ANALYSIS OF BROWNFIELDS CLEANUP ALTERNATIVES

FORMER NORTHERN STATE HOSPITAL
SEDRO-WOOLLEY, WASHINGTON

Prepared for

PORT OF SKAGIT

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Prepared by

Maul Foster & Alongi, Inc.

1329 N State Street, Suite 301, Bellingham, WA 98225

MAUL
FOSTER
ALONGI

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The material and data in this report were prepared under the supervision and direction of the undersigned.

MAUL FOSTER & ALONGI, INC.

Michael Stringer, AICP
Principal in Charge

Carolyn Wise, GIT
Project Geologist

ANDREW SCOTT KAPAROS
STATE OF WASHINGTON
49937
REGISTERED
PROFESSIONAL ENGINEER

This digital seal certifies the signatory and document content.

10.26.2018

Andrew Kaparos, PE
Senior Engineer

U.S. ENVIRONMENTAL PROTECTION AGENCY

Susan Morales
Brownfields Project Manager

Date: ____________________

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ACRONYMS AND ABBREVIATIONS

ABCA	analysis of brownfields cleanup alternatives
AOC	area of concern
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
cis-1,2-DCE	cis-1,2-dichloroethene
City	City of Sedro-Woolley
County	Skagit County
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSM	conceptual site model
CUL	cleanup level
cVOC	chlorinated volatile organic compound
Ecology	Washington State Department of Ecology
ERD	enhanced reductive dechlorination
ESA	environmental site assessment
FSA	focused site assessment
HAZWOPER	Hazardous Waste Operations and Emergency Response
IHS	indicator hazardous substance
MFA	Maul Foster & Alongi, Inc.
MNA	monitored natural attenuation
MTCA	Model Toxics Control Act
NEBA	net environmental benefit analysis
NSRA	Northern State Recreation Area
ORO	heavy-oil-range organics
PCE	tetrachloroethene
POC	point of compliance
Port	Port of Skagit
Property	the Former Northern State Hospital property at 24909 Hub Drive in Sedro-Woolley, Washington
RAO	remedial action objective
RI/FS	remedial investigation and feasibility study
SL	screening level
SMP	soil management plan
TCE	trichloroethene
USEPA	U.S. Environmental Protection Agency
WAC	Washington Administrative Code

1 INTRODUCTION AND BACKGROUND

On behalf of the Port of Skagit (the Port), Maul Foster & Alongi, Inc. (MFA) has prepared this analysis of brownfields cleanup alternatives (ABCA) report for the Former Northern State Hospital property, also known as the Sedro-Woolley Innovation for Tomorrow Center (the Property), located at 2070 Northern State Road in Sedro-Woolley, Washington (Figure 1-1). Historically, the Property was used as a treatment and residence facility for people with mental illness, and included on-site patient and staff housing, a power house, maintenance shops, a laundry, and a fueling station. The Property currently comprises over 80 buildings and structures. Tenants occupy some of the buildings, but many buildings are currently vacant.

1.1 Regulatory Framework

The Port received a U.S. Environmental Protection Agency (USEPA) Brownfields Assessment Grant to support site assessment at the Property.

Several previous investigations have been conducted at the Property to evaluate environmental impacts associated with identified areas of concern (AOCs), as described in the 2018 Phase II environmental site assessment (ESA) work plan (MFA, 2018a). All investigation activities have been conducted in general accordance with guidance put forth in the Model Toxics Control Act (MTCA) (Washington Administrative Code [WAC] 173-340).

1.2 Purpose and Objectives

The purpose of this ABCA report is to present a viable remedial alternative based on site-specific conditions, technical feasibility, and preliminary cost evaluations. The ABCA was completed to meet the requirements of USEPA Brownfields Cleanup Grant and following federal and Washington State guidelines for feasibility study of remedial action alternatives.

The objective of the ABCA was to identify and evaluate the most relevant remedial alternative(s) that would reduce contaminant exposure to levels protective of human health and the environment and that would be appropriate for the Property.

This ABCA report includes:

- Information about the AOC and contamination issues (e.g., exposure pathways, identification of contaminant sources), cleanup standards, applicable laws, and the proposed cleanup
- Effectiveness, implementability, and the cost of the preferred remedial alternative
- An assessment of the need for additional land-use controls after the remediation is complete

1.3 Property Background

The approximately 210-acre Property is in the northeast corner of the City of Sedro-Woolley (see Figure 1-1). The Property is bordered on the north, east, and south by the Northern State Recreation Area (NSRA), a public open space owned and managed by Skagit County (the County) and historically associated with the Northern State Hospital. The Property is bordered by Fruitdale Road and residential properties to the west. The Property is in sections 7, 8, 17, and 18 of township 35 north and range 5 east of the Willamette Meridian, on a small plateau with a downward topographic slope toward the east, south, and southwest in the direction of Hansen Creek and Brickyard Creek. The Property currently comprises over 80 buildings and structures. Tenants occupy some of the buildings, but many buildings are currently vacant.

The Port, in partnership with the City of Sedro-Woolley (City) and the County, is currently leading an effort to transform the Property into a center for innovation and technology that incorporates research, high-tech manufacturing, education, and recreational uses, in accordance with the Subarea Plan (City, 2015) and the Planned Action Final Environmental Impact Statement (City and Port, 2015).

1.4 Previous Investigations

Several assessments have been completed at the Property, dating back to 1993. During previous investigations, several features of environmental concern were identified and assessed (MFA, 2014, 2015; SES, 2017). Confirmed impacts to soil, groundwater, and/or soil vapor were identified in association with seven AOCs (See Figure 1-1). The AOCs have been defined based on historical sources and characteristics of impacts, which are described in Section 3.

1.5 Assumptions

Remedial alternatives are developed in this report for AOC 1, 2, 3, 4. A cleanup plan has previously been prepared for AOC 6 and is scheduled to be implemented by the end of 2018 (SES, 2017). Additional assessment of AOC 5 and 7 is needed before remedial alternatives can be adequately evaluated.

2 CONCEPTUAL SITE MODEL AND SCREENING LEVELS

A conceptual site model (CSM) defines the potentially complete exposure pathways by which human or ecological receptors could be exposed to site-related contaminants under current or future land uses. A CSM diagram is presented as Figure 2-1. The CSM is used to select appropriate screening criteria for assessing potential risk to human health and the environment. Information on current zoning and land use, and assumptions about potential future land uses made for the purposes of developing the CSM, are described below. Relevant regulations and cleanup standards are also identified below. Cleanup criteria for the Property (and sample results) are presented in the Phase II ESA (Tables 4-1 through 4-5) (MFA, 2018b).

Soil. MTCA Method A Soil cleanup levels (CULs) for unrestricted land use. For certain constituents, MTCA Method A CULs are not available and Method B CULs have been applied.

Groundwater. MTCA Method A CULs and, where appropriate based on the CSM, applicable or relevant and appropriate requirements (ARARs) for freshwater surface water. For certain constituents, MTCA Method A CULs are not available and Method B CULs have been applied. Concentrations of chlorinated volatile organic compounds (cVOCs) detected in groundwater were also compared to MTCA Method B groundwater screening levels (SLs) for protection of indoor air, provided in Ecology's draft soil vapor intrusion guidance (Ecology, 2016).

Soil Gas/Vapor. Sample results are compared to MTCA Method B sub-slab soil gas SLs (Ecology, 2016).

2.1 Land Use and Zoning

The City Comprehensive Plan Land Use Map and zoning map designates the Property as Public (P). The P zoning designation allows for a range of potential uses in the public interest, not restricted to only open-space use.

2.2 Conceptual Site Model and Exposure Pathways

The CSM describes potential chemical sources, release mechanisms, environmental transport processes, exposure routes, and receptors. The primary purpose of the CSM is to describe pathways by which human and ecological receptors could be exposed to site-related chemicals. A complete exposure pathway consists of four necessary elements: (1) a source and mechanism of chemical release to the environment, (2) an environmental transport medium for a released chemical, (3) a point of potential contact with the impacted medium (referred to as the exposure point), and (4) an exposure route (e.g., soil ingestion) at the exposure point. The CSM diagram focuses on Property receptors and potential exposure pathways related to historical releases from the Property.

2.3 Potential Receptors and Exposure Pathways

Potential human and ecological receptors and exposure pathways are shown in Figure 2-1. Based on current and potential future uses of the Property, human receptors may include construction workers, occupational workers, recreational fishers and residents. Ecological receptors could potentially be exposed to chemical impacts at the Property. Refer to Section 5.3 of the Phase II ESA report (MFA, 2018c) for a detailed description of the CSM and potential receptors.

2.4 Cleanup Standards

Cleanup standards for the Property were developed based on the CSM presented in the preliminary remedial investigation and feasibility study (RI/FS) (MFA, 2015). The CSM and cleanup standards were reevaluated based on additional data collected during the Phase II ESA.

According to MTCA, the cleanup standards for a site have two primary components: chemical-specific CULs and points of compliance (POCs). The CUL is the concentration of a chemical in a specific environmental medium that will not pose unacceptable risks to human health or the environment. The POC is the location where the CUL must be met.

2.4.1 Soil

For human health screening, soil was screened against MTCA Method A CULs for unrestricted land use. The Method A values are for protection of human health via the direct-contact or ingestion pathway and protection of groundwater via the soil-leaching-to-groundwater pathway. For certain constituents, MTCA Method A CULs are not available and Method B CULs have been applied. Method B CULs may be used at any site. This is consistent with the approach used in the preliminary RI/FS and Phase II ESA (MFA, 2015, 2018c).

During the Phase II ESA, an ecological screening of property-wide metals concentrations in soil was conducted (in accordance with terrestrial ecological evaluation guidance presented in WAC 173-340-7493) to facilitate selection of an appropriate cleanup action that would be protective of potential ecological receptors at the Property. Natural background concentrations and site-specific ecological SLs were developed for this ecological screening.

Soil CULs for the protection of potable groundwater (leaching-to-groundwater pathway) were evaluated for locations where groundwater data were not available to determine the potential for chemically impacted soil to affect groundwater resources. Potable water for the Property is provided by the Skagit Public Utility District.

2.4.1.1 Points of Compliance in Soil

The soil POC is the depth at which soil CULs shall be attained. The standard POC in soil for human direct contact and for ecological receptors is from the surface to 15 feet below ground surface (bgs) throughout the entire site. This standard POC is applied to soil on the Property.

2.4.2 Groundwater

Groundwater was screened to MTCA Method A CULs and, where appropriate based on the CSM, ARARs for freshwater surface water. For certain constituents, MTCA Method A CULs are not available and Method B CULs have been applied. This is consistent with the approach used in the preliminary RI/FS and Phase II ESA (MFA, 2015, 2018c).

Concentrations of cVOCs detected in groundwater were also compared to MTCA Method B groundwater SLs for protection of indoor air, provided in Ecology's draft soil vapor intrusion guidance (Ecology, 2016).

It is assumed, for the purposes of this ABCA, that uses of the groundwater beneath the Property will remain non-potable. See the Phase II ESA report, Section 6.2, for the basis of this assumption (MFA, 2018c).

2.4.2.1 Points of Compliance in Groundwater

For groundwater, the POC is the point or points where the groundwater CULs must be attained for a site to comply with the cleanup standards. Groundwater CULs shall be attained in all groundwater from the POC to the outer boundary of the hazardous-substance plume.

2.4.3 Soil Vapor

Soil gas concentrations were compared to MTCA Method B sub-slab soil gas SLs (Ecology, 2015). The most stringent of the carcinogenic and noncarcinogenic SLs were selected. These SLs are protective of indoor air, given attenuation of soil gas concentrations through the foundation (i.e., slab) of a building.

2.4.3.1 Points of Compliance in Soil Vapor

For soil gas collected beneath the foundation of existing buildings (i.e., sub-slab soil vapor), the standard POC is immediately below the foundation of the building. The standard POC is applied to sub-slab soil vapor at this Property.

3 AREAS OF CONCERN

3.1 Areas of Concern

The nature and the extent of contamination are presented in Section 3 of the Phase II ESA (MFA, 2018c). The AOCs are outlined below and shown on Figure 1-1.

3.1.1 AOC 1: Former Laundry Building

As discussed in previous reports, no records of dry cleaning operations at the former laundry building were located; however, the presence of tetrachloroethene (PCE) in groundwater, soil, and soil vapor in this AOC indicates that a solvent containing PCE likely was used at some point during historical operations in the building. During a review of historical building plans, laundry extractor machines were noted in building plans at the north end of the former laundry building, and utility maps identified a potential drainage pipe at the northeast corner of the building (MFA, 2018a). Given the consistent detections of PCE and/or trichloroethene (TCE) in soil, groundwater, and soil vapor in this portion of the former laundry building, it is likely that the operation of these features is the source of the PCE identified in this area. This is supported by the absence of detections in groundwater west, northwest, southwest, and southeast of the former laundry building.

Chlorinated solvents (cVOCs), including PCE, TCE, and cis-1,2-dichloroethene (cis-1,2-DCE), were detected in soil, groundwater, and/or soil vapor in the northeast area of the former laundry building (MFA, 2018a). No detections of PCE or TCE were identified at the upgradient or downgradient monitoring well locations; therefore, groundwater impacts appear to be localized to beneath the northeast corner of the former laundry building. However, given the limited number of soil and soil vapor samples, the extent of soil impacts has not yet been fully delineated and may extend below the existing building.

AOC 1 is shown on Figure 3-1.

3.1.2 AOC 2: Power House Building

Concentrations of heavy-oil-range organics (ORO) and carcinogenic polycyclic aromatic hydrocarbons (cPAHs) were detected above the MTCA Method A CULs (for unrestricted land use) in shallow soil (less than 1 foot bgs) north of the Power House (see Figure 1-1) (MFA, 2018a). Historical fill material containing coal/asphalt debris was determined to be a potential source of the ORO and cPAH impacts to shallow soil.

