

# **Third Quarter 2020 Groundwater and Surface Water Sampling and Analysis Report**

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Prepared for:  
Clark County, Washington, and  
Washington State Department of Ecology

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## 1 INTRODUCTION

This report documents the results of third quarter 2020 groundwater and surface water monitoring at the Camp Bonneville Military Reservation (Camp Bonneville) in Vancouver, Washington (Figure 1). The work was performed by PBS Engineering and Environmental Inc. (PBS) under contract to Clark County (County).

Groundwater and surface water monitoring was performed in accordance with the Health and Safety Plan for Groundwater and Surface Water Monitoring Activities (HASP),<sup>1</sup> the Supplemental Groundwater and Surface Water Remedial Investigation Sampling and Analysis Plan and Quality Assurance Project Plan (SAP/QAPP),<sup>2</sup> and Amendment #1 to the SAP/QAPP.<sup>3</sup> Laboratory analytical services were provided by Anatek Labs located in Moscow, Idaho, under contract with PBS.

Acronyms used in this report are defined on first use. Please refer to Appendix A for a list of acronyms and abbreviations.

## 2 Site Background

### 2.1 Site History<sup>4</sup>

Camp Bonneville comprises approximately 3,840 acres and is in southwestern Washington, approximately 10 miles northeast of Vancouver (Figure 1). The United States Army used Camp Bonneville for live fire of small arms, assault weapons, artillery, and field and air defense artillery between 1910 and 1995. Since 1947, Camp Bonneville has also provided training for a variety of military and nonmilitary units including the National Guard; Army Reserves; Air Force; and federal, state, and local law enforcement agencies.

In July 1995, Camp Bonneville was selected for closure under the 1995 Base Realignment and Closure (BRAC) process, and transferred to the County for public benefit, education, law enforcement training, and parks. Transfer of Camp Bonneville to the Trust for Public Land, and subsequently to the County, began in 2006. On October 3, 2006, the County entered a Prospective Purchaser Consent Decree with the Washington State Department of Ecology (Ecology) that required investigating and remediating the site.

Ordnance and explosive (OE) items were found within Camp Bonneville's boundaries, and removal efforts of OE were performed, with a few ongoing efforts. Some of the OE items were determined to be unexploded ordnance (UXO). Current activities include assessment and management of OE and UXO by qualified munitions contractors with knowledge and experience in military ordnance, ordnance components, explosives location, identification, render safe, recovery/removal, transportation, and disposal safety precautions. The historical use and storage of OE and UXO have impacted groundwater at Camp Bonneville, and monitoring these impacts is the purpose of this monitoring event.

### 2.2 Camp Bonneville Geology

Camp Bonneville is situated north of the Portland Basin in the foothills of the Cascade Range. The general area consists of Eocene and Miocene volcanic and sedimentary rocks, with Holocene sedimentary rocks in valleys

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<sup>1</sup> PBS Engineering and Environmental Inc. (November 16, 2017). *Health and Safety Plan for Groundwater and Surface Water Monitoring Activities*.

<sup>2</sup> PBS Engineering and Environmental Inc. (February 22, 2018). *Supplemental Groundwater and Surface Water Remedial Investigation Sampling and Analysis Plan and Quality Assurance Project Plan, Remedial Action Units 2C and 3, Camp Bonneville, 23201 NE Pluss Road, Vancouver, Washington 98682*.

<sup>3</sup> PBS Engineering and Environmental Inc. (March 5, 2019). *Amendment #1 – Changes to Table 4-1A and 4-1B in the Supplemental Groundwater and Surface Water Remedial Investigation Sampling and Analysis Plan and Quality Assurance Project Plan, Remedial Action Units 2C and 3, Dated February 2018, Camp Bonneville, Vancouver, Washington*.

<sup>4</sup> Shannon & Wilson. (1999). *Multi-Sites Investigation Report, Camp Bonneville, Vancouver, Washington, (Vol. 1)*. Contract No. DACA67-94-D-1014.

and areas where gravels of the Troutdale Formation can be found.<sup>5</sup> The geology at Camp Bonneville can be divided into three general areas that correspond approximately to topographic divisions.<sup>6</sup>

Lacamas Creek flows through Camp Bonneville from the northeast to southwest. The area west of Lacamas Creek comprises a series of predominantly gravelly and semi-consolidated conglomerate with scattered lenses and stringers of sand (Upper Troutdale formation). Underlying this formation and comprising the area to the north and east of Lacamas Creek are folded and faulted basalt flows, flow breccia, and pyroclastic and andesitic rocks.

The northwest portion of the site is located on a terrace where the land slopes down from the west, north, and east. Two tributaries exit ravines at the north end of the terrace and drain across the western edge to become North Fork Lacamas Creek. The terraced area likely resulted from an accumulation of material historically transported by the tributaries, contributing to the predominantly low- to medium-plasticity clay observed in the borings for the wells installed in this area. According to the boring logs in the landfill/demolition area (Landfill 4/Demolition Area 1), competent bedrock (andesite) was encountered between 440 and 460 feet above mean sea level (amsl), which is approximately 50 to 75 feet below ground surface (bgs). Sub-rounded and sub-angular gravel in the borings point to colluvial deposition of the soil.

The southwest corner of Camp Bonneville is where Lacamas Creek exits the site. The valley floor along Lacamas Creek contains unconsolidated silt, sand, and gravel valley fill, with some clay.

### **3 SITEWIDE GROUNDWATER MONITORING PROGRAM**

#### **3.1 Project Objectives**

The overall objectives of site investigations at Camp Bonneville have been to identify contaminated areas and determine the next appropriate steps toward their restoration. Contaminated areas at Camp Bonneville have been divided into five remedial action units (RAU) that are differentiated by the nature of a contaminant. This quarterly report describes the results of ongoing monitoring of RAU 2C (sitewide groundwater) to assist with achieving the goal of site restoration.

Two areas associated with RAU 2C are currently being monitored, which include Landfill 4/Demolition Area 1 located in the northwest portion of the site and Base Boundary at Lacamas Creek (Base Boundary) located in the southwest portion of the site (Figure 2). Wells have been installed in these areas to monitor shallow and deeper groundwater zones to maximum depths of approximately 75 feet bgs.

#### **3.2 Chemicals of Potential Concern**

Historical uses of Camp Bonneville's upgradient areas include firing ranges, landfills, open burning locations, open detonation locations, and general maintenance facilities. Chemicals of potential concern (COPCs) include artillery propellants, high explosives residue, missile/rocket propellants, petroleum hydrocarbons, semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), and metals. A summary of COPCs is provided in the SAP/QAPP, along with specific analytes and laboratory analysis methods, sample container types, preservation techniques, holding times, and data quality objectives (DQOs).

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<sup>5</sup> Phillips, W.M. (1987). [Map]. Geologic Map of the Vancouver Quadrangle, Washington and Oregon: Washington Division of Geology and Earth Resources Open File Report 87-10, scale 1:100,000.

<sup>6</sup> Otak, Inc. (September 1998, 2nd Revision 15 November 2005). *Camp Bonneville Reuse Plan*. Prepared for The Camp Bonneville Local Redevelopment Authority (LRA).

Results from long-term monitoring indicate analysis for specific COPCs is warranted to assess contaminant levels throughout Camp Bonneville and to determine if impacts are leaving the site. For RAU 2C (analyzed at Landfill 4/Demolition Area 1 and Base Boundary), the COPC list for quarterly monitoring is as follows:

- Explosives by Environmental Protection Agency (EPA) Method 8330B
- Perchlorate by EPA Method 6850
- VOCs by EPA Method 8260C
- Field measurements of temperature, specific conductivity, dissolved oxygen (DO), pH, oxidation reduction potential (ORP), turbidity, and depth to water levels

In the first quarter of each year, analysis for the following COPCs occurs at three on-site water supply wells:

- Explosives by EPA Method 8330B
- Perchlorate by EPA Method 6850
- VOCs by EPA Method 8260C
- Field measurements of temperature, specific conductivity, DO, pH, and ORP

In the third quarter of each year, three surface water samples are collected to determine if groundwater is impacting surface water at the site. The COPC list for the surface water samples is as follows:

- 1,3,5-Trinitro-1,3,5-triazinane (RDX) by EPA Method 8330B
- Perchlorate by EPA Method 6850
- Field measurements of temperature, specific conductivity, DO, pH, ORP, and turbidity
- Observations of stream conditions are noted on the field form

In the fourth quarter of each year, analysis for the following additional COPCs occurs at the Base Boundary wells:

- Priority pollutant metals by EPA Methods 6020/7470A
- SVOCs by EPA Method 8270C

### 3.3 Monitoring Program Locations

The current RAU 2C Camp Bonneville monitoring program requires groundwater sampling and analysis for 28 monitoring wells, shown on Figure 3 (Base Boundary) and Figure 4 (Landfill 4/Demolition Area 1). In addition, three water supply wells and three surface water locations are sampled annually.

#### 3.3.1 Monitoring Well Information<sup>7</sup>

Over the years, different numerical designations have been assigned to monitoring wells at the investigation areas. PBS uses the numbering system assigned by the US Army Center for Health Promotion and Preventive Medicine (CHPPM) in prior remedial investigation (RI) reports. Table 1 provides well information, including the monitoring well numbers used by PBS, Ecology well tag numbers, and well identification numbers for the Base Boundary and Landfill 4/Demolition Area 1 wells. The table also identifies the investigation area for each well along with total depth, screened interval, and top-of-casing elevation.

The monitoring wells located at Base Boundary and Landfill 4/Demolition Area 1 are listed below (S or A = shallow well; D or B = deeper well) according to the CHPPM numbers.

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<sup>7</sup> PBS Engineering and Environmental Inc. (August 16, 2004b). *Monitoring Well Installation Report, Landfill 4/Lacamas Creek: Camp Bonneville, Vancouver, Washington.*

- Base Boundary
  - Paired Monitoring Wells: LC-MW01S and LC-MW01D
  - Paired Monitoring Wells: LC-MW02S and LC-MW02D
  - Paired Monitoring Wells: LC-MW03S and LC-MW03D
  - Paired Monitoring Wells: LC-MW04S and LC-MW04D
  - Paired Monitoring Wells: LC-MW09S and LC-MW09D
- Landfill 4/Demolition Area 1
  - Monitoring Well L4-MW17
  - Monitoring Well L4-MW18
  - Paired Monitoring Wells: L4-MW01A and L4-MW01B
  - Paired Monitoring Wells: L4-MW02A and L4-MW02B
  - Paired Monitoring Wells: L4-MW03A and L4-MW03B
  - Monitoring Well L4-MW04A
  - Monitoring Well L4-MW05A
  - Monitoring Well L4-MW07B
  - Paired Monitoring Wells: L4-MW08A and L4-MW08B
  - Paired Monitoring Wells: L4-MW09A and L4-MW09B
  - Paired Monitoring Wells: L4-MW10A and L4-MW10B
  - Monitoring Well L4-MW11B

### **3.3.2 Surface Water Sampling Information**

PBS retained the surface water sample location and numbering that was used for a 2012 EPA investigation.<sup>8</sup> Three surface water sample locations are monitored annually during the third quarter groundwater monitoring event, as follows:

- NF02 (North Fork of Lacamas Creek, approximately 1,000 feet south of Landfill 4/Demolition Area 1)
- LC15 (Lacamas Creek at the confluence with North Fork Lacamas Creek)
- LC03 (Lacamas Creek approximately 300 feet north of well LC-MW01S)

### **3.3.3 Drinking Water Well Sampling Information**

The three on-site drinking water wells are named according to where they are located. They are monitored annually during the first quarter groundwater monitoring event, as follows:

- Bonneville (located in a well house southeast of the Bonneville cantonment)
- Killpack (located in a well house north of the Killpack cantonment)
- FBI (located at the Federal Bureau of Investigation [FBI] training area)

## **3.4 Third Quarter 2020 Scope of Work**

Monitoring activities include the following:

- Depth to water measurements from the currently sampled monitoring well network
- Collection and analysis of groundwater samples from Landfill 4/Demolition Area 1 and Base Boundary
- Collection and analysis of surface water samples from Lacamas Creek and North Fork of Lacamas Creek

This monitoring is conducted in accordance with the project SAP/QAPP. The analytical results obtained from quarterly monitoring are compared with cleanup levels established by Ecology under the Model Toxics

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<sup>8</sup> Ecology and Environment, Inc. (May 2012). *Camp Bonneville Expanded Site Inspection, Vancouver, Washington, Technical Direction Document Number: 11-02-0010.*

Control Act (MTCA)<sup>9</sup> to determine if the groundwater or surface water potentially poses an unacceptable environmental risk to human health or the environment. All data are stored in an Earthsoft Environmental Quality Information System (EQUIS) electronic database that includes data from 2007 to present.

#### **4 RECENT MONITORING ACTIVITIES**

Groundwater samples were collected from the 10 monitoring wells located at Base Boundary (Figure 3) on September 21 and 22, 2020. A field duplicate sample (labeled 03Q20LCMW140W) was collected from monitoring well LC-MW03S. An additional volume of groundwater was collected from monitoring well LC-MW03D for laboratory matrix spike/matrix spike duplicate (MS/MSD) analysis.

Groundwater samples were collected from the 18 monitoring wells at Landfill 4/Demolition Area 1 (Figure 4) on September 23, 24, and 25, 2020. Two field duplicate samples (labeled 03Q20L4MW145W and 03Q20L4MW150W) were collected from monitoring wells L4-MW11B and L4-MW10B, respectively. An additional volume of groundwater was collected from monitoring well L4-MW01A for laboratory MS/MSD analysis.

Surface water samples were collected from the three previously listed locations on September 21, 2020. A field duplicate sample (labeled 03Q20DP05SW) was collected from location LC15. An additional volume of surface water was collected from location NF02 for laboratory MS/MSD samples.

Samples were collected in new laboratory-supplied sample containers directly from the end of the dedicated pump discharge hose. Groundwater samples requiring preservatives were collected in sample bottles filled with the appropriate amounts of preservative solution by the contract laboratory.

The monitoring well and surface water locations were sampled in accordance with the procedures established in the SAP/QAPP. Additional sampling details are provided below.

##### **4.1 Groundwater Sample Collection**

A low-flow, minimal-drawdown technique was employed for monitoring well groundwater purging and sampling using dedicated Solinst bladder pumps constructed of a polyvinyl chloride (PVC) or stainless-steel body and a Teflon bladder. The low-flow purging technique is described in the SAP/QAPP. Low-flow sampling minimizes disturbance to the aquifer and is designed to ensure that representative samples are collected from the wells.

Like previous sampling events, wells L4-MW02B and L4-MW11B at Landfill 4/Demolition Area 1 and well LC-MW09D at Base Boundary had groundwater elevations drop more than 2 feet during low-flow purging prior to parameter stabilization, while the remaining wells had less than a 2-foot drop during purging. The variable well drawdown is attributed to the presence of discrete zones of lower permeability soil in the subsurface.

##### **4.2 Surface Water Sample Collection**

Surface water samples were collected using the protocol employed in the May 2012 EPA investigation. Samples were collected from downstream to upstream locations to minimize sediment disturbance that could increase turbidity. The sampling technique is described in detail in the SAP/QAPP.

Surface water perchlorate samples were transferred from a new unpreserved 250-milliliter (mL) polyethylene container filled in the stream to a 60-mL syringe for field filtering. The filtered water was placed in a second new 250-mL polyethylene container.

<sup>9</sup> <http://apps.leg.wa.gov/WAC/default.aspx?cite=173-340>



#### **4.3 Quality Assurance/Quality Control Samples**

Duplicate samples were collected at a frequency of at least one per every 10 samples and at least one per area, with one collected from Base Boundary and two from Landfill 4/Demolition Area 1. MS/MSD samples were collected at a frequency of at least one per every 20 samples, with one sample collected per area (Base Boundary and Landfill 4/Demolition Area 1). Trip blanks were submitted with all shipments containing samples for VOC analysis. Dedicated pumps in the wells at Base Boundary and Landfill 4/Demolition Area 1 eliminate the need for equipment blanks.

#### **4.4 Deviations from SAP/QAPP**

This section is intended to discuss deviations from established protocols as well as to note unusual conditions or equipment issues encountered. There were no deviations during this monitoring event.

#### **4.5 Investigation-Derived Waste (IDW)**

Gloves and other disposable field supplies were disposed as solid waste. Purged groundwater was placed in 55-gallon drums that were sealed, labeled, and placed in the maintenance shed area. The drums were picked up by NRC Environmental Services Inc. of Portland, Oregon, on September 15, 2020, and were disposed at US Ecology Treatment Facility in Portland, Oregon. A copy of the disposal receipt is provided in Appendix B. New drums are present for future sampling events.

### **5 GROUNDWATER MONITORING RESULTS**

#### **5.1 Base Boundary at Lacamas Creek**

Groundwater elevations and field parameters are provided in Table 2 for the third quarter 2020. Figure 5A illustrates groundwater contours and flow direction for the Base Boundary shallow wells, and Figure 5B for the Base Boundary deep wells.

Table 3 summarizes analytical results for the contaminants of concern (COCs) at Base Boundary. Of the 10 wells in the base boundary area, there were no COCs detected above the laboratory method reporting limits (MRLs).

#### **5.2 Landfill 4/Demolition Area 1**

Groundwater elevations are provided in Table 2 for the third quarter 2020. Figure 6A illustrates groundwater contours and flow direction for the Landfill 4 shallow wells, and Figure 6B for the Landfill 4 deep wells.

Wells L4-MW17 and L4-MW18 are located topographically downgradient from the Landfill 4 area and are not included in groundwater flow discussion. Well L4-MW07B is screened in the same area of the aquifer as the other deep wells at the Landfill 4 area (above bedrock) and is included in the deep groundwater flow discussion.

Table 3 provides detected concentrations or MRLs of non-detections for the COCs at Landfill 4/Demolition Area 1. Figures 7A and 7B show perchlorate isocontours at shallow and deep wells, respectively. Figures 8A and 8B show RDX isocontours at shallow and deep wells, respectively.

Of the 18 wells in the Landfill 4/Demolition Area 1 area, 12 had one or more detections of perchlorate, RDX, or 1,1,2,2-tetrachloroethane that exceeded MTCA Method B cleanup levels (see Table 3). Seven wells had VOC detections; only L4-MW09B had an exceedance (1,1,2,2-tetrachloroethane) above MTCA Method B cleanup levels. The results are discussed further in section 8.

## 6 SURFACE WATER MONITORING RESULTS

There were no detections of perchlorate or RDX in the surface water samples. Perchlorate and RDX have not been detected in surface water samples since sampling began in March 2013. Table 4 provides the MRLs for the analytes.

## 7 DATA QUALITY REVIEW AND VALIDATION

The overall DQO is to provide data of known and sufficient quality to evaluate the physical extent and concentration ranges of COPCs from analysis of groundwater samples, and to assure compliance with environmental and health-related agencies. DQOs for laboratory analysis are presented in the SAP/QAPP. Laboratory analytical data were evaluated with respect to quality assurance objectives for precision, accuracy, representativeness, comparability, and completeness parameters. The third quarter data met the following criteria:

- Analytical data were received from the laboratory in an electronic data deliverable (EDD) format that was imported into the EQuIS database.
- Qualifiers from the laboratory were included as well as any qualifiers resulting from data validation procedures conducted by PBS.
- The project specifications were met for all analytes, indicating that the sampling and analysis procedures were reproducible.
- The laboratory report narratives state that all quality control parameters that affect sample analysis were met, except as noted in section 7.7 below.

### 7.1 Data Validation

All analytical data were validated at a Level II review standard. Level II validation and reporting includes a brief narrative of the laboratory data along with presentation of the sample results and related quality assurance/quality control (QA/QC) analyses. Additionally, at least 20% of the analytical data (9 of 38 samples) were validated at a Level III review standard. Level III validation adds the following list to the reporting (not all method requirements are applicable to each analysis in this sampling event):

- Internal standards
- Blank association
- Serial dilution results
- Post-digestion spike results
- Gas chromatography/mass spectrometer (GC/MS) tune table
- Initial calibration table
- Continuing calibration verifications
- Calibration blanks
- Column confirmation
- Instrument run log
- Interference check solution A/interference check solution AB (ICSA/AB), contract required detection limit (CRDL), method detection limit/instrument detection limit (MDL/IDL) form

These data validation levels follow the criteria in the EPA's *Data Quality Objectives for Remedial Response Activities Development Process*,<sup>10</sup> National Technical Information Service.

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<sup>10</sup> Environmental Protection Agency (EPA). (1987b). *Data Quality Objectives for Remedial Response Activities-Development Process*. EPA/540/G-87/003, OSWER Directive 9355.07B, EPA, Washington, DC (PB88-131370).

## 7.2 Presentation of Data

There were six sample submissions over five days. Samples were placed in two sample delivery groups (SDGs) by Anatek. SDG MAI0749 was processed as a Level II data package, and MAI0747 at a Level III data package. Laboratory reports are included on a compact disc (CD) with the printed third quarter report and are in the electronic version of the report. The Level II data package is found in Appendix C, and the Level III data package is found in Appendix D.

## 7.3 Field Quality Control Sample Assessment

### 7.3.1 Trip Blanks

Trip blanks and groundwater samples for VOC analysis were consolidated daily into one cooler for shipment to the laboratory. Trip blanks were included daily from September 22 to 25, 2020. All trip blanks were analyzed for VOCs and there were no detections.

### 7.3.2 Duplicates

Duplicate samples were collected from the three study areas (Base Boundary, Landfill 4/Demolition Area 1, and Surface Water). These samples were analyzed for the same constituents as the source samples.

The relative percent difference (RPD) was calculated as the difference between the values divided by the average of the values. For samples with results greater than five times the practical quantitation limit (PQL), an RPD of less than 20% is considered good duplication. For samples with results less than five times the PQL, the difference between the sample and its duplicate must be less than the PQL to meet the quality assurance acceptance criteria. A significant difference between duplicate values for a few parameters would indicate potential problems with the precision of specific analyses. A significant difference for many parameters would indicate potential problems with the sample collection procedures. The following are the results of duplicate sampling for this event:

- **Base Boundary at Lacamas Creek Duplicate**  
The field duplicate analysis for well LC-MW03S met quality control requirements.
- **Landfill 4/Demolition Area 1 Duplicate**  
The field duplicate analyses for well L4-MW10B and L4-MW11B met quality control requirements. Please note the RPD between the parent and duplicate for carbon disulfide in well L4-MW11B was 32%, which exceeds the acceptable limit of 20%, but both results were less than five times the PQL and the difference between the results was less than the PQL; therefore, the results were acceptable.
- **Surface Water**  
The field duplicate analysis for sample NF02 met all quality control requirements.

## 7.4 Sample Handling and Control

The chain-of-custody (COC) forms indicate that samples were maintained under proper custody. Forms were signed upon release from the field and receipt at the laboratory. Samples were received by the laboratory at temperatures within acceptable limits and with proper preservation. All reported analytical results were performed within applicable method-specified holding times, except for perchlorate from well L4-MW10B.

The initial perchlorate results from L4-MW10B were reviewed and found to be an order of magnitude lower than the average historical concentrations (28.5 micrograms per liter [ $\mu\text{g/L}$ ] versus 200  $\mu\text{g/L}$ ). Additionally, the well was duplicated, and the duplicate results were 169  $\mu\text{g/L}$  indicating potential quality control issues. The laboratory reanalyzed the results out of hold and the results were within the range of historical results. The second set of results will be used, but should be considered estimated because they were analyzed out of hold and include the qualifier "H."

## 7.5 Method Reporting Limits

All samples either met laboratory specified MRLs as presented in the project SAP/QAPP or were detected with elevated MRLs due to high analyte concentrations.

## 7.6 Field Data Quality Assessment

There are no specific DQOs for the measurement of field parameters (temperature, pH, ORP, conductivity, DO, and turbidity). Temperature, pH, ORP, conductivity, and DO were measured during purging. Turbidity was measured during sample collection. The PBS standard operating procedure (SOP) for low-flow groundwater sampling describes the acceptable criteria for the measurement of field parameters. A copy of the SOP is provided in the SAP/QAPP.

