



Kennedy Jenks

303 Second Street, Suite 300 South  
San Francisco, California 94107  
415-243-2150

**RCRA Facility  
Investigation Work Plan  
Addendum, California  
Western Facility**

13 September 2022

Prepared for

**Mendocino Railway**  
Foot of Laurel Street  
Fort Bragg, California 95437

KJ Project No. 1965021\*20

# Table of Contents

---

<i>List of Tables</i> .....	<i>ii</i>
<i>List of Figures</i> .....	<i>ii</i>
<i>List of Appendices</i> .....	<i>ii</i>
<b>Section 1: Introduction .....</b>	<b>1</b>
1.1 Site History .....	1
1.2 Objectives .....	2
<b>Section 2: Conceptual Site Model, Data Gaps, and Proposed Sampling Approach .....</b>	<b>4</b>
2.1 Conceptual Site Model .....	4
2.2 Soil .....	6
2.2.1 Data Gaps .....	6
2.2.2 Proposed Sampling Approach .....	7
2.3 Groundwater .....	8
2.3.1 Data Gaps .....	8
2.3.2 Proposed Groundwater Evaluation Approach .....	10
2.3.2.1 Grab Groundwater Sampling .....	11
<b>Section 3: Sampling and Analysis Methodologies .....</b>	<b>12</b>
3.1 Shallow Soil Sampling Methodology .....	12
3.2 Grab Groundwater Sampling Methodology .....	12
3.3 Fieldwork Preparation .....	13
3.4 Sample Analysis.....	13
3.4.1 Equipment Blanks .....	13
3.4.2 Analytical Methods .....	14
3.4.2.1 Soil .....	14
3.4.2.2 Grab Groundwater .....	14
3.4.3 Sample Labeling, Packaging, Shipment .....	14
3.5 Cleaning Procedures.....	15
3.6 Investigation-Derived Waste .....	15
3.7 Surveying .....	15
<b>Section 4: Schedule and Reporting .....</b>	<b>16</b>
<i>References</i> .....	<i>17</i>

## **Table of Contents (cont'd)**

---

### **List of Tables**

---

- 1 Previous Soil Sample Results
- 2 Previous Dissolved Metal Results in Groundwater
- 3 Previous TPH Results in Groundwater
- 4 Previous VOC Results in Groundwater

### **List of Figures**

---

- 1 Site Location Map
- 2 Previous Soil Sample Locations and Results, Lead
- 3 Proposed Additional Soil Sampling Locations
- 4 Groundwater Contour Map, First Quarter 2021
- 5 Previous Groundwater Sample Locations and Results, TPHd
- 6 Previous Groundwater Sample Locations and Results, VOCs

### **List of Appendices**

---

- A Regional Groundwater Contour Map
- B Standard Operating Guidelines

## Section 1: Introduction

---

This Workplan Addendum (Workplan) was prepared by Kennedy/Jenks Consultants, Inc. (Kennedy Jenks) on behalf of Mendocino Railway for the former California Western Facility (Site) located near downtown Fort Bragg, Mendocino County, California, as shown on Figure 1. This Workplan presents an approach for collecting additional shallow soil samples in the site vicinity to address data gaps identified in the 2013 Resource Conservation and Recovery Act (RCRA) Facility Investigation Report (RFI Report) (ERM 2013).

### 1.1 Site History

Mendocino Railway owns and operates the Site, located near downtown Fort Bragg. The Site has been used as a freight and passenger railroad depot and locomotive maintenance facility for over 125 years and is currently being used to support an operating freight/passenger railroad and for locomotive maintenance. The “Roundhouse” building is located on the Site and contains two concrete maintenance pits that are used to access the undersides of the locomotives for maintenance.

California Western Railroad, one of the previous owners of the Site, had generated, stored, and/or disposed of hazardous wastes at the Site. Prior to Mendocino Railway’s ownership of the Site, the Department of Toxic Substances Control (DTSC) conducted onsite investigations and identified the presence of elevated levels of total petroleum hydrocarbons and metals at the Site (as noted in the DTSC Site Investigation Report; DTSC 1999). In June 2005, Mendocino Railway entered into a Corrective Action Consent Agreement (Consent Agreement) with DTSC (DTSC 2005). Mendocino Railway then removed and disposed of remaining ash from identified railroad tie burn sites as part of the Consent Agreement terms. DTSC approved completion of these activities in a letter dated 14 February 2011 (DTSC 2011a). Also in 2011, Mendocino Railway submitted a RCRA Facility Investigation Work Plan (RFI Workplan), which was subsequently approved by DTSC, addressing the remaining Solid Waste Management Units (SWMUs) listed in the Consent Agreement (ERM 2011). In 2012, the RFI Workplan was implemented and a RCRA Facility Investigation Report (RFI Report) outlining the results of the RFI Workplan activities was submitted in April 2013 (ERM 2013).

Based on the results of the RFI Workplan sampling activities and comments received from DTSC, additional investigation was recommended in SWMU #35 (Railroad Area Soil). SWMU #1 (Fort Bragg Train Station) is located east of the roundhouse and DTSC has agreed that the evaluation of SWMU #1 is complete<sup>1</sup>. The RFI Report recommendations included additional characterization of the extent of lead in soil in SWMU #35, analysis of future soil samples for arsenic, and additional investigation to improve understanding of groundwater gradients and the presence of dissolved phase petroleum hydrocarbon concentrations in groundwater. In a letter dated 4 November 2021, DTSC requested submittal of a RFI Workplan Addendum to address the recommendations in the RFI Workplan (DTSC 2021). In a letter dated 3 January 2022,

---

<sup>1</sup> In DTSC’s approval letter dated 28 November 2011 (DTSC 2011), DTSC agreed that the Fort Bragg Train Station (SWMU #1) was excluded from the investigation (no soil or groundwater samples needed to be collected) and that the evaluation of SWMU #1 was complete. SWMU #1 was described in the 2013 RFI Report as the area “east of the roundhouse.”

Mendocino Railway requested an extension for the RFI Workplan Addendum submittal (Mendocino Railway 2022). In a letter dated 25 January 2022, DTSC granted an extension of 90 days from the date of the 25 January 2022 letter (DTSC 2022a). In an email dated 20 April 2022, DTSC extended the deadline of the RFI Workplan Addendum submittal to 9 May 2022 (DTSC 2022b). The RFI Workplan Addendum was submitted to DSTC on 9 May 2022 (Kennedy Jenks 2022). DTSC provided comments in a letter dated 16 August 2022 (DTSC 2022c). This RFI Workplan Addendum has been updated to address DTSC comments.

Investigation activities have been completed at the adjacent Former Fort Bragg Mill Site (Mill Site). Information has been shared by the two sites in past activities, including during implementation of the RFI Workplan, and relevant information is referenced in this Workplan. For example, groundwater has been monitored at the adjacent Former Georgia-Pacific Wood Products Facility (Mill Site) since 2004 (Arcadis 2007a) and continues to be monitored at select locations in accordance with the Operable Unit C Groundwater Operation and Maintenance Plan (OU-C GW O&M Plan; Kennedy Jenks 2020). Existing monitoring wells near the Site include five downgradient monitoring wells and one background monitoring well, and provide water quality and groundwater flow direction information relevant to the California Western Facility. Additionally, background concentrations for metals in soil (Arcadis 2007b) and groundwater (Arcadis 2010) were established for the Mill Site. These background evaluations considered sampling results from background locations identified at the Mill Site, including monitoring wells and soil samples in the vicinity of the California Western Facility. Based on the historical use of the California Western Railroad facility and the adjacent former Mill Site, background conditions are expected to be consistent between the two facilities. Therefore, the two background metals reports (Arcadis 2007b, 2010) are considered appropriate for use at the California Western Facility. As previous site investigations were conducted in concert for both the California Western Railroad facility and the former Mill Site and data is used from both facilities to characterize conditions in the vicinity, established background conditions are applicable to both.

## 1.2 Objectives

The objective of this RFI Workplan Addendum is to address data gaps identified in the 2013 RFI Report and support a final RFI Report and subsequent Corrective Measure Study. These include characterization of:

- Extent of lead in soil in SWMU #35
- Potential presence of arsenic in soil in SWMU #35
- Groundwater gradients and extent of dissolved concentrations of petroleum hydrocarbons, lead, and arsenic.

These objectives will be met by proposing collection of analytical data for chemical constituents in soil associated with railroad activities in SWMU #35. These analytical data will be used to characterize the presence of lead and arsenic in SWMU #35. The Workplan also proposes the use of existing groundwater data (i.e., historical groundwater elevations and analytical results) from an ongoing groundwater monitoring program to identify the groundwater gradient and the area affected by dissolved phase petroleum hydrocarbons and volatile organic compounds

(VOCs) in groundwater. Additional evaluation of metals in groundwater based on existing data will be included in the report. A phased approach to collecting additional dissolved phase lead and arsenic data that uses soil data to evaluate the need and potential locations for grab groundwater sampling is proposed. The results of this Workplan will be integrated into the conceptual site model to support a Corrective Measure Study to evaluate the feasibility of remediation alternatives.

## Section 2: Conceptual Site Model, Data Gaps, and Proposed Sampling Approach

---

### 2.1 Conceptual Site Model

The conceptual site model (CSM) describes the relationship between potential constituent sources, constituent distribution, migration pathways, and possible exposure pathways for receptors in SWMU #35. Based on existing data, lead is a constituent of concern (COC) in soil at the Site. Arsenic is a constituent of interest because of historical use of arsenic-containing pesticides for vegetation control in the railroad industry, though no data for arsenic in soil are currently available for the site. Groundwater COCs at the Site are dissolved phase petroleum hydrocarbons and VOCs.

The SWMU #35 area has been used as a freight and passenger railroad depot and locomotive maintenance facility for over 125 years. The locomotive maintenance facility building (the Locomotive Repair Shop or “Roundhouse”) is a wood frame building approximately 60 feet by 170 feet with a concrete slab floor. Maintenance on locomotives is completed in this building via two concrete maintenance pits set into the ground that allow access the undersides of the locomotives. The Site facilities also include active railroad lines, a permanently closed aboveground storage tank (AST), and an underground fuel line associated with the AST, but no longer in use. The primary sources of Site COCs consist of historical and ongoing facility operations, including locomotive maintenance. This includes the potential use of lead-based paints, storage and use of petroleum hydrocarbons at the underground fuel line and AST (no longer in use), equipment cleaning and maintenance, historical vegetation abatement using arsenic-based herbicides, and use of pressure-treated lumber as rail ties. Locomotives and other rail vehicles used in current and historical operations are/were oil fueled and do not/did not use coal as a fuel source. Therefore, coal ash and coal cinder are not a potential source of Site COCs. Specific herbicides used historically onsite are unknown but given historical use of pesticides containing arsenic in industrial settings, pesticides may be a potential source of arsenic.

Previous samples collected on Site have found the presence of lead in soil near the Locomotive Repair Shop and the active railroad lines (see Figure 2). Concentrations of lead in soil have exceeded the commercial/industrial California Human Health Screening Level (CHHSL) for lead of 320 milligrams per kilogram (mg/kg) and background concentrations for lead established for the adjacent Mill Site<sup>2</sup>. These lead concentrations are limited to soil shallower than 1.5 feet below ground surface (ft bgs), and in areas north and south of the Locomotive Repair Shop. Lead has not been detected in samples collected deeper than 1.5 ft bgs at concentrations above the CHHSL. DTSC has requested additional sampling to improve understanding of the distribution of lead as well as arsenic<sup>3</sup> in soil at the Site (see Section 2.2 and Figure 3).

---

<sup>2</sup> The background concentration for lead in soil was reported to be 26 mg/kg in marine sediment and 75 mg/kg for fill (Arcadis 2007b).

<sup>3</sup> The background concentration for arsenic in soil was reported to be 10 mg/kg (Arcadis 2007b).

Depth to groundwater presented in the soil boring logs indicates that depth to groundwater is approximately 8.5 to 11.5 ft bgs at the Site. Grab groundwater samples collected from soil borings on the Site have found the presence of dissolved phase petroleum hydrocarbons and VOCs. Grab groundwater samples were not analyzed for lead or arsenic. Groundwater samples collected from downgradient wells on the adjacent Mill Site were analyzed for lead and arsenic; lead and arsenic were either not detected or detected at concentrations below applicable remedial goals and did not require a remedy in the Remedial Action Plan for Operable Units C and D (OU-C/D RAP; Arcadis 2015). Background concentrations for metals in groundwater<sup>4</sup> were also established for the adjacent Mill Site (Arcadis 2010). Lead and arsenic have generally not been detected above background screening levels in downgradient wells on the adjacent Mill Site. Petroleum hydrocarbons and VOCs are detected in groundwater samples collected from downgradient monitoring wells on the adjacent Mill Site, albeit at lower concentrations than those found in the onsite grab groundwater samples.

A potential migration pathway for lead (and arsenic, if found) in soil is through dust generation. However, a significant portion of the Site is hard packed soil, covered with buildings and gravel, or turf; therefore, dust generation and other soil migration pathways are not expected to be complete. No erosion or dust generation was noted during a Site walk in February 2022. Inorganic forms of lead and arsenic have low solubility under typical geochemical conditions, reducing their potential transport downward with surface water infiltration and downgradient via advective groundwater transport. Lead and arsenic from sources likely to be present at the Site, including lead paint, particles from treated wood products, and arsenic-containing pesticides tend to attach readily to soil particles. Therefore, lead and arsenic detected in soil that do not extend to the groundwater table at elevated concentrations are not expected to migrate. Naturally occurring and anthropogenic sources of arsenic are known to transform to relatively more soluble forms in the presence of reducing groundwater geochemistry, particularly where petroleum hydrocarbons or other organics are present in soil and groundwater. Dissolved arsenic will migrate within the area of affected geochemistry. However, dissolved phase arsenic typically attenuates outside the area of depleted dissolved oxygen associated with geochemically reducing conditions. Concentrations of arsenic in groundwater should be interpreted in the context of geochemical conditions.

Dissolved phase VOCs and petroleum hydrocarbons may migrate with groundwater flow. Based on existing Mill Site monitoring data, the primary groundwater flow direction is west (see Figure 4). Groundwater elevation has been measured at a large groundwater monitoring network at the Mill Site for nearly 20 years; groundwater contours generated from three recent monitoring events are presented in Appendix A. While variation in surface topography, surface recharge, well screen intervals, and lithology may result in differences on a limited scale, regional groundwater flow direction and gradients are well understood and flows to the west / southwest towards the Pacific Ocean / Fort Bragg Landing. The groundwater gradient for the area will be addressed as outlined in Section 2.3. Ongoing monitoring indicates VOCs and petroleum hydrocarbons are not migrating and are attenuating over time.

Potential exposure pathways for lead in soil are incidental soil ingestion, soil particulate inhalation, and direct dermal contact. The Site is classified as an industrial land use area, and there is no commercial or residential exposure within the railyard. The area around the

<sup>4</sup> The background concentration for arsenic in groundwater was reported to be 2.5 ug/L and the background concentration for lead in groundwater was reported to be 1.0 ug/L (Arcadis 2010).



Locomotive Repair Shop and active railroad lines is restricted to workers and contractors. The exposure for human receptors is therefore anticipated to be low. SWMU #35 is completely developed and does not offer habitat for potential ecological receptors.

Potential exposure pathways for petroleum hydrocarbons in groundwater include ingestion and dermal contact. There are no known production wells on the Site accessing groundwater. Additionally, the adjacent Mill Site is also an industrial land use area, and the downgradient portion of the Mill Site is under a Land Use Covenant which restricts the use of groundwater. Therefore, ingestion is not expected to be a complete pathway for petroleum hydrocarbons or VOCs in groundwater. Depth to groundwater is typically greater than 8 ft bgs, and direct exposure to groundwater is therefore unlikely.

## 2.2 Soil

### 2.2.1 Data Gaps

Based on existing data, lead is a COCs in soil at the Site. Recommendations for additional soil characterization in the 2013 RFI Report included additional sampling for lead in soil in SWMU #35 and analysis of future soil samples for arsenic<sup>5</sup>.

Available shallow soil and soil boring data from the RCRA Facility Investigation sampling effort were compiled and reviewed to evaluate the presence of lead and petroleum hydrocarbons in railroad area soil. Table 1 presents the analytical results for shallow soil samples and soil borings. The sample locations and lead concentration results above CHHSLs are shown on Figure 2. A summary of soil samples previously collected at the Site and identified data gaps are presented below:

- 55 soil samples have been collected at the site and analyzed for lead.
- 26 soil samples were collected from shallow borings with total depth less than 1.5 ft bgs with sampling depths of 0-0.5 ft bgs or 1-1.5 ft bgs. The commercial/industrial CHHSL for lead of 320 mg/kg was exceeded in nine (9) of the shallow soil samples with concentrations ranging from 350 mg/kg (SS-7) to 2,600 mg/kg (SS-5).
- 29 soil samples were collected from deeper soil borings with total depths up to 14 feet bgs and sampling depths throughout the vertical profile. The CHHSL for lead was exceeded in one sample, SB-2, at a depth of 0-0.5 feet bgs with a concentration of 970 mg/kg.
- Lead concentrations were below the CHHSL and local background (Arcadis 2007b) in all 22 samples collected at depths deeper than 2 feet bgs, with a maximum concentration of 41 mg/kg.

As noted in Section 2.1, background concentrations for metals in soil were established for the adjacent Mill Site (Arcadis 2007b) and are considered to be applicable to the California Western

<sup>5</sup> No samples collected at the Site have been analyzed for arsenic. The additional soil samples proposed in this workplan are recommended to be analyzed for arsenic.

facility. The background concentration for arsenic in soil was reported to be 10 mg/kg, and the background concentration for lead in soil was reported to be 26 mg/kg in marine sediment and 75 mg/kg for fill (Arcadis 2007b).

Four areas were identified where additional shallow soil sampling is recommended to characterize the presence of lead and arsenic. These areas are shown on Figure 2 and include:

- East of the locomotive repair shop and east of the RFI Report sample locations SS-7, SS-9, SS-11, SS-13, and SB-1.
- South of the locomotive repair shop and south of the RFI Report sample location SS-2 and east of location SS-1.
- North of the locomotive repair shop and north of the RFI Report sample locations SS-12 and SS-13.
- South of the Fort Bragg Depot and east of RFI Report sample locations SS-2, SS-4, and SS-6<sup>6</sup>.

## 2.2.2 Proposed Sampling Approach

Collection of soil samples at twenty (20) locations is proposed to address the data gaps identified in Section 2.1.1. Soil samples will be collected from three depth intervals at each location (0-0.5 ft bgs, 1-1.5 ft bgs, 2.5-3 ft bgs, and 4.5-5 ft bgs) and analyzed for lead and arsenic. The proposed approximate sample locations are shown on Figure 3.

Proposed sample locations SS-15, SS-16, SS-17, SS-28, and SS-29 were chosen to characterize the presence of lead and arsenic east of the locomotive repair shop. Proposed sample locations SS-18, SS-19, SS-20, SS-21, SS-26, and SS-27 were chosen to characterize the presence of lead and arsenic south of the locomotive repair shop. Proposed sample locations SS-14, SS-23, SS-24, SS-25, and SS-29 were chosen to characterize the presence of lead and arsenic north of the locomotive repair shop and further evaluate lead concentrations observed at SS-12. Proposed sample locations SS-20, SS-21, SS-22, SS-26, and SS-27 were chosen to characterize the presence of lead and arsenic west of the locomotive repair shop and further evaluate lead concentrations observed at SS-3 and SS-5, in the vicinity of the historical underground fuel line. Proposed sample location SS-26 was chosen to characterize the presence of lead and arsenic at depths below 1.5 ft bgs approximately at the previous SS-3 and SS-5 shallow soil sample locations. Proposed sample locations SS-30, SS-31, SS-32, and SS-33 were chosen to characterize the presence of lead and arsenic in the train track area south of the Fort Bragg Depot building. Sample locations may vary based onsite conditions and location accessibility at the time of sampling.

Soil sampling and analysis methodologies are presented in Section 3.

<sup>6</sup> These samples were added per DTSC request (DTSC 2022c).

## 2.3 Groundwater

### 2.3.1 Data Gaps

Identified groundwater COCs at the Site are dissolved phase petroleum hydrocarbons and VOCs. Groundwater recommendations in the 2013 RFI Report included additional investigation to improve understanding of groundwater gradients and the presence of dissolved phase petroleum hydrocarbon concentrations in groundwater. In a letter dated 4 February 2013, DTSC requested installation of two groundwater monitoring wells (one east of the Locomotive Repair Shop and one north of the Locomotive Repair Shop). However, given available grab groundwater data from the facility and downgradient groundwater monitoring data from Mill Site monitoring wells, as described below, groundwater conditions are understood sufficiently to confirm dissolved phase petroleum hydrocarbons are present below the Site at concentrations that do not allow unrestricted use, measurable free-phase LNAPL was not observed during onsite grab groundwater sampling, migration is not observed in downgradient wells, and the potential threat to human health and the environment from VOCs and petroleum hydrocarbons can be characterized and managed without installation of additional wells.

