DRAFT

Remedial Investigation Report

USG Interiors Highway 99 Site

Milton, Washington

Prepared for:
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Chicago, Illinois 60661-3676

July 11, 2012

CDM Smith

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CDM Project No. 19921.77628

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Section 1

Introduction

This report presents the results of a remedial investigation (RI) performed for USG Interiors (USG) at the former USG property located at 7110 Pacific Highway East in Milton, Washington. The site location is shown on **Figure 1.**

1.1 Agreed Order

The RI was performed to satisfy the requirements of Agreed Order DE 84-506 (Order) between the Washington Department of the Ecology (Ecology) and USG. A final RI Work Plan dated March 5, 2010 was submitted to Ecology, which addressed comments from Ecology on CDM's draft RI Work Plan. The RI was conducted in accordance with the final Work Plan.

1.2 Site Location and Description

The USG Highway 99 site is located between Pacific Highway East and Interstate 5 in Milton, Washington. **Figure 2A** shows the entire groundwater investigation area for the RI. For clarity, the extent of the exploration points shown on **Figure 2A** is referred to as the "site" throughout this report. The majority of RI fieldwork occurred in the core investigation area shown on **Figure 2B,** which is used to illustrate the RI results.

Freeway Trailer and Kanopy Kingdom currently operate at the site; their business locations are shown on **Figure 2B**. Chain link fence separates each business and the western property line along Pacific Highway East. Interstate 5 marks the eastern boundary of the site.

1.2.1 Climate

The site climate is typical of the Puget Sound Lowlands and other marine regions. Summers are typically cool and comparatively dry and winters are mild, wet, and cloudy. The climate information presented in this section was obtained from weather station KWAMILTO1 in Milton, Washington. The data was posted at http:// www.wunderground.com/weatherstation/ WXDailyHistory. asp?ID= KWAMILTO1

The warmest months are July and August, when the high temperatures average around 85 degrees Fahrenheit (°F). The coldest month is December, when the high averages around 45 ºF and lows average 30°F.

Based on local rainfall data, in 2009 the City of Milton received 32 inches of rain for the year and averaged 130 days of measurable precipitation. On average, winter months are wetter than summer months. The wettest month of the year was November, with a monthly rainfall total of approximately 7 inches.

The predominant wind direction is from the south.

1.2.2 Surface Water

The site is located in the watershed of Hylebos Creek. The two main branches of Hylebos Creek—known as East Hylebos Creek and West Hylebos Creek—originate in south King County and generally flow south. These two branches join in Milton at Porter Way (**Figure 1**), just north of the Highway 99 site on the east side of Interstate 5 (I-5).

As shown on **Figure 2B**, Hylebos Creek crosses under I-5 adjacent to the Highway 99 site. It continues flowing generally south and again crosses under Pacific Highway East before swinging to the northwest as it flows around the southern end of Fife Heights. Hylebos Creek then flows into the Hylebos Waterway, where it enters Commencement Bay as shown on **Figure 1**. The Hylebos Creek drainage basin as a whole is approximately 17 square miles. The average discharge of Hylebos Creek is approximately 20 cubic feet per second (TPCHD, 1993).

1.2.3 Geologic Setting

The site is situated in a north-trending valley that is the floodplain of Hylebos Creek and its tributaries. The valley is located just north of the lower Puyallup River valley. Alluvium associated with Hylebos Creek and the lower Puyallup River form the uppermost native soil at the property. This alluvium consists of predominantly overbank flood and slack water deposits. Glacially consolidated glacial drift and interglacial deposits hundreds to thousands of feet thick underlie the alluvial deposits. Fife Heights, the upland region northwest of the property, is largely comprised of glacial drift.

1.3 Site History

History of the Highway 99 site is poorly documented. The historical description that follows is based on CDM's interpretation of historical aerial photographs and a title search.

Industrial waste from USG's Tacoma plant was used to fill the Highway 99site. It is known that from about 1959 to 1973, the USG Tacoma plant used ASARCO slag as a raw material for mineral fiber production. Baghouse dust enriched in arsenic was reportedly used as fill at the Highway 99 site from 1971 through 1973 (Ecology, 1986). USG did not own the property during the period when this fill was placed on it.

In the early 1980s, USG became aware of the association between ASARCO slag and arsenic contamination. Subsequently, USG purchased the Highway 99 site from Partner's Financial Incorporated on August 18, 1982. That same year USG voluntarily approached Ecology to negotiate an administrative process to govern removal of fill from the property.

Cleanup of the Highway 99 site occurred between October 12, 1984 and January 25, 1985 (Ecology, 1986) under Agreed Order No. DE 84-506. The Order established an arsenic cleanup standard for soil of 5 milligrams per liter (mg/L) by the EP Toxicity (leaching) method, and required USG to conduct post-cleanup groundwater monitoring. Detailed records of the cleanup, termed the source removal action, have not been located. Ecology estimated that 20,000 to 30,000 cubic yards of material was excavated and disposed of off-site (Ecology, 1986). Native soil exceeding this cleanup standard was reportedly over-excavated in the southern portion of the property in the vicinity of monitoring well 99-1 (**Figure 2B**). This is referred to as the contaminant source area.

According to Ecology, approximately 10% of the total waste that was excavated and disposed of off-site was baghouse dust. We infer that the 20,000 to 30,000 cubic yards of waste included: 1) soil fill mixed with waste insulation; 2) baghouse dust; and 3) native soil exceeding the cleanup standard excavated from the vicinity of 99-1.

USG sold the property to Hebert Rendell in 1986. USG maintained responsibility for verification monitoring, as specified in Agreed Order No. DE 87-506.

A review of historical aerial photographs shows that the property was cleared and regraded before June 1985 (approximately 5 months after completion of the source removal action). With the exception of environmental monitoring, no remediation activities have occurred at the property since 1985.Used car, trailer, and truck canopy sales businesses currently occupy the property.

1.4 Sources of Contamination

Arsenic concentrations in site soil and groundwater exceed Model Toxics Control Act (MTCA) cleanup levels. This arsenic originated from industrial waste from the USG mineral fiber insulation manufacturing plant in Tacoma. The Tacoma plant used arsenic bearing ASARCO slag as a manufacturing feedstock. Waste and off-specification product generated from mineral fiber insulation manufacturing was used as fill at the site.

USG conducted cleanup in 1984 and 1985 to excavate and remove industrial waste fill from the Highway 99 site. Subsequent long-term groundwater sampling performed by USG showed that residual arsenic remained in groundwater at the site above the current MTCA Method A cleanup level.

1.5 Remedial Investigation Objectives

The RI was implemented to:

- Characterize arsenic in surface soil between the paved areas and Hylebos Creek.
- Characterize the extent of arsenic contamination in soil, groundwater, sediment, and surface water.
- Characterize the potential contaminant migration pathway of arsenic in soil and groundwater to Hylebos Creek.
- Gather additional environmental data affecting arsenic fate and transport to help select a cleanup action that will meet MTCA requirements.
- Evaluate exposure to terrestrial and ecological receptors.

Section 2

Field Investigation

This section describes the field work and investigation methods completed during the RI. Field work included site preparation, underground utility location, soil investigation, groundwater investigation, sediment investigation, surface water investigation, and a site survey.

The scope of work for the RI field investigation is described in the RI Work Plan (CDM, 2010). The work was completed over 16 days in April, May, and July 2010. This first phase of field investigation, described in more detail below, focused on the contaminant source area and comprised the majority of RI field work. Subsequent field investigation phases were conducted to fully define the extent of contamination (primarily groundwater; soil to a lesser extent) beyond the core investigation area shown on **Figure 2B**. Subsequent field investigations included:

- <u>Groundwater Reconnaissance Borings:</u> Groundwater reconnaissance samples for arsenic were collected north and south of the core investigation area using direct-push technology (DPT) samples. These borings are shown on **Figure 2A** and have the prefix "GW." This work was completed in April 2011.

- <u>Characterize Arsenic Extent in Groundwater (East):</u> Groundwater monitoring wells MW-10 and MW-11were installed between the paved portion of Kanopy Kingdom and Interstate 5 to characterize arsenic concentrations east of the contaminant source. These monitoring wells, shown on **Figure 2A**, were completed and sampled in October 2011.

- <u>Characterize Arsenic Extent in Groundwater (West, South, and North):</u> Groundwater monitoring wells MW-12, MW-13, and MW-14 were drilled to characterize arsenic concentrations to the west, south, and north (respectively). These monitoring wells are shown on **Figure 2A**. In addition, two soil borings were drilled in the Pacific Highway East Highway 99 right-of-way (ROW) to delineate arsenic contamination in soil to the east.

2.1 Phase 1 RI Field Investigation

2.1.1 Site Preparation

On April 20, 2010, CDM located the planned soil boring and groundwater monitoring well locations using measuring tape and compass methods. Each location was marked on the ground using white marking paint. Arrangements were made with Kanopy Kingdom, Freeway Auto, and Freeway Trailer managements to gain access to the site and have them move vehicles and equipment away from the drilling locations during the investigation.

Utilities Underground Location Center (UULC) was notified 3 days prior to drilling, as required by state law. The entire site was checked for possible underground utility conflicts at boring locations. On April 26, 2010, each of the proposed boring and monitoring well locations were cleared for underground utilities by Applied Professional Services (APS).

2.1.2 Soil Investigation

The soil investigation consisted of collecting surface and subsurface soil samples. Samples were analyzed for total arsenic by field portable x-ray fluorescence (XRF) and laboratory methods. The purpose of the soil investigation was to delineate the lateral and vertical extent of arsenic in soil. The soil investigation was completed between April 26 and 29, 2010.

Surface Soil Sampling

Six surface soil samples were collected from the vegetated area between the west bank of the Hylebos Creek and the paved parking surfaces to characterize arsenic concentrations in surface soil. **Figure 2B** shows the location of the surface soil samples.

The samples were taken at 50-foot increments in a row parallel to the direction of river flow. Sample locations were identified with a measuring tape and marked with stakes. Vegetation was cleared at each sample location before soil was collected from the ground surface and placed directly in plastic XRF measurement cups or 4-ounce glass jars. Each sample was collected by hand with a new pair of nitrile gloves. The soil in the XRF measurement cup was used for field XRF analysis of total arsenic and the sample in the 4-ounce jar was retained for possible analysis of arsenic at the off-site analytical laboratory.

The samples were labeled and placed in a cooler on ice and transported back to CDM's Bellevue office. The samples were stored under refrigeration at the CDM office until selected samples were sent to the laboratory under chain of custody protocol.

Subsurface Sampling

Thirty soil borings arrayed on a 50-foot offset grid were advanced to depths ranging from 12 feet to 24 feet below ground surface (bgs) during the RI. The purpose of the borings was to characterize the lateral and vertical distribution of arsenic in soil and to characterize the geology of the site. CDM's subcontractor—Environmental Services Northwest (ESN) of Tacoma, Washington—completed the RI soil borings using direct push technology (DPT) sampling methods. A CDM geologist supervised the DPT sampling and was responsible for soil classification and soil sample collection.

The RI soil data supplements soil assessment data collected in June 2006. **Figure 2B** shows the soil boring locations. RI borings have alpha-numeric grid designations (e.g., C-6) and the 2006 assessment borings have a “GP” prefix.

The borings were advanced using truck-mounted DPT equipment. The soil samples were collected continuously using a 4-foot-long, 1.5-inch inside-diameter sampler fitted with acetate liners. The sampler was attached to the end of DPT drive rods and pneumatically driven into the ground. After each sampler drive, the acetate liners were removed from the sampler and split open to examine the soil and collect soil samples.

Soil types were classified according to the Unified Soil Classification System (USCS). Soil samples were also inspected for evidence of vitreous slag material or other evidence of contamination. Soil descriptions were recorded on boring logs, which are provided in **Appendix A**. The DPT sampler and rods were decontaminated between each sample drive using a three-bucket Alconox wash and distilled water rinse system.

At each boring, soil samples were collected at approximate 2-foot depth intervals from the ground surface to depths of between 16 and 24 feet bgs for field XRF analysis of arsenic. The soil was collected from soil cores and placed directly into plastic XRF measurement cups or 4-ounce glass jars. The soil in the XRF measurement cup was used for field XRF analysis of total arsenic and the sample in the 4-ounce jar was retained for possible analysis at the off-site analytical laboratory. Any borings with measurements above the 20 parts per million (ppm) limit for MTCA Method A cleanup levels at 16 feet bgs were advanced until readings were below 20 ppm or until a total depth of 24 feet bgs was reached.

Samples were labeled and placed in a cooler on ice and transported back to CDM's Bellevue office. The samples were stored under refrigeration at the CDM office until selected samples were sent to the laboratory under chain of custody protocol.

Following completion of sampling at each location, the DPT borings were abandoned by backfilling with bentonite. Hydrated bentonite chips were used at all locations to abandon borings.

Field XRF Analysis

Arsenic concentrations in soil samples were measured in the field using an Innova-X Alpha Series XRF following EPA Method 6200. CDM's Work Plan (CDM, 2010) describes the XRF sample preparation and analysis procedures followed during the RI in detail. Each soil sample was analyzed by covering the XRF sample cup with a Mylar covering, placing the sample cup directly below the XRF projector, and then scanning the sample for a 90-second interval. The displayed arsenic concentration was recorded on an XRF Test Result form.

2.1.3 Groundwater Investigation

The groundwater investigation included installing monitoring wells, collecting groundwater samples at new and existing monitoring wells, and measuring the depth to groundwater at each well.

Monitoring Well Installation

Nine new groundwater monitoring wells were installed at locations shown on **Figure 2B.** Six shallow wells (MW-1 through MW-6) were screened in fine to medium sand within the upper portion of the alluvial aquifer. Two intermediate wells (MW-7 and MW-8) were screened in coarser sand within the deeper portion of the alluvial aquifer. One deep well (MW-9) was screened within sand and gravel of the glacial aquifer that underlies the alluvial aquifer.

The purpose of the shallow monitoring wells was to evaluate the extent of arsenic dissolved in groundwater and determine the groundwater flow direction and horizontal hydraulic gradient. The purpose of the intermediate and deep monitoring wells (MW-7, MW-8, and MW-9) was to evaluate vertical hydraulic gradients at the site and the vertical extent of arsenic in groundwater.

CDM's subcontractor—Environmental Drilling, Inc. (EDI) of Snohomish, Washington—performed the monitoring well drilling and installation using a Mobile B-61 HD truck-mounted hollow-stem auger drill rig equipped with 7-5/8-inch-outside-diameter, 4-1/4-inch-inside diameter drilling augers. Soil samples were collected at 5-foot intervals during drilling.

Soil samples were collected using a Standard Penetration Test (SPT) split-spoon sampler. At each sample depth the sampler was driven 18 inches using a 140-pound auto-hammer. The soil was classified in general accordance with the USCS. Soil descriptions were recorded on a boring log, which is included in **Appendix A**.

Monitoring well construction details are summarized in **Table 1** and shown graphically on the well construction logs included in **Appendix A**. The monitoring wells were constructed using 2-inch-diameter, Schedule 40 PVC flush-threaded pipe and Schedule 40 PVC factory-slotted well screen. The well screens were 5 feet long with 0.010-inch-width milled slots. A filter pack consisting of #10-20 Colorado Silica Sand was placed in the annular space between the well screen and the borehole walls. The filter pack was extended approximately 3 feet above the top of the well screen.

A hydraulic seal was constructed of Pure Gold medium bentonite chips placed from the top of the filter pack to within 2 feet of ground surface. For the intermediate wells and the deep well, a 20 percent solids pumpable bentonite grout mix (Baroid Quik-Grout) was used instead of bentonite chips. The bentonite grout was pumped into the annulus using a tremmie pipe. The top of the annular space was sealed with concrete and an 8-inch-diameter, flush mount, traffic-rated monitoring well vault was installed at the ground surface. Locking well caps were installed at each monitoring well.

The new monitoring wells were developed prior to sampling through a combination of surging, bailing, and pumping. Initially, the screen interval was surged using a surge block and solids were bailed from the bottom of the well using a stainless steel bailer. After bailing the solids from the well, the well was developed by continuous pumping with a submersible pump (Whale pump). The pump was set within the screen interval and field water quality parameters (conductivity, pH, turbidity, and temperature) were measured at regular intervals and recorded on a well development log. A Horiba U-22 water quality meter was used to measure field water quality parameters.

Well development was considered complete after the field parameters had stabilized and a minimum of 10 well casing volumes were removed from the shallow wells (a minimum of 4 casing volumes was removed from each of the intermediate and deep wells). Well development water was contained in 55-gallon drums.

Groundwater Level Measurements

On May 25 and July 15, 2010, CDM performed comprehensive groundwater level monitoring rounds on all newly installed and existing monitoring wells. The purpose of the second monitoring round was to obtain groundwater levels under equilibrium conditions in dry weather conditions. All depth to groundwater measurements were made using a SINCO water level meter, which was decontaminated between wells. The depth to groundwater measurements are summarized in **Table 2**.

Groundwater Sampling

Groundwater monitoring wells were purged and sampled using a peristaltic pump and low-flow sampling methods. Discharge from the peristaltic pump was directed into a flow-through cell. A YSI Model 556 water quality meter was used to measure temperature, conductivity, pH, dissolved oxygen (DO), and oxidation/reduction potential (ORP) in the flow-through cell. A Lamotte 2020 turbidity meter was used to monitor turbidity.

The instruments were calibrated against standards for each field parameter during each day of sampling. The peristaltic pump controller was set to a purge rate of about 0.5 liter per minute and drawdown was generally limited to less than 0.3 foot. Water levels and field parameters were monitored at regular intervals and recorded on a groundwater sampling record.

Copies of the groundwater sampling records are included in **Appendix B**. Purging was continued until field parameters had stabilized for at least three consecutive readings within the following limits:

± 0.1 unit for pH

± 5 percent for conductivity

± 20 millivolts for ORP

± 10% for dissolved oxygen < 10 NTU for turbidity

The final stabilized parameters are provided in **Table 3**.

Groundwater samples were collected immediately after parameters stabilized and all indicator parameter readings were recorded. The flow cell was disconnected and sample containers were filled directly with discharge from the sampling pump. The dissolved metals samples were collected in unpreserved containers and filtered by the laboratory prior to analysis. Sample containers, preservatives, and holding times are described in CDM's Work Plan (CDM, 2010)**.**

Following submittal of the samples, the laboratory noted varying amounts of orange-brown precipitate (determined to be an iron precipitate) in the dissolved metals bottles. The laboratory also determined that arsenic was likely substituting for iron in the precipitate to varying degrees, potentially lowering dissolved arsenic and iron values in some of the samples.

Based on these observations and the varied relative percent differences (RPD) between total and dissolved arsenic values, wells MW3, MW4 (including a field duplicate, MW-0), and 99-1 were re-sampled on July 15, 2010 for dissolved arsenic and dissolved iron.

During re-sampling the wells were again purged with low-flow technology, with pH, conductivity, ORP, and DO parameters being measured in a flow-through cell. Once these four field parameters had stabilized, the sample tubing was disconnected from the flow through cell and connected to a dedicated, disposable 0.45-micrometer (µm) filter certified clean for metals. Water that had passed through the filter was transferred directly to a bottle with nitric acid preservative for the dissolved metals analysis. Only the results of the re-sampling, which were consistent with historical data for well 99-1 and showed a comparable RPD for MW4 and field duplicate MW0, were tabulated for the dissolved arsenic and iron analyses of groundwater from these three wells.

2.1.4 Surface Water Investigation

The surface water investigation included collecting surface water samples from Hylebos Creek from six locations between the east edge of I-5 and just downstream of the site as shown on **Figure 2B**. The surface water investigation was conducted to investigate the possibility of impacts to Hylebos Creek from site groundwater by characterizing the water quality in Hylebos Creek.

At each surface water sample location, a YSI Model 556 water quality meter was used to measure temperature, conductivity, pH, DO, and ORP by lowering the probe into the stream. Parameters readings were collected after approximately 2 minutes, when parameters had stabilized. The final stabilized parameters are listed in **Table 4**.

Surface water was collected from each sampling location by extending a sample bottle attached to a swing sampler into the creek from the west bank. Once the collection bottle was filled, water was transferred directly into the remaining bottles for each sample. The surface water investigation was completed on April 25, 2010.

2.1.5 Sediment Investigation

The sediment investigation consisted of collecting bank and center samples from Hylebos Creek. These samples were analyzed for total arsenic by field XRF and laboratory methods. The purpose of the sediment investigation was to characterize arsenic in the sediments of Hylebos Creek. The sediment investigation was initiated on April 29 and completed on April 30, 2010.

Topographic Survey

The bathymetric survey was completed on June 10, 2010. The survey was completed by CDM's subcontracted surveyor, WH Pacific. The surveyor used a TCRA 1101 total station instrument to establish the bathymetry and topography of Hylebos Creek. Horizontal coordinates were referenced to the North American Datum (NAD) 83/91, South Washington Zone. Vertical coordinates were referenced to North American Vertical Datum (NAVD) 88. The elevation contours are shown in the survey plan (**Appendix C**) and **Figure 2B**.

Sediment Sampling

Fourteen sediment samples were collected at the locations shown on **Figure 2B**. The samples were collected from the farthest downstream location first, moving to upstream locations successively each day. At each sediment sample location**,** a sample was collected from the west bank and bottom of the center of Hylebos Creek. The samples were collected using a 3-inch outside-diameter sampler equipped with a slide hammer. Bank samples were taken from 6 inches below the water level of the creek.

Samples were taken in the bank by angling the drive sampler approximately 45 degrees and driving it into the bank. At each location the sampler was driven approximately 6 inches into the creek bank or bottom and then retracted. The sediment was then transferred directly from the drive sampler into a plastic XRF measurement cup or a 4-ounce pre-cleaned glass jar.

Prior to collecting each sample, the driver sampler was decontaminated using a three-bucket Alconox and distilled water rinse system. The samples were labeled and placed in a cooler on ice and transported back to CDM's Bellevue office. The samples were stored under refrigeration at CDM's office until selected samples were sent to the laboratory under chain of custody protocol.

2.2 Supplemental RI Field Investigations

This section discusses supplemental field investigations conducted after the original RI investigation. These supplemental field investigations were conducted to fully define the extent of arsenic exceeding cleanup standards in groundwater and soil.

2.2.1 Groundwater Reconnaissance Borings

Phase 1 groundwater samples from the northernmost and southernmost monitoring wells (99-2 and MW-6, respectively) exceeded the groundwater cleanup standards. The groundwater reconnaissance borings were drilled to assist in locating future groundwater monitoring wells that would define the extent of arsenic exceeding the groundwater cleanup standard. The groundwater reconnaissance borings, shown on **Figure 2B**, are designated GW-1 through GW-9.

The groundwater reconnaissance borings were drilled on April 7, 2011 using a DPT drill rig equipped with a Hydropunch™ groundwater sampling device. Borings were advanced to a depth of approximately 10 to 15 feet bgs until groundwater was noted on the drill string. The casing on the Hydropunch™ was then retracted, exposing a stainless steel screen.

Groundwater samples were collected using a peristaltic pump, filtered in the field, and placed into 250-milliliter polyethylene bottles preserved with nitric acid. Borings were abandoned with bentonite chips capped with ready-mix concrete or cold asphalt pavement patch. The groundwater samples were analyzed for arsenic by EPA Method 6020 in ESN's laboratory in Olympia, Washington.

2.2.2 Arsenic Characterization in Groundwater (East)

The easternmost monitoring wells and DPT borings ranging from GW-8 in the north to MW-5 in the south had arsenic concentrations ranging from 340 to 1,060 micrograms per liter (ug/L). The topography drops off sharply east of the paved area where these borings and monitoring wells are located, sloping down to either Hylebos Creek or a roadside ditch as shown on **Figure 2B**. East of Hylebos Creek the topography slopes up where it matches the shoulder of southbound I-5. Because of these topographic limitations, there is no place to drill a conventional monitoring well except for the shoulder of I-5. Drilling and sampling monitoring wells on the shoulder of I-5 was ruled out by USG because of safety concerns.

The decision was made to collect groundwater samples east of the paved area by installing groundwater monitoring wells using hand-drilled methods. As shown on **Figure 2B**, MW-10 is located on the east bank of Hylebos Creek, east of MW-4 and MW-5. MW-11 is located east of a ditch that flows into Hylebos Creek, east of 99-2 and GW-8.

ESN personnel worked with CDM to install these monitoring wells on October 14, 2011. Solinst Model 615 drive-point well screens were used. The Solinst drive-point well screens are constructed of ¾” stainless steel tubing about 1.1 feet long. Groundwater enters the well screen through circular holes drilled in the tubing that are backed by a 50-mesh stainless steel screen. The top of the well screen is threaded with ¾ NPT thread so standard couplings and pipe can be used as risers. The well screens are designed to be driven to depth with a fence post driver.

The well drilling procedure consisted of advancing the well boring using a hand auger to a depth of about 5 feet bgs. The drive point well screen and riser pipe were then driven to depth using a fence post driver. Colorado silica sand was poured into the boring up to about 7 feet bgs. A surface seal was constructed of bentonite chips. The wells were completed with a flush-mounted protective monument.

Wells MW-10 and MW-11 were developed and sampled on October 18, 2011. Well development was accomplished by pumping with a peristaltic pump until the turbidity was reduced. Groundwater purging and sampling procedures were the same as for the Phase 1 RI.

2.2.3 Arsenic Characterization in Groundwater (West, South, and North)

The purpose of this field investigation was to define the limits of groundwater exceeding the groundwater protection standard to the west, south, and north. Elements and methods of the investigation are summarized below.

- MW-12 was located on the west side of Pacific Highway East.
- MW-13 was located based on data gathered during the groundwater reconnaissance borings. The arsenic concentration in GW-5 (located north of Freeway Trailer building) was 21 µg/L.

Consequently, MW-13 was located farther south (approximately 230 feet) of the Freeway Trailer building.

- MW-14 was located on the north end of the Kanopy Kingdom property. The arsenic concentration in reconnaissance boring GW-6 was 19 µg/L. CDM planned to drill MW-14 approximately 120 farther north on the General Trailer property. After access negotiations broke down, MW-14 was relocated to the GW-6 location at the north end of the Kanopy Kingdom property.

ESN drilled MW-12, MW-13, and MW-14 using a DPT drill rig on May 11, 2012. The wells were constructed with a pre-packed PVC well screen and completed with flush-mounted protective covers.

MW-12, MW-13, and MW-14 were developed and sampled on May 22, 2012. The wells were developed by pumping with a peristaltic pump until the turbidity was reduced. Groundwater purging and sampling procedures were the same as for the Phase 1 RI.

2.2.4 Arsenic Characterization in Soil

The purpose of this field investigation was to define the western limits of arsenic exceeding the cleanup level between 6 and 14 feet bgs. Two soil borings, AA-6 and AA-7, were drilled on the east side of the Pacific Highway East ROW, as shown on **Figure 2B**. In addition, 4 soil samples were collected from MW-12.

2.3 Land Survey

The location of each Phase 1 RI installed groundwater monitoring well, soil boring, surface soil sample, sediment sample, and surface water sample was surveyed on June 10, 2010. Pre-existing monitoring wells MW-99-1 and MW-99-2 were also surveyed. Supplemental RI groundwater monitoring wells, groundwater reconnaissance borings, and soil borings were surveyed on June 20, 2012. All survey work was completed by WH Pacific. A copy of the survey plan is included in **Appendix C**.

At each soil boring, surface sample, sediment sample, or surface water sample location, the northing and easting of the boring and the ground surface elevation were surveyed. At each surface water sample location, the northing and easting of the sample marking stake, the elevation of the top of the marker stake, and the elevation of the Hylebos Creek water surface were surveyed. At each monitoring well, the northing and easting of the well, the elevation of the top of the PVC well casing, and the elevation of ground surface adjacent to the well were surveyed. The location of site fence lines and creek bank topography were also surveyed.

Horizontal coordinates were referenced to NAD 83/91, South Washington Zone. Vertical coordinates were referenced to NAVD 88.

2.4 Investigation Derived Waste

Soil derived from DPT borings and monitoring well installation was placed in twelve 55-gallon drums, well development and decontamination water was placed in twelve 55-gallon drums, and soiled visqueen from the drilling spill containment pads was placed in one 55-gallon drum. All drums were labeled and placed along the fence line along the northern property boundary of Freeway Trailer for temporary storage pending waste profiling and disposal. The drums were removed from the site by Emerald Services for offsite disposal.

2.5 Deviations from the Sampling and Analysis Plan

This section summarizes deviations from the CDM's Work Plan that occurred during the RI.

- Additional soil borings A4, A5, A6, A8, A9, C9, C10, and D9 were drilled in order to fully delineate the lateral extent of arsenic in soil.
- Additional sediment samples from the SED-7 location (west bank and center channel) were collected downstream of SED-6 in order to confirm the downstream extent of arsenic in sediment.
- Boring C1 was not drilled because the northern extent of arsenic was delineated by boring C2.
- Groundwater reconnaissance borings were used to help locate groundwater monitoring wells during the supplemental RI field investigation.
- Drilling methods and construction materials for groundwater monitoring wells drilled and completed for the supplemental RI deviated from the work plan.

Section 3

Site Geologic and Hydrogeologic Findings

The following subsections describe the geology and hydrogeology of the site based on data collected during the RI field investigation. **Section 4** provides the analytical results for soil, groundwater, surface water, and sediment samples collected during this investigation.

3.1 Site Geology

The site geology is summarized in geologic cross-sections A - A' and B – B', which are shown on **Figures 3** and **4**. Generalized stratigraphy consists of fill overlying alluvium, over glacial drift. These units are described below.

3.1.1 Fill

Fill at the site is differentiated into three units, described from youngest to oldest:

- Fill-3: excavation backfill
- Fill-2: residual fill containing waste from USG's Tacoma plant
- Fill-1: undifferentiated fill

Fill-3 was placed during backfilling of the remedial excavation in 1985. The soil consists of fine- to coarse-grained silty sand with gravel and silty sand (SM). The Fill-3 unit soil extends from the ground surface to maximum depths ranging from 4.5 to 14 feet bgs.

Fill-2 includes soil mixed with manmade materials. Fill-2 is likely residual fill representative of material not excavated in 1984/1985 during USG's removal action. These materials include what appears to be ASARCO slag, black and green glassy needle-like grains, glass-like gravel sized particles, and insulation debris. The ASARCO slag material does not appear to be processed like the other manmade materials. The material is associated with soil types that include poorly graded sand (SP) and sandy silt (ML). The Fill-2 material was encountered in borings A6, B6, B7, C7, and C8 at depths extending from 6 to 12.5 feet bgs.

Fill-1 includes soil that was placed during initial development of the site and consists of silt (ML), sandy silt (ML), organic silt (OH), and silty sand (SM) with traces of debris, including wood chips and gravel. The Fill-1 soil extends to a maximum depth of 9 feet bgs.

3.1.2 Alluvium

Alluvium underlies fill at the site. Alluvium pinches out to the west and was not encountered at MW-12. The alluvium can be subdivided into two units based on soil type and hydraulic properties, including:

- Upper Silt Unit
- Alluvial Aquifer

The Upper Silt Unit is the uppermost alluvial unit. Soil in this unit comprises dark brown to gray brown silt and sandy silt (ML), often with bedding laminations. Minor amounts of wood fragments and rootlets are typically present. The Upper Silt Unit ranges in thickness from 1 to 6 feet. The presence of silt and organic matter indicate deposition in a lower energy depositional environment, such as wetlands.

The Alluvial Aquifer extends from the bottom of the Upper Silt Unit to the top of the Lower Silt Aquitard, which is situated at an approximate depth of 38 feet bgs. Soil in the Alluvial Aquifer consists of fine-grained silty sand (SM), fine- to medium-grained sand (SP), and well-graded sand (SW). The soil includes minor silt (ML) interbeds, which are typically less than 0.25 inch thick. The total thickness of the Alluvial Aquifer is approximately 30 feet.

3.1.3 Glacial Units

Glacial sediments underlie the alluvium east of Pacific Highway East. At MW-12, glacial sediments occurred directly beneath fill.

The glacial sediments are subdivided into the following units based on hydraulic properties:

Lower Silt Aquitard

Glacial Aquifer

Lower Silt Aquitard

The Lower Silt Aquitard underlies the Alluvial Aquifer. Soil in this unit consists of greenish gray silt (MH or ML). The fine-grained nature of the soil indicates a low energy lacustrine (or possibly glacio-marine) depositional environment.

The total thickness of the Lower Silt Aquitard ranges from approximately 5 to 15 feet. The Alluvial Aquifer/Lower Silt Aquitard contact dips sharply to the west as shown on **Figure 4**, Section B-B'. This dipping upper surface to the Lower Silt Aquitard may be the result of erosion.

Glacial Aquifer

Water-bearing sand (SP), silty gravel (GM), and silty sand with gravel (SM) underlie the Lower Silt Aquitard. This soil is classified as glacial drift based on texture and low organic content. The upper 10 feet of this soil is not consolidated and may have been deposited in a glaciofluvial depositional environment (recessional outwash). Below 52.5 feet bgs at MW-9, the soil changes to very dense silty sand (SM) and silty gravel that has a till-like texture. This consolidated soil is interpreted as glacial till.

3.2 Site Hydrogeology

3.2.1 Alluvial Aquifer

Groundwater occurs under unconfined conditions within sand and silty sand of the Alluvial Aquifer. The low permeability soil of the Lower Silt Aquitard acts as a lower confining layer to the Alluvial Aquifer, limiting downward vertical flow. During the RI field investigation, groundwater was encountered at depths ranging from 8 to 14 feet bgs. Groundwater levels measured at each of the site monitoring wells are listed in **Table 2**.

A groundwater elevation contour map for the Alluvial Aquifer, based on the July 15, 2010 depth to groundwater measurements, is shown on **Figure 5**. The groundwater elevation contours were determined using mathematical interpolation between wells and professional judgment. The contours indicate that groundwater flows east toward Hylebos Creek and south parallel to the creek. The horizontal hydraulic gradient ranges from 0.003 foot/foot in the central area of the site, steepening to 0.03 foot/foot at the west bank of Hylebos Creek.

The vertical hydraulic gradient within the Alluvial Aquifer was calculated at the MW-5/MW-8 and MW-99-1/MW-7 well pairs. Wells in these pairs are completed within the shallow and deeper reaches of the Alluvial Aquifer, respectively. The vertical gradient was calculated by dividing the head differential between the shallow and deeper well by the vertical distance between screen midpoints. The results of the vertical hydraulic gradient calculations, summarized in **Table 5**, indicate upward vertical hydraulic gradients ranging from 0.022 to 0.035 foot/foot, based on the July 15, 2010 groundwater elevation measurements. The upward gradient indicates significant potential for groundwater flow from the deeper to shallow reaches of the aquifer.

The predominant soil types in the Alluvial Aquifer are fine-grained silty sand (SM) and sand (SP). The hydraulic conductivity these soils ranges from 0.3 to 30 feet/day, based on literature-derived hydraulic conductivity values for silty sand and fine sand (Anderson and Woessner, 1992).

Layers of coarser-grained sands (SP and SW) are also present within the Alluvial Aquifer. These sands have hydraulic conductivities ranging from 130 to 200 feet/day, based on an estimate using the Hazen (1911) method and the grain size distribution results for representative soil samples. A copy of the hydraulic calculations is included in **Appendix D** and the grain size distribution results are summarized in **Appendix E**.

The average linear velocity (seepage velocity) of groundwater flow in the Alluvial Aquifer is estimated to range from 2 feet/day in the central area of the site to 20 feet/day at the west bank of Hylebos Creek. This is considered to be a maximum seepage velocity estimate and is based on a hydraulic conductivity of 200 feet/day, which is the maximum hydraulic conductivity estimated for the layers of coarser-grained sand present within the deeper Alluvial Aquifer. The seepage velocity for the fine-grained silty sand (SM) and sand (SP), typical of the shallow Alluvial Aquifer, is expected to be much lower. A copy of the seepage velocity calculation is included in **Appendix D**.

3.2.2 Glacial Aquifer

The head differential between well pairs screened within the Alluvial Aquifer and the Glacial Aquifer (wells MW-99-1 and MW-9, respectively) was 6.58 feet based on the July 15, 2010 measurements. This large head differential indicates that the Glacial Aquifer is confined and exerting considerable hydraulic pressure on the overlying Lower Silt Aquitard. The different hydraulic and geochemical characteristics of the Glacial Aquifer and the Alluvial Aquifer indicate that the two aquifers are not in hydraulic communication.

The Glacial Aquifer comprises soil types ranging from silty sand (SM) to silty gravel (GM). Based on these soil types, the seepage velocity in the Glacial Aquifer is estimated to range from as low as 20 feet/day to as high as 70,000 feet/day. Typical hydraulic conductivity values for glacial aquifers in the site vicinity are at the lower end of this range. A copy of the hydraulic calculations is included in **Appendix D**.

Section 4
Analytical Results

This section discusses the analytical results for soil, groundwater, surface water, and sediment samples collected during the RI investigation.

4.1 Soil Results

The following subsections present the analytical results for chemical and physical testing performed on soil samples collected during the RI.

4.1.1 Arsenic in Soil

Twenty of the soil samples collected during the RI soil investigation were selected for laboratory analysis of total arsenic to confirm the XRF arsenic results. The samples were analyzed for total arsenic by EPA Method 6010B at Analytical Resources Inc.'s (ARI) Tukwila, Washington laboratory. The analytical laboratory results are included in **Appendix E**. The samples selected for laboratory analysis were chosen to represent the complete range of arsenic values measured in the field by XRF. XRF results were compared to laboratory analyzed results following the U.S. Environmental Protection Agency (EPA) guidance for field portable XRF analysis of soil and sediment samples (EPA, 1998). The results of this evaluation, provided in **Appendix F**, indicate a high degree of comparability between the XRF and analytical laboratory data and support the use of the XRF data as definitive level data.

Correlation between the XRF and confirmatory laboratory data was defined by the trendline of the plot of the natural log (Ln) of the laboratory results (on a dry weight basis) (y-axis) versus Ln of the XRF results (on a wet weight basis) (x-axis), yielding the following equation:

Ln (Laboratory Result) = 1.039*(Ln XRF Result) +0.102

The XRF results for those samples not analyzed by the analytical laboratory were corrected using the above equation. The corrected arsenic results are presented in **Table 6**.

Isocontour maps of arsenic in site soil (**Figures 6** through **13**) were prepared using computer software and krieging methods. **Figures 6** through **13** show arsenic contours in soil at depths of 0 to 2, 4 to 6, 6 to 8, 8 to 10, 10 to 12, 12 to 14, 14 to 16, and 16 to 18 feet bgs, respectively. Note that the arsenic values shown in **Figure 13** are from saturated soil samples collected below the water table.

4.1.2 Grain Size Distribution

To confirm the soil classifications assigned by the field geologist, selected soil samples were submitted for grain size distribution analysis in CDM's Bellevue, Washington geotechnical laboratory. Four samples were selected for analysis from the representative soil types encountered at borings A9 and MW9. The results of the grain size distribution analysis are included in **Appendix E** and have been incorporated into the soil description for the A9 and MW9 boring logs, included in **Appendix B**.

4.1.3 Analysis

In general, arsenic concentrations in near-surface soil are lower than at depth. This reflects the contaminant source removal action performed in 1984/1985, when fill containing arsenic bearing material was excavated, disposed of off-site, and replaced with imported fill.

The isocontour plots show elevated arsenic in soil occurring at 6 to 8 feet bgs (**Figure 8**) and continuing down to a depth of 14 to 16 feet bgs (**Figure 12**). Elevated arsenic concentrations at depth are most typically encountered in Fill-1 or alluvium underlying the base of the 1984/1985 contaminant source removal action. This arsenic is interpreted to have leached out of the Fill-2 unit and adsorbed onto the underlying soil. Residual Fill-2 was also encountered at depth as shown on **Figures 3** and **4**. Arsenic concentrations in the residual Fill-2 material are highly variable. Arsenic concentrations in soil attenuate rapidly below the water table as shown on **Figure 13**.

4.2 Groundwater Results

Groundwater samples were analyzed for arsenic and selected geochemical indicator parameters to evaluate fate and transport of arsenic in groundwater at the site. The results are summarized in **Table 7**, along with analytical methods, reporting limits, and cleanup levels for arsenic**.** Copies of complete laboratory reports are included in **Appendix E**.

4.2.1 Arsenic Distribution and Geochemical Indicator Parameters

Figure 14 is an isoconcentration map that shows the distribution of dissolved arsenic in groundwater at the site. **Figures 15** through **19** are isoconcentration maps showing dissolved iron, arsenic (+3), arsenic (+5), and ORP in groundwater.

4.2.2 Analysis

The highest arsenic concentrations were detected in the area bound by monitoring wells MW-4, MW-5, MW-99-1, MW-1, and MW-3. The dissolved arsenic concentrations in these wells ranged from 630 to 2,490 ug/L. Arsenic concentrations in monitoring well 99-1 are the highest found at the site. This corresponds to historical reports of the disposal of baghouse dust in this location and over-excavation of soil here during the 1984-85 source removal action.

Arsenic concentrations in the Alluvial Aquifer attenuate with distance from MW-99-1. Arsenic concentrations in all Alluvial Aquifer monitoring wells exceed the MTCA Method A cleanup level of 5 ug/L, including the southernmost (MW-13) and northernmost (MW-14) wells.

