FINAL

BNSF Wishram Track Switching Facility Nearshore Sediment Initial Investigation Work Plan

Prepared for

BNSF Railway Company

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CH2M HILL Engineers, Inc.
2020 SW 4th Avenue, Suite 300
Portland, OR 97201

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Acronyms and Abbreviations

°F	degree(s) Fahrenheit
AST	aboveground storage tank
bgs	below ground surface
BML	below the mudline
BNSF	BNSF Railway Company
cfs	cubic feet per second
CH2M	CH2M HILL Engineers, Inc.
COC	chemical of concern
COD	chemical oxidation demand
CRBG	Columbia River Basalt Group
CSL	Cleanup Screening Level
CSM	conceptual site model
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FS	feasibility study
LIF	laser-induced fluorescence
MTCA	Model Toxics Control Act
NAPL	nonaqueous phase liquid
NAVD88	North American Vertical Datum of 1988
PAH	polycyclic aromatic hydrocarbon
RI	remedial investigation
SAP	sampling and analysis plan
SCO	Sediment Cleanup Objective
SCUM II	*Sediment Cleanup User's Manual II: Guidance for Implementing the Cleanup Provisions of the Sediment Management Standards, Chapter 173-204 WAC*
site	Wishram Railyard Switching Facility
SMS	Sediment Management Standard
SVE	soil-vapor extraction
TOC	total organic carbon
TPH	total petroleum hydrocarbons
UST	underground storage tank
WAC	Washington Administrative Code

SECTION 1

Introduction

This work plan presents the scope of work for an initial investigation in a nearshore area adjacent to the BNSF Railway Company (BNSF) Wishram Track Switching Facility (site), in Wishram, Washington (Figure 1-1). Petroleum sheening and nonaqueous phase liquid (NAPL) droplets have been observed occasionally along an approximately 300-foot stretch of the Columbia River adjacent to the railyard (Figure 1-2) (Ecology, 2017a). This stretch of the Columbia River is impounded by The Dalles Dam and is also referred to as Lake Celilo.

The site proper is the subject of remedial investigation (RI), with work being performed pursuant to an Agreed Order (No. DE 12897) between the Washington State Department of Ecology (Ecology) and BNSF, dated October 7, 2015. The scope of work performed to date under the Agreed Order has mainly focused on the upland investigation, with limited actions related to shoreline conditions.

On March 3, 2017, Ecology directed BNSF to initiate the following:

> *Petroleum sheen was first reported along a portion of shoreline adjacent to the BNSF Track Switching Facility Site (Site) in July 2013. Additional observations of sheen in that area occurred in July 2014, June 2015, and October 2016. During the October visit, …several non-aqueous phase liquid (NAPL) sheens of relatively small extent, though larger than what was previously reported as "thumbnail"-sized, [were noted] along an approximately 300 foot stretch of shoreline…Several offshore areas were also noted to exhibit gas bubbles rising through the shallow water within the area where the sheens were observed.*
>
> *Ecology has determined that these limited actions* (upland remedial investigation and sheen monitoring} *do not comprise sufficient investigation to address potential shoreline and/or surface water impacts. We believe on the basis of several lines of evidence that further investigation is warranted beyond what has already been proposed in the current* {upland} *RI Work Plan.*
>
> *One item in particular that has to be more fully investigated is the groundwater/surface water interface including whether the process of ebullition is occurring. Other mechanisms that may produce a sheen are 1) NAPL seepage due to NAPL drainage and mobility at low water, 2) NAPL wicking along the capillary fringe; and 3) erosion leading to redistribution of NAPL from the riverbank to sediments.*
>
> *Based on these environmental concerns, Ecology requires BNSF to produce a supplemental work plan that will fully address the shoreline component of the RI* (Ecology, 2017a)*.*

An area identified by Ecology in the March 3, 2017 letter is shown on Figure 1-2. Based on discussions with Ecology, the area has been expanded to include historical features east of the sheen area and sampling to the west toward the publicly owned treatment works outfall. This area is identified as the area of interest for the nearshore RI.

The purpose of this nearshore initial investigation work plan is to investigate the potential presence of NAPL in the identified area, characterize the nature and extent of NAPL, if present, and evaluate nearshore sediment against applicable sediment cleanup standards. The nearshore initial investigation and upland RI allow the development of an integrated conceptual site model (CSM) for the Wishram Railyard and shoreline area. The integrated CSM will be used to support evaluation of potential remedial alternatives for the overall site (upland and nearshore) in a feasibility study (FS).

The initial investigation for the nearshore area will be performed in accordance with the Ecology Model Toxics Control Act (MTCA) regulations published in Washington Administrative Code (WAC) 173-340 (Ecology, 2007) and the cleanup provisions of the Sediment Management Standards (SMS) under WAC 173-204, as described in the *Sediment Cleanup User's Manual II: Guidance for Implementing the Cleanup Provisions of the Sediment Management Standards, Chapter 173-204 WAC* (SCUM II) (Ecology, 2015).

1.1 Site and Area of Interest Overview

Wishram is in Klickitat County, Washington, approximately 13 miles northeast of The Dalles, Oregon, and 0.75 mile south of Washington State Route 14, within the southwestern quarter of Section 17, Township 2 north, Range 15, east of the Willamette Meridian. The site location is shown on Figure 1-1. The location of petroleum sheening and approximate area of interest for the nearshore initial investigation is shown on Figure 1-2.

The railyard is approximately 2,000 feet long and ranges from 150 to 720 feet wide. The upland RI area encompasses the westernmost portion of the railyard. This portion of the site is approximately 350 feet long (east to west) and 450 feet wide (north to south) and covers an area of approximately 3.6 acres. The upland portion of the site is bounded by the town of Wishram to the north, the railyard to the east, Lake Celilo to the south and southwest, and railroad right-of-way to the west. Onsite structures include storage buildings, a maintenance shop (office and tool storage), two mainline tracks, and active track spur rails. Current site features are shown on Figure 1-3.

The site was originally developed by the Spokane, Portland, and Seattle Railway between 1910 and 1912. The Spokane, Portland, and Seattle Railway merged with other railroads in 1970 to become the Burlington Northern Railroad, which merged with the Santa Fe Railroad in 1995 to become what is now BNSF. The primary historical use of the railyard was railcar switching. Historically, locomotive fueling/watering and repairs also occurred at Wishram. Most track spurs, early structures, and infrastructure no longer remain. Prominent site features believed to have been present during some portions of the time between 1910 and the present are shown on Figure 1-3.

At the time the railyard was constructed, the Columbia River was free-flowing and occupied a channel approximately 300 feet south and 40 to 50 feet lower than the railyard. Construction of The Dalles Dam in 1957 impounded the Columbia River to create Lake Celilo.

Additional details regarding historical site activities, including historical plat maps, are presented in the *Site Investigation, Wishram Railyard, Wishram, Washington* (Kennedy/Jenks Consultants, 2012).

1.2 Project Objectives

The purpose of the nearshore sediment initial investigation work plan is to investigate the potential presence of NAPL in the identified area, characterize the nature and extent of NAPL, if present, and evaluate nearshore sediment against applicable sediment cleanup standards. The nearshore initial investigation data will also be used in conjunction with data collected in the upland portion of the railyard to develop an integrated CSM for the Wishram Railyard and shoreline area. This integrated CSM will be used to support evaluation of potential remedial alternatives for the overall site as part of an FS.

1.3 Work Plan Organization

This work plan is organized as follows:

- Section 1 – Introduction
- Section 2 – Project Approach
- Section 3 – Summary of Existing Information
- Section 4 – Preliminary Conceptual Site Model
- Section 5 – Data Quality Objectives for Nearshore Initial Investigation Data Gaps
- Section 6 – Project Tasks
- Section 7 – References

Tables and figures are provided following Section 7. Supporting documentation is provided in the following appendixes:

- Appendix A – Sampling and Analysis Plan
- Appendix B – Health and Safety Plan

Project Approach

The nearshore sediment initial investigation is part of the larger upland RI being conducted for the site. As documented in the *Remedial Investigation Work Plan, Wishram, Washington* (Kennedy/Jenks Consultants, 2016), the principal objective of the upland RI is to characterize the nature and extent of impacted soil and groundwater at the site and to understand conditions governing the fate and transport of NAPL and dissolved constituents to evaluate the potential risks to human health and the environment. The upland RI is also intended to develop site information to conduct an FS that will evaluate and select a remedial approach to address site conditions. The results of the RI and FS will be summarized in a comprehensive RI/FS report following completion of these activities, and any follow-on actions required by Ecology. Based on results of the RI/FS, a draft cleanup action plan will be developed for the site.

The approach for the nearshore sediment investigation includes the following work:

1. Compile and assess existing site data to develop a preliminary nearshore CSM and identify data gaps
2. Develop data quality objectives (DQOs) to fill data gaps using the U.S. Environmental Protection Agency (EPA) seven-step process (EPA, 2006)
3. Identify potential NAPL sources and chemicals of concern (COCs) associated with railyard operations
4. Characterize the distribution and migration potential of NAPL in nearshore sediment, if present.
5. Determine whether nearshore sediments are impacted by chemicals associated with petroleum NAPL and potential petroleum degradation products (metabolites) and whether the sediments are toxic to benthic organisms.
6. Refine the CSM based on interpretation of the nearshore sediment investigation data.

This work plan describes the approaches and procedures for completion of each project step. The following subsections provide information on the project team and stakeholders, project deliverables, and schedule for completion of the nearshore sediment initial investigation.

2.1 Project Team and Stakeholders

The project team is composed of BNSF project management staff and CH2M HILL Engineers, Inc. (CH2M) and Kennedy/Jenks Consultants scientists and engineers, as depicted in Table 2-1. Work will be performed in coordination with Ecology.

2.2 Project Deliverables

The deliverables associated with the nearshore sediment investigation include this work plan, associated appendixes, and a technical report documenting the results of the investigation. It is expected that the findings of the investigation will be compiled into comprehensive RI and FS reports for the entire site (uplands and nearshore).

2.3 Schedule

The project schedule will be coordinated once the work plan is approved. CH2M will coordinate with the U.S. Army Corps of Engineers to determine if lowering the pool elevations of Lake Celilo is planned for maintenance. The actual schedule may vary depending on field conditions (including weather), subcontractor availability, and a variety of other factors that may be beyond BNSF control. A tentative project schedule is provided in Table 2-2.

SECTION 3

Summary of Existing Information

This section provides a review of the existing information about the area of interest, the railyard, and the surrounding area.

3.1 Area of Interest Description

The area of interest for the nearshore sediment initial investigation consists of an approximately 300- by 60-foot area adjacent to the site where petroleum sheening, NAPL droplets, tar nodules, and gas bubbles have been observed and adjacent areas where historical features may have resulted in preferential pathways for NAPL migration. The location of the area of interest is shown on Figure 1-2.

3.2 Area of Interest Characteristics and Use

The area of interest includes submerged land that was inundated by the creation of Lake Celilo when The Dalles Dam was constructed in 1957. The following subsections describe ecological resources and site use of the area of interest.

3.2.1 Ecological Resources

The site is a fully developed transportation facility with little vegetation and wildlife habitat. The nearshore area of interest consists of submerged land that was inundated by construction of The Dalles Dam. An inventory of ecological resources has not been developed for the site.

3.2.2 Site Use

The area of interest is in Lake Celilo, which is part of the Zone 6 Treaty Indian Fishery. Nontribal commercial fishing is prohibited in the area, but noncommercial sports fishers may still fish in the area. The Confederated Tribes and Bands of the Yakama Nation still exercise treaty reserved fishing rights on the shores of the Columbia River in the direct vicinity of the railyard. This fishing activity is regulated under tribal laws through off-reservation enforcement authority. The Celilo Treaty Fishing Access Site, a tribal fishing boat launch area regulated by the Bureau of Indian Affairs, is situated directly across the Columbia River on the Oregon shore. Fisheries in this area of the main stem Columbia River (designated Zone 6) are comanaged among the Yakama Nation and the states of Washington and Oregon under a 2008 U.S. District Court order (Ecology and BNSF, 2015).

As a result of the frequent winds that occur throughout The Dalles and east through Wishram and the location of Celilo Park, recreational wind surfing and kite boarding activities occur in the river in this area.

Columbia River surface water designated uses per WAC 173-201A include Aquatic Life, Recreation, Water Supply, and Miscellaneous. Specific uses are shown in Table 3-1.

3.3 Previous Investigations and Cleanup Actions at Wishram Railyard

BNSF has performed a series of voluntary and Agreed Order-required investigations to characterize the distribution of impacted soil and groundwater in the upland portion of the site. In addition, BNSF has undertaken voluntary independent remediation activities in the upland portion of the site.

Through performance of past investigative activities completed at the site, the primary COCs identified for the site are petroleum hydrocarbons, and specifically diesel- and oil-range hydrocarbons. Other associated COCs include polycyclic aromatic hydrocarbons (PAHs), with low concentrations of carcinogenic PAHs. In addition, benzene, toluene, ethylbenzene, and xylenes and some metals (primarily arsenic and lead) have been detected at low levels in site soil and/or groundwater.

The following briefly summarizes past investigation and remediation activities that have occurred in the upland portions of the site:

- **2002** – Removed a 30,000-gallon, steel, single-walled underground storage tank (UST) adjacent to the western side of a former boiler house, collected soil samples, and removed petroleum-containing soils to the top of bedrock (16 feet below ground surface [bgs] at this location). Confirmation sampling indicated a thin layer of soil containing diesel- and oil-range hydrocarbons at concentrations above MTCA Method A soil cleanup levels for industrial properties remaining in place just above bedrock to the north, east, and south of the excavation.
- **2003** – Conducted UST site assessment to evaluate site hydrogeologic conditions and determine the extent of petroleum-containing soil south and potentially down hydraulic gradient of the former 30,000-gallon UST (Kennedy/Jenks Consultants, 2004a). Soil samples from two borings and groundwater samples from four monitoring wells were above MTCA Method A cleanup levels.
- **2004** – Conducted an overall site assessment (Kennedy/Jenks Consultants, 2004b) to locate and evaluate potential primary sources of petroleum at the site. These potential primary sources, which are shown on Figure 1-3, included:
  - Former 30,000-barrel oil aboveground storage tank (AST)
  - Former 600-gallon fuel oil and 10,000-gallon gasoline/oil USTs
  - Former 5,000-gallon oil UST at Depot
  - Former 1,000-gallon gasoline UST and Oil House
  - Former Transformer Storage Area
  - Former Engine House and Turntable
  - Former Power House
  - Former 100,000-gallon diesel ASTs, Pump House, and former 500-gallon gasoline USTs
  - Former Fueling Island and 5,000-gallon lubricating oil AST

  Petroleum-containing soil and groundwater were identified at several possible petroleum storage and use locations.
- **2005** – Used results of 2004 site assessment to guide additional remediation activities in the upland portion of the site. These activities included removal and offsite disposal of approximately 3,600 tons of petroleum-containing soil and debris, removal and recycling of approximately 1,800 gallons of petroleum from the former 5,000-gallon lube oil UST and associated piping, and removal and recycling of 10 tons of metal (Kennedy/Jenks Consultants, 2007). Excavation depths extended to the water table, typically encountered around 10 to 12 feet bgs. Confirmation sampling in excavation areas west of the current Maintenance Shop indicated some soil containing diesel-range petroleum hydrocarbons at concentrations above the MTCA Method A industrial soil cleanup level was left in place below the water table.

- **2010** – Performed supplemental investigation to identify potential primary sources of residual NAPL in the vicinity of the Maintenance Shop (Kennedy/Jenks Consultants, 2010a). The source of the NAPL appeared to be petroleum-saturated soil submerged beneath the present-day water table and likely related to historical releases from the former 30,000-gallon diesel UST. Additionally, debris and petroleum-containing soil in the vicinity of the former 28,500-gallon oil service AST were removed and disposed of offsite. Confirmation soil samples collected following the excavation activities confirmed residual hydrocarbon concentrations in the excavation area were below MTCA Method A soil cleanup levels for unrestricted land use (Kennedy/Jenks Consultants, 2010b).
- **2012** – Conducted soil and groundwater investigations focused on the southern side of the mainline tracks near the former fueling island and Former Power House (Kennedy/Jenks Consultants, 2012). Diesel-impacted soil and groundwater were found along the length of the former fueling platform south of the mainline tracks, but the source was thought to be migration of NAPL from the area north and upgradient of the mainline tracks and former fueling platform. An air sparging system and a soil-vapor extraction (SVE) system were installed north of the mainline tracks to address the NAPL. However, air sparging was discontinued in June 2012 due to the irregular presence of NAPL in monitoring wells in the area. The SVE system was also modified to operate in biovent mode (injecting, rather than pulling air through the SVE wells). Bioventing with ambient air through the SVE wells operated in continuous mode (24 hours a day, 7 days a week) between June 2012 and April 2017, when the system blower failed. The system blower was replaced on November 28, 2017, and the bioventing system was restarted, operating again in continuous mode.
- **2013** – Conducted a laser-induced fluorescence (LIF) survey to further delineate the heavy oil-affected areas in the upland portion of the site. The LIF survey was conducted by Dakota Technologies, of Fargo, North Dakota, using the Tar-specific Green Optical Screening Tool LIF system, developed specifically for coal tar and heavy oil detection (Dakota Technologies, 2013). The LIF survey included 102 sample points at approximately 12.5- to 50-foot centers, but mostly spaced on 30- to 40-foot centers. The LIF tooling was advanced to refusal (the top of bedrock surface) using a Geoprobe direct-push rig. Soil samples were collected to qualitatively correlate the LIF signal response to laboratory soil analytical concentrations for petroleum hydrocarbons. The LIF and analytical data were used to delineate the approximate distribution of heavy oil in subsurface soils at the site. During the LIF survey, on July 13, 2013, heavy oil droplets and an associated sheen were observed adjacent to the site in the Columbia River. BNSF reported the occurrence of the oil and sheen in surface water to the National Response Center and Ecology on the same date. Monthly inspections for sheen began in December 2013.

  The LIF data and additional laboratory data collected during the uplands RI will be provided as part of the uplands RI report.
- **2014** – Conducted additional investigations near the Former Power House to evaluate potential mobility of heavy oil in the saturated zone and to select locations for oil head monitoring and deep riverside monitoring wells. Additionally, petroleum sheens[1] were observed along the shoreline in July 2014.
- **2015** – Observed petroleum sheen along the shoreline in June 2015.
- **2016–Present** – Installed and monitored oil head monitoring and deep riverside monitoring wells. Continued investigation of soil and groundwater conditions in the upland portion of the site, as described in the *Remedial Investigation Work Plan* (Kennedy/Jenks Consultants, 2016). Petroleum sheen was observed along the shoreline in August and October 2016.

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[1] Sheen is a very thin layer of oil (less than 0.0002 inch or 0.005 millimeter) floating on the water surface and is the most common form of oil seen in the later stages of a spill. According to their thickness, sheens vary in color from rainbows, for the thicker layers, to silver/gray for thinner layers, to almost transparent for the thinnest layers. (NOAA, 2016)

3.4 Environmental Setting

The site occupies a flat bench along the northern side of the Columbia River at the eastern edge of the Columbia River Gorge. The gorge began forming as far back as the Miocene (12 to 17 million years ago) with the eruption and deposition of thick layers of flood basalt and continued to take shape through the Pleistocene (700,000 to 2 million years ago). The Cascade Range was forming during this time, slowly moving the Columbia River's course north to its current location (Northwest Power and Conservation Council, 2017).

The topography of the railyard is relatively flat with an average elevation of approximately 170 feet North American Vertical Datum of 1988 (NAVD88). The town of Wishram sits above the railyard at an elevation of approximately 177 feet NAVD88, just below a series of basalt cliffs and benches that lead eventually to the Columbia Plateau 2,000 feet above the river. The cliffs in the immediate vicinity of Wishram are incised by local drainage features, which appear to follow topographic gradient and distinct north-south oriented lineaments (faults or fractures) in the basalt bedrock (Figure 3-1).

At the time the railyard was constructed, the Columbia River was free-flowing and occupied a channel approximately 300 feet south and 30 to 50 feet lower than the railyard. Construction of The Dalles Dam in 1957 impounded the Columbia River to create Lake Celilo. Lake Celilo now forms the southern boundary of the railyard.

3.4.1 Geology

3.4.1.1 Regional Geology

Surface geology near Wishram, Washington consists of eroded Miocene period flood basalts (Columbia River Basalt Group [CRBG]) with interspersed pockets of glacio-fluvial l sediments deposited during ice-age floods. The CRBG was extensively eroded during a series of massive ice-age (10,000 to 15,000 years ago) floods related to periodic melting of ice dams that impounded glacial Lake Missoula (USGS, 2012). Peak flows during the Missoula Floods have been estimated at 1 to 10 cubic kilometers per hour (Benito and O’Conner, 2003), whereas the highest recorded flows in the Columbia River before dams were constructed range from 400,000 to 1,200,000 cubic feet per second (0.04 to 0.12 cubic kilometers per hour) (Bonneville Power Administration, 2001). The extreme flows during the Missoula floods eroded the basalt leaving a scoured landscape. Backflooding behind choke points in the gorge created temporary impoundments, such as prehistoric Lake Condon, which based on prominent strandlines between Maryhill and The Dalles, reached an elevation of 1,200 feet (Bjornstad, 2006). As the prehistoric lake drained, the eroded valleys and channels in the basalt were filled with silt and sand eroded from upstream areas (Carson and Poque, 1996).

The underlying and surrounding basalt bedrock at Wishram consists of CRBG. Typical vertical sequences in the basalt layers are exposed in outcrops near the site, including: (1) the colonnade (thick competent columnar basalt), (2) the entablature (narrow hackly fanning columns), and (3) the vesicular (gas bubble entrained) zones (USGS, 1988).

3.4.1.2 Local Geology

The local geology at the site, as determined by soil borings described in Section 3.3, consists of varying thickness of surface fill (sand and gravel reportedly sourced from nearby sand dunes and river deposits), followed by 10- to 95-foot-thick sequences of glacio-fluvial sediment (and silt) deposited on eroded CRBG bedrock during ice-age floods. Boring log and direct-push data were used to develop maps of alluvium thickness and bedrock topography for the western part of the railyard (Figures 3-2 and 3-3). The maps indicate that the western portion of the railyard overlies a glacio-fluvial sediment-filled erosional feature in the basalt bedrock. The complete dimensions of the sediment-filled depression are unknown, but based on local topography and historical aerial photos taken before creation of Lake Celilo, which show exposed bedrock along some portions of the historic Columbia River shoreline adjacent to the railyard, the sediment-filled depression is expected to be limited in areal extent. The thickness of sediment in the feature along the historical shoreline is unknown, but may be substantial given the presence of trees in this area prior to inundation of the area by Lake Celilo.

3.4.2 Hydrogeology

3.4.2.1 Regional Hydrogeology

Although unconfined groundwater also occurs in localized pockets of glaciofluvial sediment deposited in erosional features related to the Missoula Floods, the primary aquifer system in the Columbia River Basin occurs in the CRBG. The CRBG aquifer system covers more than 59,000 square miles in portions of Washington, Oregon, and Idaho (GSI Water Solutions, 2009) and is the primary water supply for numerous communities, agriculture, and industry.

The CRBG consists of several hundred continental flood basalt flows. The CRBG extends from the Rocky Mountain foot hills in west-central Idaho, through the Columbia Plateau of eastern and central Washington and north-central Oregon, to the Cascade Mountains and westward through the area of Portland, Oregon, and across the Coast Ranges to the Pacific Ocean. The CRBG can be thousands of feet thick. Individual CRBG flows typically cover many hundreds to several thousand square miles, and are thicker and more numerous in the central Columbia Plateau than along the edges. The extensiveness of the flows, combined with the physical characteristics of CRBG flows, indicates they formed as laterally extensive, uninterrupted sheets. The net hydrologic effect is a stratified series of confined aquifer horizons. Aquifer horizons within the CRBG are typically associated with intraflow structures at the top and bottom of sheet flows. The interiors of thick sheet flows have very limited permeability and act as aquitards, creating a series of “stacked” confined aquifers within the system. The dominant groundwater flow pathway within this aquifer system is horizontal to subhorizontal along individual, laterally extensive, interflow zones. Vertical groundwater movement through undisturbed basalt flow interiors is greatly restricted and seems to occur where basalt flow interiors are disturbed by folds or faults, truncated by flow pinchouts or erosional windows, or where they are cross-connected by wells (GSI Water Solutions, 2009).

3.4.2.2 Local Hydrogeology

The uppermost hydrogeologic unit at the site is the glaciofluvial aquifer, consisting of unconsolidated sand and silt deposited during the Missoula Floods. The aquifer is unconfined. Numerous monitoring wells have been installed at the railyard. The wells are screened in the sand/silt deposits, which can be up to 95 feet thick in the western section of the railyard. The deposits are generally homogeneous and in some areas, the sand and silt overlie a thin layer of gravel just above bedrock (Kennedy/Jenks Consultants, 2016). Given the presence of exposed bedrock surfaces east and west of the sediment area of interest as shown on historical aerial photographs and local bathymetry, the glaciofluvial aquifer likely pinches out to the south just beyond the former shoreline of the Columbia River (Figure 3-2). Groundwater occurs in the unconfined sand/silt alluvial aquifer at a depth of 10 to 12 feet bgs. Prior to construction of the dam and creation of Lake Celilo, the unconfined water table was likely at least 30 to

50 feet deeper. Although there are some variations caused by changes in lake level, groundwater flow is generally south toward the lake at a very shallow gradient (Figures 3-4A and 3-4B). Potential for impacts to the basalt aquifer and the status of former water supply Wells 1, 2, and 3, including how the wells were decommissioned, will be investigated as proposed in the Addendum to the upland RI work plan (Kennedy/Jenks Consultants, 2018).

Daily oscillations in the Columbia River stage (typically 1 to 2 feet) occur due to variable discharge rates from The Dalles Dam. Data-logging pressure transducers have recorded site groundwater levels near the river fluctuating with the river stage, indicating site groundwater is in direct hydraulic communication with the Columbia River (Figure 3-5). The magnitude at which site groundwater responds to the changes in river stage dampens as a function of distance from the riverbank (Kennedy/Jenks Consultants, 2016).

Three water supply wells were installed at the railyard during its early years of operations. The well locations are shown on Figure 1-3. Available well logs indicate thick sequences of alluvium followed by a series of black basalt layers. Well 2 was completed to a depth of 399 feet bgs and intercepted water from black porous water-bearing basalt. The well yielded 900 gallons per minute. The water supply wells are addressed as part of the RI being conducted for the upland portion of the railyard.

3.4.3 Hydrology

The Columbia River basin comprises approximately 260,000 square miles from its headwaters in British Columbia, Canada, to its mouth at Astoria, Oregon. The average flow for the river at The Dalles, Oregon, is approximately 190,000 cubic feet per second (cfs) and ranges from 120,000 cfs in a low water year to 260,000 cfs in a high-water year. Records kept since 1878 show that flows were much higher in the spring and lower in the winter before dam construction (Ecology, 2017b). Historical maps of the site show an approximate elevation of the Columbia River at 130 feet NAVD88. Historical data for the area show fluctuations of up to 16 feet during different times of the year (Hardesty, 1908). The normal pool elevation for Lake Celilo is approximately 161 feet NAVD88 (USACE, 2017).

Prior to construction of The Dalles Dam, the bed of the Columbia River from Celilo Falls to The Dalles was characterized by 82 feet of river drop in 12 miles. The portion of the river bed near Celilo Falls dropped 40 feet and the bed was characterized as exposed bedrock in many places.

Wishram is in a relatively arid region. The primary sources of surface water are spring-fed creeks at the bases of the basalt cliffs. Local surface water drainage patterns are not evident, which may be related to the porous nature of surface alluvium or to modification of natural drainage channels during development of the town and railyard. Historical maps of the railyard show several underdrains leading from the town to discharge structures on the southern side of the railyard. The locations of the underdrain nearest the area of interest are shown on Figure 1-3.

3.4.4 Climate/Meteorology

Wishram receives 13 inches of rain and 15 inches of snow per year. Average temperatures range between 37 degrees Fahrenheit (°F) in January and 81°F in July. The prevailing wind direction is from the southwest with an average speed of 5 miles per hour (Windfinder, 2017). Water temperatures measured at The Dalles at depths between 6 and 8 feet range from 35°F in January to 70°F in August (USGS, 2017).

SECTION 4

Preliminary Conceptual Site Model

This section describes the preliminary CSM for the site and the nearshore area of interest and Figure 4-1 provides an illustration.

The preliminary CSM developed is consistent with the EPA identified stages for CSM development defined in *Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model* (EPA, 2011)*.* The preliminary CSM is defined as:

> *Project milestone or deliverable based on existing data; developed prior to systematic planning to provide fundamental basis for planning effort.*
>
> *The Preliminary CSM, therefore, can act as a starting point for compiling and synthesizing existing information to support building stakeholder consensus, identifying data gaps and uncertainties, and determining subsequent data needs.*
>
> *it also includes other elements, such as known and suspected contaminants of potential concern, locations of probable source areas, the mechanisms and timing of historical and potential releases, affected environmental media, contaminant distribution data, potential migration pathways, and potential receptors.*

As such, the preliminary CSM is intended to support the investigation approach and is subjective because NAPL impacts in sediment have not been verified.

4.1 Sources and Chemicals of Interest

The primary source of NAPL in the area of interest for the nearshore sediment initial investigation is assumed to be historical releases of petroleum from one or more storage tanks or transmission lines. Confirmed historical facilities at the railyard include the following (shown on Figure 1-3):

- Former 30,000-barrel oil AST
- Former 600-gallon fuel oil and 10,000-gallon gasoline/oil USTs
- Former 5,000-gallon oil UST at Depot
- Former 1,000-gallon gasoline UST and Oil House
- Former transformer storage area
- Former Engine House and Turntable
- Former Power House
- Former 100,000-gallon diesel ASTs, pump houses, and former 500-gallon gasoline USTs
- Former fueling island and 5,000-gallon lubricating oil AST
- Associated product transfer lines

These facilities have been removed or decommissioned. In most cases, contaminated soil and NAPL in the immediate vicinity of the sources were also removed and disposed of offsite. Excavated soils in 2002, 2005, and 2010 were disposed at the Rabanco Regional Landfill in Roosevelt, Washington. Other investigation derived wastes have been transported by licensed waste handlers and disposed of at applicable facilities, based on media type (e.g., soil and water).

The primary release mechanisms from the historical sources are unknown, but may include surface spills, overfilling, surface leaks, or subsurface leaks, resulting in NAPL-impacted surface and subsurface soil. In some instances, sufficient NAPL was released to cause saturation of pore spaces in the soil allowing for vertical migration of NAPL as a separate phase to the top of the present-day water table approximately 10 feet bgs or to the top of the historical water table approximately 40 to 50 feet bgs.

Based on the presence of measurable NAPL in monitoring wells downgradient of the petroleum storage and operations area, the NAPL appears to have migrated laterally on top of whichever water table was present at the time of the release. The present-day mobility of NAPL on top of the current water table in the upland area is being investigated as part of the upland RI. Investigation activities conducted to date indicate the oil-based (i.e., Bunker C) LNAPL beneath the site (uplands area) may not be migrating. However, a similar evaluation has not been made for the lighter petroleum hydrocarbon source mass (i.e., diesel-range organics).

Extensive investigations have been conducted in the upland portion of the railyard. The principal types of petroleum released at the railyard appear to be diesel and Bunker C fuels. COCs associated with diesel and Bunker C fuels include the following:

- Total petroleum hydrocarbons (TPH)-diesel
- TPH-residual (oil range)
- PAHs

Other COCs possibly associated with railyard operations include metals and polychlorinated biphenyls, but these are not expected to be present in the nearshore sediment area of interest, which was designated based on NAPL sheening and droplets.

4.2 NAPL Release and Transport Mechanisms

NAPL sheen and blebs have been observed along the shoreline in the area of interest. The mechanism contributing to these NAPL observations has not been determined. The potential link between known areas of NAPL at the uplands and NAPL sheening and droplets in the nearshore area of interest is the focus of this nearshore initial investigation.

Additionally, the area of interest is located over a portion of the former Columbia River shoreline that appears to be covered by heavy vegetation in historical aerial photographs. Reportedly, none of the vegetation was removed prior to inundation of the area by Lake Celilo. Decomposition of the vegetation and generation of organic gases may be resulting in ebullition and transport of materials to the water surface. Ebullition and other NAPL transport mechanisms are discussed in Sections 4.2.1 through 4.2.4.

4.2.1 Gas Ebullition

Ebullition, as defined by Merriam-Webster, is “the act, process, or state of boiling or bubbling up.” As related to environmental transport, gas ebullition is a natural process whereby methane and other gases generated from biodegradation of organic matter are released from water bodies via gas bubbles. Gas ebullition occurs when the buoyant force of the gas bubble exceeds the combined cohesive forces in the sediment and the hydrostatic pressure exerted by the water column. As these bubbles rise to the surface, the occurrence can appear as if the water is boiling, from which the term ebullition was derived. Figure 4-1 includes an illustration that shows how hydrophobic NAPL droplets can coat or be entrained within the gas bubbles and then get carried to the water surface. Once on the water surface, the bubbles either burst, creating a sheen, or remain on the surface until enough gas escapes to make the droplet less dense than water and appear as a NAPL bleb.

In freshwater ecosystems, gas bubble formation is limited to the near surface sediment and is influenced by several factors that include sediment physicochemical properties and biogeochemical processes. Viana et al, 2012 refers to the 1 meter as an assumed depth for production of gas bubbles based on one research papers. The labile organic matter present is estimated as the total organic carbon to chemical oxidation demand (TOC/COD) ratio of the sediment.

In most cases, ebullition is caused by labile organic matter in the sediment. At Wishram, there are no records of vegetation being removed from the shoreline before it was inundated in 1957 following the construction of The Dalles Dam. Both natural organic matter and petroleum products can biodegrade. When the gas bubble formed by biodegradation moves through NAPL impacted sediment, the NAPL can transfer to the bubble skin regardless of how the bubble was formed. One can expect to observe sheen in either situation when the bubble reaches the sediment surface. Therefore, the decaying organic matter is a likely source of the ebullition observed by Ecology (2017a).

4.2.2 Seep Migration

This potential mechanism was described by Ecology as "NAPL seepage due to NAPL drainage and mobility at low water" (Ecology, 2017a). A NAPL seep is defined as a NAPL release where:

- NAPL is moving under a sustained NAPL gradient. Low water table increases the NAPL gradient in most cases.
- A NAPL source is located at some distance from the seep and provides the driving force.
- A recent or ongoing NAPL release is typically in association with the discharge.
- NAPL saturations are above residual.

NAPL seeps can more readily migrate through sediments previously impacted by NAPL (NAPL is the wetting phase) (Sale and Lyverse, 2014). When NAPL is nonwetting and water is the wetting phase, the NAPL migrates when the NAPL head exceeds the pore entry pressure of the groundwater. This allows NAPL to migrate to areas previously unaffected by NAPL. When NAPL is the wetting fluid, NAPL discharge is likely continuous because the driving head of NAPL continues to release NAPL along the NAPL-wetted pathway.

NAPL seeps can also occur from preferential pathways such as stormwater discharges or underdrains on the site impacted with NAPL. Groundwater seeps containing dissolve phase constituents can also discharge along these pathways. Water is typically the wetting fluid in environmental systems so there is no entry head necessary for groundwater discharge.

4.2.3 Sheen Migration

This potential mechanism was described by Ecology as "NAPL wicking along the capillary fringe" (Ecology, 2017a). This is analogous to a NAPL sheen discharge (Sale and Lyverse, 2014) where:

- Very limited amount of oil is discharged as a sheen on the water surface
- Ephemeral sheen behavior may be observed
- Former seeps have occurred
- Discharge occurs along the groundwater-air interface
- NAPL saturations are close to or below residual

NAPL sheens migrate by the difference in the surface tensions that result in a positive spreading coefficient (Sale and Lyverse, 2014). In subsurface soils, NAPL spreads on the groundwater surface in the same manner as a surface water sheen. In this way, NAPL sheen spontaneously enters water-coated, air-filled pores through capillary forces. These forces overcome gravitational forces and NAPL migrates. However, surface tensions alone are insufficient to exceed the pore entry pressure of the groundwater and migrate through nonwetted areas (areas absent of NAPL impacts). Hence, sheen migration occurs in a previous NAPL-wetted pathway at the interface of groundwater and the vadose zone such as through vadose zone transport from an upland source.

4.2.4 Bank Erosion

Bank erosion was identified by Ecology as a potential NAPL transport mechanism. However, the bank in the area of interest is heavily armored. This is not considered a viable pathway for NAPL transport at the site.

4.3 Potentially Affected Media, Exposure Pathways, and Receptors

Figure 4-2 presents the cross section locations. Figures 4-3 and 4-4 present cross sections that run perpendicular to, and along the shoreline, respectively. These cross sections were created using the boring logs generated during recent nearshore upland drilling work. The logs were reviewed for the presence of descriptions of sheening or odors in the borehole. These are considered secondary indicators of NAPL migration. The primary indicators of NAPL migration, free oil or NAPL impregnated soil cores, were not observed along the shoreline.

These figures suggest that potential low levels of NAPL impacts are at two distinct depth intervals—one along the current water table, and one at approximately 30 feet below the current lake level. Several borings along the shoreline suggest that petroleum impacts may also be present above the water table within a well-graded sand, silt, and gravel fill horizon found exclusively along the shoreline.

Potentially affected media in the area of interest are limited to surface water and sediment. Exposure pathways may include ingestion and direct contact with impacted sediment, surface water, or riprap sediment (or one or more of the three). Potential receptors include benthic and aquatic organisms in Lake Celilo. There are no reasonably anticipated direct human exposure pathways including fish consumption as well as incidental ingestion and dermal contact of contaminated sediment as the potentially impacted sediment is generally inaccessible (underwater or under large immobile basalt riprap) and land side access is restricted by the operating railyard, other than the rare trespassing occurrence.

4.4 Preliminary Nearshore Conceptual Site Model

Figure 4-1 presents a preliminary nearshore CSM developed based on the information in this work plan. The key observations from the CSM are summarized as follows:

- Observations for the shoreline boreholes and wells do not show NAPL impregnated in soil or free oil in any borings. NAPL has not accumulated in shoreline wells. Sheen and odor are observed in soil cores, but these are considered less significant indicators of a NAPL discharge.
- Sheen and odor are observed at two distinct depth intervals at the shoreline, corresponding to the historic and current water levels.
- At the shallow depth, three NAPL transport mechanisms are possible: seep migration, sheen migration, and ebullition. At the deeper depth, only seep migration is possible (the impact is now below the water table). Seep migration after the rise in water table is unlikely because:
  - NAPL moves more readily at the water table.
  - The rise in water table likely trapped the NAPL.
  - No NAPL head is observed at the shoreline.

Based on these observations, discharge from the upper interval is considered the most viable of the current transport pathways. The current discharge is likely limited to sheen migration with some seeps when water levels match higher NAPL saturated intervals of the subsurface. Once in the submerged lands, the NAPL can be subject to transport by ebullition with the gasses developed by the decaying organic matter in the submerged lands.

SECTION 5

Data Quality Objectives for Nearshore Initial Investigation Data Gaps

This section identifies the DQOs for investigations and evaluations to fill these data gaps. These DQOs were developed using the EPA seven-step process (EPA, 2006) and specify the type, quantity, and uses of data needed to adequately support the investigation and decisions in the area of interest.

An overarching problem statement was developed to guide the DQO process:

> *Oil droplets and sheen of unknown origin have been intermittently observed in the nearshore area of the Columbia River adjacent to the Wishram Railyard. The investigation will evaluate the presence or nature and extent of petroleum NAPL and associated chemicals of interest in sediment for purposes of source identification and, if applicable, remedy evaluation.*

This statement has been parsed into three sets of DQOs based on the data gaps identified through review of existing information and development of the preliminary CSM for the area of interest. The data gaps are as follows:

1. Detailed physical characteristics of the area of interest that may control transport of constituents of interest
2. Presence or absence and, if found, nature and extent of NAPL in the area of interest
3. Potential chemical impacts from COCs to nearshore sediment.

The data-gathering and decision process for the investigation is depicted on Figures 5-1 and 5-2.

5.1 DQO Set 1 – Physical Characteristics

The result of the DQO process for establishing the physical characteristics of the area of interest is summarized below.

- **Step 1 – Problem Statement.** There is uncertainty about current physical conditions in the area of interest that could affect transport and distribution of constituents of interest.
- **Step 2 – Decisions.** Additional information is required to characterize local bathymetry and geology.
- **Step 3 – Inputs to the Decision.**
  - Historical records and maps
  - Shoreline survey
  - Upland hydrogeologic information and groundwater surface water interaction
  - Bathymetry survey data
- **Step 4 – Boundaries of Study.** Area offshore of Wishram Railyard where nearshore NAPL impacts have been observed.
- **Step 5 – Decision Rules/ Evaluation Approach.** There are no formal decision rules associated with this set of DQOs. The bathymetry data will be used to establish current bottom features and to evaluate potential changes caused by sedimentation/erosion since dam construction and creation of Lake Celilo and will also be used in conjunction with upland data to develop a comprehensive CSM.
- **Step 6 – Decision Errors.** Qualitative study.

- **Step 7 – Optimize Sampling Design.** Perform bathymetric survey at appropriate locations and spacing intervals to characterize bathymetry specified levels of resolution throughout the area of interest.

5.2 DQO Set 2 –Nature and Extent of NAPL

The result of the DQO process for determining the presence or absence, and if applicable, the nature and extent of NAPL in the area of interest is summarized below.

- **Step 1 – Problem Statement.** The source of NAPL nodules and sheening in the area of interest is unknown.
- **Step 2 – Decisions.** Data are needed to determine if and where NAPL-impacted sediments are located, the extent of impacted sediment, if present, and the petrophysical (saturation and mobility) characteristics of any NAPL.
- **Step 3 – Inputs to the Decisions.**
  - Historical records and maps
  - Shoreline (topographic and bathymetric) survey
  - Upland NAPL characteristics
  - Nearshore NAPL characteristics (if present)
  - Temporal changes in NAPL/sheen appearance, location, and extent
  - Passive detector locations and depths
  - Sediment core locations and depths
  - Data for passive detectors and sediment cores
  - MTCA regulations published in WAC 173-340 (Ecology, 2007)
  - Cleanup provisions of the Sediment Management Standard (SMS) under WAC 173-204, as described in SCUM II (Ecology, 2015)
- **Step 4 – Boundaries of Study.**
  - *Spatial* – Nearshore area adjacent to the site where a petroleum sheen and NAPL have occasionally been observed on water surface over an approximately 300-foot east to west area, westward in the direction of the publicly owned treatment works outfall, and eastward in the direction of the stormwater outfall.
  - *Chemical* – Use analytical methods appropriate to NAPL mobility characterization.
- **Step 5 – Decision Rules/Evaluation Approach.** The decision rules associated with this set of DQOs concern presence or absence of NAPL impacts and, if applicable, the physical and chemical characteristics of any detected or observed NAPL. An observational approach will be used where the Dart investigation will continue laterally along the shoreline until a Dart shows no NAPL effect. After this location is determined, an additional Dart will be collected along this transect approximately 25 feet further parallel to the shoreline to confirm the extent of NAPL is delineated. A similar procedure will be used for transects perpendicular to the shoreline within the depth limits for effective and safe Dart installation.
  - Use passive detectors from multiple depth intervals and locations to identify potential NAPL presence and, as appropriate, delineate NAPL-impacted sediment in three dimensions. If NAPL is present, further characterization and delineation are needed. These efforts would include:
    - Evaluating the spatial relationships between the extent of NAPL in area of interest and NAPL in the upland area, taking local geology, hydrogeology, and NAPL characteristics into account

    - Evaluating the mobility of NAPL in area of interest based on physical properties and sediment characteristics
    - Evaluating whether the NAPL has impacted sediment (DQO Set 3)
  - If NAPL is not found, follow-up NAPL delineation and characterization efforts are not needed in the area of interest.
- **Step 6 – Decision Errors/Evaluation Approach.** Conduct qualitative and semiqualitative study. Analytical data will meet quality expectations for precision, accuracy, representativeness, comparability, and completeness as defined in the sampling and analysis plan (SAP) (Appendix A).
- **Step 7 – Optimize Sampling Design.** Perform passive detector and coring/sampling investigations at appropriate locations and depths to identify if NAPL is present, and if applicable, determine the spatial distribution of NAPL in sediment, identify potential sources, and characterize NAPL mobility. Study design is described in Section 6.1.1 and detailed in the SAP (Appendix A).

5.3 DQO Set 3 – Initial Characterization of Chemical Impacts to Sediment

The results of the DQO process for the initial characterization of potential chemical impacts to sediment from NAPL in the area of interest are summarized below.

- **Step 1 – Problem Statement.** It is unknown whether sediment in the area of interest is impacted by COCs associated with NAPL, if present.
- **Step 2 – Decisions.** Data are needed to determine if sediments in the area of interest have been impacted by COCs associated with petroleum NAPL and whether the sediments are toxic to benthic organisms and/or human health. If the sediments are impacted as defined by the Washington SMS, the area of interest would be considered a sediment cleanup site and additional sampling and/or analysis would be needed to delineate areas of impact, assess risks to ecological receptors, and assist in evaluation of potential remedial actions.
- **Step 3 – Inputs to the Decision.**
  - Results of NAPL nature and extent investigations
  - Analytical data for surface sediment samples
  - MTCA regulations published in WAC 173-340 (Ecology, 2007)
  - Cleanup provisions of the SMS under WAC 173-204, as described in SCUM II (Ecology, 2015), particularly Chapter 2 (Station Clustering and Site Identification)
  - Sediment Cleanup Objectives (SCOs) and Cleanup Screening Levels (CSLs) listed in the SMS[2]
- **Step 4 – Boundaries of Study.**
  - *Spatial* –Focus on locations where NAPL is identified as determined from the NAPL nature and extent assessment within the area of interest

[2] The SMS rule has a two-tiered decision-making framework (chemical and biological criteria at the SCO and CSL) to protect the functions and integrity of the benthic community, and is used for the initial evaluation of station clusters and site identification. The SCO includes chemical and biological criteria. Sediment values at or below the SCO are predicted to have no adverse effects on the benthic community. Sediment values above the CSL are expected to have minor adverse effects on the benthic community. Ecology allows for an optional Bioassay Override. If a station cluster of potential concern is identified, bioassay results may be used to confirm or override the chemistry results.

  - *Chemical* – Use analytical methods and detection limits appropriate to the SCOs and CSLs listed in the SMS

- **Step 5 – Decision Rules/ Evaluation Approach.** Compare analytical to SMS criteria, as shown on Figure 5-2 and summarized in the following steps.

  1. Compare surface sediment analytical results to Washington Freshwater SCOs, as listed in Table VI, WAC 173-204-53.

     a. If all concentrations are less than the SCOs, there is no sediment cleanup site and no further action or sampling is required.

     b. If one or more concentration is above the SCO, calculate an average concentration of the analyte(s) using the three samples with the highest concentrations. Go to Step 2.

  2. Compare the calculated average concentrations to the Washington Freshwater CSLs, as listed in Table VI, WAC 173-204-53.

     a. If all average concentrations are less than the CSLs, there is no sediment cleanup site and no further action or sampling is required.

     b. If one or more average concentrations are greater than the CSLs, a sediment cleanup site may be present and bioassay results are needed. Conduct bioassays on archived sediment samples to determine if sediments are toxic.

- **Step 6 – Decision Errors/Evaluation Approach.** Conduct quantitative (laboratory chemical analyses) and semiquantitative (bioassay) study. Analytical data will meet quality expectations for precision, accuracy, representativeness, comparability, and completeness as defined in the SAP (Appendix A).

- **Step 7 – Optimize Sampling Design.** Collect surface sediment samples from areas with NAPL impacted sediment, if present. Analyze for COCs, toxicity (if needed), and physical properties (TOC, grain size) to evaluate whether a sediment cleanup site is present and to assist in designing follow-up investigation and/or remedial action, if needed. Study design is described in Section 6.1.2 and detailed in the SAP (Appendix A).

SECTION 6

Project Tasks

This section provides an overview of the field sampling and data-gathering activities for the nearshore sediment initial investigation. Detailed descriptions of the activities are presented in the SAP (Appendix A).

6.1 Overview of Initial Investigation Activities

Initial investigation field activities will be conducted in three phases. The findings of each phase will be used to refine the sampling design for each subsequent phase. The data to be gathered and evaluated during each phase and the decisions to be made regarding the next phase of sampling are depicted on Figure 5-1.

6.1.1 Phase 1 – Historical Review and Bathymetric Survey

Phase 1 consists of a review of available documentation of the site and surrounding areas including:

- Historical maps and aerial photographs
- Upland data regarding NAPL nature and extent
- Bathymetric survey results

A summary of the historical review is provided in Section 3. A bathymetric survey of the Columbia River near Wishram was conducted in 2008 by the U.S. Army Corps of Engineers as part of its work to document the submerged condition of Celilo Falls (Oregon Public Broadcasting, 2008). In addition, a bathymetric survey was conducted by Solmar Hydro for this project on June 2, 2017. The results of this survey are shown on Figure 6-1. These two surveys will be compared in the RI report to assess the amount of deposition or erosion in the area of interest.

6.1.2 Phase 2 – Preliminary Identification of NAPL Impacts

Phase 2 consists of conducting and interpreting a Dart survey in the area of interest to screen for the presence or absence of NAPL and, if appropriate, delineate the extent of NAPL. The Dart sampler is a passive sampling device, consisting of a continuous rod made from or coated with solid-phase extraction media. PAHs in NAPL are attracted to and absorb into the solid-phase extraction media, which following removal from the sediment can be analyzed in the laboratory using a variety of methods, including LIF. The conceptual design for the Dart survey is shown on Figure 6-2.

The Dart samplers will be inserted into the sediment using vibracore technology and a Dart vibracore insertion tool deployed from a boat or by hand on the shoreline. Initially, 20 Darts will be installed to a target depth of 9 feet below the sediment surface.[3] The number, location, and installation depths for the Darts will be determined based on field observations/conditions and consultation with Ecology. Following installation, the Darts will be allowed to equilibrate in situ for approximately 2 days. After the equilibration period, the Darts will be extracted, individually wrapped in foil, and shipped overnight to Dakota Technologies for analysis with LIF using the Ultraviolet Optical Screening Tool. The results will be used to identify areas of probable NAPL impacts to benthic organisms and human health.

[3] Darts come in 3- and 6-foot sections that can be strung together. The longer the string, the harder to drive. The actual depth of installation will vary depending on site conditions.

The Dart investigation will continue laterally west along the shoreline until a Dart shows no NAPL effect. After this location is determined, an additional Dart will be collected along this transect parallel to the shoreline to determine if NAPL is present. A similar procedure will be used for transects perpendicular to the shoreline within the depth limits for effective and safe Dart installation. Based on field observations or other information, BNSF retains flexibility to step out or expand the sampling area. Additional Darts may be installed following the results of the initial deployment to fill data gaps.

6.1.3 Phase 3 – Characterization of NAPL Extent and Mobility/Initial Characterization of COC Impacts to Sediment

Phase 3 consists of collecting and analyzing surface and subsurface sediment samples in the area of interest to:

- Confirm Dart survey NAPL delineation.
- Characterize sediment ebullition potential.
- Characterize NAPL mobility and pore fluid saturation at locations with confirmed NAPL.
- Compare concentration of chemical constituents to SMS freshwater sediment criteria.

A brief description of sampling activities designed to support these objectives are provided below and summarized in Table 6-1. Additional information is provided in Appendix A.

Confirmatory Sediment Borings. Following review of the results of the Dart survey, up to six sediment cores may be collected using direct-push technology to confirm NAPL delineations gathered in the Dart survey. Cores will be collected using direct-push technology to approximately 10 feet below the mudline (BML). Assuming areas of probable NAPL impact are identified, up to five cores will be collected at locations with probable subsurface NAPL impact and one at an unimpacted location. Cores will be logged and screened using visual, olfactory, and photo-ionization detector observations to confirm NAPL presence at each location.

Ebullition Potential Sampling. Surface (0 to 6 inches BML) and subsurface (more than 6 inches BML) samples will be collected and analyzed for TOC and COD to support characterization of ebullition potential at various depths. Seven surface sediment samples will be collected at the site as grab samples. Surface sediment sampling will occur concurrently with surface sediment samples for COC analysis (described below). Assuming areas of probable NAPL impact are identified, up to five samples will be collected from surface NAPL impacted locations and two samples will be collected from locations with no apparent NAPL impact. Subsurface sampling will occur concurrently with the confirmatory sediment boring collection described above. Two samples will be collected from each core (12 samples total) at depths based on sampler discretion and will target areas with visible NAPL (so that the ebullition potential at depths with NAPL impacts can be assessed).

NAPL Mobility Cores. If NAPL is confirmed to be present in the confirmatory sediment borings, undisturbed sediment cores will be collected for NAPL mobility and pore fluid saturation analysis. The NAPL mobility cores will be collocated with the confirmatory sediment cores collected at locations with NAPL impacts (if present, up to five locations). Undisturbed, 5-foot cores will be collected using direct-push technology over a depth range determined based on observation of the confirmatory sediment cores (to target depths with NAPL impacts). The NAPL mobility cores will be collected in stainless steel Macro-core tubes, capped, frozen horizontally on dry ice to preserve pore fluids, and shipped for laboratory analysis. Further details regarding core collection and sampling are provided in Attachment 1 to the SAP (Appendix A) and summarized in Table 6-1.

Upon receipt by the laboratory, cores will be cut into 2-inch segments and photographed under visible and ultraviolet light. NAPL typically fluoresces under ultraviolet light and can be used to identify NAPL impacts. A subset of the core segments with NAPL impacts will be scanned with LIF and the results will be used to select a subset of core segments for NAPL mobility analysis (including assessment of pore-fluid saturation, grain size, and NAPL mobility by water drive). During this analysis, selected core segments will also be analyzed using a small version of a Dart sampler so that the NAPL mobility results can later be correlated to the Dart survey results. The relationship of Dart response to pore fluid saturation generated in the lab will be used as a means with which to assess the Dart survey data generated as part of work outlined in Section 6.1.2. Figure 6-3 presents a flowchart describing the steps in the NAPL core analysis process, which is also summarized in Table 6-1.

Surface Sediment Samples for COC Analysis. Surface sediment samples will be collected and analyzed to determine COC concentrations for comparison to SMS criteria using the process shown on Figure 5-2.

Under MTCA, surface sediment consists of the biologically active zone for benthic organisms, which, for this investigation, is assumed to be the upper 4 to 6 inches of sediment. A total of five surface sediment samples will be collected from locations with the highest suspected surface impacts, which will be selected based on results of the Dart survey (five allows for the selection of the three most-impacted samples for calculation of average concentrations if comparison to CSLs is needed [Figure 5-2]). Two additional samples will be collected from locations where impacts are not present (as determined based on the Dart survey). At least one of these locations will be upstream in an area without suspected site impacts and will serve as a reference location. The samples will be collected using a Van Veen or similar device deployed from a boat. The samples will be analyzed for TPH-diesel, TPH-residual, PAHs with selected ion monitoring, TOC, COD, and grain size using the methods listed in Table 6-1. A 4-liter portion of each surface sediment sample will be held at the laboratory to be used for bioassays, if chemical analytical results indicate exceedances of SMS criteria.[4] Descriptions of potential bioassay sampling and testing protocols tests are provided in the SAP (Appendix A).

6.2 Laboratory Analyses and Data Validation

Dart sampler, sediment, and other media samples will be submitted under chain-of-custody protocols to the subcontracted laboratories and will be analyzed on a standard turn-around basis. Sample handing, packing, shipping procedures, and data validation procedures are identified in the SAP (Appendix A).

Laboratory analyses will be conducted in accordance with the SAP (Appendix A). Analytical methods, containers, and holding times are provided in Table 6-2.

6.3 Data Evaluation

Each phase of the field investigation will be followed by data evaluation and consultation with Ecology to evaluate the need for and scope of the subsequent phase(s). The following sections summarize the evaluation process.

6.3.1 Historical Review and Bathymetric Survey

The data from the historical review and the bathymetric survey have been used—along with input from Ecology—to identify the area of interest for the nearshore RI. The information will also be incorporated into the nearshore CSM and the integrated CSM for the site proper and nearshore area.

[4] The maximum holding times allowed for sediment samples held at 4 degrees Celsius in the dark and under a nitrogen atmosphere is up to 8 weeks prior to bioassay testing.

6.3.2 Preliminary Identification of NAPL Impacts

The occurrence of NAPL in the area of interest is unknown. The results of the Dart survey will be evaluated to delineate areas of probable NAPL. Data regarding NAPL extent determined during the Dart survey will be incorporated into the integrated CSM. If present, locations of NAPL impacts determined during the Dart survey will inform the selection of locations for coring and surface sediment sampling as summarized on Figure 6-1.

6.3.3 Characterization of NAPL Extent and Mobility / Initial Characterization of COC Impacts to Sediment

Analysis of surface and subsurface sediment samples will support determination of NAPL occurrence, and, if appropriate, extant, mobility, and transport mechanisms. The analysis will also provide an initial characterization of COC impacts to sediment.

Characterization of NAPL Extent and Mobility. If areas of probable NAPL impact are identified during the Dart survey, sediment cores will be screened to confirm these results. If NAPL is confirmed, sediment cores will be screened to select depths for undisturbed NAPL mobility core collection. The results of the NAPL mobility core analyses would be used to characterize NAPL mobility and pore fluid saturation. LIF and Dart analysis incorporated into the NAPL mobility core analysis process would be used to correlate pore fluid saturation results to LIF data collected at the site proper and the Dart survey performed in the nearshore area.

If probable NAPL impacts are identified during the Dart survey, TOC and COD data will be used to estimate ebullition potential at various locations and depths and in areas with and without NAPL to understand whether ebullition-facilitated transport of NAPL is likely in the area of interest or if ebullition primarily occurs only at depths without significant NAPL. The molar flux of gases (ebullition) (GF_m) is correlated to the limiting methanogenic substrate portion of the organic matter (S_{labile}) as described by the following empirical model:

$$GF_m = 7.39 + 12.3\ T - 186\ S_{labile}$$

where T is sediment temperature (Viana et al., 2012). S_{labile} can be estimated as the sediment COD/TOC ratio. For this RI, S_{labile} will be determined for all sample locations to quantify their relative ebullition potential. The absolute flux of gases at the site is considered less relevant because this parameter is temperature dependent and, as such, varies throughout the year.

Initial Characterization of COC Impacts to Sediment. As indicated in Section 5.2, it is unknown whether sediment in the area of interest has been impacted by chemicals in NAPL such that the sediment is toxic to benthic organisms, which could designate the area as a sediment cleanup site. The process for conducting this evaluation is described in Chapter 2 of SCUM II (Ecology, 2015), summarized in Section 5.3, and depicted on Figure 5-2.

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Tables

Table 2-1. Project Team

BNSF Wishram Track Switching Facility Nearshore Sediment Initial Investigation Work Plan, Wishram, Washington

Company/Agency	Personnel	Responsibility
BNSF Railway Company	Shane DeGross	Manager Environmental Remediation
Washington State Department of Ecology	John Mefford	Cleanup Project Manager
	Chris Wend	Assistant Cleanup Project Manager
Kennedy/Jenks Consultants	Ryan Hultgren	Project Manager
	Todd Miller	Program Manager
	Alice Robinson	Field Lead/Site Safety Coordinator
	Matt Biondolillo	Subject Matter Expert, Sediment Investigation/Remediation
CH2M HILL Engineers, Inc.	Carrie Andrews	Senior Project Manager
	Jeff Gentry, PE	Senior Technical Consultant
	Marilyn Gauthier, PG	Subject Matter Expert, Geology and Sediment
	David Finney	Subject Matter Expert, NAPL
	Jeff Schut	Subject Matter Expert, Ecological Risk/Bioassay
	Jennifer Ulrich	Field Sampling Lead/Site Safety Coordinator
	Bernice Kidd	Project Chemist/Data Validation
	Dusty Berggren	NAPL Mobility Laboratory Task Lead

Note:

NAPL = nonaqueous phase liquid

Table 2-2. Tentative Project Schedule

BNSF Wishram Track Switching Facility Nearshore Sediment Initial Investigation Work Plan, Wishram, Washington

Date	Task
January 2018	Submit Sampling and Analysis Plan to Ecology
1st or 2nd Quarter 2018	Conduct Dart Survey and Analysis
	Conduct Field Sediment Sampling
1st or 2nd Quarter 2018	Complete Laboratory Analyses of Sediment Samples
1st or 2nd Quarter 2018	Submit Initial Nearshore Evaluation Report to the Ecology for Review
1st or 2nd Quarter 2018	Submit Initial Nearshore Evaluation Report and Data to Ecology in EIM System

Note:

Ecology = Washington State Department of Ecology

EIM = Environmental Information Management System

Table 3-1. Columbia River Designate Uses

BNSF Wishram Track Switching Facility Nearshore Sediment Initial Investigation Work Plan, Wishram, Washington

Aquatic Life Use	Recreation Use	Water Supply Use	Miscellaneous Use
Spawning/Rearing	Primary Contact	Domestic	Wildlife Habitat
Salmonid Migration		Industrial	Harvesting
		Agricultural	Commerce/Navigation
		Stock	Boating
			Aesthetics

Table 6-1. Sampling and Analysis Summary for Nearshore Investigation

BNSF Wishram Track Switching Facility Nearshore Sediment Initial Investigation Work Plan, Wishram, Washington

Location	Number of Locations	Matrix	Depth	Analysis	Rationale
Area of Interest	20+	Dart Sampler	0 to 9 feet	UVOST	Screen for the presence or absence of NAPL
NAPL-impacted subsurface locations (if present)	Up to 5	DPT sediment core	0 to 10 feet	Core logging and field observation	NAPL delineation conformation; selection of NAPL mobility core depths
			Two depths, sampler discretion[a]	TOC	Characterization of subsurface ebullition potential
				COD	
		Undisturbed sediment core (Macro-Core)	TBD (5-foot cores)	Core photography (visible and UV light)	Selection of core subsamples for NAPL mobility and PFS analysis
				Frozen core LIF with TarGOST	
				NAPL mobility by water drive	Characterization of NAPL mobility and PFS
				Pore fluid saturation	
				Particle size distribution	
				Core sample screening using Dart system and UVOST	Correlate PFS and Dart sampler response (so that laboratory results can be extrapolated to all locations included in the Dart survey)
NAPL-impacted surface locations (if present)[b]	5	Sediment grab	0 to 6 inches	TPH-diesel	Chemical characterization of surface sediment to support sediment cleanup site identification
				TPH-residual	
				PAH (SIM)	
				Grain size	
				TOC	Chemical characterization of surface sediment to support sediment cleanup site identification; characterization of surface ebullition potential
				COD	Characterization of surface ebullition potential
				Bioassays (if needed)[c]	Collect and hold sample for possible bioassays (Figure 5-2)

Table 6-1. Sampling and Analysis Summary for Nearshore Investigation

BNSF Wishram Track Switching Facility Nearshore Sediment Initial Investigation Work Plan, Wishram, Washington

Location	Number of Locations	Matrix	Depth	Analysis	Rationale
Unimpacted subsurface location	1	DPT sediment core	0 to 10 feet	Core logging and field observation	NAPL delineation conformation
			Two depths, sampler discretion	TOC	Characterization of subsurface ebullition potential
				COD	
Unimpacted surface locations	2[d]	Sediment grab	0 to 6 inches	TPH-diesel	Chemical characterization of surface sediment
				TPH-residual	
				PAH (SIM)	
				TOC	Characterization of surface ebullition potential
				COD	
				Bioassays (if needed)[c]	Collect and hold sample for possible bioassays (Figure 5-2)

[a]Samples will be collected at depths with visually identified NAPL impacts.

[b]If areas of probable NAPL impact are not identified in surface sediment during the Dart survey, locations will be selected in areas with the highest suspected surface sediment impacts.

[c]Bioassays will only be performed in the event that all concentrations of chemicals of concern are greater than or equal to the SCO and the average of the three highest measured concentrations for each chemical of concern is greater than the CSL (Figure 5-2).

[d]At least one unimpacted surface locations sites will be in an area upstream with clean sediment and will serve as a reference location if bioassays are performed.

Notes:

COD = chemical oxygen demand
CSL = cleanup screening level
DPT = direct-push technology
LIF = laser-induced fluorescence
NAPL = nonaqueous phase liquid
PAH = polycyclic aromatic hydrocarbon
PFS = pore fluid saturation
SCO = sediment cleanup objective
SIM = select ion monitoring
TarGOST = Tar-specific Green Optical Screening Tool
TBD = to be determined
TOC = total organic carbon
TPH = total petroleum hydrocarbons
UV = ultraviolet
UVOST = Ultraviolet Optical Screening Tool

Table 6-2. Summary of Analytical Methods, Containers, and Holding Times

BNSF Wishram Track Switching Facility Nearshore Sediment Initial Investigation Work Plan, Wishram, Washington

Parameter	Analytical Method	Container	Preservation	Maximum Holding Time
Dart Samplers				
Dart sampler analysis	UVOST	Wrap in foil	N/A	N/A
Sediment				
Total organic carbon	SW9060 (with guidance from the SCUM II Manual)	4-oz glass jar	Cool, ≤ 6°C	28 days
Chemical oxygen demand	EPA 410.4	4-oz glass jar	Cool, ≤ 6°C	28 days
Total petroleum hydrocarbons-diesel and oil ranges with EPH/VPH fractioning	NWTPH-Dx	4-oz glass jar	Cool, ≤ 6°C	14 days to extraction, 40 days to analysis
Polynuclear aromatic hydrocarbons	SW8270C or D-SIM	4-oz glass jar	Cool, ≤ 6°C	14 days to extraction, 40 days to analysis
Core photography (visible and UV light)	N/A	1 x DPT nominal 1.25-inch stainless steel Macro-Core tube (frozen)	Frozen on dry ice	N/A
LIF frozen core analysis with TarGOST	N/A			
Pore fluid saturation (water, oil) (includes bulk density, total porosity, particle density)	Dean-Stark API (1998) Sec. 4.3			
Core sample screening using Dart system and UVOST	N/A			
Grainsize (particle size including hydrometer)	ASTM D422			
Product mobility by water	ASTM 6836			
NAPL flooding				
Bioassays (if needed)[a]	(Appendix A)	1 x 5-gallon bucket[b]	Cool, 4°C, nitrogen	8 weeks

Table 6-2. Summary of Analytical Methods, Containers, and Holding Times

BNSF Wishram Track Switching Facility Nearshore Sediment Initial Investigation Work Plan, Wishram, Washington

Parameter	Analytical Method	Container	Preservation	Maximum Holding Time
Water (Equipment Blanks)				
Total petroleum hydrocarbons (diesel and oil ranges)	NWTPH-Dx	2 x 1-liter amber glass	Cool, ≤ 6°C, HCl to pH<2	7 days to extraction, 40 days to analysis
Polynuclear aromatic hydrocarbons	SW8270-SIM	2 x 1-liter amber glass	Cool, ≤ 6°C	7 days to extraction, 40 days to analysis

[a]Bioassays will only be performed in the event that all concentrations of chemicals of concern are greater than or equal to the SCO and the average of the three highest measured concentrations for each chemical of concern is greater than the CSL (Figure 5-2).

[b]Samples will be collected and held by the laboratory without further action until it is determined if bioassays are necessary (Figure 5-2). The maximum holding time allowed for sediment samples held at 4°C in the dark and under a nitrogen atmosphere is up to 8 weeks before bioassay testing.

Notes:
°C = degree(s) Celsius
≤ = less than or equal to
API = American Petroleum Institute
CSL = cleanup screening level
DPT = direct-push technology
EPA = U.S. Environmental Protection Agency
EPH = extractable petroleum hydrocarbons
HCl = hydrogen chloride
LIF = laser-induced fluorescence
N/A = Not applicable
NAPL = non-aqueous phase liquid
oz = ounce
pH = hydrogen (ion) concentration
SCO = sediment cleanup objective
TarGOST = Tar-specific Green Optical Screening Tool
UV = ultraviolet
UVOST = Ultraviolet Optical Screening Tool
VPH = volatile petroleum hydrocarbons

Figures

INSERT FIGURES

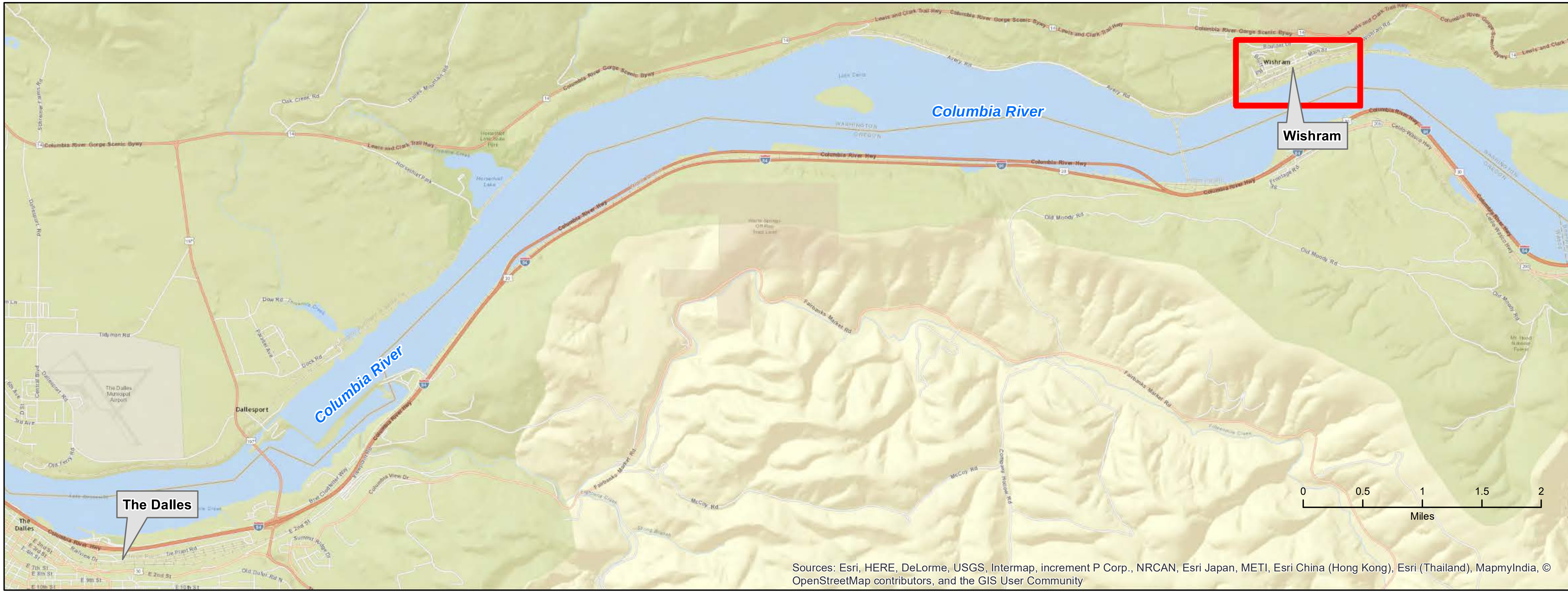


Figure 1-1. Site Location Map
BNSF Track Switching Facility
Wishram, Washington

ch2m.

\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\WORKPLAN\FIGURE1-1_SITEMAP.MXD GGEE 7/5/2017 1:27:14 PM

LEGEND

- Approximate historical lateral extent of Dissolved-Phase Diesel- and/or Oil-Range Organics above the MTCA Method A groundwater cleanup level (500 µg/L)
- Historic Yard Features
- Approximate Lateral Extent of Oil
- Ecology River Bank Sheen Observed (March 3, 2017 Letter)
- Area of Intermittent NAPL Sheening
- Small-extent NAPL Sheens Observed (Ecology, 2017)
- Potential Drainage Feature
- Approximate BNSF Property Line

Notes:
NAPL = nonaqueous phase liquid
µg/L = microgram(s) per liter
MTCA = Model Toxics Control Act

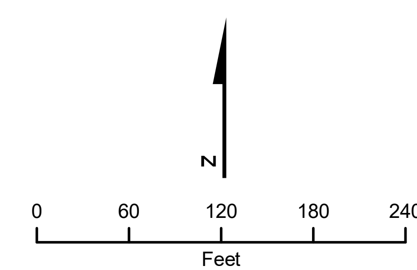


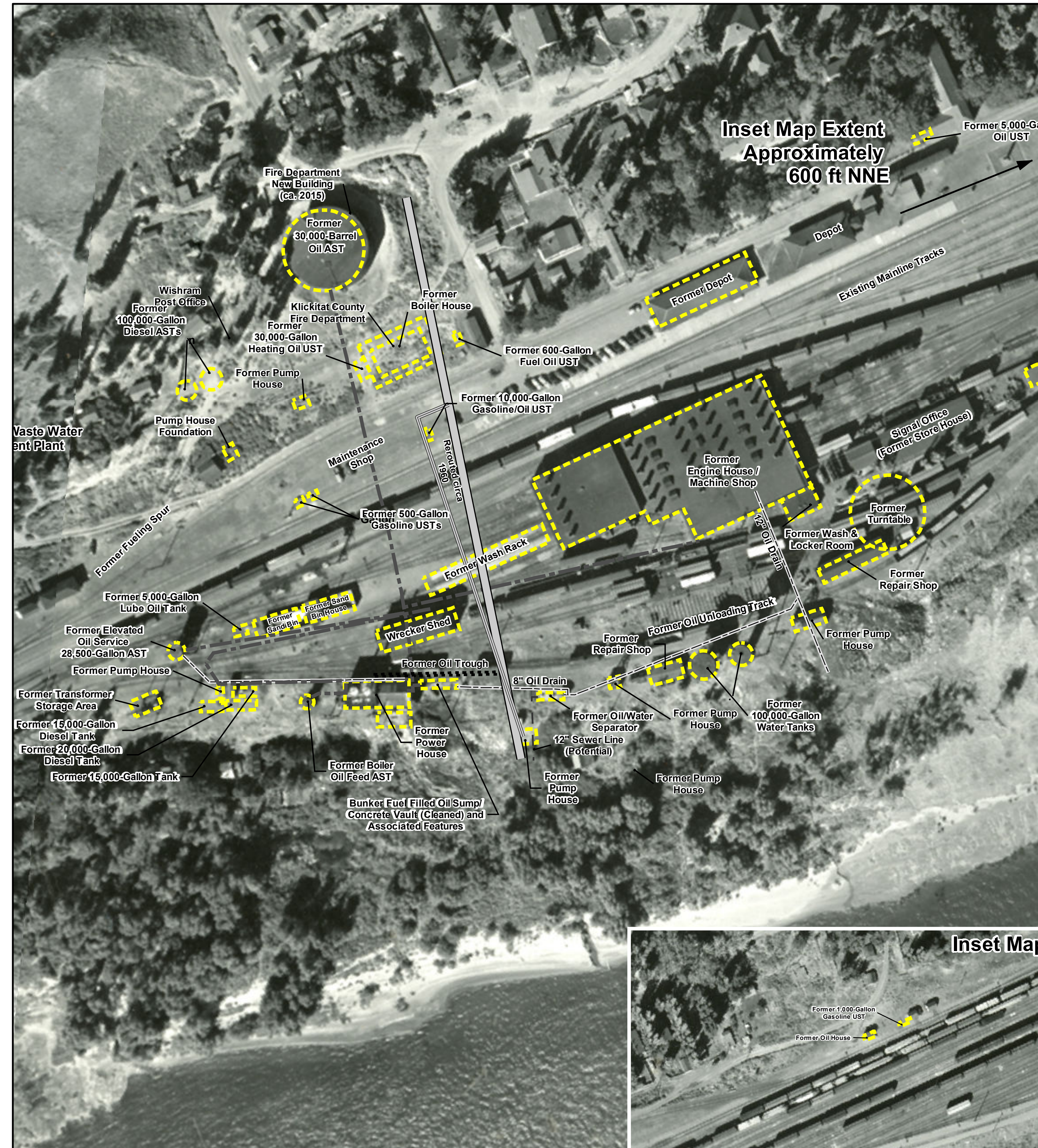
Figure 1-2. Wishram Railyard and Nearshore Sediment Area of Interest
BNSF Track Switching Facility
Wishram, Washington

ch2m

\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\WORKPLAN\FIGURE1-2_AOI.MXD SJ063666 1/24/2018 11:23:43 AM

Current Features with Former Feature Footprints (Aerial Date: 2015)

Former Features (Aerial Date: 1951)



LEGEND

- Former Bunker Fuel / Oil Pipeline
- Former Oil Drain
- Former Oil Trough
- Former Sewer Line (Potential)
- Stormwater Underdrain (A portion removed from service circa 1960)
- Stormwater Underdrain (Rerouted portion circa 1960)
- Existing Site Feature
- Former Site Feature
- Approximate BNSF Property Line
- Former Site Feature

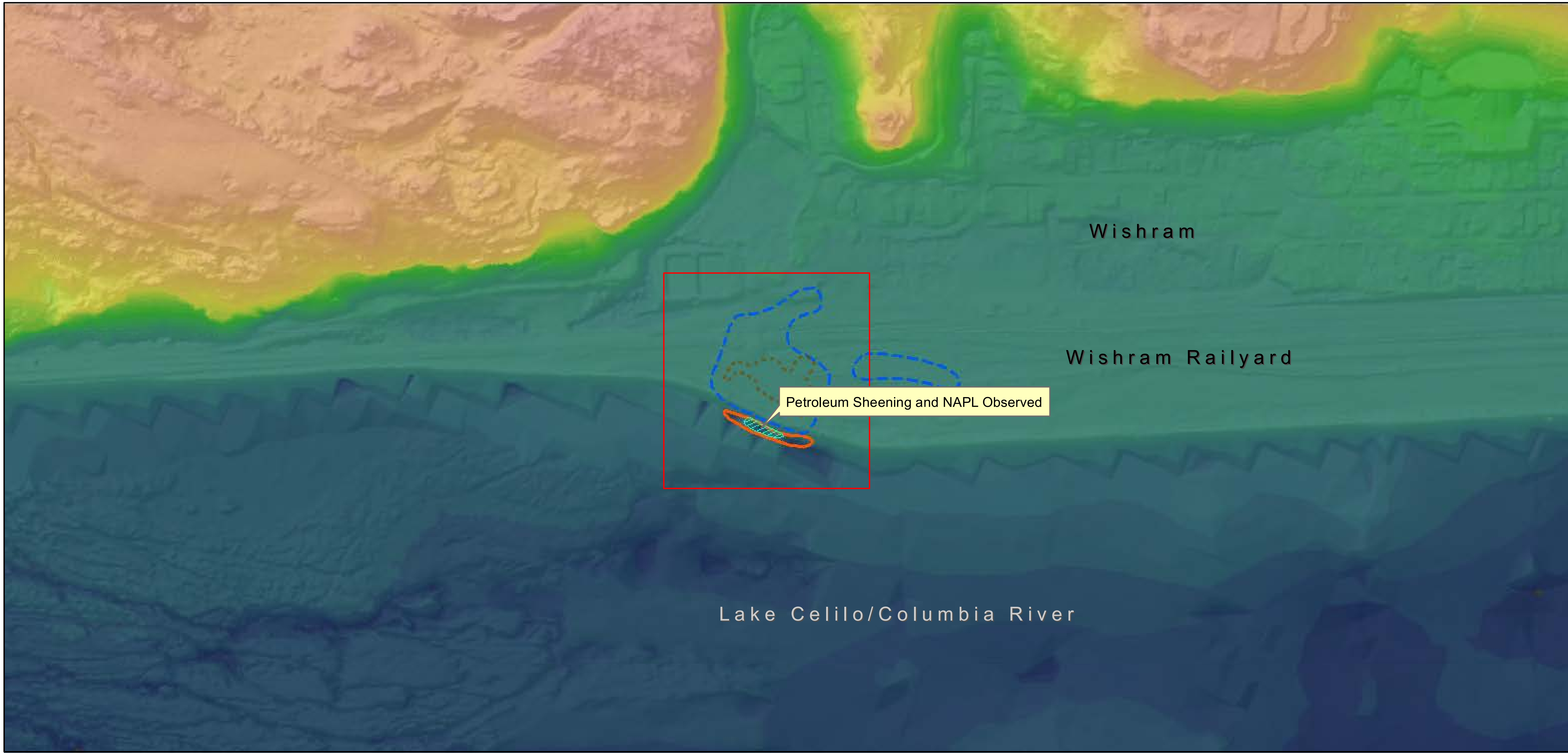
N

0 75 150 300 Feet

Figure 1-3. Current and Former Site Features
BNSF Track Switching Facility
Wishram, Washington

ch2m.

\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\WORKPLAN\FIGURE1-3_SITEFEATURES.MXD SJ063666 1/24/2018 11:28:11 AM



VICINITY MAP

LEGEND

- Approximate historical lateral extent of Dissolved-Phase Diesel- and/or Oil-Range Organics above the MTCA Method A groundwater cleanup level (CUL) (500 µg/L)
- Approximate Lateral Extent of Oil
- Area of Intermittent NAPL Sheening
- Small-extent NAPL Sheens Observed (Ecology, 2017)

Elevation (NAVD88, m)

High : 203

Low : 30

N

0 250 500 750 1,000

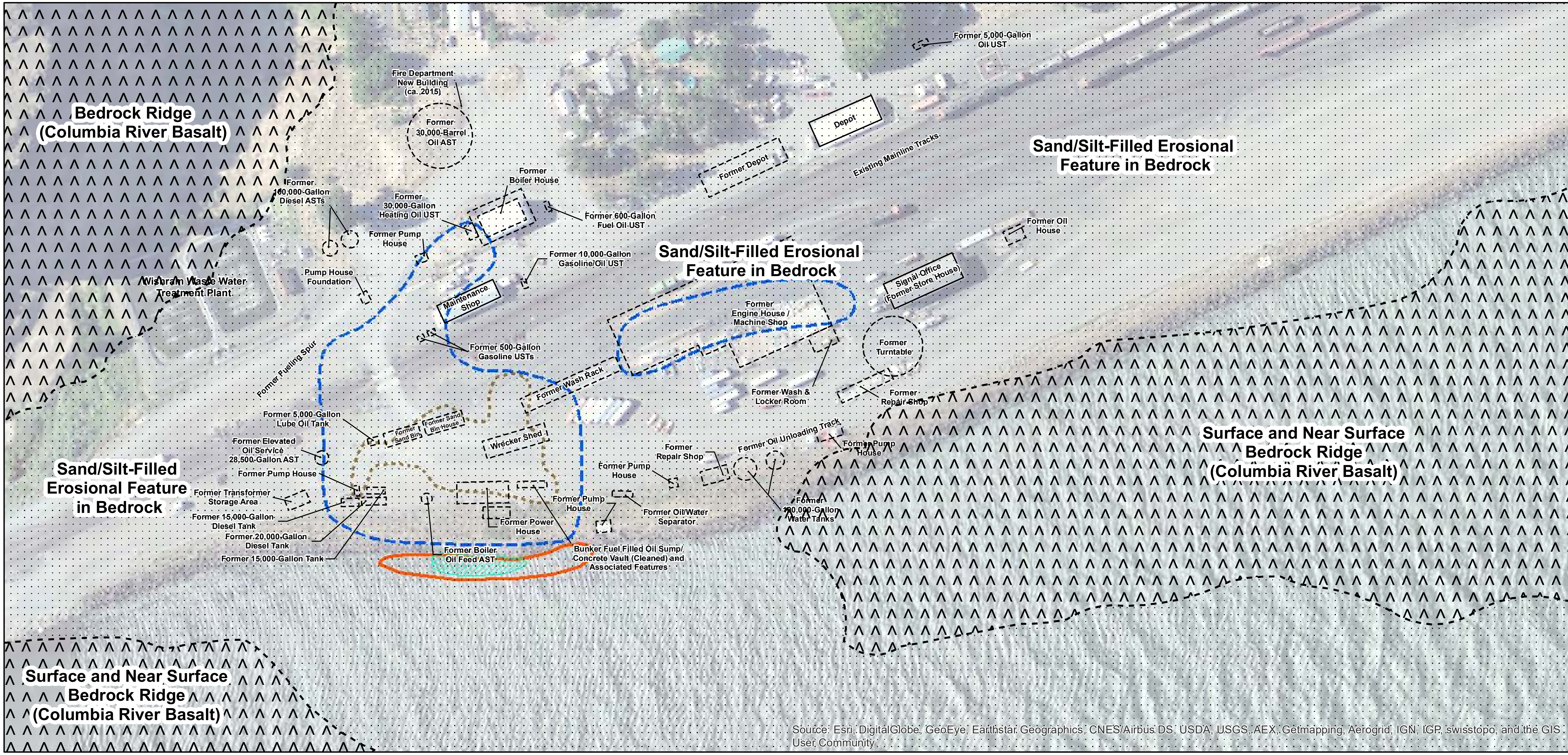
Feet

Notes:
NAPL = non-aqueous phase liquid
NAVD88 = North American Vertical Datum of 1988
m = meters
LIDAR Source: USACE, 2007.

Figure 3-1. Local Topography near Wishram Railyard
BNSF Track Switching Facility
Wishram, Washington

ch2m.

\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\WORKPLAN\FIGURE3-1_TOPOGRAPHY.MXD GGEE 7/21/2017 9:13:15 AM



VICINITY MAP

LEGEND

- Bedrock
- Sand/Silt-Filled Erosional Feature in Bedrock
- Existing Site Feature
- Former Site Feature
- Approximate historical lateral extent of Dissolved-Phase Diesel- and/or Oil-Range Organics above the MTCA Method A groundwater cleanup level (CUL) (500 µg/L)
- Approximate Lateral Extent of Oil
- Area of Intermittent NAPL Sheening
- Small-extent NAPL Sheens Observed (Ecology, 2017)

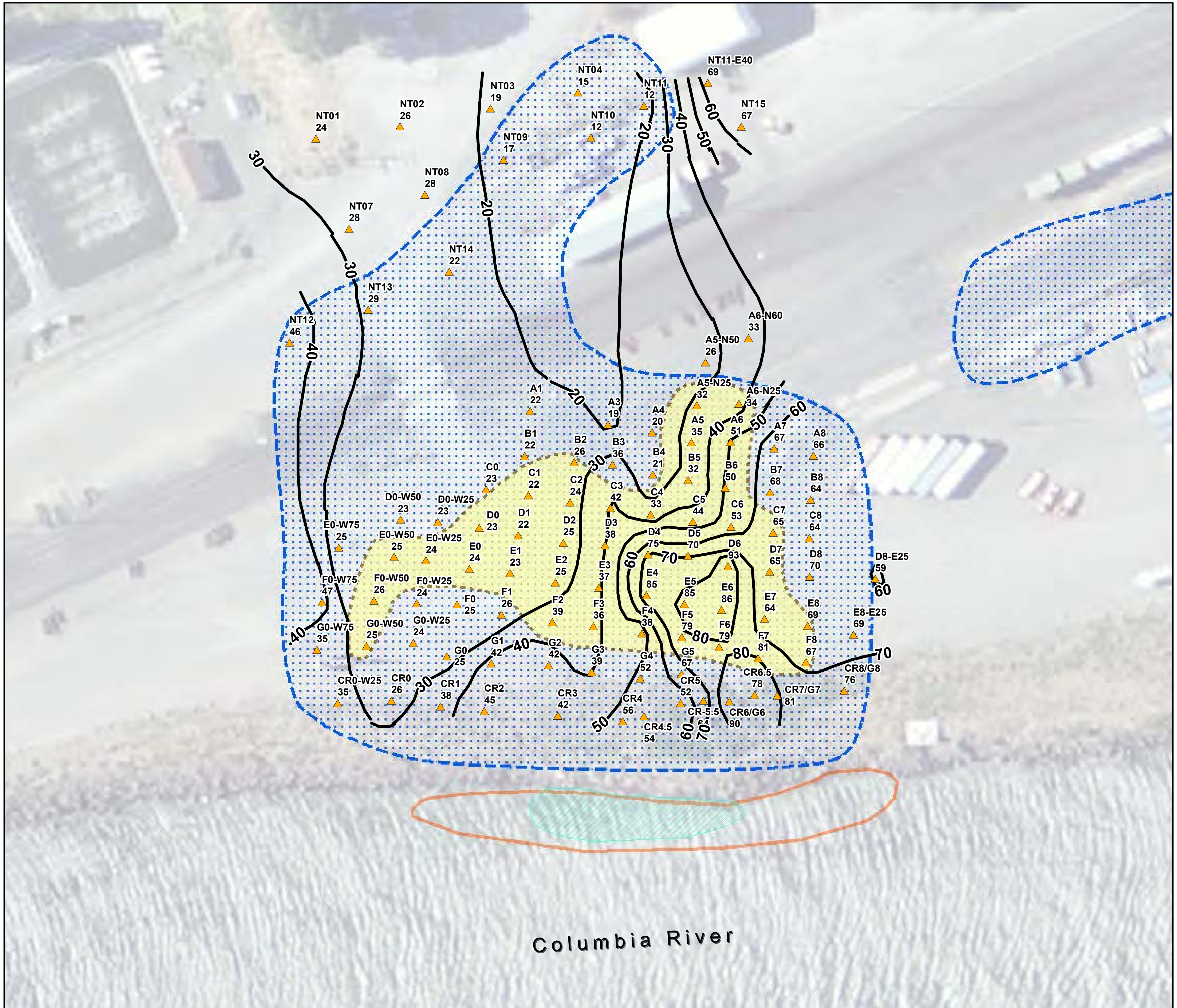
N

0 110 220 330 440
Feet

Notes:
NAPL = non-aqueous phase liquid
NAVD88 = North American Vertical Datum of 1988
m = meters

Figure 3-2. Surface Geology in Vicinity of Area of Interest
BNSF Track Switching Facility
Wishram, Washington

ch2m:



VICINITY MAP

LEGEND

- LIF Survey Location (2013) with Estimated Bedrock Depth (ft)
- Estimated Depth to Bedrock Contour[1] (ft below ground surface, 10 ft interval dashed where inferred)
- Approximate historical lateral extent of Dissolved-Phase Diesel- and/or Oil-Range Organics above the MTCA Method A groundwater cleanup level (CUL) (500 µg/L)
- Approximate Lateral Extent of Oil
- Area of Intermittent NAPL Sheening
- Small-extent NAPL Sheens Observed (Ecology, 2017)

Notes:
[1]Depth to bedrock surface approximated based on LIF survey data (Kennedy/Jenks Consultants, 2016).
LIF survey data source (Kennedy/Jenks Consultants, 2016)
NAPL = non-aqueous phase liquid
NAVD88 = North American Vertical Datum of 1988

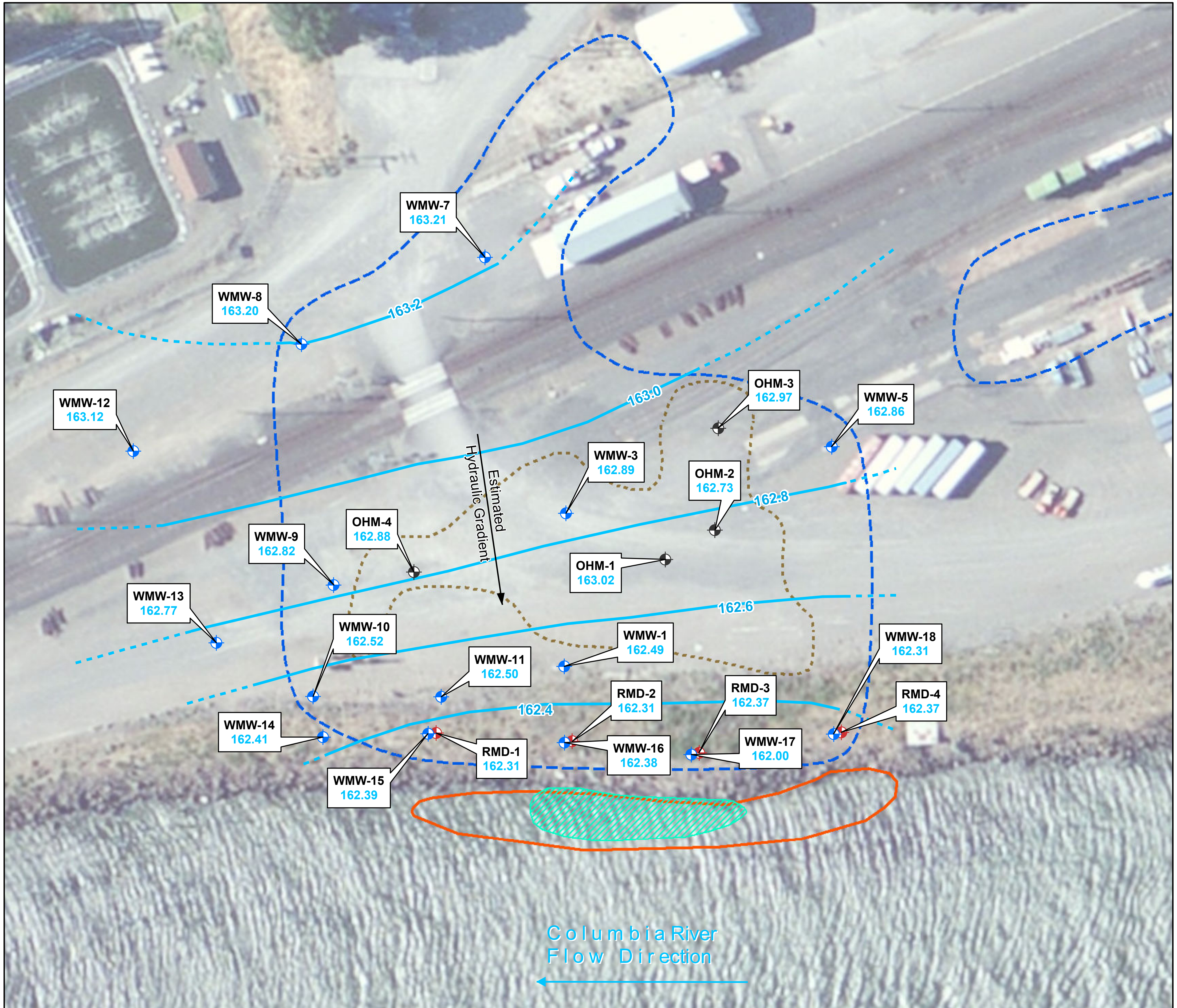
N

0 30 60 90 120
Feet

Figure 3-3. Depth to Bedrock Measurements at Wishram Railyard
BNSF Track Switching Facility
Wishram, Washington

ch2m.

\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\WORKPLAN\FIGURE3-3_BEDROCK.MXD GGEE 7/21/2017 10:18:52 AM



VICINITY MAP

LEGEND

- Deep Monitoring Well
- Oil Head Monitoring Well
- Shallow Monitoring Well
- 162.4 Approximate Potentiometric SurfaceContour (feet AMSL, Dashed Where Inferred)
- Approximate Lateral Extent of Oil
- Approximate historical lateral extent of Dissolved-Phase Diesel- and/or Oil-Range Organics above the MTCA Method A groundwater cleanup level (CUL) (500 µg/L)
- Area of Intermittent NAPL Sheening
- Small-extent NAPL Sheens Observed (Ecology, 2017)

Notes:
WMW-17* = Groundwater elevation not used for contouring.
1. All locations are approximate and have been detemined using past reports and historical maps and images.
2. Potentiometric surface contour in feet above mean sea level (AMSL) based on measurements recorded 17 April 2017.
3. Approximate BNSF property lines are based on surveys, Klickitat County parcel maps and other available information. Where relevant, actual property lines should be confirmed in the field.

NAPL = non-aqueous phase liquid
NAVD88 = North American Vertical Datum of 1988

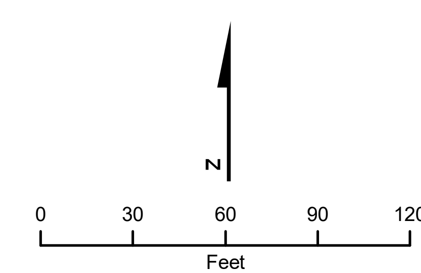
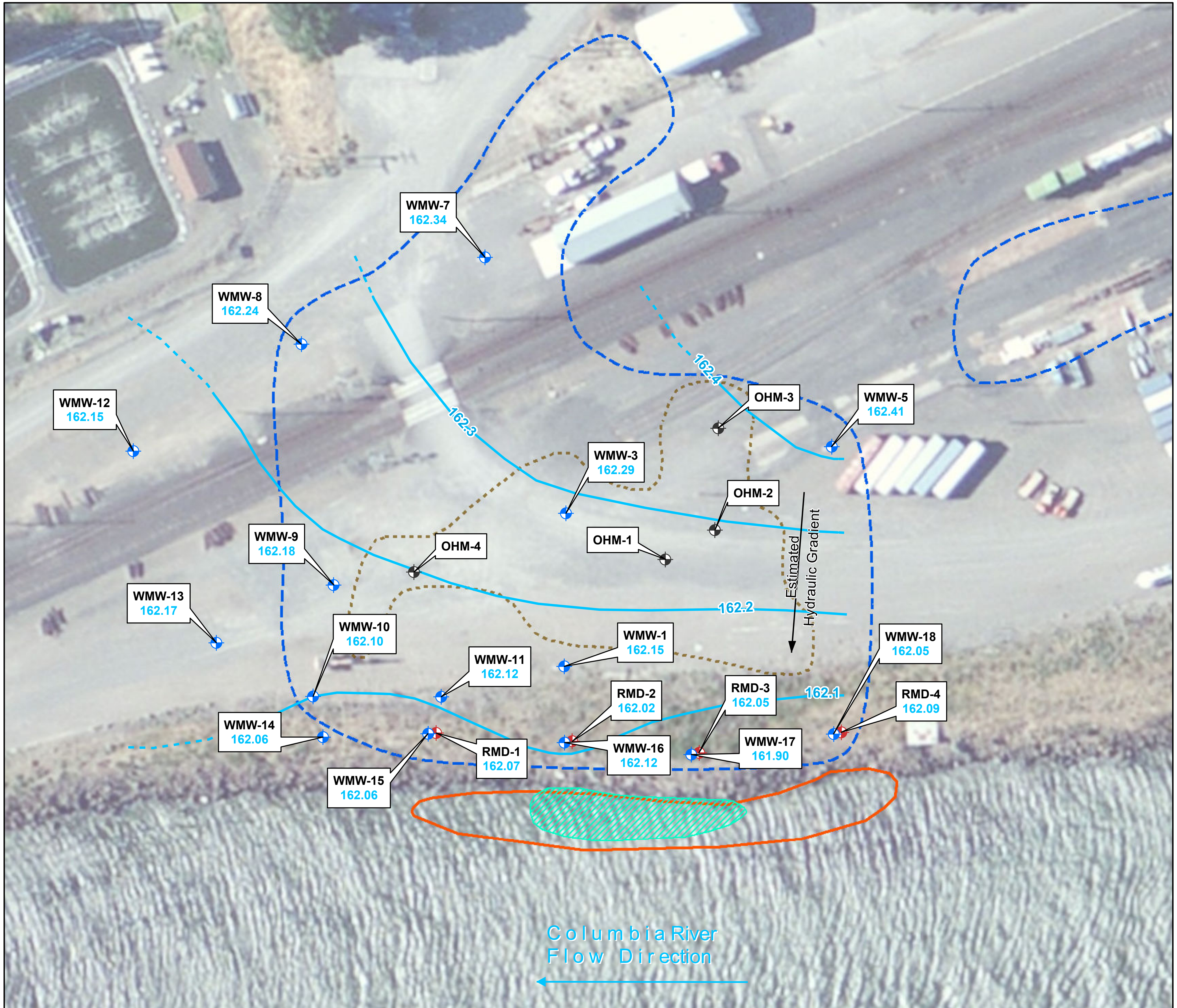


Figure 3-4A. Groundwater Elevation and Flow Direction at Wishram Railyard Flow Direction - April 2017
BNSF Track Switching Facility
Wishram, Washington

ch2m.