An objective of the monitoring wells requested by DTSC is to characterize groundwater for the presence of lead and arsenic. If lead and arsenic are not detected in soil between shallow sampling depths (typically 0 – 2 ft bgs) and groundwater, the potential exposure pathway for these constituents to groundwater is incomplete. Concentrations of lead detected in soil at the site consistently decrease by orders of magnitude with depth, including in locations where lead concentrations were detected above the CHHSL. Further, the leachability of lead was evaluated at locations with the highest lead concentrations during previous sampling events using Waste Extraction Testing methods with deionized water as the extracting agent (Table 1). Soluble lead results were approximately four orders of magnitude below soil sample results, indicating relatively low leachability, even at the locations with the highest concentrations in soil. Further, significant downgradient data, described below, is available from the former Mill Site that demonstrate lead and arsenic are not migrating downgradient of the Site. Therefore, a phased approach is proposed to characterize the potential presence of lead and arsenic in onsite groundwater. Field filtered grab groundwater samples for dissolved lead and arsenic will be collected in up to two locations where lead and arsenic are detected above background concentrations established for former Mill Site fill<sup>7</sup> (Arcadis 2007b) in the deepest soil sampling depth. Background concentrations for lead and arsenic in soil are 75 and 10 mg/kg, respectively.

Available groundwater elevations and analytical results from groundwater monitoring wells down- and cross-gradient of the Site were compiled and reviewed to improve understanding of the groundwater gradient and the area affected by dissolved phase petroleum hydrocarbons, VOCs, lead, and arsenic in the area. Groundwater has been monitored at the adjacent Former Georgia-Pacific Wood Products Facility (Mill Site) since 2004 (Arcadis 2007a) and continues to be monitored at select locations in accordance with the Operable Unit C Groundwater Operation and Maintenance Plan (OU-C GW O&M Plan; Kennedy Jenks 2020). Existing monitoring wells

<sup>7</sup> Background metals concentrations were established for marine sediment/bedrock (MSB) and surface fill for the former Georgia-Pacific Mill Site. As stated in Section 1.1, background conditions are expected to be consistent between the two facilities and established background conditions are applicable to both.

near the Site include five downgradient monitoring wells and one background monitoring well (see Figure 4). Groundwater monitoring results are presented in Tables 2 through 4. A summary of samples previously collected at the site and at the nearby groundwater monitoring wells and identified data gaps are presented below:

- At the Site:** Seven (7) grab groundwater samples were collected from soil borings advanced as part of the RFI Report sampling effort and were analyzed for dissolved phase hydrocarbons and VOCs. Sample locations were targeted in locations of potential release areas. The sample results showed the presence of petroleum hydrocarbons and VOCs, although the results are likely biased high due to fine soil particles in the grab samples. Measurable free phase hydrocarbons were not observed during grab groundwater sampling. The sample locations and concentrations above screening levels are shown on Figure 5 and Figure 6.
- Nearby Monitoring Wells:** There are five downgradient monitoring wells (MW-3.18, MW-3.3, MW-3.13, MW-3.2, and MW-3.16R) between 75 and 300 feet downgradient of the property line and the likely release area associated with former locomotive fueling and maintenance operations and one background monitoring well (MW-3.17) that are part of an ongoing groundwater O&M program at the Mill Site (Figure 4). Groundwater monitoring results from the Mill Site monitoring wells, including recent monitoring results and historical analytical results dating back to 2004, indicate lower concentrations of petroleum hydrocarbons and VOCs in nearby and downgradient groundwater than those found in the onsite grab samples. Analysis at these wells for dissolved metals indicate lead and arsenic are typically not detected or were reported at estimated concentrations below the detection limit. When detected, concentrations of lead or arsenic in samples collected from these downgradient wells were not above the drinking water MCL or RWQCB Water Quality Objectives. The groundwater contours developed from groundwater elevation measurements taken in the first quarter of 2021 are shown on Figure 4 and indicate that the primary groundwater direction is to the west (from the Site to the Mill Site).

The ongoing monitoring program includes analysis of VOCs at all six monitoring wells and TPHd at two monitoring wells. As presented in the OU-C GW O&M Plan, monitoring of certain constituents, including lead and arsenic, was discontinued at certain wells where remedial goals were met (e.g., consecutive sample results that were non-detect or had concentrations below the remedial goal; Kennedy Jenks 2020)<sup>8</sup>. The most recent results for TPHd from downgradient monitoring wells (collected in first quarter 2021 from MW-3.2 and MW-3.13) are approaching laboratory detection limits and are below the U.S. Environmental Protection Agency (EPA) Region 9 Preliminary Remediation Goal (PRG). Tetrachloroethene (PCE) and trichloroethene (TCE) concentrations are above the respective PRGs in downgradient monitoring wells in the first quarter 2021 monitoring event but are below drinking water standards at all wells with the exception of the PCE concentration at MW-3.13.

<sup>8</sup> TPHg was removed from the sampling list for the five nearby Mill Site monitoring wells and VOC monitoring continues with a focused list. The focused VOC analyte list includes 1,1-DCA, 1,1-DCE, PCE, TCE, and VC. TPHd is currently only analyzed at MW-3.2 and MW-3.13, and benzene is only analyzed at MW-3.2.

The results from grab groundwater samples that were collected as part of the RFI Report sampling effort will be reviewed with the Mill Site monitoring results to improve understanding of groundwater gradients and the presence of dissolved phase petroleum hydrocarbon concentrations in groundwater. No additional sampling is proposed.

### **2.3.2 Proposed Groundwater Evaluation Approach**

An analysis of previous analytical results of grab groundwater samples taken at the Site and previous analytical results and groundwater elevations from the Mill Site monitoring program will be completed. This analysis is proposed to be completed as part of the report to be submitted with the results of the proposed soil sampling. The basis for this analysis includes the following reasoning:

- Groundwater grab samples collected from the Site show presence of petroleum hydrocarbons and VOCs. However, the grab sample results are likely biased high due to fines in the grab samples.
- Analytical results from the Mill Site monitoring program indicate lower concentrations of petroleum hydrocarbons and VOCs than found in the onsite grab samples. These monitoring results are more recent (2021) than the grab samples collected in 2012, the monitoring wells are within 150 feet of the western edge of the California Western facility and the previous soil boring locations, and are downgradient of the historical underground fuel line and AST on the California Western facility.
- While residual petroleum hydrocarbons and VOCs are present at the Site, the length of associated plumes, as shown by nearby wells, are within the ranges established by the California State Water Resources Control Board Low-Threat Underground Storage Tank Case Closure Policy (SWRCB 2012). While the Site is not regulated under the Low-Threat Closure Policy, the reference is included here for comparison purposes, particularly as surrounding fuel dispensing sites have recently been closed under the Low-Threat Closure Policy.
- The existing data set, including both the grab groundwater samples and the samples from Mill Site monitoring wells, demonstrates that land use control and groundwater use restrictions for groundwater like those established downgradient for the adjacent Mill Site property are appropriate based on the presence of petroleum hydrocarbons and VOCs and would protect human health and the environment, while maintaining consistency with downgradient restrictions already in place.

The results of the groundwater evaluation will be presented with soil sampling results. The evaluation discussion will include:

- Discussion of the groundwater grab sample results in the context of the Mill Site monitoring results for dissolved petroleum hydrocarbons and VOCs.
- Appropriateness of land use control and groundwater use restrictions as a groundwater remedy based on the groundwater evaluation.

### **2.3.2.1 Grab Groundwater Sampling**

As discussed in Section 2.3.1, field filtered grab groundwater samples for dissolved lead and arsenic will be collected in up to two (2) locations where lead and arsenic are detected in soil above background concentrations established for former Mill Site fill (see Section 1.1 and Section 2.1; Arcadis 2007b) in the deepest soil sampling depth (if any). Background concentrations for lead and arsenic in soil are 75 and 10 mg/kg, respectively. If collected, grab groundwater samples will be evaluated with the existing Mill Site groundwater data, as discussed in Section 2.3.2.

## **Section 3: Sampling and Analysis Methodologies**

---

### **3.1 Shallow Soil Sampling Methodology**

Shallow soil samples will be collected from a total of twenty (20) locations at the Site. The proposed sample locations are shown on Figure 3. Field sampling methods will conform to guidelines set forth in the Standard Operating Guidelines (SOGs) for Surface and Shallow Soil Sampling (Appendix B) and the site-specific Health and Safety Plan.

At each of these locations, a sample will be collected from 0-0.5 ft bgs, 1-1.5 ft bgs, 2.5-3 ft bgs, and 4.5-5 ft bgs using a hand auger. If non-soil material (e.g., ballast, gravel, vegetation) is present at the sample location, the non-soil material will be cleared, and the sample will be collected from below the non-soil material. The soil sample will then be placed in a glass jar. Reasonable efforts will be made to advance the sampling tools and recover adequate sample volumes. If a sample location is inaccessible, an alternate location will be attempted nearby. Sample locations will be recorded using global positioning system (GPS) equipment.

Documentation will be made of the color, texture, visual staining, and odor of each sample. A photoionization detector (PID) measurement will be collected from each sample location. Each sample will be transferred to a cooler with ice until it is prepared for shipping to the laboratory, as described in Section 3.4.3.

### **3.2 Grab Groundwater Sampling Methodology**

One grab groundwater sample may be collected from up to two (2) locations, based on soil sampling results (see Section 2.3.2.1). Grab groundwater samples will be field filtered and analyzed for dissolved lead and arsenic.

At a grab groundwater sample location, a soil boring will be drilled and continuously cored using a hydraulic push-drive (“direct push”) drill rig in accordance with the SOG included in Appendix B. Based upon historic groundwater levels, the soil boring will be advanced to the approximate depth of groundwater (expected to be at approximately 8.5 to 11.5 ft bgs).

The hydraulic push-drive system (Geoprobe™ or equivalent) will be advanced using a dual-wall system with 3-inch outer diameter (OD) steel rods where the lead rod is fitted with a new acetate liner. The soil core is collected in the acetate liner as the rods are advanced in 4-foot or 5-foot increments. The steel rods remain in place as the acetate liners are removed, so that the borehole is continuously cased as it is advanced.

Borings will be logged in accordance with the SOG in Appendix B under the supervision of a California Professional Geologist or Professional Engineer. The boring logs will include soil descriptions using the Unified Soil Classification System (USCS), labeled depths, record of penetrations and recoveries, visual indicators such as staining and discoloration, olfactory indications of chemical impact, head space readings, estimation of proportions of grain sizes, grading, and moisture content.

To collect the groundwater sample, after the boring has been drilled a 5-foot section of new slotted ¾-inch diameter polyvinyl chloride (PVC) well screen and new PVC blank casing will be installed into the cased borehole, and the casing will be retracted 5 feet to expose the aquifer. Groundwater will be purged with a stainless-steel bailer or by attaching a stainless-steel check valve to new tubing and oscillating the tubing to displace the water to the surface. If the aquifer is adequately transmissive, water will be purged until the sediment is visually decreased or at least 1 liter has been purged. The sample will be field filtered using a 0.45-micron filter and collected in pre-preserved containers provided by the laboratory. Each sample will be transferred to a cooler with ice until it is prepared for shipping to the laboratory, as described in Section 3.4.3.

After sample collection, soil borings will be grouted using a tremie pipe or sealed with neat cement or hydrated bentonite chips, in accordance with Mendocino County requirements.

### **3.3 Fieldwork Preparation**

Underground Service Alert (USA) shall be notified of the sampling activities at least 48 hours in advance. Soil sample and boring locations will be marked with white paint or stakes to confirm that no underground utilities will be impacted.

A permit will be obtained from Mendocino County Environmental Health Division for soil borings that extend to groundwater to perform grab sampling. A drilling contractor will be mobilized to perform the soil boring and grab groundwater sample collection work. The drilling contractor will provide a vacuum truck (an “air knife” device) or employ other similar methodology to evacuate each borehole location to 7 ft bgs to check for the presence of underground utilities. If any utilities are revealed, the soil boring will be relocated, and the air-knife or other similar process repeated. Soil will be replaced and compacted in the air-knife borehole to provide support for the drilling rods.

### **3.4 Sample Analysis**

Quality assurance/quality control (QA/QC) samples will be collected in the field at the following frequency for each type of media:

- Matrix Spikes/Matrix Spike Duplicates (MS/MSD): Collected at a rate of one sample per approximately 20 samples collected for each analytical method.
- Equipment Blanks: Collected when non-disposable equipment is used. One equipment blank per day of sampling activities is expected for this field effort.
- Field Duplicate: Collected at a rate of one sample per approximately 20 samples.

#### **3.4.1 Equipment Blanks**

Equipment blanks will be collected following cleaning procedures (see Section 3.3) by carefully pouring distilled water over or through the recently cleaned equipment and collecting this directly into an appropriate sample container held over a bucket. At a minimum, one equipment



blank will be collected per sample delivery group. One equipment blank sample is expected for this field effort. Equipment blanks will be analyzed using the same analytical methods used on the unique soil samples (Section 3.2.2) and labeled and handled in the same manner as other samples (Section 3.2.3).

### **3.4.2 Analytical Methods**

Samples will be analyzed on a standard turn-around time (14 business days).

#### **3.4.2.1 Soil**

Submitted soil samples will be analyzed for lead and arsenic by the following analytical method:

- Metals by EPA Method 6010.

It is expected that 4 ounces of soil will be required for each analysis.

#### **3.4.2.2 Grab Groundwater**

If collected, grab groundwater samples will be analyzed for dissolved lead and arsenic by the following analytical method:

- Metals by EPA Method 6020.

It is expected that 500 milliliters of groundwater will be required for each analysis.

### **3.4.3 Sample Labeling, Packaging, Shipment**

Prior to shipping to the laboratory, samples will be clearly labeled. A plastic or waterproof paper label will be attached to the jar and will be filled out using water-resistant ink. Alternatively, information may be recorded directly onto the sampling container using indelible ink. Sample labels will contain the following information:

- Project number or site/project name
- Sample location identification
- Sample depth
- Date and time the sample was collected
- Sampler's name/initials.

Soil samples collected via hand trowel or hand auger will be placed in glass jars and properly labeled. Grab groundwater samples, if collected, will be placed in 1-liter polyethylene sample containers, or other containers provided by the laboratory. Following collection and labeling, samples will be immediately placed in a sample cooler with ice for temporary storage. The samples will be placed in sealed plastic bags to restrict contact with moisture in the ice chest.

Each cooler will be shipped under chain-of-custody and will be sealed with a self-adhesive custody seal. If samples are held for more than 1 day, they will be kept in a secure place on ice in a cooler.

### **3.5 Cleaning Procedures**

To reduce the likelihood of carryover from one sample to another, equipment that comes into contact with soil or water will be cleaned according to the SOG for Equipment Cleaning (Appendix B). Disposable equipment intended for one-time use will not be cleaned but will be packaged for appropriate disposal. Cleaning will occur prior to and after each use of a piece of equipment. Sampling devices used will either be single-use and pre-cleaned or be cleaned using the following procedures:

- Non-phosphate detergent and tap water wash using a brush if necessary
- Tap water rinse
- Final deionized/distilled water rinse.

### **3.6 Investigation-Derived Waste**

In the process of collecting environmental samples during the proposed field sampling program, different types of investigation-derived waste (IDW) will be generated that include the following:

- Used personal protective equipment (PPE)
- Disposable sampling equipment
- Cleaning fluids.
- Soil cuttings.

Listed below are the procedures that will be followed for handling the IDW:

- Used PPE and disposable equipment will be double-bagged and placed in a municipal refuse dumpster. These wastes are not considered hazardous and can be sent to a municipal landfill. PPE and disposable equipment marked for disposal that can still be reused will be rendered inoperable before disposal in the refuse dumpster.

### **3.7 Surveying**

All sample locations will be recorded using GPS. Photographs will be taken and logged in the field to document findings and Site conditions.

## **Section 4: Schedule and Reporting**

---

We anticipate work to be completed within 90 days of DTSC approval of this Workplan Addendum. The results of the Workplan Addendum sampling, the groundwater evaluation, and an updated conceptual site model will be presented in a RCRA Facility Investigation Report Addendum within 120 days of receiving the analytical sample results.

## References

---

- Arcadis. 2007a. *Comprehensive Monitoring Plan, Former Georgia-Pacific Wood Products Facility*. August.
- Arcadis. 2007b. *Background Metals Report, Former Georgia-Pacific Wood Products Facility*. August.
- Arcadis. 2010. *Background Screening Levels for Metals in Groundwater, Former Georgia-Pacific Wood Products Facility*. January.
- Arcadis. 2015. *Remedial Action Plan, Operable Units C and D*. June 2015.
- California State Water Resources Control Board (SWRCB). 2012. *Low-Threat Underground Storage Tank Case Closure Policy*. State Water Board Resolution No. 012-0062. 6 November 2012.
- Department of Toxic Substances Control (DTSC). 1999. *Site Inspection Report*.
- DTSC. 2005. *Corrective Action Consent Agreement: Skunk Train Facility, Mendocino Railway*. Docket HWCA: P1-04/05-011. 17 June 2005.
- DTSC. 2011a. *Approval of the Interim Measures Completion Report, Mendocino Railway Skunk Train Facility*. EPA Identification number CAL00307870 (Formerly CAD066125758). 14 February 2011.
- DTSC. 2011b. Letter from Thomas P. Lanphar, DTSC, to Robert Pinoli, Mendocino Railway, RE: Revised Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Work Plan, and Current Conditions Report, both dated November 14, 2011, Mendocino Railway (Skunk Train), Fort Bragg, California. November 28.
- DTSC. 2021. *Request Submittal RCRA RFI Workplan Addendum, California Western Railroad (Skunk Train), Fort Bragg, California*. 4 November 2021.
- DTSC. 2022a. *Request for Extension on Submittal RCRA RFI Workplan Addendum, California Western Railroad (Skunk Train), Fort Bragg, California*. 25 January 2022.
- DTSC. 2022b. Email from Tom Lanphar, DTSC, to Rachel Morgan, Kennedy Jenks Consultants, Re: Draft Workplan Addendum Outline – California Western Railroad. 20 April 2022.
- DTSC. 2022c. Letter from Tom Lanphar, DTSC, to Michael Buck, Mendocino Railway, Re: Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Workplan Addendum. August 16.
- Environmental Resources Management (ERM). 2011. *RCRA Facility Investigation Work Plan, Skunk Train, Fort Bragg, California*. 14 November 2011.

ERM. 2013. *RCRA Facility Investigation Report, Skunk Train, Fort Bragg, California*. 10 April 2013.

Kennedy/Jenks Consultants, Inc. (Kennedy Jenks). 2020. *Operable Unit C Groundwater Operation and Maintenance Plan*. 9 April 2020.

Kennedy Jenks. 2022. *RCRA Facility Investigation Work Plan Addendum, Skunk Train Facility*. May 9.

Mendocino Railway. 2022. *RCRA Facility Investigation Workplan Addendum Extension Request, Western Railroad Skunk Train Site, Fort Bragg, California*. 3 January 2022.