Arsenic concentrations in groundwater in the deeper Alluvial Aquifer (MW-7 and MW-8) are two orders of magnitude lower than arsenic concentrations in groundwater from the shallow Alluvial Aquifer and are just slightly above the MTCA Method A cleanup level, indicating that arsenic attenuates rapidly with depth within this aquifer.

Dissolved arsenic was detected at a concentration of 44 ug/L in groundwater from the Glacier Aquifer (MW-9). The arsenic detected in the Glacial Aquifer groundwater is considered to be naturally occurring rather than from an arsenic release at the site. This is based on the lower arsenic concentrations detected in the intermediate Alluvial Aquifer monitoring wells (MW-7 and MW-8) and the known natural occurrence of arsenic in nearby off-site wells that are completed in the Glacial Aquifer (e.g. the City of Fife public water supply wells and domestic wells located within the City of Milton).

4.3 Surface Water Results

Surface water samples were analyzed for arsenic and selected geochemical indicator parameters to evaluate impacts to surface water from site groundwater. The results are presented in **Table 8** and complete analytical reports are included in **Appendix E**.

Arsenic was detected in the surface water samples collected from Hylebos Creek at concentrations ranging from 2.9 to 3.1 ug/L. There was no significant variation in arsenic concentrations between the samples collected upriver, adjacent to, and downriver of the site. This indicates that arsenic originating at the site is not impacting the surface water of Hylebos Creek.

4.4 Sediment Results

The 14 samples collected from the center and south bank of Hylebos Creek were analyzed for total arsenic by ARI's Tukwila laboratory. The results are summarized in **Table 9** and complete analytical reports are included in **Appendix E**.

Elevated arsenic concentrations were detected in sediment at sample locations SED-3B, SED-4B, SED-5C, and SED-6B. The arsenic concentrations in sediment at these locations ranged from 30 to 205 milligrams per kilogram (mg/kg). These sample locations are downgradient of where the highest concentrations of arsenic were detected in groundwater, indicating that the elevated arsenic in sediment may be the result of arsenic-impacted groundwater discharging into to Hylebos Creek.

Section 5

Evaluation of Quality Control Data

5.1 Quality Assurance/Quality Control Procedures

Section 5 describes RI quality assurance/quality control (QA/QC) methods and protocol, and our evaluation of QA/QC data usability.

5.1.1 Equipment Decontamination

Small sampling equipment—including the down-hole DPT tooling, groundwater pumps, sampling spoons, driver samplers, and water quality meters—were decontaminated between sample locations to prevent cross-contamination. Decontamination of small sampling equipment included washing the equipment with a brush in Alconox detergent solution followed by a double rinse with tap water and distilled water to remove soil and detergent. Large equipment such as the sonic drill rig drill pipe was decontaminated between well locations using a steam cleaner. All decontamination water was contained and stored in 55-gallon drums pending waste profiling and disposal.

5.1.2 Equipment Calibration

The XRF analyzer was “standardized” using the supplied standardization clip, which contained a mixture of metallic elements, including arsenic, at the beginning of the day and after each battery change. The measurement cup is placed in the XRF analyzer and a direct reading measurement for arsenic is made in accordance with EPA Method 6200.

The XRF was shipped with two NIST standards reference materials: 2702, Inorganics in Marine Sediment, and 2781, Domestic Sludge containing certified amounts of metals in sediment or dried sludge material. These standards were used for accuracy and performance checks of XRF analyses after each standardization, during active sample analyses, and at the end of each working day according to EPA Method 6200. The measured value for each check standard analyte was within ±20 percent (%D) of the true value for the calibration verification check to be acceptable.

The YSI 556 water quality meter and Lamotte 2020 turbidity meter were calibrated at the beginning of each day of groundwater sampling following the manufacturer's instructions and using the standards provided by the equipment supplier.

5.2 Field QA/QC Samples

5.2.1 Duplicate Samples

A minimum of one precision sample was run each day in accordance with EPA Method 6200. Precision samples were collected by re-analyzing one sample seven times with a relative standard deviation of less than 20%. One sample per day was analyzed as a precision sample and the results of the analyses were within the 20% relative standard deviation criteria.

One duplicate groundwater sample was collected during the RI investigation. The duplicate sample was collected at groundwater monitoring well MW4 and analyzed for all analytes. Results of the analysis indicated the relative percent difference (RPD) between the field sample (USGHWY99-MW4-05/10) and duplicate sample (USGHWY99-MW0-05/10) was less than 20%.

5.2.2 Blanks

The XRF was also shipped with a blank sample of "clean" quartz or silicon dioxide matrix that is free of any analytes at concentrations above the established lower limits of detection. The blank sample was analyzed once every 20 samples, according to EPA Method 6200, to monitor for cross-contamination and contamination introduced from non-sample sources.

5.3 Laboratory QA/QC and Data Evaluation

Although formal validation was not performed on data generated during this project, all laboratory analytical data were reviewed and evaluated to ensure that they were usable and met the project objectives. Laboratory data were reviewed for inclusion and frequency of QC supporting information. Supporting QC documentation evaluated for each analytical report included some or all of the following major data:

- Sample holding times
- Method blanks
- Matrix spike/matrix spike duplicate (MS/MSD) recoveries
- RPD between MS and MSD
- Laboratory control sample (LCS) and continuous calibration control (CCV) recoveries
- Surrogate spike recoveries (organic analyses)
- Data assessment/data usability

The review included chemical data generated by ARI's laboratory, which is certified under NELAP (National Environmental Laboratory Accreditation Program).

The following subsections summarize the data evaluation associated with soil and groundwater sample analyses.

5.3.1 Sample Holding Times

The sample holding times for soil and groundwater analysis are presented in the Work Plan (CDM, 2008). These holding times were met for all soil and groundwater analysis except the nitrate and nitrite analyses of sample USGHwy99-SW5-05-10, which was analyzed one day past the 48-hour holding time due to instrument failure. The nitrate and nitrite results for this sample have been qualified with a “J” qualifier, indicating that the numbers are an estimate due to the holding time exceedance.

5.3.2 Laboratory Method Blanks

Method blanks were analyzed along with the project samples at a frequency of one blank per analytical batch. An analytical batch is defined as a maximum of 20 samples of similar matrix from one project that are analyzed together. The method blank is processed through all procedures, materials, reagents, and labware used for sample preparation and analysis. Results from the method blank analyses are presented according to matrix type and discussed in the following subsections.

No concentrations of target analytes at concentrations greater than their respective reporting limits were reported in any of the soil/sediment or aqueous method blanks except the total arsenic method blank for the ICP-MS analysis.

5.3.3 Matrix Spike/Matrix Spike Duplicates

Sample matrix spikes (MS) are prepared by adding a known amount of the pure analyte to the sample before extraction. Matrix spike duplicate (MSD) samples are prepared from a second aliquot of the sample analyzed as the matrix spike. MS and MSD results are used to assess background and interferences that may affect the sample analyte. The laboratory, in accordance with the method requirements, established control limits for MS and MSD samples. Percent recoveries for MS and MSD were reported on a QC summary sheet, included as part of the analytical report. Also included with the QC summary sheets was the calculated RPD between the MS and MSD samples and the required RPD control limits.

Based on a review of the QC summary sheets, MS and MSD or sample duplicate (Dup) samples were analyzed for each analytical method. All MS/MSD and RPD results were within the control limits specified by the laboratory, with the following exceptions:

- The arsenic result for the MS performed on soil sample C4-10 showed a spike recovery that was 1.7% less than the control limit and was qualified with an "N." The Dup performed on this same sample showed an RPD that was 4.6% outside the control limits.
- The ICP/MS dissolved arsenic result for the MS performed on aqueous sample USGHwy99-MW5-05/10 showed 0.0% recovery and was qualified with an "H" because the level of the spike (25.0 µg/L) was too low relative to the dissolved arsenic in the native sample (1,280 µg/L) to yield meaningful recovery information.
- The total organic carbon (TOC) results for the MS and MSD performed on aqueous sample USGHwy99-MW6-05/10 showed recoveries of 67.2% and 70.2%, respectively, which are 7.8% and 4.8% (respectively) below the quality control limit of 75%. However, recovery of TOC in the associated standard reference material (SRM) was in control.

5.3.4 Laboratory Control Samples and Standard Reference Materials

Laboratory control samples (LCS), also referred to as blank spikes, are prepared by spiking a known amount of the pure analyte into a method blank, which is then carried along with the samples through the entire sample preparation/analysis sequence. LCS results are used to provide information on the accuracy of the analytical method and on the laboratory's performance.

SRMs are solutions or solid materials that contain known concentrations of target analytes purchased from a third party source. Like the LCS, the SRM results are used to provide information on the accuracy of the analytical method and on the laboratory's performance.

LCS or SRM samples were analyzed with all analyses of the soil/sediment and aqueous samples. The corresponding LCS/SRM recoveries were within acceptable control limits and demonstrate acceptable accuracy. Based on a review of the QC data for the soil samples, no data warranted qualification and the data can be used for the project's intended purposes.

5.3.5 Surrogate Recoveries

Laboratory performance on individual samples is established by means of spiking activities. Surrogates are only used in organic analyses. They are not applicable to the inorganic analyses performed on these soil/sediment and aqueous samples.

5.4 Overall Data Usability

Analytical reports and all available QC data were reviewed and evaluated to assess their overall quality and usability for soil and groundwater samples. Based on these evaluations, no QC issues encountered were significant enough to warrant analytical data qualification. All data were determined to be usable for the intended project purposes.

Section 6

Site Conceptual Model

6.1 Arsenic Geochemistry

Arsenic (As) occurs in two oxidation states in natural waters: +3 (arsenite) and +5 (arsenate). As (+5) exists predominantly as a negatively charged ion (anion) above a pH of about 2. As (+5) is predominantly monovalent (charge of -1) over the pH range of 2 to 7 (H_2AsO_4), divalent from pH 7 to 11.5 ($HAsO_4^{2-}$), and trivalent at pH values above 11.5 (AsO_4^{3-}), as shown on **Figure 20**.

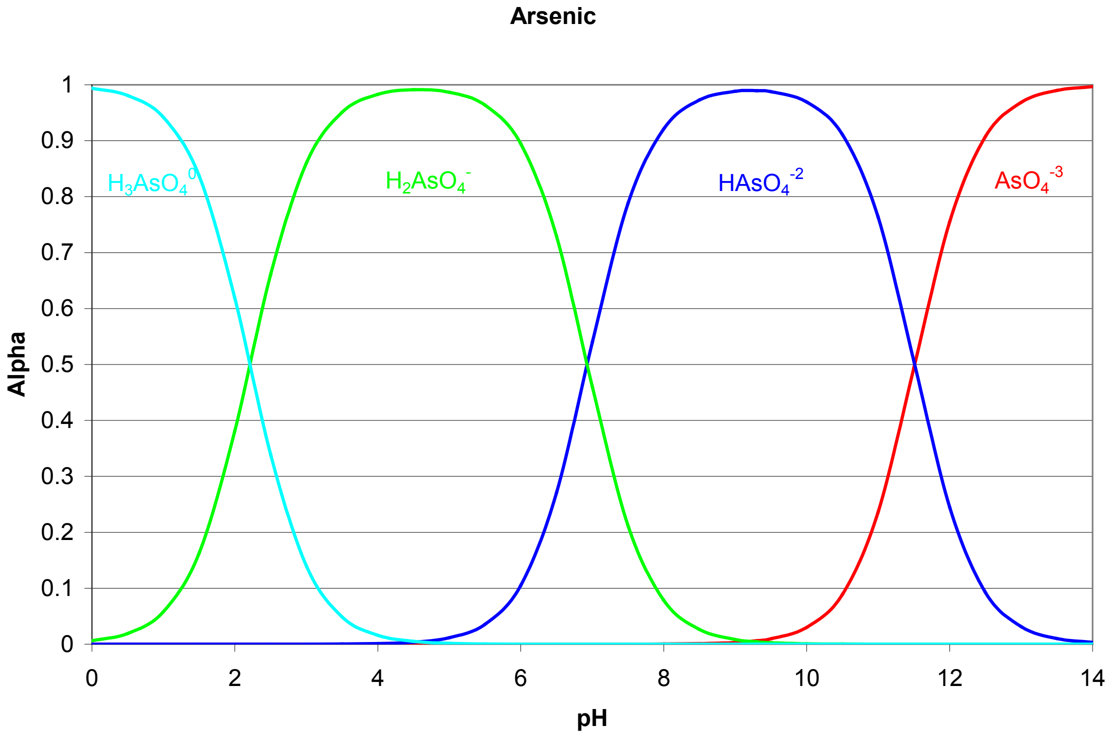

Figure 20 Arsenate Speciation as a Function of pH (alpha is the fraction of the total dissolved arsenate consisting of the given species)

The aqueous arsenate and arsenite species distribution with Eh and pH are shown on **Figure 21**.

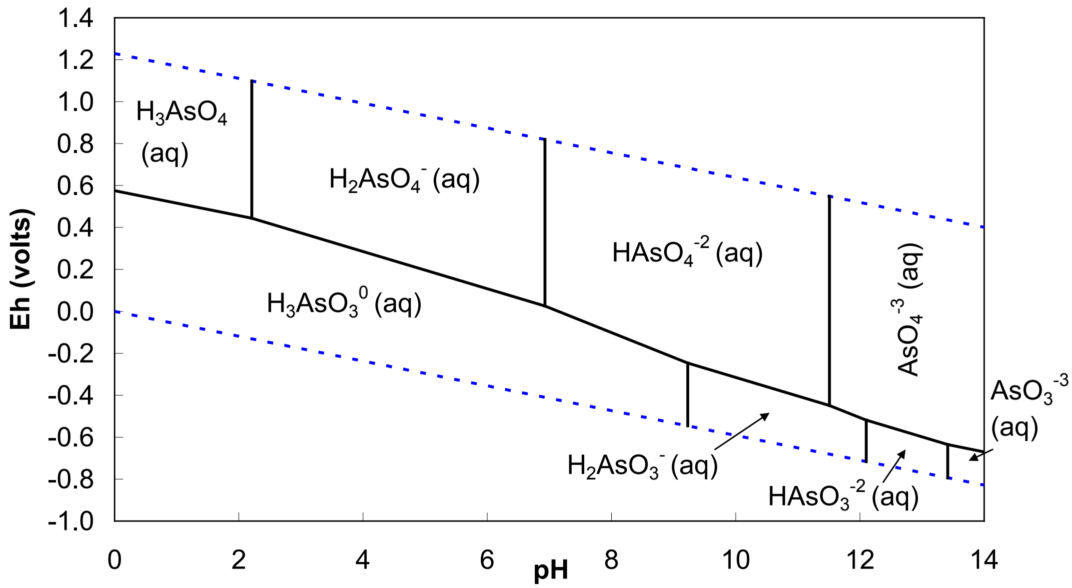

Figure 21 Eh-pH Diagram for the System As-O-H at 25º C and 1 atm

As (+3) is predominantly a neutral species ($H_3AsO_3^0$) below a pH of about 9. $H_2AsO_3^-$ and $HAsO_3^{-2}$ do not become important until the pH exceeds 9 su, which is higher than observed in the vast majority of natural waters.

6.1.1 Arsenic Pure-Phase Minerals

Pure-phase arsenic minerals such as orpiment (As_2S_3), realgar (AsS), and arsenopyrite (FeAsS) occur mainly in ore deposits formed from hydrothermal fluids within the earth's crust. A few pure-phase arsenic minerals occur under low temperature and low pressure conditions at the earth's surface, such as scorodite ($FeAsO_4 \cdot 2H_2O$ at low pH) and arsenic sulfides (under reducing conditions). However, the vast majority of pure-phase arsenic minerals are too soluble to be present in soils that are in contact with water.

6.1.2 Arsenic Solid-Solution Phases

Arsenic forms solid-solution phases with ferric hydroxide and iron hydroxysulfates such as jarosite ($HFe_3(OH)_6(SO_4)_2$) and schwertmannite ($Fe_8O_8(OH)_6SO_4$) and with amorphous silica. Arsenate, like silicate, has a tetrahedral form (a central atom coordinated with four oxygen atoms), which may facilitate the incorporation of arsenate into amorphous silica.

Amorphous phases such as ferric hydroxide or schwertmanite tend to substitute hydroxide or sulfate for arsenate. A reaction to form an iron-arsenic solid-solution is as follows:

$$Fe^{+3} + xAsO_4^{-3} + (3\text{-}3x)\ OH^- \rightarrow [FeAsO_4\ 2H_2O]_x[Fe(OH)_3]_{1\text{-}x} \quad (1)$$

The amount of substitution of arsenic into ferric hydroxide is determined by the pH of the solution (more arsenic substitution occurs at lower pH values) and the concentration of arsenic in solution (higher arsenic concentrations result in more substitution).

6.1.3 Arsenic Adsorption

Arsenic adsorbs to solid surfaces due partly to interactions between the negatively charged ions and a positively charged surface. Therefore, arsenic adsorption tends to be favored for solid materials that are positively charged. The surface charge of the material depends on the type of solid, the pH of the water, and the concentration of other anions in solution.

At low pH values, the water and mineral surfaces have higher concentrations of hydronium ion (H_3O^+), which imparts a positive charge to the surface. As the pH increases, the hydronium ion concentration decreases relative to the hydroxide ion (OH^-) concentration in both the water and the solid materials within the water.

At a specific threshold pH value called the pH of the zero-point-of-charge (ZPC), the surface charge transitions from positive to neutral to negative. Once the surface charge becomes negative, adsorption of the negatively charged arsenate ions become less prevalent. The pH of the ZPC is different for different materials, as shown in **Table 10**.

Table 10. pH of the Zero-Point-of-Charge (pH_{ZPC}) for Various Minerals

Material	Formula	pH_{ZPC}
Magnetite	Fe_3O_4	6.5
Goethite	FeOOH	7.8
Hematite	Fe_2O_3	6.7
Amorphous Ferric Hydroxide	$Fe(OH)_3$	8.5
Aluminum Hydroxide	γ-AlOOH	8.2
Aluminum Hydroxide	Ά-$Al(OH)_3$	5.0
Amorphous Silica	SiO_2	2.0
Manganese Dioxide	δ-MnO_2	2.8
Montmorillonite Clay	$Na_{0.2}Ca_{0.1}Al_2Si_4O_{10}(OH)_2 \bullet 10\ H_2O$	2.5
Kaolinite Clay	$Al_2Si_2O_5(OH)_4$	4.6

a) Data from Stumm and Morgan (1981)

The materials with a higher pH_{ZPC} are able to maintain a positive charge at a higher pH than those with a lower pH_{ZPC}. Of the materials listed in **Table 10**, amorphous ferric hydroxide is the best anion adsorbent at higher pH values
(below 8.5).

Under typical Eh/pH conditions, As (+3) is a neutral ion and does not adsorb well to negatively or positively charged surfaces. Therefore, As (+3) is roughly 4 to 10 times more mobile than As (+5) (Duel and Swoboda, 1972). In addition, As (+3) is about 60 times more toxic to humans than arsenate (Hounslow, 1980).

Arsenic has a strong affinity for iron phases and minerals. Strong correlations between arsenic and iron have been found in soils (Woolsen et al., 1971; Duel and Swoboda, 1972), in ores (Shnyukov, 1963), within ferrihydrite impurities in phosphate pebbles (Stow, 1969), and in sediments impacted by arsenic-containing groundwaters (Whiting, 1992).

The solid material properties not only control the degree to which arsenic is adsorbed at a given pH, but also the amount of arsenic that can be adsorbed before the surface of the solid becomes saturated. The process is described mathematically by the Langmuir Isotherm, which is as follows:

$$C\ (solid) = Kl*Am*C(soln)/(1+Kl*C(soln)) \qquad (2)$$

Where,

C(solid)= concentration of arsenic adsorbed to the solid phase (mg/kg)

C(soln) = concentration of arsenic dissolved in the solution phase (mg/L)

Am = maximum adsorption capacity of the solid (mg/kg)

Kl = Langmuir adsorption constant

Examples of Langmuir Adsorption Isotherms for three different solid materials are illustrated on **Figure 22**.

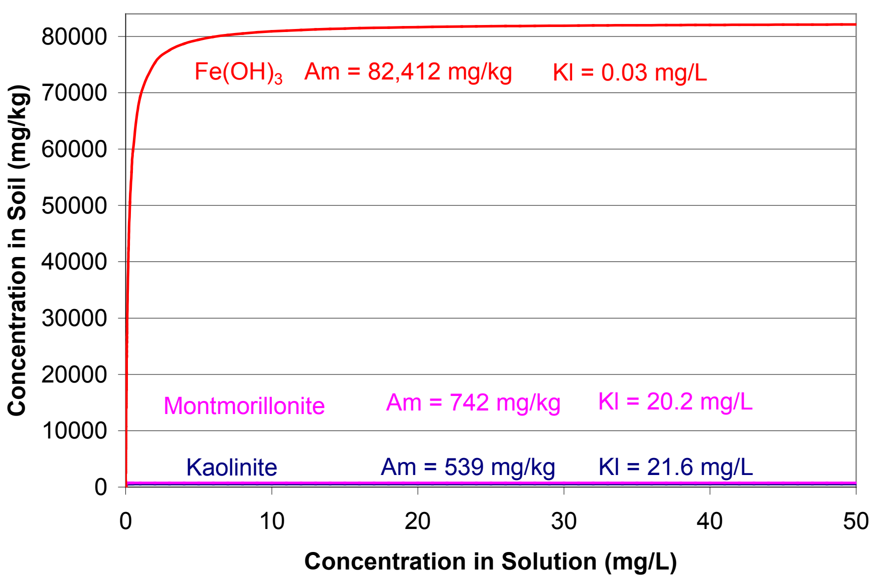

Figure 22 Langmuir Isotherms Illustrating Arsenate Adsorption Capacities of $Fe(OH)_3$(s), Kaolinite, and Montmorillonite at a pH of 5 su.

Note: Langmuir adsorption constants (Kl and Am) are from Pierce and Moore (1982) for $Fe(OH)_3(s)$ and Frost and Griffin (1977) for kaolinite and montmorillonite.

As illustrated on **Figure 22,** the adsorption of arsenate can be understood by imagining a "clean" soil or sediment that is subjected to waters with increasing arsenate concentrations (such as with the expansion of an arsenate-bearing groundwater plume). As the solution arsenate concentrations increase, increasingly greater amounts of arsenate can be "forced" onto the solid surface. The steep part of the curve is where soils arsenate concentration increases rapidly. As the arsenate concentrations on the soil continue to increase, a point is eventually reached where the solid surfaces are completely saturated with arsenate and there is no more capacity for additional arsenate adsorption.

No matter how high the dissolved arsenate concentrations become, the solid arsenate concentration remains constant. The flat part of the curve describes the saturation point of the solid. The Langmuir Am constant is the adsorption capacity and determines the level of the flat portion of the curve, while the Kl constant determines the rate at which Am is reached (the steepness of the initial segment of the curve).

Figure 22 shows that at pH 5 su, iron hydroxide has a much higher arsenate adsorption capacity than montmorillonite or kaolinite clays. Theoretically, a sample of ferric hydroxide could be analyzed, and the concentration of arsenic could be compared to Am. If analysis of the solid shows that the arsenic concentration is significantly higher than Am, then arsenate is likely controlled by coprecipitation rather than adsorption.

In practice, soils and sediments are rarely composed of a single phase, but are instead heterogeneous mixtures of different minerals with varying amounts of iron hydroxide present. However, the affinity of arsenate for iron minerals such as iron hydroxide can be used to evaluate the fate and transport of arsenate when exposed to soils of varying iron contents.

In addition, pH has a significant effect on the adsorption capacity of arsenic, as shown in **Table 11**.

Table 11. Adsorption Capacity of Arsenate and Arsenite vs. pH

	Arsenate Adsorption Capacity (mg/kg)		Arsenite Adsorption Capacity (mg/kg)
pH	**$Fe(OH)_3$ (s)[1]**	**$Al(OH)_3$ (s)[2]**	**$Fe(OH)_3$ (s)[1]**
5	82,412	119,872	34,688
6	63,682	110,732	37,685
7	34,014	88,331	38,434
8	16,932	62,783	36,561
9	10,189	37,535	31,242

1. Pierce and Moore (1982)
2. Anderson et al. (1976)

The pH dependence is due to the speciation of arsenic and the surface charge of the solid at different pH values. Arsenate is a negatively charged ion (anion) at pH values greater than about 2 (**Figure 20**), while the aluminum and iron hydroxides tend to be positively charged. However, as the pH increases, the surfaces of the solids become less positive and the arsenate species become increasingly negative, resulting in fewer adsorption sites. Arsenite, being a neutral species below pH 9 (**Figure 21**), is relatively insensitive to changes in pH.

Phosphate competes with arsenate for adsorption sites, resulting in less arsenate adsorption and greater mobility. Other ions such as chloride, sulfate, and nitrate have little or no effect on arsenic adsorption at low concentrations.

6.1.4 Effect of Silica

Dissolved silica competes with arsenic for adsorption sites, and can affect both the effectiveness and the adsorption capacity of adsorption media such as Sorb33. As the pH of the solution increases (above about 8.5 su), two reactions occur: 1) the surface charge of the media becomes negative, which tends to repel negatively charged arsenic oxyanions, and 2) the dissolved silica species go from neutral species to predominantly charged anions, which compete with arsenic for specific adsorption sites (see **Figure 23).**

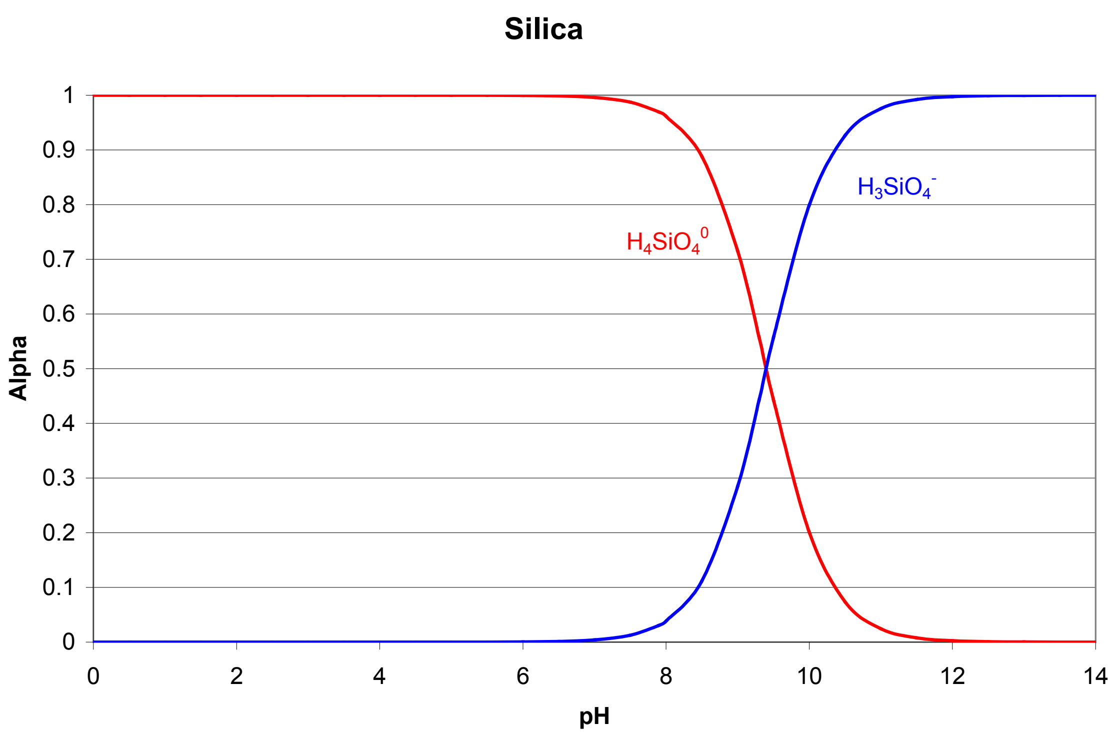

Figure 23 Silica Speciation as a Function of pH

Note: alpha is the fraction of the total dissolved silica consisting of the given species.

6.2 Arsenic Fate and Transport

6.2.1 Arsenic Speciation

As discussed previously, the fate and transport of arsenic strongly depend on the oxidation state and speciation of the ions. Arsenic speciation was determined both by direct measurement and from the Eh and pH data.

Measured Values

During the May 2010 sampling round, arsenic (3) and total arsenic were measured by the analytical laboratory, while As (5) was obtained by difference. **Table 12** compares the results of the arsenic speciation analyses with the Eh and pH data.

Table 12. Summary of Measured As (3) and As (5) Concentrations

Well	Date	As(III) (mg/L)	As(V) (mg/L)	%As(III)	pH	Eh (v)
MW-1	5/26/2010	0.46	0.03	93%	6.73	0.200
MW-2	5/25/2010	0.05	0.00	95%	6.79	0.175
MW-3	5/25/2010	0.27	0.02	93%	6.73	0.129
MW-3	7/15/2010	-	-	-	6.66	0.104
MW-4	5/26/2010	1.35	0.03	98%	6.48	0.211
MW-4	7/15/2010	-	-	-	6.61	0.119
MW-5	5/26/2010	1.41	0.04	97%	6.74	0.145
MW-6	5/26/2010	0.35	0.02	96%	6.68	0.157
MW-7	5/27/2010	-	-	-	6.99	0.202
MW-8	5/27/2010	-	-	-	7	0.228
MW-9	5/27/2010	-	-	-	7.72	0.279
99-1	5/26/2010	1.78	0.13	93%	6.92	0.152
99-1	7/15/2010	-	-	-	6.68	0.065
99-2	5/27/2010	0.31	0.04	89%	6.52	0.180
SW1	5/25/2010	0.00	0.00	16%	7.79	0.345
SW2	5/25/2010	-	-	-	7.66	0.362
SW3	5/25/2010	-	-	-	7.58	0.355
SW4	5/25/2010	0.00	0.00	17%	7.7	0.356
SW5	5/25/2010	0.00	0.00	19%	7.73	0.362
SW6	5/25/2010	-	-	-	7.76	0.372

Eh with respect to the Standard Hydrogen Electrode (SHE) in volts = (ORP in mv + (224 mv – Celsius temperature))/1000mv/v

The results indicate that, with the exception of the surface water locations, most of the arsenic is in the reduced arsenite form.

Predictions from Eh and pH

The Eh and pH data presented in **Table 12** were plotted on an Eh-pH diagram for arsenic (see **Figure 24**). These results are inconsistent with the measured arsenic speciation because the majority of the arsenic is predicted to be in the more oxidized arsenate form ($H_2AsO_4^{-1}$). Note that points that lie directly on a field boundary contain 50 percent of each of the species on either side of the line. The lack of agreement between the arsenic speciation and Eh-pH data indicates that the system is not in redox equilibrium with respect to arsenic.

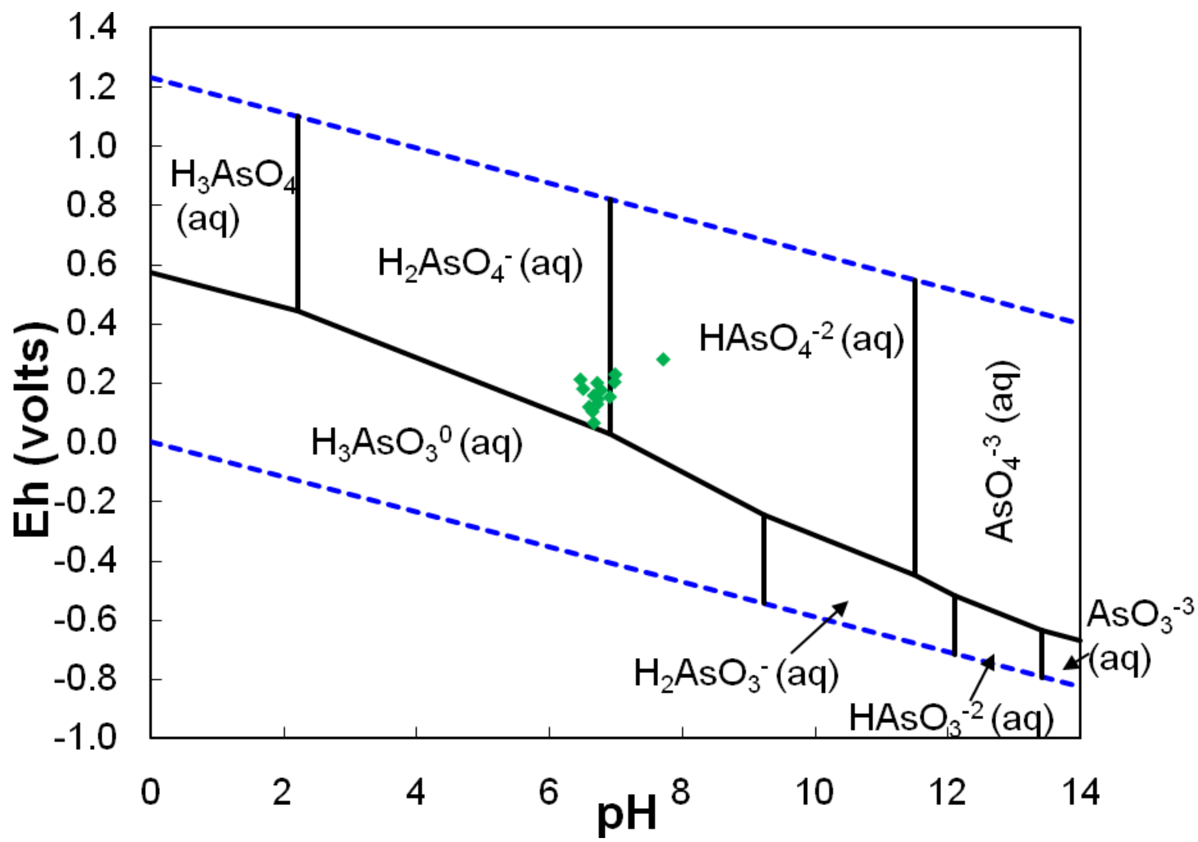

Figure 24 Arsenic Eh-pH Diagram Showing the Site Data (green diamonds)

6.3 Arsenic Attenuation

6.3.1 Coprecipitation with Iron Phases

Aqueous arsenic concentrations are often controlled by coprecipitation with iron oxyhydroxide phases. To determine if iron oxyhydroxides are forming at the site, the Eh and pH data for the wells were plotted on an Eh-pH diagram for the iron/sulfur system (see **Figure 25**). The fact that most of the points plot along the ferrous iron (Fe^{+2})/ amorphous $Fe(OH)_3$ boundary suggests that iron oxyhydroxide is forming within the aquifer.

The diagram also indicates that the redox conditions are not sulfate-reducing, and that sulfide minerals would not form within the aquifer except in microenvironments adjacent to or within organic matter.

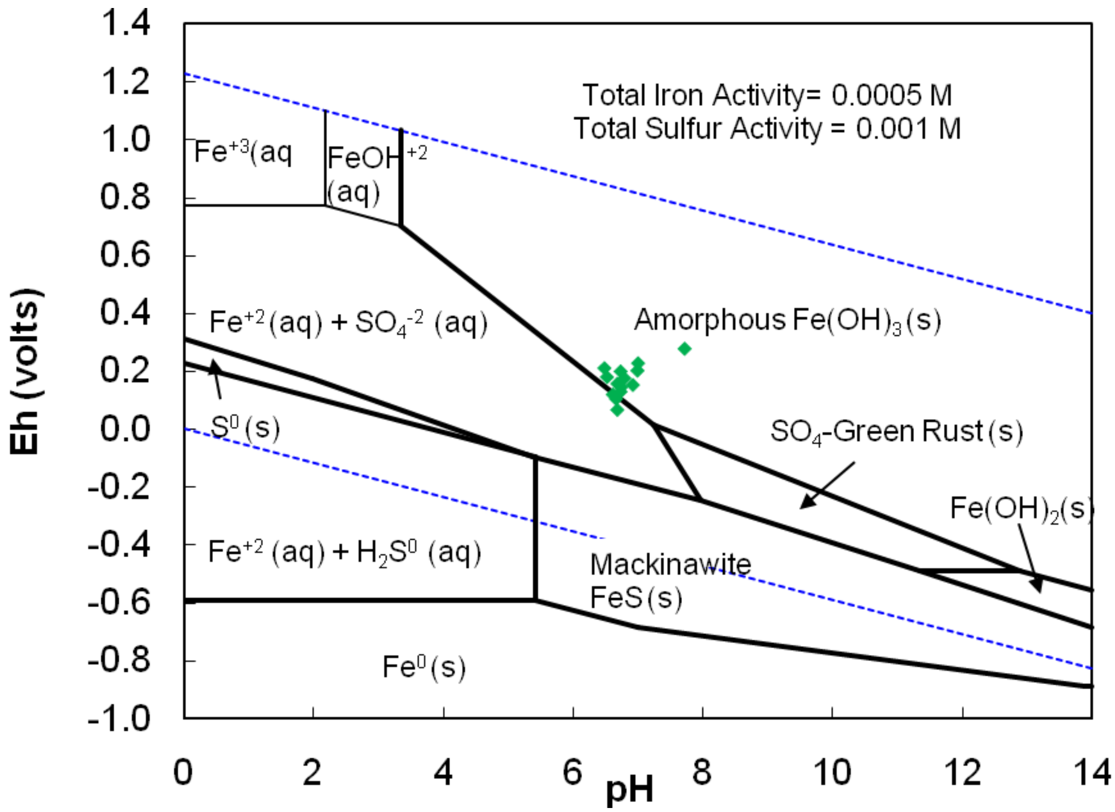

Figure 25 Iron/Sulfur Eh-pH Diagram Showing the Site Data (green diamonds) Total iron = 11 mg/L

In order to more accurately address the iron chemistry of the system, PHREEQC geochemical modeling was performed (Parkhurst and Appelo, 1999). PHREEQC is a thermodynamic equilibrium program designed to model chemical speciation in aqueous solutions, determine the saturation states of solutions with minerals and gases, and predict the results of various reactions, such as dissolution of minerals and oxidation.

The modeling shows which phases or minerals are saturated (if any) for each well. Generally, if a solution is at saturation with respect to a mineral, that mineral would be expected to be present within the aquifer matrix in which the water is in contact. Minerals which are undersaturated would dissolve when placed in contact with the solution, while minerals that are supersaturated would eventually precipitate the material (assuming the mineral forms at low temperature).

PHREEQC uses a term called the saturation index (SI) to quantify the degree of saturation of a mineral. SI is defined as follows:

$$SI = \text{Log}\,(IAP/Ksp) \quad (3)$$

Where IAP is the ion activity product and Ksp is the solubility product constant for the phase in question.

For phases at saturation, IAP = Ksp and SI = 0. A negative SI indicates that the phase is unsaturated (IAP<Ksp) while a positive SI (IAP>Ksp) indicates the phase is supersaturated. In practice, a range of 0±0.5 SI units is considered saturated due to uncertainties in analytical and thermodynamic data (Hem, 1971).

The results of the modeling are presented in **Table 13**.

Table 13. Summary of PHREEQC Results for the Highway 99 Site

Well	Saturation Index				
	Calcite ($CaCO_3$)	pCO_2	Gypsum ($CaSO_4$)	Amorphous $Fe(OH)_3$	Siderite ($FeCO_3$)
MW-1	**1.51**	$10^{0.03}$	-0.84	**1.72**	**2.48**
MW-2	**1.45**	$10^{-0.04}$	-0.55	**1.10**	**2.13**
MW-3	**1.50**	$10^{0.02}$	-0.17	**1.37**	**3.32**
MW-4	**1.55**	$10^{0.45}$	-0.87	**1.88**	**3.12**
MW-5	**1.55**	$10^{0.08}$	-2.62	**0.81**	**2.53**
MW-6	**1.64**	$10^{0.20}$	-2.57	**0.92**	**2.62**
MW-7	**1.67**	$10^{-0.10}$	-2.79	**2.09**	**2.40**
MW-8	**1.76**	$10^{-0.10}$	-2.12	**2.25**	**2.12**
MW-9	**2.04**	$10^{-1.04}$	-0.70	**2.71**	**0.06**
99-1	**1.86**	$10^{-0.08}$	-1.05	**1.52**	**2.77**
99-2	**2.01**	$10^{0.72}$	-2.57	**1.37**	**3.36**
SW-1	**2.26**	$10^{-1.21}$	-0.42	**4.84**	**0.85**
SW-4	**2.15**	$10^{-1.11}$	-0.43	**4.81**	**0.84**
SW-5	**2.17**	$10^{-1.15}$	-0.44	**4.85**	**0.69**

Shading indicates phases at saturation according to the criteria of Hem (1971).

Bold indicates phases are supersaturated.

The most important phases to consider when evaluating arsenic fate and transport are the iron minerals, due to the high affinity of arsenic for iron-bearing phases. The modeling indicates that the iron phases that are likely forming include iron oxyhydroxides and siderite. The partial pressures for carbon dioxide (pCO_2) are elevated in the groundwater compared to the atmospheric value ($10^{-3.5}$ atm at sea level), indicating that carbon dioxide degassing is predicted to occur when the groundwaters are pumped to the surface and exposed to the atmosphere. Carbon dioxide degassing results in a pH increase, which can cause the precipitation of carbonate minerals such as calcite and siderite. The supersaturation of the carbonate minerals is likely due to the pH increase resulting from CO_2 degassing.