Additional assessment was completed during the Phase II ESA to further evaluate the extent of contamination. The elevated concentrations of cPAH and ORO appear to be confined to an area immediately adjacent and to the north of the Power House, in fill material (extending less than 3 feet bgs) containing more asphalt-like fill debris underlying the existing asphalt, as observed during previous investigations (MFA, 2015; SES, 2017). Dioxins and furans were detected in shallow soil (less than 1 foot bgs) collected from borings near the former incinerator and in the fill material outside the paved area north and northeast of the Power House. These detections likely are associated with the historical operation of the Power House smokestack and the potential historical combustion of materials in the incinerator. However, the detections of dioxins and furans were below cleanup levels and did not suggest a significant source of dioxins and furans associated with the Power House AOC.

AOC 2 is shown on Figure 3-2.

3.1.3 AOC 3: Lead in Soil

Elevated concentrations of lead were identified in shallow soil immediately adjacent to some historical buildings (and at one location in the athletic field) (see Figures 3-3 through 3-5) (MFA, 2018a).

Elevated detections of lead impacts, which surround the historical buildings, appear to be localized in both vertical and lateral extent, with concentrations decreasing with depth and distance from the historical buildings (MFA, 2018c). Exceedances generally extend up to 5 feet from the building footprint and down to 1.5 feet bgs.

The cultural resources assessment report for the campus indicated that paint treated with lead and zinc had been used on the campus buildings (Artifacts Consulting, 2008). It appears that lead-containing paint has flaked or peeled off the historical building surfaces and has been deposited in adjacent shallow soil. Therefore, the elevated concentrations of lead identified in these soil samples suggests that lead paint is/was present in the exterior paint of the historical buildings and is the source of elevated lead concentrations in shallow soil at the Property.

AOC 3 is shown on Figures 3-3 through 3-5.

3.1.4 AOC 4: Arsenic in Soil

Localized, elevated concentrations of arsenic in soil have been identified at the Property during previous subsurface investigations (MFA, 2018a). There are a few potential sources for elevated arsenic concentrations in soil that may be present, including naturally occurring arsenic, historical pesticide use, and arsenic-containing wood-treatment chemicals associated with wood used in building construction and/or in building demolition debris (MFA, 2018a).

Arsenic-impacted shallow soil (less than 0.5 foot bgs) was assessed as part of the property-wide metals assessment conducted for the Phase II ESA (MFA, 2018c). Shallow and subsurface soil impacts were identified near the former Ward Building and athletic field areas, as shown on Figure 3-6.

3.1.5 AOC 5: Property-Wide Metals in Soil

The investigation and characterization of the property-wide metals in soils is discussed in detail in the Phase II ESA (MFA, 2018c). Results of this investigation were compared to MTCA Method A CULs, or B if Method A values were unavailable (to assess potential for human health risk) and to site-specific ecological SLs (to assess potential for ecological risk). Development of ecological SLs is described in detail in Appendix F of the Phase II ESA. Complete human health and ecological screening of property-wide metals data is presented in Table 4-5 of the Phase II ESA.

Nearly all surface soil samples in this evaluation were below human health CULs for all metals analyzed, with the exception of soil sample SS08-S-0.5. This sample exceeded the human health criteria for lead and was collected adjacent to the athletic field, see Figure 4-1 of the Phase II ESA.

Additional soil samples exceeded site-specific ecological SLs. These exceedances were confined to the eastern side of the Property and were concentrated in two locations: the northeast and the southeast area of the Property. The ecological SL exceedances in the northeast area of the property are in one of the most heavily-used and developed portions of the Property. This area has little-to-no habitat value as the natural habitat is significantly degraded by building development, paving, and active uses. Therefore, this northeastern area of the Property is not further considered in this ABCA. The ecological SL exceedances in the southeast area of the Property are found in areas with high quality habitat (e.g., deer, worms, squirrels, and owl pellets were observed during the Phase II ESA fieldwork). Any remedial action conducted in this vicinity may cause environmental injury to the established ecosystem. It is recommended that a net environmental benefit analysis (NEBA) be performed before any remedial alternatives are considered. As a result, this southeastern area is not c further evaluated in this ABCA. Both the northeast and southeast areas of the Property with ecological SL exceedances that are discussed here are shown on Figure 3-7.

3.1.6 AOC 6: Maintenance Building

Benzene, toluene, ethylbenzene, total xylenes, and gasoline were identified in subsurface soil and groundwater adjacent to the maintenance building at concentrations above MTCA Method A CULs (SES, 2017).

Additional assessment of this AOC is being conducted by SES via the Washington State Pollution Liability Insurance Agency, as investigation of petroleum impacts is not eligible for funding through the USEPA Brownfields Assessment Grant; therefore, this AOC was not further evaluated as part of this ABCA.

3.1.7 AOC 7: Lead and Arsenic in Groundwater

Total and dissolved arsenic and lead were detected in groundwater samples from reconnaissance groundwater borings and monitoring wells, installed across the northeastern portion of the Property, at concentrations above MTCA Method A CULs and surface water ARARs (MFA, 2018a). Given the proximity of elevated arsenic and/or lead concentrations to Hansen Creek, there is potential for groundwater with metals concentrations above surface water ARARs to discharge to the creek.

As discussed above in Section 3.1.5, widespread elevated metals concentrations have been identified in soil across the Property. Therefore, additional assessment of area-wide metals concentrations in soil was conducted during the Phase II ESA to evaluate the potential of an area-wide elevated metals condition at the Property before characterization of potential metals loading to Hansen Creek (i.e., AOC 5). As a result, this AOC was not further assessed during the Phase II ESA, but it may be included in future investigations and/or assessments of the Property.

4 ANALYSIS OF BROWNFIELDS CLEANUP ALTERNATIVES

The purpose of this ABCA is to identify and evaluate the most relevant remedial alternative that reduces contaminant exposure to levels that are protective of human health and the environment and that are appropriate for meeting the remedial action objectives (RAOs) for the Property. This ABCA was completed in general accordance with USEPA guidelines for conducting an ABCA. This document is a draft and will be presented for public comment. This ABCA contains the following elements:

- Summary of indicator hazardous substances (IHSs)
- Development of remedial action area and RAOs
- Evaluation and presentation of proposed cleanup alternatives
- Discussion of residual risks associated with recommended alternatives

4.1 Remedial Action Objectives

RAOs for the Property have been developed to protect receptors and provide the underlying basis for developing and evaluating remedial actions. The RAOs for the Property are:

- Reduce or prevent potential risk to human health and/or the environment from hazardous substances at the Property, during Property re-development

- Prevent or limit potential exposure of current and future Property users, workers, or ecological receptors to hazardous substances
- Prevent direct contact between human receptors and soil and/or groundwater that exceeds applicable risk-based concentrations
- Remediate/remove hot spots of contamination to the extent feasible
- Remove potential sources of groundwater contamination to protect aquatic ecological receptors and recreational fishers
- Remediate/remove source-area soils to the extent feasible (especially if "hot spots" are encountered following building renovations)
- Prevent migration of cVOCs into indoor air (eliminate the vapor migration pathway)
- Utilize sustainable ("green") remediation/removal strategies to the maximum extent practicable

4.2 Remedial Alternatives Considered

The objective of each of the following alternatives is to reduce exposure by managing contaminants present at the Property to levels protective of human health and the environment. Because of the nature of the contaminants, the proposed redevelopment of the Property and the limited remedial action areas, only a few remedial alternatives warrant detailed evaluation. For these reasons, the following remedial actions were considered for the Property's AOCs:

- No action
- Use of institutional controls
- Use of engineering controls
- In situ treatment
- Excavation and off-site disposal

4.2.1 AOC 1: Former Laundry Building

Previous investigations detected PCE, TCE, and cis-1,2-DCE in soil, groundwater, and/or soil vapor in the northeast area of the former laundry building (MFA, 2015, 2018c).

4.2.1.1 Alternative 1.1—No Action

Typical ABCA reports include the evaluation and analysis for a broad range of alternatives, including a no-action alternative. The no-action alternative usually serves as a benchmark against which the all other actions are compared. Under this alternative, soil and groundwater that exceeds IHSs protective of potential future residents and occupational site users will be left in place.

4.2.1.2 Alternative 1.2—Vapor Barrier and Monitored Natural Attenuation

Under Alternative 1.2, soil and groundwater that exceed the MTCA SLs would be left in place; however, engineering and institutional controls would be used to mitigate residual risk on the Property. Engineering controls would include installation of a retrofitted vapor barrier system. Institutional controls in the form of an environmental covenant or deed restriction would be recorded with the Property deed. The document would likely include the following requirements:

- Groundwater at the Site will not be extracted for drinking water, industrial use, or other purposes.
- A performance monitoring plan will be prepared to outline groundwater sampling activities as well as indoor air sampling requirements.

This alternative would include the following:

- An assessment of the existing building slab to confirm its integrity and/or implementation of site controls to ensure that the integrity of the former laundry building slab is preserved.
- Placement of a retrofitted vapor barrier, if it is determined that the building slab is not providing adequate protection against PCE and TCE impacts below the building.
- An assessment of indoor air quality in the former laundry building to confirm that impacts below the building are not volatizing into indoor air.
- The groundwater will continue to be sampled as part of a monitored natural attenuation (MNA) program for the AOC.

Note, one of the Port's tenants has near-term plans to remodel the Former Laundry Building. As such, Alternative 1.2 may be implemented as an interim action with potential follow-up work to address source contamination in the future.

4.2.1.3 Alternative 1.3—In Situ Bioremediation Injections

Under Alternative 1.3, the impacted soil and groundwater that exceeds the MTCA screening criteria would be treated by in situ bioremediation injections.

An in situ bioremediation program could be implemented to reduce the solvent concentrations in the soil and groundwater. This can be accomplished by injecting amendments directly into the ground around the building footprint (in the vicinity of GP8). A combination of amendments could be designed to enhance degradation of chlorinated ethenes through biotic and abiotic processes. This program would be designed to utilize anaerobic biodegradation of the existing chlorinated compounds through the enhanced reductive dechlorination (ERD) process. ERD is the primary anaerobic biological process by which problematic chlorinated solvents such as PCE, TCE, cis-1,2-DCE and vinyl chloride in groundwater are biologically transformed into less harmful end products such as ethene.

This alternative would use direct-push technology and a high-pressure pneumatic pump. Semiannual performance monitoring data would inform progress for the remaining PCE/TCE in the groundwater.

4.2.2 AOC 2: Power House Building

Heavy oils and cPAHs in the shallow soil and groundwater were detected in locations immediately north and northeast of the Power House building. Impacts appear to be fairly localized to the area immediately to the north and northeast of the Power House, but additional soil and groundwater impacts may be present underneath the building, particularly under the diesel ASTs.

4.2.2.1 Alternative 2.1—No Action

The no-action alternative is described above in Section 4.2.1.1.

4.2.2.2 Alternative 2.2—Soil Management Plan

Under Alternative 2.2, a soil management plan (SMP) would be prepared to address heavy oils and cPAHs present in shallow soil. Since AOC 2 is primarily paved with asphalt, the existing impervious surface is acting as a protective cap. An SMP would be prepared and implemented to guide any future construction activities that might disturb the soil (and groundwater) in the area.

The SMP would outline the location and proper handling and disposal of impacted soil during any potential redevelopment (or other construction activities). The impacted soil (and groundwater) would be addressed at the time of construction or redevelopment.

4.2.2.3 Alternative 2.3—Excavation with Off-site Disposal and Amended Backfill

Alternative 2.3 includes near surface soil excavation and backfilling with an amended soil material. The contaminated near surface soil would be removed by excavation. For the purposes of this ABCA, it is assumed that the AOC would be excavated to 6.5 feet bgs (depth to groundwater) so that the in situ bioremediation treatment is most effective. The backfill material would be amended (mixed) with a controlled-release oxygen product in order to address any residual contamination that may remain beyond the excavation (or beneath the existing building). The controlled-release oxygen product would accelerate the biodegradation of petroleum hydrocarbons in the AOC. Semiannual performance monitoring data would be collected to monitor for petroleum degradation progress in the groundwater.

4.2.3 AOC 3: Lead in Soil

Concentrations of lead exceeding the MTCA Method A CUL were identified in soil near some of the historic buildings on the campus. This investigation focused specifically on the Trevennen, Coleman, and Denny buildings because they are scheduled for renovation before other historical buildings on the Property (MFA, 2018c).

Additional characterization of the lateral and vertical extent of impacts to the soil surrounding the buildings was conducted to help guide any future redevelopment actions in those areas of the Property. The lead impacts above MTCA Method A CULs surrounding historical buildings appear to be localized in both vertical and lateral extent, with concentrations decreasing with depth and distance from the buildings. Based on the observed soil impacts, it is assumed that the historical buildings are the source of lead soil contamination (e.g., lead paint used on buildings).

4.2.3.1 Alternative 3.1—No Action

The no action alternative is described above in Section 4.2.1.1.

4.2.3.2 Alternative 3.2—Soil Management Plan

Under Alternative 3.2, an SMP would be prepared to address lead impacts in shallow soil. The SMP would guide the soil handling and disposal during future construction activities (which might encounter contaminants in the subsurface). The SMP would outline the location and proper handling and disposal of shallow soil with lead-impacts during the construction activities at the site. The SMP would also address the potential hazardous building materials and removal of existing lead impacts on the historical building exteriors during redevelopment to eliminate a contributing source to the surrounding shallow soil.

The SMP would guide and outline the proper procedures so that as these historic buildings on campus are redeveloped and the lead-impacted shallow surface soils are properly handled and disposed of.