## **Tables**

---

**Table 1: Previous Soil Sample Results<sup>(a)</sup>**

Sample Location	Depth (ft bgs) <sup>(b)</sup>	Sampling Date	Gasoline C7-C12 (mg/kg)	Diesel C10-C24 (ppm)	Motor Oil C24-C36 (ppm)	Benzene (µg/kg)	Toluene (µg/kg)	Ethylbenzene (µg/kg)	m,p-Xylenes (µg/kg)	o-Xylene (µg/kg)	Acenaphthene (µg/kg)	Acenaphthylene (µg/kg)	Anthracene (µg/kg)	Benzo(a)-anthracene (µg/kg)	Benzo(a)-pyrene (µg/kg)	Benzo(b)-fluoranthene (µg/kg)	Benzo(g,h,i)-perylene (µg/kg)	Benzo(k)-fluoranthene (µg/kg)	Chrysene (µg/kg)	Dibenz(a,h)-anthracene (µg/kg)	Fluoranthene (µg/kg)	Fluorene (µg/kg)	Indeno(1,2,3-cd)-pyrene (µg/kg)	Naphthalene (µg/kg)	Phenanthrene (µg/kg)	Pyrene (µg/kg)	B(a)P eq (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Soluble Lead <sup>(g)</sup> (mg/L)	Zinc (mg/kg)	
		CHHSL <sup>(c)</sup>	-	-	-	-	-	-	-	-	-	-	-	-	38	-	-	-	-	-	-	-	-	-	-	-	-	38,000	320	-	100,000	
		RBSC <sup>(d)</sup>	7	1,045	83,599	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
		PRG <sup>(e)</sup>	-	-	-	5,400	45,000,000	27,000	17,000,000	17,000,000	3,700,000	-	22,000,000	620	210	2,100	-	21,000	210,000	21,000	2,200,000	2,200,000	2,100	18,000	-	-	1,700,000	3,100	800	-	23,000	
		B(a)P eq <sup>(f)</sup>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.9	-	-	-	-	
SS1	0-0.5	19-Jun-12	<1	110	530	<5.2	<5.2	<5.2	5.5	<5.2	<100	<100	<100	140	110	260	<100	<100	310	<100	420	<100	<100	130	230	480	0.18	81	360	-	190	
	1-1.5	19-Jun-12	<1.1	180	860	<5.4	<5.4	<5.4	<5.4	<5.4	<50	<50	57	110	120	280	53	91	290	<50	350	<50	<50	100	180	370	0.18	82	230	-	160	
SS2	0-0.5	19-Jun-12	<1.1	62	290	<5.5	<5.5	<5.5	<5.5	<5.5	56	52	100	78	32	92	<15	19	180	<15	540	35	<15	340	450	410	0.06	56	110	-	120	
	1-1.5	19-Jun-12	<0.97	29	130	<4.9	<4.9	<4.9	<4.9	<4.9	9.5	13	19	43	29	53	12	19	69	<5	150	6.4	9.8	50	71	110	0.04	16	28	-	60	
SS3	0-0.5	19-Jun-12	<1	93	480	<5.2	<5.2	9.1	68	24	<20	29	24	31	29	94	<20	23	92	<20	140	<20	<20	55	100	170	0.05	140	980	0.096	280	
	1-1.5	19-Jun-12	<1	93	610	<5.1	<5.1	<5.1	8.8	<5.1	<10	15	11	19	46	78	23	16	64	<10	55	<10	15	22	48	53	0.06	240	2000	0.28	580	
SS4	0-0.5	19-Jun-12	<1	480	2,200	<5.2	<5.2	<5.2	30	12	<99	<99	<99	<99	<99	<99	<99	<99	100	<99	110	<99	<99	140	380	210	0.09	1,300	280	-	220	
	1-1.5	19-Jun-12	<0.99	390	1,600	<5	<5	<5	26	9.6	<51	<51	<51	<51	<51	<51	<51	<51	80	<51	92	<51	<51	110	260	170	0.04	130	240	-	130	
SS5	0-0.5	19-Jun-12	<1	130	900	<5	<5	<5	<5	<5	<35	<35	<35	40	37	100	<35	<35	99	<35	110	<35	<35	45	99	120	0.06	120	290	-	210	
	1-1.5	19-Jun-12	<1	130	850	<5.3	<5.3	<5.3	<5.3	<5.3	<9.9	51	33	130	83	200	25	65	160	<9.9	260	<9.9	23	43	110	220	0.13	420	2,600	0.39	250	
SS6	0-0.5	19-Jun-12	<0.99	190	1,000	<5	<5	<5	<5	<5	<100	<100	<100	<100	<100	<100	<100	<100	140	<100	140	<100	<100	<100	120	140	0.09	180	290	-	380	
	1-1.5	19-Jun-12	<0.93	160	950	<4.6	<4.6	<4.6	<4.6	<4.6	<5.1	17	8.2	9	<5.1	<5.1	7.6	<5.1	47	<5.1	52	6.7	<5.1	73	71	110	0.01	100	170	-	170	
SS7	0-0.5	19-Jun-12	<1.1	420	730	<5.4	<5.4	<5.4	<5.4	<5.4	<9.8	20	53	19	11	73	<9.8	22	75	<9.8	110	23	<9.8	63	200	110	0.03	93	350	-	320	
	1-1.5	19-Jun-12	<1.1	200	750	<5.3	<5.3	<5.3	<5.3	<5.3	<5.1	10	17	16	20	78	6.5	16	44	<5.1	68	6.5	<5.1	32	81	52	0.03	200	260	-	690	
SS8	0-0.5	20-Jun-12	<1	100	730	<5.1	<5.1	<5.1	14	5.5	10	17	45	25	21	100	5.1	25	73	<5.1	110	6.6	<5.1	56	79	100	0.04	89	180	-	160	
	1-1.5	20-Jun-12	<1	51	290	<5.1	<5.1	<5.1	<5.1	<5.1	<4.9	14	15	15	50	<4.9	13	40	<4.9	57	<4.9	<4.9	<4.9	21	56	60	0.02	130	200	-	140	
SS9	0-0.5	20-Jun-12	<0.93	18	150	<4.6	<4.6	<4.6	<4.6	<4.6	<5	<5	<5	<5	8.9	23	7.6	5.5	19	<5	18	<5	<5	<5	12	21	0.01	72	120	-	150	
	1-1.5	20-Jun-12	<1	1.8	7	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	0.00	27	31	-	99	
SS10	0-0.5	20-Jun-12	<1	35	96	<5.4	<5.4	<5.4	<5.4	<5.4	5.6	9.2	16	12	8	27	<5	6.4	43	<5	69	5.6	<5	37	86	69	0.01	55	250	-	130	
	1-1.5	20-Jun-12	<0.99	15	68	<5	<5	<5	<5	<5	<10	<10	11	15	11	27	<10	<10	28	<10	47	<10	<10	12	29	39	0.02	45	110	-	95	
SS11	0-0.5	20-Jun-12	<1.1	96	820	<5.4	<5.4	<5.4	<5.4	<5.4	<5	10	11	10	7	44	<5	10	40	<5	59	<5	<5	37	54	64	0.01	89	350	-	150	
	1-1.5	20-Jun-12	<1	2.1	14	<5.1	<5.1	<5.1	<5.1	<5.1	<4.9	<4.9	<4.9	<4.9	<4.9	5.3	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	0.00	82	210	-	100
SS12	0-0.5	20-Jun-12	<1	74	460	<5.3	<5.3	<5.3	<5.3	<5.3	<10	22	52	45	46	140	21	38	86	<10	100	<10	15	47	74	120	0.07	120	410	-	200	
	1-1.5	20-Jun-12	<1	30	190	<5.1	<5.1	<5.1	<5.1	<5.1	11	13	14	22	42	8.8	14	29	<5	35	<5	6	16	29	42	0.03	71	2,300	0.12	100		
SS13	0-0.5	20-Jun-12	<1.1	140	560	<5.3	<5.3	<5.3	<5.3	<5.3	<50	190	390	1,300	1,000	2,500	240	880	1,700	110	3,300	67	280	<50	1,400	2,800	1.55	110	840	0.082	350	
	1-1.5	20-Jun-12	<1.1	13	60	<5.3	<5.3	<5.3	<5.3	<5.3	<5	<5	8.3	19	17	41	12	11	31	<5	42	<5	10	<5	16	31	0.03	19	60	-	57	
	0-0.5	20-Jun-12	<0.25	50	400B	<5	<5	<5	-	<10	<25	28	10J	21J	17J	61	17J	<25	32	<25	54	<25	<25	43	73	60	0.03	120	140	-	93	
SB-1	2.5-3	20-Jun-12	<0.24	0.798J	16JB	<4.9	<4.9	<4.9	<4.9	<4.9	<9.7	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	1.3J	<4.9	NC	14	4.6	-	34
	6.5-7	20-Jun-12	<0.28	0.45J	2.1JB	<5.7	<5.7	<5.7	-	<11	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	0.95	<4.9	NC	29	6.2	-	78	
	13-14	20-Jun-12	<0.44	470	9.2JB	<4.2	<4.2	<4.2	-	<8.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	NC	19	6.1	-	-
SB-2	0-0.5	20-Jun-12	<0.25	94	620B	<5	<5	<5	-	<9.9	<25	28	41	130	78	230	42	90	180	11J	220	5.5J	36	50	120	210	0.13	220	970	-	420	
	2.5-3	20-Jun-12	<0.24	0.64J	9.7JB	<4.8	<4.8	<4.8	-	<9.6	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	1.3J	<4.9	NC	12	5.9	-	34	
	6-7	20-Jun-12	<0.25	<0.99	1.8J	<5	<5	<5	-	<10	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	<4.9	0.81J	<4.9	NC	30	5.5	-	79	
	11-12	20-Jun-12	<0.23	1.7B	<50	<4.5	<4.5	<4.5	-	<9.1	<5	<5	<5	<5	<5	<5	<5	<5	<5	1.4J	<5	<5	<5	1.2J	1.6J	NC	19	6.7	-	54		
SB-3	0-0.5	19-Jun-12	<0.25	66	130B	<4.9	<4.9	<4.9	<4.9	<4.9	19.1	4.9J	10	15	14	6.9J	48	11	10	30	<9.9	63	5J	<9.9	140	85	86	0.02	38	62	-	89
	2.5-3	19																														

**Table 2: Previous Dissolved Metal Results in Groundwater<sup>(a)</sup>**

Location	Date	Arsenic	Lead
	Unit	µg/L	µg/L
MW-3.2	22-Sep-04	<5	<3
	8-Dec-04	<5	<3
	28-Mar-05	<5 [<5]	<3 [<3]
	10-May-05	<2	<1
	16-Aug-05	<1	<1
	8-Nov-05	<b>2</b>	<1
	7-Mar-06	<1	<1
	23-May-06	<1	<1
	7-Sep-06	<1.5	<b>0.19 J/J</b>
	6-Mar-07	<b>0.42 J</b>	<b>0.27 J</b>
MW-3.3	22-Sep-04	<5	<3
	8-Dec-04	<5	<3
	28-Mar-05	<5	<3
	10-May-05	<1 [<1]	<1 [<1]
	16-Aug-05	<1	<1
	8-Nov-05	<1	<1
	7-Mar-06	<1	<1
	23-May-06	<1	<1
	7-Sep-06	<1	<b>0.11 J/J</b>
	5-Dec-06	<b>1.7 [1.3]</b>	<b>0.12 J [&lt;1.0]</b>
	6-Mar-07	<1.0 [<1.0]	<b>0.37 J [0.45 J]</b>
	12-Jun-07	<1.0 J/UB [<1.0 J/UB]	<1.0 [<1.0]
	11-Oct-07	<b>0.38 J</b>	<b>0.17 J</b>
13-Dec-07	<1.0 J/UB	<1.0	
MW-3.13	11-Oct-07	<b>0.85 J</b>	<b>0.20 J</b>
	13-Dec-07	<1.0 J/UB	<1.0
	26-Mar-08	<b>0.15 J</b>	<1.0
	4-Jun-08	<b>0.28 J</b>	<1.0
	23-Sep-08	<b>0.26 J</b>	<b>0.063 J</b>
	11-Dec-08	<1.0	<1.0
	5-Mar-09	<1.0	<1.0
	9-Jun-09	<1.0	<1.0
15-Sep-09	<1.0	<b>2.2</b>	
MW-3.16	6-Oct-08	<1.0 J/UB	<1.0



**Table 2: Previous Dissolved Metal Results in Groundwater<sup>(a)</sup>**

Location	Date	Arsenic	Lead
	Unit	µg/L	µg/L
MW-3.17	7-Oct-08	1.8	0.48 J
	11-Dec-08	2.3	<1.0
	4-Mar-09	1.8	<1.0
	10-Jun-09	2.1 [2.1]	<1.0 [<1.0]
	15-Sep-09	2.8	1.7
	8-Dec-09	2	<1.0
	16-Mar-10	1.4	<1.0
	17-Jun-10	<1.0	<1.0
	22-Sep-10	1.1	<1.0
	16-Dec-10	<1.0	<1.0
MW-3.18	7-Oct-08	<1.0 J/UB	<1.0
	11-Dec-08	<1.0	<1.0
	5-Mar-09	<1.0	<1.0
	9-Jun-09	<1.0	<1.0
	16-Sep-09	<1.0 [<1.0]	<1.0 [<1.0]
	9-Dec-09	<1.0	<1.0
	16-Mar-10	<1.0 [<1.0]	<1.0 [<1.0]
	16-Jun-10	<1.0	<1.0
	23-Sep-10	<1.0 [<1.0]	<1.0 [<1.0]
	16-Dec-10	<1.0	<1.0

**Notes:**

(a) Collected as part of an ongoing operations and maintenance plan at the Mill Site.

Well Decommissioned

**bold -** detected above reporting limit

µg/L micrograms per liter

B Analyte found in associated blank.

J Estimated concentration based on either the being less than the laboratory reporting limit or data validation findings.

U Value has been qualified as undetected due to blank contamination.

[ ] Duplicate sample results

< Not detected at or above the indicated method reporting limit.

**Table 3: Previous TPH Results in Groundwater**

Location ID	Analyte	Total Gasoline	Total Diesel
	Units	mg/L	mg/L
	RWQCB	0.05	0.1
	PRG (Cal Western 2013 RFI Report Table 2)	1.2	1.2
	Remedial Goal (RG)	0.05	0.1
	Date		
<b>Grab Groundwater Samples<sup>(a)</sup></b>			
SB-1	20-Jun-12	2.2	18
SB-2	20-Jun-12	< 0.05	<0.052
SB-2 Duplicate	20-Jun-12	< 0.05	<0.054
SB-3	20-Jun-12	1.6	5.5
SB-4	19-Jun-12	19	170
SB-5	19-Jun-12	22	99
SB-6	19-Jun-12	1.1	52
SB-7	19-Jun-12	<0.05	0.04 J
<b>Mill Site Monitoring Wells<sup>(b)</sup></b>			
MW-3.2	28-Jan-04	0.18	0.4
	24-Jun-04	0.12	0.24
	22-Sep-04	0.083	0.45
	8-Dec-04	<0.05	0.56
	28-Mar-05	0.056 [0.058]	<0.05 [<0.05]
	10-May-05	<0.05	0.12
	16-Aug-05	<0.05	0.075
	8-Nov-05	0.035	0.197
	7-Mar-06	ND	ND
	23-May-06	0.023	0.112
	7-Sep-06	ND	ND
	6-Mar-07	0.193	0.365
	26-Mar-08	0.06	0.65
	5-Mar-09	0.16	4.51
	9-Jun-09	ND /UB	0.42
	8-Dec-09	0.145	1.03
	16-Mar-10	0.063	1.34
	27-Apr-11	0.26	0.26
	6-Oct-11	0.057	0.39
	22-Mar-12	0.13	1.5
21-Jun-12	0.049 J	0.17	
20-Sep-12	0.049 J	0.48	
7-Mar-13	0.177	1.1	
20-Aug-13	Not sampled due to the presence of LPH		
05-Mar-14	0.388 /J	1.1	

**Table 3: Previous TPH Results in Groundwater**

Location ID	Analyte	Total Gasoline	Total Diesel
	Units	mg/L	mg/L
	RWQCB	0.05	0.1
	PRG (Cal Western 2013 RFI Report Table 2)	1.2	1.2
	Remedial Goal (RG)	0.05	0.1
	Date		
MW-3.2 (cont'd)	17-Sep-14	<b>0.159</b>	<b>0.49</b>
	05-Mar-15	<b>0.123</b>	<b>0.73</b>
	02-Sep-15	<b>0.073</b>	<b>0.14</b>
	10-Mar-16	<b>0.045 J</b>	<0.053
	13-Sep-16	<b>0.036 J</b>	<b>0.096</b>
	23-Feb-17	<b>0.024 J</b>	<b>0.22</b>
	30-Aug-17	<b>0.041 J</b>	<b>0.43</b>
	07-Mar-18	<b>0.081</b>	<b>0.27</b>
	12-Sep-18	<b>0.048 J</b>	<b>0.11</b>
	25-Feb-19	<b>0.024 J/ J</b>	<b>0.65</b>
	11-Sep-20	--	<b>0.58</b>
	16-Mar-21	--	<b>0.32</b>
	16-Mar-21 Dup	--	<b>0.27</b>
MW-3.3	28-Jan-04	<0.05	<0.05
	24-Jun-04	<0.05	<0.05
	22-Sep-04	<0.05	<0.05
	8-Dec-04	<0.05	<b>0.074</b>
	28-Mar-05	<0.05	<0.05
	10-May-05	<0.05 [<0.05]	<0.013 [<0.013]
	16-Aug-05	<0.05	<0.013
	8-Nov-05	ND	ND
	7-Mar-06	ND	ND
	23-May-06	<b>0.011</b>	ND
	7-Sep-06	ND	ND
	5-Dec-06	ND [ND]	<b>0.28 [0.68]</b>
	6-Mar-07	ND [ND]	ND [ND]
	12-Jun-07	ND [ND]	ND [ND]
	11-Oct-07	ND	ND
13-Dec-07	ND	ND	
MW-3.13	11-Oct-07	<b>0.601</b>	<b>2.63</b>
	13-Dec-07	<b>0.174</b>	<b>0.475</b>
	26-Mar-08	<b>0.042 /J</b>	<b>0.182</b>
	4-Jun-08	ND /UB	<b>0.447</b>
	23-Sep-08	<b>0.052</b>	<b>0.093</b>
	11-Dec-08	ND /UB	<b>0.13</b>
	5-Mar-09	ND /UB	<b>0.15</b>

**Table 3: Previous TPH Results in Groundwater**

Location ID	Analyte	Total Gasoline	Total Diesel
	Units	mg/L	mg/L
	RWQCB	0.05	0.1
	PRG (Cal Western 2013 RFI Report Table 2)	1.2	1.2
	Remedial Goal (RG)	0.05	0.1
	Date		
MW-3.13 (cont'd)	9-Jun-09	ND /UB	<b>0.015 J</b>
	15-Sep-09	ND /UB	ND
	16-Mar-10	ND /UB	<b>0.195</b>
	17-Dec-10	ND /UB	<b>0.047</b>
	27-Apr-11	<0.05 J/UB	<b>0.13</b>
	6-Oct-11	<b>0.022 J</b>	<0.053 J/UB
	22-Mar-12	<b>0.034 J</b>	<0.052
	19-Sep-12	<b>0.033 J</b>	<0.054
	6-Mar-13	<0.05	<0.15 /UB
	20-Aug-13	<0.05	<b>0.053</b>
	05-Mar-14	<50.0 /UJ [<50.0 /UJ]	<b>0.15 [0.13]</b>
	16-Sep-14	<0.1	<b>0.056</b>
	03-Mar-15	<0.1	<b>0.41</b>
	01-Sep-15	<0.05	<0.048
	08-Mar-16	<b>0.021 J</b>	<0.054
	13-Sep-16	<b>0.026 J</b>	<0.053
	21-Feb-17	<0.05	<0.053
	30-Aug-17	<0.05	<b>0.1</b>
	06-Mar-18	<b>0.025 J/J</b>	<0.059
	12-Sep-18	< 0.05	<0.051
	25-Feb-19	< 0.05 U	<b>0.32</b>
	11-Sep-20	--	<b>0.1 J</b>
	16-Mar-21	--	<b>0.061</b>

**Table 3: Previous TPH Results in Groundwater**

Location ID	Analyte	Total Gasoline	Total Diesel
	Units	mg/L	mg/L
	RWQCB	0.05	0.1
	PRG (Cal Western 2013 RFI Report Table 2)	1.2	1.2
	Remedial Goal (RG)	0.05	0.1
	Date		
MW-3.16	6-Oct-08	<b>0.012</b>	ND
MW-3.16R	11-Dec-08	ND /UB [ND /UB]	ND [ND]
	5-Mar-09	ND	ND
	9-Jun-09	ND /UB	<b>0.011</b>
	15-Sep-09	ND	ND
	8-Dec-09	ND	<b>0.01</b>
	16-Mar-10	ND /UB	ND
	16-Jun-10	ND /UB	ND
	22-Sep-10	ND [ND /UB]	ND [ND]
	16-Dec-10	ND /UB [ND /UB]	ND [ND]
	27-Apr-11	<0.05 J/UB	<b>0.041 J</b>
	6-Oct-11	<0.05	<0.054 J/UB
	22-Mar-12	<0.05	<0.052
	21-Jun-12	<0.05	<0.051
	19-Sep-12	<0.05	<0.057
	6-Mar-13	<0.05	<0.15 /UB
	12-Sep-18	< 0.05	<0.05
26-Feb-19	---	---	
11-Sep-20	---	---	
16-Mar-21	---	---	
MW-3.17	7-Oct-08	<b>1.26</b>	<b>0.16</b>
	11-Dec-08	<b>0.73</b>	<b>0.164</b>
	4-Mar-09	<b>0.47</b>	<b>0.188</b>
	10-Jun-09	<b>0.361 [0.352]</b>	<b>0.109 [0.097]</b>
	15-Sep-09	<b>0.256</b>	<b>0.146</b>
	8-Dec-09	<b>0.41</b>	<b>0.263</b>
	16-Mar-10	<b>0.35</b>	<b>0.15</b>
	17-Jun-10	<b>0.42</b>	ND
	22-Sep-10	<b>0.353</b>	<b>0.112</b>
	16-Dec-10	<b>0.305</b>	<b>0.061</b>
	13-Sep-18	<b>0.08 [0.098]</b>	<b>0.047J [0.039 J]</b>
	27-Feb-19	<b>0.074 [0.075]</b>	<0.047 U [<0.047 U]

**Table 3: Previous TPH Results in Groundwater**

Location ID	Analyte	Total Gasoline	Total Diesel
	Units	mg/L	mg/L
	RWQCB	0.05	0.1
	PRG (Cal Western 2013 RFI Report Table 2)	1.2	1.2
	Remedial Goal (RG)	0.05	0.1
	Date		
MW-3.18	7-Oct-08	<b>0.012</b>	ND
	11-Dec-08	ND /UB	ND
	5-Mar-09	ND /UB	ND
	9-Jun-09	ND /UB	<b>0.0098</b>
	16-Sep-09	ND /UB [ND /UB]	ND [ND]
	9-Dec-09	ND /UB	ND
	16-Mar-10	ND /UB [ND /UB]	<b>0.0237 [ND]</b>
	16-Jun-10	ND /UB	ND
	23-Sep-10	ND [ND /UB]	<b>0.019 [ND]</b>
	16-Dec-10	ND /UB	ND
	12-Sep-18	< 0.05	<0.05
	26-Feb-19	---	---
	11-Sep-20	---	---
	16-Mar-21	---	---

**Notes:**

(a) Collected by ERM or Arcadis as part of the 2012 RCRA Facility Investigation Report Sampling Effort. Results from grab samples likely biased high due to fines in the samples.

(b) Collected as part of an ongoing operations and maintenance plan at the Mill Site.

	Well Decommissioned
	Greater than PRG presented in 2013 RFI Report, Table 2 (Cal Western Site).
<b>bold -</b>	detected above reporting limit
RWQCB	Regional Water Quality Control Board Water Quality Objective
PRG	U.S. Environmental Protection Agency Region 9 Preliminary Remediation Goal
mg/L	milligrams per liter
B	Analyte found in associated blank.
J	Estimated concentration based on either the being less than the laboratory reporting limit or data validation findings.
U	Value has been qualified as undetected due to blank contamination.
ND	Not detected.
[ ]	Duplicate sample results
--	Not measured, not available, or not applicable.
<	Not detected at or above the indicated method reporting limit.