6.3.2 Adsorption

In addition to coprecipitation with iron oxyhydroxides, arsenic is also likely adsorbing to the surfaces of iron-bearing minerals within the aquifer such as magnetite, pyroxenes, amphiboles, and biotite.

The implication of the study for the Highway 99 site is that attenuation of arsenic within the aquifer begins with adsorption of arsenic (5), which results in the groundwater system re-equilibrating by oxidizing some of the arsenic (3) to arsenic (5).

6.3.3 Total Organic Carbon, Dissolved Oxygen, and Redox Potential

The total organic carbon and other data for comparison are presented in **Table 14**.

Table 14. Comparison of Groundwater TOC, DO, Iron, Arsenic, and Eh Data

Well	Date	TOC (mg/L)	Eh (v)	Total Dissolved Arsenic (mg/L)	Dissolved Oxygen (mg/L)	Dissolved Iron (mg/L)
MW-1	5/26/2010	12.4	0.200	0.63	0.25	4.29
MW-2	5/25/2010	2.71	0.175	0.034	0.22	1.56
MW-3	5/25/2010	19.9	0.129	0.78	0.2	29.9
MW-3	7/15/2010	-	0.104	-	0.13	-
MW-4	5/26/2010	11.1	0.211	1.03	0.26	31.5
MW-4	7/15/2010	-	0.119	-	0.15	-
MW-5	5/26/2010	5.05	0.145	1.09	0.3	5.07
MW-6	5/26/2010	9.27	0.157	0.31	0.39	6.2
MW-7	5/27/2010	4.17	0.202	0.01	0.21	1.8
MW-8	5/27/2010	3.83	0.228	0.013	0.27	0.98
MW-9	5/27/2010	<1.50	0.279	0.044	0.19	0.025
99-1	5/26/2010	4.83	0.152	2.49	0.32	6.34
99-1	7/15/2010	-	0.065	-	0.22	-
99-2	5/27/2010	25.3	0.180	0.41	0.29	45.7
SW1	5/25/2010	5.22	0.345	0.003	10.23	0.28
SW2	5/25/2010	-	0.362	0.0029	10	-
SW3	5/25/2010	-	0.355	0.003	9.36	-
SW4	5/25/2010	5.19	0.356	0.0031	9.56	0.27
SW5	5/25/2010	7.38	0.362	0.003	9.24	0.28
SW6	5/25/2010	-	0.372	0.003	9.18	-

The DOC concentrations do not appear to correlate (either positively or negatively) with ORP, total dissolved As, or DO, indicating that the system is not in equilibrium. For a system in complete equilibrium, the TOC would consume the DO in the water and the ORP would decrease. At equilibrium, TOC would also reduce As (5) to As (3) and dissolve iron minerals (both by reducing ferric iron to ferrous and by forming aqueous complexes with iron), which would tend to increase total dissolved arsenic concentrations. There is a rough correlation between TOC and total arsenic, although the highest TOC does not correspond to the highest total dissolved arsenic. The correlation between Eh and dissolved iron is closer, with Eh values in excess of 0.2 volts resulting in dissolved iron concentrations of less than 1 mg/L, and Eh values of less than 0.2 volts resulting in dissolved iron concentrations of greater than 1 mg/L.

The general lack of equilibrium with respect to redox, DO, TOC, arsenic, and iron is likely the result of a redox gradient in which more oxidizing infiltration water mixes with more reducing groundwater. At favorable locations along the gradient, iron oxidizes or partially oxidizes to form ferric oxyhydroxides or green rusts, respectively. The formation of these phases is the most likely control on dissolved arsenic concentrations.

6.3.4 Arsenic Transport Velocity

Arsenic attenuation is often described by the partition coefficient (Kd), which includes all attenuation, including adsorption, precipitation, and coprecipitation processes. The partition coefficient expression is as follows:

$$K_d = C_{soil}/C_{soln} \qquad (4)$$

Where,

K_d = The partition coefficient (L/kg)

C_{soil} = The concentration of arsenic on the soil or aquifer sediment (mg/kg)

C_{soln} = The concentration of arsenic in solution (i.e., groundwater) (mg/L)

The K_d is useful because it can be used to calculate the retardation factor (R), which is a measure of the transport velocity of arsenic at the site relative to the groundwater. The retardation factor is calculated using the following:

$$R = 1 + (\rho/n)K_d = V/V_c \qquad (5)$$

Where,

ρ = The dry bulk density of the aquifer matrix (L/kg)

n = The total porosity of the aquifer matrix (volume fraction)

V = The groundwater velocity (ft/day)

V_c = The velocity of the arsenic (ft/day)

Once R is known, the transport velocity of arsenic at the site can be determined.

The partition coefficient is typically determined by performing a bench-scale test using clean aquifer material and impacted groundwater from the site. K_d values for arsenic reported in literature vary by orders of magnitude, depending on the properties of the aquifer sediment or soil (iron content, grain size, mineralogy) and the nature of the groundwater (pH, Eh, concentration of competing ions).

Because a site-specific K_d value has not been determined for the Highway 99 site, an estimate using available site data was made. The calculations were made using equation 4, along with the groundwater data and the closest available soil data, both aerially and in terms of depth. The results are summarized in **Table 15**.

Table 15. Calculated K_d Values for the Highway 99 Site

Groundwater ID	Groundwater As (mg/L)	Soil Boring ID	Soil As Result (mg/kg)	Soil Depth (ft)	Well Screen Interval (ft)	K_d (L/kg)
MW-1	0.63	B5	7430	14	13-18	11,794
	0.63		64.5	16		102
	0.63		48.5	18		77
MW-2	0.034	A6	18.5	12	12-19	544
	0.034		12.1	14		356
	0.034		10.9	16		321
MW-3	0.78	D5	3.5	16	14.7-19.7	4.5
MW-4	1.03	D6	5.9	14	14-19	5.7
	1.03		7.1	16		6.9
MW-5	1.09	D7	7.1	14	14.5-19.5	6.5
	1.09		8.4	16		7.7
MW-6	0.31	C8	10.9	14	14.1-19.1	35
	0.31		3.5	16		11
99-2	0.41	D3	30.1	16	15-25	73
	0.41		51.1	18		125
	0.41		39.2	20		96
	0.41		37.9	20		92
	0.41		18.5	22		45
	0.41		12.1	24		30
	0.41	D2	8.4	16		20
	0.41	C2	9.6	16		23
Minimum*						**4**
Maximum*						**544**
Average*						**99**
Median*						**40**

* Excludes the K_d value of 11,794, which is a statistical outlier.

The K_d values are variable, but in general are quite high.

Using an arsenic K_d of 4 L/kg (the minimum), a dry bulk density of 1.65 L/kg, a porosity of 0.2, and a groundwater velocity of 2.0 ft/day results in an R of (1+[1.65/0.2]*4 = 34) and an arsenic velocity of 0.059 ft/day (2.0/34 = 0.059).

The time required for the groundwater to travel the approximately 50 feet from MW-99-1 to the groundwater beneath Hylebos Creek is approximately 17 years (50 ft/0.059 ft/d = 847 days = 2.3 yrs). Using the median K_d value of 44 L/kg results in an R value of 364, an arsenic velocity of 0.00549 ft/day, and an MW99-1 to Hylebos Creek travel time of 25 years. Given that the contaminant source was in place for about 10 years before removal in 1985, and the fact that the residual arsenic has been in place for about 37 years, it makes sense that the arsenic would have reached the groundwater beneath the Hylebos Creek by now, which is confirmed by the presence of arsenic in wells MW-5 (1,060 µg/L) and MW-10 (366 µg/L).

Section 7
Terrestrial Ecological Evaluation

A simplified terrestrial ecological evaluation (TEE) was conducted to assess the potential risk of exposure to wildlife from potential site contamination. The simplified TEE exposure analysis concluded that land use at the site and surrounding area makes substantial wildlife exposure unlikely (WAC 173-340-7492(2)(ii)).

Interstate 5, Pacific Highway East, and the site's paved surfaces and commercial land use form significant barriers to terrestrial wildlife movement and use (including birds) and would prevent most species from accessing the site. The site contamination is quite isolated from potential terrestrial wildlife use by highways and the risk to exposure is low. In addition, the habitats within 500 feet of the site are separated from the site by these major roadways. Species that would be expected in the forested hillside area to the west would not be attracted to the fields to the east or vice versa. Therefore, wildlife that might use the undeveloped lands to the west or east would not be expected to traverse the site.

Section 8
Summary

Findings of the RI are summarized below.

- Based on our evaluation of the overall quality and usability of soil and groundwater samples, no QC issues encountered were significant enough to warrant analytical data of analytical reports and available QC data from the field investigation. All data were determined to be usable for the intended project purposes without qualification.
- Industrial waste containing arsenic was used as fill on the site from about 1971 to 1973. The majority of this fill was excavated and disposed off-site by USG in a 1984/1985 contaminant source removal action. Arsenic impacted native soil in the vicinity of 99-1 was also removed at this time.
- The site is underlain by fill, alluvium, and glacial deposits to a depth of at least 59 feet bgs.
- Two aquifers were identified at the site: the Alluvial Aquifer and Glacial Aquifer.
- The Alluvial Aquifer is the uppermost aquifer at the site and is impacted by arsenic. There is a strong upward hydraulic gradient from the underlying Glacial Aquifer.
- The estimated average linear groundwater flow velocity in the Alluvial Aquifer is estimated to range from 2 to 20 feet/day.
- The distribution of residual arsenic in soil at the site reflects the results of the 1984/1985 contaminant source removal action. Arsenic concentrations are relatively low at ground surface. Soil excavated in 1984/1985 was restored with clean fill. The RI fully defined the lateral and vertical extent of arsenic exceeding MTCA soil cleanup levels.
- Arsenic concentrations in Alluvial Aquifer groundwater are highest at monitoring well 99-1. This well was drilled where the highest arsenic concentrations were encountered in fill and native soil during the 1984/1985 contaminant source removal action.
- Arsenic concentrations in groundwater attenuate significantly to the north and south of 99-1. However, arsenic exceeds MTCA Method A groundwater cleanup levels at the north end of the Kanopy Kingdom property and the south end of the Freeway Trailer property.
- The Alluvial Aquifer pinches out to the west of Pacific Highway East. Arsenic in groundwater east of Hylebos Creek could not be defined because of the location of Interstate 5.
- Arsenic within the Alluvial Aquifer attenuates with depth. Arsenic in the underlying Glacial Aquifer exceeds MTCA Method A cleanup standards but this exceedence does not appear to be related site activities.
- Arsenic transport in the Alluvial Aquifer is at least 34 times slower than the groundwater velocity, resulting in long travel times for arsenic to migrate downgradient from the contaminant source area.

- Arsenic in the Alluvial Aquifer does not appear to be impacting Hylebos Creek water quality.
- Hylebos Creek sediment downgradient of the contaminant source area has arsenic exceeding ecological screening criteria
- The simplified TEE exposure analysis concluded that land use at the site and surrounding area makes substantial wildlife exposure unlikely.

Section 9

References

Anderson, M.A., J.F. Ferguson and J. Gavis. 1976. *Arsenate Adsorption on Amorphous Aluminum Hydroxides.* J. Colloid & Interface Sci. v. 54 p. 391-399.

Anderson, M.P., and Woessner, W.W. 1992. *Applied Groundwater Modeling – Simulation of Flow and Advective Transport.* San Diego: Academic Press, Inc.

Camp Dresser & McKee, Inc. (CDM) 2010. *Remedial Investigation Work Plan, USG Interiors Highway 99 Site, Milton, Washington.* Dated March 5, 2010.

Duel, L.E. and A. R. Swoboda. 1972. *Arsenic Solubility in a Reducted Environment*. Soil Sci. Soc. Am. Proc. 36:276-278.

Ecology. 1986. *Memorandum to the Project File*. By Dom Reale, Washington Department of Ecology. June 30, 1986

Frost, R.R. and R.A. Griffin. 1977. *Effect of pH on Adsorption of Arsenic and Selenium from Landfill Leachate by Clay Minerals*. Soil Sci. Soc. Am. J. v. 41 p. 53-57.

Hazen. 1911. *Discussion—Dams on sand foundations*. Transactions, American Society of Civil Engineers, v. 73, p. 199.

Hem, J.D. 1971. *Study and Interpretation of the Chemical Characteristics of Natural Water*. Second Edition. USGS Water Supply Paper 1473.

Hounslow, A.W. 1980. *Ground Water Geochemistry: Arsenic in Landfills*. Ground Water v. 18 n. 4 p. 331-333.

Parkhurst, D.L. and Appelo, C.A.J. 1999. *User's Guide to PHREEQC (Version 2)- A Computer Program for Speciation, Batch-Reaction, One-Dimensional Transport, and Inverse Geochemical Calculations*. USGS Water-Resources Investigations Report 99-4259.

Pierce, M.L. and C.B. Moore. 1982. *Adsorption of arsenite and arsenate on amorphous iron hydroxide*. Water Res. 16:1247-1253.

Root, R.A., Dixit, S., Campbell, K.M., Jew, A.D., Hering, J.G. and P.A. O'Day. 2007. *Arsenic sequestration by sorption processes in high-iron sediments*. Geochimica et Cosmochimica Acta. v. 71, p. 5782-5803.

Shnyukov, E.F. 1963. *Arsenic in the Cimmerian Iron Ores of the Azov-Black Sea Region.* Geochemistry (Geokhimiya), 87-93.

Stow, S.H. 1969. *The Occurrence of Arsenic and the Color-Causing Components in Florida Land-Pebble Phosphate Rock*. Economic Geology. V. 64, p. 667-671.

Stumm, W. and J.J. Morgan. 1981. *Aquatic Chemistry: An Introduction Emphasizing Chemical Equilibria in Natural Waters*. 2nd ed. John Wiley and Sons, NY.

Su, C. and R.W. Puls. 2004. *Significance of Iron (II,III) Hydroxycarbonate Green Rust in Arsenic Remediation using Zerovalent Iron in Laboratory Column Tests*. *Environ. Sci. Technol.* v. 38, p. 5224-5231.

TPCHD. 1993. *Hylebos Creek Water Quality Project. Final Report. Prepared for Tacoma-Pierce County Health Department Water Resources Section.* Prepared by Adolfson Associates, Inc. June 1993.

EPA, 1998. *Method 6200, Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment.* January 1998.

Washington Department of Ecology (Ecology). 2008. *Agreed Order DE 84-506 Between the Washington Department of the Ecology and USG.* August 17, 1984.

Whiting, K.S. 1992. *The Thermodynamics and Geochemistry of Arsenic, with Application to Subsurface Waters at the Sharon Steel Superfund Site at Midvale, Utah.* MS Thesis T-4128 Colorado School of Mines, Golden Colorado.

Woolsen, E.A., J.H. Axley, and P.C. Kearney. 1971. The *Chemistry and Phytotoxicity of Arsenic in Soils: I Contaminated Field Soils*. Soil Sci. Soc. Am. Proc. 35:938-943.

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Tables

Table 1
Well Construction Details
Highway 99 Site
USG Interiors
Milton, Washington

Well I.D.	Northing [a]	Easting [a]	TOC Elevation (ft AMSL) [b]	Boring Total Depth (ft)	Screen Depth Interval (ft)	Casing Diameter (in)	Slot Size (in)	Screen Type	Drilled Date
MW-1	703059.65	1184681.28	23.02	19.0	13-18	2	0.01	PVC	05/05/10
MW-2	702999.60	1184652.77	22.37	19.0	12-19	2	0.01	PVC	05/04/10
MW-3	703045.13	1184763.71	20.22	21.0	14.7-19.7	2	0.01	PVC	05/07/10
MW-4	702987.85	1184749.40	20.40	20.0	14-19	2	0.01	PVC	05/05/10
MW-5	702934.84	1184745.18	19.07	20.0	14.5-19.5	2	0.01	PVC	05/06/10
MW-6	702883.36	1184710.13	19.89	20.0	14.1-19.1	2	0.01	PVC	05/06/10
MW-7	702969.79	1184715.93	21.06	39.0	25-30	2	0.01	PVC	05/05/10
MW-8	702924.45	1184744.14	19.12	40.0	34.9-40.1	2	0.01	PVC	05/06/10
MW-9	702988.01	1184715.80	20.87	59.0	43-48	2	0.01	PVC	05/04/10
MW-10	702958.17	1184783.51	14.15	12.6	10.4-11.5	3/4	0.01	Stainless Steel	10/14/11
MW-11	703185.90	1184844.31	15.41	10.5	9.3-10.5	3/4	0.01	Stainless Steel	10/14/11
MW-12	703065.01	1184585.80	21.54	20.0	14-19	1	0.01	Pre-pack PVC	05/11/12
MW-13	702495.10	1184478.55	22.16	16.0	10-15	1	0.01	Pre-pack PVC	05/11/12
MW-14	703437.40	1184781.81	30.30	20.0	13-18	1	0.01	Pre-pack PVC	05/11/12
99-1	702978.95	1184715.54	21.34	28.0	15-25	4	0.01	PVC	05/1985
99-2	703159.55	1184771.51	22.64	25.5	15-25	4	0.01	PVC	05/1985

Notes:
a) Washington State Plane North American Datum of 1983 (NAD 83), Zone 12, feet.
b) ft AMSL - feet above mean sea level. Elevations based on North American Vertical Datum of 1988 (NAVD 88).
TOC - top of casing.
PVC - Polyvinylchloride

Table 2
Summary of Groundwater Elevation Measurements
Hwy 99 Site
USG Interiors
Milton, Washington

Monitoring Well I.D.	Date Measured	Top of Casing Elevation [a] (feet)	Depth to Groundwater (ft below TOC)	Groundwater Elevation (feet)
MW1	05/25/10	23.02	10.19	12.83
	07/15/10		9.85	13.17
	05/22/12		9.04	13.98
MW2	05/25/10	22.37	8.42	13.95
	07/15/10		8.51	13.86
	05/22/12		7.71	14.66
MW3	05/25/10	20.22	7.22	13.00
	07/15/10		7.32	12.90
	05/22/12		6.28	13.94
MW4	05/25/10	20.40	7.41	12.99
	07/15/10		7.51	12.89
	05/22/12		6.63	13.77
MW5	05/25/10	19.07	6.17	12.90
	07/15/10		6.22	12.85
	05/22/12		5.32	13.75
MW6	05/25/10	19.89	7.08	12.81
	07/15/10		7.16	12.73
	05/22/12		6.19	13.70
MW7	05/25/10	21.06	7.81	13.25
	07/15/10		8.02	13.04
	05/22/12		8.15	12.91
MW8	05/25/10	19.12	5.34	13.78
	07/15/10		5.57	13.55
	05/22/12		4.59	14.53
MW9	05/25/10	20.87	1.72	19.15
	07/15/10		1.89	18.98
	05/22/12		0.63	20.25
MW10	05/22/12	14.15	0.79	13.36
MW11	05/22/12	15.41	6.90	8.51
MW12	05/22/12	21.54	0.00	21.54
MW13	05/22/12	22.16	8.27	13.89
MW14	05/22/12	30.30	10.60	19.70
99-1	05/25/10	21.34	8.22	13.12
	07/15/10		8.47	12.87
	05/22/12		7.60	13.74
99-2	05/25/10	22.64	9.62	13.02
	07/15/10		9.71	12.93
	05/22/12		8.89	13.75

Notes:

a) Datum used: NAD 83/91 Washington South Zone NAVD '88, US Feet.
ft bgs - Feet below ground surface.
TOC - top of casing.

Table 3
Groundwater General Parameters
Hwy 99 Site
USG Interiors
Milton, Washington

Monitoring Well	Date Sampled	Time Sampled	Temperature (°C)	Specific Conductance (µs/cm)	pH	Turbidity (NTU)	Dissolved Oxygen (mg/L)	ORP (mV)	Appearance/ Odor
MW1	05/26/10	1435	12.72	318	6.73	5.79	0.25	-11.7	Clear, colorless/no odor
MW2	05/25/10	1445	13.28	331	6.79	0.57	0.22	-35.4	Clear, colorless/no odor
MW3	05/25/10	1615	12.53	449	6.73	16.6	0.20	-82.8	Yellow tint, slight turbidity/no odor
	07/15/10	1430	13.01	460	6.66	3.3	0.13	-107.4	Slight yellowish color, clear, no odor
MW4	05/26/10	1310	12.22	633	6.48	5.68	0.26	-0.7	Clear, colorless/no odor
	07/15/10	1305	13.51	664	6.61	0.00	0.15	-91.5	Clear, colorless, broken organic sheen /no odor
MW5	05/26/10	1025	11.79	394	6.74	4.58	0.30	-67.1	Clear, colorless/no odor
MW6	05/26/10	0915	12.66	456	6.68	8.96	0.39	-54.5	Clear, colorless/no odor
MW7	05/27/10	1045	13.28	420	6.99	10.15	0.21	-8.3	Clear, colorless/no odor
MW8	05/27/10	0940	12.05	419	7.00	8.62	0.27	16.3	Clear, colorless/no odor
MW9	05/27/10	1200	13.35	265	7.72	9.86	0.19	68.2	Clear, colorless/no odor
MW10	10/18/11	1335	13.44	349	6.88	49.8	0.47	-94.0	Clear, colorless/no odor
MW11	10/18/11	1225	13.90	670	6.48	12.8	0.16	-129.9	Clear, colorless/no odor
MW12	05/22/12	0950	11.91	188	6.67	26.9	2.00	-75	Clear, colorless, odorless, slight turbidity observable in bucket
MW13	05/22/12	1220	13.24	1024	6.56	84	0.98	-102.1	Clear, colorless, odorless, little bit swirled organic sheen
MW14	05/22/12	1440	12.21	1249	6.54	863	0.71	-101.1	Colorless, odorless, water in bucket is slightly muddy
99-1	05/26/10	1200	12.90	415	6.92	5.62	0.32	-58.8	Clear, colorless/no odor
	07/15/10	1210	14.21	406	6.68	5.00	0.22	-144.6	Clear, slight yellowish color, odorless
99-2	05/27/10	1310	13.24	1201	6.52	17.6	0.29	-31	Clear, slight yellowish color, broken organic sheen /no odor

Notes:
°C - degrees Celsius.
µs/cm - microsiemens per centimeter.
mg/L - milligram per liter.
mV - millivolts.
NTU - nephelometric turbidity units.

Table 4
Surface Water General Parameters
Hwy 99 Site
USG Interiors
Milton, Washington

Monitoring Well	Date Sampled	Time Sampled	Temperature (°C)	Specific Conductance (µs/cm)	pH	Dissolved Oxygen (mg/L)	ORP (mV)	Appearance/ Odor
SW1	05/25/10	1310	11.47	240	7.79	10.23	132.6	Clear/no odor, colorless
SW2	05/25/10	1250	11.35	242	7.66	10.00	149.0	Clear/no odor, colorless
SW3	05/25/10	1230	11.20	242	7.58	9.36	142.1	Clear/no odor, colorless
SW4	05/25/10	1205	11.20	241	7.70	9.56	142.8	Clear/no odor, colorless
SW5	05/25/10	1135	11.13	241	7.73	9.24	149.6	Clear/no odor, colorless
SW6	05/25/10	1110	11.11	241	7.76	9.18	158.7	Clear/no odor, colorless

Notes:
°C - degrees Celsius.
µs/cm - microsiemens per centimeter.
mg/L - milligram per liter.
mV - millivolts.

Table 5
Vertical Hydraulic Gradient Between Shallow and Deeper Groundwater Monitoring Points
Alluvial Aquifer
USG Interiors/Remedial Investigation
Milton, Washington

Well Cluster	Date	Vertical Gradient Between Shallow and Deeper Groundwater Monitoring Points	
		Upward	Downward
99-1 / MW7	5/25/2010	0.017	
	7/15/2010	0.022	
MW5 / MW8	5/25/2010	0.044	
	7/15/2010	0.035	

Notes:
Vertical hydraulic gradient was calculated by dividing the head differential by the vertical distance between screen midpoint elevation for wells in each well cluster. Screen midpoint elevations used include: 99-1 = 1.3 feet; MW7 = -6.44 feet; MW5 = 1.57 feet; and MW8 = -18.38 feet.

Table 6
Arsenic in Soil
Highway 99 Site
USG Interiors
Milton, Washington

Boring I.D.	Sample Depth (ft bgs)	Date Sampled	Total Arsenic (mg/kg)
A4-2	2	04/28/10	3.5
A4-4	4	04/28/10	13.4
A4-8	8	04/28/10	2.9
A4-10	10	04/28/10	3.5
A4-12	12	04/28/10	4.1
A4-14	14	04/28/10	3.5
A4-16	16	04/28/10	8.4
A5-2	2	04/28/10	3.5
A5-4	4	04/28/10	3.5
A5-6	6	04/28/10	3.5
A5-12	12	04/28/10	59.1
A5-14	14	04/28/10	44.5
A5-16	16	04/28/10	10.9
A6-2	2	04/28/10	3.5
A6-4	4	04/28/10	9.6
A6-8	8	04/28/10	9.6
A6-10	10	04/28/10	59.1
A6-12	12	04/28/10	18.5
A6-14	14	04/28/10	12.1
A6-16	16	04/28/10	10.9
A7-2	2	04/27/10	3.5
A7-4	4	04/27/10	<5 **
A7-6	6	04/27/10	313.4
A7-12	12	04/27/10	257 **
A7-14	14	04/27/10	75.2
A7-16	16	04/27/10	142.2
A7-18	18	04/27/10	31.4
A7-20	20	04/27/10	8.4
A8-2	2	04/28/10	3.5
A8-4	4	04/28/10	157.4
A8-6	6	04/28/10	160
A8-8	8	04/28/10	47.2
A8-8	8	04/28/10	35.3
A8-8	8	04/28/10	51.1
A8-8	8	04/28/10	53.8
A8-8	8	04/28/10	49.8
A8-8	8	04/28/10	52.5
A8-8	8	04/28/10	48.5
A8-8	8	04/28/10	48.5
A8-8	8	04/28/10	49.8
A8-10	10	04/28/10	3.5
A8-12	12	04/28/10	3.5
A8-14	14	04/28/10	3.5
A8-16	16	04/28/10	3.5

Table 6
Arsenic in Soil
Highway 99 Site
USG Interiors
Milton, Washington

Boring I.D.	Sample Depth (ft bgs)	Date Sampled	Total Arsenic (mg/kg)
A9-2	2	04/29/10	3.5
A9-4	4	04/29/10	32.7
A9-6	6	04/29/10	8.4
A9-8	8	04/29/10	3.5
A9-10	10	04/29/10	8.4
A9-12	12	04/29/10	7.1
A9-14	14	04/29/10	3.5
A9-16	16	04/29/10	3.5
AA6-6	6	05/11/12	<12 **
AA6-10	10	05/11/12	<15 **
AA6-12	12	05/11/12	<13 **
AA6-14	14	05/11/12	<13 **
AA7-10	10	05/11/12	<19 **
AA7-12	12	05/11/12	<13 **
B2-2	2	04/28/10	3.5
B2-4	4	04/28/10	14.6
B2-6	6	04/28/10	3.5
B2-8	8	04/28/10	3.5
B2-10	10	04/28/10	8.4
B2-12	12	04/28/10	12.1
B2-14	14	04/28/10	8.4
B2-16	16	04/28/10	17.2
B3-2	2	04/28/10	23.6
B3-4	4	04/28/10	101
B3-6	6	04/28/10	3.5
B3-8	8	04/28/10	10.9
B3-10	10	04/27/10	3.5
B3-14	14	04/27/10	3.5
B3-15	15	04/27/10	3.5
B4-2	2	04/26/10	3.5
B4-4	4	04/26/10	3.5
B4-8	8	04/26/10	3.5
B4-10	10	04/26/10	12 **
B4-14	14	04/26/10	1680 **
B4-16	16	04/26/10	80 **
B4-18	18	04/26/10	17.2
B4-20	20	04/26/10	7.1
B5-2	2	04/26/10	43 **
B5-4	4	04/26/10	2.9
B5-6	6	04/26/10	7.1
B5-8	8	04/26/10	3.5
B5-12	12	04/26/10	3.5
B5-14	14	04/26/10	7430 **
B5-16	16	04/26/10	64.5
B5-18	18	04/26/10	48.5
B5-20	20	04/26/10	14.6

Table 6
Arsenic in Soil
Highway 99 Site
USG Interiors
Milton, Washington

Boring I.D.	Sample Depth (ft bgs)	Date Sampled	Total Arsenic (mg/kg)
B6-2	2	04/27/10	20.0 **
B6-4	4	04/27/10	3.5
B6-6	6	04/27/10	8.4
B6-8	8	04/27/10	3.5
B6-10	10	04/27/10	13.4
B6-12	12	04/27/10	13086.3
B6-14	14	04/27/10	1920 **
B6-16	16	04/27/10	73 **
B6-18	18	04/27/10	35.3
B6-20	20	04/27/10	18.5
B6-20	20	04/27/10	21.0
B6-20	20	04/27/10	21.0
B6-20	20	04/27/10	17.2
B6-20	20	04/27/10	17.2
B6-20	20	04/27/10	21.0
B6-20	20	04/27/10	14.6
B7-2	2	04/27/10	8.4
B7-4	4	04/27/10	4.1
B7-4	4	04/27/10	3.5
B7-6	6	04/27/10	158.8
B7-8	8	04/27/10	49.8
B7-10	10	04/27/10	493 **
B7-12	12	04/27/10	63.2
B7-14	14	04/27/10	20.0 **
B7-16	16	04/27/10	15.9
B8-2	2	04/28/10	4.1
B8-4	4	04/28/10	9.6
B8-6	6	04/28/10	9.6
B8-8	8	04/28/10	21
B8-10	10	04/28/10	17.2
B8-12	12	04/28/10	21
B8-14	14	04/28/10	14.6
B8-16	16	04/28/10	10.9
C2-2	2	04/28/10	3.5
C2-4	4	04/28/10	10.9
C2-8	8	04/28/10	3.5
C2-10	10	04/28/10	30.1
C2-12	12	04/28/10	21
C2-14	14	04/28/10	15.9
C2-16	16	04/28/10	9.6
C3-2	2	04/27/10	3.5
C3-4	4	04/27/10	10.9
C3-6	6	04/27/10	5.9
C3-8	8	04/27/10	3.5
C3-12	12	04/27/10	188
C3-14	14	04/27/10	293.6

Table 6
Arsenic in Soil
Highway 99 Site
USG Interiors
Milton, Washington

Boring I.D.	Sample Depth (ft bgs)	Date Sampled	Total Arsenic (mg/kg)
C3-15	15	04/27/10	199.2
C3-16	16	04/27/10	249.7
C3-18	18	04/27/10	45 **
C3-20	20	04/27/10	36.6
C3-22	22	04/27/10	4.1
C3-24	24	04/27/10	10.9
C4-2	2	04/26/10	8.4
C4-4	4	04/26/10	12.1
C4-4	4	04/26/10	9.6
C4-6	6	04/26/10	8.4
C4-8	8	04/26/10	31.4
C4-10	10	04/26/10	228 **
C4-12	12	04/26/10	40.6
C4-14	14	04/26/10	52.5
C4-16	16	04/26/10	13.4
C5-2	2	04/26/10	9.6
C5-4	4	04/26/10	14.6
C5-6	6	04/26/10	2.9
C5-8	8	04/26/10	3.5
C5-10	10	04/26/10	113.3
C5-12	12	04/26/10	61.8
C5-14	14	04/26/10	24.9
C5-16	16	04/26/10	49.0 **
C5-18	18	04/26/10	14.6
C5-20	20	04/26/10	17.2
C7-4	4	04/27/10	3.5
C7-6	6	04/27/10	4.1
C7-8	8	04/27/10	170 **
C7-10	10	04/27/10	167.1
C7-12	12	04/27/10	28.8
C7-14	14	04/27/10	28.8
C7-16	16	04/27/10	22.3
C8-2	2	04/28/10	3.5
C8-4	4	04/28/10	3.5
C8-5	5	04/28/10	10450
C8-6	6	04/28/10	287.9
C8-8	8	04/28/10	332
C8-10	10	04/28/10	59.1
C8-12	12	04/28/10	57.8
C8-14	14	04/28/10	10.9
C8-16	16	04/28/10	3.5
C9-2	2	04/29/10	57 **
C9-4	4	04/29/10	154.6
C9-6	6	04/29/10	39.2
C9-8	8	04/29/10	15.9
C9-10	10	04/29/10	3.5
C9-12	12	04/29/10	3.5

Table 6
Arsenic in Soil
Highway 99 Site
USG Interiors
Milton, Washington

Boring I.D.	Sample Depth (ft bgs)	Date Sampled	Total Arsenic (mg/kg)
C9-14	14	04/29/10	3.5
C9-16	16	04/29/10	3.5
C10-2	2	04/29/10	69.9
C10-2	1	04/29/10	14.6 *
C10-4	4	04/29/10	15.9
C10-6	6	04/29/10	18.5
C10-8	8	04/29/10	14.6
C10-10	10	04/29/10	3.5
C10-12	12	04/29/10	3.5
D1-2	2	04/29/10	14.6
D1-4	4	04/29/10	3.5
D1-6	6	04/29/10	9.6
D1-8	8	04/29/10	13.4
D1-10	10	04/29/10	3.5
D1-12	12	04/29/10	10.9
D1-14	14	04/29/10	9.6
D2-2	2	04/28/10	3.5
D2-4	4	04/28/10	24.9
D2-8	8	04/28/10	36.6
D2-10	10	04/28/10	3.5
D2-12	12	04/28/10	3.5
D2-14	14	04/28/10	3.5
D2-16	16	04/28/10	8.4
D3-2	2	04/26/10	8.4
D3-4	4	04/26/10	24.9
D3-4	4	04/26/10	23.6
D3-6	6	04/26/10	36.6
D3-8	8	04/26/10	21 **
D3-10	10	04/26/10	3.5
D3-12	12	04/26/10	44.5
D3-16	16	04/26/10	30.1
D3-18	18	04/26/10	51.1
D3-20	20	04/26/10	39.2
D3-20	20	04/26/10	37.9
D3-22	22	04/26/10	18.5
D3-24	24	04/26/10	12.1
D4-2	2	04/26/10	8.4
D4-4	4	04/26/10	7 **
D4-8	8	04/26/10	3.5
D4-10	10	04/26/10	2.3
D4-12	12	04/26/10	17.2
D4-14	14	04/26/10	18.5
D4-16	16	04/26/10	13.4
D5-2	2	04/26/10	10.9
D5-4	4	04/26/10	9.6
D5-6	6	04/26/10	10.9
D5-8	8	04/26/10	8.4

Table 6
Arsenic in Soil
Highway 99 Site
USG Interiors
Milton, Washington

Boring I.D.	Sample Depth (ft bgs)	Date Sampled	Total Arsenic (mg/kg)
D5-10	10	04/26/10	4.7
D5-12	12	04/26/10	8.4
D5-14	14	04/26/10	3.5
D5-16	16	04/26/10	3.5
D6-2	2	04/27/10	9.6
D6-4	4	04/27/10	10.9
D6-6	6	04/27/10	56.5
D6-8	8	04/27/10	47.2
D6-10	10	04/27/10	2.3
D6-12	12	04/27/10	3.5
D6-14	14	04/27/10	5.9
D6-16	16	04/27/10	7.1
D7-4	4	04/27/10	3.5
D7-6	6	04/27/10	3.5
D7-8	8	04/27/10	3.5
D7-10	10	04/27/10	3.5
D7-12	12	04/27/10	4.1
D7-14	14	04/27/10	7.1
D7-16	16	04/27/10	8.4
D8-1.5	1.5	04/29/10	30.1
D8-5	5	04/29/10	53.8
D8-8	8	04/29/10	45.8
D8-8	8	04/29/10	41.9
D8-8	8	04/29/10	45.8
D8-8	8	04/29/10	48.5
D8-8	8	04/29/10	47.2
D8-8	8	04/29/10	53.8
D8-8	8	04/29/10	48.5
D8-10	10	04/29/10	43.2
D8-12	12	04/29/10	9.6
D8-14	14	04/29/10	4.1
D8-16	16	04/29/10	12.1
D9-1	1	04/29/10	28.8
D9-4.5	4.5	04/29/10	13.4
D9-6	6	04/29/10	8.4
D9-8	8	04/29/10	12.1
D9-10	10	04/29/10	3.5
D9-12	12	04/29/10	3.5
E3	0	04/29/10	4.7
E4	0	04/29/10	13.4
E5	0	04/29/10	13.4
E6	0	04/29/10	22.3
E7	0	04/29/10	3.5
E8	0	04/29/10	18.5
GP1-5	5	06/05/06	310
GP1-10	10	06/05/06	200
GP1-15	15	06/05/06	320

Table 6
Arsenic in Soil
Highway 99 Site
USG Interiors
Milton, Washington

Boring I.D.	**Sample Depth (ft bgs)**	**Date Sampled**	**Total Arsenic (mg/kg)**
GP2-15	15	06/05/06	1400
GP3-12	12	06/05/06	19
GP3-14	14	06/05/06	23
GP4-9.5	9.5	06/05/06	570
GP4-13	13	06/05/06	31
GP5-10	10	06/05/06	240
GP5-13	13	06/05/06	15
GP6-11	11	06/05/06	72
GP7-8	8	06/06/06	<11
GP8-9	9	06/06/06	870
GP8-13	13	06/06/06	160
GP9-9	9	06/06/06	310
GP9-14	14	06/06/06	36
MW12-6	6	05/11/12	<16 **
MW12-8	8	05/11/12	<12 **
MW12-12	12	05/11/12	<13 **
MW12-14	14	05/11/12	<12 **

Notes:
Shaded concentrations exceed Washington Administration Code Chapter 173-340, Model Toxics Control Act, Method A cleanup levels
* Result from a 2nd locaton for Boring C10; moved due to refusal.
** As results from lab data.

Table 7
Arsenic in Sediment
Highway 99 Site
USG Interiors
Milton, Washington

Boring I.D.	Sample Depth (ft bgs)	Date Sampled	Total Arsenic (mg/kg)
SED-1B	Surface	04/30/10	2.9
SED-1C	Surface	04/30/10	7 **
SED-2B	Surface	04/29/10	3.5
SED-2C	Surface	04/29/10	2.9
SED-3B	Surface	04/29/10	205 **
SED-3C	Surface	04/29/10	2.9
SED-4B	Surface	04/29/10	90 **
SED-4C	Surface	04/29/10	9.6
SED-5B	Surface	04/29/10	14.6
SED-5C	Surface	04/29/10	45.8
SED-6B	Surface	04/29/10	30 **
SED-6C	Surface	04/29/10	17 **
SED-7B	Surface	04/30/10	2.9
SED-7C	Surface	04/30/10	8.1

Note:
** As results from lab data.