## 7.7 Laboratory Quality Control Assessment

The analytical data quality evaluations performed by Anatek are presented in the laboratory analysis reports in Appendix C and Appendix D (provided on the enclosed CD). Analytical results requiring qualification are flagged by the laboratory with codes describing data quality anomalies. Case narratives describing sample receipt, identification, and general comments by laboratory personnel are included in each report.

### 7.7.1 Laboratory Quality Control Samples/Indicators

#### 7.7.1.1 Blanks

There were no detections of target compounds in the method blanks for analyses reported for this sampling event.

#### 7.7.1.2 Laboratory Control Samples

Laboratory control sample (LCS) recoveries were within specified control limits.

#### 7.7.1.3 Matrix Spike/Matrix Spike Duplicates

MS/MSD recoveries and RPDs for MS/MSD pairs were within specified control limits, except for the following:

- MS and MSD recoveries were above the upper reporting limit (biased high) for dichlorodifluoromethane in batch BAJ0042. The MS/MSD RPD and LCS/LCSD recoveries were within control limits indicating the instruments were working correctly; therefore, accuracy is not expected to be affected and the data are considered accurate and valid.
- MS and/or MSD recoveries were below the lower control limit (biased low) in batch BAJ0042 for methyl isobutyl ketone (MIBK) and 2-hexanone. LCS data were within control limits, or was considered acceptable, and the affected samples were non-detect for these compounds; therefore, the data are considered accurate and valid.

#### 7.7.1.4 Surrogates

Surrogate recoveries from VOC and explosives analyses were within specified control limits; therefore, the data are considered accurate and valid.

#### 7.7.1.5 Internal Standards

Internal standard issues were not noted in the SDGs.

### 7.7.2 Level III Data Review

The data package for the SDGs receiving Level III data reporting (MAI0747) was reviewed for adherence to method criteria that exceed Level II reporting. There were no deviations from method criteria.

## 8 HYDROGEOLOGY DISCUSSION

### 8.1 Base Boundary/Lacamas Creek

The third quarter 2020 shallow and deep monitoring well groundwater contours are shown on Figures 5A and 5B. Shallow (S) wells have screen intervals between 15 and 20 feet bgs with 5-foot length screens, and deep (D) wells have screen intervals between 30 and 40 feet bgs with 10-foot length screens. Well pairs have demonstrated a downward vertical gradient for measurements available in the EQuIS database (since 2008 or well installation), except for well pair LC-MW09S/LC-MW09D, which did not have a vertical gradient in September 2018. The calculated groundwater flow direction is to the west-northwest, which is consistent with historical trends.

### 8.2 Landfill 4/Demolition Area 1

The wells near and within the Landfill 4/Demolition Area 1 area are illustrated in Figure 4. The hydrogeology discussion for this area includes six pairs of nested wells in A/B pairs, shallow wells L4-MW04A and L4-MW05A, and deep wells L4-MW07B and L4-MW11B. Wells L4-MW17 and L4-MW18 are located topographically downgradient from the Landfill 4/Demolition Area 1 area and are considered sentinel wells; they are not included in the following discussion.

Groundwater elevations and contours are shown on Figures 6A and 6B in support of the following groundwater observations:

- For the eight wells in the A grouping, there is a consistent high groundwater elevation in upgradient eastern well L4-MW01A and a westerly groundwater flow direction. From there, groundwater demonstrates a divergent radial flow pattern, generally following the topographic contour, from the northwest (toward L4-MW04A) to southwest (toward well L4-MW05A) directions, which is consistent with historical trends.
- For the eight B wells, there is a consistent high groundwater elevation in upgradient eastern well L4-MW01B. Groundwater flow direction is primarily to the west with slight fluctuations from the west-northwest to west-southwest and is consistently toward North Fork Lacamas Creek. Groundwater flow is primarily to the southwest (toward L4-MW07B) south of the main Landfill 4/Demolition Area 1 area, which is consistent with historical trends.
- The well pairs demonstrated vertical gradients as follows:
  - L4-MW01A/L4-MW01B: Upward (since second quarter 2008)
  - L4-MW02A/L4-MW02B: Downward (since second quarter 2008)
  - L4-MW03A/L4-MW03B: Downward (since second quarter 2008)
  - L4-MW08A/L4-MW08B: Downward (since installation in third quarter 2017)
  - L4-MW09A/L4-MW09B: Downward (since installation in third quarter 2017)
  - L4-MW10A/L4-MW10B: Downward (since installation in third quarter 2017)

## 9 WATER QUALITY DATA ANALYSIS

The laboratory results for COCs were compared to previous quarterly monitoring events, along with groundwater elevation, to identify trends in the data. The monitoring events included in the trend analysis cover the period of March 2015 to present for Base Boundary and Landfill 4/Demolition Area 1. Data from March 2007 are currently available in the EQuIS database for specific COCs; however, this section focuses on recent trends only. These monitoring events encompass the range of seasonal climatic (rainfall and temperature) and groundwater level variations.

The Base Boundary monitoring wells and surface water samples have had no reproducible detections above laboratory MRLs in the monitoring period from 2015 to present; therefore, these locations are not included in this trend discussion.

Groundwater concentration trends for Landfill 4/Demolition Area 1 are discussed below. Analytical results are discussed for all Landfill 4/Demolition Area 1 wells, except for wells L4-MW17 and L4-MW18.

### 9.1 Spatial Distribution of Perchlorate and RDX

Perchlorate and RDX are the only two compounds consistently detected above MTCA Method B cleanup levels in multiple wells in the Landfill 4/Demolition Area 1 area. Isocontours of perchlorate concentrations in shallow (A) and deep (B) wells are illustrated in Figures 7A and 7B, and isocontours of RDX concentrations in shallow and deep wells are illustrated in Figures 8A and 8B.

#### *Perchlorate*

The highest perchlorate concentration in shallow wells is located at well L4-MW09A and decreases in all directions. The highest perchlorate concentration in deep wells is located at well L4-MW11B, with upgradient well L4-MW02B having the second-highest concentration and wells to the north (L4-MW09B, L4-MW10B) having higher concentrations than those south (L4-MW03B) or east (L4-MW01B). The shallow and deep groundwater flow direction near these wells is generally to the west with a northwest component near wells L4-MW02A/B.

#### *RDX*

The highest RDX concentration in shallow wells is located at well L4-MW08A. Shallow groundwater flow near well L4-MW08A is generally toward well L4-MW04A, and RDX concentrations have generally demonstrated an increasing trend in well L4-MW04A. The highest RDX concentration in deep wells is located at well L4-MW11B, with upgradient well L4-MW02B having the second-highest concentration.

### 9.2 Perchlorate and RDX Concentration Trend Analysis

Trend graphs for perchlorate and RDX concentrations from 2007 to present are included in Appendix E. The trend charts are provided as one chart each for perchlorate and RDX in shallow (A) and deep (B) wells (four charts total), and per-well charts with perchlorate, RDX, and groundwater elevation shown. Wells must have at least two detections above the MRL for that analyte to be graphed.

The MTCA Method B cleanup levels are 11.0 µg/L for perchlorate and 1.10 µg/L for RDX. Please note that Ecology requests that graphs showing wells with detections need to also include data points for non-detections in those wells, recorded as one-half the MRL for that analyte.

Data from 2015 to present were examined for statistically significant trends by using a Mann-Kendall trend analysis in ProUCL version 5.1. Data were imported into ProUCL directly from EQuIS with non-detect data at the reporting limit. RDX was not detected over this time interval in wells L4-MW01B and L4-MW07B so they are not included in this discussion.

The Mann-Kendall trend analysis was performed with the null hypothesis that an upward or downward trend is not present in the data, and with the alternate hypothesis that a trend exists. The data are analyzed by comparing every new value with every preceding value to see if there are consistent increasing or decreasing trends within a set level of confidence. If the analysis is above the set level of confidence, the null hypothesis is rejected; otherwise, a trend cannot be determined.

The following wells demonstrated a statistically significant increasing trend at a 95% confidence level:

Perchlorate

- L4-MW04A
- L4-MW11B

RDX

- L4-MW04A
- L4-MW08B
- L4-MW10B
- L4-MW11B

The following wells demonstrated a statistically significant decreasing trend at a 95% confidence level:

Perchlorate

- L4-MW02B
- L4-MW03A
- L4-MW03B
- L4-MW05A
- L4-MW08A
- L4-MW09A

RDX

- L4-MW02A
- L4-MW02B
- L4-MW03A
- L4-MW08A
- L4-MW09A
- L4-MW09B

The following wells did not demonstrate a statistically significant trend over the analyzed time interval:

Perchlorate

- L4-MW01A
- L4-MW01B
- L4-MW02A
- L4-MW07B
- L4-MW08B
- L4-MW09B
- L4-MW10A
- L4-MW10B

RDX

- L4-MW01A
- L4-MW03B
- L4-MW05A
- L4-MW10A

Wells L4-MW01A and L4-MW08B are exhibiting an apparent positive correlation between groundwater elevation and perchlorate concentrations, and well L4-MW02A is exhibiting an apparent negative correlation. There are no apparent correlations between perchlorate or RDX in the remaining Landfill 4/Demolition Area 1 wells.

## 10 FUTURE ACTIVITIES

At the request of Ecology, the fourth quarter 2020 monitoring activities will not occur. The next scheduled event will occur first quarter 2021.

PBS Engineering and Environmental Inc. is pleased to present the results of the third quarter 2020 groundwater sampling event. Please contact the undersigned if there are any questions.

Sincerely,  
PBS Engineering and Environmental Inc.



Digitally signed by Scott  
Braunsten  
Date: 2020.12.29 09:08:25 -08'00'

Scott Braunsten, LG  
Senior Geologist

Date



Digitally signed by Lance A.  
Moen, PE  
Date: 2020.12.29 09:05:37  
-08'00'

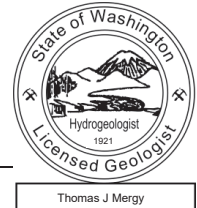
Lance A. Moen, PE  
Senior Environmental Engineer

Date



Digitally signed by  
Thomas Mergy  
Date: 2020.12.29  
08:44:17 -08'00'

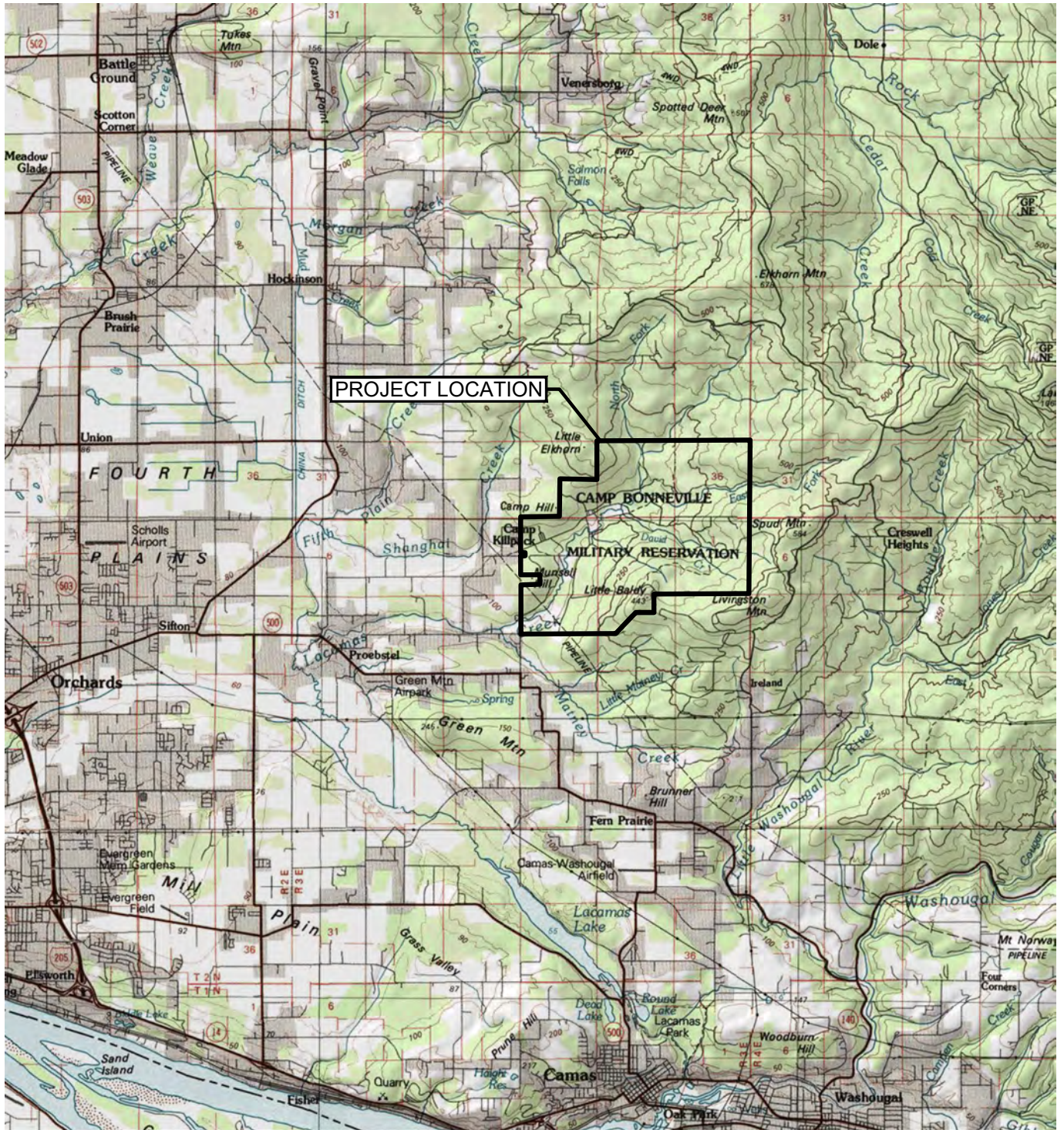
Tom Mergy, LHG  
Principal Hydrogeologist



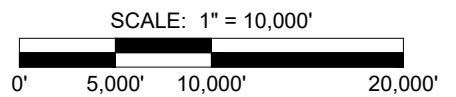


# Figures

- Figure 1. Site Vicinity Map
- Figure 2. Investigation Areas within Camp Bonneville Boundary
- Figure 3. Monitoring Well Locations at Base Boundary
- Figure 4. Monitoring Well Locations Near Landfill 4/Demo Area 1
- Figure 5A. Shallow Base Boundary Monitoring Wells with Groundwater Contours
- Figure 5B. Deep Base Boundary Monitoring Wells with Groundwater Contours
- Figure 6A. Shallow Landfill 4 Wells (A Wells) with Groundwater Contours
- Figure 6B. Deep Landfill 4 Wells (B Wells) with Groundwater Contours
- Figure 7A. Perchlorate Isocontours (A Wells), 3rd Quarter 2020 – Landfill 4 Monitoring Wells
- Figure 7B. Perchlorate Isocontours (B Wells), 3rd Quarter 2020 – Landfill 4 Monitoring Wells
- Figure 8A. RDX Isocontours (A Wells), 3rd Quarter 2020 – Landfill 4 Monitoring Wells
- Figure 8B. RDX Isocontours (B Wells), 3rd Quarter 2020 – Landfill 4 Monitoring Wells



SOURCE: USGS 100K MAP SERIES



PREPARED FOR: CLARK COUNTY, WASHINGTON

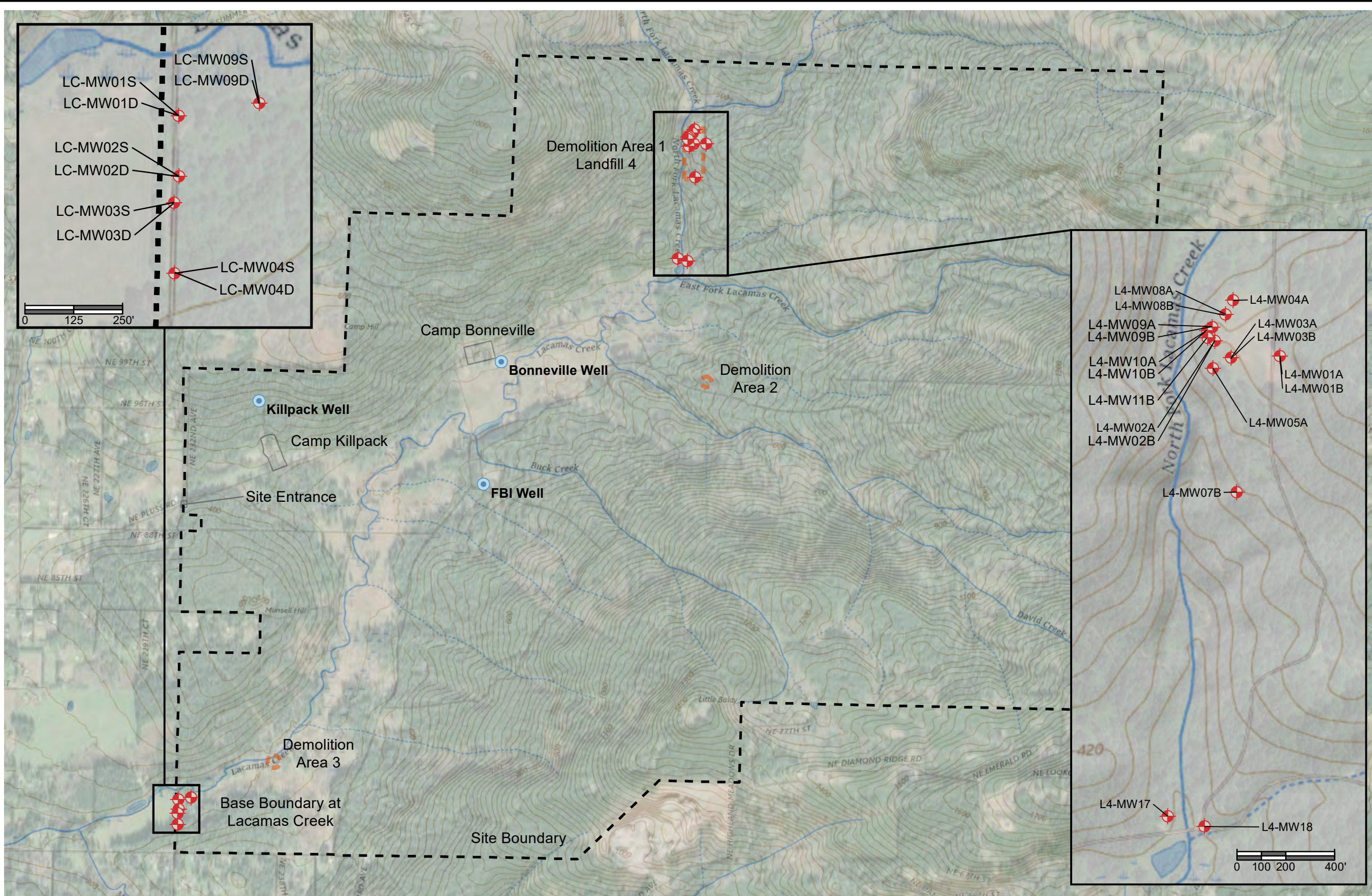


**VICINITY MAP**  
 CAMP BONNEVILLE  
 CLARK COUNTY, WASHINGTON

DEC 2020  
 76151.009  
 FIGURE  
**1**



\\pbsenv\lan\Projects\76000\76100-76199\76151\_Camp\_Bonneville\_Vancouver\DWG\GIS\2020\mxd\Fig2\_SiteMap\_2020Jun.mxd



SOURCES: USGS, ESRI WORLD IMAGERY

LEGEND			
	Approximate Location of Water Supply Well		Site Boundary
	Monitoring Well Location		Demolition Area
			Camp Boundary

1 inch = 1,600 feet  
  
 PREPARED FOR: CLARK COUNTY

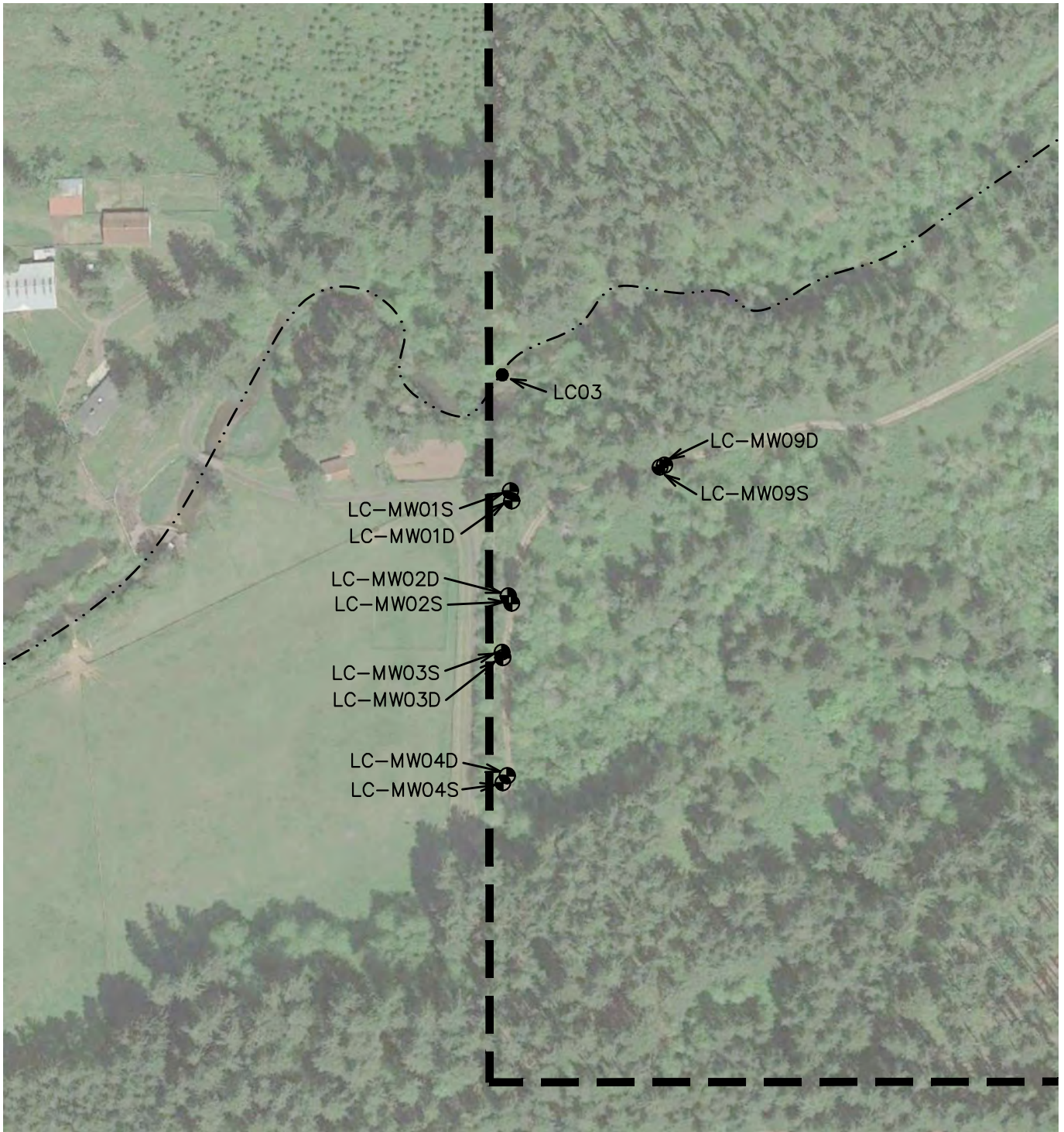
**PBS Engineering and Environmental Inc.**  
 4412 SW Corbett Ave.,  
 Portland, OR 97239  
 503.248.1939  
 pbsusa.com