**Table 4: Previous VOC Results in Groundwater**

Location	Date	1,2,4-Trichlorobenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Benzene	Naphthalene	Tetrachloroethene	Trichloroethene
	Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	PRG (Cal Western 2013 RFI Report Table 2)	7	12	12	0.15	0.093	0.1	1
	Remedial Goal (RG) <sup>(a)</sup>	---	---	---	0.15	---	0.06	1.7
	MCL	5	---	---	1	---	5	5
<b>Grab Groundwater Samples <sup>(b)</sup></b>								
SB-1	20-Jun-12	<0.5	<0.5	<0.5	<0.5	0.31J	8.3	0.66 J
SB-2	20-Jun-12	<1	<0.5	<0.5	<0.5	<1	5.5	<0.5
SB-2 Duplicate	20-Jun-12	<1	<0.5	<0.5	<0.5	<1	4.4	<0.5
SB-3	20-Jun-12	< 2.0	< 2.0	< 2.0	< 1.0	5.8	20	0.42 J
SB-4	19-Jun-12	< 2.0	< 2.0	< 2.0	< 1.0	12J	< 1.0	< 1.0
SB-5	19-Jun-12	69	< 2.0	33	< 1.0	80	< 1.0	37.8
SB-6	19-Jun-12	<5	24	5.1	<5	180	<5	<5
SB-7	19-Jun-12	<1	<1	<0.5	0.49J	<1	<0.5	<0.5
<b>Mill Site Monitoring Wells <sup>(c)</sup></b>								
MW-3.2	22-Sep-04	<0.5	<0.5	<0.5	<0.5	<0.5	2.2	0.8
	8-Dec-04	<0.5	<0.5	<0.5	<0.5	<0.5	1.5	0.5
	28-Mar-05	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<2 [ $<2$ ]	2.1 [2.1]	0.6 [0.5]
	10-May-05	<0.2	<0.08	<0.08	<0.04	<0.2	1.8	0.5 J
	16-Aug-05	<0.2	<0.08	<0.08	<0.04	<0.2	2.4	0.4 J
	8-Nov-05	<0.2	<0.1	<0.1	19	<0.05	0.9	0.4 J
	7-Mar-06	<0.2	<0.09	<0.09	0.2 J	<0.1	8.1	0.8
	23-May-06	<0.1	<0.07	<0.05	2.8	<0.06	8.2	0.8
	7-Sep-06	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	4 [3]	<2 [ $<2$ ]	3.5 [4.7]	0.7 [0.8]
	6-Mar-07	<0.5	52	16	1.6	18	3.3	0.9
	26-Mar-08	<0.5	2.4	1.3	1.2	2.5	7.7	1.5
	5-Mar-09	<0.5	48	12	2.4	8.7	1.8	1
	9-Jun-09	<0.5	5.8	1.8	2.6	0.7 J	1.9	0.6
	8-Dec-09	<0.5	35	12	2	5.2	2.2 /J	1
	16-Mar-10	<0.5	11	3.1	0.8	1.8 J	3	1.4
	12-Sep-18	---	---	---	---	---	---	---
	25-Feb-19	---	---	---	---	---	---	---
	11-Sep-20	---	---	---	0.092 J	---	1.2	2.2
16-Mar-21	---	---	---	0.11 J	---	0.27 J	0.58	
16-Mar-21 Dup	---	---	---	---	---	0.28 J	0.58	

**Table 4: Previous VOC Results in Groundwater**

Location	Date	1,2,4-Trichlorobenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Benzene	Naphthalene	Tetrachloroethene	Trichloroethene
	Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	<b>PRG (Cal Western 2013 RFI Report Table 2)</b>	<b>7</b>	<b>12</b>	<b>12</b>	<b>0.15</b>	<b>0.093</b>	<b>0.1</b>	<b>1</b>
	<b>Remedial Goal (RG) <sup>(a)</sup></b>	<b>---</b>	<b>---</b>	<b>---</b>	<b>0.15</b>	<b>---</b>	<b>0.06</b>	<b>1.7</b>
	<b>MCL</b>	<b>5</b>	<b>---</b>	<b>---</b>	<b>1</b>	<b>---</b>	<b>5</b>	<b>5</b>
MW-3.3	22-Sep-04	<0.5	<0.5	<0.5	<0.5	<0.5	1.8	<0.5
	8-Dec-04	<0.5	2.3	<0.5	<0.5	<0.5	0.9	<0.5
	28-Mar-05	<0.5	<0.5	<0.5	<0.5	<2	1.6	<0.5
	10-May-05	<0.2 [<0.2]	<0.08 [<0.1]	<0.08 [<0.1]	<0.04 [<0.04]	<0.2 [<0.05]	1.9 [1.7]	0.4 J [0.3 J]
	16-Aug-05	<0.2	<0.08	<0.08	<0.04	<0.2	1.8	0.4 J
	8-Nov-05	<0.2	<0.1	<0.1	<0.04	<0.05	0.9	0.1 J
	7-Mar-06	<0.2	<0.09	<0.09	<0.04	<0.1	1.2	0.2 J
	23-May-06	<0.1	<0.07	<0.05	0.07 J	<0.06	1.5	0.3 J
	7-Sep-06	<0.5	<0.5	<0.5	<0.5	<2	2.1	0.3 J/J
	5-Dec-06	<0.5 [<0.5]	<0.5 [<0.5]	<0.5 [<0.5]	<0.5 [<0.5]	<2.0 [<2.0]	2.3 [2.2]	<0.5 J/UB [<0.5 J/UB]
	6-Mar-07	<0.5 [<0.5]	<0.5 [<0.5]	<0.5 [<0.5]	<0.5 [<0.5]	<2.0 [<2.0]	2.5 [2.4]	0.4 J [0.4 J]
	12-Jun-07	<0.5 [<0.5]	<0.5 [<0.5]	<0.5 [<0.5]	<0.5 [<0.5]	<2.0 [<2.0]	2.4 [2.4]	0.4 J [0.3 J]
	11-Oct-07	<0.5	<0.5	<0.5	<0.5	<2.0	1.6	0.3 J
	13-Dec-07	<0.5	<0.5	<0.5	<0.5	<2.0	2.2	0.4 J
	26-Mar-08	<0.5	<0.5	<0.5	<0.5	<2.0	2.5	0.4 J
	4-Jun-08	<0.5	<0.5	<0.5	<0.5	<2.0	2.6	0.5 J
	23-Sep-08	<0.5	<0.5	<0.5	<0.5	<2.0	1.9	0.4 J
	11-Dec-08	<0.5	<0.5	<0.5	<0.5	<2.0	2.4	0.5
	5-Mar-09	<0.5	<0.5	<0.5	<0.5	<2.0	1.9	0.4 J
	9-Jun-09	<0.5	<0.5	<0.5	<0.5	<2.0	2.7	0.4 J
	15-Sep-09	<0.5	<0.5	<0.5	<0.5	<2.0	1.8	0.4 J
8-Dec-09	<0.5	<0.5	<0.5	<0.5	<2.0	1.6 /J	0.4 J	
16-Mar-10	<0.5	<0.5	<0.5	<0.5	<2.0	2.4	0.4 J	
16-Jun-10	<0.5	<0.5	<0.5	<0.5	<2.0	2.2	0.5 J	
23-Sep-10	<0.5	<0.5	<0.5	<0.5	<2.0	2.1	0.4 J	
16-Dec-10	<0.5	<0.5	<0.5	<0.5	<2.0	2.1	0.4 J	
12-Sep-18	< 0.30	< 0.30	< 0.50	< 0.20	< 1.0	2	0.58	
28-Feb-19	< 0.30 U	< 0.30 U	< 0.50 U	< 0.20 U	< 1.0 U	1.5	0.56	
16-Mar-21	--	--	--	--	--	1.7	0.57	
MW-3.13	11-Oct-07	<0.5	81	37	3.6	6.9	14	2
	13-Dec-07	<0.5	2.7	0.7	0.6	1.3 J	19	2.3
	26-Mar-08	<0.5	0.3 J	0.1 J	1.6	0.4 J	22	1.7
	4-Jun-08	<0.5	<0.5 J/UB	<0.5	0.5	<2.0	25	1.8
	23-Sep-08	<0.5	0.8	0.3 J	1.7	<2.0	24	2.9
	11-Dec-08	<0.5	1	0.3 J	1.9	<2.0	29	3
5-Mar-09	<0.5	0.2 J	<0.5	0.6	<2.0	20	2.3	



**Table 4: Previous VOC Results in Groundwater**

Location	Date	1,2,4-Trichlorobenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Benzene	Naphthalene	Tetrachloroethene	Trichloroethene
	Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	PRG (Cal Western 2013 RFI Report Table 2)	7	12	12	0.15	0.093	0.1	1
	Remedial Goal (RG) <sup>(a)</sup>	---	---	---	0.15	---	0.06	1.7
	MCL	5	---	---	1	---	5	5
MW-3.13 (cont'd)	9-Jun-09	<0.5	<0.5	<0.5	0.2 J	<2.0	21	1.6
	15-Sep-09	<0.5	<0.5	<0.5	0.5	<2.0	17	1.7
	16-Mar-10	<0.5	0.2 J	<0.5	1.5	<2.0	15	1.7
	17-Dec-10	<0.5	<0.5	<0.5	0.2 J	<2.0	16	2.5
	27-Apr-11	<1.0	<0.50	<0.50	0.73	<1.0	10	1.5
	6-Oct-11	<1.0	<0.50	<0.50	<0.50	<1.0	13	2
	22-Mar-12	<1.0	<0.50	<0.50	<0.50	<1.0	14	1.9
	19-Sep-12	<1	<0.5	<0.5	<0.5	<1	21	2
	06-Mar-13	<0.50	<0.50	<0.50	<0.50	<1.0	17.2	1.8
	20-Aug-13	<0.50	<0.50	<0.50	<0.50	<1.0	24.2	2.6
	05-Mar-14	<0.50 [ $<0.50$ ]	<0.50 [ $<0.50$ ]	<0.50 [ $<0.50$ ]	0.43 J [0.43 J]	2.4 [2.4]	11.9 [11.9]	2.0 [1.9]
	16-Sep-14	<0.50	<0.50	<0.50	0.30 J	<1.0	19.7	2.4
	3-Mar-15	<4.0 /UJ	<0.50	<0.50	0.19 J	<4.0	9.2	1.5
	01-Sep-15	<1.0	<0.50	<0.50	<0.50	<1.0	13	1.8
	08-Mar-16	<1.0	<0.50	<0.50	<0.50	<1.0	8.6	0.95
	13-Sep-16	<1.0	<0.50	<0.50	<0.50	<1.0	15	1.4
	21-Feb-17	<1	<0.5	<0.5	<0.5	<1	3.4	0.44 J
	30-Aug-17	< 1.0	< 0.50	< 0.50	< 0.50	< 1.0	7.3	2
	06-Mar-18	<1.0	<0.50	<0.50	<0.50	<1.0	10	1.6
	12-Sep-18	< 0.30	< 0.30	< 0.50	< 0.20	< 1.0	12	2.1
25-Feb-19	< 0.30 U	< 0.30 U	< 0.50 U	< 0.20 U	< 1.0 U	11	1.5	
11-Sep-20	---	---	---	< 0.20	---	21	2.0	
16-Mar-21	---	---	---	< 0.20	---	14	1.8	
MW-3.16	6-Oct-08	<0.5	<0.5	<0.5	<0.5	<2.0	1.1	0.5 J
MW-3.16R	11-Dec-08	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<2.0 [ $<2.0$ ]	0.6 [0.6]	0.1 J [ $<0.5$ ]
	5-Mar-09	<0.5	<0.5	<0.5	<0.5	<2.0	1	0.3 J
	9-Jun-09	<0.5	<0.5	<0.5	<0.5	<2.0	0.7	<0.5
	15-Sep-09	<0.5	<0.5	<0.5	<0.5	<2.0	0.6	<0.5
	8-Dec-09	<0.5	<0.5	<0.5	<0.5	<2.0	0.8	0.1 J
	16-Mar-10	<0.5	<0.5	<0.5	<0.5	<2.0	0.6	0.1 J
	16-Jun-10	<0.5	<0.5	<0.5	<0.5	<2.0	0.6 /J	0.2 J
	22-Sep-10	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<2.0 [ $<2.0$ ]	0.5 [0.5]	0.1 J [0.1 J]
	16-Dec-10	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<2.0 [ $<2.0$ ]	0.6 [0.6]	0.1 J [0.1 J]
	12-Sep-18	< 0.30	< 0.30	< 0.50	< 0.20	< 1.0	0.49 J	< 0.20
	26-Feb-19	< 0.30 U	< 0.30 U	< 0.50 U	< 0.20 U	< 1.0 U	0.59	0.066 J/ J
	11-Sep-20	--	--	--	--	--	0.59	< 0.20
	16-Mar-21	--	--	--	--	--	0.41 J	< 0.20

**Table 4: Previous VOC Results in Groundwater**

Location	Date	1,2,4-Trichlorobenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Benzene	Naphthalene	Tetrachloroethene	Trichloroethene
	Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
	PRG (Cal Western 2013 RFI Report Table 2)	7	12	12	0.15	0.093	0.1	1
	Remedial Goal (RG) <sup>(a)</sup>	---	---	---	0.15	---	0.06	1.7
	MCL	5	---	---	1	---	5	5
MW-3.17	7-Oct-08	<0.5	<0.5	<0.5	<0.5	<2.0	<0.5	<b>0.2 J</b>
	11-Dec-08	<0.5	<0.5	<0.5	<0.5	<2.0	<b>0.5</b>	<b>0.8</b>
	4-Mar-09	<0.5	<0.5	<0.5	<0.5	<2.0	<b>0.9</b>	<b>1</b>
	10-Jun-09	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<2.0 [ $<2.0$ ]	<b>0.5 J [0.4 J]</b>	<b>1.0 [1.0]</b>
	15-Sep-09	<0.5	<0.5	<0.5	<0.5	<2.0	<0.5	<b>0.8</b>
	8-Dec-09	<0.5	<0.5	<0.5	<0.5	<2.0	<b>0.3 J</b>	<b>1.7</b>
	16-Mar-10	<0.5	<0.5	<0.5	<0.5	<2.0	<b>0.4 J</b>	<b>2</b>
	17-Jun-10	<0.5	<0.5	<0.5	<0.5	<2.0	<0.5	<b>1.1</b>
	22-Sep-10	<0.5	<0.5	<0.5	<0.5	<2.0	<b>0.1 J</b>	<b>1.3</b>
	16-Dec-10	<0.5	<0.5	<0.5	<0.5	<2.0	<b>0.2 J</b>	<b>1.6</b>
MW-3.17	13-Sep-18	< 0.30 R [ $< 0.30$ ]	< 0.30 R [ $< 0.30$ ]	< 0.50 R [ $< 0.50$ ]	< 0.20 R [ $<0.20$ ]	< 1.0 R [ $< 1.0$ ]	<b>0.32 J</b> <b>[0.41 J]</b>	<b>0.57 J</b> <b>[0.78 J]</b>
	27-Feb-19	< 0.30 U [ $< 0.30$ U]	< 0.30 U [ $< 0.30$ U]	< 0.50 U [ $< 0.50$ U]	< 0.20 U [ $<0.20$ U]	< 1.0 U [ $< 1.0$ U]	<b>0.39 J/J</b> <b>[0.41 J/J]</b>	<b>0.73 [0.76]</b>
MW-3.18	7-Oct-08	<0.5	<0.5	<0.5	<b>0.2 J</b>	<2.0	<b>3.3</b>	<b>1</b>
	11-Dec-08	<0.5	<0.5	<0.5	<b>0.2 J</b>	<2.0	<b>4</b>	<b>1.4</b>
	5-Mar-09	<0.5	<0.5	<0.5	<0.5	<2.0	<b>3.3</b>	<b>1.2</b>
	9-Jun-09	<0.5	<0.5	<0.5	<0.5	<2.0	<b>3</b>	<b>1</b>
	16-Sep-09	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<2.0 [ $<2.0$ ]	<b>3.2 [3.4]</b>	<b>1.2 [1.2]</b>
	9-Dec-09	<0.5	<0.5	<0.5	<0.5	<2.0	<b>4.1</b>	<b>1.2</b>
	16-Mar-10	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<2.0 [ $<2.0$ ]	<b>2.9 [3.2]</b>	<b>1.0 [1.1]</b>
	16-Jun-10	<0.5	<0.5	<0.5	<b>0.2 J</b>	<2.0	<b>2.8</b>	<b>0.9</b>
	23-Sep-10	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<0.5 [ $<0.5$ ]	<b>0.2 J [0.2 J]</b>	<2.0 [ $<2.0$ ]	<b>5.0 [4.7]</b>	<b>1.2 [1.2]</b>
	16-Dec-10	<0.5	<0.5	<0.5	<b>0.1 J</b>	<2.0	<b>4.1</b>	<b>1.4</b>
	12-Sep-18	< 0.30	< 0.30	< 0.50	< 0.20	< 1.0	<b>4.3</b>	<b>1.7</b>
	26-Feb-19	< 0.30 U	< 0.30 U	< 0.50 U	< 0.20 U	< 1.0 U	<b>3.6</b>	<b>1.6</b>
	11-Sep-20	--	--	--	--	--	<b>4.1</b>	<b>1.2</b>
16-Mar-21	--	--	--	--	--	<b>3.6</b>	<b>1.3</b>	

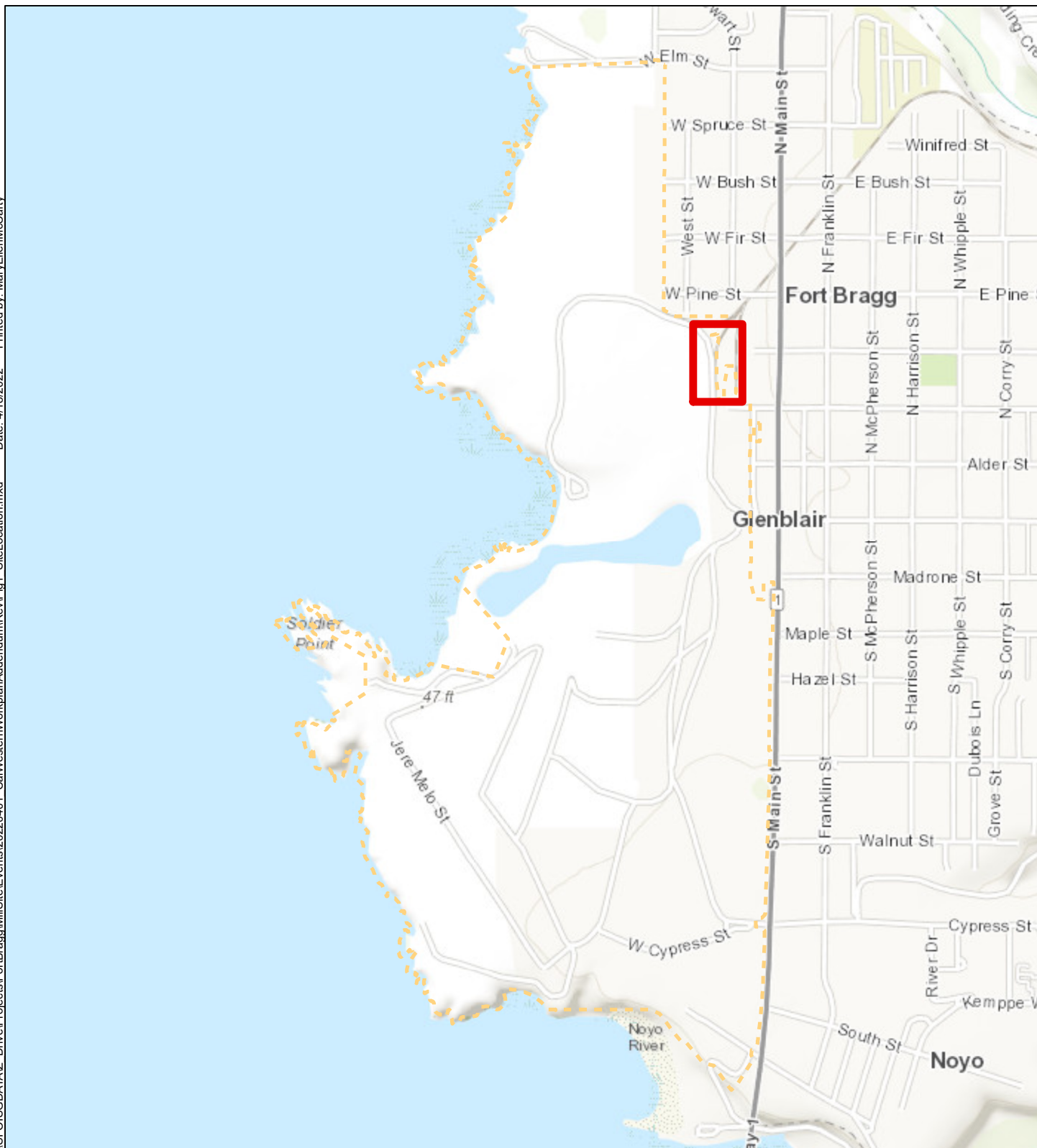
**Notes:**

- (a) Remedial Goal (RG) for Mill Site Groundwater O&M Plan monitoring program provided for reference.
  - (b) Collected by ERM or Arcadis as part of the 2012 RCRA Facility Investigation Report Sampling Effort. Results from grab samples likely biased high due to fines in the samples.
  - (c) Collected as part of an ongoing operations and maintenance plan at the Mill Site.
- Well Decommissioned
- Greater than PRG or RBSC value presented in 2013 RFI Report, Table 2 (Cal Western Site). If no value available, compared to MCL.
- bold** - detected above reporting limit
- PRG U.S. Environmental Protection Agency Region 9 Preliminary Remediation Goal
- RBSC Risk Based Screening Criteria
- µg/L micrograms per liter
- B Analyte found in associated blank.
- J Estimated concentration based on either the being less than the laboratory reporting limit or data validation findings.
- U Value has been qualified as undetected due to blank contamination.
- [ ] Duplicate sample results
- Not measured, not available, or not applicable.
- < '<' denotes not detected at or above the indicated method reporting limit.