\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\WORKPLAN\FIGURE3-4A_GROUNDWATER.MXD SJ063666 11/30/2017 2:17:43 PM



VICINITY MAP

LEGEND

- Deep Monitoring Well
- Oil Head Monitoring Well
- Shallow Monitoring Well
- 162.4 Approximate Potentiometric SurfaceContour (feet AMSL, Dashed Where Inferred)
- Approximate Lateral Extent of Oil
- Approximate historical lateral extent of Dissolved-Phase Diesel- and/or Oil-Range Organics above the MTCA Method A groundwater cleanup level (CUL) (500 µg/L)
- Area of Intermittent NAPL Sheening
- Small-extent NAPL Sheens Observed (Ecology, 2017)

Notes:
WMW-17* = Groundwater elevation not used for contouring.
1. All locations are approximate and have been detemined using past reports and historical maps and images.
2. Potentiometric surface contour in feet above mean sea level (AMSL) based on measurements recorded 17 April 2017.
3. Approximate BNSF property lines are based on surveys, Klickitat County parcel maps and other available information. Where relevant, actual property lines should be confirmed in the field.

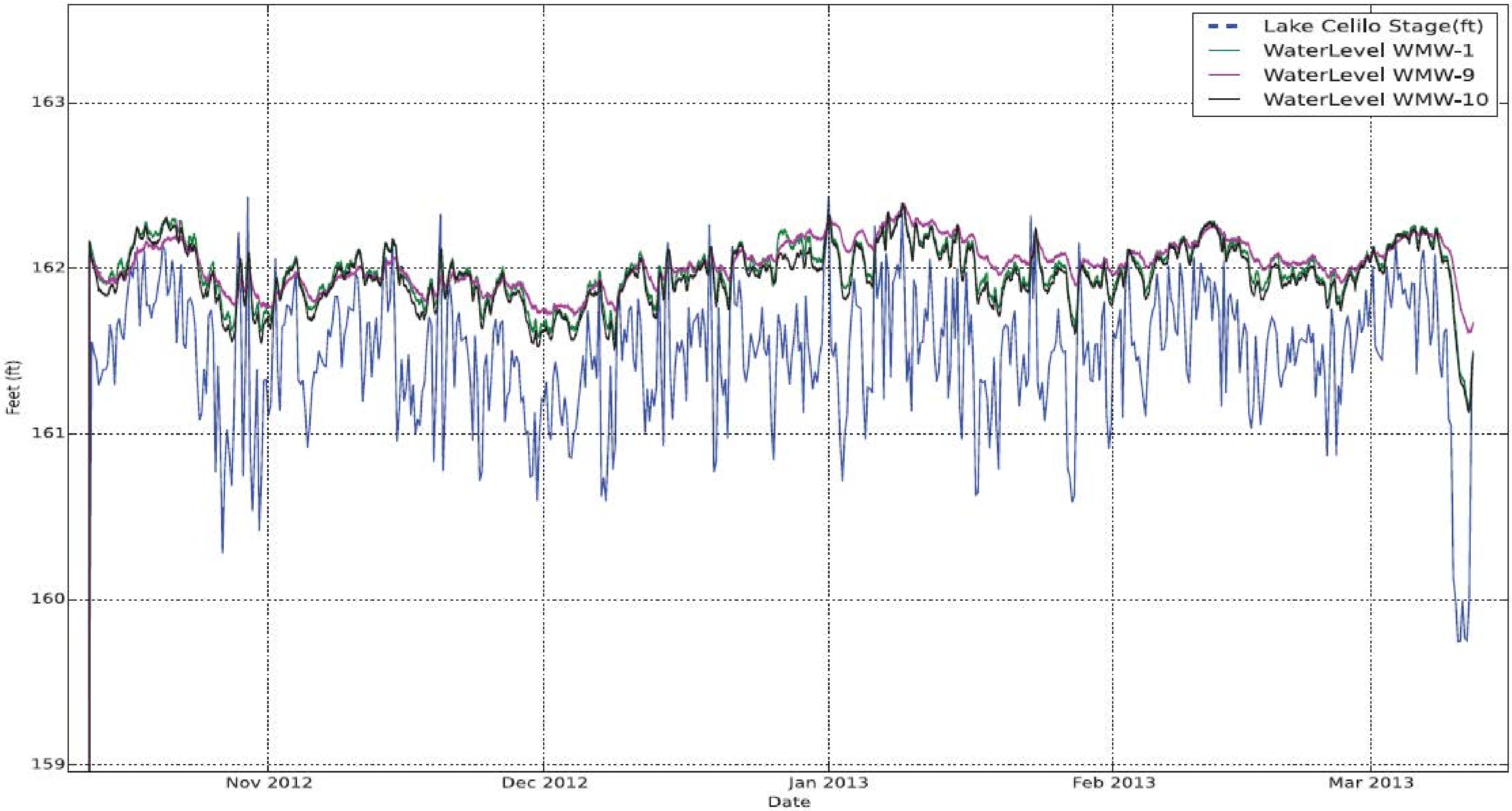
NAPL = non-aqueous phase liquid
NAVD88 = North American Vertical Datum of 1988

N

0 30 60 90 120
Feet

Figure 3-4B. Groundwater Elevation and Flow Direction at Wishram Railyard Flow Direction - September 2017
BNSF Track Switching Facility
Wishram, Washington

ch2m.

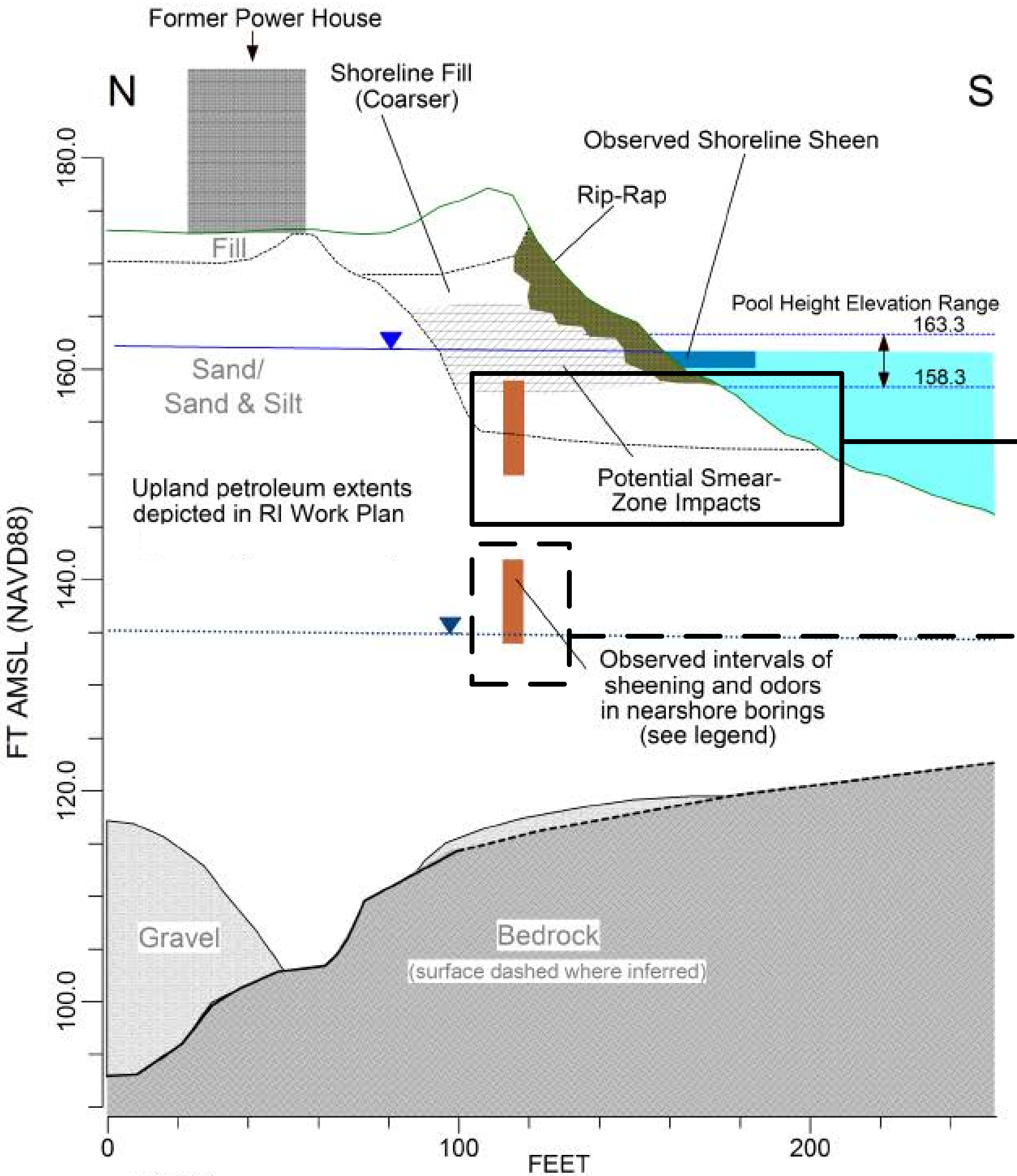


Notes:

Figure reproduced directly from Kennedy/Jenks Consultants. 2016. *Remedial Investigation Work Plan. Wishram, Washington*. August.

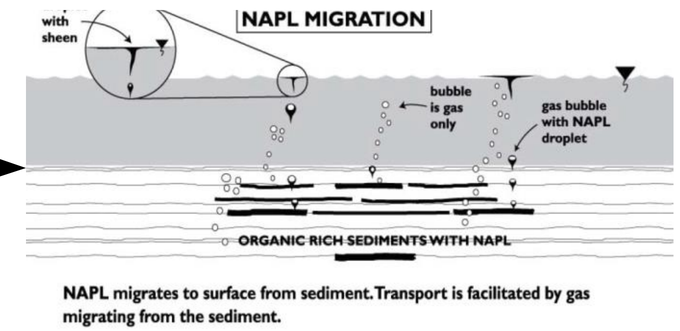
Elevations are given relative to the North American Vertical Datum-1988 (NAVD88).

Figure 3-5. Groundwater Elevations and Columbia River Stage
BNSF Track Switching Facility
Wishram, Washington

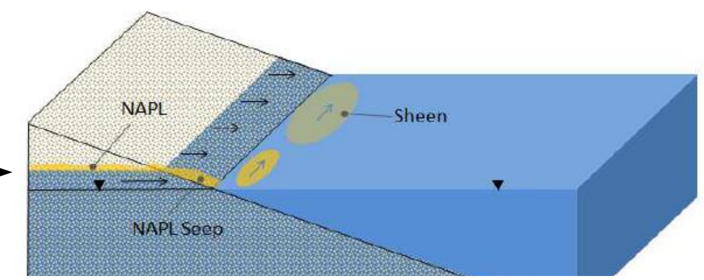


LEGEND
- Approximate current water table
- Approximate pre-1957 water table
- Interval of observed sheen and/or petroleum odor (does not necessarily indicate that concentrations of petroleum hydrocarbon fractions were measured in soil or groundwater at concentrations above soil or groundwater criteria, or that they were even detected above laboratory method detection limits)

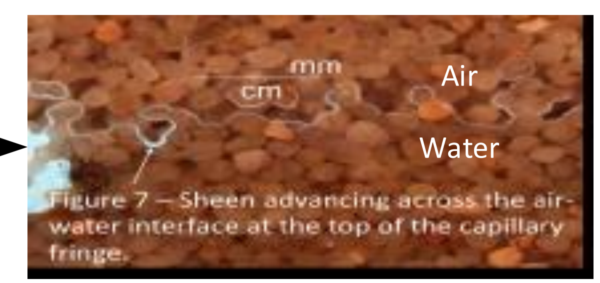
Potential NAPL Migration Mechanism	**Additional Details**
Ebullition	Ebullition transport is limited to the near surface sediment (~3 feet). Deeper sediment does not normally discharge ebullition gasses.
Seep	NAPL seeps are driven by NAPL head and can then form sheens.
Sheen	NAPL sheens are caused by the interfacial tension differences between air, NAPL and water. Sheens can form at the air-water interface and move across the capillary fringe to surface water.
(Submerged NAPL): After water table rise in 1957, NAPL is trapped by the capillary forces of the water surrounding the LNAPL body (EPA/540/S-95/500)	Deep submerged NAPL impacts are not anticipated to contribute to surface sediment impacts or observed sheening and nodules.



Source: McLinn and Stoltenberg, 2009



Source: Sale, 2014



Source: Sale, 2014

Figure 4-1. Preliminary Conceptual Site Model for Nearshore Sediment
BNSF Track Switching Facility
Wishram, Washington

Sheen mechanism figure sources:
McLinn, E.L. and T.R. Stoltenberg. 2009. "Ebullition-facilitated Transport of Manufactured Gas Plant Tar from Contaminated Sediment." *Environmental Toxicology and Chemistry*. Vol. 28, No. 11. November. p. 2298.
Sale, T. and M. Lyverse. 2014. *Sheens Associated with Subsurface Petroleum Releases—Current Knowledge and Best Practices.* Prepared for Chevron U.S.A., Inc.

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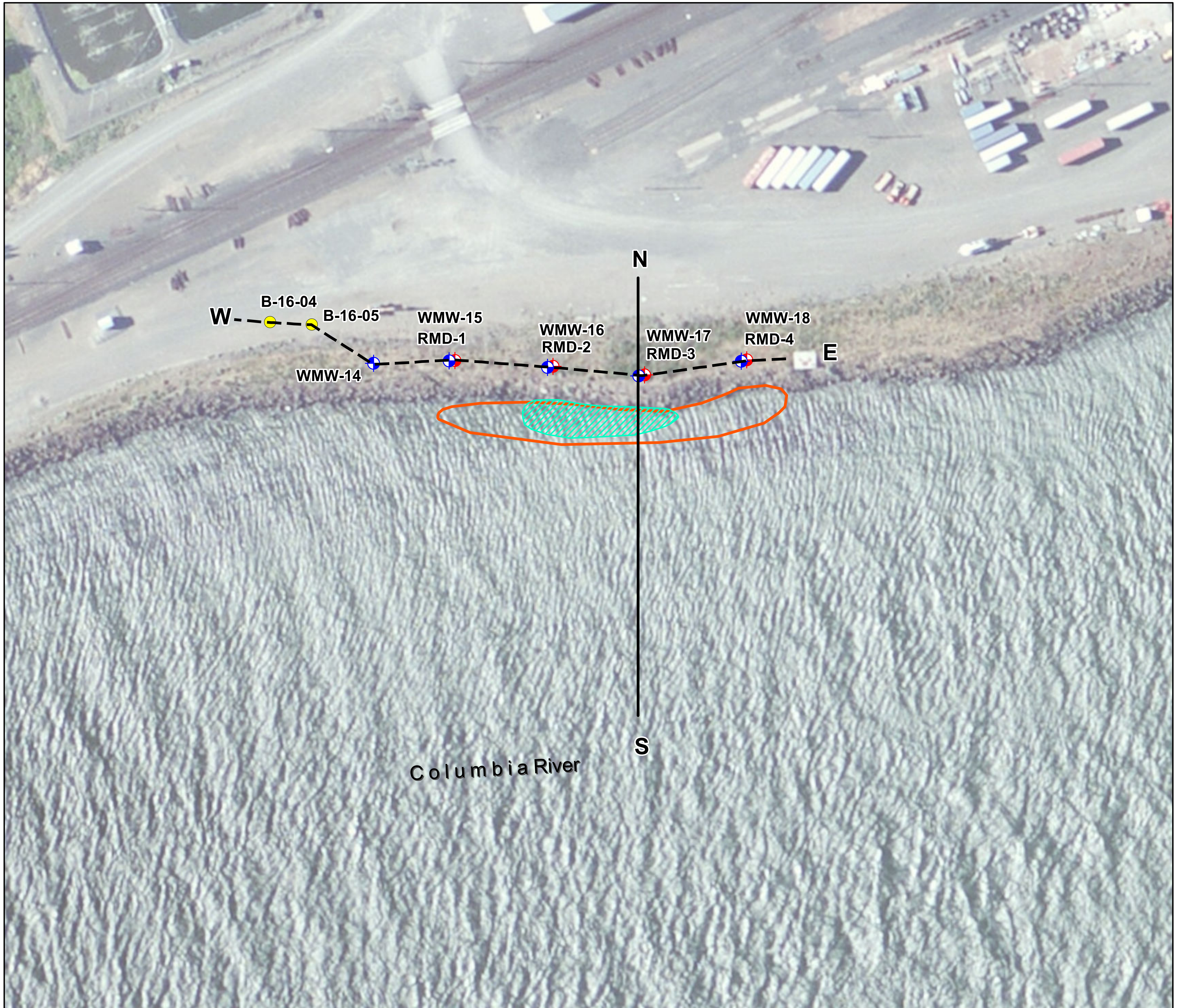


VICINITY MAP

LEGEND

Well or Boring on Cross Section

- Shallow Monitoring Well
- Deep Monitoring Well
- Soil Boring Location
- Cross Section Location (see Figures 4-2 and 4-3)
- Area of Intermittent NAPL Sheening
- Small-extent NAPL Sheens Observed (Ecology, 2017)

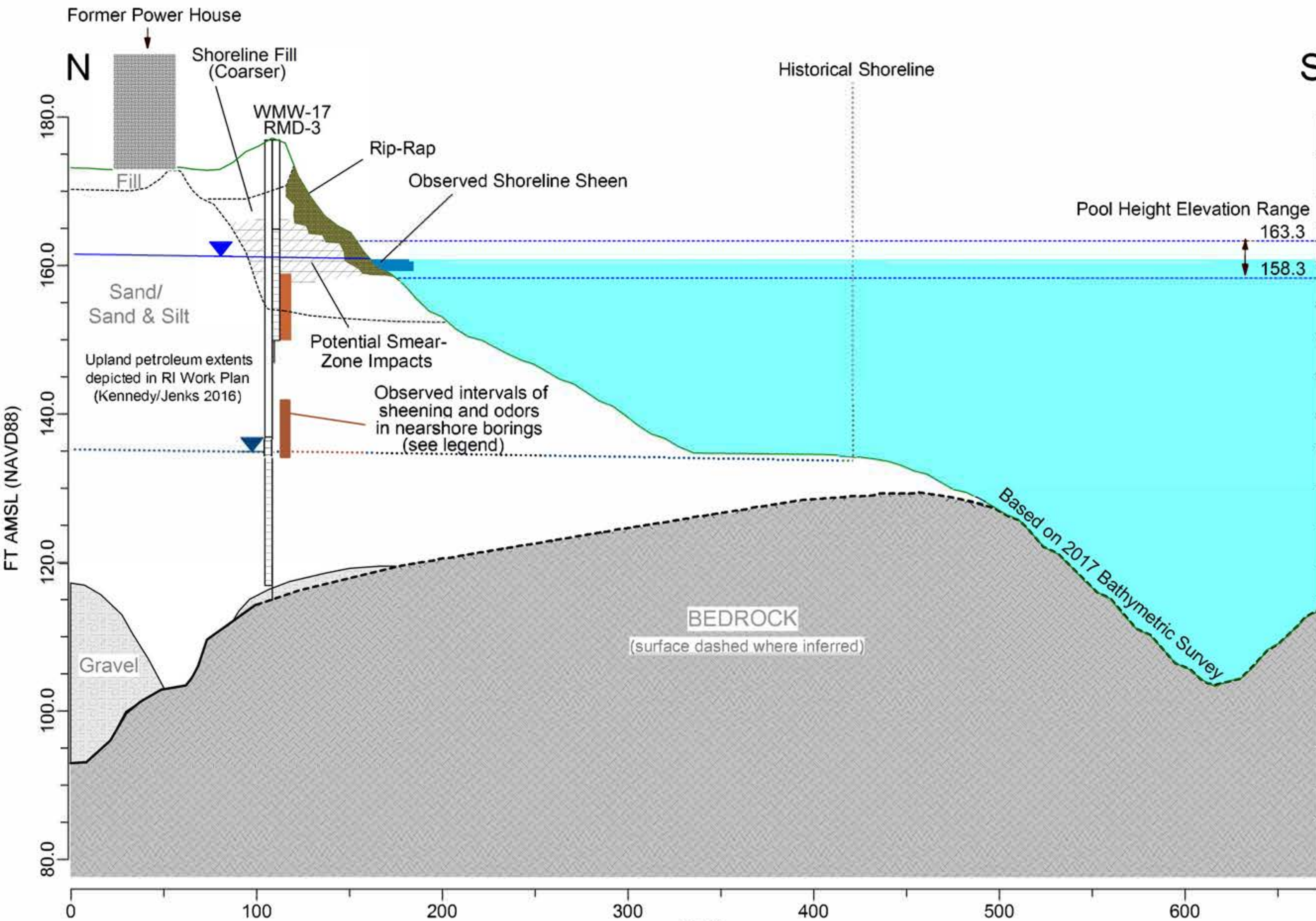
Notes:
NAPL = non-aqueous phase liquid
NAVD88 = North American Vertical Datum of 1988

N

0 40 80 120 160
Feet

Figure 4-2. Cross Section Locations
BNSF Track Switching Facility
Wishram, Washington

ch2m



LEGEND

- Approximate current water table
- Approximate pre-1957 water table
- Interval of observed sheen and/or petroleum odor (does not necessarily indicate that concentrations of petroleum hydrocarbon fractions were measured in soil or groundwater at concentrations above soil or groundwater criteria, or that they were even detected above laboratory method detection limits)

Figure 4-3. Shoreline Cross Section N-S

BNSF Track Switching Yard

Wishram, Washington

ch2m:

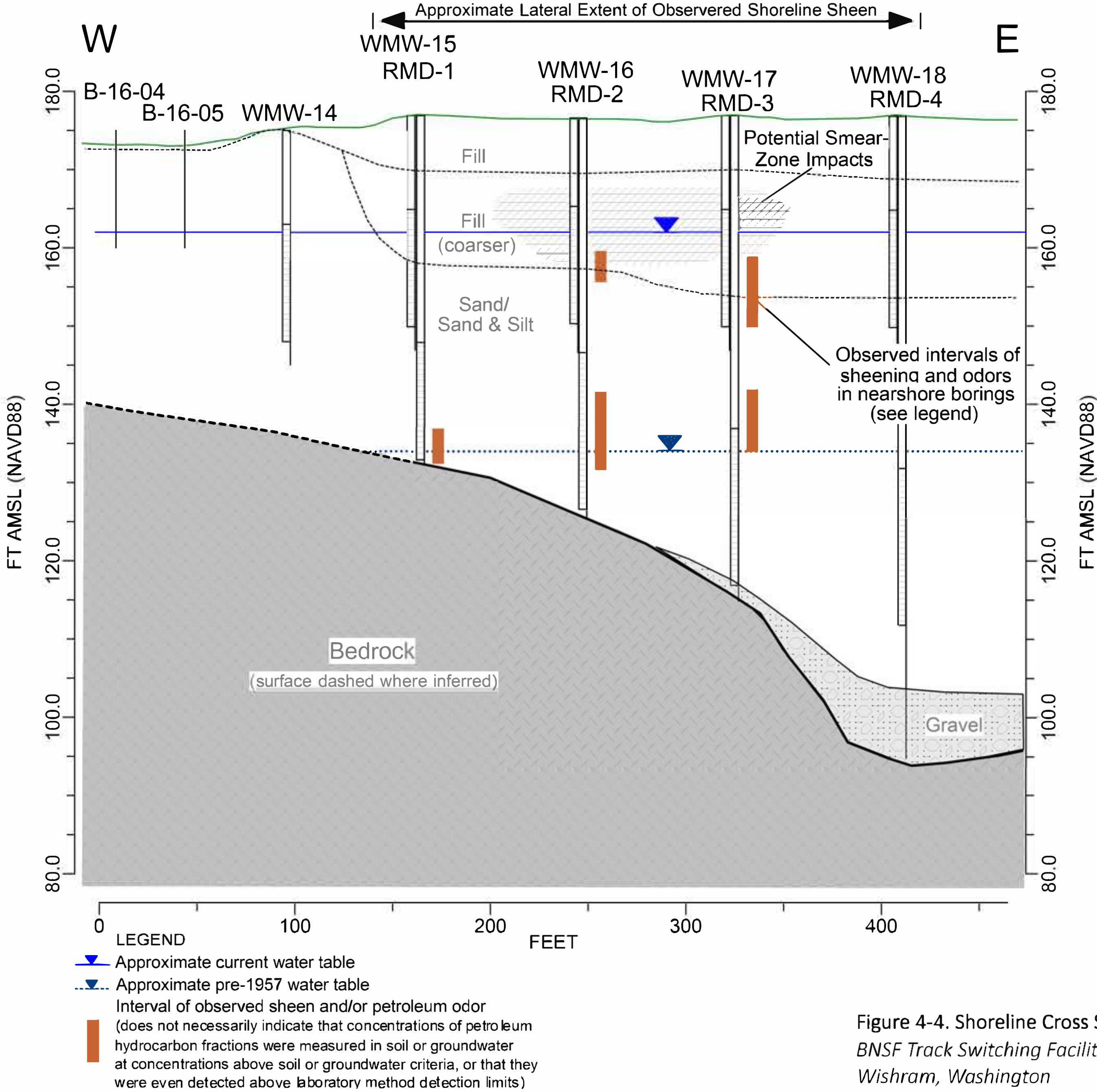


Figure 4-4. Shoreline Cross Section W-E

BNSF Track Switching Facility

Wishram, Washington

ch2m

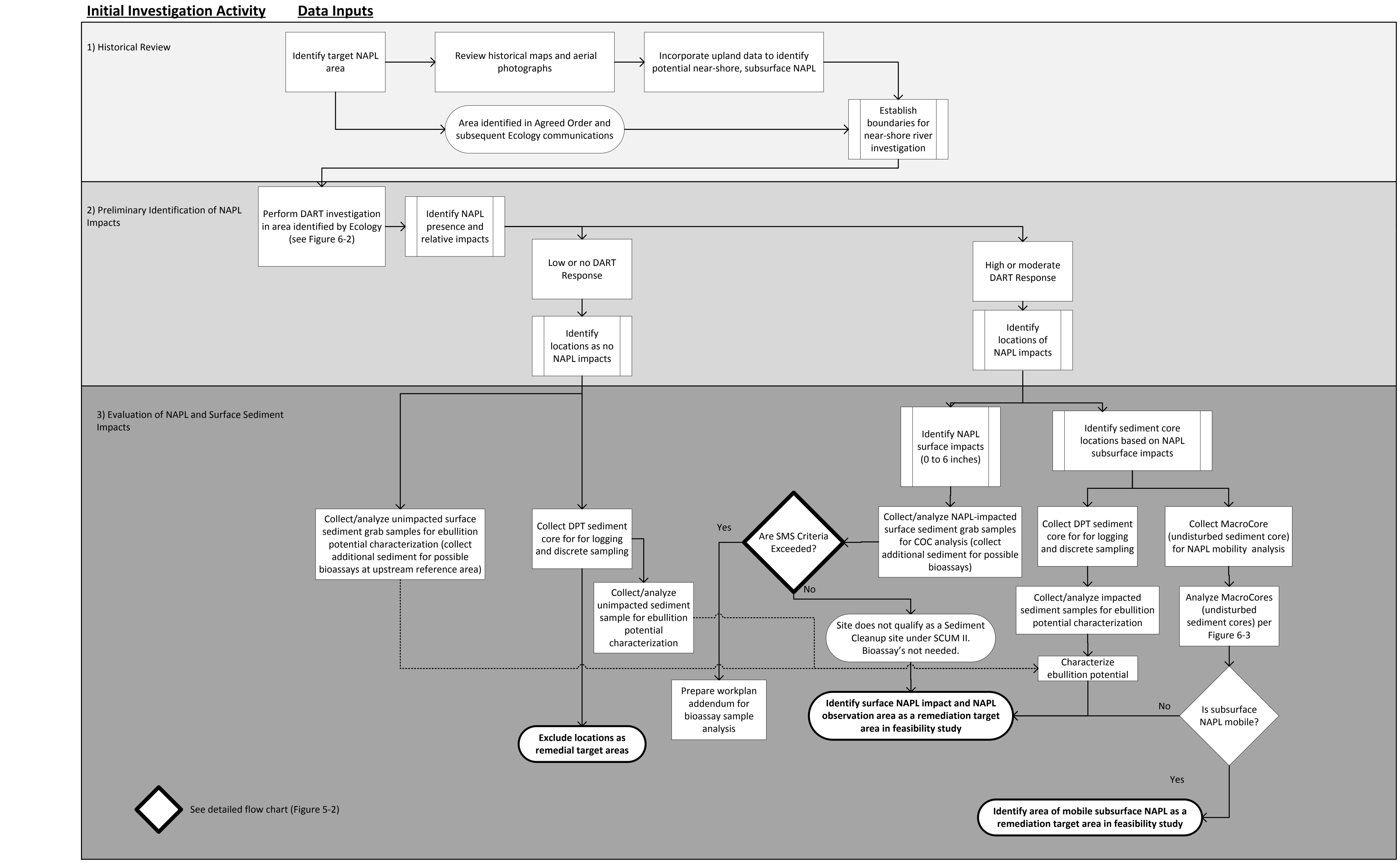
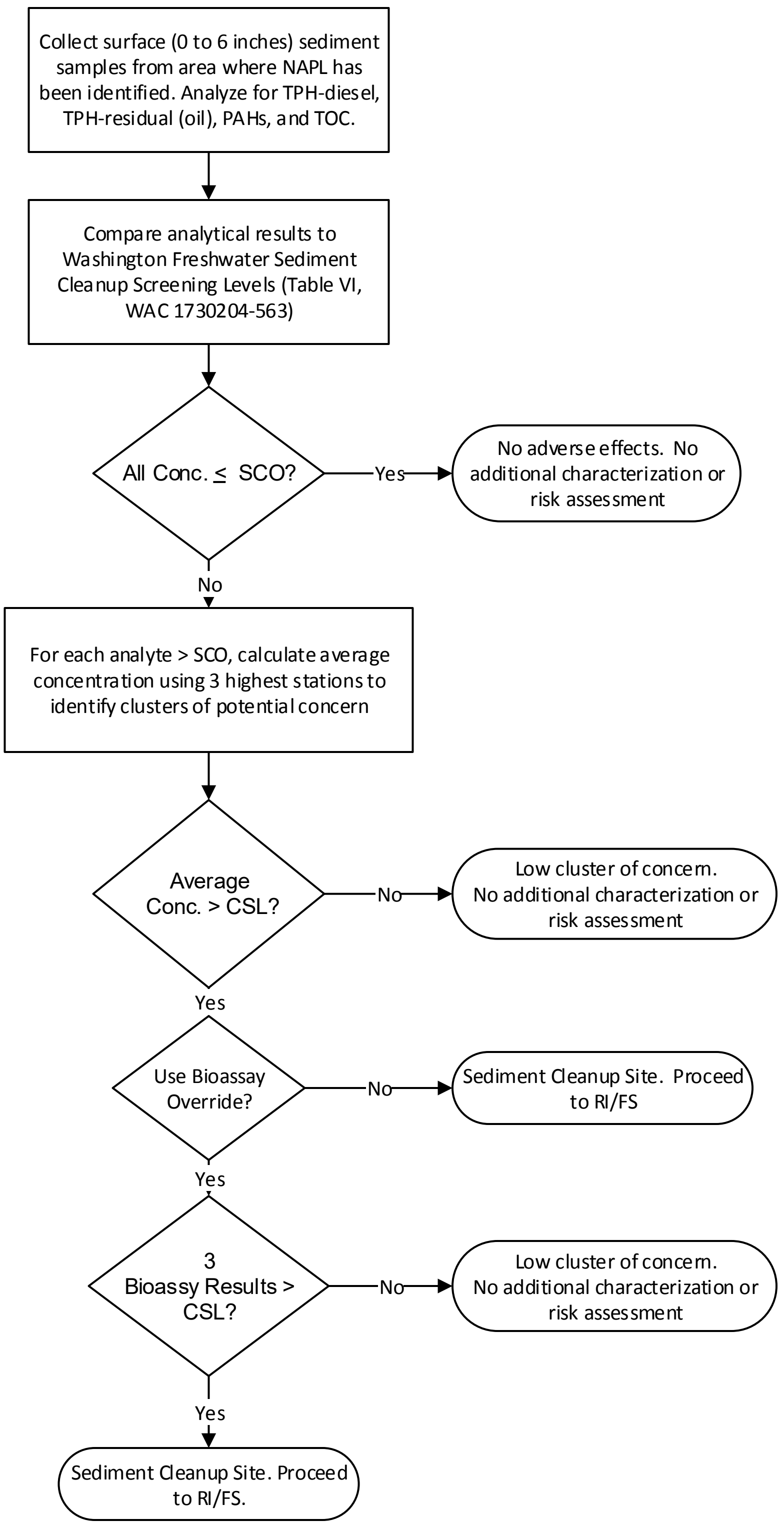


Figure 5-1. Wishram Nearshore Sediment Investigation Process
BNSF Track Switching Facility
Wishram, Washington

Initial Investigation (Chapter 2 of SCUM II)

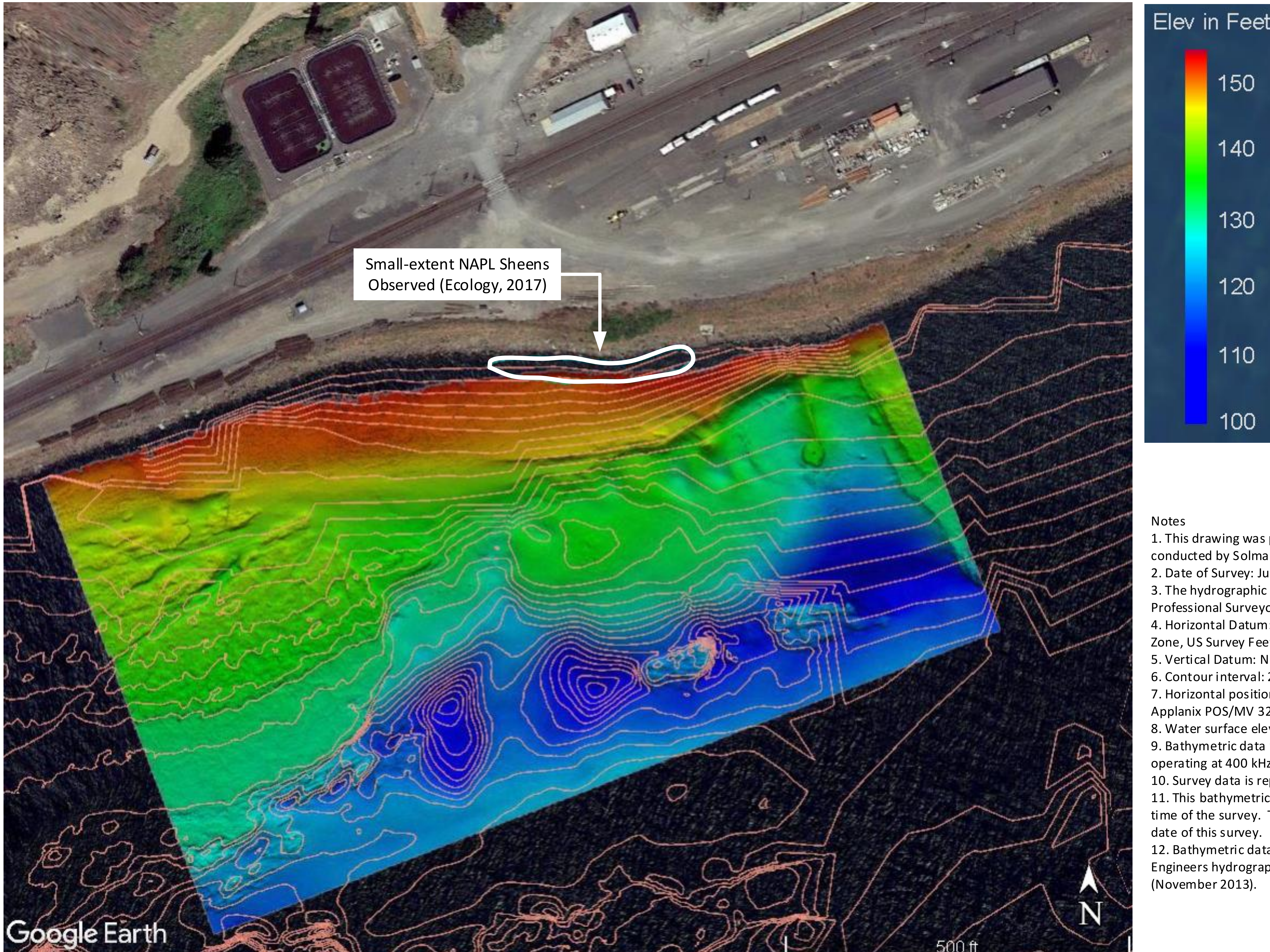
Are sediments impacted by chemicals associated with NAPL and does site qualify as Sediment Cleanup Site?



Conc. = concentrations
CSL = cleanup screening level
FS= feasibility study
NAPL = nonaqueous phase liquid
PAHs = polycyclic aromatic hydrocarbons
RI= remedial investigation
SCO = sediment cleanup objective
SCUM II = Sediment Cleanup Users Manual II
TOC = total organic carbon
TPH = total petroleum hydrocarbons
Certain situations may support performance of concurrent bioassay testing with evaluation for chemical criteria

Figure 5-2. Sediment Chemistry and Bioassay Evaluation Process
BNSF Track Switching Facility
Wishram, Washington

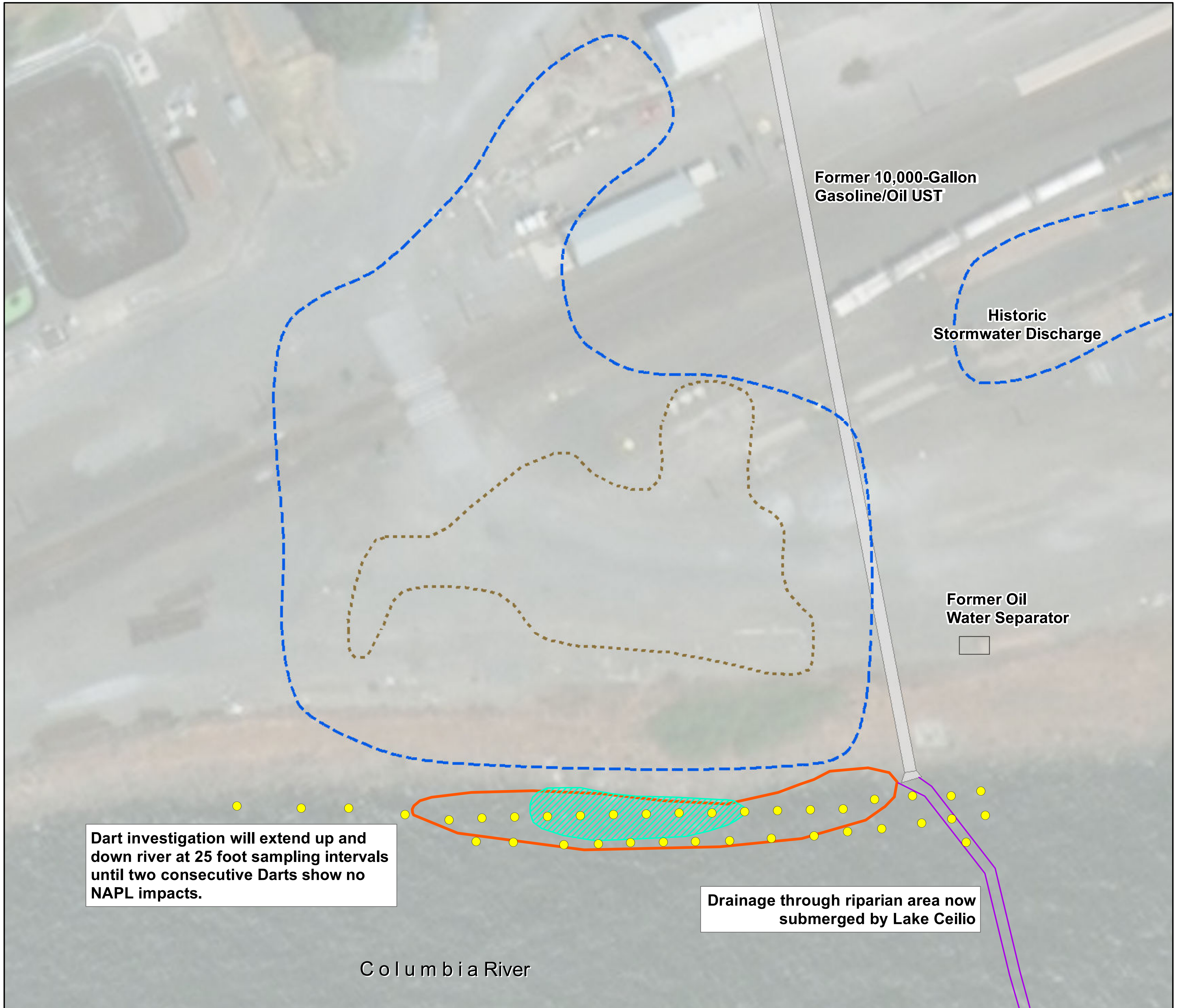
ch2m



Notes
1. This drawing was prepared using results of a multibeam bathymetric survey conducted by Solmar Hydro, Inc.
2. Date of Survey: June 2nd, 2017.
3. The hydrographic survey was completed under the direction of a National Society of Professional Surveyors (NSPS) Certified Hydrographer.
4. Horizontal Datum: NAD83/11 State Plane Coordinate System, Washington South Zone, US Survey Feet.
5. Vertical Datum: North American Vertical Datum of 1988 (NAVD88), US Survey Feet.
6. Contour interval: 2 foot.
7. Horizontal positions for navigation and data collection were determined by using an Applanix POS/MV 320 operating in Real Time Kinematic (RTK) mode.
8. Water surface elevations were derived using RTK GPS and the Geoid 2012B model.
9. Bathymetric data was collected using an R2 Sonic 2024 multibeam echosounder operating at 400 kHz.
10. Survey data is represented at a 0.5 foot grid resolution.
11. This bathymetric survey is representative of the condition of the bottom at the time of the survey. The condition of the bottom may change at any time after the date of this survey.
12. Bathymetric data was collected in accordance with the U.S. Army Corps of Engineers hydrographic manual EM-1110-02-1003 (November 2013).

Figure 6-1. Results of 2017 Bathymetric Condition Survey
BNSF Track Switching Facility
Wishram, Washington

ch2m.



VICINITY MAP

LEGEND

- Proposed Dart Location
- Potential Drainage Feature
- Area of Intermittent NAPL Sheening
- Small-extent NAPL Sheens Observed (Ecology, 2017)
- Approximate Lateral Extent of Oil
- Approximate historical lateral extent of Dissolved-Phase Diesel- and/or Oil-Range Organics above the MTCA Method A groundwater cleanup level (500 µg/L)
- Former Oil Water Separator
- Stormwater Underdrain (A portion removed from service circa 1960)

Notes:
NAPL = nonaqueous phase liquid
µg/L = microgram(s) per liter
MTCA = Model Toxics Control Act
UST = underground storage tank

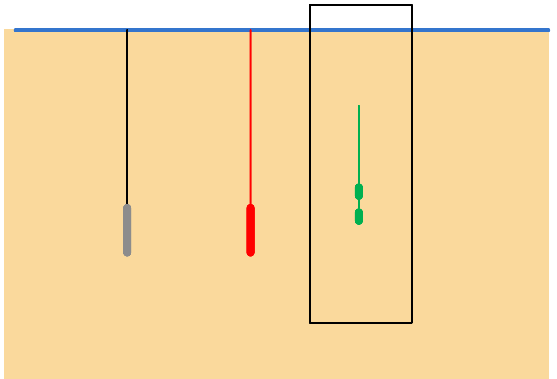
N

0 30 60 90 120
Feet

Figure 6-2. Conceptual Design for Dart Survey
BNSF Track Switching Facility
Wishram, Washington

ch2m.

\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\WORKPLAN\FIGURE6-2_DARTPTS.MXD SJ063666 1/24/2018 11:42:03 AM



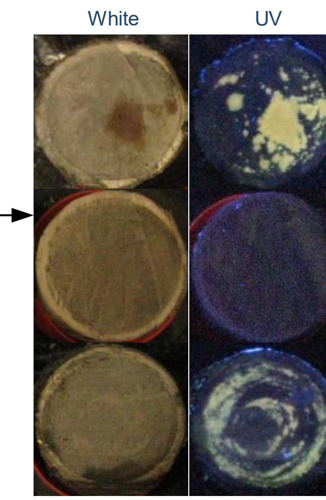
At each location, Dart data, direct push (DPT) sediment core and a 1.25 inch MacroCore is collected

Key
Black/grey – Dart (UVOST analysis)
Red – DPT Sediment Core
Green – 1.25 inch MacroCore (NAPL)

The 1.25 inch MacroCore is collected in a steel sleeve

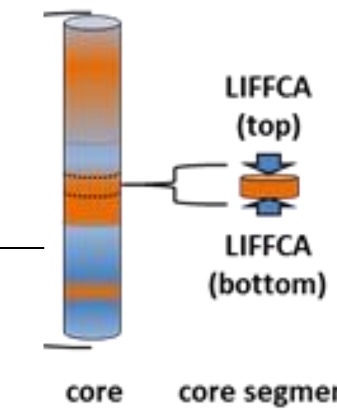
Freeze core to preserve pore fluids

Cut frozen MacroCore into segments

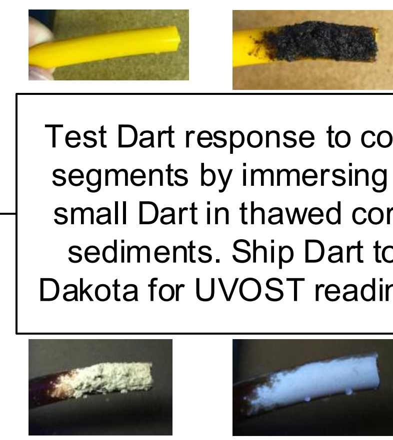


Photograph segments under visible and UV light

Identify segments with varying NAPL impacts. Ship (frozen) to Dakota Technologies for LIF Frozen Core Analysis (LIFFCA) with TarGOST.



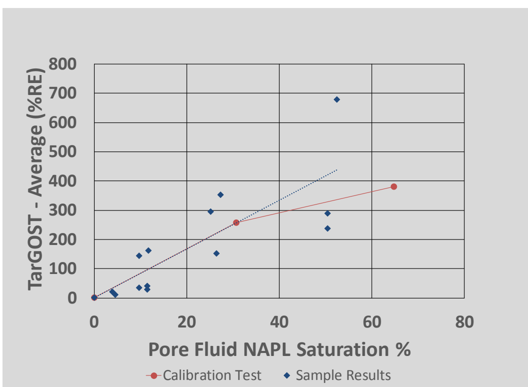
Select core segments representing a range of TarGOST responses for additional tests



Test Dart response to core segments by immersing a small Dart in thawed core sediments. Ship Dart to Dakota for UVOST reading.

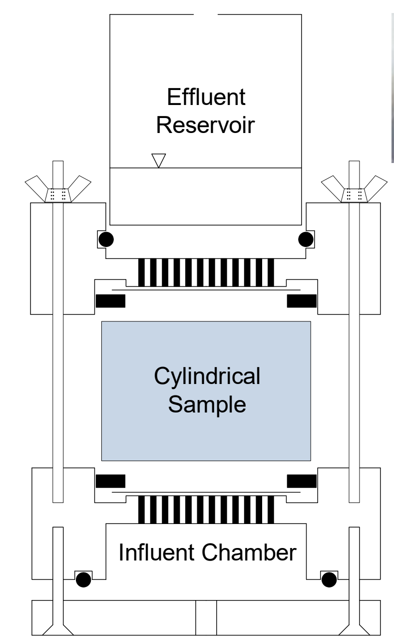
Dean-Stark Extraction (API RP40 Sec. 4.3)

Analyze thawed core segments for pore fluid saturation



Data from 2014 CH2M Internal Innovation Grant

Develop correlations between:
1. Dart UVOST response and pore fluid saturation
2. Core segment TarGOST response and pore fluid saturation



Mobile NAPL example

Perform water flood test on select segments.

Document NAPL migration.

Perform pore fluid analysis on segment after test to estimate residual saturation.

Method information: Niemet, M.R.; J.L. Gentry; M. Bruno; D.R.V. Berggren; C.D. Tsiamis. 2014. "Gowanus Canal Superfund Site. I: NAPL Mobility Testing of MGP-Impacted Sediment." J. Hazard. Toxic. Radioact. Waste. Vol. 19, Issue 1. January.

Data Use
Correlations allows Dart and TarGOST data to be converted to pore fluid saturations
- Dart correlation for near-shore sediment data
- TarGOST correlation for analysis of top of bank impacts performed as part of upland investigation
- Water Flood tests predict the residual pore fluid saturation for seep migration

Allows for NAPL mobility evaluation for both near shore sediment and upland top of bank impacts

Figure 6-3. Wishram NAPL Mobility Investigation Process
BNSF Track Switching Facility
Wishram, Washington

ch2m

Appendix A
Sampling and Analysis Plan

FINAL

Sampling and Analysis Plan for BNSF Wishram Track Switching Facility Nearshore Sediment Initial Investigation

Prepared for

BNSF Railway Company

January 2018

CH2M HILL Engineers, Inc.
2020 SW 4th Ave, Suite 300
Portland, OR 97201

Contents

Attachments

Tables

Figures

Acronyms and Abbreviations

°C	degree(s) Celsius
µg/kg	microgram(s) per kilogram
AO	Agreed Order
AST	aboveground storage tank
bgs	below ground surface
BNSF	BNSF Railway Company
CH2M	CH2M HILL Engineers, Inc.
COC	chemical of concern
COD	chemical oxygen demand
CSL	cleanup screening level
CSM	conceptual site model
DO	dissolved oxygen
DOT	U.S. Department of Transportation
DPT	direct-push technology
Ecology	Washington Department of Ecology
EIM	Ecology's Environmental Information Management System database
EPA	U.S. Environmental Protection Agency
FS	feasibility study
FSI	field safety instructions
GPS	Global Positioning System
HCl	hydrogen chloride
LIF	laser-induced fluorescence
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
MIG	Mean Individual Growth
MS/MSD	matrix spike/matrix spike duplicate
MTCA	Ecology Model Toxics Control Act
NAPL	non-aqueous phase liquid
PAH(s)	polycyclic aromatic hydrocarbons
PFS	pore fluid saturation
pH	hydrogen (ion) concentration
QA	quality assurance
QC	quality control
RI	remedial investigation
SAP	sampling and analysis plan
SCO	sediment cleanup objective
SCUM II	Sediment Cleanup User's Manual II: Guidance for Implementing the Cleanup Provisions of the Sediment Management Standards, Chapter 173-204 WAC
SIM	select ion monitoring

site	Wishram Railyard
SMS	Sediment Management Standards
SP&S Railway	Spokane, Portland, and Seattle (Railway)
SPE	solid-phase extraction
SVE	soil-vapor extraction
TarGOST	Tar-specific Green Optical Screening Tool
TOC	total organic carbon
TPH	total petroleum hydrocarbon
UST	underground storage tank
UV	ultraviolet
UVOST	ultraviolet optical screening tool
WAC	Washington Administrative Code

Introduction and Background Information

This sampling and analysis plan (SAP) has been prepared in support of the *Wishram Switching Track Facility Nearshore Sediment Initial Investigation Work Plan* for the nearshore area adjacent to the BNSF Railway Company (BNSF) Wishram Track Switching Facility (site), located in Wishram, Washington (Figure 1). Petroleum sheening and non-aqueous phase liquid (NAPL) gas bubbles have been observed along an approximately 300-foot stretch of the Columbia River known as Lake Celilo adjacent to the railyard (Figure 2) (Ecology, 2017a).

The purpose of the nearshore sediment initial investigation is to investigate the potential presence of NAPL in the identified area, characterize the nature and extent of NAPL, if present, and evaluate nearshore sediment against applicable sediment cleanup standards. The RI (upland and nearshore) will include the development of an integrated conceptual site model (CSM) for the Wishram Railyard site and shoreline area. The integrated CSM will be used to support evaluation of potential remedial alternatives for the overall site (upland and nearshore) in a feasibility study (FS).

1.1 Regulatory Framework

The site proper is the subject of an RI, with work being performed pursuant to an Agreed Order (AO) (No. DE 12897) between the Washington Department of Ecology (Ecology) and BNSF, dated October 7, 2015. The scope of work in the AO is mainly focused on the upland investigation, with limited actions related to shoreline conditions.

On March 3, 2017, Ecology directed BNSF to initiate the following:

> *Petroleum sheen was first reported along a portion of shoreline adjacent to the BNSF Track Switching Facility Site (Site) in July 2013. Additional observations of sheen in that area occurred in July 2014, June 2015, and October 2016. During the October visit …. several non-aqueous phase liquid (NAPL) sheens of relatively small extent, though larger than what was previously reported as "thumbnail"-sized, [were noted] along an approximately 300 foot stretch of shoreline…Several offshore areas were also noted to exhibit gas bubbles rising through the shallow water within the area where the sheens were observed.*
>
> *Ecology has determined that these limited actions* (upland remedial investigation and sheen monitoring) *do not comprise sufficient investigation to address potential shoreline and/or surface water impacts. We believe on the basis of several lines of evidence that further investigation is warranted beyond what has already been proposed in the current* (upland) *RI Work Plan.*
>
> *One item in particular that has to be more fully investigated is the groundwater/surface water interface including whether the process of ebullition is occurring. Other mechanisms that may produce a sheen are 1) NAPL seepage due to NAPL drainage and mobility at low water, 2) NAPL wicking along the capillary fringe; and 3) erosion leading to redistribution of NAPL from the riverbank to sediments.*
>
> *Based on these environmental concerns, Ecology requires BNSF to produce a supplemental work plan that will fully address the shoreline component of the RI.*

The area identified by Ecology in the March 3, 2017, letter is shown on Figure 2. This area is identified as the area of interest for the nearshore RI.

The nearshore RI will be performed in accordance with the Ecology Model Toxics Control Act (MTCA) regulations published in Washington Administrative Code (WAC) 173-340 (Ecology, 2007) and the cleanup provisions of the Sediment Management Standards (SMS) under WAC 173-204, as described in the *Sediment Cleanup User's Manual II: Guidance for Implementing the Cleanup Provisions of the Sediment Management Standards, Chapter 173-204 WAC* (SCUM II) (Ecology, 2015).

1.2 Site History

Wishram is located in Klickitat County, Washington, approximately 13 miles northeast of The Dalles, Oregon, and 0.75 mile south of Washington State Route 14, within the southwestern quarter of Section 17, Township 2 north, Range 15, east of the Willamette Meridian. The site location is shown on Figure 1. The location of petroleum sheening and approximate area of interest for the nearshore sediment RI are shown on Figure 2.

The railyard is approximately 2,000 feet long and ranges from 150 to 720 feet wide. The upland portion of the site currently under investigation encompasses the westernmost portion of the railyard. This portion of the site is approximately 350 feet long (east to west) and 450 feet wide (north to south) and covers an area of approximately 3.6 acres. The upland portion of the site is bounded by the town of Wishram to the north, the railyard to the east, Lake Celilo, an impoundment of the Columbia River, to the south and southwest, and railroad right-of-way to the west. Onsite structures include storage buildings, a maintenance shop (office and tool storage), two mainline tracks, and active track spur rails. Current site features are shown on Figure 3.

The site was originally developed by the Spokane, Portland, and Seattle (SP&S) Railway between 1910 and 1912. SP&S merged with other railroads in 1970 to become the Burlington Northern Railroad, which merged with the Santa Fe Railroad (also known as the Atchison, Topeka, and Santa Fe Railway) in 1995 to become what is now BNSF. The primary historical use of the railyard was railcar switching. Historically, locomotive fueling/watering and repairs also occurred at Wishram. Most of the track spurs, early structures, and infrastructure no longer remain. Prominent site features believed to have been present during some portions of the time between 1910 and the present are shown on Figure 3.

At the time the railyard was constructed, the Columbia River was free-flowing and occupied a channel approximately 300 feet south and 40 to 50 feet lower than the yard. Construction of The Dalles Dam in 1957 impounded the Columbia River to create Lake Celilo.

Additional details regarding historical site activities, including historical plat maps, are presented in the report *Site Investigation, Wishram Railyard, Wishram, Washington* (Kennedy/Jenks Consultants, 2012) and the *Nearshore Sediment RI Workplan* (CH2M 2017).

1.3 Previous Investigations

BNSF has performed a series of voluntary and AO-required investigations to characterize the distribution of impacted soil and groundwater in the upland portion of the site. In addition, BNSF has undertaken voluntary independent remediation activities in the upland portion of the site. Additional details of previous investigations are provided in Section 3 of the *Draft Work Plan, Wishram Track Switching Facility Nearshore Sediment Initial Investigation*.

SECTION 2

Sampling Design

The purpose of the nearshore RI is to investigate the potential presence of NAPL in the identified area, characterize the nature and extent of NAPL, if present, and evaluate nearshore sediment against applicable sediment cleanup standards. The nearshore RI data will also be used in conjunction with data collected in the upland portion of the railyard to develop an integrated CSM for the Wishram Railyard and nearshore area. The specific objectives of the sediment investigation are as follows:

- Determine if NAPL is present in sediment, the extent of NAPL-impacted sediment (if present), and the potential for NAPL transport (NAPL mobility characteristics and sediment ebullition potential) as appropriate (Phase 1).
- Determine if sediments in the area of interest have been impacted by chemicals of concern (COCs) associated with petroleum NAPL and whether the sediments are toxic to benthic organisms (Phase 2).

If the sediments are impacted as defined by the Washington SMS under WAC 173-204, the area of interest would be considered a sediment cleanup site and additional sampling, analysis, or both, would be needed to delineate areas of impact, assess risks to ecological receptors, and assist in evaluation of potential remedial actions. Identification of sediment cleanup sites is described in SCUM II (Ecology, 2015), particularly Chapter 2 (Station Clustering and Site Identification) and summarized on Figure 4.

Before collecting sediment samples, a Dart survey will be performed in the area of interest to screen for the presence or absence of NAPL impacts. This type of preliminary screening survey has been successfully implemented at over 20 sites by Dakota. The survey will be conducted using Dart samplers (Dakota Technologies, Fargo, North Dakota), which are passive sampling devices consisting of a continuous fiberglass rods coated with solid-phase extraction (SPE) media. PAHs in NAPL are attracted to and absorb into the SPE media, which following removal from the sediment can be analyzed in the laboratory using a variety of methods, including LIF. For the Dart survey, Dart samplers will be deployed in the area of interest, concentrating on the area of observed NAPL sheening. The conceptual design for the Dart investigation is shown on Figure 5. Additional Darts may be installed following the results of the initial deployment to fill data gaps or expand the survey area.

The results of the Dart survey will be used to select sediment sampling locations for chemical analysis. If areas of probable NAPL impacts are identified, sampling locations will be selected in areas with and without NAPL impacts. These sampling locations are the same as described in the 6.3.3. Sediment (surface and subsurface) samples will then be collected and analyzed to support the following objectives:

- Confirm Dart survey NAPL delineation.
- Characterize sediment ebullition potential.
- Characterize NAPL mobility and pore fluid saturation at locations with confirmed NAPL.
- Compare concentration of chemical constituents to SMS freshwater sediment criteria.

Additional sample material will be collected and stored to be used for bioassays if SMS freshwater criteria are exceeded (see Figure 4). Table 2-1 provides a summary of the sample locations, analyses, and rationales. Further detail is provided in the associated *Wishram Switching Track Nearshore Sediment Initial Investigation work plan* (CH2M, 2017). Applicable SMS chemical and biological criteria (including sediment cleanup objective [SCOs] and cleanup screening levels [CSLs]) are provided in Table 2-2 and Table 2-3, respectively.

Table 2-1. Sample Locations, Analyses, and Rationales

Location	Number of Locations	Matrix	Depth	Analysis	Rational
Area of Interest	20+	Dart Sampler	0 to 9 feet	UVOST	Screen for the presence or absence of NAPL
NAPL-impacted subsurface locations (if present)	Up to 5	DPT sediment core	0 to 10 feet	Core logging and field observation	NAPL delineation conformation; selection of NAPL mobility core depths
			2 depths, sampler discretion[a]	TOC	Characterization of subsurface ebullition potential
				COD	
		Undisturbed sediment core (Macro-Core)	TBD (5-foot cores)	Core photography (visible and UV light)	Selection of core subsamples for NAPL mobility and PFS analysis
				Frozen core LIF	
				NAPL mobility by water drive	Characterization of NAPL mobility and PFS
				Pore fluid saturation	
				Particle size distribution	
				Core sample screening using Dart system	Correlate PFS and Dart sampler response (so that laboratory results can be extrapolated to all locations included in the Dart survey)
NAPL-impacted surface locations (if present)[b]	5	Sediment grab	0 to 6 inches	TPH-Diesel	Chemical characterization of surface sediment to support sediment cleanup site identification
				TPH-Residual	
				PAH (SIM)	
				Grain size	
				TOC	Chemical characterization of surface sediment to support sediment cleanup site identification; characterization of surface ebullition potential
				COD	Characterization of surface ebullition potential

Table 2-1. Sample Locations, Analyses, and Rationales

Location	Number of Locations	Matrix	Depth	Analysis	Rational
NAPL-impacted surface locations (if present)[b] *(continued)*	5 *(continued)*	Sediment grab *(continued)*	0 to 6 inches *(continued))*	*Hyalella azteca* 10-day mortality (as needed[c])	Characterization of benthic organism impacts to support sediment cleanup site identification
				Chironomus dilutus 20-day mortality (as needed[c])	
				Chironomus dilutus 20-day growth (as needed[c])	
Unimpacted subsurface location	1	DPT sediment core	0 to 10 feet	Core logging and field observation	NAPL delineation conformation
			2 depths, sampler discretion	TOC	Characterization of subsurface ebullition potential
				COD	
Unimpacted surface locations	2[d]	Sediment grab	0 to 6 inches	TPH-Diesel	Chemical characterization of surface sediment
				TPH-Residual	
				PAH (SIM)	
				Grain size	
				TOC	Characterization of surface ebullition potential
				COD	
				Hyalella azteca 10-day mortality (as needed[c])	Reference sample for bioassays
				Chironomus dilutus 20-day mortality (as needed[c])	
				Chironomus dilutus 20-day growth (as needed[c])	

Table 2-1. Sample Locations, Analyses, and Rationales

Location	Number of Locations	Matrix	Depth	Analysis	Rational

[a]Samples will be collected at depths with visually-identified NAPL impacts.

[b]If areas of probable NAPL impact are not identified in surface sediment during the Dart survey, locations will be selected in areas with the highest suspected surface sediment impacts.

[c]Bioassays will only be performed in the event that all concentrations of chemicals of concern are greater than or equal to the SCO and the average of the three highest measured concentrations for each chemical of concern is greater than the CSL (see Figure 4).

[d]At least one of the unimpacted surface locations sites will be in an area upstream with clean sediment and will serve as a reference location if bioassays are performed.

Notes:
COD = chemical oxygen demand
CSL = cleanup screening levels
DPT = direct-push technology
LIF = laser-induced fluorescence
NAPL = non-aqueous phase liquid
PAH = polycyclic aromatic hydrocarbons
PFS = Pore fluid saturation
SCO = sediment cleanup objective
SIM = select ion monitoring
TBD = to be determined
TOC = total organic carbon
TPH = total petroleum hydrocarbon
UV = ultraviolet

Table 2-2. Applicable SMS Freshwater Sediment Chemical Criteria for Protection of the Benthic Community

Analyte	SCO	CSL
Polycyclic Aromatic Hydrocarbons (PAHs) (µg/kg dw)		
Total PAHs	17,000	30,000
Bulk Petroleum Hydrocarbons (mg/kg dw)		
TPH-Diesel	340	510
TPH-Residual	3,600	4,400

Notes:
Porewater assessment is another line of evidence in a weight-of-evidence approach for evaluating whether there are adverse impacts to aquatic life

All values are dry weight normalized.

µg/kg = microgram(s) per kilogram
CSL = cleanup screening level
dw = dry weight
mg/kg = milligram(s) per kilogram
PAH(s) = polycyclic aromatic hydrocarbons
SCO = sediment cleanup objective
TPH = total petroleum hydrocarbon

Table 2-3. Applicable SMS Freshwater Biological Criteria for Biological Tests (Bioassays)

Biological Test Endpoint	Performance Standard	SCO[c]		
	Control[a]	Reference[b]	CSL[c]	Performance Standard
Hyalella azteca				
10-day mortality	M_C < 20%	M_R < 25%	M_T – MC > 15%	M_T – MC > 25%
28-day mortality	M_C < 20%	M_R < 30%	M_T – MC > 10%	M_T – MC > 25%
28-day growth	MIG_C > 0.15 mg/ individual	MIG_R > 0.15 mg/ individual	MIG_T / MIG_C < 0.75	MIG_T / MIG_C < 0.6
Chironomus dilutus				
10-Day mortality	M_C < 30%	M_R < 30%	M_T – MC > 20%	M_T – MC > 30%
10-Day growth[e]	MIG_C > 0.48 mg/individual	RF / CF > 0.8	MIG_T / MIGC < 0.8	MIG_T / MIG_C < 0.7
20-Day mortality	M_C < 32%	M_R < 35%	M_T – M_C > 15%	M_T – M_C > 25%
20-Day growth[e]	MIG_C > 0.60 mg/individual[d]	RF / CF > 0.8	MIG_T / MIG_C < 0.75	MIG_T / MIG_C < 0.6

[a]These tests and parameters were developed based on the most updated American Society for Testing and Materials (ASTM International) protocols.

[b]Reference performance standards are provided for sites where Ecology has approved a freshwater reference sediment site(s) and reference results will be substituted for control in comparing test sediment to criteria.

[c]An exceedance of the SCO and CSL requires statistical significance at $p = 0.05$.

[d]The control performance standard for the 20-day test (0.60 mg/individual) is more stringent than for the 10-day test and Ecology may consider, on a case-by-case basis, a 20-day control has met QA/QC requirements if the mean individual growth is at least 0.48 mg/individual.

[e]Results should be reported on an Ash Free Dry Weight basis.

Notes:
C = Control
CSL = cleanup screening level
F = Final
M = Mortality
mg = milligram(s)
MIG = Mean Individual Growth at time final
R = Reference
SCO = sediment cleanup objective
T = Test

SECTION 3

Sample Collection and Handling Methods

Sampling stations will be located in the field using a Global Positioning System (GPS) unit within ± 2 to 3-meter accuracy. Actual latitude-longitude of sampling stations will be recorded at the time of sample collection. Horizontal data will be presented in Columbia River Datum. Vertical data will be presented in North American Vertical Datum of 1988 in units of U.S. survey feet. GPS coordinates will be recorded in decimal degrees. The vertical elevation of the top of the water column and the top of the sediment (mudline) will be obtained concurrently. Sampling will be conducted from a RV-Tieton 32-foot research vessel anchored to the bottom of the Columbia River.

3.1 Dart Survey Deployment and Recovery

Dart samplers will be inserted into the sediment using vibracore technology and a Dart vibracore insertion tool deployed from a boat or by hand on the shoreline. Following installation, the Darts will be allowed to equilibrate in situ for a period predetermined by the vendor and project team (typically 24 to 72 hours) before recovery. Samplers will be wrapped in tinfoil and shipped to the laboratory. Results from the Dart survey will be used to identify areas of probable NAPL impact.

Additional Dart deployment and recovery information is provided in Attachment 1.

3.2 Subsurface Core Collection

Up to six borings (i.e., confirmatory cores) will be advanced to a maximum of 10 feet below the mudline using vessel-mounted DPT equipment, including an approximately 3-inch-outer-diameter sampling barrel outfitted with an acetate liner and core catcher. The sediment cores retrieved from each boring will be used to (1) confirm NAPL impacts, if identified during the Dart survey, (2) collect sample to support ebullition potential characterization, and (3) select locations for collection of NAPL mobility cores if NAPL is present.

The confirmatory cores will first be field screened (visual, olfactory, and multi-rae or photoionization detection) and logged. Field observation of NAPL impacts in the cores will be compared to the Dart survey results by a senior project scientist to analyze the relationship between the indirect measurements (Dart results) and NAPL occurrence (visual observation).

The cores will also be sampled for total organic carbon (TOC) and chemical oxygen demand (COD) to support ebullition potential in the subsurface (greater than 6 inches below mudline). Two ebullition potential samples will be collected from each core (Table 2-1). In areas with NAPL impacts, samples will be collected from portions of the cores with observed NAPL. Samples will be collected from the sediment cores using a decontaminated, clean, stainless steel spoon, transferring into the appropriate containers as identified in Section 3.9.1, Sample Storage Requirements, and sent to the laboratory for analysis.

The Dart survey data, in conjunction with the confirmatory sediment core logs, will be used to identify depths for collection of NAPL mobility samples if NAPL impacts are present. One boring will be advanced immediately adjacent to each confirmatory core with observed NAPL impacts (up to 5) to collect undisturbed NAPL mobility cores. Cores will be collected using a 5-foot stainless steel, nominal 1.25-inch-inner-diameter Macro-Core tube. Tubes may be cut into 2.5-foot lengths to facilitate shipping, if necessary. Upon retrieval, samples will be sealed with either melted wax or expansion packers, capped, labeled (location ID, depth, boring number, and indication of top/bottom), sealed, frozen on dry ice, and shipped to the laboratory for analysis.

Additional information related to sediment core collection and logging is provided in Attachment 2.

3.3 Surface Sediment Collection

Surface (0 to 6 inches below mudline) sediment samples will be collected using a van Veen grab sampler deployed from a marine vessel from locations with the highest suspected surface impacts, which will be selected based on results of the Dart survey. Before collecting sediment samples, a clean plastic work space will be laid out on the bow of the boat that is anchored with the motor off. Sample bottles will remain covered in plastic bags inside the plastic-lined ice chests until ready to be filled.

Sediment samples collected with the grab sampler will be rejected if the following acceptability criteria are not met:

- The sampler is not over-filled so the sediment surface is not pressed against the top of the sampler.
- Overlying water is present (indicates minimal leakage).
- The overlying water is not excessively turbid (indicates minimal sample disturbance).
- The sediment surface is relatively flat (indicates minimal disturbance or winnowing).
- The necessary penetration depth is achieved (e.g., several centimeters more than the targeted sample depth).

Sample compositing may be necessary if the grab sampler contains an insufficient volume of sediment for the required analysis. Discrete samples will be collected and transferred to a single, decontaminated, clean stainless steel compositing bowl and unrepresentative material removed (e.g., woody debris), then thoroughly homogenized to a uniform appearance using a decontaminated, clean, stainless steel spoon. Composite sediment samples will then be spooned into clean, laboratory-supplied sample containers for transportation to the laboratory. Any remaining composite sample will be disposed of and the sampling equipment decontaminated before reuse.

Sediment samples for analysis of potentially volatile chemicals (PAHs) will be placed immediately into sample containers, and will not be composited or homogenized.

Additional information related to surface sediment collection is provided in Attachment 3.

3.4 Sampling Equipment

The following sampling equipment may be required for collection of sediment samples:

- Darts
- Dart insertion tool
- MacroCore Sampler
- van Veen grab sampler (stainless steel) – Surface sampling only
- large plastic tub
- Laboratory-supplied sample containers (jars)
- Tape Measure
- Whiteboard and marker
- GPS unit
- Decontaminated stainless steel tablespoons
- Disposable gloves (non-talc)
- Safety glasses
- Plastic sheeting
- Plastic sheeting clamps
- Sample table
- Ziploc-type bags

- Camera
- Deionized water
- Paper towels
- Duct tape
- Large garbage bags
- Water-resistant field notebooks
- Sample data sheets and field log sheets
- Chain-of-custody forms and seals
- Sample labels
- Lithology identification guide
- Pens (water-resistant pen, permanent pens, paint marker, etc.)
- Toolbox (wrench, field knife, etc.)
- Ice
- Dry ice (for storage and shipment of NAPL mobility cores only)

3.5 Equipment Decontamination

Decontamination of sampling equipment must be conducted consistently to minimize the potential for cross-contamination. Re-useable equipment that comes into contact with potentially contaminated materials will be decontaminated. Non-disposable sampling equipment will be decontaminated before each use (i.e., between each sampling station). The decontamination procedure will consist of the following steps:

- Physically remove visible debris, to the extent practicable
- Nonionic detergent wash
- Potable water rinse
- 10 percent nitric acid rinse
- Triple rinse with distilled/deionized water rinse
- Air dry
- Wrap equipment in new aluminum foil

Disposable equipment intended for one-time use that is factory wrapped generally does not need to be decontaminated before use (if evidence of contamination is present the disposable equipment will be discarded and not used). One-time use, disposable, sampling equipment and accessories will be discarded once used and a new set of equipment will be used for each subsequent sample. Disposable sampling equipment will be used as much as practical including nitrile gloves. Decontamination liquids and solids will be collected and disposed on-land in an approved wastewater receptacle.

3.6 Sample Containers and Labels

During the field investigation, a consistent sample-identification system will be employed to ensure uniqueness and clarity in sample labeling. This section describes the protocol that will be followed in labeling samples that are submitted to the analytical laboratory. This section does not apply to those samples that will be collected but not retained for laboratory analysis.

Each sample collected during the fieldwork will be assigned a unique ID number that includes the following information:

- X name (e.g., NAPL2 = NAPL #2)
- Date and time sample was taken
- Sediment Sample type (e.g., SD = Sediment core, SG = sediment grab)
- Sample core/grab number

- Surface Sample if collected (SS)
- Top of sample depth (in feet bml)
- Bottom of sample depth (in feet bml)
- Sample number (per location and depth)

A complete sample name will consist of the components listed above, using the following format:

(site/study name)(sample core type)(sample core number)- (top of sample depth)(bottom of sample depth)-(sample number)

For example, "NAPLSG01-SS-01" would represent the first sample collected NAPL mobility, sediment surface sample #1.

The above sample naming format will be modified for field duplicates as follows:

(site/study name)(sample core type)(sample core number)- (top of sample depth)(bottom of sample depth)-(1)(parent sample number)

For example, "NAPLSG01-SS-101" would represent the field duplicate of the first sample collected for NAPL Mobility #1, surface sediment.

Matrix spike/matrix spike duplicate (MS/MSD) samples will be named the same as their parent sample except with the "MS" and "MSD" designation at the end of the sample ID (e.g., NAPLSG01-SS-01MS and NAPLSD01-SS-01MSD).

The sample labeling program for trip blanks and equipment blanks will be as follows:

- Trip blanks – TB (6-digit date)-(blank number)
- Equipment blanks – EB (6-digit date)-(blank number)

For example, "*TB0101517-01*" is a trip blank #1 submitted for analysis on 15-October-17.

3.7 Field Documentation

A written record of sampling activities and field observations will be maintained in a bound, water-resistant field notebook with consecutively numbered pages. Entries will be legibly written in black or blue, indelible ink. Entry errors will be corrected by drawing one solid line through the incorrect entry, followed by the user's initials and date. The end of each workday or task will be signed and dated by the individual making the entries. Factual and objective language will be used. Entries will be complete and accurate enough to allow reconstruction of each field activity. Activities should be recorded contemporaneously. When not in use, the logbook will be stored in the permanent project file. After completion of the sampling activities, the field notebooks will be in the custody of the CH2M (CH2M) project manager.

Daily entries of the following minimum information will be recorded in the logbook, when applicable.

- Date and time, expressed in 24-hour format
- Time of arrival and departure from the site
- Meteorological and water conditions (including tidal conditions)
- Project personnel and subcontractor personnel onsite
- Any visitors onsite, their representative company and their level of protection
- Health and safety hazards and precautions
- Level of personal protection
- Field observations
- Task start/stop times
- Time of each entry
- Duration of sampling activities

- Site identification (visual sketches where appropriate)
- Location of sampling points (visual sketches where appropriate)
- Description of sample
- Sample ID and analyses to be completed
- Number of samples taken
- Time of sample collection
- Quality assurance and quality control (QA/QC) samples taken
- Type of field instrumentation (if any)
- Names of people collecting samples
- Water depth per station location
- Comments on sampling (for example, equipment or sampling difficulties)
- Volume of sample return
- Decontamination procedures
- Equipment calibration records and all calibrations done
- Any other field instruments, general observations, or notes
- Any deviations from the sampling plan or sampling protocol, if any
- Health and safety observations
- Signature of recorder

3.7.1 Photographic Log

Digital photographs will be taken in the field to document sampling locations, collected samples, site conditions, and any other site-related observations. A photographic log will be kept in which the date, location, photo ID number, brief photographic description, and direction the photographer is facing (if appropriate), and if sheen was produced during deployment of Darts will be recorded. Photographs and relevant log information will be downloaded onto a field computer on a regular basis.

3.7.2 Subsurface Sediment Core Logs

Core logs will be recorded in the field for the following observations and information:

- Sediment sampling depth for each sample
- Gross characteristics of the sediment, such as texture, color, biological structures, presence of debris, presence of oily sheen, and presence of an odor
- Comments on sample cohesiveness.

3.8 Investigation-Derived Waste Management

Waste generated during fieldwork includes personal protective equipment, disposable sampling items sediment cuttings, decontamination wash water, and other wastes generated during general sampling activities and decontamination. Investigation-derived waste will be managed consistent with upland activities as described in the *Remedial Investigation Work Plan, Wishram, Washington* (Kennedy/Jenks, 2016).

3.9 Sampling Handling Procedures

After samples are collected, they will be stored and transported under chain-of-custody as described in this section.

3.9.1 Sample Storage Requirements

The sampling container, preservation, and holding time requirements for each sample are listed below in Tables 3-1 and 3-2. Precleaned containers will be procured from the analytical laboratory. Samples will be held at or below 6 degrees Celsius (°C) in a cooler until delivery to the laboratory.

Table 3-1. Sediment Sample Containers, Preservation, and Holding Time Requirements

Parameter	Analytical Method	Container	Preservation	Maximum Holding Time
Dart sampler analysis	UVOST	Wrap in foil	N/A	N/A
Total organic carbon	SW9060 (with guidance from the SCUM II Manual)	4-oz glass jar	Cool, ≤ 6°C	28 days
Chemical oxygen demand	EPA 410.4	4-oz glass jar	Cool, ≤ 6°C	28 days
Total petroleum hydrocarbons-diesel and oil ranges (speciation may be requested)	NWTPH-Dx	4-oz glass jar	Cool, ≤ 6°C	14 days to extraction, 40 days to analysis
Polycyclic aromatic hydrocarbons	SW8270C or D-SIM	4-oz glass jar	Cool, ≤ 6°C	14 days to extraction, 40 days to analysis
Freshwater Bioassay (if needed) ***Hyalella azteca* 10-day mortality**	ASTM E1706-05/ EPA Method 100.1	1 x 5-gallon bucket[a]	Cool, 4°C, nitrogen	8-weeks
***Chironomus dilutus* 20-day mortality**	20-day mortality EPA Method 100.5			
***Chironomus dilutus* 20-day growth**	EPA Method 100.5			
Core photography (visible and UV light)	N/A	1 x DPT nominal 1.25-inch stainless steel Macro-Core tube	Frozen on dry ice	N/A
LIF frozen core analysis with TarGOST	N/A			
Pore fluid saturation (water, oil) (includes bulk density, total porosity, particle density)	Dean-Stark API (1998) Sec. 4.3			
Core sample screening using Dart system and UVOST	N/A			
Grainsize (particle size including hydrometer)	ASTM D422			
Product mobility by water/ NAPL flooding	ASTM 6836			

[a] Samples will be collected and held by the laboratory without further action until it is determined if bioassays are necessary (see Figure 4). The maximum holding time allowed for sediment samples held at 4°C in the dark and under a nitrogen atmosphere is up to 8 weeks before bioassay testing.

Notes:
°C = degree(s) Celsius
DPT = direct-push technology
EPA = U.S. Environmental Protection Agency
LIF = laser-induced fluorescence
N/A = Not applicable
NAPL = non-aqueous phase liquid
oz = ounce
UV = ultraviolet

Table 3-2. Water (Equipment Blank) Sample Containers, Preservation, and Holding Time Requirements

Parameter	Analytical Method	Container	Preservation	Maximum Holding Time
Total petroleum hydrocarbons (diesel and oil ranges)	NWTPH-Dx	2 x 1-liter amber glass	Cool, ≤ 6°C, HCl to pH<2	7 days to extraction, 40 days to analysis
Polycyclic aromatic hydrocarbons	SW8270-SIM	2 x 1-liter amber glass	Cool, ≤ 6°C	7 days to extraction, 40 days to analysis

Notes:
NWTPH-Dx Analysis to be run with and without silica gel cleanup as a sample preparation method
C = Celsius
HCl = hydrogen chloride
pH = hydrogen (ion) concentration

3.9.2 Chain-of-Custody Procedures

Procedures must be taken to preserve and ensure the integrity of samples from the time of collection through analysis. Records of the custody of samples must be maintained both in the field and in the laboratory. A sample is considered to be in someone's custody if it is in his or her physical possession or view, locked up, or kept in a secured and restricted area. Until the samples are shipped, their custody will be the responsibility of the sampling team leader.

Chain-of-custody records document sample collection and shipment to the laboratory. A chain-of-custody form will be completed in duplicate, as a minimum, for each sampling day. The original chain-of-custody form will be delivered with the sample shipping cooler, and the copy will be retained in the field documentation files. The chain-of-custody form will identify the contents of each shipment and maintain the custodial integrity of the samples. All chain-of-custody forms will be signed and dated by the responsible sampling team personnel. The "relinquished by" box will be signed by the responsible sampling team personnel, and the date, time, and air bill number (if applicable) will be noted on the chain-of-custody form.

The following information must be documented on the chain-of-custody form as a minimum:

- Project name, project number, and project manager's name and contact information
- Unique sample identification (no dashes, spaces, or commas)
- Date and time of sample collection
- Matrix
- Number of sample containers
- Analyses required
- Designation of matrix spike/matrix spike duplicate (MS/MSD) samples
- Preservative used
- Name and signature of sampler, receiver
- Bill of lading or transporter tracking number (if applicable)
- Requested turnaround time

Custody seals will be placed across the front and sides of each sample cooler lid to maintain its integrity until it is opened by the laboratory. The shipping coolers containing the samples will be sealed with a custody seal any time they are not in someone's possession or view before shipping. All custody seals will be signed and dated by the responsible sampling team personnel.

When transferring the samples, the individuals relinquishing and receiving the samples will sign, date, and note the time on the chain-of-custody form. If the samples are required to be shipped, the primary or QA laboratory coordinators will be notified of when and how samples were sent. Notification will include the following information:

- Date of shipment
- Name of shipping company
- Air bill number
- Number of coolers
- Name, phone number, and facsimile number of point of contact
- Estimated date of shipment arrival
- Type of samples (water, sediment)

On receipt of each sample cooler and after verification of the chain-of-custody records, the primary or QA laboratory will provide a cooler receipt form documenting any discrepancies such as, but not limited to, the following:

- Inappropriate sample containers or preservation
- Broken sample containers
- Cooler temperature outside range of 0°C to 6°C (where applicable)
- Missing chain-of-custody form or QA sample form
- Errors on chain-of-custody or QA sample form
- Missing custody seals

The laboratory will notify CH2M of any such discrepancies immediately of its receipt of the samples.

The chain-of-custody forms then become part of the permanent record of the project file and serve as a future reference for sample documentation.

Custody must be maintained at the laboratory once samples are received until all tests are completed. This will be accomplished using an internal custody system that requires samples to be kept in a secured and restricted area when not in use, and to be checked out and checked back in by the analysts who use them. Internal custody records must be maintained by the laboratory as part of the documentation file for each sample.

3.9.3 Sample Transport Requirements

Sample transport requirements are described below.

- **Dart Samplers.** Dart samplers will be individually wrapped in foil before packing and shipped overnight to Dakota Technologies in Fargo, North Dakota for analysis. The samplers will be shipped to Dakota as soon as possible using the shipping boxes or tubes in which they were received. If any Darts exhibit a strong naphthalene odor indicating extreme contamination, they will be segregated from the remaining Dart samples to prevent vapor phase cross-contamination.

- **NAPL Mobility Cores.** The sample tubes for the NAPL mobility will be frozen on dry ice and shipped overnight in a cooler on dry ice to the TestAmerica Applied Sciences Laboratory in Corvallis, Oregon, for NAPL mobility analyses.

- **Sediment Samples.** Sediment (grab samples and core samples will be shipped to ESC Lab Sciences in Mt. Juliet, TN. To minimize the potential for sample degradation and to maintain a temperature at or below 4°C, sediment samples will be chilled in a cooler with an ice substitute (for example, blue ice) or ice in a resealable plastic bags. The chain-of-custody form, and a QA sample form, if required, will be filled out in indelible ink, placed in a resealable plastic bag, and taped to the inside lid of the shipping cooler. It is anticipated that most project samples will be environmental samples in small volumes. Environmental samples are samples with contaminant concentrations significantly reduced by normal environmental weathering processes such as volatilization to the air, degradation caused by exposure to sunlight and microbes, or simple mixing with soil or groundwater. As such, the samples present little shipping hazard in terms of corrosiveness, flammability, and explosiveness.

The following procedures will be implemented in packing environmental samples:

- Check the sample container caps to make sure they are tightened properly. (Samples for volatile components must be discarded and recollected if the cap is loose.)
- Tape over the drain hole on the inside of the cooler.
- Place a layer of cushioning material in the bottom of the cooler.
- Enclose each bottle in a separate, clear, plastic bag and seal each bag. Place the bottles upright in the cooler and separate with packing materials so that they will not touch against each other during shipment. Place additional cushioning material around sample bottles, and fill voids between bottles.
- Place ice substitute between samples and over the containers to preserve them at or below 4°C. (Note: Loose bagged ice is not acceptable if coolers are transported by commercial aircraft.)
- Fill the cooler with cushioning material.
- Tape the cooler drain shut from the outside of the cooler.
- Place completed chain-of-custody form inside a resealable bag and tape the bag to the inside lid of the cooler.
- Close and latch the cooler. Wrap a strong adhesive tape around the ends of the cooler to secure it, making sure to cover the spigots at the bottom and any open space between the lid and the cooler. Tape the cooler latch closed with strapping tape.
- Seal the cooler with custody seals on the front and the sides, and seal the cooler with strapping tape. The signature on the custody seals should match the signature on the chain-of-custody form.
- Attach the completed shipping label to the top of the cooler; print “Laboratory Samples” and “This End Up” on the top of the cooler; and put upward-pointing arrows on all four sides. Place “Fragile” and “Chill, Do Not Freeze” labels on at least one side.

Samples will be packaged for shipment according to U.S. Department of Transportation (DOT) regulations. Marking and labeling procedures will be consistent with DOT regulations. The method of shipment, courier name(s), and other pertinent information will be entered on the chain-of-custody form. Air bills will be properly completed, and copies will be retained and placed in the project file.

For environmental samples, no DOT marking, labeling, or shipping papers are required, and there are no DOT restrictions on the mode of transportation. DOT regulations do not apply to transport by government-owned vehicles, including aircraft.

While not anticipated, if hazardous samples are encountered, the following procedures will be implemented:

- Place the sample container inside a 1-quart or 1-gallon paint can. Fill the void space with vermiculite. Place the paint can in a cooler and pack as described above.
- Complete a carrier-approved air bill or shipper’s certification for restricted articles, providing the following information in the order listed:
  - “Flammable Liquid, No. UN 1993” or “Flammable Solid, No. UN 1325”
  - “Limited Quantity” (or “Ltd. Qty.”)

  - Net weight or net volume of total sample material in cooler
  - “Laboratory Samples”
  - “Cargo Aircraft Only”

- Affix a corporate address label to the cooler with the address of the laboratory.

SECTION 4

Laboratory Analytical Methods and Test Conditions

Table 4-1 lists the laboratory preparation and analytical methods and mean reporting limit for chemical and NAPL characterization analyses. Table 4-2 lists the freshwater sediment toxicity test conditions for *Hyalelle azteca* and *Chironomus dilutes.* Sampling results will be uploaded into Ecology's Environmental Information Management System database (EIM).

Table 4-1. Laboratory Methods and Target Detection Limits

Analyte	Preparation Method	Analytical Method	Mean Reporting Limit
Dart Analysis			
LIF using UVOST	N/A	N/A	N/A
Total organic carbon (%)	Per the analytical method	SW9060	10
Chemical oxygen demand (mg/L)	DI Water	EPA 410.4	10
Polycyclic Aromatic Hydrocarbons (µg/kg)			
Total PAHs	SW3550B	SW8270C or D SIM	6
Bulk Petroleum Hydrocarbons (mg/kg) (speciation may be required for some samples)			
TPH-Diesel	SW3630, SW3665	NW-TPH-Dx	4
TPH-Residual	SW3630, SW3665	NW-TPH-Dx	10
NAPL Mobility Core Analysis			
Core photography (visible and UV light)	N/A	N/A	N/A
LIF frozen core analysis using TarGOST	N/A	N/A	N/A
Pore fluid saturation (water, oil) (includes bulk density, total porosity, particle density)	N/A	Dean-Stark API (1998) Sec. 4.3	N/A
Core sample screening using Dart system and UVOST	N/A	N/A	N/A
Grainsize (particle size including hydrometer)	N/A	ASTM D422	N/A
Product mobility by water/NAPL flooding	N/A	ASTM 6836	N/A

Notes:
NWTPH-Dx Analysis to be run with and without silica gel cleanup as a sample preparation method

LIF = laser-induced fluorescence
mg/kg = milligram(s) per kilogram
mg/L = milligram(s) per liter
N/A = not applicable
NAPL = non-aqueous phase liquid
PAH(s) = polycyclic aromatic hydrocarbon(s)
TPH = total petroleum hydrocarbon
UV = ultraviolet
UVOST = Ultra Violet Optical Screening Tool

Table 4-2. Bioassay Test Conditions (if needed): *Hyalella azteca and Chironomus dilutus*

	Performance Standard		Control Samples		Control Limits		Water Quality Monitoring Frequency	
Biological Test Endpoint	**Control[a]**	**Reference[b]**	**Negative**	**Positive**	**Temp[c] °C**	**DO[d]**	**Temp/DO**	**Hardness Alkalinity Conductivity Sulfides Ammonia**
Hyalella azteca								
10-day mortality	MC < 20%	MR < 25%	Clean sediment	Reference toxicant in freshwater	23 ± 1	40–100	Daily	pH = Daily Others at start/end of test
28-day mortality	MC < 20%	MR < 30%						
28-day growth	MIG_C > 0.15 mg/ individual	MIG_R > 0.15 mg/ individual						
Chironomus dilutus								
10-Day mortality	MC < 30%	MR < 30%	Clean sediment	Reference toxicant in freshwater	23 +/- 1	40 -100	Daily	pH = Daily Others at start/end of test
10-Day growth	MIG_C > 0.48 mg/individual	RF / CF > 0.8						
20-Day mortality	MC < 32%	MR < 35%						

[a]These tests and parameters were developed based on the most updated American Society for Testing and Materials (ASTM International) protocols.

[b]Reference performance standards are provided for sites where Ecology has approved a freshwater reference sediment site(s) and reference results will be substituted for control in comparing test sediment to criteria.

[c]Water bath or exposure chamber temperature should be continuously monitored. The daily mean temperature should be within ± 1 °C of the desired temperature. The instantaneous temperature should be within ± 3 °C of the desire temperature.

[d]Percent saturation

Notes:
C = Control
DO = dissolved oxygen
F = Final
M = Mortality
mg = milligram(s)
MIG = Mean Individual Growth at time final
pH = hydrogen (ion) concentration
R = Reference

Quality Assurance and Quality Control Requirements

This section describes for the QA/QC requirements for field quality control samples, data validation, and corrective actions.

5.1 Field Quality Control Samples

QC samples will be collected to monitor accuracy, precision, and the presence of field contamination for definitive analytical methods to be performed by the contracted primary laboratory. Field QC samples are not required for biological analyses.

5.1.1 Field Duplicate Samples

A field duplicate is an independent sample collected as close as possible to the original sample from the same source under identical conditions. Field duplicates are used to document sampling and analytical precision. They are collected at a minimum frequency of 1 per 10 samples (10 percent) for each matrix and for each type of analysis. The sampling locations of the field duplicate sample will be recorded in the field logbook. All field QC samples will be sent blind to the laboratory along with regular field samples. They will be labeled similar to regular field samples for disguise.

5.1.2 Matrix Spike/Matrix Spike Duplicate

The MS/MSD is a duplicate pair of samples collected along with an investigatory sample, to which the laboratory adds a spike containing target analytes specified for each method at known concentrations. The purpose is to assess the effect of the sample matrix on the extraction and analysis method.

For every 20 field samples of each matrix collected from each site, one location will have sample volume collected in triplicate for each analysis required and designated on the chain-of-custody form as an MS/MSD. MS/MSD samples may involve obtaining an independent pair of samples collected as close as possible to the original (parent) sample from the same source under identical conditions or prepared by the laboratory as part of their QA program and subsampled from an investigatory sample. The sampling locations for the MS/MSD will be documented in the field logbook.

5.1.3 Equipment Blanks

Equipment rinseate blanks may be collected to evaluate field sampling and decontamination procedures by pouring deionized water over the decontaminated equipment and capturing that water in laboratory-supplied containers. If required, equipment blanks will be collected for each matrix sampled and will be collected at a rate of 1 in 20 for each field crew. The equipment blanks will be analyzed for the same parameters specified for the corresponding matrix. Equipment blanks are not required where disposable or dedicated sampling equipment is used.

5.2 Data Validation

5.2.1 Laboratory Data Review

The integrity and validity of all analytical results requires the implementation of an internal QA program. The program will meet the requirements set forth in the SCUM II guidance.

Analyses not meeting test validation criteria will be described in the case narrative. If the laboratory does not expect to be able to meet any of the limits, the sampling contractor project manager will be notified in writing (email or fax) as soon as any failure is noted by the laboratory. Any variances must be approved by appropriate laboratory personnel and the sample contractor project manager before the laboratory proceeds with sample analysis.

5.2.2 Data Validation Data Review

The analytical results of the data collection effort will be validated. Data will be validated using the QC limits established by the laboratory, method-specific criteria, and the latest versions of the U.S. Environmental Protection Agency *National Functional Guidelines for Inorganic and Organic Superfunds Methods Data Review* as guidance.

Data collected during the project will be subjected to a level III data validation that will include the following items:

- Review of the data set narrative to identify any issues that the lab reported in the data deliverable
- Check of sample integrity (sample collection, preservation, and holding times)
- Evaluation of basic QC measurements used to assess the accuracy, precision and representativeness of data including QC blanks, laboratory control samples, MS/MSD, surrogate recovery when applicable, and field or laboratory duplicate results
- Review of sample results, target compound lists, and detection limits to verify that project analytical requirements are met
- Initiation of corrective actions, as necessary, based on the data review findings
- Qualification of the data using appropriate qualifier flags, as necessary, to reflect data usability limitations
- Evaluation of calibration and internal standard summary results against the project requirements.
- Other method-specific QC requirements

In addition to the data review conducted by the laboratory, this data validation process will involve a detailed review of the raw analytical data, if deemed necessary, to include the following:

- Review of sample chromatograms
- Verification of analyte identification and calculations for at least 10 percent of the data

The results of this data validation process will describe whether the reported data are considered to be from valid, representative samples, and therefore acceptable for the data endpoints for which they were intended as set forth in the project SAP. Data QA/QC and validation summaries for each sample delivery group will be included in a technical appendix to the final report.

5.3 Corrective Actions

Laboratory results that do not meet specified method criteria or the laboratory's internal QC requirements will be reanalyzed by the laboratory unless directed otherwise by the project manager.

The laboratory will review the data generated to verify that samples have been run as specified in the procedure. Laboratory personnel are alerted that corrective actions may be necessary under the following conditions:

- QC data are outside the warning or acceptable windows for precision and accuracy established for laboratory samples.
- Test validation criteria are not met as identified in the respective procedure.
- Deficiencies are detected by the laboratory QA director during internal or external audits, or from the results of performance evaluation samples.
- Reporting limits for non-detects are greater than the freshwater SMS criteria.

Corrective actions are implemented immediately when non-conformances in QC or sample results are identified. If the problem persists, cannot be identified, or cannot be remedied, the project manager must be notified about the nonconformance. All laboratory QC problems that will affect the final data must be documented. Once resolved, full documentation of the corrective action will be filed for inclusion in the project file, if data are affected. A copy of the corrective action report must be included in the laboratory data package deliverable.

Corrective actions may include the following actions:

- Reanalyzing the samples, if holding time criteria permit
- Resampling and reanalysis
- Evaluating and amending sampling and analytical procedures
- Accepting data and acknowledging level of uncertainty or inaccuracy by flagging the data and providing an explanation for their qualification

SECTION 6

Data Analysis, Record Keeping, and Reporting

Chemical concentrations in the analytical results of this sediment evaluation will be compared to the numeric SMS criteria for freshwater sediment developed by Ecology (2015), which are listed in Tables 2-2 and 2-3.

An RI report will be prepared following the AO requirements and will describe sampling results. The report will describe sample locations and depths, sampling handling and analytical methods, QA/QC, data results, and copies of field logs and laboratory data packages. In addition, valid data will be compiled and uploaded into Ecology's EIM System.

SECTION 7

Health and Safety Plan

Sediment sampling activities will be conducted according to CH2M's Health, Safety, and Environment program requirements, which include project-specific field safety instructions (FSI). In accordance with CH2M policy, all CH2M field team members and subcontractors must successfully satisfy all CH2M and site-specific health and safety requirements before working on the site, including Drug-Free Workplace training, wearing required personal protective equipment, and other requirements of the FSI. Employees working over or near water will be provided with U.S. Coast Guard-approved life jacket or buoyant work vests. Staff working on shore at the Railyard will have credentials from railroad and BNSF specific training.

SECTION 8

Schedule

Table 8-1 lists the key milestones and general dates of the Wishram Railyard Nearshore Sediment RI. Field activities will occur in two mobilizations over approximately 1 month. The first mobilization will include approximately 8 days to perform the Dart survey, including sampler placement, equilibration, and retrieval.

The second mobilization will include 3 days for surface sediment sample collection and 5 days to collect and sample subsurface sediment cores and to collect NAPL mobility cores.

Actual dates of sampling are to-be-determined.

Table 8-1. Schedule for Initial Columbia River Sediment Sampling

Date	Task
January 2018	Submit*BNSF Wishram Track Switching Facility Nearshore Sediment Initial Investigation Work Plan* to Ecology
January-March 2018	Conduct Dart Survey and Analysis
	Conduct Sediment Sampling
March 2018	Complete Laboratory Analyses of Sediment Samples
April 2018	Submit Data Evaluation Report to Ecology for Review
June 2018	Submit Final Nearshore initial investigation Report and Data to Ecology in EIM System

Project Personnel and Responsibilities

Table 9-1 lists the project personnel with their associated company/agency and responsibility.