**INVESTIGATION AREAS WITHIN CAMP BONNEVILLE BOUNDARY**  
**CAMP BONNEVILLE**  
 CLARK COUNTY, WASHINGTON






PROJECT	76151.009
DATE	DEC 2020
FIGURE	<b>2</b>





SOURCE: © 2020 GOOGLE EARTH PRO

**LEGEND**

-  LC-MW01D DEEP MONITORING WELL AND WELL NUMBER
-  LC-MW01S SHALLOW MONITORING WELL AND WELL NUMBER
-  LACAMÁS CREEK
-  BASE BOUNDARY
-  LC03 SURFACE WATER SAMPLE AND NUMBER



Scale 1" = 200'



PREPARED FOR: CLARK COUNTY, WASHINGTON



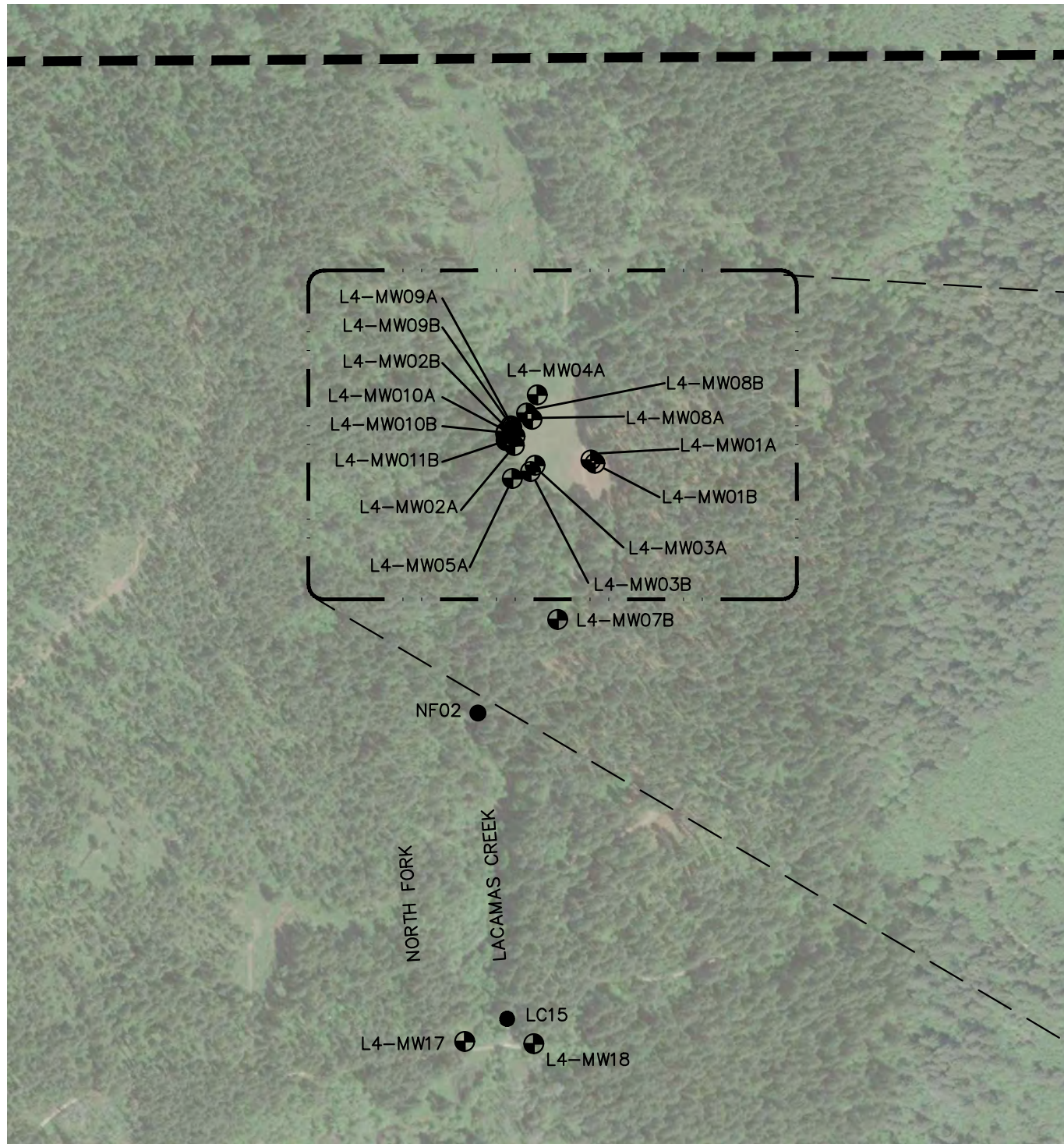
**MONITORING WELL  
LOCATIONS AT BASE BOUNDARY  
CAMP BONNEVILLE  
CLARK COUNTY, WASHINGTON**

DEC 2020  
76151.009

FIGURE

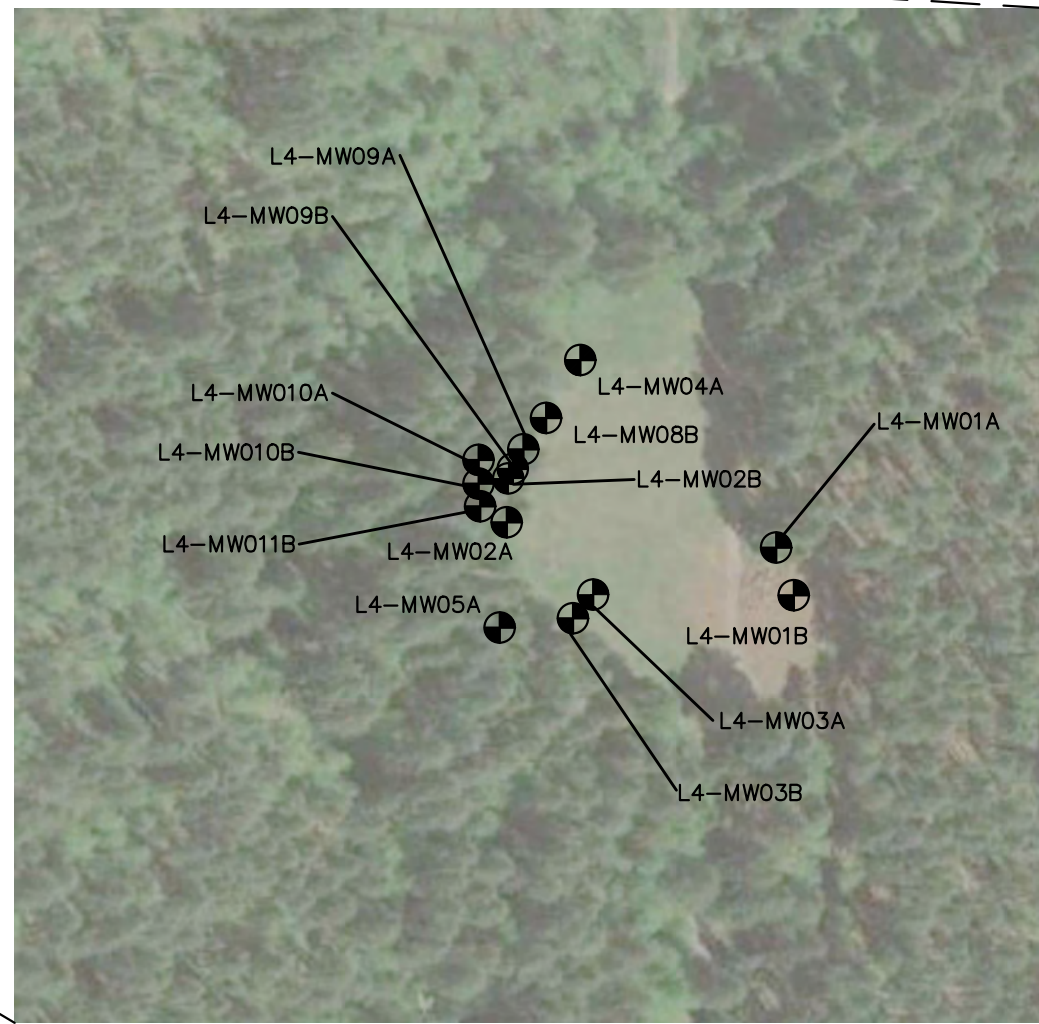
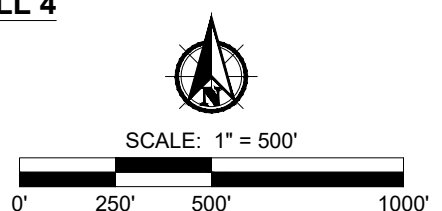
**3**





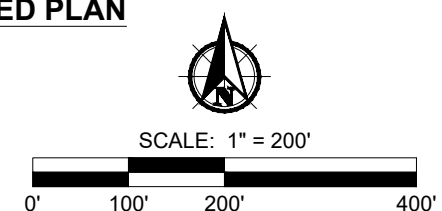
**LANDFILL 4**

SOURCE: © 2020 GOOGLE EARTH PRO



**LANDFILL 4 - ENLARGED PLAN**

SOURCE: © 2020 GOOGLE EARTH PRO



**LEGEND**

- L4-MW01A MONITORING WELL AND WELL NUMBER
- BASE BOUNDARY
- NFO2 SURFACE WATER SAMPLE AND NUMBER

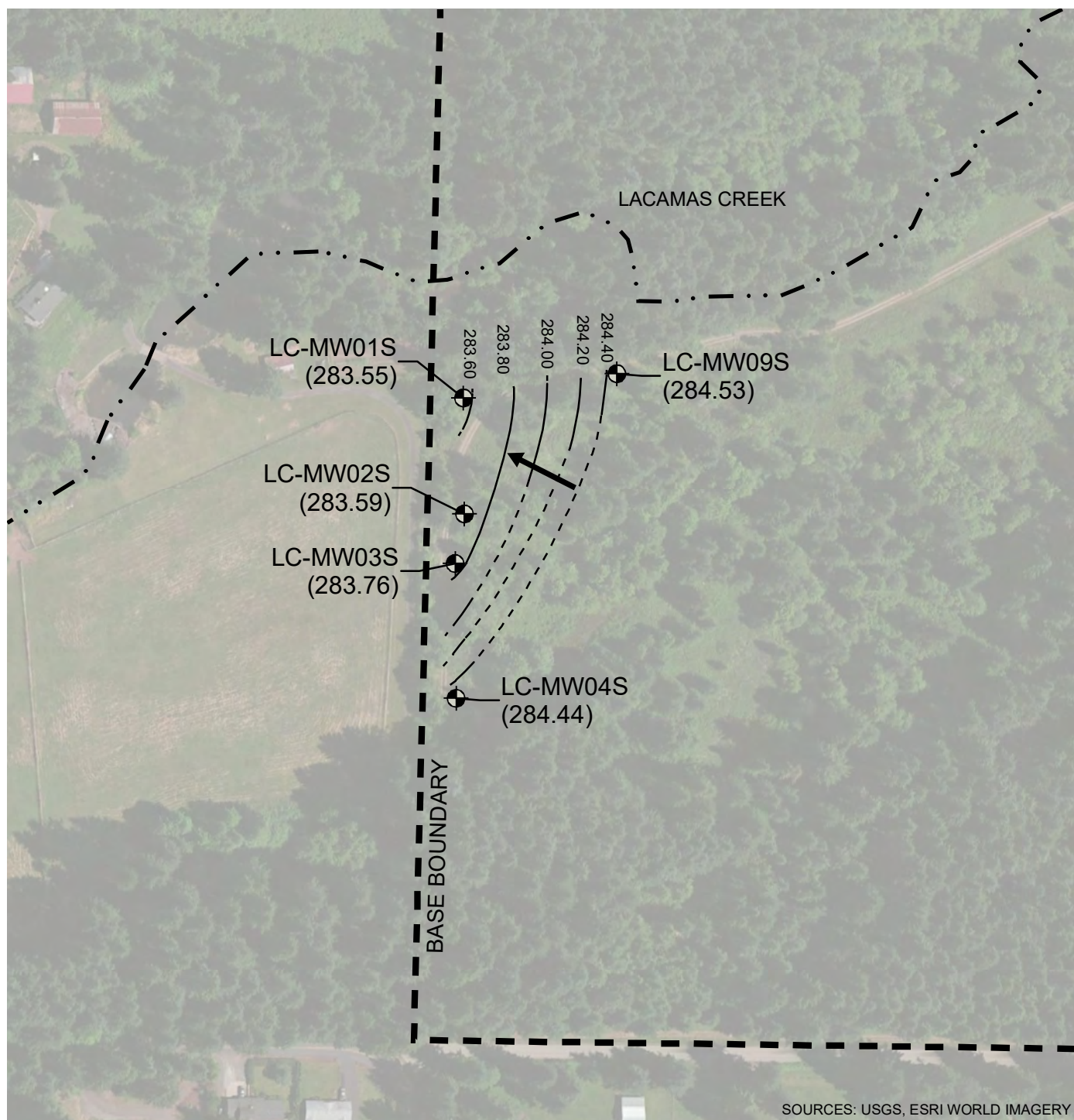


MONITORING WELL SAMPLE LOCATIONS NEAR LANDFILL 4 / DEMO AREA 1  
**CAMP BONNEVILLE**  
CLARK COUNTY, WASHINGTON

PROJECT	76151.009
DATE	DEC 2020
FIGURE	4







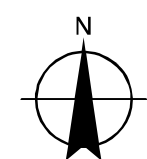
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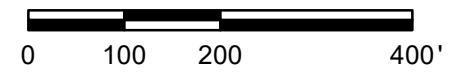
SOURCES: USGS, ESRI WORLD IMAGERY

**LEGEND**

-  LC-MW01S (283.55) MONITORING WELL AND WELL NUMBER
- GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
-  GROUNDWATER ELEVATION CONTOUR
-  INFERRED ELEVATION CONTOUR
-  GROUNDWATER FLOW DIRECTION



SCALE: 1" = 200'

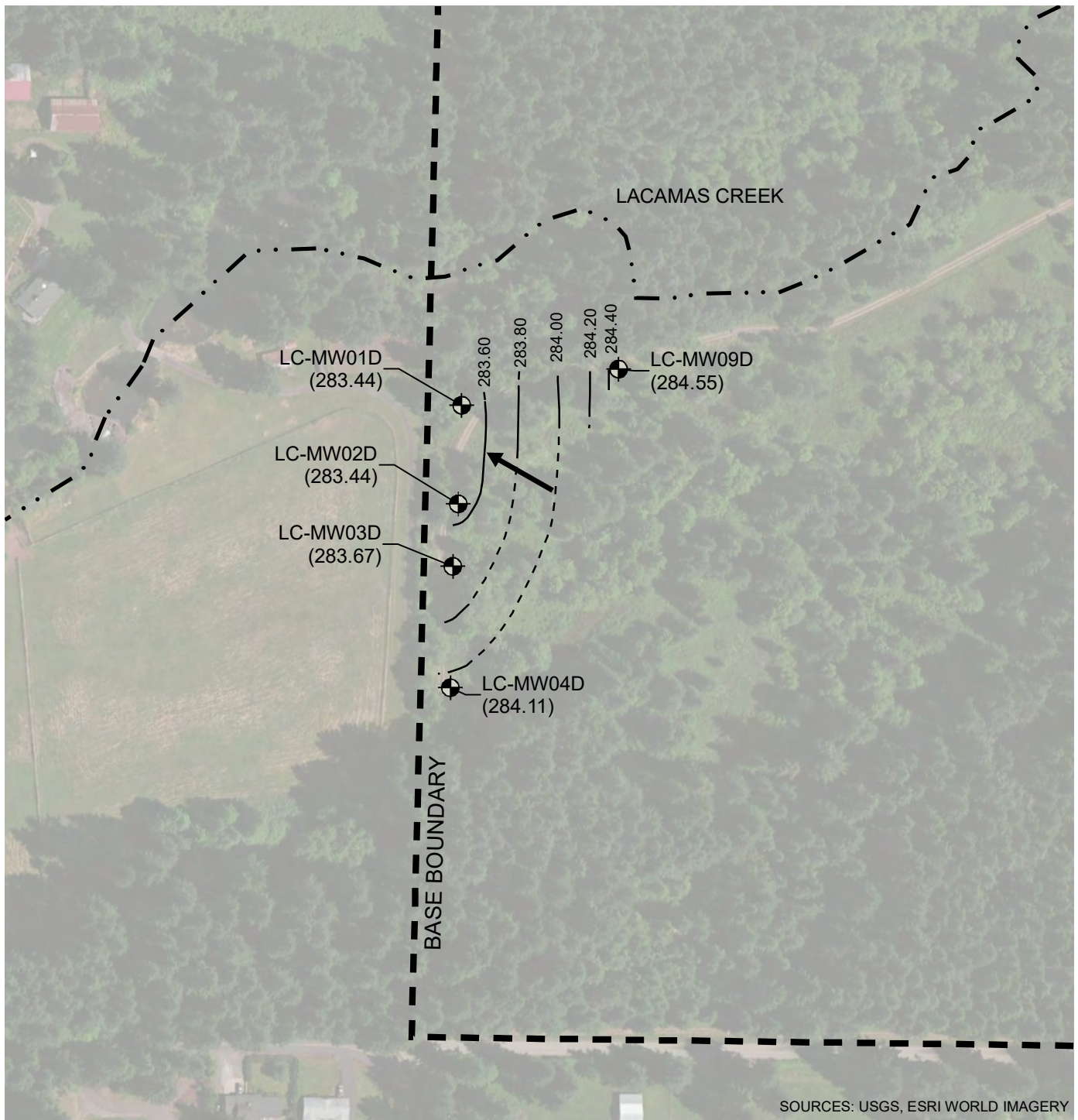


PREPARED FOR: CLARK COUNTY, WASHINGTON



**SHALLOW BASE BOUNDARY MONITORING WELLS  
WITH GROUNDWATER CONTOURS**  
CAMP BONNEVILLE  
CLARK COUNTY, WASHINGTON

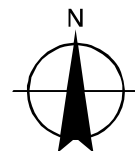
DEC 2020  
76151.009  
FIGURE  
**5A**



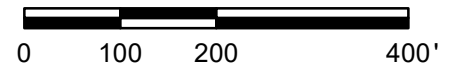
SOURCES: USGS, ESRI WORLD IMAGERY

### LEGEND

- LC-MW01D  
(283.44)
MONITORING WELL AND WELL NUMBER  
GROUNDWATER ELEVATION  
(FEET ABOVE MEAN SEA LEVEL)
- DEEP GROUNDWATER ELEVATION CONTOUR
- - -
INFERRED ELEVATION CONTOUR
- ←
GROUNDWATER FLOW DIRECTION



SCALE: 1" = 200'



PREPARED FOR: CLARK COUNTY, WASHINGTON



**DEEP BASE BOUNDARY MONITORING WELLS  
WITH GROUNDWATER CONTOURS**  
CAMP BONNEVILLE  
CLARK COUNTY, WASHINGTON

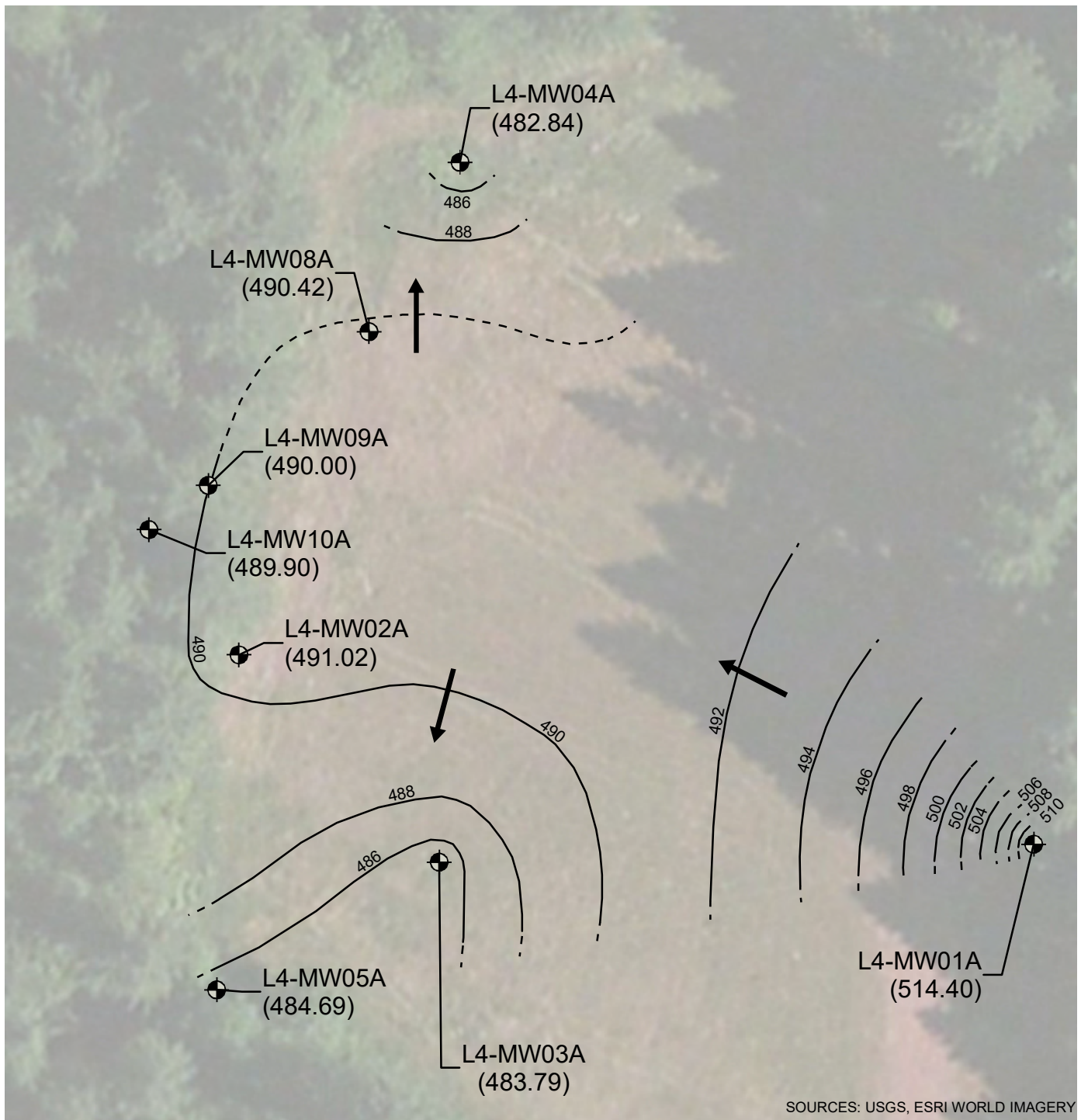
DEC 2020  
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FIGURE





**5B**

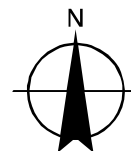


L:\Projects\76000\76100-76199\76151\_Camp Bonneville\_Vancouver\DWG\GIS\mxd\Fig6A\_Landfill4\_Shallow\_GWE\_2020Dec16.mxd

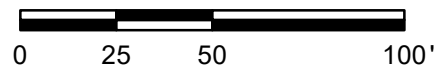


### LEGEND

-  L4-MW01A (514.40) MONITORING WELL AND WELL NUMBER
- GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
-  GROUNDWATER ELEVATION CONTOUR
-  INFERRED ELEVATION CONTOUR
-  GROUNDWATER FLOW DIRECTION



SCALE: 1" = 50'