## **Figures**

---

\\SFOISG\DATA\Z\_Drive\Projects\FortBragg\MillSite\Events\2022\0401\_CalWesternWorkplanAddendum\Rev\Fig1\_SiteLocation.mxd Date: 4/18/2022 Printed by: MaryEllenMcCarty



**Legend**

- Study Area
- - - Former Mill Site

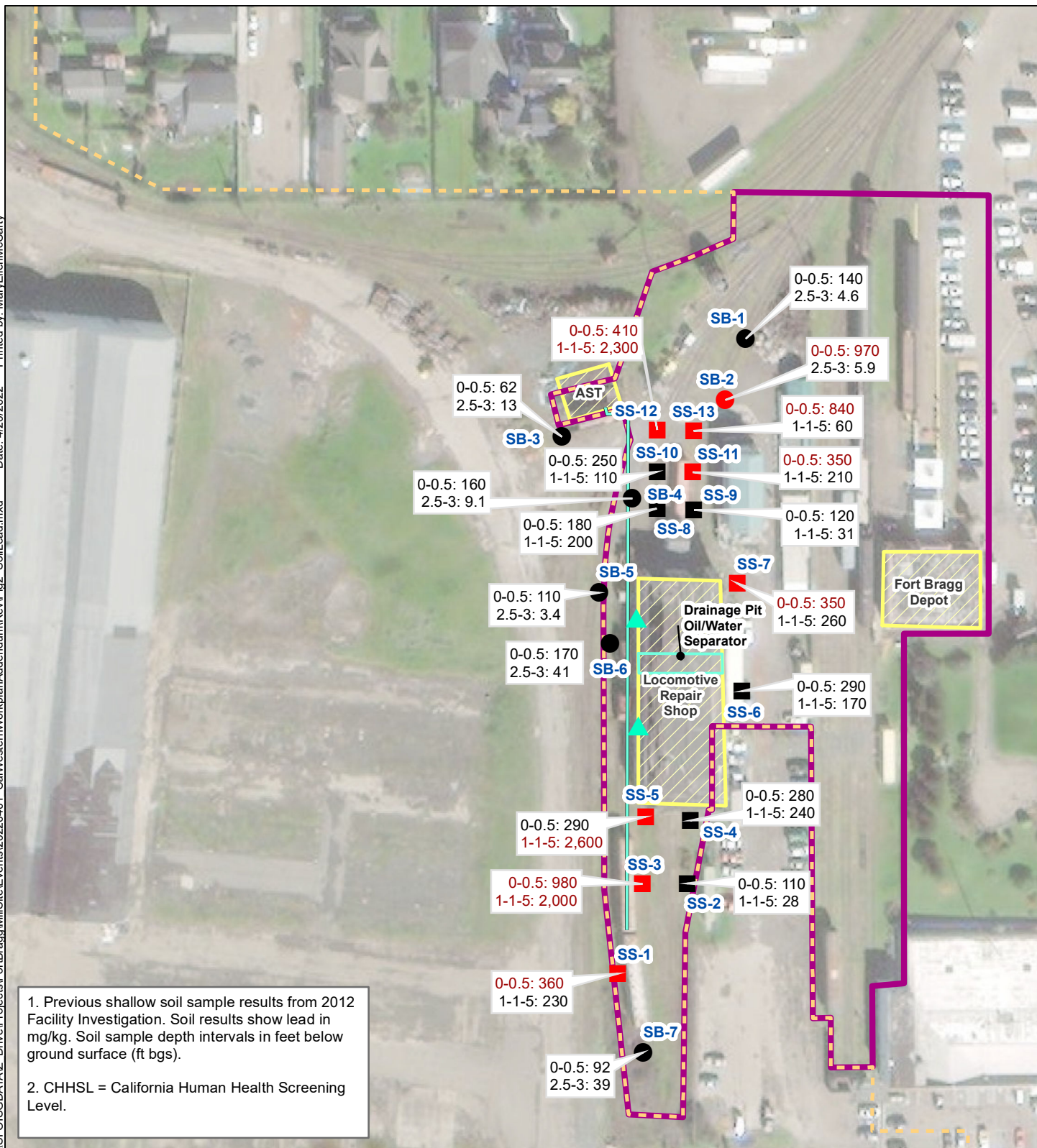
**KJ** Kennedy Jenks  
 California Western Facility  
 Fort Bragg, California

**Site Location Map**

1965021\*20  
April 2022

**Figure 1**

\\SFOISSGDATA\Z Drive\Projects\FortBraggMill\SiteEvents\20220401\_CalWesternWorkplanAddendum\Rev\Fig2\_SoilLead.mxd Date: 4/20/2022 Printed by: MaryEllenMcCarty

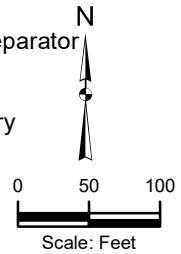


**Legend**

- Soil Boring, Previous Lead Result Above CHHSL (320 mg/kg)
- Soil Boring, Previous Lead Result Below CHHSL (320 mg/kg)
- Surface Sample, Previous Lead Result Above CHHSL (320 mg/kg)
- Surface Sample, Previous Lead Result Below CHHSL (320 mg/kg)
- ▲ Former Fuel Stations

- Underground Fuel Line
- Drainage Pit Oil/Water Separator
- ▭ Former Mill Site
- ▭ Subject Property Boundary

**Notes:**  
 1. All locations are approximate.



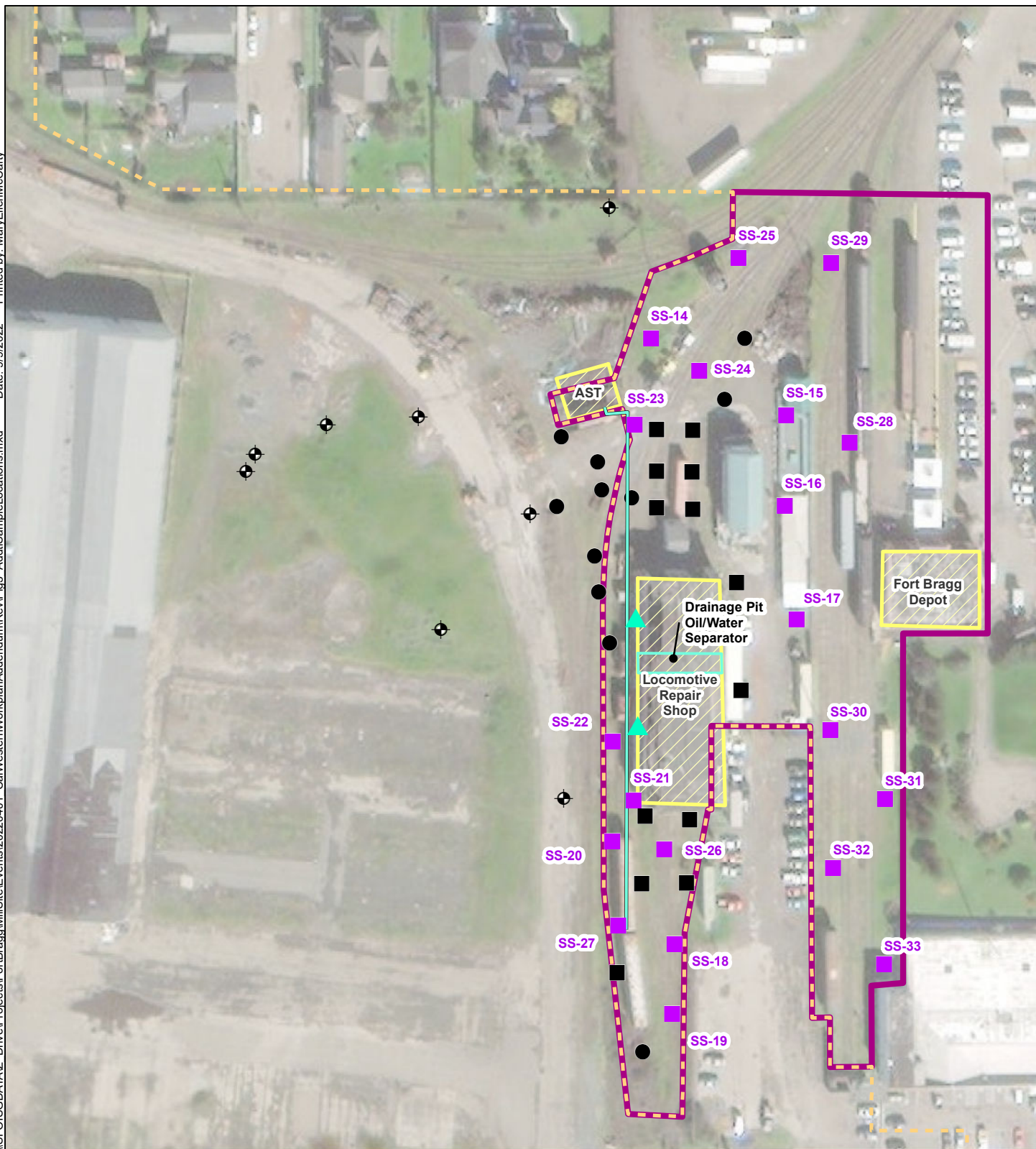
**KJ** Kennedy Jenks  
 California Western Facility  
 Fort Bragg, California

**Previous Soil Sample Locations and Results, Lead**

1965021\*20  
 April 2022

**Figure 2**

\\SFOISG\DATA\Z Drive\Projects\FortBraggMillSite\Events\20220401\_CalWesternWorkplanAddendum\Rev\Fig3\_AddtlSampleLocations.mxd Date: 9/9/2022 Printed by: MaryEllenMcCarty



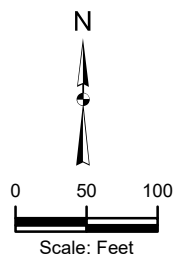
**Legend**

- Proposed Soil Sample Location for Lead and Arsenic
- ▲ Former Fuel Stations
- Underground Fuel Line
- Drainage Pit Oil/Water Separator
- Previous Boring Location
- Previous Surface Sample Location
- ⊕ Mill Site Monitoring Wells

- Former Mill Site
- Subject Property Boundary

**Notes:**

1. All locations are approximate.
2. Samples will be collected from three depth intervals: 0-0.5 feet below ground surface (ft bgs), 1-1.5 ft bgs, and 2.5-3 ft bgs.



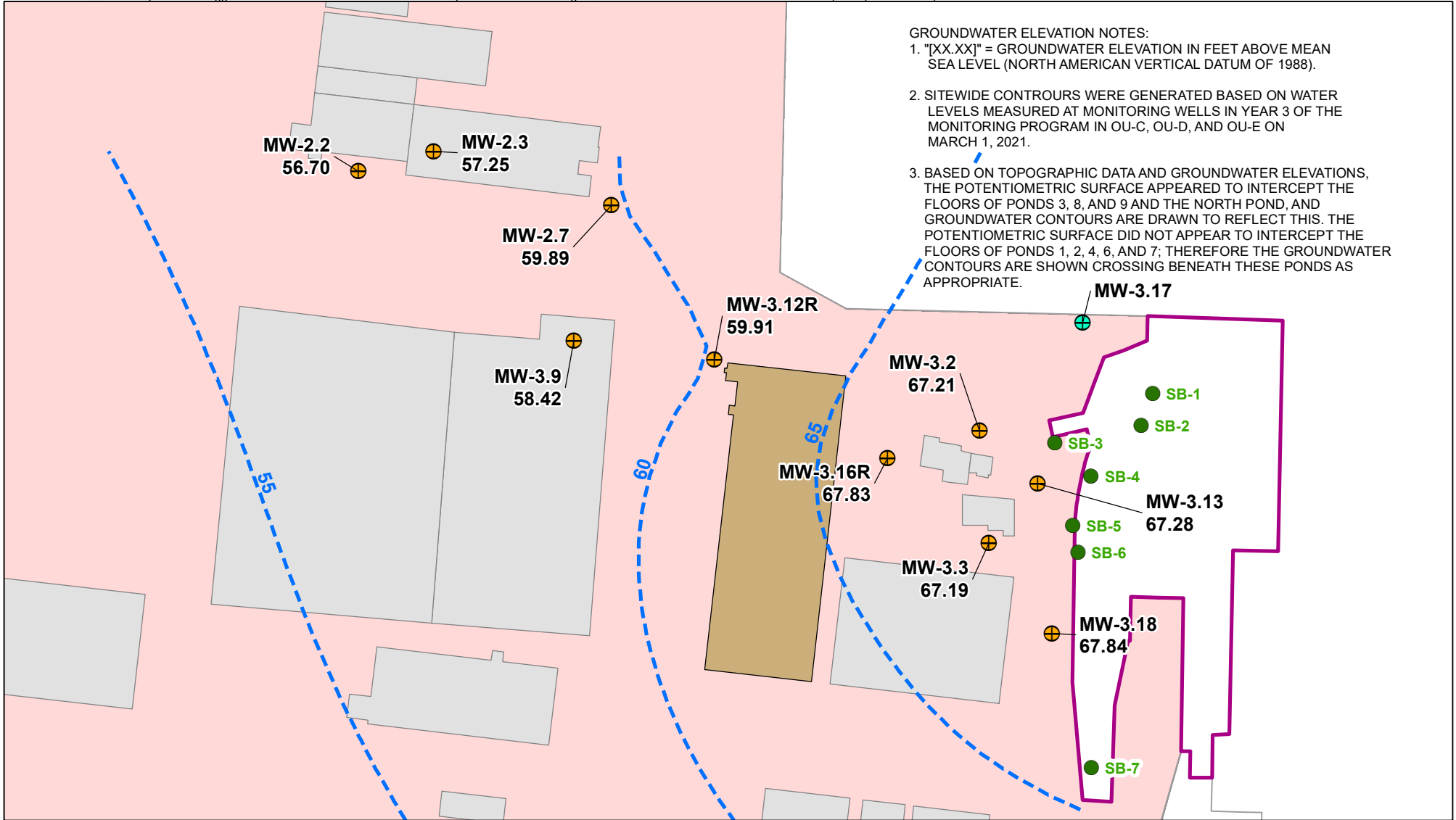
**KJ** Kennedy Jenks

California Western Facility  
Fort Bragg, California

**Proposed Additional  
Soil Sampling Locations**

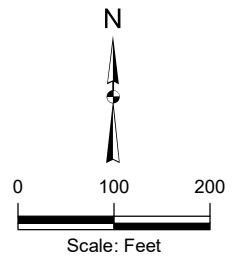
1965021\*20  
September 2022

**Figure 3**



**Legend**

- Structure
- Former Structure
- Mill Site (Operable Unit C)
- Subject Property Boundary
- ⊕ Monitoring Network (Years 3 and 5)
- ⊕ Monitoring Network (Year 5 only)
- Approximate Location of 2012 California Western Facility Investigation Soil Borings

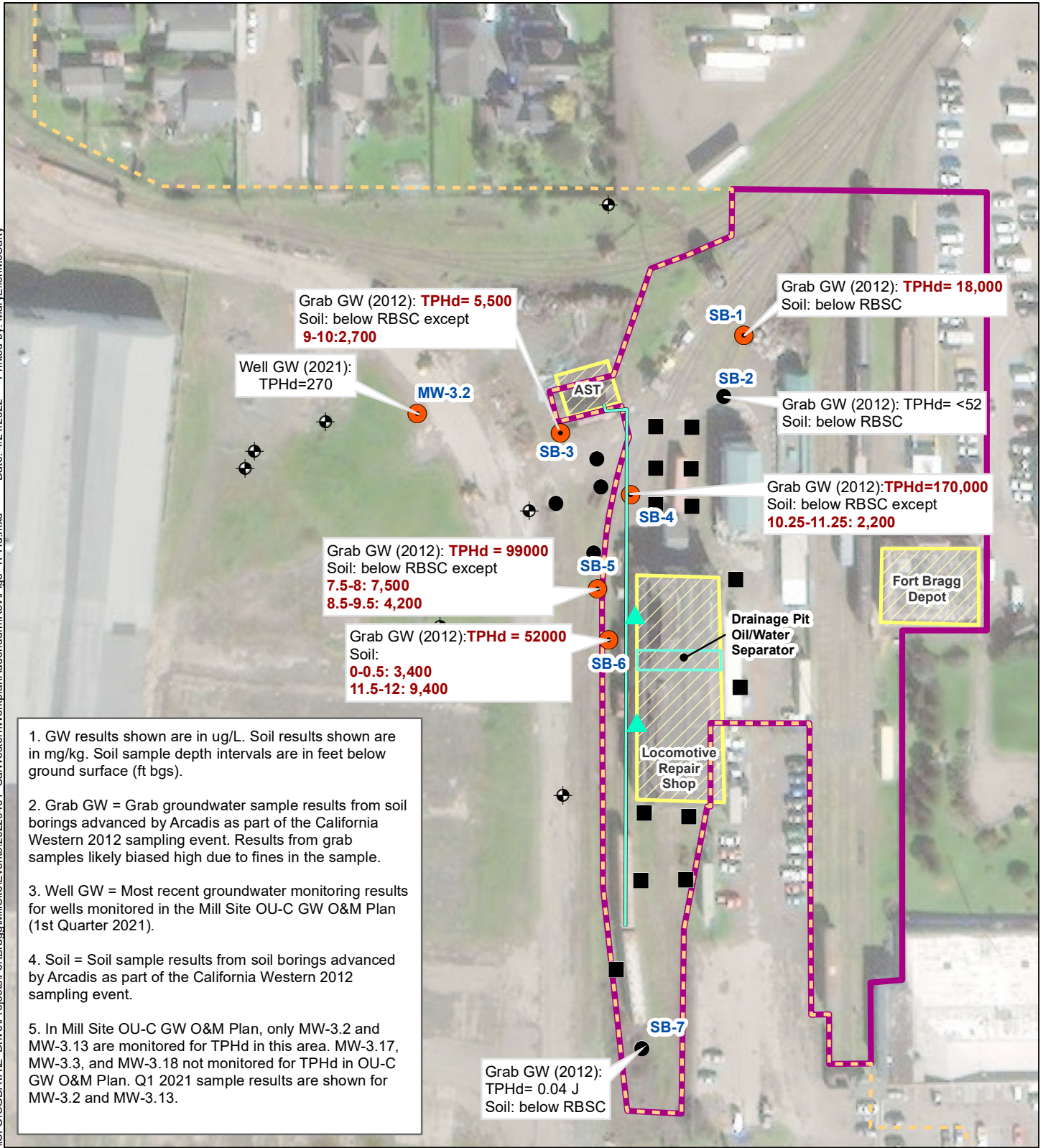


**KJ** Kennedy Jenks  
 California Western Facility  
 Fort Bragg, California

**Groundwater Contour Map  
 First Quarter 2021**

1965021\*20  
 April 2022  
**Figure 4**

\\SFOISGDATA\Z\_Drive\Projects\FortBragg\MillSite\Events\2022\0401\_CalWesternWorkplanAddendum\Rev\Fig5\_TPHd.mxd Date: 4/21/2022 Printed by: MaryEllenMcCarty

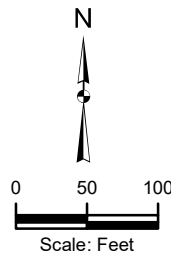


**Legend**

- ▲ Former Fuel Stations
- Underground Fuel Line
- Drainage Pit Oil/Water Separator
- Above applicable screening level
- Previous Boring Location
- Previous Surface Sample Location
- ⊕ Mill Site Monitoring Wells
- Former Mill Site
- Subject Property Boundary

**Notes:**

1. All locations are approximate.
2. TPHd Mill Site Risk Based Screening Criteria for comparison:
  - GW: 1,200 ug/L
  - Soil: 1,040 mg/kg