Table 9-1. Project Personnel and Responsibilities

Company/Agency	Personnel	Responsibility
BNSF	Shane DeGross	Manager Environmental Remediation
Washington Department of Ecology	John Mefford	Cleanup Project Manager
	Christopher Wend	Assistant Cleanup Project Manager
Kennedy/Jenks	Ryan Hultgren	Project Manager
	Todd Miller	Program Manager
	Alice Robinson	Field Lead/Site Safety Coordinator
	Matt Biondolillo	Senior Technical Consultant/Subject Matter Expert
CH2M	Carrie Andrews	Senior Project Manager
	Jeff Gentry, PE	Senior Technical Consultant
	Marilyn Gauthier, PG	Subject Matter Expert, Geology and Sediment
	David Finney	Subject Matter Expert, NAPL
	Jeff Schut	Subject Matter Expert, Ecological Risk/Bioassay
	Jennifer Ulrich	Field Sampling Lead/Site Safety Coordinator
	Bernice Kidd	Project Chemist/Data Validation
	Dusty Berggren	NAPL Mobility Laboratory Task Lead

Note:
NAPL = non-aqueous phase liquid

SECTION 10

References

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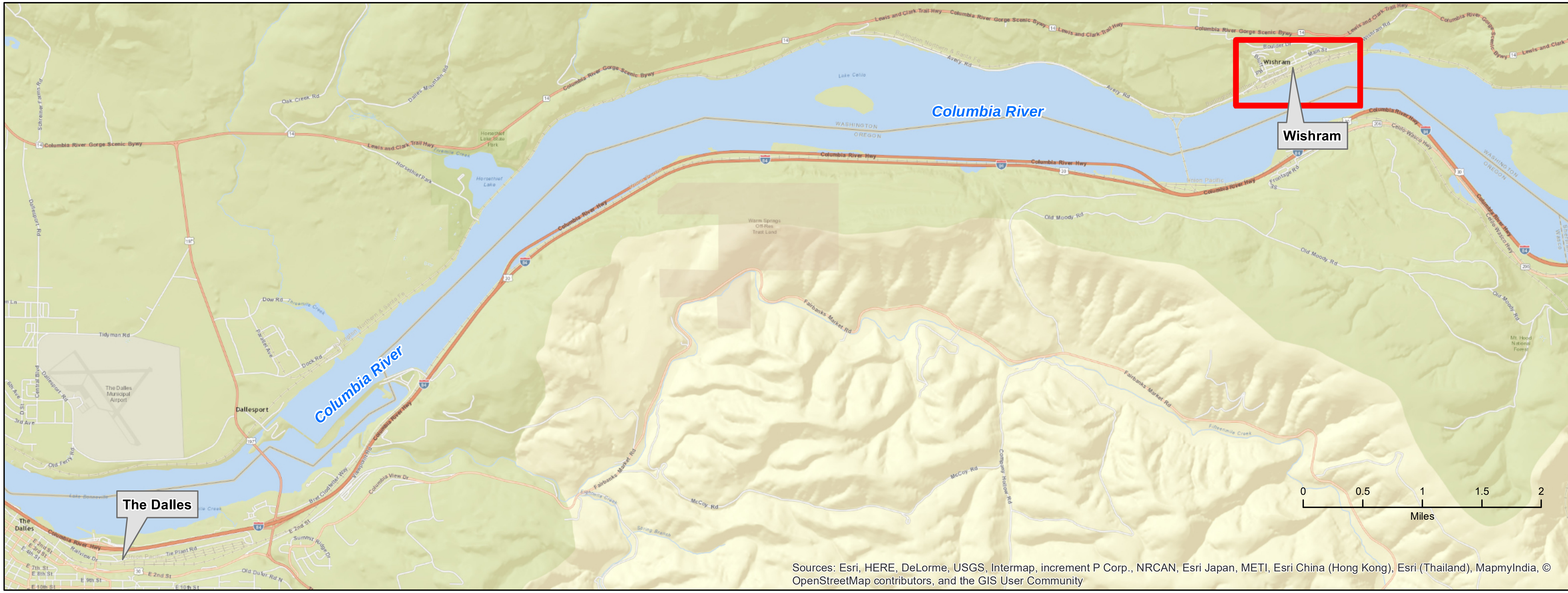
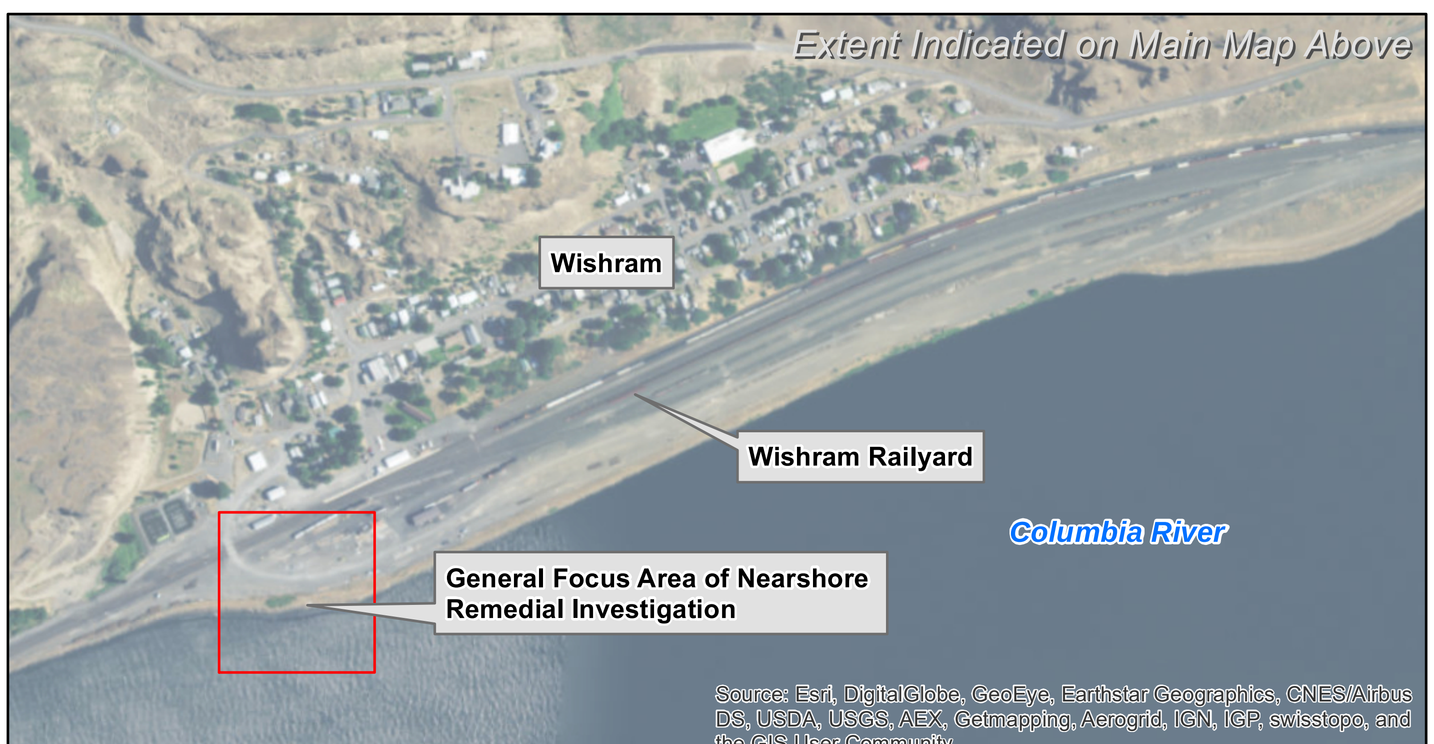
Figures





N

0 500 1,000 2,000 Feet

Figure 1. Site Location Map
BNSF Track Switching Facility
Wishram, Washington

ch2m.

VICINITY MAP

LEGEND

- Approximate historical lateral extent of Dissolved-Phase Diesel- and/or Oil-Range Organics above the MTCA Method A groundwater cleanup level (500 µg/L)
- Historic Yard Features
- Approximate Lateral Extent of Oil
- Ecology River Bank Sheen Observed (March 3, 2017 Letter)
- Area of Intermittent NAPL Sheening
- Small-extent NAPL Sheens Observed (Ecology, 2017)
- Potential Drainage Feature
- Approximate BNSF Property Line

Notes:
NAPL = nonaqueous phase liquid
µg/L = microgram(s) per liter
MTCA = Model Toxics Control Act

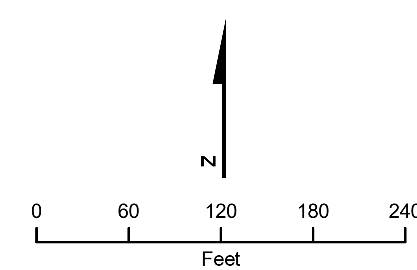
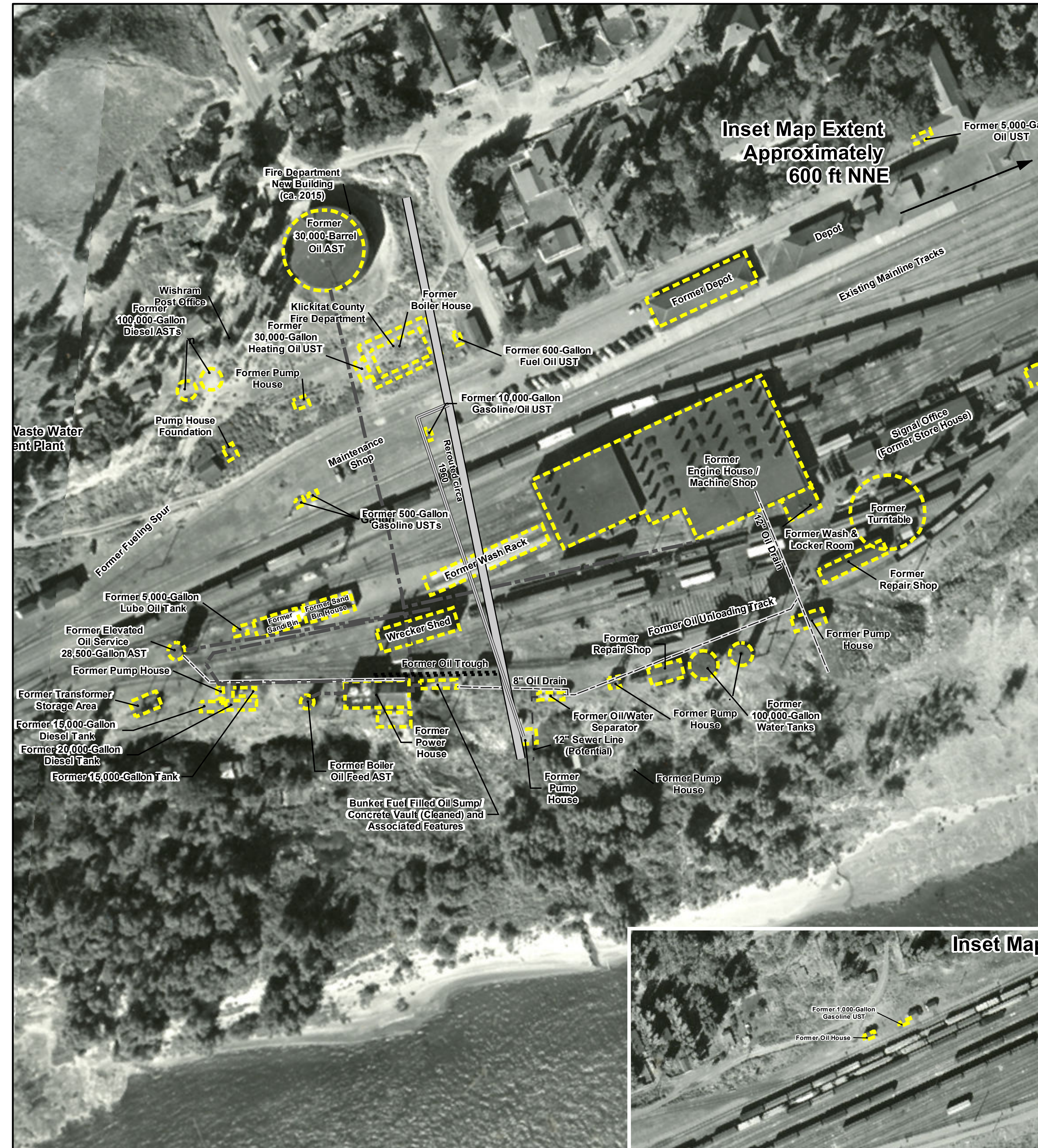


Figure 2. Wishram Railyard and Nearshore Sediment Area of Interest
BNSF Track Switching Facility
Wishram, Washington

ch2m:

Current Features with Former Feature Footprints (Aerial Date: 2015)

Former Features (Aerial Date: 1951)



LEGEND

- Former Bunker Fuel / Oil Pipeline
- Former Oil Drain
- Former Oil Trough
- Former Sewer Line (Potential)
- Stormwater Underdrain (A portion removed from service circa 1960)
- Stormwater Underdrain (Rerouted portion circa 1960)
- Existing Site Feature
- Former Site Feature
- Approximate BNSF Property Line
- Former Site Feature

N

0 75 150 300 Feet

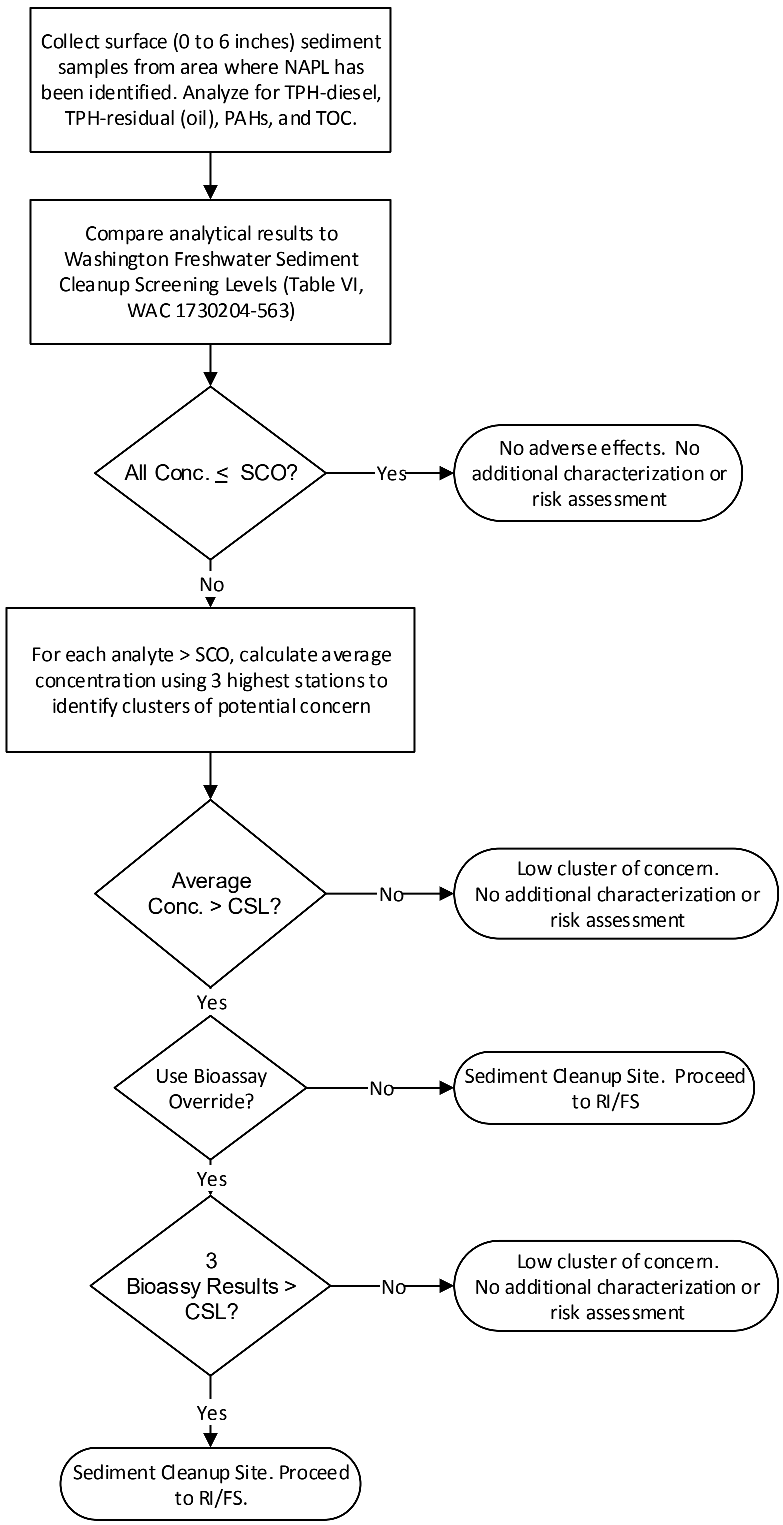
Figure 3. Current and Former Site Features
BNSF Track Swithcing Facility
Wishram, Washington

ch2m:

\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\WORKPLAN\FIGURE1-3_SITEFEATURES.MXD SJ063666 1/24/2018 11:28:11 AM

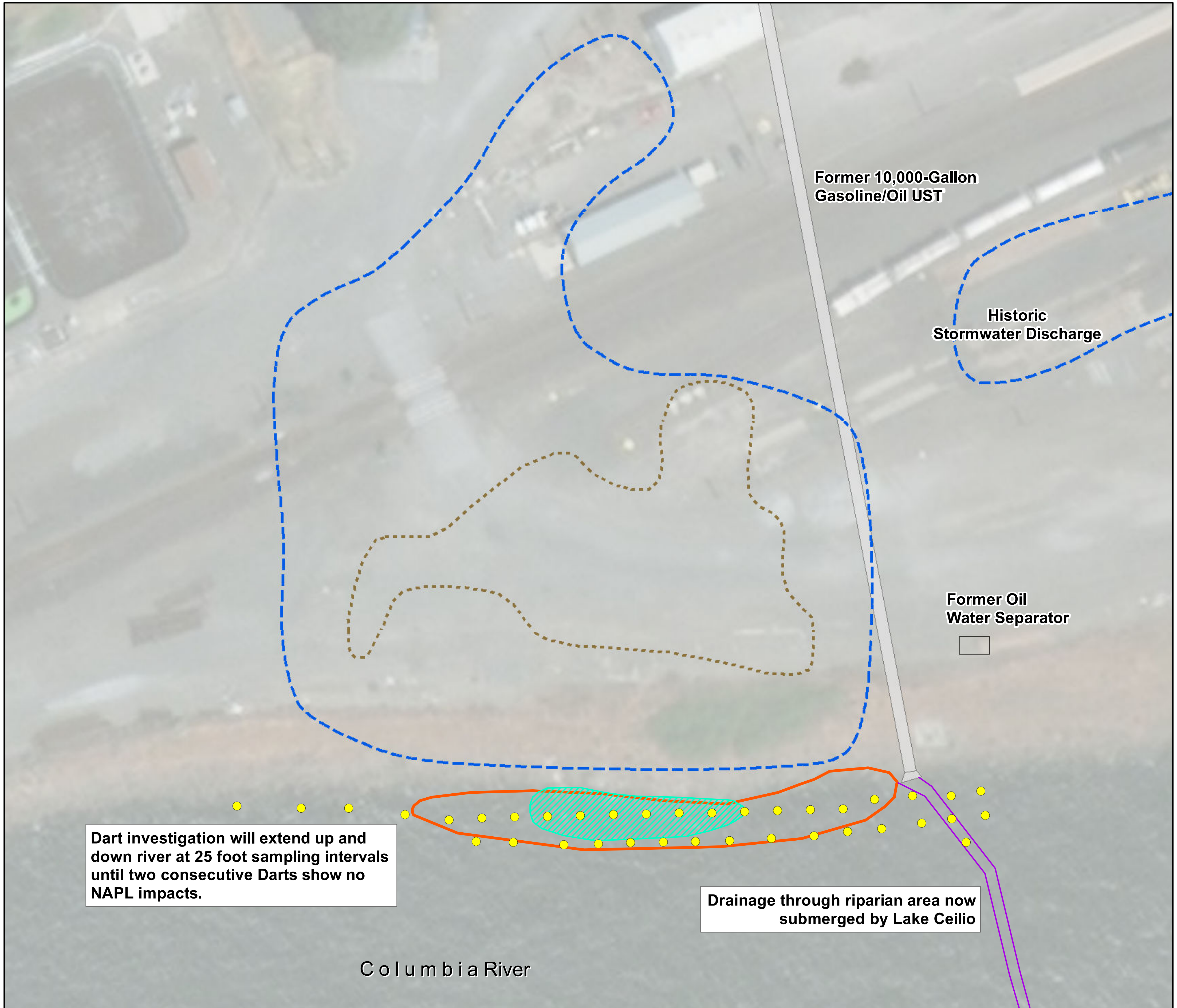
Initial Investigation (Chapter 2 of SCUM II)

Are sediments impacted by chemicals associated with NAPL and does site qualify as Sediment Cleanup Site?



Conc. = concentrations
CSL = cleanup screening level
FS= feasibility study
NAPL = nonaqueous phase liquid
PAHs = polycyclic aromatic hydrocarbons
RI= remedial investigation
SCO = sediment cleanup objective
SCUM II = Sediment Cleanup Users Manual II
TOC = total organic carbon
TPH = total petroleum hydrocarbons
Certain situations may support performance of concurrent bioassay testing with evaluation for chemical criteria

Figure 4. Sediment Chemistry and Bioassay Evaluation Process
BNSF Track Switching Facility
Wishram, Washington



VICINITY MAP

LEGEND

- Proposed Dart Location
- Potential Drainage Feature
- Area of Intermittent NAPL Sheening
- Small-extent NAPL Sheens Observed (Ecology, 2017)
- Approximate Lateral Extent of Oil
- Approximate historical lateral extent of Dissolved-Phase Diesel- and/or Oil-Range Organics above the MTCA Method A groundwater cleanup level (500 µg/L)
- Former Oil Water Separator
- Stormwater Underdrain (A portion removed from service circa 1960)

Notes:
NAPL = nonaqueous phase liquid
µg/L = microgram(s) per liter
MTCA = Model Toxics Control Act
UST = underground storage tank

N

0 30 60 90 120
Feet

Figure 5. Conceptual Design for Dart Survey
BNSF Track Switching Facility
Wishram, Washington

ch2m.

\\PDXFPP01\PROJ\BNSFRAILWAYCOMPANY\693282WISHRAMRIFS\GIS\MAPFILES\WORKPLAN\FIGURE6-2_DARTPTS.MXD SJ063666 1/24/2018 11:42:03 AM

Attachment 1
Dart Manual

User Manual

Darts

Field Deployable
Solid Phase Extraction Samplers

DAKOTA TECHNOLOGIES

Version 2.10.09

2015

Table of Contents

Introduction

The Dart system is designed to quickly and inexpensively screen for polycyclic aromatic hydrocarbons (PAHs) in sediments and similar soft soils where LIF, traditional soil boring, and other mechanized sampling methods are difficult, if not impossible.

The Dart sampler is comprised of a fiberglass rod coated with solid-phase extraction (SPE) media – the same type of material used in labs for EPA-approved cleanup and pre-concentration of PAHs in traditional grab samples. PAHs are attracted to and sorb into the SPE media. Once the PAHs have migrated into the Dart, they are held within the SPE matrix and remain trapped almost indefinitely.

The Darts are deployed by hand, manual slide-hammer, gas-powered hammer, or Vibracore into the sediments, anywhere from 1 to 12 feet deep, depending on soil conditions or survey needs. Once planted, PAHs that are sorbed to sediment soil particles, dissolved in sediment pore water, or exist as a component of non-aqueous phase liquids in the sediments, will migrate into the Dart sampler. PAHs migrate into the Dart sampler because of their high affinity for the SPE material, which exhibits a relatively low affinity for water or sediments, thus generating a considerable concentration gradient. Typically, 24 hours of equilibration time is sufficient, after which the Darts are retrieved, packaged, and sent to Dakota Technologies, Inc. (Dakota) for analysis. Additional soak time beyond 24 hours allows more PAHs to sorb. In most environments, though, soak times between 24 and 72 hours are acceptable as long as soak times remain consistent for the sample location.

Upon arrival for analysis, technicians at Dakota run the Darts through a modified Ultra-Violet Optical Screening Tool (UVOST®) LIF reader. The result is an LIF log nearly identical to a UVOST® log. As with UVOST® and TarGOST® data, the LIF response correlates to the total available PAH content of the sediment plotted against a depth scale. A graphical log in JPG format and high-resolution data files are made available to the client soon after analysis is completed.

In addition, when combined with digital global positioning system (DGPS) information, the numerical results may be visualized with Dakota's 3D conceptual site model service. This allows the client to visualize the big picture of their sediment PAH contamination at a fraction of the cost of traditional sampling and analysis.

The Dart system is particularly well suited for characterization work in shorelines, marshes, tidal zones and shallow bodies of water where profiling sediments has traditionally been difficult and expensive. Third party research suggests that Darts will be capable of acting as biological surrogates due to the similarity of the SPE material to biological tissues with regard to absorbing biologically available PAHs in sediments. This allows for surveys of biological uptake risk as opposed to total PAH analyses of sediment using aggressive Soxhlet extractions, which often overestimate risk. Dakota continues to investigate the efficacy of applying Darts to these and other screening applications.

Overview of Installation

This guide will help minimize the risk of false positives or vertical crossover contamination as you deploy, retrieve, and package Darts. The key physical property of the Dart concept is its quick absorption of oils, greases, PAHs, and nearly all organic solvents. Prior to listing a detailed and mechanical procedure, we will discuss the basics to consider before utilizing Darts. We will then describe in detail the step-by-step procedure used during a Dart survey.

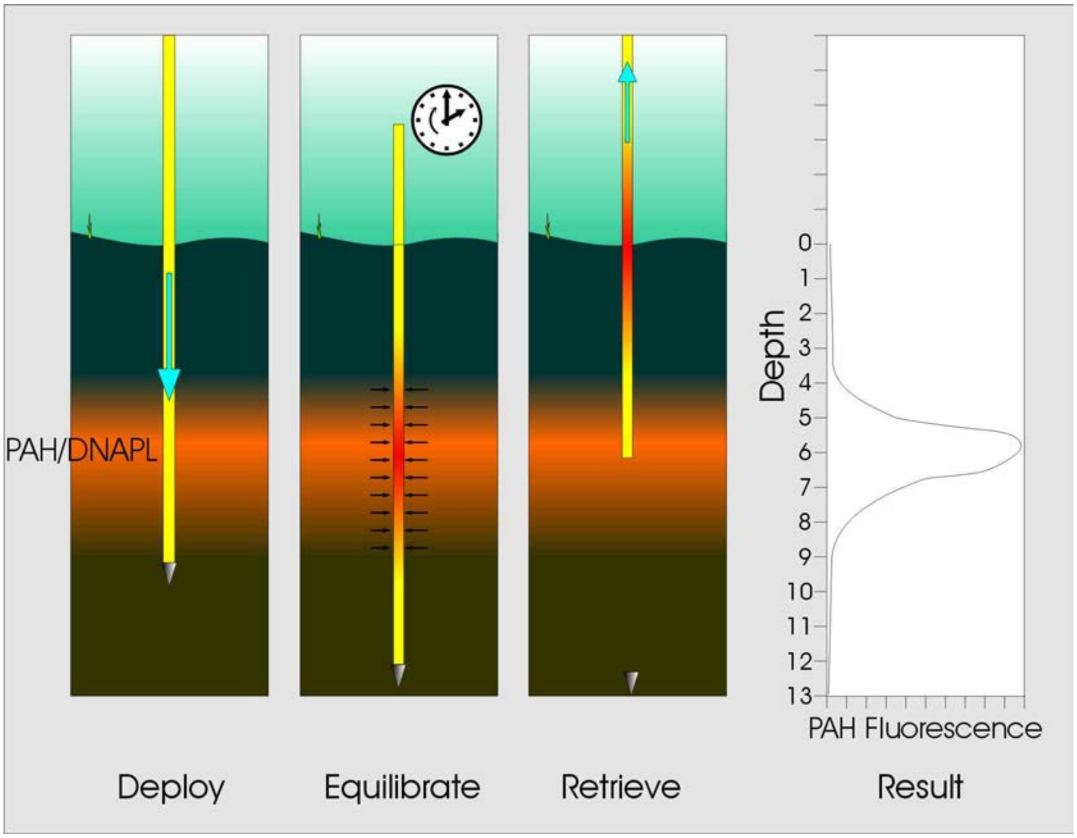


Figure 1. Basic concept behind Dart installation, exposure, and retrieval

Eliminating False Positives

The ability of the Dart to absorb organics is crucial to the Dart's ability to survey for PAH NAPL, but can easily lead to false positives. In order to minimize this risk, the following should be considered:

- Handle Darts only while wearing standard nitrile gloves. Doing so will prevent potentially fluorescent oils from being transferred to the Dart.
- Change nitrile gloves often. Whenever exposure to contamination is suspected, apply new gloves. When in doubt… glove up!
- Establish a work area with clean and dirty zones to avoid inadvertent exposure of clean tools and Darts to contamination.
- Use paper towels, tarps, plastic sheeting, or whatever is necessary to prevent cross-contamination.
- Minimize exposure of Darts to grease, tar, fuels, oils, etc. Although, the Darts are shipped in a plastic sleeve that offers protection from incidental exposure to fluorescent materials, gasoline and diesel may still penetrate the sleeve and expose the Dart to PAHs.
- Inspect delivery tooling for signs of contamination after each Dart is installed. If reasonable hygiene precautions aren't utilized between insertions, subsequent Darts can become contaminated.
- Install Darts in suspected clean zones before moving toward suspected hot zones to minimize the degree of contamination and subsequent effort of cleaning the delivery tooling. Inadvertent carryover between two hot locations is not as detrimental as carryover from a hot zone to a clean zone, which may lead to a false-positive.
- Work upstream or upwind to prevent the sheen of previous installations from contaminating subsequent Darts.
- Wrap each retrieved Dart individually. It is possible for the PAH-contaminated section of one Dart to contaminate a clean Dart if they contact one another. Dakota supplies food grade aluminum foil for wrapping each Dart to protect from this cross-contamination.
- Designate one or two Darts as trip blanks, or controls. Take them into the field but do not install them. Upon analysis, these Darts will serve as a control to verify shipping, storing, reading and other processes did not result in false-positives.
- Keep an accurate log of how much of the Dart <u>was not</u> advanced into the sediment if refusal was met. When Dart is retrieved mark this line using a zip tie. Only the portion of the Dart that was in the sediment will be read.

While Darts can pick up PAHs from relatively dry metal surfaces or dissolved phase (aqueous) fluids, they require a great amount of time (days/weeks) to do so. For faster transfer (<24 hour), the Darts must contact true NAPL or high concentrations. Thus, although the aforementioned considerations should be heeded, don't let the issue of proper hygiene consume your thoughts. As long as exposure to bare hands and potentially fluorescent materials (grease, tar, fuels, oils, etc.) from previous installations (including sheen on the surface of liquids) is prevented, the likelihood of cross-contamination is minimal.

<u>Note</u>: *Previous studies have shown Darts are immune to humics/fulvics from plant material such as sticks, leaves, peat moss, detritus, and high organic soils.*

Field Deployment

Determine the delivery method(s) most likely to fit site conditions:

Hand Delivery- In soft sediments, Darts can be installed by hand. On shorelines or banks, this is done by grasping the Dart by the top metal portion and inserting vertically. In shallow water (up to 10ft), an extendable fiberglass pole may be used (Figures 2 and 3). In waters too deep for pole installation, a diver may be required.

Figure 2. Extendable fiberglass pole

Figure 3. Dart locked into fiberglass pole

Gas Powered Hammer – In highly stiff to hard sediments, the gas powered hammer may be used. This is intended primarily for shorelines, banks and very shallow water where the technician can stand on solid ground directly over the Dart. Using a gas powered hammer from a boat is not recommended. Keep in mind - the more force necessary during installation, the harder the Darts may be to remove!

Vibracore – Often, Vibracore samples are taken in conjunction with Darts. If the equipment is available, it may be an effective method for delivering Darts. Thus, Dakota has developed a head that adapts to 3” Vibracore equipment (Figure 4).

Figure 4. Vibracore head

Slide Hammer- In moderately stiff sediments, a slide hammer may be used to pound in Darts (Figure 5). This works best along shorelines, banks, and shallow water, though it can be used underwater by divers.

Figure 5. Slide hammer

Assembly

Step 1. Glove up with standard nitriles.

Step 2. Unpack the Darts and inspect plastic sleeves for cleanliness. If any appear contaminated or torn, either refrain from using the Dart or note the damage for future reference should a positive signal be found. Note: *Keep cardboard shipping boxes and any packing material for return shipment of the Darts to Dakota for analysis.*

Step 3. Single Darts (6-foot or 3-foot) are assembled and ready to deploy. If a deeper installation is desired, two Darts may be threaded together (Figure 6). To do so, install the first Dart half-way, thread the second Dart onto the first, and then continue advancing until the desired depth is achieved. Note: *Advancing to a depth greater than 12 feet is not recommended unless sediments are very, very soft.*

Figure 6. Threaded sections of Darts,

Installation

Step 1. Advance the Dart point into the subsurface until the bottom of the yellow SPE material is flush with the surface of the sediment. When delivering from a boat, it may be difficult to determine when flush. Thus, it is best to measure the depth from the water surface to sediment and mark the corresponding point on the fiberglass pole. Note: *Do **NOT** mark the SPE material of the Dart in any way!*

Step 2. Using either static weight (simply pushing) or the appropriate delivery tool, insert the Dart to the desired depth. Although the SPE material may experience minor tearing and scarring due to this process, valid results will still be produced.

Step 3. Upon reaching the desired depth (or meeting refusal), make note of how much yellow SPE material is exposed above the sediment or, conversely, estimate how far it was advanced below the sediment. For the logs to correctly show the surface of the sediment these measurements are extremely important. Mark the sediment interface on the Dart using a zip tie upon retrieval. Dart analysis logs are "zeroed" at that line (see Recovery section). As redundancy have any notes about depth information accompany the Darts when delivered for reading.

Step 4. Record the tag ID#, location, date, and time of installation for each Dart, as well as the aforementioned "zeroing" information. Also include the water depth (if applicable), installation conditions, and any other information corresponding to the Dart location. If the **desired file names** for each Dart log differ from those of the tag ID#'s, be sure to clearly note the intended file names on each tag.

Step 5. For water projects, Dakota supplies floating rope and buoys that are useful for recovering the Darts. However, the potential for disturbance by vandalism or boat traffic is a possibility. One should consider marking the shore or using separate buoys at a predetermined offset if either circumstance is expected. Use "sinking rope" on the actual Dart which can be "fished for" with a grappling line or pole – guided by shoreline or separate buoy markers.

Figure 7. Dart buoys

Step 6. Allow each Dart to equilibrate for approximately the same amount of time, from 24-72 hours. If necessary, the Dart soak times can vary by up to 6 hours without significantly impacting the survey. <u>Note</u>: *Variance beyond 6 hours has not been experienced to date, but conducting a limited lab study on site-specific materials to determine a correction factor is an option that can be applied to the Dart logs.*

Consider: The longer the Darts equilibrate, the greater the NAPL or sorbed-PAH staining. Although it has not been empirically determined as optimal, 24 hours has been the default recommended period used in previous field and lab work.

Recovery

After 24-72 hours of equilibration, the Darts should be removed from the sediment.

The method of recovery will depend largely on how the Darts were implanted and site-specific sediment conditions. Soft sediments may allow hand removal by pulling on the attached rope and buoy. In tight sediments, the slide hammer can be used to pound out the Dart. In extreme conditions, a power winch attached to a boat or tripod has been used.

Step 1. Extract the Dart while wearing clean nitrile gloves. Take care not to cross-contaminate the Dart by allowing ooze, mud, NAPL, etc. to run or smear down the Dart.

Note: O*rient the Dart horizontally as soon as possible to prevent cross-contamination.*

Handling the portion of a Dart not advanced into sediment is acceptable – even if your glove may be slightly contaminated.

Remember: Dakota will only analyze the portion advanced below sediment surface.

Step 2. Transport the Dart to an established clean zone; a plastic sheet laid out on a work table or the river bank work well.

Step 3. If the Dart was not fully inserted into the sediments, firmly attach a zip-tie to the exact location that represents the sediment surface. This may be a visibly distinct "mud-line" on the Dart or come from notes taken during installation. It's extremely important that this location is marked. This is where the Dart will be zeroed during analysis. Only the portion below the zip tie will analyzed. Please include notes with depth information when the Darts are sent in. This can greatly reduce questions/uncertainties during the analysis phase.

Figure 8. Zip-tie indicating location of "mud-line"

Step 4. Clean the Dart of any major debris or mud. If the Dart appears grossly contaminated with tar/oil, lay out several paper towels and allow the residual material to drip off until it will no longer flow or seep along the length of the Dart. Remove chunks of contaminant or mud by wiping perpendicular to the length of the Dart; do NOT scrub lengthwise as this may smear NAPL.

Note: *Heavy NAPL will continue to source PAHs to the SPE material during shipping, potentially leading to sections of higher PAH concentration relative to other Darts only exposed to NAPL during the equilibration period.*

Step 5. Allow any residual mud or contaminant to dry. This further minimizes the potential for contaminant smearing while wrapping and during shipping.

Step 6. Wrap the Dart in aluminum foil.

Note: *If wrapped neatly, with few folds and wrinkles, the Darts should fit into their original plastic sleeves, which is recommended*.

Figure 9. Wrapping Dart in foil

Step 7. Store the packaged Darts in a dry, dark, and cool environment until shipment (storage with ice or freezing is not necessary).

Shipping

Ship the Darts back to Dakota as soon as possible using the shipping boxes or tubes in which they were received. If any Darts exhibit a strong naphthalene odor indicating extreme contamination, segregate these highly impacted Darts from those suspected to be clean to prevent vapor phase cross-contamination. The Darts will be analyzed in one session, using a reference emitter to normalize the response across all Darts for your project. ASCII and JPG images of the logs will be emailed upon the completion of analysis.

Figure 10. Darts (3' long) in a 6" x 6" x 48" cardboard box

Analysis at Dakota

Instrument

A modified Ultra-Violet Optical Screening Tool (UVOST®) is used to determine the intensity and location of any NAPL staining. The UVOST® is a laser-induced fluorescence instrument that has been used for in-situ screening of NAPLs since 1993. Modifications for the purpose of analysis include an altered optical arrangement and the addition of a lathe that rotates the Dart while simultaneously translating the excitation/emission optics along the length of the Dart. The benefit of this rotating lathe system is that the Dart is analyzed in a spiral pattern, which maximizes the analyzed surface area of the Dart.

The system developed by Dakota sends ultraviolet excitation light through a fiber optic cable to the Dart reader. The light exits the Dart reader's fiber probe within an inch of the Dart. If fluorescent compounds (ie. contaminants) are encountered as the fiber probe is advanced along the Dart, the excitation light causes the contained PAHs to fluoresce. This fluorescent response is then transmitted through a twin fiber back to an oscilloscope which converts the response into a digital representation. Dakota's LIF systems monitor four unique bands of this fluorescence emission in real-time, and graphs the signal responses against a vertical depth scale. More information on the UVOST® and laser-induced fluorescence methodology may be found at our website: www.DakotaTechnologies.com.

Dart Preparation

Dakota technicians begin by donning nitrile gloves proven to be non-fluorescent. The Darts are unpackaged from the bulk container and inspected for damage to the protective layer of tin foil packaging, as this may be a sign of potential cross-contamination. Individual Darts are then unwrapped from their aluminum foil and debris is removed using distilled water and lint-free towels. This cleaning has no impact on the absorbed NAPL due to its affinity for the Dart's SPE material as opposed to an aqueous solution. The Dart is then loaded onto the reading lathe and the optics are zeroed to the proper start-depth location on the Dart.

Calibration

A stable reference emitting material is positioned in front of the optical assembly and the resulting instrument response is recorded. This reference emitter (RE) measurement is made before every Dart and defines the unit of measurement (%RE = signal / reference * 100). Any day-to-day drift in instrument response, such as that caused by a change in laser excitation energy, is accounted for by consistently using this RE.

It is possible to generate response curves across a range of NAPL concentrations with lab testing. This is done by mixing various concentrations of site-specific NAPL with either site-specific soil sediment samples or Fisher Scientific sea sand. Short (3") Darts are then coated with these mixtures, which are subsequently analyzed after an equilibration period equal to that used in the field. The results are then used to convert the %RE values of field logs to ppm NAPL by weight. An example calibration curve figure is shown below - darker, more organic, and finer grain sediments will yield a lower response.

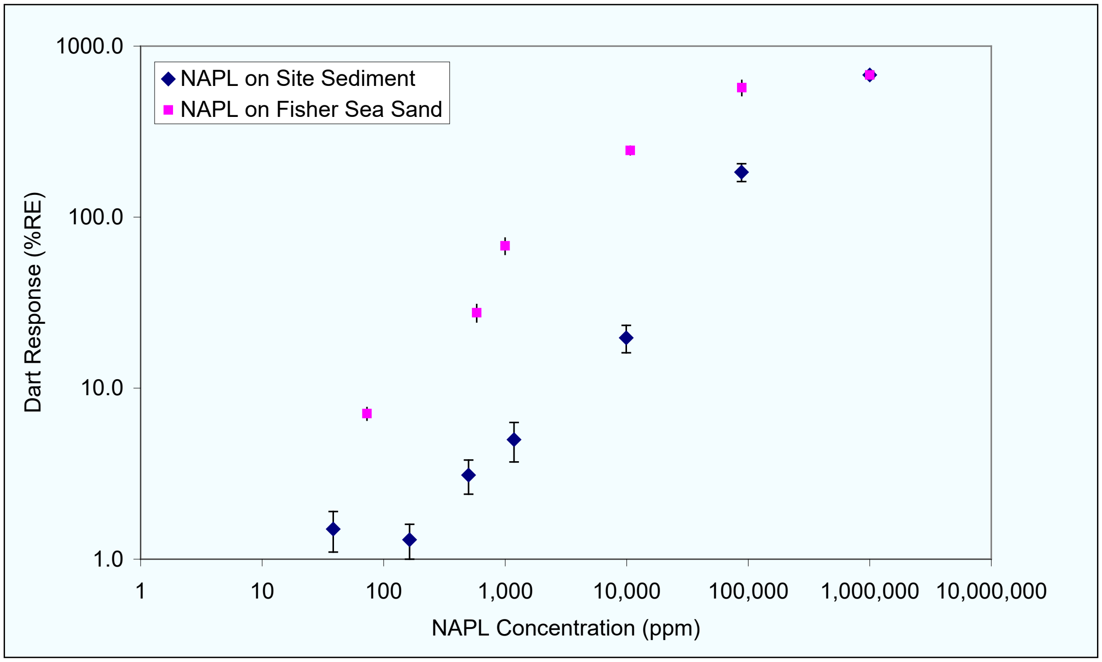


Figure 11. Dart calibration – site NAPL on two different matrices

It is also possible to calibrate the response of both Darts and TarGOST in order to relate the two technologies. In some cases, Darts and TarGOST are used simultaneously on the same site. Calibrating to both allows the creation of a consistent site-wide distribution map, thereby accounting for differences between the unique Dart and TarGOST RE materials.

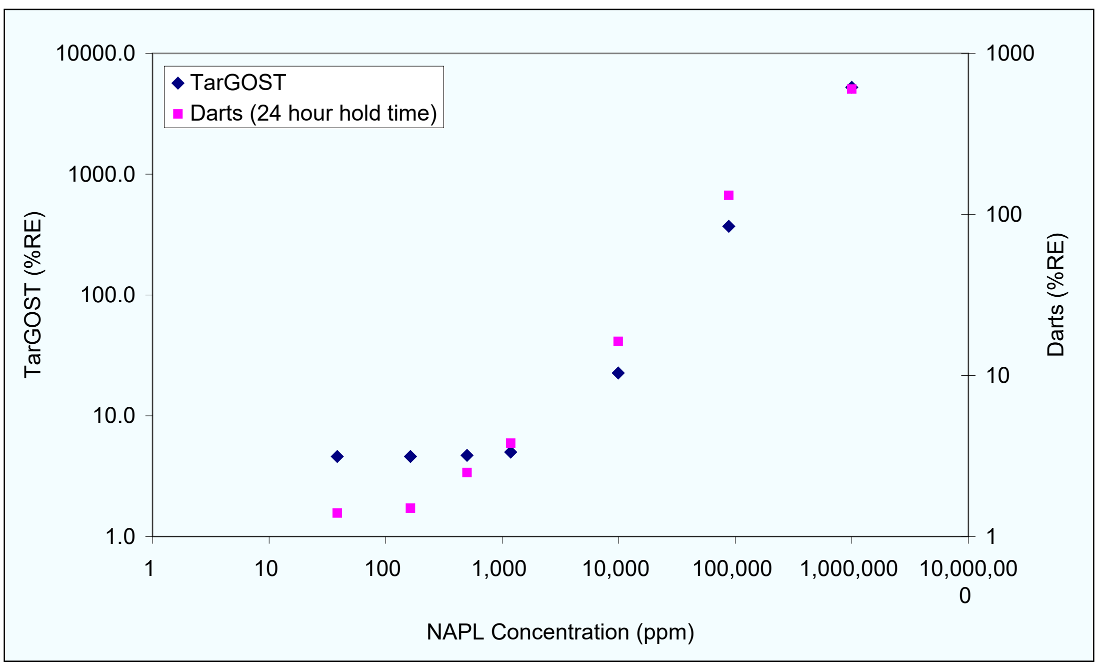


Figure 12. Darts vs. TarGOST – response to NAPL on clean site sediment

Reading

The Dart reader is designed to digitize and record the fluorescence signal at over ten data points per vertical inch (2.5 cm). Each data point represents the average fluorescence of roughly ¼ inch (0.6 cm) of spiral travel along the Dart.

Manual Inspection

Following the automated Dart reading, Dakota performs a visual inspection of the Dart under black light. Areas of interest (ie. fluorescent spotting, streaks, etc.) are noted and correlated with the measured log. By observing the resulting pattern, the potential nature of the fluorescing material may be better understood.

Data Output

Data is provided in two digital formats: as a text file (.txt) depicting depth vs. signal and as a log image (.jpg). An example log image is shown below with descriptions of the typically included information.

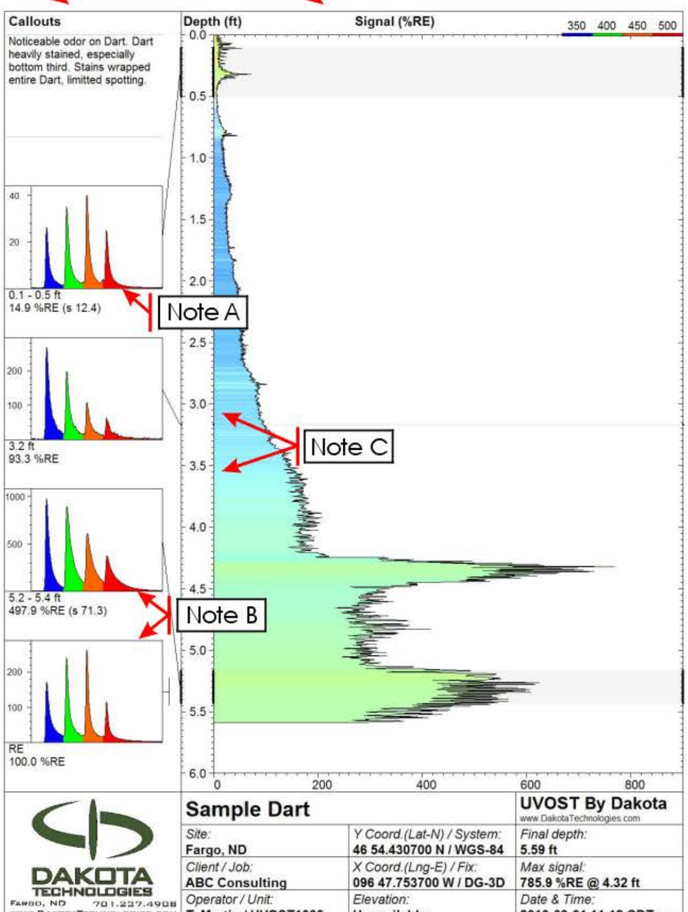
Main Plot :
Signal (total fluorescence) versus depth where signal is relative to the Reference Emitter (RE). The total area of the waveform is divided by the total area of the Reference Emitter yielding the %RE. This %RE scales with the NAPL fluorescence. The fill color is based on relative contribution of each channel's area to the total waveform area (see callout waveform). The channel-to-color relationship and corresponding wavelengths are given in the upper right corner of the main plot.

Callouts :
Waveforms from selected depths or depth ranges showing the multi-wavelength waveform for that depth.

The four peaks are due to fluorescence at four wavelengths and referred to as "channels". Each channel is assigned a color.

Various NAPLs will have a unique waveform "fingerprint" due to the relative amplitude of the four channels and/or broadening of one or more channels.

Basic waveform statistics and any operator notes are given below the callout.



Info Box :
Contains pertinent log info including name and location.

Note A :
Time is along the x axis. No scale is given, but it is a consistent 320ns wide.
The y axis is in mV and directly corresponds to the amount of light striking the photodetector.

Note B :
These two waveforms are clearly different. The first is weathered diesel from the log itself while the second is the Reference Emitter (a blend of NAPLs) always taken before each log for calibration.

Note C :
Callouts can be a single depth (see 3rd callout) or a range (see 4th callout). The range is noted on the depth axis by a bold line. When the callout is a range, the average and standard deviation in %RE is given below the callout.

Reporting

A report is generated that contains an overview of the basic steps followed during the reading and a table of the pertinent information such as: Dart ID#, retrieval date/time, location, measurement date/time, maximum %RE signal, and any relevant sample notes.

Storage

Analyzed Darts are stored in Dakota's lab until it is confirmed that re-examination is unnecessary. The storage process is identical to the recovery steps detailed earlier.

Dakota Technologies, Inc.
2201-A 12th St. N.
Fargo, ND 58102

Phone: 701-237-4908
Fax: 701-237-4926

www.dakotatechnologies.com
info@dakotatechnologies.com

Attachment 2
Standard Operating Procedures for Sediment Core Collection and Characterization

Sediment Core Collection, Characterization and Processing

1.0 Purpose

The purpose of this Standard Operating Procedure (SOP) is to describe protocols for collecting, characterizing, and processing sediment cores, including sample collection.

2.0 Collection Procedure

Sediment core collection is generally performed by a qualified subcontractor. The vessel maneuvering, positioning, and sediment core collection will be performed by the qualified subcontractor in accordance with their standard procedures and specifications noted in a Scope of Work.

The minimum following information must be recorded in the field log book by the project team representative on the vessel:

- Time and date of core collection
- Location coordinates (as-sampled)
- Surface water elevation (ft NGVD 88)
- Water depth
- Calculated sediment surface (mudline) elevation (ft NGVD 88)
- Core recovery
- Note any problems with core collection (e.g., number of attempts needed)
- Make note of any debris in area
- Note where signs of NAPL begin and end (include olfactory, visual, and multi-rae/PID observations)
- Any other pertinent information

If continuous vibracores are collected they will be segmented into manageable lengths (e.g., 4-5 feet) capped, tapped, labeled (location ID, a top/bottom designator, and indication of upper, middle, or lower core segment). This designation will be determined in the field by the field team leader. Cores will be retained upright on the sampling vessel until transfer to the shore-based processing crew.

Cores collected in stainless steel tubes will be sealed, frozen on dry ice, and shipped to the laboratory.

3.0 Materials

The following materials are needed for core characterization, processing and subsampling:

- Plastic sheeting and duct tape
- Field table
- Coolers (to accommodate shipping of NAPL mobility core sections
- Dry Ice (for storage and shipment of NAPL mobility cores only)
- Standard coolers (for shipment of all other samples)
- Ice (for shipment of all other samples)
- Electric double cut shears

- Straight bladed knife and cut resistant gloves
- Measuring tape (engineering scale)
- Dry erase board and marker
- Digital camera
- Core logging form
- Munsell color chart
- Bottleware for samples
- PPE – gloves, safety glasses, face shields
- Disposable, dedicated single-use pans and scoops (either stainless steel bowls and utensils, or aluminum pans and high-density polyethylene (HDPE) scoops)
- PID

3.1 Opening the Core

Prepare the processing tables by covering with plastic sheeting and securing with heavy duty tape (e.g. duct tape). Place the bulk core segments on the table so that the top of the core is to the left and the bottom is to the right.

Once the core segments are arranged, cut slits in the taped caps approximately 0.75 inches wide on opposite sides of the liner and cut away a small triangular portion of the cap (enough to allow the shears to access the liner).

Make two parallel cuts for each segment on opposite sides of the core and then open the core so that it splits into two separate halves that lie flat on the processing table, with the fresh sediment surfaces exposed.

Arrange tape measure next to core so that it will be visible in photos.

The contact between the accumulated soft sediment and the underlying native sediment should be identified. Composite sample intervals should be delineated prior to the collection of PID readings and samples for chemical analysis.

3.2 Field screening

Photoionization detector (PID) readings will be collected from each 2-foot interval. The readings will be collected from the mid-point of the sampling interval unless there is an area within the interval with a notable odor or staining. Note on the core log the interval from which the reading was collected. The reading will be taken from the headspace of a sealed plastic bag that is allowed to equilibrate for several minutes prior to obtaining the reading.

3.3 Sediment Core Characterization

The sediment cores will be visually characterized for sediment type, color, moisture content, texture, grain size and shape, consistency, visible evidence of staining, and any other observations. ***The observations recorded must be <u>factual and accurate</u> and must not contain any subjective conclusions about product type (i.e., NAPL observations will consist of a description of the physical properties of the material including a description of odor as standardized below).***

The Core Log Key (attached) is to be used for this characterization. The sediment will be described using the Unified Soil Classification System (USCS) (modified slightly for sediment characterization) based visual-manual identification in accordance with the American Society for Testing and Materials (ASTM) ASTM-2488 standard practice.

The colors will be designated using a Munsell color chart. Sediment logs will be recorded on the Core Log Field Form (attached).

Digital photographs of each core segment will be taken in order to visually document the undisturbed core structure. Each photograph will include a scale (i.e., tape measure), station ID, indication of depth interval, indication of top orientation, and date of core collection.

Odor: Use the descriptors ***none, strong, moderate, or faint*** *to characterize odor.*

Odor will be **only** be categorized as follows:

- **No Odor**
- **Unclassified Odor (UNC)** – used when a distinct odor is present but it cannot be classified into any of the identified categories
- **Sulfur-like Odor (S)** – used to describe a distinct rotten-egg-like odor
- **Petroleum hydrocarbon-like Odor (PHC)** – used to describe odors similar to petroleum products such as gasoline, kerosene, diesel, and fuel oil
- **Tar-like Odor (T)** – used to describe the distinctive odor of coal tar products similar to an asphalt/paving odor

Evidence of contamination: The following descriptors should be used to characterize any visible evidence of non-aqueous phase liquid (NAPL) impact:

- **NAPL** – Any free phase NAPL observed in cores should be described in terms of color, distribution, and viscosity (if determinable) as described further below. Free phase product should be described as NAPL in the “Comments” column on the core logs. ***Do not draw any conclusions about the type of product (e.g., oil, tar, fuel, coal tar, etc.)***
- **Sheen** – iridescent petroleum-like sheen. Free product is not present but a distinct film is evident.
- **Stained** – used w/ color (i.e., black or brown stained) to indicate that the soil matrix is stained a color other than the natural (unimpacted) color of the soil.
- **Coated** – sediment grains are coated with product – there is not sufficient free-phase material present to saturate the pore spaces.
- **Blebs** – observed discrete spheres of NAPL – but for the most part the sediment matrix is not visibly contaminated or saturated with NAPL.
- **Saturated** – the entirety of the pore space for a sample is saturated with free product. Care should be taken to ensure that the pore spaces are saturated with NAPL rather than water if this term is used.

3.4 Ebullition Sample Collection

Upon completion of the physical characterization, the cores will be sub-sampled for ebullition potential in the subsurface. Samples will be collected from specified elevations within the native sediment based on results of the DART survey and observations from the NAPL confirmation sediment cores.

Sediment samples will be collected at subsurface (greater than 6 inches) depths determined in the field.

The target analytes, as well as the containers, preservation requirements, and holding times, are listed in Table 3-1 of the SAP. Samples will be placed in a cooler with ice, along with the applicable COC, and shipped to the laboratory for analysis.

Sample collection times assigned will be the date/time that the core is processed and sub-sampled.

Any reusable equipment used during the core processing or for the collection of the samples will be decontaminated between samples in accordance with procedures described in the decontamination SOP. Sediment samples will be packaged and handled in accordance Section 3 of the SAP.

3.5 NAPL Mobility Sample Collection

Five undisturbed samples will be collected in stainless steel tubes at an adjacent location to the original five NAPL confirmation sediment cores. Samples will be labeled and prepared for shipment as described in Section 5.0 with no sub-sampling activities.

4.0 Maintenance

The blades on the electric shears used for opening the cores should be changed when there is a noticeable difference in the amount of force required to advance the shears through the liner. These blades typically need to be changed after opening approximately 80 to 100' of core liner. Wear rates with different liner materials will vary. If too much time lapses between blade changes, the bearings within the cutting head of the shears will begin to wear very quickly and will result in quite a bit of additional vibration. The shears should also be lubricated per manufacturers' directions when the blades are changed.

4.1 Stainless Steel Tube Handling/Shipping

The stainless steel tubes will be properly sealed before deposit at the on-shore processing facility. Undisturbed cores collected in tubes shall be wiped clean with paper towels upon receipt at on-shore processing facility. The top and bottom sample interval depths and orientation will be labeled on the cores along with the sampling location. The labeled cores will be placed in a cooler sufficiently large to hold the tubes in a flat horizontal position. For NAPL mobility cores, sufficient dry ice will be added to the cooler to keep samples frozen during shipment. No more than 3 layers of tubes shall be placed in each cooler and cushioning material should be placed between each layer of tubes. Approximately 50 pounds of dry ice shall be used per cooler. Due to the dry ice, coolers containing NAPL mobility tubes shall be shipped as Dangerous Goods following proper CH2M policies.

5.0 Precautions

There are several precautions that should be taken when handling, opening, and processing the sediment cores:

- When opening the cores, knives and/or other cutting instruments must be used. Cut resistant gloves should be worn under nitrile gloves when cores are opened.
- Staff opening cores should wear face shields; very wet sediment can spatter from the notched ends of the cores.
- The cut edges of the core liner can be very sharp and splinter like. Caution should be used and gloves should be worn when handling cut pieces of core liners.
- Sediment cores can be very heavy and due the shape of the core can be very awkward to move. The core collection team on the vessel will cut the cores to manageable lengths to the extent possible, but proper lifting technique and team lifting should be used when handling heavy cores.

- Do not transport dry ice or coolers containing dry ice in the cabin space of a vehicle due to danger of asphyxiation.
- Do not place liquid samples of groundwater and/or NAPL in the cooler with dry ice as the samples will freeze.

6.0 Attachments

- Sediment core characterization form and key
- ASTM Method

Site Name: BNSF Track Switching Facility
Project Number: 693282
Project Location: Wishram, WA
Survey Duration:

Station ID:		Latitude:			Attempt 1 / Refusal? Y/N
Sampling		Longitude:		Penetration (ft):	
Crew/Company		Datum:		Recovery (ft)	
		Depth (ft):		Date/Time:	
		Water Surface Elevation			
		St. Arrival:			Attempt 2 / Refusal? Y/N
Vessel:		St.Depart:		Penetration (ft):	
Collection:		Logged by:		Recovery (ft)	
Collector Information:				Date/Time:	

Depth below mudline (ft)	Lithology	Type	Color (Munsell)	Consistency/ Density	Cementation/ Plasticity	Structure	Moisture Content	Maximum particle size	Odor	% gravel	% sand	% fines	PID Reading (ppm)	Sample IDs (Single Letter)	Evidence of Contamination	Comments
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																

Additional Notes/Comments:

Depth below mudline (ft)	Lithology	Type	Color (Munsell)	Consistency/ Density	Cementation/ Plasticity	Structure	Moisture Content	Maximum particle size	Odor	% gravel	% sand	% fines	PID Reading (ppm)	Sample IDs (Single Letter)	Evidence of Contamination	Comments
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Sample Summary (check boxes for analysis):

Sample ID	Sample Type (N/FD/MSD)	Sample Date/Time	Depth Interval (ft)													
A																
B																
C																
D																
E																
F																
G																
H																
I																
J																
K																
L																
M																
N																
O																
P																
Q																
R																
S																
T																
U																

Reviewed by: Date:

Sediment Core Log Key

MAJOR DIVISIONS			GRAPHIC SYMBOL	GROUP SYMBOL	DESCRIPTION
COARSE-GRAINED MATERIAL	GRAVELS	CLEAN GRAVELS		GW	Well-graded gravel Well-graded gravel with sand
				GP	Poorly graded gravel Poorly graded gravel with sand
		GRAVELS WITH FINES		GW-GM	Well-graded gravel with silt Well-graded gravel with silt and sand
				GW-GC	Well-graded gravel with clay Well graded gravel with clay and sand
				GP-GM	Poorly graded gravel with silt Poorly graded gravel with silt and sand
				GP-GC	Poorly graded gravel with clay Poorly graded gravel with clay and sand
				GM	Silty gravel Silty gravel with sand
				GC	Clayey gravel Clayey gravel with sand
	SANDS	CLEAN SANDS		SW	Well-graded sands Well-graded sand and gravel
				SP	Poorly-graded sands Poorly graded sand with gravel
		SANDS WITH FINES		SW-SM	Well-graded sand with silt Well-graded sand with silt and gravel
				SW-SC	Well-graded sand with clay Well-graded sand with clay and gravel
				SP-SM	Poorly-graded sand with silt Poorly-graded sand with silt and gravel
				SP-SC	Poorly-graded sand with clay Poorly-graded sand with clay and gravel
				SM	Silty sand Silty sand and with gravel
				SC	Clayey sand Clayey sand and with gravel
FINE-GRAINED MATERIALS	SILTS AND CLAYS			CL	Lean clay * Lean clay with sand or gravel * Sandy lean clay * Sandy lean clay with gravel * Gravelly lean clay * Gravelly lean clay with sand
				ML	Silt * Silty with sand or gravel * Sandy silt * Sandy silt with gravel * Gravelly silt * Gravelly silt with sand
				CH	Fat clay * Fat clay with sand or gravel * Sandy fat clay * Gravelly fat clay * Gravelly fat clay with sand
				MH	Elastic silt * Elastic silt with sand or gravel * Sandy elastic silt * Sandy elastic silt with gravel * Gravelly elastic silt * Gravelly elastic silt with sand
				OL/OH	Organic silt * Organic silt with sand or gravel * Sandy organic silt * Sandy organic soil with gravel * Gravelly organic soil * Gravelly organic soil with sand

Well Graded (Engineering) = Poorly Sorted (Geological) = grains of all different sizes mixed together

Poorly Graded (Engineering) = Well Sorted (Geological) = grains are all same size

∩ Shell hash

λλλλ Peat/organic matter

CONSISTENCY

Penetration of thumb:
<0.25 cm = hard (H)
0.25 - 2.0 cm = firm (F)
2.0 - 4.0 cm = soft (S)
>4.0 cm = very soft (VS)

CEMENTATION

N = not cemented
W = weakly cemented
M = Moderately cemented
S = Strongly cemented

STRUCTURE

H = Homogeneous
S = Stratified
L = Laminated
M = Mottled

COLOR

from Munsell chart

MAXIMUM PARTICLE SIZE

SC = Small Cobble
CP = Coarse Pebble
MP = Medium Pebble
SP = Small Pebble
CS = Coarse Sand
MS = Medium Sand
FS = Fine Sand
VFS = Very Fine Sand
Z = Silt

SA = Sub-angular
VA = Very angular

ODOR

N = None
UNC = Unclassified
S = Sulfur-like
T = Tar-like
PHC = Petroleum hydrocarbon-like

Quantifying Descriptors

Strong
Moderate
Faint

Moisture Content

Wet
Moist
Dry

VISIBLE CONTAMINATION DESCRIPTORS

Sheen - iridescent petroleum-like sheen. Free product is not present but a distinct film is evident. Not to be used to describe a “bacterial sheen” which can be distinguished by its tendency to break up on the water surface at angles whereas petroleum sheen will be continuous and will not break up.

Stained - used w/ color (i.e. black or brown stained) to indicate that the soil matrix is stained a color other than the natural (unimpacted) color of the soil.

Coated - soil grains are coated with free product – there is not sufficient free-phase material present to saturate the pore spaces.

Blebs - observed discrete sphericals of tar/free product - but for the most part the soil matrix was not visibly contaminated or saturated. Typically this is residual product.

Saturated - the entirety of the pore space for a sample is saturated with NAPL. Care should be taken to ensure that you’re not observing water saturating the pore spaces if you use this term. Depending on viscosity, free-phase saturated materials may freely drain from a soil sample.

Designation: D 2488 – 93

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

1. Scope

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (See Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.5 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils[2]

D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]

D 2113 Practice for Diamond Core Drilling for Site Investigation[2]

D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)[2]

3. Terminology

3.1 *Definitions:*

3.1.1 Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:

Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and

Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1.2 *clay*—soil passing a No. 200 (75-μm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.1.3 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

fine—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.1.4 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.1.5 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.1.6 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.1.7 *sand*—particles of rock that will pass a No. 4

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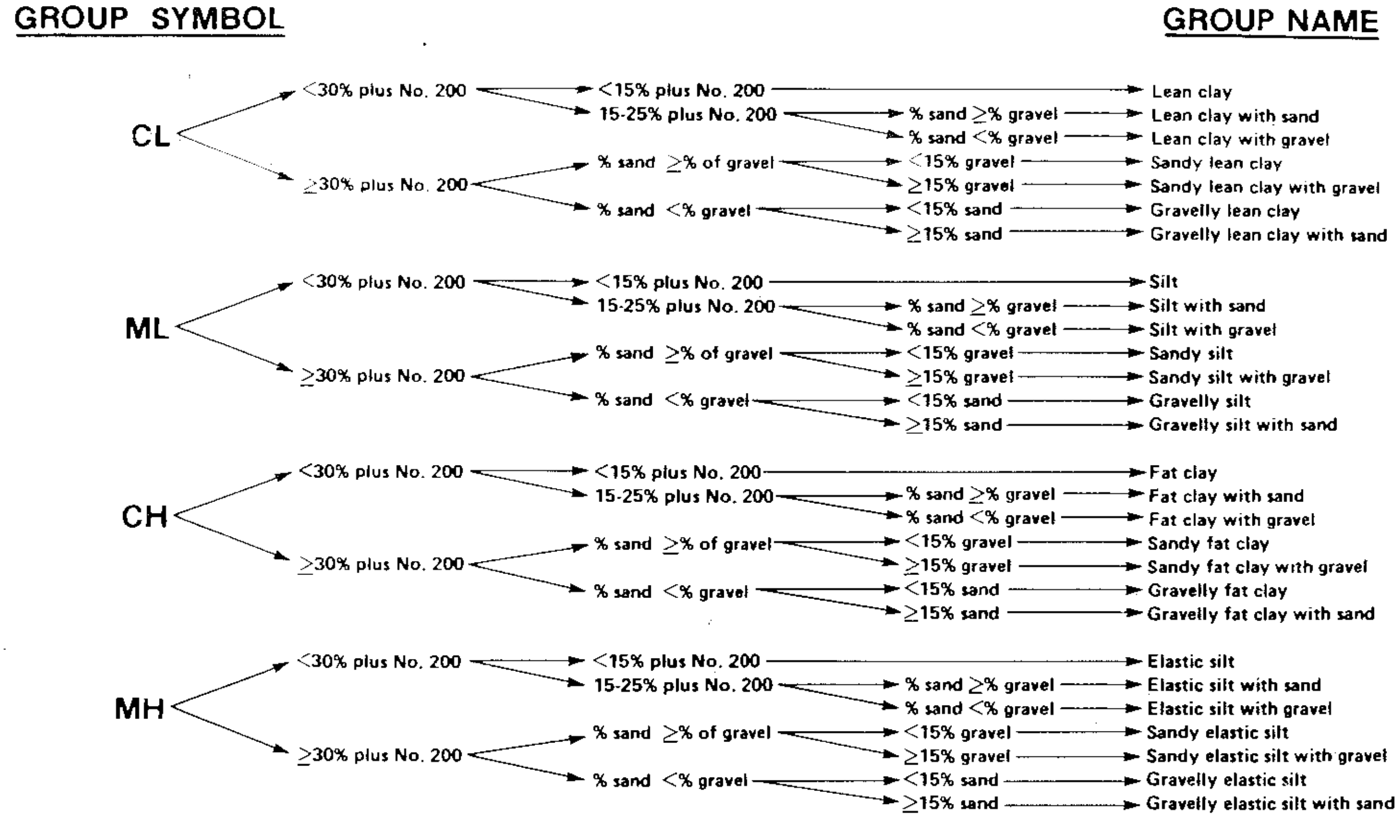
[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

Current edition approved Sept. 15, 1993. Published November 1993. Originally published as D 2488 – 66 T. Last previous edition D 2488 – 90.

[2] *Annual Book of ASTM Standards*, Vol 04.08.



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)

(4.75-mm) sieve and be retained on a No. 200 (75-µm) sieve with the following subdivisions:

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-µm) sieve.

fine—passes a No. 40 (425-µm) sieve and is retained on a No. 200 (75-µm) sieve.

3.1.1.8 *silt*—soil passing a No. 200 (75-µm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

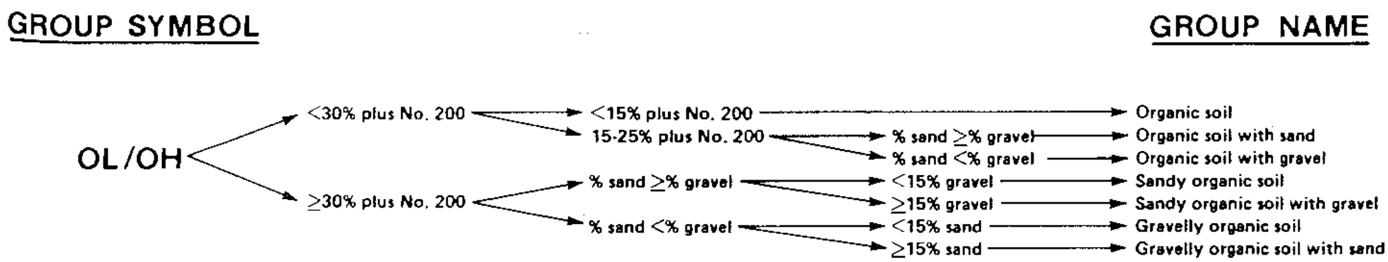
4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Figs. 1a and 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

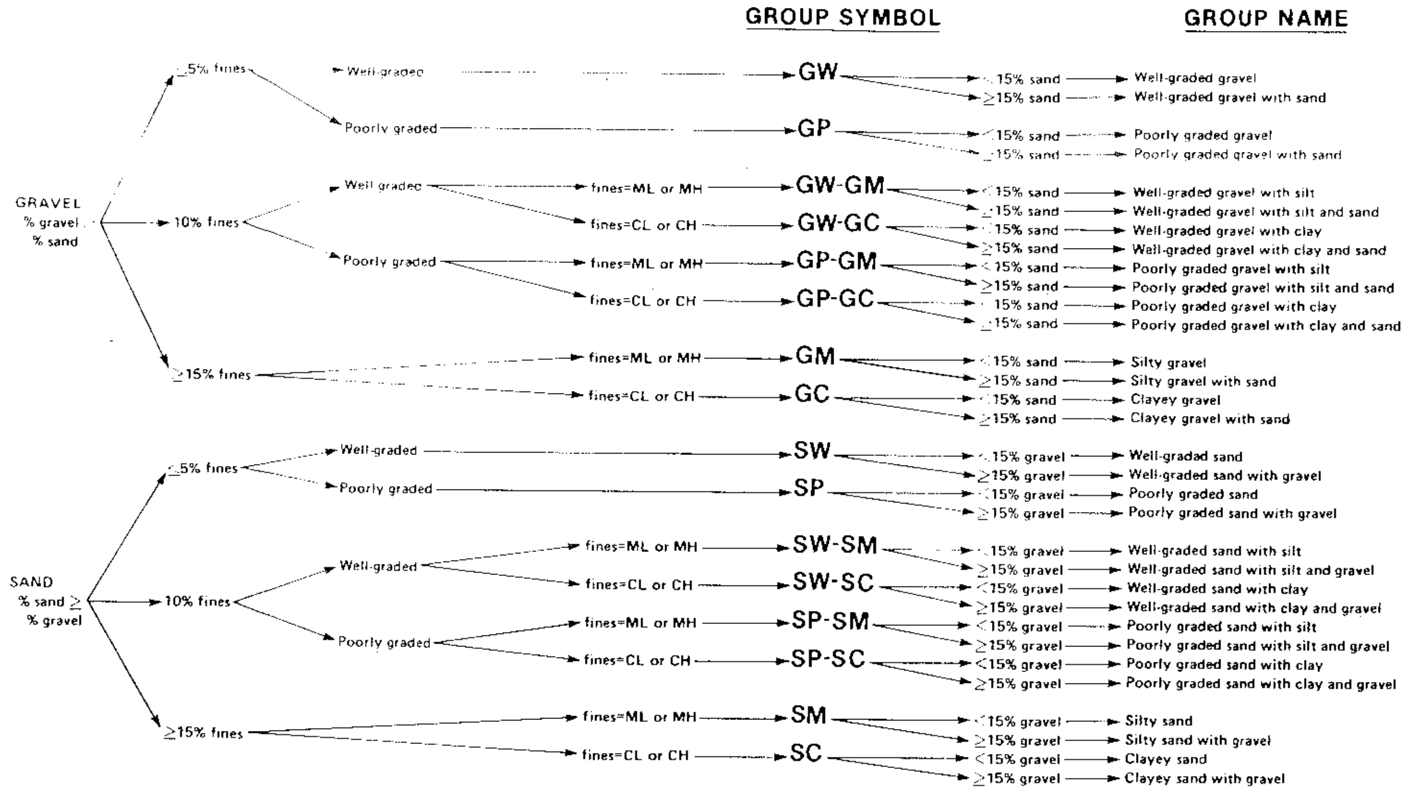
NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols*.

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)



NOTE—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

6. Apparatus

6.1 *Required Apparatus:*

6.1.1 *Pocket Knife or Small Spatula.*

6.2 *Useful Auxiliary Apparatus:*

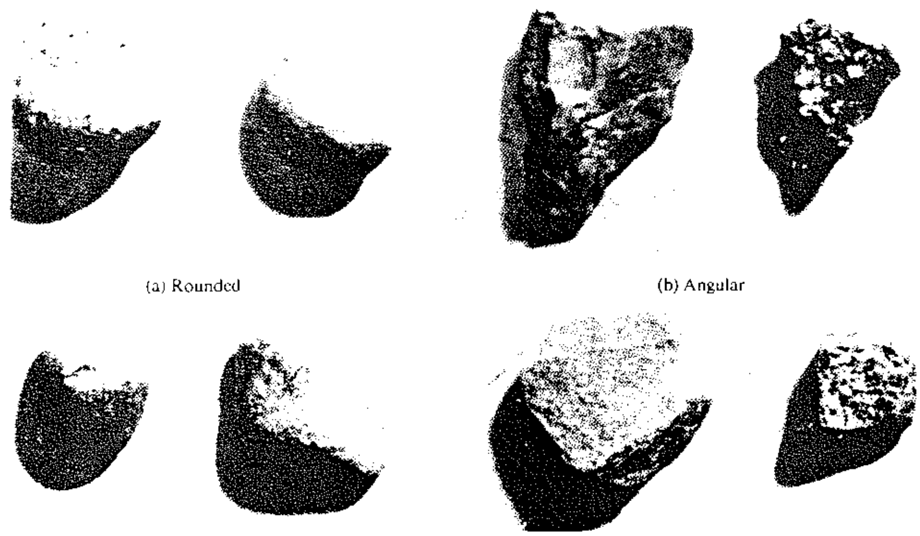
6.2.1 *Small Test Tube and Stopper* (or jar with a lid).

6.2.2 *Small Hand Lens.*

7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean water from a city water supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.



(a) Rounded (b) Angular

(c) Subrounded (d) Subangular

FIG. 3 Typical Angularity of Bulky Grains

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

9. Sampling

9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

NOTE 5—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 6—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.25 lb)
9.5 mm (3/8 in.)	200 g (0.5 lb)
19.0 mm (3/4 in.)	1.0 kg (2.2 lb)
38.1 mm (1 1/2 in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)

NOTE 7—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

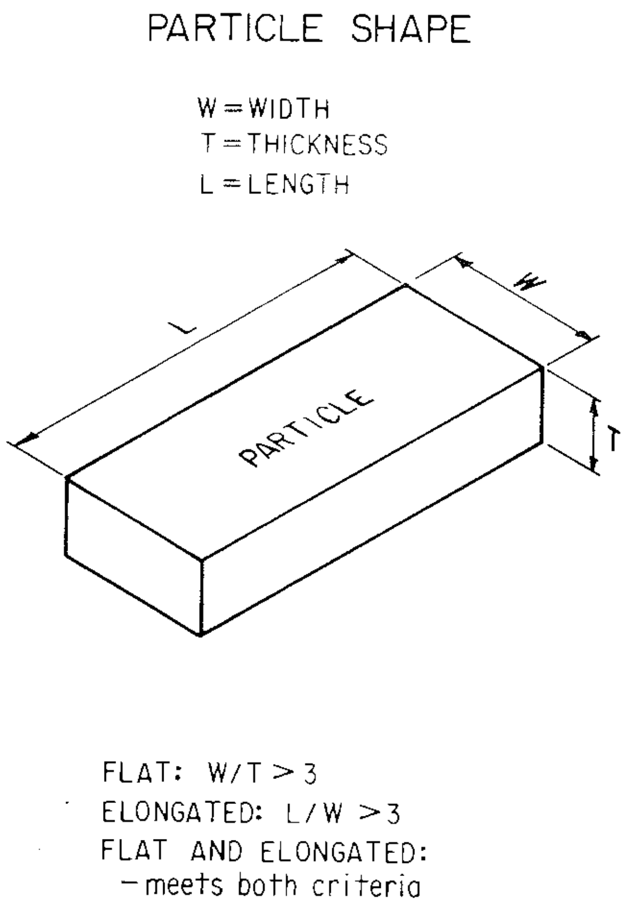


FIG. 4 Criteria for Particle Shape

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the critera in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Consistency

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼ in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¾-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpre-

TABLE 6 Criteria for Describing Cementation

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Structure

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

tation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 8—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 9—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 *Dry Strength:*

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 10—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy:*

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on

TABLE 8 Criteria for Describing Dry Strength

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness:*

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

14.7 *Identification of Inorganic Fine-Grained Soils:*

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 11—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

14.8 *Identification of Organic Fine-Grained Soils:*

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 12—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Figs. 1a and 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils (Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 13—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 14—Other examples of soil descriptions and identification are given in Appendixes X1 and X2.

NOTE 15—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %
Few—5 to 10 %
Little—15 to 25 %
Some—30 to 45 %
Mostly—50 to 100 %

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft^3; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as "Sandy Lean Clay (CL)"; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; "Poorly Graded Sand with Silt (SP-SM)"; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—About 60 % gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % fines; "Poorly Graded Gravel with Sand (GP)."

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; "Poorly Graded Gravel (GP)"; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard, angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

X5. ABBREVIATED SOIL CLASSIFICATION SYMBOLS

X5.1 In some cases, because of lack of space, an abbreviated system may be useful to indicate the soil classification symbol and name. Examples of such cases would be graphical logs, databases, tables, etc.

X5.2 This abbreviated system is not a substitute for the full name and descriptive information but can be used in supplementary presentations when the complete description is referenced.

X5.3 The abbreviated system should consist of the soil classification symbol based on this standard with appropriate lower case letter prefixes and suffixes as:

Prefix:	Suffix:
s = sandy	s = with sand
g = gravelly	g = with gravel
	c = with cobbles
	b = with boulders

X5.4 The soil classification symbol is to be enclosed in parenthesis. Some examples would be:

Group Symbol and Full Name	Abbreviated
CL, Sandy lean clay	s(CL)
SP-SM, Poorly graded sand with silt and gravel	(SP-SM)g
GP, poorly graded gravel with sand, cobbles, and boulders	(GP)scb
ML, gravelly silt with sand and cobbles	g(ML)sc

X6. RATIONALE

Changes in this version from the previous version, D 2488 – 90, include the addition of X5 on Abbreviated Soil Classification Symbols.

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Boring Installation Methods: Direct Push Technology (DPT)

1.0 Scope and Application

The purpose of this Standard Operating Procedure (SOP) is to specify the equipment, materials, and protocol for the installation of sediment borings using the Direct Push Technology (DPT) drilling method.

1.1 Direct Push Technology Materials (Provided by Contractors)

- Direct push drill rig (e.g., GeoProbe™ or equivalent)
- Barge and navigation system (that is, GPS)
- Weighted Line or Stadia Rod
- MacroCore type sampler (1.25” x 60” & 3” x 60”, or equivalent)
- Dedicated, disposable acetate core sleeve liners
- Dedicated, disposable stainless steel core sleeve liners (1.25” x 60”)
- Core cutting table and dual blade core cutter (or equivalent)

1.2 Logging and Sampling Materials (Provided by CH2M)

- Soil Boring Logs
- Logging supplies (reference charts, Munsell color chart, ruler, etc.)
- Photoionization Detector
- Sample Containers

NOTE: All materials to be provided by CH2M HILL are indicated. Remaining materials are to be provided by drilling CONTRACTOR.

2.0 General Procedures and Guidelines

Decontaminate drill stem and other non-dedicated downhole equipment in accordance with Section 3.5 of the SAP prior to beginning.

Once positioned on station and before each boring is advanced, record the following:

- The date, time, water depth, surface water elevation, and target sampling depth.
- Boring coordinates will be captured using an on-board GPS with sub-meter accuracy.
- The soft sediment will be probed using a rigid pole or probe rod to investigate whether large debris will impede or prevent drilling. If debris is encountered, the cluster will be offset accordingly and the deviation will be noted in the field documentation.
- Review project plans for drilling depths and sampling objectives for each individual boring/location. A summary of the different kinds of borings is provided below:

Boring Purpose	MacroCore Diameter and Liner Material	Target Sample Zone and Elevation (Ft NAVD88)	Notes
Dart Confirmation Observations and TOC/COD sampling	1.25" x 60" Acetate Liner	Continuous Coring to 10 feet	Compare visual/PID core observations to Dart survey results
NAPL Mobility Testing	1.25" x 60" Stainless Steel Liner	5-foot interval determined based on DPT core observations	• Coring of overburden material not required. • “Shelby Tube” type undisturbed sediment sample, attempt to advance using only rig hydraulics, minimize DPT hammering. • Orient, label and cap cores. Flash freeze core with dry ice and ship to lab frozen. • Core may be cut in half to facilitate shipping.

A site geologist will be present during all drilling and will fully describe and record all tasks performed in support of these activities in the field logbook. The site geologist will be responsible for the logging of samples, monitoring of drilling operations, and preparing the geologic soil boring logs.

Each time a sediment core is extracted; be careful to keep the core oriented distinguishing between the top (shallower portion) and bottom (deeper portion) of the core. Record the depth interval bgs of the core and log the geologic/lithologic characteristics of the core. Use soil classification charts, Munsell color charts, a PID to scan for vapors, and other references as appropriate. Review the sampling plan to determine the depth intervals to be sampled for laboratory analysis.

Decontamination of all materials will be carried out as described in the SOP on Equipment Decontamination.

Petroleum jelly, teflon tape, or lithium grease shall not be used on the threads of downhole drilling equipment. If a lubricating agent is required, the proposed lubricant MUST be reviewed for approval by the site geologist. Adequate time and information, such as Safety Data Sheets (SDSs), must be provided for the geologist’s review. Time spent for on-site review of the proposed material will be considered Down Time and will not be billable by the drilling contractor. Food grade vegetable oil is an example of an approved lubricant. Additives containing either lead or copper will not be allowed. In addition, polychlorinated biphenyls (PCBs) will not be contained in hydraulic fluids or other fluids used in the drilling rig, pumps, or other field equipment and vehicles. SDSs must be available for all such fluids.

Antifreeze used to keep equipment from freezing will not contain rust inhibitors and sealants. If the antifreeze is added to a piece of machinery, it will be completely purged from the equipment prior to use in drilling, mud mixing, or any integral part of the overall drilling operation. The contractor will note in the boring log, the following information in regard to the use of antifreeze: date, reason, quantities, and brand name. SDS will be available for review by the site geologist.

Document all quantities of drilling footage and materials used for the drilling subcontract.

Proceed to the next drilling location after decontamination of all downhole equipment, including the working surfaces of the drill rig, vessel or barge.

3.0 Direct Push Technology Procedures and Guidelines

Undisturbed sediment sampling and drilling with DPT equipment involves pushing a MacroCore sampler into the subsurface using hydraulic pressure and/or a mechanical hammer. The MacroCore barrel is advanced into the zone of interest to collect a sediment core sample that is 46-inches long when using a 4-foot MacroCore sampler and approximately 58-inches long when using a 5 foot MacroCore sampler. The nozzle of the barrel should have a "sand trap" to prevent the soil sample from falling out of the sampler, and a dedicated, disposable core sleeve liner (acetate plastic or stainless steel) is utilized with the MacroCore barrel. "Blow Counts" are not recorded using the DPT drilling method. After the MacroCore sampler has been advanced into the subsurface, it is retrieved using hydraulic tooling on the drill rig. The core sleeve is removed from the core barrel and provided by the contractor to the site geologist for examination. The sequence is repeated to collect the next sample. Depending on site geologic characteristics, an outer core barrel (dual tube sampling) may be advanced to keep the borehole from collapsing and/or a piston point may be installed in the core barrel to prevent it from filling with sediment slough prior to sampling. The piston point procedure requires an extra step of using narrow diameter threaded rods to disengage the piston plug prior to advancing the core sampler through the target sampling interval.

Following retrieval of the core liner, the subcontractor will use a dual-edge sleeve cutter and core cutting table to remove a strip from the thick acetate plastic liner and open the sampler. This activity presents risk for significant cuts and wounds if makeshift methods are used. Once the acetate sleeve is opened safely, the soil core can be broken open to expose a fresh soil surface. "Smearing" may occur on the outer surface of the soil core so it is important to expose a fresh surface for accurate logging. Observe the core, screen it with a PID and collect soil samples from the appropriate intervals(s) following the SOP on Subsurface Soil Sampling. Record lithological information for preparation of a sediment core log (see SOP on sediment core collection and characterization).

Following retrieval of stainless steel MacroCore liners that are deployed equivalent to "Shelby tubes" for undisturbed sediment core sampling, the subcontractor will seal, label, and store the tubes upright until transfer to the onshore sample custody location for sample processing by CH2M.

4.0 Collection and Disposal of Drill Cuttings

The drilling contractor will be responsible for containerizing all drill cuttings and other wastes generated by the drilling. waste will be managed consistent with upland activities as described in the *Remedial Investigation Work Plan, Wishram, Washington* (Kennedy/Jenks, 2016). The drilling contractor will be responsible for containerizing waste materials at the work location and transporting them to the designated area of the site.

5.0 Maintenance

Not applicable.

6.0 Precautions

1. Verify that the drill rig is clean and in proper working order.
2. Ensure that the drill rig operators thoroughly complete the decontamination process between sampling locations.
3. Ensure that proper drilling safety procedures are followed. Rotating machinery present significant potential for entrapment. Opening acetate core sleeves presents cutting hazards. Use proper tooling.

4. Hydraulic equipment must be allowed to ‘warm up’ sufficiently in cold weather.
5. Use caution to ensure that soil core sections are oriented the correct way (top vs. bottom) when observing lithology and collecting samples.

7.0 References

Kennedy/Jenks Consultants. 2016. *Remedial Investigation Work Plan, Wishram, Washington*. Prepared for BNSF Railway Company. August.

8.0 Attachments

None.

Attachment 3
Standard Operating Procedure for Surface Sediment Sampling

Surface Sediment Sampling

1.0 Purpose

The purpose of this Standard Operating Procedure (SOP) is to describe the collecting and handling of surface sediment samples using a sediment grab sampler. This SOP is applicable to collecting representative surficial sediment samples using a sediment grab sampler.

2.0 Equipment and Materials

The following materials are required to undertake this procedure:

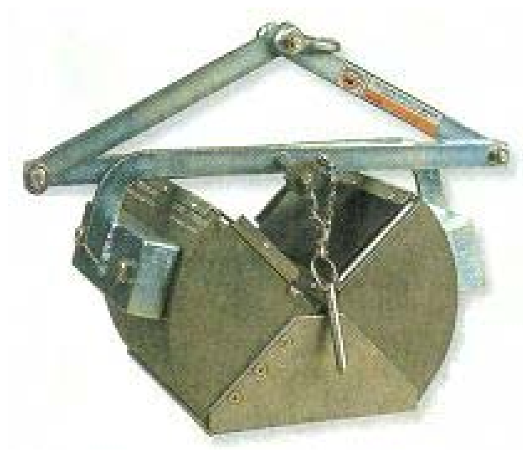
- Suitable work platform
- Sediment Sampler (e.g., van Veen, Petite Ponar, Wildco Hard Corer or Dormer Piston Sampler) and required lengths of rope
- Large plastic tub
- Stainless-steel pan
- Stainless-steel spatula
- Sample containers
- Cooler with ice
- Tape measure
- GPS unit

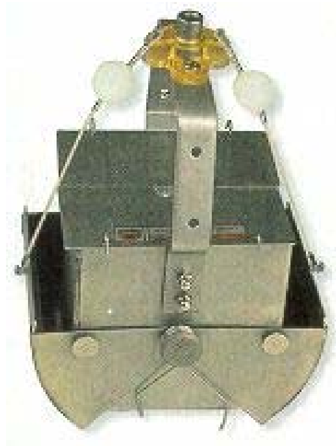
3.0 Procedures and Guidelines

3.1 Hand-Operated Dredge Samplers

Grab sediment samplers are best used from, but are not limited to, boats or piers in water bodies 3 feet (ft) or deeper. The dredge sampler is lowered using a rope and embedded 6 to 15 centimeters (cm) into the sediment, depending on sediment firmness.

Most samplers are activated once the tension has been removed from the rope or by a messenger trigger sent down the rope. This method is preferred when large amounts of surface sediment are required and sediment profiles are not important. It is very difficult not to disturb fine-grained materials of the sediment/water interface when using this method. The most common dredge sampling devices for sub-aqueous surficial sediments are the modified van Veen bottom grab, the Ekman grab, and the Ponar grab.

	**Ponar Dredge Sampler** For sampling hard bottoms such as sands, gravel and clays Widely used for quantitative samplings of benthic macro organisms in sand, gravel and clays. The self-tripping sampler features center hinged jaws and a spring-loaded pin that releases when the sampler makes impact with the bottom. Features include an underlip attachment that cleans gravel from the jaws that would normally prevent closing and removable side plates that prevent lateral loss of sample. The top is covered with a stainless steel screen with neoprene rubber flaps which allows water to flow through for a controlled descent and less interference with the sample. The standard Ponar is 230 mm x 230 mm and weighs 20 kg, and should be used with a winch and cable. Sample volume 8200 mL. Petite Ponar is 150 mm x 150 mm and weighs 11 kg. Sample volume 2400 mL.
	**Wilco Hand Corer** For sampling softer sediments A relatively undisturbed sample is captured within polyethylene liner. Sample is held in place with polyethylene core catchers which prevent sample loss. Samples can be retrieved from approximately 6.0 m with the use of extensions. Corer can take a 50 mm diameter sample which measures 500 mm long. The unit weighs 7 kg.
	**Ponar Dredge Sampler** For sampling softer sediments A relatively undisturbed sample is captured within the stainless steel casing. Sample is held in place with polyethylene core catchers and suction which prevent sample loss. Samples can be retrieved from approximately 9.0 m with the use of extensions. Corer can take a 50 mm diameter sample which measures 1 m long. The unit weighs 15 kg.

	**Ekman Bottom Grab Sampler** For sampling lakes, streams and rivers Designed for sampling in soft, finely divided bottoms that are free from vegetation and other coarse debris. Each sampler features machined jaws and hinged overlapping lids that open easily during descent to let water pass through and close during retrieval to reduce sample washout. The patented Two-Pin release mechanism has few moving parts and is very reliable. Each sampler is constructed of 316 stainless steel, including the springs, cables and fasteners. Sampler measures 150 mm x 150 mm x 150 mm. The Ekman sampler is light weight and has difficulty penetrating to depth. It is triggered by a messenger weight that travels down the rope and triggers the jaws closed. If the bottom is not flat, it can be difficult to trigger the Ekman sampler.
	**Van Veen Grab Sampler** Simple design for taking composite samples: The stainless steel Van Veen grab samplers are used for the taking of disturbed samples from the bottom of lakes, rivers etc. The jaws are pushed open at the surface, and kept open by a fastened hook. Then, after being lowered slowly, the jaws touch the bottom, and the hook loosens its grip, so that the jaws shut tight as its hoisted back up.

The jaws of these two samplers are held open until they reach the bottom and are tripped when the rope goes slack. Both have greater penetration and can collect more volume than the Ekman sampler, but overfilling may become an issue. Both of these samplers have removable weights on the outside of the sampler to help alleviate over penetration or if the sediment is very fine. Most samplers have open upper faces that are fitted with flaps.

Upon descent, the flaps are forced open by the water to minimize the bow wake, whereas upon ascent, the flaps are forced closed to prevent sample winnowing.

3.2 Collection of Minimally-disturbed Sediment Samples

The collection of minimally-disturbed sediment requires the field personnel to:

- Create a minimal bow wake when descending;
- Form a leak-proof seal when the sediment sample is taken;
- Prevent winnowing and excessive sample disturbance when ascending; and
- Allow easy access to the sample surface.

The dredge sampler should be lowered through the water column at a controlled speed of approximately 30 cm per second. Under no circumstances should the sampler be allowed to ‘free fall’ to the bottom, as this may result in premature triggering, excessive bow wake, or improper orientation upon contact with the bottom. The sampler should contact the bottom gently and only its weight or piston mechanism should be used to force it into the sediment.

3.3 Raising Sediment Sampler

After the sediment sample is taken, the sampler should be raised slowly off the bottom and then retrieved at a control speed of approximately 30 cm per second. Before the sampler breaks the water surface, the sampling vessel should head into the waves (if present) to minimise vessel rolling. The manoeuvre will minimise the swinging of the sampler after is breaks the water surface. If excessive swinging occurs or if the sampler strikes the vessel during retrieval, extra attention should be paid to evaluating sample disturbance when judging sample acceptability.

3.4 Sample Acceptability

The sampler should be secured immediately after it is brought on board the vessel. It is recommended that the sampler be placed in a large plastic tub to assist in securing the unit, and to prevent contaminating the vessel with sediments. If the sampler tips or slides around before being secured, extra attention should be paid to evaluating sample disturbance.

Once the sampler is secured on board the vessel, the surface of the sample must be made accessible without disturbing the sample. For characterising biological analytes in surficial sediments, it is recommended that the upper 10 cm be used.

After the sampler is secured on the vessel, the sediment sample should be inspected carefully before being accepted. The following criteria should be used to assess sample acceptability:

- The sampler must not be overfilled with sample so that the sediment surface is pressed against the top of the sampler
- Overlying water must be present (indicated minimal leakage)
- Overlying water must not be excessively turbid (indicated minimal sample disturbance)
- Sediment surface must be relatively flat (indicated minimal disturbance or winnowing)
- Desired penetration depth must be achieved

If a sample does not meet all the above criteria, it should be rejected and another sample collected.

3.5 Sampling Procedure

- Verify and mark sample locations.
- Start downstream and work upstream to prevent contamination of unsampled areas.
- After the vessel is anchored or dynamically located at the sampling location, measure and record the water depth to the stream / lake bottom using a survey rod attached to a 30-cm metal plate.
- Collect the sediment sample using the procedures detailed above. Make sure that the sampling location is a sufficient distance from the water depth and soft sediment location to provide a minimally-disturbed sample.
- Before samples of the sediment can be taken, the overlying water must be removed by carefully siphoning it off while tilting the sampler. Care must be taken to avoid disturbance of the sediment sample.
- Once the overlying water has been removed, the sediment can be sampled. Unrepresentative material should be removed.

- Handling of samples.
  - Samples for VOC analysis should be sampled first and placed directly into the sample container.
  - Samples for non-volatile analysis can be removed from the sampling device and homogenized in the stainless-steel pan.
  - Sample containers should be labelled with a unique identifier and stored at 4^oC until shipped to the laboratory.

3.6 Documentation

Observations and quantitative data collected during the implementation of this sampling procedure should be recorded in the field logbook. The following information should be recorded:

- Location;
- Date;
- Time;
- Personnel;
- Weather;
- Latitude / Longitude;
- Water Surface Elevation (ft NGVD 88)
- Water Depth;
- Sediment Surface (Mudline) Elevation (Calculated)
- Soft Sediment Thickness; and
- Sediment Recovery.

4.0 Attachments

None.

5.0 Key Checks and Preventative Maintenance

- Overlying water present when assessing sample suitability.
- Lower and raise sampler at constant and slow speed.

Appendix B
Health and Safety Plan

HSSE Handbook

CH2M Health, Safety, and Environment Field Handbook

February 2017

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Contents

ATTACHMENTS:

1. Introduction

1.1 CH2M Health, Safety, and Environment Policy Commitment and Goals

1.1.1 Health, Safety, and Environment Policy Commitment

Protection of people and the environment is a CH2M core value. It is our vision to create a culture that empowers employees to drive this value into all global operations and achieve excellence in health, safety, and environment (HSE) performance. CH2M deploys an integrated, enterprise-wide behavior based HSE management system to fulfill our mission and the expectations of our clients, staff, and communities based on the following principles:

- We require all management and supervisory personnel to provide the leadership and resources to inspire and empower our employees to take responsibility for their actions and for their fellow employees to prevent injuries, illnesses, and adverse environmental impacts, and create a safe, healthy, and environmentally-responsible workplace.
- We provide value to clients by tailoring HSE processes to customer needs and requiring CH2M employees and subcontractors to deliver projects that identify HSE requirements and commit to compliance with applicable HSE laws and regulations, company standards, and external requirements.
- We are committed to pollution prevention in conjunction with our Sustainability Policy and by offering our clients sustainable solutions.
- We aspire to continually improve our performance and influence others to redefine world-class HSE excellence.
- We evaluate our design engineering and physical work environment to verify safe work conditions and practices are established, followed, and corrected as needed.
- We assess and continually improve our HSE program to achieve and maintain world-class performance by setting and reviewing objectives and targets, reporting performance metrics, and routinely evaluating our program.
- We expect all employees to embrace our Target Zero culture, share our core value for the protection of people and the environment, understand their obligations, actively participate, take responsibility, and "walk the talk" on and off the job.