4.2.3.3 Alternative 3.3—Excavation and Off-site Disposal

Alternative 3.3 assumes that these hot spots with elevated lead levels in soil will be excavated and disposed of off-site (at a permitted landfill) initially, prior to the redevelopment of any historic buildings. For the purposes of this ABCA, it is assumed that an average excavation depth of 1.5-feet bgs would be needed around the exterior of the buildings with known impacts (specifically near the Trevennen, Coleman, and Denny buildings). Confirmation soil samples during excavation would be collected to ensure that lead impacts above MTCA Method A CULs are removed.

This alternative also assumes that the existing lead impacts on the historical building exteriors will be removed during redevelopment to eliminate a contributing source to the surrounding shallow soil. This alternative assumes that the surrounding soil will be excavated to approximately 1.5 feet bgs around the building exteriors and that confirmation soil samples will be collected during the excavation process to ensure that lead impacts above MTCA Method A CULs have been thoroughly removed.

It is recommended to screen for additional/potential lead impacts adjacent to other buildings on the Property through the collection of exterior paint samples and shallow soil samples. The number of exterior paint and shallow soil samples should be representative of the size of the building.

4.2.4 AOC 4: Arsenic in Soil

As described above, AOC 4 is focused on the arsenic-impacted shallow soil found near the former Ward Building and athletic field areas. Two samples in the athletic field also contained elevated lead concentrations and will be included in the proposed remedy for AOC 4.

The approximate horizontal extent of contamination is shown on Figure 3-6. It is assumed that the contamination extends to approximately 1 foot bgs in these areas. Additional characterization may be needed (below 1.5 feet) in the athletic field and former Ward building areas.

4.2.4.1 Alternative 4.1—No Action

The no action alternative is described above in Section 4.2.1.1.

4.2.4.2 Alternative 4.2—Soil Management Plan

Alternative 4.2 includes the preparation of an SMP, similar to the previously described alternatives.

4.2.4.3 Alternative 4.3—Hot-Spot Excavation and Off-site Disposal

Alternative 4.3 includes the excavation and off-site disposal of arsenic-impacted soil, similar to the alternative for lead described above in Section 4.2.3.3. However, Alternative 4.3 assumes an average excavation depth of 1 foot bgs. The impacted surface soils in the former Ward Building area and athletic field would be removed and disposed of off site, eliminating the direct-contact exposure risk.

5 EVALUATION OF REMEDIAL ALTERNATIVES

All remedial cleanup options should be verified to meet the MTCA threshold requirements before being considered as a cleanup action. Any cleanup alternatives considered should provide for a reasonable restoration time frame. Under MTCA, the most practicable permanent solution should be used as the baseline against which other alternatives are compared.

Several cleanup alternatives were evaluated based on the following criteria: effectiveness, reliability, implementability, risk, sustainability, and cost. Per USEPA guidelines (USEPA, 2018), this ABCA also considers the resilience to address potential adverse impacts caused by extreme weather events. There is minimal risk of severe weather events or climate change impacts to any of the proposed remedial actions. The Property is in an area of relatively low geological hazard risk. The AOCs are located outside of the 100-year floodplain and the Property is located inland and is not directly at risk from sea level rise. The cost estimates are conceptual with a precision of +50%/-30% (USEPA, 2000). Table 5-1 provides a cost comparison summary.

5.1 AOC 1: Former Laundry Building

5.1.1 Alternative 1.1—No Action

Under this alternative, soil and groundwater exceeding CULs will be left in place.

Effectiveness: Alternative 1.1 does not eliminate the potential for Site users to come into direct contact with contaminated soil or groundwater, nor does it protect Site users from exposure to soil gas vapors migrating to indoor air.

Long-term Reliability: Alternative 1.1 does not remove contamination or eliminate human or ecological exposure pathways, and therefore is unreliable in the long-term.

Implementability: Alternative 1.1 is considered easy to implement as it requires no action.

Implementation Risk: Alternative 1.1 implementation risk is low because no construction activities are conducted.

Sustainability: Alternative 1.1 is not sustainable in that contaminated groundwater and soils remain in place and will have continued potential to produce vapors that could enter indoor air.

Cost: the cost estimate to implement this alternative is assumed to be $0.

5.1.2 Alternative 1.2—Vapor Mitigation and MNA

Under Alternative 1.2, soil and groundwater that exceed CULs would remain in place. As described above (Section 4.2.1.2), institutional and engineering controls would be used to mitigate residual risk in the AOC with the installation of a retrofitted vapor barrier system, performance monitoring, and a land use restriction (or environmental covenant, zoning designations, and/or building permit requirements may be recorded). Groundwater at the Property would not be extracted for drinking water, industrial use, or other purposes.

Effectiveness: This proposed alternative will be effective because engineering controls eliminate the indoor air pathway, and institutional and engineering controls reduce the potential for Property users to come into direct contact with contaminated soil, groundwater, or harmful soil gas vapors.

Long-term Reliability: A restrictive covenant would be recorded on the Property that would prohibit the use of groundwater as a drinking water source. Alternative 1.2 is protective of potential soil gas vapors in the former laundry building and will include MNA.

Implementability: Both proposed alternatives are considered relatively easy to implement because they utilize available contractors and materials.

Implementation Risk: The implementation risk is low for both alternatives (Alternative 1.1 would be a lower implementation risk since it involves no action). Under Alternative 1.2, subcontractors hired to install the vapor barrier system will be current with their U.S. Occupational Safety and Health

Administration 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training. Work would be performed under a site-specific health and safety plan.

Sustainability: The proposed alternative is sustainable. Alternative 1.2 relies on an engineered system but assumes that natural processes will occur in the subsurface that decrease contamination in the subsurface over time.

Cost: the cost estimate to implement this alternative is approximately $367,000. See Table 5-2 for the detailed cost estimate.

5.1.3 Alternative 1.3—In Situ Bioremediation

Under Alternative 1.3, soil and groundwater that exceed CULs would be treated by an in situ bioremediation program. In situ injections and bioremediation products would be used to treat residual contamination within the AOC with the injection of amendments specifically designed to reduce the chlorinated solvent concentrations. Performance monitoring would also be required/completed to evaluate the injection program and determine if follow-up treatment is required.

For the purposes of the cost estimate, one injection event is assumed to be sufficient to address the residual contamination in the area. It may require multiple injection events. Groundwater monitoring will be conducted in the vicinity to verify the effectiveness of the treatment system.

Effectiveness: This proposed alternative is judged to be effective because it will eliminate the source contamination. This would eliminate the potential for Property users to come into direct contact with contaminated soil, groundwater, or harmful soil gas vapors. Alternative 1.3 is judged to be equally effective as Alternative 1.2 and more effective than Alternative 1.1.

Long-term Reliability: A restrictive covenant would be recorded on the Property that would prohibit the use of groundwater as a drinking water source. However, only Alternatives 1.2 and 1.3 are protective of potential soil gas vapors in the former laundry building and will include MNA. Alternative 1.3 will eliminate the source of contamination and, as a result, is judged to be more reliable in the long-term than Alternatives 1.1 and 1.2 (Alternative 1.2 is judged to be more reliable than Alternative 1.1 in the long-term).

Implementability: All three proposed alternatives are considered relatively easy to implement because they utilize available contractors and materials. Alternative 1.2 requires access to the existing building slab/foundation during redevelopment. Alternative 1.3 requires additional permits to inject the remediation product(s). Therefore, Alternative 1.1 would be the easiest to implement followed by Alternatives 1.2 and 1.3, respectively.

Implementation Risk: The implementation risk is low for all three alternatives (Alternative 1.1 would be a lower implementation risk since it involves no action, followed by Alternative 1.2). Under Alternative 1.2, subcontractors hired to perform the injections will be current with HAZWOPER certification. Work would be performed under a site-specific health and safety plan. The same criteria that applies to Alternative 1.2. However, Alternative 1.3 has some increased implementation risks due to permitting requirements and potential underground utilities in the vicinity of the AOC.

Sustainability: All three proposed alternatives are sustainable. Alternative 1.2 relies on an engineered system but also on natural processes to decrease contamination in the subsurface over time. Alternative 1.3 reduces source contamination in place. Therefore, Alternative 1.3 is judged to be more sustainable than the other two alternatives.

Cost: the cost estimate to implement this alternative is approximately $356,000. See Table 5-3 for the detailed cost estimate.

5.2 AOC 2: Power House Building

As described above (Section 4.2.2), the shallow surface soils directly north and northeast of the Power House Building are impacted with heavy oils and cPAHs. Impacts appear to be fairly localized, but additional soil and groundwater impacts may be present underneath the building, particularly under the diesel ASTs.

5.2.1 Alternative 2.2—Soil management plan

Alternative 2.2 assumes that an SMP (or incorporated into the SMP for AOCs 3 and/or 4, described in Sections 5.3.1 and 5.4.1, if selected as the preferred alternative for AOCs 3 and/or 4) would be prepared as described in Section 4.2.3.2.

The existing asphalt will serve as a protective cap against direct contact with impacted soils. The SMP would be prepared for use by contractors or site workers that needed to disturb the subsurface for any reason. This SMP will outline the location and the proper handling and disposal of soil from the area.

Effectiveness: The asphalt cap breaks the direct contact risk and is protective of human health and the environment. The SMP would outline protocols for safely handling impacted soils when working in the subsurface within this AOC. However, impacted soil with elevated concentrations of IHSs would remain in place. Alternative 2.2 would be effective in achieving the goals of reduction of health risks and facilitating the redevelopment of the site.

Long-term Reliability: The Port's redevelopment plan will include institutional controls (i.e., environmental covenant or deed restriction) that will prevent use of Property groundwater. The existing cap and proposed SMP will prevent site workers and visitors from contacting potentially impacted soil beneath the surface. This alternative is judged to be reliable in the long-term.

Implementability: This alternative is considered easy to implement because the asphalt is already in place and does not require any construction.

Implementation Risk: The implementation risk is low. Under Alternative 2.2, an SMP would be developed for use by workers/visitors to prevent exposure to contamination in the shallow surface soils.

Sustainability: The proposed alternative is sustainable. Alternative 2.2 relies on institutional controls (i.e., environmental covenant or deed restriction) and an SMP to prevent exposure over time.

Cost: the cost estimate to implement this alternative is approximately $54,000. This cost includes a Property-wide SMP and may include additional AOCs. See Table 5-4 for detailed cost estimate.

5.2.2 Alternative 2.3—Excavation with Off-site Disposal and Treatment

Under Alternative 2.3, soil containing IHSs at concentrations above CULs would be excavated and disposed of at an off-site permitted landfill. For the purposes of this ABCA, it is assumed that the excavation (immediately north and northeast of the Power House Building) would be 6.5 feet bgs. The horizontal extent of excavation is shown on Figure 3-2. Documentation soil samples would be collected from the sidewalls and bottom of the excavation. In order to address any potential residual contamination that may remain in place after the excavation (either beneath the building or in nearby utility trenches/corridors), an in situ bioremediation product would be added/mixed in with the clean backfill. An oxygen release product would be used to improve (oxidize) subsurface conditions and promote biological breakdown of petroleum hydrocarbons in the soil and groundwater. Follow-up groundwater/performance monitoring would be performed.

Effectiveness: Successful removal of the impacted soil with elevated concentrations of IHSs would eliminate the potential for human exposure. Some O&M monitoring may be required depending on how much material is successfully removed. Alternative 2.3 would be effective in achieving the goals of reduction of health risks associated with impacted soils and groundwater. Since Alternative 2.3 actively removes and treats source contamination, it is judged to be more effective than Alternative 2.2.

Long-term Reliability: Alternative 2.3 will remove the localized area of impacted soil, while Alternative 2.2 will simply manage the site operations. Both alternatives 2.2 and 2.3 are reliable in the long-term, but Alternative 2.3 is judged to be more reliable since it permanently addresses the impacts.

Implementability: The proposed alternatives are considered relatively easy to implement because they utilize available contractors and materials. Alternative 2.2 and 2.1 are judged to be easier to implement than Alternative 2.3, which requires more construction and disturbance to the subsurface.

Implementation Risk: The implementation risk is relatively low for all three alternatives. Under Alternative 2.3, subcontractors hired to conduct the excavation will be current with HAZWOPER certification and the work would be performed under a site-specific health and safety plan. There is greater implementation risk associated with Alternative 2.3 when compared to the other two alternatives.

Sustainability: Alternative 2.3 involves earthwork and construction that require use of heavy equipment and transportation of excavated soils and backfill. These actions have increased air emissions, including greenhouse gas emissions, and greater impact on the landscape on the Property and off-site landfill than Alternatives 2.1 and 2.2.

Cost: the cost estimate to implement this alternative is approximately $455,000. See Table 5-5 for detailed cost estimate.

5.3 AOC 3: Lead in Soil

5.3.1 Alternative 3.2—Soil Management Plan

Under Alternative 3.2, an SMP would be prepared (or incorporated into the SMP for AOCs 2 and/or 4, described in Sections 5.2.1 and 5.4.1, if selected as the preferred alternative for AOCs 2 and/or 4) to guide soil handling and disposal during future construction activities (which might encounter contaminates in the subsurface). The SMP would outline the location and proper handling and disposal of shallow soil with lead-impacts during the construction activities at the site. The SMP would also address the potential hazardous building materials and removal of existing lead impacts on the historical building exteriors during redevelopment to eliminate a contributing source to the surrounding shallow soil.

Prior to demolition/renovation of the existing building(s), an SMP would be prepared for use by contractors. This SMP would outline the location and the proper handling and disposal of soil, groundwater, and hazardous building materials during construction activities at the Property.

Effectiveness: The SMP would outline protocols for safely handling impacted soils when working or redeveloping any buildings within this AOC. However, impacted soil with elevated concentrations of IHSs would remain in place until the buildings are redeveloped. Prior to redevelopment, there is potential for human exposure. For the purposes of this ABCA, it is assumed that the SMP would be strictly followed by staff and property residents/visitors, thus eliminating the potential for human exposure, and requiring no long-term O&M monitoring. Alternative 3.2 would be effective in achieving the goals of reduction of health risks and facilitating the redevelopment of the site.