PREPARED FOR: CLARK COUNTY, WASHINGTON



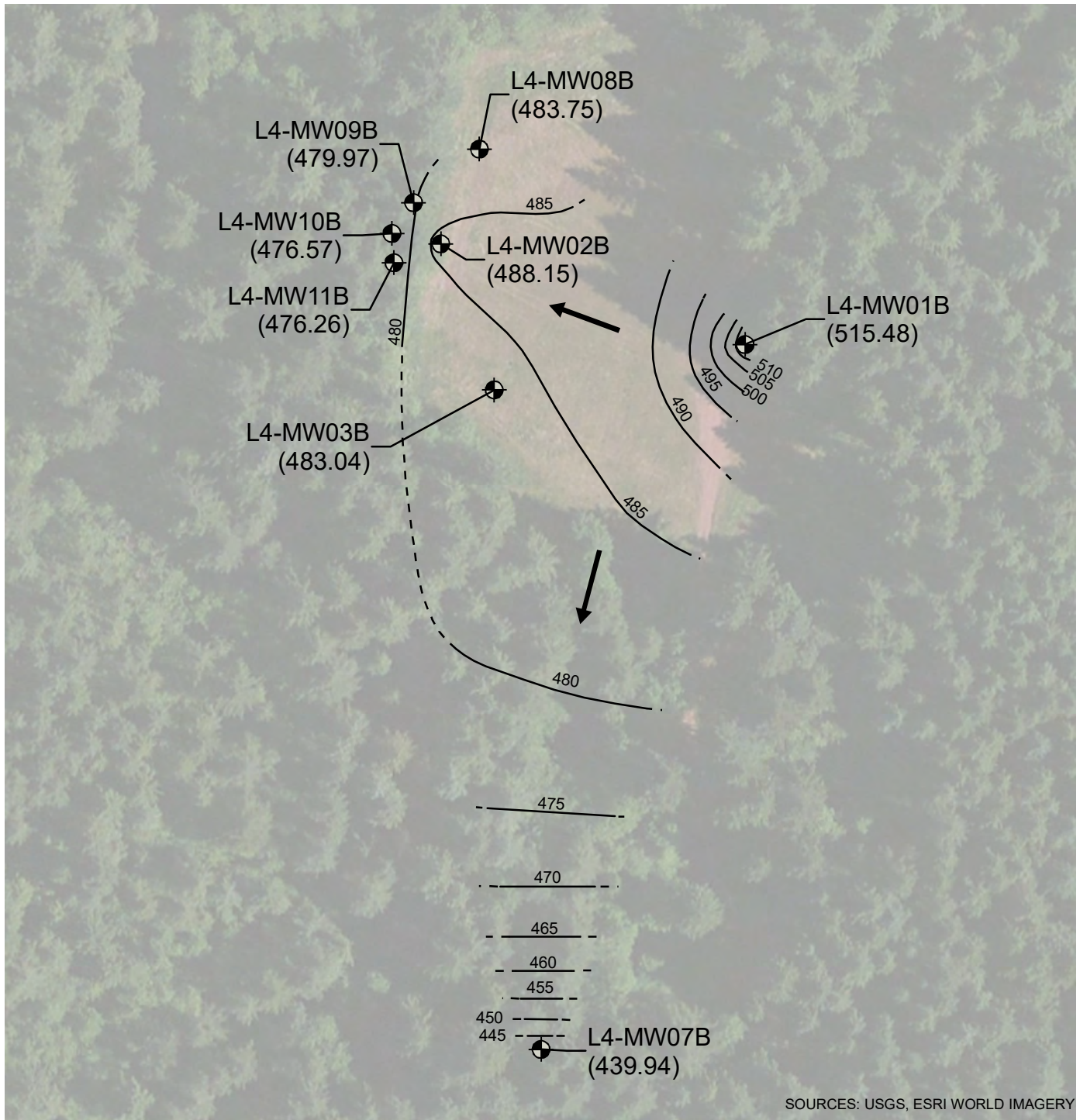
**SHALLOW LANDFILL 4 (A WELLS)  
WITH GROUNDWATER CONTOURS**  
CAMP BONNEVILLE  
CLARK COUNTY, WASHINGTON

DEC 2020  
76151.009





FIGURE

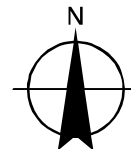
**6A**





**LEGEND**

-  L4-MW01B (515.48) MONITORING WELL AND WELL NUMBER  
 GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
-  GROUNDWATER ELEVATION CONTOUR
-  INFERRED ELEVATION CONTOUR
-  GROUNDWATER FLOW DIRECTION



SCALE: 1" = 120'



PREPARED FOR: CLARK COUNTY, WASHINGTON



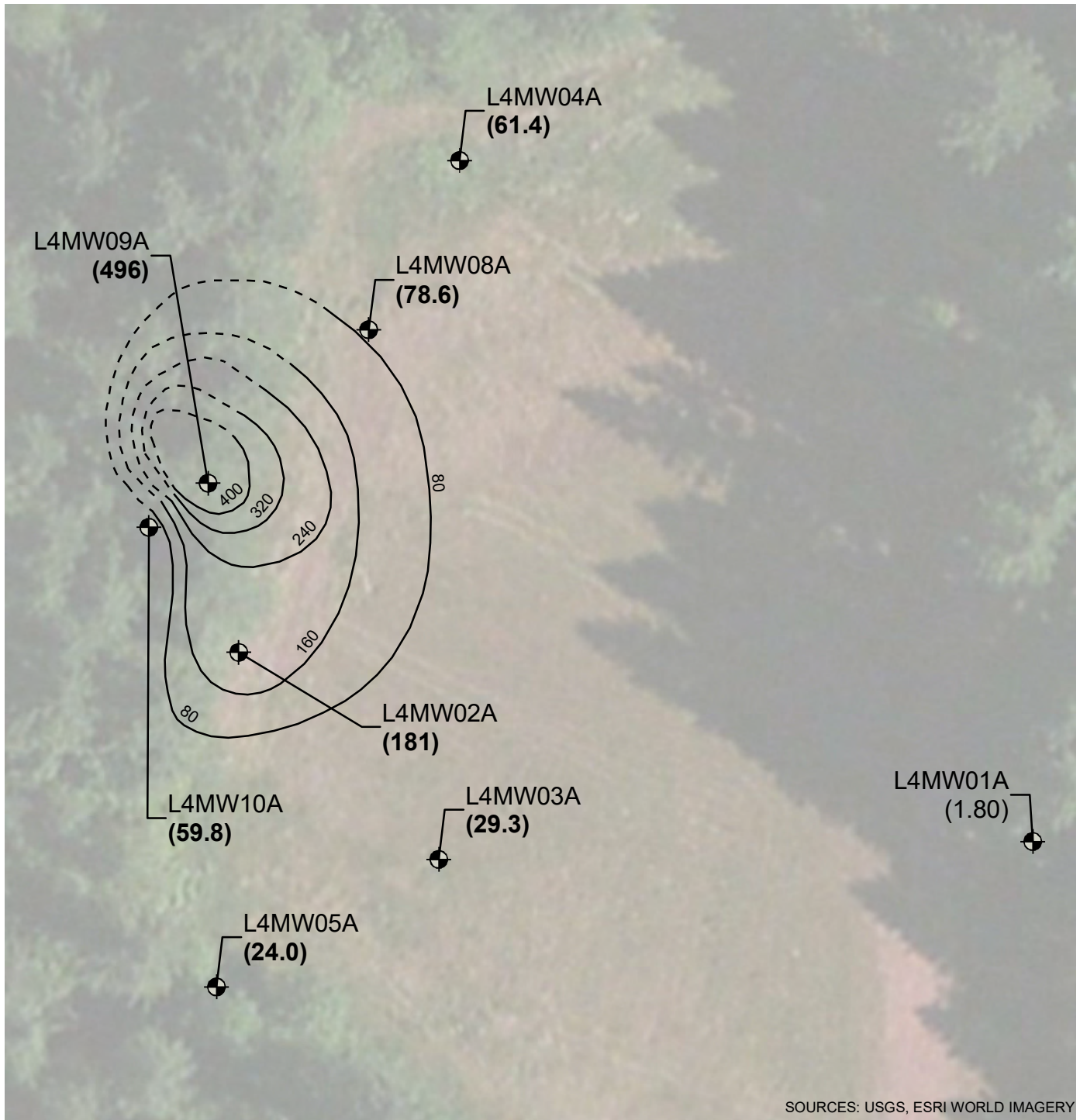
**DEEP LANDFILL 4 (B WELLS)  
WITH GROUNDWATER CONTOURS**  
CAMP BONNEVILLE  
CLARK COUNTY, WASHINGTON

DEC 2020  
76151.009

FIGURE

**6B**

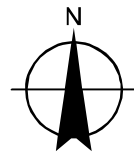
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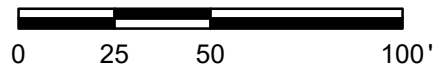
SOURCES: USGS, ESRI WORLD IMAGERY

### LEGEND

- L4-MW04A MONITORING WELL AND WELL NUMBER  
**(60.1)** PERCHLORATE CONCENTRATION ( $\mu\text{g/L}$ )
- PERCHLORATE CONCENTRATION CONTOUR
- INFERRED CONCENTRATION CONTOUR



SCALE: 1" = 50'



NOTE: **BOLD** CONCENTRATION EXCEEDS CLEANUP LEVEL OF 11.0  $\mu\text{g/L}$

PREPARED FOR: CLARK COUNTY, WASHINGTON



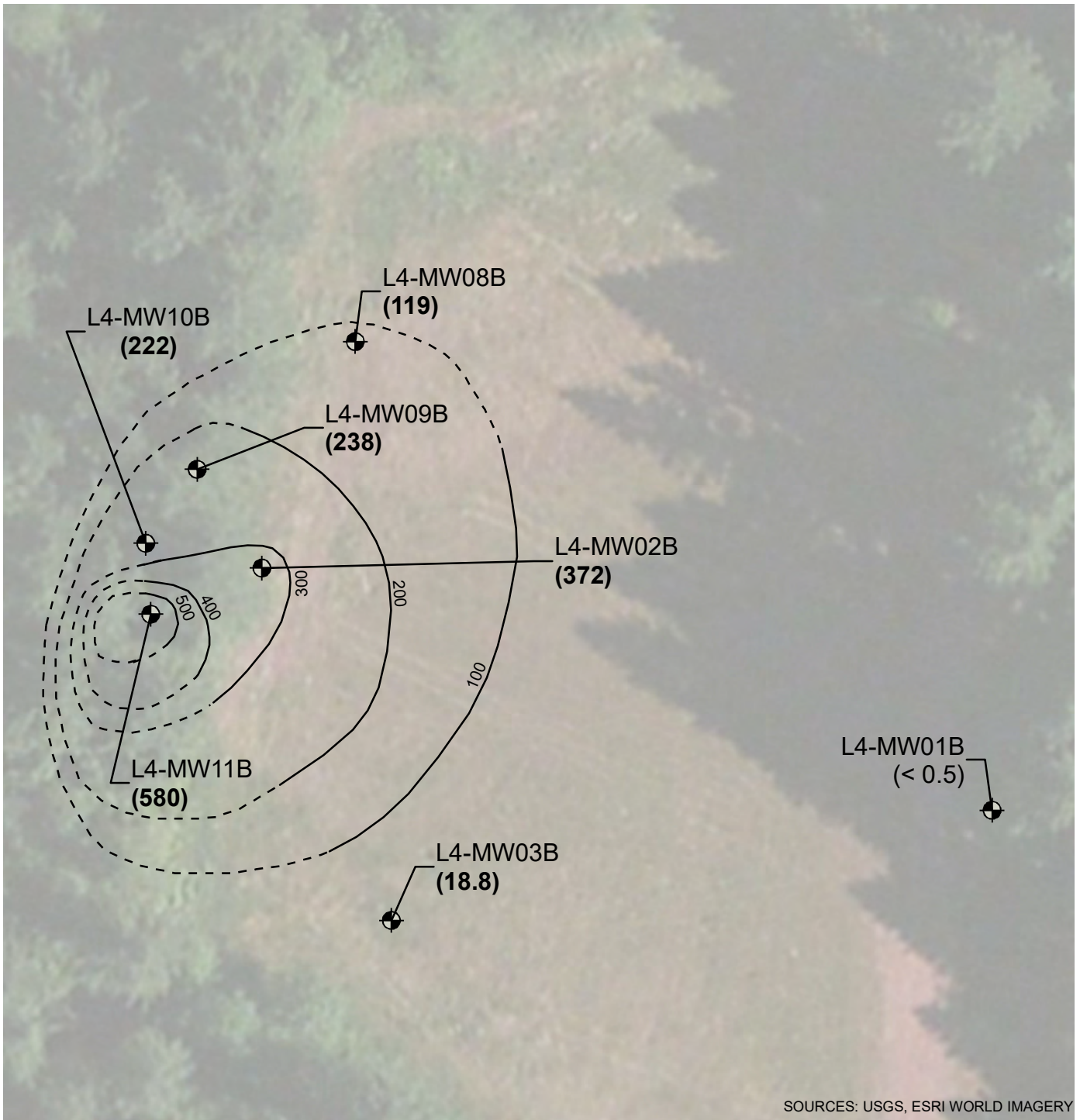
**PERCHLORATE ISOCONTOURS (A WELLS)**  
**3RD QUARTER 2020 - LANDFILL 4 MONITORING WELLS**  
 CAMP BONNEVILLE  
 CLARK COUNTY, WASHINGTON

DEC 2020  
 76151.009  
 FIGURE

**7A**

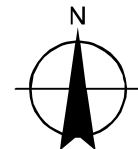


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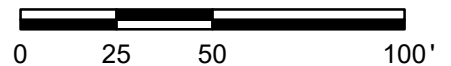


**LEGEND**

- L4-MW03B (18.8) MONITORING WELL AND WELL NUMBER PERCHLORATE CONCENTRATION IN (µg/L)
- PERCHLORATE CONCENTRATION CONTOUR
- INFERRED CONCENTRATION CONTOUR



SCALE: 1" = 50'



NOTE: **BOLD** CONCENTRATION EXCEEDS CLEANUP LEVEL OF 11.0 µg/L

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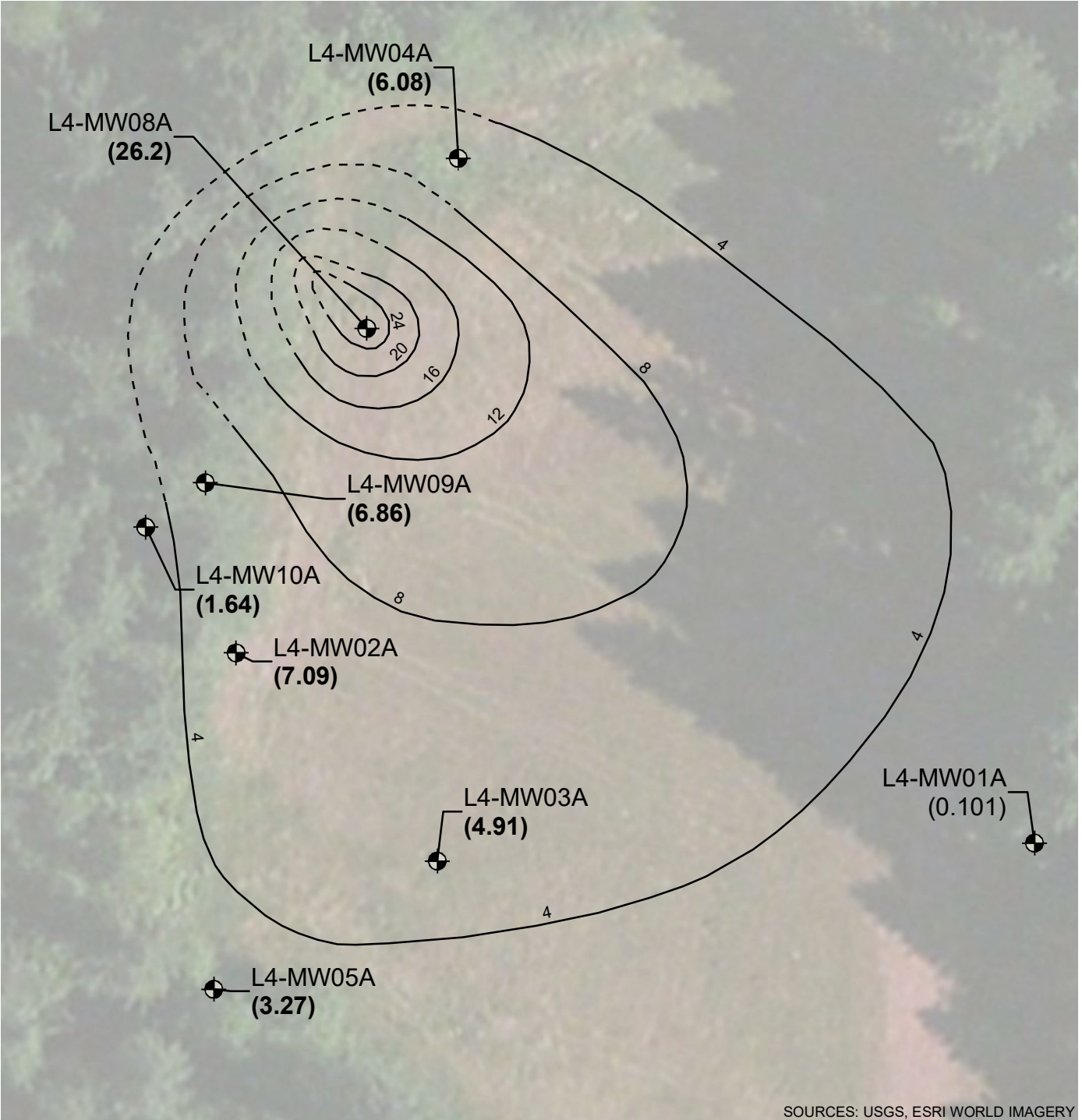


**PERCHLORATE ISOCONTOURS (B WELLS)**  
**3RD QUARTER 2020 - LANDFILL 4 MONITORING WELLS**  
 CAMP BONNEVILLE  
 CLARK COUNTY, WASHINGTON

DEC 2020  
 76151.009  
 FIGURE

**7B**

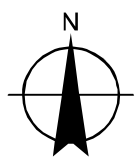
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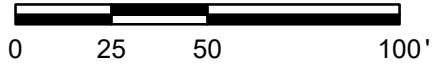
SOURCES: USGS, ESRI WORLD IMAGERY

**LEGEND**

- L4-MW08A MONITORING WELL AND WELL NUMBER  
(28.7) RDX CONCENTRATION ( $\mu\text{g/L}$ )
- RDX CONCENTRATION CONTOUR
- INFERRED CONCENTRATION CONTOUR



SCALE: 1" = 50'



NOTE: **BOLD** CONCENTRATION EXCEEDS CLEANUP LEVEL OF 1.10  $\mu\text{g/L}$

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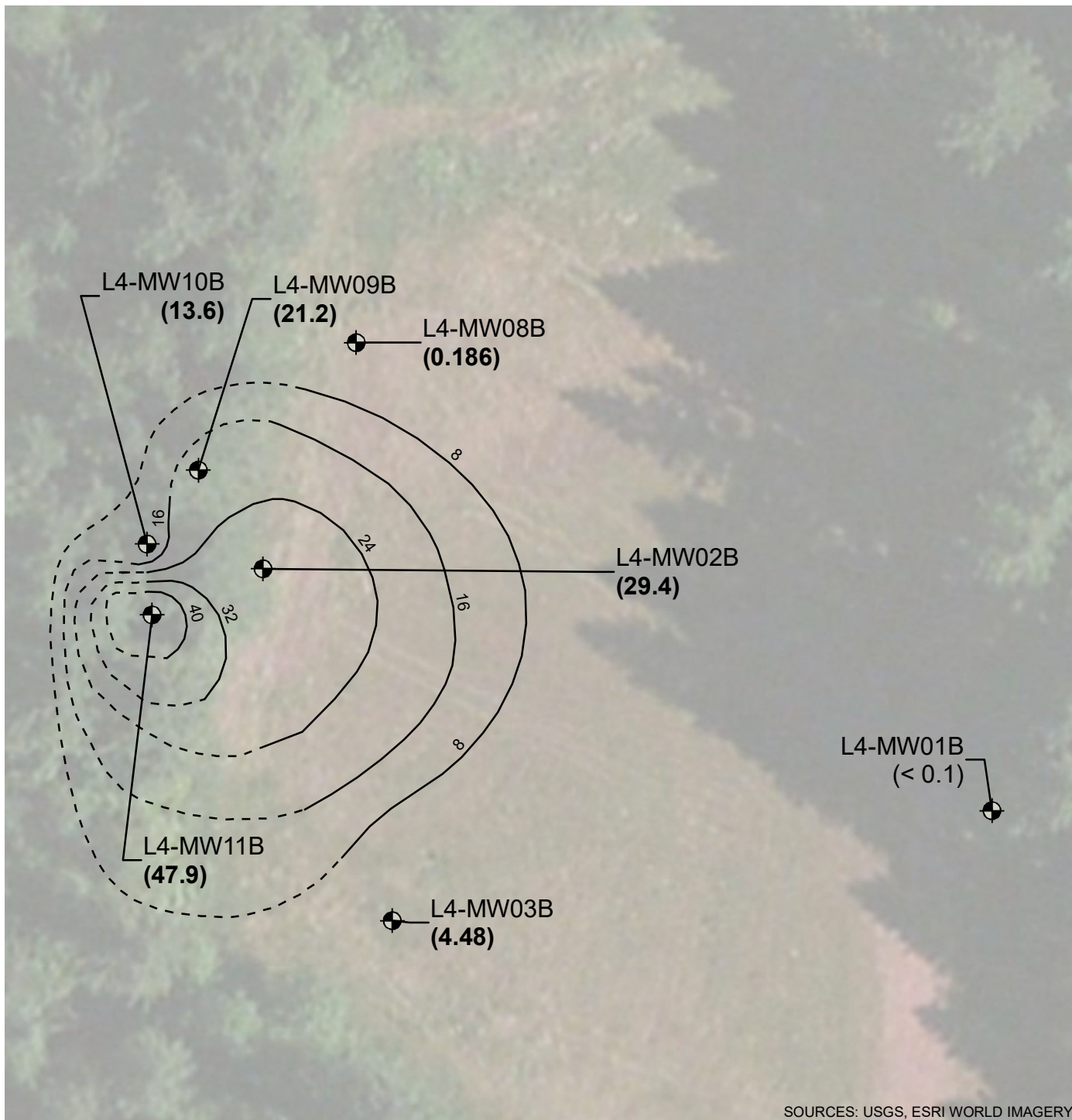


**RDX ISOCONTOURS (A WELLS),  
3RD QUARTER 2020 - LANDFILL 4 MONITORING WELLS**  
CAMP BONNEVILLE  
CLARK COUNTY, WASHINGTON

DEC 2020  
76151.009  
FIGURE  
**8A**






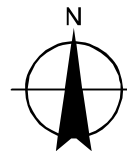
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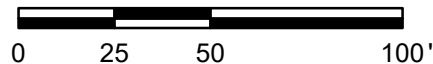
SOURCES: USGS, ESRI WORLD IMAGERY

### LEGEND

-  L4-MW02B MONITORING WELL AND WELL NUMBER  
(35.7) RDX CONCENTRATION ( $\mu\text{g/L}$ )
-  RDX CONCENTRATION CONTOUR
-  INFERRED CONCENTRATION CONTOUR



SCALE: 1" = 50'



NOTE: **BOLD** CONCENTRATION EXCEEDS CLEANUP LEVEL OF 1.10  $\mu\text{g/L}$

PREPARED FOR: CLARK COUNTY, WASHINGTON



**RDX ISOCONTOURS (B WELLS),  
3RD QUARTER 2020 - LANDFILL 4 MONITORING WELLS**  
CAMP BONNEVILLE  
CLARK COUNTY, WASHINGTON

DEC 2020  
76151.009

FIGURE

**8B**

# Tables

Table 1. Well Number and Construction Details

Table 2. Field Parameters for Groundwater Samples at Base Boundary and  
Landfill 4/Demolition Area 1, 3rd Quarter 2020