1.1.2 Project-Specific Health, Safety, and the Environment Goals

All management and employees are to strive to meet the project-specific Health, Safety, and the Environment (HSE) goals outlined below. The team will be successful only if everyone makes a concerted effort to accomplish these goals. The goals allow the project to stay focused on optimizing the health and safety of all project personnel and, therefore, making the project a great success.

CH2M has established eleven specific goals and objectives:

- Create an injury-free environment;
- Have zero injuries or incidents;
- Provide management leadership for HSE by communicating performance expectations, reviewing and tracking performance, and leading by example;
- Ensure effective implementation of the project safety plan, environmental plan (or equivalent) through education, delegation, and team work;

- Ensure 100 percent participation in HSE compliance;
- Continuously improve our safety and environmental performance;
- Maintain free and open lines of communication;
- Make a personal commitment to safety as a value;
- Focus safety improvements on high-risk groups;
- Continue strong employee involvement initiatives; and
- Achieve health, safety, and environmental excellence.

2. Applicability

This CH2M Health, Safety, and Environment Field Handbook (Handbook) applies to:

- All CH2M staff supporting projects globally, including subcontractors and tiered subcontractors of CH2M working on the site; and
- All visitors to the construction or remediation site in the custody of CH2M (including visitors from the Client, the Government, the public, and other staff of any CH2M company).

This Handbook does not apply to the third-party contractors, their workers, their subcontractors, their visitors, or any other persons not under the direct control or custody of CH2M. This document does not apply to LLC companies within CH2M.

This Handbook defines the procedures and requirements for the health and safety of CH2M staff and visitors when they are physically on the work site. The work site includes the project area (as defined by the contract documents) and the project offices, trailers, and facilities thereon.

This Handbook will be kept onsite during field activities and will be reviewed as necessary. The Handbook will be amended or revised as project activities or conditions change or when supplemental information becomes available. The Handbook adopts, by reference, the Enterprise-wide Core Standards and Standards of Practice (SOPs), as appropriate. In addition, the Handbook may adopt procedures from the project Work Plan and any governing regulations. If there is a contradiction between this Handbook and any governing regulation, the more stringent and protective requirement shall apply.

For those working in the state of California in the United States, this Handbook incorporates the regulatory requirements described in the State of California OSHA agency – Cal/OSHA Title 8 CCR, Section 3203, Injury and Illness Prevention Program (IIPP), and section 1509, Construction Injury and Illness Prevention Program. The current version of CH2M Cal/OSHA IIPP written program can be accessed on the HSE website under HSE Programs.

When this Handbook is used to supplement the project health and safety plan, all CH2M staff and subcontractors must sign the employee sign-off form included at the end of this Handbook to acknowledge review of the document. CH2M employees will send a signed copy of the sign-off form to their SPA or will maintain it in project files. The subcontractor sign-off form will be maintained on site by the project Safety Coordinator (SC).

3. Roles and Responsibilities

The sections below describe the roles and responsibilities of personnel referred to in the project-specific safety plan.

3.1 CH2M Line Management (Program/Project Managers)

Line management safely manages and executes overall program, project, or site work. The Program or Project Manager (PM) may explicitly delegate specific tasks to other staff, but retains ultimate responsibility for HSE related responsibilities including:

- Coordinate and lead Subcontractor HSE Chartering meetings prior to the start of field work;
- Designate a qualified Safety Coordinator in conjunction with the RHSM/EM;
- Ensure CH2M safety plan (and environmental plan, if applicable) is current and provide approval alongside the HSE Manager/RHSM or EM, if applicable;
- Ensure CH2M Activity Hazard Analyses (AHAs) or AHA/Environmental Impact Assessment (EIA) are in place and verify HSE Manager/RHSM has reviewed and approved;
- Notify HSE staff if changes to scope have an effect on HSE plans, documents, or requirements; review and approve any field change requests (FCRs) to the safety plan.
- Ensure copies of training and medical monitoring records, and site-specific safety procedures are being maintained in the project file accessible to site personnel;
- Provide oversight of subcontractor HSE practices per the site-specific safety plans and procedures;
- Manage the site and interfacing with 3rd parties in a manner consistent with the contract and subcontract agreements and the applicable standard of reasonable care;
- Ensure that the overall, job-specific, HSE goals are fully and continuously implemented;
- Perform a Management Inspection at least once during short-term projects or once a month on long-term projects;
- Set an example for safe work practices, attitudes, and culture through personal action and participation in the HSE program, including HSE programs, rules, procedures, processes, and training
- Intervene or stop work when an unsafe condition or behavior is observed, and/or when an environmentally compromising condition is encountered;
- Consistently and even-handedly enforce HSE rules, procedures, and requirements at the office and/or on project work sites;
- Promptly report all work-related HSE incidents or near misses;
- Conduct, cooperate, or assist with HSE incident investigations;
- Wear any required personal protective equipment when visiting project site;
- Consult with the Human Resources Delivery Partner before taking any disciplinary action (other than verbal counseling) associated with CH2M Policy 203, HSE Accountability, and/or HSE programs rules, procedures, processes and training;
- Has the overall responsibility for implementing the Drug-Free Workplace Program (Policy 810) on his/her project; and

- Coordinate HSE needs of contingent labor as required by the Contingent Worker Core Standard and Policy 809, Contingent Worker Policy.

3.2 CH2M Responsible Health and Safety Manager

The Responsible Health and Safety Manager (RHSM) is assigned by the client sector HSE Lead or designee to provide ongoing health and safety technical guidance and support to the project, program or facility. The RHSM is responsible for the following:

- Develop or review and approve CH2M safety plan(s) and revisions or amendments as well as AHAs or AHA/EIA;
- Review and accept subcontractor training and medical monitoring records prior to start of field operations;
- Review subcontractor statements of work to include project H&S requirements before they are sent to potential subcontractors ;
- Review and accept subcontractor site-specific safety procedures (including safety plans and AHAs or AHA/EIAs) for adequacy prior to start of subcontractor's field operations;
- Provide input to the PM on the selection of the SC;
- Support the oversight (or SC's direct oversight) of subcontractor and tiered subcontractor HSE practices;
- Permit upgrades and downgrades in personal protective equipment (PPE), including respiratory protection, in accordance with the site safety plan;
- Conduct audits as determined by project schedule and coordination with PM; and
- Participate in incident investigations, lessons learned, loss and near loss reporting.

3.3 CH2M Project Environmental Manager

The Responsible Project EM (REM), also referred to as the Program or Project EM, is assigned by the client sector HSE Manager or sector EM to provide ongoing environmental protection and compliance guidance and support the project, program or facility. The REM is responsible for the following:

- Provide project/task-specific environmental compliance input to include in statements of work before they are sent to potential subcontractors (when requested by the project team);
- Provide environmental program support in areas such as training, auditing, planning, permit tracking, and subcontractor oversight as needed or as specified in the project environmental plan or equivalent plan;
- Assist the PM to identify environmental requirements, including those described in the CH2M Target Zero Management System Manual, environmental risks, environmental permits and similar documents that CH2M is responsible for complying with (e.g., notices, approvals or other documents that legally bind CH2M);
- Verify that a Field Project Start-up Form (FPSF) has been submitted and that an Environmental Plan or equivalent document is available;
- Assist the PM in preparing or coordinating the preparation of regulatory-required environmental plans (e.g., SPCC, SWPPP) and contract-required environmental plans (e.g., Environmental Protection Plan);
- Review revised scopes of work and changes in project conditions to identify new environmental issues and requirements;
- Review/approve waste characterizations and client waste profiles, or engage the project Waste Coordinator to review and approve;

- Evaluate any spills, releases, or environmental permit incidents for appropriate follow-up actions, notifications, and recordkeeping requirements; and
- Provide environmental compliance and environmental management expertise, advice, and training to the project team as needed during the course of the project.

3.4 CH2M Safety Coordinator

The SC is responsible for verifying that the project is conducted in a safe manner including the following specific obligations:

- Participate in Subcontractor HSE Chartering meetings prior to the start of field work;
- Verify the project safety plan, and environmental plan, if applicable, is current and amended when project activities or conditions change;
- Verify CH2M site personnel and subcontractor personnel read this Handbook, the project safety plan, and applicable AHAs or AHA/EIA and sign the accompanying sign-off forms for each, prior to commencing field activities;
- Verify CH2M site personnel have completed any required specialty training (for example, fall protection, confined space entry, among others) and medical surveillance as identified in the project safety plan;
- Verify that project files include copies of accepted subcontractor training and medical monitoring records, and accepted site-specific safety procedures prior to start of subcontractor's field operations;
- Act as the project "Hazard Communication Coordinator" and perform the responsibilities outlined in the project safety plan;
- Act as the project "Emergency Response Coordinator" and perform the responsibilities outlined in the project safety plan;
- Post the required workplace labor posters. In the US, post the Occupational Safety and Health Administration (OSHA) job-site poster. The poster is required at sites where project field offices, trailers, or equipment-storage boxes are established. If you work in the US in a state with an OSHA State Plan, make sure the State Plan poster is posted, if required. In Canada, check the provincial Ministry of Labour website to determine which posters are required;
- Hold and/or verify that safety meetings are conducted and documented in the project file initially and as needed throughout the course of the project (as tasks or hazards change);
- Assist in implementing environmental plan requirements at the project as assigned by the PM or project EM;
- Verify that project health and safety forms and permits are being used as outlined in the project safety plan;
- Perform oversight and assessments of subcontractor HSE practices per the site-specific safety plan and verify that project activity self-assessment checklists are being used as outlined in the project safety plan;
- Ensure that deficiencies identified in self-assessment checklists are tracked through completion and closed out;
- Coordinate with the RHSM regarding CH2M and subcontractor operational performance, and 3rd party interfaces;
- Verify appropriate personal protective equipment (PPE) use, availability, and training;
- Ensure that the overall, job-specific, HSE goals are fully and continuously implemented;
- Calibrate and conduct air monitoring in accordance with the project safety plan; maintain all air monitoring records in project file;

- Maintain HSE records and documentation at the project site;
- Facilitate government agency inspections (e.g., OSHA, Occupational Health and Safety [OH&S]) including accompanying inspector and providing all necessary documentation and follow-up;
- Deliver field HSE training as needed based on project-specific hazards and activities;
- Consistently and even-handedly enforce HSE rules, procedures, and requirements at the office and/or on project work sites;
- Wear any required personal protective equipment;
- Contact the RHSM and PM in the event of an incident;
- Contact the RHSM and Project EM in the event of a spill or release immediately so evaluation of reportable quantity requirements and whether agency reporting is required;
- Conduct, cooperate, or assist with HSE incident investigations;
- Contact the PM and RHSM when standards of conduct or CH2M Policy 203 has been violated by a CH2M employee;
- When an apparent imminent danger exists, immediately remove all affected CH2M employees and subcontractors, notify subcontractor safety representative, stop affected work until adequate corrective measures are implemented, and notify the PM and RHSM as appropriate; and
- Document all verbal health and safety-related communications in project field logbook, daily reports, or other records.

3.5 CH2M Employees

All personnel have the responsibility for performing work in a safe manner and to:

- Understand and abide by CH2M and client HSE programs, rules, procedures, processes, and training, including any that are project-specific;
- Complete all required HSE training made available and accessible within established timelines;
- Always wear any required personal protective equipment;
- Intervene or stop CH2M work when an unsafe condition or behavior is encountered or observed, and/or when an environmentally compromising condition exists;
- Promptly pause work and notify a supervisor, PM, SC, or RHSM when an unsafe condition or behavior is observed, and/or when an environmentally compromising condition exists;
- Promptly report to supervisor, PM, SC, or HSE Manager/RHSM/EM all work-related health, safety , and environmental incidents or near misses;
- Attend required project HSE pre-task briefings and meeting prior to performing work;
- Cooperate or assist with HSE incident investigations; and
- Encourage safe work practices and attitudes by setting a personal example and participate in the site HSE program and meetings.

3.5.1 Employee Authority

Each employee on the project has the obligation and authority to shut down any perceived unsafe work and during employee orientation, each employee will be informed of their authority to do so.

3.6 CH2M Subcontractors

Subcontractors must comply with the following activities, and are responsible to:

- Participate in Subcontractor HSE Chartering meetings;
- Implement and comply with all HSE requirements in their subcontract;
- Comply with all local, state, provincial, and federal safety standards;
- Comply with project and owner safety requirements;
- Maintain up-to-date health and safety training, medical, and competent person qualification records at the project site, readily available for inspection;
- Assign a competent site HSE representative who has the appropriate level of authority to act on HSE issues;
- Actively participate in the project safety program and either hold or attend and participate in all required safety meetings;
- Develop and implement site- and activity-specific HSE plans and/or procedures for work they will be performing;
- Maintain safety equipment and PPE for their employees;
- Determine and implement necessary controls and corrective actions to correct unsafe conditions;
- Maintain and replace safety protection systems damaged or removed by the subcontractor's operations;
- Notify the SC of any incidents including, injury, spills or releases, environmental permit issues, near misses or property damage immediately and submit report to CH2M within 24 hours;
- Install contractually required general conditions for safety (for example, handrail, fencing, fall protection systems, floor opening covers);
- Conduct site-specific and job-specific training for all subcontractor employees, including review of the CH2M safety plan, subcontractor safety plans, and subcontractor AHAs or AHA/EIA, and sign appropriate sign-off forms;
- Provide subcontractor staff with the appropriate HSE training, qualifications, PPE, supplies and equipment necessary to safely complete assigned work; and
- Provides reports and maintains records of HSE-related activities in accordance with contract requirements and HSE Plans.

Subcontractors may be required to submit their own site-specific safety plan and other plans such as lead or asbestos abatement compliance plans. Subcontractors are responsible for the HSE procedures specific to their work, and are required to submit their plans to CH2M for review and acceptance before the start of field work.

Subcontractors are also required to prepare AHAs or AHA/EIAs before beginning each activity posing hazards to their personnel. The AHA or AHA/EIA shall identify the principle steps of the activity, potential HSE hazards or impacts for each step and recommended control measures for each identified hazard. In addition, a listing of the equipment to be used to perform the activity, inspection requirements, and training requirements for the safe operation of the equipment listed must be identified.

3.7 Client Contractors

CH2M project safety plans do not cover contractors that are contracted directly to the client or the owner. CH2M is not responsible for the health and safety or means and methods of the contractor's work, and we must never assume such responsibility through our actions (such as advising on health and safety issues). In addition to these instructions, CH2M team members should review contractor safety plans so that we remain aware of appropriate precautions that apply to us. Self-assessment checklists are to be used by the SC and CH2M team members to review the contractor's performance only as it pertains to evaluating CH2M exposure and safety. The RHSM is the only person who is authorized to comment on or accept contractor safety procedures.

Health and safety-related communications with contractors should be conducted as follows:

- Request the contractor to brief CH2M team members on the precautions related to the contractor's work;
- When an apparent contractor non-compliance or unsafe condition or practice poses a risk to CH2M team members:
    - Notify the contractor safety representative;
    - Request that the contractor determine and implement corrective actions;
    - If necessary, stop affected CH2M work until contractor corrects the condition or practice; and
    - Notify the client, PM, and RHSM as appropriate.

If apparent contractor non-compliance or unsafe conditions or practices are observed, inform the contractor safety representative (CH2M's obligation is limited strictly to informing the contractor of the observation; the contractor is solely responsible for determining and implementing necessary controls and corrective actions).

If an apparent imminent danger is observed, immediately warn the contractor employee(s) in danger and notify the contractor safety representative (CH2M's obligation is limited strictly to immediately warning the affected individual(s) and informing the contractor of the observation; the contractor is solely responsible for determining and implementing necessary controls and corrective actions).

All verbal health and safety-related communications will be documented in project field logbook, daily reports, or other records.

4. Standards of Conduct

All individuals associated with this project must strive to work injury-free and must work drug-free and comply with the following standards of conduct, and the safety requirements of CH2M. Commonly accepted standards of conduct help maintain good relationships between people. They promote responsibility and self-development. Misunderstandings, frictions, and disciplinary action can be avoided by refraining from thoughtless or wrongful acts.

4.1 HSE Accountability

(Reference CH2M Policy 203, *HSE Accountability*)

4.1.1 Prohibited Behaviors and Actions

Managers, supervisors, and employees who openly or recklessly exhibit a disregard, defiance, or disrespect for CH2M's HSE programs, rules, procedures, processes, and training, or who violate established HSE programs, rules, procedures, processes or training endangering themselves or other employees, will be subject to disciplinary actions. Without limitation, behaviors and actions that warrant disciplinary action include the following:

- Requiring, requesting, demanding, asking, or threatening another person in any manner to entice the person to engage in or work around a patently unsafe or environmentally compromising act or condition.
- Condoning or knowingly allowing a person to engage in or work around a patently unsafe or environmentally compromising act or condition.
- Recklessly, knowingly, or purposely failing to wear required PPE.
- Failing to successfully complete any required HSE training that is scheduled and made available for completion.
- Failing to promptly notify a supervisor, project safety manager, coordinator, lead, or the project manager when an unsafe condition or behavior is observed, and/or when an environmentally compromising condition is encountered.
- Failing to promptly report to a supervisor, project safety manager, coordinator, lead, or the project manager, a work-related HSE incident or near miss.
- If required of the position, failing to maintain as active and in good standing necessary health, safety, and/or environmental licenses or permits needed to support CH2M work and projects.
- Knowingly falsifying any HSE record or investigative document (whether internal to CH2M or external), or providing false testimony, during an HSE or outside agency incident investigation.
- Refusing to cooperate in an HSE incident investigation.
- Knowingly falsifying any inspection or sampling records (whether internal to CH2M or external).
- Performing field work without the required site HSE plan approved by a HSE manager.
- Engaging in any form of workplace violence described in Policy 201 Workplace Violence Awareness and Prevention, including physical encounters, destruction of property, and verbal threats of violence, harm, or mayhem.
- Failing to comply with any HSE procedures contained in any contract, subcontract, site health safety and environment plan, or any federal, state, provincial, or local health, safety, or environmental laws and regulations creating actual or potential significant risk for CH2M (whether monetary or otherwise).

In addition, no individual may have in his or her possession, bring to the project site, or maintain on CH2M property, concealed or otherwise, any weapon, explosive device or substance, firearm, ammunition or instrument that could be used as a weapon. All weapons, explosive devices or substances, firearms, and ammunition are banned from all project sites, properties, vehicles and/or any CH2M activities or events.

4.1.2 Disciplinary Actions

When CH2M employees neglect to fulfill their responsibilities and/or project-specific HSE requirements, CH2M may discipline its employees. All CH2M employees, including management and supervisory employees, are equally subject to disciplinary action for failing to meet the expectations associated with this Policy and/or HSE programs, rules, procedures, processes, and training. CH2M reserves the right in its sole discretion to determine the appropriateness of any discipline imposed, but such disciplinary action may include, without limitation, denial of access to the worksite, verbal and/or written warnings/reprimands, and termination of employment.

4.2 Subcontractor Safety Performance

CH2M should continuously endeavor to observe subcontractors' safety performance and adherence to their plans and AHAs or AHA/EIAs. This endeavor should be reasonable, and include observing for hazards or unsafe practices that are both readily observable and occur in common work areas. CH2M oversight does not relieve subcontractors of their responsibility for effective implementation and compliance with the established plan(s).

4.2.1 Observed Hazard Form

When apparent non-compliance or unsafe conditions or practices are observed, notify the subcontractor's supervisor or safety representative verbally, and document using the Observed Hazard Form, included as an attachment to the project safety plan, and require corrective action.

If necessary, stop subcontractor's work using the Stop Work Order Form until corrective actions is implemented for observed serious hazards or conditions. Update the Observed Hazard Form to document corrective actions have been taken. The subcontractor is responsible for determining and implementing necessary controls and corrective actions.

4.2.2 Stop Work Order

CH2M has the authority, as specified in the contract, and the responsibility to stop work in the event any CH2M employee observes unsafe conditions or failure of the subcontractor to adhere to its safe-work practices, or observes a condition or practice that may result in a release or violation of an environmental requirement. This authority and action does not in any way relieve the subcontractor of its responsibilities for the means and methods of the work or, therefore, of any corrective actions. Failure to comply with safe work practices can be the basis for restriction or removal of the subcontractor staff from the job site, termination of the subcontract, restriction from future work, or all three.

When an apparent imminent danger is observed, immediately stop work and alert all affected individuals. Remove all affected CH2M employees and subcontractor staff from the danger, notify the subcontractor's supervisor or safety representative, and do not allow work to resume until adequate corrective measures are implemented. Notify the PM, Buyer, and RHSM.

When repeated non-compliance or unsafe conditions are observed, notify the subcontractor's supervisor or safety representative and stop affected work by completing and delivering the Stop Work Order Form (attached to the project safety plan) until adequate corrective measures are implemented. Consult the Buyer to determine what the contract dictates for actions to pursue in event of subcontractor non-compliance including work stoppage, back charges, progress payments, removal of subcontractor manager, monetary penalties, or termination of subcontractor for cause.

4.3 Incentive Program

Each project is encouraged to implement a safety incentive program that rewards workers for exhibiting exemplary safety behaviors. Actions that qualify are those that go above and beyond what is expected. Actions that will be rewarded include spotting and correcting a hazard, bringing a hazard to the attention of your foreman, telling your foreman about an incident, coming up with a safer way to get the work done, or stopping a crew member from doing something unsafe. The program will operate throughout the project, covering all workers. The incentive program will be communicated to all employees during the project employee orientation and project safety meetings.

4.4 Reporting Unsafe Conditions/Practices

Responsibility for effective health and safety management extends to all levels of the project and requires good communication between employees, supervisors, and management. Incident prevention requires a proactive policy on near misses, close calls, unsafe conditions, and unsafe practices. All personnel must report any situation, practice, or condition which might jeopardize the safety of our projects. All unsafe conditions or unsafe practices will be corrected immediately. CH2M has zero tolerance of unsafe conditions or unsafe practices.

No employee or supervisor will be disciplined for reporting unsafe conditions or practices. Individuals involved in reporting the unsafe conditions or practices will remain anonymous.

The following reporting procedures will be followed by all project employees:

- Upon detection of any unsafe condition or practice, the responsible employee will attempt to safely correct the condition;
- The unsafe condition or practice will be brought to the attention of the worker’s direct supervisor, unless the unsafe condition or practice involves the employee’s direct supervisor. If so, the SC needs to be notified at once by the responsible employee;
- Either the responsible employee or responsible employee’s direct supervisor is responsible for immediately reporting the unsafe condition or practice to the SC;
- The SC will act promptly to correct the unsafe condition or practice; and
- Details of the incident or situation will be recorded by the SC in the field logbook or use the Observed Hazard Form if subcontractor was involved.

5. Safety Planning and Change Management

5.1 Subcontractor HSE Chartering Meeting

A subcontractor HSE chartering meeting shall be held with subcontractors performing field work on the project. The purpose of the meeting is to discuss and agree on key HSE requirements on a project, and to emphasize and reinforce CH2M expectations for subcontractor HSE performance. The target audience includes key CH2M project staff with HSE responsibilities (e.g., PM, RHSM, SC, Field Team Leader (FTL)) and key Subcontractor staff (e.g., project manager, supervisors, designated field HSE contact, drill team leads, foreman). For small scale projects (e.g., small drill crew and limited CH2M staff), all the subcontractor crew members should attend if available. The meeting should be held prior to mobilization with enough time to ensure that HSE issues identified can be addressed prior to the start of work. The meeting can be held over the phone or in person depending on project needs. An example agenda can be found at following link Program Element Guideline, "Subcontractor HSE Chartering Meeting."

5.2 Daily Safety Meetings and Pre-Task Safety Plans

Daily safety meetings are to be held with all project personnel in attendance to review the hazards posed and required HSE procedures and AHAs or AHA/EIAs that apply for each day's project activities. The Pre-Task Safety Plans (PTSPs) serve to supplement these general assembly safety meetings; the PTSPs are held between the crew supervisor and their work crews to focus on those hazards posed to individual work crews.

At the start of each day's activities, the crew supervisor completes the PTSP, provided as an attachment to the project safety plan, with input from the work crew. The day's tasks, personnel, tools and equipment that will be used to perform these tasks are listed, along with the hazards posed and required HSE procedures, as identified in this Handbook and AHA or AHA/EIA. The use of PTSPs promotes worker participation in the hazard recognition and control process while reinforcing the task-specific hazard and required HSE procedures with the crew each day. The PTSP can be completed either with the daily safety meeting or, if there are multiple crews, separately with each crew and their supervisor after the general daily safety meeting.

5.3 Change Management

This Handbook and the project safety plan address known activities and associated hazards. As work progresses, if significant changes are identified which could affect health, safety, or environmental conditions at the site, coordinate with the RHSM or EM to determine whether an update to the safety plan and/or environmental plan are necessary. Follow the change management protocol in the safety plan.

The following are examples of changes that may require a revision to the plan:

- Change in CH2M staff;
- New subcontractor to perform work;
- New chemicals brought to site for use;
- Change in scope or addition of new tasks;
- Change in contaminants of concern (COCs) or change in concentrations of COCs; and
- New hazards or hazards not previously identified that are not addressed in this Handbook or the project safety plan.

5.4 Agency Inspection Guidance

(Reference CH2M SOP HSE-201, Agency Inspections and Enforcement)

Agency inspections (e.g., OSHA, EPA, Federal Aviation Administration (FAA), and in Canada, Workplace Health and Safety, Provincial Ministry of Labour, Provincial Ministry of the Environment) are on the rise. CH2M implements safety and environmental programs in order to ensure safety to workers, the public, and the environment. Field personnel need to contact the RHSM to update the project safety plan if hazards are encountered that are not addressed.

SOP HSE-201, Agency Inspections and Enforcement, addresses agency inspections in detail. It is critical to make immediate notification to the RHSM if an inspector arrives (and EM if it is environmental-related); they can help facilitate and make additional notifications.

Review the SOP and make it a topic at a safety meeting and keep it readily available in the event of an inspection.

6. Project Hazard Analysis

A health and safety risk analysis is performed for each task of a given project. In the order listed below, the RHSM considers the various methods for mitigating the hazards. Employees are trained on this hierarchy of controls during their hazardous waste training and reminded of them throughout the execution of projects:

- Elimination of the hazards (use remote sampling methodology to avoid going into a confined space);
- Substitution (reduce exposure to vapors by using a geoprobe instead of test pitting);
- Engineering controls (ventilate a confined space to improve air quality);
- Warnings (establish exclusion zones to keep untrained people away from hazardous waste work);
- Administrative controls (implement a work-rest schedule to reduce chance of heat stress); or
- Use of PPE (use of respirators when action levels are exceeded).

Employees are trained on the hierarchy of controls during their hazardous waste training and reminded of them throughout the execution of projects.

6.1 Hazard Identification and Control – The 10 Energies

Hazards are created when an object interacts with a type of energy or combination of energies. The first step in incident prevention is recognizing the energy source(s) and the potential for an uncontrolled release of, or contact with, that energy source. Identifying potential energy sources associated with a piece of equipment or a task allows us to mitigate the hazard correctly.

The 10 types of energy to consider are:

- Chemical
- Electrical
- Gravity
- Mechanical
- Motion
- Pressure
- Sound
- Radiation
- Temperature
- Biological

As described in the hierarchy of controls above, there are four basic options available to prevent unwanted exposure of the energy or energies:

- Eliminate the energy,
- Control the energy,
- Provide a protective barrier or,
- Use stop work authority

When possible, plan or do work that does not require exposure to an energy source. Take action to remove or control the energy source, or be sure that barriers are adequate to mitigate the resulting hazard (engineering controls, PPE, etc.). Use safe work observations to look for body position and placement and use of safety equipment with respect to energy sources present and the potential for an uncontrolled release or contact (line of fire incidents!).

Identify the energy source(s) in the safety plan and AHA or AHA/EIA or during the pre-task safety briefing and **verify** controls are in place for each task or STOP work until they are.

6.2 Activity Hazard Analysis

An AHA must be developed for each CH2M field activity. The AHA or AHA/EIA shall define the work tasks required to perform each activity, along with potential HSE hazards and recommended control measures for each hazard, incorporating the hazardous energies described above. In addition, a listing of the equipment to be used to perform the activity, inspection requirements to be performed and training requirements for the safe operation of the equipment listed must be identified. Workers are briefed on the AHA or AHA/EIA before performing the work and their input is solicited prior, during, and after the performance of work to further identify the hazards posed and control measures required.

6.3 Subcontractor Activity Hazard Analysis

CH2M subcontractors are required to provide AHAs or AHA/EIAs specific to their scope of work on the project for acceptance by CH2M. Each subcontractor shall submit AHAs or AHA/EIA for their field activities, as defined in their scope of work, along with their project safety plan and procedures. Additions or changes in field activities, equipment, tools, or material used to perform work or hazards not addressed in existing AHAs or AHA/EIAs requires either a new AHA or AHA/EIA to be prepared or an existing one to be revised.

7. General Hazards and Controls

This section provides safe work practices and control measures used to reduce or eliminate potential hazards. It is a summarized list of requirements. Always consult the appropriate CH2M Core Standard and/or SOP to ensure all requirements are implemented.

7.1 Bloodborne Pathogens

(Reference CH2M SOP HSE-202, *Bloodborne Pathogens*)

Exposure to bloodborne pathogens may occur when rendering first aid or cardiopulmonary resuscitation (CPR), or when coming into contact with landfill waste or waste streams containing potentially infectious material (PIM).

Employees trained in first-aid/CPR or those exposed to PIM must complete CH2M's 1-hour bloodborne pathogens computer-based training module annually. When performing first-aid/CPR the following shall apply:

- Observe universal precautions to prevent contact with blood or other PIMs. Where differentiation between body fluid types is difficult or impossible, consider all body fluids to be potentially infectious materials;
- Always wash your hands and face with soap and running water after contacting PIMs. If washing facilities are unavailable, use an antiseptic cleanser with clean paper towels or moist towelettes; and
- If necessary, decontaminate all potentially contaminated equipment and surfaces with chlorine bleach as soon as possible. Use one part chlorine bleach (5.25 percent sodium hypochlorite solution) diluted with 10 parts water for decontaminating equipment or surfaces after initially removing blood or other PIMs. Remove contaminated PPE as soon as possible before leaving a work area.

CH2M will provide exposed employees with a confidential medical examination should an exposure to PIM occur. This examination includes the following procedures:

- Documenting the exposure;
- Testing the exposed employee's and the source individual's blood (with consent); and
- Administering post-exposure prophylaxis.

7.2 Chemical Storage

The following is general guidance for storing chemicals and other hazardous materials:

- Keep acids away from bases;
- Keep oxidizers (nitric acid, nitrates, peroxides, chlorates) and organics away from inorganic reducing agents (metals);
- Keep flammables and corrosives in appropriate storage cabinets;
- Do not store paper or other combustibles near flammables;
- Use secondary containment and lipped shelving that is secured; and
- Have a fire suppression system available.

7.2.1 Storage of Flammable/Combustible Liquids

- Only approved containers and portable tanks shall be used for storage and handling of flammable and combustible liquids.

- Approved safety cans shall be used for the handling and use of flammable liquids in quantities of 5 gallons (19 liters) or less. Do not use plastic gas cans. In Canada, use only the appropriate and approved gas cans for your specific province. In addition, the client may have specific requirements.
- For quantities of 1 gallon (3.78 liters) or less, the original container may be used for storage and use of flammable liquids.
- Flammable or combustible liquids shall not be stored in areas used for stairways or normally used for the passage of people.

7.2.2 Indoor Storage of Flammable/Combustible Liquids

- No more than 25 gallons (95 liters) of flammable or combustible liquids shall be stored in a room outside of an approved storage cabinet.
- Quantities of flammable and combustible liquids in excess of 25 gallons (95 liters) shall be stored in an acceptable or approved cabinet.
- Cabinets shall be conspicuously lettered: “FLAMMABLE: KEEP FIRE AWAY.”
- Not more than 60 gallons (228 liters) of flammable or 120 gallons (456 liters) of combustible liquids shall be stored in any one storage cabinet. Not more than three such cabinets may be located in a single storage area.

7.2.3 Outside Storage of Flammable/Combustible Liquids

- Storage of containers (not more than 60 gallons [228 liters] each) shall not exceed 1,100 gallons (4,180 liters) in any one area. No area shall be within 20 feet (6.1 meters) of any building.
- Storage areas shall be graded to divert spills away from buildings and surrounded by an earthen dike.
- Storage areas may not be located near a storm drain. Overflow and spills must be diverted away from storm drains or surface waters.
- Storage areas shall be free from weeds, debris, and other combustible materials.
- Outdoor portable tanks shall be provided with emergency vent devices and shall not be closer than 20 feet (6.1 meters) to any building.
- Signs indicating no smoking shall be posted around the storage area.

7.2.4 Storage of Hazardous Waste

- All facilities storing ignitable and combustible liquids and hazardous wastes must be designed, constructed, maintained, and operated to minimize the possibility of a fire, explosion, or any release of hazardous constituents.
- Flammable wastes should be stored more than 50 feet from the property line.

7.2.5 Storage of Chemical Injection Chemicals/Materials

- When chemical injection remediation technologies are being used at a site, the following storage guidelines must be followed:
- Some injection chemicals, such as strong oxidizers, may have stringent storage requirements per local or National Fire Codes. Verify that appropriate storage provisions are in place prior to starting work.
- NOTE: Counties and cities may have requirements specific to storing these chemicals. Also, storage and use of certain chemicals such as potassium permanganate and hydrogen peroxide may be subject to state, provincial, or federal regulations (e.g., the Chemical Facility Anti-Terrorism Standards of the Department of Homeland Security in the United States). The applicability depends on the chemical,

quantity/concentration, and type of facility. Please contact the project EM to determine whether chemicals are subject to these standards.

- Injection chemicals must be stored in a designated, secured area with spill prevention capabilities. Review Safety Data Sheet (SDS) or other information to determine potential incompatible materials. Incompatible materials shall not be stored together. Ensure all containers are labeled.

7.3 Driving Safety

(Reference CH2M HSE Policy 205, Distracted Driving – Wireless Devices, Vehicle Safety Core Standard)

All CH2M employees are prohibited from using wireless devices while operating a motor vehicle when conducting company business regardless of the location or vehicle ownership and whether or not during regular working hours.

All CH2M contractors and subcontractors are prohibited from using wireless devices while operating a CH2M- or CH2M client-owned, leased, or rented motor vehicle, or while operating any other motor vehicle on the project site.

Motorcycles, motorbikes, or other motorized devices with two or three wheels, all-terrain vehicles (ATVs) or quads are not allowed to be used for company related business. See the all-terrain vehicle (ATV)/utility-type vehicle (UTV) section of this Handbook for more information on ATVs/UTVs.

Avoid distractions from wireless devices (e.g., mobile phones, smartphones, voice recognition systems, PDAs, notebook, tablets, or laptops) by turning off or silencing the wireless devices before operating a motor vehicle.

- Prohibited use includes the following:
  - Dialing or speed dialing
  - Using a hands-free or voice recognition (blue tooth) device to dial or speed dial
  - Engaging in conversation or listening to a conversation using a wireless device
  - Checking emails or surfing the internet using a wireless device
  - Texting or e-mailing (reading, sending, or screening) with a wireless device
  - Programming or entering coordinates into a global positioning system (GPS) device (following directions by a GPS is permitted)
  - Using a wireless device for voice recording or dictation
  - Employees, contractors, and subcontractors who need to use a wireless device must pull off the road to a safe location, with the vehicle securely stopped and emergency flashers on, or wait until they reach their destination.

Follow the guidance below when operating a vehicle:

- All vehicles have blind spots to the side and the rear. Follow these safe practices for backing up:
  - Walk around your vehicle prior to moving
  - Try to position your vehicle so that you don't have to back up
  - Back into the space if possible when you're parking
  - Back to the left, if possible, so that you can see objects on the driver's side
  - Have a spotter guide your vehicle when you're backing up

  - Apply GOAL (Get Out And Look)

- Obey speed limits; be aware of blind spots or other hazards associated with low visibility. Practice defensive driving techniques, such as leaving plenty of room between your vehicle and the one ahead of you;
- Do no drive while drowsy. Drowsiness can occur at any time, but is most likely after 18 hours or more without sleep;
- Ensure seatbelts are worn at all times, and by all passengers
- Maintain focus on driving. Eating, drinking, smoking, adjusting controls can divert attention from the road. Take the time to park and perform these tasks when parked rather than while driving; and
- Ensure vehicle drivers are familiar with the safe operation of vehicles of the type and size to be operated. Large vehicles such as full size vans and pick-ups have different vision challenges and handling characteristics than smaller vehicles.

Driving in Areas with Tall Grass/Brush

- Driving in areas with tall grass/brush can present a potential fire hazard if the grass/brush gets caught under and/or remains in contact with the vehicle exhaust system. Employees should exercise the following precautions:
- When stopping vehicle, ensure it is in an area where grass is not tall.
- Do not leave vehicle idling once stopped.
- When possible, try to drive through areas where grass is not tall or grass has been beaten down.
- Ensure that a fire extinguisher is available for each vehicle.
- Keep fire extinguisher readily available in passenger area of vehicle while driving.
- Keep fire extinguisher outside of vehicle upon stopping.
- Address fire hazards and controls in daily safety briefings as appropriate.

7.4 Electrical Safety

(Reference CH2M SOP HSE-206, *Electrical Safety*)

Below are the hazard controls and safe work practices to follow when using electrical tools, extension cords, and/or other electrical-powered equipment or when exposed to electrical hazards. Ensure the requirements of the referenced SOP are followed:

- Only qualified personnel are permitted to work on unprotected energized electrical systems;
- Only authorized personnel are permitted to enter high-voltage areas;
- CH2M employees who might from time to time work in an environment influenced by the presence of electrical energy must complete Awareness Level Electrical Safety Training located on the CH2M Virtual Office;
- Do not tamper with electrical wiring and equipment unless qualified to do so. All electrical wiring and equipment must be considered energized until lockout/tagout procedures are implemented;
- Inspect electrical equipment, power tools, and extension cords for damage prior to use. Do not use defective electrical equipment, remove from service;

- CH2M has selected Ground Fault Circuit Interrupters (GFCIs) as the standard method for protecting employees from the hazards associated with electric shock;
  - GFCIs shall be used on all 120-volt, single phase 15 and 20-amphere receptacle outlets which are not part of the permanent wiring of the building or structure.
- An assured equipment grounding conductor program may be used on construction projects under the following scenarios:
  - GFCIs cannot be utilized;
  - Client requires such a program to be implemented; or
  - Business group decides to implement program in addition to GFCI protection.
- Extension cords must be equipped with third-wire grounding. Cords passing through work areas must be covered, elevated or protected from damage. Cords should not be routed through doorways unless protected from pinching. Cords should not be fastened with staples, hung from nails, or suspended with wire;
- Electrical power tools and equipment must be effectively grounded or double-insulated and Underwriters Laboratory (UL) approved;
- Operate and maintain electric power tools and equipment according to manufacturers' instructions;
- Maintain safe clearance distances between overhead power lines and any electrical conducting material unless the power lines have been de-energized and grounded, or where insulating barriers have been installed to prevent physical contact. Maintain at least 10 feet (3 meters) from overhead power lines for voltages of 50 kV or less, and 10 feet (3 meters) plus 0.4 inches (1.0 cm) for every 1 kV over 50 kV;
- Temporary lights shall not be suspended by their electric cord unless designed for suspension. Lights shall be protected from accidental contact or breakage; and
- Protect all electrical equipment, tools, switches, and outlets from environmental elements.

7.5 Extended Work Hours and Fatigue Management

(Reference CH2M Core Standard, *Fatigue Management*)

A normal work shift is considered to be eight consecutive hours during the day, five days a week, with at least an eight hour rest period. Any shift that incorporates more continuous hours, requires more consecutive days of work, or requires work during the evening should be considered extended or unusual.

Extended or unusual work shifts are typically more stressful for workers physically, mentally, and emotionally, and can lead to increased fatigue, stress, and lack of concentration. These effects can lead to an increased risk of worker error, incidents, and injuries.

If field work exceeds either criteria listed below, you must consult with your PM and HSM for approval of the extended hours/days, and fatigue management requirements must be addressed in the project Health and Safety Plan (HASP), Field Safety Instruction, or project-specific Fatigue Management Plan (FMP):

- Planning field work or vehicle operation for more than 10 hours per day, up to 14 hours total including commute time.

  Note: Working over 12 field hours in one day should be for emergency situations only and would require Project Manager and RHSM approval.

- Working more than 10 consecutive days.

- A Fatigue Management Evaluation Form can be on found on the Enterprise HSE Website under Forms & Templates.
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7.6 Field Ergonomics and Manual Lifting

(Reference CH2M SOP HSE-112, *Manual Lifting*)

Some of the most common injuries during field work are the result of performing work in an awkward body position (poor ergonomics) or pushing the body beyond its natural limits. Workers who have to lift, stoop, kneel, twist, grip, stretch, reach overhead, or work in other awkward positions regularly are at risk of developing discomfort or even an injury. Additionally, back injuries are one of the leading causes of work disability and most back injuries are the result of improper lifting techniques or overexertion.

Contact the RHSM to determine hazard control measures if your task involves:

- Repetitive motions;
- Lifting and carrying items over long distances (100 feet) or on uneven, steep, or sloped terrain;
- Heavy lifting;
- Use of vibrating tools or equipment; or
- Being in a static position for extended periods of time;

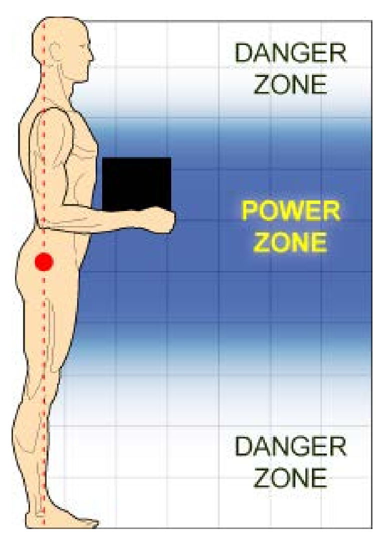
There are a variety of ergonomically designed tools and work practices that can reduce the potential for discomfort and injury. Following are requirements ("must" or "shall") and recommendations ("should") to aid in the prevention of discomfort or injuries while working in the field.

Fitness for Duty

If manual lifting and repetitive activities are not part of your normal work duties, contact your PM and/or RHSM to help determine if you have the physical capability to perform the work. In many cases adding lifting or repetitive tasks to a subcontractor's scope of work is desirable to prevent injury. If the work task causes any pain or discomfort stop and get assistance.

Manual Lifting

- All CH2M workers must have training in proper manual lifting either through New Employee Orientation or through the Manual Lifting module located on the VO;
- When possible, the task should be modified to minimize manual lifting hazards or awkward body positions;
- Lifting occasional loads weighing more than 40 pounds (18 kilograms) should be evaluated by the SC using the Lifting Evaluation Form contained in SOP HSE-112;
- When performing repetitive lifting tasks with loads over 40 pounds, the Lifting Evaluation Form contained in SOP HSE-112 shall be used, and mechanical means used where possible;
- Personnel shall seek assistance when performing manual lifting tasks that appear beyond their physical capabilities;
- Using mechanical lifting devices such as forklifts; cranes, hoists, and rigging; hand trucks; and trolleys; is the preferred means of lifting heavy objects;



- Lift and Work in the Power Zone - The power zone for lifting or working is close to the body, between mid-thigh and mid-chest height. This zone is where arms and back can lift the most with the least amount of effort. This is zone is sometimes refered to as the “strike zone”;
- Work near elbow height to avoid excessive bending (avoid working above the shoul Source: OSHA knees);
- Plan before carrying:
  - Wear appropriate shoes to avoid slips, trips or falls
  - If you wear gloves, wear gloves that fit. Tight-fitting gloves can put pressure on the hands, while loose-fitting gloves reduce grip strength and pose other safety hazards.
  - Avoid carrying large or bulky loads that limit or obstruct your vision
  - Slide, push, or roll instead of carrying when appropriate
  - When there is a choice, push instead of pull
  - Carry only as much as you can safely handle
  - Try to avoid slopes, stairs, or other obstacles that make carrying materials more difficult
  - Beware of and try to avoid slippery floors (e.g., liquids, ice, oil, and fine powders)
  - Use extra caution when moving loads that may be unstable
- In general, the following steps must be practiced when planning and performing manual lifts:
  - Examine the load and the surrounding area
  - Bend knees when lifting a load
  - Look forward to keep back straight
  - Position the load close to the body
  - Maintain a firm grip on the load
  - Test the load for stability and weight prior to lifting
  - Use smooth, controlled movements
  - Keep arms in front of body
  - Turn feet in direction of movement to avoid twisting
- Avoid carrying objects more than 100 feet;

<u>Ergonomic Work Practices</u>

- Avoid repetitive motions, overhead reaching, and kneeling when possible;
- If prolonged awkward postures are unavoidable, use a “supported” posture to compensate; a supported posture uses part of your body to support the weight of another body segment that is in an awkward position;
- Watch your pace—attempting to do something faster can cause you to lose proper form;
- Use a table or move work to a location where you don’t have to be in a bent-over position to do your work; and
- Where awkward postures or repetitive motions are unavoidable, rotate with another worker, change tasks, stretch, and take short breaks frequently.

7.7 Field Trailer/Office Setup and Maintenance

- Determine trailer placement by considering all potential hazards that could impact “office” work. Trailers usually are placed in the support zone and out of construction zones. Think about what type of PPE will be necessary when exiting the trailer, parking needs, biological hazards or other hazards that could impact location.
- Check utility configuration prior to placement, including electrical, water, and sewer.

- Use spotters when placing trailer.
- Set on flat ground.
- Be sure trailer wheels are chocked.
- When disconnecting trailer from hitch—watch pinch points and wear leather gloves.
- Carefully jack trailer using the appropriately rated jacks and following manufacturer's recommendations.
- Secure and anchor trailer to protect from wind or other severe weather.
- Place cones in front of hitch.
- Ensure proper stairs and secure stairs next to doors. Ensure stairs are "no slip" and that the platform or landing of the stairs is flush the door threshold.
- Use only qualified electricians to establish electrical service.
- Consider ergonomics when furnishing trailer with desks and chairs.
- Place fire extinguishers near doors, and place signage.
- Put up emergency contacts, evacuation and rally point map, and route to the hospital
- Place right to know posters (e.g., OSHA, Workplace, Wage and Hour, Family Medical Leave).
- Place signage on exit doors.
- Never place porta-johns at HVAC intake (usually HVAC is located at the front of trailer).
- Have capability to properly store food—temporary field offices can quickly develop rodent issues if food is not stored properly or the trailer isn't cleaned regularly.

7.8 Field Vehicles

- Field vehicles may be personal vehicles, rental vehicles, fleet vehicles, or project vehicles.
- Maintain a first aid kit and bloodborne pathogen kit in the field vehicle.
- Assess whether maintaining a fire extinguisher in the field vehicle is feasible. If fire extinguishers are readily available, for example on heavy equipment, or if the project is short duration, a fire extinguisher would not be necessary. Fire extinguishers in field vehicles need to be properly secured and inspected on a monthly basis.
- The following precautions should be implemented if work involves stopping or parking along roadways:
  - Freeways and limited access – no stopping/parking allowed
- The following applies in Canada:
  - Roads with speed limits 80 km/hr (50 mph) or higher – flashing beacon required on top of the vehicle.
  - Roads with speed limits 55 km/hr (35 mph) or higher with no/limited shoulder (not able to get fully off the road at least 12 inches from the fog line or road edge) - flashing beacon required
  - Roads with speed limits 55 km/hr (35 mph) or higher with full shoulder (are able to get fully off the road at least 12 inches from the fog line or road edge) - flashers required
  - Roads with speed limits under 55 km/hr (35 mph) - flashers required
- Familiarize yourself with rental vehicle features prior to operating the vehicle:
  - Vision Fields and Blind Spots
  - Vehicle Size
  - Mirror adjustments

- Seat adjustments
- Cruise control features, if offered
- Pre-program radio stations and Global Positioning System (GPS), if equipped

- Always wear seatbelt while operating vehicle.
- Adjust headrest to proper position.
- Tie down loose items if utilizing a van or pick-up truck. If supplies/equipment is being transported inside the vehicle, be sure to tie down or secure to prevent movement within the vehicle.
- Close car doors slowly and carefully. Fingers can get pinched in doors.
- Park vehicle in a location where it can be accessed easily in the event of an emergency. If not possible, carry a phone.
- Have a designated place for storing the field vehicle keys when not in use.
- Ensure back-up alarms are functioning, if equipped. Before backing a vehicle, take a walk around the vehicle to identify obstructions or hazards. Use a spotter when necessary to back into or out of an area.
- See the Vehicle Incident Guidance attached to the project safety plan, if a vehicle incident is experienced in a rental or fleet vehicle.

7.9 Fire Prevention

(Reference CH2M SOP HSE-403, *Hazardous Material Handling*)

Follow the fire prevention and control procedures listed below.

7.9.1 Fire Extinguishers and General Fire Prevention Practices

- Fire extinguishers shall be provided so that the travel distance from any work area to the nearest extinguisher is less than 100 feet (30.5 meters). When 5 gallons (19 liters) or more of a flammable or combustible liquid is being used, an extinguisher must be within 50 feet (15.2 meters). Extinguishers must:
  - be maintained in a fully charged and operable condition;
  - be visually inspected each month; and
  - undergo a maintenance check each year.
- The area in front of extinguishers must be kept clear.
- Post “Exit” signs over exiting doors, and post “Fire Extinguisher” signs over extinguisher locations.
- Combustible materials stored outside should be at least 10 feet (3 meters) from any building.
- Solvent waste and oily rags must be kept in a fire resistant, covered container until removed from the site.
- Keep areas neat. Housekeeping is important.

7.9.2 Dispensing of Flammable/Combustible Liquids

- Areas in which flammable or combustible liquids are dispensed in quantities greater than 5 gallons (22.7 liters) (shall be separated from other operations by at least 25 feet (7.6 meters).
- Drainage away from storm drains or surface waters or other means of containment shall be provided to control spills.
- Adequate natural or mechanical ventilation shall be provided to maintain the concentration of flammable vapor at or below 10 percent of the lower flammable limit.

- Dispensing of flammable liquids from one container to another shall be done only when containers are electrically interconnected (bonded).
- Dispensing flammable or combustible liquids by means of air pressure on the container or portable tanks is prohibited.
- Dispensing devices and nozzles for flammable liquids shall be of an approved type.

7.10 General Practices and Housekeeping

The following are general requirements applicable to all portions of the work:

- Site work should be performed during daylight hours whenever possible;
- Good housekeeping must be maintained at all times in all project work areas;
- Common paths of travel should be established and kept free from the accumulation of materials;
- Keep access to aisles, exits, ladders, stairways, scaffolding, and emergency equipment free from obstructions;
- Provide slip-resistant surfaces, ropes, or other devices to be used;
- Specific areas should be designated for the proper storage of materials;
- Tools, equipment, materials, and supplies shall be stored in an orderly manner;
- As work progresses, scrap and unessential materials must be neatly stored or removed from the work area;
- Containers should be provided for collecting trash and other debris and shall be removed at regular intervals;
- All spills shall be quickly cleaned up; oil and grease shall be cleaned from walking and working surfaces;
- Review the safety requirements of each job you are assigned to with your supervisor. You are not expected to perform a job that may result in injury or illness to yourself or to others;
- Familiarize yourself with, understand, and follow jobsite emergency procedures;
- Do not fight or horseplay while conducting the firm's business;
- Do not use or possess firearms or other weapons while conducting the firm's business;
- Report unsafe conditions or unsafe acts to your supervisor immediately;
- Report emergencies, occupational illnesses, injuries, motor vehicle incidents, and near misses immediately;
- Do not remove or make ineffective safeguards or safety devices attached to any piece of equipment;
- Report unsafe equipment, defective or frayed electrical cords, and unguarded machinery to your supervisor;
- Shut down and lock out machinery and equipment before cleaning, adjustment, or repair. Do not lubricate or repair moving parts of machinery while the parts are in motion;
- Do not run in the workplace;
- When ascending or descending stairways, use the handrail and take one step at a time;
- Do not apply compressed air to any person or clothing;
- Do not wear steel taps or shoes with metal exposed to the sole at any CH2M project location;

- Do not wear finger rings, loose clothing, wristwatches, and other loose accessories when within arm's reach of moving machinery;
- Remove waste and debris from the workplace and dispose of in accordance with federal, state, provincial, and local regulations;
- Note the correct way to lift heavy objects (secure footing, firm grip, straight back, lift with legs), and get help if needed. Use mechanical lifting devices whenever possible; and
- Check the work area to determine what problems or hazards may exist.

7.11 Hazard Communication

(Reference CH2M SOPs HSE-107, Hazard Communication and HSE-403, Hazardous Material Handling; in Canada, also refer to Provincial Workplace Hazardous Materials Information System Regulation)

For work in the US, the governing regulation is OSHA's Hazard Communication regulation, 29 CFR 1910.1200. In Canada, the national hazard communication standard is the Workplace Hazardous Materials Information System (WHMIS).

The hazard communication (HazCom) coordinator is to perform the following:

- Complete an inventory of chemicals brought on site by CH2M using the chemical inventory form included as an attachment to the project safety plan;
- Confirm that an inventory of chemicals brought on site by CH2M subcontractors is available;
- Request or confirm locations of Globally Harmonized System (GHS) compliant (i.e., consisting of 16 sections that appear in the same order and contain uniform information regarding the chemical) safety data sheets (SDSs) from the client, contractors, and subcontractors for chemicals to which CH2M employees potentially are exposed;
- For chemicals used by CH2M workers, before or as the chemicals arrive on site, obtain an SDS for each hazardous chemical and include on the chemical inventory sheet (attached to the project safety plan) and add the SDS to the SDS onsite notebook. Ensure everyone knows where SDSs are kept;
- The six required elements of the GHS label must include the product identifier, pictograms, signal word, hazard statements, precautionary statements, and the name, address, and telephone number of the chemical manufacturer, importer or other responsible party;
- The manufacturer's original label on any incoming regulated product must not be removed or defaced. The manufacturer's label and markings must be retained on the package or container until it is sufficiently cleaned of residue and purged of vapors to remove any potential hazards;
- Ensure all secondary containers are labeled in compliance with GHS labeling requirements. If GHS compliant information has not yet been provided by the manufacturer or chemical distributor, the HCC must contact the manufacturer or chemical distributor and document in the chemical inventory when the GHS labeling information will be available, until the labeling requirement is fulfilled;
- In the United States, the container label shall be in English, although labels in other languages may be kept as well. Container labels in other languages for non-speaking English speaking workers will be made available when specified by the client for their project site or facility;
- Give employees required chemical-specific HazCom training using the chemical-specific training form included as an attachment to the project safety plan and ensure that the GHS supplemental VO module has been completed; and

- Store all materials properly, giving consideration to compatibility, quantity limits, secondary containment, fire prevention, and environmental conditions.

The following are general guidelines for storing chemicals and other hazardous materials:

- Keep acids away from bases;
- Keep oxidizers (nitric acid, nitrates, peroxides, chlorates) and organics away from inorganic reducing agents (metals);
- Keep flammables and corrosives in appropriate storage cabinets;
- Do not store paper or other combustibles near flammables;
- Use secondary containment and lipped shelving that is secured; and
- Have a fire suppression system available.

7.12 Knife Use

(Reference CH2M SOP HSE-210, *Hand and Power Tools*)

Open-bladed knives (for example, box cutters, utility knives, pocket knives, machetes, and multi-purpose tools with fixed blades such as a Leatherman™) are prohibited at worksites except where the following three conditions are met:

- The open-bladed knife is determined to be the best tool for the job;
- An approved Activity Hazard Analysis (AHA) or written procedure is in place that covers the necessary safety precautions (work practices, PPE, and training); and
- Knife users have been trained and follow the AHA.

Specific precautions for knife use include:

- Employees are responsible for using cutting tools in the way they are intended, maintaining them in good working order and reporting faulty or unusable items. PPE as specified in the AHA is to be used;
- Those engaging and supervising subcontractors are to ensure that the requirements of this policy are communicated;
- The most appropriate gloves shall be identified within the AHA. In general, cut resistant gloves (e.g., Kevlar) are to be worn when using a knife in an occupational setting. Other types of gloves may be required and will be identified within the AHA. An example may be leather gloves may be worn when using the acetate sleeve cutter;
- All employees that will use a cutting tool must be trained in the proper use;
- Position the item to be cut on a stable surface. Secure it to prevent slippage, wherever possible. Select a work location which does not put your body in the line of fire of a knife slippage or failure;
- When using a knife do not cut towards yourself;
- When cutting, make the force of the cut carry the blade away from any part of your body. If you have a situation where this is not possible, protect yourself with a leather apron, or other material placed between you and the blade. Consider putting the material to be cut in a vise, or other holding device;
- Many tasks using a utility knife require a knife edge but not a sharp point. For these tasks you can add protection against puncture wounds by using a rounded-tip blade;

- In general, a pocket knife if not the preferred tool of choice as there are alternatives (e.g., retracting safety blade).
- If you use a folding knife, it must be a locking blade type.
- Never use a knife that will fold under pressure.
- If you use a fixed blade knife, make sure there is a handle guard to keep your hand from slipping forward. Also, make sure the handle is dry and non- greasy/slippery to assure a better grip. If you carry a fixed blade knife, use a sheath or holder.
- Store utility knives safely, retract the blade or sheath an open blade before storing. Never, leave a knife with the blade exposed on the floor, on a pallet, on a work surface, or in a drawer or cabinet.
- Keep your knife sharp. A dull blade requires you to use more force to cut, and consequently increases the risk of slip or mistake.
- Knives used on the job, but not carried with you, must be properly stored when not in use;
- Never use a defective knife;
- Utility knife blades are brittle and can snap easily. Don't bend them or apply side loads to them by using them to open cans or pry loose objects. Use the knife only to cut. It was not designed to work as a pry bar, screwdriver, or hole punch.

7.13 Lighting

Lighting shall be evaluated when conducting work inside buildings, confined spaces, or other areas/instances where supplemental light may be needed (e.g., work before sunrise or after sunset). A light meter can be used to evaluate the adequacy of lighting. The following are common requirements for lighting and the conditions/type of work being performed:

- While work is in progress outside construction areas shall have at least 33 lux (lx);
- Construction work conducted inside buildings should be provided with at least 55 lux light;
- The means of egress shall be illuminated with emergency and non-emergency lighting to provide a minimum 11 lx measured at the floor. Egress illumination shall be arranged so that the failure of any single lighting unit, including the burning out of an electric bulb will not leave any area in total darkness.

7.14 Personal Hygiene

Good hygiene is essential for personal health and to reduce the potential of cross-contamination when working on a hazardous waste site. Implement the following:

- Keep hands away from nose, mouth, and eyes during work;
- Keep areas of broken skin (chapped, burned, etc.) covered; and
- Wash hands with soap and water prior to eating, smoking, or applying cosmetics.

7.15 Personal Security

Follow the guidelines below for personal security measures. The RHSM and Firm-Wide Security Office can be contacted if additional, specific measures are needed (e.g., such as evaluating the needs for security service).

General Safety and Security Guidelines

CH2M Corporate Security Department recommends the following guidelines for workers in the United States:

- Stay alert and be aware of your surroundings. Avoid pre-occupations with mobile devices, while in an unfamiliar area.
- Whenever possible use the buddy system with another employee or client or subcontractor employee.
- Trust your intuition; if a situation appears strange or wrong, it probably is.
- Be confident in your walk or stride; do not give the appearance you are new in town.
- Avoid carrying and displaying large sums of cash.
- If you sense or see dangerous situations along your route, change your route and depart the area quickly. If you feel that you are being followed, go to the nearest police station or safe location and file a complaint with the police. Provide a description of the person, their vehicle, license plate number and any other useful information.
- Only walk short distances that are safe and secure while visiting an unfamiliar city or location.
- Take host approved transportation for long distances.
- “Fight or Flight?” Leaving the possible or dangerous area is always better than staying to fight.
- Always report suspicious activity to the nearest local law enforcement agency.
- Locate emergency exits in your hotel or where you are staying to ensure you know where to go in case of a fire or a natural or man-made disaster.
- Secure your electronic devices when left in your room or take them with you if you are not able to secure them properly.
- If you feel your life is in danger, call 911. Be sure to speak clearly, concisely and give the dispatcher a good description of where you are physically located.

Operating or Riding in Vehicles

- When waiting for public transportation or a taxi, remain in a store or restaurant as long as possible before catching your ride and never wait by yourself in an isolated area.
- Approach your vehicle with keys firmly in your hand and ready to unlock the car.
- Quickly check your car before entering it to determine damage or presence of an intruder.
- Vulnerable times can be stopping to find your keys to enter your vehicle or stepping out of your vehicle in an isolated area. Be aware of your surroundings before you perform these activities.
- Always keep your doors locked during transit and when the vehicle is parked.
- Never leave your vehicle unlocked, even when to performing a quick task such as checking in a hotel, getting gas or going picking up food.
- If confronted by an individual inside a vehicle pointing a weapon at you, run the opposite way from where the vehicle is facing and scream as loud as you can. This evasive action will probably cause the individual to drive away.
- If an individual in a passing car points at your tires or engine to indicate a malfunction, only pull over in a well-lit and populated gas or rest stop. Never pull over in an isolated or dimly lit area. You may have a malfunction or the passing motorist may be attempting to rob you.
- Always park your vehicle is a well-lit and secure area. If your vehicle is parked in a dimly lit or isolated area in a parking garage; ask an attendant or friend to accompany you to your vehicle.

- Secure your valuables in the trunk, or place them out of sight or cover them with a blanket or coat if there is no secure storage area in the vehicle. The would-be-perpetrator likes to see what to steal and not knowing what you have concealed will normally prevent a break in.

Riding in a Taxi

- Have your host or a designated travel agent suggest or reserve a reputable taxi service for you during your stay.
- Only use a taxi service that was vetted for safety and reliability.
- If possible, place luggage, laptop and personal belongings inside the taxi.
- When you first enter the taxi, check the driver photo identification card, normally located on the driver's visor with the driver to ensure they match.

Walking

- If you experience automotive trouble, remain inside the locked vehicle and call for assistance.
- If you can't reach assistance via a mobile phone, only walk for help in a safe area facing the traffic.
- If while walking, you are shadowed or followed by a vehicle, run back in the direction of your vehicle and enter the vehicle if possible. File a police report on the incident as soon as practicable.
- Be aware of your surroundings and those around you while walking and do not be distracted by using electronic devices.
- Regularly change your route if you are walking to and from meetings or conferences and choose only well-lit areas to walk in at night.
- If walking long distances, identify a "safe house, shop, store or restaurant" to duck into if confronted by a perpetrator.

Jogging or Running

- Always jog or run in an area that is safe, secure, and used for exercising.
- Avoid running along busy roads or highways.
- If you chose to venture out on a jog or run, check the route by vehicle prior to beginning to exercise.
- Let the host or a friend know when you leave, when you plan to return, and the route you will take during exercising.
- Take a photo identification and mobile phone with you for emergencies.
- Avoid physically over-extending yourself since reflexes and decision-making ability can be impaired.

Clothing and Jewelry

- Dress to blend in with locals, maintain a low profile and avoid drawing attention to yourself.
- Travel with inexpensive clothing and jewelry.
- Avoid wearing CH2M distinctive clothing or using CH2M logos on luggage or laptops.

Emergency Numbers and Information

- Leave your itinerary and emergency contact numbers where you can be reached with family members and only those that have a need to know.
- Pre-program emergency numbers in the mobile device you are traveling with.

- Carry a list of current medications and specific doses in your purse or wallet.
- Record medical emergency information on a document that can be readily available if you are unable to speak or unconscious.
- Have a photo copy of your driver's license, passport, and credit card information separately in case your wallet or purse is stolen.

7.16 Shipping and Transportation of Hazardous Materials

(Reference CH2M SOP HSE-417, Hazardous Materials Transportation)

Chemicals brought to the site might be defined as hazardous materials or dangerous goods by the U.S DOT, Canadian Transportation of Dangerous Goods (TDG) Regulations, or other local or country norms. This can include calibration gases used in personal exposure monitoring or field instruments. Hazardous wastes that may be shipped offsite are also defined as hazardous materials by U.S. DOT, Canadian TDG. Other wastes may also be considered hazardous materials. To confirm whether a material or a waste is a hazardous material under applicable regulations, check with the Waste Coordinator, the project EM, or the CH2M Dangerous Goods Shipping Coordinator (Rob Strehlow/MKW).

All staff who affect shipment of hazardous materials, including receiving hazardous materials, preparing profiles or manifests, packaging hazardous wastes, labeling, or transporting hazardous materials by road, are called HazMat employees (note CH2M cannot transport hazardous wastes by public road). HazMat employees must receive CH2M online training in shipping dangerous goods. CH2M's online Dangerous Goods Shipping course can be found on the CH2M HSE website.

All hazardous materials that are shipped (e.g., via Federal Express) or are transported by road must be properly identified, labeled, packed, and documented by trained staff. If the material is a product that is being shipped (e.g., calibration gas), use the HazMat ShipRight tool on the CH2M virtual office (under Company Resources – Online Shipping). Contact the Dangerous Goods Shipping coordinators, the Waste Coordinator or the project EM for additional information.

It is important that employees be aware of potential transportation security concerns and regulations. In the US, 49 CFR 172 requires that all hazmat employees be aware of potential transportation security concerns. Hazardous materials security is addressed in CH2M's Hazardous Materials SOP (HSE-403). The following points are provided as an overview of security measures to increase awareness of this important matter:

- Do not to ship calibration gas back to CH2M warehouses. See the Calibration Gas Cylinder Disposal section of this Handbook;
- It is essential that each employee understand the security risks involved with transporting hazardous materials;
- All transporters of hazardous materials must be prequalified by a Contracts Administrator who evaluate the carrier's safety rating, security measures, and employee screening procedures;
- When shipping hazardous materials, check driver credentials and ask about shipping details;
- When receiving a hazardous materials shipment, inspect packages for signs of tampering or damage to the contents. Verify the drivers and company information on the form with the driver; and
- If there is suspicious or unusual behavior (e.g., driver without credentials, evasive answers) or any discrepancies identified, do not offer or accept the shipment, and immediately notify the project manager or the RHSM.

Employees responsible for shipping hazard materials must also review the CH2M Transportation Security Plan (HSE-417 Appendix A).

7.17 Substance Abuse

(Reference CH2M Policy 810, Drugfree Workplace*)*

Employees who work under the influence of controlled substances, drugs, or alcohol may prove to be dangerous or otherwise harmful to themselves, other employees, clients, the company, the company's assets and interests, or the public. CH2M does not tolerate illegal drug use, or any use of drugs, controlled substances, or alcohol that impairs an employee's work performance or behavior.

Prohibitions onsite include:

- Use or possession of intoxicating beverages while performing CH2M work;
- Abuse of prescription or nonprescription drugs;
- Use or possession of illegal drugs or drugs obtained illegally;
- Sale, purchase, or transfer of legal, illegal or illegally obtained drugs; and
- Arrival at work under the influence of legal or illegal drugs or alcohol.

Drug and/or alcohol testing is applicable under Policy 810 in the United States. In addition, employees may be required to submit to drug and/or alcohol testing as required by clients. In the US, this testing is performed in accordance with Policy 810, Drug-Free Workplace. Contact the Drug-Free Workplace administrator, Mary Beth Thomas/DEN, if testing is necessary.

Employees who are enrolled in drug or alcohol testing are required to complete annual training located on the CH2M Virtual Office (VO).

In Canada, drug and/or alcohol testing is not applicable in Ontario, but employees may be required to submit to drug and/or alcohol testing as required by clients, or in the event of specific incidents/accidents. When required, employees will be contacted by Human Resources with forms and this testing is performed in accordance with CH2M Canadian Operations Alcohol and Drug Free Workplace Policy. Employees who are enrolled in drug or alcohol testing are required to complete annual training located on the CH2M Virtual Office (VO).
When drug testing is required outside of the US and Canada, follow applicable regulations or policy.

7.18 Unknown or Suspect Objects/Materials

If unknown or suspect objects/materials are encountered (i.e., exposed or partially buried drums, biological waste, cylinders, glass containers, munitions of explosive concern, unexpected stained/discolored soil) are encountered during site operations, ongoing activities shall be immediately suspended. CH2M or subcontractor personnel encountering unknown or suspect objects or materials shall:

- Secure the area and identify the location of the object/material to the extent possible, without causing bodily injury to yourself or others and without disturbing the object.
- Evacuate the work area.
- Immediately notify the PM and RHSM of the encountered condition.
- Do not further disturb or otherwise handle the suspect object or material.

The site supervisor or SC shall contact the Project Manager and the RHSM to evaluate potential hazards associated with the specific situation encountered. The project team will then address the need for the use of special procedures, engineering controls, PPE or specialized subcontract personnel to safely mitigate the situation.

7.19 Workplace Hazardous Materials Information System

(Reference CH2M SOPs HSE-107, Hazard Communication and HSE-403, Hazardous Material Handling; in Canada, also refer to Provincial Workplace Hazardous Materials Information System (WHMIS) Regulation)

- WHMIS is the governing regulation for hazard communication in Canada. For work in the US, the governing regulation is OSHA's Hazard Communication regulation, 29 CFR 1910.1200).
- By May 2017, requirements of WHMIS 2015 must be implemented.

The hazard communication (HazCom) coordinator is to perform the following:

- Complete an inventory of chemicals brought on site by CH2M using the chemical inventory form included as an attachment to this HSP;
- Confirm that an inventory of chemicals brought on site by CH2M subcontractors is available;
- Request or confirm locations safety data sheets (SDSs) from the client, contractors, and subcontractors for chemicals to which CH2M employees potentially are exposed;
- For chemicals used by CH2M workers, before or as the chemicals arrive onsite, obtain a SDS for each hazardous chemical and include on the chemical inventory sheet (attached to this HSP) and add the SDS to the SDS attachment section of this HSP (or maintain in an accessible binder onsite). Ensure everyone knows where SDSs are kept. SDS shall be in English and French;
- Country-specific workplace-secondary container labeling systems, such as required by Canada for Workplace Hazard Materials Identification System (WHMIS), must be used. In Canada, the label must be in English and French.
- Ensure all secondary containers are labeled in compliance with WHMIS 2015 requirements;
- Give employees required chemical-specific training using the chemical-specific training form included as an attachment to this HSP and ensure that the GHS supplemental VO module has been completed (if applicable).Store all materials properly, giving consideration to compatibility, quantity limits, secondary containment, fire prevention, and environmental conditions.

The following are general guidelines for storing chemicals and other hazardous materials:

- Keep acids away from bases;
- Keep oxidizers (nitric acid, nitrates, peroxides, chlorates) and organics away from inorganic reducing agents (metals);
- Keep flammables and corrosives in appropriate storage cabinets;
- Do not store paper or other combustibles near flammables;
- Use secondary containment and lipped shelving that is secured; and
- Have a fire suppression system available.

8. Project-Specific Hazard Controls

This section provides safe work practices and control measures used to reduce or eliminate potential hazards. These practices and controls are to be implemented by the party in control of either the work or the particular hazard. Each person onsite is required to abide by the hazard controls. Always consult the appropriate CH2M SOP to ensure all requirements are implemented. CH2M employees and subcontractors must remain aware of the hazards affecting them regardless of who is responsible for controlling the hazards. CH2M employees and subcontractors who do not understand any of these provisions should contact the RHSM for clarification.

8.1 Abrasive Blasting

(Reference CH2M SOP HSE-122, *Abrasive Blasting*)

Abrasive blasting is the cleaning or preparing of a surface by forcibly propelling a stream of abrasive material against the surface using sand, glass bead, aluminum oxide, grit, garnet, steel shot, slag, walnut shells, and others. Below are the hazard controls and safe work practices to follow when overseeing or performing abrasive blasting.

- CH2M employees who work on projects with abrasive blasting operations are required to complete the CH2M 10-Hour Construction Safety Awareness training and waste management training.
- Abrasives and the surface coatings on the materials blasted are shattered and pulverized during blasting operations and the dust formed will contain particles of respirable size. The composition and toxicity of the dust from these sources shall be considered in making an evaluation of the potential health hazards. Air monitoring instruments shall be provided if the potential for a hazardous atmosphere exists.
- Personnel shall remain a safe distance from the abrasive blasting area to reduce exposure to hazardous airborne contaminants.
- Abrasive blasting equipment shall be inspected each day, before use, to ensure safe operational condition.
- Non-silica containing abrasive blasting materials must be used to the extent possible.
- Blast nozzles must be equipped with an operating valve that must be held open manually.
- Eating, drinking, and smoking shall be prohibited in areas where blasting is performed. Employees shall wash their face and hands before eating, drinking or smoking.
- Abrasive blasting debris shall be cleaned up by using dust-free methods. Wet clean-up methods and vacuum cleaners with High Efficiency Particulate Air (HEPA) filters are recommended.
- Fugitive dust must be controlled during abrasive blasting operations by using water sprays or other methods.
- Noise must be monitored and controlled as required by state, provincial, or local regulations.
- Complete the abrasive blasting self-assessment checklist when performing or when subcontractors perform this operation.

See also SOP HSE-511, *Crystalline Silica* for requirements regarding silica hazards.

8.2 Aerial Lifts

(Reference CH2M, SOP HSE-301, *Aerial Lifts*)

Below are the hazard controls and safe work practices to follow when working around or operating aerial lifts. Ensure the requirements in the referenced SOP are followed:

- Operate aerial lifts only if you are authorized and trained to do so;

- Inspect aerial lifts and test lift controls prior to use;
- Wear a full-body harness, with a lanyard attached to the boom or platform (see also SOP HSE-308, *Fall Protection*). When working within a standard guardrail system with scissors lifts, the full-body harness and lanyard are not required;
- Do not attach lanyard to any adjacent structures or equipment while working from an aerial lift;
- Stand firmly on the floor of the platform and do not sit or climb on the railings of the platform, or use planks, ladders, or other devices to increase working height;
- Remain on the platform at all times and do not leave the platform to climb to adjacent structures;
- Position aerial lifts on firm, level surfaces when possible, with the brakes set. Use wheel chocks on inclines. If outriggers are provided, position them on solid surfaces or cribbing;
- Maintain safe clearance distances between overhead power lines and any part of the aerial lift or conducting material, unless the power lines have been de-energized and grounded, or insulating barriers have been installed to prevent physical contact. Maintain at least 10 feet (3 meters) from overhead power lines for voltages of 50 kilovolts (kV) or less, and 10 feet (3 meters) plus 0.4 inches (1.0 cm) for every 1 kV over 50 kV;
- Do not exceed the boom and basket load limits;
- Do not use aerial lifts as cranes, unless specifically designed and approved by the lift manufacturer;
- Do not work or stand below aerial lift operations;
- Do not use aerial lifts when winds exceed 30 miles per hour (48 km per hour) or per manufacturers recommendations; and
- Complete the self-assessment checklist for aerial lifts whenever aerial lifts are being used.

8.3 All-Terrain Vehicles and Utility-Type Vehicle Safety

(Reference CH2M Core Standard, *Vehicle Safety)*

An all-terrain vehicle (ATV) means any recreational vehicle with three or more tires, has handlebar steering, and a seat designed to be straddled by the operator and are not intended for use on paved roads. The only type of ATV permitted for use is the Polaris Ace model which is the only model known to have rollover protection.

Utility-type vehicle (UTV) means any recreational motor vehicle other than an ATV, motorbike, or snowmobile designed for and capable of travel over designated roads, traveling on four (4) or more tires.

Motorcycles, motorbikes, or other motorized devices with two or three wheels, ATVs or quads are not allowed to be used for company related business.

Four-wheeled, cabbed vehicles and vehicles with rollover protection structures (ROPS), with seatbelts for all passengers such, as Yamaha Mules and Polaris Rangers (and similarly designed vehicles including golf carts) are allowed for use.

Doors (plastic, metal or net) supplied by the manufacturer at the time of purchase must be utilized.

Operators shall have the proper safety training and must follow all facility, and client rules for safe operation of the vehicle.

ATVs/UTVs shall not be operated on site unless determined to be the most appropriate vehicle(s) to use and their use is pre-approved by the PM and RHSM.

Operators shall be trained and qualified before operation of the ATV or UTV onsite and will possess a valid driver’s license.

ATV/UTV operators are prohibited from using any wireless device while operating ATVs/UTVs. Equipment must be stopped before using devices such as two way radios or cell phones. If a wireless device is required for a certain operation, the PM and RHSM must authorize the wireless use on a case by case basis and make sure limitations are addressed in the project safety plan.

Training shall consist of manufacturer's operating manual, hands-on training by a competent person, a demonstration of basic skills, and when required by the state or province, completion of an ATV/UTV safety course. An AHA shall also be developed for the use of ATVs/UTVs and operators shall be trained on the AHA. All individuals are required meet all training aspects before ATV/UTV use and documentation of training shall be maintained at the site.

Some states and provinces may require an ATV/UTV license or even a motorcycle endorsement on the operator's current driver's license. Be sure to contact the local division of motor vehicles (DMV) office for details. (In the United States, the following states require a specialized driver's license: Arizona, Oregon, Georgia, and Illinois. New Hampshire's and Montana's requirements vary by city. Check your state for new local requirements.)

Keep in mind that states and provinces may still:

- Impose age restrictions for operating ATVs/UTVs;
- Require an ATV/UTV safety or education course certification (even if you're older than 18);
- Require ATV/UTV insurance.

Daily inspections of vehicles for safety and maintenance are required.

Minimum PPE required for operators and passengers on ATVs/UTVs include:

- Safety glasses, goggles, or face-shield at all times when moving;
- Leather boots or shoes (if safety-toed boots are not required by the project safety plan); and
- A properly fitted DOT/ANSI/SNELL-approved helmet (check with client, local requirements, and the project safety plan for helmet requirements when operating or riding in a golf cart or UTV with roll-over protection).

Other safety requirements include:

- ATVs and UTVs shall be operated in accordance with the manufacturer's operating manual, any state, province, or client requirements, and task-specific AHA;
- Speed is not to exceed 32 km/hr (20 mph). Keep all parts of your body inside any roll over protection;
- Always use the seat belt on ATVs/UTVs;
- Make sure the engine is turned off before dismounting the vehicle;
- Avoid driving over any extremely large obstacles (i.e., wood/logs, fences, boulders, etc);
- When using trailers, watch your turning radius;
- Shut engine down prior to refueling;
- ATVs/UTVs must have fenders;
- Utilize high visibility flag and wear high visibility vest when operating adjacent to heavy equipment or haul vehicles.

8.4 Arsenic

(Reference CH2M, SOP HSE-501, *Arsenic.* In Canada, provincial occupational regulations may apply and should be implemented as required.)

Arsenic is considered a "Confirmed Human Carcinogen." CH2M is required to control employee exposure to arsenic when exposures are at or above 5.0 micrograms per cubic meter (μg/m^3), or lower if the local regulations are more stringent, or if there is the possibility of skin or eye irritation from arsenic. The elements of the CH2M arsenic program include the following:

Exposure monitoring;

- Methods of control, including PPE and respirators;
- Medical surveillance;
- Training on hazards of arsenic and control measures (includes project-specific training and the computer-based training on CH2M's Virtual Office, *Arsenic Exposure);* and
- Recordkeeping requirements.

If air monitoring indicates there is potential exposure at the action level concentrations, notify the RHSM to ensure the above have been adequately addressed. Full implementation of SOP HSE-501, Arsenic, will be required. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met;
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas;
- Avoid skin and eye contact with liquid and particulate arsenic or arsenic trichloride;
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person; and
- Review the fact sheet included as an attachment to the SOP.

8.5 Asbestos

(Reference CH2M SOP HSE-502, Asbestos; Provincial Occupational Regulations regarding Asbestos)

Asbestos is a cancer-causing mineral that was included in many building materials. When disturbed harmful asbestos fibers can be released and inhaled and ingested by workers. Materials suspected of containing asbestos shall be treated as asbestos unless documentation and testing results indicate otherwise. Where the presence of asbestos is suspected, if at all possible, design all operations to avoid contact.

When there is a risk of disturbing asbestos and making it friable (able to release fibers when the materials are crushed, abraded or cut) the activity becomes regulated. The asbestos standard for construction regulates asbestos exposure for the following activities:

- Demolishing or salvaging structures where asbestos is present in concentrations greater than 1 percent;
- Removing or encapsulating asbestos-containing materials (1 percent or greater asbestos content);
- Constructing, altering, repairing, maintaining, or renovating asbestos-containing structures or substrates;
- Installing asbestos containing products;
- Cleaning up asbestos spills/emergencies; and
- Transporting, disposing, storing, containing and housekeeping involving asbestos or asbestos containing products on a construction site.

CH2M is required to control employee exposure to asbestos when exposures are at or above 0.1 fibers per cc (f/cc) by implementing a program that meets the requirements of the applicable regulatory agency (OSHA Asbestos standard, 29 Code of Federal Regulations (CFR) 1926.1101, Canadian Provincial OH&S Code/Regulations, etc.). The elements of the CH2M asbestos program include the following:

- Exposure monitoring;
- Methods of control, including PPE and respirators;
- Medical Surveillance;
- Training on hazards of asbestos and control measures; and
- Record keeping requirements.

If air monitoring indicates there is potential exposure at the action level concentrations, notify the RHSM to ensure the above have been adequately addressed. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met;
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas;
- Avoid skin and eye contact asbestos;
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person;
- Review the fact sheet included as an attachment to the SOP; and
- Do not disturb waste or other materials labeled “Danger - Asbestos Fibers.”

Subcontractors performing asbestos abatement activities are required to obtain state or special licenses and permits and have a written compliance/abatement plan that has been reviewed and accepted by CH2M before work begins. Subcontractors are required to provide proof that all asbestos workers medically qualified, training and a competent person has been appointed before work begins.

8.6 Barbed Wire Fences

Crossing barbed wire fences shall be avoided, in general, when performing field work. Use gates or other entryways within a reasonable walking distance whenever possible and permitted by fence owner.

In some circumstances, barbed wire fences may have to be crossed during pre-construction surveys or other similar tasks through open country. CH2M and subcontractor personnel shall follow the requirements in the safety plan which may include determining whether personnel should go over or in between the strings of barbed wire fence based on height and ability (e.g., if the fence is 3-feet high or less, most personnel may prefer to go over the fence). If going over the top string of barbed wire, use a split section of foam pipe insulation to cover the barbs while crossing over the fence. Use a buddy to hold the fence down while crossing. If personnel will be going in between two strings of barbed wire, use the buddy system to perform a step-through technique to cross through the fence. Each worker will need to take turns spreading the top and middle sections of wire, so that the second person can step through the fence. PPE shall include leather gloves and foam pipe insulation to cover the barbs.

8.7 Benzene

(Reference CH2M SOP HSE-503, Benzene. In Canada, provincial occupational regulations may apply and should be implemented as required.)

Benzene is considered a “Confirmed Human Carcinogen.” CH2M is required to control employee workplace exposure to benzene when personal exposures is at or above 0.5 parts per million (ppm) as an 8-hour time-weighted average (TWA) or above 5.0 ppm short term exposure limit (STEL), by implementing a program that meets the requirements of the local regulatory agency (OSHA Benzene standard, 29 CFR 1910.1028, Provincial OH&S Code/Regulations, etc.). [Note: Alberta, British Columbia, and Ontario state a more conservative STEL of 2.5 ppm for benzene.) The elements of the CH2M benzene program include the following:

- Exposure monitoring;
- Methods of control, including personal protective equipment (PPE) and respirators;
- Medical surveillance;
- Training on hazards of benzene and control measures (includes project-specific training and the computer-based training on CH2M's Virtual Office, *Benzene);* and
- Record keeping requirements.

If air monitoring indicates there is potential exposure at the action level concentrations above, notify the RHSM to ensure the above have been adequately addressed. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met;
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas;
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person; and
- Review the fact sheet included as an attachment to the SOP.

8.8 Blasting / Explosives

(Reference CH2M SOP HSE-610, Explosives Usage and Munitions Response)

- A (safety) Opportunity Risk Evaluation (ORE) must be conducted with the Munitions Response (MR) Safety/Quality Officer prior to the Go/No Go decision making opportunity for all projects involving the use of explosives or work to be performed on a MR site.
- Only authorized, trained and qualified personnel shall handle, use and transfer explosives.
- Blasting subcontractors are responsible for providing a competent person to oversee blasting operations.
- Personnel who will be handling explosives will not wear outer or inner garments having static electricity-generating characteristics. These include clothing made of 100 percent polyester, nylon, silk, and wool, which are all highly static producing.
- Protective shoes worn by personnel performing explosives operations should be constructed of nonferrous materials (e.g., fiberglass) to prevent interference with sensitive geophysical instruments.
- Expose the minimum number of people to the minimum amount of explosives for the minimum amount of time. Project-specific explosives safety precautions shall be developed prior to field activities and must be reviewed and approved by the MR Safety/Quality Officer and the MR Operations Manager.
- Details of explosives management and safety requirements are developed and included in a site-specific Explosives Management Plan (EMP).
- Security of explosives shall conform to the requirements set forth by federal, state, provincial, and local jurisdictions. Project site and overnight explosives security will conform to any local transportation security requirements.
- In Canada, **Type-20 Manufacturer of High Explosives License/Permit** issued by the country ATF&E is required to purchase, store, and use high explosives including on-site use of binary explosives in support of MR operations, construction projects, and demolition and deactivation (D&D) projects.

- State, Provincial and/or local explosives permits may be required for CH2M and individuals to purchase, store, and use explosives in support of MR operations, CDC operations, construction projects, and D&D projects. In addition there may be local requirements.

8.9 Boating Safety

Personnel who will operate a boat during the course of a project shall first demonstrate to the site manager that they are experienced in operating boats similar to those used for the project and that they are knowledgeable of local boating safety requirements (e.g., the National Coast Guard, Canadian Coast Guard, etc.). Project boats shall be operated by experienced boat operators in possession of a current operator's license only. Boat operators shall also possess basic mechanical knowledge necessary to troubleshoot common mechanical problems that can and do occur. The boat operator shall be responsible for the safety of all personnel on board the boat he or she is operating and for the integrity of all boat and safety equipment.

Each designated boat operator shall give a safety briefing to all occupants of the boat prior to leaving the shore. Boats are to be occupied during use by not less than one qualified operator plus one additional person.

The boat captain has the final authority with regard to boat safety and navigational safety.

Boat Requirements

All project boats will meet or exceed US, Canada, or local Coast Guard requirements for safety equipment, as applicable to the operation and type of boat. These requirements are summarized below for small craft (less than forty feet [12 meters] in length).

Flame Arresters

All gasoline engines, except outboard motors, installed in a boat must have an approved flame arrestor (backfire preventer) fitted to the carburetor.

Sound Signaling Devices

Boats shall carry at least one air horn or similar sound-signaling device. Radio or cell-phone communication must be in place as well.

Personal Flotation Devices

All personnel and passengers shall wear an approved personal flotation device (PFD) at all times when operating or being transported in a boat. A positively buoyant wet suit or dry suit may be substituted for a PFD. PFDs shall be Type II or higher (capable of turning its wearer in a vertical or slightly backward position in the water). In addition, each boat shall be equipped with at least one Type IV PFD, designed to be thrown to a person in the water and grasped and held by the user until rescued. A buoyant boat cushion equipped with straps and a float ring are two common examples of a Type IV PFD.

Fire Extinguishers

Each boat shall carry at least one Type B-I or B-II fire extinguisher (for use in gasoline, oil and grease fires) approved by Underwriters Laboratories (UL). Each fire extinguisher shall be inspected to ensure that it is sufficiently charged and that the nozzles are free and clear. Discharged fire extinguishers shall be replaced or recharged immediately.

Emergency Planning

As part of the project HSP and AHAs, emergencies and response actions must be addressed for potential emergencies such at fire, sinking, flooding, severe weather, man over-board, hazardous material incidents, etc.

Load Capacity

Boats shall not be loaded (passengers and gear) beyond the weight capacity printed on the Coast Guard information plate attached to the stern. In addition, several factors must be considered when loading a boat: distribute the load evenly, keep the load low, do not stand up in a small boat or canoe, and do not overload the boat.

Tool Kit

All motorized boats shall carry a tool kit sufficient for the boat operator to troubleshoot common mechanical problems such as fouled spark plugs, flooded carburetor, electrical shorts, etc. Boats operated in remote areas shall also carry appropriate spare parts (propellers, shear pins, patch kits, air pumps, etc). The tool kit shall be maintained by the boat operator and supplies used up shall be replaced immediately.

Communications

All boats operated shall carry a two-way radio or cellular telephone that enables communication back to the field camp or other pre-established location.

Good Housekeeping

Personnel using a boat shall properly stow and secure all gear and equipment against unexpected shifts when underway. Decks and open spaces must be kept clear and free from clutter and trash to minimize slip, trip, and fall hazards.

Fuel Management

Personnel shall utilize the "one-third rule" in boating fuel management. Use one-third of the fuel to get to the destination, one-third to return, and keep one-third in reserve.

No smoking is permitted on board vessels or during refueling operations.

Pollution Control

The Clean Water Act prohibits the discharge of oil, hazardous substances, or other materials or wastes in quantities that may be harmful into Canadian navigable waters. No person may intentionally drain oil or oily wastes from any source into the bilge of any vessel. Larger vessels equipped with toilet facilities must be equipped with a Canadian Coast Guard-approved marine sanitation device.

Employees shall report any significant oil spills to water to the SC and/or supervisor and the RHSM. The procedure for incident reporting and investigation shall be followed when reporting the spill.

Training

All operators and passengers shall be trained on the requirements outlined above, as well as trained on the HSP/AHA(s), including emergency response actions.

8.10 Cadmium

(Reference CH2M SOP HSE-504, *Cadmium.* In Canada, provincial occupational regulations may apply and should be implemented as required.)

Cadmium is considered a “Suspected Human Carcinogen.” CH2M is required to control employee workplace exposure to cadmium when personal exposure is at or above 2.5 micrograms per cubic meter ($\mu g/m^3$) by implementing a program that meets the requirements of the OSHA Cadmium standard, 29 *Code of Federal Regulations* (CFR) 1926.1127, the Provincial OH&A Code/Regulation, or other (more stringent) local regulation. The elements of the CH2M cadmium program include the following:

- Exposure monitoring;
- Methods of control, including PPE and respirators;
- Medical surveillance;
- Training on hazards of cadmium and control measures (includes project-specific training and the computer-based training on CH2M’s Virtual Office, *Cadmium);* and
- Recordkeeping requirements.

If air monitoring indicates there is potential exposure at the action level concentrations above, notify the RHSM to ensure the above have been adequately addressed. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met;
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas;
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person; and
- Review the fact sheet included as an attachment to the SOP.

8.11 Chainsaws

(Reference CH2M SOP HSE-210, *Hand and Power Tools*)

Below are the hazard controls and safe work practices to follow when working around or operating chainsaws. Ensure the requirements in the referenced SOP are followed.

8.11.1 Equipment

Only chainsaws equipped with a spark arrestor and fully functioning chain brake or “safety chain” shall be used. The following safety equipment shall be readily available while operating a chainsaw:

- Chainsaw operator’s manual;
- Fully stocked first aid kit;
- Multipurpose fire extinguisher;
- Grounded extension cord approved for outdoor use and ground fault circuit interrupter (GFCI) for electrical-powered chainsaws;
- Approved safety gasoline container and funnel or flexible nozzle for refueling gasoline-powered chainsaws; and
- Sledge hammer and non-metallic wedges when necessary to prevent pinching of the chain.

8.11.2 PPE Requirements

The following personal protective equipment shall be worn while operating chainsaws:

- Safety glasses with side shields and face shield to prevent injury from wood chips, sawdust, or other flying objects;
- Hard hat with properly fitted suspension to prevent head injury from falling debris;
- Steel-toed safety shoes or boots to prevent foot injury from falling objects and accidental contact with the moving chain;

- Hearing protection to prevent permanent damage to hearing. Ear muffs or plugs will have a decibel noise reduction rating (NRR) assigned to them. The higher the rating, the greater the protection offered;
- Non-leather, fabric work gloves to prevent hand injury from abrasions, splinters and cuts;
- Clothing that is well-fitted and free of loose edges that could become entangled in the saw; and
- Protective chaps or leggings that cover the area from the groin to about 2 inches (5.08 cm) above the ankles should be used. These chaps are made from synthetic fabrics that are designed to prevent the running saw chain from coming in contact with your legs.

8.11.3 Safe Operation

The following safe operation guidelines shall be followed regardless of the purpose for using a chainsaw:

- Inspect the chainsaw prior to use;
- Chainsaws shall be held firmly with both hands, with thumbs and fingers encircling both chain saw handles;
- Stand slightly to the left side of the saw, out of the plane of the cutting chain and guide bar to reduce the risk of injury in the event of a kickback;
- Position saw so that it is between the waist and mid-chest level. Overreaching or cutting above the mid-chest height shall be avoided;
- Maintain a full throttle setting while cutting. Chainsaws are designed to be run at full speed;
- Always be aware of what is in the saw’s downward path after the cut;
- Do not attempt to cut material that is larger than the guide bar of the saw;
- Avoid cuts that will cause the chainsaw to jam. Always cut into the compression wood first until the cut starts to close; then cut from the other side toward the compression cut;
- Use a non-metallic wedge to prevent the compression cut jamming on the blade;
- Chainsaws are designed to feed themselves into the wood and require only light pressure to cut efficiently. If extra force is required to keep cutting, the chain requires sharpening. Additional signs of a dull chain include a saw that is cutting crooked, results in fine sawdust instead of chips, or the smell of burnt wood. Do not use a dull chain;
- Bystanders and helpers shall be kept at a safe distance from operation;
- Do not operate a chainsaw when fatigued; take frequent breaks;
- Work slowly; don’t rush; and
- A fire extinguisher shall be present at all times when operating the chainsaw in forest or brushy areas.

8.11.4 Refueling the Engine

The fuel for gasoline-powered chainsaws shall be mixed in accordance with the manufacturer’s recommendations as outlined in the chainsaw operator’s manual. Fuel shall be stored and transported in an approved safety container. The following precautions should also be followed:

- The engine shall be shut off and allowed to cool before refueling; never refuel a hot engine;
- A fire extinguisher shall be present during fueling and refueling;
- Smoking around fueling or refueling operations shall be prohibited; and
- A funnel or a flexible nozzle shall be used to avoid spilling fuel on the engine.

8.12 Chemical Injections

When the remedial action objectives for a project include subsurface injection of chemicals, the procedures and handling practices identified below must be implemented.

Pre-Injection

Review the Safety Data Sheets (SDSs) for the materials which are expected to be utilized in the chemical injection processes for this contract task order and:

- Document training in accordance with the Hazard Communication section of this Handbook.
- Ensure that appropriate spill response materials are present (e.g., absorbent media for oil, neutralizing agents for potassium permanganate, secondary containment for larger chemical tanks).

Evaluate potential for “daylighting” of chemical injection in the work area:

- Evaluation should identify known or potential pathways such as existing monitoring wells screened at the same depth interval as the planned injection, wells that were not properly abandoned, and utility corridors.
- Identify potential surface release areas such as nearby sensitive areas (e.g., wetlands) storm drains, ditches, or streams, and ensure that mitigation measures are in place (e.g., temporarily blocking storm sewer drains).
- Contact the project Environmental Manager for assistance in identifying release scenarios and mitigation measures.

Injection Operations

- Operate and maintain pressure vessels, pumps and hosing in accordance with the manufacturer’s recommendations.
- Do not exceed the rated pressure of the vessels and associated piping or hoses of the system.
- The system must be provided with a pressure relief valve/controller that safely reduces the system pressure to within the system rated pressure.
- The pressure relief valve must be rated at no more than 110 percent the rated pressure of the system and must be tested at regular intervals.
- Each vessel must be equipped with a functioning pressure gauge to monitor pressure.
- For PPE and air monitoring requirements, refer to the PPE section and Site Monitoring section of the project safety plan. PPE shall be used to minimize potential exposure to identified site contaminants of concern and injection solutions during site injection operations. In addition, good personal hygiene practices and procedures must be practiced.
- Use face shields in combination with safety glasses or goggles when the potential for exposure to chemical splashes may exist.
- If repairs to injection delivery system components are necessary after the subsurface injection operations have been initiated, the injection lines must be relieved of pressure and drained before conducting repair work. See also the Lockout/Tagout section of this Handbook.
- Drums/containers of injection material shall be moved using a drum “dolly” or other appropriate material handling equipment where the weight of the drum can be properly managed and secured during the movement.
- Empty containers may require special preparation/rinsing prior to disposal. Verify requirements with the project EM.

- Only qualified personnel, by prior training or experience, may operate the injection system delivery components/array(s).
- Appropriate spill response materials for all chemicals must be present at the job site. Only qualified (by training and previous experience) who have proper PPE and equipment available shall provide spill response operations.
- Station a portable eye wash in the immediate work area where chemical injections are occurring, along with wash facilities for hygienic practices and PPE decontamination.
- If PPE becomes saturated and may potentially impact work clothing, dermal surfaces, or mucous membranes, change PPE immediately.
- Verify the competency and integrity of the chemical injection hoses/piping and connection points
- Confirm hose/piping rated for 100 psi.
- Verify the any cam-lock fitting on the injection hose/piping, well head, or direct push technology (DPT) rods are structurally sound and free of defects. Where hoses are used, ensure fittings have been secured to the hose surface via mechanical banding equipment to prevent whipping.
- When injecting under pressure, stand at a sufficient distance (i.e., ~ 20 feet) from the injection well head/point. Keep unessential project personnel away from the injection system, array, and well head(s) during injection operations.
- Remove/stow all unnecessary equipment and material in the area.
- The injection system/array must be monitored/attended at all times during the injection process and when not in use, components must be properly secured, de-energized, or stowed. If the system will operate without an attendant, plans for operating unattended must be in place an approved by the PM an RHSM/EM.
- All pressured lines and fittings should be ‘tethered’ or otherwise secured to minimize whipping or ‘launching’ of lines in the event of an equipment failure. Any “quick connect” type fittings (compressed air or fluid) should be secured with appropriate pins, clips to prevent accidental disengagement of the fitting during operation.
- Inspect all equipment, hoses, pressure lines, and fittings daily and prior to pressurizing.

Chemical Storage

- Some injection chemicals, such as strong oxidizers, may have stringent storage requirements per local or National Fire Codes. Verify that appropriate storage provisions are in place prior to starting work.
- NOTE: Counties and cities may have requirements specific to storing these chemicals. Also, storage and use of certain chemicals such as potassium permanganate and hydrogen peroxide may be subject to the new Chemical Facility Anti-Terrorism Standards of the Department of Homeland Security – the applicability depends on the chemical, quantity/concentration, and type of facility. Please contact the project Environmental Manager to determine whether chemicals are subject to these standards.
- Chemicals must be stored in a designated, secured area with spill prevention capabilities. Review SDS or other information to determine potential incompatible materials. Incompatible materials shall not be stored together. Ensure all containers are labeled.

Substrates That Create Reducing Conditions to Facilitate Bioremediation

Materials such as Emulsified vegetable oil (EVO) or emulsified oil substrate (EOS), lactate, and cheese whey are commonly used as the electron donors or “fuel” during enhanced reductive dechlorination (ERD) treatment. ERD can be an effective method for degrading various chlorinated solvents dissolved in groundwater.

Addition of these "electron donors" can also cause changes that need to be recognized and monitored, such as production of gases such as methane and hydrogen sulfide, and increases in carcinogenic byproducts, such as vinyl chloride, in groundwater or in the vadose zone. These gases or byproducts are not yet formed during the injection work, but are observed weeks following the injections as the biological process take place. These hazards must be considered during subsequent groundwater sampling activities. The air monitoring protocol and action levels, as well as required PPE, are discussed in later sections of this HSP.