Long-term Reliability: The Port's redevelopment plan will include institutional controls (i.e., environmental covenant or deed restriction) that will prevent use of Property groundwater. The SMP will prevent site workers and visitors from contacting potentially impacted soil until the buildings are redeveloped. This alternative is judged to be reliable in the long-term.

Implementability: This alternative is considered relatively easy to implement because it does not require any upfront construction.

Implementation Risk: The implementation risk is low. Under Alternative 3.2, an SMP would be developed and followed by worker/visitor to prevent exposure to contamination in the shallow surface soils.

Sustainability: The proposed alternative is sustainable. Alternative 3.2 relies on institutional controls (i.e., environmental covenant or deed restriction) and an SMP to prevent exposure over time.

Cost: the cost estimate to implement this alternative is approximately $54,000. See Table 5-4 for detailed cost estimate.

5.3.2 Alternative 3.3—Excavation and Off-site Disposal

Under Alternative 3.3, soil containing IHSs at concentrations above CULs would be excavated and disposed of at an off-site permitted landfill. For the purposes of this ABCA, it is assumed that an average excavation depth of 1.5-feet bgs would be needed around the building exteriors. Confirmation soil samples during excavation would be collected to ensure that lead impacts above MTCA Method A CULs are addressed.

Effectiveness: Successful removal of the impacted soil with elevated concentrations of IHSs would eliminate the potential for human exposure and would require no long-term O&M monitoring. Alternative 3.3 would be effective in achieving the goals of reduction of health risks and facilitating the redevelopment of the site. Alternative 3.3 is judged to be more effective than Alternative 3.2.

Long-term Reliability: The Port's redevelopment plan will include institutional controls that will prevent use of Property groundwater (i.e., environmental covenant or deed restriction). Alternative 3.3 will permanently remove the hot spots with impacted soil, while Alternative 3.2 will simply manage the site operations. Both alternatives 3.2 and 3.3 are reliable in the long-term, but Alternative 3.3 is judged to be more reliable than the other alternatives. However, if excavation and off-site disposal occur prior to the renovation of the buildings' exterior, the long-term reliability and effectiveness (since lead-based paint is a potential source for recontamination of surface soils) is reduced.

Implementability: All three proposed alternatives are considered relatively easy to implement because they utilize available contractors and materials. Alternative 3.2 and 3.1 are judged to be easier to implement than Alternative 3.3.

Implementation Risk: The implementation risk is relatively low for all three alternatives. Under Alternative 3.3, subcontractors hired to conduct the excavation would be current with HAZWOPER certification, and the work would be performed under a site-specific health and safety plan. There is greater implementation risk associated with Alternative 3.3 when compared to the other two alternatives.

Sustainability: Alternative 3.3 involves earthwork and construction that require use of heavy equipment and transportation of excavated soils and backfill. These actions have increased air emissions, including greenhouse gas emissions, and greater impact on the landscape on the Property and off-site landfill than Alternatives 3.1 and 3.2.

Cost: the cost estimate to implement this alternative is approximately $98,000. See Table 5-6 for detailed cost estimate.

5.4 AOC 4: Arsenic in Soil

5.4.1 Alternative 4.2—Soil Management Plan

Under Alternative 4.2, an SMP will be prepared (or incorporated into the SMP for AOCs 2 and/or 3, described in Sections 5.2.1 and 5.3.1, if selected as the preferred alternative for AOCs 2 and/or 3) to guide soil handling and disposal during future construction activities (as described for the previous alternative). The SMP will outline the location and proper handling and disposal of shallow soil with metals impacts during any construction activities within AOC 4.

Effectiveness: The SMP will outline protocols for safely handling impacted soils near the athletic field and former Ward Building areas. However, impacted soil with elevated concentrations of IHSs will remain in place (unless removed in the future), allowing potential human exposure. For the purposes of this ABCA, it is assumed that the SMP would be strictly followed by staff and property residents/visitors, thus eliminating the potential for human exposure. It could require some long-term O&M monitoring (maintain vegetated lawn to prevent soil exposure/erosion). However, it's worth highlighting the fact that this AOC contains an active athletic field and is used frequently by site visitors/workers. Alternative 4.2 would be effective in achieving the goals of reduction of health risks and facilitating the redevelopment of the site (although less effective than other, more aggressive, options).

Long-term Reliability: In theory, the SMP will prevent site workers and visitors from contacting potentially impacted soil. However, a portion of this AOC is located in an active athletic field and there is a high likelihood that site users will contact shallow surface soils in this area. This alternative is judged to be less reliable in the long term.

Implementability: This alternative is considered easy to implement.

Implementation Risk: The implementation risk is low. Under Alternative 4.2, the SMP would be developed and followed by worker/visitor to prevent exposure to contamination in the shallow surface soils.

Sustainability: The proposed alternative is sustainable. Alternative 4.2 relies on institutional controls and an SMP to prevent exposure over time.

Cost: the cost estimate to implement this alternative is approximately $54,000. See Table 5-4 for detailed cost estimate.

5.4.2 Alternative 4.3—Excavation and Off-site Disposal

Under Alternative 4.3, soil containing IHSs at concentrations above CULs would be excavated and disposed of at an off-site permitted landfill. For the purposes of this ABCA, it is assumed that a depth of 1 foot bgs would be excavated in the areas shown on Figure 3-6. Confirmation soil samples would be collected during the excavation to ensure that lead impacts above MTCA Method A CULs are addressed.

Effectiveness: Successful removal of the impacted soil with elevated concentrations of IHSs would eliminate the potential for human exposure and would require no long-term O&M monitoring. Alternative 4.3 would be effective in achieving the goals of reduction of health risks and facilitating the redevelopment of the site. Alternative 4.3 is judged to be more effective than Alternative 4.2.

Long-term Reliability: Alternative 4.3 will permanently remove the impacted shallow soils within AOC 4, while Alternative 4.2 will attempt to manage the site operations. Alternative 4.3 is judged to be more reliable than the other alternatives.

Implementability: All three proposed alternatives are considered relatively easy to implement because they utilize available contractors and materials. Alternative 4.2 and 4.1 are judged to be easier to implement than Alternative 4.3.

Implementation Risk: The implementation risk is relatively low for all three alternatives. Under Alternative 4.3, subcontractors hired to conduct the excavation will be current with HAZWOPER certification, and the work would be performed under a site-specific health and safety plan. There is greater implementation risk associated with Alternative 4.3 when compared to the other two alternatives.

Sustainability: Alternative 4.3 involves earthwork and construction that require use of heavy equipment and transportation of excavated soils and backfill. These actions have increased air emissions, including greenhouse gas emissions, and greater impact on the landscape on the Property and off-site landfill than Alternatives 4.1 and 4.2.

Cost: the cost estimate to implement this alternative is approximately $270,000. See Table 5-7 for detailed cost estimate.

6 PREFERRED BROWNFIELDS REMEDIAL ALTERNATIVE

A discussion of the recommended remedial alternative for each AOC is provided below.

AOC 1: Former Laundry Building—Based on the concentrations of PCE in groundwater and near the former laundry building, there are no immediate risks of exposure. However, because of the soil gas vapor exceedance and the upcoming renovation of this building to support classrooms, an interim action is recommended. Alternative 1.2 is the preferred alternative for AOC 1 because the Retro-Coat vapor barrier system could be installed concurrently with redevelopment and would be protective of soil gas vapors and indoor air. A sampling program would also be implemented to evaluate the performance of the system.

As an added protection, the Port could elect to also implement the in situ injection program described under Alternative 1.3. This would expedite the reduction of contamination in the source area, ensure that there is no soil gas vapor intrusion in the future, and eventually eliminate the need for continued monitoring.

AOC 2: Power House Building—MFA recommends Alternative 2.2 for the Power House Building. The existing asphalt surface will continue to act as a protective cap against direct contact and an SMP will be developed to protect against any future exposure due to construction activities in the vicinity.

AOC 3: Lead in Soil—For the lead-impacted surface soils (associated with historic buildings), MFA recommends including these areas under a Property-wide SMP. It is assumed that the SMP would be strictly followed by staff and property residents/visitors, thus eliminating the potential for human exposure. As the historic buildings are renovated and remodeled, the SMP can be referenced. It will provide guidance and protocols for the Contractor to properly handle the contaminated materials (metals-impacted soil and potentially hazardous building materials).

AOC 4: Arsenic in Soil—MFA recommends targeted hot-spot excavation of the impacted surface soils near the former Ward Building and athletic field areas. Although this area could be covered under the Property-wide SMP, the direct contact exposure risk relative to the cost, implementability, and effectiveness of the excavation remedy merit conducting this as an interim action. Alternatively, the athletic field portion could be addressed (excavated) separately while the Ward Building area is covered under the Property-wide SMP, thus reducing the overall cost for AOC 4.

AOC 5: Property-wide Metals—MFA recommends additional characterization of arsenic concentration is soil near GP36 and throughout the Property to identify the presence or absence of any other localized impacts and additional monitoring and characterization of arsenic in groundwater.

Additional analysis (i.e., NEBA) may be warranted to further evaluate AOC 5 and associated risks versus environmental benefit. These remedial cleanup options were developed to a conceptual level. Remedial designs should be completed before implementation of any interim actions or selection of any final cleanup options.

LIMITATIONS

The services undertaken in completing this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this report.

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TABLES

Table 5-1
Cost Estimate Summary
Former Northern State Hospital Analysis of Brownfield Cleanup Alternatives
Port of Skagit
Sedro-Woolley, Washington

Location: Northern State Hospital Sedro-Woolley, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2018 **Date:** October 208	**Description:** Comparison of the total costs for the proposed alternatives for AOCs 1 through 4. These costs are prepared at the feasibility study level (-35% to +50%) per EPA guidance.

DESCRIPTION	TOTAL NET PRESENT VALUE	INCREMENTAL COST	COST TABLE REFERENCE
AOC 1			
Alternative 1.1	$0	-$356,000	--
Alternative 1.2	$367,000	$11,000	Table 5-2
Alternative 1.3	$356,000	Baseline Cost	Table 5-3
AOC 2			
Alternative 2.2	$54,000	-$401,000	Table 5-4
Alternative 2.3	$455,000	Baseline Cost	Table 5-5
AOC 3			
Alternative 3.2	$54,000	-$44,000	Table 5-4
Alternative 3.3	$98,000	Baseline Cost	Table 5-6
AOC 4			
Alternative 4.2	$54,000	-$216,000	Table 5-4
Alternative 4.3	$270,000	Baseline Cost	Table 5-7

NOTE:

AOC = area of concern.

Table 5-2
Alternative 1.2 Cost Estimate
Former Northern State Hospital Analysis of Brownfield Cleanup Alternatives
Port of Skagit
Sedro-Woolley, Washington

Location: Northern State Hospital Sedro-Woolley, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2018 **Date:** September 2018	**Description:** Alternative 1.2 includes the installation of a vapor barrier mitigation system (and monitored natural attenuation) as part of the former laundry building redevelopment. This system will protect against soil gas vapor intrusion.

CAPITAL COSTS

Item	Quantity	Unit	Unit Cost	Cost
Site Preparation				
Mobilization/demobilization	1	LS	$ 10,000	$ 10,000
Vapor Barrier Mitigation System				
Retro-Coat™	14,800	SF	$ 8	$ 118,400
Institutional Controls				
Preparation of environmental covenant	1	LS	$ 6,000	$ 6,000
Signage to warn of hazardous materials	1	LS	$ 2,000	$ 2,000
Contingency	20%	--	--	$ 27,280
Planning Documents				
Compliance Monitoring Plan, Sampling and Analysis Plan, Health and Safety Plan	1	LS	$ 12,000	$ 12,000
Professional/Technical Services				
Project management	8%	--	--	$ 13,094
Remedial design	15%	--	--	$ 24,552
Construction management	10%	--	--	$ 16,368
TOTAL CAPITAL COSTS				**$ 229,694**

ANNUAL O&M COSTS

Item	Quantity	Unit	Unit Cost	Cost
Compliance Monitoring				
Annual monitoring (Groundwater and indoor air)	1	EA	$ 10,000	$ 10,000
Professional/Technical Services				
Project management	10%	--	--	$ 1,000
Technical support	10%	--	--	$ 1,000
Reporting	1	LS	$ 3,000	$ 3,000
TOTAL ANNUAL O&M COSTS				**$ 15,000**

PERIODIC COSTS

Item	Quantity	Unit	Unit Cost	Cost
Professional/Technical Services				
Five-year reviews and reporting	1	LS	$ 5,000	$ 5,000

Table 5-2
Alternative 1.2 Cost Estimate
Former Northern State Hospital Analysis of Brownfield Cleanup Alternatives
Port of Skagit
Sedro-Woolley, Washington

PRESENT VALUE ANALYSIS

Discount Rate	2.94%				
Total Years	10				
COST TYPE	**YEAR**	**TOTAL COST**	**TOTAL COST PER YEAR**	**DISCOUNT FACTOR**	**NET PRESENT VALUE**
Capital	0	$ 229,694	$ 229,694	1.000	$ 229,694
Annual O&M	1 - 10	$ 150,000	$ 15,000	8.556	$ 128,346
Periodic	5	$ 5,000	$ 5,000	0.865	$ 4,326
Periodic	10	$ 5,000	$ 5,000	0.748	$ 3,742
		$ 389,694			$ 366,108
TOTAL NET PRESENT VALUE OF PREFERRED ALTERNATIVE					**$ 367,000**

Present value analysis uses a discount rate of 2.94 percent (10-year treasury notes for wk of 9/10/2018).

EA = each.

LS = lump sum.

O&M = operation and maintenance.

SF = square feet.