Table 8
Analytical Results - Groundwater
Highway 99 Site
USG Interiors
Milton, Washington

Analyte	Sample I.D. and Sample Date					
	USGHWY99-MW1-05/10	**USGHWY99-MW2-05/10**	**USGHWY99-MW3-05/10**	**USGHWY99-MW4-05/10**	**USGHWY99-MW0-05/10***	**USGHWY99-MW5-05/10**
	05/25/10	**05/25/10**	**05/25/10**	**05/26/10**	**05/26/10**	**05/26/10**
Dissolved Metals (µg/L)						
EPA Methods 200.8/7060A/6010B						
Arsenic (7060A)	630	34	780 **	1,030 **	1,060 **	1,090
Iron	4,290	1,560	29,900 **	31,500 **	32,000 **	5,070
Total Metals (µg/L)						
EPA Method 200.8/7090A/6010B						
Arsenic (200.8)	--	64.2	--	--	--	--
Arsenic (7060A)	--	79	--	--	--	--
Calcium	27,100	21,200	30,200	45,300	43,500	26,900
Iron	6,660	2,970	22,100	9,980	9,670	11,800
Magnesium	14,600	13,700	16,300	25,300	24,000	17,300
Potassium	2,830	3,120	4,910	6,240	5,840	3,860
Sodium	10,500	11,800	15,700	21,700	20,500	15,500
Arsenic Speciation (µg/L)						
Arsenic (III)	455	45.9	267	1,350	1,260	1,410
Arsenic (V)	33.5	2.27	19.2	29.8	24.9	36.6
Conventionals						
Alkalinity (SM 2320; mg/L $CaCO_3$)	152	142	175	264	269	178
Carbonate (SM 2320; mg/L $CaCO_3$)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bicarbonate (SM 2320; mg/L $CaCO_3$)	152	142	175	264	269	178
Hydroxide (SM 2320; mg/L $CaCO_3$)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Dissolved Solids (EPA 260.1; mg/L)	--	--	--			
Total Suspended Solids (EPA 160.2; mg/L)	2.7	5.7	24.4	11.6	10.3	28.5
Chloride (EPA 300.0; mg/L)	4.4	6.7	5.2	9.6	10.0	7.6
N-Nitrate (EPA 300.0; mg-N/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
N-Nitrite (EPA 300.0; mg-N/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate (EPA 300.0; mg/L)	2.8	6.5	14.7	2.5	2.6	<0.1
Chemical Oxygen Demand (EPA 410.4; mg/L)	28.7	9.34	55.4	30.3	29.4	11.2
Total Organic Carbon (EPA 415.1; mg/L)	12.4	2.71	19.9	11.1	11.2	5.05

Table 8
Analytical Results - Groundwater
Highway 99 Site
USG Interiors
Milton, Washington

	Sample I.D. and Sample Date					
	USGHWY99-MW6-05/10	**USGHWY99-MW7-05/10**	**USGHWY99-MW8-05/10**	**USGHWY99-MW9-05/10**	**USGHWY99-99-1-05/10**	**USGHWY99-99-2-05/10**
Analyte	**05/26/10**	**05/27/10**	**05/27/10**	**05/27/10**	**05/26/10**	**05/27/10**
Dissolved Metals (µg/L)						
EPA Methods 200.8/7060A/6010B						
Arsenic (7060A)	310	10	13	44	2,490 **	410
Iron	6,200	1,800	980	<50	6,340 **	45,700
Total Metals (µg/L)						
EPA Method 200.8/7090A/6010B						
Arsenic (200.8)	--	--	14	--	2,220	--
Arsenic (7060A)	--	--	15	--	2,430	--
Calcium	35,300	17,600	21,400	11,000	35,600	86,900
Iron	14,400	7,400	4,870	290	4,840	57,200
Magnesium	20,200	14,400	12,900	8,230	16,900	53,900
Potassium	3,490	6,000	7,640	6,590	4,290	7,510
Sodium	14,300	36,400	35,300	28,500	17,900	31,700
Arsenic Speciation (µg/L)						
Arsenic (III)	351	--	--	--	1,780	310
Arsenic (V)	16.5	--	--	--	132	37.7
Conventionals						
Alkalinity (SM 2320; mg/L $CaCO_3$)	207	196	205	118	193	561
Carbonate (SM 2320; mg/L $CaCO_3$)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bicarbonate (SM 2320; mg/L $CaCO_3$)	207	196	205	118	193	561
Hydroxide (SM 2320; mg/L $CaCO_3$)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Dissolved Solids (EPA 260.1; mg/L)						
Total Suspended Solids (EPA 160.2; mg/L)	41.5	22.2	18.1	4.3	9.9	50
Chloride (EPA 300.0; mg/L)	7.3	5.6	6.3	5.4	7.4	9.6
N-Nitrate (EPA 300.0; mg-N/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
N-Nitrite (EPA 300.0; mg-N/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.5
Sulfate (EPA 300.0; mg/L)	<0.1	<0.1	0.2	7.5	1.6	<0.1
Chemical Oxygen Demand (EPA 410.4; mg/L)	20.5	10.9	7.75	6.48	7.43	62.7
Total Organic Carbon (EPA 415.1; mg/L)	9.27	4.17	3.83	<1.50	4.83	25.3

Table 8
Analytical Results - Groundwater
Highway 99 Site
USG Interiors
Milton, Washington

	Sample I.D. and Sample Date													
Analyte	**GW-1 04/07/11**	**GW-2 04/07/11**	**GW-3 04/07/11**	**GW-4 04/07/11**	**GW-5 04/07/11**	**GW-6 04/07/11**	**GW-7 04/07/11**	**GW-8 04/07/11**	**GW-9 04/07/11**	**MW10-10/11 10/18/11**	**MW11-10/11 10/18/11**	**MW12-05/12 05/22/12**	**MW13-05/12 05/22/12**	**MW14-05/12 05/22/12**
Dissolved Metals (µg/L)														
EPA Method 6020														
Arsenic	55	2.4	38	120	21	19	<2	340	2.1	366	23.5	2.1	14.3	10.3
Iron	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Metals (µg/L)														
EPA Method 200.8/7090A/6010B														
Arsenic (200.8)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic (7060A)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Calcium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Magnesium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Potassium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sodium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic Speciation (µg/L)														
Arsenic (III)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic (V)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Conventionals														
Alkalinity (SM 2320; mg/L $CaCO_3$)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbonate (SM 2320; mg/L $CaCO_3$)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bicarbonate (SM 2320; mg/L $CaCO_3$)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydroxide (SM 2320; mg/L $CaCO_3$)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Dissolved Solids (EPA 260.1; mg/L)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Suspended Solids (EPA 160.2; mg/L)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloride (EPA 300.0; mg/L)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N-Nitrate (EPA 300.0; mg-N/L)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N-Nitrite (EPA 300.0; mg-N/L)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Sulfate (EPA 300.0; mg/L)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chemical Oxygen Demand (EPA 410.4; mg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Organic Carbon (EPA 415.1; mg/L)	--	--	--	--	--	--	--	--	--	--	--	--	--	--

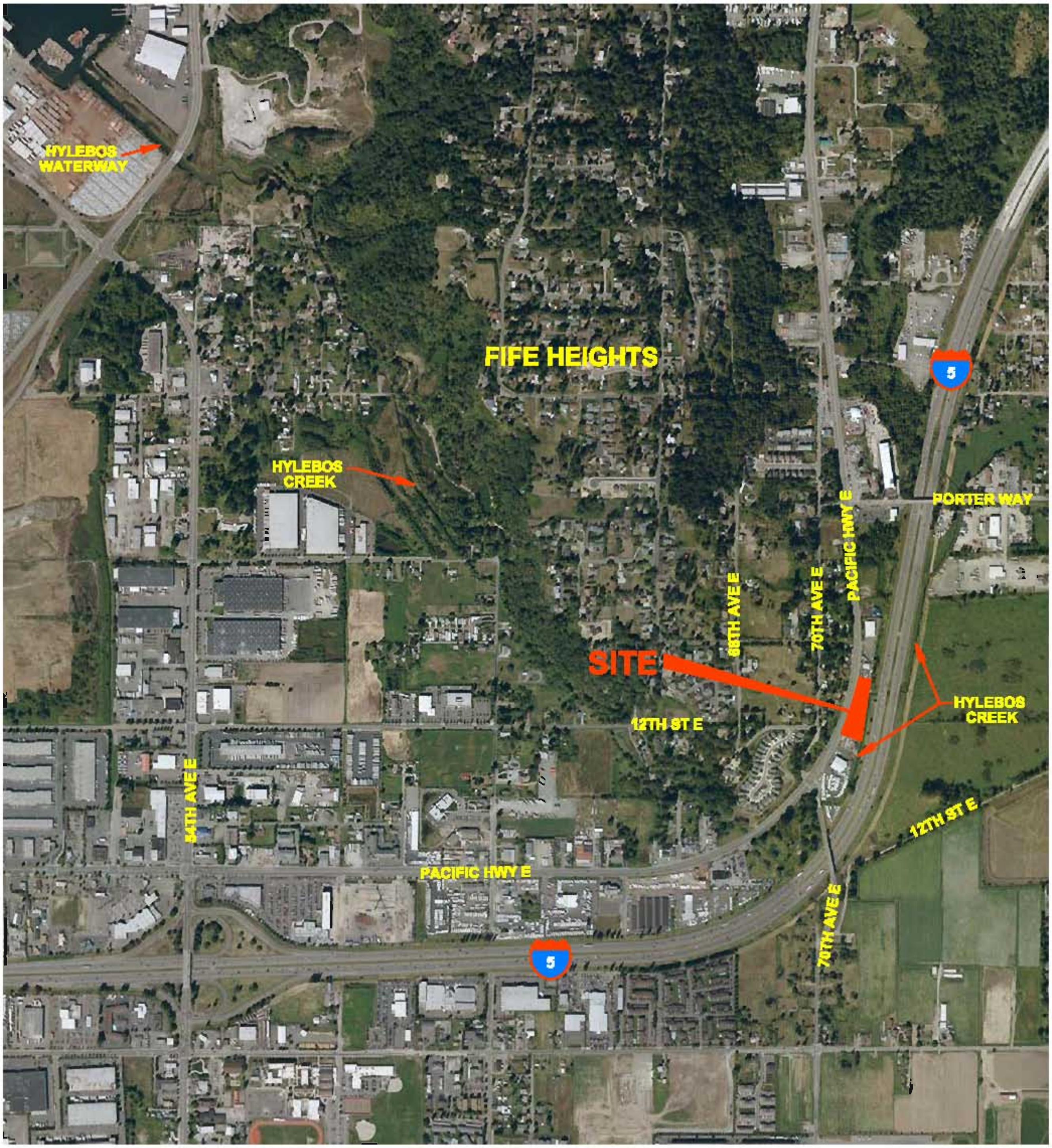
Notes:
*USGHWY-MW0-05/10 is a duplicate of USGHWY-MW4-05/10.
** Value from re-sampling on 7/15/10.
mg/L - milligrams per liter.
µg/L - micrograms per liter.
-- not analyzed.
< - analyte not detected at or greater than the listed concentration.

Table 9
Analytical Results - Surface Water
Highway 99 Site
USG Interiors
Milton, Washington

	Sample I.D. and Sample Date					
	USGHwy99-SW1-05/10	**USGHwy99-SW2-05/10**	**USGHwy99-SW3-05/10**	**USGHwy99-SW4-05/10**	**USGHwy99-SW5-05/10**	**USGHwy99-SW6-05/10**
Analyte	**05/25/10**	**05/25/10**	**05/25/10**	**05/25/10**	**05/25/10**	**05/25/10**
Dissolved Metals (µg/L)						
EPA Methods 200.8/7060A/6010B						
Arsenic (200.8)	3.0	2.9	3.0	3.1	3.0	3.0
Arsenic (7060A)	4	4	4	3	4	4
Iron	280	--	--	270	280	
Total Metals (µg/L)						
EPA Method 200.8/7090A/6010B						
Arsenic (200.8)	3.4	--	--	3.4	3.5	--
Arsenic (7060A)	3	--	--	4	4	--
Calcium	19,000	--	--	17,900	18,100	--
Iron	410	--	--	390	420	--
Magnesium	13,100	--	--	12,200	12,400	--
Potassium	1,760	--	--	1,650	1,710	--
Sodium	7,500		--	7,040	7,120	--
Arsenic Speciation (µg/L)						
Arsenic (III)	0.403	--	--	0.444	0.539	--
Arsenic (V)	2.12	--	--	2.22	2.36	--
Conventionals						
Alkalinity (SM 2320; mg/L $CaCO_3$)	99.6	--	--	98.9	97.1	--
Carbonate (SM 2320; mg/L $CaCO_3$)	<1.0	--	--	<1.0	<1.0	--
Bicarbonate (SM 2320; mg/L $CaCO_3$)	99.6	--	--	98.9	97.1	--
Hydroxide (SM 2320; mg/L $CaCO_3$)	<1.0	--	--	<1.0	<1.0	--
Total Dissolved Solids (EPA 260.1; mg/L)	170	--	--	164	164	--
Total Suspended Solids (EPA 160.2; mg/L)	1.6	--	--	1.9	10.5	--
Chloride (EPA 300.0; mg/L)	8.0	--	--	8.0	7.8	--
N-Nitrate (EPA 300.0; mg-N/L)	0.7	--	--	0.7	0.7 J	--
N-Nitrite (EPA 300.0; mg-N/L)	<0.1	--	--	<0.1	<0.1 J	--
Sulfate (EPA 300.0; mg/L)	8.4	--	--	8.4	8.2	--
Chemical Oxygen Demand (EPA 410.4; mg/L)	14.7	--	--	16.0	11.9	--
Total Organic Carbon (EPA 415.1; mg/L)	5.22	--	--	5.19	7.38	--

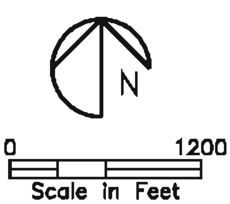
Notes:
J - Value is estimated due to exceedance of holding time
µg/L - micrograms per liter.
-- not analyzed.
< - analyte not detected at or greater than the listed concentration.

Figures



Source: GOOGLE EARTH PRO, 2009

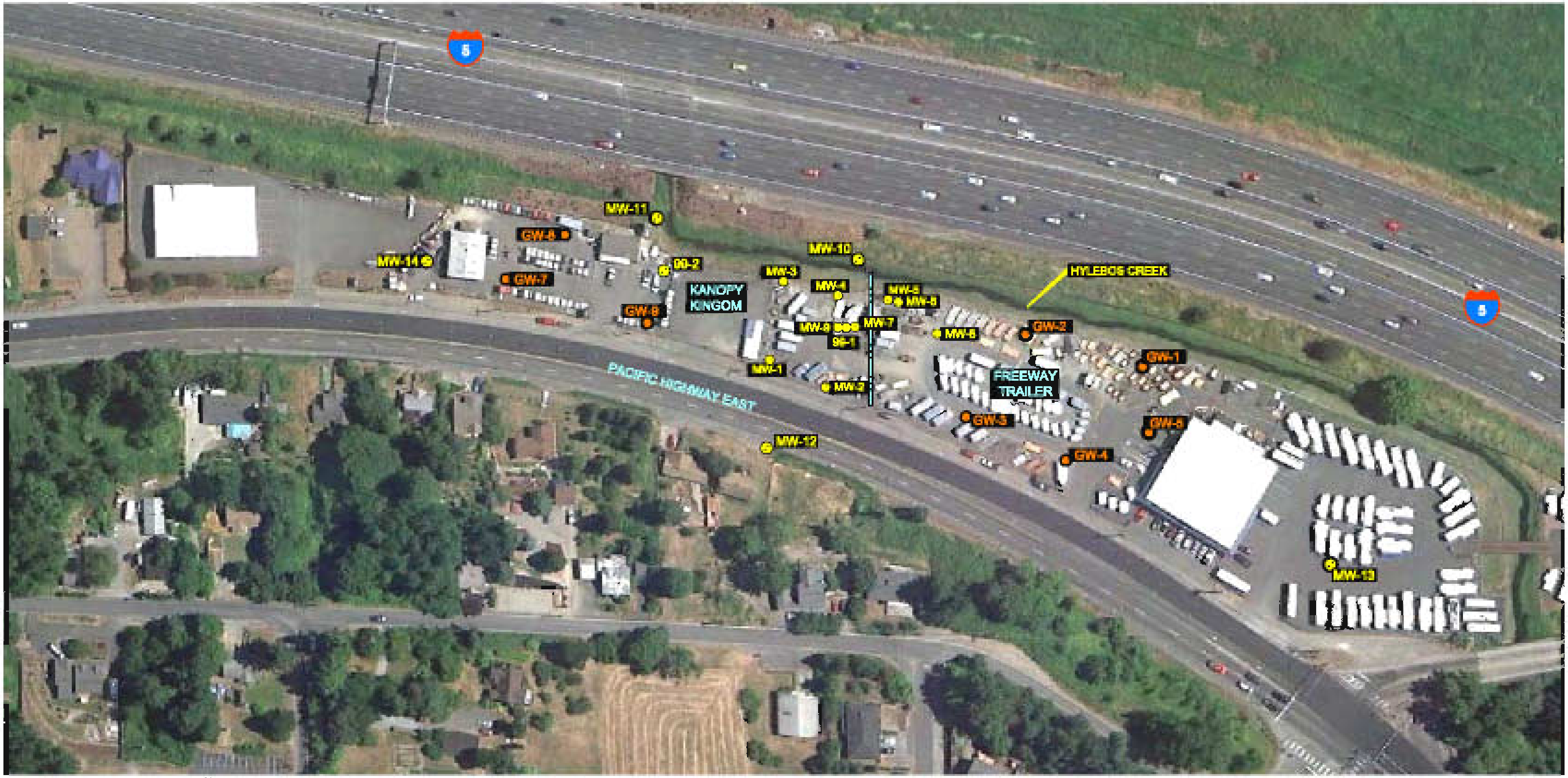
P:\19921\65021\ FIG-1 12/14/09 11:36 riehlepj



USG INTERIORS/HIGHWAY 99 SITE
MILTON, WASHINGTON

Figure No. 1
Vicinity Map

CDM



REFERENCE: GOOGLE EARTH PRO, 2012, IMAGE DATE AUGUST 20, 2011

LEGEND:

MW-12 MONITORING WELL
GW-3 PHASE 2 DPT BORING

NOTE:

MONITORING WELL MW-14 WAS DRILLED AT THE LOCATION OF GW-6

N

1" = 100'

50 0 100

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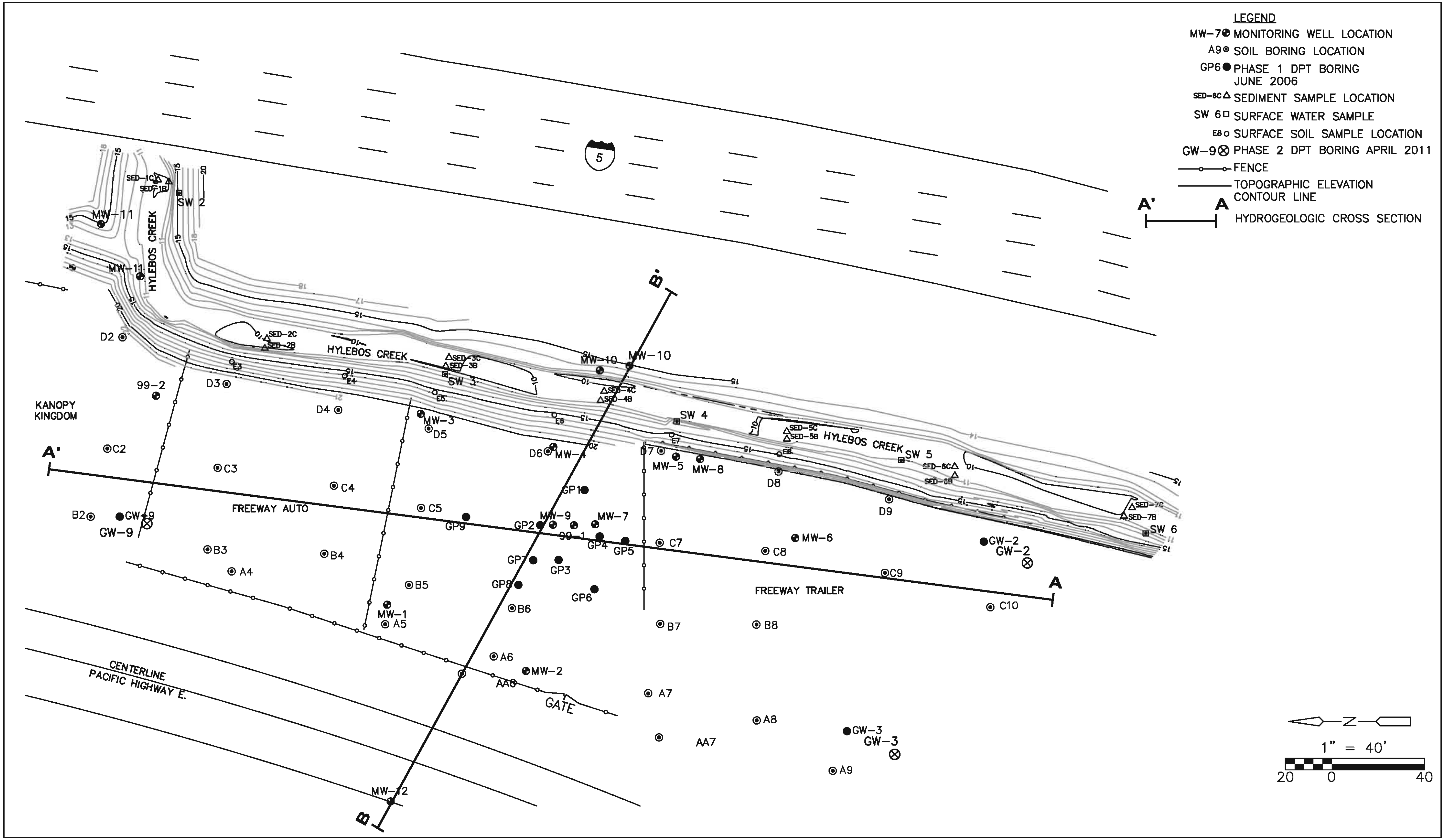
USG INTERIORS
HIGHWAY 99 SITE
MILTON, WASHINGTON

Figure No. 2A
Site Plan

P:\18921\77628\Hylebos Creek\EXPANDED SITE\ FIGURE-2A 07/10/12 12:23 rietdep) XREFS: SITEBASE-EXPANDED, HC-SITEBASE, S_1117



USG INTERIORS
HIGHWAY 99 SITE
MILTON, WASHINGTON

Figure No. 2B
Site Plan

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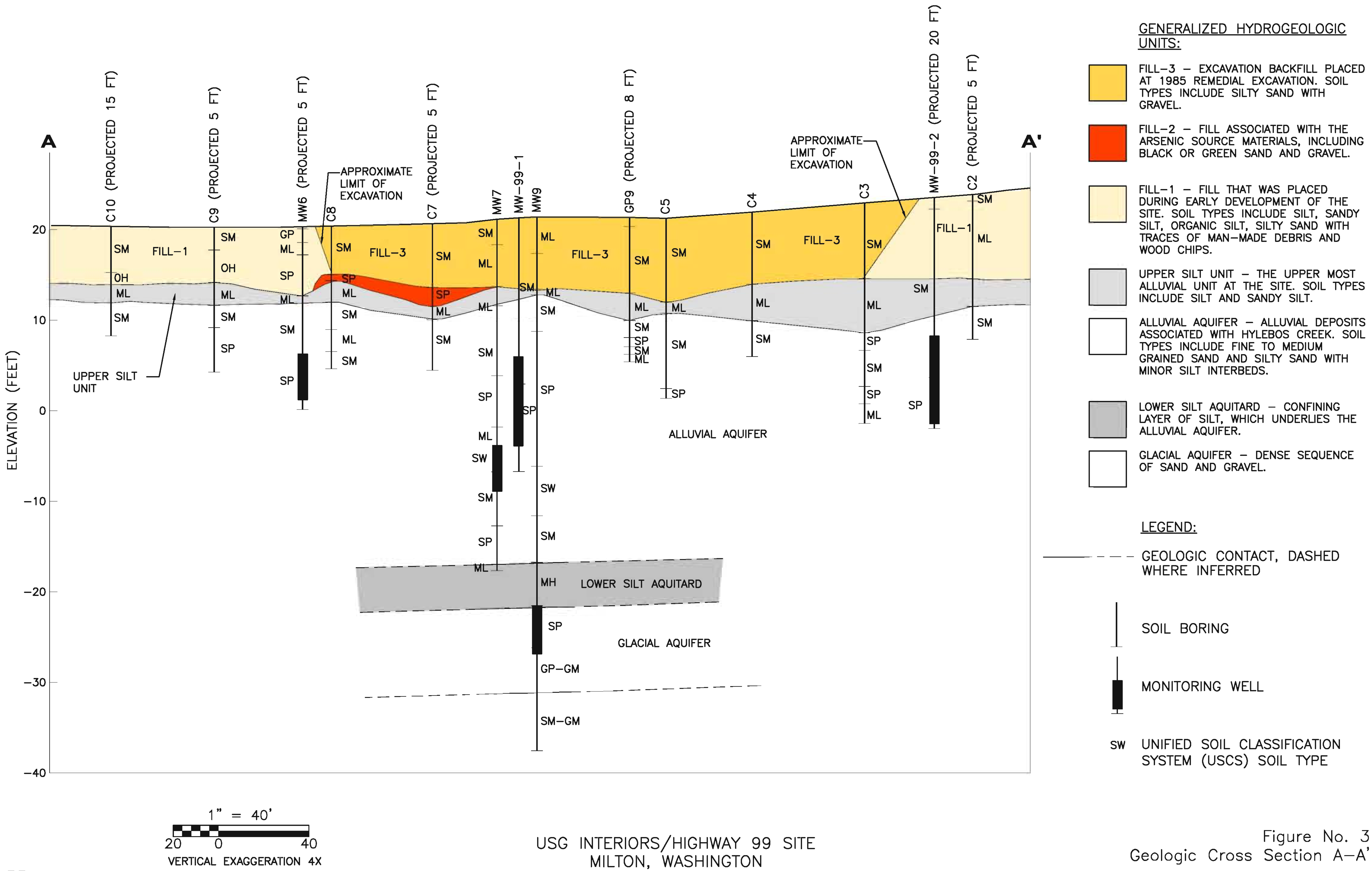
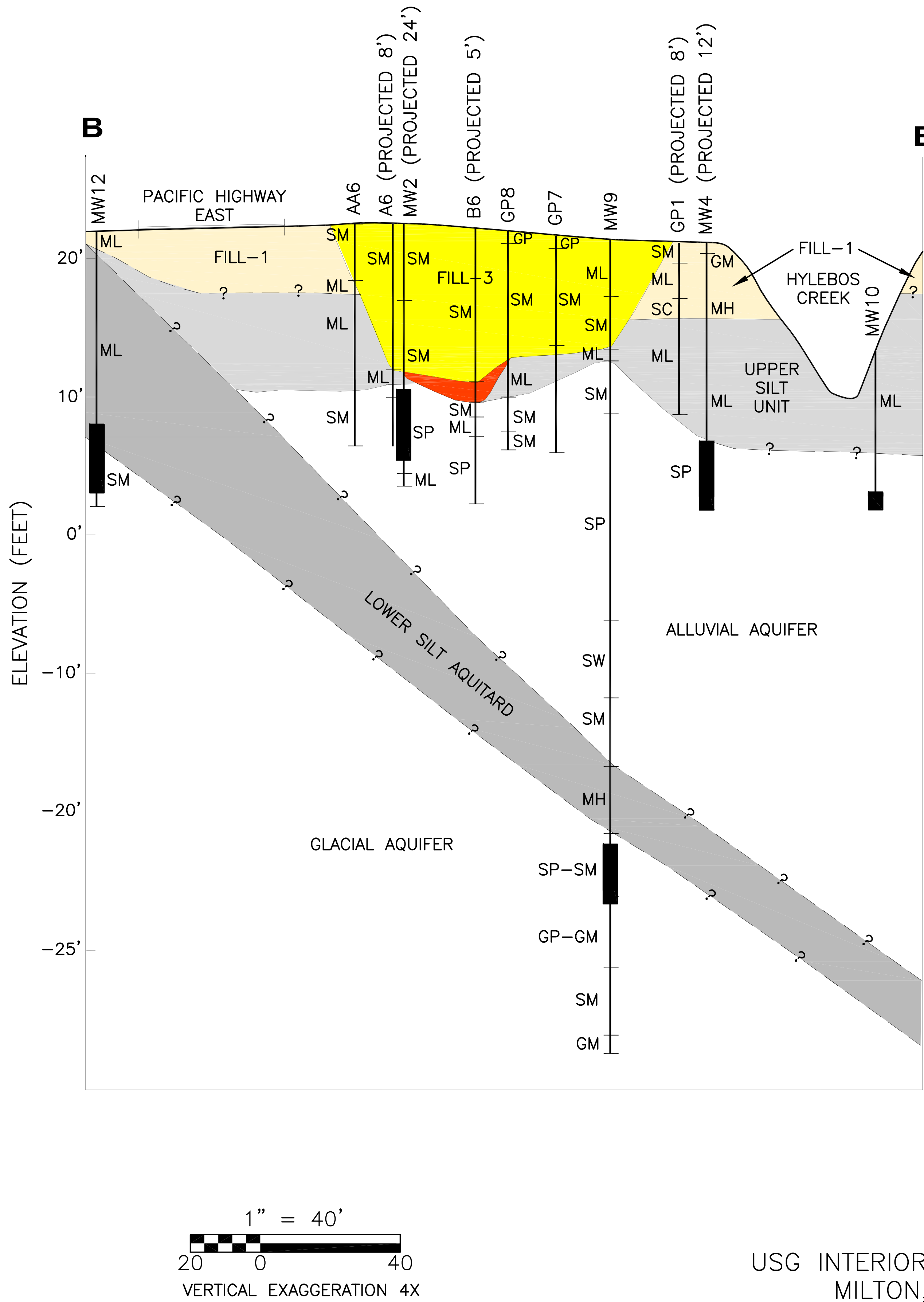


USG INTERIORS/HIGHWAY 99 SITE
MILTON, WASHINGTON

Figure No. 3
Geologic Cross Section A–A'

CDM



P:\19921\77628\Hylebros Creek\ FIG-4 REVISED 07/12/12 08:59 riehlepj XREFS: HC-11X17BD

GENERALIZED HYDROGEOLOGIC UNITS:

- FILL-3 – EXCAVATION BACKFILL PLACED AT 1985 REMEDIAL EXCAVATION. SOIL TYPES INCLUDE SILTY SAND WITH GRAVEL.
- FILL-2 – FILL ASSOCIATED WITH THE ARSENIC SOURCE MATERIALS, INCLUDING BLACK OR GREEN SAND AND GRAVEL.
- FILL-1 – FILL THAT WAS PLACED DURING EARLY DEVELOPMENT OF THE SITE. SOIL TYPES INCLUDE SILT, SANDY SILT, ORGANIC SILT, SILTY SAND WITH TRACES OF MAN-MADE DEBRIS AND WOOD CHIPS.
- UPPER SILT UNIT – THE UPPER MOST ALLUVIAL UNIT AT THE SITE. SOIL TYPES INCLUDE SILT AND SANDY SILT.
- ALLUVIAL AQUIFER – ALLUVIAL DEPOSITS ASSOCIATED WITH HYLEBOS CREEK. SOIL TYPES INCLUDE FINE TO MEDIUM GRAINED SAND AND SILTY SAND WITH MINOR SILT INTERBEDS.
- LOWER SILT AQUITARD – CONFINING LAYER OF SILT, WHICH UNDERLIES THE ALLUVIAL AQUIFER.
- GLACIAL AQUIFER – DENSE SEQUENCE OF SAND AND GRAVEL.

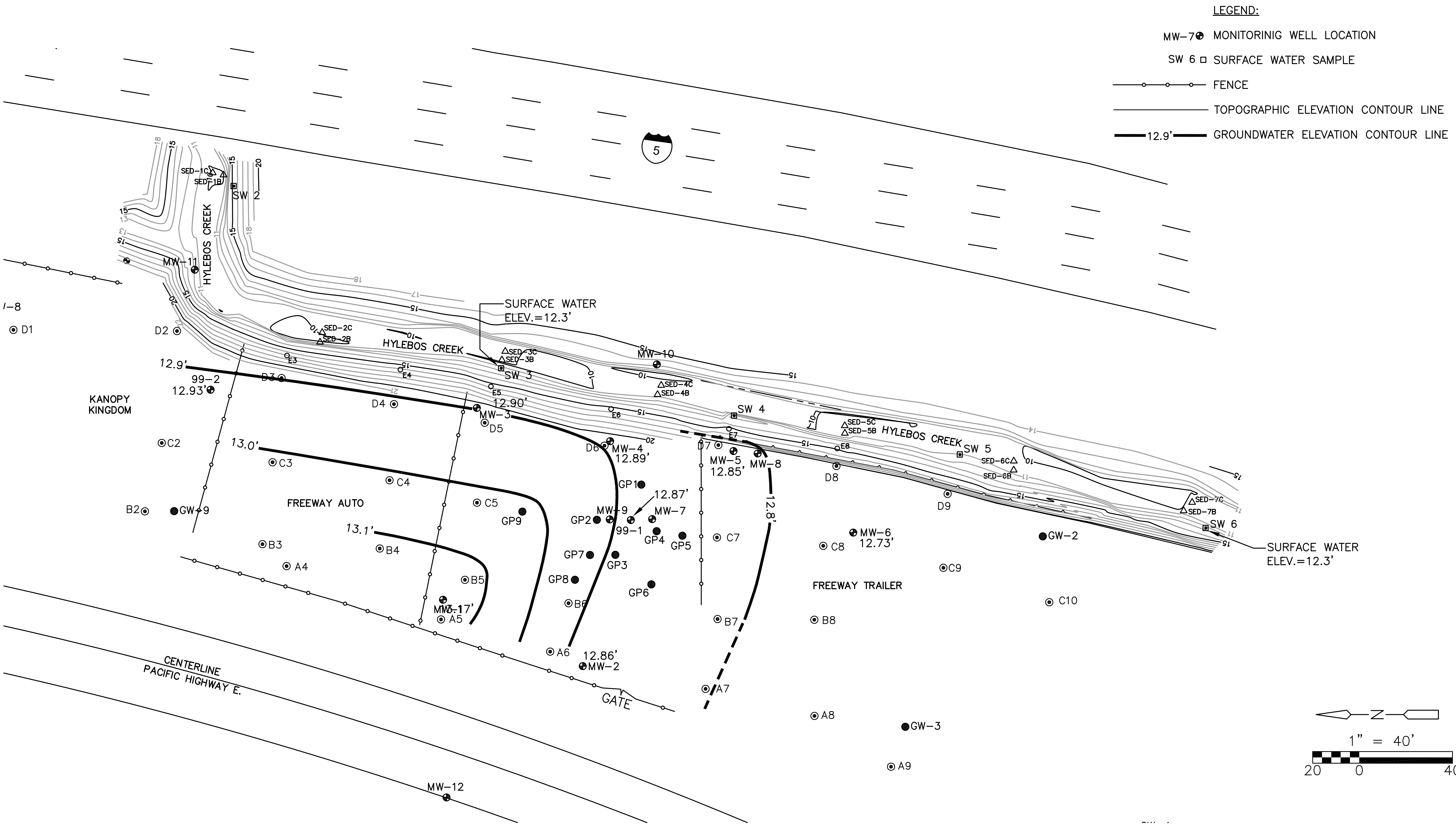
LEGEND:

- GEOLOGIC CONTACT, DASHED WHERE INFERRED
- SOIL BORING
- MONITORING WELL
- SW UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) SOIL TYPE

CDM

USG INTERIORS/HIGHWAY 99 SITE
MILTON, WASHINGTON

Figure No. 4
Geologic Cross Section B–B'



P:\19921\77628\Hylebros Creek\ FIG-5 07/12/12 09:17 riehlepj XREFS: HC-11X17BD, HC-SITEBASE

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USG INTERIORS/HIGHWAY 99 SITE
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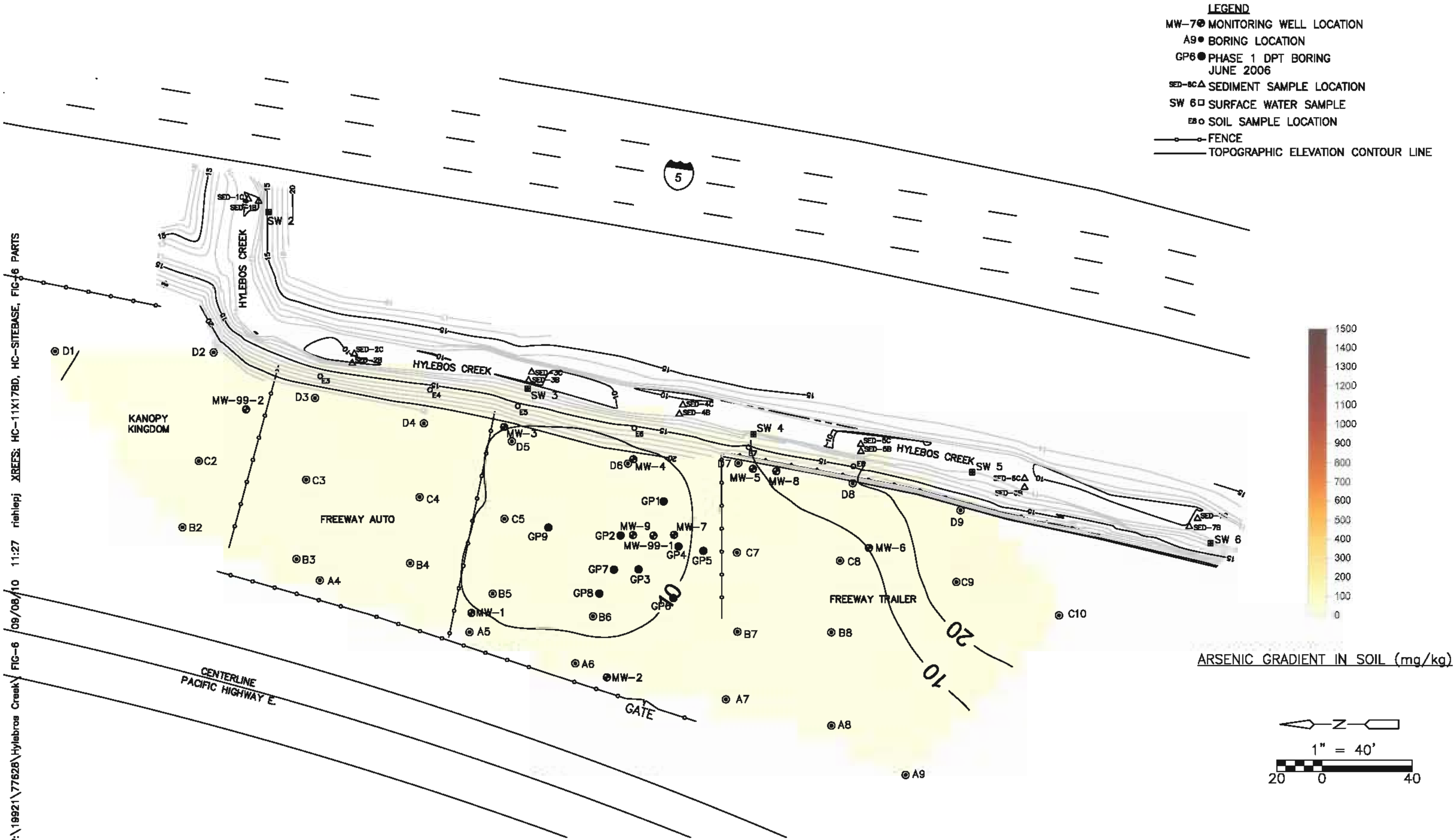
Figure No. 5
Groundwater Elevation Contour Map
Alluvial Aquifer
July 15, 2010



P:\19921\77628\Hylebros Creek\ FIG-6 09/08/10 11:27 riehlepj XREFS: HC-11X17BD, HC-SITEBASE, FIG-6 PARTS

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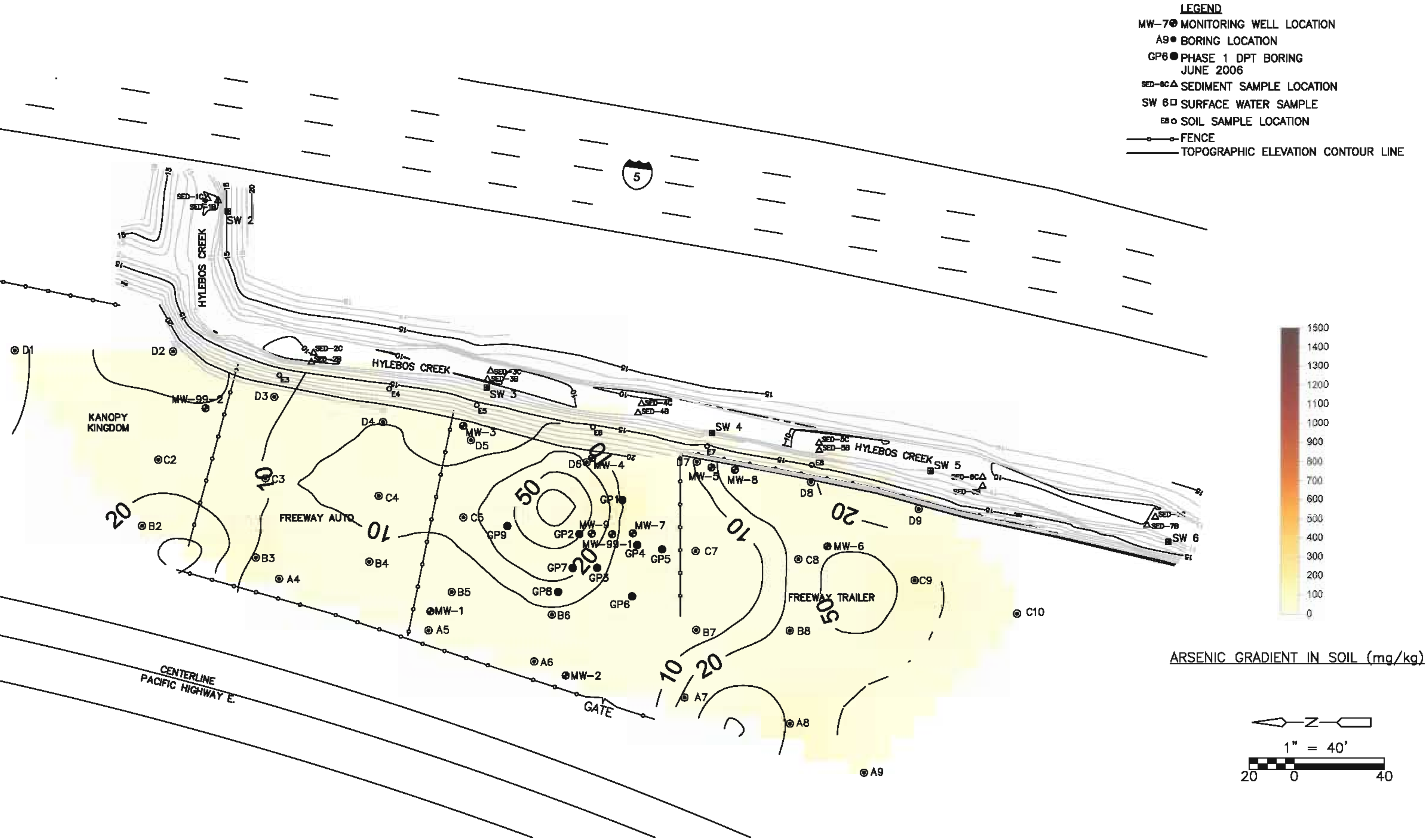
Figure No. 6
Arsenic From 0–2 Feet bgs