**KJ** Kennedy Jenks

California Western Facility  
Fort Bragg, California

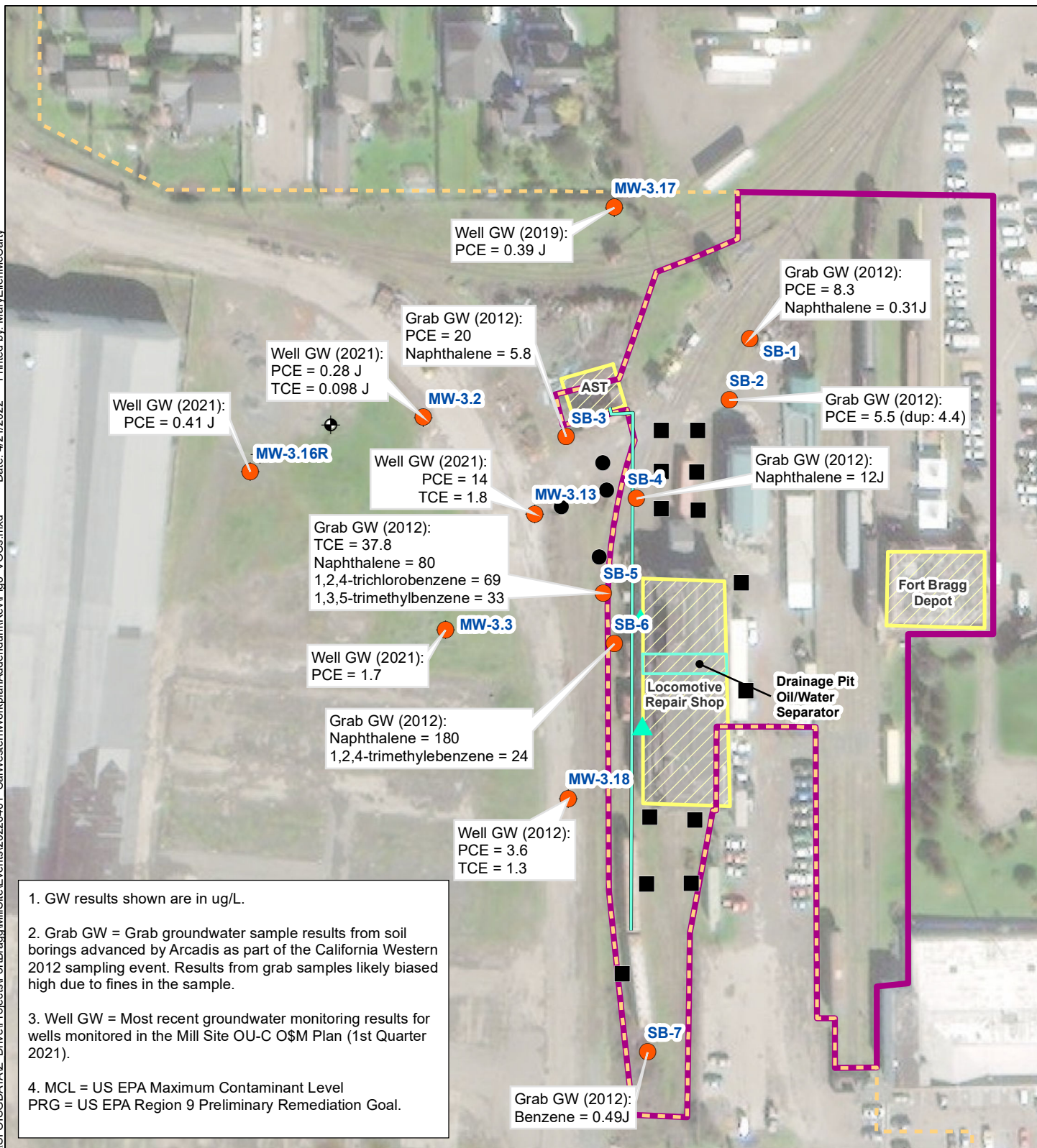
**Previous Groundwater Sample Locations and Results, TPHd**

1965021\*20  
April 2022

**Figure 5**



\\SFOISSGDATA\Z\_Drive\Projects\FortBragg\MillSite\Events\2022\0401\_CalWesternWorkplanAddendum\Rev\Fig6\_VOCs.mxd Date: 4/21/2022 Printed by: MaryEllenMcCarthy

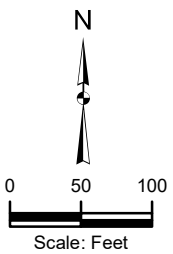


**Legend**

- Above applicable screening level (MCL or PRG)
- ▲ Former Fuel Stations
- Underground Fuel Line
- Drainage Pit Oil/Water Separator
- Previous Boring Location
- Previous Sample Location
- ⊕ Mill Site Monitoring Wells
- Former Mill Site
- Subject Property Boundary

**Notes:**

1. All locations are approximate.



California Western Facility  
Fort Bragg, California

**Previous Groundwater Sample Locations and Results, VOCs**

1965021\*20  
April 2022

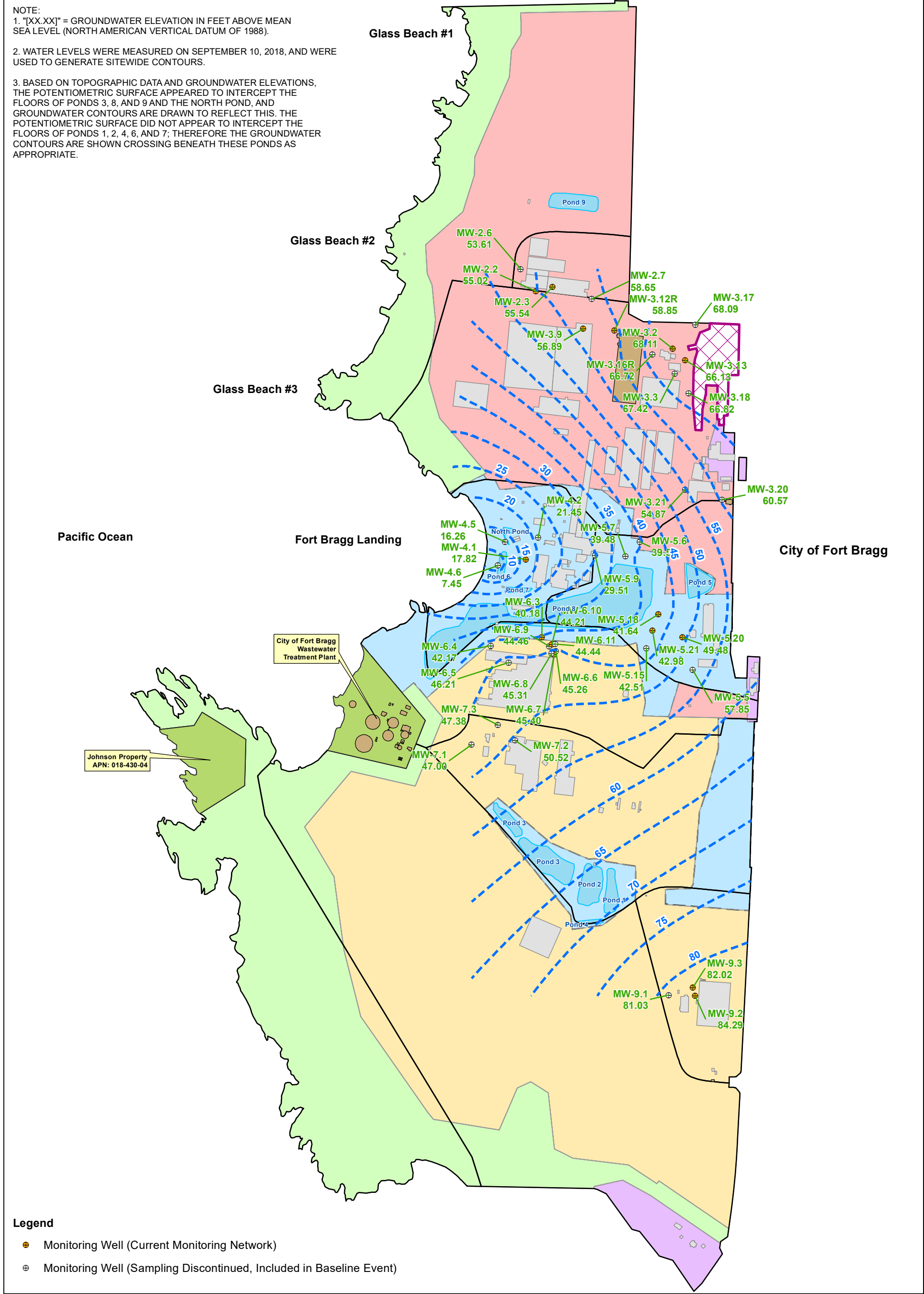
**Figure 6**

## **Appendix A**

---

Regional Groundwater Contour Map

NOTE:  
 1. "[XX.XX]" = GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL (NORTH AMERICAN VERTICAL DATUM OF 1988).  
 2. WATER LEVELS WERE MEASURED ON SEPTEMBER 10, 2018, AND WERE USED TO GENERATE SITEWIDE CONTOURS.  
 3. BASED ON TOPOGRAPHIC DATA AND GROUNDWATER ELEVATIONS, THE POTENTIOMETRIC SURFACE APPEARED TO INTERCEPT THE FLOORS OF PONDS 3, 8, AND 9 AND THE NORTH POND, AND GROUNDWATER CONTOURS ARE DRAWN TO REFLECT THIS. THE POTENTIOMETRIC SURFACE DID NOT APPEAR TO INTERCEPT THE FLOORS OF PONDS 1, 2, 4, 6, AND 7; THEREFORE THE GROUNDWATER CONTOURS ARE SHOWN CROSSING BENEATH THESE PONDS AS APPROPRIATE.

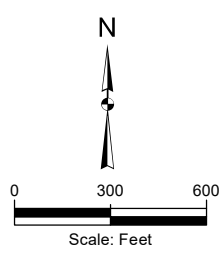


**Legend**

- Monitoring Well (Current Monitoring Network)
- ⊕ Monitoring Well (Sampling Discontinued, Included in Baseline Event)

**Legend**

Subject Property Boundary	<b>Operable Units</b>
Facility Parcel	Coastal Trail/Park Acquisition (OU-A)
Property Owned by Others	"Offsite" Non-Industrial (OU-B)
Structure	Northern (OU-C)
Former Structure	Southern (OU-D)
Pond	Ponds/Park (OU-E)

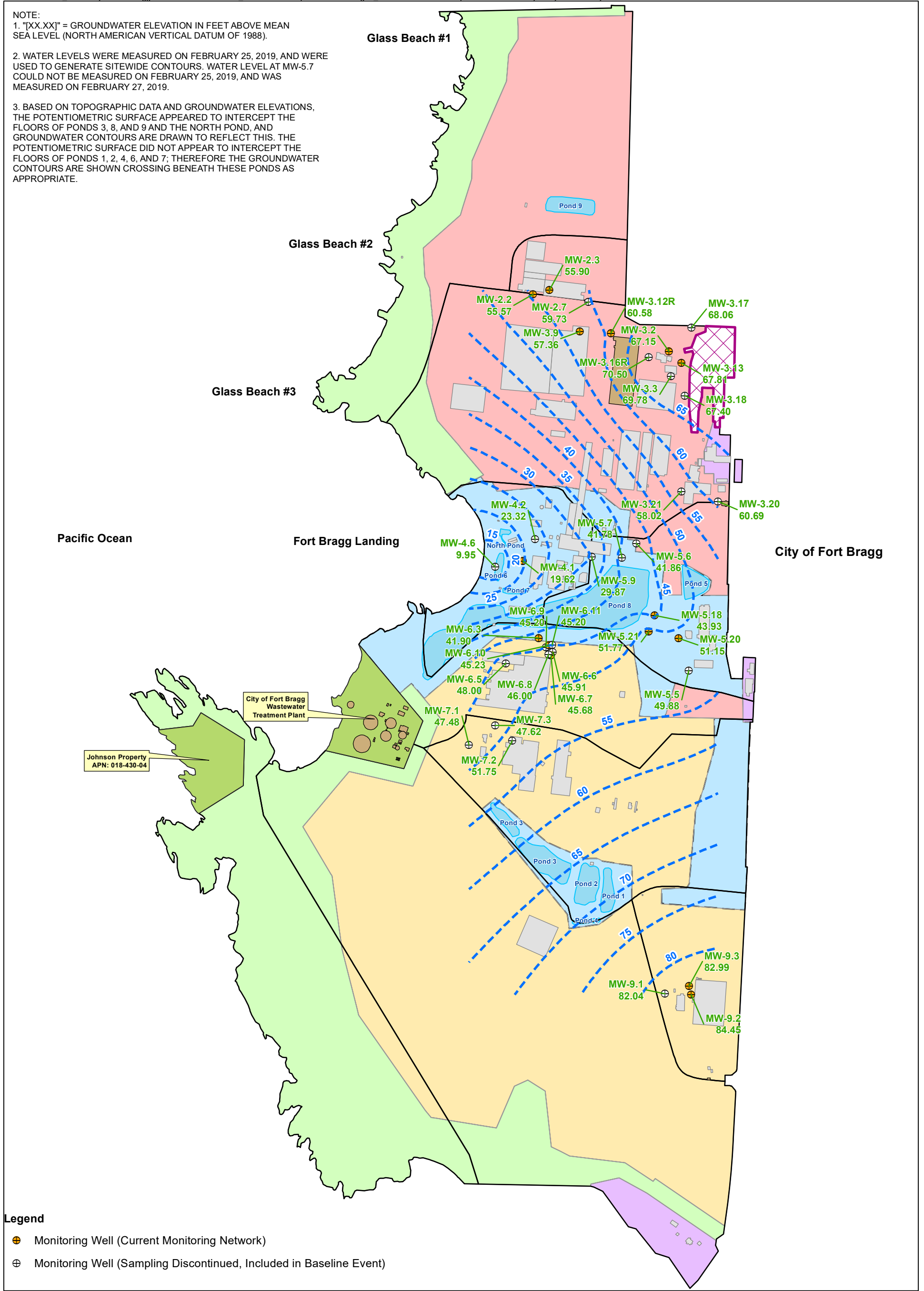


**Kennedy/Jenks Consultants**  
 Former Georgia-Pacific Wood Products Facility  
 Fort Bragg, California

**Groundwater Contour Map**  
**Baseline Monitoring Event**  
**(Second Semi-Annual Event 2018)**

1965021\*20  
 April 2022  
**Figure A1**

NOTE:  
 1. "[XX.XX]" = GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL (NORTH AMERICAN VERTICAL DATUM OF 1988).  
 2. WATER LEVELS WERE MEASURED ON FEBRUARY 25, 2019, AND WERE USED TO GENERATE SITEWIDE CONTOURS. WATER LEVEL AT MW-5.7 COULD NOT BE MEASURED ON FEBRUARY 25, 2019, AND WAS MEASURED ON FEBRUARY 27, 2019.  
 3. BASED ON TOPOGRAPHIC DATA AND GROUNDWATER ELEVATIONS, THE POTENTIOMETRIC SURFACE APPEARED TO INTERCEPT THE FLOORS OF PONDS 3, 8, AND 9 AND THE NORTH POND, AND GROUNDWATER CONTOURS ARE DRAWN TO REFLECT THIS. THE POTENTIOMETRIC SURFACE DID NOT APPEAR TO INTERCEPT THE FLOORS OF PONDS 1, 2, 4, 6, AND 7; THEREFORE THE GROUNDWATER CONTOURS ARE SHOWN CROSSING BENEATH THESE PONDS AS APPROPRIATE.

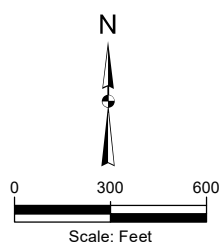


**Legend**

- ⊕ Monitoring Well (Current Monitoring Network)
- ⊖ Monitoring Well (Sampling Discontinued, Included in Baseline Event)

**Legend**

Subject Property Boundary	<b>Operable Units</b>
Facility Parcel	Coastal Trail/Park Acquisition (OU-A)
Property Owned by Others	"Offsite" Non-Industrial (OU-B)
Structure	Northern (OU-C)
Former Structure	Southern (OU-D)
Pond	Ponds/Park (OU-E)



**Kennedy/Jenks Consultants**

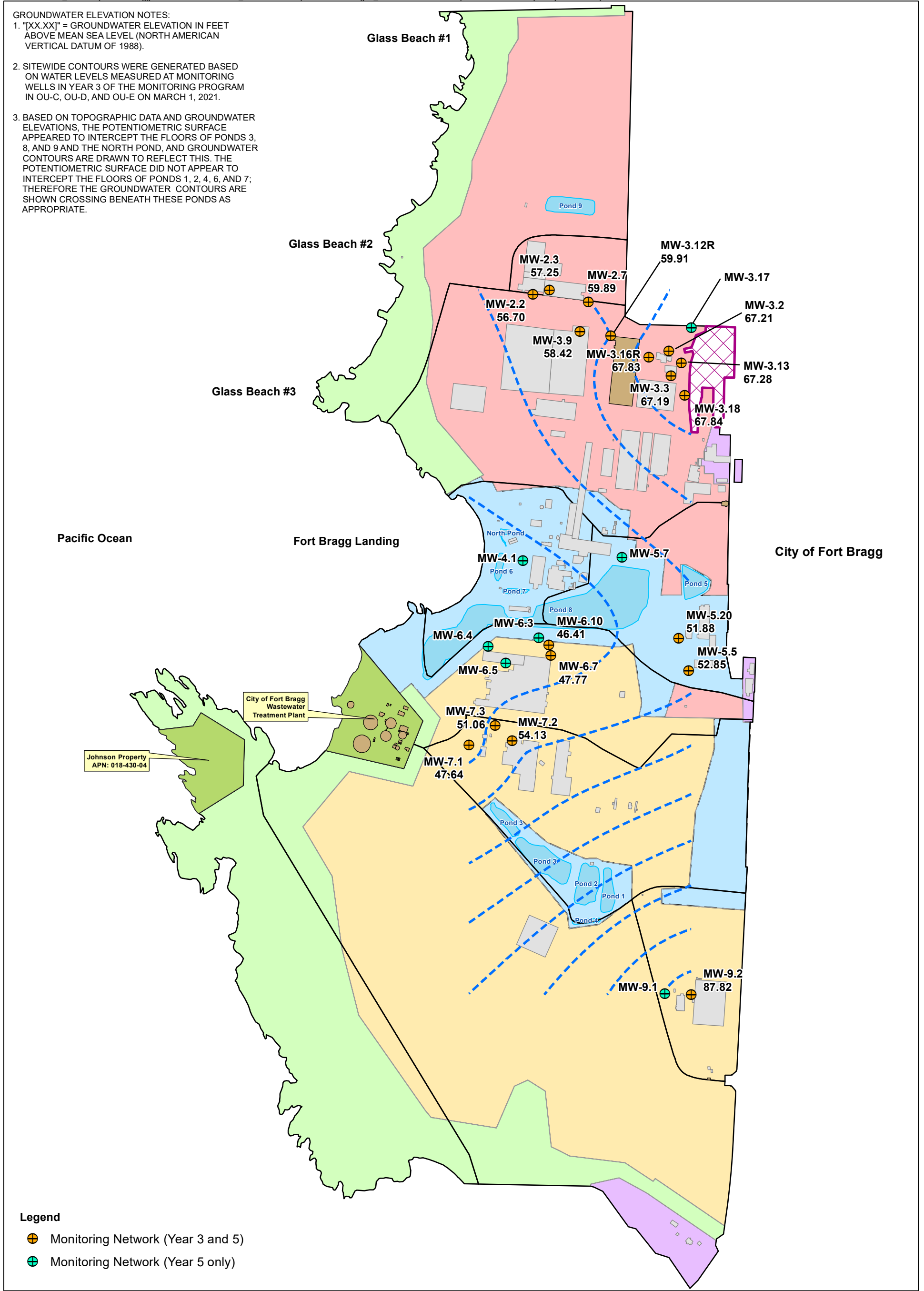
Former Georgia-Pacific Wood Products Facility  
 Fort Bragg, California

**Groundwater Contour Map  
 Baseline Monitoring Event  
 (First Semi-Annual Event 2019)**

1965021\*20  
 April 2022  
**Figure A2**

**GROUNDWATER ELEVATION NOTES:**

1. "[XX.XX]" = GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL (NORTH AMERICAN VERTICAL DATUM OF 1988).
2. SITEWIDE CONTOURS WERE GENERATED BASED ON WATER LEVELS MEASURED AT MONITORING WELLS IN YEAR 3 OF THE MONITORING PROGRAM IN OU-C, OU-D, AND OU-E ON MARCH 1, 2021.
3. BASED ON TOPOGRAPHIC DATA AND GROUNDWATER ELEVATIONS, THE POTENTIOMETRIC SURFACE APPEARED TO INTERCEPT THE FLOORS OF PONDS 3, 8, AND 9 AND THE NORTH POND, AND GROUNDWATER CONTOURS ARE DRAWN TO REFLECT THIS. THE POTENTIOMETRIC SURFACE DID NOT APPEAR TO INTERCEPT THE FLOORS OF PONDS 1, 2, 4, 6, AND 7; THEREFORE THE GROUNDWATER CONTOURS ARE SHOWN CROSSING BENEATH THESE PONDS AS APPROPRIATE.

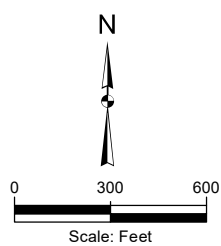


**Legend**

- ⊕ Monitoring Network (Year 3 and 5)
- ⊕ Monitoring Network (Year 5 only)

**Legend**

- |                           |                                       |
|---------------------------|---------------------------------------|
| Subject Property Boundary | <b>Operable Units</b>                 |
| Facility Parcel           | Coastal Trail/Park Acquisition (OU-A) |
| Property Owned by Others  | "Offsite" Non-Industrial (OU-B)       |
| Structure                 | Northern (OU-C)                       |
| Former Structure          | Southern (OU-D)                       |
| Pond                      | Ponds/Park (OU-E)                     |



**Kennedy/Jenks Consultants**

Former Georgia-Pacific Wood Products Facility  
Fort Bragg, California

**Groundwater Contour Map  
First Quarter 2021**

1965021\*20  
April 2022  
**Figure A3**

## **Appendix B**

---

Standard Operating Guidelines

# **Appendix B: Standard Operating Guideline Surface and Shallow Soil Sampling**

---

## **B.1 Introduction**

This guideline describes the equipment and procedures that are used by Kennedy Jenks personnel for collecting surface and shallow soil samples.