Table 5-3
Alternative 1.3 Cost Estimate
Former Northern State Hospital Analysis of Brownfield Cleanup Alternatives
Port of Skagit
Sedro-Woolley, Washington

Location: Northern State Hospital Sedro-Woolley, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2018 **Date:** September 2018	**Description:** Alternative 1.3 includes in situ injections to treat the source of chlorinated solvent contamination beneath and adjacent to the former laundry building.

CAPITAL COSTS

Item	Quantity	Unit	Unit Cost	Cost
Site Preparation				
Mobilization/demobilization	1	LS	$ 10,000	$ 10,000
In Situ Bioremediation Injections				
3-D Microemulsion, BDI plus, and CRS	1	EA	$ 34,000	$ 34,000
Contingency	20%	--	--	$ 8,800
Permitting				
Underground injection control program	1	LS	$ 5,000	$ 5,000
Planning Documents				
Compliance Monitoring Plan, Sampling and Analysis Plan, Health and Safety Plan	1	LS	$ 12,000	$ 12,000
Professional/Technical Services				
Project management	8%	--	--	$ 4,224
Remedial design	15%	--	--	$ 7,920
Construction management	10%	--	--	$ 5,280
TOTAL CAPITAL COSTS				**$ 87,224**

ANNUAL O&M COSTS

Item	Quantity	Unit	Unit Cost	Cost
Compliance Monitoring				
Quarterly monitoring (Groundwater and indoor air)	4	EA	$ 12,000	$ 48,000
Professional/Technical Services				
Project management	10%	--	--	$ 4,800
Technical support	10%	--	--	$ 4,800
TOTAL ANNUAL O&M COSTS				**$ 57,600**

PERIODIC COSTS

Item	Quantity	Unit	Unit Cost	Cost
Professional/Technical Services				
Five-year reviews and reporting	1	LS	$ 5,000	$ 5,000

Table 5-3
Alternative 1.3 Cost Estimate
Former Northern State Hospital Analysis of Brownfield Cleanup Alternatives
Port of Skagit
Sedro-Woolley, Washington

PRESENT VALUE ANALYSIS								
Discount Rate	2.96%							
Total Years	5							
COST TYPE	**YEAR**		**TOTAL COST**		**TOTAL COST PER YEAR**	**DISCOUNT FACTOR**		**NET PRESENT VALUE**
Capital	0	$	87,224	$	87,224	1.000	$	87,224
Annual O&M	1 - 5	$	288,000	$	57,600	4.585	$	264,093
Periodic	5	$	5,000	$	5,000	0.864	$	4,321
		$	380,224				$	355,638
TOTAL NET PRESENT VALUE OF PREFERRED ALTERNATIVE							**$**	**356,000**

Present value analysis uses a discount rate of 2.96 percent (5-year treasury notes for wk of 9/19/2018).

EA = each.

LS = lump sum.

O&M = operation and maintenance.

Table 5-4
Alternatives 2.2, 3.2, and 4.2 Cost Estimate
Former Northern State Hospital Analysis of Brownfield Cleanup Alternatives
Port of Skagit
Sedro-Woolley, Washington

Location: Northern State Hospital Sedro-Woolley, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2018 **Date:** September 2018	**Description:** Alternatives 2.2, 3.2, and 4.2 include the preparation of an SMP. It is assumed that the SMP would be strictly followed by staff and property residents/visitors, thus eliminating the potential for human exposure. As the historic buildings are renovated and remodeled, the SMP can be referenced. It will provide guidance and protocols for the Contractor to properly handle the contaminated materials (metals-impacted soil and potentially hazardous building materials).

CAPITAL COSTS

Item	Quantity	Unit	Unit Cost	Cost
Institutional Controls				
Preparation of environmental covenant	1	LS	$ 6,000	$ 6,000
Signage to warn of hazardous materials	1	LS	$ 9,000	$ 9,000
Planning Documents				
Soil Management Plan (includes AOCs 2, 3, and 4)	1	LS	$ 20,000	$ 20,000
Professional/Technical Services				
Project management	10%	--	--	$ 1,500
TOTAL CAPITAL COSTS				**$ 36,500**

ANNUAL O&M COSTS

Item	Quantity	Unit	Unit Cost	Cost
Annual O&M				
Site inspections (includes AOCs 2, 3, and 4)	1	LS	$ 1,000	$ 1,000
TOTAL ANNUAL O&M COSTS				**$ 1,000**

PERIODIC COSTS

Item	Quantity	Unit	Unit Cost	Cost
Professional/Technical Services				
Five-year reviews and reporting	1	LS	$ 5,000	$ 5,000

Table 5-4
Alternatives 2.2, 3.2, and 4.2 Cost Estimate
Former Northern State Hospital Analysis of Brownfield Cleanup Alternatives
Port of Skagit
Sedro-Woolley, Washington

PRESENT VALUE ANALYSIS

Discount Rate	2.94%
Total Years	10

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR	NET PRESENT VALUE
Capital	0	$ 36,500	$ 36,500	1.000	$ 36,500
Annual O&M	1 - 10	$ 10,000	$ 1,000	8.556	$ 8,556
Periodic	5	$ 5,000	$ 5,000	0.865	$ 4,326
Periodic	10	$ 5,000	$ 5,000	0.748	$ 3,742
		$ 56,500			$ 53,124
TOTAL NET PRESENT VALUE OF PREFERRED ALTERNATIVE					**$ 54,000**

Present value analysis uses a discount rate of 2.94 percent (10-year treasury notes for wk of 9/10/2018).

AOC = area of concern.

LS = lump sum.

O&M = operation and maintenance.

SMP = soil management plan.

SY = square yards.

YR = year.

[1]Rounded to the nearest $10,000.

Table 5-5
Alternative 2.3 Cost Estimate
Former Northern State Hospital Analysis of Brownfield Cleanup Alternatives
Port of Skagit
Sedro-Woolley, Washington

Location: Northern State Hospital Sedro-Woolley, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2018 **Date:** September 2018	**Description:** Alternative 2.3 includes the excavation of cPAH and heavy oil-impacted soil near the power house. The excavation will be backfilled with clean soil that is amended (thoroughly mixed) with an oxidizing bioremediation product. This in situ bioremediation will treat any contamination that remains in place after the excavation.

CAPITAL COSTS

Item	Quantity	Unit	Unit Cost	Cost
Site Preparation				
Mobilization/demobilization	1	LS	$ 10,000	$ 10,000
Excavation and Disposal				
Asphalt cutting, demolition, and disposal	2,600	SF	$ 2	$ 5,200
Excavation and soil management	626	CY	$ 12	$ 7,511
Assumes depth of 6.5 ft bgs				
Off-site waste transportation and disposal	1,080	TON	$ 60	$ 64,783
Documentation soil samples	11	EA	$ 300	$ 3,300
Backfilling with In Situ Bioremediation Amendment and Repaving				
Bioremediation amendment	1,500	lbs	$ 20	$ 30,000
Assumes use of ORC-A pellets mixed with clean backfill material				
Backfilling	720	CY	$ 25	$ 17,995
Includes import, placement, and compaction in 12" layers				
Aggregate base course	289	SY	$ 5	$ 1,338
Match existing conditions. For cost purposes, assumed crushed 3/4" stone base, compacted 3" deep				
Asphalt paving	289	SY	$ 23	$ 6,644
Procure and place hot mix asphalt, 4" in thickness				
Contingency	20%	--	--	$ 14,398
Planning Documents				
Compliance Monitoring Plan, Sampling and Analysis Plan, Health and Safety Plan	1	LS	$ 12,000	$ 12,000
Professional/Technical Services				
Project management	8%	--	--	$ 13,854
Remedial design	15%	--	--	$ 25,975
Construction management	10%	--	--	$ 17,317
TOTAL CAPITAL COSTS				**$ 230,315**

Table 5-5
Alternative 2.3 Cost Estimate
Former Northern State Hospital Analysis of Brownfield Cleanup Alternatives
Port of Skagit
Sedro-Woolley, Washington

ANNUAL O&M COSTS

Item	Quantity	Unit	Unit Cost	Cost
Compliance Monitoring				
Quarterly groundwater monitoring	4	EA	$ 10,000	$ 40,000
Professional/Technical Services				
Project management	10%	--	--	$ 4,000
Technical support	10%	--	--	$ 4,000
TOTAL ANNUAL O&M COSTS				**$ 48,000**

PERIODIC COSTS

Item	Quantity	Unit	Unit Cost	Cost
Professional/Technical Services				
Five-year reviews and reporting	1	LS	$ 5,000	$ 5,000

PRESENT VALUE ANALYSIS

Discount Rate 2.96%

Total Years 5

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR	NET PRESENT VALUE
Capital	0	$ 230,315	$ 230,315	1.000	$ 230,315
Annual O&M	1 - 5	$ 240,000	$ 48,000	4.585	$ 220,077
Periodic	5	$ 5,000	$ 5,000	0.864	$ 4,321
		$ 475,315			$ 454,714
TOTAL NET PRESENT VALUE OF PREFERRED ALTERNATIVE					**$ 455,000**

Present value analysis uses a discount rate of 2.96 percent (5-year treasury notes for wk of 9/19/2018).

CY = cubic yards.

EA = each.

ft bgs = feet below ground surface.

lb = pound(s).

LS = lump sum.

O&M = operation and maintenance.

ORC-A = oxygen release compound-advanced.

SF = square feet.

SY = square yards.

Table 5-6
Alternative 3.3 Cost Estimate
Former Northern State Hospital Analysis of Brownfield Cleanup Alternatives
Port of Skagit
Sedro-Woolley, Washington

Location: Northern State Hospital Sedro-Woolley, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2018 **Date:** September 2018	**Description:** Alternative 3.3 includes the excavation of metals-impacted soil (hot spots) near historic buildings. The excavation will be backfilled with clean topsoil.

CAPITAL COSTS

Item	Quantity	Unit	Unit Cost	Cost
Site Preparation				
Mobilization/demobilization	1	LS	$ 8,000	$ 8,000
Excavation and Disposal				
Excavation and soil management	278	CY	$ 12	$ 3,333
Excavation area	5,000	SF	--	
Assumes depth of 1.5 ft bgs				
Off-site waste transportation and disposal	479	TON	$ 60	$ 28,750
Confirmation soil samples	60	EA	$ 50	$ 3,000
Backfilling and Restoration				
Backfilling	319	CY	$ 25	$ 7,986
Includes import, placement, and compaction in 12" layers				
Restoration	1	LS	$ 1,500	$ 1,500
Hydroseeding				
Contingency	20%	--	--	$ 8,914
Planning Documents				
Compliance Monitoring Plan, Sampling and Analysis Plan, Health and Safety Plan	1	LS	$ 12,000	$ 12,000
Professional/Technical Services				
Project management	8%	--	--	$ 5,879
Remedial design	15%	--	--	$ 11,023
Construction management	10%	--	--	$ 7,348
TOTAL CAPITAL COSTS				**$ 97,733**

Table 5-6
Alternative 3.3 Cost Estimate
Former Northern State Hospital Analysis of Brownfield Cleanup Alternatives
Port of Skagit
Sedro-Woolley, Washington

PRESENT VALUE ANALYSIS					
Discount Rate	NA				
Total Years	0				
COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR	NET PRESENT VALUE
Capital	0	$ 97,733	$ 97,733	1.000	$ 97,733
		$ 97,733			$ 97,733
TOTAL NET PRESENT VALUE OF PREFERRED ALTERNATIVE					**$ 98,000**

CY = cubic yards.
EA = each.
ft bgs = feet below ground surface.
LS = lump sum.
NA = not applicable.
SF = square feet.

Table 5-7
Alternative 4.3 Cost Estimate
Former Northern State Hospital Analysis of Brownfield Cleanup Alternatives
Port of Skagit
Sedro-Woolley, Washington

Location: Northern State Hospital Sedro-Woolley, WA **Phase:** Feasibility Study (-35% to +50%) **Base Year:** 2018 **Date:** September 2018	**Description:** Alternative 4.3 includes the excavation of metals-impacted soil (hot spots) near the former Ward Building and athletic field areas. The excavation will be backfilled with clean topsoil.

CAPITAL COSTS

Item	Quantity	Unit	Unit Cost	Cost
Site Preparation				
Mobilization/demobilization	1	LS	$ 8,000	$ 8,000
Excavation and Disposal				
Excavation and soil management	1,056	CY	$ 12	$ 12,667
Excavation area	28,500	SF	--	
Assumed average depth of 1 ft bgs				
Off-site waste transportation and disposal	1,821	TON	$ 60	$ 109,250
Confirmation soil samples	60	EA	$ 100	$ 6,000
Backfilling and Restoration				
Backfilling	1,214	CY	$ 25	$ 30,347
Includes import, placement, and compaction				
Restoration	1	LS	$ 3,000	$ 3,000
Hydroseeding				
Contingency	20%	--	--	$ 32,253
Planning Documents				
Compliance Monitoring Plan, Sampling and Analysis Plan, Health and Safety Plan	1	LS	$ 12,000	$ 12,000
Professional/Technical Services				
Project management	6%	--	--	$ 12,811
Remedial design	12%	--	--	$ 25,622
Construction management	8%	--	--	$ 17,081
TOTAL CAPITAL COSTS				**$ 269,031**

Table 5-7
Alternative 4.3 Cost Estimate
Former Northern State Hospital Analysis of Brownfield Cleanup Alternatives
Port of Skagit
Sedro-Woolley, Washington

PRESENT VALUE ANALYSIS					
Discount Rate	NA				
Total Years	0				
COST TYPE	**YEAR**	**TOTAL COST**	**TOTAL COST PER YEAR**	**DISCOUNT FACTOR**	**NET PRESENT VALUE**
Capital	0	$ 269,031	$ 269,031	1.000	$ 269,031
		$ 269,031			$ 269,031
TOTAL NET PRESENT VALUE OF PREFERRED ALTERNATIVE					**$ 270,000**

CY = cubic yards.

EA = each.