CDM



P:\19921\77628\Hylebros Creek\ FIG-7 09/08/10 11:21 riehlepj XREFS: HC-11X17BD, HC-SITEBASE, FIG-7- PARTS, Map_As_4_6_contours

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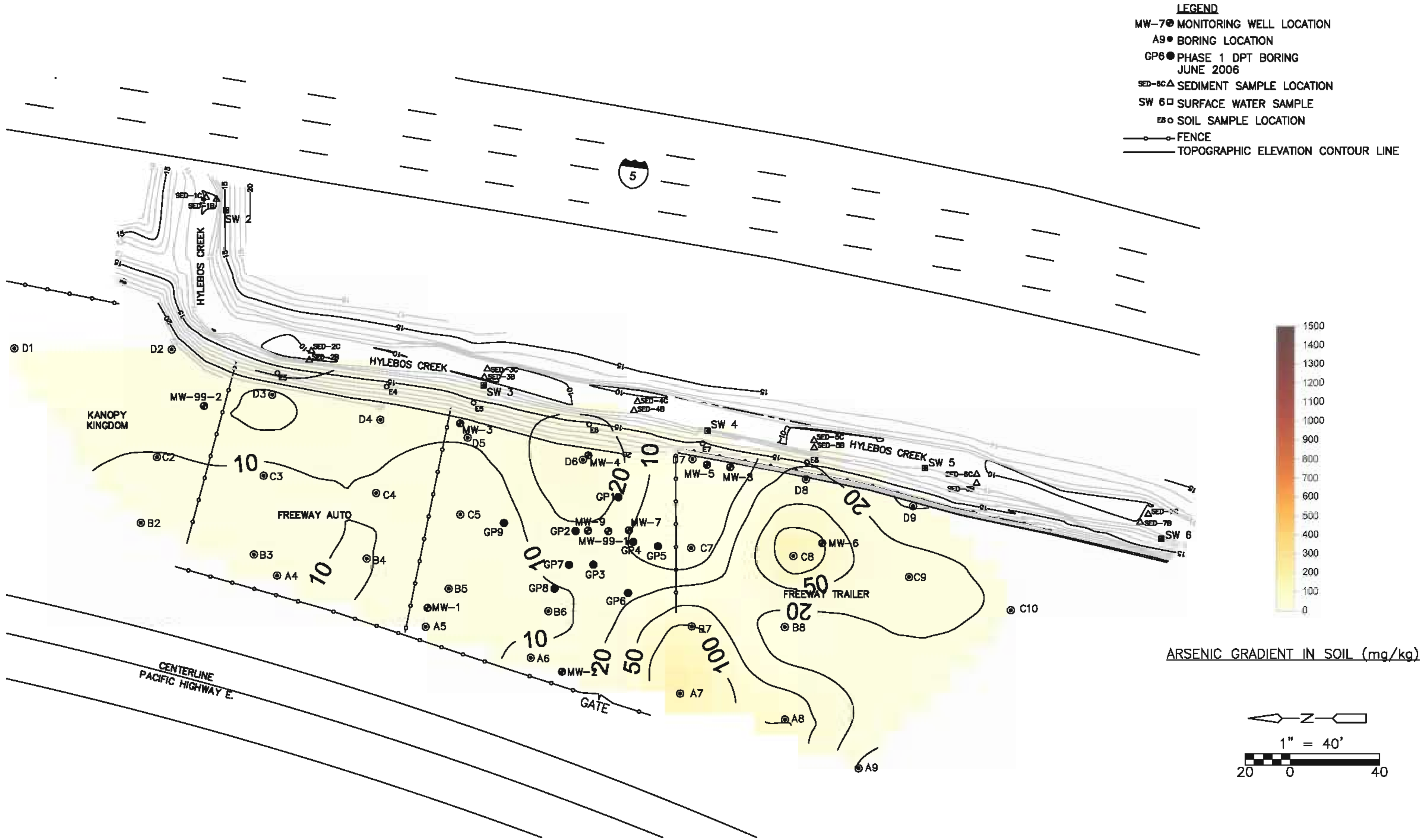
Figure No. 7
Arsenic From 4–6 Feet bgs

CDM

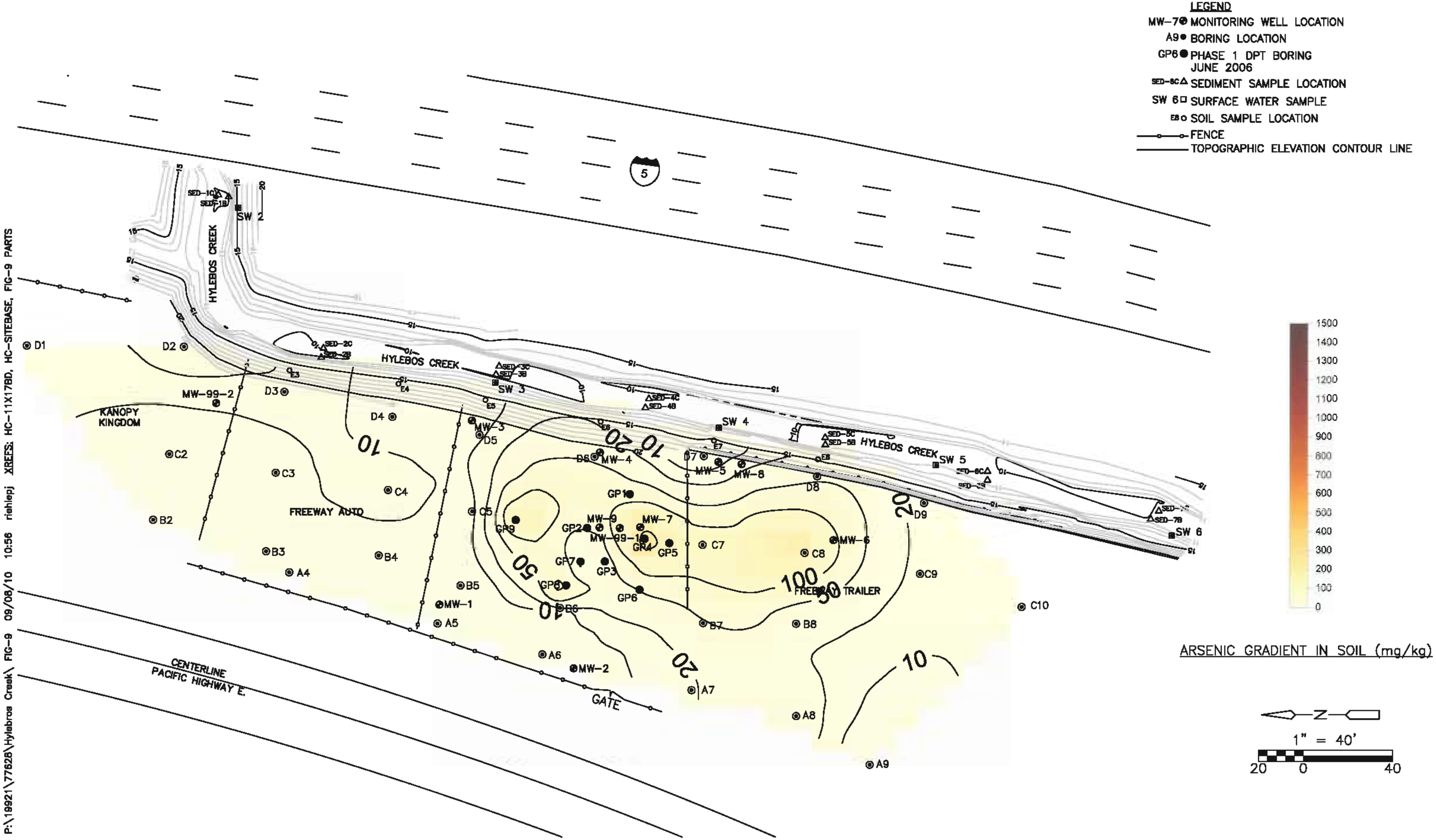


P:\19921\77628\Hylebros Creek\ FIG-8 09/08/10 11:17 riehlepj XREFS: HC-11X17BD, HC-SITEBASE, FIG-8 PARTS

USG INTERIORS/HIGHWAY 99 SITE
MILTON, WASHINGTON

Figure No. 8
Arsenic From 6–8 Feet bgs

CDM



P:\19921\77628\Hylebros Creek\ FIG-9 09/08/10 10:56 riehlepj XREFS: HC-11X17BD, HC-SITEBASE, FIG-9 PARTS

USG INTERIORS/HIGHWAY 99 SITE
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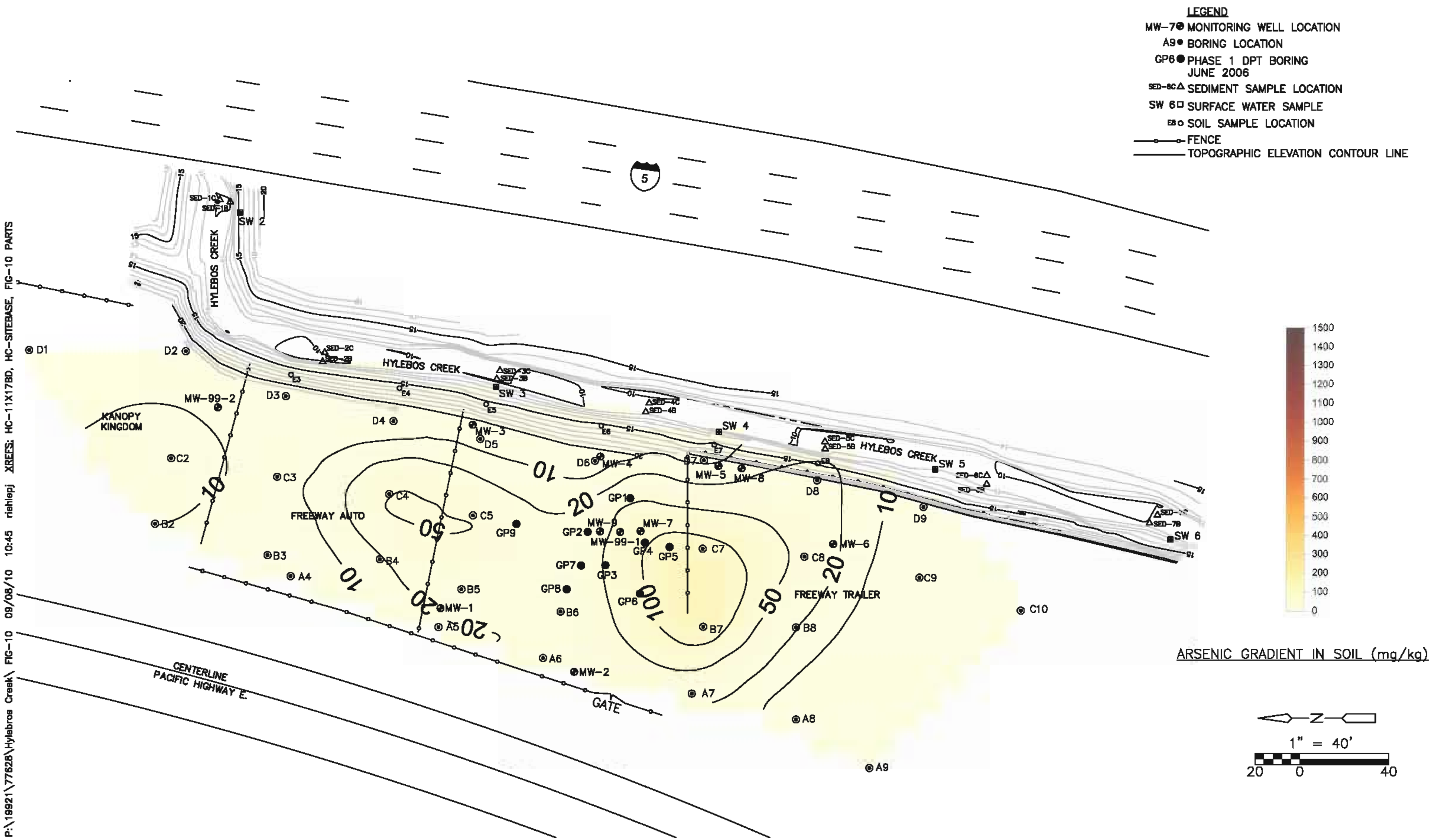
Figure No. 9
Arsenic From 8–10 Feet bgs

CDM



USG INTERIORS/HIGHWAY 99 SITE
MILTON, WASHINGTON

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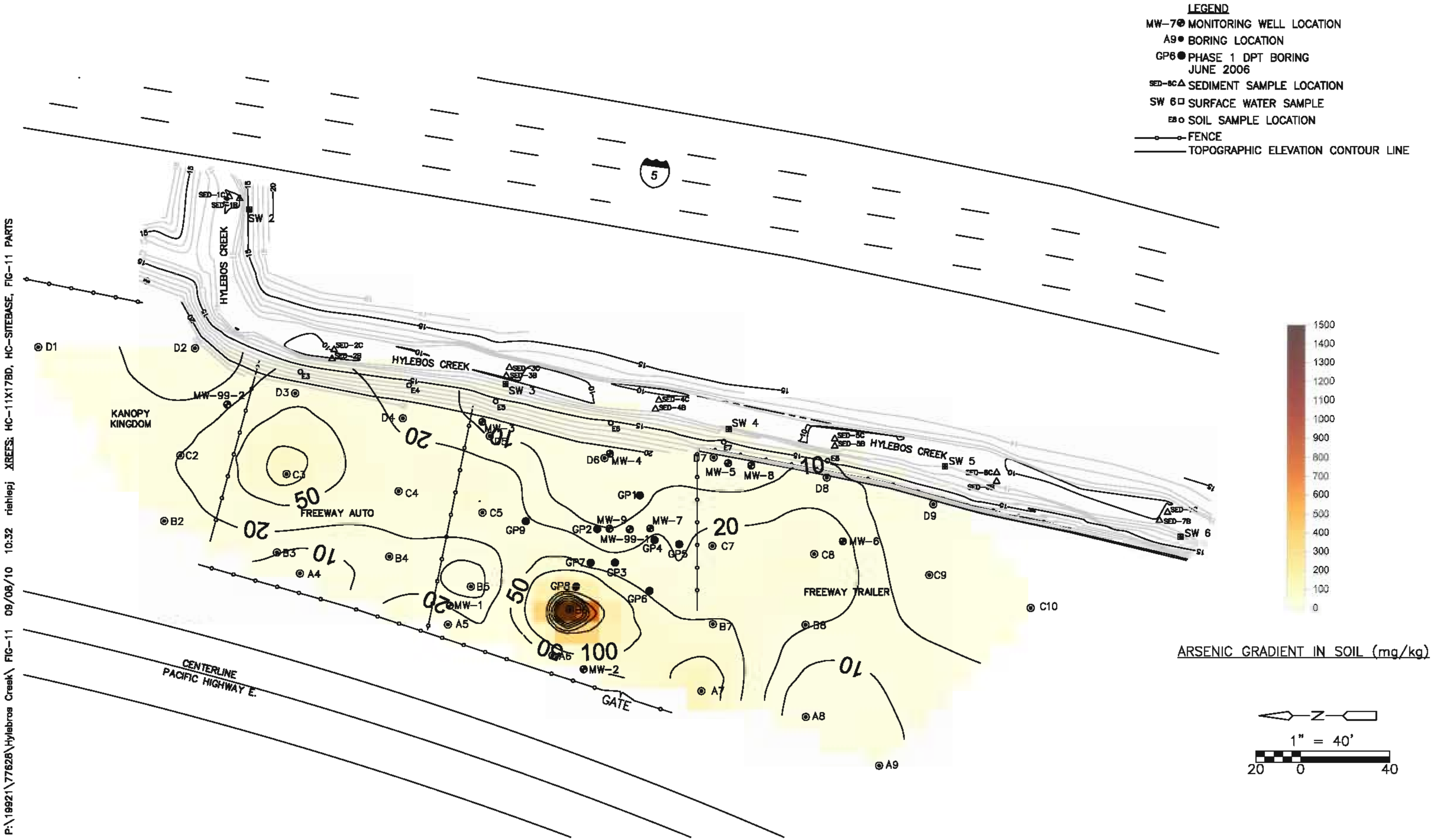
Figure No. 10
Arsenic From 10–12 Feet bgs



USG INTERIORS/HIGHWAY 99 SITE
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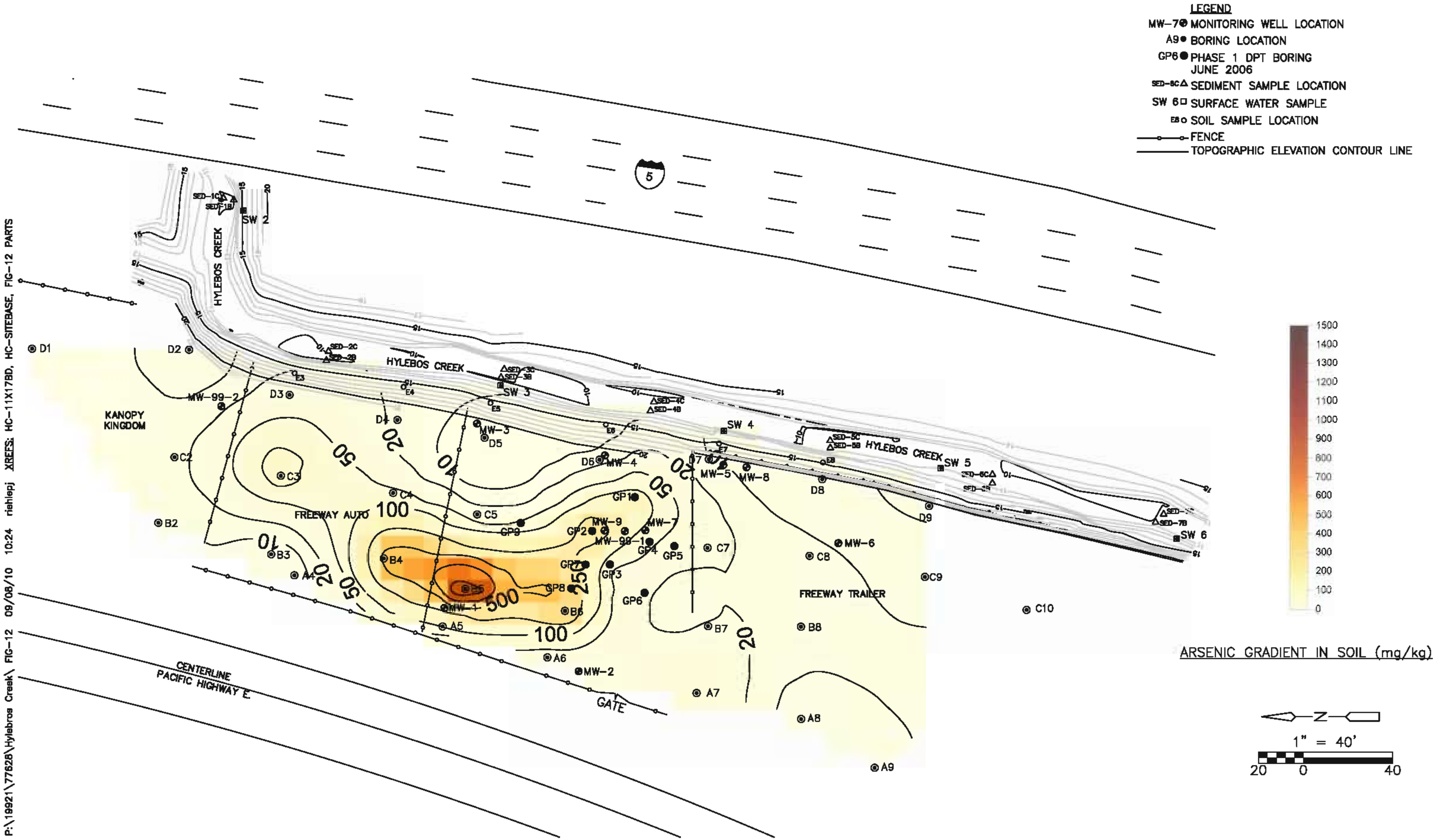
Figure No. 11
Arsenic From 12–14 Feet bgs

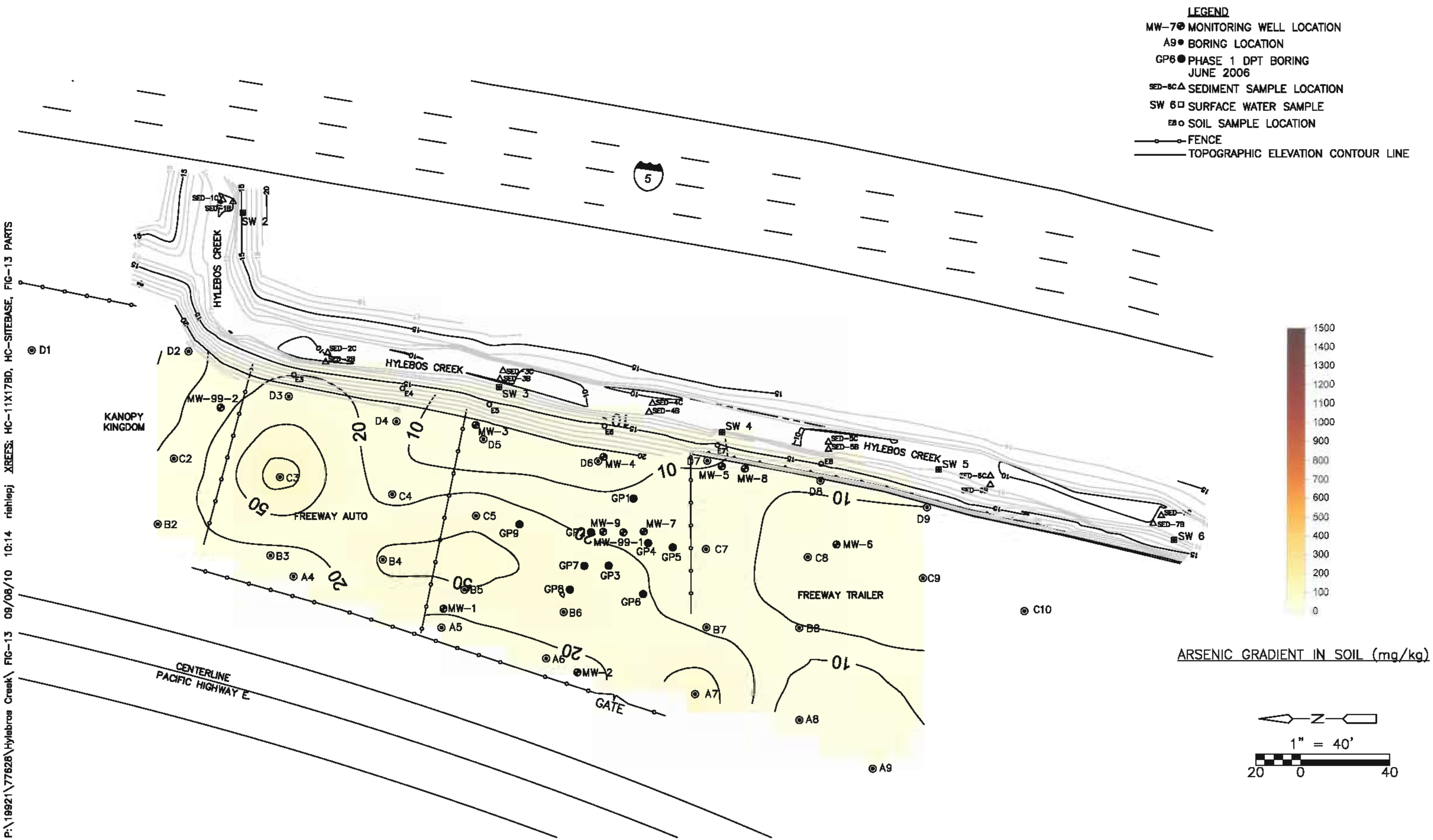
CDM



USG INTERIORS/HIGHWAY 99 SITE
MILTON, WASHINGTON

Figure No. 12
Arsenic From 14–16 Feet bgs

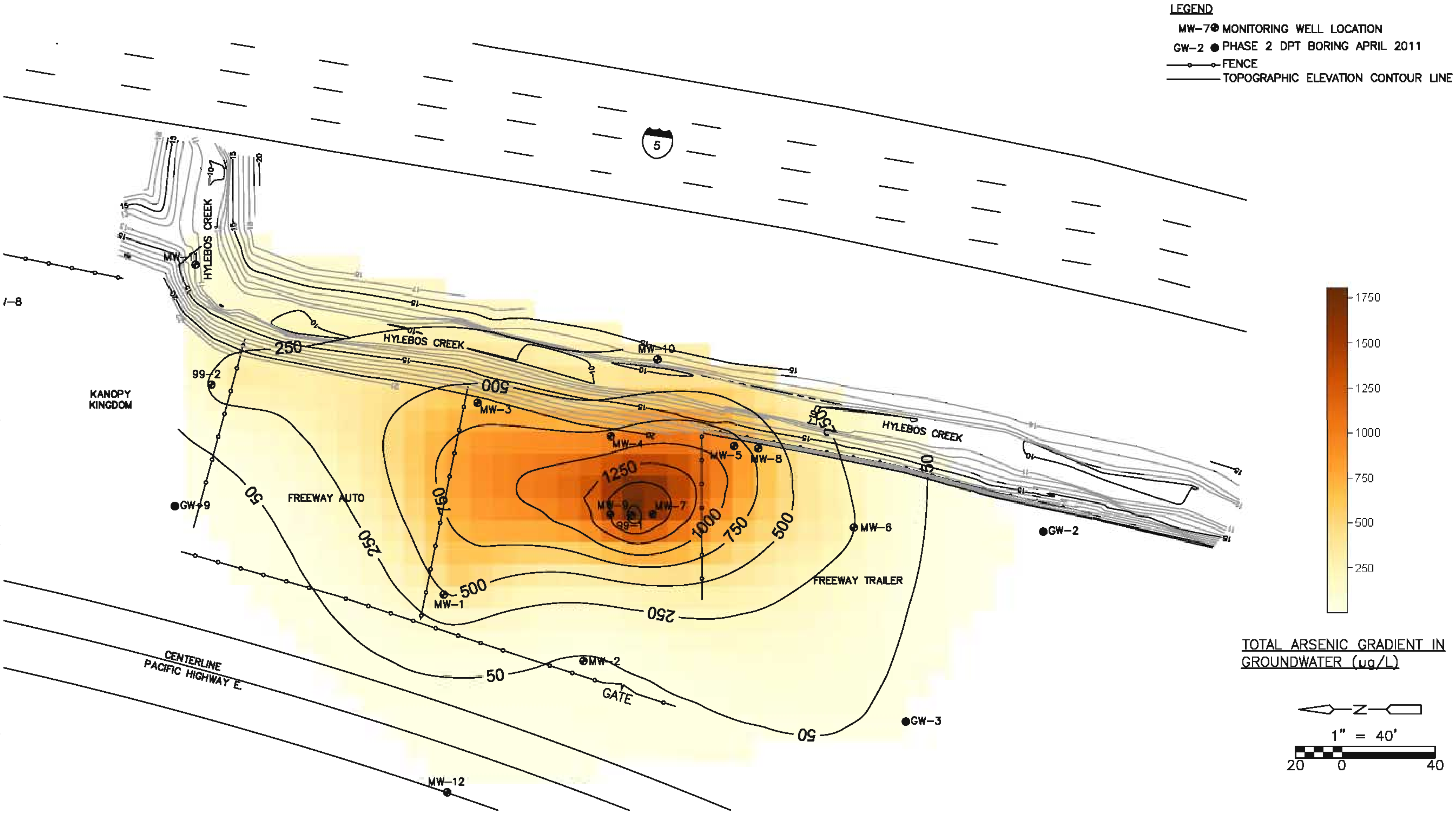
CDM



USG INTERIORS/HIGHWAY 99 SITE
MILTON, WASHINGTON

CDM

Figure No. 13
Arsenic From 16–18 Feet bgs



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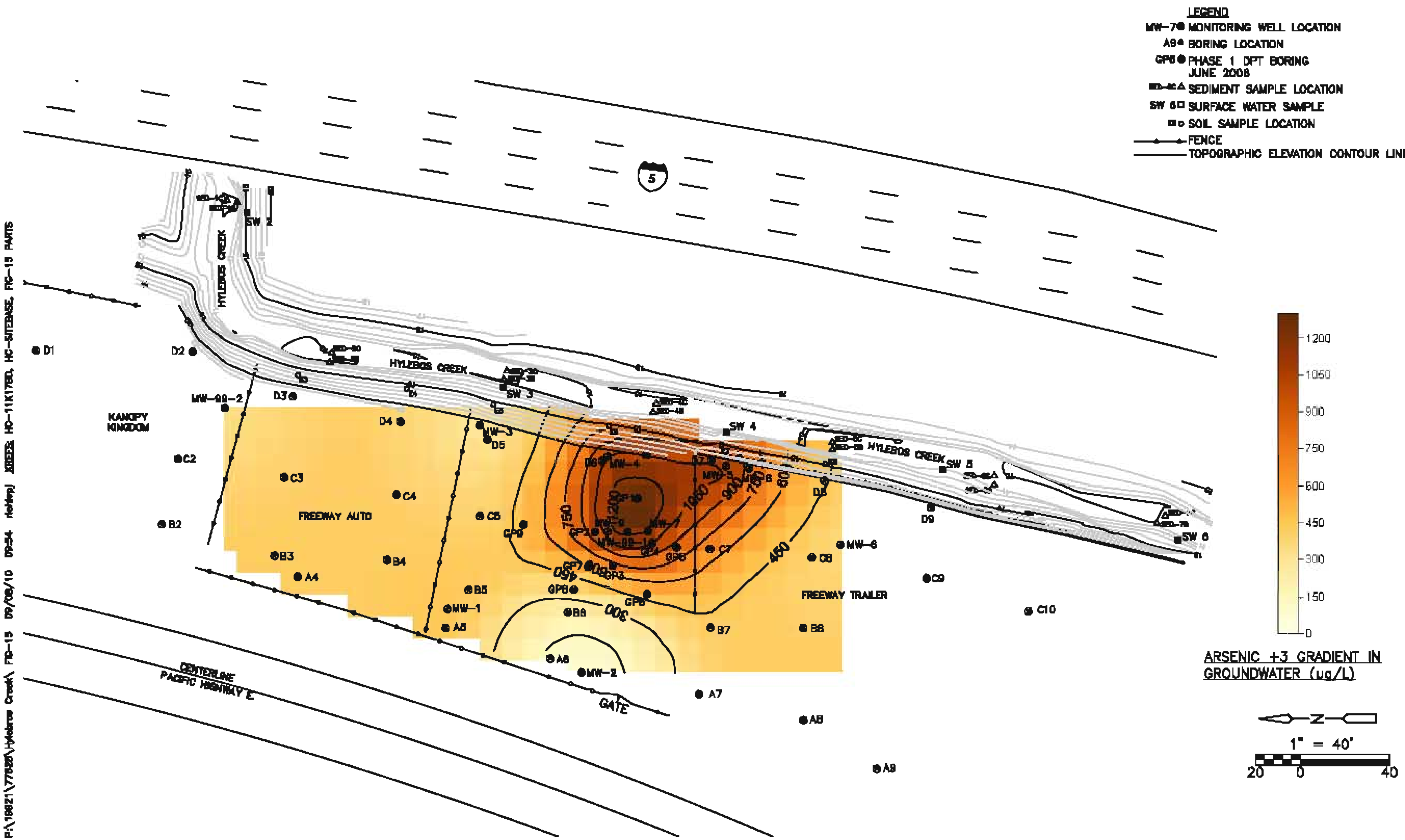
MILTON, WASHINGTON

Figure No. 14
Dissolved Total Arsenic in Groundwater

P:\19921\77628\Hylebos Creek\ FIG-14-REVISED 07/10/12 12:03 riehlepj XREFS: HC-11X17BD, HC-SITEBASE, FIG-14 PARTS