## **B.2 Equipment**

- Stainless steel or plastic scoops
- Hand auger
- Split-spoon drive sampler (2.5-inch or 2.0-inch I.D.) and associated drill rods, wrench and other tools needed to break down equipment
- Slide hammer
- 2.5-inch or 2.0-inch brass liners and sealing materials (plastic end caps, Teflon seals, silicon tape, zip-lock plastic bags)
- Shovel
- Post hole digger
- Pick
- Breaker bar
- Foxboro FID-Organic Vapor Analyzer (OVA)
- HNU PID-Organic Vapor Analyzer
- OVM
- Measuring tape or measuring wheel
- Stakes or spray paint for sampling grid
- Sampler cleaning equipment
  1. Steamcleaner (if available)
  2. Generator (if available)
  3. Stiff-bristle brushes
  4. Buckets
  5. High priority phosphate-free liquid soap, such as Liquinox
  6. Trisodium phosphate (TSD) for use if samples are oily
  7. Methanol (if necessary)
  8. 0.1N nitric acid (if necessary)
  9. Deionized water
  1. Potable water
- Insulated sample storage and shipping containers
- Personal protective equipment (as specified in site safety plan)

## **B.3 Typical Procedure**

1. Obtain applicable drilling and well construction permits, prior to mobilization, if necessary.
2. Clear locations for underground utilities and structures by Underground Service Alert (USA) and subcontractors, if necessary.
3. Measure and mark sampling locations prior to initiation of the sampling program, as specified in the sampling and analysis plan. If sampling locations are based on a grid pattern, stakes can be used to define the grid layout.

## **Appendix B: Standard Operating Guideline**

### **Surface and Shallow Soil Sampling**

---

4. Collect soil samples for chemical analysis by using precleaned scoops or a hand auger, or by driving a split-spoon drive sampler.
5. If overlying soil is to be removed (as specified in the sampling and analysis plan), use shovels, picks, or post-hole diggers, as needed.
6. Collect soil samples for lithologic logging purposes.
7. If applicable, as described in the site safety plan, use an OVA to analyze *in situ* air samples from the breathing zone and other locations as necessary.
8. Have the soils classified in the field in approximate accordance with the visual-manual procedure of the Unified Soil Classification System (ASTM D 2488-90) and the Munsell Color Classification (refer to SOG 21).
9. Prior to each sampling event, wash sampling equipment (scoops, hand auger, split-spoon drive sampler, and brass liners) with high purity phosphate-free soap. Double-rinse it with deionized water and methanol, and/or 0.1N nitric acid, as appropriate.
10. At each sampling interval, collect soil and place it in the appropriate sampling container. Fill the sample container and compact the soil to minimize air space. Minimize handling of the soil, especially if it is being collected for analysis of volatile compounds.
11. If a split-spoon drive sampler is being used, select one brass liner for potential laboratory analysis. Cover the ends of this sample in Teflon sheets, seal it with plastic caps, and wrap it with silicon or Teflon tape. Place a completed sample label on the brass liner.
12. Place the selected samples in appropriate containers and store them at approximately 4 °C.
13. As a field screening procedure (if applicable), for each sampling interval, place soil not selected for chemical analysis in an airtight container (e.g., plastic bag or jar) and allow it to equilibrate. After this, monitor the headspace in the container using either an HNU, OVM or OVA. Record the headspace concentration in the field notes (refer to SOGs 4 and 5).
14. Complete chain-of-custody forms in the field and transport the selected samples in insulated containers, at an internal temperature of approximately 4°C, to the analytical laboratory (refer to SOGs 3).

#### **B.4 Equipment Cleaning**

Prior to collection of each soil sample, the sampling equipment should be either steamcleaned or hand washed. If the sampling equipment is hand washed, wash excavation equipment with a brush, in a solution of high purity phosphate-free soap and potable water. Rinse the equipment with potable water and methanol, and/or 0.1N nitric acid, as appropriate. Follow this with double-rinsing using distilled water (refer to SOG 11).



## **Appendix B: Standard Operating Guideline Surface and Shallow Soil Sampling**

---

### **B.5 Investigation-Derived Residuals**

If sufficient volumes of soil cuttings and other residuals are generated, contain the material in appropriately labeled containers for disposition by the client. All soil samples transported to the laboratory must be returned to the client for disposition if required by the laboratory. Kennedy Jenks is available to assist the client with options for disposition of residuals (refer to SOG 20B).

# **Appendix B: Standard Operating Guideline**

## **Procedures for Using a PID Vapor Analyzer**

---

### **B.1 Introduction**

This guideline identifies the procedures that will be used by Kennedy Jenks personnel during operation of a photo ionizing detector (PID) vapor analyzer or Organic Vapor Monitor (OVM).

### **B.2 Equipment**

- H-Nu model P-10 or Thermo Analytical Model 580A PID Organic Vapor Analyzer
- Calibration gas with regulator, tubing
- Pint plastic jars
- Aluminum foil
- Small screw driver

### **B.3 Procedures**

1. Check battery charge level. If in doubt, charge battery as described in manual. Battery should typically be recharged daily after use.
2. Turn unit on. DO NOT look into sensor (ultraviolet radiation hazard).
3. The probe or pump should make an audible sound (whine or click) confirming operation.
4. Perform zero and calibration procedures as described in operating manual. Calibration for specific compounds can be performed so instrument response is proportional to the calibration gas concentration. Isobutylene calibrant is available and response factors for other compounds are provided in the instrument manual.
5. The PID does not detect methone and many compounds with an ionization potential greater than the lamp energy (typically about 10 eV). Consult the operation manual reference for ionization potentials and response factors for common compounds.
6. If so equipped, set alarm at desired level.
7. Once calibrated, unit is ready for use.
8. Position intake assembly should be in close proximity to area in question as sampling rate only allows for localized readings.
9. A slow, sweeping motion of the intake assembly will help prevent the bypassing of problem areas.
10. For screening soil samples in the field refer to the headspace method described in SOG-5.
11. Be prepared to evacuate the area if preset alarm sounds.
12. Static voltage sources; such as power lines, radio transmissions, or transformers; may interfere with measurements. See operating manual for discussion of necessary considerations.

## **Appendix B: Standard Operating Guideline Procedures for Using a PID Vapor Analyzer**

---

13. Regular cleaning and maintenance of instrument and accessories will ensure representative readings.
14. As with any field instrument, accurate results depend on the operator being completely familiar with the operator's manual for unit use.
15. Moisture may affect readings.
16. The PID is capable of recording readings at a determined rate which are logged and downloaded to a computer. Refer to manual for instructions on how to use this feature.

### **B.4 References**

HNU Systems, Inc. 1975. *Instruction Manual for Model PI 101 Photoionization Analyzer*.

*OVM - SM 580 Instruction Manual*, Thermo-Analytical.

# **Appendix B: Standard Operating Guideline Collecting Field Duplicates**

---

## **B.1 Introduction**

Duplicate analysis is a measure of precision for all sources of variability in the field and the laboratory. Laboratory replicates attempt to eliminate all sources external of imprecision, so that the difference between field duplicates and laboratory replicates is the error introduced by field techniques.

## **B.2 Equipment**

Any equipment needed to collect samples is required. Additional containers for duplicates are needed. A system for generating and tracking blind field duplicates (a permanent notebook).

### **B.2.1 Sources of Imprecision in the Field**

- Sampling techniques.
- Actual inhomogeneity of samples.

### **B.2.2 Sources of Imprecision in the Laboratory**

- Sample preparation - how well mixed and measured out.
- Analysis - inherent noise of analytical procedure.

### **B.2.3 Separating Precision Errors**

Field duplicates vs. laboratory replicates:

- Try to segregate sources of variation from field and laboratory.
- Laboratory replicates are known by the analyst to be similar (possible unconscious bias).
- Field duplicates should be "blind" to the laboratory.
- Laboratory replicates are deliberately homogenized.
- Field duplicates may be spatially or temporally separated, but logically connected - supposed to be same for some reason:
  1. e.g., collecting a waste stream at different times of day
  2. Collecting solids from different areas of a drum

## **B.3 Typical Procedures**

Field duplicates and laboratory replicates should be collected as follows.

### **B.3.1 Collecting Duplicates and Replicates for Solids:**

1. Laboratory replicates should be collected:
  - a. From same area - avoid obvious inhomogeneity.

## **Appendix B: Standard Operating Guideline Collecting Field Duplicates**

---

- b. Fill one large container with enough sample for triplicate analysis (the lab does replicate and spike analysis).
  - c. The analyst will remove large rocks, nuts and bolts, etc., and grind or screen the sample.
2. When collecting field duplicates:
- a. You must be clear on what constitutes your definition of "all the same stuff."
  - b. If it is inhomogeneous, consider compositing in duplicate.
  - c. Make the sample truly "blind" to the laboratory by using:
    - 1) Field identification numbers that are similar to other samples.
    - 2) Do not mark both samples with exactly the same time.
    - 3) Keep track of what sample the duplicate is for; keep careful notes in a permanent notebook.

### **B.3.2 Collecting Duplicates and Replicates for Liquids**

1. Laboratory replicates are actually collected in triplicates for spiking.
- a. Liquid samples are often collected in separate containers and the analysts do not mix the contents before analysis since liquids are typically homogenous, and because the volume is difficult to work with.
  - b. Try to fill like containers from the same bailer pull, or the sample tap at the same time (e.g., line up and fill all VOC vials first, then all liters, etc.).
  - c. List all samples with same identification and time (or time period) to avoid confusion at sample log in. Mark chain-of-custody and analysis request to indicate these samples are for "Lab QC".
3. Field duplicates have the same considerations as for solids above.
- a. You may want to use separate sampling equipment to prove there is no bias from contaminated device.
  - b. You may also want to collect the sample at a different time (re-purging wells is an option, or you may want to determine if time of sampling after purging has an effect).
  - c. Fill whole sets of containers for one sample, then fill duplicate set.
4. Spikes are rarely done in the field since there are too many potential sources of error to identify the reason for poor recoveries. But, consider using "travel spikes" for volatiles.

## **Appendix B: Standard Operating Guideline Collecting Field Duplicates**

---

### **B.4 Interpretation of Results**

- For laboratory replicates, there are two ways inhomogeneity can invalidate analysis: precision and accuracy can be affected.
  1. There are statistically derived limits for laboratory replicates (industrial statistic =  $[(A - B / A + B) * 100]$ )
  2. This value describes inherent variability of analytical method.
- For field duplicates there are no control limits established, but if the industrial statistic is within laboratory limits, it is safe to assume the samples are essentially the same.

Significant variation does not necessarily invalidate a field effort, just the assumption that the particular samples are representing the same source. Control checks could be established for a large field sampling project.

- Finally, quality assurance data should be considered as a whole.
  1. Field blanks and laboratory blanks.
  2. Field duplicates and laboratory replicates.
  3. Laboratory replicates and laboratory spikes.

They are often helpful in pinpointing a problem. For example, if duplicates do not make sense and a travel blank is contaminated, the source of imprecision may be outside contamination.

# Appendix B: Standard Operating Guideline

## Equipment Cleaning

---

### B.1 Introduction

This guideline describes field procedures typically followed by Kennedy Jenks personnel during the cleaning of sampling and monitoring equipment. Proper cleaning procedures minimize the potential for cross-contamination among sampling points on a single site or between separate sites.

### B.2 Equipment

- Two or three containers (e.g., 5-gallon buckets, or 5- or 10-gallon plastic tubs) for dip rinsing, washing, and collection of rinse water.
- Two or three utility brushes or test tube brushes for removal of visible contamination. A test tube brush (or similar) can be stapled to the end of a dowel and used to clean the inside of a bailer.
- Non-phosphate Alconox, Liquinox, or trisodiumphosphate (TSP) to be mixed with potable or distilled water.
- Rinse solutions, such as methyl alcohol (methanol), dilute nitric acid (0.1 molar), deionized or distilled water, and/or tap water. Deionized water is preferable to distilled water because the deionization process typically results in greater removal of organic compounds as discussed below:
  1. Acid rinse (inorganic desorption) 10% nitric or hydrochloric acid solution reagent grade nitric or hydrochloric acid and deionized water (1% to be used for low carbon steel equipment).
  2. Solvent rinse (organic desorption isopropanol, acetone, or methanol; pesticide grade).
  3. Deionized water is preferable to distilled water because the deionization process typically results in greater removal of organic compounds.
- Multi-gallon storage containers filled with potable water to be used for rinsing or washing.
- Spray bottles, squirt bottles, or garden sprayers to apply rinse liquid. A separate bottle should be used for each liquid.
- Solvex or neoprene gloves that extend, as a minimum, halfway up the forearm. In cooler weather, it is advisable to use different resistant chemicals neoprene gloves that provide better insulation against cold temperatures.
- Paper towels to wipe off gross contamination.
- Garbage bags, or other plastic bags, and aluminum foil to wrap clean sampling equipment after cleaning, to store sampling equipment or and to dispose of cleaning debris.
- Sample bottles for rinsate blanks. For these blanks, Laboratory Type II (millipore) water should be used. Purified water from the selected analytical laboratory is recommended. This water is often filtered and boiled to remove impurities.

## **Appendix B: Standard Operating Guideline Equipment Cleaning**

---

- DOT-approved container (e.g., 55-gallon drum) to store contaminated wash and rinse water. Contained cleaning wash and rinse water should be labeled appropriately.
- Steamcleaner with power source and water supply.

### **B.3 Procedures**

In most cases, the following procedures are adequate to remove contamination.

1. Preclean sampling equipment. If there is gross contamination on equipment, wipe it off with paper towels and/or rinse it off with water. Additional internal cleaning may be possible by circulation of water or cleaning solutions.
2. Wash all parts of equipment with detergent water and scrub with brushes. Take equipment apart when appropriate to remove visible contamination.
3. Steamclean sampling equipment. The steamcleaner is effective in removing contamination, especially volatile hydrocarbons. Steamcleaning is highly recommended in most cases and sometimes is the only method for cleaning equipment that is grossly contaminated with hydrocarbons.
4. Rinse equipment by dipping in rinse solution, spraying, or pouring solution over it. Dip rinsing can introduce contaminants into solution. Spraying might not allow a thorough rinsing of the equipment, but it is a more efficient rinsing method because less rinse solution is used. Appropriate rinsing solutions are specified in the project sampling and analysis plan. Some typical solutions are indicated in the equipment section of this SOG.
  1. Methanol (used to remove organic compounds)
  2. Dilute acids (used to remove metals and other cations)
  3. Tap water
  4. Deionized/distilled water.
5. Rinse the sampler with generous amounts of deionized water. Pouring water over the sampler is best, although spraying or using a squirt bottle to apply rinse water might be adequate if you are trying to minimize waste.
6. Prepare rinsate blanks. To ensure proper cleaning, submit a rinsate blank for analysis. It is best to do this just before sampling. The blank should be analyzed for the same chemicals the samples are being checked for and for the chemical used to clean equipment, if appropriate.

[Note: The heading for this section indicates procedures to remove contamination.]

To prepare a rinsate blank, pour millipore analyte-free water through or over the into the sampler. Collect the rinsate water in a clean bottle. Pour the collected rinsate water into the appropriate sample container(s). It is advisable to prepare one rinsate blank every day in the field. Use water specifically for blank preparation.



## **Appendix B: Standard Operating Guideline Equipment Cleaning**

---

7. Wipe sampling equipment with a paper towel or allow it to air dry.
8. Place samplers in clean plastic bags or sealed containers, or wrap them in aluminum foil for storage in an undisturbed location that is free of contamination.

### **B.4 Investigation-Derived Residuals**

For details of handling investigation-derived residuals refer to the project sampling and analysis plan.

### **B.5 Special Notes**

- To reduce the potential for cross-contamination, samples should be collected so that the least contaminated stations areas are sampled first. Subsequent sampling should be completed in the order of increasing contamination. Areas that typically have lower levels of contamination include those upgradient of source, background areas, and the periphery of the contaminated area.
- Prepare rinsate blanks. To ensure proper cleaning, submit a rinsate blank for analysis. It is best to do this just before sampling. The blank should be analyzed for the same chemicals the samples are being checked for and for the chemical used to clean equipment, if appropriate.
- To prepare a rinsate blank, pour analyte-free water through or into the sampler. Pour the collected rinsate water into the appropriate sample container(s). It is advisable to prepare one rinsate blank every day in the field. Use water specifically for blank preparation.
- Monitoring instruments that come into contact with sampled materials must be cleaned, along with sampling devices. They should be washed, or at least rinsed before monitoring other sampling sites.
- As determined from analysis of rinsate blanks, cleaning using soap and water is adequate in removing detectable quantities of contaminants. This type of cleaning has been compared to laboratory procedures for cleaning sampling bottles. Using methanol as a rinse does help in cases of contamination with organic compounds.

### **B.6 References**

U.S. Environmental Protection Agency. 1987. *Handbook: Groundwater*. U.S. Environmental Protection Agency, Office of Research and Development, Cincinnati, Ohio.

Washington Department of Ecology. 1982. *Methods for Obtaining Waste Samples*. Ch. 173-303 WAC. Washington State Department of Ecology, Olympia, Washington.

# **Appendix B: Standard Operating Guideline Borehole Logging**

---

## **B.1 Introduction**

This Standard Operating Guideline (SOG) provides the procedures typically followed by Kennedy Jenks personnel for classifying soils and preparing boring logs and other types of soil reports. The purpose of this SOG is to facilitate the acquisition of uniform descriptions of soils encountered during borehole programs and to promote consistency in the logging practices used by Kennedy Jenks personnel. This SOG provides guidance on procedures that are generally consistent with standard practices used to classify soils. Deviations from, and additions to, the procedures described herein may be appropriate based on project-specific objectives, site-specific conditions, and/or regulatory requirements. The user of this SOG should modify the sampling procedures used, as appropriate, to conform to the project-specific requirements and then document such deviations from this SOG in the project-specific documentation of subsurface exploration activities.

Borehole logging is the systematic observation and recording of geologic and hydrogeologic information from subsurface borings and excavations. The Unified Soil Classification System (USCS) (ASTM D2487-00) is used to identify, classify, and describe soils principally for engineering purposes, and is based on laboratory tests.

For field applications, ASTM D2488-06 (Visual-Manual Procedure) is used as the general guide adopted under this SOG.

Both ASTM D2487 and ASTM D2488 utilize the same group names and symbols. However, soil reports should state that boring logs are not formal USCS laboratory determinations but are based on the visual-manual procedures described in ASTM D2488.

This SOG contains the following sections:

- Field Equipment/Materials
- Typical Procedures
  - Soil Classification
  - Classification of Coarse-Grained Soil
  - Classification of Fine-Grained Soil including Organic Soils
- Other Logging Parameters
- Logging Refuse
- References.

## **B.2 Field Equipment/Materials**

Material/equipment typically required for classifying soils and preparing boring logs may include:

- Pens, pencils, waterproof pens, and field logbook or other appropriate field forms (e.g., boring log forms), water-tight field case.
- Daily inspection report forms
- USCS (ASTM D 2488-06) table and classification chart

## **Appendix B: Standard Operating Guideline Borehole Logging**

---

- Soil color chart (i.e., Munsell) If used, the edition of the Munsell chart should be specified on each borehole log as the color descriptions and hue, color values and chromas have changed between editions. Also, whenever possible, the newest version of Munsell's color charts should be used due to fading of color chips over time.
- American Geological Institute (AGI) Data Sheets
- Graph paper
- Engineer's scale
- Previous project reports and boring logs (if available)
- Pocket knife or putty knife
- Hand lens
- Supply of clean water
- Dilute hydrochloric acid (HCl) (make sure MSDS for HCl is included in the project HASP)
- Aluminum foil, Teflon® sheets, and paper towels
- Sample containers (brass, stainless steel or aluminum liners, plastic or glass jars)
- Clean rags or paper towels
- Sample shipping and packaging supplies
- Personnel and equipment decontamination supplies
- Personal protective equipment as described in the Health and Safety Plan (HASP).

### **B.3 Typical Procedures**

Soil classification and borehole logging should be conducted by a qualified geologist, engineer; or other personnel trained and experienced in the classification of soils.

Soils are typically logged in conjunction with advancing boreholes and sampling subsurface soils. Although the guideline focuses on classifying soil samples obtained from boreholes, this particular procedure also applies to soils and sediments collected using other techniques (e.g., post hole digger, scoop, Ekman, Ponar, or Van Veen grab samplers, and backhoe).

The USCS as described in ASTM D2488-06 categorizes soils into 15 basic group names, each with distinct geologic and engineering properties. The following steps are required to classify a soil sample:

## Appendix B: Standard Operating Guideline Borehole Logging

---

1. Observe basic properties and characteristics of the soil. These include grain-size grading and distribution and influence of moisture on fine-grained soil.
2. Assign the soil a USCS classification and denote it by the standard group name and symbol.
3. Provide a written description to differentiate between soils in the same group, if necessary.

Many soils have characteristics that are not clearly associated with a specific soil group. These soils might be near the borderline between groups, based on either grain-size grading and distribution, or plasticity characteristics. In this case, assigning dual group names and symbols might be appropriate (e.g., GW-GC or ML-CL).

The two basic soil groups are:

1. **Coarse-Grained Soils** – For soils in this group, more than half of the material is larger than No. 200 sieve (0.074 mm).
2. **Fine-Grained Soils (including Organic Soils)** – For soils in this group, one half or more of the material is smaller than No. 200 sieve (0.074 mm).