Although EVO is food-grade material, SDSs for the material must be kept onsite, as well as added to the chemical inventory, and specific training on hazards conducted and documented in the Attachments in this HSP.

The Clean Water Act requires a Spill Prevention, Control, and Countermeasures (SPCC) Plan for storage of more than 1320 gallons of oil (including EVO and EOS) in ≥55 gallon aboveground containers. Additionally, spill kits/materials capable of stopping the spread of a leak/spill must be available and accessible. Involve your Environmental Manager for assistance to determine whether a plan is required, to prepare an SPCC Plan, or to plan for spill control if EVO or other oils will be used around a body of water.

The following hazards must be acknowledged and addressed in the injection AHA or AHA/EIA:

- Slips/falls resulting from spilled EVO/EOS
- Slips/trips/falls from hoses transporting EVO/EOS and water
- Pressure in the injection lines (<20 psi)
- Potential for oil to spray on face/body if there's a breach or leak (refer to bullets above for mitigation measures)
- Hazards associated with the mixing and injection process such as electrical hazards associated with the pump, hand contact hazards during the mixing process, spills, etc.
- Other hazards applicable to the injection process.

Potassium Permanganate

- This in situ treatment technology uses potassium permanganate ($KMnO_4$) to destroy [insert COCs, i.e., DNAPL] through an oxidative reaction. The $KMnO_4$ reacts with the carbon-carbon double bonds found in chloroethenes to produce primarily carbon dioxide, chloride ions, and manganese dioxide as byproducts.
- Potassium permanganate ($KMnO_4$) is considered to be an irritant to the respiratory system affecting the nose, throat, and the lungs. Engineering controls should be employed to minimize dust generation during use (pouring). The best protection is to enclose the operation or to provide local exhaust ventilation at the site of dust generation. $KMnO_4$ also is a skin irritant and can severely burn the eyes and skin. Caution should be used to prevent the generation of dust which can contact the eyes or skin. It should be mixed with water before use. Aqueous solutions of $KMnO_4$ are much less dangerous, especially when diluted.
- Solid $KMnO_4$ is a very strong oxidizer. Keep in a tightly closed, labeled container, in a cool, dry, ventilated area. Protect against physical damage and moisture. Isolate from any source of heat or ignition. Avoid storage on wood floors. Separate from incompatibles, combustibles, organic or other readily oxidizable materials. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.
- Potassium permanganate stains the hand and clothing and should be handled with care. It causes corrosive burns on the skin, and swallowing it may lead to gastroenteritis.
- When handling, wear chemical splash-type goggles, impervious clothing, such as Polycoated-tyvek, rubber or nitrile gloves and rubber or neoprene gloves and shoe covers. Should clothing become contaminated, it should be immediately decontaminated or removed to prevent injury.

- Respiratory protection should be worn during pouring if dust cannot be controlled; follow the action levels in the Site Monitoring section of this HSP. Strict adherence to dust control measures and monitoring must be performed during the execution of this task.

Hydrogen Peroxide

- Hydrogen peroxide is an oxidizer and will release oxygen when decomposed adding to combustion. It can be corrosive to eyes, nose, throat, lungs and gastrointestinal tract.
- When handling hydrogen peroxide, wear chemical splash-type goggles and full-face shield, impervious clothing, such as Polycoated-Tyvek, rubber or nitrile gloves and rubber or neoprene gloves and shoe covers (avoid cotton, wool and leather).
- Avoid excessive heat and contamination (meaning other material getting in the container). Contamination may cause decomposition and generation of oxygen gas which could result in high pressures and possible container rupture. Hydrogen peroxide should be stored only in vented containers and transferred only in a prescribed manner (refer to the SDS). Never return unused hydrogen peroxide to original container, empty drums should be triple rinsed with water before discarding. Utensils used for handling hydrogen peroxide should only be made of glass, stainless steel, aluminum or plastic.
- Store drums in cool areas away from direct sunlight and incompatible materials such as reducing agents, wood, paper and other combustibles, iron and other heavy metals, copper alloys and caustic. Provide mechanical general and/or local exhaust ventilation to prevent release of vapor or mist into the work environment.

Sodium Permanganate

- Sodium Permanganate ($NaMnO4$) is considered to be an irritant to the respiratory system affecting the nose, throat, and the lungs. Since solution is in a liquid form, all spraying, misting, and splashing should be minimized. If used, this liquid form should alleviate the potential for dust exposure which can occur during the mixing of the potassium permanganate described above.
- Engineering controls should be implemented to prevent or minimize the potential for spraying, misting, or splashing. In addition to wearing appropriate PPE (see below), an emergency eye wash/shower facilities shall be provided in the immediate area.
- Should clothing become contaminated, it should be immediately decontaminated or removed to prevent injury. While handling, the following PPE should be worn: Face shield & chemical goggles, coveralls, rubber protective gloves (shoulder length), and a rubber apron.

Hydrogen Release Compound (HRC)

- HRC is a controlled release, electron donor material, that when hydrated is specifically designed to produce a controlled release of lactic acid. The lactic acid is critical for the production of hydrogen to fuel anaerobic biodegradation processes in soil and groundwater.
- Refer to the SDS for HRC for specific handling and storage protocol.
- HRC is considered to be a skin irritant. Should clothing become contaminated, it should be immediately decontaminated or removed to prevent injury.
- HRC is a skin irritant and can burn the eyes and skin. Caution should be used to prevent the generation of misting, spraying, or splashing. While handling, the following PPE should be worn: Face shield & safety glasses, rubber protective gloves (shoulder length) along with a rubber apron.
- Spills of HRC should be cleaned up immediately to prevent slips and falls. Adequate spill containment and clean-up material must be provided in areas of chemical use. Dry absorbent material must be maintained on hand and ready to be immediately employed should a spill occur.

8.13 Compressed Gas Cylinders

(Reference CH2M SOP HSE-403, *Hazardous Materials Handling*)

8.13.1 General

Below are the hazard controls and safe work practices to follow when working around or using compressed gas cylinders. Ensure the requirements in the referenced SOP are followed.

- Cylinders and pressure-controlling apparatus shall be inspected for defects and leakage prior to use. Damaged or defective items shall not be used. If a cylinder is found to be defective, the gas distributor shall be notified and subsequent instructions followed. If a leak should develop at a fuse plug or other safety device, the cylinder shall be removed from the work area.
- Cylinders shall be labeled with the identity of the contents. Cylinders not labeled shall be sent back to the cylinder distributor. The color of the cylinder shall not be used exclusively to identify cylinder contents.
- Valve caps must be in place when cylinders are transported, moved, or stored.
- Cylinders must be secured in an upright position at all times.
- Cylinder valves must be closed when cylinders are not being used and when cylinders are being moved.
- Cylinders must be secured on a cradle, basket, or pallet when hoisted; they may not be hoisted by choker slings.
- Eye protection (safety glasses or goggles) shall be worn when using cylinders.
- Cylinders must be shielded from welding and cutting operations and positioned to avoid being struck or knocked over; contacting electrical circuits; or exposed to extreme heat sources.
- Cylinders inside buildings shall be stored in dry, well-ventilated locations at least 20 feet (6.1 meters) from highly combustible materials. Cylinders should be stored in definitely assigned places away from elevators, stairs, or gangways. Assigned storage areas shall be located where cylinders will not be knocked over or damaged.
- Oxygen cylinders in storage shall be separated from fuel gas cylinders or combustible materials by a minimum of 20 feet (6.1 meters) or by a noncombustible barrier at least 5 feet (1.5 meters) high, having a fire resistance rating of at least 0.5 hour.
- Signs indicating no smoking shall be provided for storage areas containing flammable gas cylinders.
- Complete the self-assessment checklist for compressed gas cylinders are being used.

8.13.2 Calibration Gas Cylinder Disposal

Calibration gas for field instruments is usually shipped in non-refillable DOT-39 specification cylinders. They can be identified by a code stamped into the cylinder that begins with "DOT-39, NRC" followed by a series of other numbers and letters. These cylinders cannot be refilled and are intended to be disposed of by the end user once the contents are consumed. Because of the high cost of shipping partially full cylinders to a CH2M warehouse, equipment rental company, or the manufacturer, most calibration gas cylinders should be disposed of locally using this procedure.

Applicability

This procedure applies only to non-refillable DOT-39 specification cylinders containing calibration gas that is classified by DOT as a Division 2.2 nonflammable gas. The cylinder will display the green nonflammable gas label. Calibration gas usually contains parts per million (ppm)-range concentrations of compounds such as isobutylene, hexane, or methane. This procedure does not apply to Division 2.1 flammable gasses, Division 2.3 poison gasses, corrosive gasses, or oxidizing gasses. It also does not apply to gasses contained in larger refillable DOT-specification cylinders.

Disposal Procedure

1. Review the cylinder labeling and material safety data sheet (SDS) to verify that the material in question is calibration gas containing ppm-range concentrations of materials such as isobutylene, hexane, or methane, and that the gas is classified as a Division 2.2 nonflammable gas. If the material is a flammable gas (Division 2.1), poison gas (Division 2.3) corrosive gas, oxidizing gas, or contains toxic air contaminants such as trichloroethylene, DO NOT FOLLOW THIS PROCEDURE. Contact a dangerous goods advisor or the project EM for assistance.
2. Attach the appropriate regulator or valve to the cylinder, open the valve, and allow the gas to vent slowly to the atmosphere in an unconfined, well ventilated area outdoors.
3. If a regulator is not available, depress the valve with a non-sparking tool (e.g., pencil, stick). Be sure that the cylinder is pointed away from you at all times. The valve operates the same way as the valve on a car or bicycle tire.
4. Wear leather work gloves and keep your hands away from the flow of gas.
5. Leave the valve open until all gas is discharged from the cylinder.
6. If the cylinder has a permanently attached valve, leave it open. If a removable regulator or valve was used, remove it from the cylinder.
7. Mark the cylinder as “EMPTY” or “MT.”
8. Recycle the empty cylinder as scrap metal or dispose as solid waste after verifying that the solid waste collection company will accept this material in the trash.
9. If required to puncture the empty cylinder before disposal or recycling, do not attempt to do so using hand tools such as a hammer and nail or punch. Contact a dangerous goods advisor, the project EM, or health and safety manager for assistance.

8.14 Concrete Work and Masonry Construction Activities (Including well pad construction)

(Reference CH2M SOP HSE-302, *Concrete and Masonry*)

Below are the hazard controls and safe work practices to follow when working around or performing concrete and masonry activities. Ensure the requirements in the referenced SOP are followed.

- Wear PPE to avoid contact with concrete including gloves, mud boots, hard hat, safety glasses, long sleeved shirt and long pants.
- Consult the glove supplier or the cement manufacturer’s SDS for help in choosing the proper gloves. Butyl or nitrile gloves (rather than cotton or leather gloves) are frequently recommended for caustic materials such as Portland cement.
- Use only well-fitting gloves. Loose-fitting gloves let cement in. Often the use of gloves and clothing makes exposure worse when cement gets inside or soaks through the garment. Use glove liners for added comfort.
- Wash your hands before putting on gloves. Wash your hands every time that you remove your gloves.
- Dry your hands with a clean cloth or paper towel before putting on gloves.
- Protect your arms and hands by wearing a long sleeve shirt with the sleeves duct-taped to your gloves to prevent wet cement from getting inside the gloves.

- Follow proper procedures for removing gloves, whether reusing or disposing them.
- Clean reusable gloves after use. Before removing gloves, clean the outside by rinsing or wiping off any wet cement. Follow the manufacturer's instructions for glove cleaning. Place clean and dry gloves in a plastic storage bag and store them in a cool, dry place away from tools.
- Throw out grossly contaminated or worn-out gloves.
- Keep the inside of gloves clean and dry.
- Wear waterproof boots when necessary to prevent wet cement from coming into contact with your skin. It is as important to protect your legs, ankles, and feet from skin contact with wet cement as it is to protect your hands.
- Boots need to be high enough to prevent wet cement from getting inside. Tuck pants inside and wrap duct tape around the top of the boots to prevent wet cement from entering.
- Change protective boots if they become ineffective or contaminated on the inside with wet cement while in use.
- Change out of any work clothes that become contaminated with wet cement and keep contaminated work clothes separate from your street clothes.
- When kneeling on wet cement use waterproof kneepads or dry kneeboards to prevent the knees from coming into contact with the cement.
- Wear proper eye protection when working with Portland cement.
- Perform hazard communication training for concrete. Read SDSs heed the manufacturers' recommendations for safety precautions.
- Protruding reinforcing steel (rebar), onto which personnel could fall, must be guarded to eliminate the hazard of impalement
- During post-tensioning, only those personnel essential to the operation are permitted behind the tensioning jacks.
- Personnel shall not ride concrete buckets nor position themselves in areas where buckets are lifted overhead.
- Personnel shall maintain a safe distance from formwork and shoring being removed from concrete structures.
- Personnel shall maintain a safe distance from precast and lift-slab concrete being lifted into position until physically secured.
- Personnel shall not enter limited access zones during masonry wall construction.
- When CH2M is in control of concrete and masonry operations, a lift slab competent person will oversee all the concrete and masonry operations.
- See also SOP HSE-511, Crystalline Silica.
- Complete the self-assessment checklist for concrete and masonry activities whenever those activities are being performed.

8.15 Concrete Core Drilling

(Reference CH2M SOP HSE-204, *Drilling*)

Below are the hazard controls and safe work practices to follow when working around or performing concrete core drilling.

- Operators must read and understand the Operators Manual(s) for the equipment that will be used.
- Follow all manufacturers' operating instructions and comply with all warning labels on the equipment.
- Inspect equipment to ensure it is in proper operating condition prior to use. Equipment damage or missing parts must be corrected prior to operation.
- Follow all requirements for use of PPE. Minimum PPE includes hearing protection, safety glasses with side shields, safety toed boots. A face shield over safety glasses or liquid splash goggles may be required for wet coring.
- Inspect areas to be cored to ensure there are no obstructions, for example utilities on the opposite side of a wall to be cored through. Follow utility locate procedures for when coring slab on grade.
- Provide dust control (wet coring or local exhaust for dry coring) to avoid potential silica exposure.
- Make sure that all electrical wiring is grounded.
- The power supply line (electric cord, pneumatic or hydraulic line) must be protected from damage and routed to prevent it becoming a tripping hazard.
- When hydraulic coring equipment is uses, all workers must be aware of hydraulic lines running to the coring equipment. Preparations must be made for containment/clean up in the event of a ruptured hydraulic line.
- All workers must keep their hands and body away from the cutting saw/cable.
- The power supply must be disconnected when changing bits or conducting other maintenance on the equipment.
- Slippery conditions may exist in wet coring operations. Water needs to be controlled during cutting and proper safety toed footwear used to minimize slip potential.
- The dust created by the concrete coring needs to be controlled using the application of water or local exhaust ventilation (i.e., removing dust at the source) to reduce the amount of airborne dust generated. Contact the RHSM to determine if air monitoring/respiratory protection will be necessary. See also SOP HSE-511, *Crystalline Silica.*
- Use the Drilling Self-Assessment checklist to evaluate coring operations.

8.16 Concrete Saw Cutting

- Ensure operators are trained and familiar with the equipment are operating the saw. Operators must read and understand the Operators Manual(s) for the equipment that will be used.
- Inspect equipment to ensure it is in proper operating condition prior to use. Equipment damage or missing parts must be corrected prior to operation.
- Cutting blades shall be the correct size, installed properly, guarded at all times, and speed should not exceed the manufacturer's suggested operating speed.
- Workers shall use the correct blade for the job and inspect it for defects before each use.

- Saws shall be maintained and kept clean from dust build-up. Workers shall not push against the saw during operation to avoid the blade jumping out of the cutting path and loss of operator control.
- Inspect areas to be sawed to ensure there are no obstructions, for example rocks or other debris. Follow utility locate procedures prior to cutting.
- Personal protective equipment (PPE) saw use shall include hard hats, safety-toed boots, safety glasses and face shields, hearing protection, and leather gloves.
- The dust created by the concrete saw needs to be controlled using the application of water or local exhaust ventilation (i.e., removes dust at the source) to reduce the amount of airborne dust generated. Contact the RHSM to determine if air monitoring/respiratory protection will be necessary. See also SOP HSE-511, *Crystalline Silica.*
- If equipped, the power supply line (electric cord, pneumatic or hydraulic line) must be protected from damage and routed to prevent it becoming a tripping hazard. The power supply must be disconnected when changing blades or conducting other maintenance on the equipment.
- Ensure all utilities have been marked and located in accordance with the underground utilities section of this Handbook.
- Slippery conditions may exist in wet cutting operations. Water needs to be controlled during cutting and proper safety toed footwear used to minimize slip potential.

8.17 Confined Space Entry Activities

(Reference CH2M, SOP HSE-203, Permit Required Confined Space Entry)

OSHA and CH2M define a confined space as a space that has all of the following characteristics:

- Large enough to allow personnel to enter the space with their entire body;
- Limited openings for entry and exit; and
- Not designed for continuous human occupancy;

Examples of possible confined spaces include underground vaults, pipelines, ducts, tunnels, storage tanks, sewers, process vessels, and pits. Entry into a confined space is defined as breaking the plane of a confined space with any part of the body.

A Permit-required Confined Space (PRCS) is defined as a confined space that has one or more of the following characteristics:

- Contains or has the potential to contain a hazardous atmosphere
- Contains a material that has the potential for engulfing an entrant
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross-section, or
- Contains any other recognized serious safety or health hazard

In Canada, some individual Provinces have different definitions of confined spaces; refer to the specific Canadian Provincial code.

The following requirements apply when entering a permit-required confined space (PRCS), an Alternate Procedure Confined Space, or a PRCS reclassified as a non-permit confined space (NCS). Ensure the requirements in the referenced SOP are followed.

- Entrants, Attendants, and the Entry Supervisor shall have successfully completed Confined Space Entry training.

- The appropriate confined space entry permit shall be completed as outlined in CH2M SOP HSE-203, *Confined Space Entry*.
- The completed permit or certificate shall be posted for review near the space entrance point.
- The Entry Supervisor shall conduct a pre-entry briefing with all Authorized Entrants and Attendants prior to entry in accordance with SOP HSE-203.
- Entrants and Attendants shall verify that the Entry Supervisor has authorized entry and that all requirements of the permit or certificate have been satisfied prior to each entry.
- Atmospheric monitoring for oxygen, combustible gases, and potential toxic air contaminants shall be conducted at the frequency provided on the permit or certificate. Entry shall not be permitted if an atmospheric hazard is detected above acceptable safe levels. Atmospheric monitoring shall be performed in accordance with the Site Monitoring Section of the project safety plan and SOP HSE-203.
- Entrants shall evacuate the space upon orders of the Attendant or Entry Supervisor, when an alarm is sounded, or when a prohibited condition or dangerous situation is recognized.
- Entrants and Attendants shall inform the Entry Supervisor of any hazards confronted or created in the space, or any problems encountered during entry. The Entry Supervisor shall inform the owner of such issues.
- The Entry Supervisor shall provide a copy of the canceled permit or certificate to the SC for review and maintain it in the project file.
- Complete the self-assessment checklist for confined space entry whenever entries are being performed.

8.18 Cranes

(Reference CH2M SOP HSE-303, *Cranes*)

Below are the hazard controls and safe work practices to follow when working around or operating cranes. Ensure the requirements in the referenced SOP are followed.

- Crane operators are prohibited from using any wireless device while operating a crane. Equipment must be stopped before using devices such as two way radios or cell phones. If a wireless device is required for a certain operation, the PM and RHSM must authorize the wireless use on a case by case basis and make sure limitations are addressed in the project safety plan.
- Cranes shall be operated by a certified crane operator. After November 10, 2014, only operators possessing a certificate from a nationally accredited testing organization, an audited employer training program, or U.S. military, or state- or provincial-issuing agency will be authorized to operate cranes.
- The crane's operations manual and load chart specifically designed for the crane shall be in the crane at all times.
- The crane must have a current annual inspection to include load test certification (within the last 12 months) that meets all state and provincial and federal safety standards. Documentation of this inspection must be available for review.
- A competent person will inspect the crane daily to ensure it is in safe operating condition. The daily crane inspection log provided within the crane manufacturer's operations manual shall be used. See also the requirements for monthly inspections, among others, in SOP HSE-303.
- All rigging equipment must be inspected by a competent person prior to use for signs of excessive wear; equipment found to be damaged will be tagged and removed from service.

- A qualified and competent Assembly/Disassembly (A/D) Director shall be assigned when cranes must be assembled onsite. The A/D Director is responsible for ensuring the crane is assembled and disassembled according to manufacturer requirements; performing training for the A/D crew; and ensuring sufficient ground conditions exist for crane placement; among other responsibilities (see SOP HSE-303).
- The assembly/disassembly process must comply with requirements in HSE-303, including having an AHA for the task.
- A critical lift plan shall be prepared when the lift is estimated to be greater than 75 percent of the crane capacity or when two cranes will be used to make a lift.
- A pre-lift meeting will be conducted to include all parties involved in that day's crane operation.
- Only one qualified person shall be designated to signal the crane operator. This person shall be thoroughly familiar with the ANSI standard method of hand signals and an illustration of these signals shall be posted at the job site.
- No personnel shall be permitted under the load at any time.
- Tag lines shall be attached to every load being made by the crane.
- The swing radius of the rear rotating superstructure (counterweight) of the crane shall be barricaded and no entrance allowed.
- Suspended loads shall not pass over workers or occupied buildings at any time.
- Complete the self-assessment checklist for crane-suspended personnel platforms whenever they are being used.
- CH2M employees exposed to hazards posed by crane operations, must be trained in hazards awareness and control procedures. See requirements for training in HSE-303.

Power Line Safety

It must be determined whether equipment operations including assembly/disassembly, positioning, and crane operation (including traveling with a load) will occur in proximity to power lines within 20 feet (6.1 meters) for line voltage up to 350 kilo volts (kV), and within 50 feet (15.2 meters) for line voltage between 350 kV to 1000 kV. For power lines over 1000 kV, the distance must be determined by the utility/operator or qualified registered professional engineer in electrical power transmission and distribution.

If equipment operations are within proximity of aforementioned distances to power lines, one of the following options must be implemented to prevent encroachment and electrocution:

- Option 1: Deenergize and ground the power. Confirm from the utility/operator that the power line has been deenergized and visibly grounded at the worksite
- Option 2: If the voltage is not determined, ensure that no part of the equipment, load line, or load (including rigging and lifting accessories), gets closer than 20 feet (6.1m) by:
  - Conduct a planning meeting with the operator and other workers in the area to review the actions that will be taken to prevent encroachment and electrocution. Training requirements for working around energized power lines are described in Section 6.0, Training.
  - Use non-conductive tag lines.
  - Erect and maintain an elevated warning line, barricade or line of signs in view of the operator, either with flags or other high-visibility markings at 20 feet (1.6m) from the power line. A spotter must be used when the operator does not have clear line of sight to the elevated warning line.

- To prevent encroachment, the operator can use a proximity alarm, or position a dedicated spotter with visual aids to demarcate the encroachment and constant communication access to the operator.

If the line voltage can be determined, and if any part of the equipment, line load or load (including rigging and lifting accessories) would encroach within that specified distance listed in Table 1, then the requirements listed in Option 2 must be implemented.

TABLE 1
Minimum Clearance Distances

Voltage (nominal, kV, alternating current)	Minimum Clearance – Feet (meters)
Up to 50	10
Over 50 to 200	15
Over 200 to 350	20
Over 350 to 500	25
Over 500 to 750	35
Over 750 to 1000	45
Over 1000	Established by the utility owner/operator or by a qualified registered professional engineer in electrical power transmission and distribution

For equipment traveling within 20 feet (6.1m), under or near power lines without a load, the clearance distances described in Table 2 must be maintained and the following actions implemented.

- A dedicated spotter is assigned during equipment travel, positioned to effectively gauge the clearance distance, and is in continuous communication with the operator.
- During equipment travel, the boom/mast and support system are sufficiently lowered to ensure clearance distances are maintained, along with taking into consideration of the effects of speed and terrain.

TABLE 2
Minimum Clearance Distances While Traveling With No Load

Voltage (nominal, kV, alternating current)	Minimum Clearance – Feet (meters)
Up to 0.75	4
Over 0.75 to 50	6
Over 50 to 345	10
Over 345 to 750	16
Over 750 to 1000	20
Over 1000	Established by the utility owner/operator or by a qualified registered professional engineer in electrical power transmission and distribution

8.19 Crystalline Silica

(Reference CH2M SOP HSE-511, Crystalline Silica)

Crystalline silica can be a hazard during concrete cutting, jackhammering, well completion, building demolition or using impact or rotary drills on concrete surfaces.

CH2M and its subcontractors shall control employee exposure to crystalline silica when exposures are at or above the ACGIH TLV and the OSHA action level of 0.025 mg/m^3 by submitting for review and approval a crystalline silica exposure monitoring plan. The elements of an exposure monitoring plan include, but are not limited to the following:

- A bulk sample representative of the material to be demolished must be sent with the air monitoring sample media for analysis;
- Initial monitoring and personal air sampling must be conducted to determine the potential worker exposure to respirable crystalline silica;
- Real-time particulate monitors with a 10 micron respirable size fraction attachment may be used as part of the initial and ongoing monitoring plan to evaluate the potential worker exposure. This must include an action level established by their corporate or site health and safety professional and include actions required (e.g., implement engineering, administrative controls, respiratory protection);

Other exposure control measures include:

- Follow the engineering controls and PPE requirements for tasks called out under 29 CFR 1926.1153, Table 1 (e.g., use of jackhammers, walk behind or hand-held saws, hand-held and rig-mounted core saws or drills, among others);
- Workers shall use power tools with dust suppression controls such as a water spray or local exhaust ventilation connected to a HEPA vacuum system when cutting concrete;
- When using handheld and stand-mounted drills (including impact and rotary hammer drills) (e.g., for soil vapor probe installation):
  - Use a drill equipped with commercially available shroud or cowling with dust collection system
  - Operate and maintain tool in accordance with manufacturer's instructions to minimize dust emissions
  - The dust collector must provide the air flow recommended by the tool manufacturer, or greater, and have a filter with 99% or greater efficiency and a filter-cleaning mechanism
  - Use a HEPA-filtered vacuum when cleaning holes
- Maintaining surfaces as clean as practicable to minimize accumulation of crystalline silica containing particulate material;
- Apply dust control products or water on dry, dusty roads or piles of materials;
- Utilize heavy equipment with pressurized cabs and HEPA filter systems;
- Clean surfaces with a HEPA-filter vacuum or equivalent method;
- Implement dust suppression during demolition;
- An area on the worksite must be designated to be free of crystalline silica for workers to consume food or beverages;

- Restricting access to the work area where crystalline silica exposure may exist to only those authorized to perform work or enter the area;
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in these areas; and
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person.

8.20 Demolition

(Reference CH2M SOP HSE-305, *Demolition*)

This section is applicable to all forms of demolition. Demolition is defined as the removal or dismantling of structures or equipment by disassembly.

An engineering survey shall be completed prior to start of demolition operations. The survey shall determine the condition of the structure framing, floors, and walls; the presence of asbestos, polychlorinated biphenyls (PCBs), lead paint, or other regulated hazardous substances; the presence of hazardous materials in tanks, pipes, and equipment; and the possibility of unplanned collapse of any portion of the structure. Any adjacent structure where personnel may be exposed shall also be similarly evaluated. The survey shall be conducted by a competent person and a written record of the survey findings shall be maintained at the project site.

The demolition contractor working on this project will provide CH2M with a demolition safety plan prior to the start of work. CH2M will use this plan to verify that the subcontractor is implementing the necessary safety precautions during this activity. In addition, the following safety precautions shall be implemented by CH2M personnel. Below are the hazard controls and safe work practices to follow when working around or performing demolition. Ensure the requirements in the referenced SOP are followed.

- Appropriate warning and instructional safety signs shall be conspicuously posted where necessary.
- Fugitive dust must be controlled during demolition by using water spray or other methods.
- Remain a safe distance from the demolition zone to reduce exposure to fragmentation of glass, steel, masonry, and other debris during demolition operations.
- Do not enter the demolition zone unless completely necessary, and only after the competent person has assessed the condition of the structure and has authorized entry.
- Follow all requirements established by the competent person. The competent person shall inform personnel of the areas that are safe to enter and the areas where entry is prohibited. When possible, the competent person should escort CH2M personnel while in the demolition zone.
- All demolition activities that may affect the integrity of the structure or safety of personnel must cease until personnel have exited the demolition zone.
- During the course of demolition, work areas, passageways, stairs, ladders, and exits shall be kept free of demolition debris.
- Stay as clear as possible of all hoisting operations. Loads shall not be hoisted overhead of personnel
- Proper control measures shall be in place before welding or cutting on surfaces covered by coatings containing flammable or hazardous materials such as lead, cadmium, zinc, etc. Highly flammable or toxic coatings may require stripping of the coating a sufficient distance from the area to be heated. Welding and cutting shall be performed in accordance with the applicable governing provisions (e.g., in the US: OSHA 1926, Subpart J, “Welding and Cutting”; in Canada: provincial code, etc.). Follow “Welding and Cutting” SOP HSE-314.

The following lead-exposure-control procedures will be implemented during demolition operations involving potential exposure to lead:

- Site personnel will be provided lead-awareness training;
- Site personnel will be provided with hand-washing facilities and will wash their hands daily;
- An excavator equipped with hydraulic shears will be used only to cut painted wooden, concrete, and metal structures;
- Neither hand-held band/chop saws nor torch cutting equipment will be used on painted surfaces without proper PPE and engineering controls in place or removal of paint prior to cutting;
- During all demolition operations to control potential exposures to LBP, wet methods using water mist will be used;
- A direct-reading dust monitor will be used to monitor demolition operations that pose a potential lead-exposure hazard (that is, those with an action level requiring that additional dust control measures be employed and/or that respiratory protection be used.);
- Personal air samples will be collected and analyzed for lead to confirm that no personnel are exposed to levels above the lead action level of 30 micrograms per cubic meter ($\mu g/m^3$); and
- The selection of respiratory protection and other exposure controls will be based on the most recent exposure monitoring results obtained from the lead-exposure-competent person.
- For more information see CH2M SOP HSE-508, Lead.

8.21 Diving

(Reference CH2M's Commercial Diving Manual)

Diving operations must be conducted in accordance with the CH2M Commercial Diving Safe Practices Manual. Requirements in the manual include:

- Dive team members must have the experience and/or training in the use of tools, equipment and systems relevant to assigned tasks; techniques of the assigned diving mode; diving operations; and emergency procedures;
- Dive team members must be trained in cardiopulmonary resuscitation and standard first aid;
- Dive team members who are exposed to or control the exposure of others to hyperbaric conditions shall be trained in diving-related physics and physiology; and
- A "designated person-in-charge" must be at the dive location and in charge of all aspects of the diving operation affecting the safety and health of dive team members. The designated person-in-charge shall have experience and training in the conduct of the assigned diving operation.

8.22 Drilling Safety

(Reference CH2M SOP HSE-204, *Drilling*)

Below are the hazard controls and safe work practices to follow when working around or performing drilling. Ensure the requirements in the referenced SOP are followed.

- When considering drilling at sites with nearby monitoring wells, particularly in cases where drilling methods utilize pressurized fluids (air or water), consider the potential risk of hydraulic communication between the drilling location and the adjacent wells and/or other subsurface conduits.
- The drill rig is not to be operated in inclement weather.

- The driller is to verify that the rig is properly leveled and stabilized before raising the mast.
- Personnel should be cleared from the sides and rear of the rig before the mast is raised.
- The driller is not to drive the rig with the mast in the raised position.
- The driller must check for overhead power lines before raising the mast. Maintain a minimum distance of 10 feet (3 meters) between mast and overhead lines (<50 kV) and an additional 0.4 inches for every 1 kV over 50kV. Verify the voltage of nearby overhead power lines to determine the minimum distance.
- If the project site is suspected of munitions or explosives of concern (MEC) contamination, requirements of the *Explosives Usage and Munitions Response (MR)* SOP HSE-610 shall be followed. MECs include material potentially presenting an explosive hazard (MPPEH), discarded military munitions, materials that present a potential explosive hazard, chemical warfare materials, munitions constituents, and contaminated soil or groundwater. "Down-hole" avoidance support may be required to prevent accidental contact with MPPEH. Safety requirements will be based on the risk assessment identified within the MR (safety) ORE (Opportunity Risk Evaluation).
- All drilling sites must be evaluated for potential contamination by consulting with the client, reviewing historic data related to properties' past owners and uses, prior investigation reports or through vendor services.
- If unexpected contamination is discovered during drilling operations, all activities must immediately stop and the CH2M Safety Coordinator or Project Manager shall be immediately notified. Work shall not recommence until authorized by the CH2M Project Manager.
- If contamination is suspected or confirmed at the drilling site, the following must be implemented:
    - The standard hazardous materials/hazardous waste clause is included in our contract with the client and in our subcontract agreements
    - The drilling subcontract work plans address appropriate disclosure of potential contamination, any required training (e.g., HAZWOPER) and the requirement to plan for unexpected contamination. The subcontractor work plan and submittals are reviewed for appropriate licenses, certifications, permits, training, sampling and analytical, waste characterization, and waste management, including accumulation, transport and disposal.
- Personnel should stand clear before rig startup.
- The driller is to verify that the rig is in neutral when the operator is not at the controls.
- Become familiar with the hazards associated with the drilling method used (cable tool, air rotary, hollow-stem auger, etc.).
- Do not wear loose-fitting clothing, watches, etc., that could get caught in moving parts.
- Do not smoke or permit other spark-producing equipment around the drill rig.
- The drill rig must be equipped with a kill wire or switch, and all personnel are to be informed of its location.
- Be aware and stand clear of heavy objects that are hoisted overhead. Ensure any components subject to load bearing are rated and not shop-made.
- The driller is to verify that the rig is properly maintained in accordance with the drilling company's maintenance program.
- The driller is to verify that all machine guards are in place while the rig is in operation.
- The driller is responsible for housekeeping (maintaining a clean work area).
- The drill rig should be equipped with at least one fire extinguisher.

- If the drill rig comes into contact with electrical wires and becomes electrically energized, do not touch any part of the rig or any person in contact with the rig, and stay as far away as possible. Notify emergency personnel immediately.
- Use the drilling self-assessment checklist to evaluate drilling operations.

8.22.1 Air Rotary Drilling

- When a hydraulic communication hazard may exist, do not perform work at an adjacent structure or conduit when drilling, and be mindful of potential line-of-fire hazards. Evaluate the possibility of:
  - Increasing the distance between the proposed drilling site and the existing structure(s);
  - Abandon the adjacent structure(s)/conduit(s);
  - Consider use of an alternative drilling technology that minimizes propagation of pressures in the borehole to the adjacent formation (e.g., casing methods, continuous override methods, rotosonic); and
  - Ensure that hydraulic communication risks are addressed in your AHA or AHA/EIA.
- If drilling near a previously installed well, remove or loosen the well cap of that well to relieve pressure that may build during drilling.
- Stay clear of nearby wells that aren't protected by a secured steel casing/monument as a steel casing should provide protection from the inner well in the event of a pressure buildup.
- When opening a well in the vicinity of where air rotary drilling is being performed, or when opening a newly installed well via air rotary methods, remove the cap slowly to relieve pressure, keeping your head away from the line of fire in case the cap does pop off.

8.22.2 Cold Weather Drilling

- When possible, secure a tarp or plastic sheeting on the ground of the drilling work area overnight to reduce buildup of ice/snow.
- Place non-slip pads near work area and clean off regularly.
- Keep the drilling area clear of soil or cuttings at the surface, especially if soil is very wet, to prevent freezing and slipping/tripping hazards.
- Work at a slower pace to avoid slips
- Evaluate alternate methods for extreme conditions with PM/HSM.

8.23 Drum and Portable Tank Handling

Below are the hazard controls and safe work practices to follow when overseeing the movement of drums or when handling drums:

- Ensure that personnel are trained in proper lifting and moving techniques to prevent back injuries;
- Ensure drum or tank bungs and lids are secured and are labeled prior to moving;
- Ensure that drums and tanks remain covered except when removing or adding material or waste. Covers and/or lids will be properly secured at the end of each workday;
- Provide equipment to keep the operator removed from the drums to lessen the likelihood of injury. Such equipment might include: a drum grappler attached to a hydraulic excavator; a small front-end loader, which can be either loaded manually or equipped with a bucket sling; a rough terrain forklift; Roller conveyor equipped with solid rollers; drum carts designed specifically for drum handling;

- Make sure the vehicle selected has sufficient rated load capacity to handle the anticipated loads, and make sure the vehicle can operate smoothly on the available road surface;
- Ensure there are appropriately designed Plexiglas cab shields on loaders, backhoes, etc., when handling drums containing potentially explosive materials;
- Equipment cabs should be supplied with fire extinguishers, and should be air-conditioned to increase operator efficiency;
- Supply operators with appropriate respiratory protective equipment when needed;
- Ensure that drums are secure and are not in the operator’s view of the roadway;
- Prior to handling, all personnel should be warned about hazards of handling;
- Before moving anything, determine the most appropriate sequence in which the various drums, portable tanks, and other containers should be moved (e.g., small containers may have to be removed first to permit heavy equipment to enter and move the drums;
- Overpack drums and an adequate volume of absorbent should be kept near areas where minor spills may occur;
- Use containers or overpacks that are compatible with the waste or materials;
- Drums containing liquids or hazardous waste will be provided with secondary containment and may not be located near a storm water inlet or conveyance;
- Allow enough aisle space between drum pallets and between drums and other equipment that the drums can be easily accessed (at least 2 to 3 feet) by fire control equipment and similar equipment.; and
- Make sure that a spill kit is available in drum or tank storage areas (or where liquids are transferred from one vessel to another).

8.24 Drum Sampling Safety

Personnel are permitted to handle and/or sample drums containing certain types of waste (drilling waste, investigation-derived waste, and waste from known sources) only. Handling or sampling drums with unknown contents requires a plan revision or amendment approved by the RHSM. The following control measures will be taken when sampling drums:

- Minimize transportation of drums;
- Sample only labeled drums or drums from a known waste stream;
- Do not sample bulging or swollen drums. Contact the RHSM;
- If drums contain, or potentially contain, flammable materials, use non-sparking tools to open;
- Use the proper tools to open and seal drums;
- Reseal bung holes or plugs whenever possible;
- Avoid mixing incompatible drum contents;
- Sample drums without leaning over the drum opening;
- Transfer/sample the content of drums using a method that minimizes contact with material;
- Use the PPE and perform air monitoring as specified in the PPE and Site Monitoring sections of the project safety plan;

- Take precautions to prevent contaminated media from contacting the floor or ground, such as having plastic under the sampling area, having a spill kit accessible during sampling activities; and
- If transferring/sampling drums containing flammable or combustible liquids, drums and liquid transfer equipment should be grounded and bonded to reduce the potential of a static discharge.

8.25 Earthmoving/Heavy Equipment

(Reference CH2M, SOP HSE-306, *Earthmoving Equipment*)

Below are the hazard controls and safe work practices to follow when working around or operating heavy equipment. Ensure the requirements in the referenced SOP are followed.

- CH2M authorizes only those employees qualified by training or previous experience to operate material handling equipment.
- CH2M employees must be evaluated prior to operating earthmoving equipment by a CH2M earthmoving equipment operator evaluation designated person. This evaluation will be documented according to SOP HSE-306, Earthmoving Equipment.
- Heavy equipment operators are prohibited from using any wireless device while operating equipment. Equipment must be stopped before using devices such as two way radios or cell phones. If a wireless device is required for a certain operation, the PM and RHSM must authorize the wireless use on a case by case basis and make sure limitations are addressed in the project safety plan.
- Equipment must be checked at the beginning of each shift to ensure the equipment is in safe operating condition and free of apparent damage. The check should include: service brakes, parking brakes, emergency brakes, tires, horn, back-up alarm, steering mechanism, coupling devices, seat belts and operating controls. All defects shall be corrected before the equipment is placed in service. Documentation of this inspection must be maintained onsite at all times (use the Earthmoving Equipment Inspection form if operated by CH2M).
- Equipment must be on a stable foundation such as solid ground or cribbing; outriggers are to be fully extended.
- Equipment must not be used to lift personnel; loads must not be lifted over the heads of personnel.
- Equipment, or parts thereof, which are suspended must be substantially blocked or cribbed to prevent shifting before personnel are permitted to work under or between them. All controls shall be in a neutral position, with the motors stopped and brakes set.
- Equipment which is operating in reverse must have a reverse signal alarm distinguishable from the surrounding noise or a signal person when the operators view is obstructed.
- When equipment is used near energized power lines, the closest part of the equipment must be at least 10 feet (3 meters) from the power lines less than 50 kilovolts (kV). Provide an additional 4 feet (1.2 meters) for every 10 kV over 50 kV. A person must be designated to observe clearances and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means. All overhead power lines must be considered to be an energized until the electrical utility authorities indicate that it is not an energized line and it has been visibly grounded.
- Underground utility lines must be located before excavation begins; refer to the Utilities (underground) section.
- Operators loading and unloading from vehicles are responsible for seeing that vehicle drivers are in the vehicle cab or in a safe area.

- The parking brake shall be set whenever equipment is parked; wheels must be chocked when parked on inclines.
- When not in operation, the blade or bucket must be blocked or grounded; the master clutch must be disengaged when the operator leaves the cab. When equipment is unattended, power must be shut off, brakes set, blades or buckets landed and shift lever in neutral.

8.26 Elemental Sulphur

- Do not enter regulated work area unless training, medical monitoring and PPE requirements established by the competent person have been met.
- Do not eat, drink, smoke, chew tobacco or gum or apply cosmetics in regulated areas.
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person.
- Exposure to elemental sulphur dust may irritate eyes, skin and respiratory tract.
- Avoid breathing dust and keep clothing from dust as possible.
- If dusty conditions, wear dust mask, safety goggles and Tyvek.

8.27 Energized Electrical Work

(Reference CH2M SOP HSE-221, *Energized Electrical*)

All electrical systems shall be considered energized unless lockout/tagout procedures are implemented and zero energy verified in accordance with the Lockout/Tagout section of this Handbook.

Energized electrical work is defined as work performed on or near energized electrical systems or equipment with exposed components operating at 50 volts AC (or 100 volts DC) or greater. Working near energized live parts is any activity inside a Limited Approach Boundary.

Evaluate the use remote testing device for troubleshooting (e.g., Fluke 233 Remote Display Multimeter or equivalent). This type of testing device eliminates the exposure to unprotected energized electrical parts.

Electrical wiring and equipment shall be de-energized prior to conducting work unless it can be demonstrated that de-energizing introduces additional or increased hazards or is unfeasible due to equipment design or operational limitations. When energized electrical work is the only means that work can be performed (e.g., for voltage testing or troubleshooting), all requirements of SOP HSE-221 must be implemented including the following:

- Only qualified personnel are permitted to work on unprotected energized electrical systems. To be a CH2M qualified person, an employee must meet <u>all</u> of the following bulleted requirements:
  - The employee must be assigned one of the two worker categories and up-to-date on the requirements:
    - Energized Electrical Trained Worker Limited (EETW-L) which is restricted to working on electrical systems 480 VAC and below or working in the Limited Approach Boundary of systems that have a designated Arc Flash PPE Category of ≤ 2, which **does not** require First Aid/CPR or AED training or the buddy system.
    - Energized Electrical Trained Worker (EETW) allows individuals to work on equipment rated at Arc Flash PPE category 2, which requires the individual to complete First Aid/CPR or AED, and implement the buddy system.
  - Possess credentials, electrical educations, training and task specific knowledge, experience and capability (i.e., a qualified person may be qualified for one type of system or task, but not another).

- Attachment 4 of the Energized Electrical SOP, “Energized Electrical Qualified Person Assessment” must be completed annually by the RHSM or applicable operations lead/supervisor which requires a skill demonstration performed by the qualified person while wearing the necessary PPE and using the required tools. This form must be submitted to the SPA and maintained with the project files.
- Employees shall complete the CH2M energized electrical refresher safety training every 3 years.
- First Aid/CPR and AED training (EETW only), release of victim, completed annually (Release of victim refresher available on the VO). For annual the First Aid, CPR and AED requirement, an employee may retake the course through a certified provider (including local organizations), conduct a drill where CPR and AED skills are demonstrated, or complete the American Red Cross CPR/AED Refresher course.

- If CH2M personnel are only overseeing a qualified subcontractor performing energized electrical work and not entering the Limited Approach Boundary or tasked to perform troubleshooting near unprotected energized parts, then the ‘2015 NFPA 70E Awareness for Oversight of Work’ VO training is required (i.e., the above training requirements would not apply).
- The client sector HSE Lead must approve any energized electrical work that is above an Arc Flash PPE Category 2 or an incident energy greater than 8 calories/cm^2.
- An Electrical Hazard Analysis must be performed to identify energized electrical safe work practices before any person approaches exposed live parts within the Limited Approach Boundary (as determined by the shock hazard analysis), by performing both shock hazard analysis and flash hazard analysis, which comprise the electrical analysis.
- The Energized Electrical Work Permit must be completed prior to working on unprotected energized electrical systems.
- Provisions for first responder equipment, such as a first aid kit, AED, communication devices, and non-conductive release equipment (when disconnect means is not in the immediate vicinity of the work) shall be made available. If an AED is available at the host employer’s facility, the location of the AED must be determined and personnel trained in its use.
- CH2M employees designated as qualified persons working on live parts of energized electrical systems 480 volts and above shall implement the buddy system. This means that two EEQPs must be engaged in this work. Working on live parts of energized electrical systems 480 volts and above means actual contact with live parts or working within the Prohibited Approach Boundary, which is one inch (2.54 cm) for 480 volt systems.
- The buddy system requires the presence of an additional EEQP who shall stand by and render assistance, or summon help for the first person, in the event the first person is inadvertently shocked while performing the work. The second person shall not be assigned to additional distracting duties or tasks while the energized electrical work is being performed and shall know the location of the isolation device(s) for the equipment being worked on.
- Workers designated as qualified persons shall wear the required electric shock and arc-flash PPE, as specified by the qualified person responsible for the energized electrical operations.
- Safety signs, safety symbols or incident prevention tags, meeting applicable American National Standards Institute (ANSI) Standards, shall be used where necessary to warn employees about electrical hazards.
- Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas containing live parts. Conductive barricades shall not be used where it may cause an electrical hazard. Barricades shall be placed no closer than the Limited Approach Boundary.

- If signs and barricades do not provide sufficient warning and protection from electrical hazards, an attendant shall be stationed to warn and protect unqualified employees. The primary duty and responsibility of an attendant providing manual signaling and alerting shall be to keep unqualified employees outside a work area where the unqualified employee might be exposed to electrical hazards. An attendant shall remain in the area as long as there is a potential for employees to be exposed to the electrical hazards.
- Employees shall not perform tasks near exposed energized parts where lack of illumination or an obstruction precludes observation of the work. Employees shall not reach blindly into areas that may contain energized parts.
- Work shall be performed in accordance with National Fire Protection Association (NFPA) 70E requirements (2015 edition).
- Follow all control measures and procedures identified on the Energized Electrical Work Permit and the AHA. Complete the self-assessment checklist for energized electrical work.

8.28 Electrofishing Safety

Below are the hazard controls and safe work practices to be followed when overseeing or performing electrofishing.

- At least one member of the crew must have current first aid and CPR cards.
- Make sure every member of your crew knows where the nearest hospital is and how to get there or where to go to get help.
- All members of the crew shall have completed an electrofishing safety course.
- Before loading up equipment and heading into the field, make sure every member of the crew know the evacuation routes in case of an accident.
- Check the equipment for damaged or missing parts and for proper operation. Never use an electrofisher that is in poor condition or not working correctly as it can present a severe shock hazard.
- Check the cathodes cable for wear and burrs that may cause injury or tear holes in protective clothing. Check the insulation for damage. Replace the cathode as necessary.
- Check the anode pole for cracks in the fiberglass and handle assembly. Replace as necessary.
- Check the curl cord for cracks and abrasion. Do not use a cracked pole or a pole with a damaged curl cord.
- Check your boots and high voltage gloves for holes. Boots and gloves must be water tight without any holes. Repair as necessary.
- If you are using chest waders you should use a wading belt. A wading belt around your chest will trap air in your waders if you step or fall into a hole.
- Check all batteries for damage. Never use a damaged battery as the gelled electrolyte in these batteries is a strong acid and can cause severe chemical burns and damage clothing and the electrofisher.
- Use only dip nets with non-conductive handles. Never use an anode as a net, as it is extremely dangerous to other members of the crew and can cause severe injury to any fish caught with it.
- Never electrofish alone.
- Never electrofish if you are tired.
- Use only dip nets with insulated handles.

- Wear lineman's gloves, rated 5,000V minimum.
- Never try to reach into deeper pools with the electrodes. If you can't safely wade in an area it cannot be electrofished with a backpack electrofisher.
- Only one person on a crew can order the power for the electrofisher to be turned on, and that person is the crew leader. The crew leader is responsible for the safety of everyone on the crew.
- Any member of the crew can call for or turn off the power to the electrofisher.
- If an accident occurs, stop electrofishing and turn off the power to the unit. The person wearing the backpack unit should leave the water and take the unit to shore. The remaining members of the crew should help or attend to the accident victim. Get help for the injured person if necessary. Evaluate what happened and make the necessary procedural or equipment changes before proceeding.
- Never electrofish with spectators on shore. Electric fields can travel large distances through buried pipes, metal culverts, and metal sheet piling. If spectators show up during electrofishing, stop the operation and go explain what you are doing. Explain the risks to them being there and ask them to please leave for their own safety. If they refuse to leave, stop electrofishing, load your equipment and leave the area.

8.28.1 Safe Fishing

Electrofishing equipment uses voltages and currents that can be lethal to humans. The operators must always keep in mind that the chance of receiving an electrical shock is multiplied in or near water. Using an electrofisher is like using a firearm: if used properly and with good judgment it is perfectly safe; lose respect for it and you can lose your life.

Electrical equipment used in a moist field environment is always subject to deterioration that could lead to dangerous electrical shock. Field equipment is also subjected to vibration and impact during transporting and while in operation. Often equipment shared by different crews does not receive proper maintenance or a complete checkout. Follow the safety guidelines, and use good common sense to handle unforeseen circumstances.

All personnel involved in electrofishing should be taught the fundamentals of electricity, and have an understanding of the safety requirements.

8.28.2 Electrical Shock

It is the current that passes through the human body that does the damage. The voltage is relevant, because it is the force that "pushes" the current through the body. Experiments show that 20 to 500 HZ AC current is more dangerous than DC, or higher frequencies of AC.

The voltage used by electrofishing gear cause death by one of the following three means:

Ventricular Fibrillation – is uncoordinated contraction of the muscles of the heart. The heart quivers rather than beats. Electrical current through the chest can cause this condition,. Once a person goes into ventricular fibrillation, the only way to stop the quivering is to use a defibrillator that applies a pulse shock to the chest to restore heart rhythm. Cardiopulmonary resuscitation may help to keep a victim alive until he can be defibrillated.

Respiratory Arrest – The respiratory center is at the base of the skull. Thus, shock to the head can cause the breathing to stop. Artificial respiratory by the mouth-to-mouth method should be used in this case.

Asphyxia – is caused by contraction of the chest muscles. When current is above a certain level, a person cannot let go of an electrically hot wire. Currents above this level may not cause ventricular fibrillation, but may be enough to cause contraction of the chest muscles. If the current is not stopped, or the victim is not removed from the point of electrical contact, asphyxia will result. Artificial respiration or cardiopulmonary resuscitation may be necessary.

8.28.3 Preventing Electrical Shock

Electricity needs to have a complete electrical circuit in order for current to flow. The only way that you can get shocked is if you become the electrical conductor to complete the circuit. The current flows from the cathode to the anode through the water. The water is the electrical conductor. If you touched both the anode and the cathode you would become an electrical conductor and complete the circuit path and get a severe electrical shock. If you were to touch only one of the electrodes, you would not complete the electrical circuit and not get shocked.

WARNING: Touching any electrode is not recommended. Unless all conductive objects you come into contact with are connected to the same electrode, you will be shocked to find a current path that is not obvious, (e.g., the water or the boat).

Preventing electrical shock means preventing electrical current from entering and flowing through parts of the body. The skin is a partial but variable barrier, because it offers resistance to the passage of electrical current. Tough skin has more resistance that tender skin, and dry skin more than wet skin. But tough dry skin alone does not offer enough protection for electrofishing. Rubber lineman's gloves, rated 5,000V minimum should always be worn.

Even while wearing rubber gloves and waders, never touch an electrode while the circuit is energized. Do not work on electrical system while the generator is running. Do not enter the water while the current is on during boom shocking operations.

A severe electrical shock from electrofishing gear may result in the need for artificial respiration; therefore it is imperative that no one ever works alone.

8.28.4 Backpack Safety

- Before each operation, check that the frame emergency release is in working order and check that the tilt switch shuts off power if the unit is tipped more than 55 degrees forward.
- Wear hip boots or chest-high waders, with non-skid soles.
- Wear polarized sunglasses to help you detect sub-surface hazards and obstacles. Beware of turbid water that can hide unseen subsurface obstacles and sudden drop-offs.
- Shut off your electrofisher before entering or leaving a stream.
- Do not operate an anode pole when carrying a backpack unit weighing more than 20 pounds (9 kg) when in hazardous conditions.
- If you get water in your boots, waders, or gloves, stop work immediately and get dry clothing.
- Operate slowly and carefully. Footing in most streams is poor, and most falls often occur when operators are in a hurry.

8.29 Excavation Activities

(Reference CH2M SOP HSE-307, Excavation and Trenching Safety)

The requirements in this section shall be followed whenever excavation is being performed. Refer to the Earthmoving Equipment section and SOP for additional requirements applicable to operating/oversight of earthmoving equipment. Below are the hazard controls and safe work practices to follow when working around or performing excavation. Ensure the requirements in the referenced SOP are followed.

- If the project site is suspected of munitions or explosives of concern (MEC) contamination, requirements of the *Explosives Usage and Munitions Response (MR)* SOP HSE-610 shall be followed. MECs include material potentially presenting an explosive hazard (MPPEH), discarded military munitions, materials that present a potential explosive hazard, chemical warfare materials, munitions constituents, and contaminated soil or groundwater. "Down-hole" avoidance support may be required to prevent accidental contact with MPPEH. Safety requirements will be based on the risk assessment identified within the MR (safety) ORE (Opportunity Risk Evaluation).
- Do not enter the excavations unless completely necessary, and only after the excavation competent person has completed their daily inspection and has authorized entry. An inspection shall be conducted by the competent person prior to the start of work, as needed throughout the shift, after every rainstorm, and after any hazard increasing occurrence. Documentation of the inspection must be maintained onsite at all times.
- Follow all excavation entry requirements established by the excavation competent person and any excavation permit being used.
- Sloping, benching, shoring, shielding, or other protective systems are required to protect personnel from cave-ins except when the excavation is made entirely in stable rock or is less than 5 feet deep (1.5 meters) and there is no indication of possible cave-in, as determined by the excavation competent person. Protective systems for excavations deeper than 20 feet (6.1 meters) must be designed or approved by a registered professional engineer.
- Trenches greater than 4 feet (1.2 meters) deep shall be provided with a ladder, stairway, or ramp positioned so that the maximum lateral travel distance is no more than 25 feet (7.6 meters).
- The atmosphere of excavations greater than 4 feet (1.2 meters) deep shall be tested prior to entry when a hazardous atmosphere exists or could reasonably be expected to exist, such as excavating landfills, hazardous waste dumps; or areas containing sewer or gas utility systems, petroleum distillates, or areas where hazardous substances are stored nearby.
- Spoil piles, material, and equipment must be kept at least 2 feet (61 centimeters) from the edge of the excavation, or a retaining device must be used to prevent the material from falling into the excavation.
- Excavations shall not be entered when:
  - Protective systems are damaged or unstable;
  - Objects or structures above the work location may become unstable and fall into the excavation;
  - The potential for a hazardous atmosphere exists, unless the air has been tested and found to be at safe levels; or
  - Accumulated water exists in the excavation, unless precautions have been taken to prevent excavation cave-in.
- The excavation self-assessment checklist shall be used to evaluate excavations prior to entry.

Excavation Operations

Refer to the Excavation Entry section when entering excavations controlled by other parties. When CH2M performs the excavating, a CH2M excavation competent person will oversee all excavation operations and entry into excavations. The competent person shall:

- Complete the CH2M Excavation Permit to ensure HSE requirements have be satisfied during excavation activities;

- Complete the CH2M Daily Excavation Inspection Checklist to ensure HSE requirements have be satisfied, document that an inspection has been conducted, and to authorize entry into the excavation. A new Checklist shall be completed each day, authorizing excavation entry. Inspections should be continued as needed throughout the work shift, and after any event that could increase the potential for cave-in (e.g., rainfall); and
- Conduct daily safety briefings prior to excavation entry.

8.30 Fall Protection Activities

(Reference CH2M, SOP HSE-308, *Fall Protection*)

Below are the hazard controls and safe work practices to follow when personnel or subcontractors are exposed to unprotected heights. Ensure the requirements in the referenced SOP are followed.

- Fall protection systems must be used to eliminate fall hazards when performing construction activities at a height of 6 feet (1.8 meters) or greater and when performing general industry activities at a height of 4 feet (1.2 meters) or greater.
- CH2M staff exposed to fall hazards must complete initial fall protection training by completing either the CH2M 10-Hour Construction Safety Awareness training course or the Fall Protection computer-based training module. Staff must also and receive project-specific fall protection training using the fall protection evaluation form attached to the project safety plan. Staff shall not use fall protection systems for which they have not been trained.
- The SC or designee must complete the Project Fall Protection Evaluation Form and provide project-specific fall protection training to all CH2M staff exposed to fall hazards.
- The company responsible for the fall protection system shall provide a fall protection competent person to inspect and oversee the use of fall protection system. CH2M staff shall be aware of and follow all requirements established by the fall protection competent person for the use and limitation of the fall protection system.
- When CH2M designs or installs fall protection systems, staff shall be qualified as fall protection competent persons or work directly under the supervision of a CH2M fall protection competent person.
- When horizontal lifelines are used, the company responsible for the lifeline system shall provide a fall protection qualified person to oversee the design, installation, and use of the horizontal lifeline.
- Inspect personal fall arrest system components prior to each use. Do not use damaged fall protection system components at any time, or for any reason. Fall protection equipment and components shall be used only to protect against falls, not to hoist materials. Personal fall arrest systems that have been subjected to impact loading shall not be used. SC shall periodically inspect CH2M fall protection equipment using the Fall Protection Inspection Log form.
- Personal fall arrest systems shall be configured so that individuals can neither free-fall more than 6 feet (1.8 meters) or contact any lower level.
- Only attach personal fall arrest systems to anchorage points capable of supporting at least 5,000 pounds (2,268 kg). Do not attach personal fall arrest systems to guardrail systems or hoists.
- Rescue support shall be provided when personnel are not capable of rescuing themselves in the event of a fall. The emergency rescue requirements will be included in the Activity Hazard Analysis (AHA) for associated task(s) requiring the fall arrest system.

- Remain within the guardrail system when provided. Leaning over or stepping across a guardrail system is not permitted. Do not stand on objects (boxes, buckets, bricks, blocks, etc.) or ladders to increase working height on top of platforms protected by guardrails.
- Only one person shall be simultaneously attached to a vertical lifeline and shall also be attached to a separate independent lifeline.

8.31 Flight Line Safety

Always assume that the airfield is active. An active airfield means there is the possibility, even if an area is "closed", that aircraft or other vehicles will need access on or through a work area. There is always the potential for an incursion. If in an area of the airfield where radio contact with the control tower is required, the potential for miscommunication exists. Any mistake in communication has the potential to cause a problem with Air Operations. When maneuvering on the airfield, there are fuel trucks, helicopter rotors, jet blast, etc., all of which are potential hazards for workers. Pilots of aircraft do not expect workers to be on the airfield. If equipment is not properly marked, it may go unnoticed by pilots and present the potential for an incursion.

An aircraft always has the right of way. When working in a confined area that is "closed" to traffic, outline the work area with traffic cones or barricades that will provide a warning to other airfield traffic. This will also serve to keep vehicles from running through wet paint. Have one person designated as the point of contact who will be responsible for monitoring the radio and communicating with the control tower. That person shall be properly trained in the use of the radio, and check in daily with Air Operations to confirm work areas. Properly train workers to be aware of airfield operations going on around them, to give way to all moving aircraft, to allow great distances from aircraft, parked or running, when maneuvering on airfield.

It is inherent upon the contractor to be visible to everyone operating on the airfield. Orange and white checkered flags, flashing amber beacons, cones and/or barricades should be in good condition and clearly visible.

Speed limits on airfield area are enforced. Speed limits on an airfield are very low relative to speeds on the roads. Speeding on the airfield can lead to a possible incursion. Restricted areas, particularly on a military installation, must be strictly enforced. They are usually outlined with a red line and often have certain "Entry Control Points" painted along the red line where entry into the area is permitted. Entry into the restricted area without permission may subject the workers to arrest.

There are safety areas around runways on the airfield. All equipment and materials must be stored behind these areas. If a crew working on the runway is instructed to clear the runway, all workers and equipment must be moved beyond the safety area until given clearance by the control tower to return to the runway.

8.32 Forklift Operations

(Reference CH2M, SOP HSE-309, *Forklifts*)

Below are the hazard controls and safe work practices to follow when working around or operating forklifts. Ensure the requirements in the referenced SOP are followed.

- Forklift operators are prohibited from using any wireless device while operating forklifts. If a wireless device is required for a certain operation, the PM and RHSM must authorize the wireless use on a case by case basis and make sure limitations are addressed in the project safety plan.
- A rated lifting capacity must be posted in a location readily visible to the operator.
- A forklift truck must not be used to elevate employees unless a platform with guardrails, a back guard, and a kill switch is provided on the vehicle. When guardrails are not possible, fall arrest protection is required.
- The subcontractor operating the forklift must post and enforce a set of operating rules for forklift trucks.
- Only certified forklift operators shall operate forklifts.

- Stunt driving and horseplay are prohibited.
- Employees must not ride on the forks.
- Employees must never be permitted under the forks (unless forks are blocked).
- The driver must inspect the forklift once a shift and document this inspection.
- The operator must look in the direction of travel and must not move the vehicle until all persons are clear of the vehicle.
- Forks must be carried as low as possible.
- The operator must lower the forks, shut off the engine, and set the brakes (or block the wheels) before leaving the forklift operator's position unless maintenance or safety inspections require the forklift to be running.
- Trucks must be blocked and have brakes set when forklifts are driven onto their beds.
- Extreme care must be taken when tilting elevated loads.
- Every forklift must have operable brakes capable of safely stopping it when fully loaded.
- Forklifts must have parking brakes and an operable horn.
- When the operator is exposed to possible falling objects, industrial trucks must be equipped with overhead protection (canopy).
- If using certified CH2M forklift operators—forklifts must be inspected and documented daily using the forklift inspection form.

8.33 Groundwater Sampling/Water Level Measurements

Below are the hazard controls and safe work practices to follow when personnel or subcontractors are performing groundwater sampling and/or water level measurements.

- Full coolers are heavy. Plan in advance to have two people available at the end of the sampling effort to load full coolers into vehicles. If two people won't be available use several smaller coolers instead of fewer large ones.
- Wear the appropriate PPE when sampling, including safety glasses, nitrile gloves, and steel toe boots (see PPE section of the project safety plan).
- Monitor headspace of wells prior to sampling to minimize any vapor inhalation (refer to the "Site Monitoring" section of the project safety plan).
- Use caution when opening well lids. Wells may contain poisonous spiders and hornet or wasp nests.
- Use the appropriate lifting procedures (see CH2M SOP HSE-112) when unloading equipment and sampling at each well.
- Avoid sharp edges on well casings.
- If dermal contact occurs with groundwater or the acid used in sample preservation, immediately wash all affected skin thoroughly with soap and water.
- Avoid eating and drinking on site and during sampling.
- Use ear plugs during sampling if sampling involves a generator.
- Containerize all purge water and transport to the appropriate storage area.

- Use two people to transport full coolers/containers whenever possible. If two people are not available use a dolly to move coolers. If the coolers weigh more than 40 pounds Attachment 1 of the HSE-112, *Manual Lifting,* shall be completed by the SC. If the coolers weigh more than 50 pounds they should never be lifted by one person.

8.34 Hand and Power Tools

(Reference CH2M, SOP HSE-210, *Hand and Power Tools*)

Hands are one of the most complex parts of the body. Every employee uses their hands to help them make a living. There are more on-the-job injuries to hands than any other body part.

Below are the hazard controls and safe work practices to follow when personnel or subcontractors are using hand and power tools. Ensure the requirements in the referenced SOP are followed.

General

- Always select the right tool for the job;
- Keep cutting tools sharp—less force will be needed for the cut. Do not use pocket knives—only safety cutting tools and if using these be sure to comply with the "Knife Use" section of this Handbook;
- Carry and store tools correctly and never put sharp or pointed tools in your pocket or belt;
- Tools shall be inspected prior to use and damaged tools will be tagged and removed from service;
- Store tools properly in a place where they will not be damaged or come in contact with hazardous materials; and
- Tools used in an explosive environment must be rated for work in that environment (that is, intrinsically safe, spark-proof, etc.).
- Employees shall be trained on the "line of fire" hazards associated with operating power tools, how to look after their hands and body, and avoid pinch points or crush points. This may be accomplished by completing the Hand Safety training on the VO and reviewing the task-specific hazards and control measures in the Activity Hazard Analysis (AHA).

Hand and Power Tools

- Hand and power tools will be used for their intended use and operated in accordance with manufacturer's instructions and design limitations;
- Screwdrivers are one of the most used and abused tools, never:
  - Hammer with a screwdriver
  - Use as a pry bar
  - Use with a broken handle
  - Use with worn out tips
- Maintain all hand and power tools in a safe condition;
- When possible, use power tools over hand tools. Powered tools tend to require less exertion and reduce repetitive motion. Be sure that the weight of a powered tool (and cording) does not create additional force issues.
- Whenever possible, select tools that use a full-hand power grip rather than a precision finger grip. The greater the efforts to maintain control of a hand tool, the higher the potential for injury. A compressible gripping surface rather than hard plastic should be used.

- Avoid repetitive trigger-finger actions. Select tools with large switches that can be operated with all four fingers.
- When possible, use tools with extension handles that let you stand up while performing a floor-level task (extension handles must be manufacturer-approved)
- To lessen vibration:
  - Pad tool handles with a soft compressible surface
  - Use vibration damping (gel filled) gloves
  - Select tools (hammers and chippers) with built in damping systems (springs/hydraulics)
- Maintain straight wrists. Avoid bending or rotating the wrists; a variety of bent-handle tools are commercially available.
- Avoid static muscle loading. Reduce both the weight and size of the tool. Do not raise or extend elbows when working with heavy tools.
- Use PPE (such as gloves, safety glasses, earplugs, and face shields) when exposed to a hazard from a tool;
- Do not carry or lower a power tool by its cord or hose;
- Portable power tools will be plugged into GFCI protected outlets;
- Portable power tools will be Underwriters Laboratories (UL) listed and have a three-wire grounded plug or be double insulated;
- Disconnect tools from energy sources when they are not in use, before servicing and cleaning them, and when changing accessories (such as blades, bits, and cutters);
- Safety guards on tools must remain installed while the tool is in use and must be promptly replaced after repair or maintenance has been performed;
- If a cordless tool is connected to its recharge unit, both pieces of equipment must conform strictly with electrical standards and manufacturer's specifications; and

Machine Guarding

- Ensure that all machine guards are in place to prevent contact with drive lines, belts, chains, pinch points or any other sources of mechanical injury;
- Unplugging jammed equipment will only be performed when equipment has been shut down, all sources of energy have been isolated and equipment has been locked/tagged and tested; and
- Maintenance and repair of equipment that results in the removal of guards or would otherwise put anyone at risk requires lockout of that equipment prior to work.

8.35 Haul Trucks

Below are the hazard controls and safe work practices to follow when working around or operating haul trucks:

- Haul truck operators are prohibited from using any wireless device while operating trucks on site. Trucks must be stopped before using devices such as two way radios or cell phones. If a wireless device is required for a certain operation, the PM and RHSM must authorize the wireless use on a case by case basis and make sure limitations are addressed in the project safety plan.
- Haul truck operators should be familiar with their equipment and inspect all equipment before use;

- Haul truck operators should ensure all persons are clear before operating truck or equipment. Before moving operators should sound horn or alarm, all equipment should be equipped with a working back up alarm;
- Haulage trucks or equipment with restricted visibility should be equipped with devices that eliminate blind spots;
- Employees should stay off haul roads. When approaching a haul area, employees should make eye contact and communicate their intentions directly with the equipment operator;
- If possible minimize steep grades on haul roads;
- Where grades are steep provide signage indicating the actual grade as well as measures for a runaway truck;
- Trucks are to be operated within the manufacturer's recommendations (for example- retarder charts indicate the combination of loads, grades and speeds that should not be exceeded if the truck's retarder is to work properly – to ensure the truck does not descend grade at speeds greater than listed);
- Haul roads should be well lit, sufficiently wide (at least 50 percent of the width of the equipment on both sides of road) and equipped with reflectors to indicate access points;
- Haul roads should have adequate right-of-way signs indicating haul directions;
- Haul trucks will follow designated haul roads; and
- Haul trucks will comply with posted speed limits.

8.36 Hoists

(Reference CH2M SOP HSE-315, *Hoists*)

- Below are the hazard controls and safe work practices to follow when working around or operating hoists. Ensure the requirements in the referenced SOP are followed.
- Manufacturer's specifications and limitations applicable to the operation of material hoists shall be followed. Where manufacturer's specifications are not available, the limitations assigned to the equipment shall be based on the determinations of a professional engineer competent in the field.
- Rated load capacities, recommended operating speeds, and special hazard warnings or instructions shall be posted on hoists.
- Hoisting ropes shall be installed in accordance with the wire rope manufacturer's recommendations.
- The installation of live booms on hoists is prohibited.
- Operating rules shall be established and posted at the operator's station of on hoists.
- No person shall be allowed to ride on material hoists except for the purposes of inspection and maintenance.
- All entrances of the hoistways shall be protected by substantial gates or bars, which guard the full width of the landing entrance.
- Overhead protective coverings of 2-inch planking, ¾-inch plywood, or other solid material of equivalent strength, shall be provided on the top of every material host cage or platform.
- All hoistway entrance bars and gates shall be painted with diagonal contrasting colors, such as black and yellow.

- A qualified hoist operator will operate, inspect, maintain and oversee all hoist operations. The SC or designee shall verify hoist operator qualifications (e.g., operator to provide for the type of hoist being operated—years of experience, training, background).
- CH2M employees who are required to operate hoists shall read the hoist manufacturer's operations and maintenance manual, be evaluated and approved as qualified hoist operators. The CH2M may require operators to complete separate hoist operations training, provided by commercial training specialists.

8.37 Hydrogen Sulfide

Hydrogen sulfide (H2S) is a colorless, toxic, and flammable gas responsible for the odor of rotten eggs. It often results from the bacterial break down of organic matter in the absence of oxygen, such as in sewers. It also occurs in gases, natural gas and in well waters. H2S may be produced during the biological process when biological substrates are used to expedite the remediation process.

Chemical Properties

Hydrogen sulfide is heavier than air and may travel along the ground. It collects in low-lying and enclosed, poorly-ventilated areas such as basements, manholes, sewer lines, and underground telephone vaults. For work within confined spaces, use appropriate procedures for identifying hazards, monitoring and entering confined spaces (see Confined Space Entry section of this Handbook or the project safety plan). Additionally, H2S is a highly flammable gas and gas/air mixtures can be explosive. It may travel to sources of ignition and flash back. If ignited, the gas burns to produce toxic vapors and gases, such as sulfur dioxide.

Routes of Exposure and Exposure Limit

The primary route of exposure to H2S is inhalation, and the gas is rapidly absorbed by the lungs. Absorption through the skin is minimal. People can smell the "rotten egg" odor of H2S at low concentrations in air. However, with continuous low-level exposure, or at high concentrations, a person loses his/her ability to smell the gas even though it is still present; this is called olfactory fatigue. This can happen very rapidly and at high concentrations, the ability to smell the gas can be lost instantaneously. Therefore, DO NOT rely on your sense of smell to indicate the continuing presence of H2S or to warn of hazardous concentrations.

About half of the population can smell H2S at concentrations as low as 0.5 parts per billion (ppb) in air, and more than 90 percent can smell it at levels of 50 ppb. At higher concentrations H2S rapidly deadens the sense of smell. For most people, this occurs at approximately 150 ppm.

The American Conference of Governmental Industrial Hygienists (ACGIH) 8-hr time-weighted average (TWA) exposure limit for H2S is 1 ppm; the 15-minute short term exposure limit (STEL) is 5 ppm.

The Immediately Dangerous to Life or Health (IDLH) in air is 100 ppm. Exposure to 500 ppm can be fatal in a few breaths. Exposure to 1000 ppm is fatal.

Effects on the Body

Hydrogen sulfide is both an irritant and a chemical asphyxiant with effects on both oxygen utilization and the central nervous system. Its health effects can vary depending on the level and duration of exposure. Low concentrations irritate the eyes, nose, throat and respiratory system (e.g., burning/tearing of eyes, cough, shortness of breath). Asthmatics may experience breathing difficulties. The effects can be delayed for several hours, or sometimes several days, when working in low-level concentrations. Repeated or prolonged exposures may cause eye inflammation, headache, fatigue, irritability, insomnia, digestive disturbances and weight loss.

Moderate concentrations can cause more severe eye and respiratory irritation (including coughing, difficulty breathing, and accumulation of fluid in the lungs), headache, dizziness, nausea, vomiting, staggering and excitability.

High concentrations can cause shock, convulsions, inability to breathe, extremely rapid unconsciousness, coma and death.

H_2S as a Project Hazard

Elevated levels of H2S have not been reported during normal drilling activities, but experience has shown that high levels of H2S may be present in the well space and in the breathing zone following the injection of emulsified oil, once the biological process has had time to progress. Engineering controls shall be considered to bring the concentrations of H2S down to an acceptable level in the breathing zone, followed by administrative controls, and respiratory protection.

All employees will receive orientation on the emergency contingency plan for the specific actions to follow when there is an H_2S release from equipment, fire involving H_2S, or medical emergency involving exposure to H_2S.

Air Monitoring

Follow the air monitoring action levels in the project safety plan. If elevated levels of H2S are encountered, first implement engineering controls to reduce exposures to allowable levels. If that is not possible, then an upgrade in PPE may be required; refer to the PPE section of the project safety plan.

8.38 Ionizing Radiation

In addition to the general requirements below, refer to Section 2.4 “Radiological Hazards and Control” for project-specific information.

- CH2M Policy approval may be required for activities involving radiation; check with the project EM in the project planning stages.
- CH2M employees working onsite must complete the CH2M online Ionizing Radiation Training module available through the Virtual Office.
- Do not enter restricted work areas unless training, medical monitoring, personal monitoring equipment, and PPE requirements established by the radiation protection competent person have been met.
- Know your quarterly dose margin and do not exceed your personal limits.
- Assure personal monitoring devices are worn properly. Always calibrate pocket dosimeters prior to entering and exiting restricted areas.
- Plan activities to minimize exposure (ALARA) and waste generation.
- Limit the amount of potential waste (e.g., packaging, boxes, paperwork, etc.) brought into restricted areas.
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in restricted areas.
- Promptly report any condition which may lead to or cause a violation of radiation protection standards.
- Assure radioactive sources, containers, and the area are properly labeled and posted.
- Protective clothing and other exposure controls shall be based on the most recent survey results obtained from the radiation protection competent person.
- Know the emergency evacuation warning signals and be prepared to respond.
- Do not leave radioactive source materials and equipment unattended.

8.39 Lead

(Reference CH2M SOP HSE-508, *Lead.* In Canada, provincial occupational regulations may apply and should be implemented as required.)

CH2M is required to control employee exposure to lead when exposures are at or above 30 $\mu g/m^3$ by implementing a program that meets the requirements of the OSHA Lead standard, 29 CFR 1910.1025 and 29 CFR 1926.62, or lower if the local regulations are more stringent. The elements of the CH2M lead program include the following:

- Exposure monitoring;
- Methods of control, including personal protective equipment (PPE) and respirators;
- Medical surveillance;
- Training on hazards of lead and control measures (includes project-specific training and the computer-based training on CH2M's Virtual Office, *Lead Exposure Training);* and
- Record keeping requirements.

If air monitoring indicates there is potential exposure at the action level concentrations above, notify the RHSM to ensure the above have been adequately addressed. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met;
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas;
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person; and
- Review the fact sheet included as an attachment to the SOP.

8.40 Lockout/Tagout Activities

(Reference CH2M SOP HSE-310, *Lockout and Tagout*)

Lockout/tagout (LO/TO) shall be performed whenever service or maintenance is necessary on equipment that could cause injury to personnel from the unexpected equipment energizing or start-up or unexpected release of stored energy. Energy sources requiring lockout/tagout may include electrical, pneumatic, kinetic, and potential.

If work on energized electrical systems is necessary—contact the RHSM. Specific training and procedures are required to be followed before any work on energized electrical systems can be performed and are NOT covered in this section. Energized electrical work is defined as work performed **on or near** energized electrical systems or equipment with exposed components operating at 50 volts or greater. Working near energized live parts is any activity inside a Limited Approach Boundary (anywhere from 3.5 feet to 24 feet [1 meter 7.3 meters] depending on voltage). Examples of energized electrical work include using a voltmeter to troubleshoot electrical systems and changing out controllers.

When lockout/tagout is necessary to perform maintenance/repair of a system, all the requirements of SOP HSE-310, Lockout and Tagout, shall be met including the following bulleted items:

- When CH2M controls the work, CH2M must verify that subcontractors affected by the unexpected operation of equipment develop a written lockout/tagout program, provide training on lockout/tagout procedures and coordinate its program with other affected subcontractors. This may include compliance with the owner or facility lockout/tagout program.

- When CH2M personnel are affected by the unexpected operation of equipment they must complete the electrical safety awareness module on the VO. Authorized personnel shall inform the affected personnel of the LO/TO. Affected personnel shall not tamper with LO/TO devices.
- Standard lockout/tagout procedures include the following six steps: 1) notify all personnel in the affected area of the lockout/tagout, 2) shut down the equipment using normal operating controls, 3) isolate all energy sources, 4) apply individual lock and tag to each energy isolating device, 5) relieve or restrain all potentially hazardous stored or residual energy, and 6) verify that isolation and deenergization of the equipment has been accomplished. Once verified that the equipment is at the zero energy state, work may begin.
- All safe guards must be put back in place, all affected personnel notified that lockout has been removed and controls positioned in the safe mode prior to lockout removal. Only the individual who applied the lock and tag may remove them.
- CH2M authorized employees shall complete the LO/TO training module on the VO and either the electrical safety training module on the VO or 10-hour construction training. The authorized employee must also be trained and qualified on the system they are working on (e.g., qualified electrician for working on electrical components of a system).
- When equipment-specific LO/TO procedures are not available or when existing procedures are determined to be insufficient, CH2M authorized employees shall also complete the Equipment-Specific LO/TO Procedure Development Form, provided as an attachment to the SOP, to create an equipment-specific lockout/tagout procedure. Each lockout/tagout event shall be recorded on the Logout/Tagout Log (Attachment 4 of SOP HSE-310) to manage work and identify every point where locks and tags are applied.

8.41 Avoidance of Munitions and Explosives of Concern (MEC) and/or Materials Potentially Presenting an Explosive Hazard (MPPEH)

(Reference CH2M, SOP HSE-610, Explosives Usage and Munitions Response)

If work will be conducted on a government/military facility or ex-government/military facility; area currently or previously used as a range; or if military munitions, MEC, or material potentially presenting an explosive hazard (MPPEH) are associated with the scope of work or location immediately contact the CH2M Central Point of Contact for Explosives Usage and Munitions Response. The following will be required prior to any field work:

- Setting up a conference call with all required personnel to conduct a basic safety risk assessment over the phone.
- Providing written directions detailing job-specific requirements and what actions to take to ensure safety during the work.
- “3R Training” will be required for all affected project personnel. This training teaches personnel to Recognize, Retreat, and Report.

8.42 Marijuana Cultivation Sites

Marijuana grow sites are illegal on public lands, but are becoming more common. These sites may be encountered when working in undeveloped or “back country” areas. These sites pose risks to workers, the public, and the environment and are most often associated with organized crime. The potential for violent confrontations is high.

Most marijuana grow sites have someone always watching the site. Even unattended sites pose a significant risk. Recognize the signs of marijuana cultivation sites, and if you think you are near one, be quiet and leave the area immediately.

How to recognize a cultivation site:

- Sometimes marijuana smells like a skunk on hot days.
- Hoses or drip lines (made of black or white PVC piping or rubber hose) located in unusual or unexpected places.
- Discarded containers of herbicides, pesticides or other chemicals. A variety of chemicals for pest and animal control, including chemicals that may be so hazardous they are illegal in the United States are sometimes encountered.
- A well-used trail where there shouldn't be one.
- People standing along roads without vehicles present, or in areas where loitering appears unusual.
- Grow sites are usually found in isolated locations, in rough steep terrain. Look for signs of cultivation, cleared vegetation, soil disturbance.
- Food cached near trailheads or alongside roads.
- Sights or sounds of human activity in remote forest areas.
- Camps containing cooking and sleeping areas with food, fertilizer, weapons, garbage, rat poison, and/or dead animals.
- Small propane bottles, used to avoid the detection of wood smoke.
- Individuals armed with rifles outside of hunting season.
- Paper cups, chicken wire or plastic sheets used for starting and protecting plants.

As soon as you become aware that you have come upon a cultivation site, leave the way you came in immediately and make as little noise as possible. Never engage the growers as these are extremely dangerous people. If you can identify a landmark or it is helpful for authorities, but put your own safety first. The growers may be present and may or may not know that you have found their grow site. Get to a safe place and report as much detail about the location and incident as you can recall to authorities. Ensure you contact the RHSM and Project Manager as soon as possible.

Other precautions to take include:

- Check with local law enforcement officers to see whether they know of any dangers or concerns in the area where you will be working.
- Establish and follow check-in and checkout procedures every day.
- Make sure your supervisor and the dispatch office know where you will be working.
- If necessary, agree on a phrase that you would use to let your co-workers (SC, RHSM, or PM) know you are in danger and need law enforcement assistance immediately at your last known location.
- Make sure you have a working communication device.
- Use the buddy system. Work in pairs.
- Park your vehicle so it's pointing in the direction of escape.

8.43 Methane (as a Product of Injection Activities)

Methane is a colorless, odorless gas with a wide distribution in nature. Methane is created when organic matter decomposes (rots) without any oxygen present ("anaerobic" decomposition) and is common in landfills, marshes, septic systems and sewers.

Methane may be produced as a by-product of the biological process when biological additives are used in a remediation process (such as when emulsified oil is injected to enhance dechlorination of contaminated groundwater).

Experience has shown that methane may be present in the well space following the injection of emulsified oil, once the biological process has had time to progress. This needs to be considered when returning to collect ground water samples. Although methane degrades Engineering controls shall be considered to bring the concentrations of methane down to an acceptable level in the breathing zone.

Methane is a “simple asphyxiant,” which means that it can displace available oxygen. Methane is combustible and mixtures of methane with air are explosive within the range 5-15 percent by volume of methane (the lower and upper explosive limits). At room temperature, methane is lighter than air, so in an outdoor environment, it tends to dissipate.

Methane is not toxic when inhaled, but it can produce suffocation by reducing the concentration of oxygen inhaled. When exposed to concentrations high enough to displace oxygen, you may experience dizziness, deeper breathing, possible nausea and eventual unconsciousness.

The primary danger is from fire and explosion, so ensure that you work in a well-ventilated area, and that there is no source of ignition present. Use spark-proof tools and intrinsically safe equipment, if necessary. If working in a confined space, make sure that appropriate controls are in place and follow an approved permit-required confined space entry plan.

8.44 Methane (as Landfill Gas or Shale Formations)

Landfill gas is normally made up of 50 percent methane and 50percent carbon dioxide

Shale formations can produce methane that has the potential to be released during drilling or groundwater sampling.

Other constituents have been found in the landfill gas. These may include hydrogen sulfide, tetrachloroethene, ethyl benzene, toluene, and xylenes. Refer to the project health and safety plan for additional information on these constituents when this hazard is part of your work.

- Continuous monitoring is required when performing intrusive activities (e.g., excavation, drilling) in a methane area. This includes refuse and any cover material.
- Monitoring will be conducted with oxygen/combustible gas meters.
- All instruments will be calibrated according to manufacturer’s specifications. Instruments will be calibrated at the frequency specified by the manufacturer.
- Ventilation is the primary control to reduce the fire potential from methane. The action required for ventilation include:
- Natural Ventilation – If the wind speed across the bore hole or sampling apparatus is over 5 mph (8 kph) then natural ventilation is sufficient. Equipment and personnel must be located upwind of the potential methane source to prevent any ignition source from contacting methane in air.
- Forced Ventilation – If the wind speed across the bore hole or sampling apparatus is less than 5 mph (8 kph) then forced ventilation is required. Large air movers are preferable but standard ventilation fans may be used if the air flow is directed to the bore hole or the location in the sampling apparatus where the methane first encounters open air.

8.45 Methylene Chloride

(Reference CH2M SOP HSE-509, *Methylene Chloride.* In Canada, provincial occupational regulations may apply and should be implemented as required.)

Methylene chloride has a faint, sweet odor which is not noticeable at dangerous concentrations. Methylene chloride is shipped as liquefied compressed gas and will cause frostbite on contact.

CH2M is required to control employee workplace exposure to methylene chloride when personal exposures are at or above 12.5 parts per million (ppm) as an 8-hour time-weighted average (TWA) or above 125 ppm short-term exposure limit (STEL) by implementing a program that meets the requirements of SOP HSE-509, the OSHA Methylene Chloride standard, 29 *Code of Federal Regulations* (CFR) 1910.1052, or local regulation if more stringent The elements of the CH2M methylene chloride program include the following:

- Exposure monitoring;
- Methods of control, including personal protective equipment (PPE) and respirators;
- Medical surveillance;
- Training on hazards of methylene chloride and control measures (includes project-specific training and the computer-based training on CH2M's Virtual Office, *Methylene Chloride)* and*;*
- Recordkeeping requirements.

If air monitoring indicates there is potential exposure at the action level concentrations above, notify the RHSM to ensure the above have been adequately addressed. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met;
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas;
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person;
- Appropriate air-supplied respirators must be used when methylene chloride exposures exceed PEL or STEL;
- Air supplied to respirators must meet Grade D breathing air requirements; and
- Review the fact sheet included as an attachment to the SOP.

8.46 Naturally Occurring Radiation Materials (NORM)

Naturally Occurring Radiation Materials (NORM) is found in the earth's crust, soil, plants and many living organisms. The geologic formations that contain oil and gas deposits also contain NORM, commonly consisting of the elements of uranium, radium, thorium and their associated decay products. If present, these radio nuclides dissolve in water and can be bound into the scale deposited in production equipment handling produced water. Radon gas follows the propane/ethane streams of produced (natural) gas and the radon gas byproducts (radon daughters) can be deposited on the inside surfaces of gas handling equipment. Land can be contaminated with NORM from descaling operations, contaminated sludges, and/or residual from produced water.

Equipment that can contain NORM-contaminated scale includes equipment associated with the separators (separate gas from the oil and water) and heater treaters (divide the oil and water phases) such as flowlines, pumps, valves, and piping (especially transition pieces such as elbows and reducer) and filters.

Gas processing equipment can also be contaminated with NORM (radon daughters). This contamination, unlike scales, can be in the form of an invisible film inside gas equipment and can only be detected by internal surveying with appropriate instrumentation.

Natural gas liquid equipment can also be contaminated by radon in the gas. Sludges accumulated in this equipment may contain the heavy metal radon daughters that have attached to dust and other particles that become part of the sludge.

While NORM has generally been associated with exploration and production activities, there is some industry experience to indicate that some refinery process equipment can also be contaminated with NORM, including natural gas stream equipment, crude tank bottoms, desalters, overhead atmospheric pipestill equipment, and exchanger deposits/sludge.

Hazards of NORM

NORM generally does not present an external radiation (Gamma) hazard to employees working around closed process equipment. This is particularly the case with NORM associated with scale inside equipment handling production water due to attenuation by the scale and steel pipe wall. Recent field experience, however, indicates that some in-service gas processing equipment, particularly valves, elbows, or transition piping pieces, may have fairly high external Gamma radiation levels. If gas-processing equipment is out of service for more than 4 hours, external Gamma measurements will not detect internal accumulation of the radon daughters.

Work procedures are recommended when maintaining NORM contaminated equipment such as pipelines, filters, pumps, lines, sludge or wellhead equipment. The exposure risk is highest when grinding, cutting, polishing, or performing other work that may generate dust. These dusts present inhalation hazards that result in internal exposures to radioactive material.

- Radium, radon, and their decay products are radioactive elements of concern in petroleum production and gas processing. Exposure may occur when contaminated dusts and sludge are inhaled or ingested (internal exposure) or when radiation from surrounding equipment strikes the body (external exposure).
- Radium is found in most oil and gas fields in the world in varying concentrations. There is potential to find radium in significant amounts in almost all types of equipment. Radon is found in most natural gas deposits in the world.
- Radon itself does not present a health hazard because it is not easily absorbed into the body and is quickly cleared when absorbed.
- Radon’s radioactive breakdown products, called radon “daughters,” may be hazardous. Radon naturally breaks down into radioactive metals before becoming non-radioactive lead.
- Radon daughters may be inhaled or ingested when attached to scale or dust generated during equipment inspection and repair. Radon daughter overexposure has been associated with an increased risk of lung cancer.

NORM Hazard Control Measures

- For operations where NORM is a potential hazard, a qualified individual (s) will be assigned for implementing radiological protection of employees, members of the public, and the environment.
- Surveys and monitoring must be conducted to evaluate the potential radiological hazards. The surveys must include measurements for radiation levels based on the concentrations or quantities of radioactive material, along with any other measurements or evaluations necessary to characterize the potential radiological hazards that could be present.
- Equipment contaminated with NORM must be labeled.
- Gas processing equipment should be opened to allow gas to escape, and allowed to stand idle for at least 4 hours prior to any entry.
- Water washing of any equipment prior to entry is recommended when practical.

- Personal protective equipment (PPE) must be selected based on the hazards (both radiological and non-radiological) work activities to be conducted, and the contamination levels in the work area,
  - Level D PPE must be worn to minimize skin contact with NORM such as gloves and appropriate body protection. Disposable clothing such as TYVEK is preferred since NORM contaminated clothing should be laundered.
  - Level C PPE using full-face air-purifying respirator with high efficiency particulate air (HEPA filters) must be worn if dust exposure is expected.
- Do not sand, grind, cut, or weld on surfaces contaminated with NORM without appropriate cleaning. Equipment should be resurveyed after cleaning prior to these activities.
- NORM-contaminated equipment or material should not be shipped offsite for repair or disposal without first contacting the designated NORM coordinator (may be the RHSM and/or REM)

8.47 Mower, Brush Hog and Weed Trimmer Safety

Below are hazard controls and safe work practices to follow when personnel or subcontractors are working near or using mowers, brush hogs and weed trimmers. The brush hog is a dangerous machine that will throw rocks and debris long distances at speeds that can and have caused significant injury. It can also become entangled in rope, wire or other objects that can endanger workers in the vicinity.

Ensure that the following requirements are followed

Mower/Brush Hog

- Meet with the brush hog or mower crew during the safety tailgate meeting and immediately prior to operations to ensure all personnel understand the signal that indicates when the operator will operate the brush hog.
- Conduct a sweep of the area where the brush hog or mower is scheduled to cut vegetation and 100-foot buffer prior to mower, brush hog, masticator and trimmer operations for loose debris, rocks, logs, foreign objects, wire, rope, fencing, etc. that could present a safety hazard.
- Restrict other workers and oversight activities to 300 feet outside the staked limits of the work area while brush clearing equipment is operating.
- Workers should position themselves 180 degrees towards the rear of the mower, always maintaining >300 feet from the edge the area being cleared by the mower.
- Minimum PPE Requirements – leather boots with safety toes, safety glasses, leather gloves, hard hat, long pants, and high visibility vest.
- The equipment operator must read the owner’s manual prior to operating the equipment.
- Make all necessary adjustment prior to turning on the equipment.
- Practice operation in an open area.
- Make sure all protective guards are in place. Never remove guards.
- Determine that steering is responsive before beginning a job.
- Test the brakes.
- Clean the steps and operating platform to prevent slipping.
- Ensure that tires are properly inflated.
- Only the operator should be riding on the equipment, no passengers are allowed.
- When leaving the seat, the operator should disengage the Power Take Off (PTO), engage the brake, stop the engine, and wait for all parts to stop before dismounting.

- The operator should not adjust any mechanism of the equipment while the mower is running, making sure all parts have stopped moving prior to making any adjustments.
- When driving between mowing jobs, crossing a road, path or sidewalk, or when not using the mower, the operator should disengage the PTO to stop the mower blade.
- Operators should not mow in conditions where traction or stability is questionable. If uncertain, test drive a section with the PTO off.
- Never refuel equipment while the engine is running or extremely hot. A fire or explosion could result.
- Maintain a fire extinguisher nearby.
- When mowing on uneven ground follow these rules:
    - Reduce the travel speed so that you can see and react to hazards in your path. Overturns are four times more likely to occur when the speed is doubled.
    - Be on the alert for holes and ditches covered by grass or debris. A wheel may drop and cause an overturn.
    - Drive up and down a hill, not across.
    - Do not stop when going uphill or downhill. If the mower stops going uphill, turn off the PTO and back down slowly.
    - Do not try to stabilize the mower by putting your foot on the ground.

Weed Trimmer

- Wear snug, tight-fitting equipment while operating the weed trimmer or tri-blade. Retain long hair or any other loose items or clothing.
- Inspect guard/shield and ensure it is securely in place.
- Do not change string with equipment running. Turn off equipment before removing any jams.
- When cutting, keep spinning string low and maintain control.
- Never operate the weed trimmer one handed; hold with both hands with thumbs opposed to direction of other fingers, using a firm grip to prevent loosing grip if the tool kicks back or bucks.
- Start cutting in a position so that it is off to the side of your body, so that if the tool bucks it doesn’t come back up into your body.
- Inspect brush/weeds for any objects that could become a harmful projectile.
- Clear area of people and vehicles; minimum of 100 feet safe zone.

8.48 Off-Road Driving Safety

- Whenever possible, use only paved roads when there is a choice between un-improved roads and paved roads.
- On a project by project basis, conduct an assessment based on the degree of hazard, driving route, and location, determine whether an In Vehicle Monitoring System (IVMS) is required when driving alone in remote areas (Refer to Working Alone Core Standard). Also consider what will be used for communication when in remote areas (e.g., satellite phone, InReach device).
- When four-wheel drive (off-road) roads are used, personnel shall be experienced in off-road driving.
- Plan access routes prior to setting out. Obtain the most current maps if traveling on federal lands.
- Prepare an emergency kit with extra clothes, food, water, batteries, flashlight, and other items that may be needed if you become stranded.

- Roads can become slick with mud, may be along cliff sides with no protection, have soft shoulders/erosion, may be narrow, have blind curves, have damage or obstructions in the road. Do not attempt to drive routes you are not comfortable with. Have potential alternate routes identified wherever possible so if a road becomes more dangerous than when you used it before, you can take another road.
- Carry a compass and/or GPS when traveling to remote areas on rural roads.
- Before going off-road, inspect the vehicle. Make sure the tires (including the spare) are in good condition and inflated properly. Look under the vehicle for any leaks or mechanical problems. Make sure all fluids are topped off. Check the condition of your steering and brakes.
- Fill fuel tank before leaving populated areas. Fuel stations may be unavailable for long distances. Carry extra fuel in an approved gas can if you will be a long way from populated areas.
- Know how the 4x4 system works and how to use the controls before they are needed. Practice using the low ratio gearbox. If the vehicle is equipped with manual locking hubs, test them to ensure they are working properly.
- Know where the spare tire and jack are located and how to use them.
- Know and understand the vehicle's dimensions - height, width, length, approach angle, departure angle and ramp angle. Also know where the lowest point of clearance is - usually the differential casing.
- Keep track of preventative maintenance schedule and keep vehicle up-to-date if being used long-term.
- Pay attention to how the vehicle is loaded. Loads should be distributed evenly within the vehicle if possible. Loads behind the rear axle will sag the rear of the vehicle, limiting your departure angle and clearance. Excessive loads will change the center-of-gravity, thus making the vehicle less stable.
- Be time-conscious. What may look like a short trip on the map may take many hours in 4-wheel drive; allow enough time for safe travel.
- Drive within your ability. If you are not comfortable, do not proceed.
- Avoid surprises by surveying the road ahead before it is driven, when needed. Get a good idea where to place the tires and have a plan of approach. Follow through beyond the obstacle.
- Driving diagonally can lead to a rollover. Always drive straight down hills or steep terrain.
- Avoid driving over obstacles that may cause the vehicle to become stuck. Cross ditches or logs at an angle so that one wheel at a time goes over the obstacle; the other three help the one wheel to climb over. Dropping the tire into a ditch or crack in a rock can put you and your truck in a vulnerable position.
- When driving on narrow roads and there is no shoulder available for either vehicle to pull over safely, stop. One vehicle should back up until a safe spot is reached. By custom the vehicle closest to the safe shoulder will reverse or, on a steep hill, the vehicle traveling downhill.
- Do not expect logging trucks, cars with trailers, or other large vehicles to make room for you. Pull over early when you see them coming.
- Slow down when traversing blind curves, washboard roads, or roads with loose surfaces. Make turns and brake gently to avoid sliding or loss of control.

8.49 PCB/Ballast Handling

Fluorescent lighting used in many older buildings use ballast resistors that contain polychlorinated biphenyl (PCB) oil. PCB is colorless to light-colored, viscous liquid with a mild, hydrocarbon odor.

PCB has been found to cause, irritation eyes; chloracne; liver damage; reproductive effects; and has shown to cause cancer in lab animals.

When work requires the handling or removal of fluorescent ballast resistors, extra care and attention needs to be taken. While ballasts are usually well sealed, it is not uncommon to find a ballast resistor that has leaked. Below are the hazard controls and safe work practices to be followed when PCBs are present.

- A survey must be made to determine whether ballast resistors contain PCB fill.
- Leaking resistors must be identified and handled with appropriated PPE.
- Exposure Routes are inhalation, skin absorption, ingestion, skin and/or eye contact
- Prevent skin contact by using chemical resistant gloves, wear eye protection, and thoroughly wash hands before eating or smoking.
- Ensure eyewash is available.
- In the event of exposure, follow the following First Aid procedures:
  Eyes: Irrigate immediately
  Skin: Soap wash immediately
  Ingestion: Seek medical attention immediately
- Dispose of PCB ballast resistors in accordance with Federal, State and Local environmental regulations.