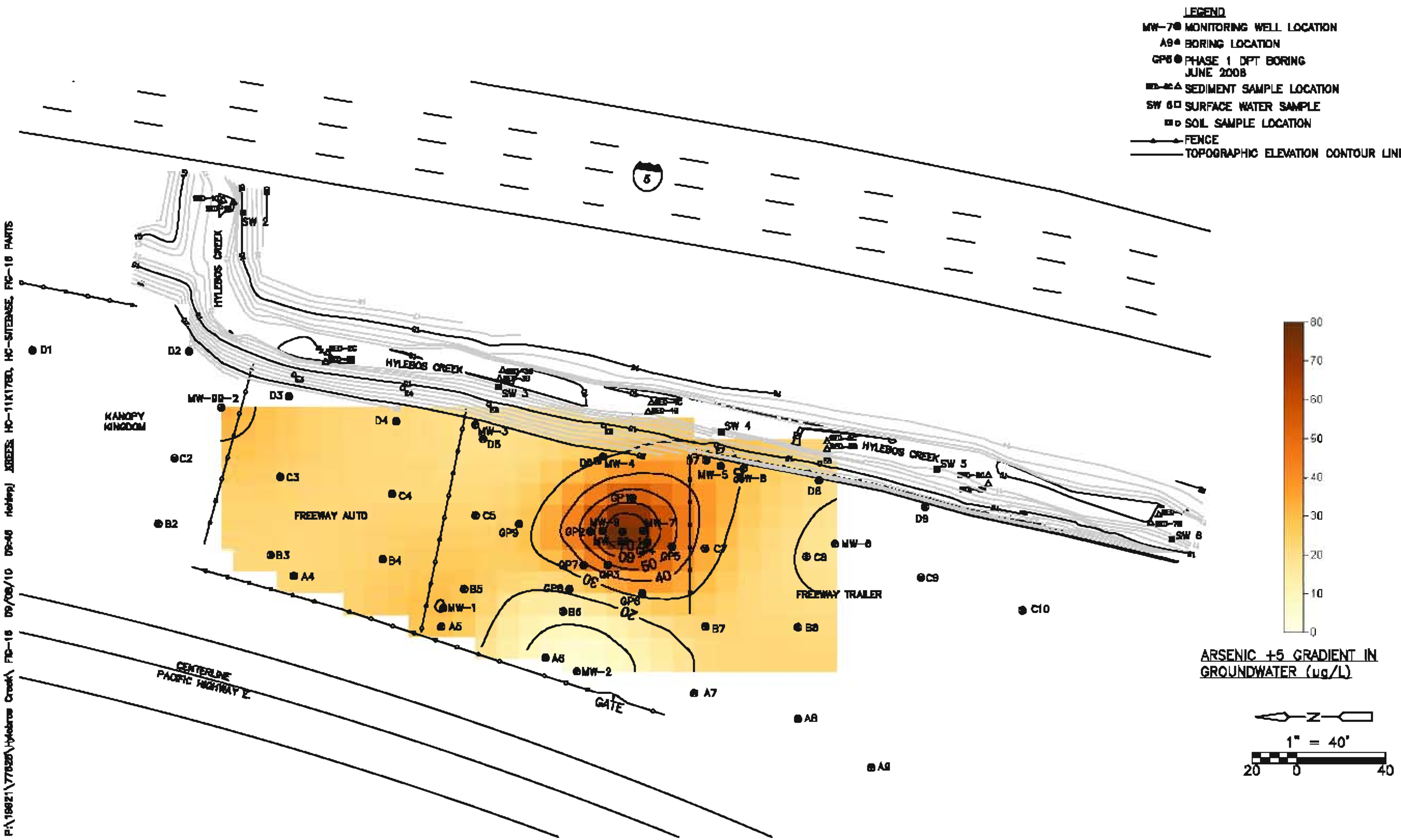
CDM



USG INTERIORS/HIGHWAY 99 SITE
MILTON, WASHINGTON

Figure No. 15
Arsenic +3 in Groundwater

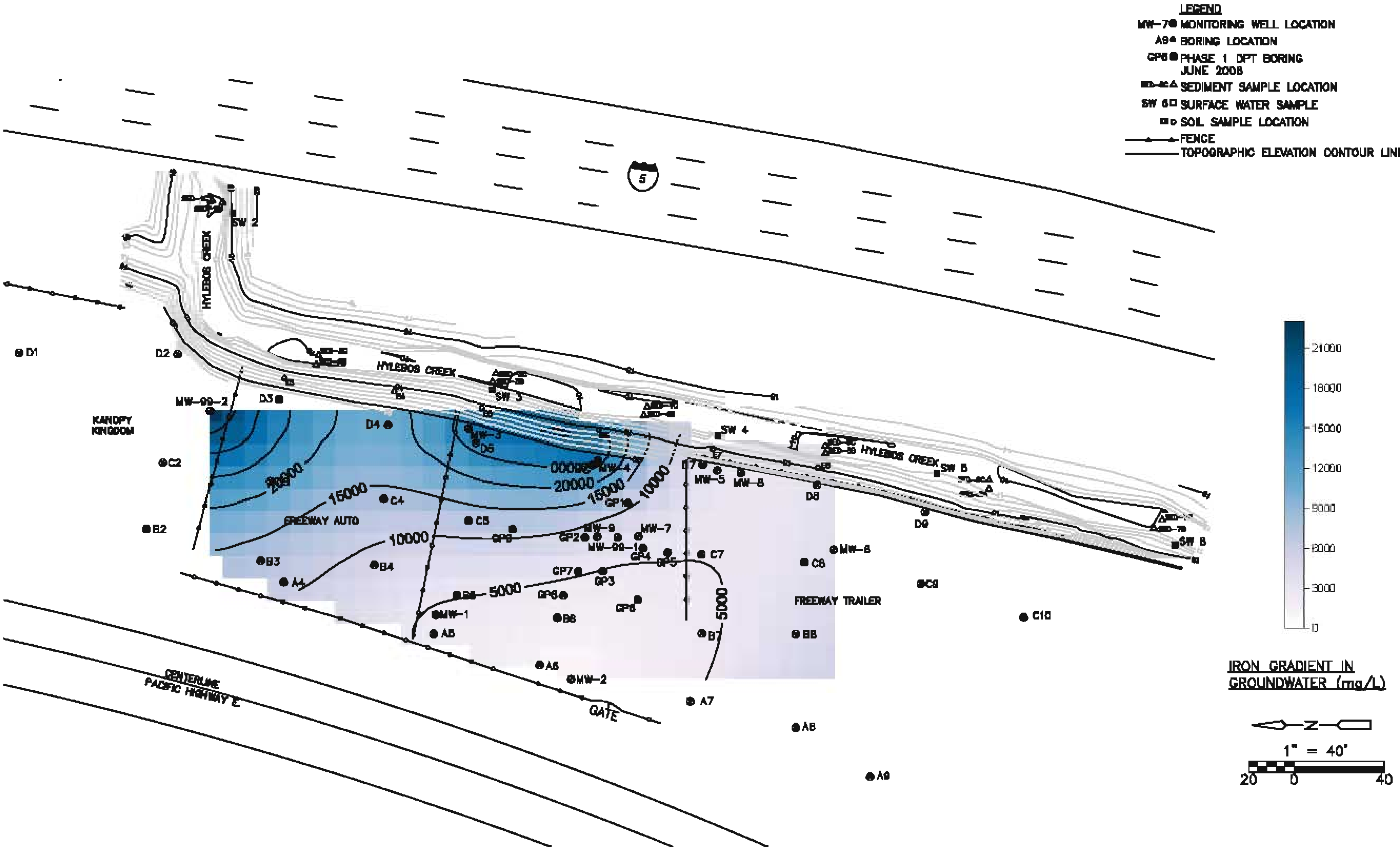
CDM



USG INTERIORS/HIGHWAY 99 SITE
MILTON, WASHINGTON

Figure No. 16
Arsenic +5 in Groundwater

CDM

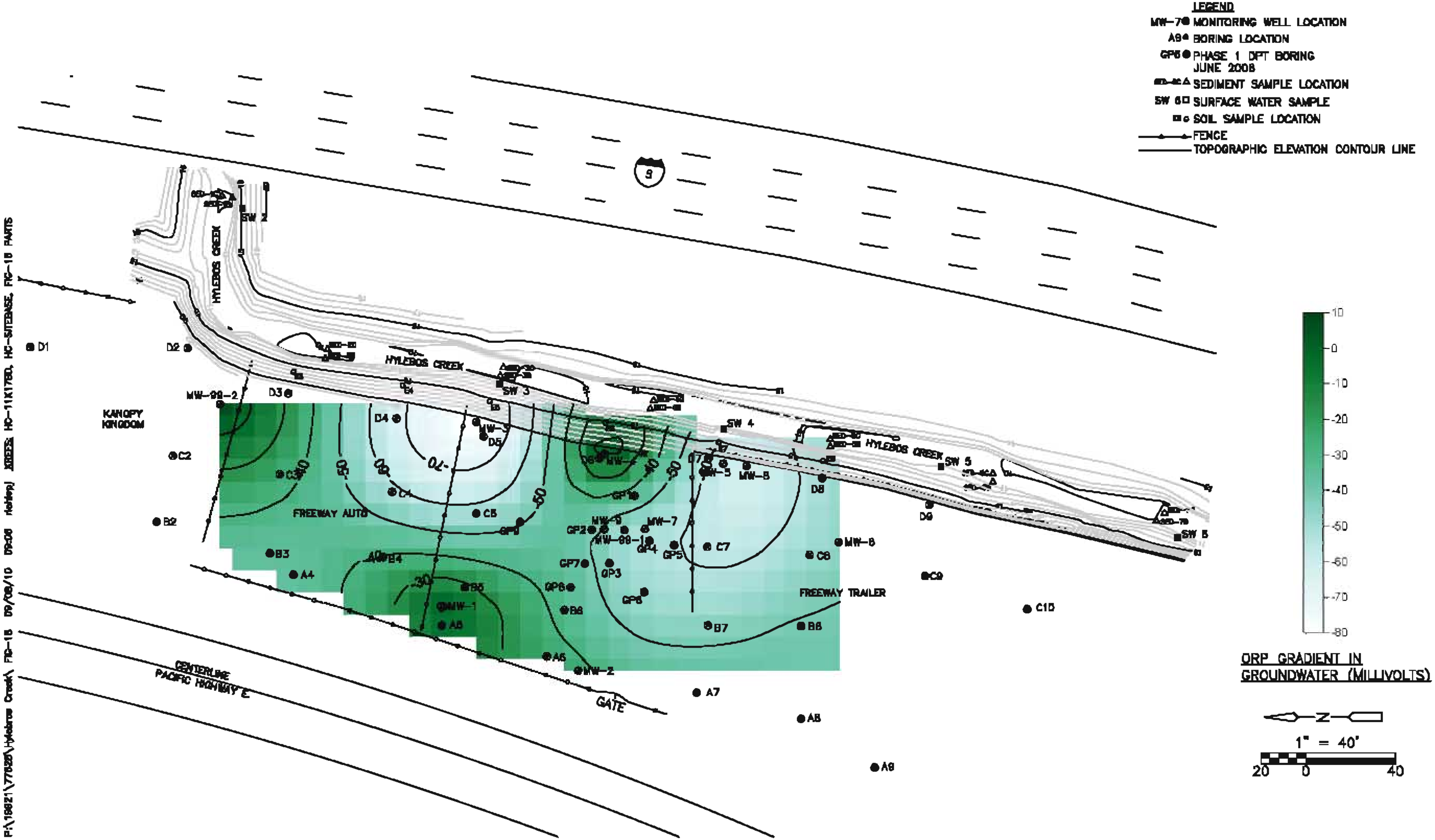


USG INTERIORS/HIGHWAY 99 SITE
MILTON, WASHINGTON

Figure No. 17
Dissolved Iron in Groundwater

CDM

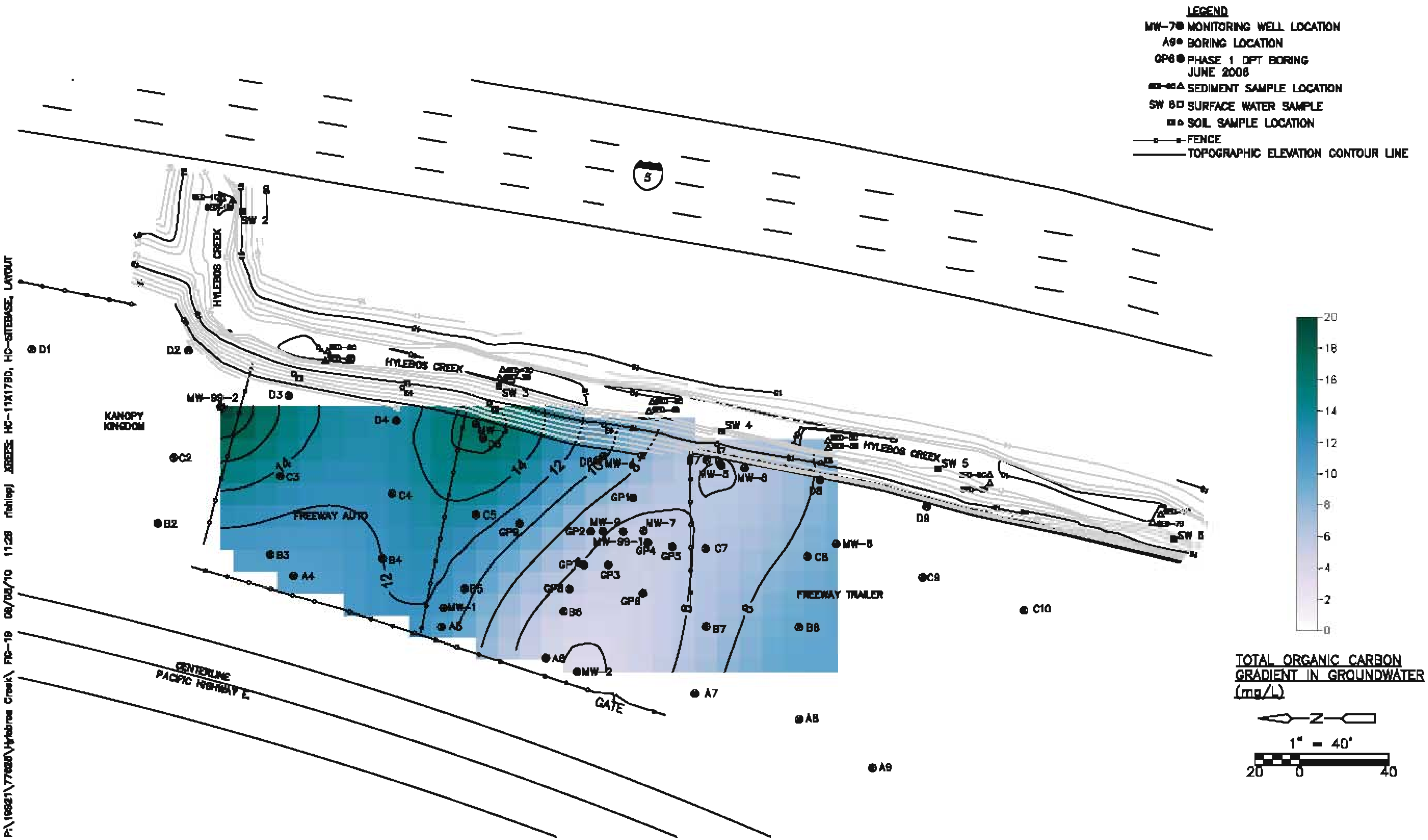
F:\1882\77520\Hylebos Creek\ FIG-17 09/08/10 09:35 XREFS: HC-11X17BD, HC-SITEBASE, FIG-17 PARTS



USG INTERIORS/HIGHWAY 99 SITE
MILTON, WASHINGTON

Figure No. 18
Oxidation Reduction Potental in Groundwater

CDM



USG INTERIORS/HIGHWAY 99 SITE
MILTON, WASHINGTON

Figure No. 19
Total Organic Carbon in Groundwater

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Appendix A
Boring Logs and Well Construction Logs

SOIL CLASSIFICATION LEGEND

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS More than half is larger than No. 200 sieve	GRAVELS More than half coarse fraction is larger than No. 4 sieve size	Clean gravels with little or no fines	GW	Well graded gravels, gravel-sand mixtures
			GP	Poorly graded gravels, gravel-sand mixtures
		Gravel with over 12% fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS More than half coarse fraction is smaller than No. 4 sieve size	Clean sands with little or no fines	SW	Well graded sands, gravelly sands
			SP	Poorly graded sands, gravelly sands
		Sands with over 12% fines	SM	Silty sand, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS More than half is smaller than No. 200 sieve	SILTS AND CLAYS Liquid limit less than 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic clays and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid limit greater than 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils

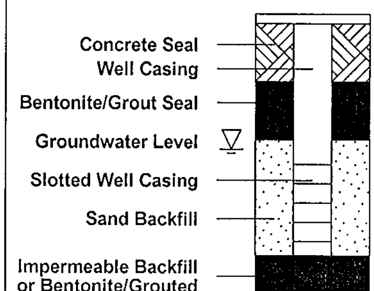
SAMPLE TYPE SYMBOLS

- Disturbed bag or jar sample
- Std. Penetration Test (2.0" OD)
- Type U Ring Sampler (3.25" OD)
- California Sampler (3.0" OD)
- Undisturbed Tube Sample
- Grab Sample
- Core Run
- Non-standard Penetration Test (with split spoon sampler)
- Bulk Sample

CONTACT BETWEEN UNITS

- Well-defined change in unit
- Gradational change in unit which was clearly noted in the exploration
- Change in unit which was not clearly defined

WELL COMPLETIONS



DESCRIPTORS FOR SOIL STRATA AND STRUCTURE (ENGLISH/METRIC)

General Thickness or Spacing

Parting:	less than 1/16 in. (1/6 cm)
Seam:	1/16 to 1/2 in. (1/6 to 1 1/4 cm)
Layer:	1/2 to 12 in. (1 1/4 to 30 1/2 cm)
Stratum:	> 12 in. (30 1/2 cm)
Scattered:	< 1 per ft. (30 1/2 cm)
Frequent:	> 1 per ft. (30 1/2 cm)

Structure

Pocket:	Erratic, discontinous deposit of limited extent
Lens:	Lenticular deposit
Varved:	Alternating seams of silt and clay
Laminated:	Alternating seams
Stratified:	Alternating layers

General Attitude

Near horizontal:	0 to 10 deg.
Low angle:	10 to 45 deg.
High angle:	45 to 80 deg.
Near Vertical:	80 to 90 deg.

STRUCTURE DESCRIPTION (cont.)

Fractured	Breaks easily along definite fractured planes
Slickensided	Polished, glossy, fractured planes
Blocky, Diced	Breaks easily into small angular lumps
Sheared	Disturbed texture, mix of strengths
Homogeneous	Same color and appearance throughout

MOISTURE DESCRIPTION

- Dry - Free of moisture, dusty
- Moist - Damp but no visible free water
- Wet - Visible free water

MODIFIERS

Trace	Particles present at levels estimated < 5%
Slightly (Clayey, Silty, Sandy, Gravelly)	Particles present at levels estimated at 5 to 12%
Clayey, Silty, Sandy, Gravelly	Particles present at levels estimated at 12 to 30%
Very (Clayey, Silty, Sandy, Gravelly)	Percentage of minor constituents estimated > 30%

RELATIVE DENSITY OR CONSISTENCY VS. SPT N-VALUE

COARSE GRAINED			FINE GRAINED		
Density	N (blows/ft)	Approx. Relative Density (%)	Consistency	N (blows/ft)	Approx. Undrained Shear Str. (psf)
Very Loose	0 to 4	0 - 15	Very Soft	0 to 2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Medium Dense	10 to 30	35 - 65	Medium Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	Over 50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	over 30	>4000

PHYSICAL PROPERTY TEST

AL -	Atterberg Limits
FC -	Fines Content
GSD -	Grain Size Distribution
MC -	Moisture Content
MD -	Moisture Content/Dry Density
SG -	Specific Gravity
Perm -	Permeability
TXP -	Triaxial Permeability
Cons -	Consolidation
Chem -	Analytical Chemical Analysis
Corr -	Corrosion
VS -	Vane Shear
DS -	Direct Shear
UC -	Unconfined Compression
TX -	Triaxial Compression
UU -	Unconsolidated, Undrained
CU -	Consolidated, Undrained
CD -	Consolidated, Drained

Notes:

1. Sample descriptions in this report are based on visual field and laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates, and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual classification methods in accordance with ASTM D 2488 were used as an identification guide. Where laboratory data are available, soil classifications are in general accordance with ASTM D 2487.

2. Dual symbols are used to indicate gravel and sand units with 5 to 12 percent fines and fine-grained units that plot in the CL-ML area of the plasticity chart.

3. WOR = weight of rod, WOH = weight of hammer.

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Project No: 19921.38072 Figure: B1

SOIL CLASSIFICATION/LEGEND FIFE GP LOGS 6-06.GPJ CDM_BLLV.GDT 11/6/06 REV.

Boring Log GP-1

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PID (ppm) [reading/background]	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)
								SP		Gravelly SAND (SP), brown.	
								SM		Silty SAND (SM), brown, with gravel, moist.	
						2		ML		Silt (ML), brown-gray, with clay, moist.	
						4		SC		Clayey SAND (SC), gray, with gravel, moist to wet.	
								SM		Silty SAND (SM), black, moist.	
						6		ML		Gravelly SILT (ML), gray, trace organics, moist.	
						8				Becomes dark brown, less gravelly, moist to wet.	
										Becomes light brown, moist.	
						∇ 10				Becomes gray, wet to saturated.	
						12				Becomes brown.	
						14		SP		Sand (SP), dark brown, with organics, saturated.	
						16				Boring terminated at 16 ft bgs. Goundwater encountered at 10 ft bgs.	

Station: ____________
Surface Elevation: ____________
Logged By: AEM

Drill Rig: Power Probe 9630 Pro
Equipment/Hammer: Continuous/
Date Completed: 6-5-06

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Boring Log GP-1 Figure: B2
Project No: 19921.38072 1 of 1

Boring Log GP-2

Depth (feet)	USCS	DESCRIPTION
0		2 inches Concrete.
0–1.5	SM	Silty SAND (SM), brown, with gravel, moist (Fill).
1.5–4	ML	SILT (ML), gray, with organics, moist (Fill).
4		Trace organics.
4–8	SM	Silty SAND (SM), gray, with gravel, moist (Fill).
8–12		No recovery from 8 to 12 ft bgs.
12–14.3	SM	Silty SAND (SM), gray, with gravel, saturated in shoe.
14.3–14.8	ML	SILT (ML), dark gray, saturated.
14.8–16	SP	SAND (SP), dark gray, trace silt, saturated, sand is interbedded with silt and silty sand.
16		Boring terminated at 16 ft bgs. Groundwater encountered at 13.5 ft bgs.

Column headings: Other Tests; Sample No.; Moisture Content (%); Dry Density (pcf); PID (ppm) [reading/background]; Penetration Resistance (blows / 6 in.); Depth (feet); Sample; USCS; Symbol; DESCRIPTION; Elev. (feet)

Station:
Surface Elevation:
Logged By: AEM

Drill Rig: Power Probe 9630 Pro
Equipment/Hammer: Continuous/
Date Completed: 6-5-06

NEIS_BORING_LOG FIFE GP LOGS 6-06.GPJ CDM_BLLV.GDT 11/6/06 REV.

CDM

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Fife, Washington

Boring Log GP-2
Project No: 19921.38072

Figure: B3
1 of 1

Boring Log GP-3

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PID (ppm) [reading/background]	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)
						0				2 inches Concrete.	
						0–4		SM		Silty SAND (SM), brown-gray, with gravel, moist (Fill).	
						4		ML		SILT (ML), gray, with gravel, moist.	
						4–11.5		SM		Silty SAND (SM), gray, with gravel, moist (Fill).	
						8				Becomes wet.	
						10 ∇				Becomes wet to saturated.	
						11.5–13.3		SM		Silty SAND (SM), brown, wet to saturated, interbedded with sand.	
						13.3–15.3		SP		SAND (SP), brown/black/red, fine grained, saturated, interbedded with silty sand and silt.	
						15.3–16		ML		SILT (ML), brown-gray, moist.	
						16				Boring terminated at 16 ft bgs. Groundwater encountered at 9.9 ft bgs.	

Station:
Surface Elevation:
Logged By: AEM

Drill Rig: Power Probe 9630 Pro
Equipment/Hammer: Continuous/
Date Completed: 6-5-06

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Boring Log GP-3 Figure: B4
Project No: 19921.38072 1 of 1

Boring Log GP-4

Depth (feet)	USCS	DESCRIPTION
0	GP	Base Course Gravel.
	SM	Silty SAND (SM), brown, with gravel, moist.
~3		Becomes gray, moist to wet (Fill).
~8		Becomes wet.
~9.3 (▽)		
~9.5	ML	Silt (ML), gray, wet to saturated.
12	SP	SAND (SP), brown-gray, with organics, saturated, interbedded with silt and silty sand.
16		Boring terminated at 16 ft bgs. Groundwater encountered at 9.3 ft bgs.

Column headings: Other Tests | Sample No. | Moisture Content (%) | Dry Density (pcf) | PID (ppm) [reading/background] | Penetration Resistance (blows / 6 in.) | Depth (feet) | Sample | USCS | Symbol | DESCRIPTION | Elev. (feet)

Station:

Surface Elevation:

Logged By: AEM

Drill Rig: Power Probe 9630 Pro

Equipment/Hammer: Continuous/

Date Completed: 6-5-06

NEIS_BORING_LOG FIFE GP LOGS 6-06.GPJ CDM_BLLV.GDT 11/6/06 REV.

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Boring Log GP-4 Figure: B5
Project No: 19921.38072 1 of 1

Boring Log GP-5

Depth (feet)	USCS	DESCRIPTION
0	GP	Base Course Gravel.
	SM	Silty SAND (SM), brown, with gravel, wet (Fill).
~3.5		Becomes gray.
~9.3		Becomes wet.
10	ML	SILT (ML), gray, with black sand, moist to wet, interbedded with brown silt and silty sand.
12.5	SP	SAND (SP), brown-gray, fine grained, saturated.
15.3	ML	SILT (ML), brown-gray, interbedded with silty sand, moist to wet.
16		Boring terminated at 16 ft bgs. Groundwater encountered at 9.3 ft bgs.

Columns: Other Tests | Sample No. | Moisture Content (%) | Dry Density (pcf) | PID (ppm) [reading/background] | Penetration Resistance (blows / 6 in.) | Depth (feet) | Sample | USCS | Symbol | DESCRIPTION | Elev. (feet)

Station:
Surface Elevation:
Logged By: AEM

Drill Rig: Power Probe 9630 Pro
Equipment/Hammer: Continuous/
Date Completed: 6-5-06

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Fife, Washington

CDM

Boring Log GP-5
Project No: 19921.38072

Figure: B6
1 of 1

Boring Log GP-6

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PID (ppm) [reading/background]	Penetration Resistance (blows / 6 in.)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0		Asphalt.	
							SM	Silty SAND (SM), brown, with gravel, moist (Fill).	
						2		Becomes gray.	
						8		Becomes wet.	
						11	ML	SILT (ML), brown-gray, interbedded with silty sand, saturated.	
						12		No recovery from 12 to 16 ft bgs.	
						16		Boring terminated at 16 ft bgs. Groundwater encountered at 10.95 ft bgs.	

Station:
Surface Elevation:
Logged By: AEM

Drill Rig: Power Probe 9630 Pro
Equipment/Hammer: Continuous/
Date Completed: 6-5-06

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Fife, Washington

Boring Log GP-6
Project No: 19921.38072

Figure: B7

Boring Log GP-7

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PID (ppm) [reading/background]	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)
										Asphalt.	
								GP		Base Course.	
										Silty SAND (SM), brown, with gravel, moist (Fill).	
						2				Becomes gray.	
						4		SM			
						6					
						8				Becomes wet. No recovery from 8 to 12 ft bgs.	
						▽ (9)					
						10					
						12				No recovery from 12 to 16 ft bgs.	
						14					
						16				Boring terminated at 16 ft bgs. Groundwater encountered at 9.0 ft bgs.	

Station: \
Surface Elevation: \
Logged By: AEM

Drill Rig: Power Probe 9630 Pro \
Equipment/Hammer: Continuous/ \
Date Completed: 6-6-06

USG Interiors \
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Fife, Washington

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Boring Log GP-7 \
Project No: 19921.38072

Figure: B8 \
1 of 1

NEIS_BORING_LOG FIFE GP LOGS 6-06.GPJ CDM_BLLV.GDT 11/6/06 REV.

Boring Log GP-8

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PID (ppm) [reading/background]	Penetration Resistance (blows / 6 in.)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	GP	3 inches Asphalt.	
								Base Course.	
							SM	Silty SAND (SM), brown, with gravel, moist (Fill).	
						2		Becomes gray.	
						4			
						6			
						8		Becomes wet.	
						9	ML	SILT (ML), brown-black, with organics, trace gravel and sand, wet.	
						10			
						12	SM	Silty SAND (SM), dark brown, interbedded with sand and silt, saturated.	
						14	ML	SILT (ML), dark brown, moist to wet.	
						16		Boring terminated at 16 ft bgs. Groundwater encountered at 9 ft bgs.	

Station:
Surface Elevation:
Logged By: AEM

Drill Rig: Power Probe 9630 Pro
Equipment/Hammer: Continuous/
Date Completed: 6-6-06

USG Interiors
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Fife, Washington

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Boring Log GP-8 Figure: B9
Project No: 19921.38072 1 of 1

Boring Log GP-9

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	PID (ppm) [reading/background]	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)
										2-1/2 inches Asphalt.	
								GP		Base Course.	
								SM		Silty SAND (SM), brown, with gravel, moist (Fill).	
						2				Becomes gray.	
						4					
						6					
						8				Becomes wet.	
								ML		SILT (ML), dark brown, with organics, trace sand and gravel, moist.	
						▽10				Becomes gray, trace organics.	
								SM		Silty SAND (SM), dark brown, moist.	
						12				Becomes gray.	
								SP		SAND (SP), dark brown, saturated.	
						14					
								ML		SILT (ML), dark brown, moist to wet.	
								SM		Silty SAND (SM), dark brown, moist.	
								ML		SILT (ML), dark brown, moist.	
						16				Boring terminated at 16 ft bgs. Groundwater encountered at 10 ft bgs.	

Station:
Surface Elevation:
Logged By: AEM

Drill Rig: Power Probe 9630 Pro
Equipment/Hammer: Continuous/
Date Completed: 6-6-06

NEIS_BORING_LOG_FIFE GP LOGS 6-06.GPJ CDM_BLLV.GDT 11/6/06 REV.

CDM

USG Interiors
Fife
Fife, Washington

Boring Log GP-9
Project No: 19921.38072

Figure: B10

SOIL CLASSIFICATION LEGEND

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS More than half is larger than No. 200 sieve	**GRAVELS** More than half coarse fraction is larger than No. 4 sieve size	Clean gravels with little or no fines	GW	Well graded gravels, gravel-sand mixtures
			GP	Poorly graded gravels, gravel-sand mixtures
		Gravel with over 12% fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS More than half coarse fraction is smaller than No. 4 sieve size	Clean sands with little or no fines	SW	Well graded sands, gravelly sands
			SP	Poorly graded sands, gravelly sands
		Sands with over 12% fines	SM	Silty sand, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS More than half is smaller than No. 200 sieve	**SILTS AND CLAYS** Liquid limit less than 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic clays and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid limit greater than 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils

SAMPLE TYPE SYMBOLS

- Disturbed bag or jar sample
- Std. Penetration Test (2.0" OD)
- Type U Ring Sampler (3.25" OD)
- California Sampler (3.0" OD)
- Undisturbed Tube Sample
- Grab Sample
- Core Run
- Non-standard Penetration Test (with split spoon sampler)

CONTACT BETWEEN UNITS

- Change in geologic unit
- Soil type change within geologic unit
- Obscure or gradational change

DESCRIPTORS FOR SOIL STRATA AND STRUCTURE (ENGLISH/METRIC)

General Thickness or Spacing

Parting:	less than 1/16 in. (1/6 cm)
Seam:	1/16 to 1/2 in. (1/6 to 1 1/4 cm)
Layer:	1/2 to 12 in. (1 1/4 to 30 1/2 cm)
Stratum:	> 12 in. (30 1/2 cm)
Scattered:	< 1 per ft. (30 1/2 cm)
Numerous:	> 1 per ft. (30 1/2 cm)

Structure

Pocket:	Erratic, discontinuous deposit of limited extent
Lens:	Lenticular deposit
Varved:	Alternating seams of silt and clay
Laminated:	Alternating seams
Interbedded:	Alternating layers

General Attitude

Near horizontal:	0 to 10 deg.
Low angle:	10 to 45 deg.
High angle:	45 to 80 deg.
Near Vertical:	80 to 90 deg.

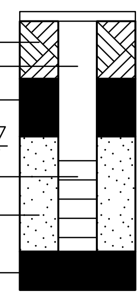
MOISTURE DESCRIPTION

Dry - Free of moisture, dusty

Moist - Damp but no visible free water

Wet - Visible free water, saturated

WELL COMPLETIONS



Concrete Seal
Well Casing
Bentonite/Grout Seal
Groundwater Level
Slotted Well Casing
Sand Backfill
Impermeable Backfill or Bentonite/Grouted

STRUCTURE DESCRIPTION (cont.)

Fractured	Breaks easily along definite fractured planes
Slickensided	Polished, glossy, fractured planes
Blocky, Diced	Breaks easily into small angular lumps
Sheared	Disturbed texture, mix of strengths
Homogeneous	Same color and appearance throughout

RELATIVE DENSITY OR CONSISTENCY VS. SPT N-VALUE

COARSE GRAINED			FINE GRAINED		
Density	N (blows/ft)	Approx. Relative Density (%)	Consistency	N (blows/ft)	Approx. Undrained Shear Str. (psf)
Very Loose	0 to 4	0 - 15	Very Soft	0 to 2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Medium Dense	10 to 30	35 - 65	Medium Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	Over 50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	over 30	>4000

PHYSICAL PROPERTY TEST

- AL - Atterberg Limits
- FC - Fines Content
- GSD - Grain Size Distribution
- MC - Moisture Content
- MD - Moisture Content/Dry Density
- Comp - Compaction Test (Proctor)
- SG - Specific Gravity
- CBR - California Bearing Ratio
- RM - Resilient Modulus
- Perm - Permeability
- TXP - Triaxial Permeability
- Cons - Consolidation
- Chem - Analytical Chemical Analysis
- Corr - Corrosion
- VS - Vane Shear
- DS - Direct Shear
- UC - Unconfined Compression
- TX - Triaxial Compression
- UU - Unconsolidated, Undrained
- CU - Consolidated, Undrained
- CD - Consolidated, Drained

Notes:

1. Sample descriptions in this report are based on visual field and laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates, and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual classification methods in accordance with ASTM D 2488 were used as an identification guide. Where laboratory data are available, soil classifications are in general accordance with ASTM D 2487.

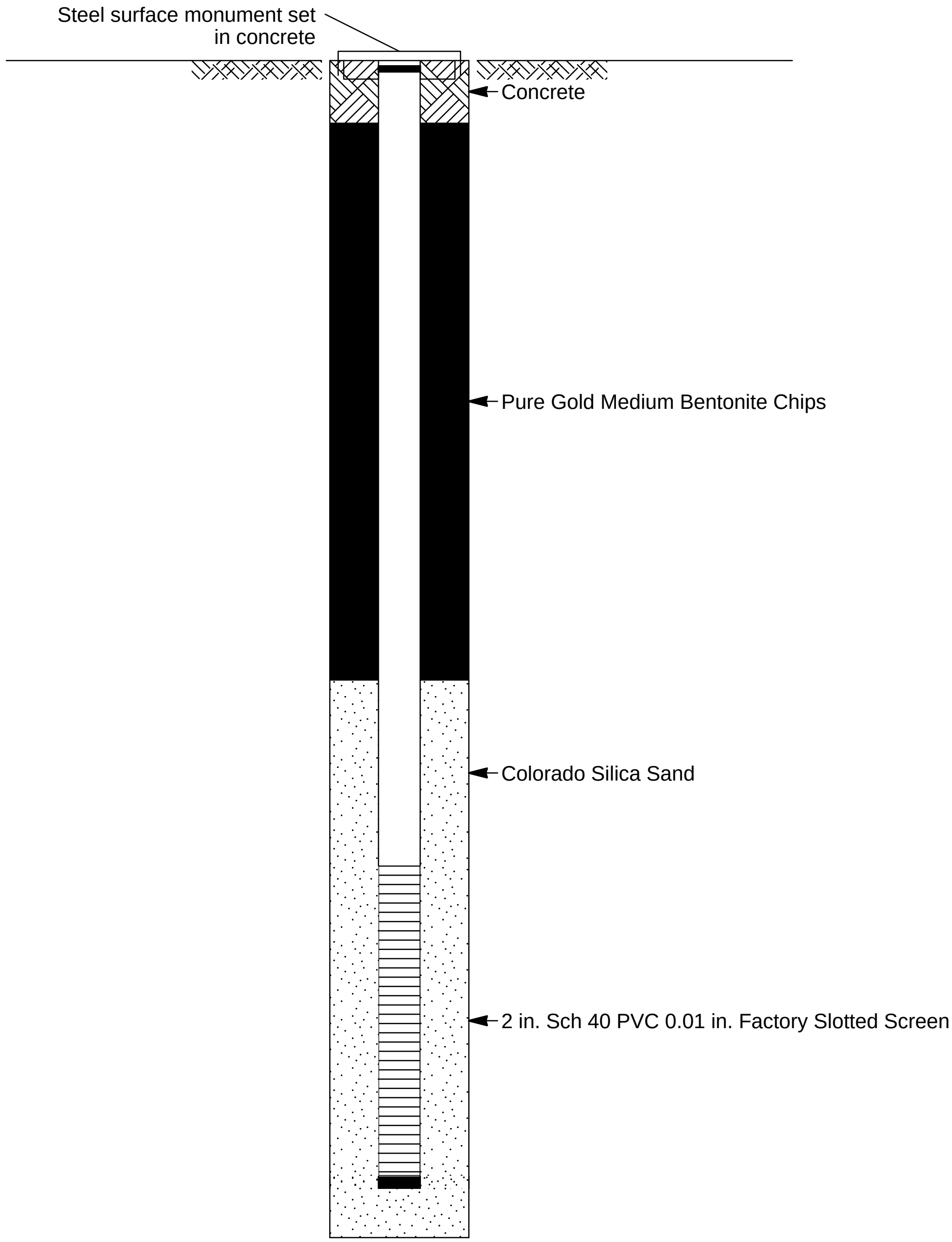
2. Dual symbols are used to indicate gravel and sand units with 5 to 12 percent fines.

3. WOR = weight of rod.

CDM Smith

USG Corporation
Hwy 99
Tacoma, Washington

Project No: 19921.65021 Figure: 1



TYPICAL MONITORING WELL CONSTRUCTION

USG Corporation
Hwy 99
Tacoma, Washington

Project No: 19921.65021 Figure: 2
1 of 1

Boring Log A4

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)
24/48	A4-2	<6			
	A4-4	11			
12/48					
	A4-8	<5			
24/48	A4-10	<6			
	A4-12	<7			
42/48	A4-14	<6			
	A4-16	7			

DESCRIPTION

USCS	Description
SM	Gravelly, Silty SAND (SM), brown-yellow, fine to medium sand, medium dense, moist.
SW	SAND (SW), gray, fine to coarse, loose, moist.
ML	Gravelly, Sandy SILT (ML), brown-gray, fine sand, fine to coarse gravel, very stiff, moist.
	Becomes wet with increased fine to medium sand content at ~4 ft bgs.
SM	Gravelly, Silty SAND (SM), brown-gray, fine sand, fine to coarse gravel, dense, moist.
ML	Sandy SILT (ML), dark gray-brown, with trace organics (wood and rootlets) and gravel, medium stiff, wet.
SM	Silty SAND (SM), dark gray-brown, fine sand, trace organics, wet, with some silt bedding.

Boring terminated at 16 ft bgs.
Groundwater encountered at 13 ft bgs.
Borehole backfilled with bentonite chips.

Depth (feet): 5, 10, 15, 20, 25

Elev. (feet)

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-28-10

USG Corporation
Hwy 99
Tacoma, Washington

Boring Log A4
Project No: 19921.65021

Figure: 3
1 of 1

CDM

Boring Log A5

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)
										Gravelly, Silty SAND (SM), dark brown, fine to coarse sand, fine to coarse gravel, medium dense, moist.	
										Cobbles encountered at ~1.5 ft bgs.	
33/48	A5-2	<6								Decreased silt content at ~2 ft bgs.	
	A5-4	<6								Increased silt content at ~4 ft bgs.	
						5				Becomes gray-brown, wet at ~5 ft bgs.	
								SM			
30/48	A5-6	<6									
<6/18						10					
										Silty SAND (SM), dark brown, fine, trace organics (wood), dense, wet, with occasional bedding and sand seams.	
						▽					
	A5-12	46									
								SM			
48/48	A5-14	35									
						15					
	A5-16	9								Boring terminated at 16 ft bgs. Groundwater encountered at ~12 ft bgs. Borehole backfilled with bentonite chips.	
						20					
						25					

Location:

Surface Elevation:

Logged By: AAL

Drill Rig: Direct Push Technology

Equipment/Hammer: Acetate Liner/

Date Completed: 4-28-10

USG Corporation
Hwy 99
Tacoma, Washington

Boring Log A5
Project No: 19921.65021

Figure: 4
1 of 1

Boring Log A6

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	SM	Gravelly, Silty SAND (SM), dark brown, fine to coarse sand, medium dense, moist. Brick debris encountered at ~0.5 ft bgs. Becomes brown at ~0.8 ft bgs.	
24/18	A6-2	<6							
	A6-4	8							
						5			
6/48									
	A6-8	8						At 8 ft bgs, color changes to gray, wet, with increased silt content.	
							ML	Sandy SILT (ML), dark gray, stiff, moist	
48/48	A6-10	46				10	ML	Layer of black slag with solid waste debris up to 3 in. at 9.5 and 10 ft bgs. SILT (ML), dark brown, stiff, moist, with occasional organics. At 10 ft bgs, color changes to gray-brown, trace organics.	
	A6-12	15					SM	Silty SAND (SM), dark brown, fine, trace organics, dense, wet, with trace silt bedding.	
48/48	A6-14	14							
						15			
	A6-16	9						Boring terminated at 16 ft bgs. Groundwater encountered at 11 ft bgs. Borehole backfilled with bentonite chips.	
						20			
						25			

Location: ________
Surface Elevation: ________
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-28-10

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USG Corporation
Hwy 99
Tacoma, Washington

Boring Log A6
Project No: 19921.65021

Figure: 5
1 of 1

Boring Log A7

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	SM	Gravelly, Silty SAND (SM), dark brown, fine to coarse, medium dense, wet. Becomes brown-yellow, fine sand at 0.5 ft bgs.	
30/48	A7-2	<6				2		Becomes gray, increased silt content at 2 ft bgs.	
	A7-4	<6				4		Becomes brown at 4.5 ft bgs.	
						5		Increased fine to medium sand content, color changes to gray, wet at 5 ft bgs.	
24/48	A7-6	229				6		Becomes dark brown, wet, fine sand, trace organics at 6 ft bgs.	
0/48						10			
						11	SP	SAND (SP), dark brown, fine to medium sand, with trace gravel, medium dense, wet.	
	A7-12	232				12 ▽			
						13	SM	Silty SAND (SM), dark brown, fine sand, dense, wet, with trace silt bedding and white lithics.	
42/48	A7-14	58				14			
						15.5	SP	SAND (SP), dark brown, fine to medium sand, dense, wet, with trace white and red lithics.	
	A7-16	107				16			
48/48	A7-18	25				18			
	A7-20	7				20		Boring terminated at 20 ft bgs. Groundwater encountered at 12 ft bgs. Borehole backfilled with bentonite chips.	
						25			

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-27-10

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USG Corporation
Hwy 99
Tacoma, Washington

Boring Log A7
Project No: 19921.65021

Figure: 6
1 of 1

Boring Log A7 Abandoned

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)
36/48								SM		Gravelly, Silty SAND (SM), dark brown, fine to coarse, dense, moist. Becomes yellow-brown and 0.5 ft bgs. Becomes gray at 1 ft bgs. Increased silt content and decreased gravel at 2 ft bgs.	
								ML		Sandy SILT (ML), gray, fine sand, with trace fine to coarse gravel, stiff, moist.	
18/48						5		SM		Silty SAND (SM), gray-brown, with some gravel, dense, moist.	
<6/48						10					
										Boring abandoned at 12 ft bgs. Moved south ~2 ft to start over. Borehole backfilled with bentonite chips.	
						15					
						20					
						25					

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-27-10

USG Corporation
Hwy 99
Tacoma, Washington

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Boring Log A7 Abandoned
Project No: 19921.65021

Figure: 7
1 of 1

Boring Log A8

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)
										Gravelly, Silty SAND (SM), brown-yellow, fine to medium sand, medium dense, moist. Becomes gray-brown at 0.5 ft bgs.	
48/48	A8-2	<6									
	A8-4	118						SM		Becomes very dark brown, with fine sand and trace gravel, also trace solid waste at 3.5 ft bgs.	
						5					
48/48	A8-6	136								4 in. layer of slag at 6 ft bgs. At 6.5 ft bgs, color changes to gray-brown.	
										Sandy SILT (ML), brown, fine sand with some organics (rootlets) and trace gravel, medium stiff, wet.	
	A8-8	28						ML		At 8 ft bgs, color changes to gray-brown.	
										2 in. sand layer at 9 ft bgs.	
										Sandy SILT (ML), dark brown, fine sand, with some organics, medium stiff, moist.	
21/48	A8-10	<6				10		ML			
										SAND (SP), gray, fine to medium sand, loose, wet.	
	A8-12	<6						SP			
								ML		Sandy SILT (ML), dark brown, fine sand with some organics, medium stiff, moist.	
42/48	A8-14	<6				▽				Silty SAND (SM), dark brown, fine, with some fine to medium sand seams, dense, wet.	
						15		SM			
	A8-16	<6								Boring terminated at 16 ft bgs. Groundwater encountered at 14 ft bgs. Borehole backfilled with bentonite chips.	
						20					
						25					

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-28-10

USG Corporation
Hwy 99
Tacoma, Washington

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Boring Log A8
Project No: 19921.65021

Figure: 8

Boring Log A9

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0–5	SM	Silty SAND (SM), light gray, fine to coarse sand, some coarse gravel, rounded, loose, moist.	
24/48	A9-2	<6							
	A9-4	26							
						5–8	ML	SILT (ML), gray-brown, trace sand, abundant rootlets, medium stiff, moist, low plasticity.	
40/48	A9-6	7							
	A9-8	<6				8–10	SM	Silty SAND (SM), gray, fine sand, medium dense, moist, some silt interbeds (1/4 in. thick).	
48/48	A9-10	7				10–11.5	ML	SILT (ML), gray-brown, abundant rootlets and organic material, trace fine sand, moist, low plasticity.	
	A9-12	6				11.5–14	SW	SAND (SW), dark gray, well graded, fine to coarse sand, subangular to subrounded, medium dense, wet.	
48/48	A9-14	<6				14–16	SM	Silty SAND (SM), gray-brown, fine sand, subangular to subrounded grains, medium dense, wet.	
	A9-16	<6				16		Boring terminated at 16 ft bgs. Groundwater encountered at 11.5 ft bgs. Borehole backfilled with bentonite chips.	

Location:
Surface Elevation:
Logged By: HY

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-29-10

USG Corporation
Hwy 99
Tacoma, Washington

CDM

Boring Log A9 Figure: 9
Project No: 19921.65021 1 of 1

Boring Log B2

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	SM	Gravelly, Silty SAND (SM), brown-yellow, fine to medium sand, fine to coarse gravel, dense, moist. Becomes gray-brown at 1 ft bgs.	
36/48	B2-2	<6							
	B2-4	12							
						5	ML	Gravelly, Sandy SILT (ML), gray, fine sand, fine to coarse gravel, medium stiff. Becomes gray-brown at 5.5 ft bgs.	
36/48	B2-6	<6							
	B2-8	<6						Sand becomes fine to coarse at 8 ft bgs.	
							ML	Sandy SILT (ML), dark brown, with some organics, medium stiff, moist.	
30/48	B2-10	7				10		Becomes gray with trace organics at 10 ft bgs.	
	B2-12	10				▽		Becomes wet at 12 ft bgs.	
							ML	SILT (ML), gray, with occasional iron mottling, very stiff, moist.	
42/48	B2-14	7				15		Becomes light gray (2 in. layer) then light brown at 15.5 ft bgs.	
	B2-16	14						Boring terminated at 16 ft bgs. Groundwater encountered at 12 ft bgs. Borehole backfilled with bentonite chips.	
						20			
						25			

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-29-10

CDM

USG Corporation
Hwy 99
Tacoma, Washington

Boring Log B2
Project No: 19921.65021

Figure: 10

Boring Log B3

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	SM	Gravelly, Silty SAND (SM), dark brown, fine to coarse sand, medium dense, moist. Becomes brown-yellow at 0.5 ft bgs.	
36/48	B3-2	19				2		Becomes gray-brown at 2 ft bgs.	
	B3-4	77				4			
						5		Becomes brown, with decreased gravel content at 5 ft bgs.	
24/48	B3-6	<6				6			
	B3-8	9				8			
						8.5		Layer of dark brown, gravelly, silty sand (3 in. thick) with metal pieces, at 8.5 ft bgs.	
36/48	B3-10	<6				10	ML	Sandy SILT (ML), gray-brown, with some gravel, medium stiff, moist. Becomes gray and wet, with increased sand content at 10 ft bgs.	
						11	SM	Gravelly, Silty SAND (SM), gray, fine to coarse sand, medium dense, wet.	
						12.3		4 in. layer of sawdust at 12.3 ft bgs.	
						12.6	SM	Silty SAND (SM), dark brown, fine sand, dense, wet, with occasional silt bedding.	
36/48	B3-14	<6				14			
	B3-15	<6				15			
						16		Boring terminated at 16 ft bgs. Groundwater encountered at 10 ft bgs. Borehole backfilled with bentonite chips.	