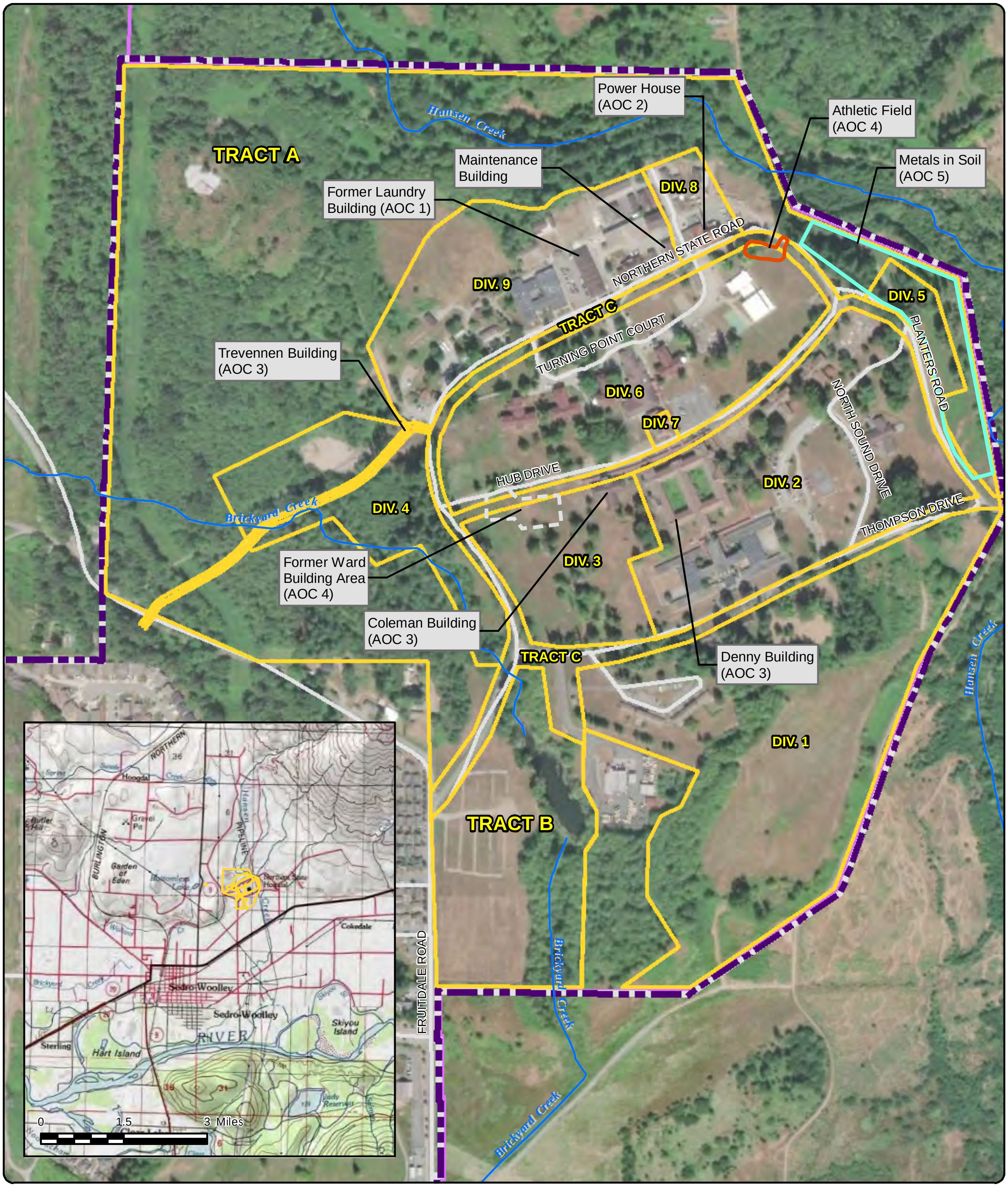
ft bgs = feet below ground surface.

NA = not applicable.

LS = lump sum.

SF = square feet.

FIGURES



Source: Aerial photograph obtained from Esri ArcGIS Online; parcels, roads, and stream datasets obtained from Skagit County; city limits dataset obtained from the City of Sedro-Woolley.

Note:
AOC = area of concern.

Legend

- Property Parcel and Parcel Number
- Sedro-Woolley City Limits (Post Annexation)
- Northern State Recreational Area
- Road
- Stream

Figure 1-1
Property Vicinity

Former Northern State Hospital
Port of Skagit County
Sedro-Woolley, Washington

0 300 600 Feet

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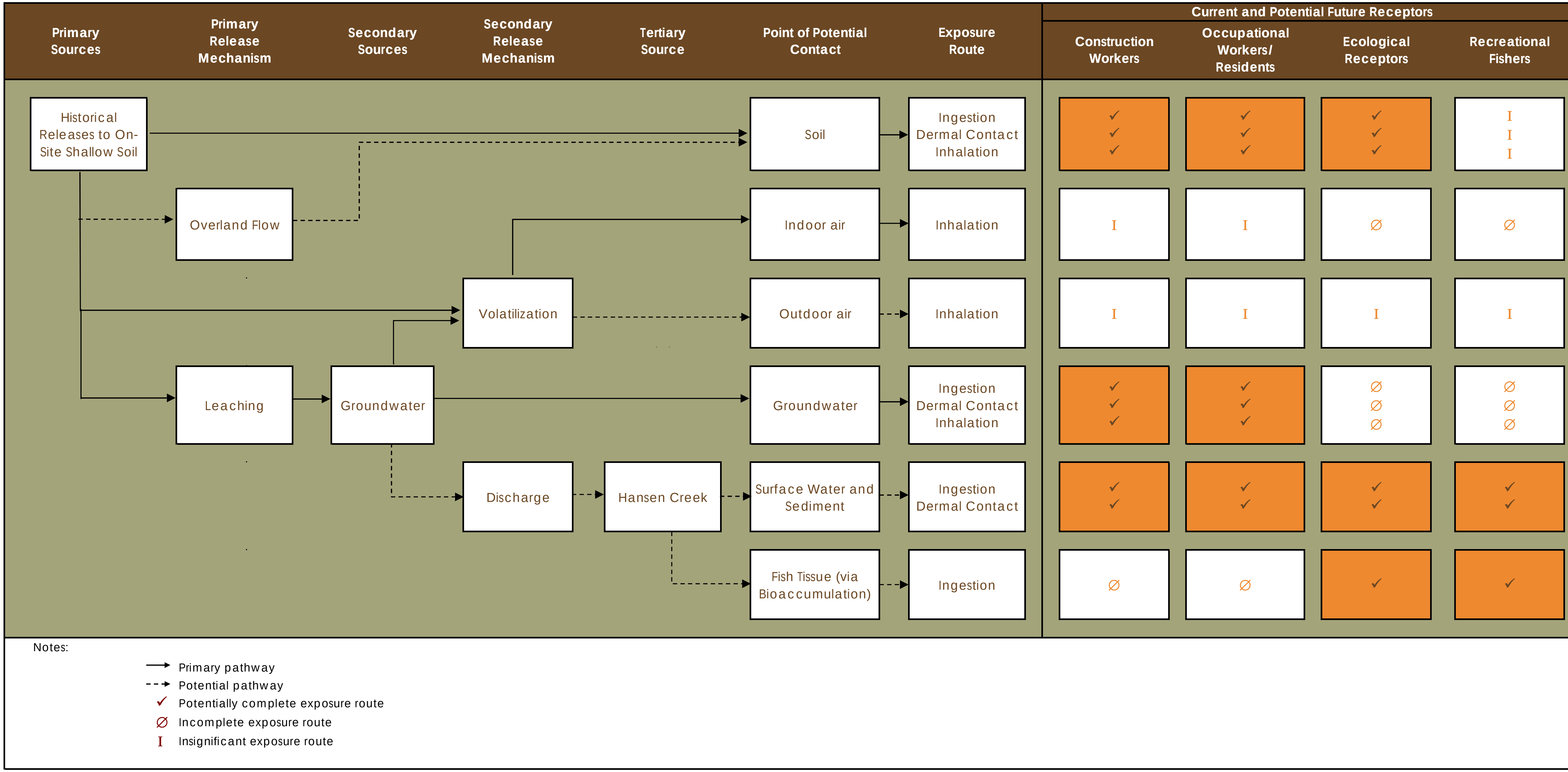
Project: 0624.04.01-01 Produced By: mjosef Approved By: Print Date: 10/3/2018 Path: X:\0624.04 Port of Skagit\10_Brownfield_Haz\Project\Cleanup Alternatives (9-18)\Fig1_Property_Vacinity_8x11P.mxd

Figure 2-1
Conceptual Site Model
Former Northern State Hospital
Port of Skagit
Sedro-Woolley, Washington



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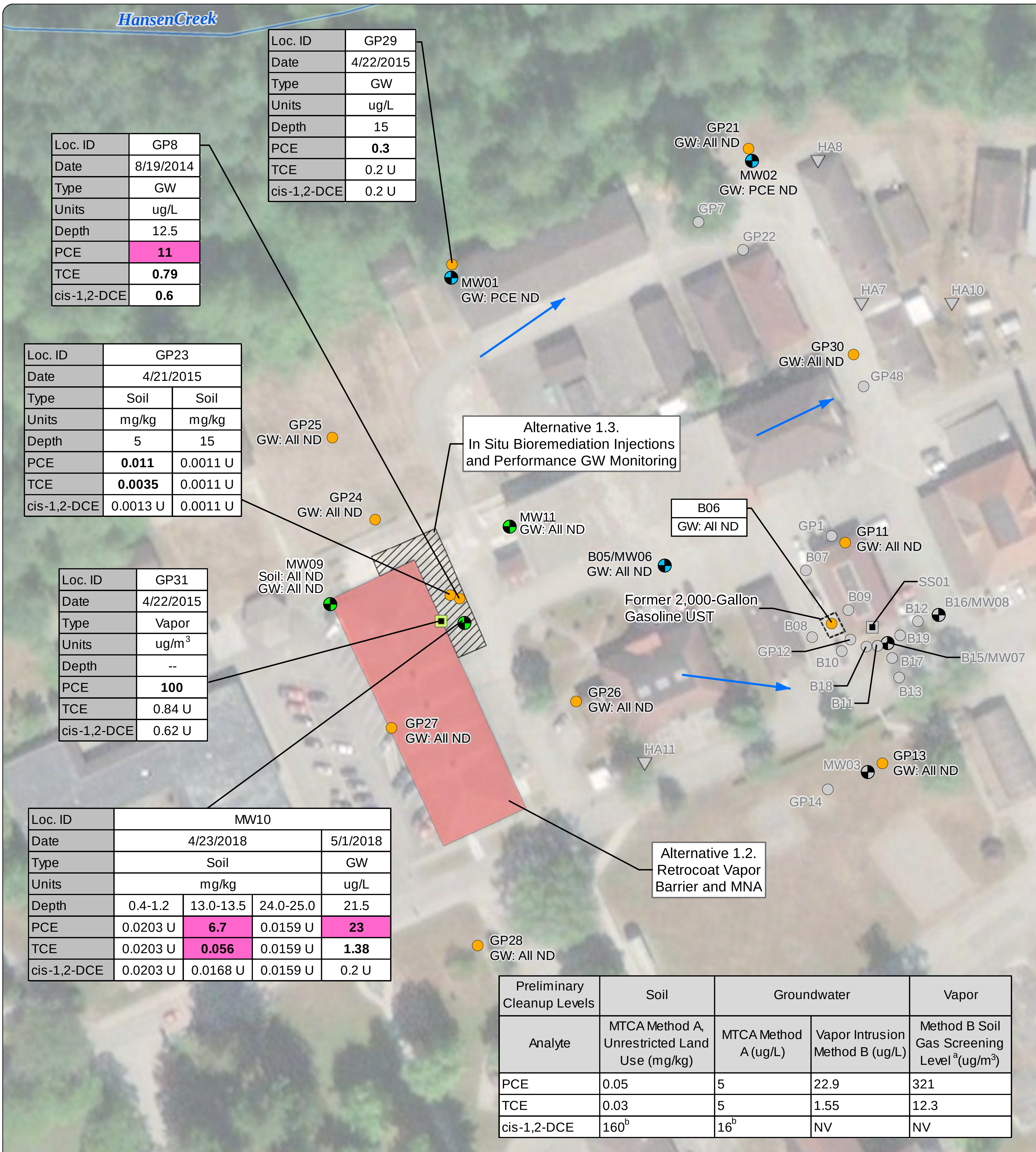

Loc. ID	GP29
Date	4/22/2015
Type	GW
Units	ug/L
Depth	15
PCE	**0.3**
TCE	0.2 U
cis-1,2-DCE	0.2 U

Loc. ID	GP8
Date	8/19/2014
Type	GW
Units	ug/L
Depth	12.5
PCE	**11**
TCE	**0.79**
cis-1,2-DCE	**0.6**

Loc. ID	GP23	
Date	4/21/2015	
Type	Soil	Soil
Units	mg/kg	mg/kg
Depth	5	15
PCE	**0.011**	0.0011 U
TCE	**0.0035**	0.0011 U
cis-1,2-DCE	0.0013 U	0.0011 U

Loc. ID	GP31
Date	4/22/2015
Type	Vapor
Units	ug/m^3
Depth	--
PCE	**100**
TCE	0.84 U
cis-1,2-DCE	0.62 U

Loc. ID	MW10			
Date	4/23/2018			5/1/2018
Type	Soil			GW
Units	mg/kg			ug/L
Depth	0.4-1.2	13.0-13.5	24.0-25.0	21.5
PCE	0.0203 U	**6.7**	0.0159 U	**23**
TCE	0.0203 U	**0.056**	0.0159 U	**1.38**
cis-1,2-DCE	0.0203 U	0.0168 U	0.0159 U	0.2 U

Preliminary Cleanup Levels	Soil	Groundwater		Vapor
Analyte	MTCA Method A, Unrestricted Land Use (mg/kg)	MTCA Method A (ug/L)	Vapor Intrusion Method B (ug/L)	Method B Soil Gas Screening Level [a](ug/m^3)
PCE	0.05	5	22.9	321
TCE	0.03	5	1.55	12.3
cis-1,2-DCE	160[b]	16[b]	NV	NV

Notes:
1. All collection depths are in feet below ground surface.
2. Detections are shown in bold.
3. Grayed out locations were not sampled for chlorinated solvents.
4. Groundwater flow direction as observed during the May 1, 2018 monitoring event.
5. MFA 2015 sub-slab vapor probe and hand auger locations are approximate. Boring locations were identified using a handheld global positioning system.
6. Skagit Surveyors & Engineers surveyed monitoring wells MW01 through MW04 on June 5, 2015 and monitoring wells MW05 through MW11 on April 27, 2018.
7. Results for only those constituents that exceed a cleanup level in soil, groundwater, and/or subslab soil vapor are shown in this figure.
8. AOC = area of concern.
9. cis-1,2-DCE = cis-1,2-dichloroethene.
10. GW = groundwater.
11. Loc. ID = location identification.
12. MFA = Maul Foster & Alongi, Inc.
13. mg/kg = milligrams per kilogram.
14. MTCA = Model Toxics Control Act.
15. MNA = monitored natural attenuation.
16. ND = not detected.
17. NV = no value.
18. PCE = tetrachloroethene.
19. TCE = trichloroethene.
20. U = analyte not detected at or above the method reporting limit.
21. ug/L = micrograms per liter.
22. ug/m^3 = micrograms per cubic meter.