Table 3. Constituents Detected in Groundwater, 3rd Quarter 2020

Table 4. Constituents Analyzed in Surface Water, 3rd Quarter 2020

**Table 1. Well Number and Construction Details**

Camp Bonneville, Vancouver, Washington

	Well No. in PBS Work Contract	Ecology Well Tag No.	Well Location	Measured Total Depth (feet)*	Well Log Total Depth (feet)**	Screened Interval (feet)***	Top of PVC Casing Elevation (feet amsl)	Well No. on Steel Casings/Caps (CHPPM No.)
Base Boundary	LC-MW01S	AHA-359	Lacamas Creek	22.71	23.00	10-20	290.15	LC-MW01S
	LC-MW01D	AHA-358	Lacamas Creek	42.21	42.50	29.5-39.5	290.26	LC-MW01D
	LC-MW02S	AHA-364	Lacamas Creek	17.46	17.70	10-15	291.15	LC-MW02S
	LC-MW02D	AHA-357	Lacamas Creek	37.83	38.10	25-35	291.57	LC-MW02D
	LC-MW03S	AHA-363	Lacamas Creek	20.09	20.35	13-18	290.87	LC-MW03S
	LC-MW03D	AHA-362	Lacamas Creek	39.36	39.48	27-37	290.93	LC-MW03D
	LC-MW04S	AHA-375	Lacamas Creek	16.49	16.80	9-14	291.63	LC-MW04S
	LC-MW04D	AHA-361	Lacamas Creek	37.03	37.13	24.5-34.5	291.79	LC-MW04D
	LC-MW09S	BJH-382	Lacamas Creek	22.05	22.38	15-20	293.52	LC-MW09S
LC-MW09D	BJH-380	Lacamas Creek	41.60	42.27	30-40	294.10	LC-MW09D	
Landfill 4 / Demolition Area 1	L4-MW01A	N/A	Landfill 4	30.17	30.40	17-27	531.43	L4-MW01A
	L4-MW01B	AGL-482	Landfill 4	55.54	56.00	43-53	529.57	L4-MW01B
	L4-MW02A	N/A	Landfill 4	40.21	40.20	27-37	519.97	L4-MW02A
	L4-MW02B	AGL-483	Landfill 4	74.97	75.00	62-72	521.70	L4-MW02B
	L4-MW03A	AGL-466	Landfill 4	48.71	49.00	41-46	514.90	L4-MW03A
	L4-MW03B	AGL-484	Landfill 4	61.85	63.00	50-60	511.49	L4-MW03B
	L4-MW04A	AGL-465	Landfill 4	46.44	46.00	33-43	511.84	L4-MW04A
	L4-MW05A	AGL-467	Landfill 4	36.63	36.00	28-33	509.74	L4-MW05A
	L4-MW07B	N/A	Landfill 4	58.86	58.90	46-56	480.49	L4-MW07B
	L4-MW08A	BJH-379	Landfill 4	40.72	40.31	28-38	515.52	L4-MW08A
	L4-MW08B	BJH-378	Landfill 4	67.41	67.31	55-65	515.72	L4-MW08B
	L4-MW09A	BJH-377	Landfill 4	42.45	42.43	30-40	523.00	L4-MW09A
	L4-MW09B	BJH-376	Landfill 4	77.65	77.36	65-75	523.27	L4-MW09B
	L4-MW10A	BJH-375	Landfill 4	42.71	42.43	30-40	523.05	L4-MW10A
	L4-MW10B	BJH-374	Landfill 4	77.30	77.17	65-75	522.48	L4-MW10B
	L4-MW11B	BJH-373	Landfill 4	77.57	77.27	65-75	522.29	L4-MW11B
	L4-MW17	ALB-252	Landfill 4	17.17	17.67	5-15	361.48	L4-MW17
	L4-MW18	ALB-251	Landfill 4	22.60	22.01	10-20	362.84	L4-MW18

Notes:

\* = depth in feet measured from top of well PVC casing in December 2007 and August 2017; sediment present at bottom of some casings

\*\* = casing depth in feet recorded on well log; measured from top of PVC casing

\*\*\* = screened interval reported on well completion logs; feet below ground surface

amsl = above mean sea level

N/A = not available

**Table 2. Field Parameters for Groundwater Samples at Base Boundary and Landfill 4/Demolition Area 1, 3rd Quarter 2020**

Camp Bonneville, Vancouver, Washington

	Sample ID	Date Sampled	Depth to Water	Water Elevation	Dissolved Oxygen	Oxidation Reduction Potential	pH	Specific Conductivity	Temperature	Turbidity
			feet below TOC	feet amsl*	mg/L	millivolts	pH units	µS/cm	degrees Celsius	NTU
Base Boundary	03Q20LCMW01DW	9/22/2020	6.82	283.44	6.78	161.3	6.40	85	11.9	--
	03Q20LCMW01SW	9/22/2020	6.60	283.55	6.03	157.7	6.28	83	12.1	0.46
	03Q20LCMW02DW	9/22/2020	8.13	283.44	6.94	164.5	6.48	88	11.9	6.11
	03Q20LCMW02SW	9/22/2020	7.56	283.59	7.26	162.0	6.40	83	12.0	3.54
	03Q20LCMW03DW	9/22/2020	7.26	283.67	7.19	160.4	6.47	91	11.7	4.45
	03Q20LCMW03SW	9/22/2020	7.11	283.76	7.54	172.0	6.33	89	12.0	5.92
	03Q20LCMW04DW	9/22/2020	7.68	284.11	7.99	170.1	6.55	92	11.9	6.05
	03Q20LCMW04SW	9/22/2020	7.19	284.44	5.73	177.4	5.81	86	12.6	3.88
	03Q20LCMW09DW	9/22/2020	9.55	284.55	5.45	138.9	6.38	93	11.8	2.14
	03Q20LCMW09SW	9/22/2020	8.99	284.53	5.60	165.9	6.01	81	12.1	1.43
Landfill 4 / Demolition Area 1	03Q20L4MW01AW	9/23/2020	17.03	514.40	6.52	248.0	4.90	23	11.5	4.56
	03Q20L4MW01BW	9/23/2020	14.09	515.48	8.59	257.2	5.15	24	10.7	3.20
	03Q20L4MW02AW	9/24/2020	28.95	491.02	7.19	317.0	4.38	19	11.5	5.78
	03Q20L4MW02BW	9/24/2020	33.55	488.15	2.71	212.0	5.25	43	12.9	5.27
	03Q20L4MW03AW	9/23/2020	31.11	483.79	6.62	282.7	4.90	20	11.2	1.98
	03Q20L4MW03BW	9/23/2020	28.45	483.04	5.54	279.2	5.40	40	11.9	4.05
	03Q20L4MW04AW	9/24/2020	29.00	482.84	5.31	279.1	4.91	15	10.8	5.46
	03Q20L4MW05AW	9/24/2020	25.05	484.69	5.20	224.7	4.90	26	10.6	3.56
	03Q20L4MW07BW	9/23/2020	40.55	439.94	5.60	213.7	5.30	30	10.0	5.07
	03Q20L4MW08AW	9/24/2020	25.10	490.42	5.86	311.3	4.71	16	11.2	2.81
	03Q20L4MW08BW	9/24/2020	31.97	483.75	3.44	173.7	6.21	61	11.7	2.87
	03Q20L4MW09AW	9/24/2020	33.00	490.00	6.14	353.1	4.39	19	11.6	5.81
	03Q20L4MW09BW	9/24/2020	43.30	479.97	1.42	309.2	4.90	29	12.2	3.11
	03Q20L4MW10AW	9/25/2020	33.15	489.90	5.36	328.0	4.21	20	11.2	5.84
	03Q20L4MW10BW	9/25/2020	45.90	476.58	2.35	256.7	5.22	43	11.0	3.62
	03Q20L4MW11BW	9/25/2020	46.02	476.27	3.11	303.4	5.09	24	11.8	2.47
	03Q20L4MW17W	9/23/2020	11.43	350.09	5.87	97.3	7.31	198	13.5	2.21
03Q20L4MW18W	9/23/2020	12.30	350.55	6.90	142.4	6.15	120	11.5	4.88	
Surface Water	03Q20LC03SW	9/21/2020	--	--	7.38	138.0	7.45	67	15.0	3.35
	03Q20LC15SW	9/21/2020	--	--	9.06	122.9	7.25	64	13.3	7.02
	03Q20NF02SW	9/21/2020	--	--	7.96	132.7	7.32	64	13.5	21.20

Field parameters were measured using a YSI Pro and a flow-through cell, with the exception of turbidity, which was measured using an HF Scientific TPW Meter

\* water level in feet above mean sea level, relative to top of PVC casing elevation survey

TOC = top of casing

amsl = above mean sea level

mg/L = milligrams per liter

µS/cm = micro-siemens per centimeter

NTU = Nephelometric Turbidity Units

Water level measurements are not collected from the Water Wells



**Table 3. Constituents Detected in Groundwater, 3rd Quarter 2020**

Camp Bonneville, Vancouver, Washington

Analyte	MTCA Method B Std. Cleanup	LCMW01D	LCMW01S	LCMW02D	LCMW02S	LCMW03D	LCMW03S	LCMW03S Duplicate	RPD (<20%)	LCMW04D	LCMW04S	LCMW09D	LCMW09S
		09/22/2020	09/22/2020	09/22/2020	09/22/2020	09/22/2020	09/22/2020	09/22/2020		09/22/2020	09/22/2020	09/22/2020	09/22/2020
<b>Explosives (µg/L)</b>													
HMX	800	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	Acceptable	< 0.1	< 0.1	< 0.1	< 0.1
RDX	1.10	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	Acceptable	< 0.1	< 0.1	< 0.1	< 0.1
Remaining Explosives	Varies	ND	ND	ND	ND	ND	ND	ND	Acceptable	ND	ND	ND	ND
<b>Perchlorate (µg/L)</b>													
Perchlorate	11.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	Acceptable	< 0.5	< 0.5	< 0.5	< 0.5
<b>Volatile Organic Compounds (µg/L)</b>													
1,1,1-Trichloroethane	16,000	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	Acceptable	< 0.5	< 0.5	< 0.5	< 0.5
1,1,2,2-Tetrachloroethane	0.220	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	Acceptable	< 0.5	< 0.5	< 0.5	< 0.5
1,1-Dichloroethane	1,600	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	Acceptable	< 0.5	< 0.5	< 0.5	< 0.5
1,1-Dichloroethene	400	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	Acceptable	< 0.5	< 0.5	< 0.5	< 0.5
Carbon Disulfide	800.000	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	Acceptable	< 0.5	< 0.5	< 0.5	< 0.5
Dichlorodifluoromethane	1,600	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	Acceptable	< 0.5	< 0.5	< 0.5	< 0.5
Remaining VOCs	Varies	ND	ND	ND	ND	ND	ND	ND	Acceptable	ND	ND	ND	ND

Notes:

- µg/L = micrograms per liter
- < = not detected above the indicated method reporting limit
- BOLD** = exceeds cleanup values
- Acceptable = No detection in original or duplicate, or the difference in detection values is less than the reporting limit
- ND = not detected
- RPD = relative percent difference

**Table 3. Constituents Detected in Groundwater, 3rd Quarter 2020**

Camp Bonneville, Vancouver, Washington

Analyte	MTCA Method B Std. Cleanup	L4MW01A	L4MW01B	L4MW02A	L4MW02B	L4MW03A	L4MW03B	L4MW04A	L4MW05A	L4MW07B	L4MW08A	L4MW08B	L4MW09A
		09/23/2020	09/23/2020	09/24/2020	09/24/2020	09/23/2020	09/23/2020	09/24/2020	09/24/2020	09/23/2020	09/24/2020	09/24/2020	09/24/2020
<b>Explosives (µg/L)</b>													
HMX	800	< 0.1	< 0.1	3.20	6.72	0.349	< 0.1	< 0.1	0.129	< 0.1	1.44	< 0.1	1.56
RDX	1.10	< 0.1	< 0.1	<b>7.09</b>	<b>29.4</b>	<b>4.91</b>	<b>4.48</b>	<b>6.08</b>	<b>3.27</b>	< 0.1	<b>26.2</b>	0.186	<b>6.86</b>
Remaining Explosives	Varies	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
<b>Perchlorate (µg/L)</b>													
Perchlorate	11.0	1.80	< 0.5	<b>181</b>	<b>372</b>	<b>29.3</b>	<b>18.8</b>	<b>61.4</b>	<b>24.0</b>	1.47	<b>78.6</b>	<b>119</b>	<b>496</b>
<b>Volatile Organic Compounds (µg/L)</b>													
1,1,1-Trichloroethane	16,000	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,1,2,2-Tetrachloroethane	0.220	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,1-Dichloroethane	1,600	< 0.5	< 0.5	< 0.5	1.30	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,1-Dichloroethene	400	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Carbon Disulfide	800.000	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.740	< 0.5	1.81
Dichlorodifluoromethane	1,600	< 0.5	< 0.5	< 0.5	1.46	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.610	< 0.5
Remaining VOCs	Varies	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

- µg/L = micrograms per liter
- < = not detected above the indicated method reporting limit
- BOLD** = exceeds cleanup values
- Acceptable = No detection in original or duplicate, or the difference in detection values is less than the reporting limit
- ND = not detected
- RPD = relative percent difference

**Table 3. Constituents Detected in Groundwater, 3rd Quarter 2020**

Camp Bonneville, Vancouver, Washington

Analyte	MTCA Method B Std. Cleanup	L4MW09B	L4MW10A	L4MW10B	L4MW10B Duplicate	L4MW11B	L4MW11B Duplicate	L4MW17	L4MW18		
		09/24/2020	09/25/2020	09/25/2020	09/25/2020	RPD (<20%)	09/25/2020	09/25/2020	RPD (<20%)	09/23/2020	09/23/2020
<b>Explosives (µg/L)</b>											
HMX	800	1.66	0.230	< 0.1	< 0.1	Acceptable	< 0.1	< 0.1	Acceptable	< 0.1	< 0.1
RDX	1.10	<b>21.2</b>	<b>1.64</b>	<b>13.6</b>	<b>12.6</b>	8%	<b>47.9</b>	<b>47.6</b>	1%	< 0.1	< 0.1
Remaining Explosives	Varies	ND	ND	ND	ND	Acceptable	ND	ND	Acceptable	ND	ND
<b>Perchlorate (µg/L)</b>											
Perchlorate	11.0	<b>238</b>	<b>59.8</b>	<b>222</b>	<b>220</b>	1%	<b>580</b>	<b>588</b>	1%	< 0.5	< 0.5
<b>Volatile Organic Compounds (µg/L)</b>											
1,1,1-Trichloroethane	16,000	4.60	< 0.5	5.83	6.07	4%	3.78	3.64	4%	< 0.5	< 0.5
1,1,2,2-Tetrachloroethane	0.220	<b>1.32</b>	< 0.5	< 0.5	< 0.5	Acceptable	< 0.5	< 0.5	Acceptable	< 0.5	< 0.5
1,1-Dichloroethane	1,600	6.33	< 0.5	6.36	6.45	1%	5.26	4.86	8%	< 0.5	< 0.5
1,1-Dichloroethene	400	4.00	< 0.5	5.53	5.66	2%	2.98	2.90	3%	< 0.5	< 0.5
Carbon Disulfide	800.000	1.57	< 0.5	< 0.5	0.560	Acceptable	0.770	0.560	32%	< 0.5	< 0.5
Dichlorodifluoromethane	1,600	13.0	< 0.5	19.3	18.9	2%	10.3	11.2	8%	< 0.5	< 0.5
Remaining VOCs	Varies	ND	ND	ND	ND	Acceptable	ND	ND	Acceptable	ND	ND

Notes:

µg/L = micrograms per liter  
 < = not detected above the indicated method reporting limit

**BOLD** = exceeds cleanup values  
 Acceptable = No detection in original or duplicate, or the difference in detection values is less than the reporting limit

ND = not detected  
 RPD = relative percent difference

## Table 4. Constituents Analyzed in Surface Water, 3rd Quarter 2020

Camp Bonneville, Vancouver, Washington

Analyte	MTCA Method B Std. Cleanup Values	LC03	LC15	LC15 Duplicate		NF02
		09/21/2020	09/21/2020	09/21/2020	RPD (<20%)	09/21/2020
<b>Perchlorate (µg/L)</b>						
Perchlorate	11.0	< 0.5	< 0.5	< 0.5	Acceptable	< 0.5
<b>Explosives (µg/L)</b>						
RDX	1.10	< 0.1	< 0.1	< 0.1	Acceptable	< 0.1

**Notes:**

The most stringent MTCA Method B Standard value is used

µg/L = micrograms per liter

**BOLD** = exceeds cleanup values

RPD = relative percent different

< = not detected above the indicated MRL

Acceptable = No detection in original or duplicate

# **Appendix A**

## **List of Acronyms and Abbreviations**

## List of Acronyms and Abbreviations

amsl	above mean sea level
AP	ammonium perchlorate
bgs	below ground surface
CD	compact disc
BRAC	Base Realignment and Closure
CHPPM	US Army Center for Health Promotion and Preventative Medicine
COC	chain of custody
COPC	chemical of potential concern
DNR	State of Washington Department of Natural Resources
DO	dissolved oxygen
DQO	data quality objectives
EDD	electronic data deliverable
EPA	US Environmental Protection Agency
GC/MS	gas chromatography/mass spectrometer
HASP	health and safety plan
HE	high explosives 2,4 DNT, 2,6 DNT
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
IC	ion chromatography
IDW	investigation-derived waste
LCS	laboratory control spike
µg/L	micrograms per liter (approximately equal ppb)
µm	micrometer
MDL	method detection limit
mg/L	milligrams per liter (approximately equal ppm)
mL	milliliters
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
MTCA	Washington Model Toxics Control Act (Chapter 173-340 WAC)
NG	nitroglycerine
OE	ordinance and explosives
ORP	oxidation reduction potential
PA	picric acid
PAH	polycyclic aromatic hydrocarbons
PBS	PBS Engineering and Environmental Inc.
PCBs	polychlorinated biphenyls
PES	polyethersulfone
PETN	pentaerythritol tetranitrate
ppb	parts per billion
ppm	parts per million

PQL	practical quantitation limit
PVC	polyvinyl chloride
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine (Cyclonite)
RI	remedial investigation
RPD	relative percent difference
SAP	sampling and analysis plan
SDG	sample delivery groups
SDS	sample data sheets
SI	site investigation
SOP	standard operating procedure
SOW	statement of work
SVOC	semi-volatile organic compound
TBD	to be determined
TIC	tentatively identified compound
TNT	2,4,6-trinitrotoluene
TOC	total organic carbon
TPH	total petroleum hydrocarbons
USACE	United States Army Corps of Engineers
UXO	unexploded ordnance
VOC	volatile organic compound

# **Appendix B**

## **Drum Disposal Receipts**





Record # 9-15-2020-01

156531

Generator Name: CAMP BONNEVILLE  
 Customer Name: CAMP BONNEVILLE  
 Generator Address: 23201 NE PLUSS RD  
 City/State/Zip: VANCOUVER, WA  
 Contact: MICHELLE CISON Phone: \_\_\_\_\_

Profile	Description	Quantity	Unit
9-15-2020-01	OILY WATER 'B' WASTE	165	GAL

54 miles  
1331  
34mmS

TRANSPORTER

Name: NRC / US ECOLOGY  
 Address: 6211 N. EUSIGN ST  
 City/State/Zip: PORTLAND, OR

I CERTIFY THAT THE INFORMATION SUPPLIED ON THIS MATERIAL IS TRUE, THAT IT ACCURATELY DESCRIBES THE WASTE AND THE SOURCE OF THE WASTE PRESENTED AT THE TIME OF THIS SUBMISSION, AND THAT THE WASTE ONLY CONSISTS OF NON-HAZARDOUS MATERIAL LISTED ABOVE TO THE BEST OF MY KNOWLEDGE

Driver Signature: *Maureen Canterbury* Date: 9/18/20  
 Print Name: Maureen Canterbury

PRE-SCREENING RESULTS

Manifest # 9-15-2020-01 Screening: Pass  Fail  pH: 7.6  
 Truck # FLAT Capacity: 55 gal Sample #: \_\_\_\_\_  
 Time Rec'd: 1100 Contents: % Water 99 % Solids 6 % Oil 1

RECEIVING FACILITY

8828 NE Killingsworth, Portland, OR 97220: ✓  
 10985 SW Clutter Road, Sherwood, OR 97140 \_\_\_\_\_

THIS IS TO CERTIFY THAT THE ABOVE-REFERENCED MATERIAL HAS BEEN ACCEPTED BY THE NRC FACILITY LISTED ABOVE. NRC ACKNOWLEDGES RECEIPT OF ALL REFERENCED MATERIAL AND CERTIFIES THAT ALL MATERIAL HAS OR WILL BE RECYCLED OR DISPOSED OF IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE OR LOCAL LAWS AND REGULATIONS.

Signature: *Donovan S. McClutchedu* Date: 9/18/20  
 Print Name: DONOVAN S. MCCLUTCHEDU

9-15-2020-01

NON-HAZARDOUS WASTE MANIFEST

1. Generator ID Number

CESQ11

2. Page 1 of 1

3. Emergency Response Phone

800-899-4672

4. Waste Tracking Number

9-15-2020-01

5. Generator's Name and Mailing Address

Camp Bonneville  
Clark PUD  
23201 NE PLUSS RD  
Vancouver, WA

Generator's Site Address (if different than mailing address)

Camp Bonneville

Generator's Phone:

6. Transporter 1 Company Name

US Ecology / NRC

U.S. EPA ID Number

CAR 000030114

7. Transporter 2 Company Name

U.S. EPA ID Number

8. Designated Facility Name and Site Address

Killingsworth - US Ecology Treatment facility  
NE Killingsworth St  
Portland, OR 97217

U.S. EPA ID Number

CAR 000030114

Facility's Phone:

9. Waste Shipping Name and Description

1. Material Not Regulated by DOT  
"B" waste

10. Containers

No.

Type

11. Total Quantity

12. Unit Wt./Vol.

03

DM

165 gal

9 gal

13. Special Handling Instructions and Additional Information

Truck # 1331 Job# 156531

14. GENERATOR'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Generator's/Offor's Printed/Typed Name

Greg Johnson

Signature

[Signature]

Month Day Year

9 15 20

15. International Shipments

Import to U.S.

Export from U.S.