8.50 Portable Generator Hazards

(Reference CH2M SOP HSE-206, Electrical Safety)

- Portable generators are useful when temporary or remote electric power is needed, but they also can be hazardous. The primary hazards to avoid when using a generator are carbon monoxide (CO) poisoning from the toxic engine exhaust, electric shock or electrocution, and fire.
- NEVER use a generator indoors or in similar enclosed or partially-enclosed spaces. Generators can produce high levels of carbon monoxide (CO) very quickly. When you use a portable generator, remember that you cannot smell or see CO. Even if you can't smell exhaust fumes, you may still be exposed to CO.
- If you start to feel sick, dizzy, or weak while using a generator, get to fresh air RIGHT AWAY. DO NOT DELAY. The CO from generators can rapidly lead to full incapacitation and death.
- If you experience serious symptoms, get medical attention immediately. Inform project staff that CO poisoning is suspected. If you experienced symptoms while indoors have someone call the fire department to determine when it is safe to re-enter the building.
- Follow the instructions that come with your generator. Locate the unit outdoors and away from doors, windows, and vents that could allow CO to come indoors.
- Generators rated greater than 5 kilowatts that are not vehicle- mounted need to be grounded in accordance with regulatory and manufacturer requirements. Always refer to the manufacturer grounding requirements for any generator used on site.
- Keep the generator dry and do not use in rain or wet conditions. To protect from moisture, operate it on a dry surface under an open, canopy-like structure. Dry your hands if wet before touching the generator.
- Plug appliances directly into the generator. Or, use a heavy duty, outdoor-rated extension cord that is rated (in watts or amps) at least equal to the sum of the connected appliance loads. Check that the entire cord is free of cuts or tears and that the plug has all three prongs, especially a grounding pin.

- Most generators come with Ground Fault Circuit Interrupters (GFCI). Test the GFCIs daily to determine whether they are working
- If the generator is not equipped with GFCI protected circuits plug a portable GFCI into the generator and plug appliances, tools and lights into the portable GFCI.
- Never store fuel near the generator or near any sources of ignition.
- Before refueling the generator, turn it off and let it cool down. Gasoline spilled on hot engine parts could ignite.

8.51 Powder-Actuated Tools

(Reference CH2M SOP HSE-210, *Hand and Power Tools*)

Below are the hazard controls and safe work practices to follow when working around or using powder-actuated tools. Ensure the requirements in the referenced SOP are followed.

- Only trained personnel are permitted to operate powder-actuated tools. CH2M employees using powder-actuated tools must be trained in the operation of the particular tool in use. Training and certification are provided by the tool manufacturer.
- Inspect and test powder-actuated tools each day before they are loaded per manufacturer's instruction. Remove from service any tool that is not in proper working order.
- Wear appropriate personal protective equipment (eye, face, and hearing protection) when using powder-actuated tools.
- Never point powder-actuated tools at other workers, whether empty or loaded. Tools shall not be loaded until just before use. Never leave loaded tools unattended.
- Do not drive fasteners into very hard or brittle materials such as, cast iron, glazed tile, surface-hardened steel, glass block, live rock, face brick, or hollow tile.
- Avoid driving fasteners into easily penetrable materials unless backing is provided. Pins or fasteners can otherwise become flying missiles when they pass right through such materials.
- Use powder-actuated tools with the manufacturer's specified guard, shield, or other attachment.
- Do not use powder-actuated tools in explosive or flammable atmospheres.

8.52 Pressure Line/Vessel Systems

- Operate and maintain pressure vessels, pumps and hosing in accordance with the manufacturer's recommendations.
- Do not exceed the rated pressure of the vessels and hosing of the system.
- The system must be provided with a pressure relief valve/controller that safely reduces the system pressure to within the system rated pressure.
- The pressure relief valve must be rated at no more than 110 percent the rated pressure of the system and must be tested at regular intervals.
- Each vessel must be equipped with a functioning pressure gauge to monitor pressure.

8.53 Pressure Washing Operations

Below are the hazard controls and safe work practices to follow when working around or performing pressure washing.

- Only trained, authorized personnel may operate the high-pressure washer.
- Follow manufacturer's safety and operating instructions.
- Inspect pressure washer before use and confirm deadman trigger is fully operational
- The wand must always be pointed at the work area.
- The trigger should never be tied down
- Never point the wand at yourself or another worker.
- The wand must be at least 42 inches (1.1 meter) from the trigger to the tip and utilize greater than 10 degree tips.
- The operator must maintain good footing.
- Non-operators must remain a safe distance from the operator.
- No unauthorized attachment may be made to the unit.
- Do not modify the wand.
- All leaks or malfunctioning equipment must be repaired immediately or the unit taken out-of-service.
- Polycoated Tyvek or equivalent, 16-inch-high steel-toed rubber boots, safety glasses, hard hat with face shield, and inner and outer nitrile gloves will be worn, at a minimum.

8.54 Process Safety Management

(Reference CH2M SOP HSE-213, *Process Safety Management*)

- All CH2M projects require a systematic evaluation of processes to prevent, or minimize the consequences of, catastrophic releases of toxic, reactive, flammable, or explosive chemicals at or above the specified threshold quantities. In the US, these are listed in Appendix A, List of Highly Hazardous Chemicals, Toxics, and Reactives in OSHA Standard 29 CFR 1910.119, Process Safety Management.
- A Process Hazard Analysis (PHA) is required of all processes covered by PSM.
- Operating procedures shall be developed and implemented that provide clear operating instructions consistent with the process safety information.
- Contractors, whether considered to be CH2M or a subcontractor of CH2M, performing maintenance or repair, turnaround, major renovation, or specialty work on or adjacent to a covered process shall be informed by the client of the known potential fire, explosion, and toxic release hazards related to the contractor work and the provisions of the emergency action plan.
- CH2M projects shall develop and implement the written procedure requirements to maintain the mechanical integrity of pressure vessels, storage tanks, piping systems, relief and vent systems, emergency shutdown systems, and controls and pumps process systems.
- A hot work permit shall be completed for any CH2M work involving welding, cutting, brazing, or similar flame- or spark-producing operations conducted near a covered process.
- Written procedures shall be developed, updated, and implemented to manage changes in chemicals, technology, equipment, and facilities.

- An incident report form (IRF) shall be completed within 24 hours of a PSM-related incident. Incidents involving a release of highly hazardous chemicals shall be reported following the Serious Incident Reporting section of SOP HSE-111.
- An investigation shall be initiated as soon as possible, but no later than 48 hours following an incident that resulted in, or could reasonably have resulted in, a catastrophic release of a highly hazardous chemical.
- An emergency action plan shall be developed and implemented for the entire plant, including procedures for handling small releases.
- A facility or process audit shall be performed every three years to certify compliance with the PSM standard.
- All information regarding compliance with PSM requirements shall be made available to affected personnel without regard to possible trade secret status.
- CH2M employees shall be trained before operating a newly assigned process or when involved in maintaining equipment. Refresher training shall be provided at least every three years and more often if necessary to assure the employee understands and adheres to the current operating procedures of the process.

8.55 Radar Hazards

Airports and all branches of the military use radar of significant power for buildings, towers, aircraft, ships, armor vehicles, and installations in general. Radar devices may emit harmful microwave radiation emissions. Microwave radiation is absorbed by the body and dissipated in the tissue as heat.

The penetration ability of the radiation depends on the wavelength. Microwave wavelengths of 25-200 centimeters have the ability to reach the internal organs with potentially damaging effects. Wavelengths less than 25 centimeters are absorbed and dissipated by the skin and the human body is thought to be transparent to microwave wavelengths greater than 200 centimeters. The health effects of microwave radiation include deep burns and thermal damage to any organ or organ system with low blood flow, most notably the lenses of the eyes. If adequate time has elapsed between exposures, the repair mechanisms of the lens seem to limit damage. Microwave radiation cannot be seen and its effects cannot be felt until serious damage has already occurred.

The OSHA exposure limit is 10 milliwatts per square centimeter (10 mW/cm^2) averaged over any 6-minute period.

Warning signs must be posted in areas where potentially damaging microwave radiation exists.

The prevention method for microwave radiation exposure is to not be in the path of radar or other microwave emitting devices by either ensuring that the device is not operating or ensuring that there is sufficient shielding between you and the microwave source.

8.56 Rail Road Safety

Careful observation of railroad safety requirements is essential and in the US is governed by the Federal Railroad Administration (FRA). For railroads involving Union Pacific Railroads (UPRR), refer to the “Minimum Safety Requirements for Engineering Department Contractors,” of the HSE SharePoint site which addresses training, minimum PPE, and safety requirements.

Permission to enter railroad property must be obtained from the local railroad. Working alone is not anticipated for this work. Contact the RHSM if working alone in the vicinity of railroads becomes necessary. Additional hazard controls will be evaluated by the RHSM and incorporated into the project safety plan.

If required by the client or railroad, all employees must participate in and comply with any job briefings conducted by the railroad's employee in charge (EIC). During these briefings, the railroad's EIC will specify safe work procedures, the potential hazards of the job, and emergency response procedures.

The following PPE must be worn when working around trains and rail-yards.

- Reflective/high-visibility safety vests (orange or green-yellow);
- ANSI Z87.1-approved safety glasses shall be worn to protect from flying debris;
- ANSI-approved hard hat;
- Safety-toed boots (ANSI, CSA, or country/region equivalent);
- Hearing protection is required when employees are within 100 feet of locomotive or roadway/work equipment; 15 feet of power operated tools 150 feet of jet blowers or pile drivers 150 feet of retarders in use (when within 10 feet, employees must wear dual ear protection – plugs and muffs); and
- Any other PPE as required by the PPE section of the project safety plan.

Other general safety requirements include:

- Any work conducted within 25 feet of active tracks must first be approved by the client and any EIC requirements addressed (preferably in an AHA). Training (i.e., On-track Railroad Safety Training) is required in the US Federal Railroad Administration in these instances and may be required in other countries/localities. Coordinate this training with the RHSM or Safety Program Assistant (SPA).
- Attend client's safety training courses, as required, and carry or maintain proof of training as required by the client;
- Always pay attention to moving trains – never assume they are looking out for you;
- Work as far from traveled way as possible to avoid creating confusion for trains;
- Use the "buddy system" when work does not face the direction in which trains are coming from;
- The railroad must be promptly notified of any reportable injury;
- The railroad must be promptly notified of any damage to railroad property;
- All waste must be properly disposed of. No fires are permitted;
- All contractor's vehicles stop at all railroad crossings to ascertain the way is clear;
- Always be on alert for moving equipment in either direction on the tracks. Do not stop or walk on the top of rail, frog, switches, guard rails, or other track components;
- When walking around a standing rail car, stay at least 20 feet behind it. Do not walk between rail cars unless there is a 50 feet clearance between cars. Do not sit on, lie under, or cross between cars; and
- No tools or materials are to be left close to the track when trains are passing.

8.57 Rigging

(Reference CH2M SOP HSE-316, *Rigging*)

Below are the hazard controls and safe work practices to follow when personnel are overseeing or performing rigging. Ensure the requirements in the referenced SOP are followed.

8.57.1 General

- All rigging equipment shall be used only for its intended purpose, inspected by a competent person prior to use, and shall not be loaded in excess of its capacity rating. Defective rigging shall be removed from service.

- When CH2M is in control of rigging operations, CH2M shall provide a rigging competent person that will inspect, maintain oversee all rigging operations. The competent person shall use the appropriate rigging inspection log form to inspect wire rope, synthetic slings and/or shackles.
- Tag lines shall be attached to every load being lifted by a crane.
- Rigging equipment shall be protected from flame cutting and electric welding operations, and or contact avoided with solvents and chemicals.
- Rigging equipment, when not in use, shall be stored in an area free from damage caused by environmental elements, hazardous substances, and other factors that may compromise equipment integrity and performance.
- No modification or addition, which that could affect the capacity and or safe operation of the equipment, shall be made without the manufacturer's written approval.
- Rigging equipment shall not be shortened with knots, bolts or other makeshift devices.
- The manufacturer's recommendations shall be followed in determining the safe working loads of the various sizes and types of specific and identifiable hooks. All hooks for which applicable manufacturer's recommendations are available shall be tested to twice the intended safe working load before they are initially put into their initial use. Venders or suppliers will provide documentation of proof testing documentation.
- Special hoisting devices, slings, chokers, hooks, clamps, or other lifting accessories shall be marked to indicate the safe working loads and shall be proof -tested prior to initial use to 125 percent of their rated load. Vendors or suppliers will provide documentation of proof testing documentation.

8.57.2 Equipment

- Protruding end strands of wire rope shall be covered or blunted.
- Wire rope shall not be used, if in any length of eight diameters, the number of total number of visible broken wires exceeds 10 percent of the total number of wires, or if the rope shows other signs of excessive wear, corrosion, or defect.
- When inspecting the end fittings of wire rope slings, if more than one wire in a lay is broken in the fitting, do not use the sling.
- Synthetic web slings shall be immediately removed from service if any of the following conditions are present:
  - acid or caustic burns; melting or charring of any part of the sling
  - surface; snags, punctures, tears or cuts; broken or worn stitches; distortion of fittings;
  - discoloration of or rotting; red warning line showing.
- Never use makeshift hooks, links or other fasteners. Job or shop hooks and links, or makeshift fasteners, formed from bolts, rods, etc., or other such attachments, shall not be used.
- Alloy steel chains shall have permanently affixed identification stating size, grade, rated capacity and reach.
- Shackles and hooks shall be constructed of forged alloy steel with the identifiable load rating on the shackle or hook.

8.57.3 Rigging Use

- Rigging shall not be pulled from under a load when the load is resting on the rigging.
- Place sling(s) in center bowl of hook.

- When attaching slings to the load hoist hook, corners and sharp edges should be "packed" to prevent cutting or damaging the rope or slings.
- Never use nylon, polyester, or polypropylene web slings, or web slings with aluminum fittings shall not be used where fumes, vapors, sprays, mists or liquids of acids, caustics or phenolics are present.
- Natural and synthetic fiber rope slings, except for wet frozen slings, may be used in a temperature range form from minus 20º F to plus 180º F without decreasing the working load limit. For operations outside this temperature range, and for wet frozen slings, the sling manufacturer's recommendations shall be followed.
- When used for eye splices, the U-bolt shall be installed so that the "U" section is in contact with the dead end of the rope.

8.58 Scaffolds

(Reference CH2M SOP HSE-311, *Scaffolds*)

Below are the hazard controls and safe work practices to follow when personnel or subcontractor personnel are using scaffolds. Ensure the requirements in the referenced SOP are followed.

8.58.1 Working from Scaffolds

- All scaffolds must be designed by a qualified person and installed under the supervision of a competent person.
- Do not access scaffolds until the competent person has completed the work shift inspection and has authorized access.
- Follow all requirements established by the competent person or as identified on the scaffold tag.
- Do not access scaffolds until authorized by the competent person.
- Do not access scaffolds that are damaged or unstable at any time and for any reason.
- Only access scaffolds by means of a ladder, stair tower, ladder stand, ramp, integral prefabricated scaffold access, or other equivalent safe means of access. Scaffold cross-bracing shall not be used to access scaffold platforms.
- Remain within the scaffold guardrail system when provided. Leaning over or stepping across a guardrail system is not permitted.
- Use personal fall arrest systems when required by the competent person and when working from suspension scaffolds or boatswains' chairs.
- Do not stand on objects (boxes, buckets, bricks, blocks, etc.) or ladders on top of scaffold platforms to increase working height unless the platform covers the entire floor area of the room.
- Do not work on scaffolds covered with snow, ice, or other slippery material or work on scaffolds during storms or high winds unless personal fall arrest systems or wind screens are provided and the competent person determines it is safe to remain on the scaffold.
- Do not overload scaffold planks over their rated weight bearing capacity. When feasible, place loads directly over the scaffolds vertical weight bearing structures.

8.58.2 Supported Scaffolds

This section covers the erection, use, and dismantling of supported scaffolds. Supported scaffolds consist of one or more platforms supported by outrigger beams, brackets, poles, legs, uprights, posts, frames, or similar rigid support. Supported scaffolds include frame, fabricated frame, tube and coupler, pole, bricklayer's, and step platform. The common requirements for all supported scaffolds are addressed here; the competent person shall ensure scaffold type specific requirements are included as applicable.

- CH2M staff erecting, dismantling, or working on scaffolds must complete the CH2M 10-Hour Construction Safety Awareness training course. Staff must also and receive project-specific scaffold training from a qualified person. Staff shall not use scaffold systems for which they have not been trained.
- A CH2M scaffold competent person shall be assigned to direct and oversee the erection, dismantling, and use of scaffolds. Additionally, they must inspect scaffolds each day prior to use.
- Scaffolds shall be designed by a qualified person and shall be constructed and loaded in accordance with that design.
- Stationary scaffolds over 125 feet (38.1 meters) in height and rolling scaffolds over 60 feet (18.3 meters) in height must be designed by a professional engineer.
- A tag and permit system shall be used to inform personnel of the construction status of the scaffold. At a minimum, the system used shall inform users when a scaffold is complete and safe to be used and when a scaffold is under construction and is not ready to be used. When additional precautions are required to use the scaffold safely, for example, the use of fall protection systems, the system shall identify the precautions to be taken. The tag or permit shall be placed at each means of access to the scaffold. The competent shall be responsible for the tag and permit system.
- A daily safety briefing shall be conducted with all scaffold personnel to discuss the work planned for the day and the HSE requirements to be followed.
- Scaffolds and scaffold components must be capable of supporting, without failure, their own weight and at least 4 times their maximum intended load.
- The site must be inspected to determine ground conditions, strength of supporting structure, and for proximity of electric power lines, overhead obstructions, wind conditions, the need for overhead protection or weather protection coverings.
- Supported scaffolds must be set on base plates, mudsills, or other adequate firm foundation.
- Frame spacing and mudsill size can only be determined after the total loads to be imposed on the scaffold and the strength of the supporting soil or structure are calculated and considered. This analysis must be done by a qualified person.
- Base plates or screwjacks with base plates must be in firm contact with both the sills and the legs of the scaffolding. Compensate for uneven ground with screwjacks with base plates. DO NOT USE unstable objects such as blocks, loose bricks, etc.
- Scaffolds and scaffold components must be inspected for visible defects before each shift by a competent person, and after each occurrence that could affect a scaffold's integrity (such as being struck by a crane).
- Maintain scaffolding and materials (e.g., paint roller extensions, building material) at least 10 feet (3 meters) from overhead power lines for voltages of 50 kV or less, and 10 feet (3 meters) plus 0.4 inch (1.0 cm) for every 1 kV over 50 kV.
- All portable electric equipment must be protected by ground-fault circuit interrupters (GFCIs) or an assured equipment grounding conductor program.

8.58.3 Suspended Scaffolding

Suspension scaffolds consist of one or more platforms suspended by ropes or other non-rigid means from an overhead structure(s). The common requirements for suspended scaffolds are addressed here; the competent person shall ensure scaffold type specific requirements are included as applicable.

- CH2M staff erecting, dismantling, or working on scaffolds must complete the CH2M 10-Hour Construction Safety Awareness training course. Staff must also and receive project-specific scaffold training from a qualified person. Staff shall not use scaffold systems for which they have not been trained.
- A CH2M scaffold competent person shall be assigned to direct and oversee the erection, dismantling, and use of scaffolds. Additionally, they must inspect scaffolds each day prior to use.
- Scaffolds shall be designed by a qualified person and shall be constructed and loaded in accordance with that design.
- A tag and permit system shall be used to inform personnel of the construction status of the scaffold. At a minimum, the system used shall inform users when a scaffold is complete and safe to be used and when a scaffold is under construction and is not ready to be used. When additional precautions are required to use the scaffold safely, for example, the use of fall protection systems, the system shall identify the precautions to be taken. The tag or permit shall be placed at each means of access to the scaffold. The competent shall be responsible for the tag and permit system.
- A daily safety briefing shall be conducted with all scaffold personnel to discuss the work planned for the day and the HSE requirements to be followed.
- Scaffolds and scaffold components must be capable of supporting, without failure, their own weight and at least 4 times their maximum intended load.
- The site must be inspected to determine the strength of supporting structure, and for proximity of electric power lines, overhead obstructions, wind conditions, the need for overhead protection or weather protection coverings.
- Scaffolds and scaffold components must be inspected for visible defects before each shift by a competent person, and after each occurrence that could affect a scaffold's integrity (such as being struck by a crane).
- Maintain scaffolding and materials (e.g., paint roller extensions, building material) at least 10 feet (3 meters) from overhead power lines for voltages of 50 kV or less, and 10 feet (3 meters) plus 0.4 inch (1.0 cm) for every 1 kV over 50 kV.
- All portable electric equipment must be protected by ground-fault circuit interrupters (GFCIs) or an assured equipment grounding conductor program.

8.58.4 Fall Protection on Suspended Scaffolds

- Each employee on a multi-point or two-point adjustable suspension scaffold must be protected by both a guardrail system and a personal fall arrest system.
- Personal fall-arrest systems used on scaffolds shall be attached by lanyard to a vertical lifeline, horizontal lifeline, or scaffold structural member.
- Guardrail systems must be installed along all open sides and ends of platforms, and must be in place before the scaffold is released for use by employees other than erection/dismantling crews.

8.59 Spotters during Vehicle Backing Operations and Heavy Equipment Tasks

Spotters should be used for these tasks as indicated below.

- Evaluate vehicle operations prior to performing the task to assess the following:
  - Can the distance of reversing the vehicle be eliminated or minimized?
  - Are there any hazards along the route that would interfere with the safe completion of the job including any points along the path of travel where the spotter may be placed in a dangerous position or line of fire?
  - Can the route be modified to make the task safer?

- Can the route be cleared of workers (pedestrians) within 8 feet (2.5m) of the moving vehicle? If not, do not proceed. Contact HSM and PM.

- In additional to verbal communications, the driver/operator and spotter must agree to communicate via one of the following: hand signals, two-way radio, lights, handheld air horn or other (specify in daily safety briefings, PTSP, etc.).
- Only one spotter should be used at a time.
- Spotters responsibilities are:
  - Position to enable the driver to maintain visual contact with me
  - Never cross the path of travel of a **moving** vehicle
  - Maintain a minimum 8 feet (2.5 m) distance from **moving** vehicle
  - Wear a high visibility vest
  - Wear the PPE requirements for the area
  - Communicate to the driver to **STOP** immediately if any unexpected hazards are observed
  - Never ride on the vehicle while it is moving
  - Keep the route free of people that don't need to be there
- Driver responsibilities include:
  - STOP immediately if visual contact with the spotter is lost
  - STOP immediately if instructed by the spotter
  - STOP immediately if anyone comes within 8 feet (2.5 m) of the vehicle
  - Operate the vehicle so speed does not exceed the walking pace of the spotter
  - Communicate the blind spots of the vehicle to the spotter
  - Turn radio and any other distractions off in the cab of vehicle
  - Make sure window(s) are open to receive spotter communications
  - Make sure windows and mirrors are clear to ensure good visibility

8.60 Stairways and Ladders

(Reference CH2M SOP HSE-214*, Stairways and Ladders*)

Below are the hazard controls and safe work practices to follow when using stairways and ladders. Ensure the requirements in the referenced SOP are followed.

- Stairway or ladder is generally required when a break in elevation of 19 inches (48.3 cm) or greater exists.
- Personnel should avoid using both hands to carry objects while on stairways; if unavoidable, use extra precautions.
- Personnel must not use pan and skeleton metal stairs until permanent or temporary treads and landings are provided the full width and depth of each step and landing.
- Ladders must be inspected by a competent person for visible defects prior to each day's use. Defective ladders must be tagged and removed from service.
- Always obey and pay attention to warning labels or stickers on the specific ladder being used.
- Ladders must be used only for the purpose for which they were designed and shall not be loaded beyond their rated capacity.
- Ladder safety training on safe use (take the Stairways and Ladders safety training module located on the VO).
- Only one person at a time shall climb on or work from an individual ladder.

- User must face the ladder when climbing; keep belt buckle between side rails.
- Ladders shall not be moved, shifted, or extended while in use.
- User must use both hands to climb; use rope to raise and lower equipment and materials.
- Straight and extension ladders must be tied off to prevent displacement.
- Ladders that may be displaced by work activities or traffic must be secured or barricaded.
- Personnel climbing ladders shall face the ladder and maintain 3 points of contact with the ladder.
- Portable ladders must extend at least 3 feet (91.5 cm) above landing surface.
- Straight and extension ladders must be positioned at such an angle that the ladder base to the wall is one-fourth of the working length of the ladder.
- Stepladders are to be used in the fully opened and locked position.
- Users are not to stand on the top two steps of a stepladder; nor are users to sit on top or straddle a stepladder.
- Fixed ladders $\geq$ 24 feet (7.3 meters) in height must be provided with fall protection devices.
- Fall protection should be considered when working from extension, straight, or fixed ladders greater than six feet (1.8 meters) from lower levels and both hands are needed to perform the work, or when reaching or working outside of the plane of ladder side rails.

8.61 Steel Erection

(Reference CH2M SOP HSE-312*, Steel Erection*)

Below are the hazard controls and safe work practices to follow when working around or performing steel erection activities. Ensure the requirements in the referenced SOP are followed.

- Protruding reinforcing steel (rebar), onto which personnel could fall, must be guarded to eliminate the hazard of impalement.
- Structural steel loads shall not be released from the hoisting line until the members are secured with at least two bolts, or the equivalent at each connection and drawn up wrench tight.
- Tag lines shall be used for controlling loads.
- Containers shall be provided for storing or carrying rivets, bolts, and drift pins, and secured against accidental displacement when aloft.
- Air line hose sections shall be secured together, except when quick disconnect couplers are used to join sections.
- Impact wrenches used for bolting shall be provided with a locking device for retaining the socket.
- Turnbuckles shall be secured to prevent unwinding while under stress.
- Plumbing-up guys shall be removed only under the supervision of a competent person.
- Metal decking of sufficient strength shall be laid tight and secured to prevent movement.
- Provisions shall be made to secure temporary flooring against displacement. Planks shall overlap the bearing on each end by a minimum of 12 inches (30.5 cm). Wire mesh, exterior plywood, or equivalent, shall be used around columns where planks do not fit tightly.
- All unused openings in floors, temporary or permanent, shall be completely planked over or guarded.

8.62 Slips, Trips and Falls

General

- Institute and maintain good housekeeping practices.
- Designate foot traffic paths in and out of sites, when necessary, to ensure paths are kept free from slip, trip, and fall hazards or to deter personnel from taking “shortcuts” where slip, trip, hazards may be.
- Mitigate icy conditions by keeping foot traffic paths clear of ice and snow.
- Watch footing as you walk to avoid trip hazards, animal holes, or other obstacles, especially in tall grassy areas.

Muddy Conditions

- Muddy conditions present a slipping hazard. Use mats or other similar surface to work from if footing cannot be stabilized.
- Take shortened steps across muddy areas.
- Use a walking staff or other similar means to assist with balance.

Steep Slopes/Uneven Ground/Rock and Vertical Slopes

- Be aware that escarpments can slough. Avoid these areas.
- Exercise caution in relying on rocks and trees/tree stumps to support yourself – many times they are loose.
- Whenever possible, switchback your way up/down steep areas, and maintain a slow pace with firm footing.
- Employees walking in ditches, swales and other drainage structures adjacent to roads or across undeveloped land must use caution to prevent slips and falls which can result in twisted or sprained ankles, knees, and backs.
- Whenever possible observe the conditions from a flat surface and do not enter a steep ditch or side of a steep road bed.
- If steep terrain must be negotiated coordinate with RHSM to evaluate the need for ladders or ropes to provide stability.

Snow and Ice on Walking/Working Surfaces

<u>Housekeeping and Preparedness</u>

- Evaluate whether the work can be postponed until site conditions improve for both our work and our subcontractors.
- Remove snow from walkways regularly and use ice-melt or sand, when necessary.
- Notify those responsible for clearing walkways and work areas when we observe a potentially hazardous location. At our project sites, be sure someone is responsible for maintaining walkways.
- Don’t assume that the walk path is not slippery if it has been plowed and sanded already.
- Mark potential hazards (e.g., holes, rebar, plastic, etc.) prior to snowfall. Designate walkways that avoid such hazards.
- Avoid any ice or snow-covered location where a hazard may exist; use a vehicle rather than walking, when possible.
- If you cannot avoid the area, wear shoes or boots that provide traction on snow and ice or use YakTrax™, ice cleats, or similar product (see links below). *Note* - Additional hazards could be introduced if these

types of footwear are worn inside, on stairs, etc. Be sure appropriate donning and doffing areas are established.

- Inspect your footwear before wearing it.
- Ensure that your safety plan or Activity Hazard Analysis is up to date and adequately addresses hazards of winter work environments.

How to Walk in Icy Conditions

- Give yourself sufficient time and plan your route.
- Keep your eyes on where you are stepping and GO S-L-O-W-L-Y!! This will help your reaction time to changes in traction.
- Be aware of hazards you might have missed such as black ice and ice covered by snow.
- Keep both hands free for balance --NOT in your pockets.
- When handrails are available – USE THEM!
- Wear gloves to keep hands warm and readily available to hold snow-covered handrails.
- Take short steps or shuffle for stability, bend slightly, and walk flat-footed. Keep your center of gravity directly over your feet as much as possible. Keep your eyes on where you are going. Remember the "Walk like a penguin" method.
- Don't carry too much or block your line of vision.
- Be prepared to fall!

How to Fall

Have you ever practiced falling? In the event that you slip and fall while walking in the office, to your car, or on a project site try and remember the following:

- Do not try to break your fall by sticking out your arm, elbow or wrist due to potential for fractures or ligament damage.
- Try instead to create a large surface area by either outstretching your arm and landing on your side or tucking your arm and curling to a ball and landing on your back.

Getting in and out of Vehicles on Icy or Snowy Surfaces

Use special care when entering and exiting vehicles:

- Use the vehicle for support
- Step out planting foot firmly on the ground
- Have hands free for support

8.63 Stream Crossing

Traversing streams present significant hazards, including drowning, hypothermia, and abrasions. When crossing streams, be sure to implement the bulleted items below.

- When walking in streams, first plan the route. Look ahead for exits should there be any difficulty during the crossing, and "read" the water for spots to avoid such as drop offs, sunken logs, and tricky currents.
- Do seek out the safest route – narrow, low flow, shallow. Evaluate deeper and faster moving sections with caution. Backtracking is often dangerous or impossible once committed.
- If streams to be crossed are deeper than "knee deep", find an alternate crossing location that is less deep.
- Streams should be crossed while facing upstream, stepping side to side, and using a sturdy walking stick. When possible, wade a stream diagonally, moving downstream. Move slowly, keeping the foot on the upstream side in the lead and pointed forward. Your rear, or anchor, foot should point downstream and be

at right angles to the lead foot. Move the lead foot forward about half a step, feeling for a solid hold. Next, move the anchor foot forward the same distance – shuffle across so that your anchor foot never passes the lead. This way both feet are always in position to lend support. If you must turn around, do so toward the upstream direction.

- Don't attempt to cross above rocky rapids or a cascade. Step on submersed rocks with great care.
- If you are working in streams, algae covered rocks should be assumed slippery until tested. Always be alert for unstable and extremely slippery rocks.
- Rocks with green moss or attached plants offer better traction or even better, look for gravel and sand pockets among the stream boulders, which are much more stable, and use a wading staff (if not carrying one, find a suitable one nearby) to steady your balance while crossing. Use a solid wading staff instead of the collapsible type.
- Be cautious of areas where there are submerged or partially submerged trees/tree branches – these can create entanglement hazards during a crossing or a "swim".
- If streams are crossed that are deeper than "crotch deep", personnel must use either ropes and/or wear chest waders.
- Choose the right waders (with RHSM/SC involvement).
- Footwear with felt-bottom soles are ideal for rocky bottom streams. The rough texture cuts through algae growing on the rocks and grips well. For very slippery conditions, consider studded felt soles or a slipover, studded sandal. However, felt soles do not provide good traction on muddy, slippery banks. Cleated soles work well for mud or sand bottom streams (a hard molded tread pattern similar to a hiking boot).
- Wear a wading belt with chest waiters to keep your waders from billowing out like a parachute; the currents will carry you and move you in ways you don't want to move.
- Never wade alone.
- If the wader fills with water, don't panic. Waders full of water weigh less in water than on land and the water inside doesn't add any weight as long as you are in the water. Also a common fear is that air trapped in the waders will raise the feet higher than the head and force the face underwater is unfounded. Waders do streamline your legs and kicking is useless. Follow these steps if the waders fill with water:
  - Don't try to take them off in the water
  - In calm water, wade or swim to shore
  - In fast-moving water, ride the current:
  - Pull your feet up in front of you, bend your knees
  - Point your feet downstream (so the feet, not the head will bounce off the rocks)
  - Sculling with your hands will help direct to the nearest shallow area
  - When you reach calm water, go ashore and empty your waders
  - Don't waste energy in the vertical position going for the bottom. This position is virtually impossible to maintain and leads quickly to exhaustion (the major cause of drowning).
  - Concentrate on getting out of the water and not saving the equipment.
- The higher the elevation you are at, the steeper the stream gradient is. This means the stream can rise quicker and return to lower flow more quickly.

- Always wait out a swollen stream if at all possible.
- If you do slip into the water and are being swept downstream, don't panic. Cold water will be a shock for 2-3 seconds. Pull your knees up, face your feet downstream and lean back, using your hands as best you can to navigate and get to the bank. Keep your head up; you don't want your head underwater banging into rocks. If you stay calm, you can reach water where you can stand up or swim to the bank.
- When walking along stream banks and not entering streams, wear work boots.

8.64 Traffic Control

(Reference CH2M SOP HSE-216, *Traffic Control*)

The following precautions must be taken when working around traffic, and in or near an area where traffic controls have been established by a subcontractor. Ensure the requirements in the referenced SOP are followed.

- CH2MHILL employees must never perform traffic control activities for 3rd party subcontractors.
- Exercise caution when exiting traveled way or parking along street – avoid sudden stops, use flashers, etc.
- Park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so that it can serve as a barrier.
- All staff working adjacent to traveled way or within work area must wear reflective/high-visibility safety vests.
- Eye protection should be worn to protect from flying debris.
- Remain aware of factors that influence traffic related hazards and required controls – sun glare, rain, wind, flash flooding, limited sight-distance, hills, curves, guardrails, width of shoulder (i.e., breakdown lane), etc.
- Always remain aware of an escape route (e.g., behind an established barrier, parked vehicle, guardrail, etc).
- Always pay attention to moving traffic – never assume drivers are looking out for you.
- Work as far from traveled way as possible to avoid creating confusion for drivers.
- When workers must face away from traffic, a "buddy system" should be used, where one worker is looking towards traffic.
- When working on highway projects, obtain a copy of the contractor's traffic control plan.
- Work area should be protected by a physical barrier – such as a K-rail or Jersey barrier.
- Review traffic control devices to ensure that they are adequate to protect your work area. Traffic control devices should: 1) convey a clear meaning, 2) command respect of road users, and 3) give adequate time for proper traffic response. The adequacy of these devices are dependent on limited sight distance, proximity to ramps or intersections, restrictive width, duration of job, and traffic volume, speed, and proximity.
- Either a barrier or shadow vehicle should be positioned a considerable distance ahead of the work area. The vehicle should be equipped with a flashing arrow sign and truck-mounted crash cushion (TMCC). All vehicles within 40 feet (12.2 meters) of traffic should have an orange flashing hazard light atop the vehicle.
- Except on highways, flaggers should be used when 1) two-way traffic is reduced to using one common lane, 2) driver visibility is impaired or limited, 3) project vehicles enter or exit traffic in an unexpected manner, or 4) the use of a flagger enhances established traffic warning systems.
- Lookouts should be used when physical barriers are not available or practical. The lookout continually watches approaching traffic for signs of erratic driver behavior and warns workers.

- Vehicles should be parked at least 40 feet (12.2 meters) away from the work zone and traffic. Minimize the amount of time that you will have your back to oncoming traffic.
- Traffic control training module on the VO shall be completed when CH2M workers who work in and around roadways and who exposed to public vehicular traffic.

8.65 Utilities (underground)

An assessment for underground utilities must be conducted where there is a potential to contact underground utilities or similar subsurface obstructions during intrusive activities. Intrusive activities include excavation, trenching, drilling, hand augering, soil sampling, or similar activities.

The assessment must be conducted <u>before any intrusive subsurface activity</u> and must include at least the following elements:

- A background and records assessment of known utilities or other subsurface obstructions.
- Contacting and using the designated local utility locating service.
- Conducting an independent field survey to identify, locate, and mark potential underground utilities or subsurface obstructions. *Note: This is independent of, and in addition to, any utility survey conducted by the designated local utility locating service above.*
- A visual survey of the area to validate the chosen location.
- When required by the project-specific safety plan, using the Utility Verification Checklist.

When any of these steps identifies an underground utility within 5 feet (1.5 meters) of intrusive work, then non-aggressive means must be used to physically locate the utility before a drill rig, backhoe, excavator or other aggressive method is used.

Aggressive methods are never allowed within 2 feet of an identified high risk utility (see paragraph below).

Any deviation from these requirements must be approved by the Responsible HS Manager and the Project Manager.

Background and Records Assessment of Known Utilities

Identify any client- or location-specific permit and/or procedural requirements (e.g., dig permit or intrusive work permit) for subsurface activities. For military installations, contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.

Obtain available utility diagrams and/or as-built drawings for the facility.

Review locations of possible subsurface utilities including sanitary and storm sewers, electrical lines, water supply lines, natural gas lines, fuel tanks and lines, communication lines, lighting protection systems, etc. Note: Use caution in relying on as-built drawings as they are rarely 100 percent accurate.

Request that a facility contact with knowledge of utility locations review and approve proposed locations of intrusive work.

Designated Local Utility Locating Service

Contact your designated local utility locating service (e.g., Dig-Safe, Blue Stake, One Call) to identify and mark the location of utilities. In the US, call 811 in the go to www.call811.com to identify the appropriate local service group. Contacting the local utility locating service is a legal requirement in most jurisdictions. (Some US states, [e.g., Washington] require that the entity performing the intrusive work be the responsible for contacting the local service.) Where subcontractors are responsible for the intrusive work, CH2M personnel shall verify the subcontractor has contacted the designated local utility locating service.

Independent Field Survey (Utility Locate)

The organization conducting the intrusive work (CH2M or subcontractor) shall arrange for an independent field survey to identify, locate, and mark any potential subsurface utilities in the work area. This survey is in addition to any utility survey conducted by the designated local utility locating service.

The independent field survey provider shall determine the most appropriate instrumentation/technique or combinations of instrumentation/techniques to identify subsurface utilities based on their experience and expertise, types of utilities anticipated to be present, and specific site conditions.

A CH2M or subcontractor representative must be present during the independent field survey to observe the utility locate and verify that the work area and utilities have been properly identified and marked. If there is any question that the survey was not performed adequately or the individual was not qualified, then arrangements must be made to obtain a qualified utility locate service to re-survey the area. Obtain documentation of the survey and clearances in writing and signed by the party conducting the clearance. Maintain all documentation in the project file.

If the site owner (military installation or client) can provide the independent field survey, CH2M or the subcontractor shall ensure that the survey includes:

- Physically walking the area to verify the work location and identify, locate, and mark underground utility locations:
- Having qualified staff available and instrumentation to conduct the locate;
- Agreeing to document the survey and clearances in writing.
- Should any of the above criteria not be met, CH2M or subcontractor must arrange for an alternate independent utility locate service to perform the survey.
- The markings from utility surveys must be protected and preserved until the markings are no longer required. If the utility location markings are destroyed or removed before intrusive work commences or is completed, the PM, SC, or designee must notify the independent utility locate service or the designated local utility locating service to resurvey and remark the area.

Visual Assessment before and during Intrusive Activities

Perform a “360 degree” assessment. Walk the area and inspect for utility-related items such as valve caps, previous linear cuts, patchwork in pavement, hydrants, manholes, utility vaults, drains, and vent risers in and around the dig area.

The visual survey shall include all surface landmarks, including manholes, previous liner cuts, patchwork in pavement, pad-mounted transformers, utility poles with risers, storm sewer drains, utility vaults, and fire hydrants.

If any unanticipated items are found, conduct further research before initiating intrusive activities and implement any actions needed to avoid striking the utility or obstruction.

Completion of the Utility Verification Checklist

When required by the safety plan, the utility verification checklist shall be completed by the SC and submitted to the PM and HSM for review and signature. Follow the instructions on the form and keep it accessible in the field during intrusive operations. Evaluate intrusive activities for changed conditions and contact the PM and HSM to ensure hazards are addressed and whether a new checklist needs to be completed.

Subsurface Activities within 5 feet of an Underground Utility or if there is Uncertainty

When aggressive intrusive activities will be conducted within 5 feet (1.5 meters) of an underground utility or when there is uncertainty about utility locations, locations must be physically verified by non-aggressive means such as air or water knifing, hand digging, or human powered hand augering. Non-conductive tools must be used if electrical hazards may be present. If intrusive activities are within 5 feet (1.5 meters) and parallel to a marked existing utility, the utility location must be exposed and verified by non-aggressive methods every 100 feet (30.5 meters). Check to see if the utility can be isolated during intrusive work.

Intrusive Activities within 2 feet of an Underground Utility

Use non-aggressive methods (hand digging, vacuum excavation, etc.) to perform intrusive activities within 2 feet of a high risk utility (i.e., a utility that cannot be de-energized or would cause significant impacts to repair/replace). Hazardous utilities shall be de-energized whenever possible.

Spotter

A spotter shall be used to monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon, presence of pea gravel or sand in soils, presence of concrete or other debris in soils, refusal of auger or excavating equipment). If any suspicious conditions are encountered stop work immediately and contact the PM or RHSM to evaluate the situation. The spotter must have a method to alert an operator to stop the intrusive activity (e.g., air horn, hand signals).

8.66 Utilities (overhead)

Proximity to Power Lines

It must be determined whether equipment operations including, positioning, and traveling will occur in proximity to power lines within 20 feet (6.1 meters) for line voltage up to 350 kilo volts (kV), and within 50 feet (15.2 meters) for line voltage between 350 kV to 1000 kV. For power lines over 1000 kV, the distance must be determined by the utility/operator or qualified registered professional engineer in electrical power transmission and distribution.

Operations adjacent to overhead power lines are PROHIBITED unless one of the following conditions is satisfied:

- Power has been shut off, positive means (such as lockout) have been taken to prevent the lines from being energized, lines have been tested to confirm the outage, and the utility company has provided a signed certification of the outage.
- The minimum clearance from energized overhead lines is as shown in the tables below, or the equipment will be repositioned and blocked to ensure that no part, including cables, can come within the minimum clearances shown in the table. [NOTE: Outside of the US, check with local and provincial code for more stringent requirements. The more stringent requirement will be followed.]
- The power line(s) has been isolated through the use of insulating blankets which have been properly placed by the utility. If insulating blankets are used, the utility will determine the minimum safe operating distance; get this determination in writing with the utility representative’s signature.
- All inquiries regarding electric utilities must be made in writing and a written confirmation of the outage/isolation must be received by the PM prior to the start of work.

MINIMUM DISTANCES FROM POWERLINES - US

Powerlines Nominal System Kv	Minimum Required Distance, Feet (Meters)
0-50	10 (3.0)
50-200	15 (4.6)
201-350	20 (6.1)
351-500	25 (7.6)
501-750	35 (10.7)
751-1000	45 (13.7)

Over 1000	Established by utility owner/operator or by a professional engineer in electrical power transmission/distribution

(These distances have been determined to eliminate the potential for arcing based on the line voltage.)

MINIMUM DISTANCES FROM POWERLINES – ALBERTA

Operating voltage between conductors of overhead powerline	Safe limit of approach distance for persons and equipment
0-750 volts (insulated or polyethylene covered conductors – entire length)	300 millimetres
0-750 volts (bare, uninsulated)	1.0 metre
Above 750 volts (insulated conductors – entire length, rated and tested)	1.0 metre
750 volts to 40 kilovolts	3.0 metres
69 kilovolts, 72 kilovolts	3.5 metres
138 kilovolts, 144 kilovolts	4.0 metres
230 kilovolts, 260 kilovolts	5.0 metres
500 kilovolts	7.0 metres

(These distances have been determined to eliminate the potential for arcing based on the line voltage.)

MINIMUM DISTANCES FROM POWERLINES – British Columbia, Manitoba, NWT, Ontario, Saskatchewan, and Yukon

Voltage of live Powerlines	Minimum Required Distance, Metres (Feet)
750 to 75,000 volts	3 (10)
75,000 to 250,000 volts	4.5 (15)
250,000 to 550,000 volts	6 (20)

(These distances have been determined to eliminate the potential for arcing based on the line voltage.)

8.67 Vacuum Trucks

When CH2M personnel are exposed to vacuum truck operations, the following safe work practices/hazard controls shall be implemented.

- A pre-operational check should be performed on the vacuum truck before use. Operators must be familiar with the operator’s manual.
- Operators of vacuum trucks should be trained and familiar with the equipment. At least one person should be operating the boom and one person signaling and assisting the boom operator.
- Before use the hoses and lines should be checked for fraying and connections checked for leakage. Proper selection of hose diameter and type of hose (smooth bore hose vs. corrugated hose) is vital before the job is performed.
- The amount of force produced by a vacuum truck can kill hose operators. If an eight-inch hose gets stuck to your body at 27 inches Hg, it can be fatal. All trucks should be equipped with an emergency release the hose operator or assistant can initiate if a worker gets sucked into a hose. A remote release, manual release near the truck and an inline “T” should be present on the truck. The inline “T” should be installed

between the very last section of hose and the working section of hose. The cord that releases the in-line relief should be tethered to the hose handler's belt or a watch buddy should be nearby holding the cord and ready to relieve in the event of an emergency. Operators should never attempt to vacuum hose with any part of their body to check for suction.

- Tanks on vacuum trucks are a confined space. Before the tank is opened and anyone enters a confined space assessment should be performed.
- The truck should always be grounded before use. The static electricity produced when sucking materials into the system can produce a spark and ignite anything in the tank or hose. Use of a grounding wire will prevent static electric explosions. Vacuum trucks should not be used to pump mixtures with a flash point less than 140 degrees or less - this is an accepted industry standard - refer to the operators manual for more information.
- When positioning truck to work, be extra cautions of personnel and other equipment located next to truck.
- Wet and dry material should not be mixed in the tank.
- When swinging the boom, change directions slowly.
- Do not load dump body beyond rated capacity. Be aware of possible load surge when turning or braking.

8.68 Vinyl Chloride

(Reference CH2M, SOP HSE-512, *Vinyl Chloride*)

Vinyl Chloride is considered a "Confirmed Human Carcinogen." Vinyl Chloride has a mild, sweet, chloroform-like odor.

CH2M is required to control employee workplace exposure to vinyl chloride when personal exposures are at or above 1.0 ppm as an 8-hour time-weighted average (TWA) or above 5.0 ppm short term exposure limit (STEL), by implementing a program that meets the requirements of the governing regulatory agency (e.g., in the US: Occupational Safety and Health Administration (OSHA) Vinyl Chloride standard, 29 CFR 1910.1017; in Canada: Provincial OH&S Code/Regulation, etc.). The elements of the CH2M vinyl chloride program include the following:

- Exposure monitoring
- Methods of control, including personal protective equipment (PPE) and respirators
- Medical surveillance
- Training on hazards of vinyl chloride and control measures (includes project-specific training and the computer-based training on CH2M's Virtual Office, *Vinyl Chloride)*
- Record keeping requirements

If air monitoring indicates there is potential exposure at the action level concentrations above, notify the RHSM to ensure the above have been adequately addressed. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met.
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person.
- Review the fact sheet included as an attachment to the SOP.

8.69 Welding and Cutting

(Reference CH2M, SOP-314, *Welding and Cutting*)

Below are the hazard controls and safe work practices to follow when working around or performing welding and cutting. Ensure the requirements in the referenced SOP are followed.

- Workers designated to operate welding and cutting equipment shall have been properly instructed and qualified to operate such equipment.
- Before welding or cutting is permitted, the area shall be inspected by the individual responsible for authorizing the welding or cutting operation. The authorization, preferably in the form of a written permit, shall detail precautions to be taken before work is to begin.
- Suitable fire extinguishing equipment shall be immediately available in the work area.
- Flame-resistant blankets shall be used to control sparks produced by welding and cutting operations from traveling to lower levels or adjacent surfaces.
- If the valve on a fuel-gas cylinder is found to leak around the valve stem, the valve shall be closed and the gland nut tightened. If this does not stop the leak, the cylinder is to be tagged and removed from service.
- Nothing should be placed on top of a cylinder or manifold that will damage it or interfere with the quick closing of the valve.
- Flow gages and regulators shall be inspected prior to use and removed from cylinders when not in use.
- Hoses, leads, and cables shall be not be routed through doorways and walkways unless covered, elevated, or protected from damage. Where hoses, leads, and cables pass through wall openings, adequate protection shall be provided to prevent damage.
- Flash arresters shall be installed at the torch handle.
- Arc welding electrodes shall not be struck against compressed gas cylinders to strike an arc.
- All arc welding or cutting operations shall be shielded by noncombustible or flame resistant screens to protect employees or other persons in the vicinity from the direct rays of the arc.
- Proper ventilation shall be provided so as to maintain the level of contaminants in the breathing zone of welders below applicable permissible exposure limits.
- When the potential for an explosive atmosphere exists in the immediate area of welding or cutting operations, air monitoring instruments shall be used to verify that no explosive atmosphere is present before or during welding or cutting operations.
- An assigned Fire Watch shall be maintained at least a half an hour after the welding or cutting operation was completed. The fire watch must be identifiable with a distinguishable hard hat and/or vest.
- Minimum personal protective equipment includes the following:
  - Safety-toed shoes or boots, hard hats, and safety glasses
  - Body protection (such as gloves, coveralls, or Tyvek) when chemical hazards exist
  - Hearing protection when working in close proximity to loud equipment and machinery
  - Protective clothing and gloves to prevent burns
  - Suitable eye protective equipment for the type of welding or cutting performed
  - Opaque screens to block arc flash from arc welding and cutting operations

- Mechanical ventilation systems for welding and cutting operations conducted in enclosed or confined spaces
- Air monitoring or sampling equipment to evaluate airborne concentrations of welding and cutting contaminants
- Respiratory protection when airborne concentrations of contaminants exceed regulatory limits

8.69.1 Compressed Gas Cylinders

- Cylinders being transported, moved, or stored shall have valve protection caps installed. When transported by motor vehicle, hoisted, or carried, cylinders shall be in the vertical position.
- Oxygen cylinders in storage shall be separated from fuel-gas cylinders or combustible materials by a minimum of 20 feet (6.1 meters) or by a noncombustible barrier at least 5 feet (1.5 meters) high having a fire resistant rating of at least one half hour.
- Inside of buildings, cylinders shall be stored in well-ventilated, dry locations at least 20 feet (6.1 meters) from highly combustible materials. Cylinders should be stored in definitely assigned places away from elevators, stairs, or gangways. Assigned storage areas shall be located where cylinders will not be knocked over or damaged.
- During use, cylinders shall be kept far enough away from the actual welding and cutting operations to prevent sparks, hot slag, or flames from reaching them. When impractical, fire resistant shields shall be provided.
- Cylinders containing oxygen or fuel-gas shall not be taken into confined spaces.
- If cylinders are frozen, warm (not boiling) water shall be used to thaw them.

8.69.2 Welding and Cutting Equipment

- Fuel-gas and oxygen hoses shall be easily distinguishable from each other and shall not be interchangeable between fuel-gas and oxygen.
- Hoses shall be inspected at the beginning of each shift. Defective hoses shall be removed from service.
- Hose couplings shall be designed to be disconnected with a rotary motion, not by straight pull.
- Torches shall be inspected at the beginning of each shift for leaking valves, connections, and couplings. Defective torches shall be removed from service.
- Torches shall be ignited with friction lighters, not open flames or hot work.

8.69.3 Arc Welding and Cutting

- Only manual electrode holders that are designed for arc welding or cutting and are capable of safely handling the maximum rated current shall be used.
- Only cable that is free from repair or splices for a minimum distance of 10 feet (3 meters) from the cable’s attachment to the electrode holder shall be used.
- Any current-carrying part that arc welders or cutters grip in their hand, as well as the outer surfaces of the jaws of the holder, shall be fully insulated against the maximum voltage encountered to ground.
- The frames of arc welding or cutting machines shall be grounded. Grounding circuits, other than by means of the structure, shall be checked to ensure that the circuit between the ground and the grounded power conductor has resistance low enough to permit sufficient current flow to cause the fuse or circuit breaker to interrupt the current.

- When electrode holders are left unattended, the electrode shall be removed and the holder placed where it cannot harm employees.
- Hot electrode holders shall not be dipped in water to cool them.
- When welding or cutting is stopped for any appreciable length of time, or before the welding or cutting machine is moved, the power shall be shut off.
- Before starting welding or cutting operations, all connections to the machine shall be checked.

8.69.4 Toxic Fumes and Gases

- General mechanical or local exhaust ventilation shall be provided when welding or cutting in a confined space.
- Contaminated air exhausted from the work area shall be discharged into the open air or otherwise clear of the intake air.
- Other employees exposed to the same atmosphere as the welder or cutter shall be protected in the same manner as the welder or cutter.
- In enclosed spaces, all surfaces covered with toxic preservative coatings shall be stripped to a distance of at least four inches from the area to be heated, or the worker shall be protected with an air-line respirator.
- Welding or cutting in an enclosed space shall be performed with local exhaust ventilation or air-line respirators when the following metal bases, fillers, or coatings are involved: lead, cadmium, mercury, zinc, stainless steel, or beryllium.
- Employees welding or cutting in the open air and who are exposed to the metals noted above shall be protected with filter-type respirators; however, when working with beryllium, the employee shall be protected with an air-line respirator.

8.69.5 Fire Prevention

- When the potential for an explosive atmosphere exists in the immediate area of welding or cutting operations, air monitoring instruments shall be used to verify that no explosive atmosphere is present before or during welding or cutting operations.
- When welding or cutting on walls, floors, or ceilings, the same precautions shall be taken on the opposite side as for the welding or cutting side.
- Whenever openings or cracks in the floor, walls, or doorways cannot be closed, precautions shall be taken to prevent combustible materials in other areas from coming in contact with sparks.
- To prevent fire in enclosed spaces, the gas supply to the torch shall be shut off at some point outside the enclosed space whenever the torch is not in use or is left unattended.
- Drums or hollow structures that have contained toxic or flammable substances shall be filled with water or thoroughly cleaned, ventilated, and tested before welding or cutting on them.
- Before heat is applied to a drum, container, or structure, a vent or opening shall be provided to release built-up pressure during the application of heat.
- Before welding or cutting on any surface covered by a preservative coating whose flammability is unknown, a competent person shall test to determine its flammability.
- Preservative coatings shall be considered highly flammable when scrapings burn rapidly.
- When preservative coatings are determined to be highly flammable, they shall be stripped from the area to be heated.

8.70 Working Around Material Handling Equipment

When CH2M personnel are exposed to material handling equipment, the following safe work practices/hazard controls shall be implemented:

- Never approach operating equipment from the rear. Always make positive contact with the operator, and confirm that the operator has stopped the motion of the equipment.
- Never approach the side of operating equipment; remain outside of the swing and turning radius.
- Maintain distance from pinch points of operating equipment.
- Never turn your back on any operating equipment.
- Never climb onto operating equipment or operate contractor/subcontractor equipment.
- Never ride contractor/subcontractor equipment unless it is designed to accommodate passengers and equipped with firmly attached passenger seat.
- Never work or walk under a suspended load.
- Never use equipment as a personnel lift; do not ride excavator buckets or crane hooks.
- Always stay alert and maintain a safe distance from operating equipment, especially equipment on cross slopes and unstable terrain.
- Wear a high visibility safety vest or high visibility clothing.

8.71 Working Alone

(Reference CH2M Core Standard, *Working Alone*)

Personnel can only be tasked to work alone by the Project Manager who shall assess potential hazards and appropriate control measures, with assistance from the Responsible Health and Safety Manager (RHSM).

"Lone workers" with an accountability system in place is permitted, depending on the hazards presented during the execution of the task. Reference the "Lone Worker Protocol" included as an attachment to the project safety plan.

Only limited operations task are permitted to be performed alone. Activities that are not permitted to be performed by a lone worker include the following:

- Working at heights (e.g., on ladders, lifts, scaffolding);
- Energy isolation (e.g., lockout/tagout);
- Any entry into a confined space; and
- Work involving electricity or other hazardous equipment (e.g., chainsaws);
- Work over or near water; and
- Working in an area where there is an increased potential for violence.

An AHA shall be developed that shall include:

- Type or nature of work to be conducted by the lone worker;
- Location of the work
- Length of time the worker will be working alone; and
- Any characteristics of the individual working alone which may increase the risk to the worker (e.g., medical conditions).

The employee working alone shall at all times be equipped with a working voice communication device such as a cellular phone, satellite phone, personal alarms, or two-way radio to check-in to their project contact (s) at predetermined times. For some work, a satellite-based communication system may be appropriate (i.e., a "SPOT" device).

Call-In System for Lone Worker Accountability

The employee working alone shall at all times be equipped with a working voice communication device such as a cellular phone, satellite phone, personal alarms, or two-way radio to check-in to their project contact (s) at pre-determined times.

Each time before going into the field, a "Call in contact Form" shall be completed by the lone worker and given to the call-in office worker contact prior to going into the field.

During field work, a copy of "The Lone Worker Call-In Contact Form" should be maintained by both the "Office Contact Worker" and the field-worker ("Lone Worker"). Lone Worker and Office Contact Worker must both have cell phones and each other's phone number, plus one other alternate phone number.

Lone worker shall call the office contact worker when he/she has arrived on-site, before exiting his/her vehicle. On this phone call, a time shall be arranged for a "check-in" call to be made by the field worker, based on duration of task. On each "check-in" call a time should be arranged for the next "check-in" call. Document these times on the form.

Lone Worker shall carry his or her cell-phone throughout the field event and put the ringer on its loudest setting as wind or other noise can muffle the sound. If, for any reason the cell-phone becomes inoperable, the field-worker shall immediately stop work, leave the site and find an alternative method of contacting the Office Contact Worker to verify their safety and to inform them of the issue.

Work shall not proceed in the field until the Lone Worker has a working device that provides communication with the Office Contact Worker.

Upon completion of work activities, Lone Worker should pack up all materials and prepare to leave site. Then, before starting the engine of the vehicle to leave site, the Lone Worker should contact the office-worker and inform him or her that work is complete and that he or she is leaving the site. A final call shall be made by the lone work to the office worker to confirm he/she has reached their destination.

If at any time, the Office Contact Worker does not receive a "check-in" call at the scheduled time he/she should attempt to contact Lone Worker. If no contact is made then the Office Contact Worker should contact the facility contact person to check on the Lone Worker.

If no contact is made with the Lone Worker, then the Office Contact Worker shall contact the PM and/or RHSM to let them know they are going to inform emergency services inform that there is a possible emergency and instruct them to go to the field location and assist the Lone Worker. The Office Contact Worker will provide to emergency services the Lone Worker's name, their last known location, vehicle description and their contact information.

Call in contact Form shall be completed by lone worker and given to call in contact prior to going into the field. Refer to the "Lone Worker Protocol" attached to the project safety plan.

8.72 Working Over Water

If any activities pose a risk to drowning implement the following during the activity:

- Fall protection should be provided to prevent personnel from falling into water. Where fall protection systems are not provided and the danger of drowning exists, Coast Guard-approved personal flotation devices (PFDs), or a life jacket, shall be worn.
- Provide employees with an approved life jacket or buoyant work vest (USCG for U.S. operations).
  - Employees should inspect life jackets or work vests daily before use for defects. Do not use defective jackets or vests.

- Post ring buoys with at least 90 feet (27.4 meters) of 3/8-inch solid-braid polypropylene (or equal) line next to the work area. If the work area is large, post extra buoys 200 feet (61 meters) or less from each other.
- Provide at least one life saving skiff, immediately available at locations where employees are working over or adjacent to water.
  - Ensure the skiff is in the water and capable of being launched by one person and is equipped with both motor and oars.
- Designate at least one employee on site to respond to water emergencies and operate the skiff at times when there are employees above water.
  - If the designated skiff operator is not within visual range of the water, provide him or her with a radio or provide some form of communication to inform them of an emergency.
  - Designated employee should be able to reach a victim in the water within three to four minutes.
- Ensure at least one employee trained in CPR and first aid is on site during work activities.

9. Physical Hazards and Controls

Physical hazards include exposure to temperature extremes, sun, noise, and radiation. If you encounter a physical hazard that has not been identified in this Handbook or the project safety plan, contact the RHSM so hazard controls can be addressed.

9.1 Noise

(Reference CH2M SOP HSE-108, *Hearing Conservation*)

CH2M is required to control employee exposure to occupational noise levels of 85 decibels, A-weighted, (dBA) and above by implementing a hearing conservation program that meets the requirements of the OSHA Occupational Noise Exposure standard, 29 CFR 1910.95 (in Canada: Provincial OH&S Code/Regulations). A noise assessment may be conducted by the RHSM or designee based on potential to emit noise above 85 dBA and also considering the frequency and duration of the task.

- Areas or equipment emitting noise at or above 90dBA shall be evaluated to determine feasible engineering controls. When engineering controls are not feasible, administrative controls can be developed and appropriate hearing protection will be provided.
- Areas or equipment emitting noise levels at or above 85 dBA, hearing protection must be worn.
- Employees exposed to 85 dBA or a noise dose of 50 percent must participate in the Hearing Conservation program including initial and annual (as required) audiograms.
- The RHSM will evaluate appropriate controls measures and work practices for employees who have experienced a standard threshold shift (STS) in their hearing.
- Employees who are exposed at or above the action level of 85 dBA are required to complete the online Noise Training Module located on CH2M's virtual office.
- Hearing protection will be maintained in a clean and reliable condition, inspected prior to use and after any occurrence to identify any deterioration or damage, and damaged or deteriorated hearing protection repaired or discarded.
- In work areas where actual or potential high noise levels are present at any time, hearing protection must be worn by employees working or walking through the area.
- Areas where tasks requiring hearing protection are taking place may become hearing protection required areas as long as that specific task is taking place.
- High noise areas requiring hearing protection should be posted or employees must be informed of the requirements in an equivalent manner and a copy of the OSHA standard (29 CFR 1910.95), Provincial OH&S Code/Regulation, or other governing regulation shall be posted in the workplace.

9.2 Ultraviolet Radiation (sun exposure)

Health effects regarding ultraviolet (UV) radiation are confined to the skin and eyes. Overexposure can result in many skin conditions, including erythema (redness or sunburn), photoallergy (skin rash), phototoxicity (extreme sunburn acquired during short exposures to UV radiation while on certain medications), premature skin aging, and numerous types of skin cancer. Implement the following controls to avoid sunburn.

Limit Exposure Time

- Rotate staff so the same personnel are not exposed all of the time.
- Limit exposure time when UV radiation is at peak levels (approximately 2 hours before and after the sun is at its highest point in the sky).

- Avoid exposure to the sun, or take extra precautions when the UV index rating is high.

Provide Shade

- Take lunch and breaks in shaded areas.
- Create shade or shelter through the use of umbrellas, tents, and canopies.
- Fabrics such as canvas, sailcloth, awning material and synthetic shade cloth create good UV radiation protection.
- Check the UV protection of the materials before buying them. Seek protection levels of 95 percent or greater, and check the protection levels for different colors.

Clothing

- Reduce UV radiation damage by wearing proper clothing; for example, long sleeved shirts with collars, and long pants. The fabric should be closely woven and should not let light through.
- Head protection should be worn to protect the face, ears, and neck. Wide-brimmed hats with a neck flap or "Foreign Legion" style caps offer added protection.
- Wear UV-protective sunglasses or safety glasses. These should fit closely to the face. Wrap-around style glasses provide the best protection.

Sunscreen

- Apply sunscreen generously to all exposed skin surfaces at least 20 minutes before exposure, allowing time for it to adhere to the skin.
- Re-apply sunscreen at least every 2 hours, and more frequently when sweating or performing activities where sunscreen may be wiped off.
- Choose a sunscreen with a high sun protection factor (SPF). Most dermatologists advocate SPF 30 or higher for significant sun exposure.
- Waterproof sunscreens should be selected for use in or near water, and by those who perspire sufficiently to wash off non-waterproof products.
- Check for expiration dates, because most sunscreens are only good for about 3 years. Store in a cool place out of the sun.
- No sunscreen provides 100 percent protection against UV radiation. Other precautions must be taken to avoid overexposure.

9.3 Temperature Extremes

(Reference CH2M SOP HSE-211, *Heat and Cold Stress*)

Each employee is responsible for the following:

- Recognizing the symptoms of heat or cold stress;
- Taking appropriate precautionary measures to minimize their risk of exposure to temperature extremes (see following sections); and
- Communicating any concerns regarding heat and cold stress to their supervisor or SC.

9.3.1 Heat

Heat-related illnesses are caused by more than just temperature and humidity factors.

Physical fitness influences a person's ability to perform work under heat loads. At a given level of work, the more fit a person is, the less the physiological strain, the lower the heart rate, the lower the body temperature (indicates less retrained body heat—a rise in internal temperature precipitates heat injury), and the more efficient the sweating mechanism.

Acclimatization is a gradual physiological adaptation that improves an individual's ability to tolerate heat stress. Acclimatization requires physical activity under heat-stress conditions similar to those anticipated for the work. With a recent history of heat-stress exposures of at least two continuous hours per day for 5 of the last 7 days to 10 of the last 14 days, a worker can be considered acclimatized. Its loss begins when the activity under those heat-stress conditions is discontinued, and a noticeable loss occurs after 4 days and may be completely lost in three to four weeks. Because acclimatization is to the level of the heat-stress exposure, a person will not be fully acclimatized to a sudden higher level; such as during a heat wave.

Dehydration reduces body water volume. This reduces the body's sweating capacity and directly affects its ability to dissipate excess heat.

The ability of a body to dissipate heat depends on the ratio of its surface area to its mass (surface area/weight). **Heat dissipation** is a function of surface area, while heat production depends on body mass. Therefore, overweight individuals (those with a low ratio) are more susceptible to heat-related illnesses because they produce more heat per unit of surface area than if they were thinner. Monitor these persons carefully if heat stress is likely.

When wearing **impermeable clothing**, the weight of an individual is not as important in determining the ability to dissipate excess heat because the primary heat dissipation mechanism, evaporation of sweat, is ineffective.

SYMPTOMS AND TREATMENT OF HEAT STRESS

	Heat Syncope	Heat Rash	Heat Cramps	Heat Exhaustion	Heat Stroke
Signs and Symptoms	Sluggishness or fainting while standing erect or immobile in heat.	Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure.	Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours.	Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid thready pulse and low blood pressure; oral temperature normal or low	Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature.
Treatment	Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete.	Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.	Remove to cooler area. Rest lying down. Increase fluid intake.	Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.	Cool rapidly by soaking in cool–but not cold–water. Call ambulance, and get medical attention immediately!

Precautions

- Drink 16 ounces of water before beginning work. Disposable cups and water maintained at 50°Fahrenheit (10 degrees Celsius [C]) to 60°Fahrenheit (F) (15.6 degrees C) should be available. Under severe conditions, drink 1 to 2 cups every 20 minutes, for a total of 1 to 2 gallons (7.5 liters) per day. Remind employees to drink water throughout their work shift.
- Alternating water consumption with a sports drinks (e.g., Gatorade, Powerade, Sqwincher) to help maintain electrolyte balance, especially when working in hot conditions for more than 2 hours, may be necessary. The recommended hydration protocol is alternating water with a sports drink at a one-to-one ratio. Also eating regular meals and salt-containing snacks can also replace electrolytes lost during sweating.
- Do not use alcohol in place of water or other nonalcoholic fluids. Decrease your intake of coffee and caffeinated soft drinks during working hours.
- Acclimate to site work conditions by slowly increasing workloads; for example, do not begin site work with extremely demanding activities. Closely monitor employees during their first 14 days of work in the field.
- Supervisors and SCs must continually observe employees throughout the work shift for signs and symptoms of heat stress or illness. Employees must monitor themselves for heat stress as well as observe their co-workers.
- Effective communication must be maintained with employees throughout the work shift either by voice, observation, or electronic device.
- Use cooling devices, such as cooling vests, to aid natural body ventilation. These devices add weight, so their use should be balanced against efficiency.
- Use mobile showers or hose-down facilities to reduce body temperature and cool protective clothing.
- Conduct field activities in the early morning or evening and rotate shifts of workers, if possible.
- Avoid direct sun whenever possible, which can decrease physical efficiency and increase the probability of heat stress. Take regular breaks in a cool, shaded area. Use a wide-brim hat or an umbrella when working under direct sun for extended periods.
- Provide adequate shade to protect personnel against radiant heat (sun, flames, hot metal).

- Use portable fans for convection cooling or in extreme heat conditions, an air-conditioned rest area when needed.
- In hot weather, rotate shifts of workers.
- Maintain good hygiene standards by frequent changes of clothing and showering. Clothing should be permitted to dry during rest periods. Persons who notice skin problems should consult medical personnel.

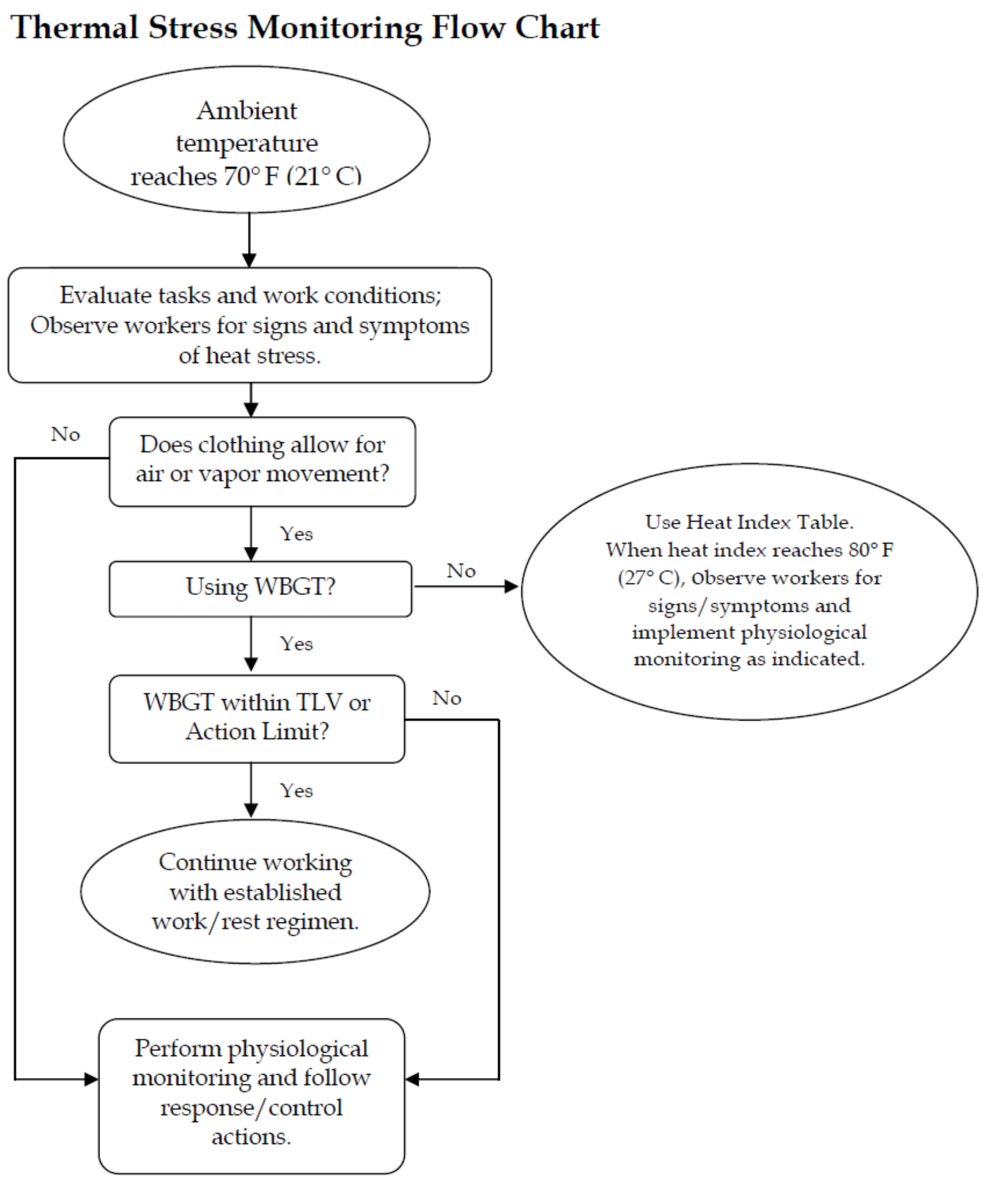
- Brief employees initially before the project work begins and routinely as part of the daily safety briefing, on the signs and symptoms of heat-relatedness illnesses, precautions and emergency procedures to follow as described in the project safety plan.
- Observe one another for signs of heat stress. PREVENTION and communication is key.

California has a specific heat illness prevention regulation that must be implemented. This includes,

- Having enough water onsite so that each worker can consume at a minimum, one quart per hour per shift.
- Frequent reminders and/or water breaks shall be taken so that each person can consume enough water.

- Access to shade (i.e., blockage from direct sunlight) shall be provided at all times and shall be reasonably close to the work area. Keep in mind that a vehicle or other enclosed are with no air conditioning is NOT considered shade. Must be a well ventilated area or have air conditioning.
- Workers shall be allowed to take a work-free cool-down rest/recovery period in the shade for a minimum of five minutes at any time when they feel the need to do so to protect themselves from overheating, or at the first sign of heat illness-related symptoms. (NOTE: If heat related symptoms are occurring, contact the RHSM).
- Training on risk factors, signs and symptoms of heat illness, importance of hydration and acclimatization, and importance of reporting symptoms and what to do in case of heat illness emergency, and contacting emergency medical services.

Thermal Stress Monitoring



Permeable Clothing – Monitoring Using WBGT

A Wet Bulb Globe Thermometer (WBGT) is the established and preferred means of measuring the environmental factors associated with heat stress and for providing indication of when physiological monitoring or rest regimens should be incorporated into the work schedule. The WBGT is the composite temperature used to estimate the effect of temperature, humidity, wind speed, and solar radiation on the human body.

When permeable work clothes are worn (street clothes or clothing ensembles over modesty clothes), physiological monitoring may be required based on the outcome of the WBGT measurements, taking into account the clothing adjustment factors. Use of the WBGT should generally begin when the heat index reaches 80° F (27° C) as indicated in the Heat Index Table below, or when workers exhibit symptoms of heat stress as indicated above.

If the WBGT is within the TLV (acclimatized workers) or Action Limit (unacclimatized workers) per the tables below, then work may continue while maintaining the established work/rest regimen. If the WBGT reading meets or exceeds either the TLV or Action Level for a work/rest regimen of 15 minutes work and 45 minutes rest, then physiological monitoring will be implemented.

Screening Criteria for TLV and Action Limit for Heat Stress Exposure

Allocation of work in a cycle of work and recovery	TLV (WBGT Values in ˚F/C˚) (Acclimatized Workers)				Action Limit (WBGT Values in ˚F/˚C˚) (Unacclimatized Workers)			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
75-100%	88/31	82/28	—	—	82/28	77/25	—	—
50-75%	88/31	84/29	82/28	—	83/29	79/26	75/24	—
25-50%	90/32	86/30	84/29	82/28	85/30	81/27	78/26	76/25
0-25%	91/33	89/32	87/31	86/30	86/30	84/29	82/28	81/27

Work Category Descriptions:

Light	Sitting or standing with light manual work using hands or arms; occasional walking.
Moderate	Sustained moderate hand, arm, and leg work; light pushing and pulling; normal walking.
Heavy	Intense arm and trunk work, carrying, shoveling, manually sawing, pushing and pulling heavy loads, walking at a fast pace.
Very Heavy	Very intense activity at fast to maximum pace.

Notes:
WBGT values are expressed to the nearest degree.
"—"Dashes indicate the need for physiological monitoring because screening criteria are not recommended for this type of work.

Clothing Adjustment Factors for Some Clothing Ensembles*

Clothing Type	Addition to WBGT ˚F/˚C˚
Work Clothes (sleeved shirt and pants)	0/0
Cloth (woven material) coveralls	0/0
Double-layer woven clothing	5.4/3
Polypropylene coveralls	0.9/0.5
Limited Use Vapor barrier coveralls	19.8/11

* These values must not be used for completely encapsulating (impermeable) coveralls/suits. Coveralls assume that only modesty clothing is worn beneath.

Thermal Stress Monitoring – Permeable or Impermeable Clothing

When **permeable work clothes** are worn (street clothes or clothing ensembles over street clothes), regularly observe workers for signs and symptoms of heat stress and implement physiological monitoring as indicated below. This should start when the heat index reaches 80° F (27° C) [see Heat Index Table below], or sooner if workers exhibit symptoms of heat stress indicated in the table above. These heat index values were devised for shady, light wind conditions; exposure to full sunshine can increase the values by up to 15°F (8°C). Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

When wearing **impermeable clothing** (e.g., clothing doesn't allow for air or water vapor movement such as Tyvek), physiological monitoring as described below shall be conducted when the ambient temperature reaches 70° F (21° C) or sooner when climatic conditions may present greater risk of heat stress combined with wearing unique variations of impermeable clothing, or workers exhibit symptoms of heat stress

Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Streuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Heat Index	Possible Heat Disorders	Minimum Frequency of Physiological Monitoring
80°F - 90°F (27°C - 32°C)	Fatigue possible with prolonged exposure and/or physical activity	Conduct initial monitoring as baseline and observe workers for signs of heat stress and implement physiological monitoring if warranted.
90°F - 105°F (32°C - 41°C)	Sunstroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity	Conduct initial monitoring as baseline, then at least every hour, or sooner, if signs of heat stress are observed.
105°F - 130°F (41°C - 54°C)	Sunstroke, heat cramps, or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity.	Conduct initial monitoring as baseline, then every 30 minutes or sooner if signs of heat stress are observed.
130°F or Higher (54°C or Higher)	Heat/Sunstroke highly likely with continued exposure.	Conduct initial monitoring as baseline, then every 15 minutes or sooner if signs of heat stress are observed.

Source: National Weather Service

Physiological Monitoring and Associated Actions

For employees wearing permeable clothing, follow the minimum frequency of physiological monitoring listed in the Heat Index Table.

For employees wearing impermeable clothing, physiological monitoring should begin initially at a 15 minute interval, then if the employee's heart rate or body temperature is within acceptable limits, conduct the subsequent physiological monitoring at 30 minutes, and follow the established regimen protocol below.

When physiological monitoring is required, use either radial pulse or aural temperature and follow actions below:

- The sustained heart rate during the work cycle should remain below 180 beats per minute (bpm) minus the individual's age (e.g., 180 – 35 year old person = 145 bpm). The sustained heart rate can be estimated by measuring the heart rate at the radial pulse for 30 seconds as quickly as possible prior to starting the rest period.
- The heart rate after one minute rest period should not exceed 120 beats per minute (bpm).
- If the heart rate is higher than 120 bpm after the FIRST minute into the rest period, the next work period should be shortened by 33 percent, while the length of the rest period stays the same.
- If the pulse rate still exceeds 120 bpm at the beginning of the next rest period, the following work cycle should be further shortened by 33 percent.
- Continue this procedure until the rate is maintained below 120 bpm after the FIRST minute into the rest period.

Alternately, the body temperature can be measured, either oral or aural (ear), before the workers have something to drink.

- If the oral or aural temperature exceeds 99.6° F (37.6 ° F) at the beginning of the rest period, the following work cycle should be shortened by 33 percent.
- Continue this procedure until the oral or aural (ear) temperature is maintained below 99.6 ° F (37.6° C). While an accurate indication of heat stress, oral temperature is difficult to measure in the field, however, a digital aural (aural) thermometer is easy to obtain and inexpensive to purchase.

Procedures for when Heat Illness Symptoms are Experienced

- Always contact the RHSM when any heat illness related symptom is experienced so that controls can be evaluated and modified, if needed.
- In the case of cramps, reduce activity, increase fluid intake, move to shade until recovered.
- In the case of all other heat-related symptoms (fainting, heat rash, heat exhaustion), and if the worker is a CH2M worker, contact the occupational physician at 1-866-893-2514 and immediate supervisor.
- In the case of heat stroke symptoms, call 911, have a designee give location and directions to ambulance service if needed, follow emergency medical treatment section of the project safety plan.
- Follow the Incident Notification, Reporting, and Investigation section of this Handbook.

9.3.2 Cold

General

Low ambient temperatures increase the heat lost from the body to the environment by radiation and convection. In cases where the worker is standing on frozen ground, the heat loss is also due to conduction.

Wet skin and clothing, whether because of water or perspiration, may conduct heat away from the body through evaporative heat loss and conduction. Thus, the body cools suddenly when chemical protective clothing is removed if the clothing underneath is perspiration soaked.

Movement of air across the skin reduces the insulating layer of still air just at the skin's surface. Reducing this insulating layer of air increases heat loss by convection.

Non-insulating materials in contact or near-contact with the skin, such as boots constructed with a metal toe or shank, conduct heat rapidly away from the body.

Certain common drugs, such as alcohol, caffeine, or nicotine, may exacerbate the effects of cold, especially on the extremities. These chemicals reduce the blood flow to peripheral parts of the body, which are already high-risk areas because of their large surface area to volume ratios. These substances may also aggravate an already hypothermic condition.

Precautions

- Be aware of the symptoms of cold-related disorders, and wear proper, layered clothing for the anticipated fieldwork. Appropriate rain gear is a must in wet weather.
- Consider monitoring the work conditions and adjusting the work schedule using guidelines developed by the U.S. Army wind-chill index and the National Safety Council (NSC) [in Canada: Environment Canada Will Chill Chart].
- Wind-Chill Index (below) is used to estimate the combined effect of wind and low air temperatures on exposed skin. The wind-chill index does not take into account the body part that is exposed, the level of activity, or the amount or type of clothing worn. For those reasons, it should only be used as a guideline to warn workers when they are in a situation that can cause cold-related illnesses.
- Persons who experience initial signs of immersion foot, frostbite, and/or hypothermia should report it immediately to their supervisor/PM to avoid progression of cold-related illness.
- Observe one another for initial signs of cold-related disorders.
- Obtain and review weather forecast – be aware of predicted weather systems along with sudden drops in temperature, increase in winds, and precipitation.

SYMPTOMS AND TREATMENT OF COLD STRESS

	Immersion (Trench) Foot	**Frostbite**	**Hypothermia**
Signs and Symptoms	Feet discolored and painful; infection and swelling present.	Blanched, white, waxy skin, but tissue resilient; tissue cold and pale.	Shivering, apathy, sleepiness; rapid drop in body temperature; glassy stare; slow pulse; slow respiration.
Treatment	Seek medical treatment immediately.	Remove victim to a warm place. Re-warm area quickly in warm–but **not** hot–water. Have victim drink warm fluids, but **not** coffee or alcohol. Do not break blisters. Elevate the injured area, and get medical attention.	Remove victim to a warm place. Have victim drink warm fluids, but **not** coffee or alcohol. Get medical attention.

Wind Chill Chart

Wind (mph) \ Temperature (°F)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Environment Canada Wind Chill Chart!

Actual Air Temperature T_{air} (°C)

T_{air} (°C) / V10 (km/h)	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50
5	4	-2	-7	-13	-19	-24	-30	-36	-41	-47	-53	**-58**
10	3	-3	-9	-15	-21	-27	-33	-39	-45	-51	**-57**	**-63**
15	2	-4	-11	-17	-23	-29	-35	-41	-48	-54	**-60**	**-66**
20	1	-5	-12	-18	-24	-30	-37	-43	-49	**-56**	**-62**	**-68**
25	1	-6	-12	-19	-25	-32	-38	-44	-51	**-57**	**-64**	**-70**
30	0	-6	-13	-20	-26	-33	-39	-46	-52	**-59**	**-65**	**-72**
35	0	-7	-14	-20	-27	-33	-40	-47	-53	**-60**	**-66**	**-73**
40	-1	-7	-14	-21	-27	-34	-41	-48	-54	**-61**	**-68**	**-74**
45	-1	-8	-15	-21	-28	-35	-42	-48	**-55**	**-62**	**-69**	**-75**
50	-1	-8	-15	-22	-29	-35	-42	-49	**-56**	**-63**	**-69**	**-76**
55	-2	-8	-15	-22	-29	-36	-43	-50	**-57**	**-63**	**-70**	**-77**
60	-2	-9	-16	-23	-30	-36	-43	-50	**-57**	**-64**	**-71**	**-78**
65	-2	-9	-16	-23	-30	-37	-44	-51	**-58**	**-65**	**-72**	**-79**
70	-2	-9	-16	-23	-30	-37	-44	-51	**-58**	**-65**	**-72**	**-80**
75	-3	-10	-17	-24	-31	-38	-45	-52	**-59**	**-66**	**-73**	**-80**
80	-3	-10	-17	-24	-31	-38	-45	-52	**-60**	**-67**	**-74**	**-81**

where
T_{air} = Actual Air Temperature in °C
$V_{10\,m}$ = Wind Speed at 10 metres in km/h (as reported in weather observations)

Notes:

1. For a given combination of temperature and wind speed, the wind chill index corresponds roughly to the temperature that one would feel in a very light wind. For example, a temperature of -25°C and a wind speed of 20 km/h give a wind chill index of -37. This means that, with a wind of 20 km/h and a temperature of -25°C, one would feel as if it were -37°C in a very light wind.
2. Wind chill does *not* affect objects and does *not* lower the actual temperature. It only describe how a human being would feel in the wind at the ambient temperature.
3. The wind chill index does *not* take into account the effect of sunshine. Bright sunshine may reduce the effect of wind chill (make it feel warmer) by 6 to 10 units.

10. Biological Hazards and Controls

Biological hazards are everywhere and change with the region and season. During project planning stages, ask the site Point of Contact if there are insect or other biological hazards have been noted in any of the work sites.

Biological hazards are everywhere and change with the region and season. If you encounter a biological hazard that has not been identified in the project safety plan or in this Handbook, contact the RHSM so that hazard controls can be addressed. Whether it is contact with a poisonous plant, a poisonous snake, or a bug bite, do not take bites or stings lightly. If there is a chance of an allergic reaction or infection, or to seek medical advice on how to properly care for the injury, contact the occupational nurse at 1-866-893-2514.

10.1 Black Bears

Bears may inhabit wooded areas where there is scarce continuous human presence. Make your presence known- especially when vegetation and terrain make it hard to see. Make noise, sing, or talk loudly. Avoid thick brush. Try to walk with the wind at your back so your scent will warn bears of your presence.

Give bears plenty of room. Every bear has a “personal space” - the distance within which a bear feels threatened – that can be from a few feet to a few hundred feet. If you stray within that zone, a bear may act aggressively. Never approach bears, even if only out of curiosity, and never attempt to feed bears.

If a bear cannot recognize you, he may come closer or stand on his hind legs for a better view. You may try to back away slowly diagonally, but if the bear follows, stop and stand your ground. If the bear moves closer or acts aggressively, stay close together and wave your arms and shout.

Do not climb a tree – black bears are good climbers.

Do not run. Bears have been clocked at speeds of up to 35 mph, and like dogs, will chase fleeing animals. Bears often make bluff charges, sometimes up to 10 feet away without making contact. Continue waving your arms and shouting. Never imitate bears sounds or use high-pitched squeals.

If attacked, do not run. Clasp your hands tightly over the back of your neck or if you are carrying a backpack use it to protect your head and neck and remain still.

For Black bears, if the attack lasts for more than a few seconds, respond aggressively - use sticks, rocks, your fists or noise. Black bears will sometimes back off if they are challenged.

10.2 Bees and Other Stinging Insects

Bees and other stinging insects may be encountered almost anywhere and may present a serious hazard, particularly to people who are allergic.

Precautions include:

- Watching for and avoiding nests.
- Keep exposed skin to a minimum.
- Carry a kit if you have had allergic reactions in the past, and inform your supervisor and/or a buddy. When working at a remote location, ensure that first-aid kits contain over-the-counter allergy and itch medication (e.g., Benadryl, Claritin, etc.) as well as other over-the-counter medications that may not be available to aid in symptom treatment.
- If bees or other stinging insects are known to be present, determine whether additional protective clothing should be donned before entering/working in brushy areas.

- Before entering a heavily vegetated or brushy area, observe the area for several minutes to see if bees or other stinging insects may be present. If nests or individual insects are observed, retreat and inquire whether a specialist or a client service can be contacted to clear the area before work proceeds.
- Consider if heavy-weight clothing or tyvek, or head netting would provide additional protection in areas where wasps/bees are known or suspected. Be aware of heat stress conditions additional clothing may cause.
- Use insect repellent on clothing. Wear light-colored clothing and remove bright reflective safety-colored clothing if not working near a roadway as these may attract the wasps.
- Wear fragrance-free or lightly-scented sunscreen, and body lotions. Bees are attracted to sweet scents. Avoid using floral scented soaps, shampoos, or conditioners.
- Move slowly and calmly through vegetated areas and try to avoid major disturbance of vegetation as wasps/bees often react to aggressive movement.
- If you encounter a wasp, back away slowly and calmly, do not run or swat at the insect. Wait for it to leave, or gently move or brush it off gently with a piece of paper or other light object. Do not use your hand.

If you are stung, contact the occupational nurse at 1-866-893-2514, no matter how minor it may seem. If a stinger is present, remove it as soon as possible using something with a thin, hard edge (e.g., credit card) to scrape the stinger out. Be sure to sanitize the object first with hand sanitizer, alcohol or soap and water. Wash and disinfect the wound, cover it, and apply ice. Watch for an allergic reaction if you have never been stung before. Call 911 if the reaction is severe.

10.3 Bird Droppings

Large amounts of bird droppings may present a disease risk. The best way to prevent exposure to fungus spores in bird droppings is to avoid disturbing it. A brief inhalation exposure to highly contaminated dust may be all that is needed to cause infection and subsequent development of fungal disease.

If disturbing the droppings or if removal is necessary to perform work, follow these controls:

- Use dust control measures (wetting with water or HEPA vacuuming) for all activities that may generate dust from the accumulated droppings.
- Wear Tyvek with hoods, disposable gloves and booties, and air-purifying respirators with a minimum N95 rating.
- Put droppings into plastic/poly bags and preferably into a 55-gallon drum to prevent bag from ripping.

10.4 Cactus

Contact with cacti can result in dermatitis as well as causing immunologic and infectious reactions. The spines can scratch the skin or induce wounds and multiple abrasions. Some cacti have glochids (hair-like spines or short prickles, generally barbed). Glochids can induce more troublesome, more persistent, dermatological manifestations such as papules or nodules.

Set up the work area to ensure avoidance of cacti. Wear leather glove if working near cacti. Keep any clothing such as jackets away from cacti as spines can become lodged into the clothing and can be contacted by the skin later. Contact the occupational nurse if cactus contact occurs.

10.1 Canada Geese

If Canadian geese are present at the worksite, do not attempt to feed or go near geese or nesting areas. Canada Geese can be extremely aggressive during mating and nesting periods. If the project work requires staff to work in areas where geese may be nesting, please contact the SC and/or client site supervisor to determine the correct course of action to be taken. Minimize direct contact with goose droppings, remove shoes prior to entering home or work following contact and wash hands thoroughly with antibacterial soap

10.2 Cougars/Mountain Lions

Like bears, cougars will often retreat if given the opportunity. Walking in groups and making noise will give the cougar the chance to retreat and reduce the likelihood of a sudden encounter. Be especially cautious during dusk and dawn.

If you see a cougar—do not play dead, do not run. Running may trigger an attack. Face the cougar and retreat slowly maintaining eye contact. If the cougar continues advancing, raise your arms above your head to make yourself look larger than normal. This may help to intimidate the cougar. Sometimes aggressive yelling and rock throwing may scare it off.

If attacked, fight back with whatever is at hand (without turning your back)—people have utilized rocks, jackets, garden tools, tree branches, and even bare hands to turn away cougars.

10.3 Coyotes

While far from domesticated, coyotes show little fear of humans and have become comfortable living in close proximity to our communities. Although they tend to do most of their hunting after dusk, coyotes can be active at any time. Under normal circumstances, a coyote is not a danger to humans. They are, however, territorial and will respond aggressively if they or their family are threatened.

If you encounter a coyote that behaves aggressively, you have probably gotten too close to its prey or its family. Try to scare the coyote by yelling and waving your arms. Throw rocks, sticks or other objects. Do not turn away and run.

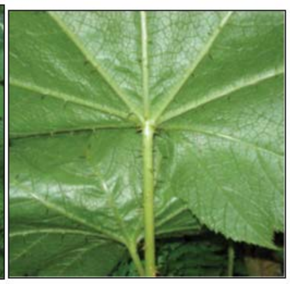
10.4 Devil's Club

Devil's Club (scientific name: Oplopanax horridus) is a large plant which thrives in moist woods and along streams. The plant is native to British Columbia and found all along the Pacific coast from Alaska to southern Oregon. Devil's Club grows up to 19 feet (6 meters) tall and has large 7 to 15 inch (20 to 40 centimeters), maple-shaped leaves. It produces small white flowers in spring and bright red fruit (clustered berries) in summer. The fruit is considered poisonous to humans but is eaten by bears.

Both the stem and leaves are covered with sharp thorns that are up to over a half an in (2 centimeters) long. In addition to physical damage to the eyes and skin, there is evidence that the spiny thorns can cause serious allergic reactions in some individuals.

Wear long-sleeved shirts and long pants when working in areas where Devil's Club is growing. Protective goggles or safety glasses with side shields are recommended when walking through patches of brush that exceed shoulder height. Wear heavy, leather or canvas gloves when handling the plants.   When cutting devil's club with a chainsaw make sure the hand protection is in place to protect the operators knuckles

Avoid devil's club if possible. The thorns are barbed and cannot be fully removed. Wounds from devil's club thorns often become infected and fester from the imbedded barbs. If skin contacts occurs, immediately remove any thorns with tweezers and wash the skin carefully with soap and water. Application of an anti-inflammatory cream (e.g., a 0.5% hydrocortisone cream) may reduce skin irritation. Seek medical assistance and contact the Injury Management hotline at 1-866-893-2514.


10.5 Feral Dogs and Cats

Below are hazard controls when dogs or cats are encountered.

- Do not attempt to handle or capture a stray dog or cat.
- Avoid all dogs – both leashed and stray. Do not disturb a dog while it is sleeping, eating, or caring for puppies.
- If a dog approaches to sniff you, stay still. An aggressive dog has a tight mouth, flattened ears and a direct stare.
- If you are threatened by a dog, remain calm, do not scream and avoid eye contact. If you say anything, speak calmly and firmly. Do not turn and run, try to stay still until the dog leaves, or back away slowly until the dog is out of sight or you have reached safety (e.g., vehicle).
- If attacked, retreat to vehicle or attempt to place something between you and the dog. If you fall or are knocked to the ground, curl into a ball with your hands over your head and neck and protect your face.
- If bitten, contact the occupational nurse at 1-866-893-2514. Report the incident to the local authorities.

10.6 Fire Ants

There are several types of fire ants in the United States that can cause painful bites and allergic reactions. Fire ants aggressively defend their nests by stinging several times after climbing on their victims. Large ant mounds are easily visible, but there can be smaller mounds or nests with little "worked" soil that can be stepped on inadvertently. They can also be under rocks, wood or other debris. Implement the following when fire ants are observed:

- Be aware of fire ants and take care not to stand on ant nests;
- Use insect repellents on clothing and footwear to temporarily discourage ants from climbing; and
- Tuck pants into socks.

If stung, get away from the area you are standing on, briskly brush off ants—wash affected area with soap. Call your Supervisor and HSM and contact Injury Care for Employees hotline at 1-866-893-2514.

10.7 Giant Hogweed

Giant hogweed is a noxious weed that has become established in the US and Canada.

Its sap, in combination with moisture and sunlight, can cause phytophotodermatitis—a serious skin inflammation and severe eye irritation leading to blindness. Contact between the skin and the sap of this plant occurs either through brushing against the bristles on the stem or breaking the stem or leaves. Eye exposure to the sap can occur during the breaking of the stems (during clearing/grubbing). Heat, sunlight, and moisture worsen the skin reaction.

Giant hogweed is a biennial or perennial which can grow up to 12 feet (approximately 3.5 meters) or more. Its hollow, ridged stems grow 2-4 inches (5-10 cm) in diameter and have dark reddish-purple blotches. Its large compound leaves can grow up to five feet (1.5 meters) wide. Its white flower heads can grow up to 2.5 feet (approximately 1 meter) in diameter.

Symptoms of exposure include initial itching and redness, then painful blisters form within 48 hours with the area becoming dark and pigmented. Long-term effects include scarring, sensitivity of the affected area to sunlight, temporary or permanent blindness if it gets into the eyes.

As with all hazardous plants, recognition and avoidance is key. Do not touch any portion of the plant. Become familiar with the identity of these plants (see below). Wear protective clothing that covers exposed skin and clothes. Avoid contact with plants and the outside of protective clothing. If skin contacts a plant, wash the area with soap and cold water immediately.   Keep exposed area away from sunlight for 48 hours. Contact your supervisor, RHSM and the Injury Care for Employees hotline at 1-866-893-2514.

10.8 Hantavirus

Hantavirus pulmonary syndrome (HPS) is a disease caused by a virus which can be transmitted from certain rodents to humans and is prevalent throughout North America. Avoid disturbing rodent nests. Contact is most likely to occur when there is a current rodent infestation in things like control boxes, storage sheds, wellheads, remediation equipment, or trailers. Once excreted into the environment by the rodent, hantaviruses can survive in the environment and remain infectious for a period of 2-3 days. Ultraviolet rays in sunlight inactivate hantaviruses.

Nesting material and droppings must be removed if work is necessary in a rodent-infested area. PPE for removal shall include:

- Tyvek coveralls;
- Rubber boots or disposable shoe covers;
- Rubber, latex, or vinyl gloves;
- Respiratory protection such as a full face or half-mask air-purifying respirator with a high-efficiency particulate air (HEPA) filter; and
- Protective goggles if wearing a half-mask respirator.

Spray any urine, droppings, and nesting materials with either a bleach and water solution (1 parts bleach to 9 parts water) or a household disinfectant prepared according to the label instructions for dilution and disinfection time. Soak well and let stand for 15 minutes. Use a paper towel or rag to pick up the materials and dispose of them.

Mop floors after spraying them using bleach and water solution or a disinfectant. Dirt floors can be sprayed with either bleach and water solution or a disinfectant.

Personal protective gear shall be decontaminated upon removal at the end of the day. All potentially infective waste material (including respirator filters) from clean-up operations shall be double-bagged in plastic bags.

Symptoms of HPS

Symptoms develop between 14 and 31 days after exposure to infected rodents and include fatigue, fever, and muscle aches, especially the large muscle groups—thighs, hips, back and sometimes shoulders. About half of all HPS patients also experience headaches, dizziness, chills and/or abdominal pain. Four to 10 days after the initial phase of the illness, late symptoms of HPS may appear. These include coughing and shortness of breath. If you develop symptoms suggestive of HPS, call the occupational nurse at 1-866-893-2514.

10.9 Hazards during Hunting Seasons

Various times of the year can be particularly hazardous for personnel working in the field. The danger is highest for our teams doing cross-country surveys of pipelines and transmission lines, but everyone doing field work should be aware of the hunting seasons that are active where you are working.

Big game hunting can be very dangerous, but also be aware of water fowl seasons and hunting seasons for less common game in your area. Work in wetlands can bring us in close proximity to these types of hunters.

If possible consider postponing field surveys so they do not coincide with hunting seasons but if you must be in the field be as visible as possible at all times.