[a]Soil gas screening levels are for sub-slab soil vapor for protection of indoor air to MTCA Method B cleanup levels.
[b]MTCA A cleanup level not available, therefore MTCA B cleanup level applied.

Source: Aerial photograph obtained from Esri ArcGIS Online

Legend

- New Monitoring Well
- Previous Monitoring Well
- Previous Monitoring Well Not Sampled
- Previous Boring Location
- Previous Boring Location Not Sampled
- Exceedance of MTCA Cleanup Levels
- Sub-Slab Vapor Probe
- Sub-Slab Vapor Probe Not Sampled
- Hand Auger Location Not Sampled
- Groundwater Flow Direction
- Alternative 1.2: Vapor Barrier (Retrocoat) and MNA
- Alternative 1.3: In Situ Bioremediation Injections

0 40 80
Feet

Figure 3-1
AOC 1: Former Laundry Building

Former Northern State Hospital
Port of Skagit County
Sedro-Woolley, Washington

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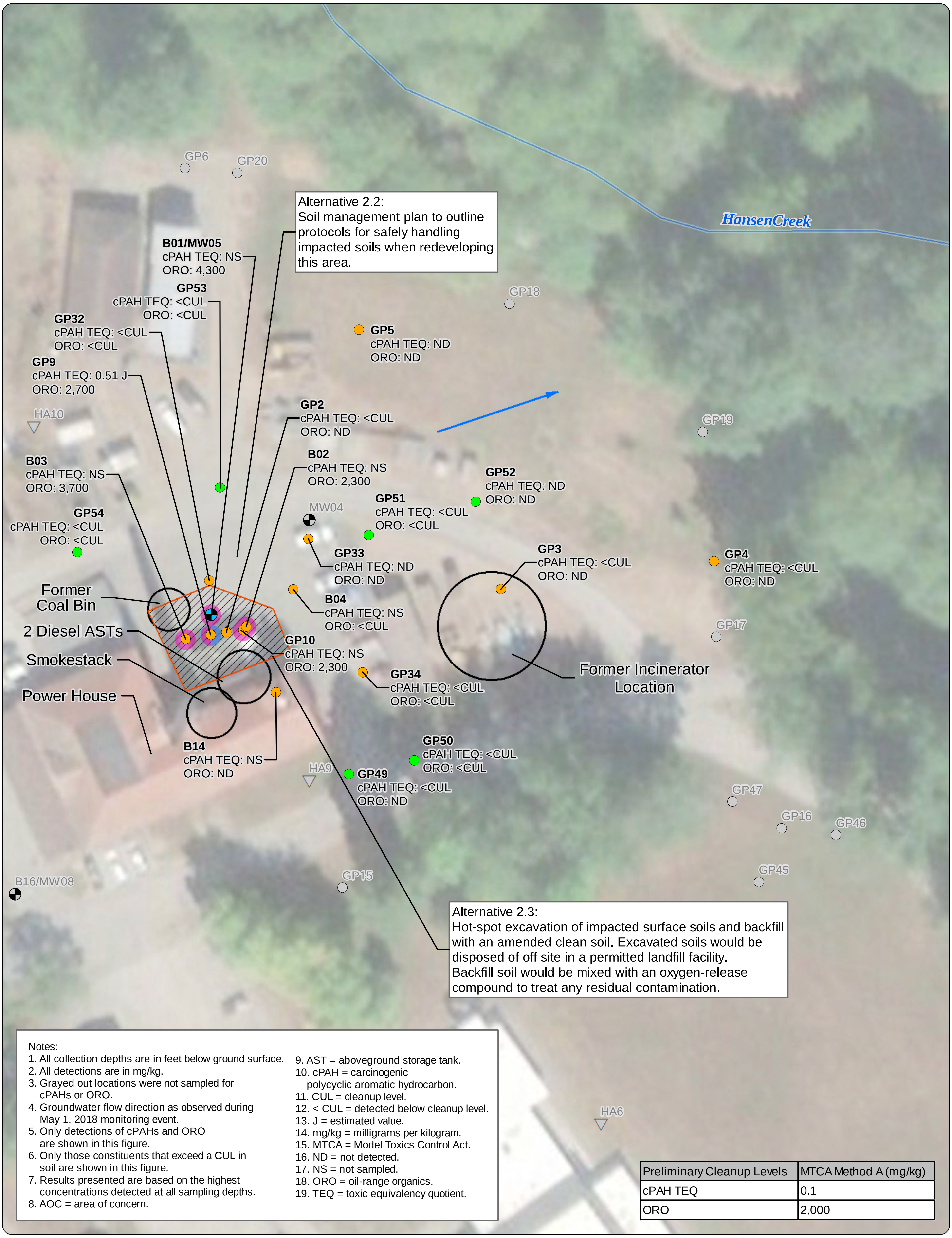

Notes:
1. All collection depths are in feet below ground surface.
2. All detections are in mg/kg.
3. Grayed out locations were not sampled for cPAHs or ORO.
4. Groundwater flow direction as observed during May 1, 2018 monitoring event.
5. Only detections of cPAHs and ORO are shown in this figure.
6. Only those constituents that exceed a CUL in soil are shown in this figure.
7. Results presented are based on the highest concentrations detected at all sampling depths.
8. AOC = area of concern.
9. AST = aboveground storage tank.
10. cPAH = carcinogenic polycyclic aromatic hydrocarbon.
11. CUL = cleanup level.
12. < CUL = detected below cleanup level.
13. J = estimated value.
14. mg/kg = milligrams per kilogram.
15. MTCA = Model Toxics Control Act.
16. ND = not detected.
17. NS = not sampled.
18. ORO = oil-range organics.
19. TEQ = toxic equivalency quotient.

Preliminary Cleanup Levels	MTCA Method A (mg/kg)
cPAH TEQ	0.1
ORO	2,000

Source: Aerial photograph obtained from Esri ArcGIS Online

Legend

- Boring Location
- Previous Boring Location
- Previous Boring Location Not Sampled
- Previous Monitoring Well Location
- Previous Monitoring Well Location Not Sampled
- cPAH TEQ Exceeds CUL
- ORO Exceeds CUL
- Groundwater Flow Direction
- Hand Auger Location Not Sampled
- Alternative 2.3: Hot Spot Excavation and Treatment

0 25 50
Feet

Figure 3-2
AOC 2: Power House Building
Former Northern State Hospital
Port of Skagit County
Sedro-Woolley, Washington

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Path: X:\10624.04 Port of Skagit\10_Brownfield_Haz\Project\Cleanup Alternatives (9-18)\Fig3-2_AOC2_Power_Building.mxd
Print Date: 10/2/2018
Approved By:
Produced By: mjosef
Project: 0624.04.10

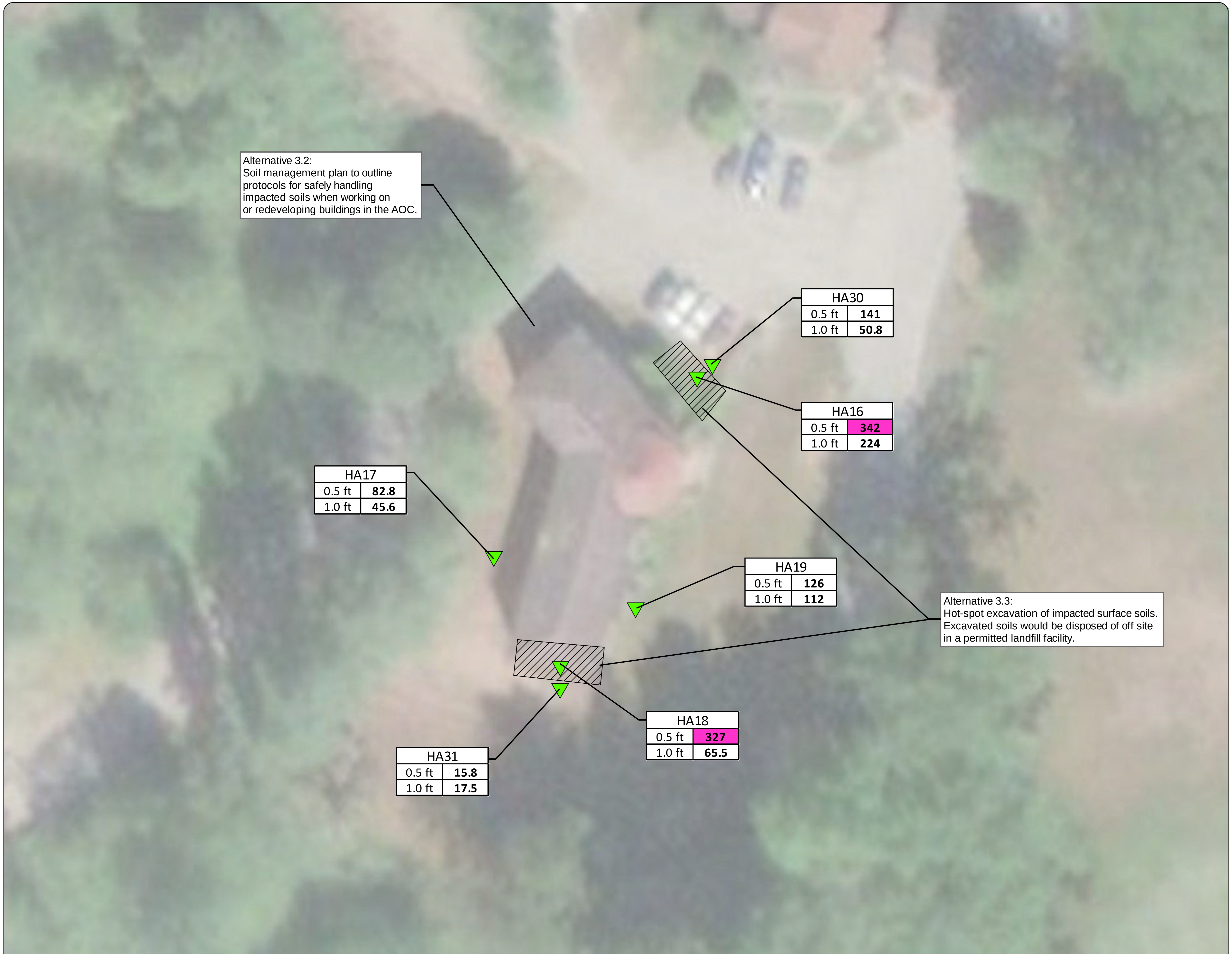

Figure 3-3
AOC 3: Lead in Soil - Trevennen

Former Northern State Hospital
Port of Skagit County
Sedro-Woolley, Washington

Legend

- Hand Auger Location
- Alternative 3.3: Hot Spot Excavation
- Exceedance of the MTCA Method A CUL

Notes:
1. Hand auger locations were identified using a handheld global positioning system.
2. The MTCA Method A CUL for lead is 250 mg/kg.
3. AOC = area of concern.
4. CUL = cleanup level.
5. mg/kg = milligrams per kilogram.
6. MTCA = Model Toxics Control Act.

0 25 50 Feet

Source: Aerial photograph obtained from Esri ArcGIS Online; streams dataset obtained from Skagit County.