Port of entry/exit:

Date leaving U.S.:

16. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name

Mauraen Canterbury

Signature

[Signature]

Month Day Year

09 15 20

Transporter 2 Printed/Typed Name

Signature

Month Day Year

17. Discrepancy

17a. Discrepancy Indication Space

Quantity

Type

Residue

Partial Rejection

Full Rejection

Manifest Reference Number:

17b. Alternate Facility (or Generator)

U.S. EPA ID Number

Facility's Phone:

17c. Signature of Alternate Facility (or Generator)

Month Day Year

18. Designated Facility Owner or Operator: Certification of receipt of materials covered by the manifest except as noted in Item 17a

Printed/Typed Name

DANON S. MCCORMACK

Signature

[Signature]

Month Day Year

9 15 20

GENERATOR

INT'L

TRANSPORTER

DESIGNATED FACILITY

# **Appendix C**

## **TestAmerica, Level II Data Package**

(Electronic files provided on enclosed CD)

# **Appendix D**

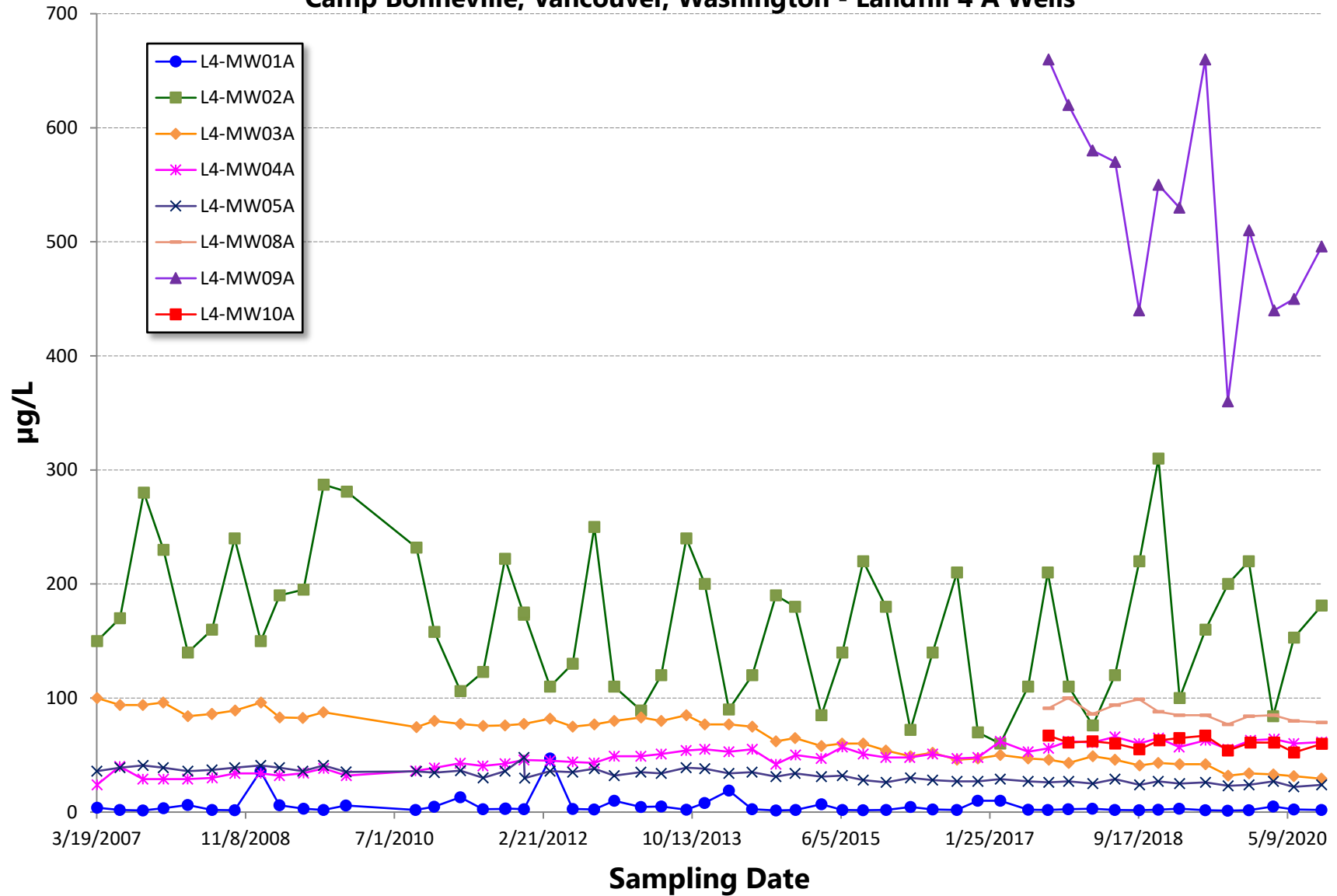
## **TestAmerica, Level III Data Package**

(Electronic files provided on enclosed CD)

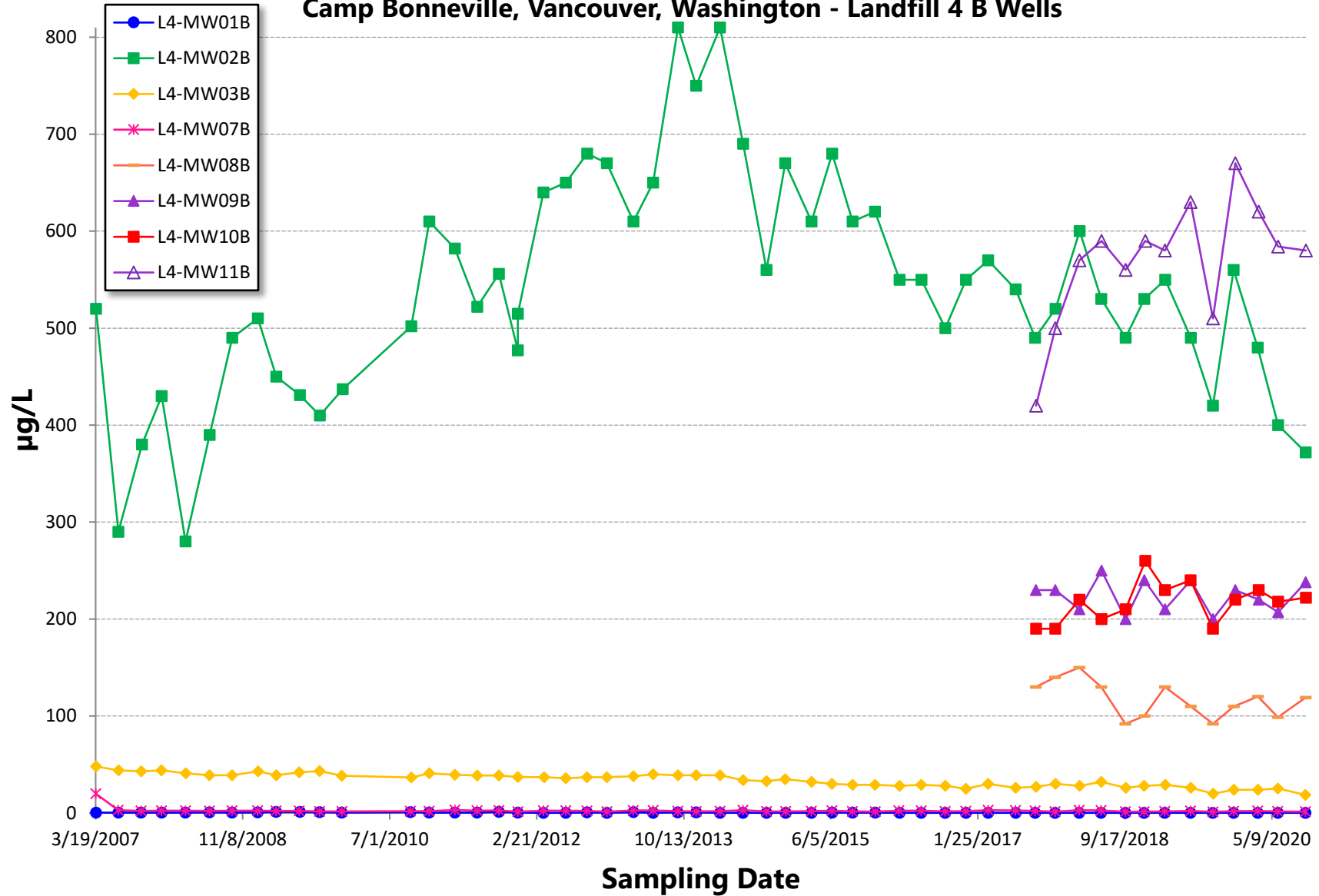
# **Appendix E**

## **Trend Graphs**

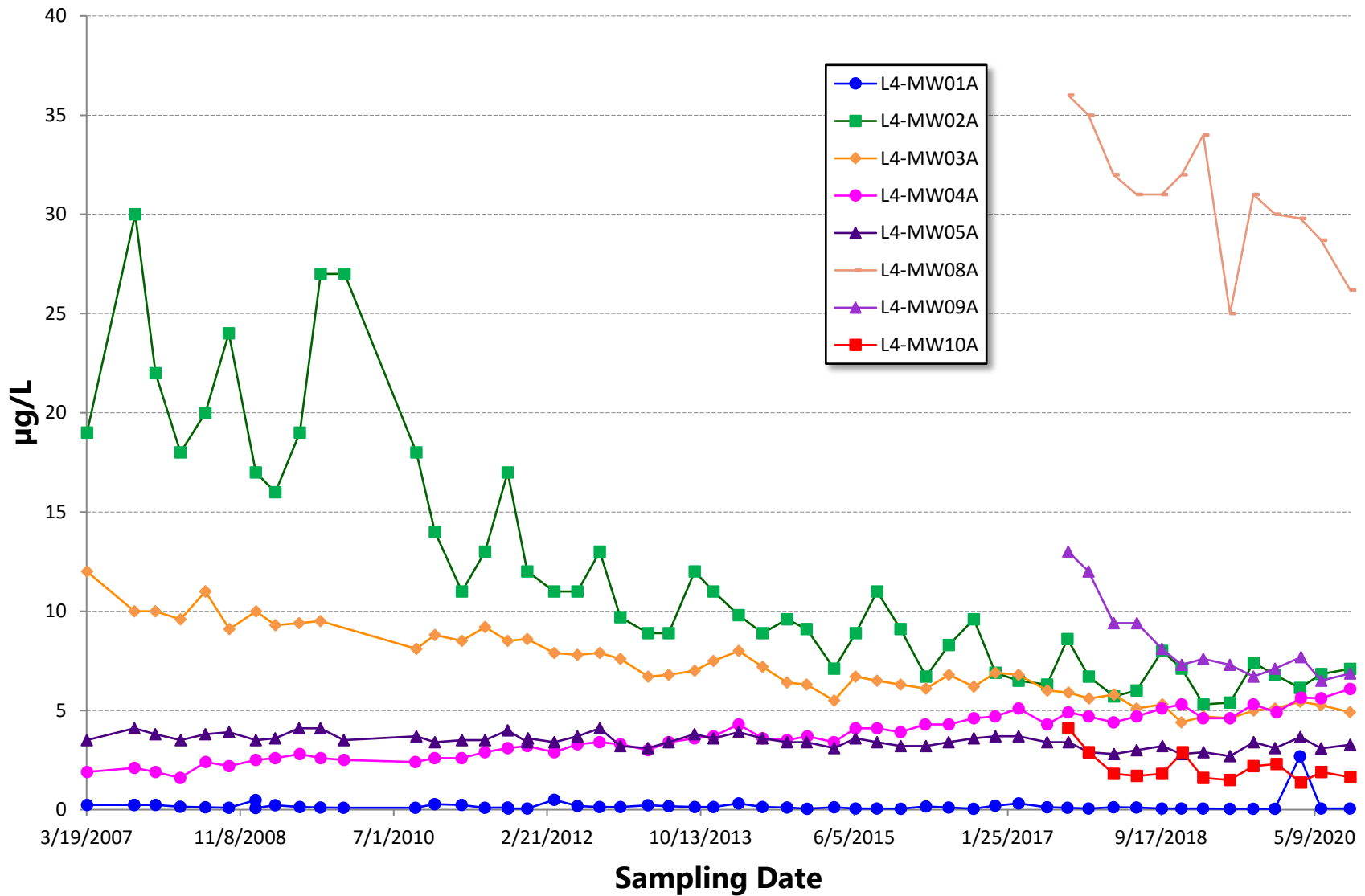
## Historical Perchlorate Concentrations in Groundwater Camp Bonneville, Vancouver, Washington - Landfill 4 A Wells



## Historical Perchlorate Concentrations in Groundwater Camp Bonneville, Vancouver, Washington - Landfill 4 B Wells

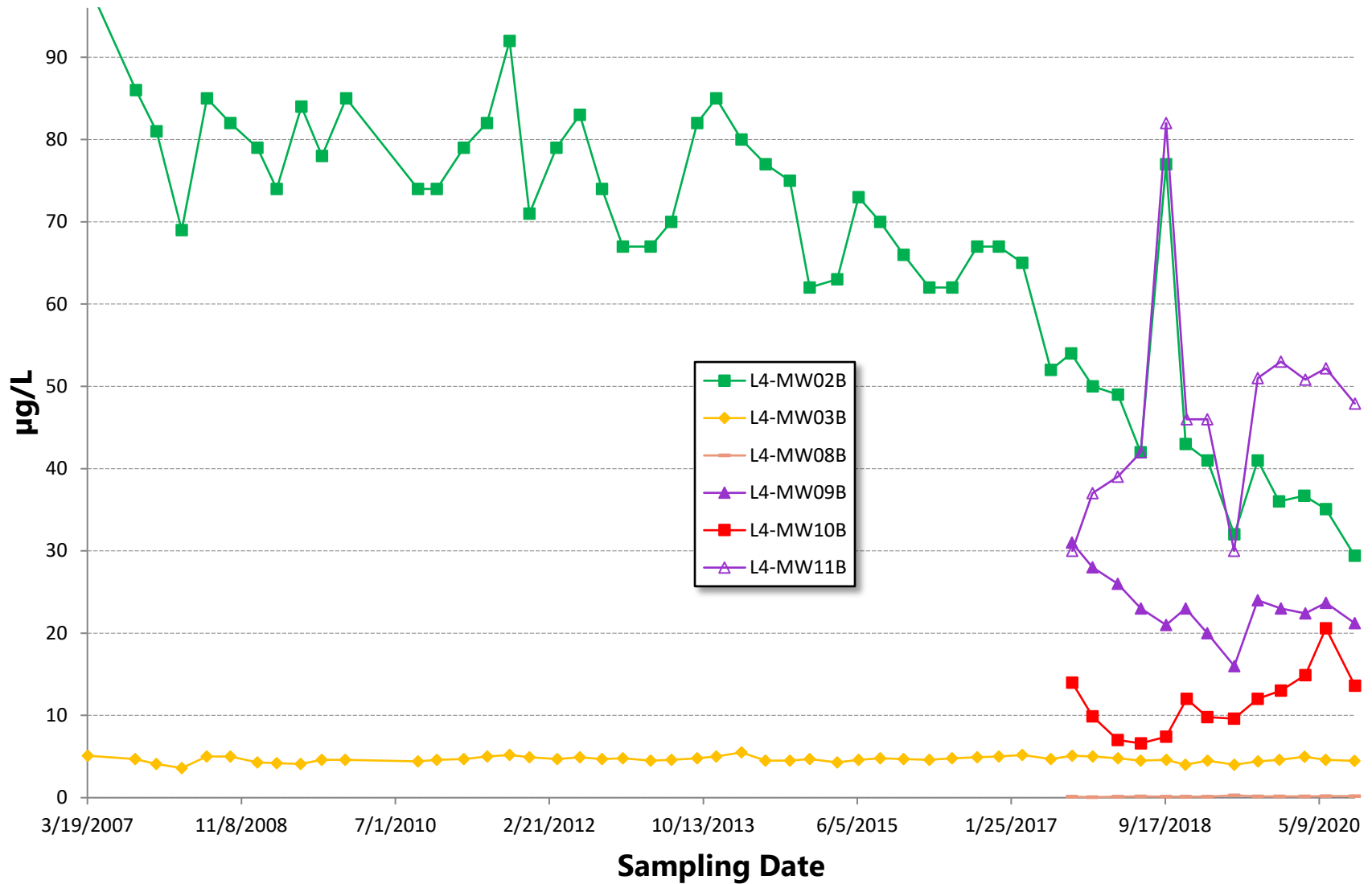


## Historical RDX Concentrations in Groundwater Camp Bonneville, Vancouver, Washington - Landfill 4 A Wells

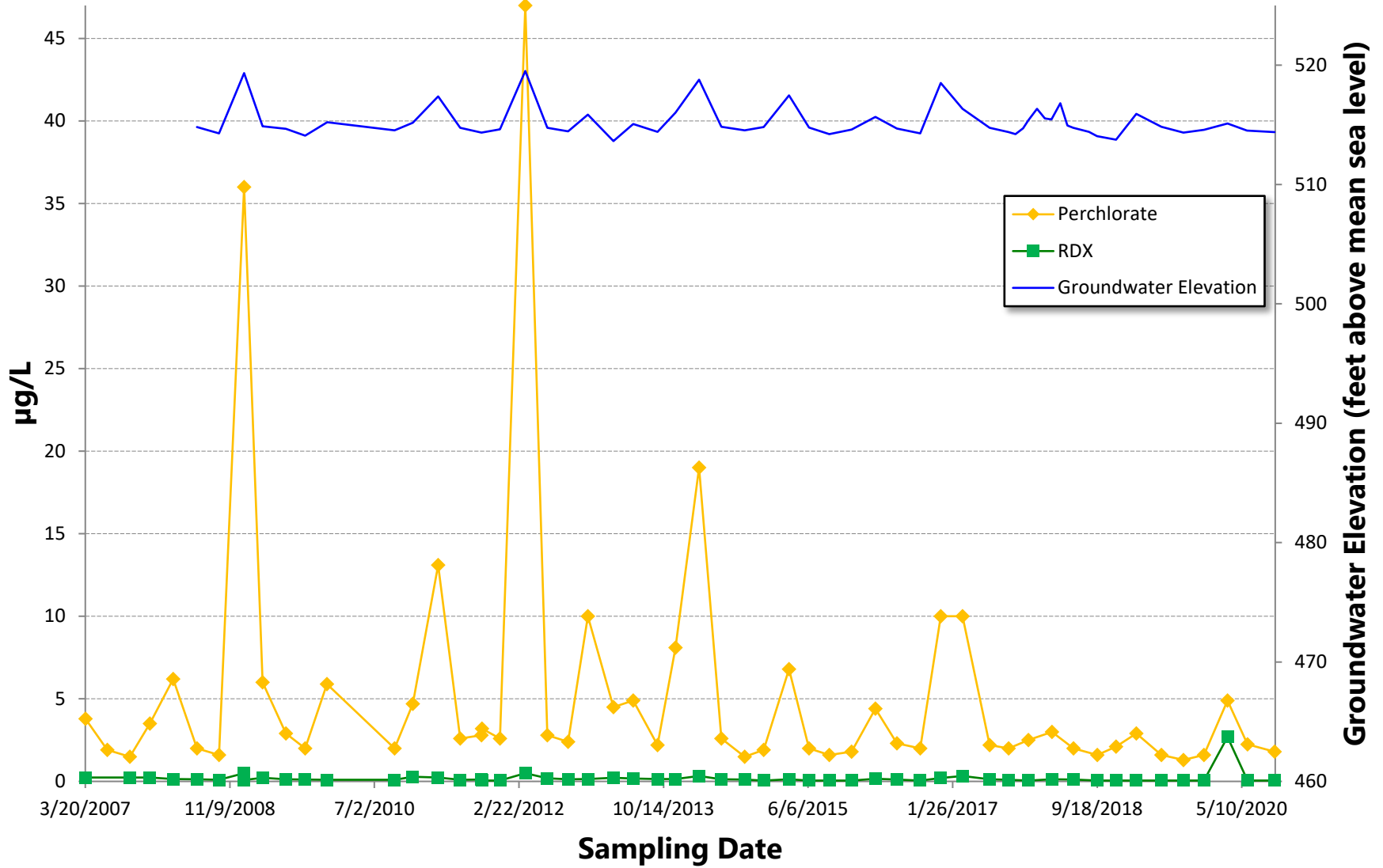




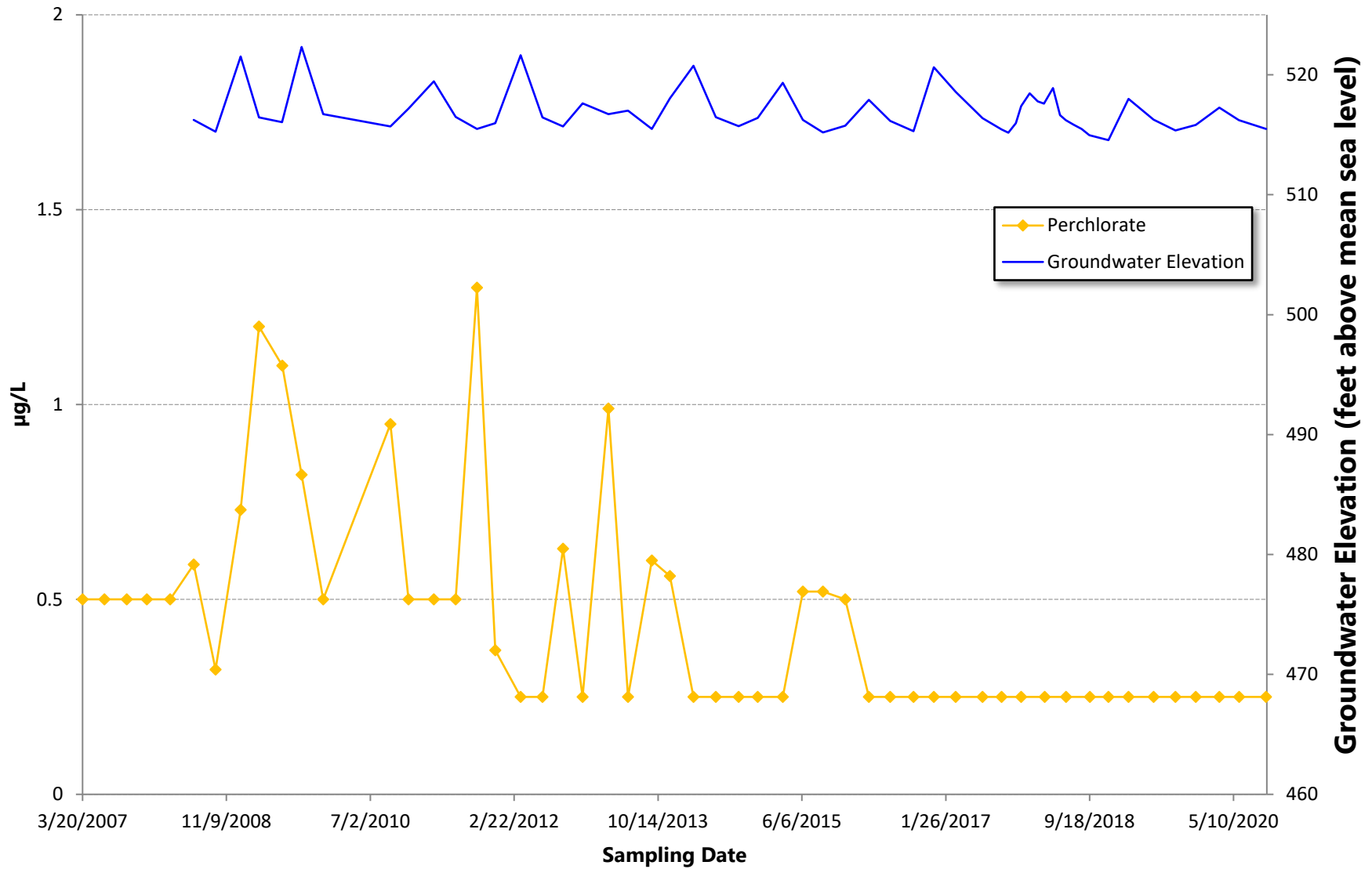
# Historical RDX Concentrations in Groundwater Camp Bonneville, Vancouver, Washington - Landfill 4 B Wells



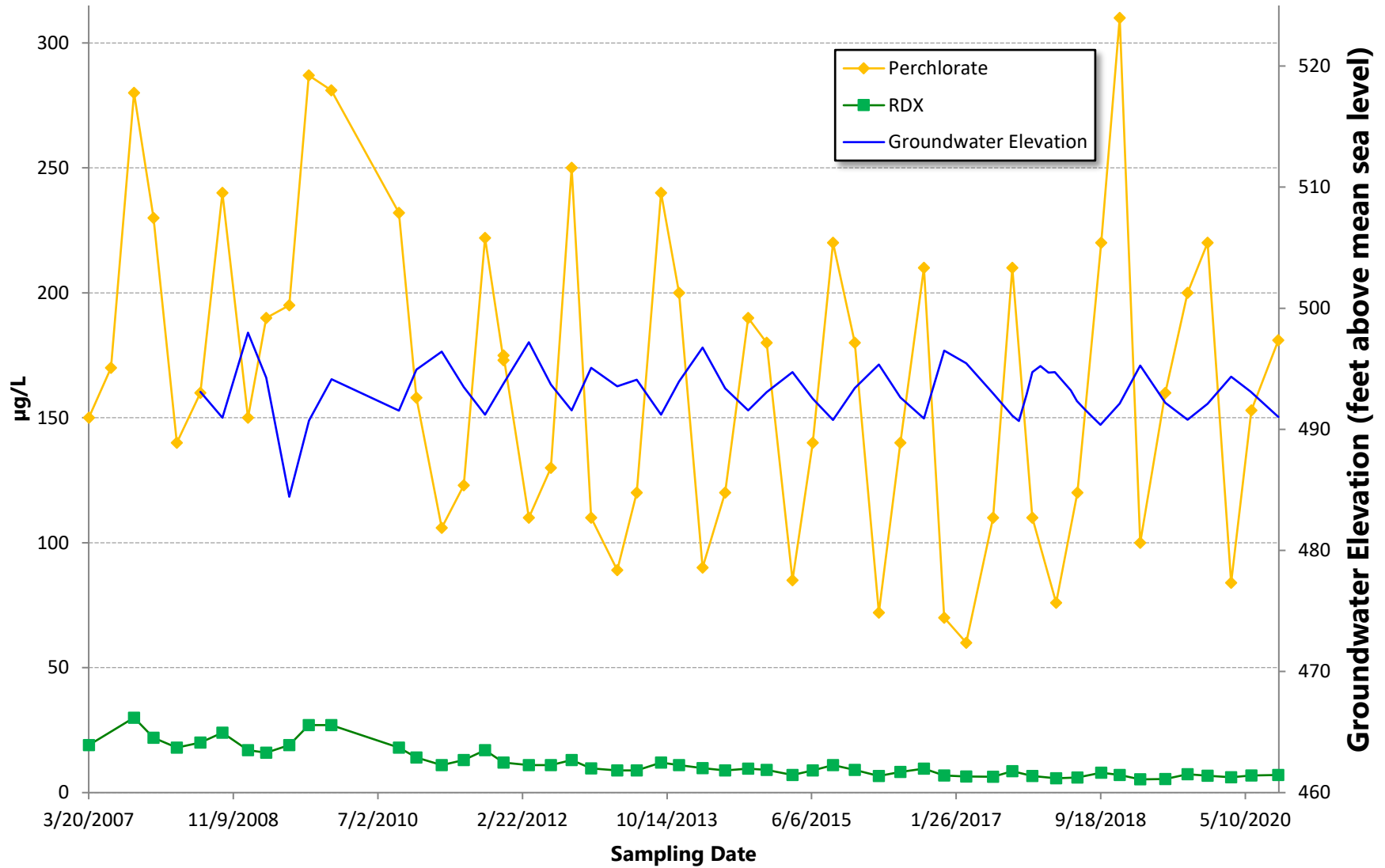
## Historical Groundwater Concentrations Camp Bonneville, Vancouver, Washington - Well L4-MW01A