(In the US, this site gives all the different hunting seasons by state: [www.huntinfo.org/)](http://www.huntinfo.org/)

Implement the following if hunting may be a hazard:

- Do not wear kaki, brown or tan clothing, wear high visibility colors including hats and vests;
- Avoid wearing white or light colored scarves, gloves, handkerchiefs (a woman wearing white mittens hanging laundry was shot and killed as bad hunter shot at flash of white);
- When carrying white plans, field data sheets etc keep them in binder or backpack;
- Wear your safety vest at all times including standing by car/truck;
- Wear a safety hat/cap or put florescent markers on hard hats;
- Be alert particularly in early mornings and at end of day when most hunters are present;
- Avoid being in field altogether at dawn or dusk - start a little later in the morning and make sure you get out of the field earlier;
- Stop at local hardware or convenience market and pick up hunter safety gloves, caps, rolls of tape etc. All the stores carry them and they are cheap visual protection.
- Make your presence known, such as slamming car doors, honk horn, talk loudly when getting out to a field site; and
- Stop and survey your surroundings. Many hunters are up in tree stands.

10.10 Leeches

Leeches are bloodsucking aquatic or terrestrial worms. They can crawl through or over your socks or brush onto you from shrubbery. They carry no disease and there is low risk of significant blood loss. Leech bites do not hurt since they release an anesthetic, but they can bleed profusely due to an anticoagulant they release to facilitate the flow of blood.

Possible Complications

- Some people suffer allergic reaction from leech bites and require urgent medical care. Symptoms include an ulcer infection, itchy rash, red blotches or an itchy rash over the body, swelling around the lips or eyes, feeling faint or dizzy, and difficulty breathing. If you experience any of these symptoms, seek medical attention immediately.

Prevention options

- The best protection against leeches is covering up and using tropical strength insect repellent on socks and clothing.
- Use anti leech socks and fit over outer garments which served as a barrier.
- Various reports suggest applying salt, dettol spray, bath soap, eucalyptus oil or lemon juice to your skin.
- Inspect your body after leaving leech-infested waters or area, removing them promptly.

First Aid

- Locate the head with a sucker attached to the wound. It will be the narrow end of leech's body.
- Use your fingernail or other flat, blunt object to break the seal of the oral sucker at which point the leech's jaws will detach. Repeat with the posterior end.
- Quickly flick the leech away before it bites you again and reattaches.
- Treat the wound with soap and water and antiseptic wipes; then bandage to stop bleeding.
- Do not just pull off the leech as this may cause a severe wound and the jaws may stay imbedded in the skin
- If the leech has attached to an orifice such ear, nose or mouth use salt or strong (drinkable) alcohol to cause it to release before it expands.
- Apply pressure to the area and a cold pack to reduce pain or swelling.
- The wound normally itches as it heals, but should not be scratched, as this may complicate healing and introduce other infections. Apply an antihistamine if necessary to reduce itching.
- If assisting a bitten person, use the usual protective universal precautions to protect against blood borne pathogens
- Call the RHSM, Workers Supervisor and Injury Management hotline at 1-866-893-2514 (as necessary).

10.11 Mosquitos and Dengue, Chikungunya, Zika, and West Nile Viruses

(Source: Centers for Disease Control)

Aside from being itchy and annoying, the bite of an infected female mosquito (Aedes aegypti or Aedes albopictus) can spread dengue, chikungunya, or Zika viruses. People become infected with dengue, chikungunya, or Zika after being bitten by an infected mosquito.

- Female mosquitoes lay several hundred eggs on the walls of waterfilled containers. Eggs stick to containers like glue and remain attached until they are scrubbed off. When water covers the eggs, they hatch and become adults in about a week.
- Adult mosquitoes live inside and outside.
- They prefer to bite during the day.
- A few infected mosquitoes can produce large outbreaks in a community and put your family at risk of becoming sick.

<u>Protect Yourself, Your Family, and Community from Mosquitoes</u>

1. Eliminate standing water in and around your home:

- Once a week, empty and scrub, turn over, cover, or throw out items that hold water, such as tires, buckets, planters, toys, pools, birdbaths, flowerpots, or trash containers. Check inside and outside your home.
- Tightly cover water storage containers (buckets, cisterns, rain barrels) so that mosquitoes cannot get inside to lay eggs.
- For containers without lids, use wire mesh with holes smaller than an adult mosquito.

2. If you have a septic tank, follow these steps:

- Repair cracks or gaps.
- Cover open vent or plumbing pipes. Use wire mesh with holes smaller than an adult mosquito.

3. Keep mosquitoes out of your home:

- Use screens on windows and doors.
- Repair holes in screens.
- Use air conditioning when available.
- Put plants in soil, not in water.
- Drain water from pools when not in use.
- Recycle used tires or keep them protected from rain.
- Drain & dump any standing water.
- Weekly, scrub vases & containers to remove mosquito eggs.

4. Prevent mosquito bites:

- Use an Environmental Protection Agency (EPA)-registered insect repellent with one of the following active ingredients. All EPA-registered insect repellents are evaluated to make sure they are safe and effective.

Active ingredient Higher percentages of active ingredient provide longer protection	**Some brand name examples***
DEET	Off!, Cutter, Sawyer, Ultrathon
Picaridin, also known as **KBR 3023, Bayrepel**, and **icaridin**	Cutter Advanced, Skin So Soft Bug Guard Plus, Autan (outside the United States)
IR3535	Skin So Soft Bug Guard Plus Expedition, SkinSmart
Oil of lemon eucalyptus (OLE) or **para-menthane-diol** (PMD)	Repel
* Insect repellent brand names are provided for your information only. The Centers for Disease Control and Prevention and the U.S. Department of Health and Human Services cannot recommend or endorse any name brand products.	

  - Always follow the product label instructions.
  - Reapply insect repellent every few hours, depending on which product and strength you choose.
  - Do not spray repellent on the skin under clothing.
  - If you are also using sunscreen, apply sunscreen first and insect repellent second.

- Treat clothing and gear (such as boots, pants, socks, and tents) with permethrin or purchase permethrin-treated clothing and gear.
  - Treated clothing remains protective after multiple washings. See product information to find out how long the protection will last.
  - If treating items yourself, follow the product instructions carefully.
  - Do not use permethrin products, intended to treat clothing, directly on skin.
- Wear long-sleeved shirts and long pants.
- Use BugOut Suits™ or equivalent as necessary.

<u>Signs and symptoms of common mosquito-borne diseases</u>

Below are signs and symptoms of common mosquito-borne diseases.

Contact the project RHSM with questions, and immediately report any suspicious symptoms to your supervisor, PM, and contact the occupational nurse at 1-866-893-2514.

Signs and symptoms of chikungunya virus disease (chikungunya)
Common symptoms include fever and severe joint pain. Other symptoms may include headache, muscle pain, joint swelling, or rash.

Symptoms usually begin 3—7 days after being bitten by an infected mosquito.

Most patients will feel better within a week. In some people, the joint pain may persist for months. Death is rare.

People at risk for more severe disease include newborns infected around the time of birth, older adults (≥65 years), and people with medical conditions such as high blood pressure, diabetes, or heart disease.

Signs and symptoms of Dengue
The principal symptoms of dengue are:

- High fever and at least two of the following:
  - Severe headache
  - Severe eye pain (behind eyes)
  - Joint pain
  - Muscle and/or bone pain
  - Rash
  - Mild bleeding manifestation (e.g., nose or gum bleed, petechiae, or easy bruising)
  - Low white cell count

Generally, younger children and those with their first dengue infection have a milder illness than older children and adults.

Watch for warning signs as temperature declines 3 to 7 days after symptoms began. Seek immediate medical attention if any of the following warning signs appear:

- Severe abdominal pain or persistent vomiting
- Red spots or patches on the skin
- Bleeding from nose or gums
- Vomiting blood
- Black, tarry stools (feces, excrement)
- Drowsiness or irritability
- Pale, cold, or clammy skin
- Difficulty breathing

Signs and symptoms of Zika
About 1 in 5 people infected with Zika virus become ill (i.e., develop Zika). The most common symptoms of Zika are:

- Fever, rash, joint pain, or conjunctivitis (red eyes).
- Other common symptoms include muscle pain and headache.

The incubation period (the time from exposure to symptoms) for Zika virus disease is not known, but is likely to be a few days to a week. The illness is usually mild with symptoms lasting for several days to a week.

People usually don't get sick enough to go to the hospital, and they very rarely die of Zika.

Zika virus usually remains in the blood of an infected person for about a week but it can be found longer in some people.

Signs and symptoms of West Nile Virus

Most infections are mild, and symptoms include fever, headache, and body aches, occasionally with skin rash and swollen lymph glands. More severe infection may be marked by headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, paralysis, and, rarely, death.

The West Nile Virus incubation period is from 3 to 15 days.

Contact the project RHSM with questions, and immediately report any suspicious symptoms to your supervisor, PM, and contact the Injury Care for Employees hotline at 1-866-893-2514.

10.12 Poison Ivy, Poison Oak, and Poison Sumac

Poison ivy, poison oak, and poison sumac typically are found in brush or wooded areas. They are more commonly found in moist areas or along the edges of wooded areas. Shrubs are usually 12 to 30 inches high, or can also be a tree-climbing vine, with triple leaflets and short, smooth hair underneath. Plants are red and dark green in spring and summer, with yellowing leaves anytime especially in dry areas. Leaves may achieve bright reds in fall, but plants lose its (yellowed, then brown) leaves in winter, leaving toxic stems. All parts of the plant remain toxic throughout the seasons. These plants contain urushiol a colorless or pale yellow oil that oozes from any cut or crushed part of the plant, including the roots, stems and leaves and causes allergic skin reactions when contacted. The oil is active year round.

Become familiar with the identity of these plants (see below). Wear protective clothing that covers exposed skin and clothes. Avoid contact with plants and the outside of protective clothing. If skin contacts a plant, wash the area with soap and water immediately. If the reaction is severe or worsens, seek medical attention.

Poison Ivy

Poison Sumac

Poison Oak

Contamination with poison ivy, sumac or oak can happen through several pathways, including:

- Direct skin contact with any part of the plant (even roots once above ground foliage has been removed).
- Contact with clothing that has been contaminated with the oil.
- Contact from removing shoes that have been contaminated (shoes are coated with urishol oil).
- Sitting in a vehicle that has become contaminated.
- Contact with any objects or tools that have become contaminated.
- Inhalation of particles generated by weed whacking, chipping, vegetation clearing.

If you must work on a site with poison ivy, sumac or oak the following precautions are necessary:

- Do not drive vehicles onto the site where it will come into contact with poison ivy, sumac or oak. Vehicles which need to work in the area, such as drill rigs or heavy equipment must be washed as soon as possible after leaving the site.
- All tools used in the poison ivy, sumac or oak area, including those used to cut back poison oak, surveying instruments used in the area, air monitoring equipment or other test apparatus must be decontaminated

before they are placed back into the site vehicle. If on-site decontamination is not possible, use plastic to wrap any tools or equipment until they can be decontaminated.

- Personal protective equipment, including Tyvek coveralls, gloves, and boot covers must be worn. PPE must be placed into plastic bags and sealed if they are not disposed immediately into a trash receptacle.
- As soon as possible following the work, shower to remove any potential contamination. Any body part with suspected or actual exposure should be washed with Zanfel, Tecnu or other product designed for removing urishiol. If you do not have Zanfel or Tecnu wash with cold water. Do not take a bath, as the oils can form and invisible film on top of the water and contaminate your entire body upon exiting the bath.
- Tecnu may also be used to decontaminate equipment.
- Use IvyBlock or similar products to prevent poison oak, ivy and sumac contamination. Check with a local drug sotre the closest CH2M warehouse to see if these products are available. Follow all directions for application.
- If you do come into contact with one of these poisonous plants and a reaction develops, contact your supervisor and the occupational nurse 1-866-893-2514. Be aware that in some instances, there can be a delay between contact with poisonous plants and the symptoms. If you are working near poison ivy or other poisonous plants and feel a mild skin irritation, apply Zanfel/Technu immediately and contact the occupational nurse.

10.13 Scorpions

Scorpions usually hide during the day and are active at night. They may be hiding under rocks, wood, or anything else lying on the ground. Some species may also burrow into the ground. Most scorpions live in dry, desert areas; however, some species can be found in grasslands, forests, and inside caves.

When entering an area that has the potential to contain scorpions, the following PPE is recommended: long pants, long sleeved shirts with collars, leather work gloves and leather work boots. Reaching into enclosures or recesses without prior visual inspection is not recommended. Thoroughly inspect each area before accessing. Shake out clothing, jackets, shoes or boots prior to putting them on.

If you are stung by a scorpion, call the Injury Care for Employees hotline 1-866-893-2514 and try to note the description of the scorpion. Cleanse the sting area and apply ice.

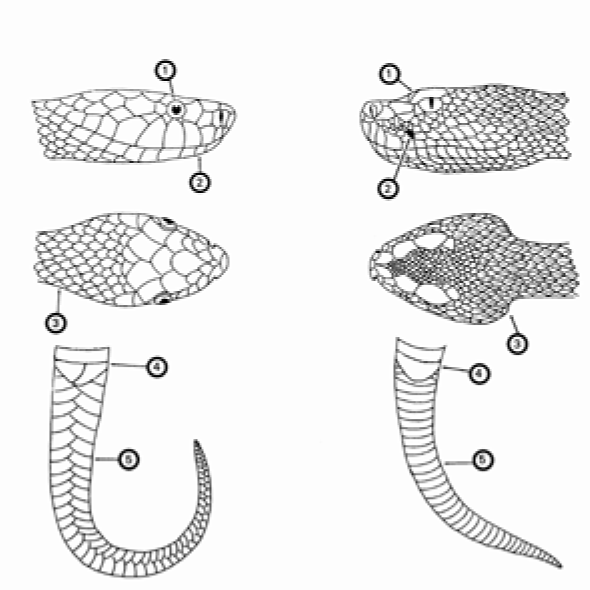
10.14 Snakes

Snakes typically are found in underbrush and tall grassy areas. If you encounter a snake, stay calm and look around; there may be other snakes. Turn around and walk away on the same path you used to approach the area. If bitten by a snake, wash and immobilize the injured area, keeping it lower than the heart if possible. Call the occupational nurse at 1-866-893-2514 immediately. Do not apply ice, cut the wound, or apply a tourniquet. Try to identify the type of snake: note color, size, patterns, and markings. Below is a guide to identifying poisonous snakes from non-poisonous snakes.

Ontario’s only venomous snake is the Eastern Massassauga rattlesnake, which only occurs in four isolated areas: Southern Georgian Bay, the Bruce Peninsula, Wainfleet Bog near Port Colborne, and Ojibway Prairie near Windsor. The chances of encountering this rattlesnake outside of these areas is very low.

Identification of Poisonous Snakes

Major Identification Features Non-venomous Snake	Major Identification Features Venomous Snake
1. Round pupils 2. No sensing pit 3. Head slightly wider than neck 4. Divided anal plate 5. Double row of scales on the underside of the tail	1. Elliptical pupils 2. Sensing pit between eye and nostril 3. Head much wider than neck 4. Single anal plate 5. Single scales on the underside of the tail



10.15 Spiders - Brown Recluse and Widow

The Brown Recluse spider can be found most anywhere in North America. It varies in size in shape, but the distinguishing mark is the violin shape on its body. They are typically non-aggressive. Keep an eye out for irregular, pattern-less webs that sometimes appear almost tubular built in a protected area such as in a crevice or between two rocks. The spider will retreat to this area of the web when threatened.

The Black Widow, Red Widow and the Brown Widow are all poisonous. Most have globose, shiny abdomens that are predominantly black with red markings (although some may be pale or have lateral stripes), with moderately long, slender legs. These spiders are nocturnal and build a three-dimensional tangled web, often with a conical tent of dense silk in a corner where the spider hides during the day.

Hazard Controls

- Inspect or shake out any clothing, shoes, towels, or equipment before use.
- Wear protective clothing such as a long-sleeved shirt and long pants, hat, gloves, and boots when handling stacked or undisturbed piles of materials.
- Minimize the empty spaces between stacked materials.
- Remove and reduce debris and rubble from around the outdoor work areas.
- Trim or eliminate tall grasses from around outdoor work areas.
- Store apparel and outdoor equipment in tightly closed plastic bags.

- Keep your tetanus boosters up-to-date (every 10 years). Spider bites can become infected with tetanus spores.

If you think you have been bit by a poisonous spider, immediately call the Injury Care for Employees number at 1-866-893-2514 and follow the guidance below:

- Remain calm. Too much excitement or movement will increase the flow of venom into the blood;
- Apply a cool, wet cloth to the bite or cover the bite with a cloth and apply an ice bag to the bite;
- Elevate the bitten area, if possible;
- Do not apply a tourniquet, do not try to remove venom; and
- Try to positively identify the spider to confirm its type. If the spider has been killed, collect it in a plastic bag or jar for identification purposes. Do not try to capture a live spider—especially if you think it is a poisonous spider.

Black Widow Brown Recluse

10.16 Ticks

Every year employees are exposed to tick bites at work and at home putting them at risk of illness. Ticks typically are in wooded areas, bushes, tall grass, and brush. Ticks are black, black and red, or brown and can be up to one-quarter inch (6.4 mm) in size.

In some geographic areas exposure is not easily avoided. Wear tightly woven light-colored clothing with long sleeves and pant legs tucked into boots; spray only outside of clothing with permethrin or permanone and spray skin with only DEET; and check yourself frequently for ticks.

Where site conditions (vegetation above knee height, tick endemic area) or when tasks (having to sit or kneel in vegetation) diminish the effectiveness of the other controls mentioned above, bug-out suits (check with your local or regional warehouse) or Tyvek shall be used. Bug-out suits are more breathable than Tyvek.

Take precautions to avoid exposure by including pre-planning measures for biological hazards prior to starting field work. Avoid habitats where possible, reduce the abundance through habitat disruption or application of acracide. If these controls aren't feasible, contact your local or regional warehouse for preventative equipment such as repellants, protective clothing and tick removal kits. Use the buddy system and perform tick inspections prior to entering the field vehicle. If ticks were not planned to be encountered and are observed, do not continue field work until these controls can be implemented.

See Tick Fact Sheet attached to project safety plan for further precautions and controls to implement when ticks are present. If bitten by a tick, follow the removal procedures found in the tick fact sheet, and call the occupational nurse at 1-866-893-2514.

Be aware of the symptoms of Lyme disease or Rocky Mountain spotted fever (RMSF). Lyme disease is a rash that might appear that looks like a bull's eye with a small welt in the center. RMSF is a rash of red spots under the skin 3 to 10 days after the tick bite. In both RMSF and Lyme disease, chills, fever, headache, fatigue, stiff neck, and bone pain may develop. If symptoms appear, again contact the occupational nurse at 1-866-893-2514.

Be sure to complete an Incident Report (either use the Hours and Incident Tracking System [HITS] system on the VO) if you do come in contact with a tick.

11. Personal Protective Equipment

(Reference CH2M- SOP HSE-117, *Personal Protective Equipment*)

11.1 Required Personal Protective Equipment

PPE must be worn by employees when actual or potential hazards exist and engineering controls or administrative practices cannot adequately control those hazards.

A PPE assessment has been conducted by the RHSM based on project tasks (see PPE specifications below). Verification and certification of assigned PPE by task is completed by the RHSM in each project safety plan. Below are items that need to be followed when using any form of PPE:

- Employees must be trained to properly wear and maintain the PPE; if you are unsure of how to use or maintain your PPE, ask your RHSM for guidance.
- Employees must be trained in the limitations of the PPE; if you are unsure, ask your RHSM for guidance.
- In work areas where actual or potential hazards are present at any time, PPE must be worn by employees working or walking through the area;
- Areas requiring PPE should be posted or employees must be informed of the requirements in an equivalent manner;
- PPE must be inspected prior to use and after any occurrence to identify any deterioration or damage;
- PPE must be maintained in a clean and reliable condition;
- Damaged PPE shall not be used and must either be repaired or discarded; and
- PPE shall not be modified, tampered with, or repaired beyond routine maintenance.

Each project safety plan will outlines PPE to be used according to task based on project-specific hazard assessment. Long pants and short-sleeve shirts that cover the shoulders, with a minimum three-inch sleeve length, are required to be worn for all field project sites. The minimum PPE typically required for field project sites is: hard hat, safety glasses and safety footwear. The minimum PPE required on construction, operations and maintenance project sites is: hard hat, safety glasses, high visibility vest (when exposed to heavy equipment operations or vehicular traffic), safety footwear and appropriate work gloves.

11.2 Respiratory Protection

(Reference CH2M SOP HSE-121, *Respiratory Protection*)

Implement the following when using respiratory protection:

- Respirator users must have completed appropriate respirator training within the past 12 months. Level C training is required for air-purifying respirators (APR) use and Level B training is required for supplied-air respirators (SAR) and self-contained breathing apparatus (SCBA) use. Specific training is required for the use of powered air-purifying respirators (PAPR);
- Respirator users must complete the respirator medical monitoring protocol and been approved for the specific type of respirator to be used;
- Tight-fitting facepiece respirator (negative or positive pressure) users must have passed an appropriate fit test within past 12 months;

- Respirator use shall be limited to those activities identified in the safety plan. If site conditions change that alters the effectiveness of the specified respiratory protection, the RHSM shall be notified to amend the written plan;
- Tight-fitting facepiece respirator users shall be clean-shaven and shall perform a user seal check before each use;
- Canisters/cartridges shall be replaced according to the change-out schedule specified in the safety plan. Respirator users shall notify the SC or RHSM of any detection of vapor or gas breakthrough. The SC shall report any breakthrough events to the RHSM for schedule upgrade;
- Respirators in regular use shall be inspected before each use and during cleaning;
- Respirators in regular use shall be cleaned and disinfected as often as necessary to ensure they are maintained in a clean and sanitary condition;
- Respirators shall be properly stored to protect against contamination and deformation;
- Field repair of respirators shall be limited to routine maintenance. Defective respirators shall be removed from service;
- When breathing air is supplied by cylinder or compressor, the SC or RHSM shall verify the air meets Grade D air specifications; and
- The SC or designee shall complete the Self-Assessment Checklist – Respiratory Protection included in the SOP and/or in the safety plan to verify compliance with CH2M's respiratory protection program.

12. Worker Training and Qualification

12.1 CH2M Worker Training

(Reference CH2M SOP HSE-110, *Training*)

12.1.1 CH2M Worker Category Training

All employees shall be assigned a worker category by their supervisor with assistance from the RHSM or SPA based on the type of work activities they are anticipated to perform throughout the year. It is CH2M policy to require an appropriate level of HSE training for all employees, including contingent workers or contractors under CH2M supervision, so they can recognize and mitigate workplace hazards and perform their jobs in a safe and environmentally sound manner, and to comply with applicable regulations.

An employee's Worker Category may change based on changing work assignments, and/or the employee may have more than one Worker Category based on assigned work scope or location. If an employee falls into more than one category listed below, or works on a site with multiple hazards (e.g., construction and hazardous waste), they must meet the training requirements for each category.

See the Worker Category resources on the Enterprise HSE VO page for additional information.

12.1.2 Hazardous Waste Operations Training

All employees engaging in hazardous waste operations and emergency response (HAZWOPER) activities, as well as site investigations, characterization, remedial action, shall receive appropriate training as required by US regulations 29 CFR 1910.120/29 CFR 1926.65. At a minimum, the training shall have consisted of instruction in the topics outlined in 29 CFR 1910.120/29 CFR 1926.65. CH2M International Regions will provide HAZWOPER-equivalent training, with concurrence from the Enterprise HSE Training Manager, and to meet any country-specific training related to hazardous waste operations or emergency response. Personnel who have not met these training requirements shall not be allowed to engage in hazardous waste operations or emergency response activities.

12.1.2.1 Initial Training

General site workers engaged in hazardous waste operations shall, at the time of job assignment, have received a minimum of 40 hours of initial health and safety training for hazardous waste site operations, unless otherwise noted in the above-referenced standards.

Employees who may be exposed to health hazards or hazardous substances at treatment, storage, and disposal (TSD) operations shall receive a minimum of 24 hours of initial training to enable the employee to perform their assigned duties and functions in a safe and healthful manner.

Employees engaged in emergency response operations shall be trained to the level of required competence in accordance with the US regulation 29 CFR 1910.120.

12.1.2.2 Three-Day Actual Field Experience

General site workers for hazardous waste operations shall have received three days of actual experience (on-the-job training) under the direct supervision of a trained, qualified supervisor and shall be documented. If the field experience has not already been received and documented at a similar site, this supervised experience shall be accomplished and documented at the beginning of the assignment of the project.

12.1.2.3 Refresher Training

General site workers and TSD workers shall receive 8-hours of refresher training annually (within the previous 12-month period) to maintain qualifications for fieldwork. Employees engaged in emergency response operations shall receive annual refresher training of sufficient content and duration to maintain their competencies or shall demonstrate competency in those areas at least annually.

12.1.2.4 Eight-Hour Supervisory Training

On site management or supervisors who will be directly responsible for, or supervise employees engaged in hazardous waste site operations, will have received at least 8 hours of additional specialized training on managing such operations. Employees designated as Safety Coordinator – Hazardous Waste are considered 8-hour HAZWOPER Site Safety Supervisor trained.

12.1.3 Competent Person

The term "Competent Person" is used in many US (OSHA) and International standards and documents. Generally, a "competent person" is defined as one who, by way of training and/or experience, is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them. Some standards add additional specific requirements which must be met by the competent person.

CH2M's practice is that the employer responsible for directing the means and methods of an activity (typically the employer responsible for actually performing the work) is responsible for designating the qualified competent person for that activity. This is typically a subcontractor or a third party contractor, unless CH2M is actually self-performing the work. The RHSM will review and accept subcontractor competent persons.

Should CH2M self-perform work and an employee needs to be designated as a competent person, the CH2M site or project manager and/or supervisor shall coordinate with the client sector HSE Lead or RHSM to verify that the employee has the requisite training and experience to be identified as the competent person. A competent person designation form must be completed and kept with the project files, along with any accompanying documentation (training, experience) in accordance with SOP HSE-110, Training.

12.1.4 First Aid/Cardiopulmonary Resuscitation

First aid and CPR training consistent with the requirements of a nationally recognized organization such as the Red Cross Association, National Safety Council, or equivalent country organization shall be administered by a certified trainer. A minimum of two personnel per active field operation will have first aid and CPR training. Bloodborne pathogen training located on CH2M's Virtual Office is also required for those designated as first aid/CPR trained.

12.1.5 Safety Coordinator Training

SCs are trained to implement the HSE program on CH2M field projects. A qualified SC is required to be identified in the project safety plan for CH2M field projects. SCs must also meet the requirements of the worker category appropriate to the type of field project (construction or hazardous waste). In addition, the SCs shall have completed additional safety training required by the specific work activity on the project that qualifies them to implement the HSE program (for example, fall protection, excavation).

12.1.6 Site-Specific Training

Site-specific training will be addressed in the project safety plan. Prior to commencement of field activities, all field personnel assigned to a project will have completed site-specific training that will address the contents of applicable project safety plans, including the activities, procedures, monitoring, and equipment used in the site operations. Site-specific training will also include site and facility layout, potential hazards, risks associated with identified emergency response actions, and available emergency services. This training allows field workers to clarify anything they do not understand and to reinforce their responsibilities regarding safety and work operations for their particular activity.

13. Medical Surveillance and Qualification

(Reference CH2M SOP HSE-113, *Medical Surveillance)*

All site workers participating in HAZWOPER work will maintain an adequate medical surveillance program in accordance with the Medical Surveillance Enterprise Standard Operating Procedure HSE-113, 29 CFR 1910.120/29 CFR 1926.65 and other applicable OSHA standards or provincial requirements. Documentation of employee medical qualification (e.g., physician's written opinion) will be maintained in the project files and made available for inspection.

13.1 Hazardous Waste Operations and Emergency Response

CH2M personnel expected to participate in on site HAZWOPER tasks are required to have a current medical qualification for performing this work. Medical qualification shall consist of a qualified physician's written opinion regarding fitness for duty at a hazardous waste site, including any recommended limitations on the employee's assigned work. The physician's written opinion shall state whether the employee has any detected medical conditions that would place the employee at increased risk of material impairment of the employee's health from work in hazardous waste operations or emergency response, or from respirator use.

13.2 Respirator User Qualification

Personnel required to wear respirators must have a current medical qualification to wear respirators. Medical qualification shall consist of a qualified physician's written opinion regarding the employee's ability to safely wear a respirator in accordance with 29 CFR 1910.134 or provincial requirement.

13.3 Hearing Conservation

Personnel working in hazardous waste operations or operations that fall under 29 CFR 1910.95 (in the US), Provincial OH&S Code/Regulations (in Canada) or other country norms, and exposed to noise levels in excess of the 85dBA time-weighted average shall be included in a hearing conservation program that includes annual audiometric testing.

14. Site-Control Plan

14.1 Site-Control Procedures

(Reference CH2M SOP HSE-218, *Hazardous Waste Operations)*

Site control is established to prevent the spread of contamination throughout the site and to ensure that only authorized individuals are permitted into potentially hazardous areas.

The SC will implement site control procedures including the following bulleted items.

- Establish support, contamination reduction, and exclusion zones. Delineate with flags or cones as appropriate. Support zone should be upwind of the site. Use access control at entry and exit from each work zone.
- Establish onsite communication consisting of the following:
  - Line-of-sight and hand signals;
  - Air horn; and
  - Two-way radio or cellular telephone if available.
- Establish offsite communication.
- Establish and maintain the “buddy system.”

14.2 Remediation Work Area Zones

(Reference CH2M SOP HSE-218 Hazardous Waste Operations)

A three-zone approach will be used to control areas where site contaminants exist. Access will be allowed only after verification of appropriate training and medical qualification. The three-zone approach shall include an EZ, Contamination Reduction Zone (CRZ) and a Support Zone (SZ). The three-zone approach is not required for construction work performed outside contaminated areas where control of site contamination is not a concern.

Specific work control zones shall be established as necessary during task planning. Site work zones should be modified in the field as necessary, based on such factors as equipment used, air monitoring results, environmental conditions, or alteration of work plans. The following guidelines shall be used for establishing and revising these preliminary zone designations.

14.2.1 Support Zone

The SZ is an uncontaminated area (trailers, offices, field vehicles, etc.) that will serve as the field support area for most operations. The SZ provides field team communications and staging for emergency response. Appropriate sanitary facilities and safety and emergency response equipment will be located in this zone. Potentially contaminated personnel/materials are not allowed in this zone. The only exception will be appropriately packaged and decontaminated materials, or personnel with medical emergencies that cannot be decontaminated.

14.2.2 Contamination Reduction Zone

The CRZ is established between the EZ and the SZ, upwind of the contaminated area where possible. The CRZ provides an area for decontamination of personnel, portable handheld equipment and tools, and heavy equipment. In addition, the CRZ serves as access for heavy equipment and emergency support services.

14.2.3 Exclusion Zone

The EZ is where activities take place that may involve exposure to site contaminants and/or hazardous materials or conditions. This zone shall be demarcated to prevent unauthorized entry. More than one EZ may be established if there are different levels of protection to be employed or different hazards that exist in the same work area. The EZ shall be large enough to allow adequate space for the activity to be completed, including field personnel and equipment, as well as necessary emergency equipment.

The EZ shall be demarcated with some form of physical barrier or signage. The physical barrier or signage shall be placed so that they are visible to personnel approaching or working in the area. Barriers and boundary markers shall be removed when no longer needed.

14.2.4 Other Controlled Areas

Other work areas may need to be controlled due to the presence of an uncontrolled hazard, to warn workers of requirements, or to prevent unauthorized entry. Examples include general construction work areas, open excavations, high noise areas, vehicle access areas, and similar activities or limited access locations. These areas shall be clearly demarcated with physical barriers (fencing, cones, reinforced caution tape or rope) as necessary and posted with appropriate signage.

15. Decontamination

(Reference CH2M SOP HSE-218, *Hazardous Waste Operations*)

Decontamination areas will be established for work in potentially contaminated areas to prevent the spread of contamination. Decontamination areas should be located upwind of the exclusion zone where possible and should consider any adjacent or nearby projects and personnel. The SC must establish and monitor the decontamination procedures and their effectiveness. Decontamination procedures found to be ineffective will be modified by the SC. The SC must ensure that procedures are established for disposing of materials generated on the site.

No eating, drinking, or smoking is permitted in contaminated areas and in exclusion or decontamination zones. The SC should establish areas for eating, drinking, and smoking.

15.1 Contamination Prevention

Preventing or avoiding contamination of personnel, tools, and equipment will be considered in planning work activities at all field locations. Good contamination prevention and avoidance practices will assist in preventing worker exposure and result in a more efficient decontamination process. Procedures for contamination prevention and avoidance include the following:

- Do not walk through areas of obvious or known contamination;
- Do not directly handle or touch contaminated materials;
- Make sure there are no cuts or tears in PPE;
- Fasten all closures in suits and cover them with duct tape, if appropriate;
- Take particular care to protect any skin injuries;
- Stay upwind of airborne contamination, where possible;
- Do not eat or drink in contaminated work areas;
- Do not carry food, beverages, tobacco, or flame-producing equipment into contaminated work areas;
- Minimize the number of personnel and amount of equipment in contaminated areas to that necessary for accomplishing the work;
- Choose tools and equipment with nonporous exterior surfaces that can be easily cleaned and decontaminated;
- Cover monitoring and sampling equipment with clear plastic, leaving openings for the sampling ports, as necessary; and
- Minimize the amount of tools and equipment necessary in contaminated areas.

15.2 Personnel and Equipment Decontamination

Personnel exiting an EZ must ensure that they are not spreading potential contamination into clean areas or increasing their potential for ingesting or inhaling potential contaminants. Personal decontamination may range from removing outer gloves as exiting the EZ, to proceeding through an outer layer doffing station including a boot and glove wash and rinse, washing equipment, etc. Equipment that has come into contact with contaminated media must also be cleaned/decontaminated when it is brought out of the EZ.

15.3 Decontamination During Medical Emergencies

Standard personnel decontamination practices will be followed whenever possible. For emergency life-saving first aid and/or medical treatment, normal decontamination procedures may need to be abbreviated or omitted. In this situation, site personnel shall accompany contaminated victims to advise emergency response personnel on potential contamination present and proper decontamination procedures.

Outer garments may be removed if they do not cause delays, interfere with treatment, or aggravate the problem. Protective clothing can be cut away. If the outer garments cannot be safely removed, a plastic barrier between the individual and clean surfaces should be used to help prevent contaminating the inside of ambulances or medical personnel. Outer garments can then be removed at the medical facility.

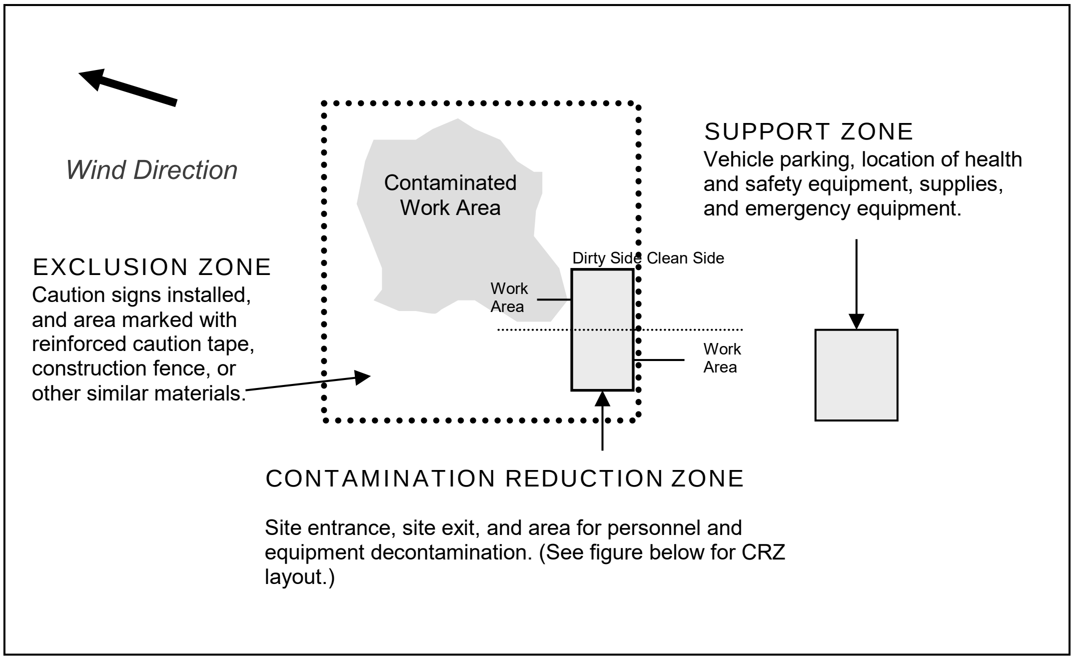
15.4 Waste Collection and Disposal

All contaminated material generated through the personnel and equipment decontamination processes (e.g., contaminated disposable items, gross debris, liquids, sludges) will be properly containerized and labeled, stored at a secure location, and disposed in accordance with the project plans.

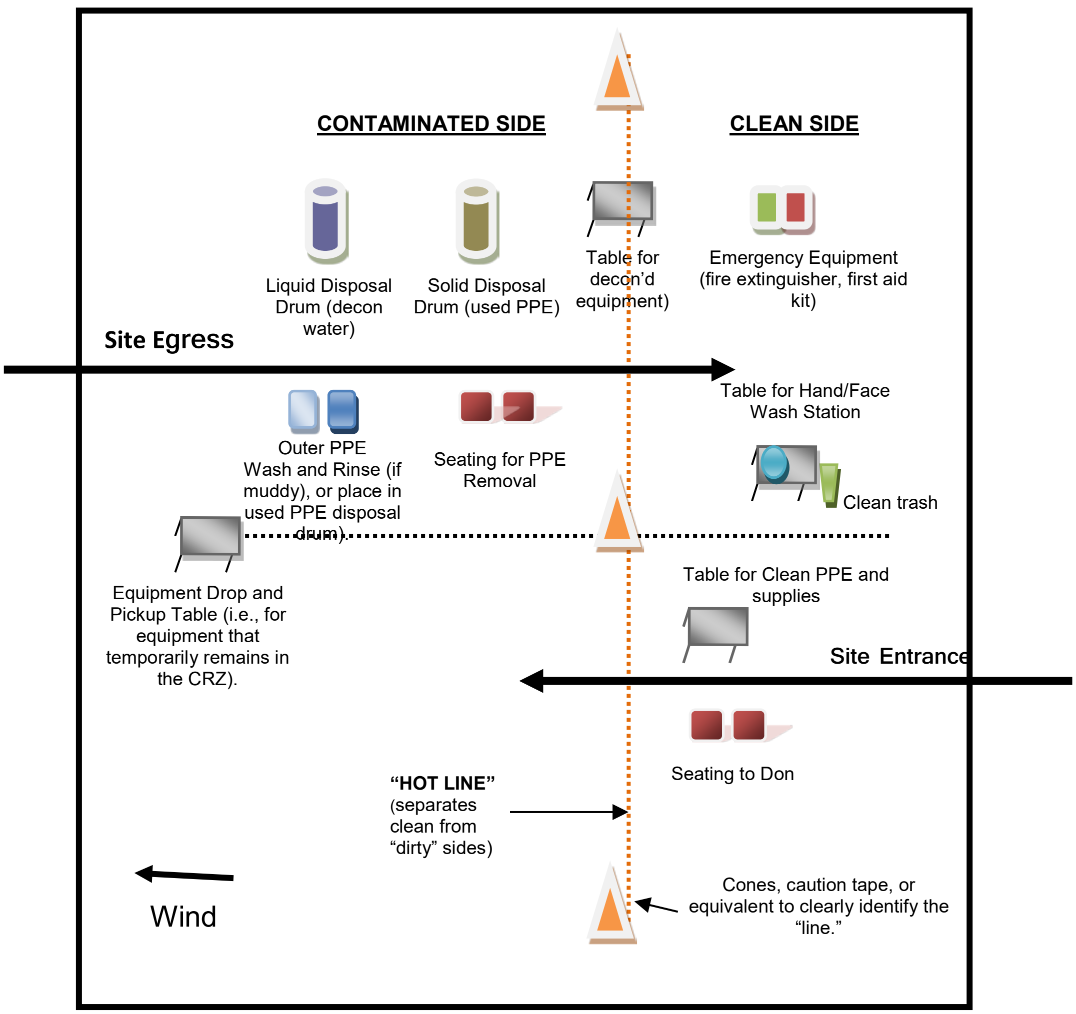
15.5 Diagram of Personnel-Decontamination Line

The following figure illustrates a conceptual establishment of work zones, including the decontamination line. Work zones are to be modified by the SC to accommodate task-specific requirements.

Work Area - Set up appropriately based on wind direction



Typical Contamination Reduction Zone



16. Emergency Preparedness

(Reference CH2M SOP HSE-106, *Emergency Planning*)

16.1 Pre-Emergency Planning

The Emergency Response Coordinator (ERC), typically the SC or their designee, performs the applicable pre-emergency planning tasks before starting field activities and coordinates emergency response with CH2M onsite parties, the facility, and local emergency-service providers as appropriate. Pre-Emergency Planning activities performed by the ERC include:

- Review the facility emergency and contingency plans where applicable;
- Determine what onsite communication equipment is available (two-way radio, air horn);
- Determine what offsite communication equipment is needed (nearest telephone, cell phone);
- Confirm and post the “Emergency Contacts” page and route to the hospital located in this section in project trailer(s) and keep a copy in field vehicles along with evacuation routes and assembly areas. Communicate the information to onsite personnel and keep it updated;
- Field Trailers: Post “Exit” signs above exit doors, and post “Fire Extinguisher” signs above locations of extinguishers. Keep areas near exits and extinguishers clear;
- Review changed site conditions, onsite operations, and personnel availability in relation to emergency response procedures;
- Where appropriate and acceptable to the client, inform emergency room and ambulance and emergency response teams of anticipated types of site emergencies;
- Inventory and check site emergency equipment, supplies, and potable water;
- Communicate emergency procedures for personnel injury, exposures, fires, explosions, and releases;
- Rehearse the emergency response plan before site activities begin. This may include a “tabletop” exercise or an actual drill depending on the nature and complexity of the project. Drills should take place periodically but no less than once a year;
- Brief new workers on the emergency response plan; and
- The ERC will evaluate emergency response actions and initiate appropriate follow-up actions.

16.2 Incident Response

In fires, explosions, or chemical releases, actions to be taken include the following:

- Notify appropriate response personnel;
- Shut down CH2M operations and evacuate the immediate work area;
- Account for personnel at the designated assembly area(s);
- Assess the need for site evacuation, and evacuate the site as warranted;
- Implement HSE-111, Incident Notification, Reporting and Investigation; and
- Notify and submit reports to clients as required in contract.

Small fires or spills posing minimal safety or health hazards may be controlled with onsite spill kits or fire extinguishers without evacuating the site. When in doubt evacuate. Follow the incident reporting procedures in the "Incident Notification, Reporting, and Investigation" section of this Handbook.

16.3 Emergency Medical Treatment

Emergency medical treatment is needed when there is a life-threatening injury (such as severe bleeding, loss of consciousness, breathing or heart has stopped). When in doubt if an injury is life-threatening or not, treat it as needing emergency medical treatment.

- Notify 911 or other appropriate emergency response authorities as listed in the "Emergency Contacts" page located in this section.
- The ERC will assume charge during a medical emergency until the ambulance arrives or until the injured person is admitted to the emergency room.
- Prevent further injury, perform decontamination (if applicable) where feasible; lifesaving and first aid or medical treatment takes priority.
- Initiate first aid and CPR where feasible.
- Notify supervisor and if the injured person is a CH2M employee, the supervisor will call the occupational nurse at 1-866-893-2514 and make other notifications as required by HSE SOP-111, *Incident Notification, Reporting and Investigation*.
- Make certain that the injured person is accompanied to the emergency room.
- Follow the Serious Incident Reporting process in HSE SOP-111, Incident Notification, Reporting and Investigation, and complete incident report using the HITS system on the VO or if not feasible, use the hard copy forms provided as an attachment to the project safety plan.
- Notify and submit reports to client as required in contract.

16.4 Evacuation

- Evacuation routes, assembly areas, and severe weather shelters (and alternative routes and assembly areas) are to be specified on the site map.
- Evacuation route(s) and assembly area(s) will be designated by the ERC or designee before work begins.
- Personnel will assemble at the assembly area(s) upon hearing the emergency signal for evacuation.
- The ERC and a "buddy" will remain on the site after the site has been evacuated (if safe) to assist local responders and advise them of the nature and location of the incident.
- The ERC will account for all personnel in the onsite assembly area.
- A designated person will account for personnel at alternate assembly area(s).
- The ERC will follow the incident reporting procedures in the "Incident Notification, Reporting and Investigation" section of this Handbook.

16.5 Evacuation Signals

Signal	Meaning
Grasping throat with hand	Emergency-help me.
Thumbs up	OK; understood.
Grasping buddy's wrist	Leave area now.

Continuous sounding of horn	Emergency; leave site now.

16.6 Inclement Weather

Sudden inclement weather can rapidly encroach upon field personnel. Preparedness and caution are the best defenses. Field crew members performing work outdoors should carry clothing appropriate for inclement weather. Personnel are to take heed of the weather forecast for the day and pay attention for signs of changing weather that indicate an impending storm. Signs include towering thunderheads, darkening skies, or a sudden increase in wind. If stormy weather ensues, field personnel should discontinue work and seek shelter until the storm has passed.

Protective measures during a lightning storm include seeking shelter; avoiding projecting above the surrounding landscape (don't stand on a hilltop—seek low areas); staying away from open water, metal equipment, railroad tracks, wire fences, and metal pipes; and positioning people several yards apart. Some other general precautions include:

- Know where to go and how long it will take to get there. If possible, take refuge in a large building or vehicle. Do not go into a shed in an open area;
- The inclination to see trees as enormous umbrellas is the most frequent and most deadly mistake. Do not go under a large tree that is standing alone. Likewise, avoid poles, antennae, and towers;
- If the area is wide open, go to a valley or ravine, but be aware of flash flooding;
- If you are caught in a level open area during an electrical storm and you feel your hair stand on end, drop to your knees, bend forward and put your hands on your knees or crouch. The idea is to make yourself less vulnerable by being as low to the ground as possible and taking up as little ground space as possible. Lying down is dangerous, since the wet earth can conduct electricity. Do not touch the ground with your hands; and
- Do not use telephones during electrical storms, except in the case of emergency.

Remember that lightning may strike several miles from the parent cloud, so work should be stopped and restarted accordingly. The lightning safety recommendation is 30-30: Seek refuge when thunder sounds within 30 seconds after a lightning flash; and do not resume activity until 30 minutes after the last thunder clap.

High winds can cause unsafe conditions, and activities should be halted until wind dies down. High winds can also knock over trees, so walking through forested areas during high-wind situations should be avoided. If winds increase, seek shelter or evacuate the area. Proper body protection should be worn in case the winds hit suddenly, because body temperature can decrease rapidly.

16.6.1 Tornado Safety

Recognizing imminent tornado signs include seeing an unusually dark sky, possibly with some green or yellow clouds. You may hear a roaring or rumbling sound like a train, or a whistling sound like a jet. Large hail may also be falling. You may be able to see funnels, or they may be hidden by rain or hail.

Listen to your radio for tornado warnings during bad thunderstorms. If a tornado warning is issued, don't panic. Instead, listen and look. Quickly but calmly follow directions for getting to shelter.

Take cover. Indoors you should go down into the basement and crouch down under the stairs, away from windows. Do not take an elevator. If you can't get to a basement, go into a closet or bathroom and pull a mattress over you or sit underneath a sturdy piece of furniture on the ground floor near the center of the building. Pull your knees up under you and protect your head with your hands.

A bad place to be in a tornado is in a building with a large freestanding roof such as a gymnasium, arena, auditorium, church or shopping mall. If you are caught in such a building, take cover under something sturdy.

More than half of tornado deaths occur in mobile homes. If a tornado threatens, get out and go to a building with a good foundation, or lay down in a ditch away from vehicles and other objects.

If you are driving, get to a shelter, lie down in a ditch or seek cover up under the girders of an overpass or bridge. Stay as close to the ground as you can. Protect your head and duck flying debris.

Stay away from metal and electrical equipment because lightning accompanies tornadoes.

If you have time before the tornado strikes, secure objects such as garbage cans and lawn furniture which can injure people. While most tornado damage is a result of the violent winds, most injuries and deaths actually result from flying debris.

16.1 International Travel

It is the employee's responsibility to:

- Book ALL international travel (all modes of transportation and all accommodations) through your local CH2M-approved travel agent. This is essential to keep track of international travelers in times of crisis, and allows for the Travel Department to provide international travelers with up-to-date information regarding safety and security risks associated with their intended destination.
- Advise the in country CH2M office of your travel arrangements, including local hotel details and itinerary changes. Make changes through the approved travel agency.
- If the country you are visiting is categorized as a high or extreme risk country, complete the high/extreme risk travel form and notify the cognizant Regional Security Manager (RSM).
    - To determine a country's rating please go to the Enterprise Security site and look for Country/Area Risk/Threat Ratings under Quick Links
- Should CH2M not have an office in the country you are traveling to, advise your home HR contact of your travel arrangements, including your contact details.

If working on an international project site, ensure the HSM and Enterprise Security is involved and has had input into the safety plan, including any precautions for emergency planning and evacuation. Ensure that International SOS (ISOS) contact numbers and instructions are included with the safety plan. A separate security asset protection plan may be advised by Enterprise Security depending on country threat level.

17. Inspections

17.1 Management/Leadership Health, Safety, Security, and Environment Inspections

Management Leadership is an integral part of CH2M's HSE culture. The Management Inspection Checklist is intended to facilitate PM leadership, provide an opportunity for PM's to mentor field staff on HSE and identify any big picture actions that need to be addressed. Observations that would improve global HSE program should also be included on the form. This Checklist does NOT take the place of a formal HSE audit. The PM shall:

- Complete one checklist per month during field work when visiting the site. The PM may delegate completion to the task lead, field team leader, or construction manager if the project is short duration and a visit is not planned for.
- Complete applicable sections of the checklist (can by typed or hand-written). Address issues with the field team, taking the opportunity to mentor staff by identifying the "root cause" of observation (e.g., why are SBOs not being completed, had this hazard been noted by any other team members?).
- E-mail the completed form to the address listed at the bottom of the form, and courtesy copy the Project Delivery Manager, Sector HSE Lead, and RHSM for tracking and review. Original should be kept in the project files.

The results of the site visit should be communicated with the site or project team during the visit. Other forms may be used to document management/leadership site visits.

17.2 Project Activity Self-Assessment Checklists

In addition to the hazard controls specified in this document, Project Activity Self-Assessment Checklists are contained as an attachment to the project safety plan. The Project-Activity Self–Assessment Checklists are based upon minimum regulatory compliance and some site-specific requirements may be more stringent. The objective of the self-assessment process is to identify gaps in project safety performance, and prompt for corrective actions in addressing these gaps. The self-assessment checklists, including documented corrective actions, shall be made part of the permanent project records and maintained by the SC.

The self-assessment checklists will also be used by the SC in evaluating the subcontractors and any client contractors' compliance on site.

17.3 Safe Work Observations

Safe Work Observations (SWOs, formerly referred to as Safe Behavior Observations, SBOs)) are a tool to be used by supervisors to provide positive reinforcement for work practices performed correctly, while also identifying and eliminating deviations from safe work procedures that could result in a loss.

The SC or designee shall perform at least one SWO each week for any field work performed by subcontractors or when there are at least two CH2M personnel performing field work.

The SC or designee shall complete the SWO form (attached to the project safety plan) for the task/operation being observed and submit them weekly.

E-mail the completed form to the appropriate e-mail address at the bottom of the SWO Form.

18. Incident Notification, Reporting, and Investigation

(Reference CH2M SOP HSE-111, Incident Notification, Reporting and Investigation)

18.1 General Information

This section applies to the following:

- All injuries involving employees, third parties, or members of the public;
- Damage to property or equipment;
- Interruptions to work or public service (hitting a utility);
- Incidents which attract negative media coverage;
- Near misses;
- Spills, leaks, or regulatory violations; and
- Motor vehicle incidents.

Documentation, including incident reports, investigation, analysis and corrective measure taken, shall be kept by the SC and maintained onsite for the duration of the project.

18.2 Section Definitions

Incident: An incident is an event that causes or could have caused undesired consequences. An incident may be caused by natural forces, employees, subcontractors, or third parties in any location associated with CH2M operations, including offices, warehouses, project sites, private property, or public spaces. Incidents include:

- Injury or illness to a CH2M employee or subcontractor employee
- Property damage
- Spill or release of hazardous or regulated material
- Environmental or permit violation
- A “near-miss”
- A “near serious injury”
- Other such as a Worker Welfare issue, fire, explosion, bomb threat, workplace violence, or threats

Near Miss: A near-miss occurs when an intervening factor prevented an injury or illness, property damage, spill or release, permit violation or other event from occurring. Examples of near-miss situations include: a hard hat or other personal protective equipment (PPE) prevented an injury; secondary containment or emergency shutoff prevented a spill; or an alert co-worker prevented an incident.

Near Serious Injury Incident: A near serious injury is an incident that could have resulted in a serious injury (as described below) if not for an intervening factor that reduced or eliminated the severity.

Serious Incident

A Serious Incident must be immediately reported to senior management includes:

- Work related death, or life threatening injury or illness of a CH2M employee, subcontractor, or member of the public;
- Kidnap/missing person;
- Acts or threats of terrorism;

- Event that involves a fire, explosion, or property damage that requires a site evacuation or is estimated to result in greater than $ 500,000 in damage; or
- Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment.

18.3 Incident Notification and Reporting Requirements

All employees and subcontractors' employees shall immediately report any incident in which they are involved or witness verbally to the SC or HS Manager and Field Team Leader/Site Supervisor or PM (including "near misses").

Incident notification is made verbally through both the HSE and the Operations chain of command. Upon notification of an incident, the SC or HS Manager initiates the HSE notification chain, and the Field Team Leader or Supervisor initiates the Operations notification chain.

All recordable incidents and regulatory agency actions are reported up to the Sector President and the HSE Director. Other incident notification is made up the chains to the indicated group depending on the severity, and any project, geographic, or client specific notification and reporting requirements.

For serious injury and near serious injury incidents (CH2M or CH2M Subcontractor), the Sector HSE Manager must notify the HSE Director as soon as practical but within two hours of knowledge of the injury, and ensure that a rigorous incident investigation/root cause analysis process is implemented in a timely manner. Also, the incident cause analysis must identify the Plan, Do, Check, Act classification in accordance with Attachment 5 of SOP HSE-111.

If the incident was an environmental permit issue (potential permit non-compliance, other situation that result in a notice of violation) or a spill or release, contact the Project EM immediately so evaluation of reportable quantity requirements and whether agency reporting is required. Spills and releases must be reported without delay because "immediately" has been interpreted in many jurisdictions to mean 15 minutes.

The CH2M team shall comply with all applicable statutory incident reporting requirements (e.g., OSHA, OH&S (MOL, MOE) the police, or state or Federal environmental agency).

For all Worker Welfare incidents (listed in Policy 113, Worker Welfare, Section 3, Figure 1, The Division of Worker Welfare Issues), CH2M project worker, subcontractor worker, and third party contractor worker (when CH2M has health and safety oversight) will be reported to the PM and RHSM, who will contact the Regional Managing Director.

CH2M project workers, subcontractor workers, and third party Contractor workers when CH2M has health and safety oversight may submit a confidential concern regarding a Worker Welfare issue through the The Guideline. The issue will be assigned to the RHSM and/or Region HSM.

18.4 Drug and Alcohol Testing for CH2M Employees

As required by CH2M Policy 810, employees may be subject to post-incident and reasonable suspicion drug and alcohol testing. The Employee must submit to drug and alcohol testing if the supervisor has a reasonable suspicion, and when any of the following occur:

- Work-related injury in which the Company reasonably believes (under the Reasonable Suspicion provisions in the Policy) that drug and/or alcohol use is a contributing factor;
- Incident resulting in property damage over USD$500 as determined by the Company;
- Injury on or in Company Property/Workplace (to Employee or third parties) involving the Employee's use of heavy machinery as determined by the Company;
- Incident considered to be a serious near-miss injury that occurs in the field or in the office as determined by the Company and where the Company reasonably believes (under the Reasonable Suspicion provisions in the Policy) that drug and/or alcohol use is a contributing factor to the serious near miss injury;

- Other circumstances as dictated by Employee Relations; or
- An Employee contributes to any of the above.

Except in emergencies, the employee must remain available for testing. Failure to remain available will be considered as a refusal to submit to the testing, which will result in disciplinary action. Following the test, if there is no reasonable suspicion, the Employee returns to work. The employee will not be allowed to operate any company vehicle or company equipment, or work in any designated areas, pending the result of the drug and/or alcohol test.

Employees who are required to submit to reasonable suspicion testing are prohibited from transporting themselves to or from the collection site. The supervisor will arrange for transportation; the employee will be transported by a CH2M staff member. The employee must remain under the direct observation of the supervisor until turned over to the transporter. The employee will not be allowed to eat or drink unless instructed by the collector as this may hinder or decrease the company's ability to obtain a valid sample once the drug and/or alcohol test is administered.

After returning from the collection site, the employee must make arrangements to be transported home or to his/her residence. Supervisors must contact local authorities if an employee insists on driving a vehicle. Pending receipt of the drug and alcohol test results, the employee may not return to work.

18.5 Drug and Alcohol Testing for Subcontractors

The drug and alcohol testing requirements stated above apply to subcontractors when required by the subcontract.

18.6 HITS System and Incident Report Form

CH2M maintains a HITS entry and/or Incident Report Form (IRF) for all work-related injuries and illnesses sustained by its employees in accordance with recordkeeping and insurance requirements. A HITS entry and/or IRF will also be maintained for other incidents (property damage, fire or explosion, spill, release, potential violation, and near misses) as part of our loss prevention and risk reduction initiative.

The SC shall complete an entry into the Hours and Incident Tracking System (HITS) database system located on CH2M's Virtual Office (or if VO not available, use the hard copy Incident Report Form and Root Cause Analysis Form and forward it to the RHSM) within 24 hours and finalize those forms within 3 calendar days.

18.7 Injury Care for Employees (for U.S./Canada/Puerto Rico based CH2M Staff Only)

(Reference CH2M, SOP HSE-124, Injury Care for Employees)

18.7.1 Background

The Injury Care for Employees (ICE) Program has been established to provide orderly, effective and timely medical treatment and return-to-work transition for an employee who sustains a work-related injury or illness. It also provides guidance and assistance with obtaining appropriate treatment to aid recovery, keep supervisors informed of employee status, and to quickly report and investigate work-related injury/illnesses to prevent recurrence.

To implement the ICE Program successfully, supervisors and/or SC should:

- Ensure employees are informed of the ICE Program;
- Become familiar with the Notification Process (detailed below); and
- Post the ICE Poster.

18.7.2 The Injury Care for Employees Notification Process:

- If the injury or illness is serious, get help and start the emergency response process.

- Employee verbally informs their supervisor. Verbal **notifications must be made as soon as possible: notify the Safety Coordinator (SC), the Project Manager (PM), the Responsible H&S Manager (RHSM), and the Operations Leader (OL)**.
- Employee calls the ICE Program toll free number 1-866-893-2514 immediately and speaks with the Occupational Injury Nurse. This number is operable 24 hours per day, 7 days a week. **Employees are encouraged to enter this phone number into their cell phones prior to starting field work.**
- Supervisor ensures employee immediately calls the ICE Program number. Supervisor makes the call with the injured worker or for the injured worker, if needed.
- Nurse assists employee with obtaining appropriate medical treatment, as necessary schedules clinic visit for employee (calls ahead, and assists with any necessary follow up treatment). The supervisor or SC accompanies the employee if a clinic visit is necessary to ensure that employees receive appropriate and timely care.
- Supervisor or SC completes the HITS entry or Incident Report Form immediately (within 24 hours) and forwards it to the Project Manager and RHSM.
- Nurse notifies appropriate CH2M staff by e-mail (supervisor, Health & Safety, Human Resources, Workers' Compensation).
- Nurse communicates and coordinates with and for employee on treatment through recovery.
- Supervisor ensures suitable duties are identified and available for injured or ill workers who are determined to be medically fit to return to work on transitional duty (temporary and progressive).
- Supervisor ensures medical limitations prescribed (if any) by physician are followed until the worker is released to full duty.

18.8 Serious Incident Reporting Requirements

(Reference CH2M SOP HSE-111, Incident Reporting, Notification and Investigation)

The serious incident reporting requirements ensures timely notification and allows for positive control over flow of information so that the incident is handled effectively, efficiently, and in conjunction with appropriate corporate entities. This standard notification process integrates HSE and Firm Wide Security Operations requirements for the consistent reporting of and managing of serious events throughout our operations.

18.8.1 Serious Incident Determination

The following are general criteria for determining whether an incident on CH2M owned or managed facilities or program sites is considered serious and must be immediately reported up to Group President level through the reporting/notification process:

- Work related death, or life threatening injury or illness of a CH2M employee, subcontractor, or member of the public;
- Kidnap or missing person;
- Acts or threats of terrorism;
- Event that involves a fire, explosion, or property damage that requires a site evacuation or is estimated to result in greater than $ 500,000 in damage; or
- Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment.

18.8.2 Serious Incident Reporting

If an incident meets the "Serious Incident" criteria, the Project Manager is to immediately contact the Crisis Manager at 720-286-4911, then follow the standard incident reporting procedure.

For all serious incidents this standard reporting process is implemented immediately so as to ultimately achieve notification to the Business Group President within 2 hours of incident onset or discovery, and notification to appropriate corporate Crisis Management Support Team.

Ontario and Alberta have additional serious incident reporting requirements; refer to your health and safety plan for details or speak to your health and safety manager.

18.9 Cause Analysis/Incident Investigation

The sector conducts incident investigations to determine how an incident happened, to identify the root causes, and to prevent recurrence by implementing corrective actions.

Specific guidelines for conducting an incident investigation are described in Section 5.6 of SOP HSE-111.

All incidents must be investigated, and the investigation must be based on facts that clearly identify the sequence of events and the factors that contributed to the incident to determine the immediate and basic causes.

In accordance with the SOP, a Root Cause Analysis (RCA) is completed for all recordable incidents, serious injuries/near serious injuries, property damage incidents in excess of $5,000.00 (U.S.), environmental permit violations, spills and releases, which are required to be reported to regulatory agencies, and any other incident, including near misses, where the HSE Manager/RHSM or PM determines a RCA is appropriate.

A RCA must be completed using the process or equivalent described in Attachment 5 of the SOP. The incident investigation team should include the HSE Manager/RHSM or designee, the involved party(ies), a responsible operations representative (e.g. PM, construction Manager, crew supervisor, etc.), and an independent management representative not associated with the incident.

During the incident investigation phase, one of the tools that can be used is the Det Norske Veritas (DNV) Systematic Cause Analysis Technique (SCAT) chart. The chart consistently identifies direct and root causes and facilitates tracking and trending areas for improvement. By using a consistent cause analysis system, trending can be performed for individual projects, programs, Sectors or regions as needed. The SCAT chart can be used along with any client-required cause analysis system, or other common cause analysis techniques such as the "5-WHYS."

Recordable injury and near serious injury incidents must include identifying the Plan, Do, Check, Act incident cause(s).

The HSE Manager/RHSM/REM makes certain that an investigation is complete and results are entered into HITS.

Investigation information, including the results of a RCA, is entered into the applicable evaluation sections in HITS, such as the immediate cause(s), root cause(s), and corrective action(s). When corrective actions are verified as completed, the HITS should be closed by the HSE Manager/RHSM/EM. Non-crisis investigations will be documented by updating the HITS incident report and describing the investigation facts in the Evaluation sections.

19. Records and Reports

An organized project filing system is essential for good documentation and recordkeeping. There are many benefits to an organized filing system:

- Other CH2M employees can easily and quickly find documents;
- Records are readily available for review;
- Records may be needed during regulatory agency investigations, audits, or other legal matters;
- Records may be needed on short notice in case of an injury, illness or other emergency; and
- Systematic recordkeeping aids in overall project organization.

The project filing system shall be established at the beginning of the project and maintained throughout all phases of construction and archived in accordance with CH2M's Records Retention Policy. The information contained in the filing system shall be updated regularly and/or as specified in this document. The PM and SC are responsible for collecting documentation, including subcontractor documentation, and maintaining a complete and organized filing system.

Below are examples of records that must be maintained as the project progresses:

- Exposure records includes air monitoring data (including calibration records), SDSs, exposure modeling results;
- Physical hazard exposure records include noise, ionizing radiation, non-ionizing radiation, vibration, and lasers exposure assessments and measurements;
- Respiratory fit test records;
- Training records;
- Incident reports, investigations and associated back-up information such as agency notifications, calculations, and corrective actions taken;
- Federal, provincial, or state agency inspection records;
- Waste analytical data;
- Waste profiles;
- Manifests;
- Permit inspection records;
- Agency submittals and reports;
- Certifications [such as Notice(s) of Intent, state-required erosion and sediment control inspector certifications, Stormwater Pollution Prevention Plan (if permit requires certification), and discharge, wastewater, and monitoring data];
- Other Records:
  - Ergonomic evaluations;
  - HSE audits and assessments;
  - Project-specific HSE plans;
  - Confined space entry permits;
  - Equipment inspections;

- Equipment maintenance;
- Emergency equipment inspection records;
- SBOs;
- Self-assessment checklists

- The RHSM shall coordinate with the PM or designee to ensure that final project-specific HSE records described in this section, including negative exposure determinations, are maintained with the project files in accordance with the CH2M records retention schedule, or forwarded to the Medical Surveillance Program Administrator, as appropriate. Records retention requirements are detailed in the Recordkeeping and Access to Records SOP, HSE-119.

CH2M Employee Sign-Off

I hereby acknowledge that I have received, read, understand, and will comply with this Handbook.

Name (printed):____

Signature: ____

Employee Number (GEN):_______________________________________

Date:____

Make a photo copy or scan and send this completed sign-off page to your CH2M Safety Program Assistant (SPA).

Subcontractor Sign-Off

CH2M HSE FIELD HANDBOOK

The CH2M subcontractors listed below have been provided with this Handbook, have read and understand it, and agree to abide by its provisions.

This sign-off sheet shall be maintained with the project safety plan.

Project Name: **Project Number:**

EMPLOYEE NAME (Please print)	**EMPLOYEE SIGNATURE**	**COMPANY**	**DATE**

Chemical Inventory/Register Form

CH2MHILL

CHEMICAL INVENTORY/REGISTER FORM

Refer to SOP HSE-107, Attachment 1, for instructions on completing this form.

Location:

HCC:

☐ Office ☐ Warehouse ☐ Laboratory ☐ Project:

Project No.:

Regulated Product	Location	Container labeled (✓if yes)	SDS available (✓if yes)

MSDS for the listed products will be maintained at:

Chemical-Specific Training Form

CH2MHILL

CHEMICAL-SPECIFIC TRAINING FORM

Refer to SOP HSE-107 Attachment 1 for instructions on completing this form.

Location:	Project # :
HCC:	Trainer:

TRAINING PARTICIPANTS:

NAME	SIGNATURE	NAME	SIGNATURE

REGULATED PRODUCTS/TASKS COVERED BY THIS TRAINING:

The HCC shall use the product MSDS to provide the following information concerning each of the products listed above.

☐ Physical and health hazards

☐ Control measures that can be used to provide protection (including appropriate work practices, emergency procedures, and personal protective equipment to be used)

☐ Methods and observations used to detect the presence or release of the regulated product in the workplace (including periodic monitoring, continuous monitoring devices, visual appearance or odor of regulated product when being released, etc.)

Training participants shall have the opportunity to ask questions concerning these products and, upon completion of this training, will understand the product hazards and appropriate control measures available for their protection.

Copies of MSDSs, chemical inventories, and CH2M HILL's written hazard communication program shall be made available for employee review in the facility/project hazard communication file.

CH2M HILL Health and Safety Plan

Attachment 4

Project Activity Self-Assessment Checklists/Permits/Forms

Biological safety

Boating Safety

Drilling Safety

Hand and Power Tools

Hazardous Materials Handling

Heat stress physiological monitoring form

Manual Lifting

Personal Protective Equipment

HS&E Self-Assessment Checklist—Biological Prevention Measures

CH2MHILL

This checklist shall be used by personnel and shall be completed by each crew entering the work area at the frequency of one per day or otherwise specified in the project's Health and Safety Plan/Field Safety Instruction (HSP/FSI). The checklist should be completed prior to entry and at the end of the day to document that appropriate checks have been completed.

This checklist is to be used at locations where the possibility exists that contact with biological hazards is possible.

Site Safety Coordinator (SSC) will request any CH2M HILL subcontractor to take necessary precautions in eliminating the exposure to biological hazards, but shall not direct the means and methods.

Project Name: ____ Project No.: ____________________
Location: ____ PM: _______________________________
Auditor: ___________________________ Title: _________________________ Date: ____________

- Check "Yes" if an assessment item is complete or correct.
- Check "No" if an item is incomplete or deficient. Section 2 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

SECTION 1 – PRE-ENTRY	Yes	No	N/A	N/O
SITE HAZARD EVALUATION				
1. Inform field members of hazards (types, symptoms)	☐	☐	☐	☐
2. Can work be completed without entering the work zone	☐	☐	☐	☐
3. Have controls been implemented where possible (clearing vegetation, spraying)	☐	☐	☐	☐
4. Has an inspection been made to identify nests, hives or areas where insects may concentrate	☐	☐	☐	☐
5. Will working at different time will reduce exposure	☐	☐	☐	☐
SENSATIVITIES				
6. Does any staff have existing reactions to stings or bites	☐	☐	☐	☐
7. If yes to #6, is special required and medication available on site (epi-pen)	☐	☐	☐	☐
8. Has anyone with an existing condition briefed other team members about symptoms and first aid which may be required	☐	☐	☐	☐
EMERGENCY RESPONSE				
9. Are first aid kits, along with tick removal kits, readily available to all staff	☐	☐	☐	☐
10. Does each member of the field staff have ability to communicate (phone, radios, and visual)	☐	☐	☐	☐
11. Are emergency contacts available (base emergency, local police, or local EMT	☐	☐	☐	☐
12. If working in remote areas, is transport readily available (less than 5 minutes)	☐	☐	☐	☐
13. Have you planned an emergency exit from the site in the event of a swarm	☐	☐	☐	☐

HS&E Self-Assessment Checklist: BIOLOGICAL PREVENTION MEASURES

SECTION 2 - PPE	Yes	No	N/A	N/O
SELECTION OF PPE				
14. Will weather (heat, rain, ice) impact the safety of workers wearing protective suits	☐	☐	☐	☐
15. Will visibility be limited to unacceptable levels if a hood is worn	☐	☐	☐	☐
16. Will the use of equipment be difficult if a suit is worn	☐	☐	☐	☐
17. Will heavy vegetation be encountered that could rip or damage a suit	☐	☐	☐	☐
18. Will a Bug-Out suit or Tyvek suit be used by staff (if not, please give additional rationale in writing in Section 4)	☐	☐	☐	☐
TYPE OF PPE USED OTHER THAN BUG-OUT OR TYVEK SUIT				
19. Is staff wearing light-colored clothes	☐	☐	☐	☐
20. Is staff wearing long sleeve shirts	☐	☐	☐	☐
21. Are pant legs tucked into socks	☐	☐	☐	☐
22. Are shirts tucked into pants	☐	☐	☐	☐
23. Has tape been placed around sock/pant leg line and around waist	☐	☐	☐	☐
24. Have hand and wrist areas been sealed	☐	☐	☐	☐
25. Are hats being worn	☐	☐	☐	☐
26. Have clothes been pre treated with Permethrin	☐	☐	☐	☐
27. Has team member inspected coworker's suits or clothing to ensure no spaces exist for insects to penetrate	☐	☐	☐	☐

SECTION 3 – CHECKS AND DECONTAMINATION	Yes	No	N/A	N/O
DAILY CHECKS (TO BE COMPLETED DURING AND AT END OF DAY)				
28. Were tick/insect checks performed during the day (if not, please provide reason in Section 4)	☐	☐	☐	☐
29. Was one unclothed tick check completed	☐	☐	☐	☐
30. Were ticks found on the outerwear (if yes, please note the number in Section 4)	☐	☐	☐	☐
31. Were ticks found inside the Bug-Out, Tyvek, or personal clothing	☐	☐	☐	☐
32. Were suits turned inside out and inspected prior to putting away	☐	☐	☐	☐
33. Were showers taken by field staff immediately upon arrive from the field	☐	☐	☐	☐
34. Were clothing placed in a garbage bag and sealed to prevent any insects from spreading	☐	☐	☐	☐
35. If ticks were found embedding in skin, were they properly removed and saved	☐	☐	☐	☐
36. Have vehicles been inspected for ticks on a daily basis and before the vehicle is turned in	☐	☐	☐	☐
REPORTING				
37. If a tick was found on your skin, could you tell where it entered so that it could be addressed	☐	☐	☐	☐
38. If a tick was found embedded, did you contact the PM, complete a HITS form and contact the Occupational Physician at 1-866-893-2514	☐	☐	☐	☐
39. Did you contact field staff on the project to provide potential corrective measures	☐	☐	☐	☐
40. Did you follow the IM/RTW procedure to ensure you received the proper medical attention (if not, provide an explanation in Section 4)	☐	☐	☐	☐

SECTION 4

Complete this section for all items where further information was requested in the previous sections.

Item #	Rationale	Corrected (either next day or intended on future projects)

Auditor: ________________________________ Project Manager: _____________________________

Health and Safety Self Assessment Checklist-BOATS

This self assessment is only to be used at locations where CH2M HILL controls the work. It is not to be used at locations where others control the work.

Project Name: ____ Project No.: ____________________________

Location: ____ PM: ___________________________________

Auditor: __________________________________ Title: ______________________________ Date: __________

If an assessment item is complete/correct the "Yes" box should be checked. If an item is incomplete or deficient the "No" box should be checked. Items that are considered to be imminently dangerous must be corrected immediately or all exposed personnel must be removed from the hazard. All deficiencies shall be brought to the attention of the appropriate party that is responsible for correcting the deficiency. If an item is not applicable, the "N/A" box should be checked. If an item is applicable but was not observed during the assessment, the "N/O" box should be checked.

	Yes	No	NA	N/O
GENERAL				
1. Weather forecast checked.	☐	☐	☐	☐
2. At Least one Team Member is trained in First Aid/CPR.	☐	☐	☐	☐
3. Lights, horn, battery, fuel, steering, bilge pump, anchor & propeller checked.	☐	☐	☐	☐
4. Daily safety briefing/meeting conducted with crew	☐	☐	☐	☐
5. Personal Floatation Devices (PFD's) inspected daily.	☐	☐	☐	☐
6. Fire extinguisher available, charged and accessible.	☐	☐	☐	☐
7. First aid kit available	☐	☐	☐	☐
8. Project Instructions and H&S Plan available	☐	☐	☐	☐
9. Potable water available	☐	☐	☐	☐
10. Sunscreen & Bug Spray available	☐	☐	☐	☐
11. Distress communications available (flare gun, air horn, Cell phone, CB)	☐	☐	☐	☐
12. An oar is available on board the boat in the event of mechanical failure	☐	☐	☐	☐
BOAT TRANSPORT				
13. Boat motor secured prior to boat transport	☐	☐	☐	☐
14. Turn signals and brake lights verified as operable.	☐	☐	☐	☐
15. Safety chains available on trailer and secured in a criss-cross fashion	☐	☐	☐	☐
16. Trailer winch engaged	☐	☐	☐	☐
17. Ball hitch seated and latch pin installed	☐	☐	☐	☐
18 Tools and equipment secured prior to boat movement	☐	☐	☐	☐
19 Personnel not allowed ride on boat as it is being towed	☐	☐	☐	☐
20. Safe distance is maintained with traveling around power lines	☐	☐	☐	☐
21. Backup alarm or spotter used when backing boat	☐	☐	☐	☐
22. Boat is unhitched on a level and stabile surface	☐	☐	☐	☐
BOAT OPERATION				
23. Boat holds appropriate size load	☐	☐	☐	☐
24. Personnel cleared during boat start-up	☐	☐	☐	☐
25. Kill switch clearly identified and operational	☐	☐	☐	☐
26. Personnel wearing appropriate PPE	☐	☐	☐	☐
27. All personnel wearing PFD's	☐	☐	☐	☐
28. Boat will not be used for recreational purposes	☐	☐	☐	☐

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Attachment 1: Subcontractor Safety Procedure Criteria - Drilling

The following criteria are not intended to be all-inclusive, but are provided as a tool to facilitate development and review of subcontractor safety procedures. Subcontractors are expected to address the following items, at a minimum, in their safety procedures.

Minimum Acceptable Criteria for Subcontractor Drilling Safety Procedures:

1. Provide name and qualifications of the drilling "competent person" responsible for drilling (years and type of experience, training background, etc.):
2. Describe drill rig and equipment inspection criteria or procedures (frequency of inspections, visual vs. written inspections, items that are inspected):
3. Describe methods of identifying underground utilities (contacting utility companies, third party instrumented locates, drawing review, personnel interviews, detection equipment, etc.):
4. Describe methods of avoiding contact with overhead power lines (de-energizing and grounding, insulating, safe clearance distances):
5. Describe methods to identify hazardous atmospheres and controls used to eliminate (detection equipment and controls):
6. Describe leveling and stabilizing methods for drill rig (drilling pad preparation, jacks, cribbing, guy wires):
7. Verify that rig equipment is in good operational condition (including "kill" switch, cathead, ropes, pressurized hoses and lines, operator controls, machine guards, and drilling tools):
8. Describe procedures for operating in inclement weather, including lightning, high winds, severe rain storms:
9. Describe other safe work practices for equipment operation (drill rig, equipment, tools, rig transportation, rig travel):
10. Describe on-the-job maintenance procedures, including lockout/tagout:
11. Describe safe work practices for other activities to be performed during this project (use of ladders, fall protection, use of electrical power tools, use of personal protective equipment, etc.):
12. Describe methods for disposal of non-hazardous drill cuttings and purge water (including accumulation, transport, and disposal):
13. If hazardous waste project, provide documentation of hazardous waste worker training and medical surveillance records for all project personnel (40-hour or 24-hour training, 8-hour refresher training) and describe methods of hazardous waste management (including accumulation, transport, and disposal):
14. Submit a copy of drilling license/certification and drill rig permit:
15. Describe methods and responsibilities for submittal of notifications and logs:

16. Complete the Waste Subcontractor Qualification Form for each proposed transport and disposal facility:

17. Describe procedures for drilling site clean-up upon job completion.

If drilling in areas with known or potential Munitions and Explosives of Concern (MEC) hazards:

18. Provide documentation of UXO qualifications, hazardous waste worker training, medical surveillance records, and drug testing for all project personnel (Technical EOD/UXO training certificate, 40-hour or 24-hour training, 8-hour refresher training):

19. Describe procedures for MEC avoidance, identification and marking the boundaries of a clear approach path and work site for the sampling crews, vehicles, and equipment to enter the site:

20. Describe the procedures for drilling and monitoring, and the process for encountered MEC.

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Attachment 2: HSE Self-Assessment Checklist - Drilling

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's written safety plan.

This checklist is to be used at locations where: 1) CH2M HILL employees are potentially exposed to drilling hazards, 2) CH2M HILL staff are providing support function related to drilling activities, and/or 3) CH2M HILL oversight of a drilling subcontractor is required.

Safety Coordinator may consult with drilling subcontractors when completing this checklist, but shall not direct the means and methods of drilling operations nor direct the details of corrective actions. Drilling subcontractors shall determine how to correct deficiencies and we must carefully rely on their expertise. Items considered being imminently dangerous (possibility of serious injury or death) shall be corrected immediately, or all exposed personnel shall be removed from the hazard until corrected.

Project Name: ______________________________ Project No.: ______________

Location: ______________________________ PM: ______________________

Auditor: ____________________ Title: ____________________ Date: __________

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposures to drilling hazards (complete Section 1).
☐ Evaluate CH2M HILL support functions related to drilling activities (complete Section 2)
☐ Evaluate a CH2M HILL subcontractor's compliance with drilling safety requirements (complete entire checklist).
Subcontractors Name: ______________________________

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the drilling subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in SOP HSE-204.

SECTION 1 - SAFE WORK PRACTICES - 5.1

	Yes	No	N/A	N/O
1. Personnel cleared during rig start-up, positioning and setup	☐	☐	☐	☐
2. Personnel clear of rotating parts	☐	☐	☐	☐
3. Personnel not positioned under hoisted loads	☐	☐	☐	☐
4. Loose clothing and jewelry removed	☐	☐	☐	☐
5. Smoking is prohibited around drilling operation	☐	☐	☐	☐
6. Personnel wearing appropriate personal protective equipment (PPE), per HSP or FSI	☐	☐	☐	☐
7. Personnel instructed not to approach equipment that has become electrically energized	☐	☐	☐	☐

SECTION 2 - SUPPORT FUNCTIONS - 5.2

AQUIFER DESIGNATIONS (5.2.1)

8. Aquifer designations determined and BGEM consulted when required.	☐	☐	☐	☐

LOCATION OF UTILITIES (5.2.2)

9. Location of underground and overhead utilities and structures identified	☐	☐	☐	☐
10. Utility company contacted to de-energize/ground power lines due to clearance	☐	☐	☐	☐

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SUPPORRT FUNCTIONS – 5.2 (Continued)

	Yes	No	N/A	N/O
WASTE MANAGEMENT (5.2.3)				
11. Drill cuttings and purge water managed and disposed properly	☐	☐	☐	☐
12. Wastes generated evaluated for proper disposal	☐	☐	☐	☐
13. Appropriate decontamination procedures being followed, per project's written safety plan	☐	☐	☐	☐
DRILLING AT ORDNANCE EXPLOSIVES OR UNEXPLODED ORDNANCE SITES (5.2.4)				
14. MEC plan prepared and approved	☐	☐	☐	☐
15. MEC avoidance provided, routes and boundaries cleared and marked	☐	☐	☐	☐
16. Initial pilot hole established by UXO technician with hand auger	☐	☐	☐	☐
17. Personnel remain inside cleared areas	☐	☐	☐	☐
SECTION 3 - DRILLING SAFETY REQUIREMENTS -5.3				
GENERAL (5.3.1)				
18. Only authorized personnel operating drill rigs	☐	☐	☐	☐
19. Daily safety briefing/meeting conducted with crew	☐	☐	☐	☐
20. Daily inspection of drill rig and equipment conducted before use	☐	☐	☐	☐
21. Good housekeeping maintained on and around rig	☐	☐	☐	☐
SAFETY EQUIPMENT (5.3.2)				
22. Safety-toed boots, hardhats, safety glasses w/side shields, gloves and hearing protection worn	☐	☐	☐	☐
23. Drill rig equipped with fire extinguisher	☐	☐	☐	☐
24. Air monitoring instruments provided when required	☐	☐	☐	☐
25. Reflective/high visibility vests worn when required	☐	☐	☐	☐
26. PPE for protection from chemical hazards worn if required	☐	☐	☐	☐
BURIED UTILITY AND OVERHEAD CLEARANCE (5.3.3)				
27. Location of underground utilities and structures identified, including third party locate	☐	☐	☐	☐
28. 360^0 visual observation conducted	☐	☐	☐	☐
29. Hand digging, air knifing conducted to expose utilities before drilling	☐	☐	☐	☐
30. Safe clearance distance maintained from overhead power lines	☐	☐	☐	☐
31. Power lines de-energized and grounded when safe distances cannot be maintained	☐	☐	☐	☐
DRILL RIG PLACEMENT (5.3.4)				
32. Drilling pad established, when necessary	☐	☐	☐	☐
33. Drill rig leveled and stabilized	☐	☐	☐	☐
34. Additional precautions taken when drilling in restricted areas	☐	☐	☐	☐
35. In Karst topography use remote sensing or geologist review for sinkholes	☐	☐	☐	☐
DRILL RIG TRAVEL (5.3.5)				
36. Rig shut down and mast lowered and secured prior to rig movement	☐	☐	☐	☐
37. Tools and equipment secured prior to rig movement	☐	☐	☐	☐
38. Only personnel seated in cab wearing a seat belt are riding on rig during movement	☐	☐	☐	☐
39. Backup alarm or spotter used when backing rig	☐	☐	☐	☐
40. Spotter used when backing rig in tight or restricted areas or when low clearances exist	☐	☐	☐	☐
41. Safe clearance distance maintained while traveling under overhead power lines	☐	☐	☐	☐
EMERGENCY – CONTACT WITH OVERHEAD OR UNDERGROUND ELECTRICAL LINES (5.3.6)				
42. Personnel understand emergency procedures in the event of contact with overhead or underground electrical lines	☐	☐	☐	☐
DRILL RIG OPERATION (5.3.7)				
43. Drill rig operated in accordance with operators' manual	☐	☐	☐	☐
44. Personnel clear while mast is being raised	☐	☐	☐	☐
45. Kill switch clearly identified, operational, and in reach of the operator control station	☐	☐	☐	☐

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SECTION 3 - DRILLING SAFETY REQUIREMENTS - 5.3 (Continued)

46. All machine guards are in place	☐	☐	☐	☐
47. Rig ropes never wrapped around any part of the body	☐	☐	☐	☐
48. Pressurized lines and hoses secured to prevent whipping hazards	☐	☐	☐	☐
49. Drilling operation stopped during inclement weather	☐	☐	☐	☐
50. Air monitoring conducted per written safety plan for hazardous atmospheres	☐	☐	☐	☐
51. Rig gear boxes placed in neutral when operator not at controls	☐	☐	☐	☐
52. Operator shuts rig engine down prior to leaving the drill rig vicinity	☐	☐	☐	☐
DRILL RIG SITE CLOSURE (5.3.8)				
53. Ground openings/holes filled or barricaded	☐	☐	☐	☐
54. Equipment and tools properly stored	☐	☐	☐	☐
55. All vehicles locked and keys removed	☐	☐	☐	☐
DRILL RIG MAINTENANCE (5.3.9)				
56. Rig properly maintained per drilling company's maintenance program and records on-site/available for review	☐	☐	☐	☐
57. Defective components repaired immediately	☐	☐	☐	☐
58. Lockout/tagout procedures used prior to maintenance	☐	☐	☐	☐
59. Cathead in clean, sound condition	☐	☐	☐	☐
60. Drill rig ropes in clean, sound condition	☐	☐	☐	☐
61. Fall protection used for fall exposures of 6 feet (U.S.) 1.5 m or greater	☐	☐	☐	☐
62. Rig in neutral and augers stopped rotating before cleaning	☐	☐	☐	☐
63. Good housekeeping maintained on and around rig	☐	☐	☐	☐
FORMS/PERMITS AND CHECKLISTS (7.0)				
64. Driller license/certification obtained	☐	☐	☐	☐
65. Well development/abandonment notifications and logs submitted and in project files	☐	☐	☐	☐
66. Groundwater withdrawal permit obtained where required	☐	☐	☐	☐
67. Dig permit obtained where required	☐	☐	☐	☐

SECTION 3

Complete this section for all items checked “No” in previous sections. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: ____________________________ Project Manager: _______________________________

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Attachment 1: Subcontractor Safety Procedure Criteria-Hand and Power Tools

The following criteria are not intended to be all-inclusive, but are provided as a tool to facilitate development and review of subcontractor hand and power tool procedures. Subcontractors are expected to address the following items in their safety procedures.

Minimum Acceptable Criteria for Subcontractor Hand and Power Tool Safety Procedures:

1. Describe the method of training and qualifying personnel in the use of powder-actuated tools if such tools are to be used on the project.
2. Provide safe work practice guidelines on use and limitations for the types of hand and power tools to be used.
3. Provide a list of the types, work areas, and activities where special hand and power tools will be used.
4. Describe plans for the inspection of hand and power tools prior to introducing such tools to the work environment (i.e., tools brought on site by equipment rental vendors, home office storage facilities/yards, new purchases, employee supplied, etc.).
5. Provide a description of hand and power tool inspection criteria or procedures (frequency of inspections and items that are inspected).

The following safety procedures criteria, specifically applies to chain saw operations:

6. Provide qualifications of chainsaw operators (training, years and type of experience, etc.)
7. Describe personal protective equipment to be used by chain saw operators.
8. Describe safety equipment to be provided to ensure safe chain saw operation.
9. Describe inspection criteria or procedures (frequency of inspections per work shift, as needed throughout day; visual versus written inspections; items that are inspected).
10. Describe safe work practices (safe operation, refueling, maintenance, transport).
11. Describe methods of avoiding contact with overhead power-lines (contacting utilities, de-energizing and grounding, insulating, safe clearance distances).
12. Describe methods of protecting the public and others onsite (barricading, danger zone established, traffic control, etc.).
13. Describe safe work practices or procedures for the specific work to be performed (tree feeling, limbing standing trees, limbing fallen trees, bucking trees, etc.).

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Attachment 2 - HSE Self-Assessment Checklist—HAND AND POWER TOOLS Page 1 of 4

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP/FSI.

This checklist is to be used at locations where: (1) CH2M HILL employees are exposed to hand and power tool hazards and/or (2) CH2M HILL provides oversight of subcontractor personnel who are exposed to hand and power tool hazards.

SC may consult with subcontractors when completing this checklist, but shall not direct the means and methods of hand and power tool use nor direct the details of corrective actions. Subcontractors shall determine how to correct deficiencies and we must carefully rely on their expertise. Items considered being imminently dangerous (possibility of serious injury or death) shall be corrected immediately or all exposed personnel shall be removed from the hazard until corrected.

Project Name: ______________________________ Project No.: ____________

Location: ______________________________ PM: ____________________

Auditor: ____________________ Title: __________________ Date: _______

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposure to hand and power tool hazards.
☐ Evaluate a CH2M HILL subcontractor's compliance with hand and power tool requirements.
Subcontractors Name: ______________________________

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard Operating Procedure HSE-210.

SECTION 1

SAFE WORK PRACTICES (5.1)

	Yes	No	N/A	N/O
1. All tools operated according to manufacturer's instructions and design limitations.	☐	☐	☐	☐
2. All hand and power tools maintained in a safe condition and inspected and tested before use.	☐	☐	☐	☐
3. Defective tools are tagged and removed from service until repaired.	☐	☐	☐	☐
4. PPE is selected and used according to tool-specific hazards anticipated.	☐	☐	☐	☐
5. Power tools are not carried or lowered by their cord or hose.	☐	☐	☐	☐
6. Tools are disconnected from energy sources when not in use, servicing, cleaning, etc.	☐	☐	☐	☐
7. Safety guards remain installed or are promptly replaced after repair.	☐	☐	☐	☐
8. Tools are stored properly.	☐	☐	☐	☐
9. Cordless tools and recharging units both conform to electrical standards and specifications.	☐	☐	☐	☐
10. Tools used in explosive environments are rated for such use.	☐	☐	☐	☐
11. Knives/open blade tools only used when approved with written precautions, PPE, and training	☐	☐	☐	☐
12. Consider controls to avoid muscular skeletal, repetitive motion, and cumulative trauma stressors.	☐	☐	☐	☐

SECTION 2	Yes	No	N/A	N/O
GENERAL (5.2.2)				
13. PPE is selected and used according to tool-specific hazards anticipated.	☐	☐	☐	☐
14. Tools are tested daily to assure safety devices are operating properly.	☐	☐	☐	☐
15. Damaged tools are removed from service until repaired.	☐	☐	☐	☐
16. Power operated tools designed to accommodate guards have guards installed.	☐	☐	☐	☐
17. Rotating or moving parts on tools are properly guarded.	☐	☐	☐	☐
18. Machines designed for fixed locations are secured or anchored.	☐	☐	☐	☐
19. Floor and bench-mounted grinders are provided with properly positioned work rests.	☐	☐	☐	☐
20. Guards are provided at point of operation, nip points, rotating parts, etc.	☐	☐	☐	☐
21. Fluid used in hydraulic-powered tools is approved fire-resistant fluid.	☐	☐	☐	☐
ELECTRIC-POWERED TOOLS (5.2.3)				
22. Electric tools are approved double insulated or grounded and used according to SOP HSE-206.	☐	☐	☐	☐
23. Electric cords are not used for hoisting or lowering tools.	☐	☐	☐	☐
24. Electric tools are used in damp/ wet locations are approved for such locations or GFCI installed.	☐	☐	☐	☐
25. Hand-held tools are equipped with appropriate on/off controls appropriate for the tool.	☐	☐	☐	☐
26. Portable, power-driven circular saws are equipped with proper guards.	☐	☐	☐	☐
ABRASIVE WHEEL TOOLS (5.2.4)				
27. All employees using abrasive wheel tools are wearing eye protection.	☐	☐	☐	☐
28. All grinding machines are supplied with sufficient power to maintain spindle speed.	☐	☐	☐	☐
29. Abrasive wheels are closely inspected and ring-tested before use.	☐	☐	☐	☐
30. Grinding wheels are properly installed.	☐	☐	☐	☐
31. Cup-type wheels for external grinding are protected by the proper guard or flanges.	☐	☐	☐	☐
32. Portable abrasive wheels used for internal grinding are protected by safety flanges.	☐	☐	☐	☐
33. Safety flanges are used only with wheels designed to fit the flanges.	☐	☐	☐	☐
34. Safety guards on abrasive wheel tools are mounted properly and of sufficient strength.	☐	☐	☐	☐
PNEUMATIC-POWERED TOOLS (5.2.5)				
35. Tools are secured to hoses or whip by positive means to prevent disconnection.	☐	☐	☐	☐
36. Safety clips or retainers are installed to prevent attachments being expelled.	☐	☐	☐	☐
37. Safety devices are installed on automatic fastener feed tools as required.	☐	☐	☐	☐
38. Compressed air is not used for cleaning unless reduced to < 30 psi, with PPE, and guarded.	☐	☐	☐	☐
39. Manufacturer's safe operating pressure for hoses, pipes, valves, etc. are not exceeded.	☐	☐	☐	☐
40. Hoses are not used for hoisting or lowering tools.	☐	☐	☐	☐
41. All hoses >1/2-inch diameter have safety device at source to reduce pressure upon hose failure.	☐	☐	☐	☐
42. Airless spray guns have required safety devices installed.	☐	☐	☐	☐
43. Blast cleaning nozzles are equipped with operating valves, which are held open manually.	☐	☐	☐	☐
44. Supports are provided for mounting nozzles when not in use.	☐	☐	☐	☐
45. Air receiver drains, handholes, and manholes are easily accessible.	☐	☐	☐	☐
46. Air receivers are equipped with drainpipes and valves for removal of accumulated oil and water.	☐	☐	☐	☐
47. Air receivers are completely drained at required intervals.	☐	☐	☐	☐
48. Air receivers are equipped with indicating pressure gauges.	☐	☐	☐	☐
49. Safety, indicating, and controlling devices are installed as required.	☐	☐	☐	☐
50. Safety valves are tested frequently and at regular intervals to assure good operating condition.	☐	☐	☐	☐

SECTION 2 (continued)

	Yes	No	N/A	N/O
LIQUID FUEL-POWERED TOOLS (5.2.6)				
51. Liquid fuel-powered tools are stopped when refueling, servicing, or maintaining.	☐	☐	☐	☐
52. Liquid fuels are stored, handled, and transported in accordance with SOP HSE-403	☐	☐	☐	☐
53. Liquid fuel-powered tools are used in confined spaces in accordance with SOP HSE-203.	☐	☐	☐	☐
54. Safe operating pressures of hoses, valves, pipes, filters, and other fittings are not exceeded.	☐	☐	☐	☐
POWDER-ACTUATED TOOLS (5.2.7)				
55. Only trained employee operates powder-actuated tools.	☐	☐	☐	☐
56. Powder-actuated tools are not loaded until just prior to intended firing time.	☐	☐	☐	☐
57. Tools are not pointed at any employee at any time.	☐	☐	☐	☐
58. Hands are kept clear of open barrel end.	☐	☐	☐	☐
59. Loaded tools are not left unattended.	☐	☐	☐	☐
60. Fasteners are not driven into very hard or brittle materials.	☐	☐	☐	☐
61. Fasteners are not driven into easily penetrated materials unless suitable backing is provided.	☐	☐	☐	☐
62. Fasteners are not driven into spalled areas.	☐	☐	☐	☐
63. Powder-actuated tools are not used in an explosive or flammable atmosphere.	☐	☐	☐	☐
64. All tools are used with correct shields, guards, or attachments recommended by manufacturer.	☐	☐	☐	☐
JACKING TOOLS (5.2.8)				
65. Rated capacities are legibly marked on jacks and not exceeded.	☐	☐	☐	☐
66. Jacks have a positive stop to prevent over-travel.	☐	☐	☐	☐
67. The base of jacks are blocked or cribbed to provide a firm foundation, when required.	☐	☐	☐	☐
68. Wood blocks are place between the cap and load to prevent slippage, when required.	☐	☐	☐	☐
69. After load is raised, it is cribbed, blocked, or otherwise secured immediately.	☐	☐	☐	☐
70. Antifreeze is used when hydraulic jacks are exposed to freezing temperatures.	☐	☐	☐	☐
71. All jacks are properly lubricated.	☐	☐	☐	☐
72. Jacks are inspected as required.	☐	☐	☐	☐
73. Repair or replacement parts are examined for possible defects.	☐	☐	☐	☐
74. Jacks not working properly are removed from service and repaired or replaced.	☐	☐	☐	☐
75. Wrenches are not used when jaws are sprung to the point of slippage.	☐	☐	☐	☐
76. Impact tools are kept free of mushroomed heads.	☐	☐	☐	☐
77. Wooden handles of tools are kept free of splinters or cracks and are tightly fitted in tool.	☐	☐	☐	☐
78. Cutting tools maintained and used following requirements in AHA or procedure	☐	☐	☐	☐

CHAIN SAWS (5.2.10)				
79. Chainsaw equipped with spark arrestor and fully functioning chain brake	☐	☐	☐	☐
80. Chainsaw operator's manual readily available	☐	☐	☐	☐
81. Fully stocked first aid kit and multipurpose fire extinguisher available	☐	☐	☐	☐
82. Appropriate personal protective equipment available and worn	☐	☐	☐	☐
83. Clothing free of loose edges that could become entangled in the saw	☐	☐	☐	☐
84. Chainsaw handles kept dry, clean, and free of oil or fuel mixture	☐	☐	☐	☐
85. Chainsaws held firmly with both hands and used right-handed	☐	☐	☐	☐
86. Operator standing to the left of the saw out of the plane of the chain	☐	☐	☐	☐
87. Saw used between the waist and mid-chest level	☐	☐	☐	☐
88. Full throttle maintained while cutting	☐	☐	☐	☐
89. Operator aware of position of guide bar tip, does not contact tip with anything being cut	☐	☐	☐	☐
90. Bumper spikes maintained as close to the object as possible	☐	☐	☐	☐
91. Operator aware of what is in the saw's downward path after the cut	☐	☐	☐	☐
92. No attempt made to cut material that is larger than the guide bar of the saw	☐	☐	☐	☐
93. Cuts avoided that will cause chain to jam	☐	☐	☐	☐
94. Non-metallic wedges used to prevent compression cuts from jamming the blade	☐	☐	☐	☐
95. Bystanders and helpers kept at a safe distance from operation	☐	☐	☐	☐
96. Chainsaw not operated when fatigued	☐	☐	☐	☐
96. Fire extinguisher present when operating the chainsaw in forest or brushy areas	☐	☐	☐	☐

SECTION 3

Complete this section for all items checked "No" in Sections 1 or 2. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: ______________________________ Project Manager: ________________________________

CH2MHILL

HSE Self-Assessment Checklist: HAZARDOUS MATERIALS HANDLING

This checklist is provided as a method of verifying compliance with regulations pertaining to the handling of hazardous materials. It shall be used at locations where CH2M HILL employees handle hazardous materials, or are required to perform oversight of subcontractor personnel handling hazardous materials, or both.

