 6.3 J | 5.9 J | 28 J | 6.2 J |
| PCB-057 | NA | 9.5 U | 1.9 J | 2.1 J | 10 U |
| PCB-058 | NA | 19 U | 20 U | 19 U | 1.2 J |
| PCB-059 AND 062 AND 075 | NA | 6.3 J | 6.1 J | 59 J | 7.1 J |
| PCB-060 | NA | 3.2 J | 3.2 J | 7.5 J | 3.6 J |
| PCB-061 AND 070 AND 074 AND 076 | NA | 39 J | 41 J | 160 J | 39 J |
| PCB-063 | NA | 1.6 J | 20 U | 5.3 J | 20 U |
| PCB-064 | NA | 14 J | 15 J | 90 J | 15 J |
| PCB-066 | NA | 28 J | 30 J | 90 J | 29 J |
| PCB-067 | NA | 19 U | 1.3 J | 7.4 J | 1.1 J |
| PCB-068 | NA | 19 U | 1.2 U | 3.7 U | 20 U |
| PCB-069 AND 049 | NA | 43 J | 44 J | 310 J | 47 J |
| PCB-072 | NA | 19 U | 1.3 J | 5.6 J | 0.97 J |

# Table I2-9. PCB Congeners in Surface Water (pg/L)

| Location Name | | SW1-18 | SW1-19 | | SW1-20 |
|---|---|---|---|---|---|
| Sample Name | | SW1-18-190603 | FD-190603-01 | SW1-19-190603 | SW1-20-190603 |
| Sample Type | | P | FD | N | N |
| Analyte | PAL | Result | Result | Result | Result |
| PCB-073 | NA | 19 U | 1.1 J | 19 U | 1.2 J |
| PCB-077 | NA | 2.7 J | 2.1 J | 7.1 J | 2.3 J |
| PCB-078 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-079 | NA | 9.5 U | 1.1 J | 9.3 U | 10 U |
| PCB-080 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-081 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-082 | NA | 3.7 J | 4 J | 12 J | 3.2 J |
| PCB-083 | NA | 1.8 J | 20 U | 7.3 J | 2.8 J |
| PCB-084 | NA | 14 J | 14 J | 77 J | 14 J |
| PCB-088 AND 091 | NA | 8.5 J | 9.5 J | 36 J | 9.3 J |
| PCB-089 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-092 | NA | 10 J | 8.7 J | 37 J | 11 J |
| PCB-093 AND 100 | NA | 19 U | 20 U | 3.5 J | 20 U |
| PCB-094 | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-095 | NA | 50 J | 59 J | 220 | 53 J |
| PCB-096 | NA | 19 U | 20 U | 3.1 J | 0.36 J |
| PCB-098 AND 102 | NA | 1.5 J | 20 U | 8.6 J | 2.8 J |
| PCB-099 | NA | 29 J | 34 J | 80 J | 27 J |
| PCB-103 | NA | 9.5 U | 9.9 U | 3.4 J | 10 U |
| PCB-104 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-105 | NA | 16 J | 20 | 32 | 16 J |
| PCB-106 | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-107 AND 124 | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-108 AND 119 AND 086 AND 097 AND 125 AND 087 | NA | 29 J | 32 J | 85 J | 30 J |
| PCB-109 | NA | 2.3 J | 3.5 J | 6.2 J | 2.9 J |
| PCB-110 AND 115 | NA | 53 J | 60 J | 160 J | 55 J |
| PCB-111 | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-112 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-113 AND 090 AND 101 | NA | 53 J | 61 J | 150 J | 58 J |
| PCB-114 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-117 AND 116 AND 085 | NA | 9.2 U | 11 U | 21 J | 11 U |
| PCB-118 | NA | 46 | 55 | 99 | 52 |
| PCB-120 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-121 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-122 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-123 | NA | 9.5 U | 9.9 U | 2.6 J | 1.1 J |
| PCB-126 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-127 | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-128 AND 166 | NA | 7.6 J | 8.5 J | 14 J | 8.6 J |
| PCB-130 | NA | 3.4 J | 3.6 J | 5 J | 3.2 J |
| PCB-131 | NA | 19 U | 1 J | 1 J | 0.89 J |
| PCB-132 | NA | 10 J | 15 J | 23 J | 11 J |
| PCB-133 | NA | 9.5 U | 9.9 U | 1 J | 10 U |
| PCB-134 AND 143 | NA | 2.2 J | 2 J | 4.1 J | 1.2 J |
| PCB-136 | NA | 2.8 J | 5 J | 11 J | 3.8 J |
| PCB-137 | NA | 1.9 J | 2.1 J | 3.8 J | 2.3 J |
| PCB-138 AND 163 AND 129 | NA | 47 J | 57 J | 80 J | 55 J |
| PCB-139 AND 140 | NA | 19 U | 1 J | 1.4 J | 0.96 J |
| PCB-141 | NA | 4.6 J | 4.9 J | 8.7 J | 5.1 J |
| PCB-142 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-144 | NA | 9.5 U | 1.3 J | 2.8 J | 1.1 J |
| PCB-145 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-146 | NA | 5.4 J | 5.8 J | 9.6 J | 5.1 J |
| PCB-147 AND 149 | NA | 23 J | 27 J | 52 J | 26 J |
| PCB-148 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-150 | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-151 AND 135 | NA | 7.9 J | 8.5 J | 19 J | 6.7 J |
| PCB-152 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-153 AND 168 | NA | 31 J | 35 J | 53 J | 31 J |

**Table I2-9. PCB Congeners in Surface Water (pg/L)**

| Location Name | | SW1-18 | SW1-19 | | SW1-20 |
|---|---|---|---|---|---|
| Sample Name | | SW1-18-190603 | FD-190603-01 | SW1-19-190603 | SW1-20-190603 |
| Sample Type | | P | FD | N | N |
| Analyte | PAL | Result | Result | Result | Result |
| PCB-154 | NA | 9.5 U | 1.1 J | 1.2 J | 1 J |
| PCB-155 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-156 AND 157 | NA | 6.3 J | 7.8 J | 12 J | 5.3 J |
| PCB-158 | NA | 4.5 J | 5.8 J | 7.6 J | 5.5 J |
| PCB-159 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-160 | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-161 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-162 | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-164 | NA | 2.5 J | 2.6 J | 5 J | 2.8 J |
| PCB-165 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-167 | NA | 2.3 J | 2.5 J | 3.7 J | 2.2 J |
| PCB-169 | NA | 9.5 U | 9.9 U | 0.7 J | 10 U |
| PCB-170 | NA | 4.2 J | 5.5 J | 7.6 J | 3.5 J |
| PCB-171 AND 173 | NA | 19 U | 2 J | 19 U | 1.4 J |
| PCB-172 | NA | 9.5 U | 9.9 U | 1.1 J | 10 U |
| PCB-174 | NA | 2.2 J | 1.9 J | 4.7 J | 2.2 J |
| PCB-175 | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-176 | NA | 9.5 U | 9.9 U | 9.3 U | 0.48 J |
| PCB-177 | NA | 2 J | 1.2 J | 3.6 J | 2.1 J |
| PCB-178 | NA | 9.5 U | 9.9 U | 1.4 J | 10 U |
| PCB-179 | NA | 1.2 J | 1.5 J | 2 J | 0.65 J |
| PCB-180 AND 193 | NA | 5.3 J | 6.2 J | 11 J | 5.2 J |
| PCB-181 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-182 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-183 | NA | 2.9 U | 3.3 U | 4.9 U | 2.4 U |
| PCB-184 | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-185 | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-186 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-187 | NA | 4.1 J | 3 J | 6.9 J | 3.4 J |
| PCB-188 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-189 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-190 | NA | 19 U | 0.87 J | 1 J | 20 U |
| PCB-191 | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-192 | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-194 | NA | 19 U | 0.99 J | 2.1 J | 0.92 J |
| PCB-195 | NA | 19 U | 1.3 J | 0.98 J | 20 U |
| PCB-196 | NA | 0.52 J | 20 U | 19 U | 0.54 J |
| PCB-197 | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-198 AND 199 | NA | 0.71 U | 1 U | 2.1 U | 0.87 U |
| PCB-200 | NA | 19 U | 0.21 J | 19 U | 0.29 J |
| PCB-201 | NA | 19 U | 20 U | 0.62 J | 20 U |
| PCB-202 | NA | 9.5 U | 9.9 U | 9.3 U | 0.43 U |
| PCB-203 | NA | 0.71 J | 0.47 J | 1 J | 1.1 J |
| PCB-204 | NA | 19 U | 20 U | 19 U | 20 U |
| PCB-205 | NA | 9.5 U | 9.9 U | 0.77 J | 10 U |
| PCB-206 | NA | 1.2 J | 1.1 J | 1.9 J | 0.68 J |
| PCB-207 | NA | 9.5 U | 9.9 U | 9.3 U | 10 U |
| PCB-208 | NA | 9.5 U | 9.9 U | 0.4 J | 10 U |
| PCB-209 | NA | 1.9 U | 1.4 U | 2.3 U | 2 U |
| TOTAL POLY-CHLORINATED BIPHENYLS (PCBS) | 170 (a)<br>14,000 (b)<br>30,000 (c) | 1,752 | 1,807 | 19,376 | 1,805 |