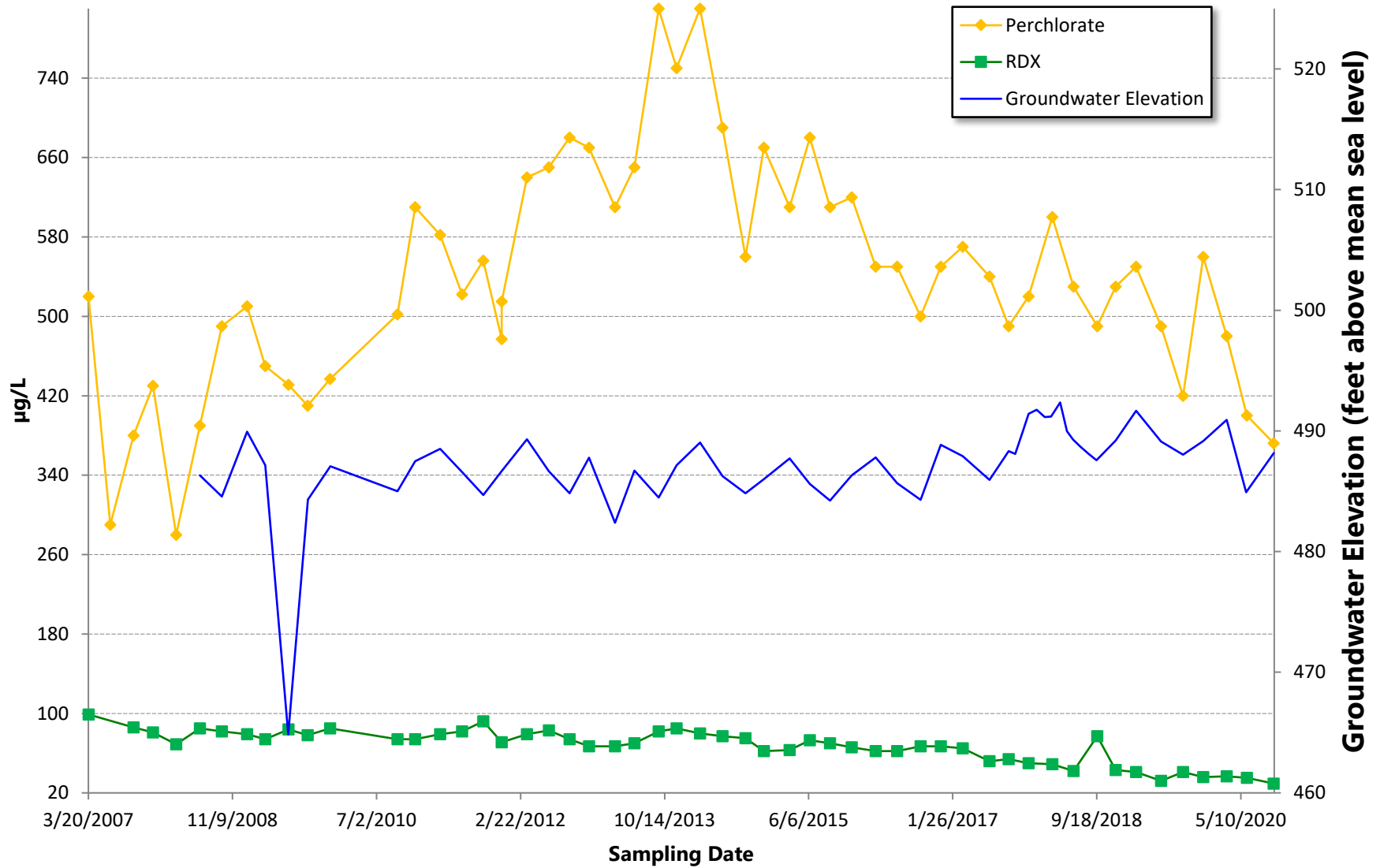
# Historical Groundwater Concentrations Camp Bonneville, Vancouver, Washington - Well L4-MW01B



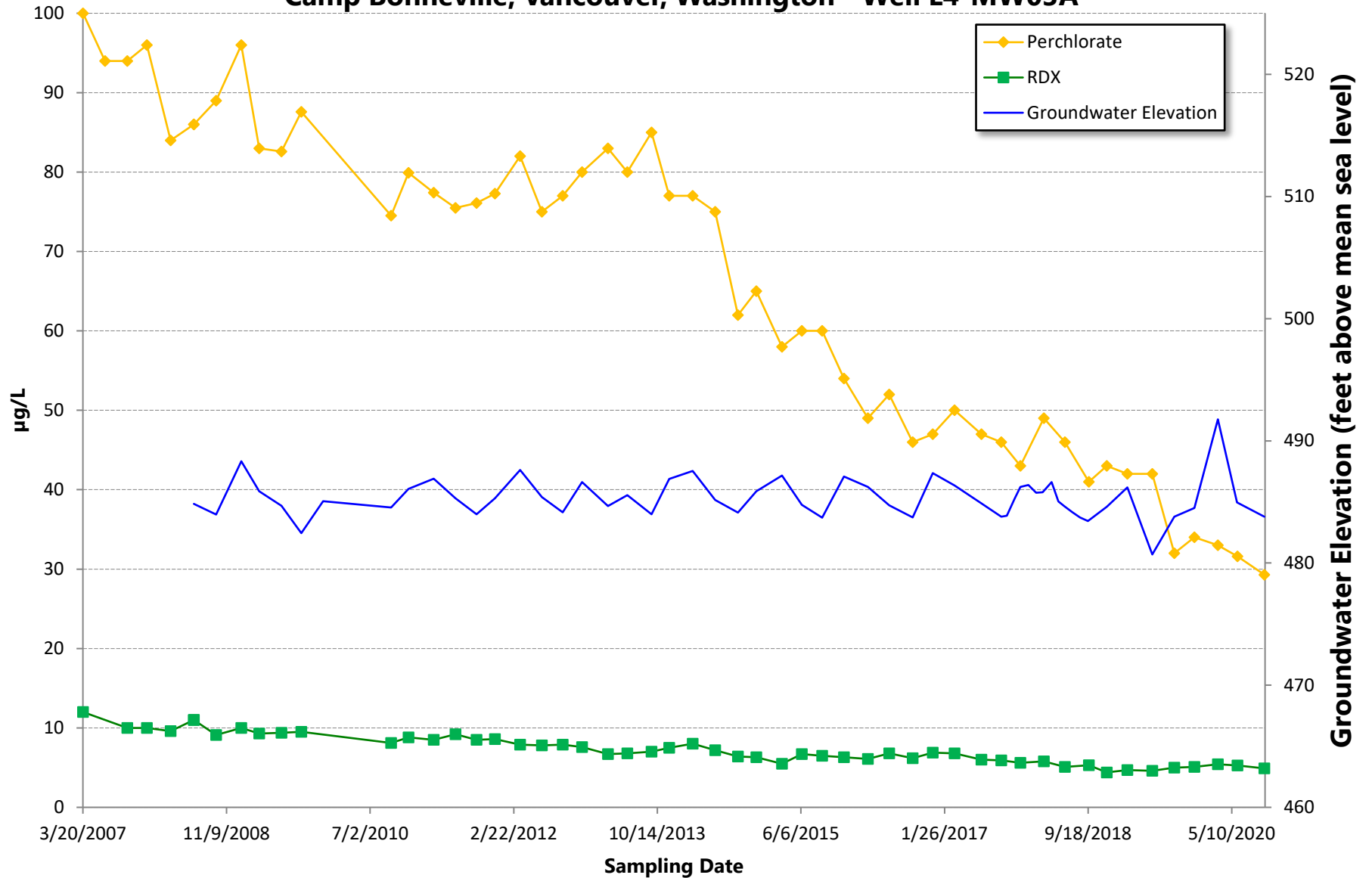
# Historical Groundwater Concentrations Camp Bonneville, Vancouver, Washington - Well L4-MW02A



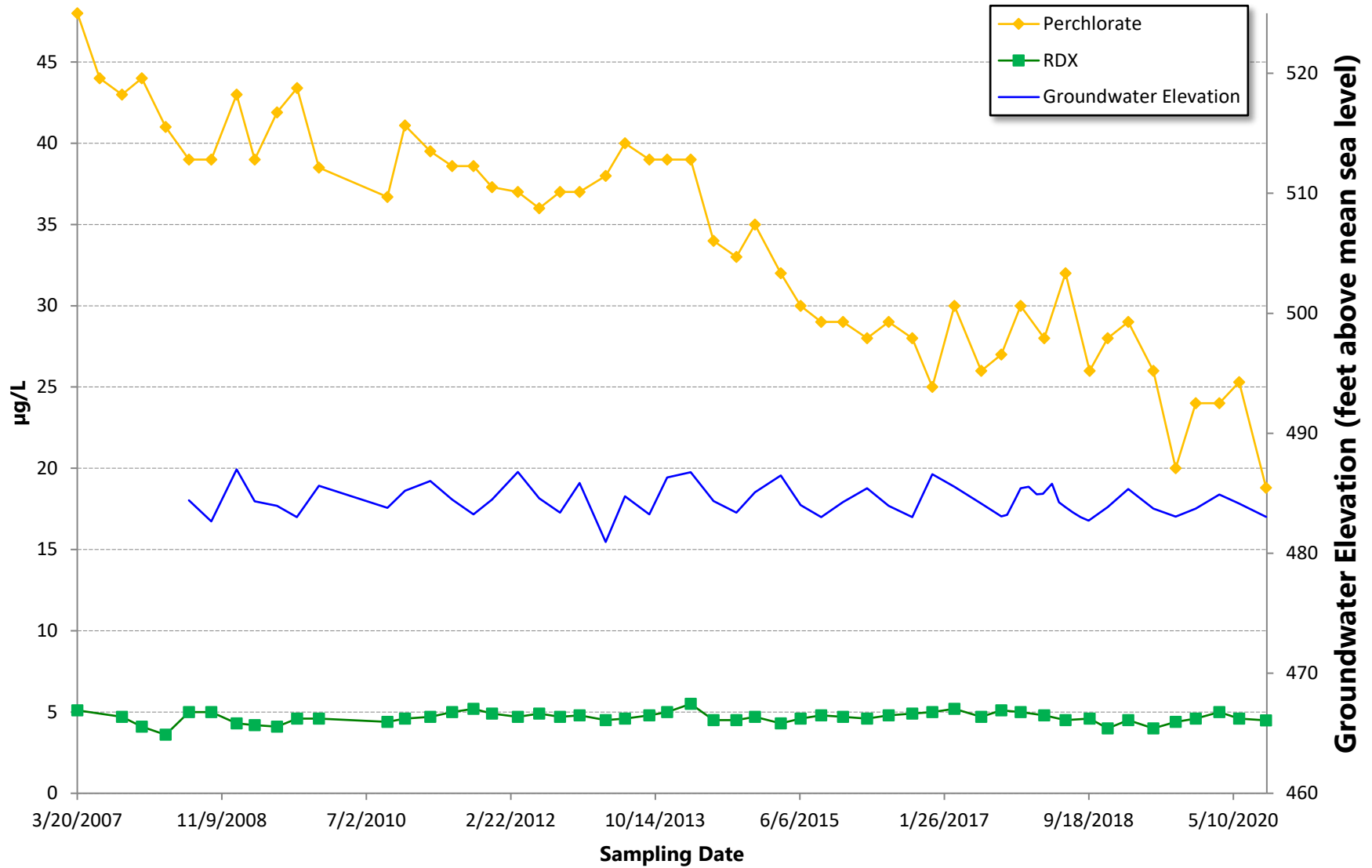
## Historical Groundwater Concentrations Camp Bonneville, Vancouver, Washington - Well L4-MW02B



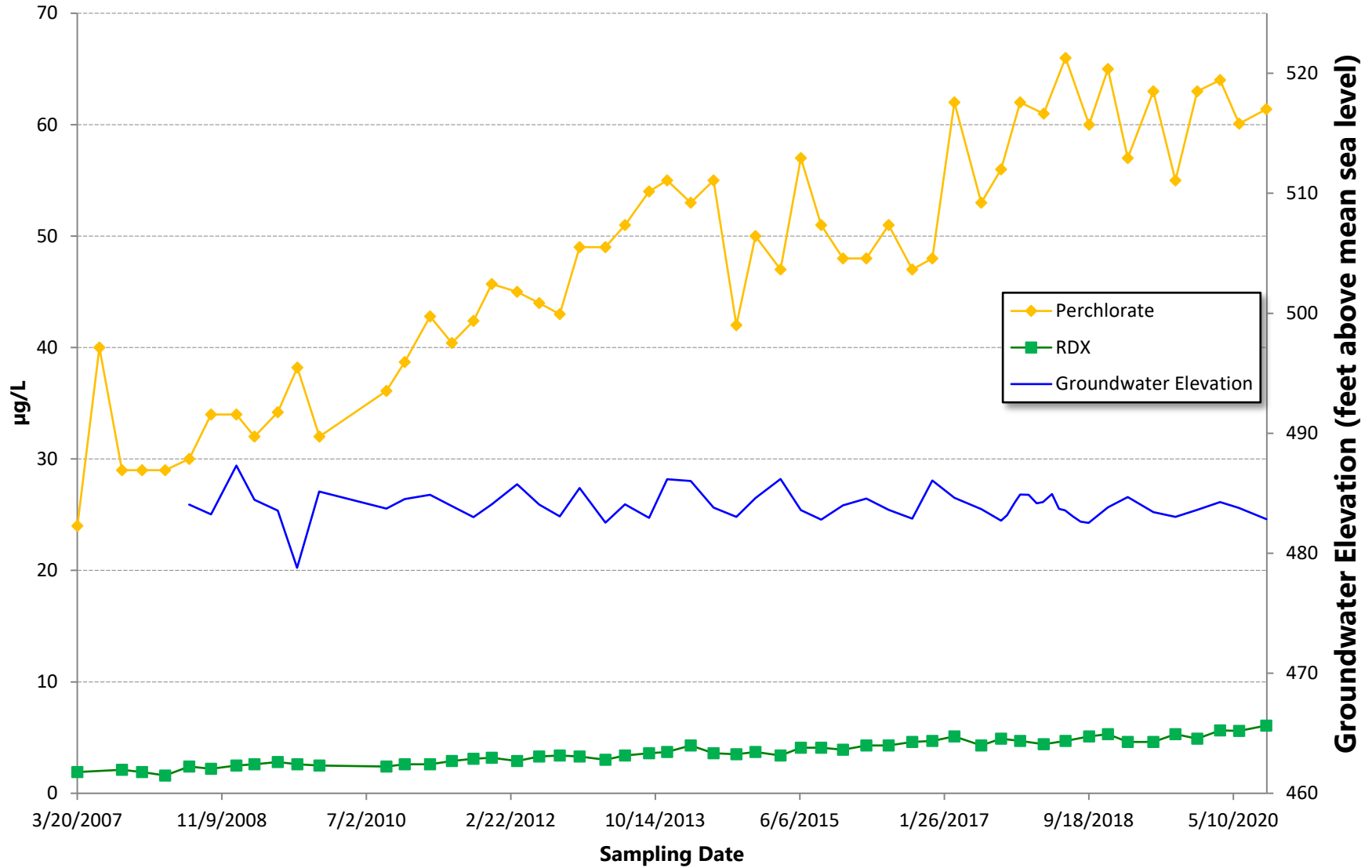
## Historical Groundwater Concentrations Camp Bonneville, Vancouver, Washington - Well L4-MW03A