CH2M HILL staff shall not direct the means and methods of subcontractor operations nor direct the details of corrective actions. The subcontractor must determine how to correct deficiencies, and CH2M HILL staff must carefully rely on the subcontractor's expertise. Items considered imminently dangerous (possibility of serious injury or death) must be corrected immediately, or all exposed personnel must be removed from the hazard until it is corrected.

Project Name: ______________________________ Project No.: ______________
Location: ______________________________ PM: ______________
Auditor: ______________________ Title: ______________________ Date: __________

This specific checklist has been completed to (check only one of the boxes below):

☐ Evaluate CH2M HILL compliance with hazardous material handling requirements (SOP HSE-403)
☐ Evaluate a CH2M HILL subcontractor's compliance with hazardous material requirements
Subcontractor's Name: ______________________________

- Check "Yes" if an assessment item is complete or correct.
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard Operating Procedure HSE-403.

SECTION 1

GENERAL GUIDELINES (5.2)	Yes	No	N/A	N/O
1. Acids are stored away from bases.	☐	☐	☐	☐
2. Oxidizers and organics are stored away from inorganic reducing agents.	☐	☐	☐	☐
3. Flammables and corrosives are stored in appropriate storage cabinets.	☐	☐	☐	☐
4. Paper and other combustibles are not stored near flammables.	☐	☐	☐	☐
5. Secondary containment and lipped shelving are in place in storage areas.	☐	☐	☐	☐
6. A fire suppression system is available.	☐	☐	☐	☐
FLAMMABLE AND COMBUSTIBLE LIQUIDS (5.3)				
GENERAL STORAGE (5.3.1)				
7. Only approved containers/portable tanks used to store flammable and combustible liquids.	☐	☐	☐	☐
8. Approved safety cans used for handling flammable liquids in quantities 1-5 gallons.	☐	☐	☐	☐
9. For quantities of one gallon or less, the original container must be used for storage.	☐	☐	☐	☐
10. Flammable or combustible liquids are not stored in stairways or personnel passageways.	☐	☐	☐	☐

SECTION 1 (continued)	Yes	No	N/A	N/O
INDOOR STORAGE (5.3.2)				
11. Quantities of flammable or combustible liquids > 25 gallons stored in approved storage cabinet.	☐	☐	☐	☐
12. No more than 25 gallons of flamm. or comb. liquids can be stored outside an approved cabinet.	☐	☐	☐	☐
13. Cabinets are labeled with "'FLAMMABLE: KEEP FIRE AWAY."	☐	☐	☐	☐
14 No more than 60 gallons of flamm. or 120 gallons of comb. liquids stored in one storage cabinet.	☐	☐	☐	☐
15. Not more than three cabinets located in a single storage area.	☐	☐	☐	☐
OUTSIDE STORAGE (5.3.3)				
16. Storage of containers (not more than 60 gallons each) do not exceed 1,100 gallons in any area.	☐	☐	☐	☐
17. Storage areas are not within 20 feet of any building.	☐	☐	☐	☐
18. Storage areas graded to divert spills away from buildings and surrounded by an earth dike.	☐	☐	☐	☐
19. Storage areas are free from weeds, debris, and other combustible materials.	☐	☐	☐	☐
20. Outdoor portable tanks are provided with emergency vent devices.	☐	☐	☐	☐
21. Outdoor portable tanks are no closer than 20 feet from any building.	☐	☐	☐	☐
22. Signs indicating no smoking are posted around the storage area.	☐	☐	☐	☐
DISPENSING (5.3.4)				
23. Areas where liquids are dispensed in >5-gal quantities are separated from other operations by 25'.	☐	☐	☐	☐
24. Drainage or other means provided to control spills.	☐	☐	☐	☐
25. Adequate natural or mechanical ventilation provided to maintain concentration of flammable vapor < 10% of the lower flammable limit.	☐	☐	☐	☐
26. Dispensing of flammable liquids from one container to another is done only when containers are electrically interconnected (bonded).	☐	☐	☐	☐
27. Dispensing flammable or combustible liquids by means of air pressure on the container or portable tanks prohibited.	☐	☐	☐	☐
28. Dispensing devices and nozzles for flammable liquids are of an approved type.	☐	☐	☐	☐
USE (5.3.5)				
29. Flammable liquids are kept in closed containers when not in actual use.	☐	☐	☐	☐
30. Leakage or spillage of flammable or combustible liquids is disposed of promptly and safely.	☐	☐	☐	☐
31. Sources of ignition are kept at least 50 feet from flammable liquids.	☐	☐	☐	☐
LIQUID PETROLEUM GAS (5.4)				
32. LPG containers meet DOT requirements.	☐	☐	☐	☐
33. Each container or system has a safety relief device or valve in good working order.	☐	☐	☐	☐
34. Portable heaters using LPG have an automatic shutoff device in the event of flame failure.	☐	☐	☐	☐
35. Storage of LPG within buildings is prohibited.	☐	☐	☐	☐
36. LPG storage location has at least one portable fire extinguisher rated not less than 20-B:C.	☐	☐	☐	☐
COMPRESSED GAS CYLINDERS (5.5)				
GENERAL (5.5.1)				
37. Cylinders and apparatus inspected for defects and leakage prior to use. Damaged items not used.	☐	☐	☐	☐
38. Gas distributor notified and subsequent instructions followed for defective cylinders.	☐	☐	☐	☐
39. Leaking cylinders removed from the work area.	☐	☐	☐	☐
40. Cylinder users do not modify, tamper, or attempt repair on cylinders or apparatus.	☐	☐	☐	☐
41. Only cylinder owners or authorized agent refill cylinders or attempt to mix gases in a cylinder.	☐	☐	☐	☐
42. Cylinders labeled with the identity of the contents.	☐	☐	☐	☐

SECTION 1 (continued)	Yes	No	N/A	N/O
TRANSPORTING (5.5.2)				
43. Cylinders not rolled in the horizontal position or dragged; suitable material-handling device used.	☐	☐	☐	☐
44. Cylinders being transported have valve protection caps installed.	☐	☐	☐	☐
45. Cylinders in vertical position when transported by motor vehicle, hoisted, or carried.	☐	☐	☐	☐
46. Cylinders hoisted by a cradle or pallet designed for such use, and not by magnets, slings, or their valve protection caps.	☐	☐	☐	☐
STORAGE (5.5.3)				
47. Cylinders are stored in the vertical position with valve protection caps installed.	☐	☐	☐	☐
48. Cylinders are secured from being knocked over by a chain or other stabilizing device.	☐	☐	☐	☐
49. Cylinders are stored away from readily ignitable substances.	☐	☐	☐	☐
50. Cylinders are protected from exposure to temperature extremes.	☐	☐	☐	☐
51. Oxygen cylinders in storage are separated from fuel gas cylinders or combustible materials > 20’	☐	☐	☐	☐
or by a ½-hour fire-resistant barrier at least 5’ high.	☐	☐	☐	☐
52. Cylinders inside buildings are stored in dry, well-ventilated locations > 20’ from comb. materials.	☐	☐	☐	☐
53. Cylinders are stored in definitely assigned places away from elevators, stairs, or gangways.	☐	☐	☐	☐
54. Signs indicating no smoking are provided for storage areas containing flammable gas cylinders.	☐	☐	☐	☐
PLACEMENT FOR USAGE (5.5.4)				
55. Cylinders are located where they will not be knocked over or damaged.	☐	☐	☐	☐
56. Cylinders are secured in the vertical position.	☐	☐	☐	☐
57. Cylinders are not placed where they can become part of an electrical circuit.	☐	☐	☐	☐
58. Cylinders are kept far enough away from welding and cutting operations to prevent sparks, hot slag, or flames from reaching them. When impractical, fire resistant shields are provided.	☐	☐	☐	☐
59. Cylinders are not taken into confined spaces.	☐	☐	☐	☐
CYLINDER CONNECTIONS (5.5.5)				
60. Pressure-controlling apparatus is compatible with the particular gas used.	☐	☐	☐	☐
61. Cylinders and pressure-controlling apparatus are kept free of oil and grease.	☐	☐	☐	☐
62. Pressure-controlling apparatus is kept gastight to prevent leakage.	☐	☐	☐	☐
63. Cylinders not attached to process where backflow could occur unless check valves or traps used.	☐	☐	☐	☐
64. Manifolds designed for product used at the appropriate temperatures, pressures, and flow rates.	☐	☐	☐	☐
65. Manifolds are labeled and placed in well-ventilated and accessible locations.	☐	☐	☐	☐
66. Cylinders are not cross-connected with plant air lines.	☐	☐	☐	☐
67. Flash arrestors or reverse flow check valves are installed on all flammable gas cylinders.	☐	☐	☐	☐
USAGE (5.5.6)				
68. Eye protection (safety glasses or goggles) is worn when using cylinders.	☐	☐	☐	☐
69. Cylinder valve and regulator are inspected for foreign material before connecting.	☐	☐	☐	☐
70. If cylinders are frozen, warm (not boiling) water is used to thaw cylinders.	☐	☐	☐	☐
71. Cylinder valve remains closed except when the cylinder is in use.	☐	☐	☐	☐
72. Fuel gas cylinder valves are not opened more than 1½ turns, for quick closing.	☐	☐	☐	☐
73. If a special wrench is used to open a cylinder valve, it is left in position on the valve.	☐	☐	☐	☐
74. Acetylene cylinders are used in the vertical position.	☐	☐	☐	☐
75. Acetylene cylinders are not used > 15 psig or > 30 psia.	☐	☐	☐	☐
76. Copper pipe or fittings are not used with acetylene systems.	☐	☐	☐	☐
77. Compressed gas is not used to dust off clothing.	☐	☐	☐	☐
78. Cylinder valve closed and regulator relieved of internal pressure before regulators are removed.	☐	☐	☐	☐

HEAT STRESS PHYSIOLOGICAL MONITORING FORM

Project Name:

Date: | Company:

1. Record start and stop time for break, pulse at the beginning of your break and a second pulse 60 seconds later, fluid intake (water or electrolyte replacement), shade (Y/N) and A/C (Y/N).
2. Follow the Physiological Monitoring Protocol in the attached safety bulletin or FSI.
3. Never continue work if you are experiencing sudden and severe fatigue, nausea, dizziness, or lightheadedness, immediately call your Field Lead/Safety Coordinator/RHSM.

Employee:

Describe action taken if heart rate measurements are exceeded:

Time	Start	Stop	Start	Stop	Start	Stop	Start	Stop
Pulse								
Fuilds								
Shade								
A/C								

Employee:

Describe action taken if heart rate measurements are exceeded:

Time	Start	Stop	Start	Stop	Start	Stop	Start	Stop
Pulse								
Fuilds								
Shade								
A/C								

Employee:

Describe action taken if heart rate measurements are exceeded:

Time	Start	Stop	Start	Stop	Start	Stop	Start	Stop
Pulse								
Fuilds								
Shade								
A/C								

Employee:

Describe action taken if heart rate measurements are exceeded:

Time	Start	Stop	Start	Stop	Start	Stop	Start	Stop
Pulse								
Fuilds								
Shade								
A/C								

CH2MHILL®

HSE Self-Assessment Checklist—Lifting

This checklist shall be used **only** by CH2M HILL personnel and shall be completed at the frequency specified in the project's HSP/FSI.

This checklist is to be used at locations where: (1) CH2M HILL employees perform manual lifting activities (office or projects), and/or (2) CH2M HILL provides oversight of a subcontractor performing manual lifting activities.
SC or Office Safety Coordinators/Committee members may consult with subcontractors (if applicable) when completing this checklist but shall not direct the means and methods of activities nor direct the details of corrective actions. Subcontractors shall determine how to correct deficiencies, and we must carefully rely on their expertise.
Conditions considered imminently dangerous (possibility of serious injury or death) shall be corrected immediately or all exposed personnel shall be removed from the hazardous area until corrected.
Complete the appropriate project or office information:

Project Information
Project Name: ____ Project No.: _____________________
Location: ____ PM: ___________________________________
Auditor: ________________________________ Title: _______________________________ Date: _____________

Office Information
Office Location: ____
Auditor: ________________________________ Title: _______________________________ Date: _____________

This specific checklist has been completed to:
☐ Evaluate CH2M HILL employee manual lifting activities.
☐ Evaluate a CH2M HILL subcontractor's manual lifting activities.
Subcontractor Name: ____

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the subcontractor.
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard Operating Procedure HSE-112.

Planning Activities	**Yes**	**No**	**N/A**	**N/O**
1. Efforts have been made to inquire about receiving equipment or supplies in containers weighting less than 50 pounds (23 kilograms).	o	o	o	o
2. Equipment or supplies are being delivered as close as possible to their use point.	o	o	o	o
3. Heavy equipment or supplies are being stored off the ground and no lower than knee height.	o	o	o	o
4. Adequate space has been provided to access and lift equipment or supplies without reaching or twisting.	o	o	o	o

Safe Work Practices (5.1)	**Yes**	**No**	**N/A**	**N/O**
5. Tasks or activities have been modified to reduce or minimize manual lifting.	o	o	o	o
6. All employees performing manual lifting have received training on how to lift safely.	o	o	o	o
7. Manual lifting control measures are evaluated during assessments.	o	o	o	o

		Yes	No	N/A	N/O
8.	Manual lifting incidents are reviewed as part of the HSE Program reviews.	o	o	o	o
9.	Manual lifting incidents are reviewed as part of the HSE Program reviews.	o	o	o	o
Office Environments (5.1.1)		**Yes**	**No**	**N/A**	**N/O**
10.	Employees have received lifting training.	o	o	o	o
11.	Mechanical devices are readily available to employees handling equipment or supplies weighing more than 40 pounds (18 kilograms).	o	o	o	o
Field Projects (5.1.2)		**Yes**	**No**	**N/A**	**N/O**
12.	All manual lifting tasks or activities have been addressed in the written site safety plan.	o	o	o	o
13.	Employees have received safe lifting training as required by the written site safety plan.	o	o	o	o
Mechanical Lifting (5.2)		**Yes**	**No**	**N/A**	**N/O**
14.	Hand trucks and trolleys are visually inspected before use.	o	o	o	o
15.	Hand trucks and trolleys do not have any broken or damaged parts.	o	o	o	o
16.	Hand truck and trolley paths are free of uneven surfaces, water, oil, or cracks and holes.	o	o	o	o
17.	Loads carried by hand trucks are balanced and sturdy.	o	o	o	o
18.	Hand trucks or dollies are being pushed when on level ground.	o	o	o	o
19.	When going up or down a slope using a hand truck or trolley, the load is downslope of the person.	o	o	o	o
20.	Employees using hand trucks or dollies are moving slowly and cautiously.	o	o	o	o
21.	Employees using hand trucks or trolleys are able to see over the load.	o	o	o	o
Assisted Lifting (5.3)		**Yes**	**No**	**N/A**	**N/O**
22.	Personnel are not performing manual lifting beyond their physical capabilities.	o	o	o	o
23.	Loads are evenly distributed when being handled by multiple people.	o	o	o	o
Manual Lifting (5.4)		**Yes**	**No**	**N/A**	**N/O**
24.	Before the lift, the load and path was assessed.	o	o	o	o
25.	Loads being lifted are free of sharp edges, slivers, or wet or greasy spots.	o	o	o	o
26.	Gloves are used for manual lifts of loads with sharp or splintered edges.	o	o	o	o
27.	Employees performing manual lifts use the proper lifting techniques.	o	o	o	o
28.	Special tools fabricated for lifting grates or manhole covers are used.	o	o	o	o

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Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: ______________________ Project Manager: ______________________

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HSE Self-Assessment Checklist: PPERSONAL PROTECTIVE EQUIPMENT

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP/FSI.

This checklist is to be used at locations where CH2M HILL employees are required to wear PPE or are required to perform oversight of a subcontractor using PPE or both.

CH2M HILL staff shall not direct the means and methods of subcontractor use of PPE nor direct the details of corrective actions. The subcontractor must determine how to correct deficiencies and CH2M HILL staff must carefully rely on their expertise. Conditions considered to be imminently dangerous (possibility of serious injury or death) must be corrected immediately or all exposed personnel must be removed from the hazard until corrected.

Project Name: ____ Project No.: ______________________

Location: ____ PM: __________________________________

Auditor: ____________________________ Title: __________________________ Date: _____________

This specific checklist has been completed to (check only one of the boxes below):

☐ Evaluate CH2M HILL compliance with its PPE program (SOP HSE-117)
☐ Evaluate a CH2M HILL subcontractor's compliance with its PPE program
Subcontractor's Name: ____

Check the appropriate box, as follows:

- Check "Yes" if an assessment item is complete or correct.
- Check "No" if an item is incomplete or deficient. Section 2 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard Operating Procedure HSE-117.

SECTION 1	**Yes**	**No**	**N/A**	**N/O**
GENERAL				
1. Required PPE listed in HSP FSI or AHA.	☐	☐	☐	☐
2. PPE available for use by employees.	☐	☐	☐	☐
3. PPE cleaning supplies available for use.	☐	☐	☐	☐
4. PPE stored appropriately to prevent deformation or distortion.	☐	☐	☐	☐
5. PPE written certification has been completed.	☐	☐	☐	☐
EYEWEAR (Glasses/Goggles/Face Shields)				
6 Eyewear cleaning supplies available.	☐	☐	☐	☐
7 Safety glasses in good condition and lenses free of scratches.	☐	☐	☐	☐
8 Goggles adjustment strap not cracked or frayed, not deformed, or lenses not scratched.	☐	☐	☐	☐
9. Face shields in good condition, including adjustment band, and free of scratches or chips.	☐	☐	☐	☐

SECTION 1 (Continued)	Yes	No	N/A	N/O
HEAD PROTECTION				
10. Hard hat bill and suspension attached as allowed by manufacturer.	☐	☐	☐	☐
11. Shell is pliable, free of dents, cracks, nicks, or any damage due to impact.	☐	☐	☐	☐
12. Suspension maintained at 1.25 inches from inside of shell.	☐	☐	☐	☐
13. Suspension free of cuts or fraying, torn headband, adjustment strap workable.	☐	☐	☐	☐
14. Electrical hard hat matched to hazard classification.	☐	☐	☐	☐
15. Dated to determine whether within manufacturer's allowable 5-year use time period.	☐	☐	☐	☐
HAND PROTECTION				
16. Available in sizes matched to employee.	☐	☐	☐	☐
17. Gloves free of rips tears, abrasions, or holes.	☐	☐	☐	☐
18. Matched to manufacturer's specification for chemicals used onsite.	☐	☐	☐	☐
19. Electrical gloves matched to hazard and periodically inspected for insulating rating.	☐	☐	☐	☐
20. Maintained in a clean and sanitary condition, decontaminated or disposed properly.	☐	☐	☐	☐
BODY PROTECTION				
21. Available in sizes matched to employee.	☐	☐	☐	☐
22. Maintained in a clean and sanitary condition, decontaminated or disposed properly.	☐	☐	☐	☐
23. Vapor-tight fully encapsulated suits tested at required periodic intervals.	☐	☐	☐	☐
24. Flame-resistant clothing matched to electrical hazard and arc flash rating.	☐	☐	☐	☐
25 Welding gear matched to degree of hazard and free of cuts, tears or burn holes.	☐	☐	☐	☐
26 Flotation gear available for work near or on water and in good condition.	☐	☐	☐	☐
HOT AND COLD BODY PROTECTION				
27 Cooling gear available based on degree of heat stress hazard.	☐	☐	☐	☐
28 Cooling gear in operable, clean, and sanitary condition.	☐	☐	☐	☐
29 Cold-weather gear provided based on needs assessment.	☐	☐	☐	☐
30. Cold-weather gear available in sizes to match employees.	☐	☐	☐	☐
31 Cold-weather gear is in free of tears, rips, or holes and in maintained in a clean condition.	☐	☐	☐	☐
TRAINING				
32 Initial PPE training completed by employees.	☐	☐	☐	☐
33 Training conducted when new types or styles of PPE are issued.	☐	☐	☐	☐
34 PPE selection, use, and maintenance reviewed at daily safety briefings.	☐	☐	☐	☐

SECTION 2

Complete this section for all items checked “No” in Section 1. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned or Taken	Date Corrected

Auditor: ________________________________ Project Manager: ___________________________________

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Attachment 1: Information for Voluntary Use of Respirators

Respirators are an effective method of protection against designated hazards when properly selected and worn. Respirator use is encouraged, even when exposures are below the exposure limit, to provide an additional level of comfort and protection for workers. However, if a respirator is used improperly or not kept clean, the respirator itself can become a hazard to the worker. Sometimes, workers may wear respirators to avoid exposures to hazards, even if the amount of hazardous substance does not exceed the limits set by OSHA standards. If your employer provides respirators for your voluntary use, or if you provide your own respirator, you need to take the following precautions to be sure that the respirator itself does not present a hazard.

1. Read and heed all instructions provided by the manufacturer on use, maintenance, cleaning and care, and warnings regarding the respirator's limitations.
2. Choose respirators certified for use to protect against the contaminant of concern. NIOSH, the National Institute for Occupational Safety and Health of the U.S. Department of Health and Human Services, certifies respirators. A label or statement of certification should appear on the respirator or respirator packaging. This label will tell you what the respirator is designed for and how much it will protect you.
3. Do not wear your respirator into atmospheres containing contaminants that your respirator is not designed to protect against. For example, a respirator designed to filter dust particles will not protect you against gases, vapors, or very small solid particles of fumes or smoke.
4. Keep track of your respirator so that you do not use someone else's respirator by mistake.

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Attachment 2: HS&E Self-Assessment Checklist— Respiratory Protection

H&S Self-Assessment Checklist: RESPIRATORY PROTECTION

This checklist is provided as a method of verifying compliance with the OSHA respiratory protection standard. It shall be used at locations where CH2M HILL personnel are using respiratory protection, or as a tool to assess subcontractors when CH2M HILL is required to perform oversight of a subcontractor using respiratory protection.

CH2M HILL staff shall not direct the means and methods of subcontractor use of respiratory protection nor direct the details of corrective actions. The subcontractor must determine how to correct deficiencies and CH2M HILL staff must carefully rely on their expertise. Items considered to be imminently dangerous (i.e., possibility of serious injury or death) must be corrected immediately or all exposed personnel must be removed from the hazard until corrected.

Completed checklists must be sent to the Responsible Health and Safety Manager (RHSM) for review.

Project Name: ______________________________ Project No.: ____________

Location: ______________________________ PM: ____________________

Auditor: ____________________ Title: ____________________ Date: ________

This specific checklist has been completed to (check only one of the boxes below):

☐ Evaluate CH2M HILL compliance with its respiratory protection program (SOP HSE-121)
☐ Evaluate a CH2M HILL subcontractor's respiratory protection program
Subcontractor's Name: ______________________________

Check the appropriate box, as follows:

- Check "Yes" if an assessment item is complete or correct.
- Check "No" if an item is incomplete or deficient. Section 2 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard Operating Procedure HSE-121.

SECTION 1	**Yes**	**No**	**N/A**	**N/O**
TRAINING (6.0)				
1. Respirator users have completed appropriate training on the respirator to be used.	☐	☐	☐	☐
2. Training is current within the past 12 months.	☐	☐	☐	☐
3. Attachment 1 of SOP HSE-121 distributed to employees using respirators voluntarily.	☐	☐	☐	☐
MEDICAL EVALUATION (5.2)				
4. Respirator users completed medical evaluation protocol.	☐	☐	☐	☐
5. Respirator use does not exceed any physician's written recommendation limitations.	☐	☐	☐	☐
6. Respirator users know to report any medical signs or symptoms related to respirator use.	☐	☐	☐	☐
FIT TESTING (5.3)				
7. Respirator users of tight-fitting facepieces have passed a fit test.	☐	☐	☐	☐
8. Fit test is current within the past 12 months.	☐	☐	☐	☐
9. Respirator users know to have new fit test performed if any change affects respirator fit.	☐	☐	☐	☐

SECTION 1 (Continued)	Yes	No	N/A	N/O
RESPIRATOR SELECTION (5.4)				
10. All feasible engineering controls have been considered in reducing exposure levels.	☐	☐	☐	☐
11. Appropriate respiratory protection and limitations are specified in HSP/FSI.	☐	☐	☐	☐
12. Cartridge or canister change-out schedule is specified in HSP/FSI.	☐	☐	☐	☐
RESPIRATOR USE (5.5)				
13. Respirator uses are limited to those specified in HSP/FSI.	☐	☐	☐	☐
14. HSM notified of changes in site conditions that may alter effectiveness of specified respirators.	☐	☐	☐	☐
15. Respirator users of tight-fitting facepieces are cleanly shaven.	☐	☐	☐	☐
16. Respirator users of tight-fitting facepieces perform user seal check before each use.	☐	☐	☐	☐
17. Cartridges or canisters replaced according to change-out schedule in HSP/FSI.	☐	☐	☐	☐
18. Respirator users informed to report any gas or vapor breakthrough to SSC/RHSM.	☐	☐	☐	☐
19. SC reports any gas or vapor breakthrough to RHSM.	☐	☐	☐	☐
20. Personnel not entering IDLH areas until standby-person established with appropriate equipment.	☐	☐	☐	☐
RESPIRATOR INSPECTION (5.6)				
21. Respirators in regular use are inspected before each use and during cleaning.	☐	☐	☐	☐
21. Emergency response respirators are inspected and documented monthly.	☐	☐	☐	☐
22. Defective respirators are taken out of service or repaired.	☐	☐	☐	☐
RESPIRATOR CLEANING AND DISINFECTING (5.7)				
23. Respirators in regular use are cleaned and disinfected as necessary.	☐	☐	☐	☐
24. Emergency and transferred respirators are cleaned and disinfected after use.	☐	☐	☐	☐
RESPIRATOR STORAGE (5.8)				
25. Respirators are properly stored to prevent contamination and deformation.	☐	☐	☐	☐
26. Emergency respirators are accessible and clearly marked as emergency respirators.	☐	☐	☐	☐
RESPIRATOR REPAIRS (5.9)				
27. Respirator repair is limited to routine maintenance.	☐	☐	☐	☐
28. Respirators beyond routine repair are removed from service.	☐	☐	☐	☐
BREATHING AIR SUPPLIED BY CYLINDER (5.10.1)				
29. Cylinders are marked with NIOSH-approval label.	☐	☐	☐	☐
30. Certificate of analysis meets Grade D specifications.	☐	☐	☐	☐
31. Certificate of analysis is kept onsite.	☐	☐	☐	☐
BREATHING AIR SUPPLIED BY COMPRESSOR (5.10.2)				
32. Breathing air meets Grade D specifications.	☐	☐	☐	☐
33. Compressor intake is located away from exhaust gases.	☐	☐	☐	☐
34. Compressor is provided with sorbent filters.	☐	☐	☐	☐
35. Sorbent filter change-out documentation is kept on the compressor.	☐	☐	☐	☐
36. High-temperature or carbon monoxide alarm provided on oil-lubricated compressors.	☐	☐	☐	☐
37. If high-temperature alarm is used alone, carbon monoxide levels are monitored.	☐	☐	☐	☐
38. Practical measures taken to control carbon monoxide levels on non oil-lubricated compressors.	☐	☐	☐	☐

SECTION 2

Complete this section for all items checked “No” in Section 1. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned or Taken	Date Corrected

Auditor: ________________________________ Project Manager: ______________________________

CH2M HILL Health and Safety Plan

Attachment 5

Key Target Zero Program Elements

(Blank forms for field use)

Project Health and Safety Field Change Request Log

Management Health, Safety, Security and Environment Inspection

Activity Hazard Analysis

Pre-Task Safety Plans

Safe Behavior Observation

Incident Report and Investigation
(use electronic form when possible)
HITS

Lessons Learned Template

Air Monitoring Form

Project Health and Safety Field Change Request Log

INSERT PROJECT NAME

FCR Number	Description of changes	Date of issue
	.	

HSE TargetZero
Protecting People and the Environment

Management Health, Safety, Security and Environment Inspection

Program/Project Name: ______________________ **Work Being Performed:** ______________________

Management Inspector: ______________________ **Project Number:** ______________________

Date: ______________________ **Sector:** ______________________

1. Job Information/Postings	**A**	**C**	**I**	**N/A**	**Comments/Corrective Action(s)**
a. Required postings in place (OSHA/State/Country)					
b. Emergency Contacts and Phone list posted					
c. Directions and map to hospital posted					
d. Incident Reporting Flow Chart posted					
2. HSSE Documentation					
a. HASP current (within 1 year), onsite, and signed					
b. AHAs available for all work and reviewed/signed					
c. Daily Pre-Task Safety Plan/Meeting completed					
d. SBO's completed weekly and emailed					
e. Self-Assessment checklists completed per HASP					
f. Environmental Plan available					
g. Emergency drill completed and documented					
h. E Permit compliance assurance measures documented					
i. HSE training up to date and documented					
3. Housekeeping/First Aid					
a. Work areas clean and organized					
b. Fire extinguisher, eye wash, 1st aid/BBP kit in place					
c. Materials and waste labeled and in closed containers					
4. PPE and Air Monitoring					
a. PPE being worn as specified in HASP/AHA					
b. Air monitoring done per HASP and documented					
5. Heavy Equipment and Construction Operations					
a. Documentation of Competent/Qualified Operators					
b. Back-up alarms audible & no cell phone use					
c. High-visibility vests on ground personnel					
d. Daily inspections completed and documented					
e. Windshields/mirrors OK and seat belts worn					
6. Excavation, Trenching, and Land Disturbing Activities					
a. Competent person identified					
b. Daily inspection completed prior to entry					
c. Proper setup (sloping, shoring, exits, spoils)					
d. 3rd party Utility Locate service used					
d. Storm water PPP and inspections/sampling conducted					
d. Erosion/sediment controls and dust controls in place					
7. Hand Tools					
a. Hand tools inspected prior to use					
b. Guards in place on tools					
c. Right tool for the job at hand					
8. Electrical					
a. All electrical cords, prongs, receptacles OK					
b. GFCI used on all circuits					
c. No energized electrical work incl. voltage testing					
d. Written Lockout Tagout system in use					

(Column - A=Adequate, C=Needs Consideration, I=Needs Immediate Action, N/A= Not Applicable or Not Assessed)

9. Ladders and Scaffolds	A	C	I	N/A	Comments/Corrective Action(s)
a. Ladders extend 36” above the landing and secured					
b. Ladders selected and used properly					
c. Scaffold planked, unaltered, and in good condition					
d. Scaffold/ladder users trained in inspection and use					
10. Hot Work					
a. Gas cylinders stored upright and secured					
b. Minimum 20’ distance between fuels and oxygen					
c. PPE in use per HASP/AHA					
d. Fire watch in place w/adequate fire extinguishers					
11. Cranes					
a. Outriggers extended, swing radius protected					
b. Operator CCO licensed, competent person for rigging					
c. Annual certified crane inspection					
d. Chains and slings inspected, have rating tag					
e. Suspended load tag lines - no one underneath					
12. Drill Rigs					
a. Overhead electrical clearance adequate					
b. Daily inspections completed and available					
c. Emergency shut off functioning					
d. 3rd party Utility Locate service used					
13. Hazard Communication and Chemical Use					
a. MSDS’s present for all chemicals					
b. Chemical Inventory current and in HSP or on file					
c. Hazard communication briefing for all chemicals					
d. All chemicals labeled/stored as required					
e. SPCC Plan implemented for >1320 gals fuels/oils on site					
14. Fall Protection					
a. Full body harness worn properly, workers tied off over 6’					
b. Guard rails 42” high					
15. Material Handling					
a. Proper body positioning					
b. Objects less than 40 lbs. for one person lift					
16. Site Control					
a. Work Zones delineated, necessary signage in place					
b. Decontamination method is adequate					
17. Waste and Hazardous Materials Management					
a. Waste Tracking Log					
b. Hazardous waste onsite for <90 days					
c. Containers labeled, inspections conducted/documented					
d. HW manifests signed, tracked, copies kept on site					
e. HW Transporters trained and licensed, placards used					
18. Security and Emergency Planning					
a. Emergency coordinator designated					
b. Severe weather plans/controls in place					
c. Security plan/measures adequate					
19. Demolition					
a. ACM and Hazardous Materials Survey					
b. Asbestos/Lead based paint work approved per policy					

(Column - A=Adequate, C=Needs Consideration, I=Needs Immediate Action, N/A= Not Applicable or Not Assessed)

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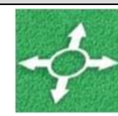
ACTIVITY HAZARD ANALYSIS

Date:	Task Risk Assessment Code (RAC):
Project:	
Site Supervisor:	
Site Safety Coordinator:	
HSM Review/Approval:	
Job/Activity:	
Description of the work:	

L = Low
E = Extremely High Risk
H = High Risk
M = Moderate Risk

		Probability				
		Frequent	Likely	Occasional	Seldom	Unlikely
Severity	**Catastrophic**	E	E	H	H	M
	Critical	E	H	H	M	L
	Marginal	H	M	M	L	L
	Negligible	M	L	L	L	L

TYPES OF POTENTIAL ENERGY:									
									
1	2	3	4	5	6	7	8	9	10
BIOLOGICAL	CHEMICAL	ELECTRICAL	GRAVITY	MECHANICAL	MOTION	PRESSURE	RADIATION	SOUND	TEMPERATUR E

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)

Equipment to be used (List equipment to be used in the work activity)	Inspection Requirements (List inspection requirements for the work activity)	Training Requirements (List training requirements including hazard communication)

ACTIVITY HAZARD ANALYSIS

	PRINT NAME	SIGNATURE	
Supervisor Name:	______________________	______________________	Date/Time:___________________
Safety Officer Name:	______________________	______________________	Date/Time:___________________
Employee Name(s):	______________________	______________________	Date/Time:___________________
	______________________	______________________	Date/Time:___________________
	______________________	______________________	Date/Time:___________________
	______________________	______________________	Date/Time:___________________
	______________________	______________________	Date/Time:___________________
	______________________	______________________	Date/Time:___________________
	______________________	______________________	Date/Time:___________________
	______________________	______________________	Date/Time:___________________
	______________________	______________________	Date/Time:___________________

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Pre-Task Safety Plan (PTSP) and Safety Meeting Sign-in Sheet

Project:______________________ Location: ____________ Date:____________

Supervisor: __________________________ Job Activity:_______________________________

____

Attendees: Print Name Sign Name

____
____
____
____
____
____
____

List Tasks and verify that applicable AHAs have been reviewed:

____
____
____

Tools/Equipment Required for Tasks (ladders, scaffolds, fall protection, cranes/rigging, heavy equipment, power tools):

____
____
____

Potential H&S Hazards, including chemical, physical, safety, biological and environmental (check all that apply):

__ Chemical burns/contact	__ Trench, excavations, cave-ins	__ Ergonomics
__ Pressurized lines/equipment	__ Overexertion	__ Chemical splash
__ Thermal burns	__ Pinch points	__ Poisonous plants/insects
__ Electrical	__ Cuts/abrasions	__ Eye hazards/flying projectile
__ Weather conditions	__ Spills	__ Inhalation hazard
__ Heights/fall > 6 feet	__ Overhead Electrical hazards	__ Heat/cold stress
__ Noise	__ Elevated loads	__ Water/drowning hazard
__ Explosion/fire	__ Slips, trip and falls	__ Heavy equipment
__ Radiation	__ Manual lifting	__ Aerial lifts/platforms
__ Confined space entry	__ Welding/cutting	__ Demolition
__Underground Utilities	__ Security	__ Poor communications

Other Potential Hazards (Describe):

____
____
____

Hazard Control Measures (Check All That Apply):			
PPE __ Thermal/lined __ Eye __ Dermal/hand __ Hearing __ Respiratory __ Reflective vests __ Flotation device __ Hard Hat __ Safety-Toed Boots	Protective Systems __ Sloping __ Shoring __ Trench box __ Barricades __ Competent person __ Locate buried utilities __ Daily inspections __ Entry Permits/notification	Fire Protection __ Fire extinguishers __ Fire watch __ Non-spark tools __ Grounding/bonding __ Intrinsically safe equipment	Electrical __ Lockout/tagout __ Grounded __ Panels covered __ GFCI/extension cords __ Power tools/cord inspected __ Overhead line clearance __ Underground utils ID'd
Fall Protection __ Harness/lanyards __ Adequate anchorage __ Guardrail system __ Covered opening __ Fixed barricades __ Warning system	Air Monitoring __ PID/FID __ Detector tubes __ Radiation __ Personnel sampling __ LEL/O2 __ No visible dust __ Other	Proper Equipment __ Aerial lift/ladders/scaffolds __ Forklift/heavy equipment __ Backup alarms __ Hand/power tools __ Crane with current inspection __ Proper rigging __ Operator qualified	Welding & Cutting __ Cylinders secured/capped __ Cylinders separated/upright __ Flash-back arrestors __ No cylinders in CSE __ Flame retardant clothing __ Appropriate goggles
Confined Space Entry __ Isolation __ Air monitoring __ Trained personnel __ Permit completed __ Rescue	Medical/ER __ First-aid kit __ Eye wash __ FA-CPR trained personnel __ Route to hospital	Heat/Cold Stress __ Work/rest regime __ Rest area __ Liquids available __ Monitoring __ Training	Vehicle/Traffic __ Traffic control __ Barricades __ Flags __ Signs
Permits __ Hot work __ Confined space __ Lockout/tagout __ Excavation __ Demolition __ Energized work	Demolition __ Pre-demolition survey __ Structure condition __ Isolate area/utilities __ Competent person __ Hazmat present	Inspections: __ Ladders/aerial lifts __ Lanyards/harness __ Scaffolds __ Heavy equipment __ Drill rigs/geoprobe rigs __ Cranes and rigging __ Utilities marked	Training: __ Hazwaste (current) __ Construction __ Competent person __ Task-specific __ FA/CPR __ Confined Space __ Hazcom
Underground Utilities __Dig alert called __3rd Party locater __As-builts reviewed __Interview site staff __Client review __soft locate necessary?	Incident Communications __Work stops until cleared by TM/CM __Immediate calls to TM/CM __Client notification __24 hour notification setup __Clear communications	AHA' s __reviewed and approved by HSM __on site and current __applicable for this day's work __Communication and incident processes included?	
Field Notes (including observations from prior day, etc.): ______________________________ ______________________________ ______________________________			

Name (Print): ______________________________

Signature: ______________________________ Date: ________________

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Safe Behavior Observation Form

☐ Federal ☐Commercial (check one) ☐ International	☐Construction or ☐Consulting (check one)
Project Number (required):	Client/Program:
Project Name:	Observer: Date:
Position/Title of worker observed:	Background Information/ comments:
Task/Observation Observed:	

- ❖ Identify and reinforce safe work practices/behaviors
- ❖ Identify and improve on at-risk practices/acts
- ❖ Identify and improve on practices, conditions, controls, and compliance that eliminate or reduce hazards
- ❖ Proactive PM support facilitates eliminating/reducing hazards (do you have what you need?)
- ❖ Positive, corrective, cooperative, collaborative feedback/recommendations

Actions & Behaviors	**Safe**	**At-Risk**	**Observations/Comments**
Current & accurate Pre-Task Planning/Briefing (Project safety plan, STAC, AHA, PTSP, tailgate briefing, etc., as needed)			**Positive Observations/Safe Work Practices:**
Properly trained/qualified/experienced			
Tools/equipment available and adequate			
Proper use of tools			**Questionable Activity/Unsafe Condition Observed:**
Barricades/work zone control			
Housekeeping			
Communication			
Work Approach/Habits			
Attitude			
Focus/attentiveness			**Observer's Corrective Actions/Comments:**
Pace			
Uncomfortable/unsafe position			
Inconvenient/unsafe location			
Position/Line of fire			
Apparel (hair, loose clothing, jewelry)			
Repetitive motion			**Observed Worker's Corrective Actions/Comments:**
Other…			

For ES Federal Sector projects please email completed forms to: CH2M HILL ES FED Safe Behavior Observation
For ES Commercial Sector projects please email completed forms to: CH2M HILL ES COM Safe Behavior Observation
For CNR ES staff please email completed forms to: cnressafe@ch2m.com
For International ES projects please e-mail completed forms to: ESINTLSafeBehaviorObservation@ch2m.com

HITS Incident Report Hardcopy (Phase 1 – Initial Entry)

Phase 1 – Initial Entry

Type of Incident (May select more than one)

☐ Injury/Illness	☐ Spill/Release	☐ Near Miss
☐ Property Damage	☐ Environment/Permit	☐ Other

General Information Section

Preparer's Name: ______________________ **Preparer's Phone Number:** ______________

Date of Incident: ______________ **Time of Incident**: ____________ AM / PM

What Business Group is accountable for this incident: ______________________

What Business Group SubGroup is accountable for this incident: ______________________

What CH2M HILL Company is accountable for this incident: ______________________

Where did the Incident occur?

- ☐ United States, Geographic Region: ______________________
- ☐ Canada, Province/Territory: ______________________
- ☐ International, County: ______________________

Location of Incident?

- ☐ Company Premises, CH2M HILL Office (use 3 letter office code if available): ______________
- ☐ Project, Project name: ______________________
- ☐ In Transit
  - Traveling from: ______________________
  - Traveling to: ______________________
- ☐ At Home
- ☐ Other, Specify: ______________________

Describe the incident: ______________________

____

____

Describe how this event could have been prevented: ______________________

____

Provide Witness Information:

Name: ______________________ Phone: ______________

Name: ______________________ Phone: ______________

Name: ______________________ Phone: ______________

Personnel Notified of Incident (Provide name, date and time):

CH2M HILL Personnel:

____

Client Personnel:

____

Additional Comments:

____

____

Injury/Illness Section **[Complete only if Injury/Illness Incident type selected]**

Who was injured?

- ☐ CH2M HILL Employee or CH2M HILL Temp Employee
- ☐ Subcontractor to CH2M HILL (Non-LLC Joint Venture Project)
- ☐ LLC Joint Venture Partner Employee
- ☐ LLC Joint Venture Project Subcontractor/Contractor
- ☐ Other

Name of Injured: ______________________ **Job Title:** ______________

Employer Name: ______________________ **Supervisor of Employee:** ______________

Complete for CH2M HILL Employee Injuries

Business Group of Injured Employee: ______________________

Has the employee called the Injury Management Administrator (1-866-893-2514)?

☐ Yes ☐ No ☐ Not Sure

Has the injured employee's supervisor been notified of this incident?

☐ Yes ☐ No ☐ Not Sure

Complete for Non-CH2M HILL Employee Injuries

Has the project safety coordinator been notified of this incident?

☐ Yes ☐ No ☐ Not Sure

Project Safety Coordinator: ______________________________

Body Part Affected: ______________________________

Injury/Illness (Result): ______________________________

Describe treatment provided (if medication provided, identify whether over-the-counter or prescription): ______________________________

____

Describe any work restriction prescribed (include dates and number of days): ______________________________

____

Physician/Health Care Provider Information

Name: ______________________________ Phone: ______________

Was treatment provided away from the worksite?

☐ No

☐ Yes

Facility Name:

____

Address:

____

City: ______________________________ Phone Number:

____

Was injured treated in an emergency room?

☐ No ☐ Yes

Was injured hospitalized overnight as an in-patient?

☐ No ☐ Yes

General Information Environmental Section **[Complete only if Environment/Permit or Spill/Release Incident type selected]**

Who had control of the area during the incident?

☐ CH2M HILL, Company: ______________________________

☐ Subcontractor, Company: ______________________________

☐ Joint Venture Partner/Contractor/Subcontractor, Company: ______________________________

☐ Other, Company: ______________________________

Relationship to CH2M HILL: ______________________________

Property Damage Section **[Complete only if Property Damage Incident type selected]**

Property Damaged: ______________________________

Property Owner: ______________________________

Damage Description: ______________________________

Estimated US Dollar Amount: ______________________________

Spill or Release Section **[Complete only if Spill/Release Incident type selected]**

Substance: ______________________________

Estimated Quantity: ______________________________

Did the spill/release move off the property?: ______________________________

Spill/Release From: ______________________________

Spill/Release To: ______________________________

Environment/Permit Section **[Complete only if Environment/Permit Incident type selected]**

Describe Environmental or Permit Issue: ______________________________

Permit Type: ______________________________

Permitted Level or Criteria (e.g., discharge limit): ______________________________

Permit Name and Number (e.g., NPDES No. ST1234): ______________________________

Substance and Estimated Quantity: ______________________________

Duration of Permit Exceedence: ______________________________

HSSE	Lessons Learned [Date] ESBG LL-11-xx
Subject	**[Insert Descriptive Name of Lessons Learned]**
CH2M HILL Project?	[Yes or No]
Situation	[Describe incident or situation that occurred in general terms. Try to be brief and avoid unnecessary details such as names of people or projects, business groups, divisions, dates, location, etc.]
Lessons Learned ***(Recommendations and Comments)***	• Bullet out any lessons learned, recommendations or other important "take away" information that would benefit others. Tie the recommendations to the incident or event, and avoid including information that is not directly tied to the event.
Submitted By	[Name/Office Location/Phone]
Additional Information Contact	[Name/Office Location/Phone]
Keywords/Categories	[Insert any keywords or incident categories that would aid in a search for this lessons learned]

Send completed Lessons Learned to the ESBG HSSE Director for posting and distribution. Please include a recommended distribution list.

CH2M HILL Health and Safety Plan

Attachment 6

Fact Sheets

Benzene Fact Sheet

Tick Fact Sheet

Vehicle Accident Guidance

Working Alone

Tick-Borne Pathogens — A Fact Sheet

Most of us have heard of Lyme disease or Rocky Mountain Spotted Fever (RMSF), but there are actually six notifiable tick-borne pathogens that present a significant field hazard. In some areas, these account for more than half of our serious field incidents. The following procedures should be applied during any field activity—even in places that are predominantly paved with bordering vegetation.

Hazard Recognition

An important step in controlling tick related hazards is understanding how to identify ticks, their habitats, their geographical locations, and signs and symptoms of tick-borne illnesses.

Tick Identification

There are five varieties of hard-bodied ticks that have been associated with tick-borne pathogens. These include:

- Deer (Black Legged) Tick (eastern and pacific varieties)
- Lone Star Tick
- Dog Tick
- Rocky Mountain Wood Tick

These varieties and their geographical locations are illustrated on the following page.

Tick Habitat

In eastern states, ticks are associated with deciduous forest and habitat containing leaf litter. Leaf litter provides a moist cover from wind, snow, and other elements. In the north-central states, is generally found in heavily wooded areas often surrounded by broad tracts of land cleared for agriculture.

On the Pacific Coast, the bacteria are transmitted to humans by the western black-legged (deer) tick and habitats are more diverse. For this region, ticks have been found in habitats with forest, north coastal scrub, high brush, and open grasslands. Coastal tick populations thrive in areas of high rainfall, but ticks are also found at inland locations.

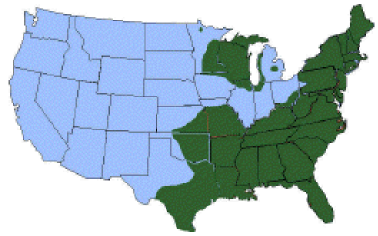
Illnesses and Signs & Symptoms

There are six notifiable tick-borne pathogens that cause human illness in the United States. These pathogens may be transmitted during a tick bite—normally hours after attachment. The illnesses, presented in approximate order of most common to least, include:

- Lyme (bacteria)
- RMSF (bacteria)
- Ehrlichiosis (bacteria)
- STARI (Southern Tick-Associated Rash Illness) (bacteria)
- Tularemia (Rabbit Fever) (bacteria)
- Babesia (protozoan parasite)

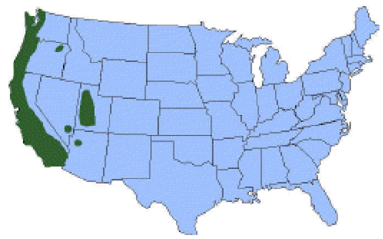
Symptoms will vary based on the illness, and may develop in infected individuals typically between 3 and 30 days after transmission. Some infected individuals will not become ill or may develop only mild symptoms. These illnesses present with some or all of the following signs & symptoms: fever, headache, muscle aches, stiff neck, joint aches, nausea, vomiting, abdominal pain, diarrhea, malaise, weakness, small solid, ring-like, or spotted rashes. The bite site may be red, swollen, or develop ulceration or lesions. For Lyme disease, the bite area will sometimes resemble a target pattern. A variety of long-term symptoms may result if the illness is left untreated, including debilitating effects and death.

Deer Tick



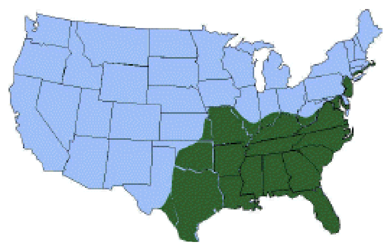
Distribution of Deer Tick (dark green)

From Left: adult female, adult male, nymph, and larvae Deer Tick (cm scale)



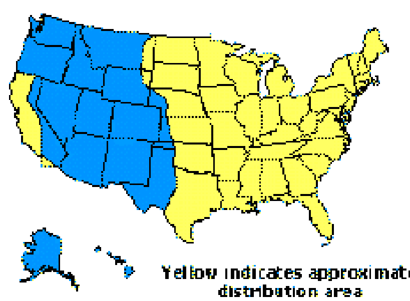
Distribution of Pacific Deer Tick (dark green)

Lone Star Tick

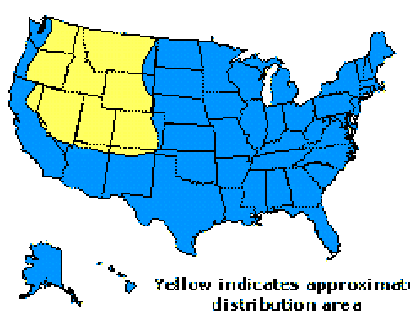


Distribution of Lone Star Tick (Green)

Dog Tick



Rocky Mountain Wood Tick



Hazard Control

The methods for controlling exposure to ticks include, in order of most- to least-preferred:

- Avoiding tick habitats and ceasing operations in heavily infested areas
- Reducing tick abundance through habitat disruption or application of acracide
- Personal protection through use of repellants and protective clothing
- Frequent tick inspections and proper hygiene

Vaccinations are not available and preventative antibiotic treatment after a bite is generally not recommended.

Avoidance and Reduction of Ticks

To the extent practical, tick habitats should be avoided. In areas with significant tick infestation, consider stopping work and withdrawing from area until adequate tick population control can be achieved. Stopping and withdrawing should be considered as seriously as entering an area without proper energy control or with elevated airborne contaminants—tick-borne pathogens present risk of serious illness!

In areas where significant population density or infestation exists, tick reduction should be considered. Tick reduction can be achieved by disrupting tick habitats and/or direct population reduction through the use of tick-toxic pesticides (Damminix, Dursban, Sevin, etc.).

Habitat disruption may include only simple vegetative maintenance such as removing leaf litter and trimming grass and brush. Tick populations can be reduced by between 72 and 100 percent when leaf litter alone is removed. In more heavily infested areas, habitat disruption may include grubbing, tree trimming or removal, and pesticide application (Damminix, Dursban, Sevin, etc.). This approach is practical in smaller, localized areas or perimeter areas that require occasional access. Habitat controls are to be implemented with appropriate health and safety controls, in compliance with applicable environmental requirements, and may be best left to the property owner or tenant or to a licensed pesticide vendor. Caution should be exercised when using chemical repellents or pesticides in or around areas where environmental or industrial media samples will be collected for analysis.

Personal Protection

After other prevention and controls are implemented, personal protection is still necessary to control exposure to ticks. Personal protection must include all of the following steps:

- So that ticks may be easily seen, wear light-colored clothing. Full-body New Tyvek (paper-like disposable coveralls) may also be used
- To prevent ticks from getting underneath clothing tuck pant legs into socks or tape to boots
- Wear long-sleeved shirts, a hat, and high boots
- Apply DEET repellent to exposed skin or clothing per product label
- Apply permethrin repellent to the outside of boots and clothing before wearing, per product label
- Frequently check for ticks and remove from clothing
- At the end of the day, search your entire body for ticks (particularly groin, armpits, neck, and head) and shower

- To prevent pathogen transmission through mucous membranes or broken/cut skin, wash or disinfect hands and/or wear surgical-style nitrile gloves any time ticks are handled

Pregnant individuals and individuals using prescription medications should consult with their physician and/or pharmacists before using chemical repellents. Because human health effects may not be fully known, use of chemical repellents should be kept to a minimum frequency and quantity. Always follow manufacturers' use instructions and precautions. Wash hands after handling, applying, or removing protective gear and clothing. Avoid situations such as hand-to-face contact, eating, drinking, and smoking when applying or using repellents.

Remove and wash clothes per repellent product label. Chemical repellents should not be used on infants and children.

Vaccinations are generally not available for tick-borne pathogens. Although production of the LYMErix™ Lyme disease vaccination has been ceased, vaccination may still be considered under specific circumstances and with concurrence from the consulting physician.

Tick Check

A tick check should be performed after field survey before entering the field vehicle (you do not want to infest your field vehicle with ticks). Have your field partner check your back; the backs of your legs, arms, and neck; and your hairline. Shake off clothing as thorough as possible before entering the vehicle. Once the field day is complete, repeat this procedure and perform a thorough self check.

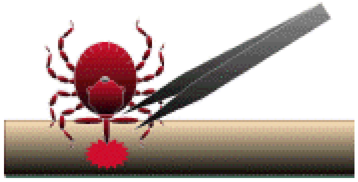
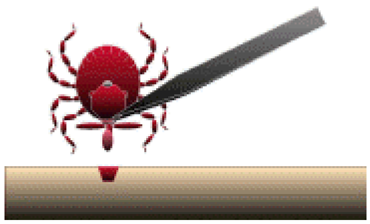
If a tick has embedded itself into the skin, remove the tick as described below.

Tick Removal

1. Use the tick removal kit obtained through the CH2M HILL Milwaukee warehouse, or a fine-tipped tweezers or shield your fingers with a tissue, paper towel, or nitrile gloves.

Error! Objects cannot be created from editing field codes.

2. Grasp the tick as close to the skin surface as possible and pull upward with steady, even pressure. Do not twist or jerk the tick; this may cause the mouthparts to break off and remain in the skin. If this happens, remove mouthparts with tweezers. Consult your healthcare provider if infection occurs.

3. Avoid squeezing, crushing or puncturing the body of the tick because its fluids (saliva, hemolymph, gut contents) may contain infectious organisms. Releasing these organisms to the outside of the tick's body or into the bite area may increase the chance of infectious organism transmission.

4. Do not handle the tick with bare hands because infectious agents may enter through mucous membranes or breaks in the skin. This precaution is particularly directed to individuals who remove ticks from domestic animals with unprotected fingers. Children, elderly persons, and immunocompromised persons may be at greater risk of infection and should avoid this procedure.

5. After removing the tick, thoroughly disinfect the bite site and wash your hands with soap and water.

6. Should you wish to save the tick for identification, place it in a plastic bag, with the date of the tick bite, and place in your freezer. It may be used at a later date to assist a physician with making an accurate diagnosis (if you become ill).

Note: Folklore remedies such as petroleum jelly or hot matches do little to encourage a tick to detach from skin. In fact, they may make matters worse by irritating the tick and stimulating it to release additional saliva, increasing the chances of transmitting the pathogen. These methods of tick removal should be avoided. In addition, a number of tick removal devices have been marketed, but none are better than a plain set of fine tipped tweezers.

First-Aid and Medical Treatment

Tick bites should always be treated with first-aid. Clean and wash hands and disinfect the bite site after removing embedded tick. Individuals previously infected with Lyme disease does not confer immunity—re-infection from future tick bites can occur even after a person has contracted a tick-borne disease.

The employee should contact the Injury Management/Return To Work provider (IMRTW), WorkCare using the toll-free number 866-893-2514 to report the tick bite. WorkCare will follow-up with each CH2M Hill employee who reports a tick bite and is at risk of developing Lyme disease by monitoring for symptoms up to 45 days, and will refer the employee to a medical provider for evaluation and treatment as necessary.

2018 Vehicle Accident Guidance

Definitions

Auto Liability: Injury or damage caused by a vehicle a Jacobs employee is driving

Auto Physical Damage: Damage to the vehicle the Jacobs employee is driving

NOTE: When driving your personal vehicle on company business, your personal auto insurance will respond to any automobile accident.

Insurance Cards

Please print and place in your vehicle
Fleet Vehicles: VO – Corporate Functions/Insurance & Bonding, Additional Resources, Auto ID Cards, Fleet: 2017-2018 Auto ID Cards FLEET (choose the state where the vehicle is garaged)
Rental Vehicles: VO – Corporate Functions/Insurance & Bonding, Additional Resources, Auto ID Cards, 2017-2018 Auto ID Cards Hired & Non-Owned (choose the state your driver's license issued)

NOTE: ALL Rental Vehicles should be rented through **Travel and Transport** or by using the **Corporate Code** to obtain the corporate rental rate as well as the Loss Damage Waiver. If the vehicle is not rented through Travel and Transport with the appropriate Company Code, the **entire cost of the auto accident could be charged to your Project.**

Rental Company	Company Code
Enterprise	XZ12139 (cars)
Enterprise	TK00442 (trucks)
National	XZ12139
Hertz	71499
Budget	T694100
Avis	A679700

When and Incident Occurs

In case of emergency – call 911
Notify your supervisor, Project Manager, and Project Health and Safety Manager

At the scene of the accident:

- ✓ Call the Police
- ✓ Take precautions to protect the scene of the accident from further accidents
- ✓ Provide emergency care for injured persons
- ✓ Request medical assistance
- ✓ Do not provide transportation
- ✓ Gather as much information as possible
- ✓ Take pictures
- ✓ Obtain witness names and addresses

Never admit liability. If asked, state that the claim will be or has been reported to your insurance carrier and an adjuster will contact them.

Complete a HITS Report – VO – Policies & Resources/Health, Safety & Environment/Program, HITS

Claim Reporting

Rental Vehicle:
Contact the rental company and report the claim
Notify Mary Ellegood-Oberts via email: mary.ellegoodoberts@ch2m.com

Leased Vehicle:
Notify Michelle Garcia via email: michelle.garcia@ch2m.com
Notify Mary Ellegood-Oberts via email: mary.ellegoodoberts@ch2m.com
Report claim to Broadspire via telephone: 800 753-6737, if there is damage to a 3rd party vehicle or injury

Rental Vehicles not rented through Travel and Transport

Rented with Corporate VISA:

Report claim to the rental company
Report claim to VISA – 800 847-2911
Notify Mary Ellegood-Oberts via email: mary.ellegoodoberts@ch2m.com
Report claim to Broadspire via telephone: 800 753-6737

Not Rented with Corporate VISA:

Report claim to rental company
Notify Mary Ellegood-Oberts via email: mary.ellegoodoberts@ch2m.com
Report claim to Broadspire via telephone: 800 753-6737

Note: We are self-insured for physical damage on our leased vehicles unless the vehicle is added to our policy. In most cases there is no physical damage coverage on Leased Vehicles.

If You are Injured in the Accident

- ✓ **Notify your supervisor, Project Manager, and Project Health and Safety Manager**
- ✓ **Call JacobsCare (U.S. only, except AK) at 1-855-328-6547**

  - Alaska employees continue to call +1 888 297-2725
  - Canada, contact your supervisor and your HSE representative and call the Nurse Triage number at 1-877-424-5256
  - Puerto Rico will contact their HR Representative, Lesly Leon (Direct: (+1) 786-507-5936 or Extension: x55936)
  - For International, contact your supervisor, HSE representative and HR representative

WORKING ALONE PROTOCOL
CALL – IN CONTACT FORM

Date of site work:_______________ Expected start time:______________
Name of CH2M HILL employee in the field:_____________________________________
Name of CH2M HILL employee responsible to receive contact:
Client Emergency Contact (if any):
CH2M HILL employee's contact numbers:
Radio #__________________________
Cell Phone #______________________
Address and Location of work:____
Directions/Map:

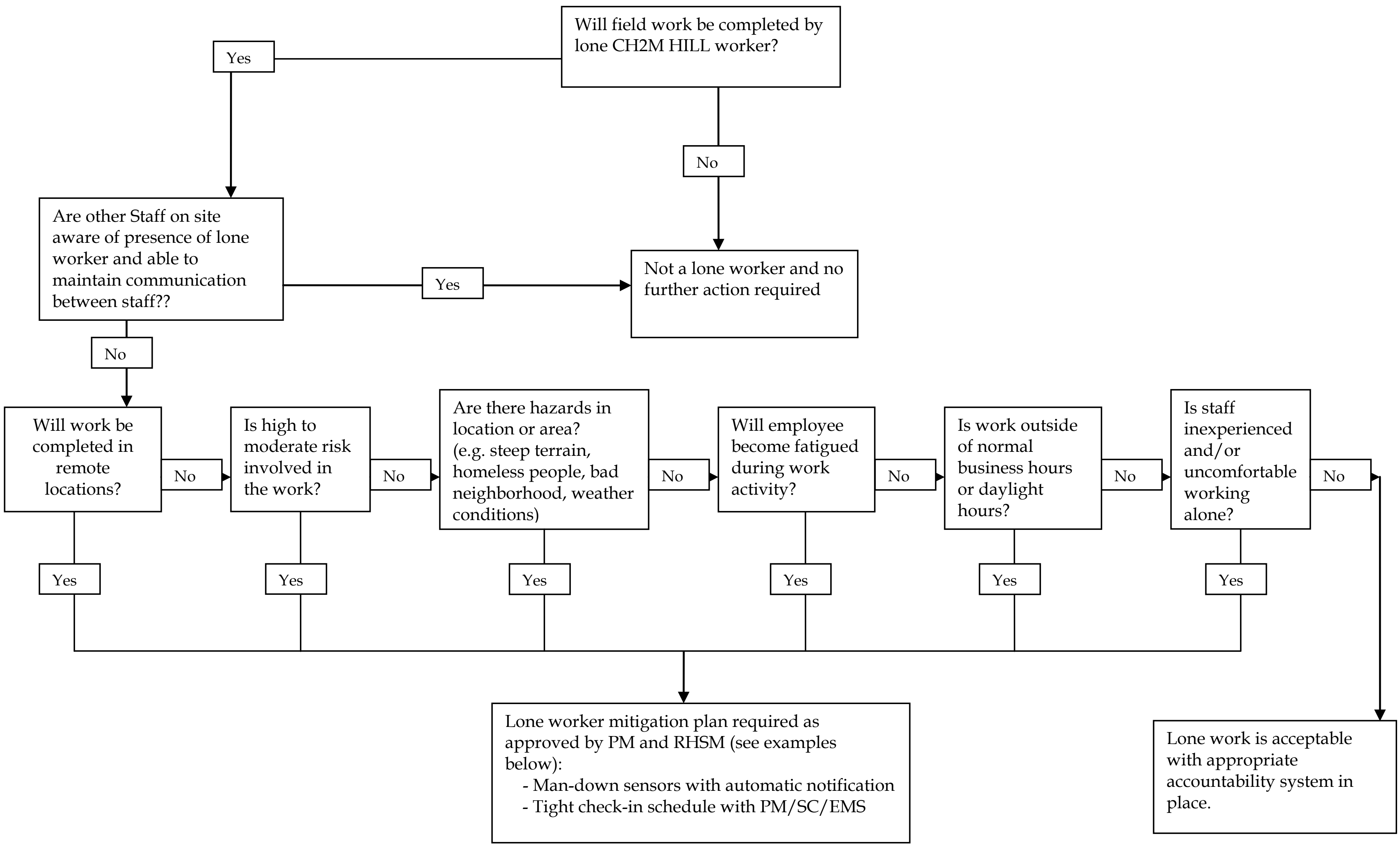
Planned Activity:____
Specified Frequency and time for call in:____

Time	Verified	Location

If lone worker fails to call in at specified frequency/time:

1) Call worker's radio and cell to determine if an emergency exists.
2) If no reply, immediately call Client security/emergency service if there is one at the site.
3) If there is no client security call Emergency Services (911). Inform the dispatcher there is a lone worker that cannot be contacted and there may be an emergency on site. Provide the lone worker's name, their last known location, and your contact information.
4) After Emergency Services have been contacted, call the other emergency contacts, Project Manager, and Responsible Health and Safety Manager.

Lone Worker Protocol



Observed Hazard Form

CH2MHILL

OBSERVED HAZARD FORM

Name/Company of Observer (*optional*):

Date reported**:**___________________

Time reported**:**_____________________

Contractor/s performing unsafe act or creating unsafe condition**:**

1. ____

2. ____

3. ____

Unsafe Act or Condition**:**

____
____
____
____
____
____
____
____
____

Location of Unsafe Act or Condition**:**

Name of CH2M HILL Representative:

____

Corrective Actions Taken**:** Date**:** ___________

____
____
____
____
____

Project Safety Committee Evaluation**:** Date**:** ___________

____
____
____
____

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 8

Stop Work Order Form

CH2MHILL

Stop Work Order

REPORT PREPARED BY:

Name:	**Title:**	**Signature:**	**Date:**

ISSUE OF NONPERFORMANCE:

Description:	Date of Nonperformance:
	________________

SUBCONTRACTOR SIGNATURE OF NOTIFICATION:

Name:	**Title:**	**Signature:**	**Date:**

** Corrective action is to be taken immediately. Note below the action taken, sign and return to CCI.* Work may not resume until authorization is granted by CH2M HILL Constructors, Inc. Representative,*

SUBCONTRACTOR'S CORRECTIVE ACTION

Description:	Date of Nonperformance:
	________________

SUBCONTRACTOR SIGNATURE OF CORRECTION

Name:	**Title:**	**Signature:**	**Date:**

Agency Inspection Target Zero Bulletin

Environmental Services Business Group

TARGET ZERO BULLETIN

Subject: HSSE Agency Inspections (OSHA, EPA, DOT, State Health Department)

Do you know what YOU would do if an agency inspector arrived at your site unannounced?

Recently, a State Occupational Safety and Health Administration (OSHA) inspector made an unannounced visit to one of our Federal project sites. OSHA, U.S. Environmental Protection Agency (EPA), and authorized state or local agencies have authority to inspect any facility that is subject to health, safety, and environmental legislation. Inspections may be announced or unannounced. This particular inspector indicated that the project was targeted for an inspection because the work was funded by the American Recovery and Reinvestment Act (ARRA).

Enterprise Standard Operating Procedure (SOP) HSE-201, *Agency Inspections and Communications,* describes the responsibilities, procedures, and requirements associated with inspections conducted by external regulatory agencies, as well as the methods for communicating information to key individuals. This Target Zero Bulletin is a brief summary of what to do in the event of an agency inspection at your site. Refer to the SOP for more specific guidance.

Notification of Inspections

- If the inspection is an announced regulatory agency inspection, the Project Manager (PM) should notify the Responsible Health and Safety Manager (RHSM) and Responsible Environmental Manager (REM) well in advance of the inspection.
- If an unannounced agency inspector visits one of our projects, Field personnel must immediately notify the project Emergency Response Coordinator (ERC). Typically the ERC is the Safety Coordinator (SC).
- The ERC must immediately notify the RHSM/REM, as appropriate, of unannounced inspections, or designate someone to call the RHSM/REM. The RHSM/REMs can provide guidance to the field staff and PM.

Inspector Credential Verification

- Upon arrival, the ERC must request the inspector to provide official credentials. Record the inspector's name and office phone number or obtain the inspector's business card.
- The inspector shall sign the visitors log and be given a site-specific health, safety, and environmental protection briefing.
- The inspector shall meet any site access requirements associated with security clearances, specialized training, and medical monitoring. The CH2M HILL representative shall verify that the inspector possesses these requirements; access will only be granted to those areas where appropriate access requirements are met. Some inspectors have the authority to gain access to any work area at any time, such as an inspector with a search warrant. In these cases, we can stop work operations as necessary to protect the safety of the inspector(s).

Opening Conference

- The CH2M HILL Project Manager, ERC, RHSM, or REM, and the inspector shall determine attendees for the opening conference. The RHSM (for OSHA and other worker health and safety inspections) or REM (for environmental inspections) shall join the opening conference via conference call.
- The inspector shall inform CH2M HILL of the purpose of the inspection and provide a copy of the complaint, if applicable.
- The inspector shall outline the scope of the inspection, including employee interviews conducted in private, physical inspection of the workplace and records, possible referrals, discrimination complaints, and the closing conference(s).

Requests for OSHA Logs

- An OSHA inspector may request to review the project OSHA Injury/Illness log, better known as the OSHA 300 Log. Contact your RHSM for assistance in obtaining the OSHA 300 Log.

- Field projects with a continuous duration of one year or longer are considered to be separate establishments and are required to maintain an OSHA 300 log specific to the project. The project OSHA 300 log should be maintained onsite and kept current.
- Recordable injuries and illnesses sustained on field projects less than one year in duration are maintained on the CH2M HILL office log where the injured employee is based.

The Inspection

- The scope of the inspection shall be limited to that indicated by the inspector in the opening conference. The inspector shall be escorted to relevant areas only. The ERC or other designated by the RHSM or REM must accompany the inspector during the inspection.
- Ensure that the inspection is limited to the scope that the inspector disclosed during the opening conference. The ERC should always take notes which identify: areas inspected, machinery or equipment and materials examined, employees or other persons interviewed, and photographs taken by the inspector.
- The inspector will observe safety, health, and environmental conditions and practices and document the inspection process. The inspector may also take photos and instrument readings, examine records, collect air samples, measure noise levels, survey existing engineering controls, and monitor employee exposure to toxic vapors, gases, and dusts.
- CH2M HILL should gather duplicate information (photographs, readings, samples) in the same manner and condition as the inspector. If the equipment needed to take duplicate samples is not onsite, ask the inspector if the sampling can wait until the equipment is available. If samples are taken, request a description of the tests that the agency intends to perform on the samples and request results as soon as they are available.
- Employees may be questioned during the inspection tour. The employee can refuse to speak to an inspector, can speak to the inspector with a company representative (including management) present, or can speak to the inspector privately. It is CH2M HILL policy that employees who wish to speak to the inspector are not discriminated against, intimidated, or otherwise mistreated for exercising their rights during compliance inspections.
- Copies of documents should not be provided to the inspector without the approval of the RHSM or REM or Legal Insurance Department (LID). **DO NOT** voluntarily release documents. Respond only to inspection team requests.
- During the course of the inspection, the inspector may point out violations. For each violation, the CH2M HILL representative should ask the inspector to discuss possible corrective action. Where possible, violations detected by the inspector should be corrected immediately and noted by the inspector as corrected.
- For those items which cannot be corrected immediately, an action plan shall be formulated for timely correction. In any instance, employees exposed to hazards shall be removed from the area.

Closing Conference

After the inspection, a closing conference is normally held as follows:

- The CH2M HILL PM, ERC, RHSM or REM shall be involved via conference call in the closing conference, at a minimum;
- The inspector shall describe the apparent violations found during the inspection and other pertinent issues as deemed necessary by the inspector. CH2M HILL shall be advised of their rights to participate in any subsequent conferences, meetings or discussions. Any unusual circumstances noted during the closing conference shall be documented by the ERC;
- The inspector shall discuss violations observed during the inspection and indicate for which violations a citation and a proposed penalty may be issued or recommended;
- The ERC shall request receipts for all samples and approved documents photocopied by the inspector, request a photocopy of the inspector’s photograph log, and request a copy of the final inspection report; and
- Any documentation from an agency inspection must be transmitted immediately to the RHSM or REM, and LID.

Unannounced regulatory agency inspections may happen at any time on our projects -

Get your RHSM/REM and PM involved immediately if an Inspector arrives.

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 10

Completed CH2M HILL AHAs

CH2MHILL

ACTIVITY HAZARD ANALYSIS

Date: 7/27/2017	Task Risk Assessment Code (RAC): L/M
Project: BNSF – Wishram	L = Low
Site Supervisor:	E = Extremely High Risk
Site Safety Coordinator:	H = High Risk
HSM Review/Approval: Eric Hamm/SCO	M = Moderate Risk
Job/Activity: Drilling, sample collection **Description of the work**: Subcontractor oversight **NOTE:** Many hazard controls listed are aimed at the Drilling Subcontractor, but are listed here as an aide for the Oversight crew. CH2M HILL personnel should not perform work associated with the drilling activities, outside of handling/logging samples from soil borings. A separate Subcontractor Drilling AHA guiding driller activities will be prepared by the driller. .	

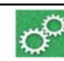
Probability

Severity	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

TYPES OF POTENTIAL ENERGY:

1	2	3	4	5	6	7	8	9	10
BIOLOGICAL	CHEMICAL	ELECTRICAL	GRAVITY	MECHANICAL	MOTION	PRESSURE	RADIATION	SOUND	TEMPERATURE

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
General preparation	Forgotten safety equipment, no cell phone coverage, lack of emergency preparedness, untimely reporting of an injury or other incident	NA	• Complete HSP, AHA review • Complete PTSP, daily safety meeting. • Check for cell phone coverage. • Designate rally point and evacuation point (daily if working in new locations each day). • Check daily weather report and plan activities around severe weather. • Review, inspect and locate safety equipment including fire extinguisher, first aid kit, insect repellant, PPE, water, food, spill kits, etc.

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
			• Be sure to review the requirements for incident notification, reporting and investigation section of the HSP. Report all injuries, no matter how minor. If you are unsure whether an event should be reported, contact your RHSM. Be sure to report near misses.
Operating Vehicles - General	Break-downs; Flat Tires; Collisions, etc.	  	Make sure vehicle is current on preventive maintenance. Conduct vehicle walk around prior to leaving for the field to check for low tires, fluid leaks, debris and operating hazards. Check lights, windshield wipers, fluid levels, seat belts. Make sure emergency flashers are functional.
Operating Vehicles -Travel to and from site. Travel on Secondary Roads, Gravel Roads and Trails	Collision with other vehicles; Collision with animals or objects; Running or skidding off road; wet and/or muddy roads; Poor visibility; Backing; Vehicle wear/tear, etc.		• Inspect the vehicle prior to departure. • If driving a rental car, become familiar with the safe operation of vehicles of the type and size to be operated. Large vehicles such as full size vans and pick-ups have different vision challenges and handling characteristics than smaller vehicles. • Exercise caution – “Drive Defensively” (described below) • Observe all laws and regulations • Drive defensively and safely, watch ahead for oncoming traffic. Maintain 1 car length (approximately 10 feet) for every 10 mph of highway speed. • Watch for debris on the road or materials falling from other vehicles. Stay back 300 feet from trucks hauling rock or similar materials. • Do not drive off-road if it has rained in the past 48 hours • Do not drive or park over tall brush. • Do not drive on soft gravel shoulders. Pull over to use a cell phone, GPS unit or map. • Park at pull-through parking spaces. • When descending steep grades, use lower gears to control speed, rather than the brakes or riding the clutch.

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
			• Drivers shall not use cellular phones, or other two-way communication devices while driving (including hands-free devices). Pull over and park the car to make or take phone calls, text, or e-mail. • Be sure to take adequate rest breaks when driving, especially on long distance trips. • Obey speed limits; be aware of blind spots or other hazards associated with low visibility. Practice defensive driving techniques, such as leaving plenty of room between your vehicle and the one ahead of you. • If vehicle is malfunctioning, don't pull over off the road suddenly. Give the traffic behind you notice that you are pulling off. • Always wear seatbelt in vehicle, regardless of length of drive. • Apply Get Out and Look (GOAL) when returning to the vehicle to prevent property damage and injury by looking for obstructions, personnel or other items. Back slowly and use a spotter when view is obstructed.
Walking / Site Observations	Traffic Snakes Barbed wire fences Slips/trips/falls Sunburn	 	• Wear high-visibility safety vests, hard hats and safety glasses. Wear gloves as appropriate. • Do not handle or harass any harmful wildlife including venomous snakes. • If a venomous snake is encountered, stop and retreat in the opposite direction/same path taken. Do not harass wildlife. Wear snake chaps if walking in grassy areas or brush where you cannot see venomous snakes. • Do not climb any fences. Cross fences through gates. • Apply sunscreen as-needed and wear light-colored clothing. If feasible, wear long sleeved shirts, and always wear long pants. Large-brimmed hardhat will offer extra protection against UV.

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
			• Always be on the lookout while walking the sites. Avoid using mobile devices while walking so you can be on the lookout for holes, depressions, uneven terrain that can cause sprains or other injury. Be vigilant for hazards as surveys can take place in remote areas where people have not been. • Use proper auger/shovel form when sampling soils, inspecting ground conditions, or otherwise as appropriate.
Hazards and controls applicable to all steps of field work.	Temperature Extremes **(heat)**	 	• Acclimatize to work in hot weather by working in heat and taking more frequent breaks, systematically building up tolerance to heat. • Conduct field activities in the early morning if possible to avoid heat or inclement weather. • Having enough water onsite so that each worker can consume at a minimum, one quart per hour per shift. • Frequent reminders and/or water breaks shall be taken so that each person can consume enough water. • Access to shade (i.e., blockage from direct sunlight) shall be provided at all times and shall be reasonably close to the work area. Keep in mind that a vehicle or other enclosed are with no air conditioning is NOT considered shade. Must be a well ventilated area or have air conditioning. • Workers suffering from heat illness-related symptoms OR if needed for preventative recovery shall be provided access to shade for at least 5 minutes, or longer, for recovery. (if heat related symptoms are occurring, contact the RHSM). • Training on risk factors, signs and symptoms of heat illness, importance of hydration and acclimatization, and importance of reporting symptoms and what to do in case of heat illness emergency, and contacting emergency

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
			medical services (see HSP, Temperature Extremes section). • Read and follow heat stress precautions specified in the HSP. • Follow the requirements for physiological monitoring as stated in the HSP. (e.g., During work in temperatures above 80 degrees , perform physiological monitoring—see safety plan if wearing Tyvek for when to start monitoring) and document on the heat stress physiological monitoring form. • Be conscious of your individual tolerance to work in hot weather and monitor yourself and co-workers for signs and symptoms of heat stress. • Take breaks as necessary in shady or cool areas and drink plenty of liquids. • Take regular breaks in an air-conditioned truck or trailer during warm weather. Use a wide-brim hat or an umbrella or have a place where shade has been set up (tent or other temporary structure) when working under direct sun for extended periods. • Persons who experience signs of heat or cold stress should contact the SC, PM and RHSM. Call the occupational nurse first if symptoms are severe at 1-866-893-2514.
	Ticks		• Wear light colored long sleeve shirts and pants. Use repellent on exposed skin (with at least 35% DEET) if ticks/other biting insects are suspected in the area. Whenever you use an insecticide or insect repellent, be sure to read and follow the manufacturer's DIRECTIONS FOR USE, as printed on the product. Tape bottoms of pant legs or tuck pants into socks. Use double sided tape around ankles, waist and wrists. • Wear protective clothing such as Tyvek or Bug-out suits if ticks are abundant in addition to controls above.

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
			• Have tick removal kits accessible. Use the buddy system and perform tick inspections prior to entering the field vehicle. If ticks were not planned to be encountered and are observed, do not continue field work until these controls can be implemented. • See Tick Fact Sheet attached to the HSP for further precautions and controls to implement when ticks are present. If bitten by a tick, follow the removal procedures found in the tick fact sheet..
	Wasps		• Keep exposed skin to a minimum. • Carry a kit if you have had allergic reactions in the past, and inform your supervisor and/or a buddy. When working at a remote location, ensure that first-aid kits contain over-the-counter allergy and itch medication (e.g., Benadryl, Claritin, etc) as well as other over-the-counter (OTC) medications that may not be available to aid in symptom treatment. WARNING: Some OTC medications will cause drowsiness. Do not operate equipment or vehicles if you feel drowsy. • If bees or other stinging insects are known to be present, determine whether additional protective clothing should be donned before entering/working in brushy areas. • Consider if heavy-weight clothing or Tyvek, or head netting would provide additional protection in areas where wasps/bees are known or suspected. Be aware of heat stress conditions additional clothing may cause. • Use insect repellent on clothing. Wear light-colored clothing and remove bright reflective safety-colored clothing if not working near a roadway as these may attract the wasps. • Wear fragrance-free or lightly-scented sunscreen, and body lotions. Bees are attracted to sweet scents.

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
			Avoid using floral scented soaps, shampoos, or conditioners. • If you encounter a wasp, back away slowly and calmly, do not run or swat at the insect. Wait for it to leave, or gently move or brush it off gently with a piece of paper or other light object. Do not use your hand. • If you are stung, notify your supv, no matter how minor it may seem. If a stinger is present, remove it as soon as possible using something with a thin, hard edge (e.g., credit card) to scrape the stinger out. Be sure to sanitize the object first with hand sanitizer, alcohol or soap and water. Wash and disinfect the wound, cover it, and apply ice. Watch for an allergic reaction if you have never been stung before. Call 911 if the reaction is severe. • Use wasp/bee spray if necessary in accordance with manufacturer's labeling and direction for use.
	Other biological hazards		Refer to the HSP for controls on other biological hazards possibly present dependent on season/location, including snakes, spiders, and poisonous plants.
	Inclement weather		• Sudden inclement weather can rapidly encroach upon field personnel. Preparedness and caution are the best defenses. Carry clothing appropriate for inclement weather. • Take heed of the weather forecast for the day and pay attention for signs of changing weather that indicate an impending storm. Signs include towering thunderheads, darkening skies, or a sudden increase in wind. If stormy weather ensues, field personnel should discontinue work and seek shelter until the storm has passed. • Avoid working during thunderstorms. Practice 30-30 rule for lightning shutdown/restart. • If caught in one, seek shelter.

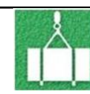
Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
			• Avoid lone trees as shelter and open, bare areas. • If caught in open area, place feet close together and crouch down as small as possible, without lying on the ground. • Ground strikes are known to be initiated by "leaders", or charges, from the earth making a connection to the charge in the clouds. This may cause your hair to stand up, and since you do not want to be part of a leader that makes the connection to form a cloud-to-ground strike, immediately crouch as described above. • Avoid low lying areas such as washes after rain as they can flood. • Take time to review where the closest structure that can be used when severe weather occurs and what route will be used to get there. Listen to weather reports and plan for severe weather. Designate an emergency evacuation assembly area and evacuation routes for non-weather related emergencies (fire, etc.). Keep a copy of the Emergency Contact page from the HSP accessible.
	Injury from lifting and moving heavy or awkward loads; injury from working in awkward or static positions for extended periods of time (field ergonomics)	 	• Use proper lifting techniques such as keeping back straight, lifting with legs, limiting twisting and keep the load close to your body. • Mechanical devices (e.g., fork lifts and hand trucks) should be used to reduce manual handling of materials. • Team lifting should be utilized for items that weigh more than 40lbs, if mechanical devices are not available. • Contact the RHSM to determine hazard control measures your task involves: − Repetitive motions; − Lifting and carrying items over long distances or on steep or sloped terrain;

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
			− Heavy lifting; − Use of vibrating tools or equipment; or − Being in a static position for extended periods of time; There are a variety of ergonomically designed tools and work practices that can reduce the potential for discomfort and injury.
Mobilize to drilling location, drill set up, set up decon area for augers/cores	Contact, caught, fall, and driving hazards. Exertion-heavy lifting. Striking or coming into contact with buried or overhead utilities may potentially expose personnel to hazards including high voltage, electricity, natural gas, industrial wastewater, and raw sewage.	  	• Complete Drilling Safety Checklist • Check well locations for underground and overhead utilities. • All locations will be marked with paint and work will not proceed until underground utilities have been cleared. • Observe rig mast set up, so no contact with overhead obstacles. • Ensure that all overhead utilities are at least 20 feet away from the mast of the drilling rig • Proper rig set up and leveling. Remind everyone never to leave hand tools on rig. • Utilize proper lifting procedure when loading and unloading vehicles and equipment (i.e. augers, sand bags, and bentonite). Use mechanical means when available or necessary. • Bend down at the knees and lift with your legs rather than bending and lifting with your back. Do not lift and twist. • Personnel should stay out of the operator's blind spots while equipment if being moved and set up between borings. • Wear high visibility traffic vests. • Ensure that all heavy equipment has reverse alarms. • Remain alert and attentive to location of and movement of all drilling equipment.

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
	Fire/explosion/Spill Hazards associated with drill rig	 	• Use non-sparking tools as potential to contact free product (gasoline) is possible. • Ensure drill rig is grounded. • Have spill materials and 20-lb ABC fire extinguisher in the area. • Have fire extinguisher accessible within work area. Where exposure to free product is possible, use non-sparking tools. • Eliminate static electricity by grounding, where applicable/feasible. • Keep ignition sources away from the work area. • No smoking in the area • Set-up zones large enough to keep public at safe distance.
Hand clear soil boring location to assure no underground improvements (if appropriate and necessary). (Hand dig to 5 feet bgs in areas where suspected utilities may be, but not showing on utility surveys.)	Contact, Exposure, Exertion Hazards Striking or coming into contact with utilities may potentially expose personnel to hazards including high voltage, electricity, natural gas, industrial wastewater, and raw sewage.	  	• Hand clear slowly, do not force through soil may contact/break underground lines ("soft dig" technologies recommended). • If an obstruction is encountered, suspend work and determine what it is. If it cannot be determined, contact client or project representative—location may have to be moved. • Wear proper PPE: safety glasses with side shields, hard hat, safety boots, leather gloves, high-visibility traffic vest, chemical resistant over-gloves, if necessary. • Slowly hand clear and use a balanced stance with feet shoulder width apart to avoid back, neck, and wrist strain. • Take turns to avoid fatigue • Drink plenty of water (hot, warm, and cold weather).
Hand augering	Contact, Exposure, Exertion Hazards		• Hand auger slowly, do not force through soil. • If an obstruction is encountered, suspend work and determine what it is. If it cannot be determined,

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
			contact client or project representative—location may have to be moved. • Wear proper PPE: safety glasses with side shields, hard hat, safety boots, leather gloves, high visibility traffic vest (if necessary), chemical resistant over- gloves, if necessary.
Begin Drilling/ Soil Boring	Exposure to loud noise, flying debris, dust, chemical contamination, and entanglement with rotating equipment. Exposure to overhead suspended loads	    	• Do not allow the drill rig to be running when the driller is not present. • If an obstruction is encountered, suspend work and determine what it is. If it cannot be determined, contact client or project representative—location may have to be moved. • Stay away from moving rotating parts (i.e. augers, drill drive shaft) • Personnel shall not wear loose fitting clothing to avoid the potential for entanglement with rotating equipment. • Do not attempt to operate drill unless emergency shut-down is necessary. • Bend down at the knees and lift with your legs rather than bending and lifting with your back. • Drink plenty of water/gatorade. • Air monitoring will be performed in breathing zone in accordance with site HSP. Action levels will be followed in site HSP. • Wear proper PPE: safety glasses with side shields, hard hat, safety boots, high visibility safety vest, leather and/or chemical resistant gloves, hearing protection, if necessary, and coveralls or Tyvek if there is potential for contacting potentially contaminated soil. • Personnel conducting oversight duties shall wear hearing protection if it is not possible to communicate with another person standing next to you using your normal voice.

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
			• If necessary to keep personal clothing clean, or if in areas with potential contamination, personnel shall wear Tyvek to minimize contact with contaminated dust/soil that may be generated during drilling activities. • Use good housekeeping practices, keeping the work area clear of trip hazards • Ensure water does not accumulate in the drilling area. Designate a specific area to place all soil cuttings, try to place the cuttings in a location that is outside of the general work flow • Be aware of the symptoms of associated with heat- and cold-related physical disorders • Wear appropriate field clothing, including layers and rain gear in cold weather. • Do NOT stand beneath suspended loads.
Collecting soil samples (if applicable)	Exposure, Contact, Slips, Trips, Falls	   	• Wear proper PPE: safety glasses with side shields, hard hat, safety boots and chemical resistant gloves. • Stay alert while logging soil samples of all drilling activities. • Maintain clean work area, keep walkways clean and clear, tools picked up, and soil containerized. • Use dedicated pen for logging information into field book to prevent potential contact with contaminants. STAY ALERT. • Utilize appropriate nonreactive tools (plastic spoons, stainless steel trowels, etc.) to collect media from the collection equipment. • Air monitoring will be performed in breathing zone in accordance with site HSP. Action levels will be followed in site HSP. Monitor discharge from soil gas sampling pump with PID.

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
Preparation to mob to next drilling location or leave site**.**	Contact, Caught, Exposure, Exertion Hazards	   	• Ensure an observer is watching the lowering of the drill rig mast so no lines or overhead obstacles are contacted. • Prior to lowering rig off of outriggers make sure all tools and personnel are clear of the drill rig. • Bend down at the knees and lift with your legs rather than bending and lifting with your back while loading tools. • Wear proper PPE (hard hat, safety glasses with side shield, hearing protection (while rig is operational) steel toe boots, leather work gloves. • Prior to driving to next location make sure auger racks are in. • While rig is moving on site have spotters verify clearance so no overhead obstacles are contacted and no obstacles are hit while backing. • Properly remove PPE and wash hands and face, no smoking, drinking, eating in the work area, EZ or CRZ.
Load Equipment	Back strain - Improper lifting technique	 	• Utilize proper lifting procedure when loading coolers and equipment back into truck. (to avoid lifting heavy/awkward coolers leave cooler on tailgate to load samples and ice into). • Bend down at the knees and lift with your legs rather than bending and lifting with your back.
Take down work area (cones, flags, barricades)	Traffic which includes being struck by pedestrian or other vehicles. Pedestrian traffic trying to cross work area- slips, trips, falls Damage to equipment. Injury to other personnel.	 	• Wear highly visible clothing such as orange reflective traffic vests or clothing. • Stay alert to surroundings and traffic (if possible move truck over to work area to reduce take down time and loading, use flashing light and truck hazard lights for added safety). • Load all equipment into truck neatly.

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
	Slips, trips, and falls Back strain - Improper lifting technique		• Keep work area clear of caution tape and cords during removal of traffic control. • Utilize proper lifting procedure when loading traffic control equipment back into truck.
Sample Preparation & Packaging			
Managing Prep and Pack in a heavy traffic area.	Weather Conditions: Rainy, snowy days Spilled DI water / slipping causing bodily injury Debris on floor/slip, trip and fall.	 	• Mop floor, keep slip preventive rugs in area. • Keep doorway and walkway clean.
Preparation of sample containers	Handling of chemicals/spilling of chemicals on skin, clothes or eyes.		• Never leave open chemicals unattended. • Know location of nearest eyewash station. • Wear proper PPE. (nitrile gloves, safety glasses, acid apron) • Keep prep and pack area well ventilated (open window) • Know location of MSDS, absorbent spill cloth, Hazmat spill kit • Make sure all caps are secure • Know location of MSDS forms
Receiving pre-preserved bottles	Glass containers/broken glass, cuts to hands Packaging material / acid leak		• Use caution when opening package • Wear proper PPE (nitrile gloves, safety glasses)
Receiving coolers from the field	Heavy coolers/back injury Ticks, insects/Lyme Disease, spider bites and stings Poison Ivy, Sumac/ rash	 	• Bend at knees, ask for assistance • Use handtruck when necessary • Use caution when taking contents out of cooler. Inspect coolers for ticks/spiders • Apply ivy block
Preparing coolers for delivery	Strapping machine/ tripping over unrolled tape. Tape gun/cuts to hands Heavy coolers/back injury	 	• Make sure strapping machine is properly rolled. • Use caution, be aware of cutting edge; To extent possible, break tape by pushing tape gun away from you; ensure hands and legs are not in the path of the tape gun • Bend at knees, ask for assistance

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
			• Use handtruck as necessary
Neutralizing sampling containers	Handling of chemicals/spilling of chemicals on skin, clothes, and eyes. Disposal of glass containers/cuts, broken glass.		• Wear proper PPE (nitrile gloves, glasses, acid apron, absorbent cloth) • Dispose of glass waste properly. • Follow proper procedures for neutralizing samples.
Receiving coolers from the field	Heavy coolers/back injury Ticks, insects/Lyme Disease, spider bites and stings Poison Ivy, Sumac/ rash	 	• Bend at knees, ask for assistance • Use handtruck when necessary • Use caution when taking contents out of cooler. Inspect coolers for ticks/spiders • Apply ivy block
Preparing coolers for delivery	Strapping machine/ tripping over unrolled tape. Tape gun/cuts to hands Heavy coolers/back injury	  	• Make sure strapping machine is properly rolled. • Use caution, be aware of cutting edge; To extent possible, break tape by pushing tape gun away from you; ensure hands and legs are not in the path of the tape gun • Bend at knees, ask for assistance • Use handtruck as necessary

Equipment to be used (List equipment to be used in the work activity)	Inspection Requirements (List inspection requirements for the work activity)	Training Requirements (List training requirements including hazard communication)
Field Vehicle	Ensure that vehicle is safe to operate prior to field work	Only licensed drivers can operate vehicles
Drill Rig	Utilize Drilling Safety Checklist	None
• Hand and power tools • Drill rig, heavy equipment • Sampling equipment/containers • Well installation supplies • PID • Fire extinguisher(s) • Fuel storage/equipment • Portable eye wash • First Aid/Bloodborne pathogen/CPR kit • Traffic control equipment Support vehicles	• Inspection of all equipment and tools prior to each use • Calibrate PID prior to use • Visual Inspections of work area daily • Use of applicable project self-assessment checklists • Inspect vehicles prior to operation	• OSHA 40-hour HAZWOPER initial training, current 8- hr refresher, 3-day OJT, and medical clearance. • Hazard Communication training, as appropriate • Training on CH2M HILL HSP and Subcontractor's HSP (and applicable AHAs) • Qualified subcontractor operators (for equipment such as drill rigs, forklifts, aerial lifts) • Documented training on MSDSs for any chemicals used. • Qualified SC-HW training
PPE Hard hat High visibility safety vest or shirt Safety glasses with side shields Leather boots with lugged soles Leather gloves Nitrile gloves	Check safety vest for excessive fading and missing reflective strips. Replace as necessary. Check boots/gloves for defects and/or signs of wear. Replace as necessary.	Comply with manufacturers recommendations when wearing PPE.

CH2MHILL

ACTIVITY HAZARD ANALYSIS

	PRINT NAME	SIGNATURE	
Supervisor Name:	______________	______________	Date/Time:______________
Safety Coordinator Name:	______________	______________	Date/Time:______________
Employee Name(s):	______________	______________	Date/Time:______________
	______________	______________	Date/Time:______________
	______________	______________	Date/Time:______________
	______________	______________	Date/Time:______________
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	______________	______________	Date/Time:______________

CH2MHILL

ACTIVITY HAZARD ANALYSIS

Date: 7/27/2017

Project: BNSF – Wishram

Site Supervisor:

Site Safety Coordinator:

HSM Review/Approval: Eric Hamm

Job/Activity: Boating

Description of the work:

Observing sample practices from a boat. Drilling and sediment sampling.

Task Risk Assessment Code (RAC): **M – L**

L = Low

E = Extremely High Risk

H = High Risk

M = Moderate Risk

Severity \ Probability	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

TYPES OF POTENTIAL ENERGY:

1	2	3	4	5	6	7	8	9	10
BIOLOGICAL	CHEMICAL	ELECTRICAL	GRAVITY	MECHANICAL	MOTION	PRESSURE	RADIATION	SOUND	TEMPERATURE

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
Review emergency procedures	Delays/Inadequate response to emergency situations		Review AHA, Communication Plan, Pre-Task Safety Plan, & Safety Fact Sheet; daily completion of boat safety checklist

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
Stage equipment at boat, boarding (and leaving)	Slips & Trips Poisonous plants/insects Fires	  	Ensure safe footing, keep area around boat clear of obstructions. Maintain good housekeeping inside and outside of boat. Observe surroundings – able to identify poison ivy. Wear protective clothing that covers exposed skin. If skin contacts a plant, wash area with soap and water immediately. Maintain an operational (inspected prior to launch…fully charged, tamper seal affixed, etc.) fire extinguisher on the boat. Ensure all boat occupants have had fire extinguisher training.
Check communication equipment	Delays/Inadequate response to emergency response		Ensure cell phones are fully charged. Air horn on the boat and functional.
Don PPE	General hazards such as drowning, overhead (DPT rig), etc.		Employees are required to wear the following PPE: personal flotation devices (PFD's with adequate reflective material for night operations), safety shoes and glasses
Boat use	Injuries and illnesses Struck-by hazard, run into equipment or debris Drowning		Boating team must include at least one person qualified in First Aid. First aid kit required in boat. All operations will be directed by a qualified and experienced boater as the team leader Aware of proper

Work Task Sequence (List steps you need to take to complete the activity.)	Potential Health and Safety Hazards (How can you be harmed? Cut, struck, exposed…)	Potential Energy(ies) Associated with Task	Hazard Controls (List the **specific controls** for each potential hazard. Refer to EN&N Market HSSE Handbook for required controls)
			boat operation (who has right-a-way), drive defensively, keep wide berth from other boats/equipment, Bowman watch out for floating debris, etc. Observe and comply with safety markers. Boat must be operated in accordance with U.S. Coast Guard regulations for: speed, lighting, right-a-way, etc.
Boat use at night	Poor visibility		PRIOR TO ANY BOAT ACTIVITY CONDUCTED AT NIGHT, CH2M Hill SAFETY MUST AGREE TO ACTIVITY. Flashlights required for employees (dawn/dusk). PFD must have reflective material
	Inclement Weather		Any “observable” lightning or thunder – stop work and return to shore. Team leader must monitor appropriate sources to track developing potential for lightning, high winds, tornado’s, etc. Sustained wind speeds of 20 mph or wind gusts of 25 mph will cease boat operations – return to shore. Tornado warnings in the general area will require work to stop and return to shore.

Equipment to be used (List equipment to be used in the work activity)	Inspection Requirements (List inspection requirements for the work activity)	Training Requirements (List training requirements including hazard communication)
Boat	Inspect boat for damage; Utilize self-assessment checklist for boating safety	Qualified/Experienced boat operator
PPE plus PFD	PFD that meets Coast Guard requirements	Individual training for use and proper fit
First Aid Kit	Inspect contents to ensure all supplies are available	At least one person first aid trained
Cell Phone	Ensure fully charged	
Fire Extinguisher	Inspect prior to boat launch	Must have fire extinguisher training per 29 CFR1910.157 requirements

CH2MHILL

ACTIVITY HAZARD ANALYSIS

	PRINT NAME	SIGNATURE	
Supervisor Name:	______________________	______________________________	Date/Time:__________________________________
Safety Coordinator Name:	______________________	______________________________	Date/Time:__________________________________
Employee Name(s):	______________________	______________________________	Date/Time:__________________________________
	______________________	______________________________	Date/Time:__________________________________
	______________________	______________________________	Date/Time:__________________________________
	______________________	______________________________	Date/Time:__________________________________
	______________________	______________________________	Date/Time:__________________________________
	______________________	______________________________	Date/Time:__________________________________
	______________________	______________________________	Date/Time:__________________________________
	______________________	______________________________	Date/Time:__________________________________
	______________________	______________________________	Date/Time:__________________________________

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 11

Safety Data Sheets