Notes:
(a) Criteria for consumption of organisms WAC 173-201A, Table 240
(b) Aquatic life freshwater chronic standard WAC 173-201A
(c) Aquatic life marine standard WAC 173-201A
FD – field duplicate
J – The reported value is an estimated concentration.
N – Sample is not part of a field duplicate pair.
NA – Not applicable
P – Parent sample of field duplicate.
PAL – project action limit
PCB – Polychlorinated biphenyls
pg/L – picograms per liter
U – The analyte was not detected at or above the limit of detection. (Sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).

## Table I2-10. PCB Aroclor Analysis in Sediments (µg/kg)

| | Location Name | MA-19 | | MA-21 | | MA-22 | | MA-23 | | | | TF-18 | | TF-20 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Sample Name** | SED-MA19-190604 | | SED-MA21-190604 | | SED-MA22-190604 | | SED-MA23-190604 | | FD-190604-01 | | SED-TF18-190605 | | SED-TF20-190604 | | SED-TF21-190604 | |
| | **Sample Type** | N | | N | | N | | P | | FD | | N | | N | | N | |
| **Analyte** | **PAL** | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | | **Result** | |
| AROCLOR-1016 | NA | 99 | U | 98 | U | 97 | U | 98 | U | 99 | U | 97 | U | 98 | U | 96 | U |
| AROCLOR-1221 | NA | 150 | U | 150 | U | 140 | U | 150 | U | 150 | U | 140 | U | 150 | U | 140 | U |
| AROCLOR-1232 | NA | 200 | U | 200 | U | 190 | U | 200 | U | 200 | U | 190 | U | 200 | U | 190 | U |
| AROCLOR-1242 | NA | 200 | U | 200 | U | 190 | U | 200 | U | 200 | U | 190 | U | 200 | U | 190 | U |
| AROCLOR-1248 | NA | 150 | U | 150 | U | 140 | U | 150 | U | 150 | U | 140 | U | 150 | U | 140 | U |
| AROCLOR-1254 | NA | 99 | U | 98 | U | 55 | J | 70 | J | 52 | J | 97 | U | 98 | U | 96 | U |
| AROCLOR-1260 | NA | 99 | U | 98 | U | 97 | U | 98 | U | 99 | U | 97 | U | 98 | U | 96 | U |
| AROCLOR-1262 | NA | 200 | U | 200 | U | 190 | U | 200 | U | 200 | U | 190 | U | 200 | U | 190 | U |
| AROCLOR-1268 | NA | 200 | U | 200 | U | 190 | U | 200 | U | 200 | U | 190 | U | 200 | U | 190 | U |
| Total PCBs (Aroclor) | 12,000 | 200 | U | 200 | U | 55 | J | 70 | J | 52 | J | 190 | U | 200 | U | 190 | U |

Notes:
Samples analyzed for Aroclor analysis by Method 8082 A.
FD – field duplicate
J – The reported value is an estimated concentration.
N – Sample is not part of a field duplicate pair.
NA – Not applicable
P – Parent sample of field duplicate.
PAL – project action limit

PCB – polychlorinated biphenyl
U – The analyte was analyzed but not detected at or above limit of detection. (Sometimes validators will elevate the limit due to the "B" qual using the 5x/10x rule so this definition is different than the lab description).
µg/kg – micrograms per kilogram

Total PCBs (Aroclors) are derived based on the sum of the concentrations of Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268.
When all chemicals in a group are undetected, only the single highest individual chemical quantitation limit in a group should be reported and appropriately qualified. If some concentrations were detected and others were not, only the detected concentrations are included in the sum.