## Historical Groundwater Concentrations Camp Bonneville, Vancouver, Washington - Well L4-MW03B

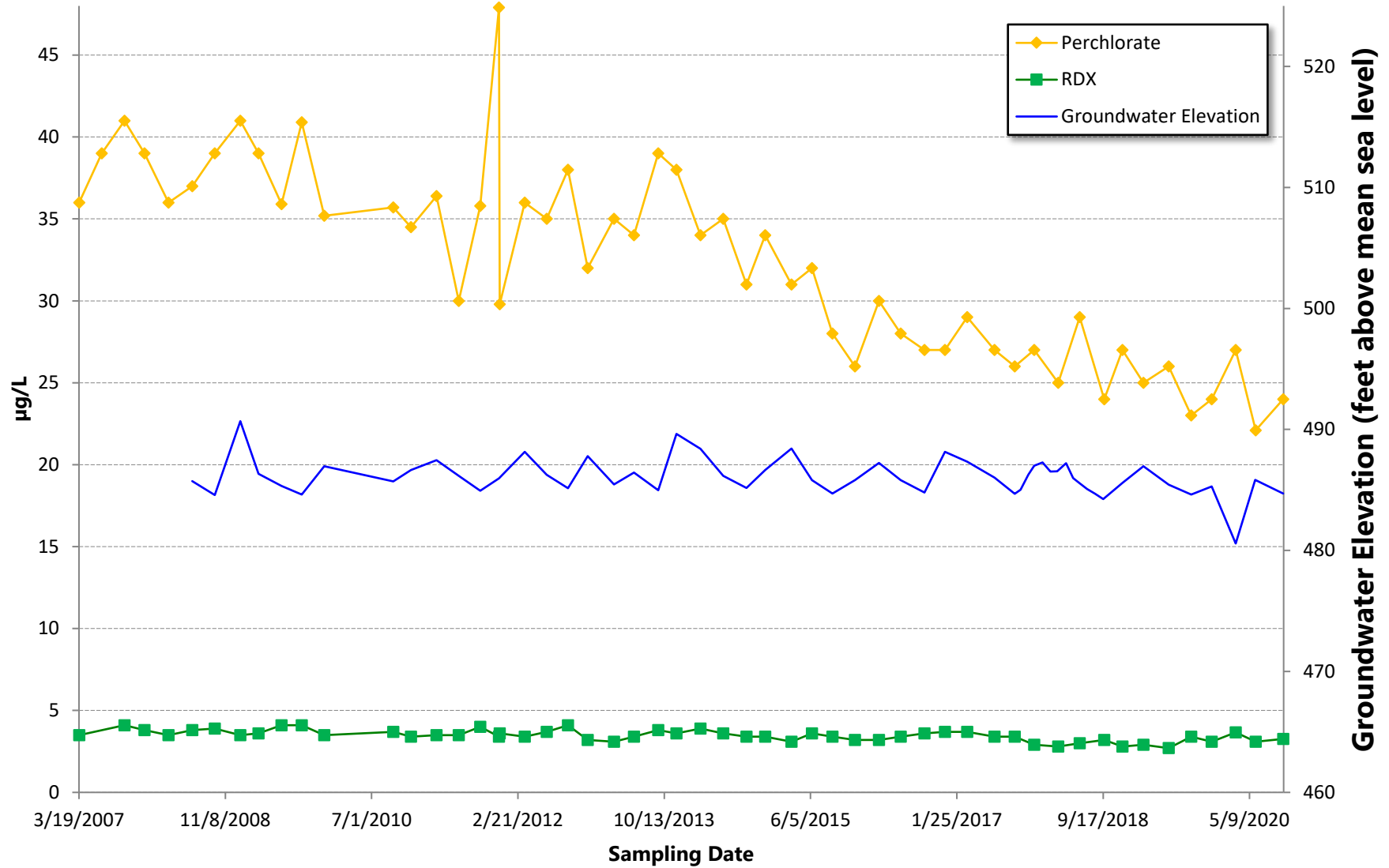


# Historical Groundwater Concentrations Camp Bonneville, Vancouver, Washington - Well L4-MW04A

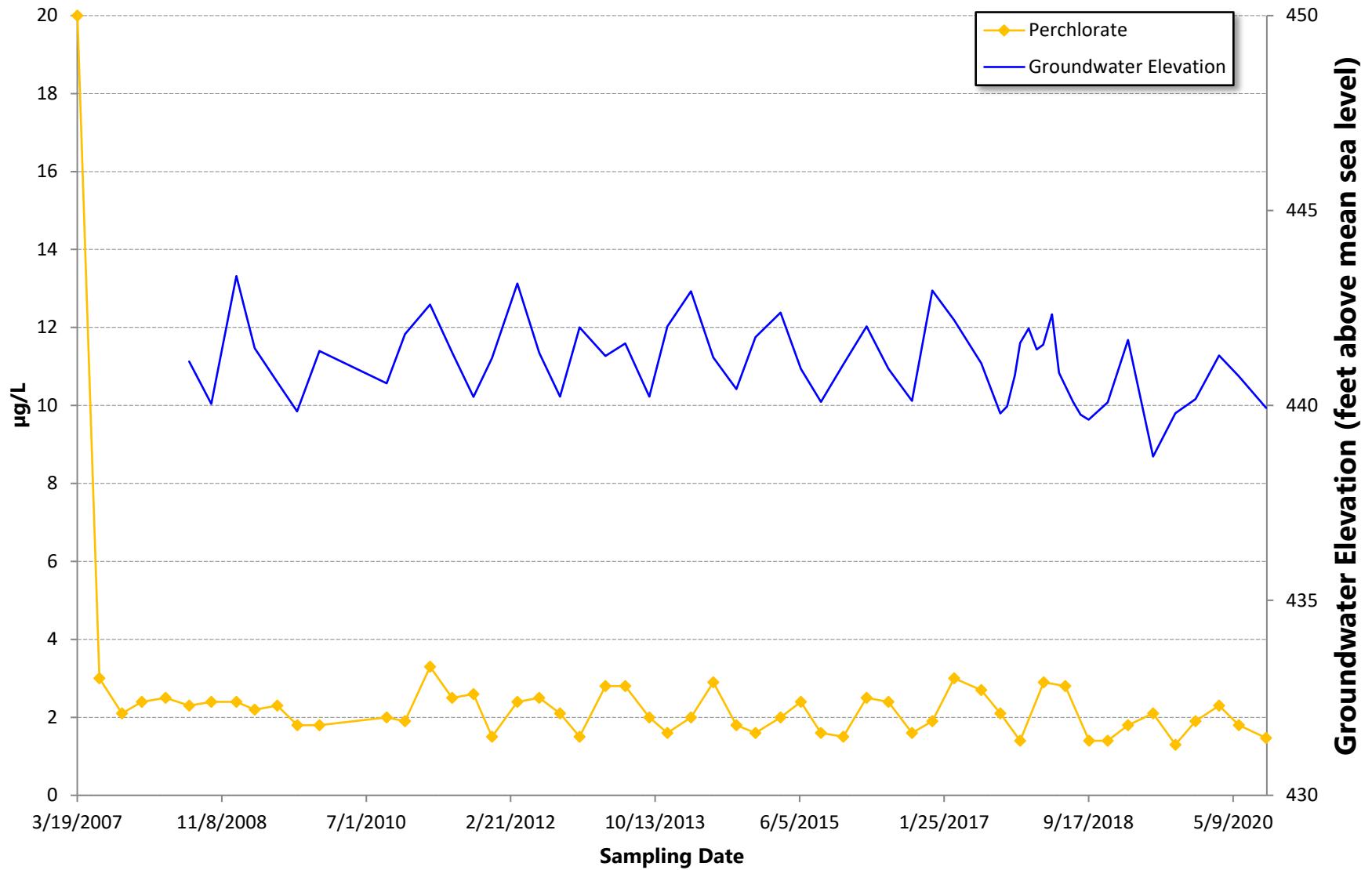




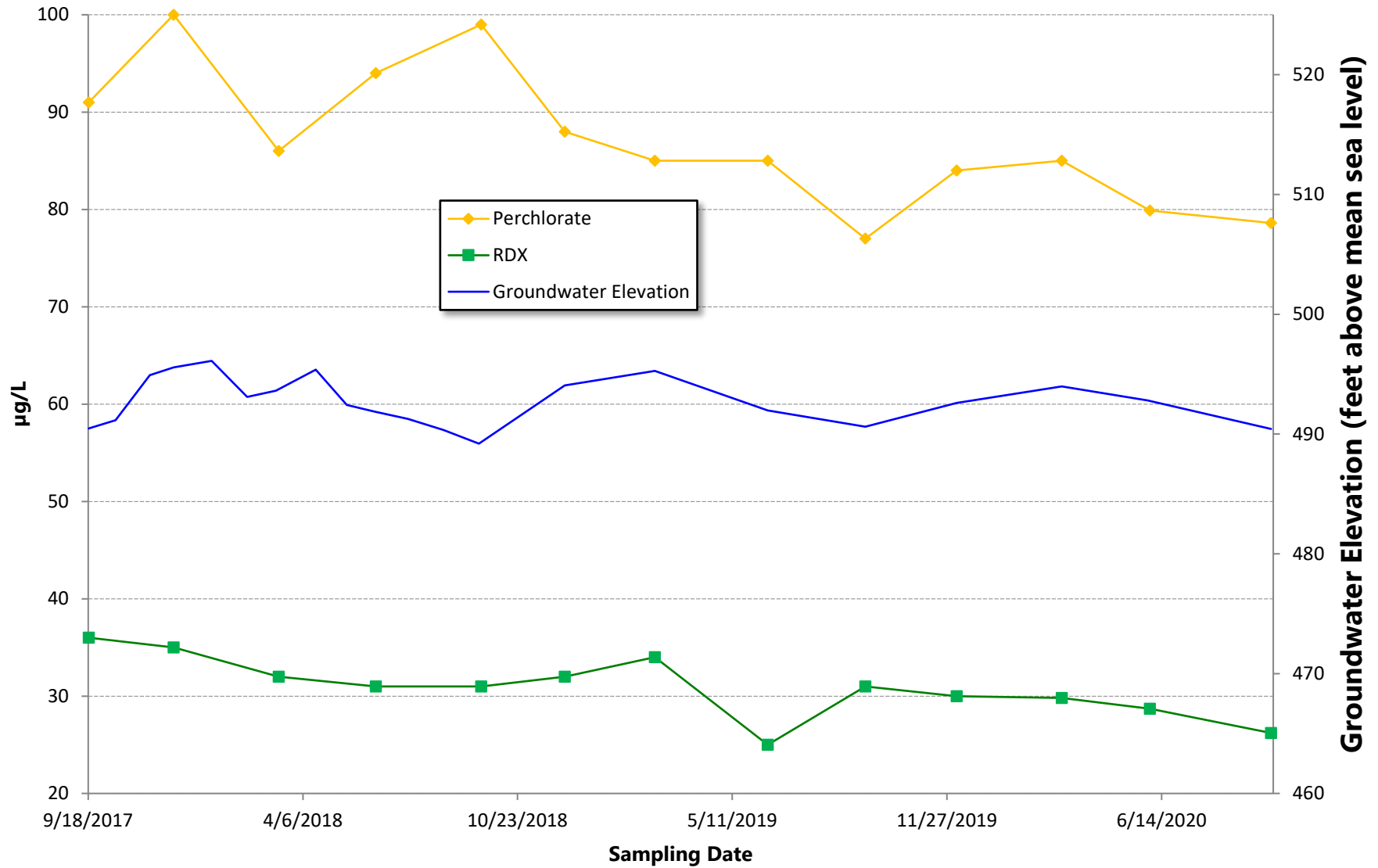
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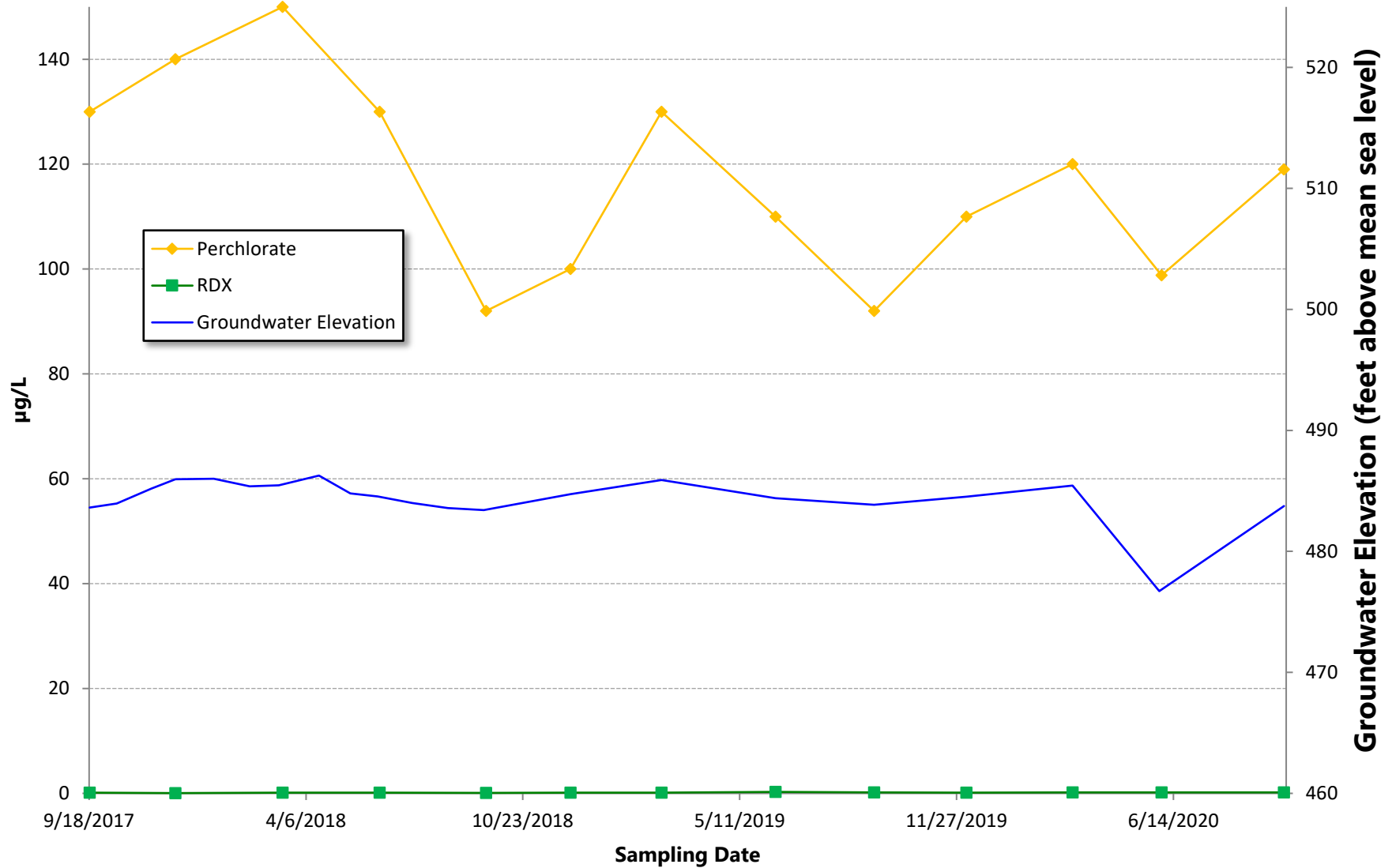
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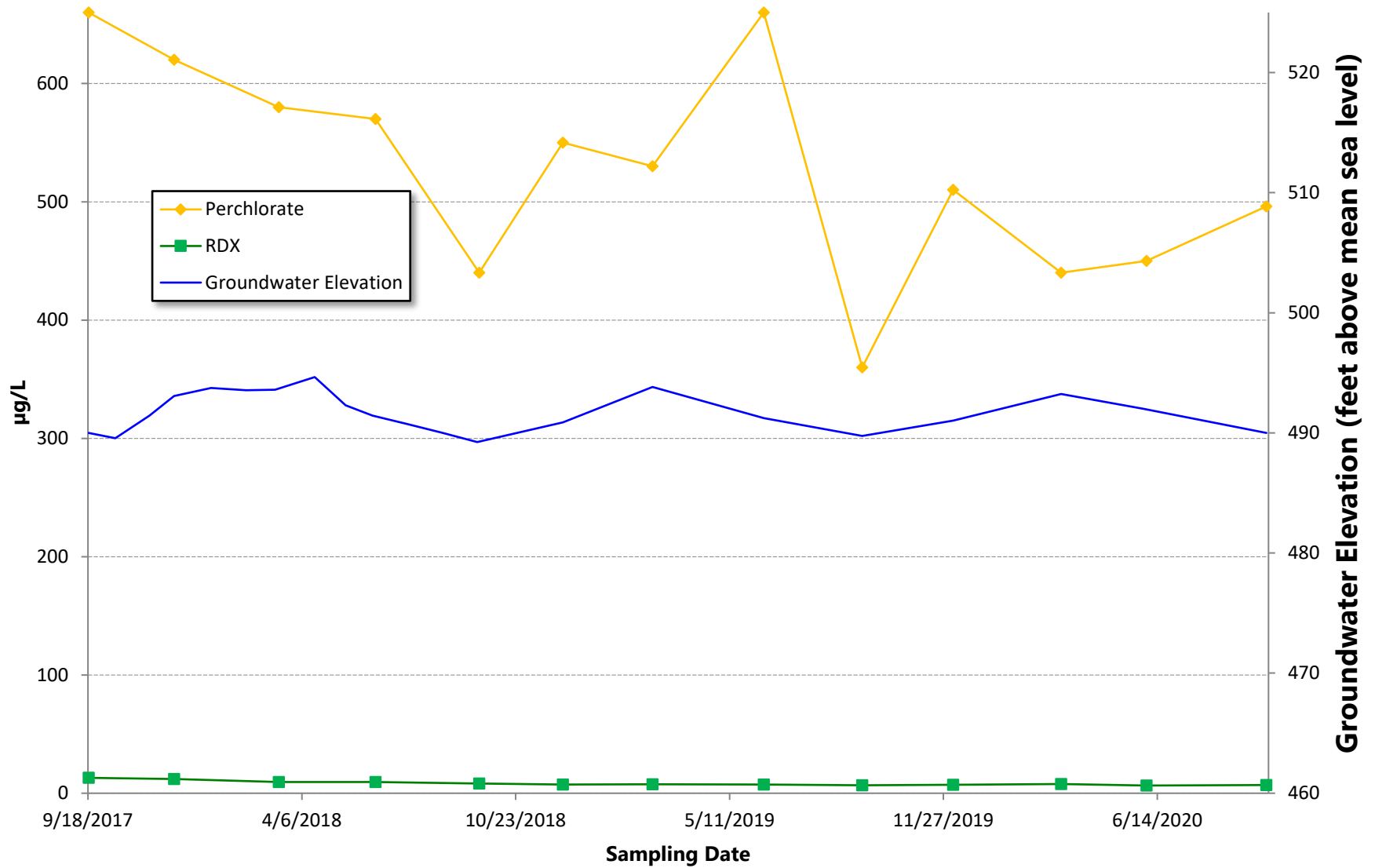
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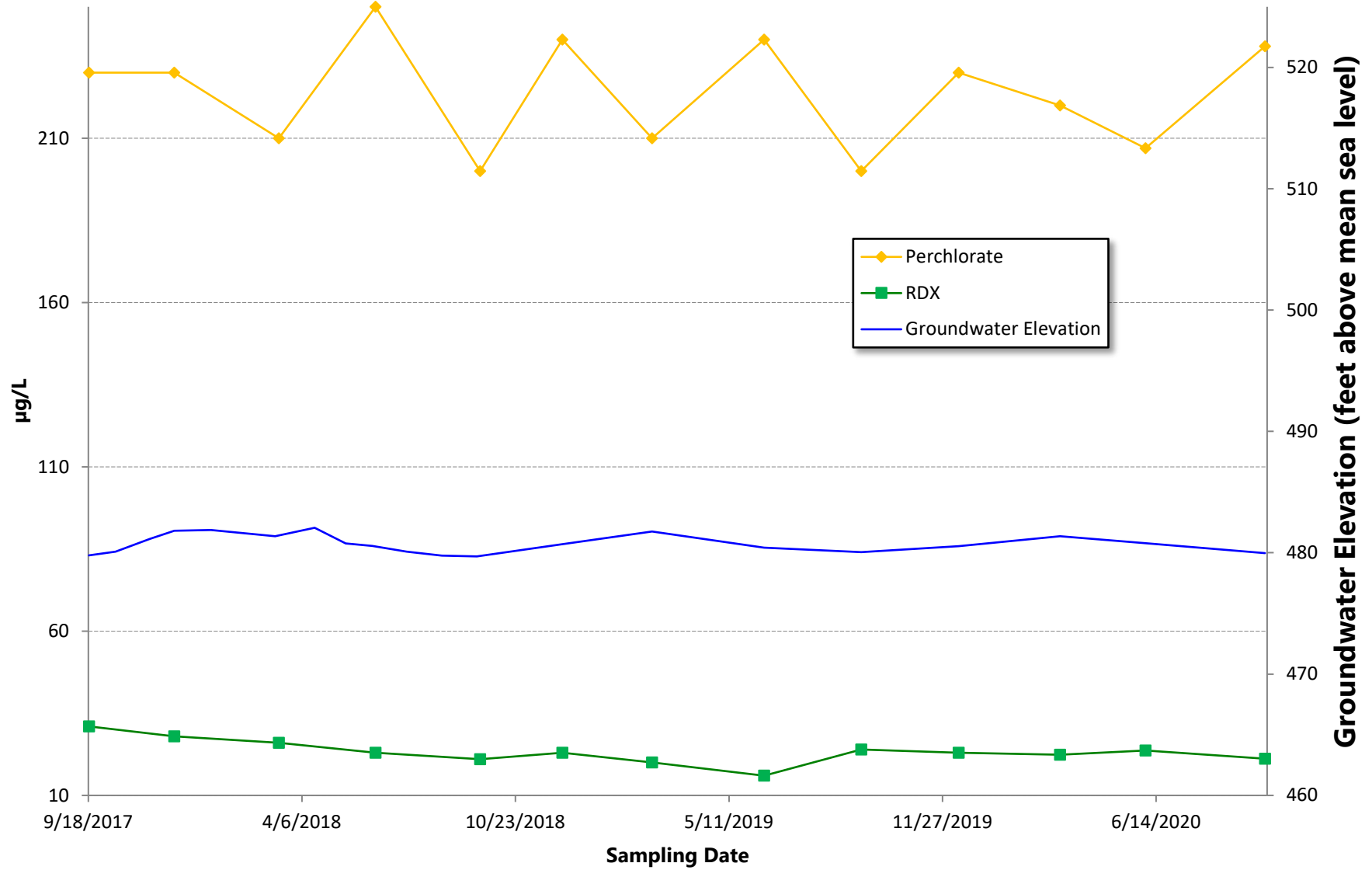
## Historical Groundwater Concentrations Camp Bonneville, Vancouver, Washington - Well L4-MW08B



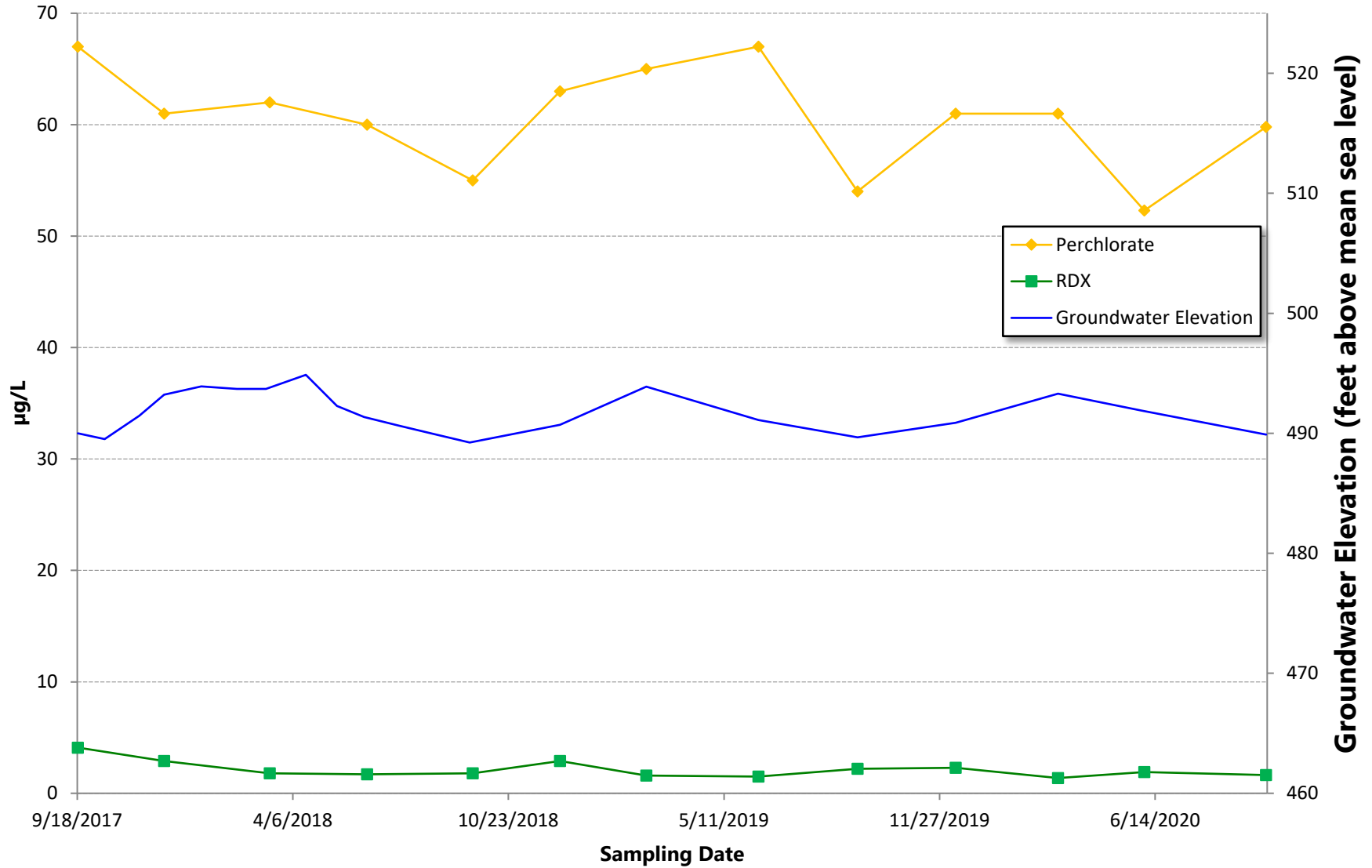
# Historical Groundwater Concentrations Camp Bonneville, Vancouver, Washington - Well L4-MW09A



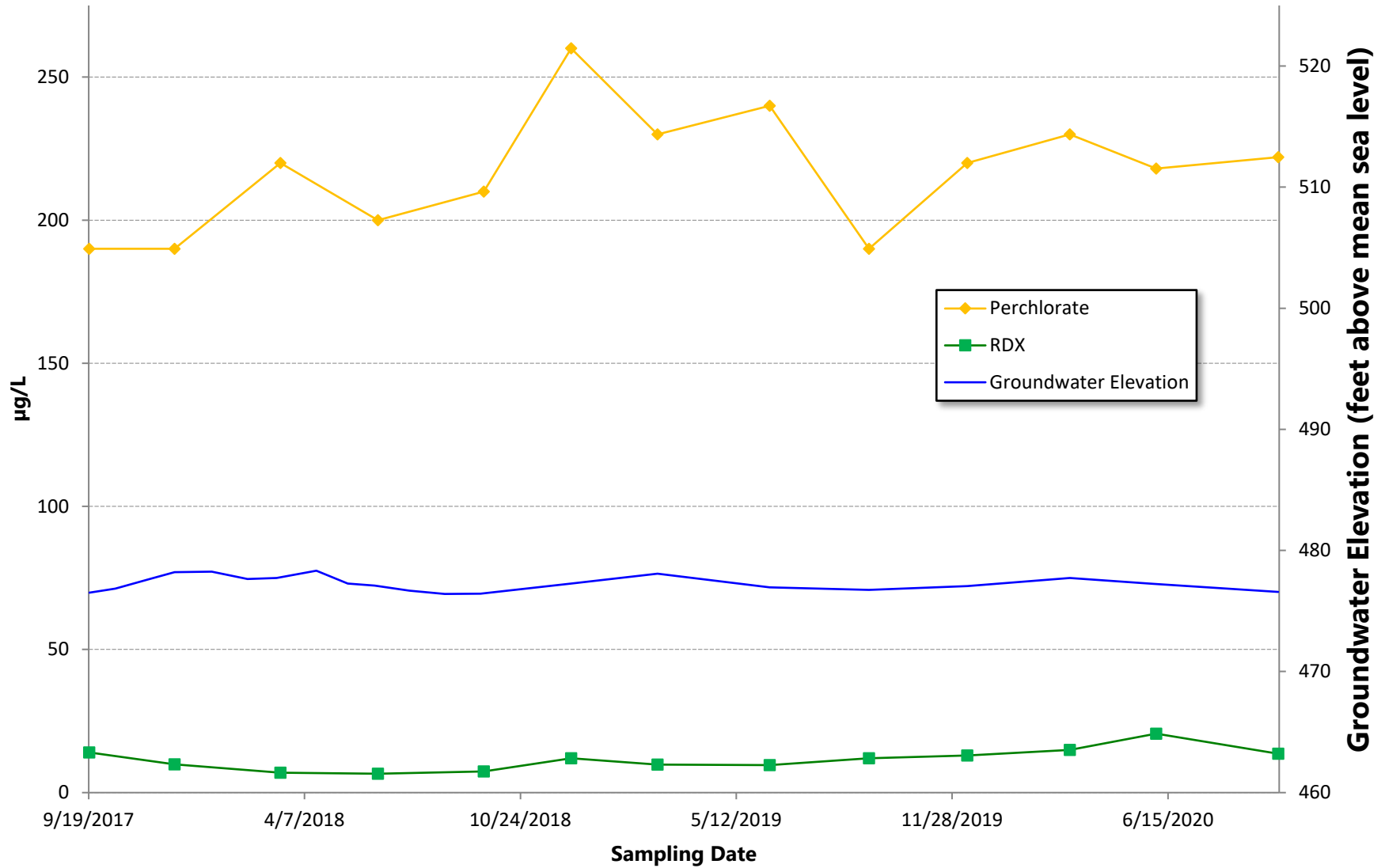
# Historical Groundwater Concentrations Camp Bonneville, Vancouver, Washington - Well L4-MW09B



## Historical Groundwater Concentrations Camp Bonneville, Vancouver, Washington - Well L4-MW010A



# Historical Groundwater Concentrations Camp Bonneville, Vancouver, Washington - Well L4-MW010B





# Historical Groundwater Concentrations Camp Bonneville, Vancouver, Washington - Well L4-MW011B