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-27-10

USG Corporation
Hwy 99
Tacoma, Washington

Boring Log B3
Project No: 19921.65021

Figure: 11
1 of 1

CDM

Boring Log B4

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)
						0				Gravelly, Silty SAND (SM), dark brown, fine to coarse, medium dense, moist.	
										Becomes gray-brown at 1 ft bgs.	
36/48	B4-2	<6									
										Increased silt content at 3 ft bgs.	
	B4-4	<6						SM			
						5					
12/48											
	B4-8	<6									
										Sandy SILT (ML), gray, with some gravel, stiff, moist.	
						▽		ML		Wet from 9 to 9.5 ft bgs.	
										Significant wood debris (sawdust?) from 9.5 to 10 ft bgs.	
30/48	B4-10	10				10				Silty SAND (SM), gray, with some gravel, moist, dense.	
								SM			
24/48	B4-14	604								Silty SAND (SM), dark brown, fine, with organics, dense, moist.	
						15				3 in. layer of sand at 15 ft bgs. Becomes brown, with silt bedding and white lithics, trace organics at 15.3 ft bgs.	
	B4-16	84									
								SM			
48/48	B4-18	14									
	B4-20	6				20				Boring terminated at 20 ft bgs. Groundwater encountered at 9.5 ft bgs. Borehole backfilled with bentonite chips.	
						25					

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-26-10

USG Corporation
Hwy 99
Tacoma, Washington

CDM

Boring Log B4
Project No: 19921.65021

Figure: 12
1 of 1

Boring Log B5

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
							GP	Sandy GRAVEL (GP), very dark brown, loose, moist.	
							SM	Gravelly, Silty SAND (SM), brown, fine to coarse sand and gravel, medium dense, moist.	
								Becomes gray with fine to medium sand at 1.5 ft bgs.	
30/48	B5-2	35							
	B5-4	<5							
						5		Becomes brown-gray at 5 ft bgs.	
36/48	B5-6	6							
							SM	Gravel becomes fine to medium at 7 ft bgs.	
	B5-8	<6							
								Becomes wet at 8.5 ft bgs.	
24/48						10			
	B5-12	<6						Becomes loose at 12 ft bgs.	
48/48	B5-14	3140					ML	Sandy SILT (ML), dark brown, with trace organics and bedding features, very stiff, wet, with layers of medium sand and gravelly, silty sand and organics to 0.25 in.	
						15 ∇			
							SM	Silty SAND (SM), dark gray-brown, fine, dense, wet, bedding features (6 in. thick).	
	B5-16	50							
48/48	B5-18	38							
							SP	SAND (SP), dark gray, fine to medium sand, medium dense, wet, with white and red lithics.	
	B5-20	12				20		Boring terminated at 20 ft bgs. Groundwater encountered at 15.5 ft bgs. Borehole backfilled with bentonite chips.	
						25			

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-26-10

USG Corporation
Hwy 99
Tacoma, Washington

Boring Log B5
Project No: 19921.65021

Figure: 13
1 of 1

CDM

Boring Log B6

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	SM	Gravelly, Silty SAND (SM), dark brown, fine to coarse sand and gravel, medium dense, moist. Becomes brown-yellow at 1 ft bgs. Becomes gray-brown, fine to medium sand at 1.3 ft bgs.	
30/48	B6-2	24							
	B6-4	<6						Layer of fine to coarse sand with fine to coarse gravel (3 in. diameter) at 4.5 ft bgs. Increased silt content, cobble encountered at 4.8 ft bgs.	
						5			
30/48	B6-6	7							
	B6-8	<6						At 9 ft bgs, becomes wet, 2 in. brick fragment.	
36/48	B6-10	11				10		At 10 ft bgs, decreased silt content, becomes dark brown.	
							SP	SAND (SP), very dark brown-black, fine to medium sand, well rounded sand, with glass-like gravel, loose, wet.	
	B6-12	8311						3 in. layer of sandy silt at 12.5 ft bgs.	
							SP	SAND (SP), gray, medium grained sand, medium dense, wet.	
45/48	B6-14	1123				▽	ML	Sandy SILT (ML), dark brown, very fine sand, with trace organics, medium stiff, wet. Wood debris (1 in.) at 14.4 ft bgs.	
						15	SM	Silty SAND (SM), dark brown, with silt bedding features, dense, wet.	
	B6-16	65					SP	SAND (SP), dark gray, fine to medium, dense, wet, with trace white lithics and silt bedding features. Small wood fragment at 17 ft bgs.	
48/48	B6-18	28						Increased white grains and some red lithics at 19 ft bgs.	
	B6-20	15				20		Boring terminated at 20 ft bgs. Groundwater encountered at 13.75 ft bgs. Borehole backfilled with bentonite chips.	
						25			

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-27-10

USG Corporation
Hwy 99
Tacoma, Washington

Boring Log B6
Project No: 19921.65021

Figure: 14
1 of 1

CDM

Boring Log B7

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	SM	Gravelly, Silty SAND (SM), fine to coarse sand, medium dense, dry. Becomes moist with increased silt content, yellow-red at 1 ft bgs. Becomes gray-brown at 1.5 ft bgs. Filter fabric encountered at 2.5 ft bgs. Rock encountered at 3 ft bgs.	
36/48	B7-2	7							
	B7-4	<7							
						5	SP	SAND (SP), dark brown, fine to medium sand, with some gravel and vitreous, needle-like grains, medium dense, moist. Layers of insulation-like material at 5 and 7.5 ft bgs. Also particles of the insulation-like material dispersed throughout. Possible hydrogen sulfide odor at 7.5 ft bgs.	
42/48	B7-6	119							
	B7-8	39							
45/48	B7-10	270				10	ML	Sandy SILT (ML), dark brown, fine sand, with some organics, medium stiff, wet.	
						▽ (11)	SM	Silty SAND (SM), dark brown, fine sand, dense, wet, with some silt bedding features and trace white lithics. Becomes fine to medium grained at 15.5 ft bgs.	
	B7-12	49							
48/48	B7-14	28				15			
	B7-16	13				16		Boring terminated at 16 ft bgs. Groundwater encountered at 11 ft bgs. Borehole backfilled with bentonite chips.	
						20			
						25			

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-27-10

USG Corporation
Hwy 99
Tacoma, Washington

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Boring Log B7
Project No: 19921.65021

Figure: 15
1 of 1

Boring Log B8

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	SM	Gravelly, Silty SAND (SM), dark brown, fine to coarse sand, wet. Becomes yellow-brown at 0.5 ft bgs.	
24/48	B8-2	8				2	SM		
						3	SM	Cobble encountered at 3 ft bgs, becomes gray.	
	B8-4	<7				4	SM		
						4.5	ML	Sandy SILT (ML), gray-brown, fine sand, with trace fine gravel and sand seams, stiff, moist.	
48/48	B8-6	8				6.5	ML	Sandy SILT (ML), dark brown, fine sand, with numerous organics, stiff, moist. Becomes gray-brown, with decreased organics at 7.5 ft bgs.	
	B8-8	17				8.5	ML	Becomes mottled gray-brown and light brown at 8.5 ft bgs.	
45/48	B8-10	14				9.5	SM	Silty SAND (SM), dark brown, with trace silt bedding and sand layers, dense, wet. 2 in. brown organic-rich layer at 10.3 ft bgs.	
	B8-12	17				12	SM		
48/48	B8-14	12				14	SM		
	B8-16	9				16		Boring terminated at 16 ft bgs. Groundwater encountered at 9.5 ft bgs. Borehole backfilled with bentonite chips.	

Location: ____
Surface Elevation: ____
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-28-10

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Hwy 99
Tacoma, Washington

Boring Log B8
Project No: 19921.65021

Figure: 16

Boring Log C2

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
							SM	Gravelly, Silty SAND (SM), brown-yellow, fine to medium sand, medium dense, moist.	
							ML	Sandy SILT (ML), gray-brown, fine sand, very stiff, moist, with occasional iron mottling.	
36/48	C2-2	<6						Becomes gray with increased fine to medium sand at 2.5 ft bgs.	
	C2-4	9						Increased gravel content at 4 ft bgs. 2 in. layer of gravelly , silty sand at 4.5 ft bgs.	
						5	ML		
18/48									
	C2-9	<6							
								Decreased sand content at 9.3 ft bgs.	
							ML	Sandy SILT (ML), dark brown, with some organics, fine sand, medium stiff, moist.	
24/48	C2-10	24				10			
	C2-12	17				▽		Becomes gray and brown mottled at 12 ft bgs.	
							SM	Silty SAND (SM), dark gray-brown, fine, dense, wet, with some silt bedding and trace organics.	
42/48	C2-14	13							
						15			
	C2-16	8						Boring terminated at 16 ft bgs. Groundwater encountered at 12.5 ft bgs. Borehole backfilled with bentonite chips.	
						20			
						25			

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-28-10

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USG Corporation
Hwy 99
Tacoma, Washington

Boring Log C2
Project No: 19921.65021

Figure: 17
1 of 1

LOG OF BORING WITH WELL 19921-65021-APR 26-28 2010.GPJ CDM_BLLV.GDT 5/21/10 REV.

Boring Log C3

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	SM	Gravelly, Silty SAND (SM), dark brown, fine to coarse sand and gravel, medium dense, moist. Becomes brown-yellow at 0.5 ft bgs.	
36/48	C3-2	<6				2	SM	Increased silt, decreased gravel, sand is fine grained from 1.5 to 2 ft bgs. Becomes gray at 2 ft bgs.	
	C3-4	9				4	SM	Becomes gray-brown at 4 ft bgs.	
						5	SM		
36/48	C3-6	5				6	SM	Filter fabric encountered at 6 ft bgs.	
	C3-8	<6				8	ML	Sandy SILT (ML), gray, fine sand, with trace gravel, mottling and organics, medium stiff.	
12/48						10	ML		
	C3-12	140				12	ML		
						13	ML	Becomes dark brown at 13 ft bgs. Wood debris from 13.3 to 13.5 ft bgs.	
36/48	C3-14	215				14 (groundwater)	SP	SAND (SP), gray, fine to medium sand, medium dense, wet. 2 in. brown silty sand layer at 14.5 ft bgs.	
	C3-15	148				15	SP		
	C3-16	184				16	SM	Silty SAND (SM), dark brown, fine sand, dense, wet, with trace white lithics and silt bedding. 2 in. yellow discoloration at 17.5 ft bgs.	
48/48	C3-18	64				18	SM		
	C3-20	29				20	SP	SAND (SP), dark gray, with trace organics (wood fragments) and white and red lithics, dense, wet.	
42/48	C3-22	7				22	ML	SILT (ML), gray-brown, with some bedding features, stiff, wet. Becomes dark gray at 23 ft bgs. Becomes gray with iron mottling at 23.5 ft bgs.	
	C3-24	9				24		Boring terminated at 24 ft bgs. Groundwater encountered at 14 ft bgs. Borehole backfilled with bentonite chips.	
						25			

Location: ______
Surface Elevation: ______
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-27-10

USG Corporation
Hwy 99
Tacoma, Washington

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Boring Log C3 Figure: 18
Project No: 19921.65021 1 of 1

Boring Log C4

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
							SM	Gravelly, Silty SAND (SM), dark brown, fine to coarse, loose, moist. Becomes brown at 1 ft bgs.	
36/48	C4-2	7					ML	Sandy SILT (ML), brown-gray, stiff, moist, with some iron mottling and gravel.	
							SM	Gravelly, Silty SAND (SM), gray, dense, moist.	
	C4-4	10					ML	Sandy SILT (ML), brown, stiff, moist.	
						5	SM	Gravelly, Silty SAND (SM), gray, fine sand, fine to coarse gravel, dense, moist.	
42/48	C4-6	7						Becomes wet with increased silt content at 7 ft bgs.	
	C4-8	25					ML	Sandy SILT (ML), brown-light brown, trace organics and sand layers and mottling, stiff, moist.	
36/48	C4-10					10		Becomes dark brown-gray mottled at 10.5 ft bgs.	
	C4-12					▽	SM	Silty SAND (SM), dark brown, fine, trace organics and white lithics, wet, with occasional silt bedding.	
	C4-14								
						15			
	C4-16	11						Boring terminated at 16 ft bgs. Groundwater encountered at 12 ft bgs. Borehole backfilled with bentonite chips.	
						20			
						25			

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-26-10

USG Corporation
Hwy 99
Tacoma, Washington

Boring Log C4
Project No: 19921.65021

Figure: 19
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Boring Log C5

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0–4	SM	Gravelly, Silty SAND (SM), very dark brown, fine to coarse sand and gravel, loose, moist. Becomes brown-yellow at 0.5 ft bgs.	
36/48	C5-2	8						Becomes brown with fine to medium sand at 2 ft bgs. Becomes gray at 2.5 ft bgs.	
	C5-4	12				4–9.5	SM	Gravelly, Silty SAND (SM), dark brown, fine to medium sand and gravel, medium dense, moist. Becomes gray, with fine sand and fine to coarse gravel. Trace wood debris encountered at 4.8 ft bgs. Becomes brown at 5 ft bgs. Becomes gray at 5.5 ft bgs.	
30/48	C5-6	<5							
	C5-8	<6							
48/48	C5-10	86				9.5–10.5	ML	Sandy SILT (ML), dark brown, with trace organics and bedding features, stiff, moist. Becomes gray at 10 ft bgs. 2 in. brown layer at 10.5 ft bgs.	
	C5-12	48				10.5–19	SM	Silty SAND (SM), dark brown, fine sand, dense, wet, with occasional silt bedding features.	
48/48	C5-14	20							
	C5-16	90							
48/48	C5-18	12							
	C5-20	14				19–20	SP	SAND (SP), dark gray, fine to medium, medium dense, wet, with white and red lithics.	

Groundwater level symbol at 10 ft.

Boring terminated at 20 ft bgs.
Groundwater encountered at 10.5 ft bgs.
Borehole backfilled with bentonite chips.

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-26-10

LOG OF BORING WITH WELL 19921-65021-APR 26-28 2010.GPJ CDM_BLLV.GDT 5/24/10 REV.

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Boring Log C5
Project No: 19921.65021

Figure: 20
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Boring Log C7

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	SM	Gravelly, Silty SAND (SM), dark brown, fine to medium sand, fine to coarse gravel, medium dense, moist. Sand becomes fine grained at 0.5 ft bgs.	
12/48									
	C7-4	<6						Becomes yellow-brown at 4 ft bgs. Becomes gray at 4.5 ft bgs.	
						5			
42/48	C7-6	<7							
	C7-8	231					SP	SAND (SP), dark brown, fine to medium, with some gravel and green vitreous, needle-like grains, medium dense, moist, insulation-like material distributed throughout. Becomes wet at 8 ft bgs.	
48/48	C7-10	125				10	ML	Sandy SILT (ML), dark brown, fine sand, with some organics, stiff, wet. 4 in. wood debris encountered at 9.3 ft bgs. Becomes brown at 9.5 ft bgs.	
						▽	SM	Silty SAND (SM), dark brown, fine, with trace white lithics and silt bedding features, dense, wet.	
	C7-12	23						Trace seams (~0.4 in.) of sand from 12 to 16 ft bgs.	
48/48	C7-14	23							
						15		Wood debris encountered at 15 ft bgs.	
	C7-16	18						Boring terminated at 16 ft bgs. Groundwater encountered at 10.8 ft bgs. Borehole backfilled with bentonite chips.	
						20			
						25			

Location:

Surface Elevation:

Logged By: AAL

Drill Rig: Direct Push Technology

Equipment/Hammer: Acetate Liner/

Date Completed: 4-27-10

USG Corporation
Hwy 99
Tacoma, Washington

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Boring Log C7
Project No: 19921.65021

Figure: 21

Boring Log C8

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)
24/48	C8-2	<6			
	C8-4	<6			
	C8-5.5	6693			
27/48	C8-6	211			
	C8-8	242			
45/48	C8-10	46			
	C8-12	45			
48/48	C8-14	9			
	C8-16	<6			

Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
0–5.5	SM	Gravelly, Silty SAND (SM), brown-yellow, fine to coarse, medium dense, moist. Becomes gray-brown with decreased silt and gravel content at 0.5 ft bgs.	
5.5–6	SP	Gravelly SAND (SP), black, fine to medium, with angular, vitreous gravel, medium dense, moist. Becomes wet at 6 ft bgs.	
6–8.5	ML	Sandy SILT (ML), dark brown, with some organics (rootlets) and trace silt bedding, stiff, moist. Becomes brown to light brown mottled at 6.3 ft bgs.	
8.5–11.5	SM	Silty SAND (SM), dark gray-brown, with some silt bedding and layers and trace organics, dense, wet.	
11.5–14	ML	Sandy SILT (ML), dark brown, with some organics and trace silt bedding, medium stiff, moist.	
14–16	SM	Silty SAND (SM), dark gray-brown, with trace silt bedding and some sand layers, dense, wet.	
16		Boring terminated at 16 ft bgs. Groundwater encountered at 8.5 ft bgs. Borehole backfilled with bentonite chips.	

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-28-10

USG Corporation
Hwy 99
Tacoma, Washington

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Boring Log C8
Project No: 19921.65021

Figure: 22

Boring Log C9

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
							SM	Silty SAND (SM), gray, fine to coarse, some coarse gravel and concrete debris, loose, moist.	
24/48	C9-2	59							
							OH	Organic SILT (OH), dark brown,soft, moist, abundant wood chips and decomposed wood.	
	C9-4	116							
						5			
46/48	C9-6	31					ML	SILT (ML), brown mottled with pale green, trace fine sand, medium stiff, moist, low plasticity, abundant rootlets and wood fragments.	
	C9-8	13							
							SM	Silty SAND (SM), gray-brown, fine sand, subangular to subrounded, medium dense, wet, abundant interlayers of gray silt up to 1/4 in. thick.	
48/48	C9-10	<6				10			
							SP	SAND (SP), gray, poorly graded, medium grained, subangular to subrounded, moist.	
						▽	SM	Silty SAND (SM), as at 8.5 ft bgs.	
	C9-12	<6					SP	SAND (SP), gray, poorly graded, fine sand, subangular to subrounded, trace silt, medium dense, wet.	
48/48	C9-14	<6						2 in. fragment of wood.	
						15			
	C9-16	<6						Boring terminated at 16 ft bgs. Groundwater encountered at 12 ft bgs. Borehole backfilled with medium bentonite chips.	
						20			
						25			

Location:
Surface Elevation:
Logged By: HY

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-29-10

USG Corporation
Hwy 99
Tacoma, Washington

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Boring Log C9 Figure: 23
Project No: 19921.65021 1 of 1

Boring Log C10

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0–5	SM	Silty SAND (SM), brown, fine to coarse, some coarse gravel, well rounded, loose, dry, concrete debris.	
36/48	C10-2	12							
	C10-4	13							
						5	OH	Organic SILT (OH), dark brown, soft, moist, abundant wood chips.	
48/48	C10-6	15					ML	SILT (ML), gray-brown, trace sand, medium stiff, moist, low plasticity, abundant rootlets.	
	C10-8	12					SM	Silty SAND (SM), gray-brown mottled with light gray, fine grained sand, subangular to subrounded, moist, minor interlayers of light gray silt up to 1/4 in. thick.	
48/48	C10-10	<6				10			
	C10-12	<6				12		Boring terminated at 12 ft bgs. Borehole backfilled with medium bentonite chips.	

Location:
Surface Elevation:
Logged By: HY

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-29-10

USG Corporation
Hwy 99
Tacoma, Washington

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Boring Log C10
Project No: 19921.65021

Figure: 24

Boring Log D1

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	GP	Asphalt over gravel base, asphalt is 2 in. thick. GRAVEL (GP), gray-brown, some sand, gravel is coarse, dry.	
						1	ML	SILT (ML), gray-brown, medium stiff, moist, low plasticity.	
42/48	D1-2	12				2	SM	Silty SAND (SM), gray-brown, some gravel, loose, moist.	
	D1-4	<6				4	ML	Sandy SILT (ML), some fine to coarse sand, some coarse gravel, medium stiff, moist, low plasticity, some asphalt and concrete debris.	
24/48	D1-6	8				6			
	D1-8	11				8 (groundwater ▽)	SM	Silty SAND (SM), light gray, fine to coarse sand, some gravel, well rounded, coarse gravel, loose, wet.	
40/48	D1-10	<6				10			
						11.5		Wood debris at 11.5 ft bgs.	
	D1-12	9				12			
36/48						12.5	ML	SILT (ML), dark brown, some sand, soft, moist, low plasticity, abundant organic material. 1 in. layer of medium sand at 13 ft bgs. 1 in. long wood fragment at 13.5 ft bgs.	
	D1-14	8				14			
						15		Boring terminated at 15 ft bgs. Groundwater encountered at 8 ft bgs. Borehole backfilled with bentonite chips.	

Location:
Surface Elevation:
Logged By: HY

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-29-10

USG Corporation
Hwy 99
Tacoma, Washington

Boring Log D1
Project No: 19921.65021

Figure: 25
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CDM

Boring Log D2

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)
										Gravelly, Sandy SILT (ML), gray-brown, fine sand, very dense, moist.	
36/48	D2-2	<6								Becomes brown at 2 ft bgs.	
	D2-4	20						ML			
						5					
30/48											
	D2-8	29								Becomes gray-brown, wet with increased fine to medium sand content at 8 ft bgs.	
										Gravelly, Silty SAND (SM), gray, fine to coarse, loose, wet.	
33/48	D2-10	<6				10		SM			
	D2-12	<6				∇		ML		Sandy SILT (ML), dark brown, fine sand, with some organics, soft, moist to wet.	
										Silty SAND (SM), dark gray to brown, fine, with trace silt bedding and organics, dense, wet, trace white lithics.	
48/48	D2-14	<6						SM			
						15					
	D2-16	7								Boring terminated at 16 ft bgs. Groundwater encountered at 12.5 ft bgs. Borehole backfilled with bentonite chips.	
						20					
						25					

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-28-10

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Hwy 99
Tacoma, Washington

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Boring Log D2
Project No: 19921.65021

Figure: 26
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Boring Log D3

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	SM	Gravelly, Silty SAND (SM), dark brown, fine to medium sand, medium dense, moist.	
							ML	Sandy SILT (ML), brown, with some gravel, very stiff, moist.	
36/48	D3-2	7				2		Becomes gray from 2 to 2.5 ft bgs. Becomes brown and mottled from 2.5 to 3 ft bgs.	
	D3-4	20				4			
						5	ML		
36/48	D3-6	29				6		4 in. layer of silty sand at 6 ft bgs. Becomes gray with silt bedding at 6.5 ft bgs.	
	D3-8	17				8		5 in. layer of silty sand at 8 ft bgs.	
						8.5	ML	Sandy SILT (ML), dark gray, trace gravel, with organics, medium stiff, moist, silt bedding.	
48/48	D3-10	<6				10			
						11 (groundwater)	SM	Silty SAND (SM), dark brown, fine sand, dense, wet, with occasional silt bedding features.	
	D3-12	35				12			
36/48						14			
						15			
	D3-16	24				16			
48/48	D3-18	40				18			
	D3-20	31				20		With white lithics at 19.5 ft bgs.	
48/48	D3-22	15				22	ML	Sandy SILT (ML), gray-brown, very stiff, wet, with occasional bedding and organics.	
	D3-24	10				24		Boring terminated at 24 ft bgs. Groundwater encountered at 11 ft bgs. Borehole backfilled with bentonite chips.	
						25			

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-26-10

USG Corporation
Hwy 99
Tacoma, Washington

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Boring Log D3
Project No: 19921.65021

Figure: 27
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Boring Log D4

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0–2	SM	Gravelly, Silty SAND (SM), very dark brown, fine to medium sand, loose, moist. Becomes brown at 0.5 ft bgs.	
6/48	D4-2	7				2–3.5	ML	Sandy SILT (ML), gray-brown, medium stiff, moist. 2 in. layer of dark gray gravel at 2.5 ft bgs. Increased sand content from 3 to 3.5 ft bgs.	
	D4-4	<5				3.5–8	ML	Sandy SILT (ML), gray, fine sand, with trace gravel, stiff, moist.	
24/48									
	D4-8	<5				8–11	ML	Sandy SILT (ML), brown, stiff, moist. Trace organics, mottling and bedding features from 8 to 10.5 ft bgs.	
42/48	D4-10	<4							
	D4-12	14				11–16	SM	Silty SAND (SM), dark brown, fine, with trace organics, dense, wet, occasional silt bedding features.	
48/48	D4-14	15							
	D4-16	11						4 in. wood fragment at 15.5 ft bgs.	
						16		Boring terminated at 16 ft bgs. Groundwater encountered at 11 ft bgs. Borehole backfilled with bentonite chips.	

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-26-10

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Hwy 99
Tacoma, Washington

Boring Log D4
Project No: 19921.65021

Figure: 28
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Boring Log D5

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	SM	Gravelly, Silty SAND (SM), very dark brown, fine to medium sand, medium dense, moist, with brick fragments.	
36/48	D5-2	9				2		Becomes gray-brown and moist at 2 ft bgs.	
							SM	Silty SAND (SM), brown, fine, dense, moist. Becomes gray at 2.5 ft bgs.	
							ML	SILT (ML), gray, very stiff, moist.	
	D5-4	8				4	SM	Gravelly, Silty SAND (SM), brown, fine to coarse, medium dense, moist.	
						5	ML	Sandy SILT (ML), gray-brown, stiff, moist, with some iron mottling. Becomes dark brown at 5 ft bgs.	
36/48	D5-6	9							
							ML	Sandy SILT (ML), very dark brown, with trace organics.	
	D5-8	7						Becomes mottled, with some bedding features at 8 ft bgs.	
42/48	D5-10	4				10		Becomes brown at 10 ft bgs.	
	D5-12	7				▽ 12		Becomes wet, mottled with bedding features and trace organics at 12 ft bgs.	
48/48	D5-14	<6				14	SP	SAND (SP), dark gray, fine, medium dense, wet, with bedding features (mainly silt bedding), with white and red lithics.	
						15	SM	Silty SAND (SM), gray, fine, dense, wet, with bedding features.	
	D5-16	<6				16		Boring terminated at 16 ft bgs. Groundwater encountered at 12 ft bgs. Borehole backfilled with bentonite chips.	
						20			
						25			

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-26-10

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Tacoma, Washington

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Boring Log D5
Project No: 19921.65021

Figure: 29
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Boring Log D6

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	SM	Gravelly, Silty SAND (SM), dark brown, fine to medium sand, loose, moist. Cobble encountered at 0.5 ft bgs.	
36/48	D6-2	8					ML	Sandy SILT (ML), brown, fine sand, with trace organics, very stiff, moist.	
	D6-4	6						3 in. silty sandy gravel layer at 4 ft bgs. Becomes gravelly, fine to coarse, wet at 4.5 ft bgs.	
30/48	D6-6	44				5			
	D6-8	37				8 (groundwater)	SM	Gravelly, Silty SAND (SM), gray-brown, fine to coarse gravel, fine to coarse sand, loose, wet.	
48/48	D6-10	<4				10	ML	Sandy SILT (ML), dark brown, fine sand, with some organics, stiff, moist. Becomes light brown at 9.5 ft bgs. Becomes gray at 10 ft bgs. Becomes dark gray-brown at 10.5 ft bgs.	
	D6-12	<6						<1 in. layers of organics from 12.5 to 15 ft bgs. Becomes dark brown at 13 ft bgs.	
42/48	D6-14	5				15	SM	Silty SAND (SM), dark gray-brown, fine to medium sand, dense, moist, with <1 in. organic layers. Becomes gray-brown, fine at 15 ft bgs.	
	D6-16	6				16		Boring terminated at 16 ft bgs. Groundwater encountered at 8 ft bgs. Borehole backfilled with bentonite chips.	
						20			
						25			

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-27-10

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Tacoma, Washington

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Boring Log D6
Project No: 19921.65021

Figure: 30

Boring Log D7

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	ML	Gravelly, Sandy SILT (ML), gray-brown, fine sand, medium stiff to stiff, moist.	
12/48									
	D7-4	<6						Becomes brown, no gravel at 4 ft bgs.	
						5		Becomes gray, with trace organics at 5 ft bgs.	
30/48	D7-6	<6							
							ML	Sandy SILT (ML), gray-brown, fine sand, stiff, wet, with some mottling.	
	D7-8	<6				▽ 9			
							SM	Silty SAND (SM), dark brown, fine sand, dense, wet.	
42/48	D7-10	<6				10			
	D7-12	<7						Wood fragments encountered at 12.5 ft bgs.	
42/48	D7-14	6							
						15			
	D7-16	7						Boring terminated at 16 ft bgs. Groundwater encountered at 9 ft bgs. Borehole backfilled with bentonite chips.	
						20			
						25			

Location:
Surface Elevation:
Logged By: AAL

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-27-10

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Tacoma, Washington

Boring Log D7
Project No: 19921.65021

Figure: 31
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Boring Log D8

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
18/48	D8-1.5	24					SM	Silty SAND (SM), medium brown, fine to coarse sand, some coarse gravel, subangular, medium dense, wet. Concrete debris from 2 to 5 ft bgs, trace wood fragments to 2 in.	
18/48	D8-5	42				5			
	D8-8	36					ML	SILT (ML), gray-brown, medium stiff, moist, low plasticity, minor subhorizontal bedding laminations.	
48/48	D8-10	34				10	SM	Silty SAND (SM), gray, fine sand, subangular to subrounded, medium dense, wet, occasional silt layer up to 1/4 in. thick, bedding laminations.	
	D8-12	8							
36/48	D8-14	<9							
						15	SP	SAND (SP), dark gray, poorly graded, medium sand, subangular to subrounded, medium dense, wet.	
	D8-16	10					SM	Silty SAND (SM), gray, fine sand, subangular to subrounded, medium dense, wet.	
						20		Boring terminated at 16 ft bgs. Groundwater encountered at 10 ft bgs. Borehole backfilled with bentonite chips (Hydroplug 3/8 in.).	
						25			

Location:
Surface Elevation:
Logged By: HY

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-29-10

USG Corporation
Hwy 99
Tacoma, Washington

CDM

Boring Log D8 Figure: 32
Project No: 19921.65021 1 of 1

LOG OF BORING WITH WELL 19921-65021-APR 26-28 2010.GPJ CDM_BLLV.GDT 5/24/10 REV.

Boring Log D9

Recovery/ Sample Length (in)	Sample No.	XRF Arsenic (ppm)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
13/48	D9-1	23				0–4.5	SM	Silty SAND (SM), medium brown, fine to coarse, subangular to subrounded, some well rounded gravel, loose, moist.	
24/48	D9-4.5	11				4.5–10	ML	Silt (ML), gray-brown, trace fine sand, medium stiff, moist, low plasticity, occasional silty sand interbed.	
	D9-6	7							
	D9-8	10							
48/48	D9-10	<6				10–12	SM	Silty SAND (SM), gray, fine sand, subangular to subrounded, medium dense, wet, minor interbeds of light gray silt 1/4 in. thick.	
	D9-12	<6							

Boring terminated at 12 ft bgs.
Groundwater encountered at 10 ft bgs.
Borehole backfilled with bentonite chips.

Depth scale: 5, 10, 15, 20, 25

Location:
Surface Elevation:
Logged By: HY

Drill Rig: Direct Push Technology
Equipment/Hammer: Acetate Liner/
Date Completed: 4-29-10

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Boring Log D9
Project No: 19921.65021

Figure: 33

Boring Log MW1

Recovery/ Sample Length (in)	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / 6 in.)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0		3 in. Asphalt at surface.	
						0.25–8	SM	Silty SAND (SM), brown, fine to medium sand, some coarse gravel and cobbles, well rounded, medium dene, dry, trace brick fragments (Fill).	
6"/18"					9 11 12				
18"/18"					3 3 5			As above, color changes to light gray-brown (Fill).	
						9–14	ML	SILT (ML), gray-brown, trace fine sand, medium stiff, moist, low plasticity, trace wood fragments (Alluvium).	
18"/18"					1 3 20			At 12 ft bgs, a 12 in. long wood fragment with grain oriented vertically was captured by the sampler.	
						14–19	SP	SAND (SP), dark gray, poorly graded sand, fine grained sand, subrounded grains, trace silt, medium dense, wet, trace wood fragments.	
14"/18"					3 5 7			At 18 - 19 ft bgs, numerous 1/2 in. thick gray silt interbeds.	
						19		Boring terminated at 19 ft bgs. Monitoring well installed in borehole.	

Well or Piezometer Completion

Location:
Surface Elevation:
Logged By: HY

Drill Rig: Hollow Stem Auber (Mobile B61)
Equipment/Hammer: SPT - Autohammer/
Date Completed: 5-5-10

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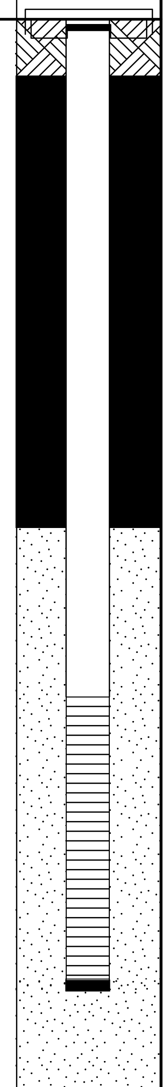
Boring Log MW1
Project No: 19921.65021

Figure: 34

Boring Log MW2

Recovery/ Sample Length (in)	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / 6 in.)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	SM	Silty SAND (SM), gray, with some coarse gravel and cobbles up to 3 in. diameter, well rounded, medium dense, moist.	
12"/18"					10 14 11				
						5	SM	Silty SAND (SM), dark gray-brown, fine to coarse sand, trace fine gravel, loose, moist (Fill).	
18"/18"					2 3 2			As above, loose, moist (Fill).	
						10			
18"/18"					2 4 6	▽	SP	SAND (SP), dark gray, poorly graded, fine to medium grained, subangular to subrounded grains, black, white and red grains, medium dense, wet.	
						15			
18"/18"					2 2 3			As above, loose, wet.	
							ML	SILT (ML), dark brown, medium stiff, moist, low plasticity, trace brown organics.	
								Boring terminated at 19 ft bgs. Monitoring well installed in borehole.	
						20			
						25			

Well or Piezometer Completion



Location:
Surface Elevation:
Logged By: HY

Drill Rig: Hollow Stem Auber (Mobile B61)
Equipment/Hammer: SPT - Autohammer/
Date Completed: 5-4-10

USG Corporation
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Boring Log MW2
Project No: 19921.65021

Figure: 35
1 of 1

Boring Log MW3

Recovery/ Sample Length (in)	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)	Well or Piezometer Completion
						0		GM		Silty GRAVEL (GM), gray, fine gravel, angular, loose, moist (Fill).		
										SILT (ML), light gray-brown, soft, moist, low plasticity, some fine sand, trace rootlets (Fill).		
					4 2 2			ML				
						5						
					2 2 5					SILT (ML), brown mottled and interlayered with light gray-brown, medium stiff, moist, low plasticity, some laminations, some rootlets (Alluvium).		
						10		ML				
					1 2 5	▽				At 13 ft bgs, silt is interlayered with fine, wet silty sand, 1/2 in. layers.		
										SAND (SP), dark gray, poorly graded, fine subrounded grains, red, black, and white grains, medium dense, wet.		
						15		SP				
					2 5 7					Sand is heaving at 19 ft bgs.		
										Boring terminated at 19 ft bgs. Monitoring well installed in borehole.		
						20						
						25						

Location:
Surface Elevation:
Logged By: HY

Drill Rig: Hollow Stem Auber (Mobile B61)
Equipment/Hammer: SPT - Autohammer/
Date Completed: 5-7-10

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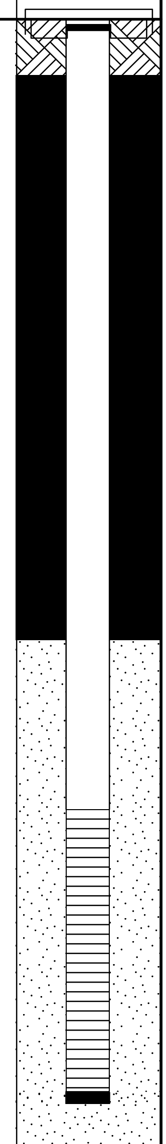
Boring Log MW3
Project No: 19921.65021

Boring Log MW4

Recovery/ Sample Length (in)	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / 6 in.)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	GM	Silty GRAVEL (GM), gray, angular, loose, moist.	
							MH	SILT (MH), light gray-brown, medium stiff, moist, medium plasticity, trace brown oxidation, trace rootlets.	
12"/18"					1 2 3				
						5			
18"/18"					2 2 3				
							ML	SILT (ML), brown mottled with gray, medium stiff, moist, low plasticity, trace gray laminations, trace rootlets (Alluvium).	
						10			
18"/18"					1 2 3			At 13 ft bgs, trace SAND (SP) layers, <1/4 in. thick.	
						▽	SP	SAND (SP), dark gray, poorly graded, fine grained sand, subrounded grains, very loose, wet, trace organics, red, whit, & black grains.	
						15			
18"/18"					0 0 1			As above, very loose, wet.	
						20		Boring terminated at 20 ft bgs. Monitoring well installed in borehole.	
						25			

Well or Piezometer Completion



Location:
Surface Elevation:
Logged By: HY

Drill Rig: Hollow Stem Auber (Mobile B61)
Equipment/Hammer: SPT - Autohammer/
Date Completed: 5-5-10

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Boring Log MW4
Project No: 19921.65021

Figure: 37
1 of 1

LOG OF BORING WITH WELL 19921-65021-APR 26-28 2010.GPJ CDM_BLLV.GDT 5/24/10 REV.

Boring Log MW5

Recovery/ Sample Length (in)	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / 6 in.)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0–1.5	GP	GRAVEL (GP), light gray, coarse, angular, loose, dry (Fill).	
						1.5–3	SM	Silty SAND (SM), gray-brown, fine to medium sand, subangular, trace gravel, loose, wet (Fill).	
12"/18"					3 5 7	3–7.5	ML	SILT (ML), brown, firm, moist, low plasticity, some orange-brown oxidation, trace concrete fragments.	
18"/18"					2 2 5	7.5–14	ML	SILT (ML), gray-brown, trace sand, soft, moist, low plasticity, trace organics, some subhorizontal laminations (Alluvium).	
14"/14"					1 1 2				
						14–20	SP	SAND (SP), dark gray, poorly graded, fine to medium grained, mostly fine, subrounded grains, red, black and white colored grains, loose, wet, trace wood fragments.	
16"/18"					3 3 5				
						20		Boring terminated at 20 ft bgs. Monitoring well installed in borehole.	

Depth (feet): 5, 10, 15, 20, 25

Well or Piezometer Completion

Location:
Surface Elevation:
Logged By: HY

Drill Rig: Hollow Stem Auber (Mobile B61)
Equipment/Hammer: SPT - Autohammer/
Date Completed: 5-6-10

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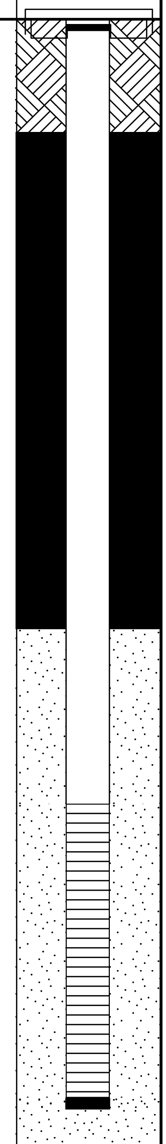
Boring Log MW5
Project No: 19921.65021

Figure: 38
1 of 1

Boring Log MW6

Recovery/ Sample Length (in)	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / 6 in.)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0–1.5	GP	GRAVELLY (GP), light gray, coarse grained, angular, loose, dry (Fill).	
						1.5–3	ML	Sandy SILT (ML), dark brown, trace gravel, medium stiff, moist, low plasticity.	
12"/18"					4 3 3	3–7.5	SP	SAND (SP), gray, poorly graded, medium grained sand, subangular to subrounded, trace fine gravel, loose, dry, trace wood debris (Fill).	
2"/18"					8 12 8	7.5–12.5	ML	Sandy SILT (ML), dark brown, trace gravel, very stiff, moist, low plasticity (Fill).	
18"/18"					7 9 10	12.5–15	SM	Silty SAND (SM), gray-brown, fine grained sand, some gray silt interbeds, medium dense, wet (Alluvium).	
0"/18"					7 10 12	15–20	SP	SAND (SP), dark gray, poorly graded, fine to medium subrounded grains, medium dense, wet, heaving at 20 ft bgs (description based on auger cuttings).	
						20		Boring terminated at 20 ft bgs. Monitoring well installed in borehole.	