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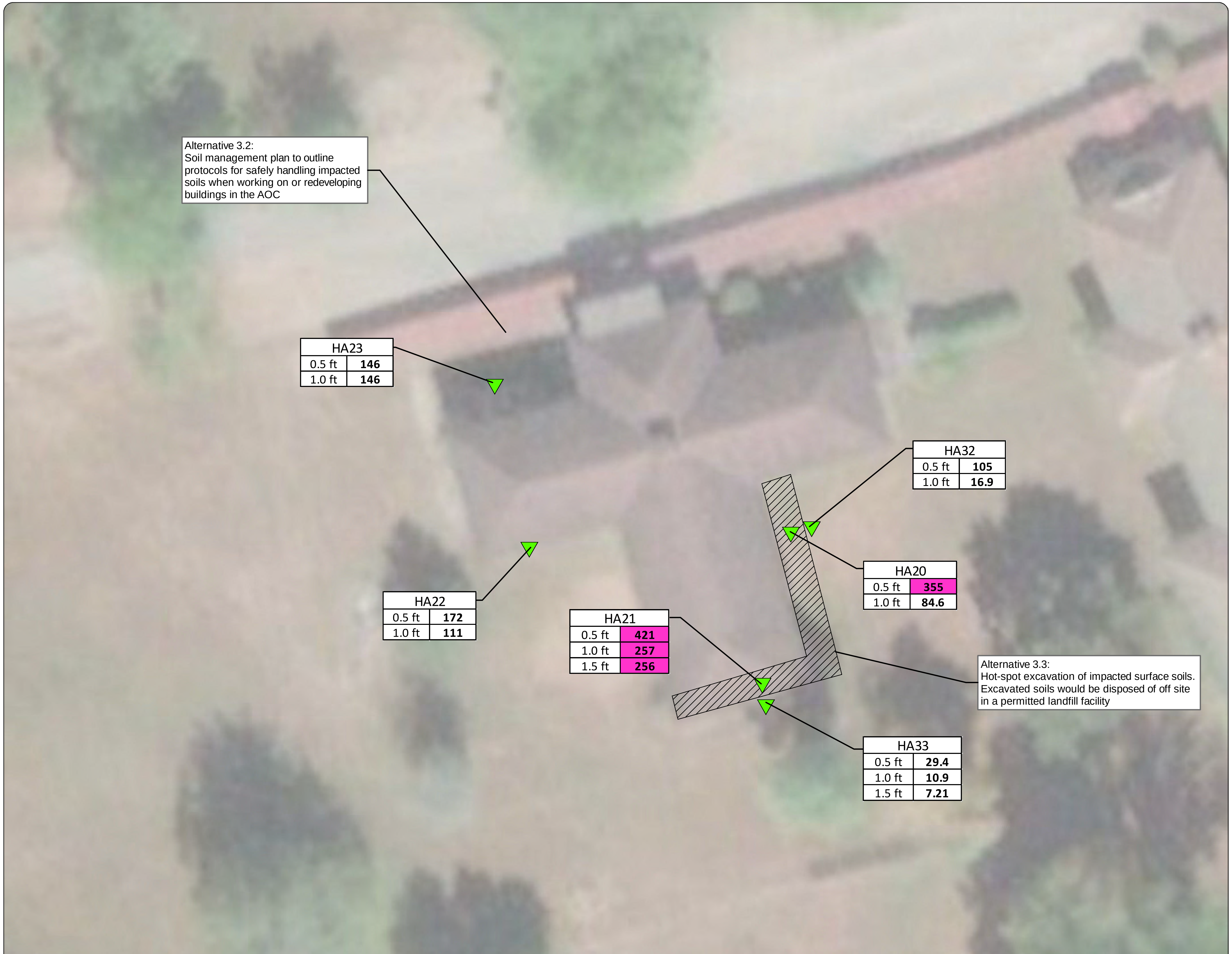
Print Date: 10/2/2018
Approved By: H. Hirsch
Produced By: mjosef
Project: 0624.01

Figure 3-4
AOC 3: Lead in Soil - Coleman

Former Northern State Hospital
Port of Skagit County
Sedro-Woolley, Washington



Legend

- Hand Auger Location
- Alternative 3.3: Hot Spot Excavation
- Exceedance of the MTCA Method A CUL

Notes:
1. Hand auger locations were identified using a handheld global positioning system.
2. The MTCA Method A CUL for lead is 250 mg/kg.
3. AOC = area of concern.
4. CUL = cleanup level.
5. mg/kg = milligrams per kilogram.
6. MTCA = Model Toxics Control Act.

0 25 50 Feet

Source: Aerial photograph obtained from Esri ArcGIS Online; streams dataset obtained from Skagit County.

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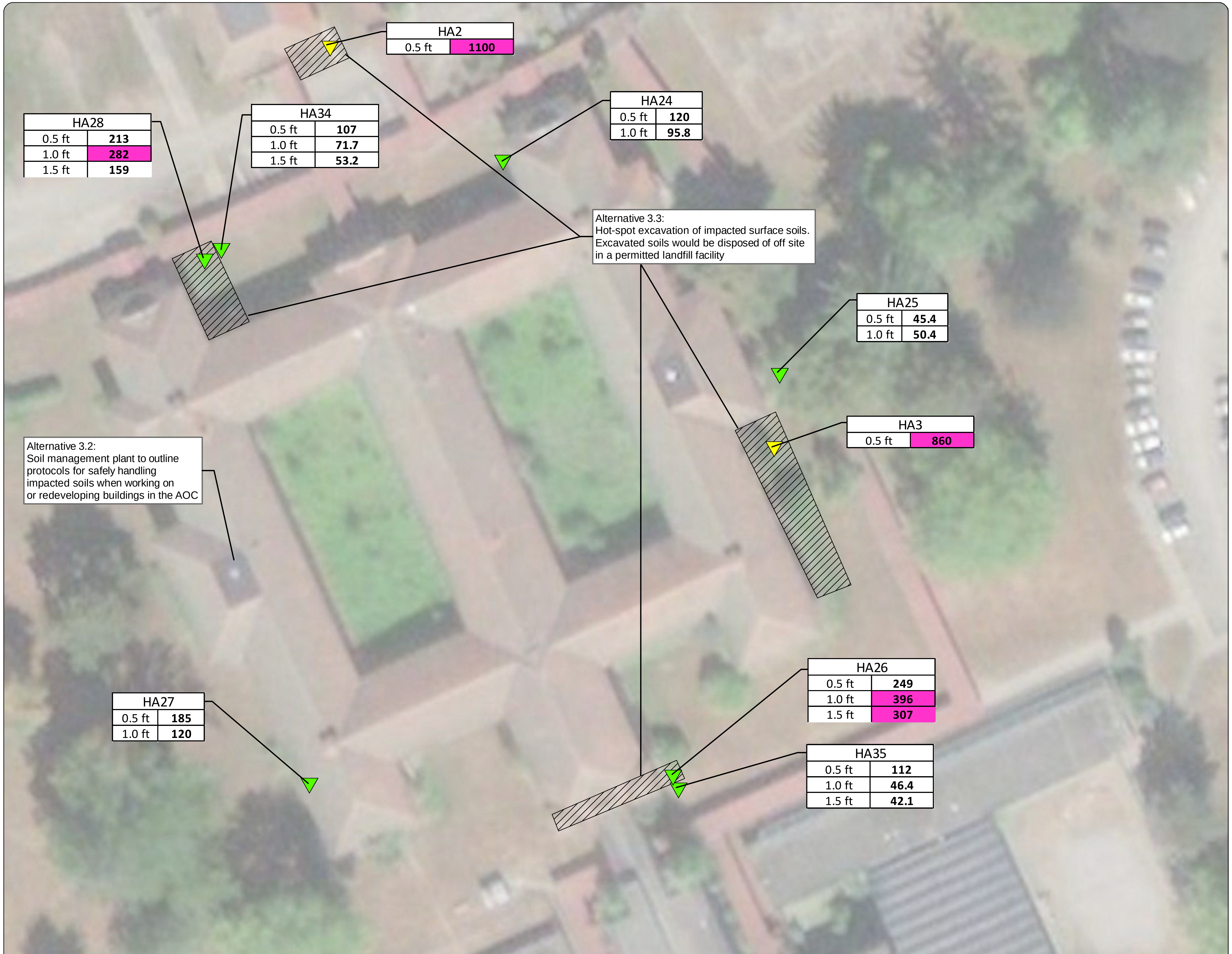
Figure 3-5
AOC 3: Lead in Soil - Denny

Former Northern State Hospital
Port of Skagit County
Sedro-Woolley, Washington



Legend

- Hand Auger Location
- Previous Hand Auger Location
- Alternative 3.3: Hot Spot Excavation
- Exceedance of the MTCA Method A CUL

Notes:
1. Hand auger locations HA24 through HA35 were identified using a handheld global positioning system. All other hand auger locations are approximate.
2. The MTCA Method A CUL for lead is 250 mg/kg.
3. AOC = area of concern.
4. CUL = cleanup level.
5. mg/kg = milligrams per kilogram.
6. MTCA = Model Toxics Control Act.

0 30 60 Feet

Source: Aerial photograph obtained from Esri ArcGIS Online; streams dataset obtained from Skagit County.

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Print Date: 10/2/2018
Approved By: H. Hirsch
Produced By: mjosef
Project: 0624.04.10

Source: Aerial photograph obtained from Esri ArcGIS Online; parcels and streams datasets obtained from Skagit County.

Notes: All property features are approximate.
AOC = area of concern.
DU = decision unit.
GP = geoprobe with reg mark.
HA = hand auger sample.

Legend

- Boring Location
- Discrete Soil Sample Location (lead)
- Hand Auger Location
- Arsenic in Soil
- Arsenic and Lead in Soil
- Stream

Figure 3-6
AOC 4: Arsenic in Soil

Northern State Hospital Property
Port of Skagit County
Sedro-Woolley, Washington

0 100 200
Feet

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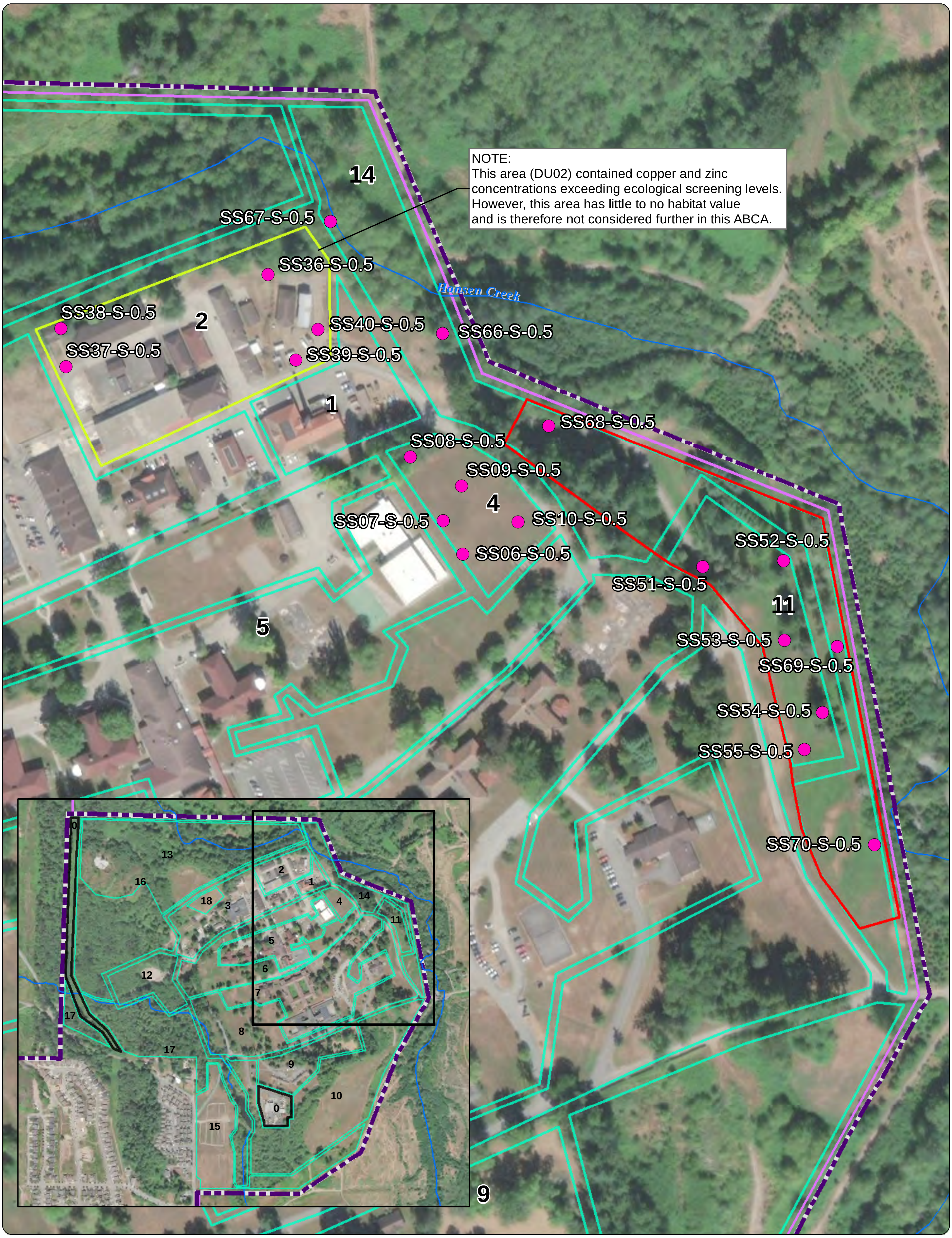
Print Date: 10/2/2018
Approved By: mstringer
Produced By: mjosef
Project: 0624.04.01-01



Source: Aerial photograph obtained from Esri ArcGIS Online; parcels and roads and streams datasets obtained from Skagit County; city limits dataset obtained from City of Sedro-Woolley.

Property address:
24909 Hub Drive
Sedro-Woolley, Washington

Notes:
ABCA = analysis of brownfield cleanup alternatives.
AOC = area of concern.
ISM = incremental sampling methodology.
SL = screening level.

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Legend

- Discrete Soil Sample Location
- Northeast Area with Ecological SL Exceedances
- Southeast Area with Ecological SL Exceedances
- Area Excluded from Soil Sampling
- Decision Unit Boundary with Identification No.
- Sedro-Woolley City Limits (Post Annexation)
- Northern State Recreational Area
- Stream

0 250 500
Feet

Figure 3-7
AOC 5: Metals in Soil - Discrete Sample Locations

Former Northern State Hospital
Port of Skagit County
Sedro-Woolley, Washington

Path: X:\0624.04 Port of Skagit\10_Brownfield_Haz\ProjectCleanup Alternatives (9-18)\Fig3-7_AOC5_Discrete_Sample_Locations.mxd
Print Date: 10/2/2018
Approved By: mstringer
Produced By: mjosef
Project: 0624.04.01-01