## Table I2-11. Sediment PCB Congener Analysis (pg/g)

| | Location Name | MA-19 | MA-21 | MA-22 | MA-23 | | TF-18 | TF-20 | TF-21 |
|---|---|---|---|---|---|---|---|---|---|
| | **Sample Name** | SED-MA19-190604 | SED-MA21-190604 | SED-MA22-190604 | SED-MA23-190604 | FD-190604-01 | SED-TF18-190605 | SED-TF20-190604 | SED-TF21-190604 |
| | **Sample Type** | N | N | N | P | FD | N | N | N |
| **Analyte** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| PCB-001 | NA | 39 | 6.4 J | 51 | 19 J | 21 | 6.5 J | 4.1 J | 9.7 J |
| PCB-002 | NA | 28 | 38 | 110 | 68 | 80 | 52 | 34 | 81 |
| PCB-003 | NA | 1.7 J | 4 J | 34 | 19 J | 16 J | 6.8 J | 2.7 J | 8.8 J |
| PCB-004 | NA | 100 | 36 | 280 | 110 | 140 | 8 J | 2.5 J | 19 J |
| PCB-005 | NA | 5 U | 4.9 U | 4.9 U | 4.9 U | 4.9 U | 4.9 U | 4.9 U | 5 U |
| PCB-006 | NA | 8.4 J | 31 | 280 | 100 | 140 | 4.9 J | 4.9 U | 27 |
| PCB-007 | NA | 5 U | 4.9 U | 13 J | 4.9 U | 4.9 U | 4.9 U | 4.9 U | 5.2 J |
| PCB-008 | NA | 14 J | 50 | 440 | 170 | 200 | 25 | 8.2 J | 54 |
| PCB-009 | NA | 5 U | 4.9 U | 11 J | 4.9 U | 4.9 U | 4.9 U | 4.9 U | 5 U |
| PCB-010 | NA | 3.4 J | 4.9 U | 12 J | 6 J | 7.1 J | 4.9 U | 4.9 U | 5 U |
| PCB-011 | NA | 9.1 J | 20 U | 45 | 27 | 31 | 18 J | 9.6 J | 28 |
| PCB-012 AND 013 | NA | 5 J | 9.8 U | 72 | 37 J | 42 | 4.4 J | 9.8 U | 12 J |
| PCB-014 | NA | 5 U | 4.9 U | 4.9 U | 4.9 U | 4.9 U | 4.9 U | 4.9 U | 5 U |
| PCB-015 | NA | 29 | 87 | 490 | 250 | 300 | 35 | 14 J | 65 |
| PCB-016 | NA | 8.6 J | 35 | 220 | 94 | 120 | 4.8 J | 2 U | 17 J |
| PCB-017 | NA | 11 J | 49 | 310 | 150 | 180 | 14 J | 4.4 J | 38 |
| PCB-019 | NA | 3.3 J | 20 | 110 | 51 | 64 | 2 J | 2 U | 13 J |
| PCB-021 AND 033 | NA | 14 J | 33 J | 180 | 89 | 94 | 18 J | 5.6 J | 46 |
| PCB-022 | NA | 10 J | 32 | 150 | 75 | 88 | 8.9 J | 3.1 J | 20 |
| PCB-023 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-024 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-025 | NA | 16 J | 41 | 250 | 140 | 160 | 8.7 J | 2.6 J | 51 |
| PCB-026 AND 029 | NA | 39 J | 78 | 530 | 320 | 360 | 12 J | 3.9 J | 110 |
| PCB-027 | NA | 6.4 J | 29 | 170 | 84 | 100 | 5.1 J | 0.98 U | 49 |
| PCB-028 AND 020 | NA | 63 | 170 | 850 | 450 | 520 | 67 | 23 J | 140 |
| PCB-030 AND 018 | NA | 21 J | 92 | 620 | 270 | 370 | 13 J | 3.6 J | 63 |
| PCB-031 | NA | 54 | 140 | 720 | 390 | 430 | 41 | 13 J | 110 |
| PCB-032 | NA | 7.2 J | 29 | 200 | 110 | 130 | 21 | 5.2 J | 38 |
| PCB-034 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-035 | NA | 1.1 J | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 3 J | 0.95 J | 4.4 J |
| PCB-036 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-037 | NA | 17 J | 35 | 140 | 83 | 100 | 29 | 10 J | 40 |
| PCB-038 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-039 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-040 AND 071 | NA | 24 J | 42 | 390 | 240 | 270 | 15 J | 3.6 J | 96 |
| PCB-041 | NA | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U |
| PCB-042 | NA | 9.8 J | 27 | 170 | 100 | 120 | 11 J | 2.6 J | 34 |
| PCB-043 | NA | 1.4 J | 4.4 J | 36 | 13 J | 19 J | 1.1 J | 0.98 U | 4.7 J |

**Table I2-11. Sediment PCB Congener Analysis (pg/g)**

| | Location Name | MA-19 | MA-21 | MA-22 | MA-23 | | TF-18 | TF-20 | TF-21 |
|---|---|---|---|---|---|---|---|---|---|
| | Sample Name | SED-MA19-190604 | SED-MA21-190604 | SED-MA22-190604 | SED-MA23-190604 | FD-190604-01 | SED-TF18-190605 | SED-TF20-190604 | SED-TF21-190604 |
| | Sample Type | N | N | N | P | FD | N | N | N |
| Analyte | PAL | Result | Result | Result | Result | Result | Result | Result | Result |
| PCB-044 AND 047 AND 065 | NA | 56 J | 120 | 870 | 570 | 630 | 51 J | 11 J | 190 |
| PCB-045 | NA | 4 J | 13 J | 78 | 46 | 51 | 1.7 U | 0.57 U | 9.2 J |
| PCB-046 | NA | 2.3 J | 8.9 J | 49 | 26 | 32 | 1.3 J | 0.98 U | 7.9 J |
| PCB-048 | NA | 4.7 J | 10 J | 63 | 37 | 42 | 4.6 J | 1.2 J | 13 J |
| PCB-050 AND 053 | NA | 12 J | 32 J | 220 | 140 | 160 | 6.7 J | 1.9 J | 63 |
| PCB-051 | NA | 2.1 J | 4.5 J | 35 | 22 | 26 | 3 J | 0.8 J | 11 J |
| PCB-052 | NA | 120 | 220 | 1,800 | 1,200 | 1,400 | 83 | 16 J | 480 |
| PCB-054 | NA | 0.99 U | 0.98 U | 3.9 J | 2.5 J | 3.2 J | 0.98 U | 0.98 U | 3.5 J |
| PCB-055 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-056 | NA | 13 J | 24 | 140 | 92 | 100 | 19 J | 4.8 J | 36 |
| PCB-057 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-058 | NA | 1.4 J | 2.9 J | 22 | 22 | 24 | 1.2 J | 0.98 U | 4.9 J |
| PCB-059 AND 062 AND 075 | NA | 5.8 J | 13 J | 100 | 62 | 69 | 4.4 J | 1 J | 26 J |
| PCB-060 | NA | 6.8 J | 9.2 J | 57 | 36 | 43 | 11 J | 3.1 J | 17 J |
| PCB-061 AND 070 AND 074 AND 076 | NA | 58 J | 110 | 870 | 370 | 540 | 80 | 18 J | 190 |
| PCB-063 | NA | 1.2 J | 2.2 J | 17 J | 7.6 J | 9.5 J | 1.7 J | 0.4 J | 3.4 J |
| PCB-064 | NA | 13 J | 30 | 190 | 120 | 140 | 13 J | 3 J | 39 |
| PCB-066 | NA | 58 | 93 | 730 | 360 | 440 | 80 | 18 J | 170 |
| PCB-067 | NA | 1 J | 2 J | 17 J | 7.4 J | 8.9 J | 1.2 J | 0.98 U | 2 J |
| PCB-068 | NA | 1.4 J | 2 J | 15 J | 11 J | 11 J | 1.7 J | 0.45 U | 4.9 J |
| PCB-069 AND 049 | NA | 63 | 120 | 990 | 690 | 710 | 56 | 12 J | 290 |
| PCB-072 | NA | 2 J | 2.8 J | 26 | 19 J | 18 J | 2.2 J | 0.42 J | 7.4 J |
| PCB-073 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-077 | NA | 12 | 15 | 89 | 71 | 74 | 25 | 7.3 | 41 |
| PCB-078 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-079 | NA | 1.8 J | 6.2 J | 19 J | 19 J | 22 | 1.9 J | 0.98 U | 5.6 J |
| PCB-080 | NA | 0.94 J | 1.9 J | 9.7 J | 13 J | 13 J | 1.1 J | 0.98 U | 3 J |
| PCB-081 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-082 | NA | 13 J | 24 | 170 | 200 | 210 | 14 J | 2.5 J | 42 |
| PCB-083 | NA | 6 J | 21 | 77 | 89 | 96 | 6.7 J | 2.1 J | 28 |
| PCB-084 | NA | 25 | 56 | 460 | 220 | 460 | 21 | 3.2 J | 95 |
| PCB-088 AND 091 | NA | 16 J | 31 J | 300 | 2 U | 240 | 16 J | 2.5 J | 61 |
| PCB-089 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-092 | NA | 32 | 58 | 410 | 470 | 500 | 40 | 7.3 J | 110 |
| PCB-093 AND 100 | NA | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U |
| PCB-094 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-095 | NA | 56 | 110 | 840 | 850 | 980 | 48 | 10 J | 200 |
| PCB-096 | NA | 0.59 J | 1.3 J | 13 J | 11 J | 12 J | 0.71 J | 0.17 J | 3.3 J |
| PCB-098 AND 102 | NA | 2 U | 3.9 J | 39 | 28 J | 38 J | 2 U | 2 U | 10 J |
| PCB-099 | NA | 130 | 180 | 1,500 | 1,400 | 1,400 | 160 | 31 | 440 |