**Note:** No. 200 sieve is the smallest size that can be seen with the naked eye.

### B.4 Classification of Coarse-Grained Soils

Coarse-grained soils are classified on the basis of:

4. Grain size and distribution
5. Quantity of fine-grained material (i.e., silt and clay)
6. Character of fine-grained material

Classification uses the following symbols:

<b>Basic Symbols</b>	<b>Modifying Symbols</b>
G - gravel	W - well graded
S - sand	P - poorly graded
	M - with silt fines
	C - with clay fines

The following are basic facts about coarse-grained soil classification:

- The basic symbol G is used if the estimated volume percentage of gravel is greater than that for sand. In contrast, the symbol S is used when the estimated volume percentage of sand is greater than the percentage of gravel.
- Gravels include material in the size range from 3 inches to 0.2 inch (i.e., retained on No. 4 sieve). Sand includes material in the size range from 0.2 inches to 0.003 inches. Use the

## Appendix B: Standard Operating Guideline Borehole Logging

---

grain size scale used by engineers (ASTM Standards D422-63 and D643-78) to further classify grain size as specified by the USCS.

- Although not specifically treated in ASTM D2488-06, cobbles range in size from 3 inches to 10 inches and boulders refer to particles with a single dimension greater than 10 inches. They are included here for the purpose of completeness and for their hydrogeologic significance.

**Note:** The ASTM grain size scale differs from the Modified Wentworth Scale used in teaching most geologists. Also, it introduces a distinction between sorting and grading (i.e., well graded equals poorly sorted and poorly graded equals well sorted.)

- The modifying symbol W indicates good representation of a range of particle sizes in a soil.
- The modifying symbol P indicates that there is a predominant excess or absence of particle sizes.
- The symbol W or P is only used when a sample contains less than 15 percent fines.
- Modifying symbol M is used if fines have little or no plasticity.
- Modifying symbol C is used if fines have low to high plasticity (clayey)

The following rules apply for the written description of the soil group name:

<b>Types of Soil</b>	<b>Rule</b>
Sands and gravels (clean)	Less than 5 percent fines
Sands (or gravels) with fines	5 to 15 percent fines
Silty (or clayey) sands or gravels	Greater than 15 percent fines

- Other descriptive information may include:
  - Color (e.g., Munsell Soil Color chart, specify edition). Soil color is named and coded using the Munsell Soil Color chart if required for the project. The code should be in parentheses immediately following the written description. Presence of mottling and banding is also recorded. For example, “dk brn (7.5 YR, 3/4).”
  - Relative Density/Penetration Resistance. For cohesionless materials use very loose, loose, medium, dense, or very dense estimated from drive sample hammer blows or other field tests. Blow counts may be used, if reliable.
  - Maximum grain size (fine, medium, coarse, as described in AGI data sheets or USCS). Note the largest cross-sectional dimension measured in tenths of an inch for grains larger than sand size.
  - Composition of grains (mineralogy)

## **Appendix B: Standard Operating Guideline Borehole Logging**

---

- Approximate percentage of gravel, sand, and fines (use a percentage estimation chart as provided in the AGI data sheets)

### **Modifiers Description**

Trace	Less than 5 percent
Few	5 to 10 percent
Little	15 to 25 percent
Some	30 to 45 percent
Mostly	50 to 100 percent

- Angularity (round, subround, angular, subangular)
- Shape (flat or elongated)
- Moisture Condition (dry, moist, wet)
  - o Dry - Absence of moisture to the touch.
  - o Damp - Contains enough water to keep the sample from being brittle, dusty or cohesionless; is darker in color than the same material in the dry state.
  - o Moist - Leaves moisture on your hand, but displays no visible free water.
  - o Wet - Displays visible free water.
- HCl Reaction (none, weak, strong)
- Cementation (Crumbles under finger pressure: weak, moderate, or strong)
- Range of Particle Sizes (sand, gravel, cobble, boulder)
- Maximum Particle Size (fine, medium, coarse)
- Cementation (weak, moderate, or strong)
- Hardness (breaks with hammer blow)
- Structure (stratified, laminated, fissured, slickensided, blocky, lensed, homogeneous)
- Organic material
- Odor
- Iridescent sheen (based on sheen test)
- Debris (e.g., paper, wood, plastic, cloth, concrete, construction materials, etc.).
  - o Additional Comments (e.g., roots or rootholes, difficult drilling, borehole caving, presence of mica, contact and/or bedding dip, bedding features, sorting, structures, fossils, cementation, geologic origin, formation name, minerals, oxidation, etc.

### **B.5 Classification of Fine-Grained Soils**

Fine-grained soils are classified on the basis of:

1. Liquid limit
2. Plasticity

## Appendix B: Standard Operating Guideline Borehole Logging

---

Classification uses the following symbols:

Basic Symbols	Modifying Symbols
M - silt	L - low liquid limit
C - clay	H - high liquid limit
O - organic	
Pt - peat	

The following rules apply for the written description of the soil group name:

Types of Soil	Rule
Silts and clays with sand and/or gravel	5 to 15 percent sand and/or gravel
Sandy or gravelly silts or clays	Greater than 15 percent sand and/or gravel

The following are basic facts about fine-grained soil classification:

- The basic symbol M is used if the soil is mostly silt, while symbol C applies if it consists mostly of clay. Use of symbol O indicates that organic matter is present in an amount sufficient to influence soil properties. The symbol Pt indicates soil that consists mostly of organic material.
- Modifying symbols are based on the following hand tests conducted on a soil sample:
  - Dry strength (crushing resistance : none, low, medium, high, very high)
  - Dilatancy (molded ball reaction to shaking: none, slow, rapid)
  - Toughness (resistance to rolling or kneading near plastic limit : low, medium, high)
  - Plasticity (nonplastic, low, medium, high).
- Soil designated ML has little or no plasticity and can be recognized by none to low dry strength, slow to rapid dilatancy, and low toughness.
- CL (lean clay) indicates soil with medium plasticity, which can be recognized by medium to high dry strength, no or slow dilatancy, and medium toughness.
- OL is used to describe an organic, fine-grained soil that is less plastic than CL soil and can be recognized by low to medium dry strength, medium to slow dilatancy, and low toughness. In some cases, it may be possible to differentiate organic silts (OL) from organic clays (OH), based on correlations between dilatancy, dry strength, toughness, or laboratory tests.
- MH soil has low to medium plasticity and can be recognized by low to medium dry strength, no to slow dilatancy, and low to medium toughness.
- Soil designated CH (fat clay) has high plasticity and is recognizable by its high to very high dry strength, no dilatancy, and high toughness.
- OH is used to describe an organic fine-grained soil that is less plastic than CH soil and can be recognized by medium to high dry strength, slow dilatancy, and low to medium toughness. In some cases, it may be possible to differentiate organic silts (OL) from organic

## Appendix B: Standard Operating Guideline

### Borehole Logging

---

clays (OH), based on correlations between dilatancy, dry strength, toughness, or laboratory tests.

Note: PT (peat) is used to describe a highly organic soil composed primarily of vegetable tissue with a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor.

- Other descriptive information includes:
  - Color (e.g., Munsell) Soil color is named and coded using the Munsell Soil Color chart if required for the project. The code should be in parentheses immediately following the written description. Presence of mottling and banding is also recorded. For example, “reddish brn (5YR, 4/4).”
    - Moisture condition,
  - Omit moisture terms below the regional water table and when drilling with mud or air-mist rotary systems.
  - Consistency (thumb penetration test: very soft, soft, firm, hard, very hard . For fine sediments use very soft, soft, medium, stiff, very stiff, and hard.) These are estimated from drive sample hammer blows or other field tests. Blow counts may also be used, if reliable.
    - Structure (same descriptors as coarse grain)
    - Compactness (loose, dense) for silts
    - Odor
    - Iridescent sheen (based on sheen test)
    - Debris (e.g., paper, wood, plastic, cloth, concrete, construction materials, etc.).
    - HCl Reaction (none, weak, strong).
  - Additional Comments (e.g. roots or rootholes, difficult drilling, borehole caving, presence of mica, , contact and/or bedding dip, bedding features, cementation, structures, fractures, fracture fillings, fossils, formation name, minerals, oxidation).

#### Fine-Grained Rock Description

- Textural Classification
- Color. Rock color is named and coded using the Geological Society of America rock color chart. The code should be in parentheses immediately following the written description. Presence of mottling and banding is also recorded. For example, “gry grn (5G, 5/2).”
- Hardness. Very hard, hard, medium, soft, very soft..
- Moisture Content. Dry, damp, moist, wet (saturated).
- Size Distribution. Approximate percentage of gravel, sand, and fines (silt and clay).



## **Appendix B: Standard Operating Guideline Borehole Logging**

---

- Estimated Permeability. Very low, low, moderate, or high. This is based primarily on grain size, sorting, and cementation. Estimate secondary permeability due to natural rock fractures when applicable.
- Miscellaneous. Odor, contact and/or bedding dip, cementation, bedding, inclusions, secondary mineralization, fossils, structures, formation name, and fractures.
- Fractures are identified by depth, angle, width, and associated mineralization if applicable. The interpretation of the fracture type (i.e., as natural [N], coring induced [CI], or handling induced [HI]) should be stated. For example, "NF @90.8', 25 deg to axis, 0.1" wide, minor calcite."
- Coarse-Grained Rock Description
- Textural Classification.
- Color. Rock color is named and coded using the Geological Society of America rock color chart. The code should be in parentheses immediately following the written description. Presence of mottling and banding also is recorded. For example, "gry olive grn (5GY, 3/2)."Hardness. Very hard, hard, medium, soft, very soft.
- Moisture Content. Dry, damp, moist, and wet (saturated).
- Size Distribution. Approximate percentage of gravel, sand, and fines (silt and clay).
- Grain Shape. Angular, subangular, subrounded, rounded, or well-rounded, for grains larger than sand size.
- Grain Size. The largest cross-sectional dimension measured in tenths of an inch for grains larger than sand size.
- Miscellaneous. Odor, contact and/or bedding dip, cementation, bedding, inclusions, secondary mineralization, fossils, structures, formation name, and fractures.
- Fractures are identified by depth, angle, width, and associated mineralization, if applicable. The interpretation of the fracture type (i.e., as natural [N], coring induced [CI], or handling induced [HI]), should be stated. For example, "NF @126.1', 35 deg to axis, 0.1" wide, minor calcite."

### **B.6 Other Logging Parameters**

#### Rock Quality Designation

This designation generally follows ASTM D6032-08 Standard Test Method for Determining Rock (RQD) of Rock Core.

The RQD denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long

## Appendix B: Standard Operating Guideline Borehole Logging

---

are summed and divided by the total length of the core run. This method is generally applied to core barrel samples.

### Standard Penetration Tests

This method generally follows ASTM D1586-08A Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils. This method provides a means of assigning a relative density to the soil by counting the number of hammer blows (blow counts) required to advance a split-barrel sampler a specified distance into the undisturbed soil ahead of the lead auger. This method is not applicable to boreholes advanced with direct-push sampling equipment. It is used primarily in conjunction with hollow stem auger drilling apparatus as the test can be performed through the auger string without removal of the augers thereby allowing the borehole to remain open to the bottom of the drill string without risk of caving. As the sampler is advanced by the repeated drop of a hammer of known weight, the blow counts are recorded on the log and used to provide a relative density descriptor to the soil penetrated during the test.

The number of blows required to drive the sampler 6 inches by a 140-lb hammer falling 30 inches. Fifty blow counts per 6-inch drive is considered "refusal," and sampling at this depth is usually terminated. In addition, a total of 100 blow counts per 18-in. drive, or no observed advance of the sampler during ten successive hammer blows, is also considered "refusal." During coring, leave this section blank. Normally, the second and third 6-inch intervals are recorded and added as the number of blows per feet.

Sampler Type/Depth. Give sampler type by the letter code listed below and identify the depth at the top of the sampling interval in feet below ground surface (bgs).

Sampler type	Inside diameter(in.)	Code
Standard penetrometer	1.38	SP
Split-barrel (small)	2.0	SBS
Split-barrel (large)	2.5	SBL
HQ wireline core	2.3	PC

Those descriptors are as follows for coarse grained soils:

Very Loose	0 to 3 SPT Sampler	0 to 4 Mod CA Sampler
Loose	4 to 7 SPT Sampler	5 to 10 Mod CA Sampler
Medium Dense	8 to 23 SPT Sampler	11 to 30 Mod CA Sampler
Dense	24 to 38 SPT Sampler	31 to 50 Mod CA Sampler
Very Dense	> 38 SPT Sampler	>50 Mod CA Sampler

Relative Density Descriptors for fine grained soils are as follows:

Very Soft	<1 SPT Sampler	0 to 1 Mod CA Sampler
-----------	----------------	-----------------------

## **Appendix B: Standard Operating Guideline Borehole Logging**

---

Soft	1 to 3 SPT Sampler	2 to 4 Mod CA Sampler
Firm	4 to 6 SPT Sampler	4 to 8 Mod CA Sampler
Stiff	7 to 12 SPT Sampler	8 to 15 Mod CA Sampler
Very Stiff	13 to 23 SPT Sampler	15 to 30 Mod CA Sampler
Hard	> 23 SPT Sampler	>30 Mod CA Sampler

Regardless of the degree of adherence to the ASTM Standard Method, split barrel samplers are used as the preferred method of undisturbed sample acquisition in a hollow stem auger drilling. Upon retrieval of the sampler from the borehole, the sampler should be opened without making contact with its interior contents and the logging personnel should record the percent recovery or length of the sample recovered. Sample containers should be removed with a clean gloved (gloves may not be needed, depending upon requirements of HASP) hand and placed in a clean, dry area for examination and logging. The sample will be described per the above. Any lithologic changes that may be observable in the exposed ends of the intact core over the sampled interval should be recorded on the log before any disturbance thereof. The depth of the lithologic changes should be estimated and recorded on the boring log. The least disturbed sample container of the two deeper six-inch sample increments should be secured with Teflon® or aluminum end sheets and snug fitting plastic end caps, sealed with silicon tape, depending upon testing, sampler may be filled with one inch rings instead of 6 inch. Sealing material should also be compatible with subsequent testing requirements.

### Ambient Temperature Head-Space:

Organic vapor analyzers such as photoionization detectors (PIDs) or flame ionization detectors (FIDs) are generally used to assess the relative concentration of volatile hydrocarbons in the soil as the borehole is advanced and recorded as a value in parts per million on the boring log. This can be done by placing a uniform amount of soil in a Ziploc® bag, glass jar or other clean container, allowing the soil in the container to equilibrate to the ambient temperature, then inserting the probe of the PID or FID into the sealed container and recording the maximum PID or FID reading.

### Non-Aqueous Phase Liquid (NAPL) Containing Soil

Appropriate observations of NAPL containing soil should include the following:

**Appearance:** If a separate phase liquid appears to be present, it might be described as “dark brown viscous fluid or liquid observed in the soil matrix.” This remark should follow the lithologic description in the borehole log. Observations of color should be made such as “black streaks” or “mottled gray to “olive brown”, however, it should not be inferred or remarked that the color is a necessary consequence of petroleum staining.

**Odor:** If the soil smells like petroleum it might be remarked that it has a “petroleum like” or “solvent like” odor. The use of terms like “strong” or “slight” should be avoided because there is no way to ensure that these terms can be applied uniformly in the field between various persons performing the logging (i.e., each person’s olfactory sense is different). The use of terms like “chemical odor” should also be avoided as there is no common reference point. Notations regarding the type of

## **Appendix B: Standard Operating Guideline Borehole Logging**

---

petroleum distillate present (e.g., "diesel-like odor" or "gasoline odor") are inappropriate as these are determinations that can only be accurately made by laboratory analysis.

### **B.7 Logging Refuse**

This procedure applies to the logging of subsurface samples collected from a landfill or other waste disposal sites:

1. Observe refuse as it is brought up by the hollow stem auger, bucket auger, or backhoe.
2. If necessary, place the refuse in a plastic bag to examine the sample.
3. Record observations according to the following:
  - a. Composition (by relative volume), e.g., paper, wood, plastic, cloth, cement, construction debris. Use such terms as "mostly" or "at least half." Do not use percentages.
  - b. Moisture content: dry, damp, moist, wet.
  - c. State of decomposition: highly decomposed, moderately decomposed, slightly decomposed, etc.
  - d. Color: obvious mottling included.
  - e. Texture: spongy, plastic (cohesive), friable.
  - f. Odor.
  - g. Combustible gas indicator readings (measure downhole).
  - h. Miscellaneous: dates of periodicals and newspapers, degree of drilling effort (easy, difficult, very difficult).

### **B.8 References**

*Grain Size Scale Used by Engineers.* ASTM D422-63 and ASTM D643-78.

Compton, R. R. 1962. *Manual of Field Geology.* New York: John Wiley & Sons, Inc.

International Society for Rock Mechanics. Commission on Classification of Rocks and Rock Masses. *Int. J. Rock Mech. Min. Sci. & Geomech. Abstr.* 1981, Vol. 18, pp. 85-110, Great Britain.

## **Appendix B: Standard Operating Guideline Borehole Logging**

---

*Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils.*  
ASTM D1586-08A

*Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).*  
ASTM D2488-06.

*Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).* ASTM D2487-00

*Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core.*  
ASTM D6032-08.

U.S. Department of the Interior. 1989. *Earth Manual*. Washington, D.C.: Water and Power Resources Service.

# **Appendix B: Standard Operating Guideline Typical Hydraulic Push/Drive Sampling Procedures**

---

## **B.1 Introduction**

This guideline describes the equipment and procedures typically used by Kennedy Jenks personnel for collecting soil and reconnaissance groundwater samples with a hydraulic push/drive system.

## **B.2 Equipment**

- Portable, hydraulic push/drive sampling system
- 6-inch long, 1.75-inch O.D. stainless steel or brass liners and liner sealing materials (Teflon sheets, plastic end caps, Ziploc plastic bags)
- Type II Portland cement
- 1-inch O.D. Schedule 40 PVC screen (0.010-inch slot size)
- 1-inch O.D. Schedule 40 PVC blank casing
- 0.75-inch diameter stainless steel or Teflon bailer
- FID or PID organic vapor analyzer
- Water level indicator
- Temperature, specific conductivity and pH meters
- Equipment cleaning materials
  1. Steam cleaner
  2. Generator
  3. Stiff-bristle brushes
  4. Buckets
  5. High-purity phosphate-free liquid soap
  6. Deionized water
  7. Rinsate collection system
- Personal protective equipment
- Appropriate groundwater sample containers
- Chain-of-custody forms
- Insulated sample storage container and ice substitute

## **B.3 Typical Procedures**

1. Applicable drilling permits will be obtained prior to mobilization.
2. Sample locations will be cleared for underground utilities.
3. All downhole equipment will be steam cleaned prior to use at each location.
4. Soil borings will be advanced using a portable, hydraulic push/drive sampling system that simultaneously drives two nested, steel sampling rods into the ground to collect continuous soil cores.
5. As the sampling rods are advanced, the soil core will be collected in a 1-7/8-inch diameter, 3-foot long sample barrel, which is attached to the end of the inner rods. After being advanced 3 feet, the inner rods will be removed from the borehole with a hydraulic winch. The sampler (containing new stainless steel liners) and inner rods will then be lowered back into the borehole to the previous depth and the rods are driven another 3 feet. This process will be repeated until the desired depth is reached.

## **Appendix B: Standard Operating Guideline Typical Hydraulic Push/Drive Sampling Procedures**

---

6. The soil samples will be retained for lithologic logging and chemical analyses, if appropriate.
7. The soils will be classified in the field in approximate accordance with the visual-manual procedure of the Unified Soil Classification System (ASTM D-2488-93), and the Munsell Color Classification.
8. If required, soil samples will be collected at selected intervals for laboratory analysis. At these intervals, the ends of one or more of the soil sample liners will be covered with Teflon end sheets and plastic end caps, and labeled. Labels will document the sample designation, type, date and time of collection, collector(s), location, and any additional information.
9. If groundwater samples will not be collected, the soil borings will be grouted to the ground surface with a neat cement grout (Type II Portland cement) using the tremie method.
10. Upon encountering the uppermost groundwater surface during sampling, the sample barrel and inner rods will be removed, and the well screen and casing will be installed within the outer drive casing to facilitate collection of a groundwater sample. The drive casing will be pulled up approximately 3 feet to expose the slotted PVC casing. Groundwater samples will then be collected from within the PVC casing with a 0.75-inch diameter Teflon or stainless steel bailer.
11. The depth to groundwater will be measured prior to groundwater sampling.
12. The sample will be drained directly from the bailer into sample containers. The containers will be labeled to document the sample designation, type, date and time of collection, collector(s), location, and any additional information.
13. After collecting the reconnaissance groundwater sample, decant groundwater into a clean container and record the following field parameters/observations:
  - a. Temperature (°C)
  - b. pH
  - c. Specific conductivity ( $\mu\text{mhos/cm}$ )
  - d. Depth to water
  - e. Color
  - f. Other observations (odors, free-phase product)
14. After sample collection, the boring will be grouted to ground surface with a neat cement grout (Type II Portland cement) using the tremie method.

### **B.4 Equipment Cleaning**

1. Downhole equipment (rods, sampler) will be steam cleaned prior to each borehole.

## **Appendix B: Standard Operating Guideline Typical Hydraulic Push/Drive Sampling Procedures**

---

2. Sampling equipment (sampler) will be steam cleaned or washed with a brush in a solution of high-purity phosphate-free soap and potable water, then rinsed with potable water followed by double rinsing with deionized water prior to each sampling run.
3. Downhole equipment and vehicles which warrant it, will be steam cleaned prior to leaving site at completion of sampling.

### **B.5 Investigation-Derived Residuals**

Soil cuttings will be placed in labeled 5-gallon DOT-approved pails with bolt-on covers. Decontamination water and groundwater residuals will be contained in labeled 55-gallon DOT-approved drums with bolt-on covers. All residuals generated during sampling activities will be stored at the site.