Well or Piezometer Completion



Location:
Surface Elevation:
Logged By: HY

Drill Rig: Hollow Stem Auber (Mobile B61)
Equipment/Hammer: SPT - Autohammer/
Date Completed: 5-6-10

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Tacoma, Washington

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Boring Log MW6
Project No: 19921.65021

Figure: 39

Boring Log MW7

Recovery/ Sample Length (in)	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / 6 in.)	Depth (feet)	USCS	DESCRIPTION
							SM	Silty SAND (SM), light brown, fine to medium sand, some fine to coarse gravel and cobbles, loose, moist (Fill).
6"/18"					3 2 4			
						5	ML	Sandy SILT (ML), light gray, fine to coarse sand, trace coarse rounded gravel, medium stiff, moist, low plasticity.
								As above, but medium stiff, wet.
12"/18"					1 7 11	10	ML	SILT (ML), brown, very stiff, moist, low plasticity, trace light gray laminations, trace brown wod fragments (Alluvium).
14"/18"					2 3 6	15	SM	Silty SAND (SM), gray-brown, fine grained sand, subangular to subrounded grains, loose, moist, some gray silt layers, subhorizontal, trace brown wood fragments.
18"/18"					1 1 3	20	SP	SAND (SP), gray, poorly graded, fine grained, subangular to subrounded grains, trace silt, red, black, and white grains, loose, wet.
								As above, but fine to medium grained sand.
18"/18"					6 6 10		ML	SILT (ML), light gray, trace organics, trace gravel, very stiff, moist, low plasticity.
						25		SAND (SW), dark gray, well graded, fine to coarse, subangular to subrounded, red, black, and white

Elev. (feet)

Well or Piezometer Completion

Location:
Surface Elevation:
Logged By: HY

Drill Rig: Hollow Stem Auber (Mobile B61)
Equipment/Hammer: SPT - Autohammer/
Date Completed: 5-5-10

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Boring Log MW7
Project No: 19921.65021

Figure: 40

Boring Log MW7

Recovery/ Sample Length (in)	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)	Well or Piezometer Completion
								SW		lithics, medium dense, wet, heaving sand.		
18"/18"					1 1 2							
								SM		Silty SAND (SM), gray-brown, fine grained sand, subangular to subrounded, very loose, wet, some 1/4 in. horizontal silt layers.		
						30		SM		Silty SAND (SM), gray-brown, fine grained sand, subangular to subrounded, medium dense, wet, some 1/4" gray silt layers, subhorizontal.		
						35		SP		SAND (SP), dark gray, poorly graded, fine to medium grained, subrounded grains, trace silt, medium dense, wet.		
								ML		SILT (ML), gray-brown, some fine sand, very stiff, moist, low plasticity.		
						40				Boring terminated at 39 ft bgs. Monitoring well installed in borehole.		
						45						
						50						

Location:
Surface Elevation:
Logged By: HY

Drill Rig: Hollow Stem Auber (Mobile B61)
Equipment/Hammer: SPT - Autohammer/
Date Completed: 5-5-10

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Tacoma, Washington

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Boring Log MW7
Project No: 19921.65021

Figure: 40

Boring Log MW8

Recovery/ Sample Length (in)	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)	Well or Piezometer Completion
								GP		GRAVEL (GP), light gray, coarse, angular, loose, dry, some concrete debris.		
12"/18"					1 1 1			SM		Silty SAND (SM), fine to medium sand, some fine gravel, very loose, moist.		
						5		ML		Sandy SILT (ML), brown, fine to medium sand, soft, moist, low plasticity (Fill).		
18"/18"					2 2 1	10		ML		SILT (ML), light gray-brown, interlayered with gray, fine silty sand at 7.5 to 8.5 ft bgs, soft, moist, low plasticity, subhorizontal laminations.		
14"/18"					3 3 4	▽						
						15		SP		SAND (SP), dark gray, poorly graded, fine to medium grained sand, subrounded grains, trace brown organics, red, black, and white grains, loose, wet.		
18"/18"					2 10 12	20		ML		SILT (ML), light gray-brown, very stiff, moist, low plasticity, subhorizontal laminations of gray fine sand.		
18"/18"					2 3 4			SP		SAND (SP), dark gray, poorly graded, fine to medium sand, subrounded grains, loose, wet, trace wood fragments.		
						25				SILT (ML), gray, medium stiff, moist, low plasticity, some subhorizontal laminations and interbeds of fine SAND (SP).		

Location:
Surface Elevation:
Logged By: HY

Drill Rig: Hollow Stem Auber (Mobile B61)
Equipment/Hammer: SPT - Autohammer/
Date Completed: 5-6-10

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Tacoma, Washington

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Boring Log MW8
Project No: 19921.65021

Figure: 41

Boring Log MW8

Recovery/ Sample Length (in)	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)	Well or Piezometer Completion
								ML				
18"/18"					5 7 7			SP		SAND (SP), dark gray, poorly graded, fine grained, subrounded grains, red, black and white grains, medium dense, wet, some silt.		
18"/18"					2 3 7	30		SP-SM		SAND with SILT (SP-SM), dark gray, fine grained, subrounded grains, black, white and red grains, some silt, medium dense, wet.		
12"/18"					2 9 11	35		SP		SAND (SP), dark gray, poorly graded, fine to medium grained, subrounded grains, trace silt, red, black and whit grains, medium dense, wet.		
										At 39 ft bgs, some fine GRAVEL (GP), subrounded grains. At 40 ft bgs, the sand is heaving.		
						40				Boring terminated at 40 ft bgs. Monitoring well installed in borehole.		
						45						
						50						

Location:
Surface Elevation:
Logged By: HY

Drill Rig: Hollow Stem Auber (Mobile B61)
Equipment/Hammer: SPT - Autohammer/
Date Completed: 5-6-10

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LOG OF BORING WITH WELL 19921-65021-APR 26-28 2010.GPJ CDM_BLLV.GDT 5/24/10 REV.

Boring Log MW9

Recovery/ Sample Length (in)	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)	Well or Piezometer Completion
										SILT (ML), greenish-gray, trace gravel, stiff, moist, low plasticity, trace concrete rubble (Fill) 2 in. asphalt layer at depth of 6 in..		
6"/18"					7 5 5			ML				
						5		SM		Silty SAND (SM), light gray-brown, fine to medium sand, some fine gravel, loose, moist (Fill).		
16"/18"					1 1 1			ML		SILT (ML), brown, trace sand, soft, moist, low plasticity, laminated.		
						10		SM		Silty SAND (SM), gray-brown, fine grained, subangular to subrounded grains, very loose, moist, trace silt layers and laminations.		
18"/18"					0 6 6	∇				SAND (SP), gray, poorly graded, fine grained sand, subangular to subrounded grains, trace silt, medium dense, wet.		
						15						
16"/18"					0 4 4			SP		At 17.5 ft bgs, as above, medium dense, wet. At 18.5 ft bgs, 2 in. wood fragment.		
						20						
18"/18"					4 5 10					SAND (SP), dark gray, poorly graded, fine to medium grained, subangular to subrounded grains, whit, red, and black lithics, medium dense, wet.		
						25		SP				

Location:
Surface Elevation:
Logged By: HY

Drill Rig: Hollow Stem Auber (Mobile B61)
Equipment/Hammer: SPT - Autohammer/
Date Completed: 5-4-10

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Boring Log MW9
Project No: 19921.65021

Figure: 42
1 of 3

LOG OF BORING WITH WELL 19921-65021-APR 26-28 2010.GPJ CDM_BLLV.GDT 5/24/10 REV.

Boring Log MW9

Recovery/ Sample Recovery (in)	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / 6 in.)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
12"/18"					2 5 5		SW	SAND (SW), dark gray, well graded, fine to coarse grains, subangular to subrounded grains, white, red and black lithics, medium dense, wet. At 29 ft bgs, 1 in. wood fragment, heaving sand.	
						30			
18"/18"					6 35 54/3"		SM	Silty SAND (SM), gray-brown, fine grained, very dense, wet, some 1/4 in. gray silt layers, laminated, trace brown organics.	
						35			
18"/18"					4 3 4		MH	SILT (MH), greenish gray, medium stiff, moist, medium plasticity, trace dark brown organics. At 38.5 ft bgs, 3 in. silty sand layer.	
						40			
16"/18"					0 3 6		SP	SAND (SP), dark yellow-brown, poorly graded, fine to medium grained, mostly medium, subrounded grains, loose, wet.	
						45			
12"/18"					12 20 14		GM	Silty GRAVEL (GM), dark yellow-brown, fine to coarse gravel, some sand, fine to coarse, well rounded grains, dense, wet.	
						50			

Well or Piezometer Completion

Location:
Surface Elevation:
Logged By: HY

Drill Rig: Hollow Stem Auber (Mobile B61)
Equipment/Hammer: SPT - Autohammer/
Date Completed: 5-4-10

USG Corporation
Hwy 99
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Boring Log MW9
Project No: 19921.65021

Figure: 42

Boring Log MW9

Recovery/ Sample Length (in)	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVA (ppm)	Penetration Resistance (blows / 6 in.)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)	Well or Piezometer Completion
12"/18"					24 49 50/3"					Silty SAND with GRAVEL (SM), fine to coarse gravel, well rounded, very dense, wet, till-like.		
						55		SM				
/16"					14 34 50/4"			GM		Silty GRAVEL (GM), gray, fine gravel, subangular to subrounded, very dense, wet, till-like.		
										Boring terminated at 59 ft bgs. Monitoring well installed in borehole.		
						60						
						65						
						70						
						75						

Location:
Surface Elevation:
Logged By: HY

Drill Rig: Hollow Stem Auber (Mobile B61)
Equipment/Hammer: SPT - Autohammer/
Date Completed: 5-4-10

LOG OF BORING WITH WELL 19921-65021-APR 26-28 2010.GPJ CDM_BLLV.GDT 5/24/10 REV.

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SOIL CLASSIFICATION LEGEND

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS More than half is larger than No. 200 sieve	GRAVELS More than half coarse fraction is larger than No. 4 sieve size	Clean gravels with little or no fines	GW	Well graded gravels, gravel-sand mixtures
			GP	Poorly graded gravels, gravel-sand mixtures
		Gravel with over 12% fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS More than half coarse fraction is smaller than No. 4 sieve size	Clean sands with little or no fines	SW	Well graded sands, gravelly sands
			SP	Poorly graded sands, gravelly sands
		Sands with over 12% fines	SM	Silty sand, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS More than half is smaller than No. 200 sieve	SILTS AND CLAYS Liquid limit less than 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic clays and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid limit greater than 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils

SAMPLE TYPE SYMBOLS

- Disturbed bag or jar sample
- Std. Penetration Test (2.0" OD)
- Type U Ring Sampler (3.25" OD)
- California Sampler (3.0" OD)
- Undisturbed Tube Sample
- Grab Sample
- Core Run
- Non-standard Penetration Test (with split spoon sampler)

CONTACT BETWEEN UNITS

- Change in geologic unit
- Soil type change within geologic unit
- Obscure or gradational change

DESCRIPTORS FOR SOIL STRATA AND STRUCTURE (ENGLISH/METRIC)

General Thickness or Spacing

Parting:	less than 1/16 in. (1/6 cm)
Seam:	1/16 to 1/2 in. (1/6 to 1 1/4 cm)
Layer:	1/2 to 12 in. (1 1/4 to 30 1/2 cm)
Stratum:	> 12 in. (30 1/2 cm)
Scattered:	< 1 per ft. (30 1/2 cm)
Numerous:	> 1 per ft. (30 1/2 cm)

Structure

Pocket:	Erratic, discontinuous deposit of limited extent
Lens:	Lenticular deposit
Varved:	Alternating seams of silt and clay
Laminated:	Alternating seams
Interbedded:	Alternating layers

General Attitude

Near horizontal:	0 to 10 deg.
Low angle:	10 to 45 deg.
High angle:	45 to 80 deg.
Near Vertical:	80 to 90 deg.

MOISTURE DESCRIPTION

Dry - Free of moisture, dusty

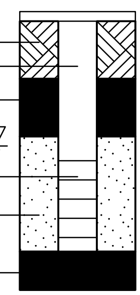
Moist - Damp but no visible free water

Wet - Visible free water, saturated

STRUCTURE DESCRIPTION (cont.)

Fractured	Breaks easily along definite fractured planes
Slickensided	Polished, glossy, fractured planes
Blocky, Diced	Breaks easily into small angular lumps
Sheared	Disturbed texture, mix of strengths
Homogeneous	Same color and appearance throughout

WELL COMPLETIONS



RELATIVE DENSITY OR CONSISTENCY VS. SPT N-VALUE

COARSE GRAINED			FINE GRAINED		
Density	N (blows/ft)	Approx. Relative Density (%)	Consistency	N (blows/ft)	Approx. Undrained Shear Str. (psf)
Very Loose	0 to 4	0 - 15	Very Soft	0 to 2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Medium Dense	10 to 30	35 - 65	Medium Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	Over 50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	over 30	>4000

PHYSICAL PROPERTY TEST

AL - Atterberg Limits
FC - Fines Content
GSD - Grain Size Distribution
MC - Moisture Content
MD - Moisture Content/Dry Density
Comp - Compaction Test (Proctor)
SG - Specific Gravity
CBR - California Bearing Ratio
RM - Resilient Modulus
Perm - Permeability
TXP - Triaxial Permeability
Cons - Consolidation
Chem - Analytical Chemical Analysis
Corr - Corrosion
VS - Vane Shear
DS - Direct Shear
UC - Unconfined Compression
TX - Triaxial Compression
UU - Unconsolidated, Undrained
CU - Consolidated, Undrained
CD - Consolidated, Drained

Notes:

1. Sample descriptions in this report are based on visual field and laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates, and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual classification methods in accordance with ASTM D 2488 were used as an identification guide. Where laboratory data are available, soil classifications are in general accordance with ASTM D 2487.

2. Dual symbols are used to indicate gravel and sand units with 5 to 12 percent fines.

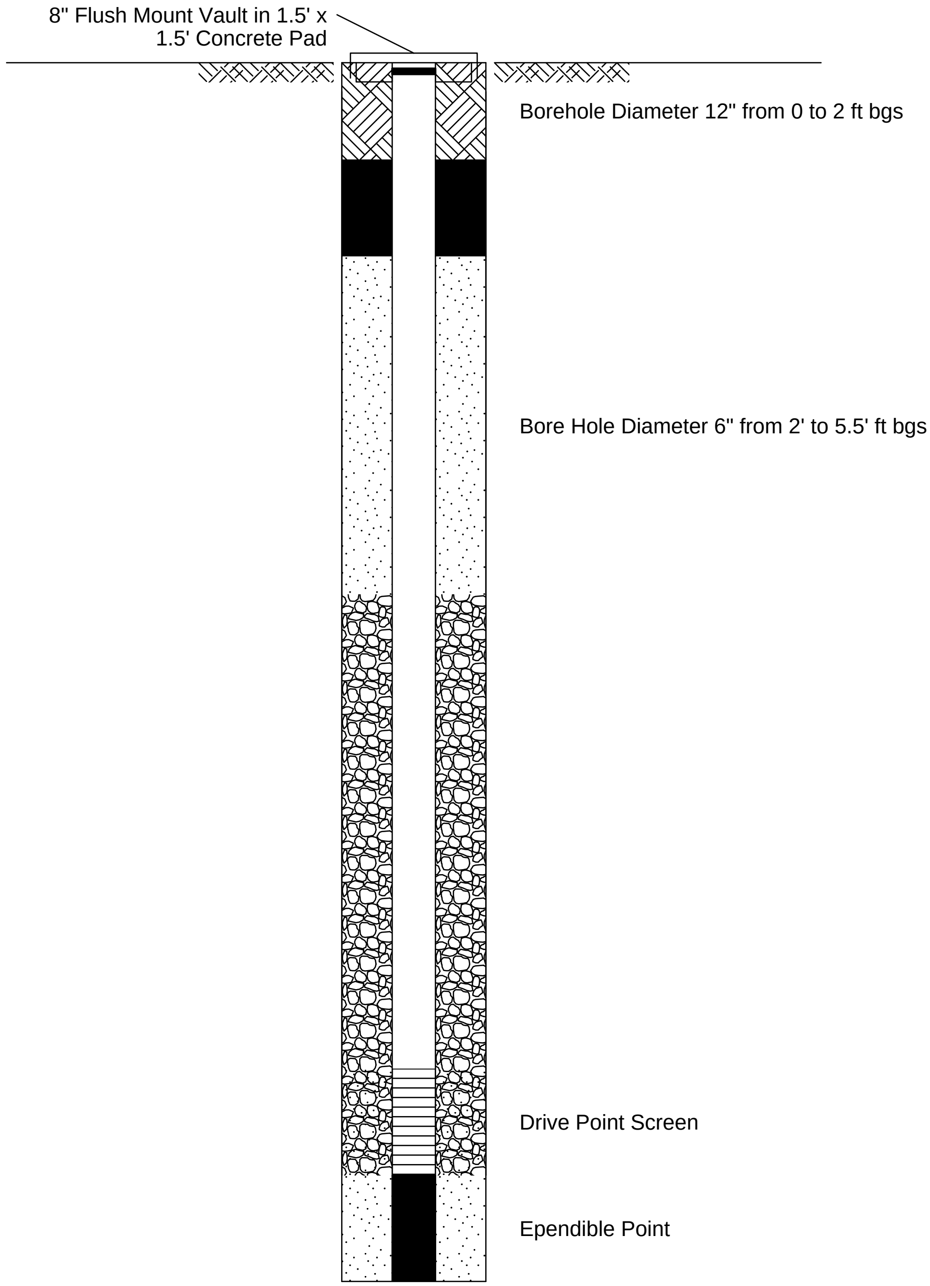
3. WOR = weight of rod.

CDM Smith

USG Interiors Inc.
Highway 99
Milton, Washington

Project No: 19921.77628 Figure: 1

SOIL CLASSIFICATION/LEGEND 19921-77628-MW-10 AND MW-11.GPJ CDM_BLLV.GDT 7/12/12 REV.



TYPICAL MONITORING WELL CONSTRUCTION

Gull Industries, Inc.
Highway 99
Milton, Washington

Project No: 19921.77628 Figure: 2

CDM Smith

Boring Log MW10

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVM (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)	Well or Piezometer Completion
						0–5.5		ML		SILT (ML), gray-brown, firm, moist, trace rootlets, low plasticity.		
						5.5–12.6				Soil not logged below 5.5 ft bgs.		
						10				At 10 ft bgs driller notes harder to drive the well point.		
						12.6				Boring terminated at 12.6 ft bgs. Groundwater first encountered at 6 ft bgs.		

Depth scale: 2, 4, 6, 8, 10, 12, 14

Location:

Surface Elevation:

Logged By: HY

Drill Rig:

Equipment/Hammer: Hand Auger & Drive/

Date Completed: 10-14-11

CDM Smith

USG Interiors Inc.
Highway 99
Milton, Washington

Boring Log MW10
Project No: 19921.77628

Figure: 3

Boring Log MW11

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVM (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	Sample	USCS	DESCRIPTION	Elev. (feet)
						0–1		ML	SILT (ML).	
						1–5 (groundwater ∇ at 4)		SP	SAND with GRAVEL (SP), light yellowish-brown, poorly graded, fine to medium sand, 20% fine to coarse gravel, subrounded grains, well rounded, trace cobbles, medium dense, wet.	
						5–8		ML	SILT (ML), very dark brown, firm, moist, trace wood debris, trace rootlets, medium plasticity.	
						8–9.5		SM	Silty SAND (SM), gray, fine grained, subangular to subrounded, medium dense, wet.	
						9.5–10.5		SW	SAND (SW), gray, well graded, fine to coarse grained, subangular to subrounded, medium dense, wet, black, white, and red grains.	
						10.5			Boring terminated at 10.5 ft bgs. Groundwater first encountered at 4.01 ft bgs.	

Depth scale: 2, 4, 6, 8, 10, 12, 14

Well or Piezometer Completion

Location:

Surface Elevation:

Logged By: HY

Drill Rig:

Equipment/Hammer: Hand Auger/

Date Completed: 10-14-11

LOG OF BORING WITH WELL 19921-77628-MW-10 AND MW-11.GPJ CDM_BLLV.GDT 7/12/12 REV.

CDM Smith

USG Interiors Inc.
Highway 99
Milton, Washington

Boring Log MW11
Project No: 19921.77628

Figure: 4
1 of 1

SOIL CLASSIFICATION LEGEND

MAJOR DIVISIONS					TYPICAL NAMES
COARSE GRAINED SOILS More than half is larger than No. 200 sieve	GRAVELS More than half coarse fraction is larger than No. 4 sieve size	Clean gravels with little or no fines	GW		Well graded gravels, gravel-sand mixtures
			GP		Poorly graded gravels, gravel-sand mixtures
		Gravel with over 12% fines	GM		Silty gravels, gravel-sand-silt mixtures
			GC		Clayey gravels, gravel-sand-clay mixtures
	SANDS More than half coarse fraction is smaller than No. 4 sieve size	Clean sands with little or no fines	SW		Well graded sands, gravelly sands
			SP		Poorly graded sands, gravelly sands
		Sands with over 12% fines	SM		Silty sand, sand-silt mixtures
			SC		Clayey sands, sand-clay mixtures
FINE GRAINED SOILS More than half is smaller than No. 200 sieve	SILTS AND CLAYS Liquid limit less than 50		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL		Organic clays and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid limit greater than 50		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH		Inorganic clays of high plasticity, fat clays
			OH		Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			PT		Peat and other highly organic soils

SAMPLE TYPE SYMBOLS

- Disturbed bag or jar sample
- Std. Penetration Test (2.0" OD)
- Type U Ring Sampler (3.25" OD)
- California Sampler (3.0" OD)
- Undisturbed Tube Sample
- Grab Sample
- Core Run
- Non-standard Penetration Test (with split spoon sampler)

CONTACT BETWEEN UNITS

- Change in geologic unit
- Soil type change within geologic unit
- Obscure or gradational change

DESCRIPTORS FOR SOIL STRATA AND STRUCTURE (ENGLISH/METRIC)

General Thickness or Spacing

Parting:	less than 1/16 in. (1/6 cm)
Seam:	1/16 to 1/2 in. (1/6 to 1 1/4 cm)
Layer:	1/2 to 12 in. (1 1/4 to 30 1/2 cm)
Stratum:	> 12 in. (30 1/2 cm)
Scattered:	< 1 per ft. (30 1/2 cm)
Numerous:	> 1 per ft. (30 1/2 cm)

Structure

Pocket:	Erratic, discontinuous deposit of limited extent
Lens:	Lenticular deposit
Varved:	Alternating seams of silt and clay
Laminated:	Alternating seams
Interbedded:	Alternating layers

General Attitude

Near horizontal:	0 to 10 deg.
Low angle:	10 to 45 deg.
High angle:	45 to 80 deg.
Near Vertical:	80 to 90 deg.

MOISTURE DESCRIPTION

Dry - Free of moisture, dusty

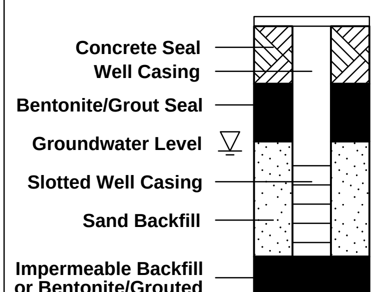
Moist - Damp but no visible free water

Wet - Visible free water, saturated

STRUCTURE DESCRIPTION (cont.)

Fractured	Breaks easily along definite fractured planes
Slickensided	Polished, glossy, fractured planes
Blocky, Diced	Breaks easily into small angular lumps
Sheared	Disturbed texture, mix of strengths
Homogeneous	Same color and appearance throughout

WELL COMPLETIONS



RELATIVE DENSITY OR CONSISTENCY VS. SPT N-VALUE

COARSE GRAINED			FINE GRAINED		
Density	N (blows/ft)	Approx. Relative Density (%)	Consistency	N (blows/ft)	Approx. Undrained Shear Str. (psf)
Very Loose	0 to 4	0 - 15	Very Soft	0 to 2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Medium Dense	10 to 30	35 - 65	Medium Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	Over 50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	over 30	>4000

PHYSICAL PROPERTY TEST

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RM - Resilient Modulus
Perm - Permeability
TXP - Triaxial Permeability
Cons - Consolidation
Chem - Analytical Chemical Analysis
Corr - Corrosion
VS - Vane Shear
DS - Direct Shear
UC - Unconfined Compression
TX - Triaxial Compression
UU - Unconsolidated, Undrained
CU - Consolidated, Undrained
CD - Consolidated, Drained

Notes:

1. Sample descriptions in this report are based on visual field and laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates, and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual classification methods in accordance with ASTM D 2488 were used as an identification guide. Where laboratory data are available, soil classifications are in general accordance with ASTM D 2487.

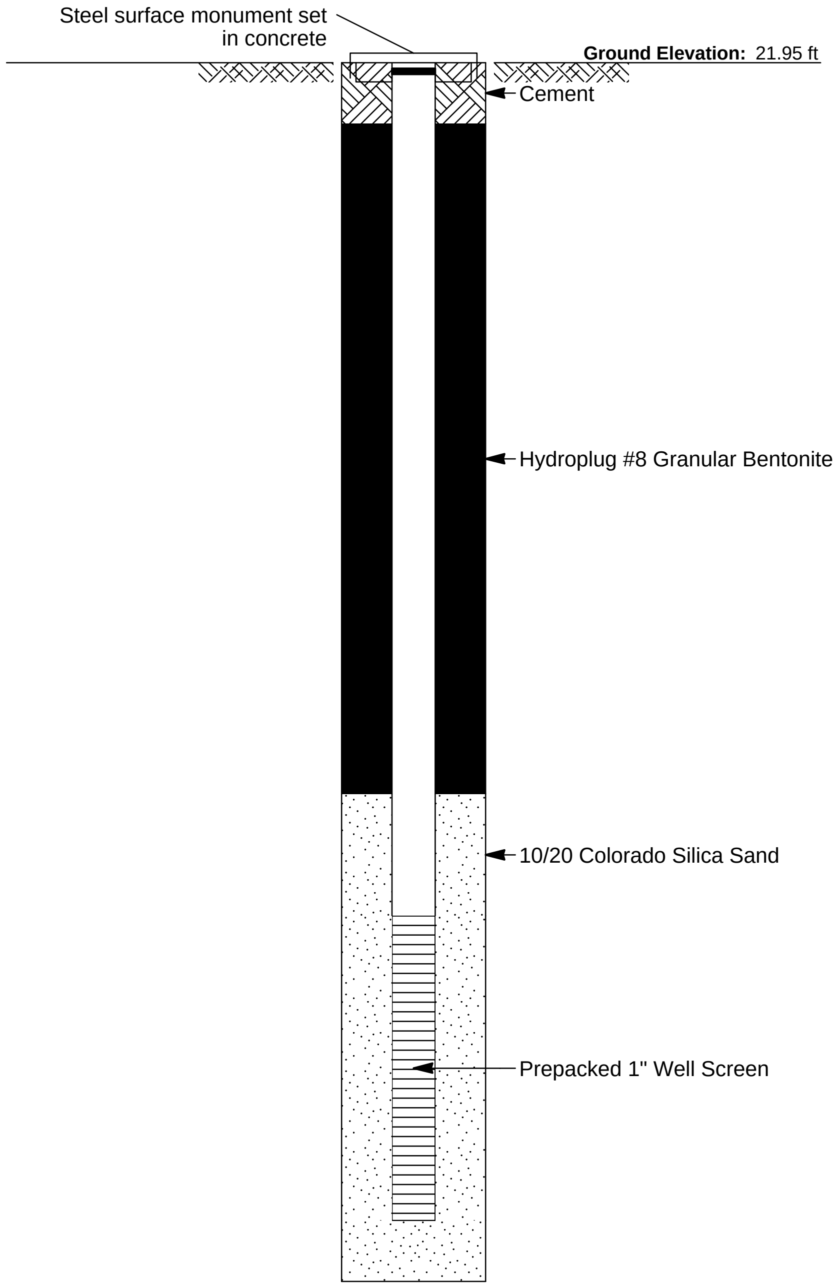
2. Dual symbols are used to indicate gravel and sand units with 5 to 12 percent fines.

3. WOR = weight of rod.

CDM Smith

USG Interiors Inc.
Highway 99
Milton, Washington

Project No: 19921.77628.TK3 GW Figure: 1



MONITORING WELL CONSTRUCTION 19921-77628-MW12-MW14 5-11-12.GPJ CDM_BLLV.GDT 7/12/12 REV.

TYPICAL MONITORING WELL CONSTRUCTION

USG Interiors Inc.
Highway 99
Milton, Washington

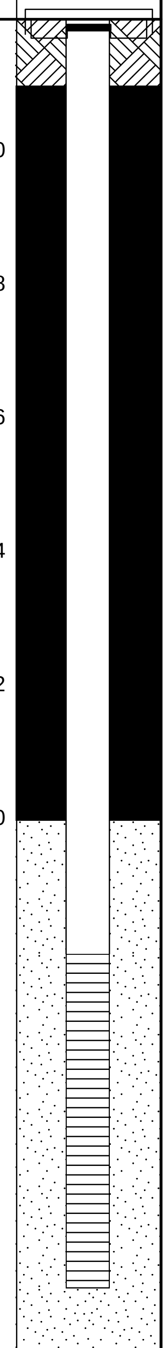
CDM Smith

Project No: 19921.77628.TK3 GW

Figure: 2

Boring Log MW-12

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVM (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)	Well or Piezometer Completion
						0–1		SM		Slightly Gravelly SAND (SM), brown, fine to coarse sand and gravel, with trace organics (rootlets), loose, moist (FILL).		
						~1		GW		~2" thick layer of black gravel with white sand at ~1 ft bgs.		
						2		ML		Sandy SILT (ML), gray-olive, fine to medium sand, with trace fine to coarse gravel, stiff, moist. Becomes gray and orange mottled at ~2.5 ft bgs.	20	
						4				Becomes gray @ 4 ft bgs. Becomes light gray and orange mottled with increased clay content and increased plasticity at ~4.5 ft bgs.	18	
						6					16	
						8					14	
						10				Increased moisture, sand and gravel at 10.5 ft bgs, becomes medium stiff.	12	
						12				Becomes light red-brown with occasional medium sand lenses at 12 ft bgs.	10	
						14 ▽				Becomes saturated at 14 ft bgs.	8	
						16		SM		Silty SAND (SM), brown, fine, loose, saturated.	6	
						18					4	
						19–20				Becomes wet from 19 to 20 ft bgs.		
						20				Boring terminated at 20 ft bgs. Groundwater encountered at 14 ft bgs.	2	



Location:
Surface Elevation: 21.95'
Logged By: A. Lopez

Drill Rig: DPT
Equipment/Hammer: Acetate Liner/NA
Date Completed: 5-11-12

USG Interiors Inc.
Highway 99
Milton, Washington

CDM Smith

Boring Log MW-12
Project No: 19921.77628.TK3 GW

Figure: 3
1 of 1

Boring Log MW-13

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVM (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0–3	SM	Gravelly, Silty SAND (SM), brown, fine to coarse sand and gravel, loose, moist (FILL). Becomes gray-green with deceased silt and gravel at ~6", moist to wet. Cobble encountered at 2 ft bgs.	
						3–9	ML	Sandy SILT (ML), dark brown, with trace gravel and trace organics (wood), stiff, moist. Cobble encountered at 3.5 ft bgs. Becomes gray-olive at 5 ft bgs. Increased plasticity and clay content from 6.5 to 7 ft bgs, underlain by a layer of organics (grass). Becomes brown with increased fine sand at 7 ft bgs.	
						9–16	SM	Grades to Silty SAND (SM), dark brown, fine sand, medium dense, saturated (0, 70, 30). Wood fragment encountered at 14 ft bgs.	
						16		Boring terminated at 16 ft bgs. Groundwater encountered at 9.5 ft bgs.	

Well or Piezometer Completion

Location:
Surface Elevation:
Logged By: A. Lopez

Drill Rig: DPT
Equipment/Hammer: Acetate Liner/NA
Date Completed: 5-11-12

CDM Smith

USG Interiors Inc.
Highway 99
Milton, Washington

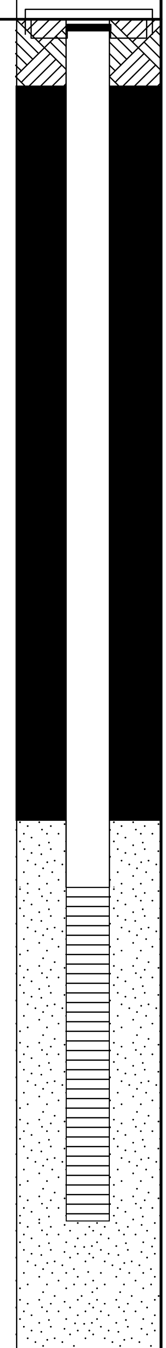
Boring Log MW-13
Project No: 19921.77628.TK3 GW

Figure: 4

Boring Log MW-14

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVM (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0–1.25	SM	Gravelly, Silty SAND (SM), brown, fine to coarse sand and gravel, loose, moist (FILL).	
						1.25–2.9	ML	Grades to Sandy SILT (ML), red-brown, with gravel, medium stiff, moist.	
						2.9–3.3	OH	SILT (OH), dark gray, with rootlets and wood, soft, moist.	
						3.3–4	ML	Sandy SILT (ML), gray, fine sand, stiff, moist.	
						4–14.5	SM	Grades to Gravelly, Silty SAND (SM), gray, fine to coarse sand and gravel, dense, moist. Becomes brown at 10 ft bgs. As above, limited recovery from 8 to 12 ft bgs. Layer of organics (marsh grass) encountered at 14.5 ft bgs.	
						14.5–20	ML	Clayey, Sandy SILT (ML), dark gray, fine sand, numerous organics, soft, moist, plastic. Thin sand (SP), lens (~1" thick) at 15 ft bgs, wet. Becomes gray with decreased organics and decreased plasticity at 15.5 ft bgs. Numerous sand lenses (saturated) from 16 to 16.5 ft bgs. Decreased plasticity, becomes gray-brown mixed at 18 ft bgs.	
						20		Boring terminated at 20 ft bgs. Groundwater encountered at ~15 ft bgs.	

Well or Piezometer Completion



Location:
Surface Elevation:
Logged By: A. Lopez

Drill Rig: DPT
Equipment/Hammer: Acetate Liner/NA
Date Completed: 5-11-12

USG Interiors Inc.
Highway 99
Milton, Washington

CDM Smith

Boring Log MW-14
Project No: 19921.77628.TK3 GW

Figure: 5
1 of 1

SOIL CLASSIFICATION LEGEND

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS More than half is larger than No. 200 sieve	**GRAVELS** More than half coarse fraction is larger than No. 4 sieve size	Clean gravels with little or no fines	GW	Well graded gravels, gravel-sand mixtures
			GP	Poorly graded gravels, gravel-sand mixtures
		Gravel with over 12% fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS More than half coarse fraction is smaller than No. 4 sieve size	Clean sands with little or no fines	SW	Well graded sands, gravelly sands
			SP	Poorly graded sands, gravelly sands
		Sands with over 12% fines	SM	Silty sand, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE GRAINED SOILS More than half is smaller than No. 200 sieve	**SILTS AND CLAYS** Liquid limit less than 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic clays and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid limit greater than 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils

SAMPLE TYPE SYMBOLS

- Disturbed bag or jar sample
- Std. Penetration Test (2.0" OD)
- Type U Ring Sampler (3.25" OD)
- California Sampler (3.0" OD)
- Undisturbed Tube Sample
- Grab Sample
- Core Run
- Non-standard Penetration Test (with split spoon sampler)

CONTACT BETWEEN UNITS

- Change in geologic unit
- Soil type change within geologic unit
- Obscure or gradational change

DESCRIPTORS FOR SOIL STRATA AND STRUCTURE (ENGLISH/METRIC)

General Thickness or Spacing

Parting:	less than 1/16 in. (1/6 cm)
Seam:	1/16 to 1/2 in. (1/6 to 1 1/4 cm)
Layer:	1/2 to 12 in. (1 1/4 to 30 1/2 cm)
Stratum:	> 12 in. (30 1/2 cm)
Scattered:	< 1 per ft. (30 1/2 cm)
Numerous:	> 1 per ft. (30 1/2 cm)

Structure

Pocket:	Erratic, discontinuous deposit of limited extent
Lens:	Lenticular deposit
Varved:	Alternating seams of silt and clay
Laminated:	Alternating seams
Interbedded:	Alternating layers

General Attitude

Near horizontal:	0 to 10 deg.
Low angle:	10 to 45 deg.
High angle:	45 to 80 deg.
Near Vertical:	80 to 90 deg.

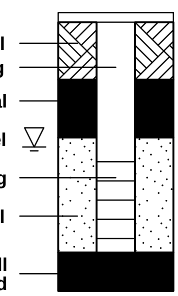
MOISTURE DESCRIPTION

- Dry - Free of moisture, dusty
- Moist - Damp but no visible free water
- Wet - Visible free water, saturated

STRUCTURE DESCRIPTION (cont.)

Fractured	Breaks easily along definite fractured planes
Slickensided	Polished, glossy, fractured planes
Blocky, Diced	Breaks easily into small angular lumps
Sheared	Disturbed texture, mix of strengths
Homogeneous	Same color and appearance throughout

WELL COMPLETIONS



RELATIVE DENSITY OR CONSISTENCY VS. SPT N-VALUE

COARSE GRAINED			FINE GRAINED		
Density	N (blows/ft)	Approx. Relative Density (%)	Consistency	N (blows/ft)	Approx. Undrained Shear Str. (psf)
Very Loose	0 to 4	0 - 15	Very Soft	0 to 2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Medium Dense	10 to 30	35 - 65	Medium Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	Over 50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	over 30	>4000

PHYSICAL PROPERTY TEST

- AL - Atterberg Limits
- FC - Fines Content
- GSD - Grain Size Distribution
- MC - Moisture Content
- MD - Moisture Content/Dry Density
- Comp - Compaction Test (Proctor)
- SG - Specific Gravity
- CBR - California Bearing Ratio
- RM - Resilient Modulus
- Perm - Permeability
- TXP - Triaxial Permeability
- Cons - Consolidation
- Chem - Analytical Chemical Analysis
- Corr - Corrosion
- VS - Vane Shear
- DS - Direct Shear
- UC - Unconfined Compression
- TX - Triaxial Compression
- UU - Unconsolidated, Undrained
- CU - Consolidated, Undrained
- CD - Consolidated, Drained

Notes:

1. Sample descriptions in this report are based on visual field and laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates, and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual classification methods in accordance with ASTM D 2488 were used as an identification guide. Where laboratory data are available, soil classifications are in general accordance with ASTM D 2487.

2. Dual symbols are used to indicate gravel and sand units with 5 to 12 percent fines.

3. WOR = weight of rod.

CDM Smith

USG Interiors Inc.
Highway 99
Milton, Washington

Project No: 11921.77628.TK2 Soil Figure: 1

Boring Log AA-6

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVM (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	Sample	USCS	Symbol	DESCRIPTION	Elev. (feet)
						0–4		SM		Gravelly, Silty SAND (SM), brown, fine to coarse, loose, moist (Fill).	22, 20
						2					
						4		ML		Sandy SILT (ML), dark gray, fine sand, fine to coarse gravel, medium stiff, moist.	18
	AA6-6					6					16
	AA6-8					8		ML			14
	AA6-10					10				Note organic-rich layer at 10 ft bgs.	12
	AA6-12					12 ▽		SM		Silty SAND (SM), brown, fine sand, medium dense, wet.	10
	AA6-14					14		SM			8
	AA6-16					16				Boring terminated at 16 ft bgs. Groundwater encountered at 12 ft bgs. Backfilled with bentonite chips.	6

Location:
Surface Elevation: 23.16'
Logged By: AAL

Drill Rig: DPT
Equipment/Hammer: Acetate Liner/NA
Date Completed: 5-11-12

USG Interiors Inc.
Highway 99
Milton, Washington

CDM Smith

Boring Log AA-6 Figure: 2
Project No: 11921.77628.TK2 Soil 1 of 1

Boring Log AA-7

Other Tests	Sample No.	Moisture Content (%)	Dry Density (pcf)	OVM (ppm)	Penetration Resistance (blows / foot)	Depth (feet)	USCS	DESCRIPTION	Elev. (feet)
						0	SM	Gravelly, Silty SAND (SM), brown, fine to coarse, loose, moist (Fill).	
						2			20
	AA7-3								
						4			18
							ML	Gravelly, Sandy SILT (ML), gray-olive, fine sand, stiff, moist.	
						▽		Becomes saturated at 5.5 ft bgs.	16
	AA7-6					6			
	AA7-8					8			14
	AA7-10					10			12
	AA7-12					12	SM	Silty SAND (SM), brown, fine sand, medium dense, wet.	10
	AA7-14					14			8
	AA7-16					16		Boring terminated at 16 ft bgs. Groundwater encountered at 5.5 ft bgs. Backfilled with bentonite chips.	6
									4

Location:
Surface Elevation: 21.76'
Logged By: AAL

Drill Rig: DPT
Equipment/Hammer: Acetate Liner/NA
Date Completed: 5-11-12

CDM Smith

USG Interiors Inc.
Highway 99
Milton, Washington

Boring Log AA-7
Project No: 11921.77628.TK2 Soil

Figure: 3
1 of 1

Appendix B
Groundwater Purge and Sampling Logs

Appendix C
Land Survey Report

Appendix D
Hydrogeologic Calculations

Appendix E
Analytical Laboratory Reports

Appendix F
XRF Data Confirmation