# Table I2-11. Sediment PCB Congener Analysis (pg/g)

| | Location Name | MA-19 | MA-21 | MA-22 | MA-23 | | TF-18 | TF-20 | TF-21 |
|---|---|---|---|---|---|---|---|---|---|
| | **Sample Name** | SED-MA19-190604 | SED-MA21-190604 | SED-MA22-190604 | SED-MA23-190604 | FD-190604-01 | SED-TF18-190605 | SED-TF20-190604 | SED-TF21-190604 |
| | **Sample Type** | N | N | N | P | FD | N | N | N |
| **Analyte** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| PCB-103 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 7.5 J |
| PCB-104 | NA | 0.99 U | 0.98 U | 0.58 J | 0.54 J | 0.53 J | 0.98 U | 0.26 J | 0.32 J |
| PCB-105 | NA | 110 | 140 | 1,000 | 830 | 930 | 120 | 26 | 300 |
| PCB-106 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-107 AND 124 | NA | 5 J | 8.2 J | 59 | 47 | 59 | 6.3 J | 1.2 J | 18 J |
| PCB-108 AND 119 AND 086 AND 097 AND 125 AND 087 | NA | 100 J | 170 | 1,300 | 1,300 | 1,400 | 94 J | 17 J | 320 |
| PCB-109 | NA | 19 J | 24 | 180 | 160 | 160 | 28 | 5.4 J | 58 |
| PCB-110 AND 115 | NA | 210 | 340 | 2,500 | 2,900 | 3,000 | 200 | 33 J | 630 |
| PCB-111 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-112 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-113 AND 090 AND 101 | NA | 180 | 310 | 2,300 | 2,300 | 2,500 | 210 | 39 J | 680 |
| PCB-114 | NA | 3.9 | 4.5 | 36 | 27 | 38 | 3.7 | 0.75 J | 10 |
| PCB-117 AND 116 AND 085 | NA | 38 J | 55 J | 430 | 420 | 430 | 41 J | 7.9 J | 110 |
| PCB-118 | NA | 290 | 400 | 3,100 | 2,400 | 2,700 | 350 | 70 | 870 |
| PCB-120 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 4.9 J |
| PCB-121 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-122 | NA | 2.9 J | 4 J | 26 | 29 | 36 | 3.2 J | 0.98 U | 6.6 J |
| PCB-123 | NA | 4 | 6 | 45 | 31 | 43 | 4.2 | 1.2 J | 10 |
| PCB-126 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.67 J | 1 U |
| PCB-127 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-128 AND 166 | NA | 50 | 60 | 530 | 710 | 690 | 60 | 11 J | 150 |
| PCB-130 | NA | 17 J | 21 | 200 | 280 | 280 | 22 | 4.4 J | 53 |
| PCB-131 | NA | 2.2 J | 3.2 J | 30 | 46 | 47 | 0.98 U | 0.98 U | 7.5 J |
| PCB-132 | NA | 45 | 71 | 670 | 1,000 | 1,000 | 56 | 9.5 J | 180 |
| PCB-133 | NA | 2.7 J | 3.4 J | 32 | 41 | 40 | 4.6 J | 0.98 J | 8.7 J |
| PCB-134 AND 143 | NA | 9.4 J | 12 J | 130 | 170 | 190 | 8.5 J | 1.8 J | 31 J |
| PCB-136 | NA | 14 J | 20 | 220 | 290 | 300 | 17 J | 4.1 J | 61 |
| PCB-137 | NA | 13 J | 18 J | 160 | 240 | 230 | 12 J | 2 J | 41 |
| PCB-138 AND 163 AND 129 | NA | 270 _ | 330 _ | 2,900 _ | 3,900 _ | 3,900 _ | 340 _ | 66 _ | 830 _ |
| PCB-139 AND 140 | NA | 4.5 J | 5.6 J | 57 | 73 | 74 | 5 J | 0.85 J | 15 J |
| PCB-141 | NA | 18 J | 29 | 240 | 430 | 410 | 18 J | 3.1 J | 59 |
| PCB-142 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-144 | NA | 5.5 J | 7.1 J | 71 | 110 | 110 | 4.9 J | 1.3 J | 17 J |
| PCB-145 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-146 | NA | 29 | 34 | 310 | 420 | 410 | 47 | 11 J | 95 |
| PCB-147 AND 149 | NA | 120 | 150 | 1,500 | 2000 | 2,000 | 150 | 31 J | 430 |
| PCB-148 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-150 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-151 AND 135 | NA | 35 J | 49 | 460 | 670 | 670 | 50 | 12 J | 130 |

## Table I2-11. Sediment PCB Congener Analysis (pg/g)

| Location Name | | MA-19 | MA-21 | MA-22 | MA-23 | | TF-18 | TF-20 | TF-21 |
|---|---|---|---|---|---|---|---|---|---|
| Sample Name | | SED-MA19-190604 | SED-MA21-190604 | SED-MA22-190604 | SED-MA23-190604 | FD-190604-01 | SED-TF18-190605 | SED-TF20-190604 | SED-TF21-190604 |
| Sample Type | | N | N | N | P | FD | N | N | N |
| Analyte | PAL | Result | Result | Result | Result | Result | Result | Result | Result |
| PCB-152 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-153 AND 168 | NA | 190 | 230 | 2,000 | 2,500 | 2,500 | 270 | 59 | 610 |
| PCB-154 | NA | 3 J | 3.6 J | 35 | 39 | 37 | 5.8 J | 1.5 J | 13 J |
| PCB-155 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-156 AND 157 | NA | 43 | 49 | 390 | 450 | 470 | 44 | 8.4 | 120 |
| PCB-158 | NA | 28 | 32 | 310 | 400 | 410 | 25 | 4.4 J | 76 |
| PCB-159 | NA | 0.99 U | 0.54 J | 3.3 J | 7 J | 6.2 J | 0.48 J | 0.98 U | 0.88 J |
| PCB-160 | NA | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U | 2 U |
| PCB-161 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-162 | NA | 1.2 J | 1.3 J | 10 J | 15 J | 15 J | 1.3 J | 0.33 J | 3 J |
| PCB-164 | NA | 11 J | 16 J | 140 | 210 | 200 | 13 J | 2.2 J | 35 |
| PCB-165 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-167 | NA | 15 | 18 | 140 | 180 | 180 | 16 | 3.2 | 40 |
| PCB-169 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-170 | NA | 35 | 36 | 260 | 450 | 430 | 39 | 9.3 J | 73 |
| PCB-171 AND 173 | NA | 9.2 J | 11 J | 85 | 130 | 130 | 13 J | 3.2 J | 26 J |
| PCB-172 | NA | 3.7 J | 5 J | 35 | 62 | 59 | 6.3 J | 1.6 J | 11 J |
| PCB-174 | NA | 13 J | 19 J | 130 | 260 | 250 | 19 J | 4.6 J | 38 |
| PCB-175 | NA | 1.1 J | 1 J | 11 J | 16 J | 16 J | 2.3 J | 0.59 J | 3.5 J |
| PCB-176 | NA | 2.4 J | 2.7 J | 27 | 44 | 44 | 3.8 J | 1 J | 7.7 J |
| PCB-177 | NA | 13 J | 15 J | 110 | 180 | 180 | 23 | 6.1 J | 38 |
| PCB-178 | NA | 4.7 J | 5 J | 46 | 62 | 63 | 13 J | 3.7 J | 18 J |
| PCB-179 | NA | 5.6 J | 6.7 J | 65 | 110 | 100 | 12 J | 3.6 J | 20 |
| PCB-180 AND 193 | NA | 45 | 58 | 390 | 680 | 640 | 68 | 17 J | 120 |
| PCB-181 | NA | 0.53 J | 0.62 J | 4.3 J | 6.7 J | 6 J | 0.39 J | 0.98 U | 1.1 J |
| PCB-182 | NA | 0.23 J | 0.21 J | 3.2 J | 3.5 J | 3.9 J | 0.75 J | 0.26 J | 1 J |
| PCB-183 | NA | 14 J | 18 J | 130 | 210 | 200 | 25 | 6.7 J | 43 |
| PCB-184 | NA | 0.99 U | 0.98 U | 0.72 J | 0.88 J | 0.77 J | 0.31 J | 0.13 J | 0.29 J |
| PCB-185 | NA | 1.7 J | 1.7 J | 12 J | 23 | 21 | 0.85 J | 0.33 J | 3.2 J |
| PCB-186 | NA | 0.99 U | 0.98 U | 0.99 U | 0.27 J | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-187 | NA | 26 | 28 | 250 | 350 | 340 | 68 | 20 | 94 |
| PCB-188 | NA | 0.4 U | 0.31 U | 1.5 J | 1.5 J | 1.6 J | 1 J | 0.43 U | 1.1 J |
| PCB-189 | NA | 1.6 J | 2 | 13 | 21 | 19 | 2.1 | 0.76 J | 4.3 |
| PCB-190 | NA | 5.4 J | 7 J | 47 | 76 | 70 | 5.7 J | 1.4 J | 13 J |
| PCB-191 | NA | 1.3 J | 1.6 J | 10 J | 17 J | 17 J | 1.4 J | 0.39 J | 3.1 J |
| PCB-192 | NA | 0.99 U | 0.98 U | 0.99 U | 0.99 U | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-194 | NA | 7.7 J | 15 J | 49 | 86 | 82 | 17 J | 4.3 J | 18 J |
| PCB-195 | NA | 2.9 J | 5 J | 17 J | 31 | 29 | 4.5 J | 1.2 J | 5.7 J |
| PCB-196 | NA | 3.7 J | 5.8 J | 35 | 63 | 59 | 13 J | 3.8 J | 14 J |
| PCB-197 | NA | 0.51 J | 0.41 J | 3.6 J | 4.1 J | 3.9 J | 1.3 J | 0.5 J | 1.4 J |

**Table I2-11. Sediment PCB Congener Analysis (pg/g)**

| | **Location Name** | MA-19 | MA-21 | MA-22 | MA-23 | | TF-18 | TF-20 | TF-21 |
|---|---|---|---|---|---|---|---|---|---|
| | **Sample Name** | SED-MA19-190604 | SED-MA21-190604 | SED-MA22-190604 | SED-MA23-190604 | FD-190604-01 | SED-TF18-190605 | SED-TF20-190604 | SED-TF21-190604 |
| | **Sample Type** | N | N | N | P | FD | N | N | N |
| **Analyte** | **PAL** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** | **Result** |
| PCB-198 AND 199 | NA | 8.4 J | 11 J | 66 | 120 | 110 | 29 J | 7.9 J | 30 J |
| PCB-200 | NA | 0.66 J | 0.88 J | 7.2 J | 15 J | 14 J | 1.6 J | 0.53 J | 2.3 J |
| PCB-201 | NA | 1.6 J | 1.7 J | 14 J | 19 J | 19 J | 5.7 J | 1.7 J | 6.2 J |
| PCB-202 | NA | 3.4 J | 3.7 J | 21 | 28 | 27 | 9.4 J | 3.1 J | 11 J |
| PCB-203 | NA | 4.9 J | 6.7 J | 42 | 70 | 65 | 12 J | 3.5 J | 14 J |
| PCB-204 | NA | 0.99 U | 0.98 U | 0.14 J | 0.15 J | 0.99 U | 0.98 U | 0.98 U | 1 U |
| PCB-205 | NA | 0.55 J | 0.8 J | 3.2 J | 5.4 J | 5.2 J | 0.74 J | 0.25 U | 1 J |
| PCB-206 | NA | 8 J | 9.6 J | 3.6 J | 6.4 J | 5.2 | 37 | 7.8 J | 29 |
| PCB-207 | NA | 1.2 J | 1.2 J | 6.4 J | 11 J | 9.1 J | 5.8 J | 1.2 J | 4.1 J |
| PCB-208 | NA | 3.4 J | 3.6 J | 20 | 40 | 24 | 21 | 4.4 J | 15 J |
| PCB-209 | NA | 15 J | 11 J | 58 | 100 | 66 | 120 | 14 J | 48 |
| TOTAL POLYCHLORINATED BIPHENYLS (PCBS) | 12,000,000 | 3,400 | 5,357 | 40,595 | 38,605 | 41,180 | 4,005 | 889 | 10,541 |
| TOTAL DIOXIN-LIKE PCB CONGENERS [a] | 0.7 [b] | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 |

Notes:
[a] Dioxin-like PCB congeners: PCB-77, PCB-81, PCB-105, PCB-114, PCB-118, PCB-123, PCB-126, PCB-156/157, PCB-167, PCB-169, PCB-189
[b] Based on Ecology 2017 SCUM II toxicity equivalence (TEQ) value
FD – Field duplicate
J – The reported value is an estimated concentration.
N – Sample is not part of a field duplicate pair.
NA – not applicable
P – Parent sample of field duplicate
PAL – project action limit

PCB – Polychlorinated biphenyls

pg/g – picograms per gram
U – The analyte was not detected at or above the limit of detection. (Sometimes validators will elevate the limit due to the "B" qualifier using the 5x/10x rule so this definition is different than the lab description).

## Table I2-12. Summary of Analytical Results for OU 1 Sediment, June 2019 LTM Program, PCB Aroclors

| Location ID | Sample ID | Sampling Date | Aroclor 1016 | Aroclor 1221 | Aroclor 1232 | Aroclor 1242 | Aroclor 1248 | Aroclor 1254 | Aroclor 1260 | Total PCBs |
|---|---|---|---|---|---|---|---|---|---|---|
| SP1-1 | AREA-1-19-250 | 6/18/2019 | 14 J | 22 UM | 22 UM | 22 UM | 22 UM | 22 UM | 34.67 | **48.67 J** |
| SP1-1 (DUP) | AREA-1-19-251 | 6/18/2019 | 12 J | 16.5 UM | 16.5 UM | 16.5 UM | 16.5 UM | 16.5 UM | 24 | **36 J** |
| MA-09 | AREA-1-19-252 | 6/18/2019 | 6.77 UM J1 | 6.77 UM | 6.77 UM | 6.77 UM | 6.77 UM | 1.15 J | 6.77 UM | 1.15 J |
| MA-14 | AREA-1-19-253 | 6/18/2019 | 7.17 UM | 7.17 U | 7.17 UM | 7.17 UM | 7.17 UM | 1.2 J | 7.17 UM | 1.2 J |
| TF-21 | AREA-1-19-254 | 6/20/2019 | 5.58 UM | 5.58 U | 5.58 UM | 5.58 UM | 5.58 UM | 5.58 U | 5.58 UM | 5.58 UM |
| | **Sediment Quality Standard (mg/kg OC)** | | **NE** | **NE** | **NE** | **NE** | **NE** | **NE** | **NE** | **12** |

Notes:

All concentrations are in milligrams per kilogram and have been normalized for organic carbon (mg/kg OC).
D – The report results is from a diluted analysis.
DUP – field duplicate
GW – groundwater
J – analyte positively identified, but result is estimated
J1 – The quantitation is an estimation due to discrepancies in meeting certain analyte-specific quality control criteria.
P – The relative percent difference is greater than 40 percent between the results on the two analytical columns.
PCB – polychlorinated biphenyl
SQS – sediment quality standard
U – The analyte was not detected at or above the indicated practical quantitation limit.
UJ – The analyte was not detected, but the reported quantitation/detection limit is estimated.
**Bold** indicates detected concentration is equal to or exceeds the SQS of 12 mg/kg for total PCBs in sediment.

## Table I2-13. Summary of Analytical Results for OU 1 Sediment, June 2019 LTM Program, PCB Congeners

| Congener | SP1-1 | | SP1-1 (DUP) | | MA-09 | | MA-14 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | AREA-1-19-250 | | AREA-1-19-251 | | AREA-1-19-252 | | AREA-1-19-253 | | AREA-1-19-254 | |
| PCB-1 | 550 | M | 360 | M | 6.2 | J | 3.9 | J M | 7.4 | J |
| PCB-2 | 100 | | 73 | M | 43 | | 39 | M | 83 | |
| PCB-3 | 430 | | 310 | M | 4.2 | J | 4.1 | J | 7.7 | J |
| PCB-4 | 13,000 | D M | 13,000 | D M | 24 | M | 16 | J M | 61 | M |
| PCB-5 | 110 | U | 110 | U | 20 | U | 20 | U | 20 | U |
| PCB-6 | 11,000 | D M | 9,900 | D M | 23 | M | 18 | J M | 43 | M |
| PCB-7 | 140 | M | 130 | M | 20 | U | 20 | U | 20 | U |
| PCB-8 | 13,000 | D M | 11,000 | D M | 35 | M | 29 | M | 58 | M |
| PCB-9 | 240 | M | 200 | M | 20 | U | 20 | U | 20 | U |
| PCB-10 | 340 | | 380 | | 20 | U | 20 | U | 20 | U |
| PCB-11 | 410 | M | 370 | M | 19 | J M | 23 | J M | 28 | M |
| PCB-12/13 | 1,600 | M | 1,300 | M | 13 | J M | 9 | J M | 9 | J M |
| PCB-14 | 100 | U | 100 | U | 20 | U | 20 | U | 20 | U |
| PCB-15 | 8,300 | D | 7,400 | D M | 64 | M | 58 | M | 53 | M |
| PCB-16 | 4,900 | D | 4,400 | D | 20 | | 15 | J | 20 | |
| PCB-17 | 6,700 | D | 6,000 | D | 30 | | 18 | J | 34 | |
| PCB-18/30 | 15,000 | D | 14,000 | D | 53 | | 35 | J | 49 | |
| PCB-19 | 3,600 | D | 3,800 | D | 9.5 | J | 6.7 | J M | 13 | J |
| PCB-20/28 | 11,000 | D | 9,200 | D M | 110 | q | 100 | | 94 | |
| PCB-21/33 | 2,400 | D M | 1,900 | M | 21 | J q | 25 | J | 22 | J |
| PCB-22 | 2,400 | D | 1,900 | D M | 19 | J | 20 | | 14 | J M |
| PCB-23 | 100 | U | 100 | U | 20 | U | 20 | U | 20 | U |
| PCB-24 | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |

## Table I2-13. Summary of Analytical Results for OU 1 Sediment, June 2019 LTM Program, PCB Congeners

| Congener | SP1-1<br>AREA-1-19-250 | | SP1-1 (DUP)<br>AREA-1-19-251 | | MA-09<br>AREA-1-19-252 | | MA-14<br>AREA-1-19-253 | | TF-21<br>AREA-1-19-254 | |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB-25 | 3,400 | D | 3,000 | D M | 28 | q | 20 | M | 19 | J |
| PCB-26/29 | 5,800 | D | 5,000 | D | 66 | q | 42 | M | 35 | J |
| PCB-27 | 4,300 | D | 4,400 | D | 19 | J | 11 | J | 21 | |
| PCB-31 | 9,900 | D | 8,000 | D M | 100 | | 89 | | 67 | |
| PCB-32 | 4,000 | D | 3,700 | D | 18 | J | 12 | J | 21 | |
| PCB-34 | 140 | M | 120 | M | 20 | U | 20 | U | 20 | U |
| PCB-35 | 110 | U | 110 | U | 20 | U | 2.5 | J M | 2.3 | J M |
| PCB-36 | 92 | U | 94 | U M | 3.4 | J q | 20 | U | 20 | U |
| PCB-37 | 1,900 | | 1,400 | M | 29 | | 37 | | 26 | M |
| PCB-38 | 100 | U | 100 | U | 20 | U | 20 | U | 20 | U |
| PCB-39 | 100 | U | 110 | U | 20 | U | 20 | U | 20 | U |
| PCB-40/71 | 2,800 | | 2,700 | | 36 | J | 26 | J M | 16 | J M |
| PCB-41 | 170 | U | 290 | U | 20 | U | 20 | U | 20 | U |
| PCB-42 | 2,400 | D | 2,000 | D | 19 | J | 16 | J | 11 | J |
| PCB-43 | 320 | M | 340 | M | 2.8 | J M | 2.2 | J M | 20 | U |
| PCB-44/47/65 | 8,300 | D | 7,200 | D | 98 | | 78 | | 50 | J |
| PCB-45 | 1,900 | M | 1,800 | M | 10 | J M | 7.5 | J M | 6.7 | J M |
| PCB-46 | 1,200 | | 1,200 | | 5.3 | J | 3.6 | J | 3.6 | J |
| PCB-48 | 740 | | 730 | | 7.6 | J | 7 | J | 4.7 | J |
| PCB-49/69 | 7,600 | D | 6,700 | D | 110 | | 72 | | 59 | |
| PCB-50/53 | 4,000 | | 4,200 | D | 25 | J | 14 | J | 17 | J |
| PCB-51 | 500 | M | 440 | M | 3.2 | J M | 1.7 | J M | 2.8 | J M |
| PCB-52 | 15,000 | D | 13,000 | D M | 230 | M | 190 | M | 110 | M |
| PCB-54 | 90 | | 80 | M q | 0.74 | J M | 0.71 | J M | 20 | U |

## Table I2-13. Summary of Analytical Results for OU 1 Sediment, June 2019 LTM Program, PCB Congeners

| Congener | SP1-1<br>AREA-1-19-250 | | SP1-1 (DUP)<br>AREA-1-19-251 | | MA-09<br>AREA-1-19-252 | | MA-14<br>AREA-1-19-253 | | TF-21<br>AREA-1-19-254 | |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB-55 | 31 | U M | 22 | U M | 20 | U M | 20 | U M | 20 | U M |
| PCB-56 | 1,100 | M | 870 | M | 19 | J | 27 | | 14 | J M |
| PCB-57 | 35 | M | 36 | M | 20 | U | 20 | U | 20 | U |
| PCB-58 | 31 | U | 230 | M | 6 | J M | 20 | U M | 1.2 | J M |
| PCB-59/62/75 | 1,200 | | 1,300 | | 11 | J | 7.9 | J | 5.6 | J |
| PCB-60 | 350 | M | 260 | M | 9.2 | J | 14 | J | 8.3 | J M |
| PCB-61/70/74/76 | 4,200 | M | 3,000 | M | 85 | M | 150 | M | 49 | J M q |
| PCB-63 | 120 | M | 100 | M | 2.1 | J M | 2.5 | J M | 1.3 | J |
| PCB-64 | 2,000 | | 1,900 | | 22 | | 28 | M | 11 | J |
| PCB-66 | 3,900 | D | 3,000 | D | 79 | M | 90 | M | 47 | M |
| PCB-67 | 180 | M | 27 | M | 1.8 | J M | 2 | J M | 0.72 | J q |
| PCB-68 | 75 | M | 68 | M | 1.6 | J | 1.7 | J M | 1.1 | J |
| PCB-72 | 120 | | 100 | M | 2.3 | J | 2.3 | J | 1.3 | J |
| PCB-73 | 91 | U | 150 | U | 20 | U | 20 | U | 20 | U |
| PCB-77 | 660 | | 390 | M | 22 | | 24 | | 20 | |
| PCB-78 | 39 | U | 28 | U | 20 | U | 20 | U | 20 | U |
| PCB-79 | 300 | | 100 | M | 4.9 | J | 4.5 | J M | 1.7 | J M |
| PCB-80 | 100 | M | 93 | M | 3.2 | J | 3.2 | J M | 0.89 | J |
| PCB-81 | 45 | U M | 31 | U M | 2 | U | 2 | U M | 2 | U |
| PCB-82 | 1,200 | | 770 | | 46 | | 42 | | 9.7 | J |
| PCB-83 | 660 | M | 560 | M | 20 | M | 15 | J M | 6.6 | J M |
| PCB-84 | 4,600 | D | 2,700 | D | 84 | M | 74 | M | 16 | J M |
| PCB-85/116/117 | 2,000 | | 1,400 | | 97 | | 110 | | 33 | J |
| PCB-86/87/97/108/119/125 | 8,500 | M | 6,000 | M | 320 | M | 330 | M | 79 | J M |
| PCB-88/91 | 2,000 | M | 1,400 | M | 45 | M | 52 | M | 13 | J M |

## Table I2-13. Summary of Analytical Results for OU 1 Sediment, June 2019 LTM Program, PCB Congeners

| Congener | SP1-1 | | SP1-1 (DUP) | | MA-09 | | MA-14 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | AREA-1-19-250 | | AREA-1-19-251 | | AREA-1-19-252 | | AREA-1-19-253 | | AREA-1-19-254 | |
| PCB-89 | 230 | U | 160 | U | 20 | U | 20 | U | 20 | U |
| PCB-90/101/113 | 18,000 | D | 10,000 | D | 530 | | 520 | | 160 | |
| PCB-92 | 3,500 | D | 2,100 | D | 100 | | 100 | | 28 | |
| PCB-93/100 | 240 | U | 230 | M | 40 | U | 40 | U | 40 | U |
| PCB-94 | 270 | U | 190 | U | 20 | U | 20 | U | 20 | U |
| PCB-95 | 16,000 | D M | 9,400 | D M | 220 | M | 260 | M | 50 | M |
| PCB-96 | 120 | | 62 | M | 1.6 | J | 1.2 | J | 0.73 | J M |
| PCB-98/102 | 460 | M | 360 | M | 7.4 | J M | 8 | J M | 3 | J M |
| PCB-99 | 5,600 | D M | 3,900 | D M | 260 | M | 260 | M | 100 | M |
| PCB-103 | 220 | U | 150 | U | 20 | U | 20 | U | 20 | U |
| PCB-104 | 4 | J | 2 | J M | 0.25 | J | 0.24 | J M | 20 | U |
| PCB-105 | 4,100 | D | 2,200 | D | 220 | J J1 | 270 | | 100 | |
| PCB-106 | 160 | U | 110 | U | 20 | U | 20 | U | 20 | U |
| PCB-107/124 | 400 | | 250 | | 9.6 | J | 21 | J | 5.2 | J |
| PCB-109 | 1,200 | M | 710 | M | 38 | M | 50 | M | 20 | M |
| PCB-110/115 | 17,000 | D | 9,900 | D | 590 | | 680 | | 160 | |
| PCB-111 | 180 | U | 120 | U | 20 | U | 20 | U | 20 | U |
| PCB-112 | 140 | U M | 99 | U M | 20 | U M | 20 | U M | 20 | U M |
| PCB-114 | 190 | U | 130 | U | 7.9 | M | 11 | M | 3.3 | M |
| PCB-118 | 13,000 | D B | 7,200 | B D | 590 | J J1 B M | 690 | B | 270 | B |
| PCB-120 | 150 | U | 100 | U | 20 | U | 20 | U | 20 | U |
| PCB-121 | 160 | U | 110 | U | 20 | U | 20 | U | 20 | U |
| PCB-122 | 230 | U | 160 | U | 9.1 | J M | 11 | J M | 3.5 | J M |
| PCB-123 | 200 | U | 140 | M | 7.6 | M | 10 | M | 4.5 | M |

## Table I2-13. Summary of Analytical Results for OU 1 Sediment, June 2019 LTM Program, PCB Congeners

| Congener | SP1-1 | | SP1-1 (DUP) | | MA-09 | | MA-14 | | TF-21 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | AREA-1-19-250 | | AREA-1-19-251 | | AREA-1-19-252 | | AREA-1-19-253 | | AREA-1-19-254 | |
| PCB-126 | 500 | M | 210 | M | 4.3 | U | 6.2 | U | 2.4 | U |
| PCB-127 | 190 | U | 130 | U | 20 | U | 20 | U | 20 | U |
| PCB-128/166 | 4,500 | D | 2,200 | | 130 | | 150 | | 51 | |
| PCB-129/138/163 | 47,000 | D | 21,000 | D | 730 | | 850 | | 310 | |
| PCB-130 | 2,700 | D | 1,400 | | 45 | | 60 | | 20 | |
| PCB-131 | 290 | M | 140 | M | 7.2 | J | 7.3 | J | 2 | J M |
| PCB-132 | 11,000 | D | 4,900 | D | 160 | | 180 | | 47 | M |
| PCB-133 | 510 | | 280 | M | 6.8 | J | 9 | J | 4 | J M |
| PCB-134/143 | 1,400 | M | 830 | M | 28 | J M | 29 | J M | 8.5 | J M |
| PCB-135/151 | 12,000 | D | 5,600 | D | 110 | M | 130 | | 44 | M |
| PCB-136 | 3,800 | D M | 1,800 | M | 48 | M | 45 | | 16 | J |
| PCB-137 | 840 | | 530 | M | 37 | | 46 | | 12 | J |
| PCB-139/140 | 500 | M | 270 | M | 13 | J | 12 | J | 4.1 | J M |
| PCB-141 | 8,600 | D | 3,600 | D | 66 | | 84 | | 23 | |
| PCB-142 | 160 | U | 81 | U | 20 | U | 20 | U | 20 | U |
| PCB-144 | 1,600 | M | 800 | M | 17 | J | 17 | J M | 5.8 | J |
| PCB-145 | 97 | U | 50 | U | 20 | U | 20 | U | 20 | U |
| PCB-146 | 6,400 | D | 2,900 | D | 67 | | 83 | | 38 | |
| PCB-147/149 | 28,000 | D | 13,000 | D | 320 | | 370 | | 130 | M |
| PCB-148 | 140 | U | 73 | U | 20 | U | 20 | U | 20 | U |
| PCB-150 | 100 | U | 53 | U | 20 | U | 20 | U | 20 | U |
| PCB-152 | 91 | U | 47 | U | 20 | U | 20 | U | 20 | U |
| PCB-153/168 | 43,000 | D | 19,000 | D | 440 | | 470 | | 230 | |
| PCB-154 | 650 | M | 350 | M | 6.6 | J M | 5.6 | J M | 4.2 | J |
| PCB-155 | 120 | U | 69 | U | 20 | U | 20 | U | 20 | U |
| PCB-156/157 | 4,100 | D | 2,300 | | 90 | | 120 | | 37 | |
| PCB-158 | 4,200 | D | 1,900 | | 72 | | 76 | | 25 | |

## Table I2-13. Summary of Analytical Results for OU 1 Sediment, June 2019 LTM Program, PCB Congeners

| Congener | SP1-1 AREA-1-19-250 | | SP1-1 (DUP) AREA-1-19-251 | | MA-09 AREA-1-19-252 | | MA-14 AREA-1-19-253 | | TF-21 AREA-1-19-254 | |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB-159 | 360 | | 170 | | 1.1 | J | 1.8 | J M | 0.89 | J |
| PCB-160 | 130 | U M | 66 | U M | 20 | U M | 20 | U M | 20 | U M |
| PCB-161 | 99 | U M | 51 | U M | 20 | U M | 20 | U M | 20 | U M |
| PCB-162 | 240 | M | 120 | M | 2.5 | J M | 4.3 | J M | 1.3 | J M |
| PCB-164 | 2,800 | D | 53 | U | 32 | | 43 | | 12 | J |
| PCB-165 | 120 | U | 64 | U | 20 | U | 20 | U | 20 | U |
| PCB-167 | 2,200 | D | 1,200 | | 32 | | 42 | | 14 | |
| PCB-169 | 77 | M | 37 | U | 2 | U | 2 | U | 2 | U |
| PCB-170 | 19,000 | D | 7,100 | D | 47 | | 79 | | 40 | |
| PCB-171/173 | 4,800 | D | 2,200 | M | 18 | J | 28 | J | 16 | J |
| PCB-172 | 2,900 | D | 1,300 | | 7.6 | J | 13 | J | 7.1 | J |
| PCB-174 | 13,000 | D | 5,200 | D | 32 | | 61 | M | 32 | M |
| PCB-175 | 610 | | 220 | | 2.2 | J | 2.7 | J | 2.9 | J M |
| PCB-176 | 1,500 | | 530 | | 5.1 | J | 7.2 | J | 5 | J |
| PCB-177 | 7,900 | D | 3,200 | D | 26 | | 44 | | 27 | |
| PCB-178 | 2,900 | D | 1,000 | | 11 | J | 15 | J | 12 | J |
| PCB-179 | 5,100 | D | 1,600 | | 13 | J M | 21 | | 15 | J |
| PCB-180/193 | 39,000 | D | 14,000 | D | 83 | M | 140 | M | 91 | |
| PCB-181 | 120 | U | 51 | U | 1.1 | J | 1.7 | J M | 20 | U |
| PCB-182 | 110 | M | 33 | M | 0.5 | J M | 0.29 | J M q | 0.5 | J M |
| PCB-183 | 11,000 | D M | 3,800 | D M | 32 | M | 40 | M | 31 | M |
| PCB-184 | 20 | | 8 | J | 0.086 | J M q | 20 | U | 0.23 | J M |
| PCB-185 | 950 | M | 590 | M | 1.8 | J M | 2.9 | J M | 2.4 | J M |
| PCB-186 | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |

## Table I2-13. Summary of Analytical Results for OU 1 Sediment, June 2019 LTM Program, PCB Congeners

| Congener | SP1-1<br>AREA-1-19-250 | | SP1-1 (DUP)<br>AREA-1-19-251 | | MA-09<br>AREA-1-19-252 | | MA-14<br>AREA-1-19-253 | | TF-21<br>AREA-1-19-254 | |
|---|---|---|---|---|---|---|---|---|---|---|
| PCB-187 | 17,000 | D M | 6,000 | D M | 51 | M | 77 | M | 67 | M |
| PCB-188 | 51 | | 25 | | 0.5 | J M | 0.47 | J M | 0.93 | J |
| PCB-189 | 800 | M | 300 | M | 3.2 | M | 4.8 | | 2.6 | M |
| PCB-190 | 3,500 | D | 1,400 | | 10 | J M | 16 | J M | 7.8 | J |
| PCB-191 | 750 | | 310 | | 2.4 | J M | 3.1 | J M | 1.6 | J |
| PCB-192 | 99 | U | 41 | U | 20 | U | 20 | U | 20 | U |
| PCB-194 | 5,900 | D | 2,600 | D | 14 | J | 27 | | 25 | |
| PCB-195 | 2,300 | D | 1,600 | | 5 | J | 10 | J | 8.7 | J |
| PCB-196 | 4,200 | D | 1,000 | | 7.2 | J | 11 | J | 15 | J |
| PCB-197 | 210 | | 51 | | 0.71 | J | 0.81 | J M q | 1.5 | J M |
| PCB-198/199 | 6,900 | D | 1,600 | | 15 | J | 28 | J | 31 | J |
| PCB-200 | 660 | | 200 | | 1.4 | J | 2.4 | J M | 2.1 | J M |
| PCB-201 | 920 | | 240 | | 2.9 | J | 4.1 | J | 5.9 | J |
| PCB-202 | 1,600 | | 620 | | 5.6 | J | 10 | J | 11 | J |
| PCB-203 | 4,500 | D | 1,100 | M | 9 | J | 15 | J | 14 | J |
| PCB-204 | 20 | U | 20 | U | 20 | U | 20 | U | 20 | U |
| PCB-205 | 410 | | 160 | | 0.79 | J | 1.5 | J | 1.2 | J M |
| PCB-206 | 1,800 | D | 930 | | 15 | J | 32 | | 25 | |
| PCB-207 | 280 | | 110 | | 2.1 | J | 3.6 | J M | 4.3 | J |
| PCB-208 | 550 | | 230 | | 6.1 | J | 14 | J | 13 | J |
| PCB-209 | 370 | | 340 | | 25 | | 46 | | 50 | |
| Total PCB Congeners (pg/g) | 630,842 | | 366,488 | | 7,696 | | 8,522 | | 3,906 | |
| Total PCB Congeners (mg/kg) | 0.6308 | | 0.3665 | | 0.0077 | | 0.0085 | | 0.0039 | |
| Total Organic Carbon | 1.50% | | 2.00% | | 0.96% | | 0.92% | | 1.20% | |
| Total PCB congeners (mg/kg OC) | **42.0561** | | **18.3244** | | 0.8017 | | 0.9263 | | 0.3255 | |

## Table I2-13. Summary of Analytical Results for OU 1 Sediment, June 2019 LTM Program, PCB Congeners

| Congener | SP1-1<br>AREA-1-19-250 | | SP1-1 (DUP)<br>AREA-1-19-251 | | MA-09<br>AREA-1-19-252 | | MA-14<br>AREA-1-19-253 | | TF-21<br>AREA-1-19-254 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Cleanup Goal (mg/kg)** | **12** | | **12** | | **12** | | **12** | | **12** | |

Notes:
All concentrations are in picograms per gram (pg/g), except where noted.
B – the analyte was detected above one-half the reporting limit in an associated blank.
D – the reported from a diluted analysis
J – analyte positively identified, but result is estimated
J1 – the quantitation is an estimation due to discrepancies in meeting certain analyte-specific quality control criteria.
M – a manual integration was performed by the laboratory analyst
mg/kg OC - milligrams per kilogram normalized for organic carbon
PCB – polychlorinated biphenyl
q – The reported concentration is the estimated maximum possible concentration for this analyte. The measured ion ratio does not meet qualitative identification criteria and indicates a possible interference.
**Bold** indicates detected concentration exceeds the RG of 12 mg/kg for total PCBs.